



APPLICATION SOFTWARE

Original manual

# RAYGUIDE

**RAYGUIDE**  
USER MANUAL

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# 1 INTRODUCTION

## 1.1 About RAYGUIDE

RAYGUIDE is a laser processing software suite. Its powerful and flexible UI makes it easy to design or import text, barcode and graphic elements in order to realize complex and extensive laser process projects.

RAYGUIDE offers two user interfaces:

- The graphical user interface (GUI). It allows users to directly manage complex laser processing jobs without programming knowledge.
- The RAYGUIDE Software Development Kit (SDK), a programmable API based on the Microsoft .NET environment. This means that the entire functionality of RAYGUIDE can be integrated into a customized system application entirely according to customer requirements.

## 1.2 Compatibility

The RAYGUIDE software application is compatible with the RAYLASE SP-ICE-3 scan controller. Please note that the software can even operate without the scan controller connected. The integrated emulation of the controller makes it possible to work "offline", set up parameters and edit designs to define laser processing tasks.



## 1.3 Features

- Full-scale integration of the SP-ICE-3 scan controller. An emulated scan controller is also available.
- Support of multiple SP-ICE-3 scan controllers.
- Support of many laser types, using precise parameter sets.
- Support of lasers with Brightline technology.
- Support of deflection units with up to 5 axes.
- Plug-and-play configuration of digital deflection units.
- Support of different user roles with specific permissions.
- User interface (GUI) with maximum flexibility that permits, for example, a customised layout of the panels.
- Choice of 7 different languages for the software interface
- Import of a variety of graphic formats: DXF, PLT, SVG, DWG, GBR, CGM, JPG, BMP, GIF.
- Import and layer-by-layer processing of solids for deep engraving.
- Efficient layout editing tools for vector graphics, including unlimited undo / redo.
- Large barcode and text style libraries, with serialisation of barcodes and text.
- Sophisticated pen concept for maximum flexibility and assignment of process parameters.
- Parameter finders for fast determination of optimum application parameters.
- Definition of multi-slope power ramps plus ramp visualisation.
- Support of MOTF processes, including various trigger and automated path sorting options.
- Support of combined workspaces when working with multiple scan controllers.
- Predefinition of laser processing jobs for scan controller stand-alone mode.
- Special plug-ins for solar wafers or electrode geometry of battery foils.
- Remote interface for remote control of the RAYGUIDE GUI via PLC.
- Support of customer-specific plug-ins.

## 1.4 Scope of delivery

The following components are included in the scope of delivery:

- RAYGUIDE software installation file. Required to install all program and library files needed for the RAYGUIDE API and / or GUI.
- RAYGUIDE manual as PDF file
- License agreement as PDF file
- Example codes for the programmable interface
- RAYGUIDE SDK, manual for the programmable interface
- Sample correction files for getting familiar with the RAYGUIDE device configuration
- Optional: Hardware dongle as license carrier

## 1.5 Laser Safety

The user is responsible for safe operation and for safeguarding the surrounding area against hazards caused by laser radiation. OEM customers must ensure compliance with all local and national regulations.

### **WARNING**

#### **Avoid unsafe laser operation**

Turn on the PC before turning on the laser system. This prevents the laser from behaving in an uncontrolled manner when the PC is turned on. Check your application carefully before using the laser system. Defective software can block the entire system and lead to uncontrolled operation of the laser or deflection unit.

Refer to the user manuals of the laser system and the deflection unit for safety information on those components.




## 1.6 About this Manual

This manual describes the entire functionality and performance features of the RAYGUIDE software when used with the graphical user interface (GUI).

There is a separate manual for the RAYGUIDE software development kit (SDK).

### Conventions

- Emphasized phrases are printed in **bold**.
- Important notes and remarks are introduced with **NOTE:**, **RULE:**, etc.
- Folder and file names are printed in *italics*.
- The names of windows, dialogues and tabs are given as normal text: On the Settings tab.
- Menu options are shown in bold and italics: Select ***File > Save as...***
- The names of dialogue options (function buttons, checkboxes) are specified in italics: Select *Fixed*, if you ...
- Buttons are bold and in italics and shown in brackets: Click ***[Apply]***.
- Buttons labelled with graphic icons are described by words.

Example:  is a ***[Zoom]*** button.

- References to other pages in the manual are indicated by italics: See *page 22, Setup*.
- Links to web addresses are underlined: Visit [RAYLASE](#).
- Important technical terms are explained in the glossary, see *page 340, Glossary*.

### 1.6.1 Version reference

The following table references the manual version of the corresponding software product version.

| Manual version | RAYGUIDE version |
|----------------|------------------|
| V2.7           | v2.3.0           |

## 1.7 Legal Information

### Copyright

RAYLASE reserves the right to make changes to the product described in this manual and to the contents of this manual at any time without notice.

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### License agreement

The text of the license agreement is delivered as a PDF file together with the software.

### Warranty

The rights of the customer in case of material or legal defects of the product are listed in the General Terms and Conditions of RAYLASE. These can be viewed at: <https://www.raylase.de/en/terms-and-conditions.html>.

No implied warranty or guarantee is given as to fitness for a particular purpose. RAYLASE is not responsible for any damage caused by using the application. Custom assemblies or other assemblies manufactured by RAYLASE may be subject to different warranty terms. Further information can be found in the respective manuals.

## 1.8 Addresses

### Manufacturer

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Telephone: +49 8153 9999 699  
Fax: +49 8153 9999 296  
E-mail: [info@raylase.de](mailto:info@raylase.de)

### Customer service

The RAYLASE customer service would be happy to help you at any time if you have any problems with the software or this manual.

Availability: Monday to Friday, 9:00 am to 7:00 pm  
UTC+1 (April to October: UTC+2)  
Telephone: +49 8153 9999 297  
E-mail: [support@raylase.de](mailto:support@raylase.de)

## 2 INSTALLATION AND STARTUP

### Requirements

To successfully install the RAYGUIDE software on a computer, the following requirements have to be met:

- Supported operating systems (32 or 64 bit in each case):
  - Microsoft Windows 10 (also Windows 10 Enterprise LTSC)
  - Microsoft Windows 11.

**NOTE:** The Linux Operating System is not supported

- Minimum hardware requirements:
  - Microsoft .NET Framework version 4.8 or higher
  - 8 GB working memory
  - 300 MB of free disk space

### Scan controller

A scan controller is required for operation of the complete laser system.

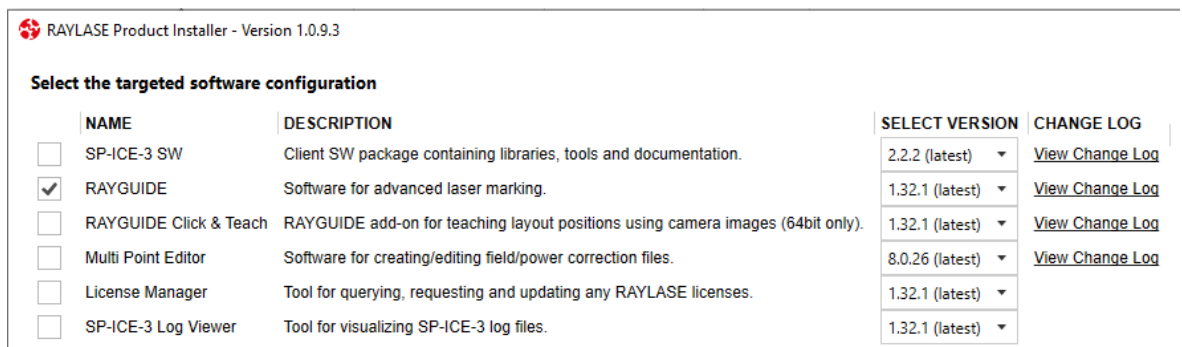
#### NOTES:

- Installation and setup of the scan controller are described in a separate user manual.
- To install, execute and configure the RAYGUIDE software, it is **not mandatory** to have a scan controller installed.

### Installation process

For the installation of all RAYLASE software products (therefore also the RAYGUIDE application), RAYLASE provides the so-called RAYBOARD PRODUCT INSTALLER (RBPI) free of charge as a central tool on its website.

Using the “Select the targeted software configuration” menu item, select the latest version of RAYGUIDE.



| NAME  | DESCRIPTION   | SELECT VERSION    | CHANGE LOG                      |
|---|---|-------------------|---------------------------------|
| <input type="checkbox"/> SP-ICE-3 SW            | Client SW package containing libraries, tools and documentation.                | 2.2.2 (latest) ▾  | <a href="#">View Change Log</a> |
| <input checked="" type="checkbox"/> RAYGUIDE    | Software for advanced laser marking.  | 1.32.1 (latest) ▾ | <a href="#">View Change Log</a> |
| <input type="checkbox"/> RAYGUIDE Click & Teach | RAYGUIDE add-on for teaching layout positions using camera images (64bit only). | 1.32.1 (latest) ▾ | <a href="#">View Change Log</a> |
| <input type="checkbox"/> Multi Point Editor     | Software for creating/editing field/power correction files.                     | 8.0.26 (latest) ▾ | <a href="#">View Change Log</a> |
| <input type="checkbox"/> License Manager        | Tool for querying, requesting and updating any RAYLASE licenses.                | 1.32.1 (latest) ▾ |                                 |
| <input type="checkbox"/> SP-ICE-3 Log Viewer    | Tool for visualizing SP-ICE-3 log files.  | 1.32.1 (latest) ▾ |                                 |

Fig. 2.1: AER

The direct link to the change log lets you review the latest changes relative to the predecessor version. The RBPI then downloads the RAYGUIDE installation file and displays the installation options.

The following installation options are available for RAYGUIDE:

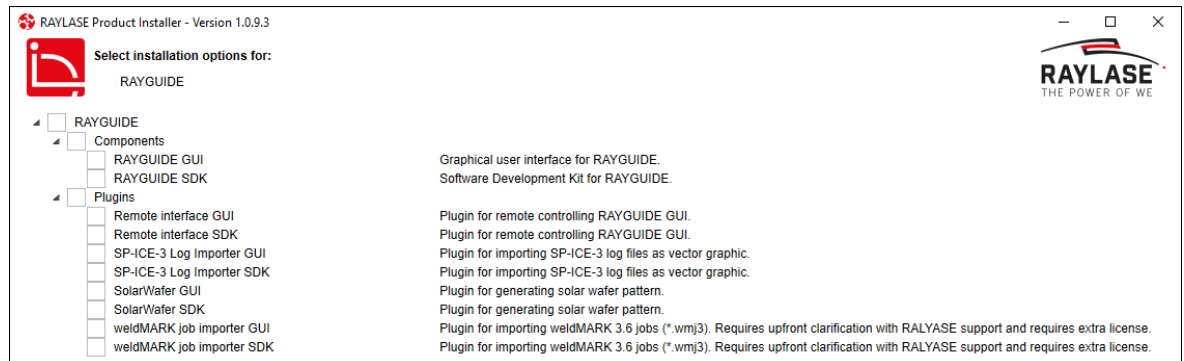


Fig. 2.2: AES

1. Select whether you would like to install the GUI and / or the SDK components of RAYGUIDE.
2. Select the RAYLASE plug-ins (see *page 310, RAYLASE plug-ins*) that you want to have installed.

After selecting the installation options, you need to consent to the license agreement; then the RAYGUIDE application will be installed.

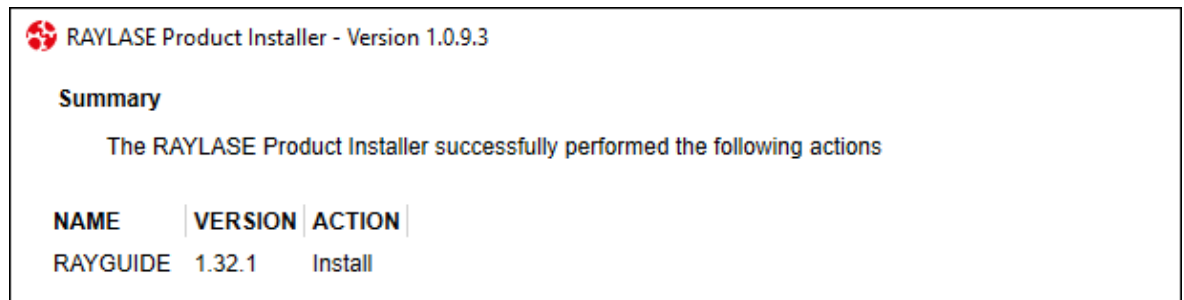


Fig. 2.3: AET

By default, the installation process creates the following folders:

- *For the program:*  
C:\Program Files\RAYLASE\RAYGUIDE\
- *To store configuration files, log files, and other resources:*  
C:\ProgramData\RAYLASE\RAYGUIDE\
- User-specific data is stored in this folder:  
C:\users\Benutzername\AppData\Local\RAYLASE\RAYGUIDE\
- The software environment for the license management is also installed.

The installation process places an icon on the computer's desktop for directly launching the RAYGUIDE application:



Fig. 2.4: AAE

### Starting the software

For example, use the RAYGUIDE desktop icon to start the software.



Fig. 2.5: RG-AAE

**NOTE:** When RAYGUIDE **is started for the first time**, the main GUI is displayed but no devices are configured and are not therefore available for use. For details on device configuration, see *page 41, Device Configuration and Calibration*.

When the RAYGUIDE application software is started, the first license check also takes place. If no valid license is found, RAYGUIDE starts in demo mode.



## 3 LICENSES AND UPDATES

### Licenses

There are licenses available for two product variants:

- The RAYGUIDE SDK license allows the full use of API functions to develop customised laser processing applications, typically integrated into a laser processing machine HMI. It comprises only a basic version of the software's Graphical User Interface (GUI), the so-called "demo" version. It can be used to configure and calibrate the system, but cannot run or save actual jobs.
- The RAYGUIDE license allows full use of the GUI and its functions. It includes the use of the RAYGUIDE SDK. This license is also required if you want to embed all or parts of the RAYGUIDE GUI in your HMI.

The license is distributed in two ways:

- A hardware dongle (hardware license key), to be inserted into a USB port of the computer running the software. This variant allows you to install the software on more than one computer and use the same dongle on each of them in turn. When the software is installed or started with the dongle attached, the license is found and activated automatically.
- A software key (activation license key), which is valid only for a specific computer. To use a software key, a "fingerprint" of the designated computer has to be generated. In the menu, select RAYGUIDE **Help > Licence > Generate licence request...**, and send the generated file to RAYLASE (license@raylase.de). RAYLASE will return an activation file which can be selected by selecting **Help > Licence > Activate licence**.

To view the license and version information for the installed software, in the RAYGUIDE menu, select the **Help > About** option.

Example:

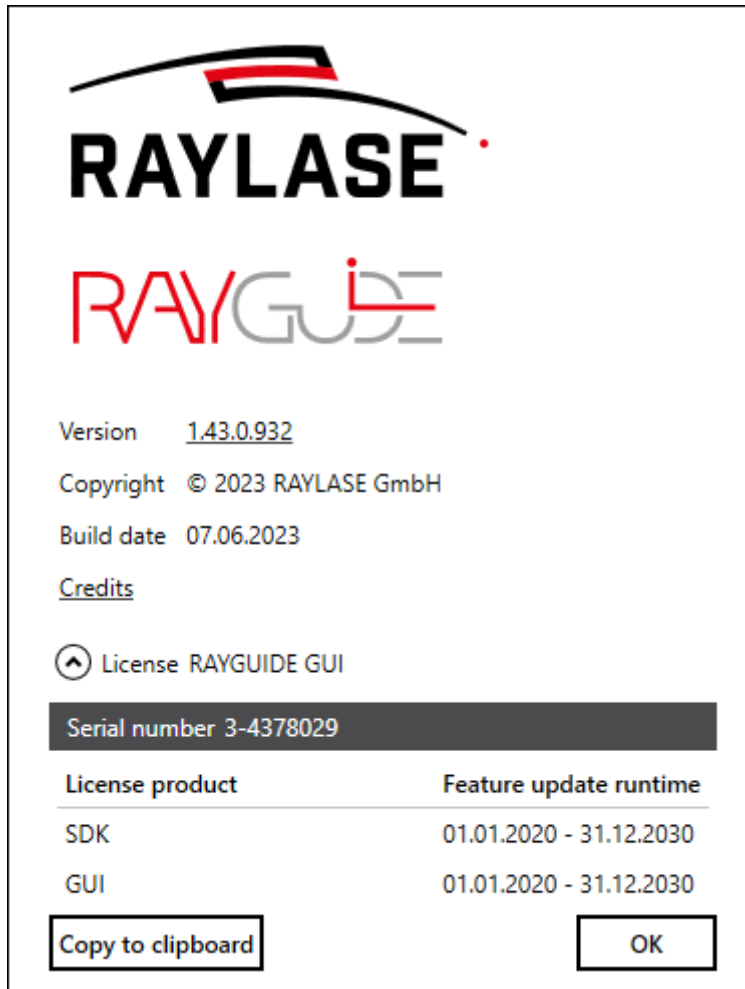


Fig. 3.1: RG-AAH

## Feature updates

Each license or each license product comes with a predefined runtime for feature updates at the time of purchase. As a rule, this is 2 years. After the expiration of the runtime it can happen that new features are not automatically usable by installing updates. Then it is up to you to purchase a runtime extension.

The update of the feature update runtime is done via license file import.

RAYLASE reserves the right to decide which features are only usable with current feature update runtime.

The import of new releases / updates by means of the RAYBOARD PRODUCT INSTALLER is possible independently of this at any time.

### **Expansion with additional licensed products**

If you want to add further license products to your existing license, please contact your sales contact. We only need the serial number of your license. You can then import the licence extension file (\*.WibuCmRaU) via **Help > Licence > Activate licence**.

### **Troubleshooting**

The import of new software versions for the purpose of troubleshooting is possible at any time and does not require a license update. Also for this purpose, use the RAYBOARD PRODUCT INSTALLER, to update your RAYGUIDE version and get associated bug fixes.

### **Credits**

Link to an overview table with all foreign libraries used in RAYGUIDE and their licensing.

# 4 INTRODUCTION TO THE USER INTERFACE

## 4.1 Overview

When the software is started, the RAYGUIDE user interface (GUI) is displayed in the standard panel layout:

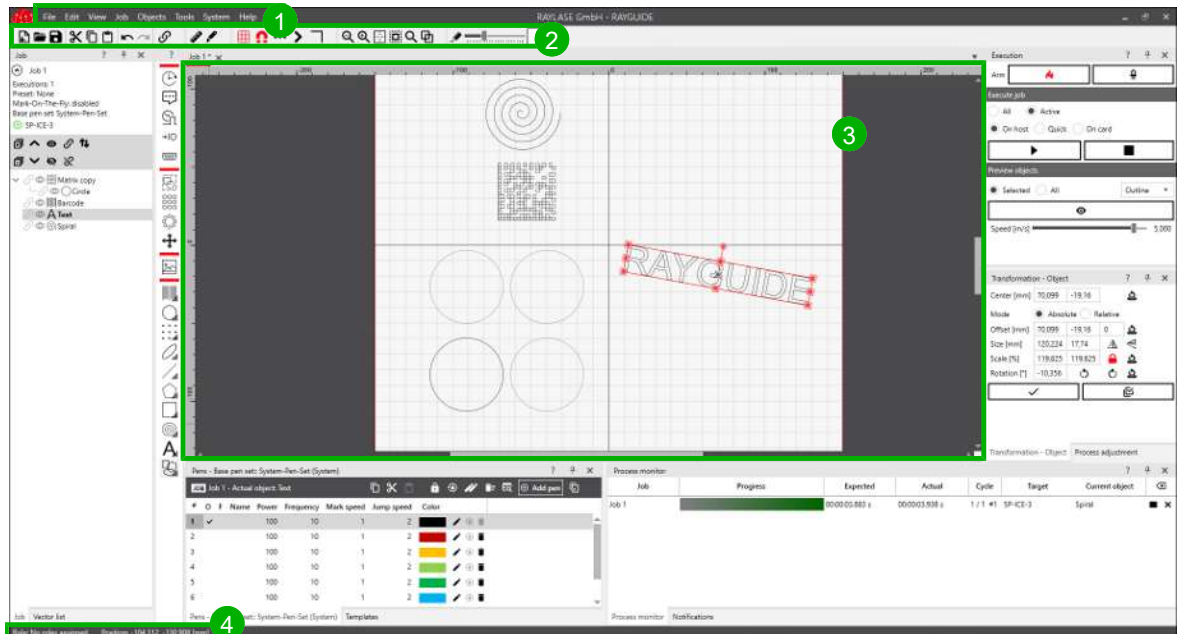


Fig. 4.1: RG-AAI

### Menu

① The main menu provides access to all important functions. For details, see *page 22, Menu*.

### Toolbar

② The buttons in the toolbar offer shortcuts to program functions. For details, see *page 23, Toolbar*.

### Viewport

③ The viewport is the area where the geometric layout of the graphic objects is displayed, created, and modified. For details, see *page 31, Viewport*.

## Status bar

④ The status bar displays the current user role (left) and status information (right).

## Panels

Program functions are available on a variety of user interface panels. They can be presented and moved to various places of the GUI. For details, see *page 34, Panels*.

## Dialogs

Most configuration, layout and processing parameters are entered in pop-up dialogs.

## Online help

In all dialogs and user interface panels you find a "?" in the headline. Click on the "?" to open the online help on the desired section in your default browser.

## Related presets

Main toolbar and status bar visibility can be turned on/off. Select **System > Preferences** from the menu to open the Settings dialog. Go to the System (all users) tab and to the Visibility sub-tab, Bars section.

| Setting    | Explanation                      |
|------------|----------------------------------|
| Toolbar    | Turns the main toolbar on / off. |
| Status bar | Turns the status bar on / off.   |

Tab. 4.1: RG-001

The size of toolbar buttons can be specified.

Select **System > Preferences** from the menu to open the Settings dialog. Go to the System (all users) tab and to the user interface sub-tab.

| Setting                   | Explanation                            |
|---------------------------|--|
| Toolbar icon size [pixel] | Size of object toolbar icons in pixels |

Tab. 4.2: RG-002

## 4.2 Menu

The main menu at the top of the GUI offers some essential functions.

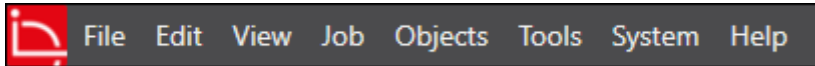


Fig. 4.2: RG-AAJ

Some standard functions of the software require no further explanation.






- The **File** menu refers to common job file tasks. RAYGUIDE job files will be saved with the file extension \*.rg. The menu also offers the option of importing layout objects and exporting jobs to other file formats such as DXF.
 



**NOTE:** Bitmap elements are not included in the export, while text elements are exported as vector graphics.
- The **[Edit]** menu contains common operations that can be applied to the selected objects. This menu also contains the "Click to modify" object transformations. For details, see [page 23, Toolbar](#).
- The **View** menu is described in [page 28, View Options](#).
- The **Job** menu refers to working with jobs.
- The **Objects** menu can be used to insert objects into the job, just like the Object panel (see [page 113, Graphic job design](#)). In addition, available templates are listed for each object type (see [page 218, Templates](#)).
- The **Tools** menu provides access to the "Distance measurement", "Split object" and "Parameter finder" tools (see [page 241, Pen parameter finder](#) and [page 277, MOTF parameter finder](#)).
- The **System** menu provides access to the **Devices** and their configuration dialogs, as well as the Laser Diagnostic and RAYGUIDE Settings dialogs to define the available settings. With the export or import option available here, you can save or read in all important configurations (both the RAYGUIDE application and the device configuration, see [page 99, Saving / Restoring system settings](#)).
- It also gives you access to the library pen set and its pen configurations. The stand-alone control card mode dialog is also started from this menu item.
- The **Help** menu displays brief information about the software (for instance software version with link to the change history) and provides access to licence management. You can also launch an email with all relevant information automatically attached and send it to your responsible support contact. For more information, see [page 334, Error messages](#).

Applicable keyboard shortcuts are shown behind most menu options.













## 4.3 Toolbar

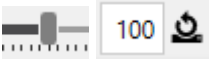
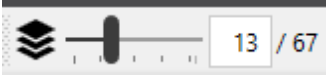
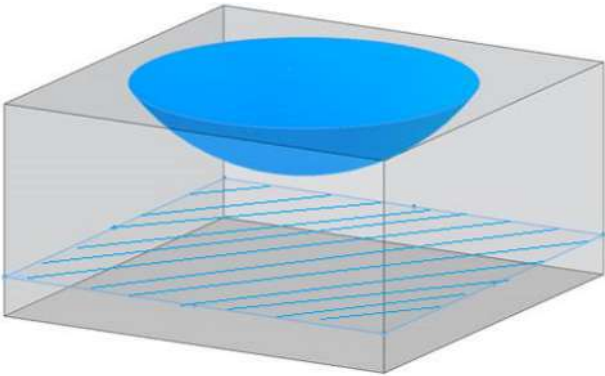
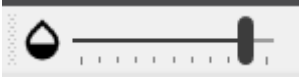
The toolbar (below the main menu) offers the following functions:




| Tool  | Explanation  |
|---|--|
| <b>Jobs</b>   |  |
|    | Adds a blank job document.   |
|    | Opens / Saves a job document.  |
| <b>[Cut], Copy, [Paste]</b>   |  |
|    | Cuts, copies and pastes selected items.  |
| <b>Undo, Redo</b>   |  |
|   | <p>As long as the job document has not been closed, every step of your work can be undone. To do so, repeatedly click the undo button (arrow to left). To restore a step that was undone, click on the redo button (arrow to right).</p> <p>For complex operations (e.g. when objects with a large number of vector objects are deleted or modified), a larger amount of memory is required to undo the operation. Therefore, the software may prompt you with the following query.</p> <div style="border: 1px solid black; padding: 5px;"> <p>Undo confirmation <span style="float: right;">×</span></p> <p>The undo operation for this object could consume significant processing and memory resources. Do you wish RAYGUIDE to add this operation to the undo list?</p> <p><b>Yes</b><br/>The operation can be undone. However, due to the memory consumption, the performance and responsiveness of your computer may be impaired.</p> <p><b>No</b><br/>You will not be able to undo this operation.</p> <p><input type="checkbox"/> Remember choice</p> </div> <p>This gives you the choice of whether or not you want the operation to be reversible. By setting the checkbox on the lower edge of the dialog, your selection will be saved for future events.</p> <p>The saved selection can be found again via <b>Preferences &gt; User (current user) &gt; UI</b> (see page 96, UI).</p> |
|  | <p>Lock / Unlock workspace.</p> <p>This option locks all (current and new) layout objects in the viewport against mouse operation. Applies to all open jobs.</p>   |

| Tool  | Explanation   |               |  |      |         |          |                    |
|---|---|---------------|--|------|---------|----------|--------------------|
| <b>Extras</b>   |   |               |  |      |         |          |                    |
|    | <p>Tool to <b>measure</b> distances.</p> <p>Click once to the start point of the distance, and then pull the mouse to the second point of distance or right click once for the start point and a second time for the end point of the distance.</p> <p>Keep <b>[Shift]</b> pressed to measure horizontal / vertical only.</p> <p>Keep <b>[Ctrl]</b> pressed to stay in measurement mode, e. g. for subsequent measures. The cursor icon indicates the measurement mode by switching from "arrow" to "crosshairs".</p> <p>After each measurement, the distance is:</p> <ul style="list-style-type: none"> <li>■ Temporarily shown in the status bar</li> <li>■ Noted in the notifications panel:</li> </ul> <table border="1"> <thead> <tr> <th colspan="2">Notifications</th> </tr> <tr> <th>Time</th> <th>Message</th> </tr> </thead> <tbody> <tr> <td>11:45:47</td> <td>Measured 56,725 mm</td> </tr> </tbody> </table> <p>To measure an exact distance from one thumb to another thumb, please refer to the context menu of the thumb. For details, see <i>page 203, More Object-related Operations in the Context Menu</i>.</p> | Notifications |  | Time | Message | 11:45:47 | Measured 56,725 mm |
| Notifications   |   |               |  |      |         |          |                    |
| Time  | Message   |               |  |      |         |          |                    |
| 11:45:47  | Measured 56,725 mm  |               |  |      |         |          |                    |
|  | <p><b>Splits</b> the selected objects.</p> <p>Any selected object can be split into two parts.</p> <p>First, select the object for which the tool should be available. Click in the viewport to define the first point of the split-line that is visible now. Click again to define the second point of the split-line. (Press <b>[Shift]</b> to get a horizontal / vertical line.) The object will be split now.</p> <p><b>NOTE:</b> All objects that are content based (e.g. text, codes) produce vector-based parts after splitting.</p> <p><b>NOTE:</b> Fills of split objects lose their fill attribute, and are created as part of the object geometry in a new layer of their own.</p> <p><b>NOTE:</b> Containers as a whole cannot be split with this tool. However, multiple objects can be selected.</p>  |               |  |      |         |          |                    |



| Tool  | Explanation   |
|---|---|
|    | Pen parameter finder, see <i>page 241, Pen parameter finder</i> .   |
|    | MOTF parameter finder, see <i>page 277, MOTF parameter finder</i> .   |
| <b>Zoom</b>   |   |
| The zoom functions apply to the viewport.   |   |
|    | Zooms out and in. Alternatively, you can use the scroll wheel of the mouse.   |
|    | Fits the entire workspace into the viewport.  |
|    | Fits the area defined by the cursor into the viewport.  |
|    | Fits the selected graphic object or the selected sub-object (layer, path) into the viewport.                                  |
|    | Zooms to fit all graphic objects into the viewport. If there is no graphic object, the workspace is fitted into the viewport. |
| You can also use the scroll wheel of the mouse to zoom in / out. If you keep the mouse wheel pressed, you can move the view area in the viewport with mouse movement. |   |
| <b>Display options</b>  |   |
| Toggle icons to enable / disable the use of the main display options. For details, see <i>page 28, View Options</i> .   |   |
|    | Display grid  |
|    | Display guidelines  |
|    | Display jumps   |
|    | Display vector tips   |
|    | Display sharp corners   |

| Tool  | Explanation  |
|---|--|
| <b>Stroke width</b>   |  |
|    | <p>Globally increases or decreases the line width of all graphics in the viewport. The value corresponds to the number of pixels (relative to the screen resolution). Note that this is just display-related. It does not affect the spot size of the laser beam on the material and therefore has no impact on the process result.</p> <p>Use the slider or enter a value in the input field.</p> <p>Use the <b>[Reset]</b> button to reset to default.</p> |
| <b>Slice navigator*</b>   |  |
|    | <p>Use the navigator to select the index of the slice from the solid that can be seen in the viewport.</p> <p><b>NOTE:</b> When using a solid file with a negative form, the slice may be empty as soon as you navigate under the negative form.</p> <p>Example:</p>   |
| <b>Opacity</b>  |  |
|  | <p>The sliders can be used to adjust the opacity of the background images.</p>   |

| Tool   | Explanation   |
|--|---|
| <b>Click-to-fit*</b>   |   |
| <b>NOTE:</b> With all three variants, after the <i>Click-to-fit</i> action the resulting transformation is displayed in the Notifications panel. |   |
|   | Shifting and rotating (transformation 1)<br>Adapts the position of the selected objects by manually picking two source points and then picking two target points.<br>The object selection is not scaled.  |
|   | Shift, rotate and scale with the same factor for X/Y (transformation 2)<br>Adapts the position and size of the selected objects by manually picking two source points and then picking two target points.<br>The scale factors are the same for both dimensions (X/Y).                        |
|    | Shift, rotate and scale with different factors for X/Y (transformation 3)<br>Adapts the position and size of the selected objects by manually picking three source points and then picking three target points.<br>The scale factors are independent of each other for both dimensions (X/Y). |
| * This toolbar is hidden by default. It can be activated via <b>View &gt; Toolbar</b> .  |   |

Tab. 4.3: RG-003

The tool bar is subdivided into groups that can be shown and hidden independently. See *page 28, View Options*.

### Tooltips (quick info)

In many cases, a short explanatory text appears when you move the cursor over a GUI element, such as a button or a field:



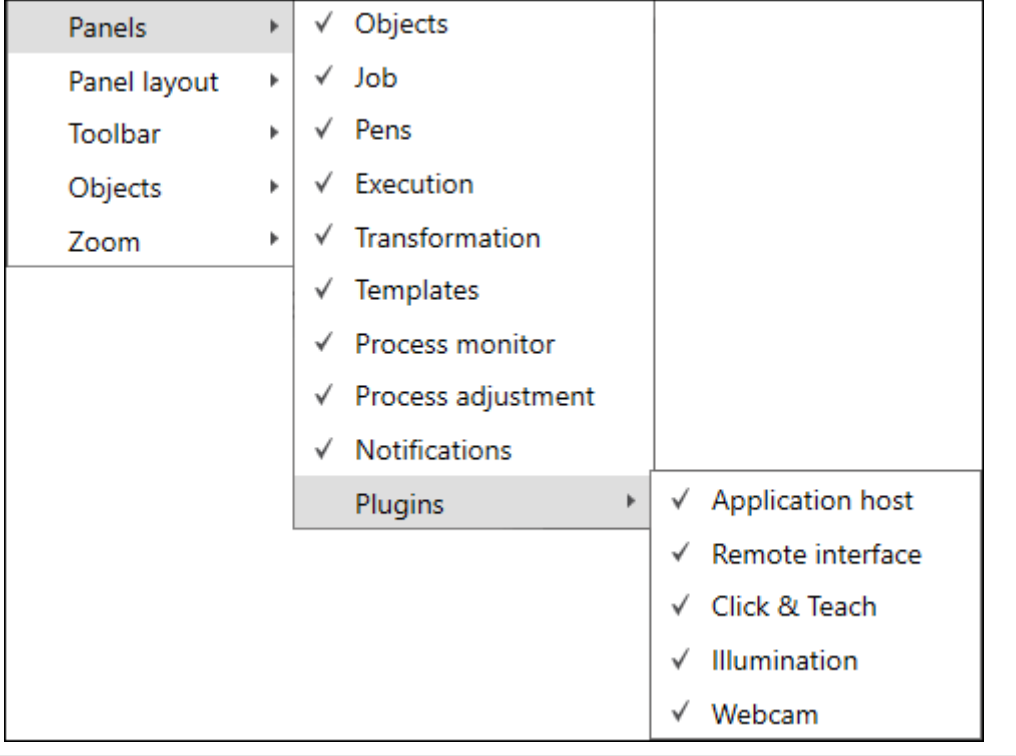
Fig. 4.3: RG-AAK

## 4.4 View Options

Select **View** from the menu to activate supporting information to be displayed in the viewport. Viewing jumps, vector directions and identifying certain vector angles will help you to investigate the process order of layout elements or their current shortcomings.

**NOTE:** The display options are only visible when not in **edit mode**.

| Setting       | Explanation  |
|---------------|--|
| Grid          | Toggles the display of viewport grid lines. The grid spacing automatically adjusts to the zoom level.  |
| Guidelines    | Select this menu item to show / hide the guidelines.   |
| Jump vectors  | Toggles the display of the jump vectors. The display shows all jumps within and between all current layout objects.<br>A limit for the display can be defined in <b>System &gt; Preferences &gt; System (all users) &gt; UI</b> .  |
| Vector tips   | Toggles the display of vector sequences / directions of all current layout objects. A circle also marks the starting point of the object.<br>A limit for the display can be defined in <b>System &gt; Preferences &gt; System (all users) &gt; UI</b> .  |
| Sharp corners | Switches the highlighting of specific vector transitions in all layout objects on and off.<br>Useful, for example, when the Skywriting feature is active to see which vector transitions are effected, depending on its "change of heading angle". Also, unintentional u-turns of consecutive vectors can be highlighted.<br>The angle limit to define a "sharp corner" is to be set in <b>System &gt; Preferences &gt; System (all users) &gt; UI</b> . |
| Panels        | Toggles the display of the various user interface panels.<br>All panels that belong to plug-ins or have been implemented by users are summarised under the <b>Plugins</b> category.  |

| Setting      | Explanation  |
|--------------|--|
|              |   |
| Panel layout | Offers a sub-menu to store / load panel arrangements per user. You also find options to <b>[Reset]</b> panel layouts to the default arrangement. |
| Toolbar      | Switches the display of various groups in the toolbar on and off.  |
| Objects      | Switches the display of the icons for automation objects, containers and marking objects in the Objects panel on or off.                         |
| <b>Zoom</b>  | Provides a sub-menu for using the various zoom functions.  |

Tab. 4.4: RG-004

### Related presets

Select **System > Preferences** to adapt some preset variables related to view options.

| Setting                                  | Explanation  |
|--|--|
| <b>System (all users) &gt; UI</b>        |  |
| Sharp corner limit [°]                   | If sharp corners in the layout are a critical issue, you may set a minimum change of heading angle (in degrees) here. Corners where the vector changes direction with at least this angle will be highlighted in the layout if the corresponding view option is set. |
| Path start / sharp corner radius [pixel] | Radius (in pixel) of the circle that highlights path starts and sharp corners  |
| <b>User (current user) &gt; UI</b>       |  |
| Jump vectors in pen color                | Displays the jumps in the colour of the pen which defines also the jump parameters – if the display option “show jumps” is activated.  |

Tab. 4.5: RG-005

## 4.5 Viewport

The viewport is the central area of the RAYGUIDE user interface where the job layout is defined and edited.

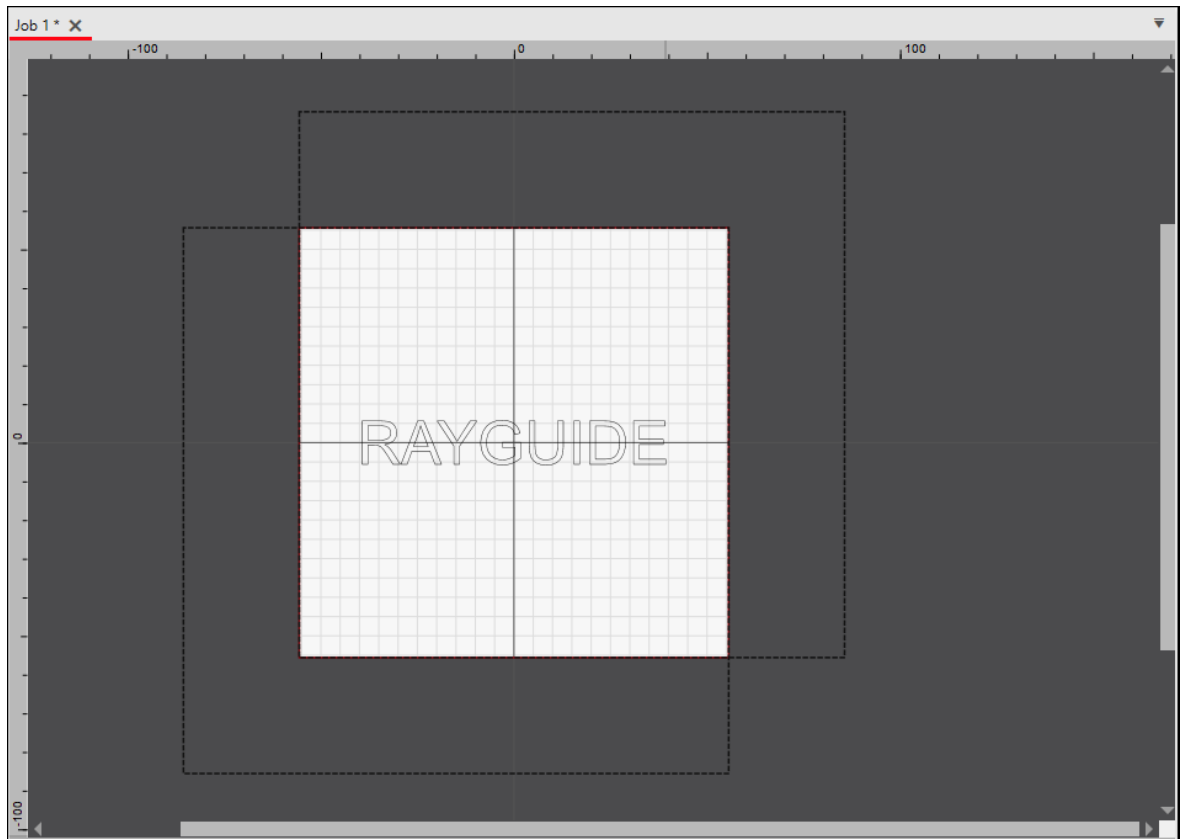


Fig. 4.4: RG-AAL - as an example you see 2 overlapping scan fields

- The crosshairs mark the origin of the so-called “workspace” to which all vector coordinates and the offset of the object transformation refer.
- The maximum workspace area is framed by rulers.
- To view the area of a defined workspace, activate the display of grid lines. The grid lines show up only in the workspace area.
- When multiple scan fields are used, they are displayed by dashed frames.
- The current cursor position in the corresponding coordinate plane is displayed at the bottom left.
- At the bottom right, the view of the coordinate plane (XY or XZ or YZ) can be selected, provided that a correction file with a 3D volume is being used.

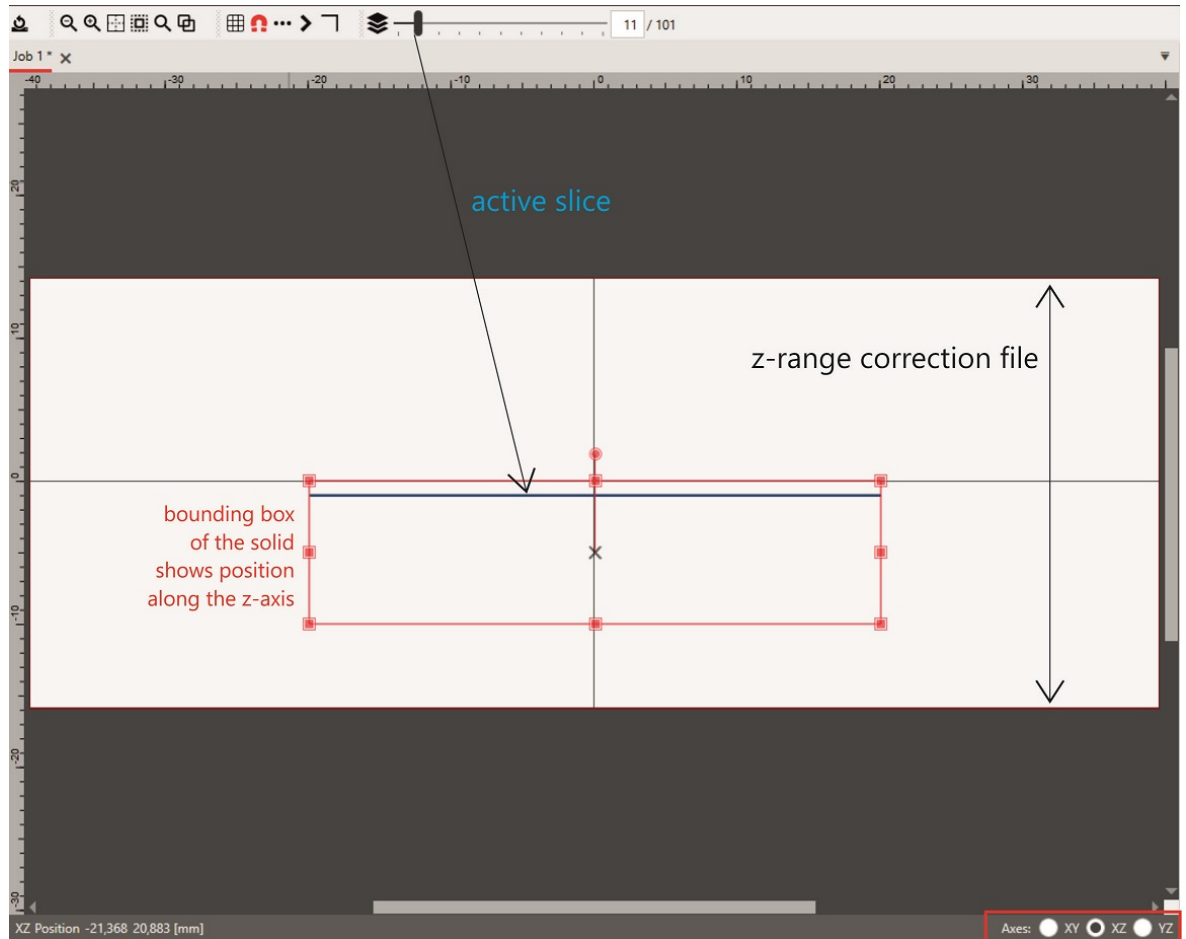


Fig. 4.5: AEM – A solid and its slice in the XZ axis view are shown here, for example.



## 4.5.1 Guidelines

The guidelines are aids to align the arrangement of layout objects using horizontal and / or vertical lines.

To add a guideline to the viewport, drag it from the ruler area into the viewport while holding down the left mouse button. Then release the mouse button to place the line at the desired position.

The guidelines act like magnets and can be used to attach either the thumbs of graphic objects or the corner points of the object frame.

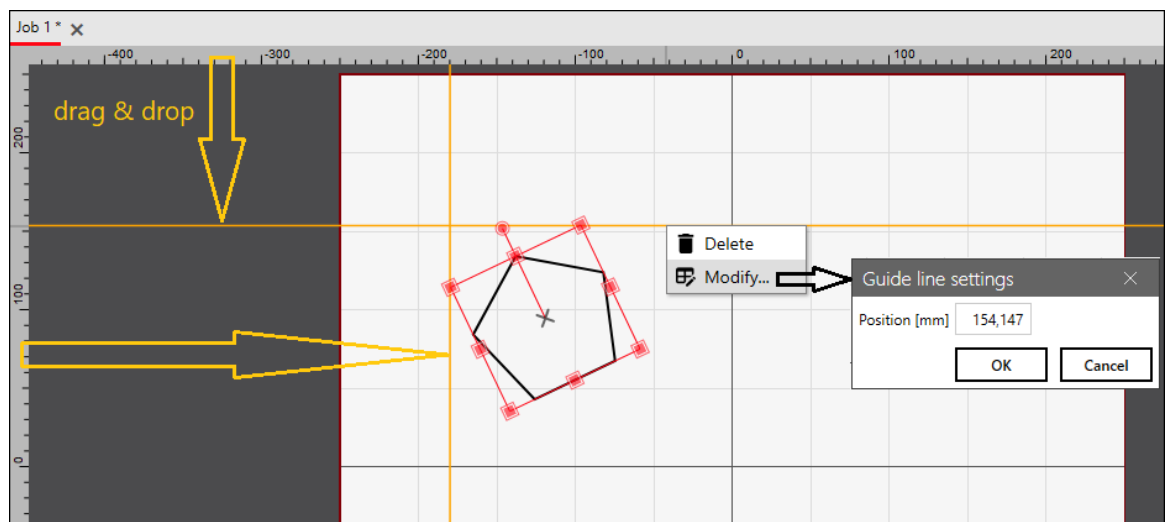


Fig. 4.6: RG-ADH

- Use the right-click context menu for the **Modify** or **[Delete]** options.
- Use the **Modify** option to enter a specific axis position for the guideline.

**NOTE:** The guidelines belong to a single job and are not saved.

**NOTE:** To temporarily disable the "magnetic behaviour" of guidelines, press the **[Alt Gr]** key.

## 4.6 Panels

Program functions are available on a variety of user interface panels.

In the standard panel layout, some panels are stacked. That means the screenshot below does not show all of them.

Use the tabs at the bottom of the panels to toggle between alternative panel contents.

### Available panels

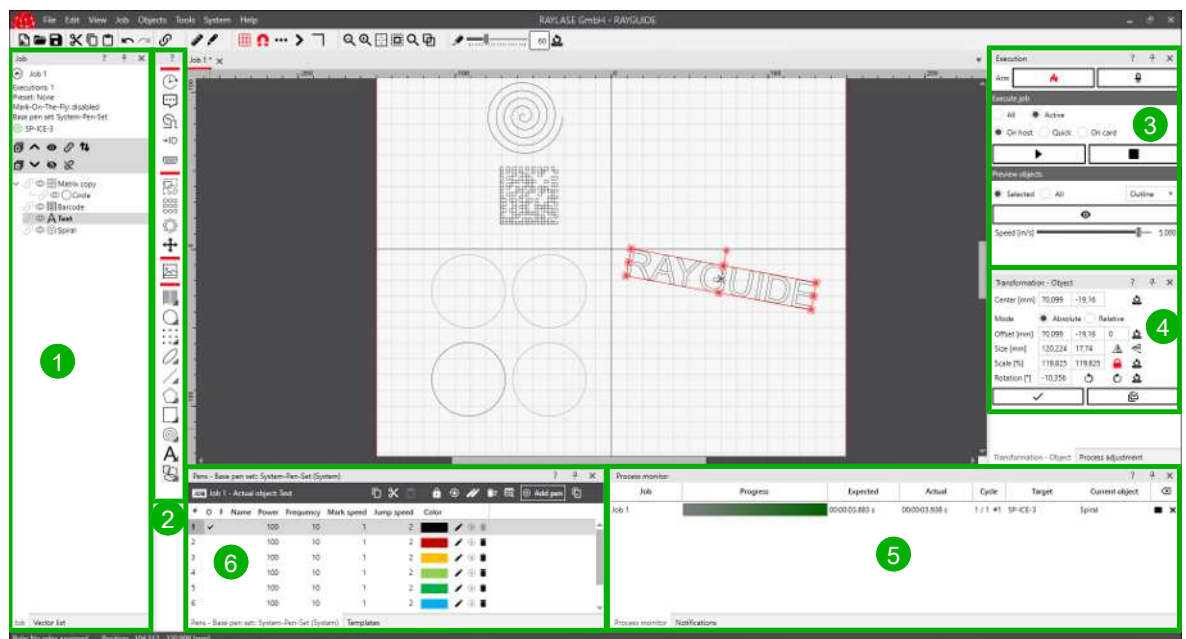


Fig. 4.7: RG-AAM

Panel contents are explained in detail in the respective chapters of this manual. Follow the links.

- ① **Jobs**: Overview of the job main settings and the job tree (see page 113, *Graphic job design*)
- or **Vector list**: List of graphic commands (see page 113, *Graphic job design*)
- ② **Objects** (see page 113, *Graphic job design*)
- ③ **Execution** (see page 285, *Running a Job*)
- ④ **Transformation** (see page 168, *Object Transformation*) or **Process adjustment** (see page 305, *Process Adjustment*)
- ⑤ **Process monitor** (see page 292, *Process Monitor*)
- ⑥ **Pens** (see page 220, *Process Parameters (Pens)*) or **Templates** (see page 218, *Templates*)
- ⑦ **Notifications**: Table which traces the latest RAYGUIDE status information.

In addition, a custom user interface panel can be activated. This panel hosts controls which could be added by customer user interface plug-ins (see page 332, *Customer plug-ins*).

### Rearranging panels

The panel layout can be rearranged according to your current work objectives and personal settings.

- Select **View > Panels** in the main menu to toggle on/off the visibility of certain panels.
- Now drag the panel towards a new position with the mouse:
  - Point to the title bar of a panel, press the left mouse button and keep it pressed.
  - Now drag the panel towards a new position. A positioning tool appears on the screen.

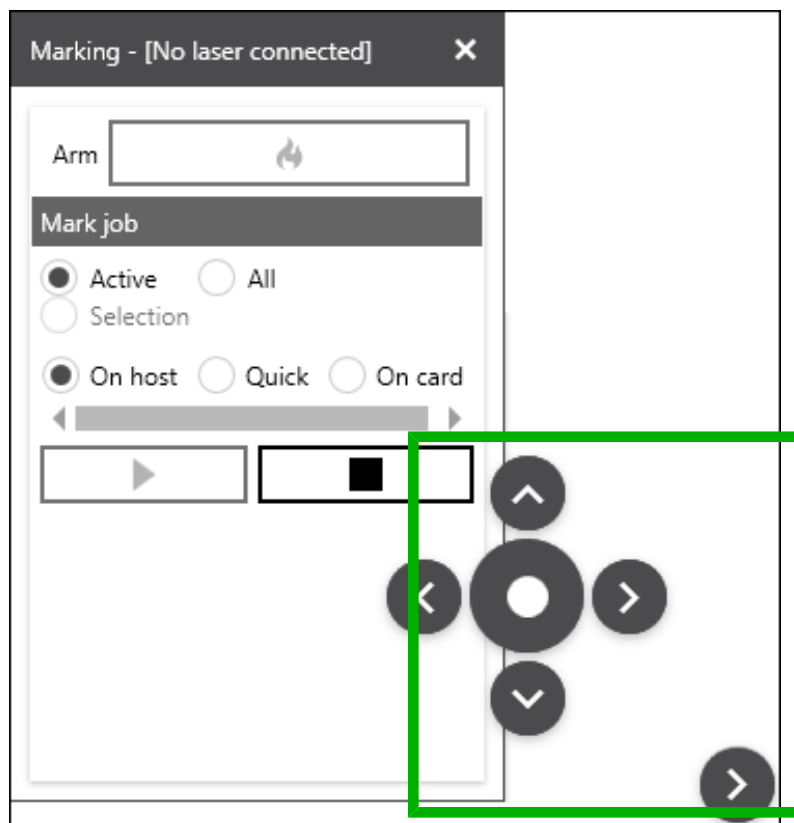


Fig. 4.8: RG-AAN

- To dock the panel beside another panel, drag the mouse point to one of the arrows and release it there.
  - The circle in the centre of the positioning tool makes the panel (overlaid) dock on another panel.
  - If two panels are on top of each other, grab the panel by its tab to detach it from the other panel.

- Use the pin button on the panel's title bar to minimise the panel to a sidebar (pin bar). Click the tabs of the pin bar to maximise a panel at the previous position.
- Use the **[x]** button on the panel's title bar to close the panel.
- Select **View > Panel layout > Reset** to return to the standard panel layout.

### Saving panel layout

- Navigate to **View > Panel layout**: You can save the actual panel layout or open already saved panel layouts per user. Thus, one user can be allowed to define multiple panel layouts per task, for example, one panel layout for job design tasks and another for job execution tasks.

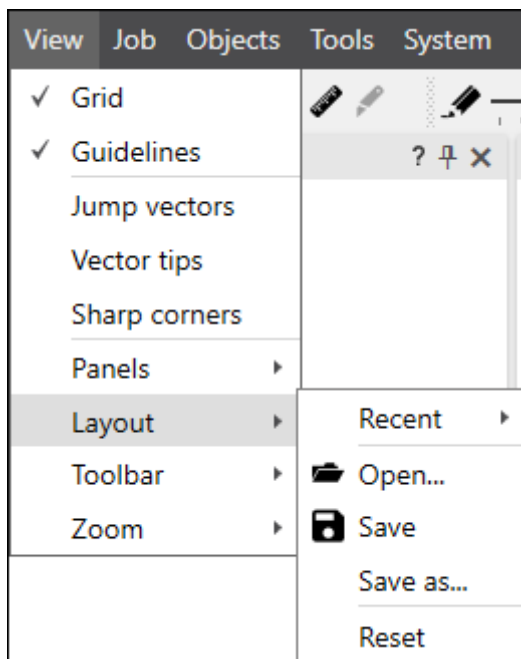
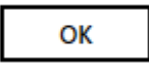

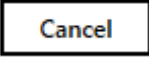


Fig. 4.9: RG-AAO

## 4.7 Buttons, Icons, Shortcuts

### Text Buttons








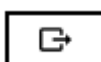
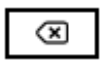
Throughout the GUI and its dialogs, text buttons are used for common functions:




















| Button  | Meaning   |
|---|---|
|  | Activates the setting changes and closes the dialog.      |
|  | Activates the setting changes without closing the dialog. |
|  | Discards the setting changes and closes the dialog.       |
| Other buttons are labelled appropriately.   |   |


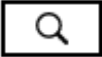


Tab. 4.6: 006

### Icon / symbol buttons


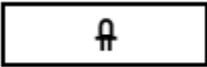



Throughout the GUI and its dialogs, icon buttons are used to access functions. Frequently used icons are:

| Button / buttons  | Referenced as      | Function  |
|---|--------------------|---|
|  | <b>[Add]</b>       | Adds a new item, e.g. a job, a pen set, depending on context. |
|  | <b>[Delete]</b>    | Deletes or closes the active / selected element(s).           |
|  | <b>[Edit]</b>      | Edits selected items.   |
|  | <b>[Save]</b>      | Saves to templates.   |
|  | <b>[Reset]</b>     | Sets the settings / parameters back to the default values.    |
|  | <b>[Refresh]</b>   | Refreshes the displayed information.                          |
|  | <b>[Import]</b>    | Imports a file.   |
|  | <b>[Export]</b>    | Exports data into a file.                                     |
|  | <b>[Clear all]</b> | In process monitor: Clears all jobs from the table.           |

| Button / buttons  | Referenced as                           | Function  |
|---|---|---|
|    | <b>[Abort]</b>                          | In process monitor: Aborts job execution.   |
|    | <b>[Clear]</b>                          | In process monitor: Clears one job from the table.  |
|    | <b>[Expand]</b>                         | Shows dialog parts in the dialog.   |
|    | <b>[Collapse]</b>                       | Hides parts of the dialog in the dialog.  |
|    | <b>[Expand all]</b>                     | Expands list of items.  |
|    | <b>[Collapse all]</b>                   | Collapses list of items.  |
|    | <b>[Previous] / [Next]</b>              | Goes to previous / next item.   |
|    | <b>[Reverse order]</b>                  | Reverses order.   |
|    | <b>[Lock / Unlock]</b>                  | In pen panel: It makes all values of selected pens local.   |
|  | <b>[Reset pen]</b>                      | In pen panel: Restores the default values for selected pens.  |
|  | <b>[Cut]</b>                            | Deletes selected item to the clipboard.   |
|  | <b>[Copy selected]</b>                  | Copies selected items to the clipboard.   |
|  | <b>[Transfers the pen set]</b>          | Transfers the current pen set to the library by either creating a new library pen set or overwriting an existing one. |
|  | <b>[Paste]</b>                          | Pastes selected items from the clipboard.   |
|  | <b>[Create]</b>                         | Creates selected item.  |
|  | <b>[Apply filling]</b>                  | Applies a filling template to a selected object.  |
|  | <b>[Apply filling without removing]</b> | Applies a filling template to a selected object without removing an existing filling.                                 |
|  | <b>[Copy settings]</b>                  | Copies settings to adjacent dialog section.   |
|  | <b>[Execute]</b>                        | Starts processing of selected jobs / objects.   |

| Button / buttons  | Referenced as                   | Function   |
|---|---------------------------------|--|
|    | <b>[Stop]</b>                   | Stops processing.  |
|    | <b>[Search]</b>                 | Searches the network for scan controller cards.                        |
|   | <b>[Connect] / [Disconnect]</b> | Connects to or disconnects from the scan controller card (IP address). |

Tab. 4.7: RG-007

| <b>Toggle buttons</b>   |                                  |   |
|---|----------------------------------|---|
| <b>Some button buttons serve as toggle switches. Clicking them activates/deactivates the function. In some cases the icon turns red when activated.</b> |                                  |   |
|   | <b>[Auto connect at startup]</b> | Automatically connect to the control card when the program starts.  |
|    | <b>[Pointer]</b>                 | Activates the pointer.  |
|    | <b>[Arm/Disarm]</b>              | Arms and disarms the laser. An armed laser is ready for operation.  |
|    | <b>[Preview]</b>                 | Starts / stops a preview.   |
|    | <b>[Show pen]</b>                | In pen panel: Activates / deactivates the colour highlighting of elements in the tree structure that use the selected pens. |
| <b>Transformation buttons</b>   |                                  |   |
| Buttons used for object transformation on the Process adjustment panel are described separately, see <i>page 305, Process Adjustment</i> .              |                                  |   |

Tab. 4.8: RG-008

## Keyboard Shortcuts

Some functions can be accessed using function keys on the keyboard:

| Key          | Function                               |
|--------------|--|
| [F1]         | Help                                   |
| [F2]         | Rename                                 |
| [F3]         | System settings                        |
| [Ctrl]+[F3]  | Device configuration                   |
| [Ctrl]+[N]   | New job                                |
| [Ctrl]+[S]   | Save job                               |
| [Ctrl]+[L]   | Laser diagnostics                      |
| [F4]         | Zoom to workspace                      |
| [Ctrl]+[F4]  | Close job                              |
| [Alt]+[F4]   | Exit application                       |
| [F5]         | Object properties                      |
| [F6]         | Pen set configuration                  |
| [F8]         | <b>Start</b> preview                   |
| [F10]        | Enable marking with keyboard shortcuts |
| [F11]        | Job settings                           |
| [Ctrl]+[F11] | Job presets                            |
| [Ctrl]+[F12] | Stand-alone mode dialog                |

Tab. 4.9: RG-009



## 5 DEVICE CONFIGURATION AND CALIBRATION

Before using RAYGUIDE to define and execute laser processing jobs or any other tasks, the system devices have to be configured. There are four types of devices available:

- Control cards
- Lasers
- Deflection units and
- System / Computer serial controllers

### **Suggested workflow**

The hardware devices must be configured according to their interfaces, characteristics, and optical setup. Perform all following steps, however, the order is arbitrary.

**Add the device** to the *Managed Devices* section in the device configuration window.

**Step 1**

From the menu, select **System > Devices > Configure...**, or press **[F3]**.

After the initial installation of RAYGUIDE, the right side of the dialog appears empty:

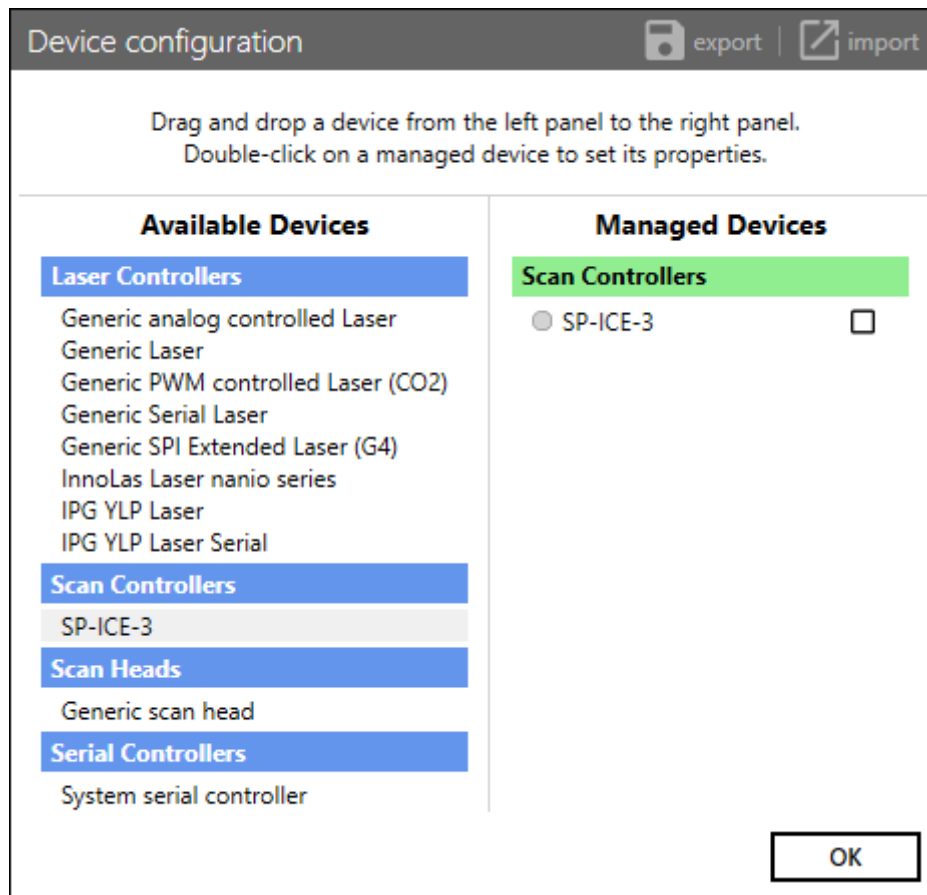


Fig. 5.1: RG-ADT

Configuration window with example content:

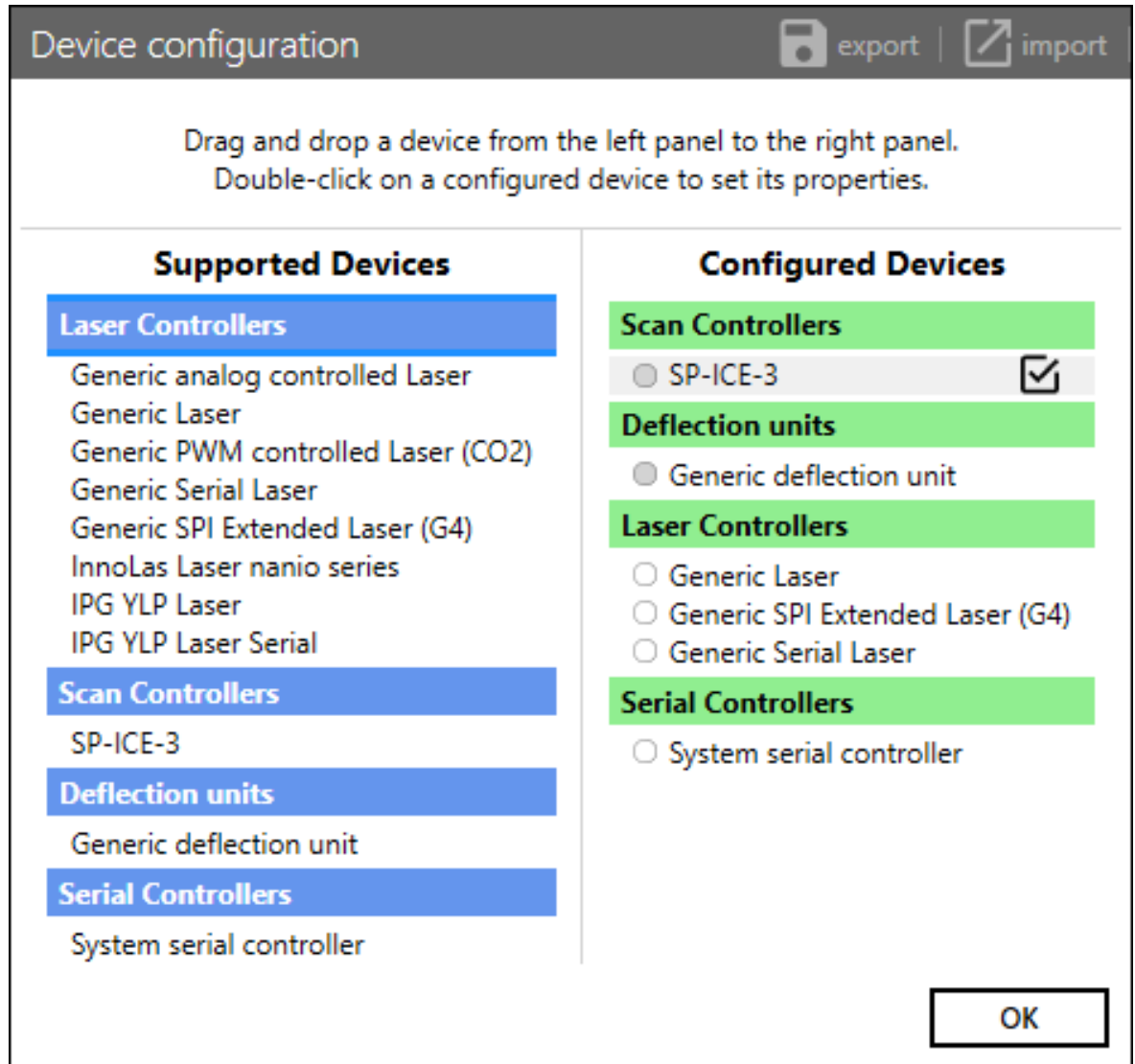


Fig. 5.2: RG-AAP

To add devices such as a control card or laser, use the mouse to drag it from the **Available Devices** window area to the **Managed Devices** section. You can add a supported device type to the Configured devices multiple times.

**NOTE:** We suggest starting by adding at least one scan controller.

**Step 2**

Configure the device. Double-clicking the entry from the device opens its configuration dialog.

Settings and options in the configuration dialogs are described in the following sections of this manual.

### Step 3

The scan controller must know which devices it should communicate with. Assign a laser and a deflection unit to the scan controller as follows:

- Go to the scan controller's configuration dialog and select the respective device from the drop-down list for lasers and deflection units. The scan controller's configuration dialog lists all the devices currently present in configured devices.
- Use the **[Edit]** button to configure the device (if not already done).

### Result:

After the devices have been linked to a scan controller, the corresponding short designation of the scan controller is displayed behind the device entry in the configuration overview.

### Colour code:

- **White:** No connection information available
- **Grey:** Connection status available, not connected
- **Green:** Connection status available and connected

The checkmark behind the scan controller indicates that this scan controller and the devices linked to it are defined as primary devices. When using multiple scan controllers, you can adjust the definition of the primary devices by moving the checkmark.

## 5.1 Scan Controller Configuration

Open the control card configuration dialog. There are three ways to do so:

- In the **Configure devices** menu, double-click on the entry of the control card (right-hand side), or use the context menu of the control card and select **Properties**.
- Select **System > Devices > Scan controllers > (device name)** from the menu.
- Double-click on the card entry in the job overview.

The configuration window of the control card has five tabs: **Setup**, **General**, **I/O**, **MOTF**, **Serial**.

### 5.1.1 Setup

Important configuration settings of the control card.

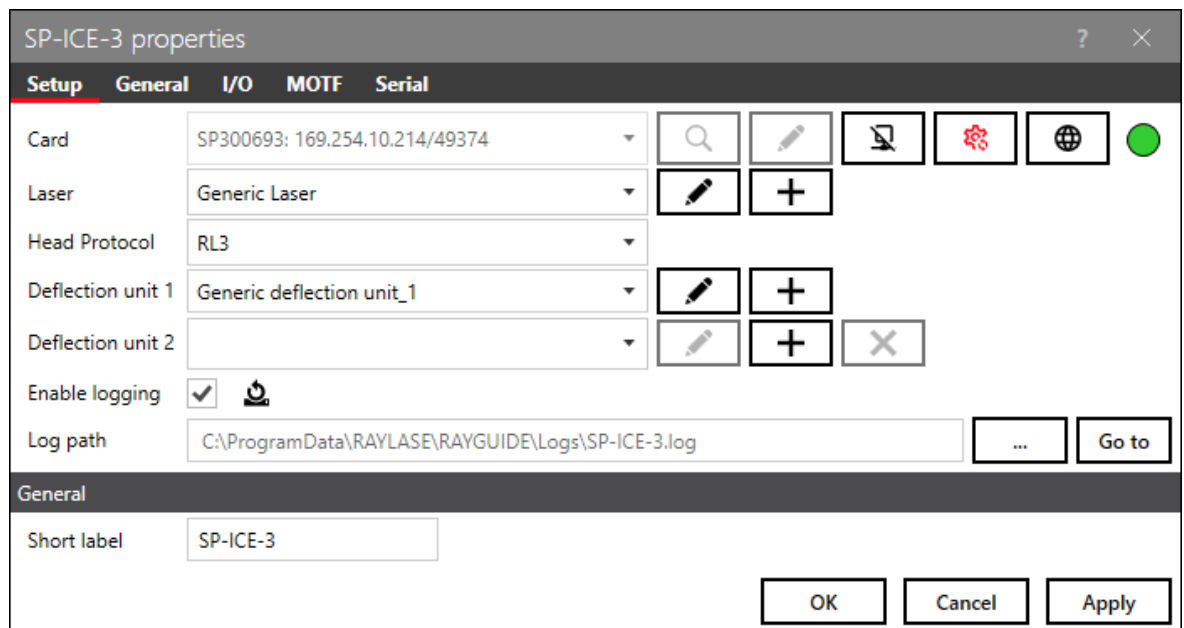


Fig. 5.3: RG-AAQ

| Setting | Explanation   |
|---------|---|
| Card    | <p>Name and address of the scan controller.</p> <p>Click the <b>[Search]</b> button to search for available scan controllers on the network.</p> <p>The available scan controllers within the network are listed showing their serial numbers and IP addresses.</p> <p>Identify the SP-ICE-3 control card by its serial number and select it. In most cases, each scan controller appears once with its IP4 and once with its IP6 address.</p> <p><b>NOTE:</b> Which IP address family is selected for the scan controller does not affect the connection speed to the scan controller.</p> <p>Alternatively, you can click the <b>[Edit]</b> button to add a scan controller by entering its IP address directly.</p> <p>Click on the <b>[Connect]/[Disconnect]</b> button to connect to (or disconnect from) the control card. An active scan controller connection is indicated by a green "traffic light".</p> <p>If you are setting up a system with multiple scan controllers involved, repeat this step per scan controller and its individual configuration dialog.</p> <p><b>[Auto connect at startup]</b> toggle button to define if the control card should be connected automatically when RAYGUIDE starts. If you disconnect from the card and do not want it to reconnect automatically the next time you start up the program, you must disable this button. The button is activated by default.</p> <p>Click <b>[Webinterface]</b> to go to the scan controller web interface. This interface can be used, for example to update the scan controller's firmware. For more information, please refer to the manual for SP-ICE-3.</p> |
| Laser   | <p>Select a suitable laser to be controlled by the scan controller.</p> <p>Click the <b>[Edit]</b> button to open the laser dialog.</p> <p>Click the <b>[Add]</b> button to add another laser device to the configured devices list.</p>  |

| Setting       | Explanation   |
|---------------|---|
| Head Protocol | <p>Select a suitable head protocol for the deflection unit. This protocol defines the command-resolution and the number of controllable axes.</p> <ul style="list-style-type: none"> <li>■ XY2: <ul style="list-style-type: none"> <li>– 16 bit resolution protocol</li> <li>– Can control up to 3 axes</li> <li>– Requires an additional XY2-100 adapter card on the SP-ICE-3</li> <li>– Single head mode only</li> <li>– Supports feedback channel</li> </ul> </li> <li>■ SL2: <ul style="list-style-type: none"> <li>– 20 bit resolution protocol</li> <li>– Can control 2 axes per protocol port / cable. For a deflection unit with 3 or 4 axes, two SL2-100 connections (and consequently two cables) are required</li> <li>– “Dual head” mode possible</li> <li>– Supports feedback channel</li> </ul> </li> <li>■ RL3 <ul style="list-style-type: none"> <li>– 20 bit resolution protocol</li> <li>– Can control 6 axes per control port / cable (a deflection unit with up to 6 axes can be run on a single data connection)</li> <li>– “Dual head” mode possible</li> <li>– Supports feedback channel</li> </ul> </li> </ul> <p><b>NOTE:</b> The subtype of the head protocol is defined by the chosen correction file on the deflection unit dialog.</p> |
| Scan head 1   | <p>Select the type for the first deflection unit.</p> <p>Click the <b>[Edit]</b> button to open the deflection unit dialog for the deflection unit.</p> <p>Click the <b>[Add]</b> button to add another deflection unit device to the configured devices list.</p>  |
| Scan head 2   | <p>Select the type for the second deflection unit. This only applies if you have selected a head protocol that includes "Dual head".</p> <p>Click the <b>[Edit]</b> button to open the deflection unit dialog for the deflection unit.</p> <p>Click the <b>[Add]</b> button to add another deflection unit device to the configured devices list.</p>   |

| Setting        | Explanation  |
|----------------|--|
| Enable logging | Enables SP-ICE-3 API logging. The log file records all SP-ICE-3 API commands sent to this scan controller. This is important for troubleshooting. See <i>page 334, Error Handling and Log Files</i> .<br>Click <b>[Reset]</b> to reset the log file. |
| Log path       | Path to the log file.<br>Click <b>[...]</b> to select a path or click <b>[Go to]</b> to open the respective folder.  |
| Short label    | A name for this scan controller that is easy to remember. It is recommended to name the scan controller according to your function or assignment in the system, so that you can easily assign it later.  |

Tab. 5.1: RG-010



## 5.1.2 General

Basic information about the scan controller.

SN\_31633 properties ? ×

Setup
General
I/O
MOTF
Serial

| Card info        |            | Detected adapter boards |
|------------------|------------|-------------------------|
| Serial Number    | SP312633   | PortD SPIAdapter        |
| Firmware version | 3.1.0.1542 |                         |
| Client version   | 3.1.0.1538 |                         |

System Time

|                   |  |  |
|-------------------|--|--|
| System Time (UTC) | Donnerstag, 12. Oktober 2023 09:53:08    | <span style="border: 1px solid black; padding: 2px;">Set from host's local time</span> |
| System Time (TZ)  | Donnerstag, 12. Oktober 2023 09:53:08    |  |
| Time Zone         | UTC <span style="float: right;">▼</span> |  |

Stand-Alone

|                  |   |   |
|------------------|---|---|
| Status           | Disabled  | <span style="border: 1px solid black; padding: 2px;">Stand-Alone manager</span> |
| Execution status | Idle <span style="font-size: 1.2em; vertical-align: middle;">↻</span> |   |

Deflection unit monitoring

|                        |  |  |
|------------------------|--|--|
| Enabled                | <input type="checkbox"/>                               | Periodically queries status of deflection unit.<br>Execution will be aborted, if more errors than<br>'Min consecutive errors' are returned in a row. |
| Period [ms]            | <input style="width: 50px;" type="text" value="1000"/> |  |
| Min consecutive errors | <input style="width: 50px;" type="text" value="1"/>    |  |

OK
Cancel
Apply

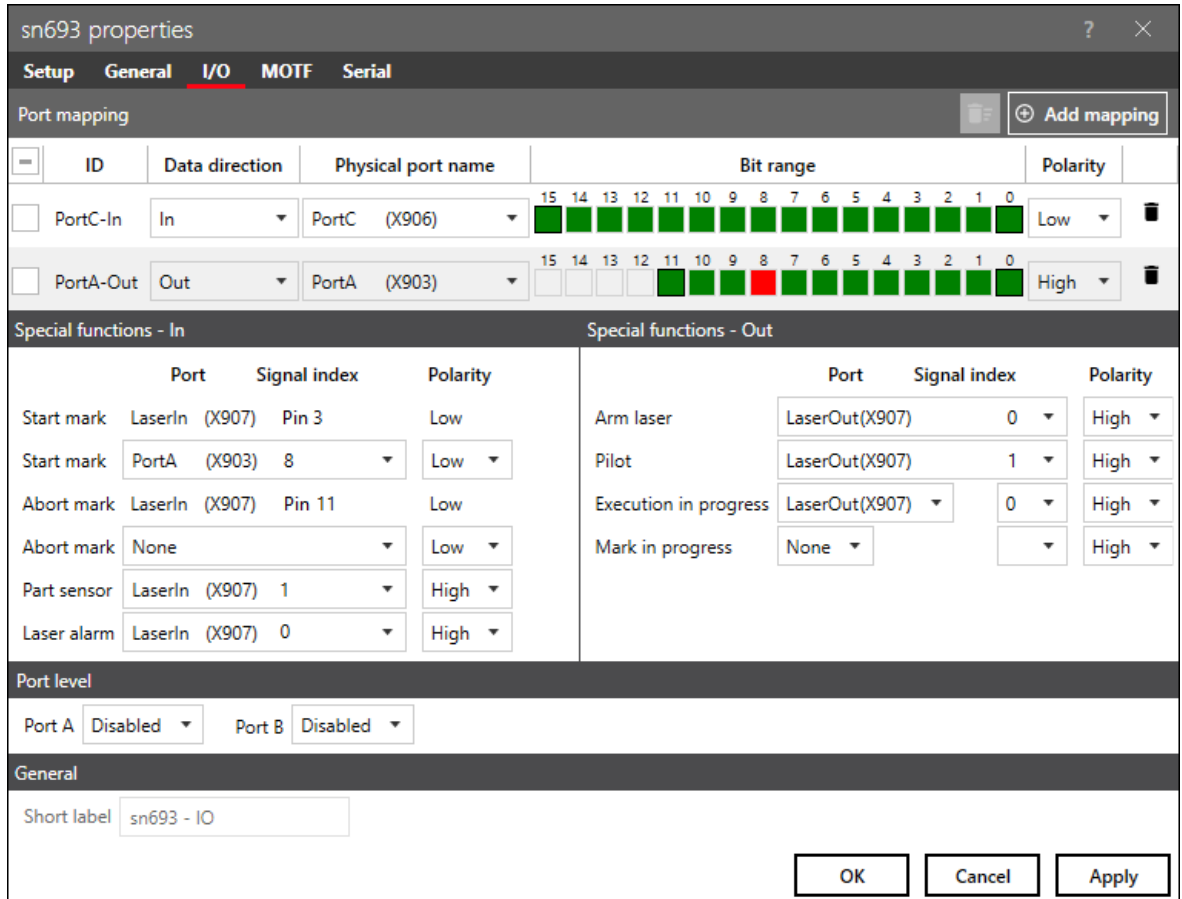
Fig. 5.4: RG-AAR

| Setting                    | Explanation  |
|----------------------------|--|
| Card Info                  | Display of the major control card information such as its serial number and firmware version.  |
| Detected adapter boards    | Displays the IO ports and connected adapter cards (if detected).<br><b>NOTE:</b> For details on the adapter cards, see the manual of the SP-ICE-3 control card.  |
| System Time                | Display of the control cards operating system time   |
| Stand-Alone                | Indicates the operating status of the control cards and whether a list is being executed.<br>The <b>[Settings]</b> button takes you directly to the dialog of the stand-alone configuration.   |
| Deflection Unit Monitoring | <b>NOTE:</b> If monitoring is activated and the number of consecutive errors exceeds a defined limit, the control card terminates any active execution. When operating in stand-alone mode, this will call up the so-called "error list".<br>The cause for the termination can also be communicated to external devices using the "Error handling" option. See <i>page 294, Automated Error Handling</i> . |
| Enabled                    | Activates the control card to monitor the status of the connected deflection unit, by querying its head status word.   |
| Period                     | Time interval, in which the card is querying the status word.<br><b>NOTE:</b> We suggest not to set the period too short (recommendation not below 500 ms), as this stresses the data exchange unnecessarily.  |
| Min. consecutive errors    | Number of consecutive errors that is tolerated before all active executions are terminated.  |

Tab. 5.2: RG-076

### 5.1.3 I/O Port Configuration

Used to configure the **SP-ICE-3** scan controller's I/O ports.



The screenshot shows the 'sn693 properties' dialog box with the 'I/O' tab selected. The 'Port mapping' section contains two entries: 'PortC-In' with 'In' data direction and 'PortC (X906)' physical port name, and 'PortA-Out' with 'Out' data direction and 'PortA (X903)' physical port name. The 'Special functions - In' section lists: Start mark (LaserIn X907, Pin 3, Low), Abort mark (LaserIn X907, Pin 11, Low), Abort mark (None, Low), Part sensor (LaserIn X907, 1, High), and Laser alarm (LaserIn X907, 0, High). The 'Special functions - Out' section lists: Arm laser (LaserOut X907, 0, High), Pilot (LaserOut X907, 1, High), Execution in progress (LaserOut X907, 0, High), and Mark in progress (None, High). The 'Port level' section shows Port A and Port B as Disabled. The 'General' section has a Short label 'sn693 - IO'. Buttons for OK, Cancel, and Apply are at the bottom right.

Fig. 5.5: RG-AAS

| Setting   | Explanation   |
|---|---|
| <b>Port mapping</b>   |   |
| Click <b>[Add mapping]</b> to start the configuration or to add a new port configuration. |   |
| Checkbox  | Check the box to select the port for further actions (e.g. delete).   |
| ID  | Use the ID to give the port a name under which it can be selected later in the GUI.<br><b>CAUTION:</b> Existing references to this port, for example in automation objects, are cleared when the ID is changed.                                   |
| Data direction  | Select <b>In</b> if the port receives signals from another device, or <b>Out</b> if the port provides signals for other devices.<br><b>NOTE:</b> Some I/O ports of the SP-ICE-3 scan controller can be split into an input and an output section. |

| Setting   | Explanation   |
|---|---|
| Physical port name  | Select an available port. A description of the available ports together with their physical arrangement as well as names can be found in the manual for the SP-ICE-3 scan controller.   |
| Bit range   | Use the mouse to set the range of bits to be used. Click at the first and the last bit. The range of available bits / pins is determined by the selected port. Non-selected bits are ignored.<br>Colour code: <ul style="list-style-type: none"> <li>■ Green: Marks the selected bit range. To resolve the range, click on the outermost marked box.</li> <li>■ Grey: This bit has already been assigned elsewhere.</li> <li>■ Red: This bit was assigned twice!</li> </ul> |
| Polarity  | Use the polarity to define whether a logic "1" is applied at 0 V=Low or 5 V=High.   |
| [Delete]  | Click on <b>[Delete]</b> to delete the corresponding port configuration.  |
| <b>Special functions In / Out</b>   |   |
| <b>In</b> <ul style="list-style-type: none"> <li>■ Start mark</li> <li>■ Abort mark</li> <li>■ Part sensor</li> <li>■ Laser alarm</li> </ul>    | Use the drop-down list and set the port and its signal index for the signal to be queried for incoming signals for the signal to be set for outgoing signals.<br><b>NOTE:</b> The SP-ICE-3 scan controller provides two dedicated pins on the <i>Laser In</i> (X907) port for the input of the start / stop signal, which therefore do not require any configuration.   |
| <b>Out</b> <ul style="list-style-type: none"> <li>■ Arm Laser</li> <li>■ Pilot</li> <li>■ Mark in progress</li> <li>■ Marking active</li> </ul> | Define the signal polarity in the second drop-down list.<br><b>NOTE:</b> If you set the I/O pins for the start signal inputs, abort signal, part detection sensor, laser alarm as "High Active" but do not connect anything (= floating state), you thus create a permanent logical "TRUE" state of the respective signal due to the input resistance. For more information, please refer to the manual for SP-ICE-3.   |
| <b>Port level</b>   |   |
| Port A / Port B   | Select the value of the port level to be 0 V, 3,3 V or 5 V.   |
| <b>General</b>  |   |
| Short label   | Enter a name to recognise which ports are associated with which scan controller.  |

Tab. 5.3: RG-012

**"Execution in progress" signal vs. "Mark in progress" signal:**

Both signals are generated by the RAYGUIDE application. The "Execution in progress" signal is already set while an execution is waiting for a trigger signal or a belt distance, for example. In contrast, the "Mark in progress" signal is not set during a wait condition and thus is only active when layout objects are actually being processed / marked.

**NOTE:** The MIP signal is active independently of whether the laser is armed or not. Thus, the signal is also active during a preview, for example.

**Binning**

Using signal patterns from external devices, for example, a PLC can be used to control whether a job (stand-alone mode only) or an object should be processed.

For details on binning, refer to *page 296, Setting up the stand-alone card operation* and *page 153, Common Properties of Marking Objects*.

**Port masking**

It is possible to configure the same physical port multiple times, each with a different bit selection.

Use case:

You want to control the execution of different job objects by "port masking". Let's assume you have two objects within one job and the following three variants:

- Only object 1 should be processed
- Only object 2 should be processed
- Both objects should be processed

You need to define the same binning port twice, where, for example, the first port checks only bit 0 and the second port checks only bit 1.

The control will now be as follows:

- Only bit 0 = active
- Only bit 1 = active
- Bits 1 and 2 = active

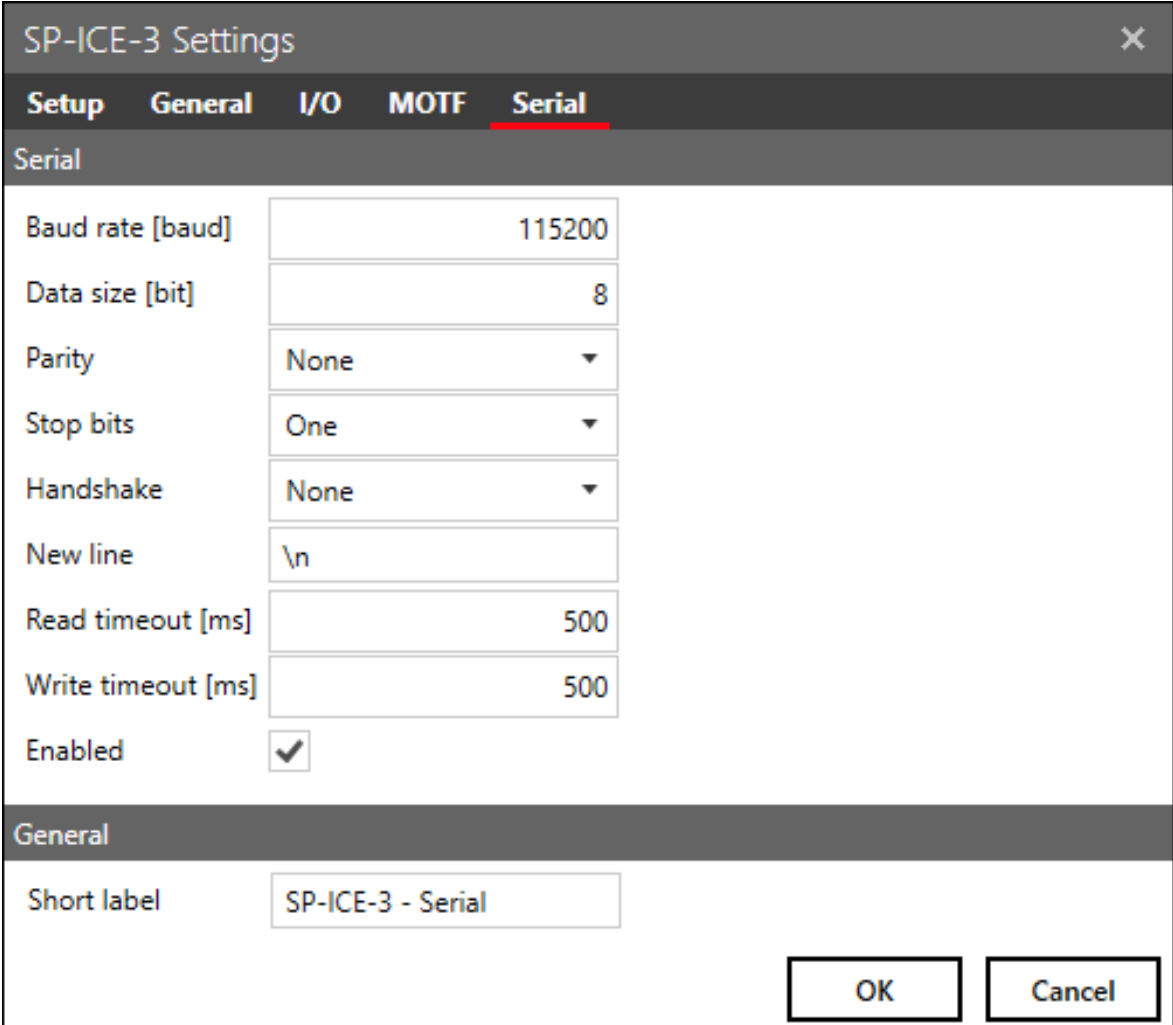
**5.1.4 MOTF Configuration**

Use to configure settings in case your application required "marking-on-the-fly".

For details, refer to *page 268, MOTF Jobs*.

### 5.1.5 Serial Port Configuration

Configures the scan controller card's serial port for communication purposes. Set according to commonly used general serial communication settings.



The image shows a software dialog box titled "SP-ICE-3 Settings" with a close button (X) in the top right corner. The dialog has five tabs: "Setup", "General", "I/O", "MOTF", and "Serial". The "Serial" tab is selected and underlined in red. Below the tabs, the "Serial" section contains the following settings:

|                    |                                     |
|--------------------|-------------------------------------|
| Baud rate [baud]   | 115200                              |
| Data size [bit]    | 8                                   |
| Parity             | None ▼                              |
| Stop bits          | One ▼                               |
| Handshake          | None ▼                              |
| New line           | \n                                  |
| Read timeout [ms]  | 500                                 |
| Write timeout [ms] | 500                                 |
| Enabled            | <input checked="" type="checkbox"/> |

Below the "Serial" section is the "General" section, which contains a "Short label" field with the text "SP-ICE-3 - Serial". At the bottom right of the dialog are two buttons: "OK" and "Cancel".

Fig. 5.6: RG-AAT

## 5.2 Laser Controller Configuration

Open the configuration dialog for the laser controller. There are three ways to do so:

- In the Device configuration menu, double-click the laser source entry (right side) or select the Properties item in the context menu.
- In the scan controller configuration dialog, click the **[Edit]** button next to the selected laser device.
- Select **System > Devices > Laser > (device name)** from the menu.

**NOTE:** Some laser types offer special control options and, consequently, special pen parameters.

| Laser                           | Specific parameters  |
|---------------------------------|--|
| Trumpf TruPulse Nano / SPI (G4) | Waveform, simmer voltage   |
| IPG YLPS AMB                    | Second laser power   |
| IPG YLPN APD                    | Optical pulse width  |
| JPT MOPA                        | Optical pulse width  |
| nLight AFX                      | Beam profile index   |
| Coherent Highlight ARM          | Second laser power, automatic IO configuration of the control card |

Tab. 5.4: RG-082

The following configuration dialog for lasers contains all conceivable (generic) settings.

**Generic Laser properties** ? ×

|  |  |
|--|--|
| <p><b>Power control</b></p> <p>Main power target <span style="float: right;">Dac0 ▾</span></p> <p>Secondary power target <span style="float: right;">Dac1 ▾</span></p>   | <p><b>Power correction</b></p> <p>Enable position dependent <input type="checkbox"/> 2nd channel <input type="checkbox"/></p> <p>Correction file <span style="float: right;">... not selected</span></p>   |
| <p><b>Features</b></p> <p>Visible pointer <input checked="" type="checkbox"/></p>  | <p><b>Signal timing</b></p> <p>Operating mode <span style="float: right;">Pulsed ▾</span></p> <p>Min frequency [kHz] <span style="float: right;">0,02</span></p> <p>Max frequency [kHz] <span style="float: right;">250</span></p> <p>Pulse width definition <span style="float: right;">Fixed ▾</span></p> <p>Pulse width [µs] <span style="float: right;">1</span></p> <p>Max duty cycle [%] <span style="float: right;">100</span></p> <p>Power change setup [µs] <span style="float: right;">0</span></p> <p>Latch power delay [µs] <span style="float: right;">1</span></p> <p>Latch power width [µs] <span style="float: right;">1</span></p> <p>On delay [µs] <span style="float: right;">0</span></p> <p>Off delay [µs] <span style="float: right;">0</span></p> |
| <p><b>Laser modulation</b></p> <p>Gate signal polarity <span style="float: right;">High ▾</span></p> <p>LM signal polarity <span style="float: right;">High ▾</span></p> <p>Enable gate modulates LM <input type="checkbox"/></p> <p>Enable laser synchronization <input type="checkbox"/></p> <p>Enable equally spaced pulses <input checked="" type="checkbox"/></p> <p>Gate setup [µs] <span style="float: right;">0</span></p> <p>Gate hold [µs] <span style="float: right;">0</span></p> <p>Laser trigger delay [µs] <span style="float: right;">0</span></p> | <p><b>Simmer</b></p> <p>Simmer power target <span style="float: right;">None ▾</span></p> <p>Only while marking <input checked="" type="checkbox"/></p> <p>Activation delay [µs] <span style="float: right;">0</span></p>  |
| <p><b>Power settings</b></p> <p>Power scale [%] <span style="float: right;">100</span></p> <p>Nominal laser power [W] <span style="float: right;">100</span></p> <p>↔ 2nd channel [W] <span style="float: right;">100</span></p>   | <p><b>Tickle</b></p> <p>Enable tickle <input type="checkbox"/></p> <p>Frequency [kHz] <span style="float: right;">5</span></p> <p>Pulse width [µs] <span style="float: right;">1</span></p>  |
| <p><b>Power validation</b></p> <p>Unit <span style="float: right;">Percent ▾</span></p> <p>Min. power <span style="float: right;">0</span></p> <p>Max. power <span style="float: right;">100</span></p> <p>Validate total power <input type="checkbox"/></p>   | <p><b>First pulse suppression</b></p> <p>Polarity <span style="float: right;">High ▾</span></p> <p>Setup time [µs] <span style="float: right;">30</span></p> <p>Pulse width [µs] <span style="float: right;">0</span></p>  |
| <p><b>Power calibration</b></p> <p>Enable power calibration <input type="checkbox"/> 2nd channel <input type="checkbox"/></p> <p>Calibration file <span style="float: right;">... not selected</span></p> <p>↔ 2nd channel <span style="float: right;">... not selected</span></p>   | <p><b>General</b></p> <p>Short label <span style="float: right;">Generic Laser</span></p>  |

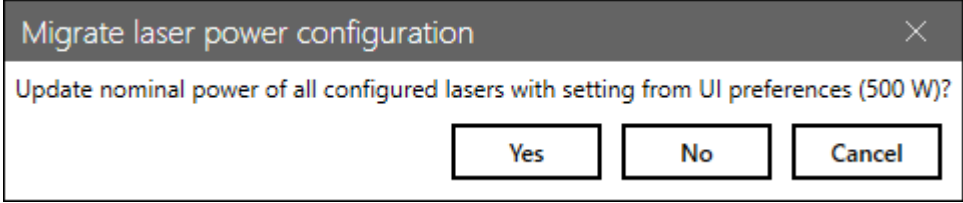
OK
Cancel
Apply

Fig. 5.7: RG-AAU



| Setting                 | Explanation  |
|-------------------------|--|
| <b>Power control</b>    |  |
| Hot power target        | <p>Defines by which signal type the (primary) laser source receives its power information (DAC0, DAC1 / Digital1bit, Digital2bit, Digital8bit, Digital16bit / LmWidth, LmFrequency).</p> <p>Depending on the selected "available" laser, a predefined entry is already set. Select DAC for analogue controlled laser, or LmWidth for standard CO2 laser.</p> |
| Secondary power target  | <p>Define the power signal type for a possible second analogue power setting here. Only Dac0 or Dac1 are available for selection.</p>  |
| <b>Features</b>         |  |
| Visible pointer         | <p>Defines whether the corresponding laser is equipped with a pointer so that the preview function can be offered.</p>   |
| <b>Laser modulation</b> |  |
| Gate Signal polarity    | <p>Polarity of the gate signal to high vs. low, according to the laser input interface description</p>   |
| LM signal polarity      | <p>Polarity of the LM (laser modulation) signal to high vs. low according to the laser input interface description.</p> <p>On the laser side, this signal is often named "Trigger", or PWM (Pulse Width Modulation), or PRR (Pulse Repetition Rate).</p>   |

| Setting                        | Explanation  |
|--------------------------------|--|
| Enable gate modulates LM       | Required only if the dashed line feature is used with lasers that do not offer gate input (e.g. CO2 laser).  |
| Enable laser synchronization   | For lasers which have an internal pulse train, in order to adapt the vector position to laser timing   |
| Enable equally spaced pulses   | Causes the frequency to be modulated in relation to the actual marking speed. In this way, equidistant laser pulses are achieved, even with speed changes such as those caused by accelerating / decelerating the deflection mirrors.<br><b>NOTE:</b> This function is based on the value of the tracking error of the deflection unit. That means this value must be specified correctly. |
| Gate setup [ $\mu$ s]          | Time span in which the gate signal advances to the actual marking start.<br>Positive setup times extend the time the gate is asserted.<br>Negative setup times reduce the time the gate is asserted.   |
| Gate hold [ $\mu$ s]           | Time span in which the gate signal advances to the actual marking start.<br>Positive values extend the time the gate is asserted.<br>Negative values reduce the time the gate is asserted.   |
| Laser trigger delay [ $\mu$ s] | Time in which the optical pulse is generated after the trigger edge was received by the laser.<br>The value must be provided by the laser manufacturer.  |
| <b>Power settings</b>          |  |

| Setting                                 | Explanation   |
|---|---|
| Power scale [%]                         | Global power scale in [%]<br>Example:<br>If an analogue controlled laser requires the power range controlled by a 0 V to 5 V voltage range, you can scale the power output to 50%.  |
| Nominal laser power [W]                 | Specification of the maximum laser power in [watts], which corresponds to 100%.<br><b>ATTENTION:</b> This specification may previously have been provided under <b>System &gt; Preferences &gt; User (current user) &gt; User interface &gt; Units</b> . In this case, the value can be applied automatically. The following message would then appear, for example:<br> |
| ↔ 2nd channel [W]*                      | Specify the maximum laser power in [watts] for the possible second laser channel, which corresponds to 100%.  |
| <b>Power validation</b>                 |   |
| Unit                                    | Select the unit for validating the laser power of the pens used.<br><b>NOTE:</b> Selection of the unit does not define in which unit the power is specified in the pens, see <i>page 96, UI</i> .   |
| Validate total power                    | Define whether the combined power from primary and secondary power should be validated. This is how you ensure that the total power does not exceed the specification of the deflection unit.   |
| Min. power<br>Max. power                | Fields to define the laser power limits which can be used for pen value validation. For example, some lasers can be a little unstable when operated in a power range that is too low.   |
| <b>Enable power calibration</b>         |   |
| Enable power calibration / 2nd channel* | Define whether you want to use a power calibration (optionally also for the second power channel).  |
| Calibration file                        | Navigate to the desired laser calibration file in the Windows Explorer and load it.<br>You also have the option of selecting a calibration file for the second power channel.<br><b>NOTE:</b> The calibration file is generated with the <i>SPICE3PowerCalibrator.exe</i> program, which is part of the SP-ICE-3 software tools.  |

| Setting                                  | Explanation   |
|--|---|
| <b>Power correction</b>                  |   |
| Enable position dependent / 2nd channel* | Define whether you want to apply a power correction dependent on the field position to influence the laser power as a function of the current scan field position (optionally also for the second power channel).   |
| Correction file                          | Navigate to the desired laser power correction file (*.PC3) in Windows Explorer and load it.<br><b>NOTE:</b> The power correction file is generated using the MULTI POINT EDITOR application. If you use the second power channel, it can contain correction data for both channels.  |
| <b>Signal timing</b>                     |   |
| Operating mode                           | Select whether the laser operates only in the pulsed or continuous-line mode or whether the mode should be selectable in the pen.<br><b>NOTE:</b> The limits of the pulse frequencies can be defined as follows if necessary. The pens provide fields for setting the pulse frequency and selecting the operating mode.   |
| Min. frequency [kHz]                     | Minimum frequency the laser can manage  |
| Max. frequency [kHz]                     | Maximum frequency the laser can manage  |
| Pulse width definition                   | <i>Fixed:</i> The pulse width of the laser modulation signal gets set to a fixed value. The value can be entered in the next field. Please check the related laser manual for the expected default pulse width.<br><i>Relative:</i> The ratio of pulse width and pulse duration is variable as it depends on the frequency and laser power [in percentage] as defined by the pen. Usually used by CO2 lasers with hot power target "LMWidth".<br><i>Manuel:</i> Select this option if the pulse width is to be set individually per pen.<br><b>NOTE:</b> This pulse width value affects the control pulse, not necessarily the optical pulse. |
| Pulse width [ $\mu$ s]                   | Fixed value for the pulse width of the provided LM signal   |
| Max. duty cycle [%]                      | Defines the maximum ratio of the pulse duration to the pulse period that the laser accepts.   |
| Power change setup [ $\mu$ s]            | Time the laser needs to change the output power. The value is provided by the laser manufacturer or evaluated by application tests.   |
| Latch power delay [ $\mu$ s]             | Time the power write signal is set to, according to the power command.  |
| Latch power width [ $\mu$ s]             | Pulse width of the power write signal   |

| Setting  | Explanation  |
|--|--|
| On delay [ $\mu\text{s}$ ]   | Specification of a delay time when switching on that is added individually per laser source to the laser-on delay specified in the pen.<br><b>NOTE:</b> This may be necessary when using several lasers, as even the same laser models from the same manufacturer have slightly different reactions. |
| Off delay [ $\mu\text{s}$ ]  | Specification of a delay time when switching off that is added individually per laser source to the laser-off delay specified in the pen.  |
| <b>Simmer</b>  |  |
| Simmer power target  | Define the power signal type for the simmer voltage here.<br><b>NOTES:</b> <ul style="list-style-type: none"> <li>■ Dac1 is used here by default.</li> <li>■ This specification is primarily to be made for laser types TruPulse nano / SPI G4.</li> </ul>   |
| Only while marking   | Enable if the simmer voltage is to be set only when marking.   |
| Activation delay [ $\mu\text{s}$ ]   | Time the simmer voltage must be set prior to marking.  |
| <b>Tickle</b>  |  |
| Enable tickle  | Enables the use of the tickle signal. Refer to the laser manual to find out if your laser requires this signal.  |
| Frequency  | Frequency of the laser tickle signal, according to the description in the laser manual   |
| Pulse width [ $\mu\text{s}$ ]  | Pulse width of the laser tickle signal, according to the description in the laser manual   |
| <b>First pulse suppression</b>   |  |
| Polarity   | Defines the polarity of the laser FPS signal (high vs. low), according to the description of the laser interface.  |
| Setup time [ $\mu\text{s}$ ]   | Defines the time the FPS pulse needs to be set prior to the optical pulse.   |
| Pulse width [ $\mu\text{s}$ ]  | Defines the pulse width of the FPS signal, according to the description of the laser interface.  |
| <b>General</b>   |  |
| Short label  | Assign a name used to identify the laser in the GUI, e.g. manufacturer, type.  |
| <b>*NOTE:</b> Certain settings for the laser are only possible or necessary if a second power channel is used. |  |

Tab. 5.5: RG-013

## 5.2.1 Advanced configuration of lasers with serial interface

Some lasers are capable of exchanging additional data or receiving commands, usually via an additional serial interface.

Currently, only PC serial controllers (e.g. COM1) can be used. These are then automatically configured by the respective laser module.

**CAUTION:** Thus, the control options described below are only effective in job execution mode "On host" or "Quick".

The laser configuration contains the option to enable the interface for the serial communication and select the serial port.

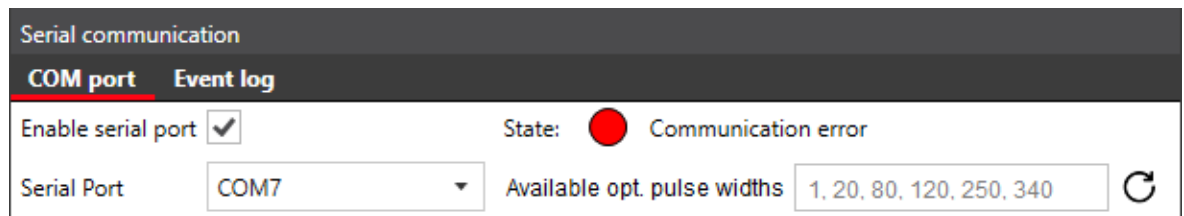


Fig. 5.8: AEF

The colour indicator is used as an indicator of the laser operating state.

RED = Laser is not responding (because it is not connected or not switched on)

Yellow = Laser is still in warm-up phase

Green = Laser is ready for operation

On a second tab, you can view the exchanged commands in the event log. These are also recorded in the RAYGUIDE log.

Currently, 2 laser types feature the option of additional serial communication:

### 5.2.1.1 IPG laser type YLPN-APD

In this laser type, the pulse width values of the optical laser pulse can be set (these are preset by IPG according to the individual laser).

The APD mode transmission to the laser is performed via the I/O connection by the scan controller and adapter board. This makes an **additional connection via the serial interface optional**.

**CAUTION:** RAYGUIDE supports fast-APD mode only. Please check with the laser manufacturer if your laser has this mode.

**CAUTION:** To enable the laser to implement the signal sequence to switch the "adjustable-pulse-duration" via the I/O interface of the IPG-compatible adapter of the SP-ICE-3 scan controller, jumper W3 on the adapter board must connect contacts 2 and 3. This applies regardless of the IPG interface type! For details, see the SP-ICE-3 Manual, chapter 4.3.4.

The pulse width values can be queried for the indices via the serial interface and read in. This enables the display of the values in the pens.

**NOTE:** In IPG lasers, the so-called optical pulse width does not correspond to the pulse width of the laser modulation signal.

**NOTE:** The values of the optical pulse width for the respective APD mode are stored in the *Device.json* file, but can be queried again manually via the **[Refresh]** button in case the laser source has been replaced.

### 5.2.1.2 InnoLas laser type Nanio AIR / BLIZZ

In this laser type, information on the operating state of the laser can be called up via the serial interface to avoid starting a job execution while the laser is still in the warm-up phase.

The laser status request is always issued automatically when a job is to be executed.

If the laser is not ready for operation, a corresponding device validation message appears in the GUI.

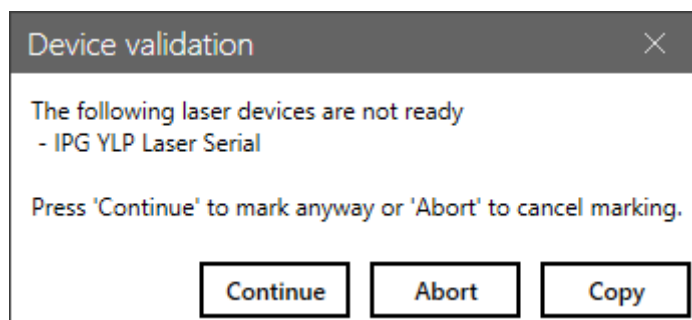



Fig. 5.9: AEE

## 5.2.2 Additional laser-specific options

### 5.2.2.1 nLight AFX Laser



Fig. 5.10: RG-AFK

| nLight-specific   |   |
|---|---|
| Initialize on start   | If activated, RAYGUIDE automatically switches the nLight AFX laser to the standby or emission state when the application starts.<br>If not activated, the nLight AFX laser is only set to the emission state when the laser is manually armed.  |
| Disarm to Off state   | If activated, the nLight AFX laser switches to the <i>Off state</i> during disarming.<br>If not activated, the nLight AFX laser switches to the <i>Ready state</i> .<br><b>NOTES:</b> <ul style="list-style-type: none"> <li>For the nLight AFX laser, the interlock may only be opened in the <i>Off state</i>; otherwise, an error message will be output and the laser will be forced to switch into the <i>Off state</i>.</li> <li>Independently of this, a preview with the pointer is possible both in the <i>Ready state</i> and in the <i>Off state</i>.</li> </ul> |
| Device status   | <i>Off / Ready / Emission / Error</i><br>Indicates one of 3 possible states of the laser source. For further details on the statuses, please see the manual of the laser source.  |
| Status water flow   | <i>Yes / No</i><br>Indicates whether the laser source is water-cooled.  |
|  | Can be used to manually reset the error status of the laser source.<br><b>NOTE:</b> Only enabled if the laser source has an active error.   |

Tab. 5.6: RG-083


### 5.2.2.2 Coherent Highlight ARM Laser

This laser type lets you have the freely definable I/Os of the scan controller automatically configured appropriately for the connection of analogue controlled lasers (X907 of the SP-ICE-3 scan controller):



I/O configuration

Auto configure



| Special functions - In |                                   |              |                                  | Special functions - Out |                                   |              |                                  |
|------------------------|-----------------------------------|--------------|----------------------------------|-------------------------|-----------------------------------|--------------|----------------------------------|
|                        | Port                              | Signal index | Polarity                         |                         | Port                              | Signal index | Polarity                         |
| Start mark             | LaserIn (X907)                    | Pin 3        | Low                              | Arm laser               | LaserOut(X907)                    | 0 ▾          | High ▾                           |
| Start mark             | <input type="text" value="None"/> |              | <input type="text" value="Low"/> | Pilot                   | LaserOut(X907)                    | 1 ▾          | High ▾                           |
| Abort mark             | LaserIn (X907)                    | Pin 11       | Low                              | Execution in progress   | <input type="text" value="None"/> |              | <input type="text" value="Low"/> |
| Abort mark             | <input type="text" value="None"/> |              | <input type="text" value="Low"/> | Mark in progress        | <input type="text" value="None"/> |              | <input type="text" value="Low"/> |
| Part sensor            | <input type="text" value="None"/> |              | <input type="text" value="Low"/> |                         |                                   |              |                                  |
| Laser alarm            | LaserIn (X907)                    | 0 ▾          | High ▾                           |                         |                                   |              |                                  |

Fig. 5.11: AEU

**NOTE:** If you make use of this autoconfiguration, the corresponding inputs should be wired.

## 5.3 Deflection Unit Configuration

Open the deflection unit configuration dialog for the laser controller. There are three ways to do so:

- In the Device configuration menu, double-click the deflection unit entry (right side) or select the Properties item in the context menu.
- In the scan controller configuration dialog, click the **[Edit]** button next to the respective device.
- Select **System > Devices > Deflection units > (device)** from the menu.

The deflection unit configuration window has three tabs: **General, Calibration, Deflection unit status**.

**NOTE:** If you use a deflection unit with different correction files and / or field sizes, you should ease your work by "cloning" the existing deflection unit as a second deflection unit with another correction file and probably another calibration assigned.

**CAUTION:** If you use several deflection units with the same optical setup and therefore the same correction file, it is strongly recommended to duplicate the original correction file and add a suffix to the file names for each deflection unit to prevent the correction files from being mixed up.

### 5.3.1 General

? X
Generic deflection unit properties

General
Calibration
Deflection unit status

Model/Article number SS-IV-30 SC VC KIT AS FIBER / 10153  
 RLT25Ngen\_8350\_AM\_NOTINV / 999916

Correction file  
 2D\_AS-F-30-Y\_500\_WD566\_off1,5\_02.fc3 X ... Go to +  
 2D\_AS-F-30-Y\_500\_WD566\_off1,5\_02\_#2.fc3 X ... Go to

Field size [mm] 350,000 350,000 0,000

Correction file info

|                       |    |                            |       |
|-----------------------|----|----------------------------|-------|
| Axes                  | 3  | Working distance [mm]      | 383,1 |
| Zoom axis             | No | Input beam size (FBD) [mm] | 30    |
| Sensor axis           | No | Dimensions                 | 2     |
| Auxiliary sensor axis | No |                            |       |

Settings

|                    |                          |  |  |
|--------------------|--------------------------|--|--|
| Orientation        | 0° ▾                     | <input type="checkbox"/> Invert X-axis | <input type="checkbox"/> Invert Y-axis |
| Set transfer delay | <input type="checkbox"/> | Interpolation time                     | 20 ↻                                   |
| Max. speed [m/s]   | 100                      | Max current [A]                        | 3                                      |
| Max magnification  | 1                        | Spot size [mm]                         | 1                                      |

Tuning (Database) ↻

|    | Storage | Name     | Tracking error [μs] | Acceleration time [μs] | Default | Active |
|----|---------|----------|---------------------|------------------------|---------|--------|
| XY | 0       | Preset 0 | 200                 | 308                    | ●       | ●      |
|    | Storage | Name     | Tracking error [μs] | Acceleration time [μs] | Default | Active |
| Z  | 0       | Preset 0 | 1.500               | 2.308                  | ●       | ●      |

General

Short label

Fig. 5.12: RG-AAV

| Setting                | Explanation   |
|------------------------|---|
| Model / Article Number | <p>The data is automatically read out from the deflection unit. In order to read this data from the deflection unit, the deflection unit must be physically connected. In addition, the correct protocol must already have been set on the General tab of the configuration dialog of the control card.</p>   |
| Correction file        | <p>A correction file has to be selected.</p> <p>RAYLASE provides appropriate correction files for the customer's particular optical setup.</p> <p>Correction files should be stored to and loaded from: C:<br/> \ProgramData\RAYLASE\CorrectionFiles\</p> <p>The correction file format must be <i>FC3</i> or <i>GCD</i>.</p> <p>To make sure that the correction file is updated on the control card immediately, click on <b>[Apply]</b> after selecting the correction file – especially if you plan to continue with field calibration right away.</p> <p><b>[...]</b> opens the folder that contains the correction files to select a correction file.</p> <p><b>[Go to]</b> opens the folder that contains the correction files but with no further actions.</p> <p><b>[+]</b> adds another line to optionally select an additional correction file that can be loaded onto and used on the same control card. A maximum of 4 correction files can be loaded for one (exclusive) deflection unit.</p> <p><b>CAUTION:</b> The additional correction file can only be loaded if:</p> <ul style="list-style-type: none"> <li>■ It has the same optical setup as the first correction file</li> <li>■ The file name is not completely identical.</li> <li>■ The number of four correction files is limited to correction files that support a maximum of three optical axes.</li> </ul> <p><b>NOTE:</b> For information on what correction file is used when, and how this is assigned, see <i>page 104, Setup, page 217, Setting the correction file index and page 262, Job Properties</i>.</p> |
| Correction file info   | <p>Information is displayed such as the working distance, input beam size, number of optical axes, which additional axes are available, number of field dimensions. Depending on the correction file, additional information may be displayed.</p> <p>Use the expander to display information.</p>  |

| Setting             | Explanation   |
|---------------------|---|
| Orientation         | <p>Defines the tiling directions of the X-Y coordinate system of the RAYGUIDE GUI relative to the current orientation of the deflection unit. The directions of the layout in the RAYGUIDE viewport should correctly reflect those of the workspace of the deflection unit. Can be set to 0°, 90°, 180°, 270°. If in doubt, do a marking test to determine the correct setting.</p> <p>According to RAYLASE conventions, an orientation of 0 degrees means that the +X axis points in the tiling direction where the laser enters the deflection unit. For those units where the laser beam enters from above (e.g. AS FIBER ), the default +X-axis points in direction of the device front side.</p> |
| Invert Axis         | Checkboxes for the X and Y axes to invert individual coordinate axes.   |
| Set transfer delay  | <p>Enable this option if you have not yet defined a transfer delay for the control card.</p> <p>The transfer delay is made up of a value that depends on the protocol and the interpolation time of the deflection unit.</p> <p>The interpolation time is either read out automatically from the deflection unit or can be entered manually. The <b>[Refresh]</b> button can be used to repeat the of interpolation time query at any time.</p> <p><b>NOTES:</b></p> <ul style="list-style-type: none"> <li>■ The transfer delay will have an impact on the timing between the laser and deflection position.</li> <li>■ The option is implemented from RAYGUIDE version v.1.17.</li> </ul>           |
| Speed limit [m/s]   | Sets an optional speed limit for the deflection unit. Default setting is 100 m/s. This setting does not overrule the speed set in pens, but can be used in job validation. See <i>page 285, Running a Job</i> .   |
| Max. current [A]    | <p>Sets an optional upper limit for the current consumption of the galvanometer motor of the deflection unit. Default setting is 6A.</p> <p>The value is used exclusively for job validation of the wobble parameters in the pens used (see <i>page 93, General</i>).</p>   |
| Max. magnification* | Display of the maximum value for the spot magnification factor (according to the loaded correction file).   |
| Spot size [mm]*     | <p>Specification of the "diameter" of the laser spot on the material at magnification factor 1. This value is used in the pens to convert the spot size from relative to absolute.</p> <p>(See <i>page 96, UI</i>)</p>  |

| Setting   | Explanation  |
|---|--|
| <p><b>Tuning</b></p> <p>The data in the section below can be either read out from an internal database or from the connected deflection unit itself.</p> <p>Use the [Refresh Data] button to update the tuning list and the related dynamic data, e.g. when a different deflection unit has been connected.</p> <p><b>NOTE:</b> In order to get the data automatically, the axis article number information displayed above is necessary. If an older deflection unit is connected that does not support the enhanced protocol, the values must be entered manually.</p> <p>The dynamic data for the X- and Y-axes is always identical and is therefore listed as a bundle.</p> |  |
| Storage   | The storage index number (always starts counting from zero) is the internal identifier of the tuning.  |
| Name  | The name specified for the tuning can be overwritten. This means that you can enter a suitable name for each tuning that fits best to its associated dynamic behaviour in your application. This name is also shown to enable you to select the tuning in the "Send Enhanced Command" automation object.   |
| Tracking error [ $\mu\text{s}$ ]  | <p>The value is either read out from an internal database according to the axes set article number, or, if the head is equipped with DICON2.5 electronic, read out from the deflection unit itself.</p> <p><b>NOTE:</b> The value can be corrected or entered manually if necessary (e.g. if the deflection unit cannot provide information such as axes article number). Use right-mouse-click &gt; reset to default in order to return to the original value.</p> <p>About the value:</p> <p>Time interval that the respective optical axis requires to follow a new position command.</p> <p>The value depends on the sluggishness of the optical axis (and thus on the substrate material and diameter) and the so-called tuning. If you have any questions, the values can be found in the data sheet or in the deflection unit manual.</p> |
| Acceleration time [ $\mu\text{s}$ ]   | <p>The value is by default related to the tracking error value.</p> <p><b>NOTE:</b> The value can be corrected or entered manually if necessary (e.g. if the deflection unit cannot provide information such as axes article number). Use right-mouse-click &gt; reset to default in order to return to the original value.</p> <p>About the value:</p> <p>Time [microseconds] which the respective optical axis needs to reach the intended speed set in the pen.</p> <p>This value is only used when marking bitmaps.</p>  |

| Setting   | Explanation   |
|---|---|
| Default   Active  | Select which of the available tunings is to be set. <ul style="list-style-type: none"> <li>■ Default = Tuning that is loaded when the deflection unit is powered up.</li> <li>■ Active = Tuning that is active unless a different tuning is set manually via the "<i>Send Enhanced Command</i>" automation object.</li> </ul> |
| Short label   | A name for this deflection unit that is easy to remember. You may include the field size.   |
| *These fields are only available if the loaded correction file supports spot magnification. |   |

Tab. 5.7: RG-014

### 5.3.2 Deflection Unit Calibration

The field calibration must be performed to ensure that the marked geometry matches the precision requirements. You can also use it to adapt the position of the scan field to the machine geometry.

Suggested workflow:

Before starting to calibrate the deflection unit

- Ensure that the laser has already been configured and assigned to the card in order to perform a laser processing job
- Apply the assignation of the deflection unit to the scan controller in the scan controller dialog
- Apply the assignation of the correction file in the deflection unit dialog

The file name of the correction file associated with the calibration (execution and preview) is displayed via the two areas for "Execution" and "Preview".

If more than one correction file was loaded onto the scan controller, the correction file belonging to the calibration can be picked out of a drop-down list here.

The Calibration dialog is divided into the following sections:

- Execution: Calibration of the scan field while the actual laser source is working and executing jobs.
- Preview: Calibration of the visible laser source. This calibration data are therefore applied during a preview.

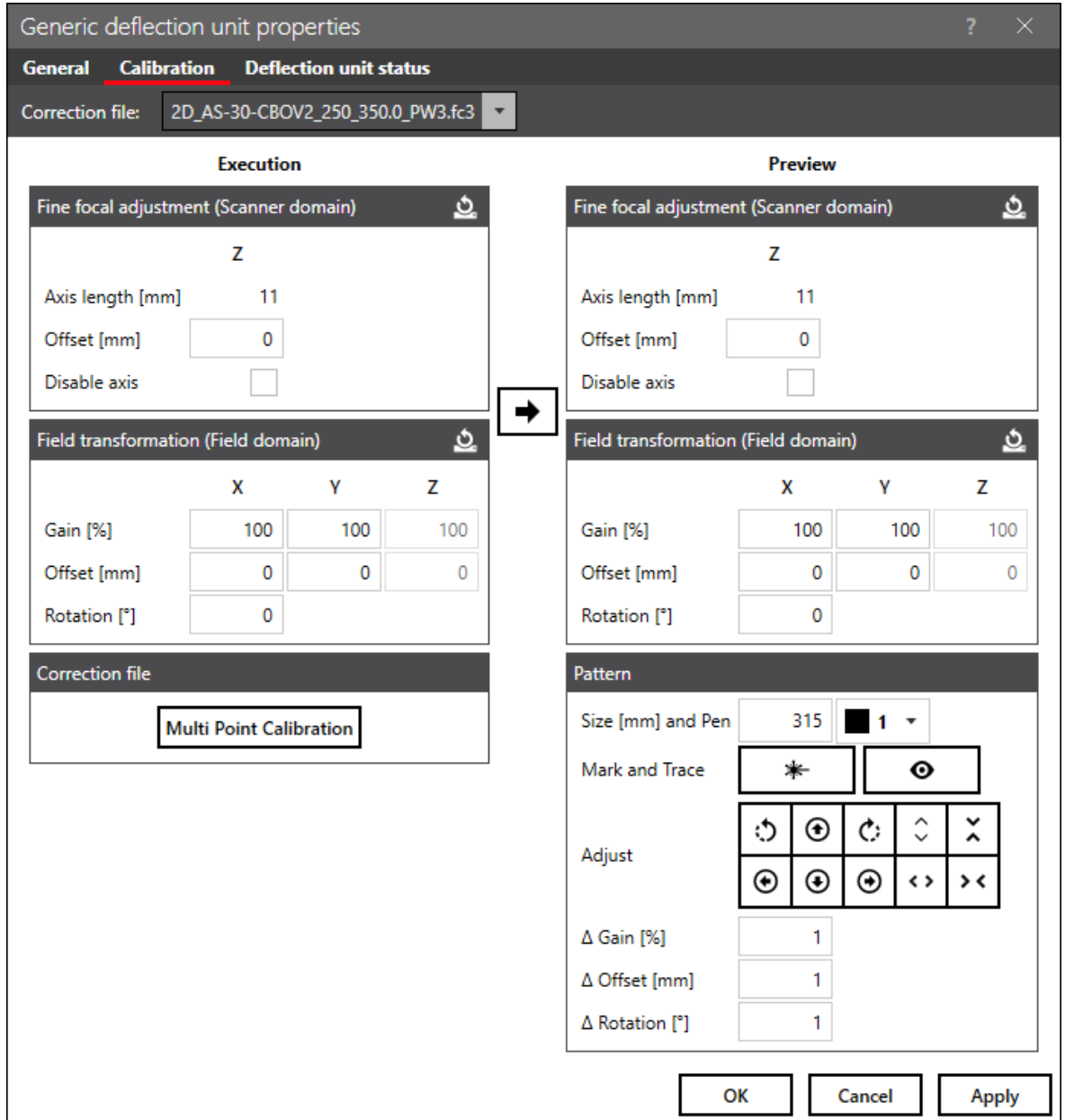


Fig. 5.13: RG-AAW

In the “Execution” section, the geometric correction is defined for the executions of laser processing jobs with the processing laser.



| Setting   | Explanation  |
|---|--|
| <p><b><i>Fine focal adjustment (Scanner domain)</i></b></p> <p>This option is only available if the correction file controls the pre-focusing optics, e.g. for deflection units of the AXIALSCAN type.</p> <p>Focal adjustment always applies to the position of Z-axis of the pre-focusing unit. It can be used to adjust the global focus position.</p> |  |
| Axis length [mm]  | Length of the movement range of the Z-axis [mm] (read-only field as provided by the correction file)   |
| Offset [mm]   | Offset value in [mm], which applies directly to the Z-lens position. Only positive values are allowed, unless the correction file has a preset offset included. A positive offset will shift the focus downwards.  |
| Disable axis  | The user can decide to disable each available Z-axis if necessary.   |
| <p><b><i>Field transformation (Field domain)</i></b></p> <p><b>NOTE:</b> Transformation values for offset and rotation as well as scaling above 100% reduce the available workspace according to the correction file.</p> <p><b>NOTE:</b> These transformations are applied to the vectors to be marked and do not edit the correction file.</p>          |  |
| Gain [%]  | <p>Can be defined separately for X- and Y-axes.</p> <p>Reduces or increases the length of the vectors mapped by the deflection unit until they are true to size with the defined geometry.</p> <p>Mark an orthogonal square and measure its edge lengths. The ratio of the measured value to the target length results in the scale factor per axis, which you enter in [%]. Repeat the marking to verify the result by measuring again.</p> |
| Offset [mm]   | <p>Moves the projected coordinate system relative to another coordinate system (e.g. to align it with a machine coordinate system or another scan field).</p> <p>Editable for X- and Y-axes.</p>   |
| Rotation [°]  | <p>Rotates the projected coordinate system relative to another coordinate system (e.g. to align it with a machine coordinate system or another scan field).</p>  |

| Setting   | Explanation  |
|---|--|
| <b>Correction file</b>  |  |
| Multi-point calibration always applied to the selected correction file. |  |
| Multi Point Calibration   | <p>Opens the Multi Point Editor (MPE).</p> <p>The MPE makes it possible to correct any field distortions. The in case of a deflection unit with 3 or 4 axes, it also allows for correction of the focus dependent on the field position. It applies to the correction file selected on the General tab.</p> <p>You can use pens for marking as defined in the default library pen set.</p> <p>After calibration, you work with an edited duplicate of the original correction file, as the MPE application automatically replaces the file and saves the original file.</p> <p>Detailed information on functions and operation can be found in the separate Multi Point Editor manual attached to the PDF.</p> |

Tab. 5.8: RG-015

In the Preview section, the geometric correction of the preview is set up. This may be necessary as the laser source emits at a different wavelength than the actual laser and, due to a different diffraction, is projected differently on the workpiece.

For details, see *page 281, Preview*.

| Setting  | Explanation |
|--|-------------|
| <b>Fine focal adjustment (Scanner domain)</b>  |             |
| The same principles apply as in the Laser section.   |             |
| Laser-source specific: You can deactivate the Z-axis operation during the preview to reduce stress on the Z-axis galvanometer motor. Check the option "disable z-axis" and the lens will pause in the default position while the preview is running – likely causing a larger laser source spot. |             |
| <b>Field transformation (Field domain)</b>   |             |
| The same principles apply as in the Laser section. See the table above for details.  |             |
| To start calibration of the laser source, the values from the Execution section can be transferred into the Preview section with the arrow button.   |             |

| Setting                               | Explanation  |
|---------------------------------------|--|
| <b>Pattern</b>                        |  |
| To define a calibration test pattern. |  |
| Size [mm] and Pen                     | Choose a size for a square to mark and a pen from the default pen set as process parameters. By default, the square is positioned in the field centre.                             |
| Mark and Trace                        | First, mark the square using <b>[Mark]</b> .<br>Then, trace the shape of the square with the laser source using <b>[Trace]</b> .   |
| Adjust                                | Use <b>[Gain]</b> , <b>[Shift]</b> and <b>[Rotate]</b> to superimpose the preview shape on the marked square.  |
| Delta fields                          | Define the delta of the scale, shift, and rotate effects when the adjust buttons are clicked.<br>Specify the delta values in the corresponding units for gain / offset / rotation. |

Tab. 5.9: RG-016

### 5.3.3 Deflection Unit Status Information

If you use a digital deflection unit (e.g. SUPERSCAN IV) and a fitting protocol was selected, this tab will display status information of the deflection unit.

Use the "Automatic refresh" option if the displayed values are to be continuously refreshed. Several virtual status LEDs indicate the current device status. For the interpretation of the LEDs, see the deflection unit's manual.

Status information can be useful in case you have trouble with the deflection unit performance or wish to check the currently active tuning.

The current mirror position can be read here, too.

Generic deflection unit Settings

General Calibration **Deflection unit status**

| Deflection unit axis information               |             |            | Deflection unit information              |                         |
|--|-------------|------------|--|-------------------------|
|  | X           | Y          |  |                         |
| Galvo Scanner Temperature [°]                  | 30          | 30         | Serial Number                            | 100044754               |
| Servo Board Temperature [°]                    | 33          | 33         | Article Number                           | 8849                    |
| Running Time                                   | 492d 8h 12m | 492d 8h 7m | Firmware Version                         | 5772                    |
| Tuning Number (Actual/Default)                 | 0/0         | 0/0        | Aperture [mm]                            | 15                      |
| SetPosAcknowledgeLevel (Actual/Default)        | 183/183     | 183/183    | Wavelength [nm]                          | 532                     |
| Position [bit]                                 | -27098      | -10532     | Interpolation Time (Actual/Default) [µs] | 20/20                   |
| Mirror not tilted                              | ✓           | ✓          | Axes operational                         | ✓                       |
| Controller parameter                           | ✓           | ✓          | Galvo Temperature                        | ✓                       |
| Axis not within a critical position            | ✓           | ✓          | Field                                    |                         |
| ADC initialized                                | ✓           | ✓          | Position [mm]                            | 165,395 -57,185 -17,523 |
| External supply voltages                       | ✓           | ✓          | <input type="checkbox"/> Auto refresh    |                         |
| No permanent error case                        | ✓           | ✓          |  |                         |
| Boot process finished                          | ✓           | ✓          |  |                         |
| Tracking error inside tracking error window    | ✓           | ✓          |  |                         |
| Voltages (incl generated) within allowed range | ✓           | ✓          |  |                         |
| Output stage active                            | ✓           | ✓          |  |                         |
| Target current of output stage                 | ✓           | ✓          |  |                         |
| Output stage current within allowed range      | ✓           | ✓          |  |                         |
| Galvo temperature                              | ✓           | ✓          |  |                         |
| Servo board temperature                        | ✓           | ✓          |  |                         |
| DSP core voltage                               | ✓           | ✓          |  |                         |
| DSP supply voltage                             | ✓           | ✓          |  |                         |
| ADC supply voltage                             | ✓           | ✓          |  |                         |
| Analogue supply voltages                       | ✓           | ✓          |  |                         |
| AGC of position detector within allowed range  | ✓           | ✓          |  |                         |

OK Cancel Apply

Fig. 5.14: RG-ADM

## 5.4 Configuring the PC / computer serial interface

Open the dialog for the serial controllers. There are two ways to do so:

- In Device configuration menu, double-click an entry for the serial controllers or select the Properties item in the context menu.
- Select **System > Devices > Serial controllers > (device name)** from the menu.

You can now set up a serial RS232 port at the computer for communication purposes.

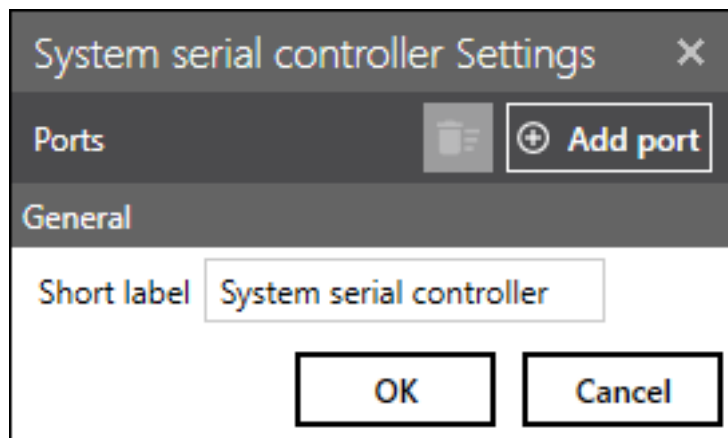


Fig. 5.15: RG-AAX

| Setting        | Explanation  |
|----------------|--|
| Ports          | Click <b>[Add port]</b> to define a new serial port. A new dialog opens. Multiple ports can be defined. The columns represent common settings for a serial port communication. |
| <b>General</b> |  |
| Short label    | A name for this PC serial port that is easy to remember.   |

Tab. 5.10: RG-017

## 5.5 Configuration Backup and Replication

### Saving / Restoring the device configuration

The settings of the device configuration are automatically saved in configuration files. The settings are preserved in case of a software update.

Nevertheless, it is recommended to save the current configuration as a backup file (*JSON* format).

In the device configuration window

- Click the **[Export]** button to create / save a configuration backup file.
- Click the **[Import]** button to import / apply a configuration backup file.

### System replication

A configuration backup file is also convenient if you move to another computer or if you want to replicate your complete system. Replication means having one or more laser processing systems (scan controller, laser, deflection unit, computer with RAYGUIDE) that are similar to the original one. Using the configuration backup saves the time for configuring another system from scratch. However, a new system typically needs to connect to its own scan controller, using a unique IP address. This is a manual process, even if a configuration backup is used:

1. Search for the scan controller (IP address).
2. Select the scan controller.
3. Connect with the scan controller.

### Cloning devices

In the Configuration menu, an already configured device can be duplicated by cloning. This is useful

- If you use multiple scan controllers and want to use the same or similar hardware (lasers and deflection units) with them. In this case it is necessary to add additional instances of the hardware to the managed devices.
- If you use the same deflection unit with different optical setups, for example, different F-Theta lenses (with different field sizes). Instead of switching the correction file each time you change the lens, it is more convenient to have a deflection unit configuration for each, especially as each setup requires its own calibration.

To clone a device, point at it in the Configured devices list and select **[Clone]** from its context menu.

When the clone is created, it can be reconfigured if necessary.

You can also clone the scan controller configuration, but you must connect the cloned scan controller configuration to a different physical scan controller.

### **Correction files**

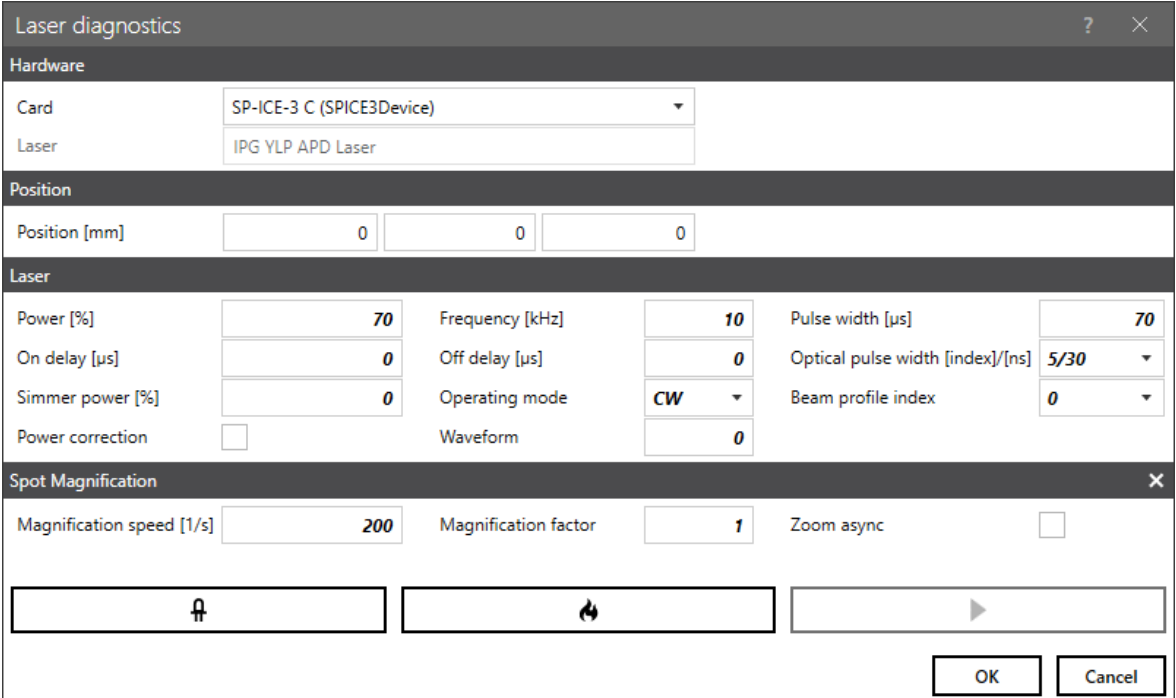
Any employed correction file is not saved with the configuration, as any changes to it can only be valid for a specific system and are not suited for replication.

For a new system, you must always start with an original correction file.

## 5.6 Laser Diagnostics

The laser diagnostic tool can only be used to control the laser in order to measure its power output, e.g., to create a laser calibration file.

To open the laser diagnostics dialog, select **System > Devices > Laser diagnostics...** from the menu:



| Laser diagnostics  |                           |                                  |      |
|--|---------------------------|----------------------------------|------|
| <b>Hardware</b>  |                           |                                  |      |
| Card   | SP-ICE-3 C (SPICE3Device) |                                  |      |
| Laser  | IPG YLP APD Laser         |                                  |      |
| <b>Position</b>  |                           |                                  |      |
| Position [mm]  | 0                         | 0                                | 0    |
| <b>Laser</b>   |                           |                                  |      |
| Power [%]  | 70                        | Frequency [kHz]                  | 10   |
| On delay [µs]  | 0                         | Off delay [µs]                   | 0    |
| Simmer power [%]   | 0                         | Operating mode                   | CW   |
| Power correction   | <input type="checkbox"/>  | Waveform                         | 0    |
| Pulse width [µs]   | 70                        | Optical pulse width [index]/[ns] | 5/30 |
| Beam profile index   | 0                         |                                  |      |
| <b>Spot Magnification</b>  |                           |                                  |      |
| Magnification speed [1/s]  | 200                       | Magnification factor             | 1    |
| Zoom async   | <input type="checkbox"/>  |                                  |      |
| <input type="button" value="⏪"/> <input type="button" value="⏩"/> <input type="button" value="▶"/> |                           |                                  |      |
| <input type="button" value="OK"/> <input type="button" value="Cancel"/>                            |                           |                                  |      |

Fig. 5.16: RG-AAY



### ! WARNING

#### Laser operation

Observe all applicable precautions for safe laser operation.

Refer to the user manuals of the laser system and the deflection unit (scan head) for safety information.



To measure, proceed as follows:

1. Select the scan controller with the laser attached. Verify that the laser is switched on.
2. Enter the coordinates for the 2 or 3 dimensions where the laser beam is to be fired. Be sure that a suitable target is at that position, for example, a laser power measuring probe.
3. Enter all relevant laser parameters for the measurement. The available laser parameters may vary depending on the laser type and visibility settings for pens. See also *page 228, Pen Properties*.
4. Arm the laser if it isn't already armed.  
Click on the **[Arm / Disarm]** button.  
An armed laser shows a red fire button on the button.
5. Click on the **[Laser on / off]** button to begin laser emission. The laser continues to emit until the button is clicked again.
6. Close the dialog with **[OK]** or **[Abort]**. *OK* stores the settings until the feature is used again.

## 6 PREFERENCES

The RAYGUIDE software can be configured with respect to user interface properties, process behaviour, permissions, etc.

Some settings need to be set only once when you set up the system after the initial installation. Others can be edited while you are working with the corresponding functions.

**View options** can be used to set various options for the display of the user interface for the display of the user interface.

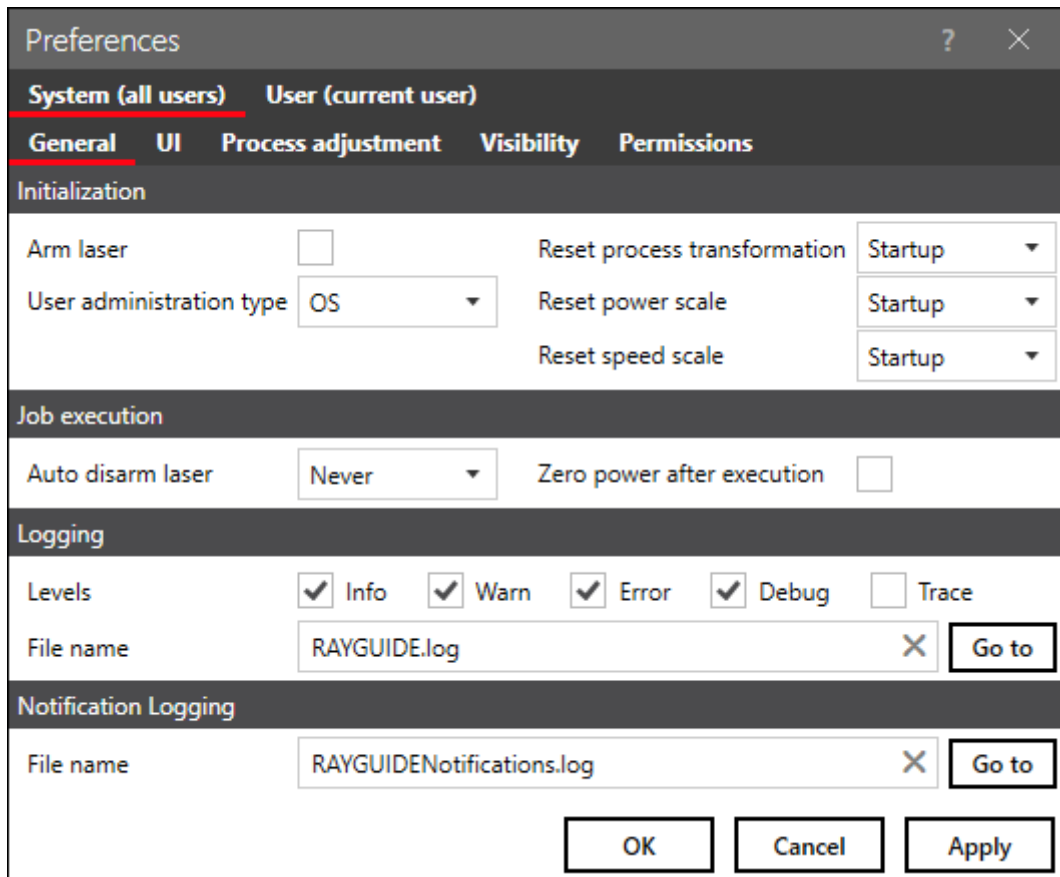
Settings made under **System** affect all users. You can use permissions to block selected users from changing system-wide settings (e.g., everyone except the administrator).

Settings made under **Current user** can be set separately for each user. A logged-in user can define their own settings.

## 6.1 System Preferences

### 6.1.1 General

Select **System > Preferences** from the menu or press **[F3]** to open the Preferences dialog. Go to the System tab (all users) and then to the sub-tab **General** to select some basic options.

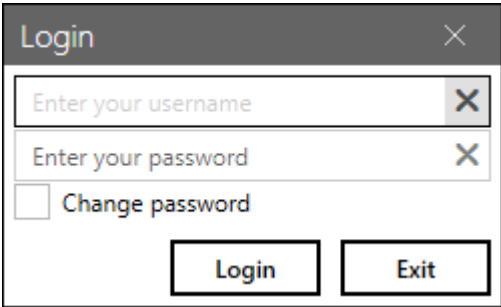


The screenshot shows the 'Preferences' dialog box with the 'System (all users)' tab selected. The 'General' sub-tab is active. The dialog is organized into several sections:

- Initialization:**
  - Arm laser:
  - User administration type: OS (dropdown)
  - Reset process transformation: Startup (dropdown)
  - Reset power scale: Startup (dropdown)
  - Reset speed scale: Startup (dropdown)
- Job execution:**
  - Auto disarm laser: Never (dropdown)
  - Zero power after execution:
- Logging:**
  - Levels:  Info,  Warn,  Error,  Debug,  Trace
  - File name: RAYGUIDE.log (text input with 'Go to' button)
- Notification Logging:**
  - File name: RAYGUIDENotifications.log (text input with 'Go to' button)

At the bottom of the dialog are three buttons: OK, Cancel, and Apply.

Fig. 6.1: RG-AAZ

| Setting                 | Explanation  |
|-------------------------|--|
| <b>Initialization</b>   |  |
| Arm laser on startup    | Sets the laser to ready-for-operation at software start up. Once checked, it is no longer required to manually arm the laser prior to the job execution (unless you disarm manually).  |
| User management variant | <p>Specify which user management you want to use to set up the authorisations:</p> <ul style="list-style-type: none"> <li>■ <i>Operating system:</i><br/>Users have to be created as users in the operating system in order to be assigned a role.</li> <li>■ <i>Local:</i><br/>The administrator creates users in directly in a RAYGUIDE user list and assigns them to a role there. This allows the authorisation role to be changed without logging out of the operating system.</li> </ul> <p><b>NOTES:</b></p> <ul style="list-style-type: none"> <li>■ Local users have to log in with user name and password each time the RAYGUIDE application starts.</li> <li>■ The default user with the administrator role is called "#rayguide#".</li> <li>■ The selection list contains all previously created users. The last user that logged in is selected by default.</li> <li>■ The initial password for all (newly) created users is "raylase" until the user changes it to an customised password. The password can also be left <i>blank</i>.</li> </ul> <div>  </div> <p>Additional specifications are made under <b>System &gt; Permissions &gt; Users / Groups</b>.</p> <p><b>CAUTION:</b> After changing the user administration variant, the RAYGUIDE application must be restarted.</p> |

| Setting   | Explanation  |
|---|--|
| Reset process transformation,<br>Reset power scale,<br>Reset speed scale                          | Select when to reset all process transformations and scale settings for the laser power value and / or speeds made on the <b>Process adjustment</b> panel: <ul style="list-style-type: none"> <li>■ For <i>Startup</i></li> <li>■ For <i>Execution</i></li> <li>■ <i>Never</i></li> </ul>  |
| <b>Job execution</b>  |  |
| Auto disarm laser   | Select an event for which the laser is to be automatically disarmed: <ul style="list-style-type: none"> <li>■ <i>Never</i></li> <li>■ <i>Abort</i><br/>If job execution is terminated by clicking on the corresponding buttons or with an abort signal to the control card, the laser is also disarmed at the same time.</li> <li>■ <i>Error</i><br/>If an error is reported, the laser is disarmed at the same time.</li> <li>■ <i>Abort or Error</i><br/>Selection for both cases</li> </ul> |
| Zero power after execution  | If this option is set, the power value is set to 0% after execution of each job.<br>Otherwise, the power value at the output of the control card stays at the last commanded power value.  |
| <b>Logger</b>   |  |
| These settings refer to the RAYGUIDE protocol (not to the log file of the control card).          |  |
| Levels  | Set the checkmark for the log data to be recorded.<br>By default, all but <i>Trace</i> is checked. Trace data is very detailed and creates huge log files. The <i>Trace</i> option should only be selected if this data is requested by RAYLASE support.   |
| File name   | Name of the log file.<br>Click <b>[Go to]</b> to open the respective folder.   |
| <b>Notification logging</b>   |  |
| All messages from the Notifications panel are logged here (status messages, measurement results). |  |
| File name   | Name of the log file<br>Click <b>[Go to]</b> to open the respective folder.  |

Tab. 6.1: RG-018

## 6.1.2 UI

Select **System > Preferences** from the menu or press **[F3]** to open the Preferences dialog. Go to the System (all users) tab and to the UI sub-tab.

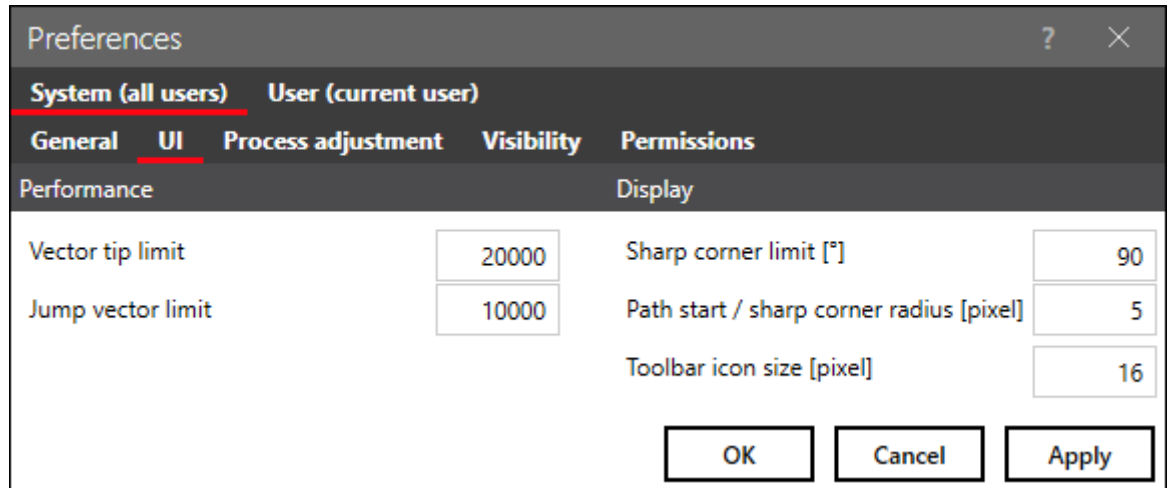


Fig. 6.2: RG-ABB

| Setting                                  | Explanation   |
|--|---|
| <b>UI</b>                                |   |
| <b>Performance</b>                       |   |
| Vector tip limit                         | Defines the maximum number of vector tips that can be displayed so as not to overload the graphic display.            |
| Jump vector limit                        | Defines the maximum number of jump vectors that can be displayed so as not to overload the graphic display.           |
| <b>Display</b>                           |   |
| Sharp corner limit [°]                   | See page 28, View Options.  |
| Path start / sharp corner radius [pixel] | See page 28, View Options.  |
| Toolbar icon size [pixel]                | Size of the toolbar buttons in pixels. This function is helpful if the user interface is operated on a touch monitor. |

Tab. 6.2: RG-020

### 6.1.3 Process Adjustment

You define limits for the two sliders here in the Process adjustment panel, see *page 305, Process Adjustment*.

Select **System > Preferences** from the menu or press **[F3]** to open the Settings dialog. Go to the **System (all users) > Process adjustment** tab.

Specify the upper and lower threshold value for global scaling of the laser power and the process speeds (mark as jump).

The upper and lower threshold value for the preview scan speed is also defined in this tab. For more details on the preview, see *page 281, Preview*.

## 6.1.4 Visibility

You may hide parts of the GUI or its dialogs, depending on your requirements.

Select **System > Preferences** from the menu or press **[F3]** to open the Settings dialog. Go to the System (all users) tab and to the Visibility sub-tab.

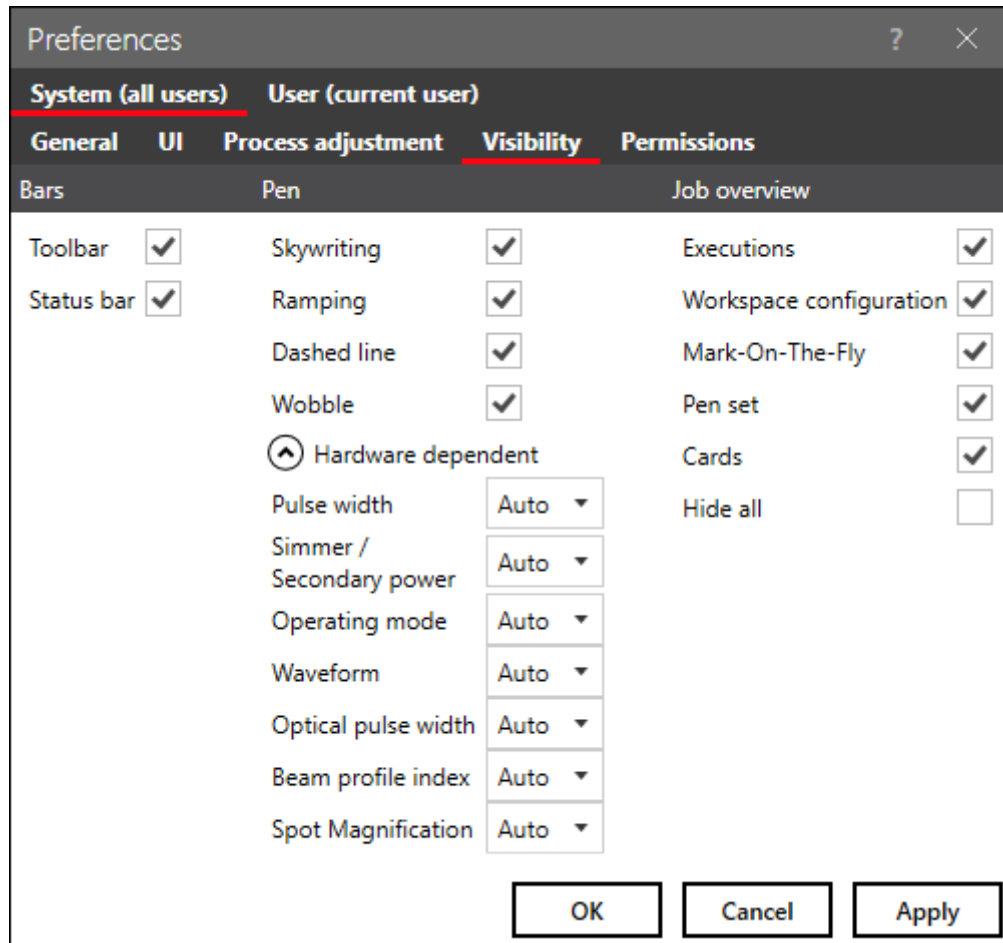


Fig. 6.3: RG-ABC



Make your selection in the following categories:

- **Bars:** Enables / disables the display of the toolbar and the status bar.  
The status bar is the grey bar at the bottom of the user interface. It shows current status information such as permission roles, cursor position, etc.
- **Pen-related settings,** to adapt the pen dialog according to your needs. For a description, see *page 228, Pen Properties*.
- **Job overview information to be displayed:** For a description, see *page 102, About Jobs*.

### 6.1.5 Permissions

Using permissions, different user roles can be defined, each of which has specific permissions to use the RAYGUIDE functions.

There are two options available for managing users, see *page 83, General*.

#### NOTES:

- After initial software installation, no users are set up. That means that anyone who starts the software will have all permissions. It is advisable to set permissions as soon as possible.
- All created users are available to both variants of the user administration. When assigning user names, please note whether users should be able to act in both variants or not.

**CAUTION:** As soon as a user has been created in the **Local user administration** variant, a user is automatically created for the **Operating system** variant.

That is why it is advisable to also create an operating system user with the administrator role under local user administration. Otherwise, there will no longer be a user with administrator rights when switching from the local to the operating system variant.

Select **System > Preferences** from the menu or press **[F3]** to open the Settings dialog. Change to the **System (all users)** tab and then to the **Permissions** sub-tab.

#### Assigning users and / or user groups to roles

Go to the Users / Groups tab.

### 6.1.5.1 Variant: User management via operating system

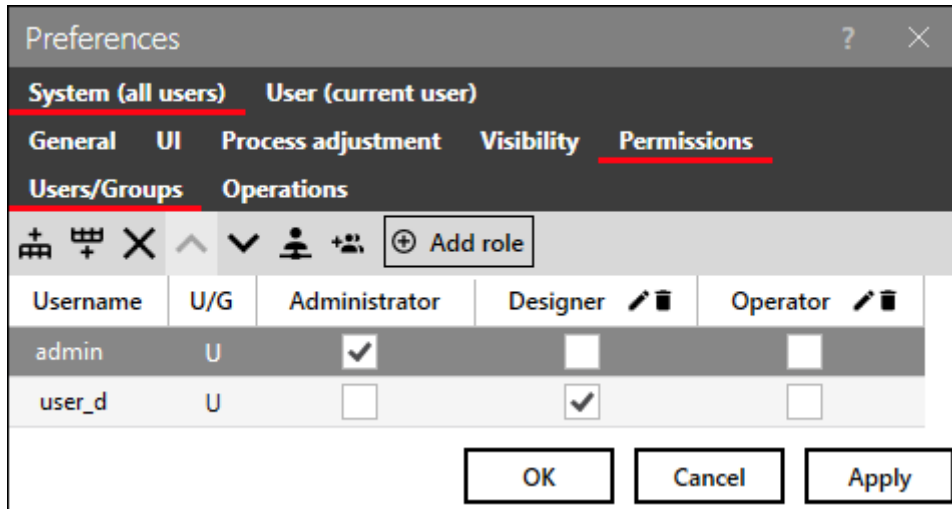







Fig. 6.4: RG-ABD

| Setting   | Explanation  |
|---|--|
|  | Add a new entry (line) above/below to create a new user.<br>The user name is entered directly into the first column. The "U/G" column indicates whether it is a user (U = User) or a user group (G = Group).<br><b>NOTE:</b> At least one user with administrator rights must be created.  |
|  | Deletes the user entry.  |
|  | Moves the line up/down.  |
|  | Button for adding a user/user group from the network administration. To add a Windows-defined user group, the object type has to be switched from U (User) to G (Group). <ul style="list-style-type: none"> <li>■ A Windows dialog window opens in which you have to enter the login name of the user. Several names can be entered (separated by a semicolon).</li> <li>■ Click <b>[Check name]</b>. If the user or the user group is found, confirm with <b>[OK]</b>.</li> </ul> <b>NOTE:</b> If the designated RAYGUIDE user is not available, the user has to be created at Windows level first. For details on the PC user management, ask your IT administrator. |
|  | Button for adding all users/user group from the network administration.  |
| <b>[Add role]</b>   | Button for adding a new column for another role.   |

Tab. 6.3: RG-094

### 6.1.5.2 Variant: User management local

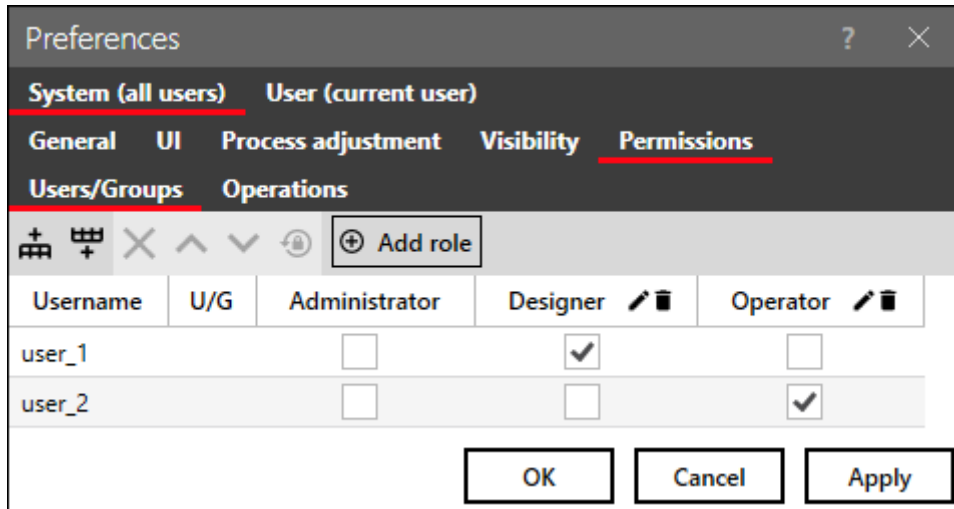






Fig. 6.5: RG-AFE

#### NOTES:

- The administrator user is not listed here.
- Only users who have been assigned a role are saved.
- User names cannot be changed directly. To do this, the user must be deleted and then recreated.

| Setting   | Explanation  |
|---|--|
|  | Add a new entry (line) above/below to create a new user.<br>The user name is entered directly into the first column. |
|  | Deletes the user entry.  |
|  | Moves the line up/down.  |
|  | Resets the password for the selected user to the initial password ("raylase").                                       |
| <b>[Add role]</b>   | Button for adding a new column for another role.   |

Tab. 6.4: RG-093

To change the local user, go to **System > Logout**. The login dialog for logging in as a different user appears.

### 6.1.5.3 Assigning roles and permissions

Go to the Operations tab.

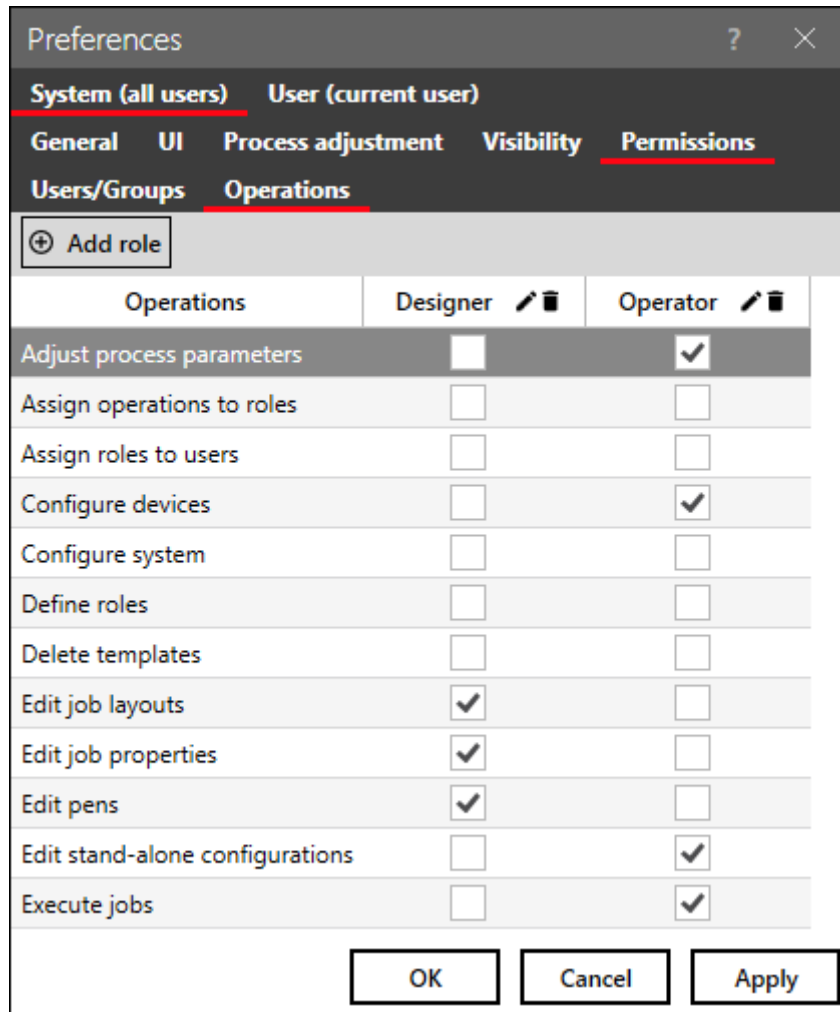


Fig. 6.6: RG-ABE

In the table you can assign various functions to the roles by setting checkmarks. The administrator always has all the permissions. New roles can also be added here.

#### NOTES:

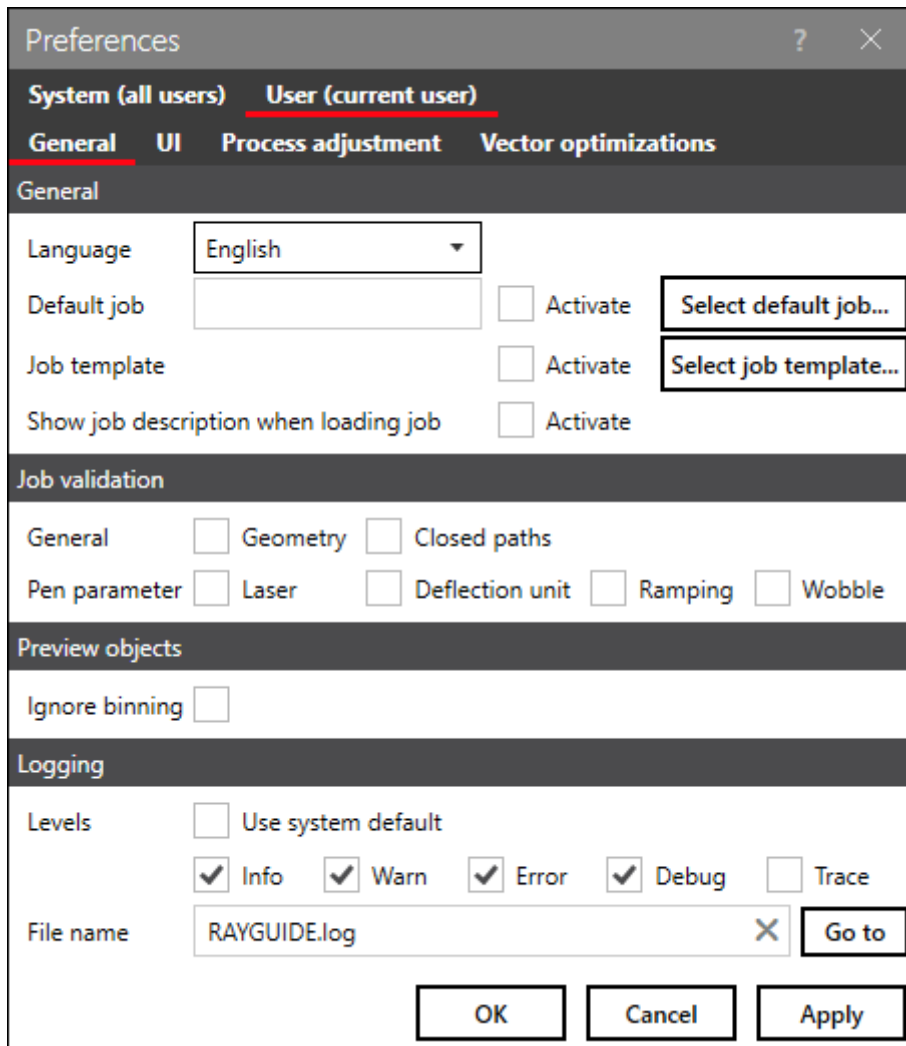
- The role of the currently active user is displayed in the status bar at the bottom left of the RAYGUIDE main window.
- The administrator role is not listed here. This role allows all activities by default, meaning you cannot withdraw any activities from this role.

## 6.2 User Preferences

All preferences in the User section are stored per PC user and are not locked by any user permission setting.

### 6.2.1 General

Select **System > Preferences** from the menu or press **[F3]** to open the Preferences dialog. Go to the User (current user) tab and to the General sub-tab.



The screenshot shows the 'Preferences' dialog box with the 'User (current user)' tab selected. The 'General' sub-tab is active, showing various settings:

- Language:** English (dropdown menu)
- Default job:** [Empty text box]  Activate
- Job template:** [Empty text box]  Activate
- Show job description when loading job:**  Activate
- Job validation:**
  - General:  Geometry  Closed paths
  - Pen parameter:  Laser  Deflection unit  Ramping  Wobble
- Preview objects:** Ignore binning
- Logging:**
  - Levels:  Use system default
  - Info  Warn  Error  Debug  Trace
  - File name: RAYGUIDE.log

Buttons at the bottom: OK, Cancel, Apply.

Fig. 6.7: RG-ABF

| Setting   | Explanation   |
|---|---|
| <b>General</b>  |   |
| Language  | Select from the list of available GUI languages. Currently available: English, German, Chinese, French, Spanish, Italian, Japanese.   |
| Default job   | <i>Activate</i> the option and select a job file that is loaded by default when the RAYGUIDE application is started. <i>Deactivate</i> this option if you want an empty job to be displayed when you start RAYGUIDE.  |
| Job template  | <i>Activate</i> the option and select a job file if you want a predefined job content when starting a new job. <i>Deactivate</i> the option if you want to have a blank job when you create a new job.<br><br>Use case: Use case: Each job must start with a "Wait condition" and end with a "Set I/O output" object. |
| Show job description when loading job   | Activate this option if you want the content of the job description to be displayed when the job is loaded.<br><br>This allows you to indicate any points that are relevant to job execution.   |
| <b>Job validation</b>   |   |
| Check the box if you want jobs to be validated with respect to the following aspects before execution (all validations are enabled by default).   |   |
| <b>General</b>  |   |
| <ul style="list-style-type: none"> <li>■ Whether the layout fits into the workspace / scan field.<br/><b>NOTE:</b> In case on a MOTF job, validation is performed only for the configured workspace.<br/><b>NOTE:</b> If a tiler container is used, it is also checked whether the layout fits into the tile pattern.<br/><b>NOTE:</b> Job validation also will consider field calibration and process transformation, however, it does not consider vector extension by Skywriting or any wobble geometry.</li> <li>■ Whether the job contains marking objects with open paths or whether all paths are closed.</li> <li>■ Whether MOTF settings of the job are problematic. For instance, it is contradictory if the value for the minimum segment width is greater than the maximum width of the MOTF split.</li> </ul>  |   |
| <b>Pen parameters</b>   |   |
| <ul style="list-style-type: none"> <li>■ Whether the laser-related pen values exceed a limit (e.g. the power range as defined in the laser dialog).</li> <li>■ Whether the scan head-related pen values exceed a limit (e.g. the speed limit as defined in the deflection unit dialog).</li> <li>■ Whether the pen settings with regard to ramping, in particular the accumulated ramp length, will exceed the length of the respective path.</li> <li>■ Whether the pen settings with respect to the wobble parameters would exceed the maximum current consumption of the galvanometer motor (see page 67, <i>General</i>).</li> </ul> <p><b>NOTE:</b> To use wobble validation, your deflection unit must have firmware from rev7130 or later. You can view the firmware version via the configuration dialog of the deflection unit (see page 75, <i>Deflection Unit Status Information</i>).</p> <p><b>NOTE:</b> Job validation is not available in stand-alone mode.</p> <p>For more information, see page 285, <i>Running a Job</i>.</p> |   |

| Setting  | Explanation  |
|--|--|
| <b>Preview objects</b>   |  |
| Ignore binning   | Setting to display all objects in a preview, regardless of possible binning conditions.  |
| <b>Logger</b>  |  |
| These settings refer to the RAYGUIDE protocol (not to the log file of the control card). |  |
| Levels   | The system default settings, i.e., the system settings, are used by default. The current user can also use other protocol levels as needed.<br><b>NOTE:</b> The <i>Trace</i> protocol level should only be set when requested by RAYLASE support as otherwise a large number of unnecessary files will be created. |
| File name  | Name of the log file<br>Click <b>[Go to]</b> to open the respective folder.  |

Tab. 6.5: RG-021

## 6.2.2 UI

Select **System > Preferences** from the menu or press **[F3]** to open the Preferences dialog. Go to the User (current user) tab and to the UI sub-tab.

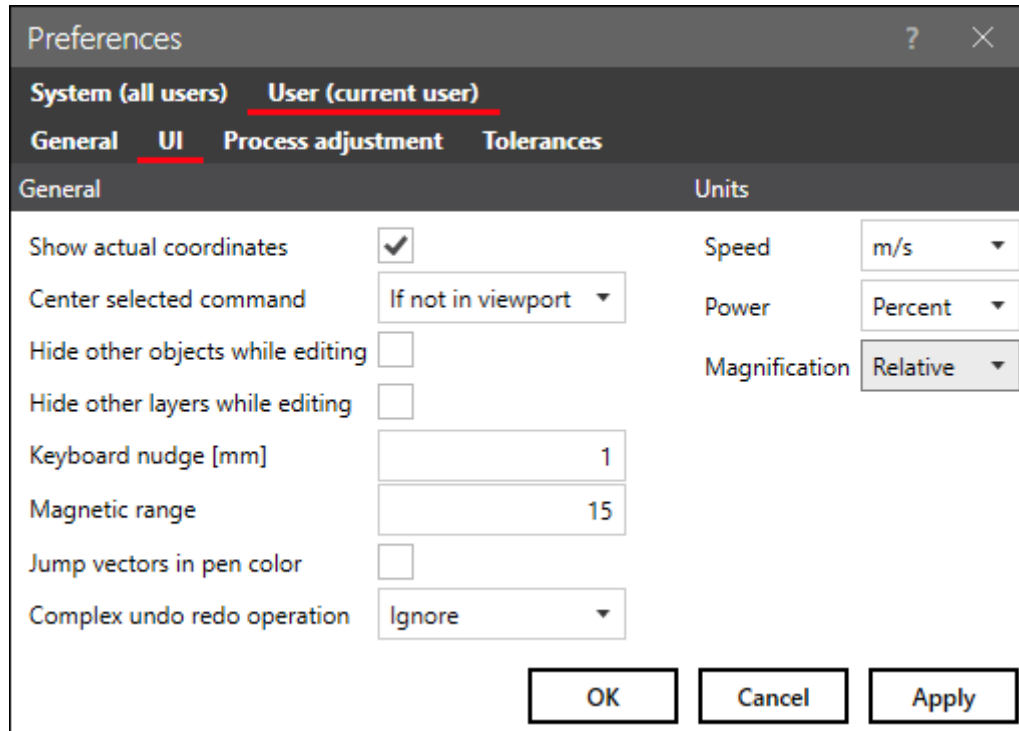


Fig. 6.8: RG-ABG

| Setting                          | Explanation  |
|----------------------------------|--|
| <b>General</b>                   |  |
| Show actual coordinates          | Check if you want to show the coordinates of a graphic <b>including</b> its transformations in its properties dialog.  |
| Center selected command          | Check if you want to show the graphic element you have selected in the job tree in the centre of the viewport.<br>Check one of the following settings: <ul style="list-style-type: none"> <li>■ <i>Never</i></li> <li>■ <i>Always</i></li> <li>■ <i>If not in Viewport</i>: Only if the selected graphic element is not already visible in the current image section of the viewport.</li> </ul> |
| Hide other objects while editing | Check if you only want to see the actively edited object in the viewport (which is particularly useful when multiple graphic objects are superimposed onto each other).  |
| Hide other layers while editing  | Check if you only want to see the layer actively selected in the job tree in the viewport (which is particularly useful when multiple layers are superimposed onto each other).  |



| Setting  | Explanation   |
|--|---|
| Keyboard nudge [mm]  | Sets how much selected objects or graphic elements are moved with one keyboard stroke (arrow keys) in [mm].   |
| Jump vectors in pen color  | When the display option "show jumps" is activated:<br>Displays the jumps in the colour of the pen which also defines the jump parameters.   |
| Magnetic range [pixel]   | Defines the area in pixels around a thumb, control point, or guide line in which they act magnetically on other points of the inset or bounding box.  |
| Complex undo redo operation  | For complex undo redo operations (e.g. when objects with a large number of vector objects are deleted or modified), a larger amount of memory is required to undo the operation.<br>This function defines how complex undo / redo operations are handled.   |
| <b>Units</b>   |   |
| If you change the units, you must restart the software to apply the change to all forms and dialogs. |   |
| Speed  | Select the global speed unit: <ul style="list-style-type: none"> <li>■ [m/s]</li> <li>■ [mm/s]</li> </ul>   |
| Power  | Select the global unit for the laser power: [%] or [watts].<br>The translation from [%] to [watts] is now defined in the laser configuration (see page 55, <i>Laser Controller Configuration</i> ).   |
| Magnification  | Select the global unit for spot magnification: <ul style="list-style-type: none"> <li>■ <i>Relative</i> (factor) or</li> <li>■ <i>Absolute</i> (diameter in [mm])</li> </ul> The conversion factor for this is defined in the configuration of the deflection unit (see page 67, <i>General</i> ) |

Tab. 6.6: RG-022

### 6.2.3 Process Adjustment

Define the preset deltas that edit the process transformation (offset, rotation, scale) when using the buttons.

Select **System > Preferences** from the menu or press **[F3]** to open the Preferences dialog. Go to the User (current user) tab and to the Process adjustment sub-tab.

For a description, see *page 305, Process Adjustment*.

### 6.2.4 Vector optimisations

Various settings can be made in advance before using functions for automated vector optimisation.

Select **System > Preferences** from the menu or press **[F3]** to open the Settings dialog. Go to the **Current user** tab and then to the **Vector optimisation** sub-tab.

For detailed information on the application cases, see *page 174, Automated vector optimisation*.

## 6.3 Saving / Restoring system settings

To save all settings and configurations for system recovery or system duplication made in RAYGUIDE, you have the following option:

**System > Import / Export settings**

### 6.3.1 Exporting settings

In the **[Export]** sub-menu, you can select which settings should be included in the backup.

The export file has this name by default: "RAYGUIDEBackup\_Timestamps"

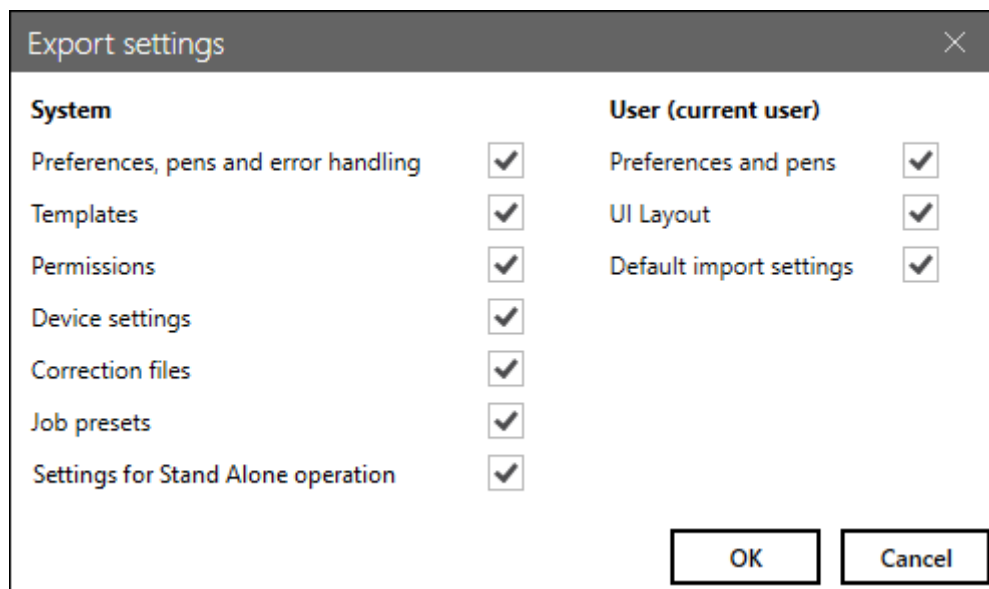


Fig. 6.9: RG-AFI

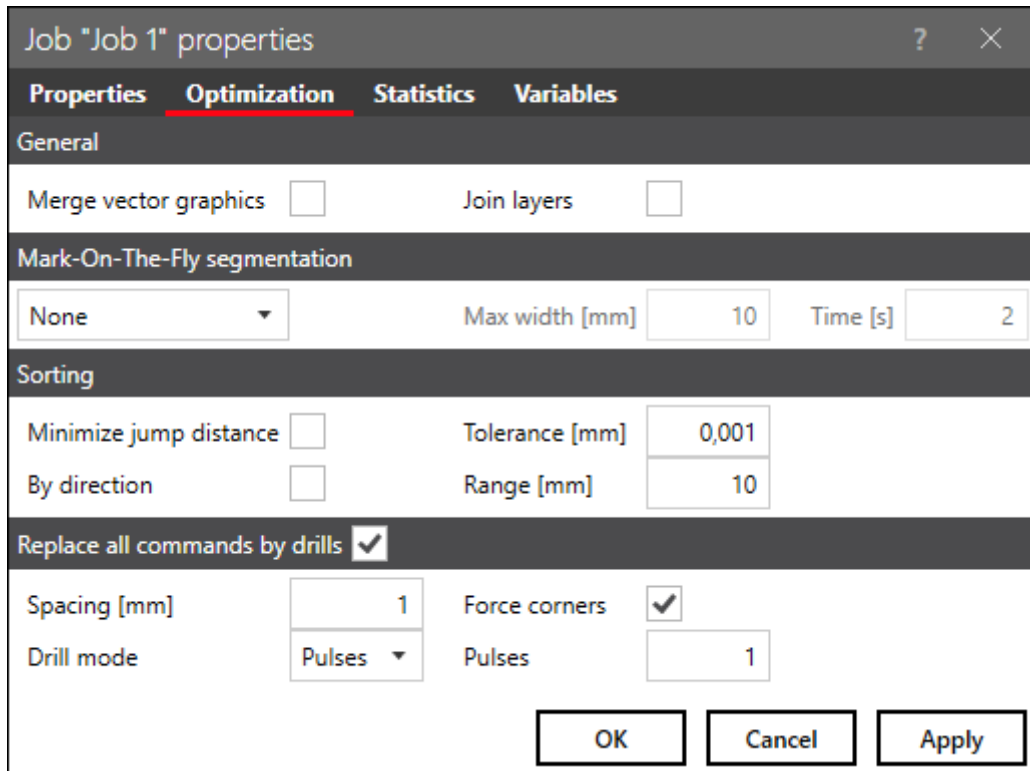
| Setting                              | Explanation   |
|--------------------------------------|---|
| <b>System</b>                        |   |
| Preferences, pens and error handling | Contains all settings that were made according to <i>page 83, General to page 88, Visibility</i> .<br>All system pen sets and the settings for automatic error handling are also included (see <i>page 294, Automated Error Handling</i> ). |
| Templates                            | Contains all templates generated for objects and fillings, see <i>page 218, Templates</i> .   |
| Permissions                          | Contains the created users and their rights.  |

| Setting                    | Explanation   |
|----------------------------|---|
| Device settings            | Contains all configured devices, see <i>page 41, Device Configuration and Calibration</i> .<br><b>NOTE:</b> However, the correction files are not included. |
| Correction files           | Contains all correction files for the configured deflection units, laser correction files for the configured lasers and files for laser power calibration.  |
| Job presets                | Contains all created job presets, see <i>page 104, Job Presets</i> .  |
| Stand-alone settings       | Contains all configurations that have been set up for stand-alone mode, but without the linked job files.   |
| <b>User (current user)</b> |   |
| Preferences and pens       | Contains all settings that were made according to <i>page 83, General</i> to <i>page 88, Visibility</i> .<br>All user pen sets are also included.           |
| UI Layout                  | Contains the current arrangement of panels and settings for the visibility of the job element buttons and toolbars.   |
| Default import settings    | Contains the current settings for importing vector graphics and the last import directories used.   |

Tab. 6.7: RG-095

## 6.3.2 Importing settings

The settings from the backup are displayed during import.



The screenshot shows a dialog box titled "Job 'Job 1' properties" with a close button (X) and a help button (?). The "Optimization" tab is selected. The settings are as follows:

| General  |                                     |
|--|-------------------------------------|
| Merge vector graphics  | <input type="checkbox"/>            |
| Join layers  | <input type="checkbox"/>            |
| Mark-On-The-Fly segmentation                                       |                                     |
| Segmentation   | None                                |
| Max width [mm]   | 10                                  |
| Time [s]   | 2                                   |
| Sorting  |                                     |
| Minimize jump distance   | <input type="checkbox"/>            |
| By direction   | <input type="checkbox"/>            |
| Tolerance [mm]   | 0,001                               |
| Range [mm]   | 10                                  |
| Replace all commands by drills <input checked="" type="checkbox"/> |                                     |
| Spacing [mm]   | 1                                   |
| Drill mode   | Pulses                              |
| Force corners  | <input checked="" type="checkbox"/> |
| Pulses   | 1                                   |

Buttons: OK, Cancel, Apply

Fig. 6.10: RG-AFJ

**CAUTION:** The settings from the imported backup file may overwrite all current settings that were made in the various places in RAYGUIDE.

**NOTE:** Please note that after importing the device configuration, the control cards must be re-connected after import. The link to correction files must also be recreated.

# 7 LASER PROCESS JOBS

## 7.1 About Jobs

A job is a combination of graphic elements, process parameters, job parameters and job execution settings.

To generate a new job, you can click on **File > New** or the **[Add]** button in the main tool bar. Alternatively, you can also use the key combination **[Ctrl]+[n]**.

The number of open jobs is not limited. A \* on the job tab indicates that the job has been modified since it was opened or created.

The figure shows an example with two open jobs:

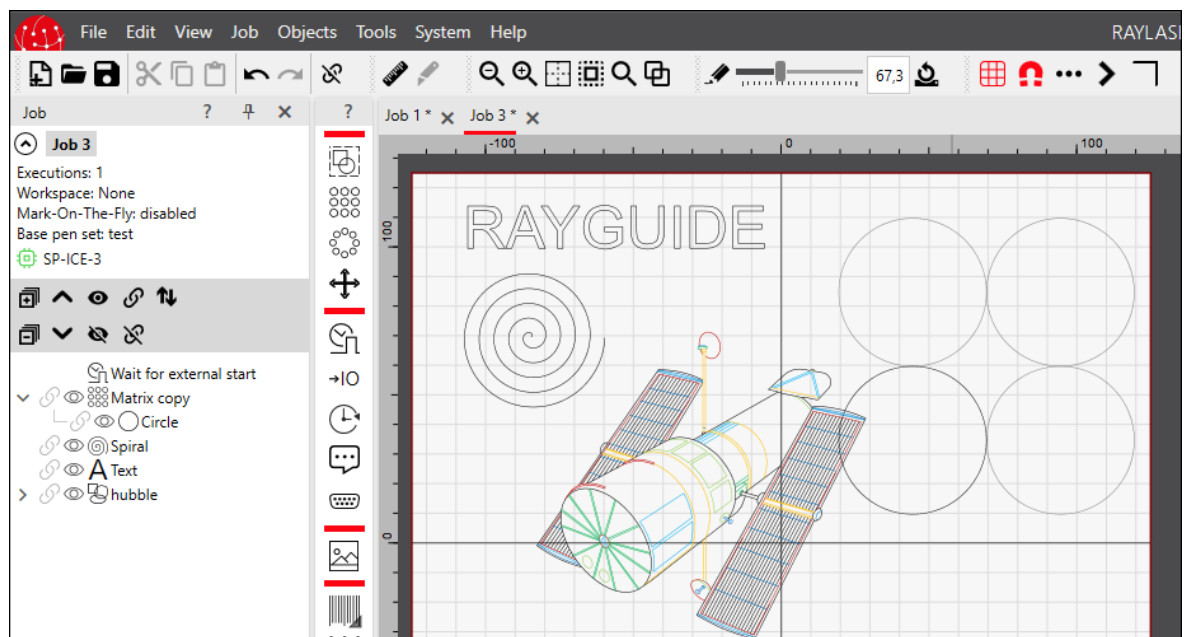


Fig. 7.1: RG-ABH

The **Job panel** is divided in 2 sections:

On top, important job settings and the job-linked scan controller cards are shown. You may collapse / expand the job overview. You may also enable / disable the display of the single job information per preset.

Select **System > Preferences** from the menu or press **[F3]** to open the Settings dialog. Go to the System (all users) tab and to the Visibility sub-tab Job.

The lower section provides the so-called job tree.

All job elements are listed in the order in which they get processed. For details, see *page 113, Job Content Creation*.

### 7.1.1 Save and Open Jobs

To save a created job, click on **[Save]** or the **File > [Save]** or **Save as...** item in the main menu. The job file type is \*.rg.

**NOTE:** We strictly advise against processing job files in any application other than RAYGUIDE.

To open an existing job, click on **[Open file]** or on **File > Open** in the main menu to navigate to the desired job file. Alternatively, use "recent documents" to select one of the last used jobs from the provided list.

To open multiple jobs simultaneously, select all job files in the Explorer and drag them into the open RAYGUIDE GUI using the mouse.

When opening a job that was created on another RAYGUIDE installation, that job refers to a different scan controller and possibly to other hardware devices. Therefore, RAYGUIDE prompts you to reference the missing devices to available devices in the actual RAYGUIDE installation. Suitable devices are listed in the respective drop-down lists.

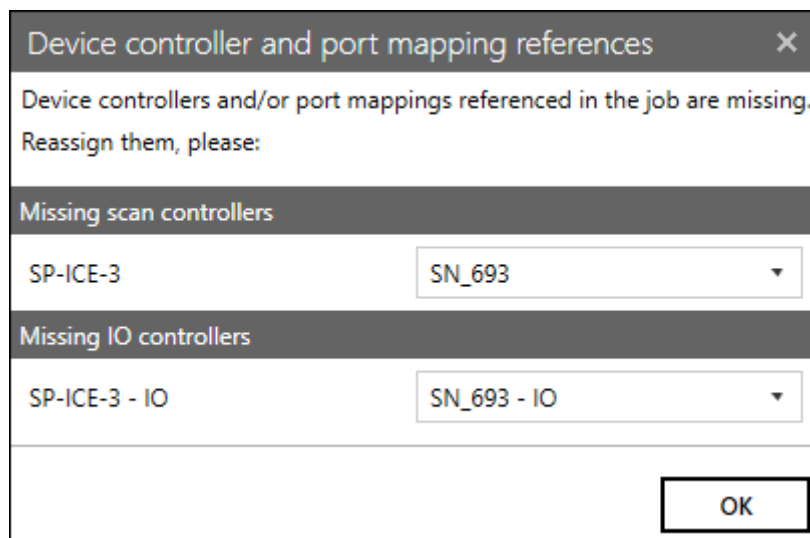


Fig. 7.2: RG-ADC

**NOTE:** If any of the requested devices or ports do not get assigned a new reference, the job cannot be properly processed.

## 7.1.2 Job Presets

In this menu option, you define and store presets for jobs such as the workspace setup, commonly used MOTF settings and automated job optimisations.

Select **Job > Presets** in the menu or press **[Ctrl]+[F11]** to open the **J Job presets** dialog.

As a user, you can define multiple configurations as a preset:

- Click **[Add]** and enter the name for a new preset.
- Click **[Edit name]** to change the name of an existing preset.
- Click **[Delete]** to remove an existing preset.
- Click **[Duplicate]** to make a copy of an existing preset. The duplicate receives a corresponding suffix.
- Check *Default* if you want each new job to use this preset definition.

### 7.1.2.1 Setup

This tab is used to define the setup of the workspace.

#### Use cases

- If you use multiple scan controllers and therefore multiple scan fields.
- If you want to limit the usable working area relative to the available scan field.
- If you want to extend the working area beyond the scan field for MOTF applications.



## Appearance in viewport

The defined workspace area itself can be made clearly visible by activating the display of grid lines. In addition, lighter areas indicate areas that can in principle be reached by the deflection units, especially if the selected multi field mode is taken into account.

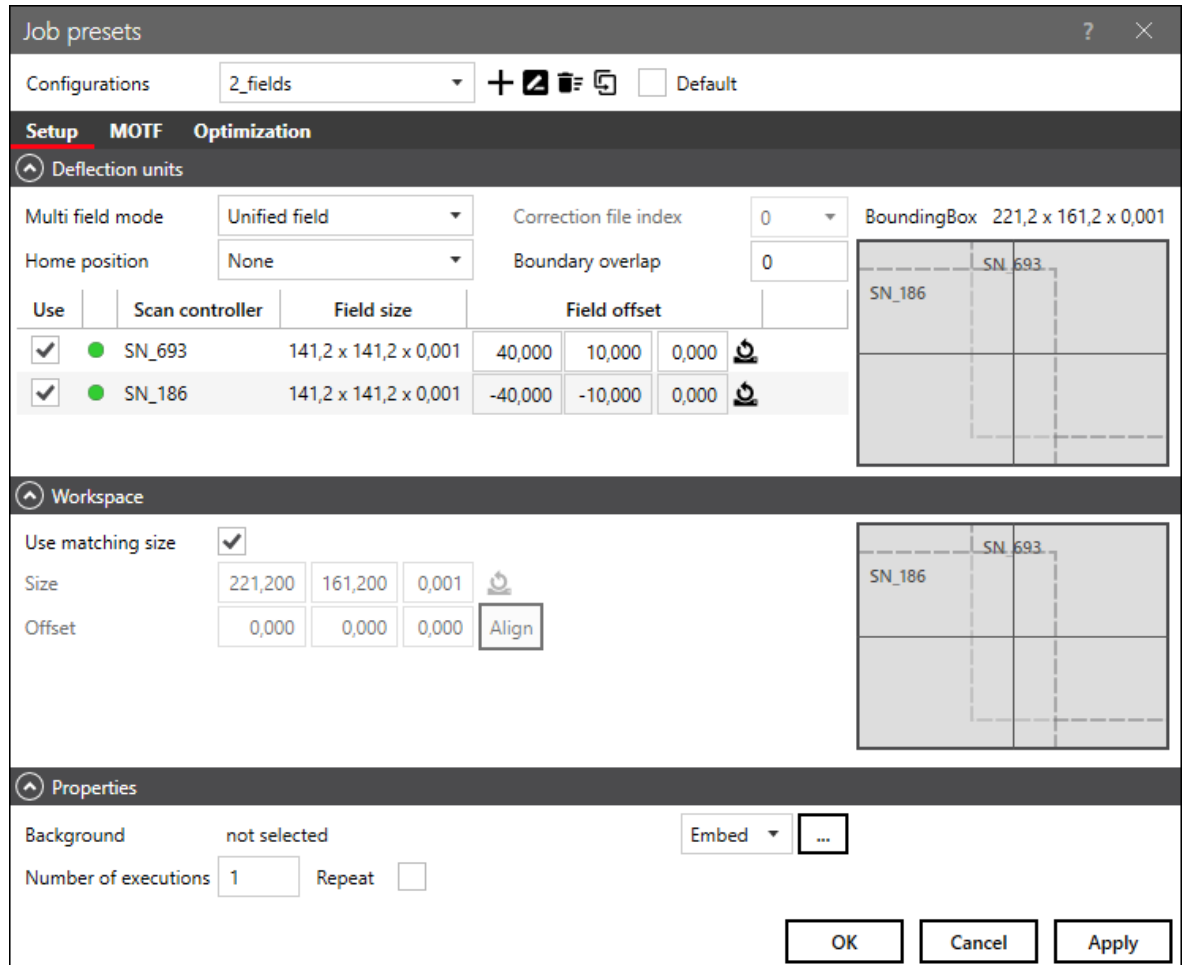
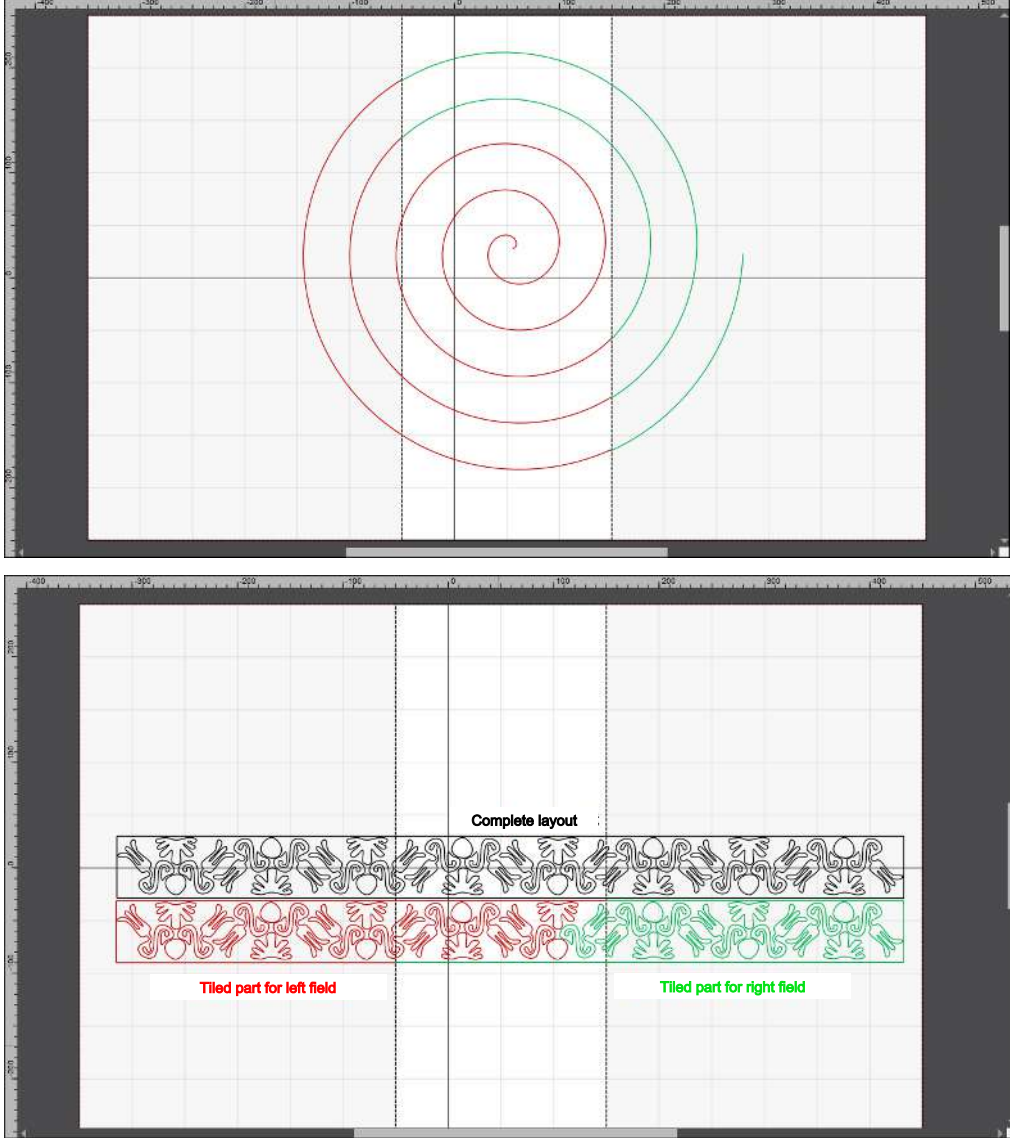
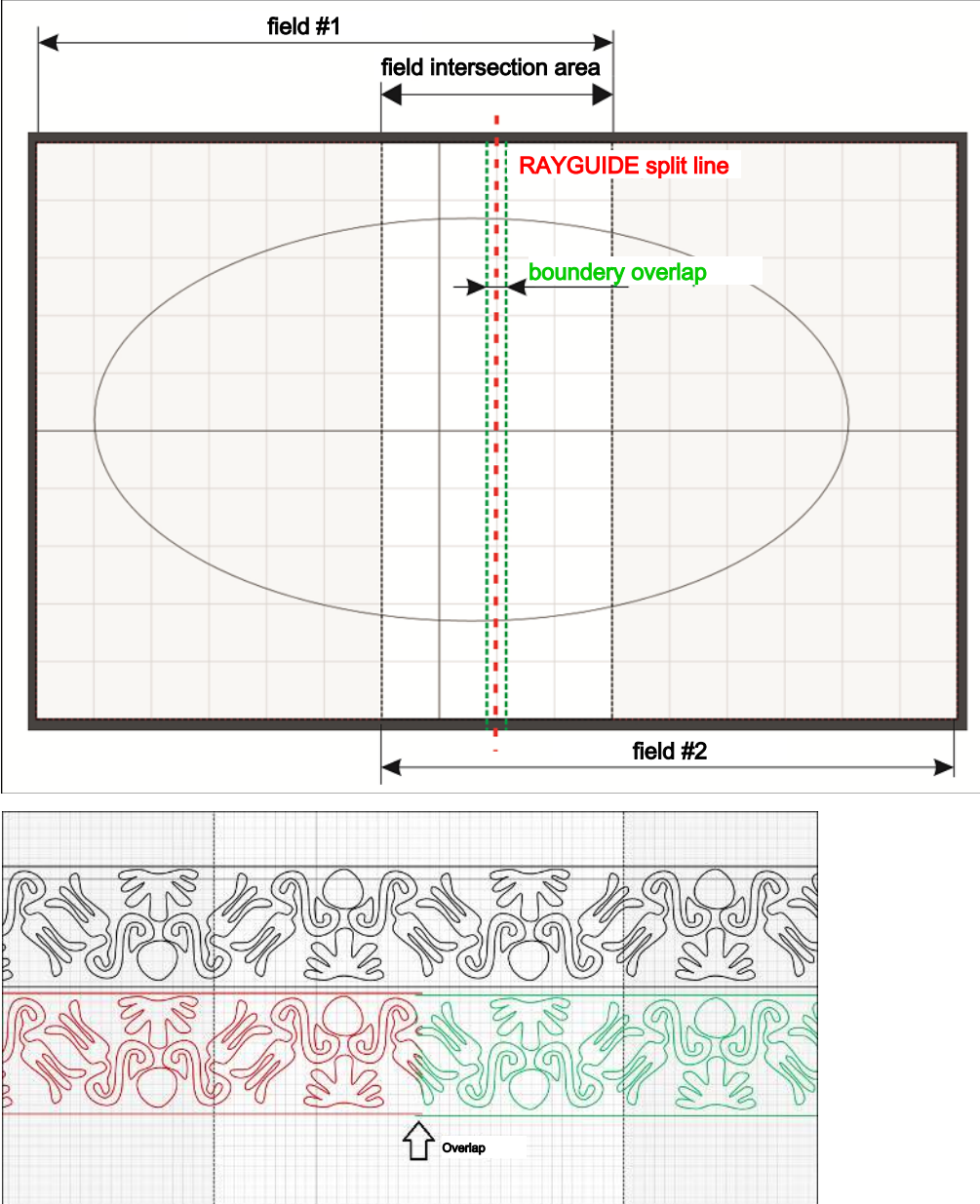


Fig. 7.3: RG-ABA

| Setting                 | Explanation  |
|-------------------------|--|
| <b>Deflection units</b> |  |
| Multi field mode        | <p>If more than one control card is connected, the controlled deflection units and their scan fields can interact in a variety of ways.</p> <p><i>Individual fields:</i> The different scan fields do not overlap. Use this option if you want to execute the same job on multiple deflection units in parallel. Select all SP-ICE-3 control cards to be used for this scenario.</p> <p><b>NOTE:</b> The field offset is not applicable in this mode and is ignored by the software.</p> <p><i>Unified field:</i> All scan fields are used together to cover a combined workspace where layout objects can be positioned.</p> <p><b>NOTES:</b></p> <ul style="list-style-type: none"> <li>■ If a graphic object fits completely within the intersection area of the scan fields, it is automatically processed by the control card listed first. This automatic behaviour can be changed in the dialog for the object settings. For this purpose, select the <b>Manual</b> option and then the desired control card.</li> <li>■ If a layout object extends over several scan fields, it must be split so that each deflection unit can process its accessible part. RAYGUIDE splits the layout object according to the rules listed below and taking into account the <b>Boundary overlap</b> value.</li> </ul> <p>Depending on the boundary overlap, two cases can be distinguished:</p> <ol style="list-style-type: none"> <li>1. Boundary overlap = 0 [mm]</li> <li>2. Boundary overlap ≠ 0 [mm]</li> </ol> |

| Setting | Explanation  |
|---------|--|
|         | <p><u>Case a) Boundary overlap= 0 [mm]</u></p> <p>If the value of the boundary overlap = 0 [mm], all paths are split where necessary so that as few separation points as possible are created.</p> <p>Example:</p>  |

| Setting | Explanation  |
|---------|--|
|         | <p><u>Case b): Boundary overlap <math>\neq 0</math> [mm]</u></p> <p>If the value of the boundary overlap <math>\neq 0</math>, the required paths are split in the middle of the field intersection area, and half of the boundary overlap value extends the vectors for each scanner to the other side of the field. In this way, the paths from both sides have a defined intersecting area, which prevents the line ends from being connected at points.</p> <p>Example:</p>  |

| Setting               | Explanation  |
|-----------------------|--|
|                       | <p><i>Intersection field</i>: Use this option if only the area in which all scan fields overlap is to be used to define the available workspace in which the layout objects are to be positioned.</p> <p><b>NOTE:</b> To divide the processing load among all the control cards involved, you must manually assign each graphic object to one of the control cards. Therefore open the object settings dialog, select Manual and select the respective control card. All objects that are set to Auto are always processed by the control card listed first.</p> |
| Home position         | <p>Select if the deflection unit should "jump" to a specific position at the end of all job elements.</p> <p>The choices are:</p> <ul style="list-style-type: none"> <li>■ <i>None</i></li> <li>■ <i>Defined position</i>: Specify the coordinates in the list per control card.</li> <li>■ <i>Start position of the job</i>: Position where the first marking path starts.</li> </ul>   |
| BoundingBox           | Shows the dimensions of the shared field areas or, for 3D correction files, the shared volume.   |
| Boundery overlap      | In "Unified field" multiple field mode, on the one hand, defines where paths are split, and on the other hand, how far they are marked as overlapping on both sides in [mm].   |
| Correction file index | <p>Define the index of the correction file that is to be active when the execution of the job begins.</p> <p><b>NOTE:</b> The option is only usable if at least one deflection unit has been assigned two correction files in the configuration. See <i>page 67, General</i>.</p>  |
| List control cards    | <p>The table shows the connected control cards. Check the ones to be used in this configuration.</p> <p>Use the offset to define how the individual scan fields are actually positioned to each other. When using correction files with a z-range, the offset of the zero layer is displayed in the column for the z-values. The figure next to it shows you the result.</p> <p>If necessary, enter the desired coordinates for the end position per control card.</p>   |

| Setting   | Explanation   |
|---|---|
| <b>Workspace</b>  |   |
| <p>Defines the size and position of the workspace in relation to the scan field. Typically, the workspace size matches the deflection unit's field size. However, there may be special cases, such as the following:</p> <p><b>Use case 1:</b> A smaller workspace size will limit the area of operation. This can be necessary, for example, because machine parts reach into the scan field area that are not hit by the laser beam. However, this may result in a warning when the layout exceeds the defined workspace.</p> <p><b>Use case 2:</b> Visualise a part of the virtual field for MOTF applications so that the user can place the layout objects accordingly. In this case, the workspace size may well exceed the size of the scan field.</p> |   |
| Use matching size   | Set the tab to force that the workspace size matches the scan field size.<br>Uncheck the tab if you want to edit the workspace and / or offset it.  |
| Size  | Desired workspace size in X-Y-Z dimensions in [mm].   |
| Field offset  | Define an offset to manually arrange the workspace in relation to the scan fields or click <b>[Align]</b> to use one of the predefined layouts.   |
| <b>Properties</b>   |   |
| Background  | <p>Option for inserting an image as a background picture in the workspace.<br/>Valid formats are: JPG, JPEG, BMP, PNG, GIF, EXIF.</p> <p>Select:</p> <ul style="list-style-type: none"> <li>■ <i>Embed</i> if the image is to be saved as part of the job.</li> <li>■ <i>Link</i> if you only want to link the image file to the job locally.</li> </ul> <p><b>NOTE:</b> The image is scaled to the size of the workspace in both dimensions.</p> <p><b>NOTE:</b> The opacity of the background image can be set using the opacity slider, which is part of the toolbar. See <i>page 23, Toolbar</i>.</p> |
| <b>Number of executions</b>   | Specify the job repetitions for jobs with this preset.  |
| <b>Repeat</b>   | Activate the option if jobs with this preset are to be executed in an endless loop.   |

Tab. 7.1: RG-019

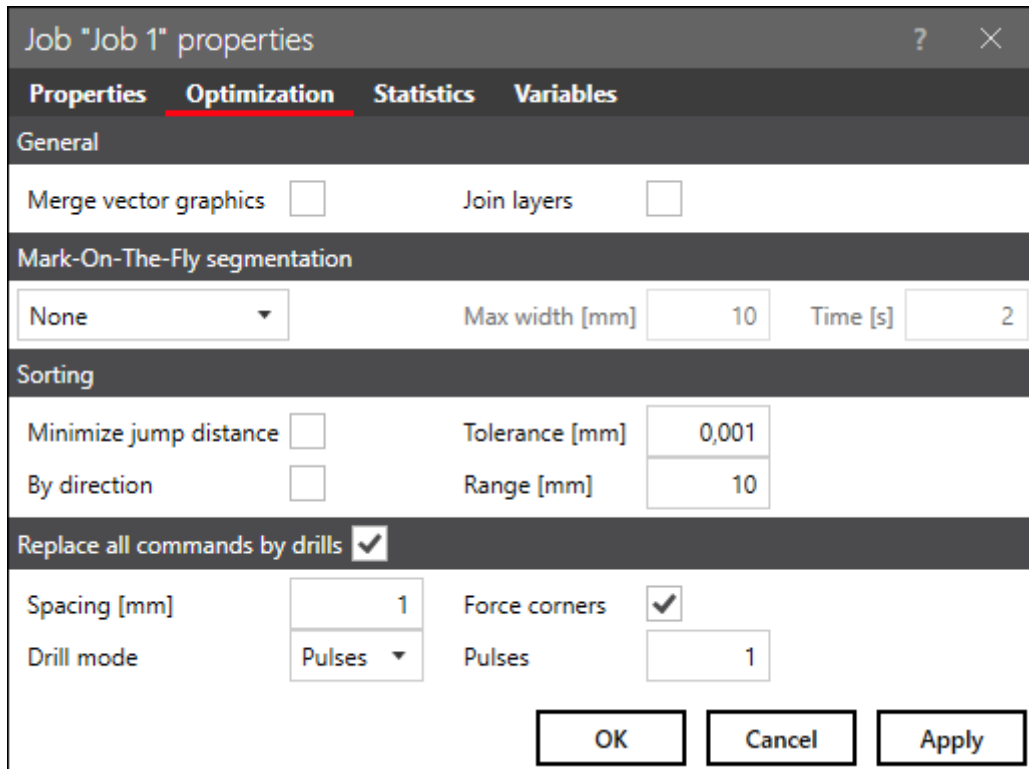
### 7.1.2.2 MOTF

| Setting                | Explanation  |
|------------------------|--|
| Enable Mark-On-The-Fly | For explanations and settings for Mark-On-the-Fly (MOTF), see <i>page 268, MOTF Jobs</i> . |
| Start trigger          |  |
| Distance               |  |
| Repeat trigger         |  |
| Execution pitch [mm]   |  |

Tab. 7.2: RG-072

### 7.1.2.3 Optimizations

On the following tab, you can define a selection of optimizations that are performed by RAYGUIDE in the background and before actual execution on the control card.



Job "Job 1" properties

Properties **Optimization** Statistics Variables

General

Merge vector graphics  Join layers

Mark-On-The-Fly segmentation

None Max width [mm] 10 Time [s] 2

Sorting

Minimize jump distance  Tolerance [mm] 0,001

By direction  Range [mm] 10

Replace all commands by drills

Spacing [mm] 1 Force corners

Drill mode Pulses Pulses 1

OK Cancel Apply

Fig. 7.4: RG-AFA

| Setting  | Explanation   |
|--|---|
| <b>General</b>   |   |
| Merge vector graphics  | <p>Merges all vector graphics to one graphic object.</p> <p>When merging, the following rules must be observed: If objects vary in their main settings (such as <i>sequences</i> or <i>binning</i>), they are not merged. If automation objects are placed in the job tree between vector objects, the collection of the objects to be merged is terminated.</p> <p><b>RECOMMENDATION:</b> Use this option if your job encompasses multiple objects that are not sorted in the process order and the job with the MOTF condition is to be executed since the "<i>Sort by direction</i>" option sorts the paths per individual object and layer.</p> |
| Join layers  | <p>Activate this option if, for example, you want to ensure that concatenated paths are merged in advance.</p> <p><b>RECOMMENDATION:</b> Use this option if your job encompasses objects with multiple layers and the job with the MOTF condition is to be executed since the "<i>Sort by direction</i>" option sorts the paths per individual object and layer.</p>  |
| <b>Mark-On-The-Fly</b>   |   |
| Segmentation mode  | See page 274, <i>MOTF Optimizations</i> .   |
| Max. Width [mm]  |   |
| Time [s]   |   |
| <b>Sort</b>  |   |
| Minimize jump distance   | Activate this option to ensure that concatenated paths are merged and jumps are re-sorted to avoid superfluous jumps.   |
| By direction   | See page 274, <i>MOTF Optimizations</i> .   |
| <b>Replace all commands by drill holes</b>   |   |
| <p>If this option is activated, contour lines are automatically replaced with drill holes when the job is executed. The following fields are then available for required specifications.</p> |   |
| Spacing [mm]   | For details, see page 199, <i>Related settings</i>  |
| Force corners  |   |
| Drill mode   |   |
| Pulse / Time   |   |

Tab. 7.3: RG-073



## 7.2 Job Content Creation

### 7.2.1 Graphic job design

A graphic design, defined for a laser process is always part of a specific job.

All created or imported layout elements are displayed in the viewport by contour lines. Bitmaps are displayed as gray scale images. Drill dots are represented by small crosses.

Each layout element is also listed in the job tree on the Jobs panel.

#### 7.2.1.1 Objects Overview

Graphic elements which make up the processing geometry are called objects.

For a detailed description of the graphic elements, refer to *page 121, Basic Marking Objects* and *page 122, Extended Marking Objects*.

Essential types of graphic objects:

- **Vector:** Geometric object made of lines. Examples: Circle, polygon.  
**Pre-formed** vector objects (as available in the object toolbar) are described by mathematical properties (e. g. diameter).  
**Free-shaped** vector objects (often imported from a graphics file) are made out of layer(s), path(s), path elements(s), and the vector coordinates.  
Text and code objects are made of vectors, too, defined by the actual text / code content.
- **Drill points:** A single laser emission point or a free grid of laser emission points.
- **Bitmaps:** A raster image that is processed as a line of image points (pixels), where the pixel intensity generates the picture contrast.
- **Graphic content of a SP-ICE-3 log file.**

Besides graphic objects, the following special object types are available:

- **Automation objects** – see *page 210, Automation Objects*.
- **Containers** – refer to *page 247, Containers*.

**NOTE on buttons:**

After RAYGUIDE is installed, the buttons are not displayed for all objects by default. The required buttons can be added or deselected at any time in the **View > Objects** menu.




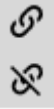

### 7.2.1.2 Job Panel

This panel provides an overview of the major job settings. To open the settings dialog directly from the current job, simply double-click in this area.

Below the Job overview, the assigned control cards are shown. To open the control card dialog directly, double-click on the corresponding control card entry.

#### Job tree and its controls

All objects which are part of a job are listed in the job tree on the Job panel. The default order is the sequence in which they have been added.

| Setting   | Explanation   |
|---|---|
| <b>Tree controls</b>  |   |
|   | Use the <b>[Expand] / [Collapse]</b> buttons to expand or collapse all freely shaped marking objects in a single step across all hierarchy levels.  |
|  | Use the <b>[Up] / [Down]</b> arrow keys to navigate step-by-step through the job elements and their individual thumbs.<br><b>NOTE:</b> Collapsed hierarchy elements are automatically expanded.<br>Instead, use the up / down arrow keys of the keyboard if you only want to scroll, step-by-step, in the currently expanded hierarchy of the tree. |
|  | Use the <b>[Hide / Unhide all]</b> buttons to hide / show all current graphic objects in the viewport.<br>This option has priority over the single object setting.  |
|  | Use the <b>[Lock / Unlock all]</b> buttons to lock all current graphic objects in the viewport against mouse modifications in the viewport.<br>This option has priority over the single object setting.<br><b>NOTE:</b> Locked objects are always displayed with less intensity.  |
|  | Use the <b>[Reverse order]</b> button to reverse the order of all current job elements.   |

Tab. 7.4: RG-069

To re-arrange the order of the objects according to process requirements, use the mouse to pull the objects to the desired position in the tree. Multi-selection is possible.

Free-formed vector objects are always structured in the hierarchy (object > layer > path > path element). They can be expanded or collapsed by using the arrow symbols left of the object names.

Each single layout object listed in the job tree also provides single action buttons again to hide / show and lock / unlock the object in the viewport.

### Object tooltip

For a better overview, a tooltip that shows some information about the object is displayed when the mouse is hovered over the object.

Example 1

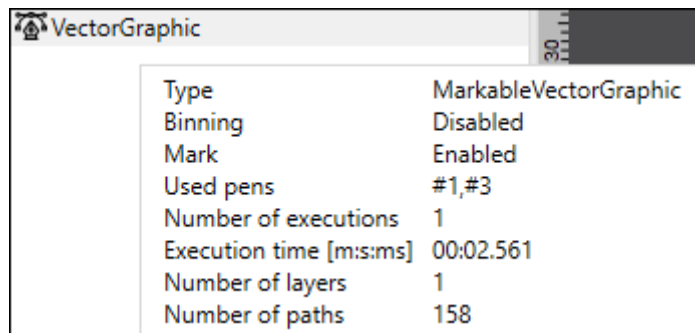


Fig. 7.5: AFK

Example 2

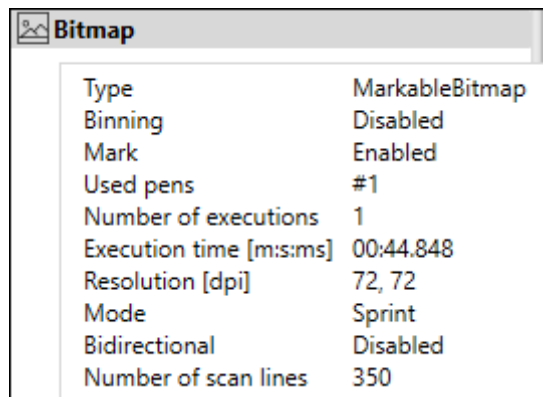


Fig. 7.6: AFL

Example 3

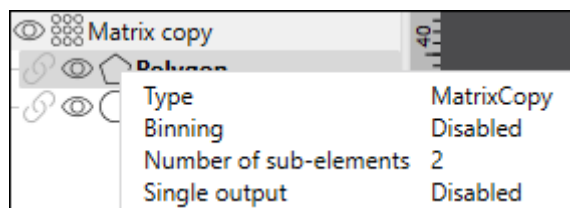


Fig. 7.7: AFM

### 7.2.1.3 Objects Panel

The objects panel (like the equivalent Objects menu) offers buttons to add objects to the job content or draw markable objects.

The panel is divided into 4 sections separated by a red line at the top border of its section. Its appearance can be rearranged in various ways:

- A double-click on the red line collapses or expands the section.
- The order of the sections can be rearranged. To do this, drag the red line of a section to another red line.
- The buttons within each section can also be rearranged with the mouse.

#### 7.2.1.3.1 Adding an object from the panel

- Click on an object button. The Properties dialog of the respective object then opens. It contains tabs for settings, pens, fills and statistics (if available).

When the settings are made, press the **[Apply]** button.

The object is created and shown in the job tree and in the viewport (in the centre of the workspace if no offset has been defined).

- A right click on the triangle corner opens the action menu. To add an object, select **Create**, and the object properties dialog also opens.

When the settings are made, press the **[Apply]** button.

The object is created and shown in the job tree and in the viewport (in the centre of the workspace if no offset has been defined).

- With the left mouse button, drag and drop the object into the viewport. The object appears at the workspace position where it was dropped. In the job tree, the object is inserted after the last existing object.
- With the left mouse button, drag and drop the object into the job tree. This way, the object is inserted in the targeted position in the job tree. In the viewport, the object is positioned in the centre of the workspace if no standard object of this object with offset has been defined.

**NOTE:** When a layout object was saved as a default template (see *page 218, Templates*) the settings of a newly added layout object will match the template. In addition, Filling and Transformation may be predefined in a template.

### 7.2.1.3.2 Draw an Object from the Panel

The small triangle corner indicates all markable objects that can be added or drawn:

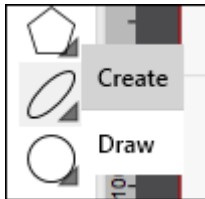


Fig. 7.8: RG-ADI

Click on the corner and select **Draw** if you want to draw the object with the mouse cursor.

| Drawing of objects             |   |
|--------------------------------|---|
| Line                           | Define the start and end points of the line by clicking on the corresponding positions in the viewport.<br><b>NOTE:</b> If you want to draw a line chain, use the drawing mode of the vector graphic.   |
| Rectangle                      | Define the first and second (diagonal) corners of the rectangle by clicking on the corresponding positions.<br>Press <b>[Ctrl]</b> to fix the X/Y ratio.<br>When drawing, the general default settings of the object are still used (see object-related settings).            |
| Circle, Ellipse                | Define the first and second (diagonal) corners of the object bounding box by clicking on the corresponding positions.<br>Press <b>[Ctrl]</b> to fix the X/Y ratio.  |
| Polygon, Spiral, Content, Code | Define the first and second (diagonal) corners of the object bounding box by clicking on the corresponding positions.<br>Press <b>[Ctrl]</b> to fix the X/Y ratio.<br>When drawing, the general default settings of the object are still used (see object-specific settings). |

| Drawing of objects                |  |
|-----------------------------------|--|
| Vector graphic, SP-ICE-3 protocol | <p>First, define the start position of a path by clicking on the corresponding positions (a single blue point appears). Right-click on the point to open the context menu for drawing paths:</p> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p>Add line</p> <p>Add circular arc</p> <p>Add elliptical arc</p> <p>Add quadratic curve</p> <p>Add cubic curve</p> </div> <p>The path can now be compiled using basic graphic commands: Line, circular arc, elliptical arc, quadratic curve and cubic curve.</p> <p>Keep <b>[Ctrl]</b> pressed as long as you want a chain of the same graphic commands.</p> <p>Keep <b>[Shift]</b> pressed to draw vertically / horizontally only.</p> <p><b>RULE:</b> Each new graphic command is always appended at the end of the path.</p> |

Tab. 7.5: RG-067

#### 7.2.1.4 Object Properties Dialog

To open an object settings dialog:

- Double-click the object in the job tree or in the viewport.
- Right-click the object and select **[Properties]** from the context menu.
- Select the object and press **[F5]**.

The figure shows the object panel on the left, the workspace with an ellipsoidal object with its outer enclosing rectangle (red), and the ellipsoid's **[Properties]** dialog:

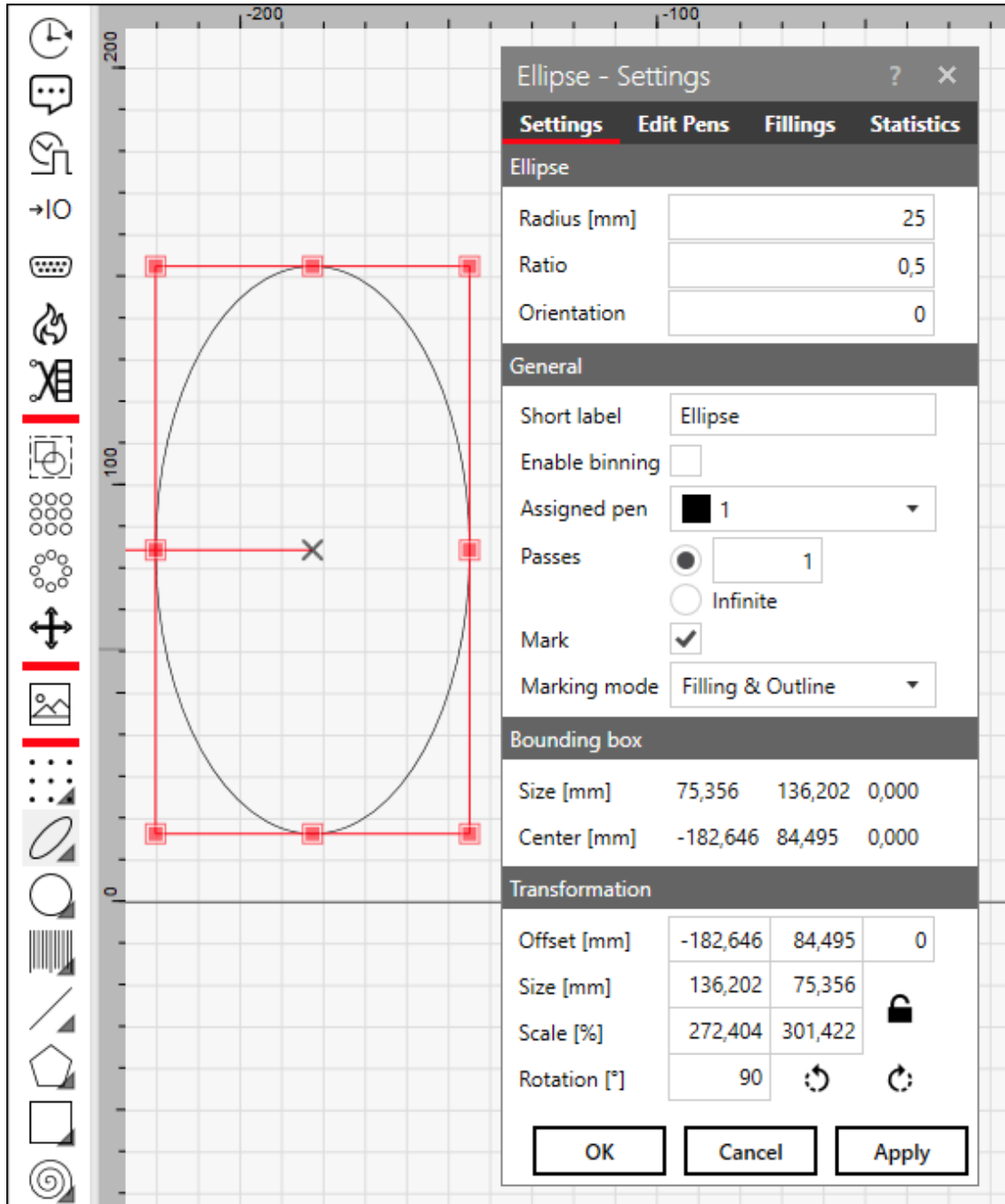


Fig. 7.9: RG-ABI

The object settings dialog provides the following tabs:

- Properties  
For further information, refer to the following sections of this manual in the appropriate chapter for the respective object type.
- Pens  
For details, see *page 228, Pen Properties*.
- Fillings (optional)  
Layout objects that contain closed outlines / paths can also fill these areas with a line patterns, so-called fillings.  
For further information on fillings, refer to *page 159, Object Fillings*.

### **Transformations**

Every layout object carries transformation information:

- The object's offset and therefore the position of the object centre with respect to the workspace origin.
- The object's size and scaling factor and thus the ratio with respect to the original size (after adding or importing a layout object).
- The angle of the object's coordinate system in regard to the workspace coordinate system.

For further information on transformations, refer to *page 168, Object Transformation*.

#### **7.2.1.5 Object Statistics Tab**

On this tab, you can display the object-related statistics. Detailed information on the provided values is explained on *page 266, Job Statistics*.

#### **7.2.1.6 Vector List Panel**

To open the Vector list panel, click the corresponding tab next to the job panel.

The Vector list panel shows the absolute coordinates of paths plus the end coordinate of each path element of the currently selected object.







Coordinates are rounded to one decimal digit. Bitmaps provide no vector information.



## 7.2.2 Basic Marking Objects

### Basic objects and their essential settings

Simple objects in the arrangement are pre-formed vector objects that can be displayed and edited using a single graphic command.

| Object type / Button in panel |   | Essentially defined by (mathematic properties)  |
|-------------------------------|---|---|
| Line                          |    | Length [mm]   |
| Rectangle                     |    | Width, height [mm], Corner radius [mm] (for rounded corners)  |
| Polygon                       |    | Type (regular or star shaped), Radius outer circle [mm], Corner radius [mm] (for rounded corners), number of edges  |
| Circle                        |   | Radius [mm]   |
| Ellipse                       |  | Radius [mm], Ratio, Orientation   |
| Spiral                        |  | Radius [mm], Pitch [mm], Chord length [mm], Start angle [°], Inner radius [mm], Turn direction, Feed direction<br>The chord length controls how smooth the spiral is rounded by defining the length of the polyline segments. |

Tab. 7.6: RG-023

### Additional settings

Additional settings include:

- Common settings for all marking objects; refer to *page 153, Common Properties of Marking Objects*.
- For transformations; refer to *page 168, Object Transformation*.

## 7.2.3 Extended Marking Objects

Compared to basic objects, extended marking objects are more complex and have more properties.

- Drills (see page 122, *Drill*)
- Texts (see page 123, *Text*)
- Barcodes (see page 129, *Barcode*)
- Vector graphics (see page 134, *Vector Graphic*)
- Bitmaps (see page 148, *Bitmap*)

### 7.2.3.1 Drill



Button

A drill object is used to apply the laser beam to one or more points on the material, for example, to drill a hole or mark a dot / dot array.

#### Essential settings

| Setting   | Description   |
|---|---|
| <b>Drill</b>  |   |
| Mode  | <i>Pulse:</i> The dwell time per drill point is defined on the basis of the number of pulses and the frequency defined in the pen and the resulting pulse period.<br><i>Time:</i> The dwell duration per drill point is defined directly as the target value. |
| Pulses / Time   | Number of laser pulses or duration [ms]   |
| <b>Import</b>   |   |
| A table of X-Y coordinates can be imported (CSV, TXT), defining a drill pattern. Click the <b>[Import]</b> button to select a file. The <b>[Reset]</b> button dismisses the pattern and returns to a single drill point mode.<br><b>NOTE:</b> The first line of the import file must already contain coordinates (no text / headlines).<br>If you aim for a pattern with regular distances in both X and Y directions, you may integrate the drill object in a matrix copy container. See page 247, <i>Containers</i> . |   |
| Unit  | Unit to be applied to the coordinates being imported.   |

Tab. 7.7: RG-024

#### Additional settings

Additional settings include:

- Common settings for all marking objects; refer to page 153, *Common Properties of Marking Objects*.
- For transformations; refer to page 168, *Object Transformation*.

## 7.2.3.2

**Text**

A text object adds text, numbers, and date / time items to your job.



Button

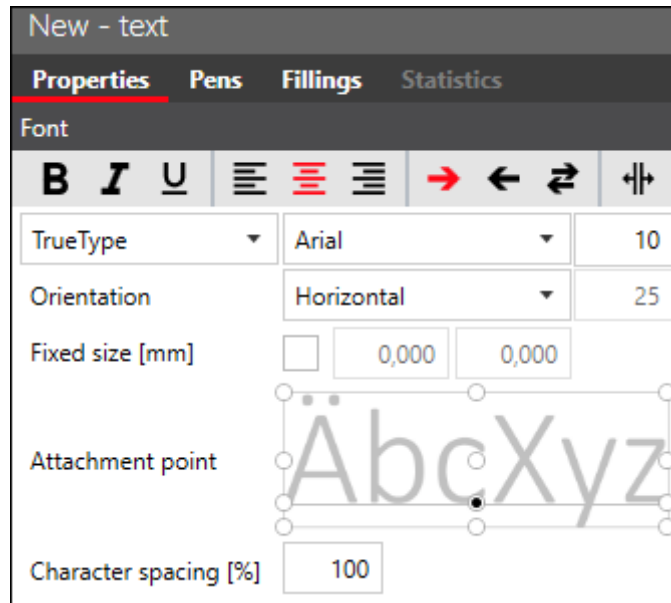




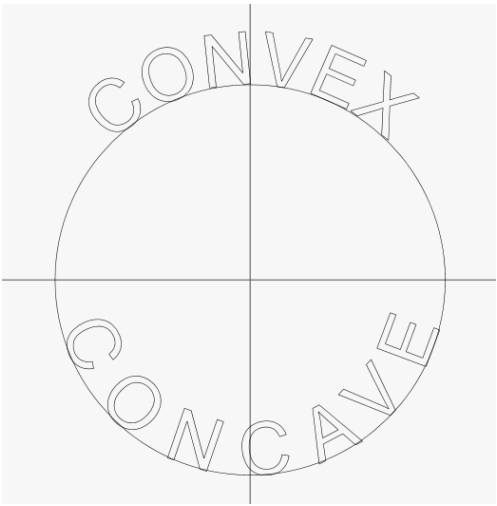

**Essential settings**

Fig. 7.10: RG-ADU

| Setting   | Description  |
|---|--|
| <b>Text style icons</b>   |  |
| <b>B I U</b>  | Use the well-known buttons to define a <b>bold</b> , <i>italic</i> , <u>underlined</u> text style.<br><b>NOTE:</b> The underlined style is not available for circular text. Each style will always apply to the entire text content. |
| <b>Multiline adjustment icons</b>   |  |
|  | Use the well-known buttons to define whether multi-line text is left-, centre- or right-aligned.   |
| <b>Process direction icons</b>  |  |
|  | Use the buttons to define whether all text lines are processed from left to right, from right to left or in both directions.   |

| Setting   | Description   |
|---|---|
| <b>Textsetting icon</b>   |   |
|  | Use the button to actively prevent font-specific ligatures as well as undercuts.  |
|   | <p>Example ligature:</p>   |
| <b>Font</b>   |   |
| Type  | True Type fonts are defined by a contour. All True Type fonts installed on the PC are available.<br>Stroke fonts are simple lines, provided internally by RAYGUIDE. |
| Font name   | Select the font to be applied.  |
| Font height [mm]  | The value defines the height of the font based on the upper case character "M".   |

| Setting     | Description  |
|-------------|--|
| Orientation | <p>Defines the layout of the text characters:</p> <ul style="list-style-type: none"> <li>■ <i>Horizontal</i>: The characters are arranged next to each other (= default setting).</li> <li>■ <i>Stacked</i>: The characters are arranged one below the other.</li> <li>■ <i>Convex</i>: The characters are arranged on the outside of a circular path.</li> <li>■ <i>Concave</i>: The characters are arranged on the inside of a circular path.</li> </ul> <div style="display: flex; justify-content: space-around; align-items: center;">  <div style="text-align: center;">  </div> </div> |
| Radius [mm] | Specification of the radius in [mm] for concave / convex text layout.  |

| Setting               | Description   |
|-----------------------|---|
| Fixed size [mm]       | <p>Specify a fixed frame size into which the text content must fit, independent of the number of characters and text size.</p> <p><b>NOTE:</b> If you only wish to fix the text length, but the text height is to be a function of the type size, enter the fixed text length as an X value for the frame and "Zero" or the Y value.</p> <p><b>NOTE:</b> This option can only be used with horizontally arranged or stacked text.</p>   |
| Fixed angle [°]       | <p>Specify a fixed angle in which the radially arranged text content should fit, regardless of the number of characters.</p> <p><b>NOTE:</b> This option can only be used with concave or convex text.</p>  |
| Attachment point      | <p>Click on one of the fixation points:</p> <ul style="list-style-type: none"> <li>■ <i>Left / Centre / Right point:</i> The text is enlarged from this point.</li> <li>■ <i>Upper / Basic / Lower point:</i> The text is fixed for all character heights on this line.</li> </ul> <p>If the text varies in length, its fixation point is also adjusted.</p>  |
| Character spacing [%] | <p>Spacing of characters in percent. Values greater than 100% increase the spacing predefined by the font, values less than 100% decrease the spacing.</p>  |
| <b>Data</b>           |   |
| Source                | <p>Select a source for the text.</p> <p><b>String:</b> The text as entered from the Text field below.</p> <p><b>File:</b> Text from a source file. In the file, the text can run over one line or over multiple lines. Multiple lines are used with the following settings:</p> <ul style="list-style-type: none"> <li>■ <i>Start:</i> The number of the line in the source file to start with.</li> <li>■ <i>Increment:</i> Delta of lines after the batch has been processed.</li> <li>■ <i>Batch:</i> The increment is only applied after n executions.</li> <li>■ <i>File:</i> To select the data source file (TXT, CSV format)</li> <li>■ <i>Current iteration:</i> Displays the current increment status.</li> <li>■ <i>Auto reset:</i> <ul style="list-style-type: none"> <li>– <i>Never</i></li> <li>– <i>[Execute]</i> &gt; Resets the iteration value every time a job is executed.</li> <li>– <i>Load</i> &gt; Resets the iteration value whenever a job is loaded.</li> </ul> </li> <li>■ Checkbox "<i>Wrap around</i>": Enable this tab if you want to continue again with the first line of the source file when the end of the source file is reached.</li> <li>■ Checkbox "<i>Cache</i>": This tab is set by default, as RAYGUIDE usually caches the content of the source file in the working memory. Disable the tab if you want to edit the content of the source file during runtime.</li> </ul> <p><b>Date:</b> Select one of various date format presets. In the Format field, Custom and Sortable formats can be manually edited.</p> <p><b>Increment:</b> Creates a number that will be incremented as follows.</p> |

| Setting | Description   |
|---------|---|
|         | <ul style="list-style-type: none"> <li>■ <i>Start</i>: Number to start with.</li> <li>■ <i>Increment</i>: Delta in counter after the batch has been processed.</li> <li>■ <i>Batch</i>: The increment is only applied after n executions.</li> <li>■ <i>Digits</i>: How many leading zeros are added to the number.</li> <li>■ <i>Current iteration</i>: Displays the current increment status.</li> <li>■ <i>Auto reset</i>: <ul style="list-style-type: none"> <li>– <i>Never</i></li> <li>– <i>[Execute]</i>: Resets the iteration value every time a job is executed.</li> <li>– <i>Load</i>: Resets the iteration value whenever a job is loaded.</li> </ul> </li> </ul> <p><b>Custom:</b> Text-, number characters and date / time items can be combined. Click the <b>[Placeholder]</b> drop-down list to display a list with predefined placeholders for several formats. You may combine them according to your needs.</p> <p>In addition, the content of variables can be inserted by means of syntax % <b>(NameVariable)</b>. The content of variables can be assigned via pop-up dialogs (dynamic – see page 212, <i>Dialog</i>), via the job settings (static – see page 267, <i>Job variables</i>) or via a text- / code object (dynamic).</p> <p><b>NOTES:</b></p> <ul style="list-style-type: none"> <li>■ The assignment of the variable content must be done in the job flow before the variable is inserted.</li> <li>■ The variable name is case sensitive.</li> <li>■ The variable and its content are also listed on the Variables tab of the job properties (see page 267, <i>Job variables</i>).</li> </ul> <p>Optional fields in case the custom string contains an incrementing number:</p> <ul style="list-style-type: none"> <li>■ <i>Start</i>: Number to start with.</li> <li>■ <i>Increment</i>: Delta in counter after the batch has been processed.</li> <li>■ <i>Batch</i>: The increment is only applied after n executions.</li> <li>■ <i>Digits</i>: How many leading zeros are added to the number.</li> <li>■ <i>Current iteration</i>: Displays the current increment status.</li> <li>■ <i>Auto reset</i>: <ul style="list-style-type: none"> <li>– <i>Never</i></li> <li>– <i>[Execute]</i> &gt; Resets the iteration value every time a job is executed.</li> <li>– <i>Load</i> &gt; Resets the iteration value whenever a job is loaded.</li> </ul> </li> </ul> <p><b>NOTE:</b> The date separator character corresponds to the local format in the operating system.</p> |

| Setting                  | Description  |
|--------------------------|--|
| Content                  | Field for the definition of content. For dynamic data sources, the placeholders or even date formats are displayed here.<br><b>NOTE:</b> The size of the text field in the dialog can be adjusted. Click on the black triangle in the lower right corner and drag it using the mouse until it reaches the desired size. Otherwise, the text will wrap automatically. |
| Add character            | Click on the label and a dialog opens to select special characters that are not part of the regular alphabet.  |
| Log                      | Available option if the content of the text is variable. You can define a file (name and location) which then logs all text content that is processed. The protocol always adds a timestamp per processed content.   |
| Resulting content        | In this line you see the resulting text that appears after you have pressed the <b>[Apply]</b> button.   |
| Save content to variable | Select if the previously defined content is to be assigned by the text object as variable content.<br>In the field next to it, specify the name of the variable.   |

Tab. 7.8: RG-025

**NOTE:** Variable text content features are not supported when a job is executed at the scan controller level.

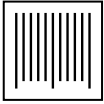
### Additional settings

Additional settings include:

- Common settings for all marking objects; refer to *page 153, Common Properties of Marking Objects*.
- For transformations; refer to *page 168, Object Transformation*.



### 7.2.3.3 Barcode



Button

The barcode is a layout element that encodes content using either a barcode (1D) consisting of lines of varying thickness, or 2D codes and filled cells.

#### Essential settings

| Setting   | Description  |
|---|--|
| <b>Barcode</b>  |  |
| Type  | List of all available standard code types. The last three code types used are shown in extra list on top.<br>The most common 2D codes like Datamatrix, QRCode, MicroPDF, PDF417, as well as common barcodes like Code 128, Codabar and many more are offered.                          |
| Optional code settings: Depending on the selected code type, one or more optional settings are available. A detailed explanation of their purpose and the available parameters can be found in the code library manual contained in this PDF.<br>Below, some of the generic settings are explained. |  |
| Subset  | Some codes are grouped to certain types. The specific code is defined here, for example: Type = Postal > SubType = AustralianPstRouting<br>See the code library manual for details.  |
| Narrow wide ratio   | Defines the ratio of narrow gaps / bars to the wide gaps / bars.<br>The range of values extends from 2 to 3.<br><b>NOTE:</b> This parameter is available only for some barcodes.   |
| Bar width reduction [%]   | Reduces the bar width of all bars by as much in absolute terms as the percentage drop in relation to the narrowest bar.<br>The parameter can be used to compensate the laser spot width for very narrow code bars.<br><b>NOTE:</b> This parameter is available only for some barcodes. |
| Code format   | Format that is available for some code types.  |
| Size mode   | Choose if you want to fix the size of the 2D code or the size of a code cell.  |
| Cell size [mm]  | Enter the size of code cells in [mm].<br>Usable only for 2D codes  |
| Size  | Enter the size of the complete code in [mm].<br>For other codes than 2D, the size value refers to the X-dimension.   |

| Setting                    | Description   |
|----------------------------|---|
| Invert                     | Inverts the appearance of the code pattern. If inverted, it is recommended to define the "Quiet zone" as well to have a black frame surrounding the code pattern. Useful when marking on a dark material.   |
| Quiet zone [cells]         | An area free of any printing or marks that precedes the start character of a barcode and follows the stop character of the barcode.<br>See the code library manual for details.   |
| Translate escape sequences | Check this box if you want to use non-printable or special characters in a barcode, preceded by an escape sequence, e.g. a backslash. It is recommended to specify the values for the ASCII characters primarily in HEX format and not in decimal format.<br><br>Some typical examples are:<br>GS (Group Separator) = \x1d<br>RS (Record Separator) = \x1e<br>EOT (End of Transmission) = \x4 |
| Show text                  | This option is only available for 1D barcodes.<br><br>Deselect this option if the code is to be created without the readable text. Otherwise, it will be included with the 1D barcode by default.   |

| Setting     | Description  |
|-------------|--|
| <b>Data</b> |  |
| Source      | <p>Select a source for the text.</p> <p><b>String:</b> The text as entered from the Text field below.</p> <p><b>File:</b> Text from a source file. In the file, the text can run over one line or over multiple lines. Multiple lines are used with the following settings:</p> <ul style="list-style-type: none"> <li>■ <b>Start:</b> The number of the line in the source file to start with.</li> <li>■ <b>Increment:</b> Delta of lines after the batch has been processed.</li> <li>■ <b>Batch:</b> The increment is only applied after n executions.</li> <li>■ <b>File:</b> To select the data source file (TXT, CSV format)</li> <li>■ <b>Current iteration:</b> Displays the current increment status.</li> <li>■ <b>Auto reset:</b> <ul style="list-style-type: none"> <li>– <i>Never</i></li> <li>– <i>[Execute]</i> &gt; Resets the iteration value every time a job is executed.</li> <li>– <i>Load</i> &gt; Resets the iteration value whenever a job is loaded.</li> </ul> </li> <li>■ Checkbox "<i>Wrap around</i>": Enable this tab if you want to continue again with the first line of the source file when the end of the source file is reached.</li> <li>■ Checkbox "<i>Cache</i>": This tab is set by default, as RAYGUIDE usually caches the content of the source file in the working memory. Disable the tab if you want to edit the content of the source file during runtime.</li> </ul> <p><b>Date:</b> Select one of various date format presets. In the Format field, Custom and Sortable formats can be manually edited.</p> <p><b>Increment:</b> Creates a number that will be incremented as follows.</p> <ul style="list-style-type: none"> <li>■ <b>Start:</b> Number to start with.</li> <li>■ <b>Increment:</b> Delta in counter after the batch has been processed.</li> <li>■ <b>Batch:</b> The increment is only applied after n executions.</li> <li>■ <b>Digits:</b> How many leading zeros are added to the number.</li> <li>■ <b>Current iteration:</b> Displays the current increment status.</li> <li>■ <b>Auto reset:</b> <ul style="list-style-type: none"> <li>– <i>Never</i></li> <li>– <i>[Execute]</i>: Resets the iteration value every time a job is executed.</li> <li>– <i>Load</i>: Resets the iteration value whenever a job is loaded.</li> </ul> </li> </ul> <p><b>Custom:</b> Text, number characters and date / time items can be combined. Click the <b>[Placeholder]</b> drop-down list to display a list with predefined placeholders for several formats. You may combine them according to your needs.</p> |

| Setting | Description  |
|---------|--|
|         | <p>In addition, the content of variables can be inserted by means of syntax % <b>(NameVariable)</b>. The content of variables can be assigned via pop-up dialogs (dynamic – see <i>page 212, Dialog</i>), via the job settings (static – <i>page 267, Job variables</i>) or via a text- / code object (dynamic).</p> <p><b>NOTES on variables:</b></p> <ul style="list-style-type: none"> <li>■ The assignment of the variable content must be done in the job flow before the variable is inserted.</li> <li>■ The variable name is case sensitive.</li> <li>■ The variable and its content are also listed on the Variables tab of the job properties (see <i>page 267, Job variables</i>).</li> </ul> <p>Optional fields in case the custom string contains an incrementing number:</p> <ul style="list-style-type: none"> <li>■ <i>Start</i>: Number to start with.</li> <li>■ <i>Increment</i>: Delta in counter after the batch has been processed.</li> <li>■ <i>Batch</i>: The increment is only applied after n executions.</li> <li>■ <i>Digits</i>: How many leading zeros are added to the number.</li> <li>■ <i>Current iteration</i>: Displays the current increment status.</li> <li>■ <i>Auto reset</i>: <ul style="list-style-type: none"> <li>– <i>Never</i></li> <li>– <i>[Execute] &gt;</i> Resets the iteration value every time a job is executed.</li> <li>– <i>Load &gt;</i> Resets the iteration value whenever a job is loaded.</li> </ul> </li> </ul> <p><b>NOTE:</b> The date separator character corresponds to the local format in the operating system.</p> |

| Setting                  | Description  |
|--------------------------|--|
| Content                  | Field for the definition of content. For dynamic data sources, the placeholders or even date formats are displayed here.<br><b>NOTE:</b> The size of the text field in the dialog can be adjusted. Click on the black triangle in the lower right corner and drag it using the mouse until it reaches the desired size. Otherwise, the text will wrap automatically. |
| Add character            | Click on the label and a dialog opens to select special characters that are not part of the regular alphabet.  |
| Resulting content        | In this line you see the resulting code content that appears after you have pressed the <b>[Apply]</b> button.   |
| Log                      | Available option if the content of the text is variable. You can define a file (name and location) which then logs all text content that is processed. The protocol always adds a timestamp per processed content.   |
| Save content to variable | Select if the previously defined content is to be assigned by the text object as variable content.<br>In the field next to it, specify the name of the variable.   |
| Statistics               | <i>Characters</i> = Displays the number of characters from the defined content, as the code size depends on it.<br><i>Cells</i> = Displays the number of cells per code row / column (available only for 2D codes)   |

Tab. 7.9: RG-026

**NOTE:** Variable code content features are not supported when a job is executed at the scan controller level.

### Additional settings

Additional settings include:

- Common settings for all marking objects; refer to *page 153, Common Properties of Marking Objects*.
- For transformations; refer to *page 168, Object Transformation*.

### 7.2.3.4

## Vector Graphic



Button

A vector graphic consists of a collection of geometric figures such as lines, polylines, Bezier-curves, circles and ellipses, which can be mathematically described. Some vector graphics can also contain text elements.

### Structure of vector graphics

A vector graphic always has a hierarchical structure:

Object> Layer> Path> Path element

A layer is a group of paths; a path is a chain of path elements. Path elements consist of graphic commands or action commands. A graphic command is a mathematically described geometric figure.

This manual refers to layers, paths, and graphic commands as (graphic) elements.

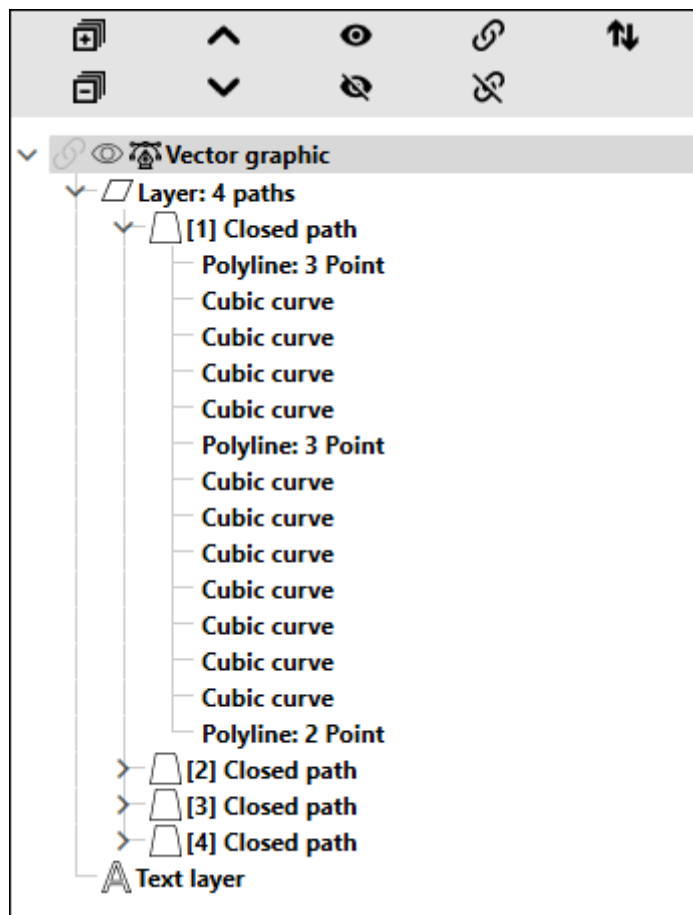


Fig. 7.11: RG-ADA

- Level: All graphics content is contained in one or more layers. A layer contains one or more paths. Its geometry level entry also displays the count of its paths.

- Text layer: Represents a special form of the "Layer" hierarchy, since this layer does not consist of the classic paths, but of a text element. The text element has all the properties described in *page 123, Text*, but is an integral part of the vector graphic. This type of layer is mostly used when importing corresponding graphic files.
- Path: A path is a continuous line or outline (straight and / or curved) that can be processed with continuous laser emission. A path can be open (start and end point are not identical) or closed. All path segments are described by commands.
- Path element: A path element is either a geometrical object (graphic command, described mathematically) or a process-related instruction (action command).

There are 5 graphic commands and 2 action commands.

| Path elements  |   |
|--|---|
| <b>Graphic commands</b>  |   |
| Polyline   | A straight line or combination of straight lines defined by vector coordinates. |
| Circular arc   | A segment of a circle defined by an angle and the centre point.                 |
| Ellipse  | A curve surrounding two focal points.   |
| Quadratic curves   | A parabola that is the graph of a quadratic function.                           |
| Cubic curve  | A curve described by cubic equations.   |
| <b>Action commands</b> (control the laser behaviour in a path) |   |
| <i>Laser on</i>  | Switches the laser on for a defined amount of time. Similar to a drill object.  |
| <i>Change pen</i>  | Selects another pen to switch to different process parameters.                  |



Tab. 7.10: RG-091

**NOTE:** The start point coordinate of each graphic command is either the coordinate of the path geometry level (if first graphic command) or the end point of the previous graphic command. In the dialog for the properties of the graphic command, however, the "start point coordinate" is additionally displayed as read-only information.

**NOTE:** Some graphic commands additionally display information like length or radius.



For each type of hierarchical graphic element, a settings dialog is used to define the element's properties. Double-click an element or choose **Properties** from its context menu.

The following table explains all settings for **layers**.

| Setting  | Explanation  |
|--|--|
| Tree Icon  |  Ordinary layer<br> Text layer   |
| Index  | When adding paths: Number of the level within an object  |
| Name   | Optional name of a layer   |
| Sequences  | The sequence "inherits" the layer from the object structure layer. The process runs defined in the sequence cannot be changed in the layers structure layer, but the pens used can be changed if necessary.  |
| Mark   | Selection indicating whether this layer is to be executed with all its paths or not.<br><b>NOTE:</b> If you merge multiple layers with different settings, you obtain 2 layers: one that contains all paths to be marked, and one that contains all paths that are not to be marked. |
| <b>Tab Fillings</b>  |  |
| The layer itself can be filled with the default fill options.<br><b>NOTE:</b> Only closed areas of paths are considered by the fill routine.<br><b>NOTE:</b> When you are processing a layer, you are in the processing mode. This means that the filling will not be visible until you leave the processing mode. The layer symbol is now greyed out. |  |

Tab. 7.11: RG-027

The following table explains all settings for **paths**.

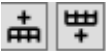



| Setting   | Explanation  |
|-----------|--|
| Tree Icon |  For closed paths<br> For open paths |
| Index     | When adding paths: Ordinal number of the path within a level   |
| Sequences | The sequence "inherits" the path from the object structure layer. The process runs defined in the sequence cannot be changed in the path structure layer, but the pens used can be changed if necessary.   |
| Location  | Coordinates of the path's start point  |



| Setting  | Explanation |
|--|-------------|
| <b>Tab Fillings</b>  |             |
| <p>A closed path itself can be filled with the standard fill options.</p> <p>Open paths can either use the inset fill with a counted number of contour lines or the filling ends at virtual closing lines.</p> <p><b>NOTE:</b> The path filling routine does not consider closed areas that arise in combination with other paths.</p> <p><b>NOTE:</b> When you are processing a path, you are in the processing mode. This means that the filling will not be visible until you leave the processing mode. The path symbol is now greyed out.</p> |             |

Tab. 7.12: RG-028

For **graphic commands**, the settings depend on the respective graphic command type. The following table explains the settings for graphic commands.

| Setting   | Explanation   |
|---|---|
| <b>Polyline</b>   |   |
|  | Adds a coordinate point before or after the actual coordinate point graphic command.                                  |
|  | Removes a point with or without closing the gap by connecting the next nearest points.                                |
|  | Moves a point up and down in the sequence of the points.  |
|  | Splits the graphic command in two polylines before the marked point.  |
| <b>Arc</b>  |   |
| Angle [°]   | Angle in degrees. Positive values turn anti-clockwise, negative values turn clockwise.                                |
| Center [mm]   | Coordinates of the virtual centre point of the arc.<br>The radius results from the distance between start and centre. |
| <b>Ellipse</b>  |   |
| Sweep angle [°]   | The angle the contour will cover.   |
| Orientation angle [°]   | The angle of the longer side axis in relation to the coordinate system of the object.                                 |
| Axes ratio  | Ratio of the longer axis to the shorter axis.   |
| Center [mm]   | Coordinate of the centre point.   |

| Setting   | Explanation   |
|---|---|
| <b>Quadratic curve</b>  |   |
| Control point [mm]  | Coordinates to define the point positions.  |
| End point [mm]  | This curve is defined using one control point.  |
| <b>Cubic curve</b>  |   |
| <b>Control point 1 [mm]</b>   | Coordinates to define the point positions.<br>This curve is defined using two control points.   |
| Control point 2 [mm]  |   |
| End point [mm]  |   |
| <b>Laser on</b>   |   |
| Same concept as with a drill object. The laser turns on for a defined amount of time. The coordinate is either the coordinate of the path geometry level (if first graphic command) or the end point of the previous graphic command. |   |
| Mode  | Select <i>Pulse</i> to enter the number of laser pulses to apply at this point.<br>Select <i>Time</i> to enter the duration of laser application at this point. |
| Pulses or Time  | Number of pulses or time in $\mu\text{s}$   |
| <b>Set pen</b>  |   |
| Pen number  | Pen (from the job's base pen set) to be used for the succeeding graphic commands. Use the <b>[Edit]</b> button to edit the pen's settings.                      |

Tab. 7.13: RG-029

You can add any hierarchy element by using the context menu of the higher-level hierarchy element. For example, use a layer's context menu to add a new path.

### Import, conversion or creation of a vector graphic

In most cases, the vector graphic is generated in a CAD or design program and imported into the workspace from a file.

To add a vector graphic to the job by import it, you have the following options to choose from in the corresponding import dialog:

- Click on **[Vector graphic]** in the object panel.
- Main menu: **File > Import > Vector graphic**
- Main menu: **Objects > Vector graphic**, and then double-click on the corresponding entry in the job tree.
- Drag the mouse from the **[Vector graphic]** button in the object panel (holding down the left mouse button) to the desired position in the job tree and then double-click the corresponding entry.

Alternatively, you can also drag the vector file(s) directly from the Explorer folder into the viewport. In this case, the import dialog is skipped for the time being, as the default settings for the import are applied.

The subsequent import dialog for vector graphics makes the following settings available:

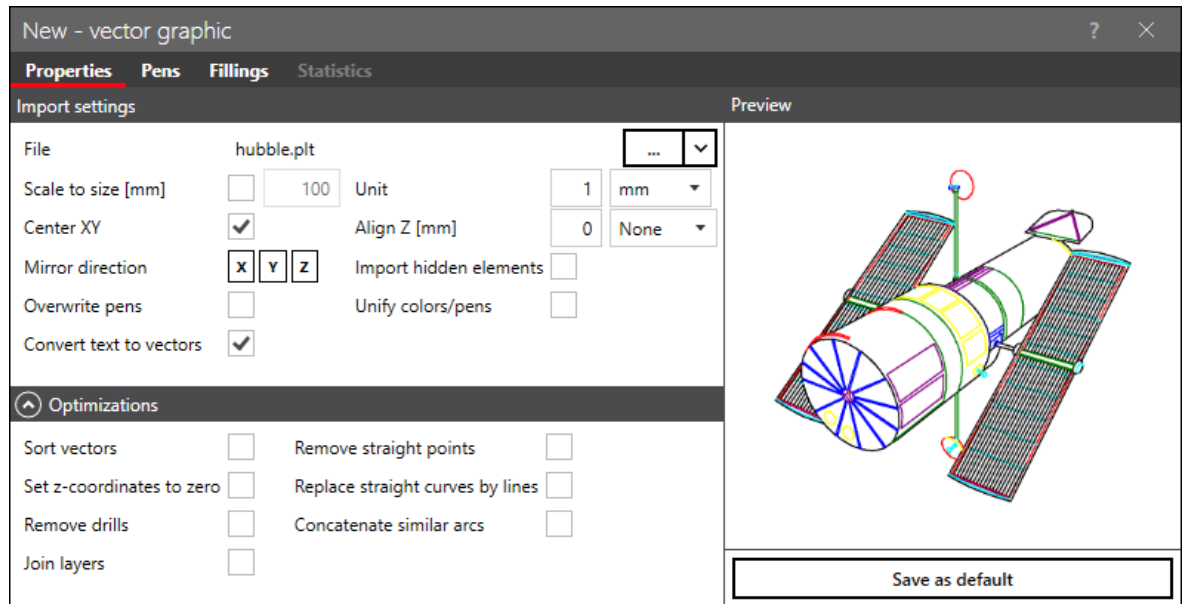


Fig. 7.12: RG-ADS

| Setting                | Description   |
|------------------------|---|
| <b>Import settings</b> |   |
| File                   | <p>Opens a file browser to navigate to the graphic file you want to import. After selecting the file, click <b>[Open]</b> in the browser and the preview displays the file content.</p> <p>If files were already previously imported, these are made available in the drop-down list for renewed selection.</p> <p>Supported file formats are: <i>DXF, PLT, SVG, DWG, CGM, HPGL, GBR, CSV*, TXT*</i>.</p> <p><b>*NOTE:</b> You can import a contour realised as polyline defined as a coordinate table: X / Y / (Z) / pen number.</p> <p>Valid separators are: Space, semicolon and “\t”.</p> |
| Scale to size          | Activate to scale the size of the imported graphic to the specified size in [mm].   |
| Unit                   | Defines the unit of the imported vectors. This is usually the value = 1 and the unit in which the layout was created. Select from [mm], [ $\mu$ m] and [inch]. A value $\neq$ 1 would additionally add a scale factor to it. Only applicable if scaling is not used.  |
| Center XY              | Incorporates the vector graphic centred on the XY axes of the workspace.  |

| Setting   | Description   |
|---|---|
| Align Z [mm]  | Specification of the Z position in [mm], according to which either the upper side, centre position or underside of the 3D vector graphic file aligns itself when importing.   |
| Import hidden elements                                | Some file formats (e.g. DXF) can contain layers marked as hidden. These layers are ignored during import by default. Use this option if to import them anyway.  |
| Mirror direction                                      | Activate the toggle buttons for the X / Y / Z direction if the vector graphic is to be mirrored accordingly when imported.  |
| Overwrite pens  | Overwrites the pens defined for the job (only the colour and the dashed line pattern setting) by the pens defined in the imported file.   |
| Unify colors/pens                                     | Assigns the job's default pen to all layout elements of the imported graphic. Thus, all original multiple colours are unified to one colour = one pen.  |
| Convert text to vectors                               | <p>If the vector graphics file contains text-based elements, these will be converted to vector-based layers during import.</p> <p>If this option is not active, text-based elements are displayed as so-called "text layers" after import.</p> <p><b>NOTE:</b> This option is active by default.</p>  |
| <b>Optimizations</b>                                  |   |
| Optimisation functions applied in the import process. |   |
| Sort vectors  | Optimises the vector order to reduce jumps and to get a time-optimised vector sequence.   |
| Set z-coordinates to zero                             | If the imported graphic contains Z coordinates that are not zero, they will be reset to zero.   |
| Remove drills   | Deletes inadvertent drill points from the graphic.  |
| Join layers   | Merges multiple layers to one layer.  |
| Remove straight points                                | <p>Deletes unnecessary intermediate points from polylines. If points are on a straight line between the end points, they can be removed. This speeds up the marking process.</p> <p>A corresponding tolerance value can be set in the system settings: <b>System &gt; Preferences &gt; User (current user), Tab Tolerances</b>, collinear distance.</p> |
| Straight curves by lines                              | <p>Converts graphic elements that are straight into straight line graphic commands.</p> <p>The corresponding tolerance value, which determines how close the curve shape equals a straight line, is defined under <b>System &gt; Preferences &gt; User (current user), Tolerances</b> tab, <i>collinear distance</i>.</p>                               |

| Setting                  | Description   |
|--------------------------|---|
| Concatenate similar arcs | Combines multiple arcs to one arc, if they appear to have same radius and the same centre coordinate.<br>The corresponding tolerance value to determine if the centre points are equal is: <b>System &gt; Preferences &gt; User (current user), tab Tolerances, Location.</b> |
| <b>[Save as default]</b> | Button to save the created settings as default settings for future imports of vector graphics.  |

Tab. 7.14: RG-030

**NOTE:** Once a vector graphic file has been imported, the object properties only provide the usual settings: General, bounding box, transformation.

### Additional settings

Additional settings include:

- Common settings for all marking objects; refer to *page 153, Common Properties of Marking Objects*.
- For transformations; refer to *page 168, Object Transformation*.

Additional layers, paths, and path elements can always be added to a vector graphic in RAYGUIDE – even after import.

It is also possible to convert a pre-shaped vector object into a free-shaped vector graphic: Open the context menu of an object and select *Convert to vector graphic*.

Alternatively, you can generate a vector graphic performing the following base-steps:

1. Add a new vector object to the job tree with no import file associated to it.
2. Add a new layer to the empty object. (**NOTE:** The layer must be of type "vector graphic" to add paths afterwards. If you add a layer of type "Text", its content is determined purely by the text properties).
3. Add a new path to an empty layer.
4. Add a new path element to an empty layer.

Another alternative is to "draw" the graphic directly, refer to *page 117, Draw an Object from the Panel*.

### 7.2.3.5 Dynamic vector graphic



Button optional,  
see page 113,  
Objects Overview

Dynamic vector graphics primarily differ by the kind of usage compared to regular vector graphics.

Every time the job is reloaded, the graphic is to be automatically imported again from the referenced source file. Likewise, when job execution is repeated, this graphic can be imported again from the referenced source file. This enables you to mark graphics that change dynamically with the changing content of the source file.

In return, the dynamic vector graphic does without the basic structure in the job tree of the regular vector graphic (Object > Layer > Path > Path element). Modifications to the graphic can only be made directly during the import using the standard import options. See page 134, *Vector Graphic*.

Dynamic vector graphics can only be added to a processing job by importing a corresponding graphic file.

- To add a dynamic vector graphic to the job by import it, you have the following options to choose from in the corresponding import dialog:
- Click on the **[Dynamic vector graphic]** button in the object panel
- Main menu: **File > [Import] > Dynamic vector graphic**
- Main menu: **Objects > Dynamic vector graphic**, and then double-click on the corresponding entry in the job tree.
- Drag the mouse from the **[Dynamic vector graphic]** button in the object panel (holding down the left mouse button) to the desired position in the job tree and then double-click the corresponding entry.

The subsequent import dialog for dynamic vector graphics makes the following settings available:

| Setting  | Explanation  |
|--|--|
| <b>Import settings</b>   |  |
| Primarily the same import settings are available to you here that are also available for the regular vector graphic; see page 134, <i>Vector Graphic</i> . |  |
| Automatic reload   | Check if the vector graphic is to be re-imported from the referenced source file every time the job execution is repeated. |
| <b>Optimizations</b>   |  |
| Optimisation functions applied in the import process.  |  |
| The same optimisation functions are available to you here that are also available for the regular vector graphic; see page 134, <i>Vector Graphic</i> .    |  |

Tab. 7.15: RG-087

**NOTES** on application:

If the changing graphics have slightly different dimensions or positions in the original graphic file, but should always be marked in the same position and more or less with the same size in the RAYGUIDE job, it is useful to use the following import settings: *Center XY* and *Scale to size*. An additional object transformation then acts equally on all automatic graphic imports.

If graphics are imported in the sequence that otherwise are partially or completely outside of the workspace area, the geometry validation will not be able to catch this. Consequently, there will also be no marking.

**NOTE** on job execution types:

The option to reload the graphic on each job execution only works in the "On PC" execution mode.

**Dynamic vector graphics within a copy container**

In general, the graphic is reloaded per copy during execution, provided that the container option *Single output* is not selected. The decisive factor here is whether you manage to exchange the contents of the referenced source file fast enough before marking of the subsequent copy starts.

**NOTE** on job file transfer:

Jobs that contain a dynamic vector graphic cannot be easily opened on another PC RAYGUIDE unless the referenced graphic file is also located in the same directory path.

**7.2.3.6**

Button optional,  
see page 113,  
*Objects Overview*

**Solid**

A solid represents a 3-dimensional volume, or its surface. The surface is described using triangular facets in the STL file format currently in use.

The solids being imported are primarily used for laser processes such as deep engraving, "in-glass marking" and additive manufacturing. The solid is always divided into horizontal slices that are processed in a specific order, and are usually also provided with a filling. The focal position is changed between the filled slice geometries. This requires the use of a corresponding deflection unit (e.g. RAYLASE FOCUSHIFTER, AXIALSCAN, AS FIBER, AM-MODULE) and the corresponding configuration with a 3-dimensional correction file.

To add a solid object to a job, you have the following options:

- Click on the **[Solid]** button in the object panel
- Main menu: **File > [Import] > Solid**
- Main menu: **Objects > Solid**, and then double-click on the corresponding entry in the job tree.
- Drag the mouse from the **[Solid]** button in the object panel (holding down the left mouse button) to the desired position in the job tree and then double-click the corresponding entry.

The subsequent import dialog for solid objects makes the following settings available:

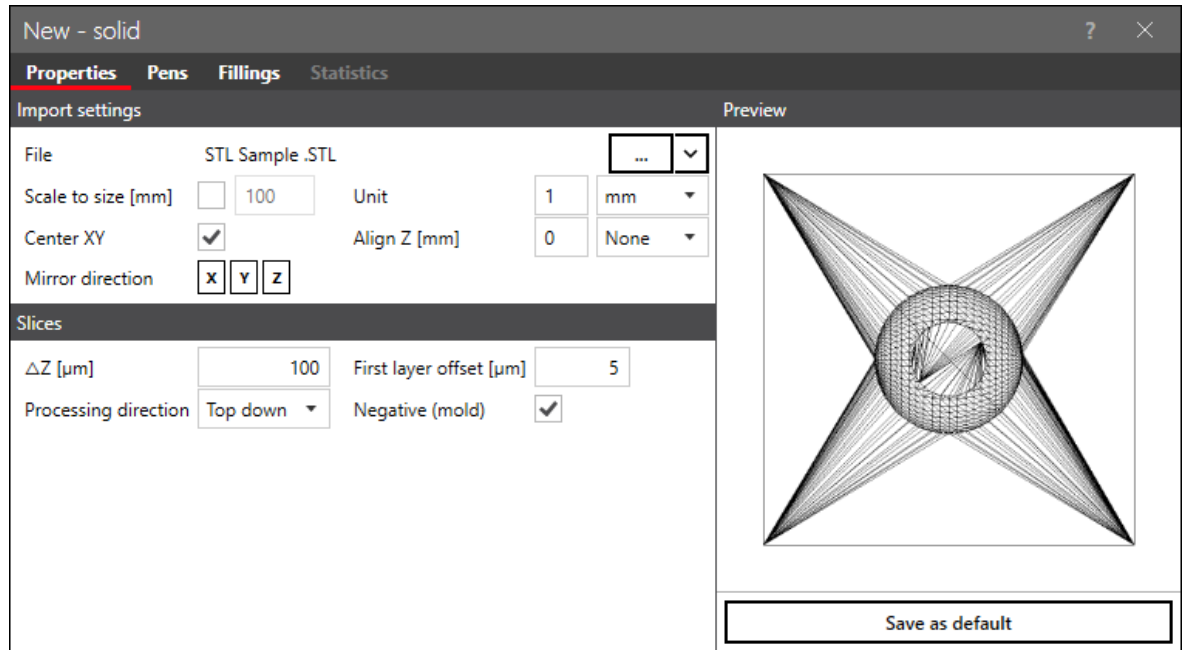


Fig. 7.13: AEN

| Setting                | Explanation   |
|------------------------|---|
| <b>Import settings</b> |   |
| File                   | <p>Opens a file browser to navigate to the file of the solid you want to import. After selecting the file, click <b>[Open]</b> in the browser. The preview displays the file content.</p> <p>If files were already previously imported, these are made available in the drop-down list for renewed selection.</p> <p>Supported file formats are: *.STL (stereolithography file)</p> |
| Scale to size          | Activate to scale the size of the imported solid to the specified size in [mm]. It is always the longest edge of the bounding box that is scaled to the value.  |
| Unit                   | Defines the unit of the coordinates being imported. This is usually the value = 1 and the unit in which the file was created. Select from [mm], [μm] and [inch]. A value ≠ 1 would additionally add a scale factor to it. This can only be applied if the "Scale to size" option was not yet used.  |
| Center XY              | Incorporates the solid object centred in the XY axis view (corresponds to the view from above) of the workspace.  |
| Align Z [mm]           | Specification of the Z position in [mm], according to which either the upper side, centre position or underside of the 3D model aligns itself when importing.   |

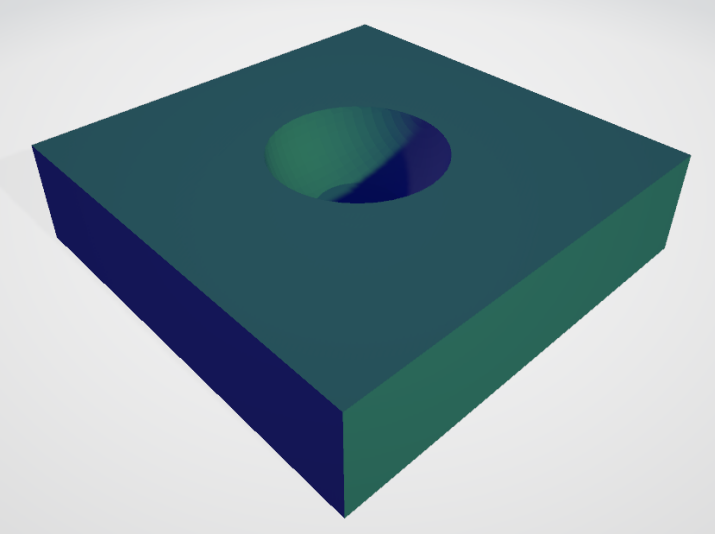


| Setting                  | Explanation  |
|--------------------------|--|
| Mirror direction         | Activate the toggle buttons for the X / Y / Z direction if the solid is to be mirrored accordingly when imported.  |
| <b>[Save as default]</b> | Button to save the created settings as default settings for future imports of body objects.<br><b>NOTE:</b> For solid objects, the standard also contains the settings for the slices. |

Tab. 7.16: RG-085

The following settings are available for importing solid objects and can be found in the object settings:

| Setting                              | Explanation  |
|--------------------------------------|--|
| <b>Slices</b>                        |  |
| $\Delta Z$ [ $\mu\text{m}$ ]         | The distance between the slices in [ $\mu\text{m}$ ]. Depending on the process direction, the value is specified either from the upper edge or the lower edge of the solid.  |
| First layer offset [ $\mu\text{m}$ ] | The distance between the absolute highest point of the solid and the first slice shown in the navigator (see page 23, <i>Toolbar</i> ).<br><b>NOTE:</b> Due to the nature of STL files (triangular facets of the surface), it can happen that individual points minimally protrude beyond a surface that appears to be flat. If a slice was displayed here, it would consist of only one point or a fragment of a slice. |
| Processing direction                 | Select whether the slice of a solid is to be processed from top-to-bottom (e.g., for deep engraving) or from bottom-to-top (e.g., for additive manufacturing).   |

| Setting          | Explanation   |
|------------------|---|
| Negative (mold)  | <p>Define whether the STL file being imported contains the solid as a negative form.</p> <p>This selection determines which areas of the slices are filled, for example for the engraving process.</p> <p>Example of an STL file with a negative form for deep engraving:</p>  |
| Number of slices | <p>Shows the number of slices resulting from the object height and <math>\Delta Z</math>.</p> <p><b>NOTE:</b> This display is only available in the object settings, not in the import dialog.</p>  |

Tab. 7.17: RG-086

**NOTES** on the character of the solid:

We recommend, regardless of the laser application, to primarily use solids that do not represent a negative form.

If negative forms are used, note the following:

The number of slices is not based only on the depth of the negative form, but also on the total component height. Thus, empty slices can also occur in the slice navigator.

### Special case of a negative form

When the negative form reaches to the edge of the solid.

Example:

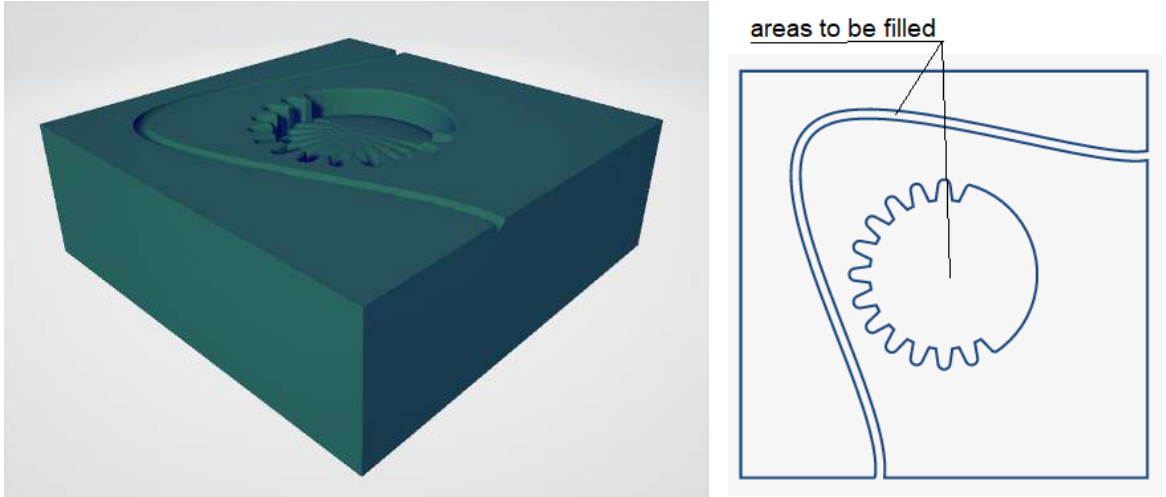


Fig. 7.14: AEO

In this case, the outer contour is interrupted in some slices, which would lead to an unusable filling result when using the regular filling routine. For this reason, the *Invert fillings* option must be used in these cases (see *page 159, Object Fillings*). At the same time, the "Filling only" marking mode must be used as otherwise the outermost boundary contour for the filling is executed for all slices.

### Further special case of a negative form

The surface to be engraved is not flat.

Example:

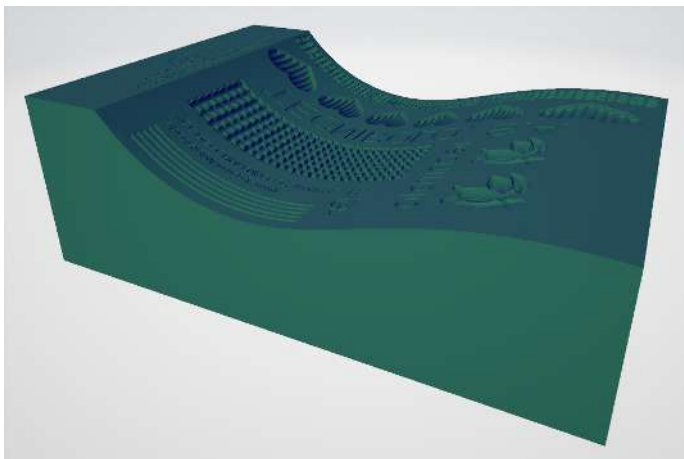


Fig. 7.15: AEP

This type of solid for deep engraving is not supported.

**NOTE** on solid objects and sequences:

- In solids, each slice geometry is treated as a *Layer* hierarchy element.
- For this reason, the *Execution loop assignment* option is set to *Layer* by default.
- The *Alternate contour/filling* option is likewise set by default.

**NOTE** on solid and execution options:

- The *Quick mark* option only executes the currently selected slice.
- The preview likewise only shows the selected slice.

**NOTE** on solid and statistics:

- For a solid object, the statistics (regardless of whether object statistics or job statistics) only show the values for the active slice. In addition, the number of slices based on the height of the complete solid is indicated.

### 7.2.3.7



Button

### Bitmap

A bitmap graphic is a two-dimensional array of pixels, representing an image. It is always imported from a file. The greyscale value of each pixel is either translated into a laser power value or into the time of laser emission per pixel.

To add a bitmap graphic to the job, it must be imported.

To open the import dialog, you can choose between the following options

- Click on **[Bitmap]** in the object panel.
- Main menu: **File > [Import] > Bitmap**
- Main menu: **Objects > Bitmap (Bitmap)**, and then double-click on the corresponding entry in the job tree.
- Drag the mouse from the **[Bitmap]** button in the object panel (holding down the left mouse button) to the desired position in the job tree and then double-click the corresponding entry.

Alternatively, you can also drag the bitmap file(s) directly from the Explorer folder into the viewport. In this case, the import dialog is skipped for the time being, as the default settings for the import are applied.

The subsequent import dialog for bitmap graphics makes the following settings available:

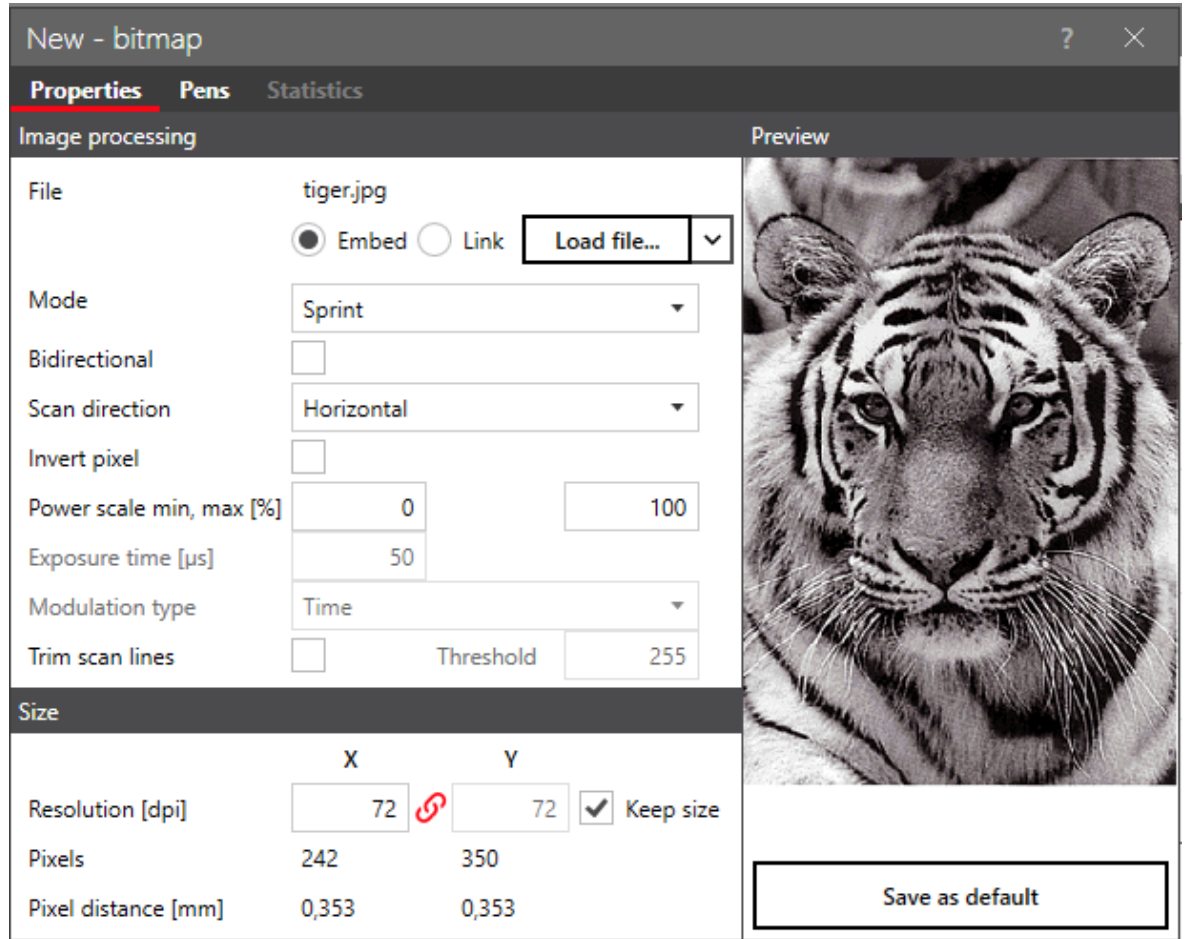


Fig. 7.16: AEO

| Setting                 | Description  |
|-------------------------|--|
| <b>Image processing</b> |  |
| File                    | <p><b>[Load file...]</b> opens a file browser to select a bitmap file.</p> <p>Choose the <i>Insert</i> option to embed the file content into the job file (important if you want to send the job file to another user).</p> <p>Choose <i>Link to File</i> to store only the file path in the job file.</p> <p>Supported file formats are: <i>JPG, BMP, EXIF, GIF, PNG, JPEG</i>.</p> |

| Setting                 | Description  |
|-------------------------|--|
| Mode                    | <ul style="list-style-type: none"> <li>■ <i>Sprint</i>: The laser beam moves in lines with continuous speed and emits <b>one</b> laser pulse per pixel.<br/>The greyscale value of the pixel modulates the laser power, resulting in the desired degree of contrast.<br/>The greyscale value has a resolution of 16 bit.<br/><b>APPLICATION NOTE:</b> In Sprint mode, the laser frequency results from the pixel density (DPI) and the marking speed. The LM frequency named in the pen is not used.</li> <li>■ <i>PointAndShoot</i>: The mirror position jumps from pixel to pixel and the laser beam stays at each pixel for a certain period of time, according to the greyscale value, in order to reach the desired degree of contrast.<br/><b>NOTE:</b> "White" pixels are automatically skipped.</li> </ul> |
| Bidirectional           | Enables alternating processing directions of the bitmap lines.   |
| Scan direction          | <p>Sets the major processing direction:</p> <ul style="list-style-type: none"> <li>■ Horizontal ↑ : Starts at the bottom and goes up row by row.</li> <li>■ Horizontal ↓ : Starts at the top and goes down row by row.</li> <li>■ Vertical → : Starts at the left and goes to the right row by row.</li> <li>■ Vertical ← : Starts at the right and goes to the left row by row.</li> </ul> <p><b>APPLICATION NOTE:</b> For bitmaps with a vertically orientated rectangle shape, vertical processing saves more time as it reduces the number of bitmap lines and therefore the number of line wraps.</p>   |
| Invert pixel            | Inverts the greyscale value of each pixel. The appearance of the bitmap in the GUI does not change.  |
| Power scale [%] Min/Max | <p>Scales the laser power per pixel greyscale value in a linear fashion between the minimum and maximum power.</p> <p>Example: If 80% laser power already results in a completely black pixel, any excess would probably cause laser burns and consume time. For this reason, 80 should be set as the maximum value in this case. Likewise, a minimum value may be necessary for the laser effect in order to generate any effect on the material at all.</p>  |
| Exposure time [μs]      | <p>Only relevant for PointAndShoot mode.</p> <p>Maximum duration [μs] that the laser emits on a pixel. The actual time is modulated by the greyscale value of the pixel.</p>   |
| Modulation type         | <p><b>Time:</b> The greyscale value of the pixel modulates the emission time, resulting in the desired degree of contrast.</p> <p><b>Power:</b> The greyscale value of the pixel modulates the laser power, resulting in the desired degree of contrast.</p>   |

| Setting                        | Description  |
|--------------------------------|--|
| Trim scan lines /<br>Threshold | <p>Bitmaps are always imported as rectangular objects. However, the lines of the bitmap do not necessarily begin or end with visible pixels.</p> <p>Enable this feature to shorten the marking time for the bitmap by completely omitting pixels which are equal to or exceed the specified threshold value (255 = White).</p> <p>Instead of moving to any pixel position in any line regardless of visibility, the scanners move immediately from the last visible pixel of the current line to the first visible pixel of the next line.</p> |
| <b>Size</b>                    |  |
| Resolution [dpi]               | <p>Sets the pixel resolution in [dpi] (dots-per-inch) for the X and Y directions. More dots per inch result in a finer resulting image, however, the image will take more time.</p> <p>The X-Y ratio can be locked / unlocked with the <b>[Lock / Unlock]</b> button.</p> <p><i>Keep size</i> forces the resulting image dimensions to remain at the original size - regardless of the specified resolution.</p>   |
| Pixels<br>Pixel distance [mm]  | Displays values for the number of pixels in the X-Y direction and the pixel spacing corresponding to the currently set resolution.   |
| <b>[Save as default]</b>       | Click on <b>[Save as default]</b> to save the created settings as default settings for future imports of bitmaps.  |

Tab. 7.18: RG-031

### Additional settings

Additional settings include:

- Common settings for all marking objects; refer to *page 153, Common Properties of Marking Objects*.
- Pen settings, detailing object-related process parameters; refer to *page 228, Pen Properties*.

**NOTE on display:** Bitmaps are always displayed in greyscale, with the opacity of the pixels corresponding to their greyscale value. This makes it possible to see the superimposed graphics in the same way as they are marked on the material, regardless of their sequence in the job tree.

Example:



Fig. 7.17: AEL



## 7.2.4 Common Properties of Marking Objects

The table shows settings that are similar for all object types. They are included in the setting dialogs of all objects.

| Setting        | Explanation   |
|----------------|---|
| <b>General</b> |   |
| Short label    | Appropriate name for the object, according to its content / purpose. For imported files, the file name is used by default.  |
| Enable binning | <p>Starts object processing only if a specified condition is fulfilled. The dialog has been extended to include other inputs:</p> <ul style="list-style-type: none"> <li>■ <i>I/O controller</i>: Select the control card where the I/O signals will arrive.</li> <li>■ <i>I/O port</i>: Select the preconfigured I/O port of the respective control card (see page 45, <i>Scan Controller Configuration</i>, I/O section).</li> <li>■ <i>Binning value</i>: Set the bit pattern to be received to process this object.<br/>You can also use the masking technique. For details, see page 45, <i>Scan Controller Configuration</i> Port masking section.</li> <li>■ The "Ahead-of-time evaluation" option is set by default and ensures that the condition (bit pattern) is checked in advance so no time is lost during the process. In cases in which the condition may only be set when the object is about to be processed, this option should be disabled. This may be the case after a preceding wait condition, for example.</li> </ul>  |
| Sequences      | <p>The pens that the object uses are assigned here, arranged by contour and filling. The pen for the filling is, as a rule, preselected in accordance with the pen for the contour.</p> <p>In addition, the number of passes is defined. The number of passes can also be set to "Infinite". This infinite loop can only be exited by aborting the execution either using the <b>[Abort]</b> button or with an external stop signal at the control card. However, this leads to the fact that subsequent objects or sequences will never be executed.</p> <p>The number of executions is also passed on to all lower-level structure layers and cannot be changed there.</p> <p>The number of execution loops and the pens used in the process are referred to as sequences.</p> <p>The "+" can be used to add more sequences, which are executed one after the other.</p> <p><b>NOTE:</b> The coloured depiction of the pens always corresponds to the 1st sequence.</p> <p><b>NOTE:</b> If, in a sequence, a pen with power ramp(s) is used in order to repeat one or more closed contours with n-iterations, the execution loop must be assigned to the path structure level in order to obtain only one start ramp at the beginning and one end ramp at the end of the execution loop.</p> <p>Below the table, further explanations are presented on the basis of various examples.</p> |

| Setting                       | Explanation  |
|-------------------------------|--|
| Mark                          | Select whether the object is to be processed.  |
| Marking mode                  | Use the available options to select whether contour and / or filling are to be executed and in which order to each other.<br>Select if only filling or contour is to be marked, or filling before contour, or filling after contour.   |
| Alternating contour / filling | Use this option if you want to change between contour and filling per executions within one sequence. <b>REQUIREMENT:</b> The filling must have been used on the same structure layer as selected in the subsequent assignment.  |
| Execution loop assignment     | Defines whether the whole object, only a whole layer, or only a path is to be executed in the loop before the next loop, if any, starts.   |
| Scan controllers              | Only appears if the job is assigned to several control cards. Set to "Auto" by default.<br>In "Auto" mode, the RAYGUIDE logic automatically assigns the graphic object to the responsible control card. Select "Manual" if you want to manually select the explicit control card for the object.<br><b>NOTE:</b> This setting is only relevant if the complete graphic object can in principle be executed by several control cards. |
| <b>BoundingBox</b>            |  |
| Size, Center                  | Read-only values, showing the size of an imaginary orthogonal rectangle surrounding the whole object.  |

Tab. 7.19: RG-032

An additional group of common settings are object transformations; see *page 168, Object Transformation*.

### Examples for sequences

How a sequence will be executed ultimately depends on the sequence itself, the execution mode, the assignment of the execution loop, and the option to alternate between the filling and outline.

#### Legend:

- [...] = Encloses a sequence
- {...} = Encloses an execution loop

**Example 1:** 2 sequences with different pens for outline and filling, outline before.

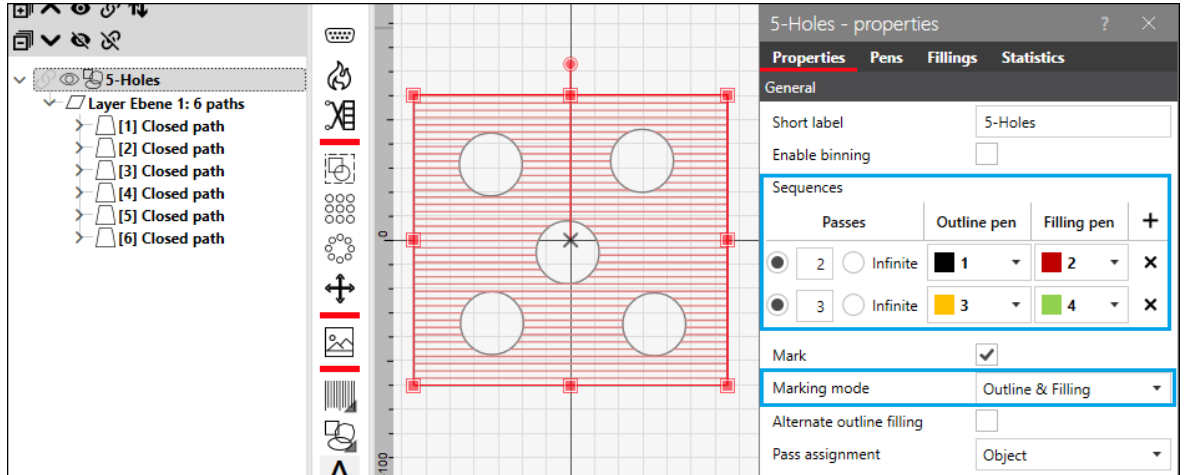


Fig. 7.18: AEG

Executed order:

[2 x complete outlines with pen 1 > 2 x filling with pen 2] > [3 x complete outline with pen 3 > 3 x filling with pen 4]

**Example 2:** Here, in contrast to example 1, the alternate outline / filling option is enabled.

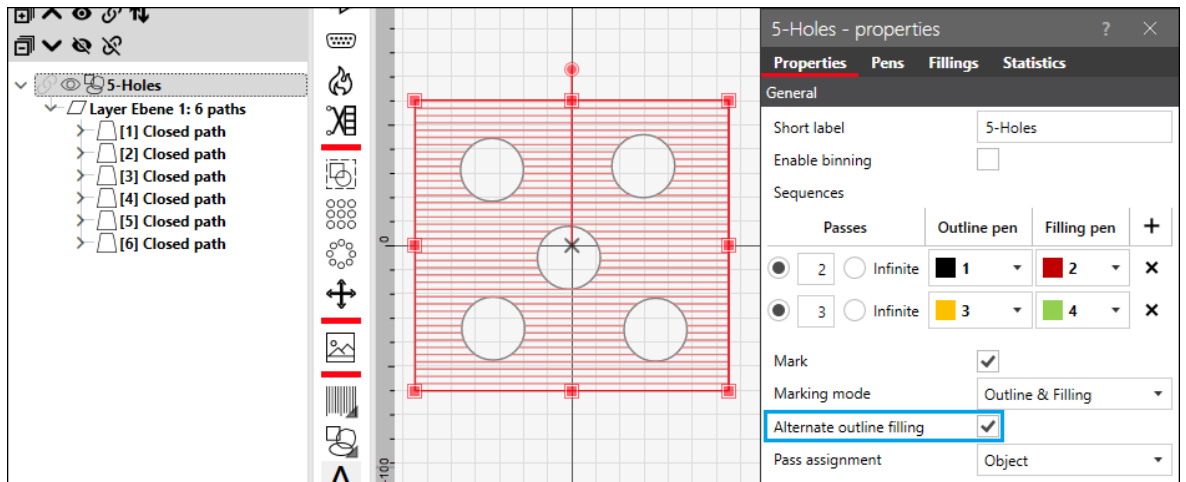


Fig. 7.19: AEH

Executed order:

[[1 x complete outline with pen 1 > 1 x filling with pen 2] > {1 x complete outline with pen 1 > 1 x filling with pen 2}] >

[[1 x complete outline with pen 3 > 1 x filling with pen 4] > {1 x complete outline with pen 3 > 1 x filling with pen 4}] > {1 x complete outline with pen 3 > 1 x filling with pen 4}]

**Example 3:** Here, in contrast to example 2, the assignment of the execution loops is set on the path layer.

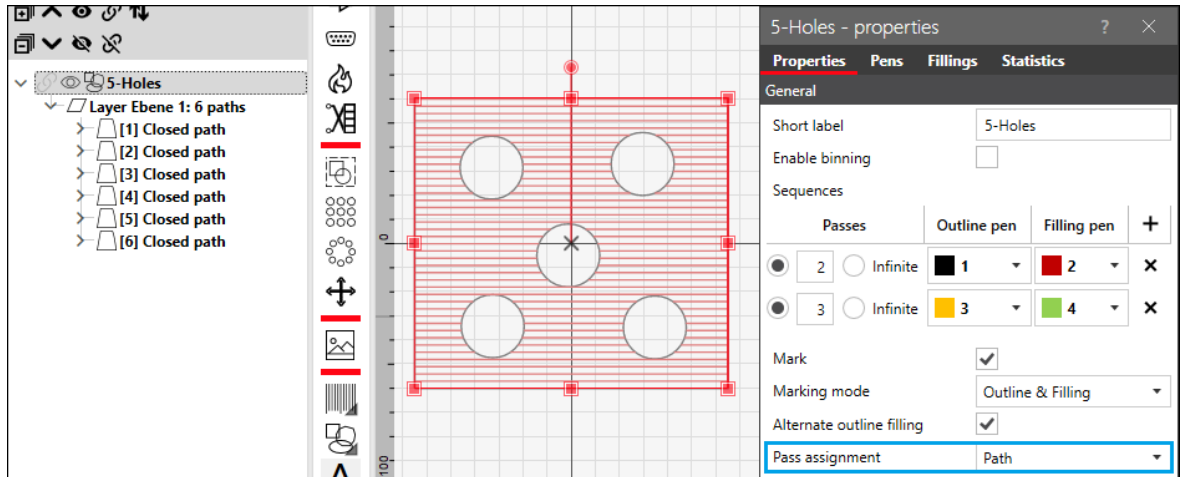


Fig. 7.20: AEI

Executed order:

[2 x 1st path with pen 1] > [3 x 1st path with pen 3] >  
 [2 x 2nd path with pen 1] > [3 x 2nd path with pen 3] >  
 ...  
 [2 x 6th path with pen 1] > [3 x 6th path with pen 3] >  
 [2 x filling with pen 2] > [3 x filling with pen 4]

Each path is run through in accordance with the number of executions of a sequence before the next path is started. However, there is no alternating between outline and filling. The reason for this in this example is that the filling is on the object layer while the sequence was assigned to the path layer.

**NOTE:** Alternating between outline and filling only works if the filling is assigned to the corresponding structure layer; see the following example 4:

**Example 4:** Here 2 of the circular paths have been filled at path level.

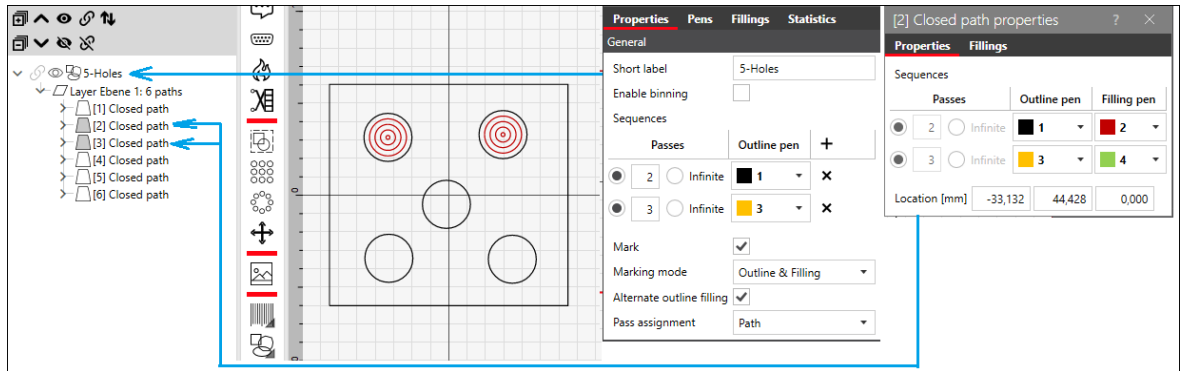


Fig. 7.21: AEJ

Executed order:

[2 x 1st path with pen 1] > [3 x 1st path with pen 3] >

[[1 x 2nd path with pen 1 > 1 x filling 2nd path with pen 2] >

{1 x 2nd path with pen 1 > 1 x filling 2nd path with pen 2}]>

[[1 x 2nd path with pen 3 > 1 x filling 2nd path with pen 4] >

{1 x 2nd path with pen 3 > 1 x filling 2nd path with pen 4} >

{1 x 2nd path with pen 3 > 1 x filling 2nd path with pen 4}]>

[[1 x 3rd path with pen 1 > 1 x filling 3rd path with pen 2] >

{1 x 3rd path with pen 1 > 1 x filling 3rd path with pen 2}]>

[[1 x 3rd path with pen 3 > 1 x filling 3rd path with pen 4] >

{1 x 3rd path with pen 3 > 1 x filling 3rd path with pen 4} >

{1 x 3rd path with pen 3 > 1 x filling 3rd path with pen 4}]>

[2 x 4th path with pen 1] > [3 x 4th path with pen 3] >

[2 x 5th path with pen 1] > [3 x 5th path with pen 3] >

[2 x 6th path with pen 1] > [3 x 6th path with pen 3]

### 7.2.4.1 Edit common object properties

For example, it may be necessary to assign the same number of passes to all marking objects. Instead of changing this parameter object by object, you can change it for a multiple selection of objects:

- Select all desired objects in the tree structure.
- Right mouse click > **Context menu**
- Select **common properties**.
- Edit the desired parameter and it will be applied to all selected objects.

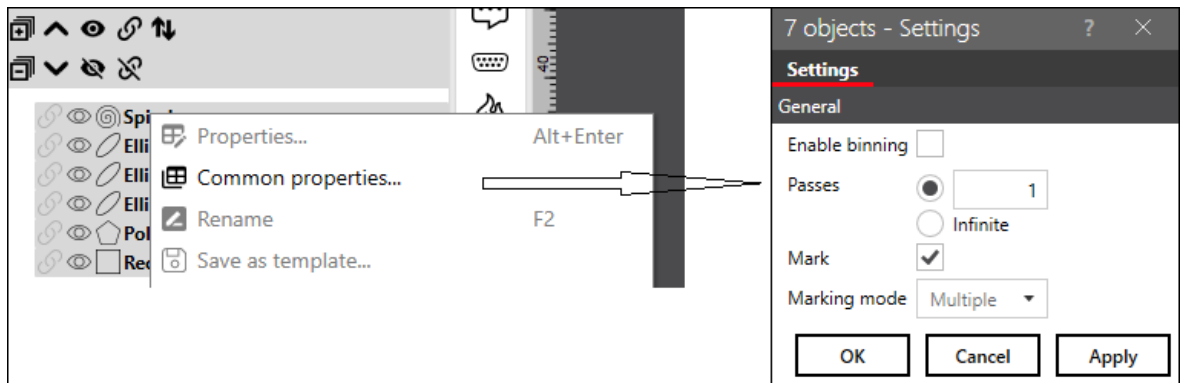


Fig. 7.22: RG-ADY

**NOTE:** For objects of different types, only the general properties are available for editing. For objects (only basic marking objects) of the same type (e.g. rectangles) you can also edit the object-specific parameters.

## 7.2.5 Object Fillings

A two-dimensional vector object which has at least one closed path, can be filled with a pattern. Individual layers or path entities of a freeform vector object can also be filled. Please note the rules mentioned in the tables, refer to *page 134, Vector Graphic*.

The example shows a vector graphic before and after filling with a spiral pattern.

Example:

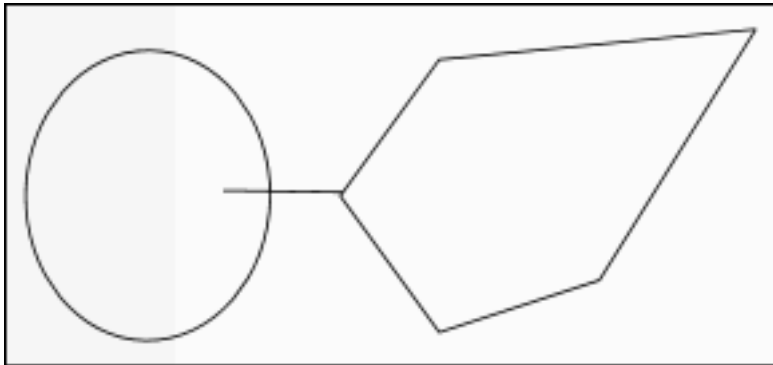


Fig. 7.23: RG-ABJ

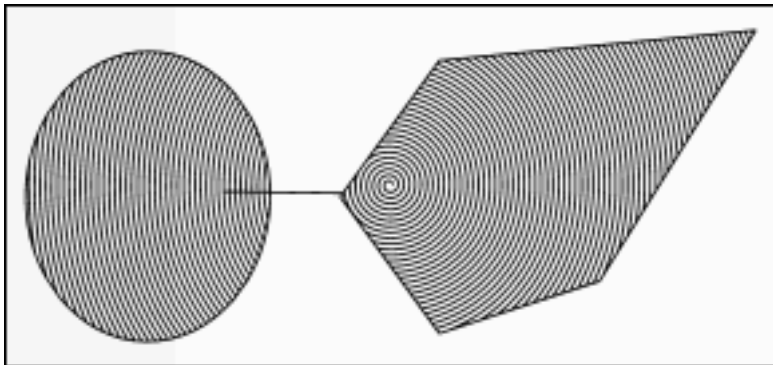


Fig. 7.24: RG-ABK

A filling applies only to a selected object.

If an object contains paths which lay inside each other, the filling starts with the outermost area, skips the next area, and continues with the next area, and so on.

If the closed paths create intersecting areas, the filling algorithm will fill or not fill these areas alternately.

Example:

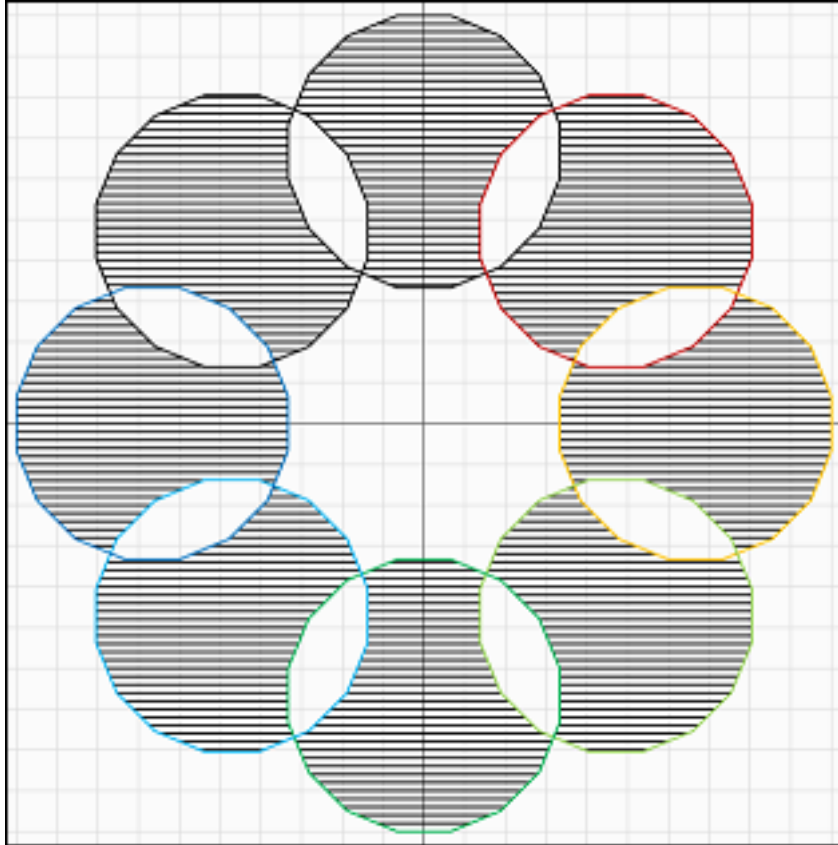


Fig. 7.25: RG-ABL

To create a filling, select an object, open its settings dialog, and go to the Fillings tab. To add a fill pattern, click the red plus sign for **[Add]**. Select one of the following pattern types for the filling:

| Type          | Explanation  |
|---------------|--|
| Hatching      | Parallel lines   |
| Inset         | Duplicates the outline contour of the respective area continuously towards the inside of the object.<br>The inset fill follows the outer contour, while inner contours are cut out of the fill pattern like a stencil.             |
| Spiral        | The fill pattern is defined by a single spiral. Here, the object contour acts like a mask that lies in front of this spiral and whose closed areas alternately show the background spiral.<br>Spiral-specific value: Chord length. |
| Drill points  | The fill pattern consists of a homogeneous arrangement of drill points.  |
| Cell hatching | Defines a discrete number of fill lines per cell. Only available with barcode type objects, most useful for 2D codes.  |



| Type        | Explanation  |
|-------------|--|
| Cell drill  | Define the number of point grids per cell. Only available with barcode type objects, most useful for 2D codes. |
| Cell circle | Fills a 2D code cell with circles.   |

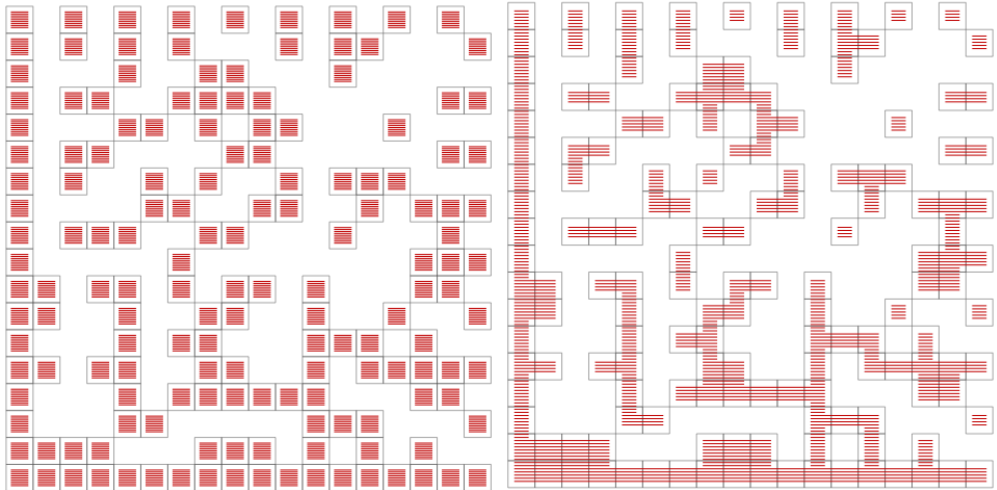
Tab. 7.20: RG-033

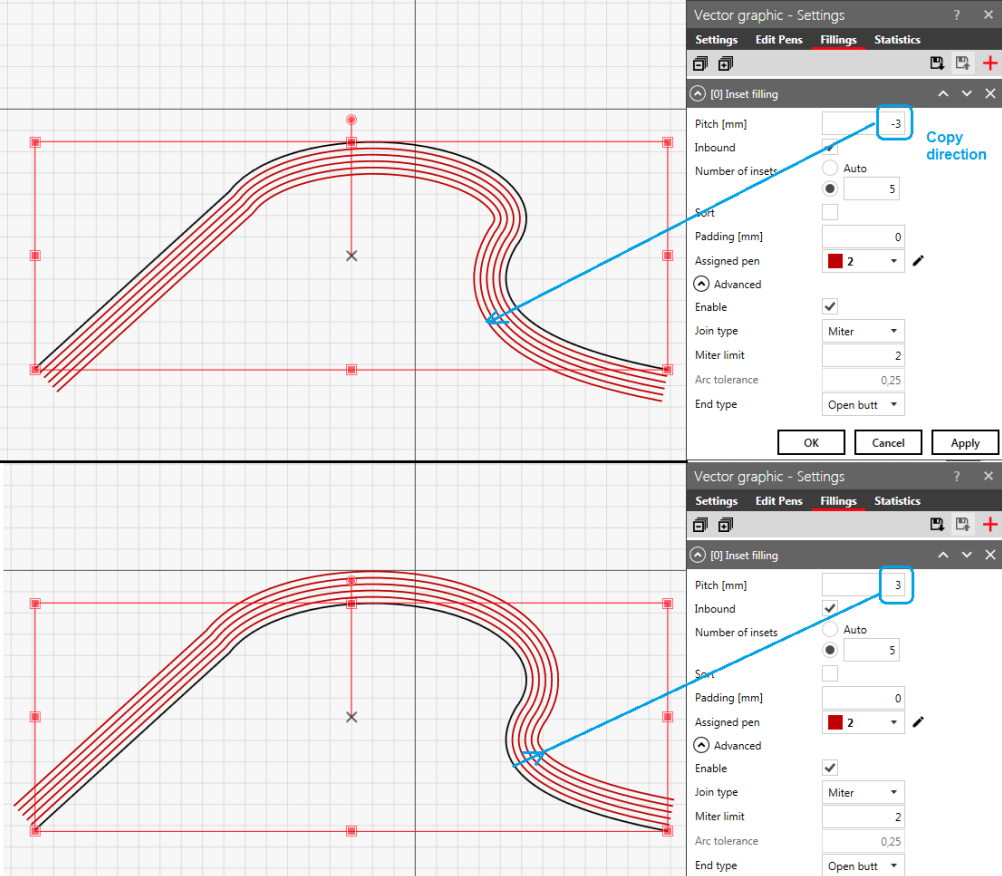
Multiple fillings can be added and combined.

**NOTE:** If you have chosen a small pitch value and you do not see the fill lines as separated lines, you can reduce the display stroke width (in the main toolbar).

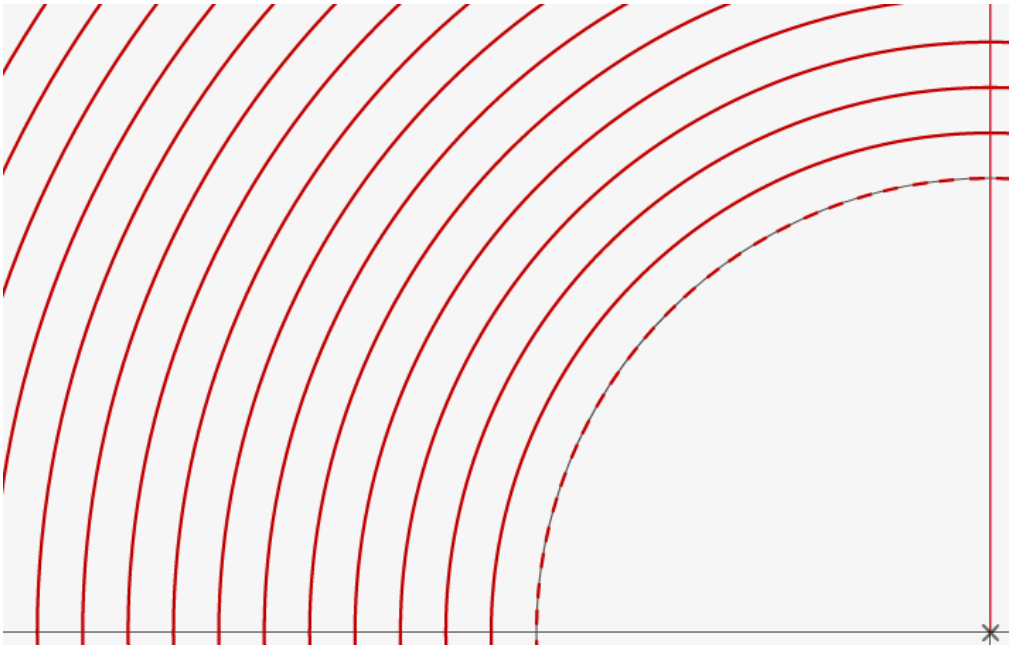
Each filling pattern has its own settings dialog:

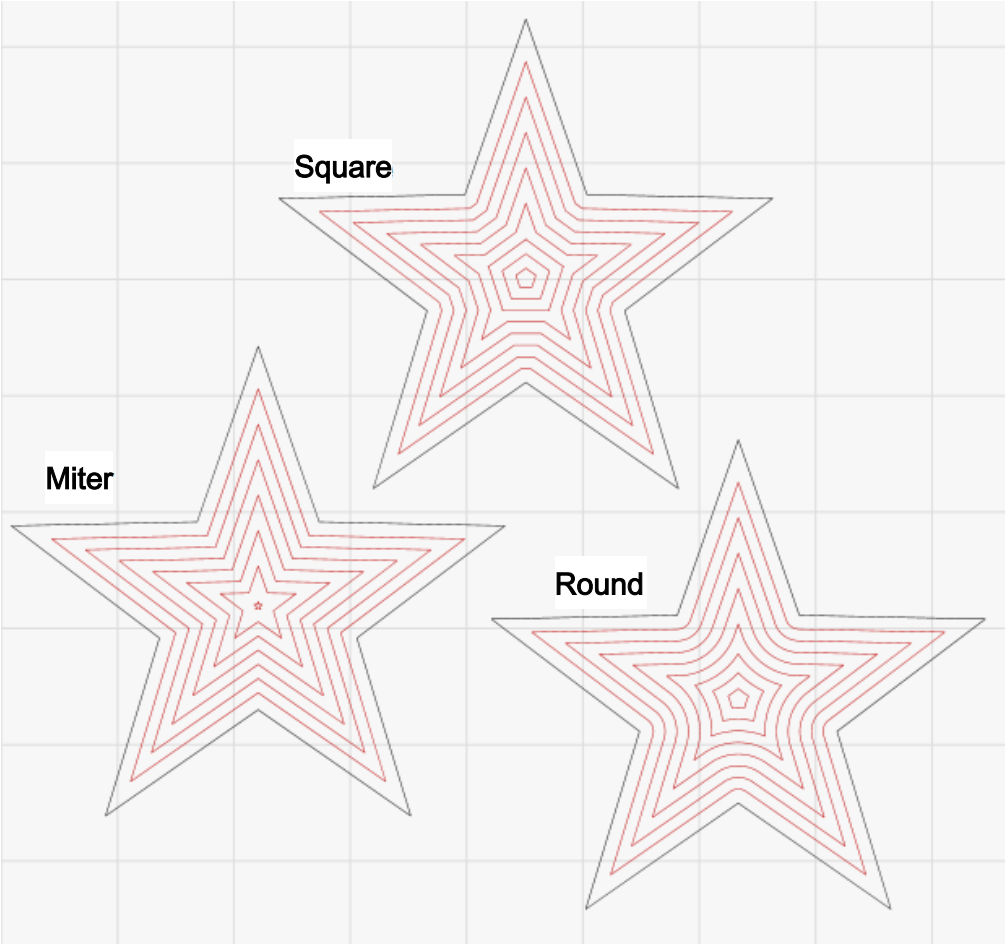
| Setting                                      | Explanation   |
|--|---|
| <b>Common settings for all filling types</b> |   |
| Pitch [mm]                                   | Distance between fill lines   |
| Invert*                                      | Inverts the filling logic. A virtual rectangular frame is always drawn around the layout object as the outer filling boundary. In doing so, the following parameter of the quiet zone is taken into account.  |
| Quiet zone*                                  | Entry in [mm] indicating the distance between the virtual rectangular frame and the layout object. The value always has a positive sign, and zero is permitted.<br><b>NOTE:</b> The object size is adjusted according to the filled quiet zone. The red, enclosing rectangle continues to be in relation to the actual layout object. |
| Sort   | Select whether the processing sequence of the fill lines and thus the jumps should be optimised automatically to save process time.<br>Check, if you want the filling to be processed with the minimum number of required jumps to save process time.   |

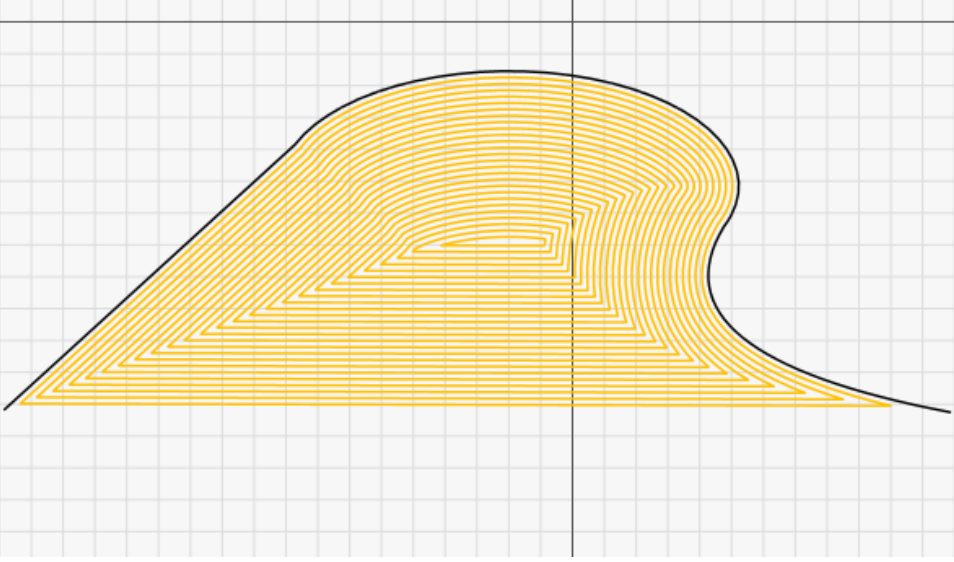
| Setting                                 | Explanation   |
|---|---|
| Padding [mm]                            | <p>Creates a non-filled frame between filling and respective filling outline.</p> <p>Positive values generate a distance toward the inside (from the contour to the filling), while values with a negative sign generate a distance toward the outside.</p> <p><b>NOTE:</b> For 2D codes, connected cells are filled together. The parameter operates differently depending on whether a specific cell filling or a generic filling is used:</p>  <p style="text-align: center;"> <span>specific cell filling plus padding</span> <span style="margin-left: 200px;">generic hatch filling plus padding</span> </p> |
| <b>Additional settings for hatching</b> |   |
| Angle [°]                               | <p>Angle of fill lines related to the object's own coordinate system!</p> <p><b>NOTE:</b> The fill lines are processed from the bottom to the top by default (with respect to the object). To change processing from the top to the bottom, an angle of 180° must be entered.</p>   |
| Delta angle                             | Angle in degrees by which the filling rotates per execution.  |
| Offset [mm]                             | Shifts the filling vertically to the fill line direction by the respective value.   |
| Delta shift                             | Shift of the fill lines in [mm] by which the fill lines move per execution.   |
| Cross hatch                             | <p>Select to define a cross hatch filling style. Equal spacing is used for both directions and the cross angle is fixed to 90 degrees.</p> <p>If you want the filling directions to be at a different angle to each other, simply add a second filling and define the angles accordingly.</p> <p>If you require a different cross angle, simply add a second hatch filling and adjust the angles accordingly.</p>   |
| Direction                               | <p><i>Unidirectional / Bidirectional / Meander</i></p> <p>Bidirectional provokes alternating processing directions of the fill lines.</p> <p>The meander is equally bidirectional, but the u-turn jumps are marked.</p>   |

| Setting                                   | Explanation   |
|---|---|
| <b>Additional settings for inset fill</b> |   |
| Inbound                                   | Select the checkbox (tick the box) if you want to process the filling from the inside to the outside (standard setting). Deselect it if you want to process the filling from the outside to the inside.   |
| Number of insets                          | <ul style="list-style-type: none"> <li>■ <i>Auto</i>: Closed contours get filled completely.</li> <li>■ <i>Defined number</i>: Useful to create a defined number of contour lines equidistant from the master path. Therefore, it is also ideal for open paths. Algebraic sign of the pitch value defines whether the contour copies are added to the left or right from the path.</li> </ul> <p>Example:</p>  <p><b>NOTE:</b> To design a contour copy as in the example, the advanced fill option <b>End type</b> must be set to <b>Open butt</b>.</p> |




| Setting  | Explanation   |
|--|---|
| <b>Additional settings for spiral fillings</b>   |   |
| Angle [°]  | Inside starting angle of the spiral line.   |
| Offset [mm]  | Shifts the centre of the spiral relative to the centre of the object bounding box   |
| Chord length [mm]  | Length of the polyline segment that represents the spiral shape   |
| <b>Additional settings for drill points</b>  |   |
| Distance X / Y   | Distance at which the drill points will be arranged in the X and Y directions.  |
| Mode   | <i>Pulse:</i> The dwell time per drill point is defined on the basis of the number of pulses and the frequency defined in the pen and the resulting pulse period.<br><i>Time:</i> The dwell duration per drill point is defined directly as the target value. |
| Pulses / Time  | Number of laser pulses or duration [ms].  |
| <b>Additional settings for circular filling of code cells</b>  |   |
| Count  | Number of circles per row / column or number of concentric circles.   |
| Roundness [%]  | A value of 100% corresponds to a circle. A value of 0% corresponds to a square. All values in between yield squares with rounded corners.   |
| Scale [%]  | Scales the diameter of the circle(s), which otherwise adjusts itself to the cell size.  |
| Concentric   | Activates the concentric arrangement of the circles instead of a matrix arrangement.  |
| <b>Advanced settings</b>   |   |
| Click <b>[Expander]</b> to open the advanced settings section.   |   |
| It is not recommended to use all available settings in the advanced sections. The advanced settings options are only relevant for "Contour" filling pattern. |   |
| Some of the relevant settings are listed below.  |   |
| Activate   | Select whether this fill profile is to be executed or not.<br><b>NOTE:</b> This option is active by default. Can be used if an object has several fill profiles but not all are to be executed.   |

| Setting       | Explanation   |
|---------------|---|
| Clipping zone | <p>Specification in [mm] for a zone around the contour in which fill lines are trimmed or omitted completely.</p> <p><b>NOTE:</b> This parameter does not change the position of the fill lines compared to the value padding.</p> <p>Application example:<br/>If a circular contour fill line overlaps with a circular contour line, both are converted into polygons by the fill routine so that, this fill line results as a stroke line unintentionally:</p>  <p>The diagram illustrates a series of red curved lines representing fill lines. A vertical red line is positioned on the right side, representing a circular contour line. One of the fill lines overlaps with this contour line, resulting in a stroke line that follows the contour's path. A small asterisk is located at the bottom right corner of the diagram area.</p> |

| Setting   | Explanation  |
|-----------|--|
| Join type | <p>Varies the way the filling lines meet on inner corners:<br/>Miter vs. Round vs. Square</p>  <p>Square</p> <p>Miter</p> <p>Round</p> |

| Setting  | Explanation   |
|--|---|
| End type   | <ul style="list-style-type: none"> <li>■ <i>Open butt</i>: Is used for contour copy of open paths</li> <li>■ <i>Closed polygon</i>: Closes an open path with a virtual line as a fill border</li> </ul> <p>Example:</p>  |
| <p><b>*NOTE:</b> Not available for spiral filling and special code fillings.</p> |   |

Tab. 7.21: RG-034

| Type  | Explanation   |
|---|---|
| <b>Use of fill dialog buttons</b>   |   |
|  | Use the <b>[Expand]</b> / <b>[Collapse]</b> buttons to expand or collapse the various sections of fillings.   |
|  | Use the arrow keys for <b>[Up]</b> / <b>[Down]</b> to change the order (corresponds to the processing sequence) for a multiple-fill pattern.            |
|  | Use the <b>[Save]</b> , button to store the actual filling as a filling template. Use <b>[Load]</b> to list all filling templates available to add one. |

Tab. 7.22: RG-066

## 7.2.6 Layout Modification

### 7.2.6.1 Object Transformation

Every layout object carries transformation information.

When an object is placed on the workspace for the first time, it is registered in the job file with its initially defined parameters. The initial / original values are not changed by a transformation. Instead, any change to the object is additionally stored as either a transformation or a direct edit of a graphic command or vector position.

#### Types of transformations

- The object's offset and thus the position of the object centre in relation to the workspace origin.
- The size and scaling factor (scaling change per click) of the object (or the surrounding rectangle) and thus the axes ratio in relation to the original size (after adding or importing a layout object).
- The rotation of an object around its transformation centre.

#### Access to transformations

Transformations can be performed with the mouse in the viewport or by entering values. You can use three GUI locations:

- The viewport, using the mouse (cursor) or the arrow keys (limited to translation in the XY plane)
- Transformation panel
- Object settings dialog



### Transformation panel

The main location to perform transformations is the Transformation panel (by default, on the right side of the screen). Here, all transformation options are available.

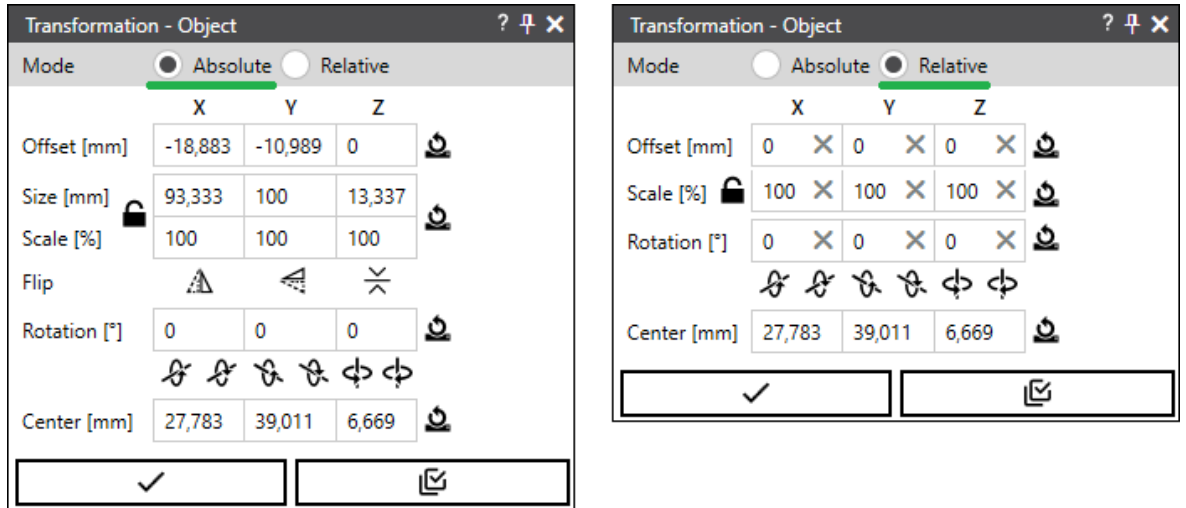


Fig. 7.26: RG-ABM

### Object settings dialog

The settings in this dialog reflect the settings provided in the Transformation panel. To open an object's settings dialog, go to the Settings tab, section Transformation.


| Transformation |   |        |    |       |
|----------------|---|--------|----|-------|
| Offset [mm]    |   | 0      | 0  | 0     |
| Size [mm]      |  | 46,667 | 50 | 6,669 |
| Scale [%]      |   | 50     | 50 | 50    |
| Rotation [°]   |   | 0      | 0  | 0     |

Fig. 7.27: RG-ABN

The table shows the current offset and the dimensions of the object, and thus its scaling factors, in relation to the original values (i.e. at the time of initial creation).

## Object selection

Transformations can be applied to pre-formed objects and to free-formed graphics as a whole, to an object's layers, paths, and path elements, or even at container level. When a container element is transformed, the transformation is applied to the container as a whole and to all of its subordinate objects (so-called "children"). (If a pattern object is taken out of the container again, it loses this transformation.)

## Coordinate systems

Please note that there are two coordinate systems to consider when performing transformations:

- The coordinate system of the workspace.
- The coordinate system of a graphic object. Each object has its own coordinate system.

Each transformation always relates to a transformation centre of an object (or a group of selected objects). Note the following definitions:

- Coordinate origin of the workspace: Zero coordinates of the workspace, which can be a combination of multiple scan fields. In case of multiple scan fields: The workspace origin is equal to the origin in the workspace definition and its scan field offsets.
- Object centre: Centre of the enclosing rectangle which encloses an object
- Object origin: Mathematical starting point of a pre-formed object. The origin of the object is generally the centre of the object, with the exception of polygons and spirals, for example.
- Transformations centre: By default, the transformation centre is the object centre. Transformations of scale and rotation relate to the transformation centre. The absolute position of the transformation centre is available in the panel under "Centre point". The position can be shifted with the mouse and reset to the object centre by using the **[Reset]** button next to the "Centre point" coordinates.

The following example figure shows the essential items regarding transformations:

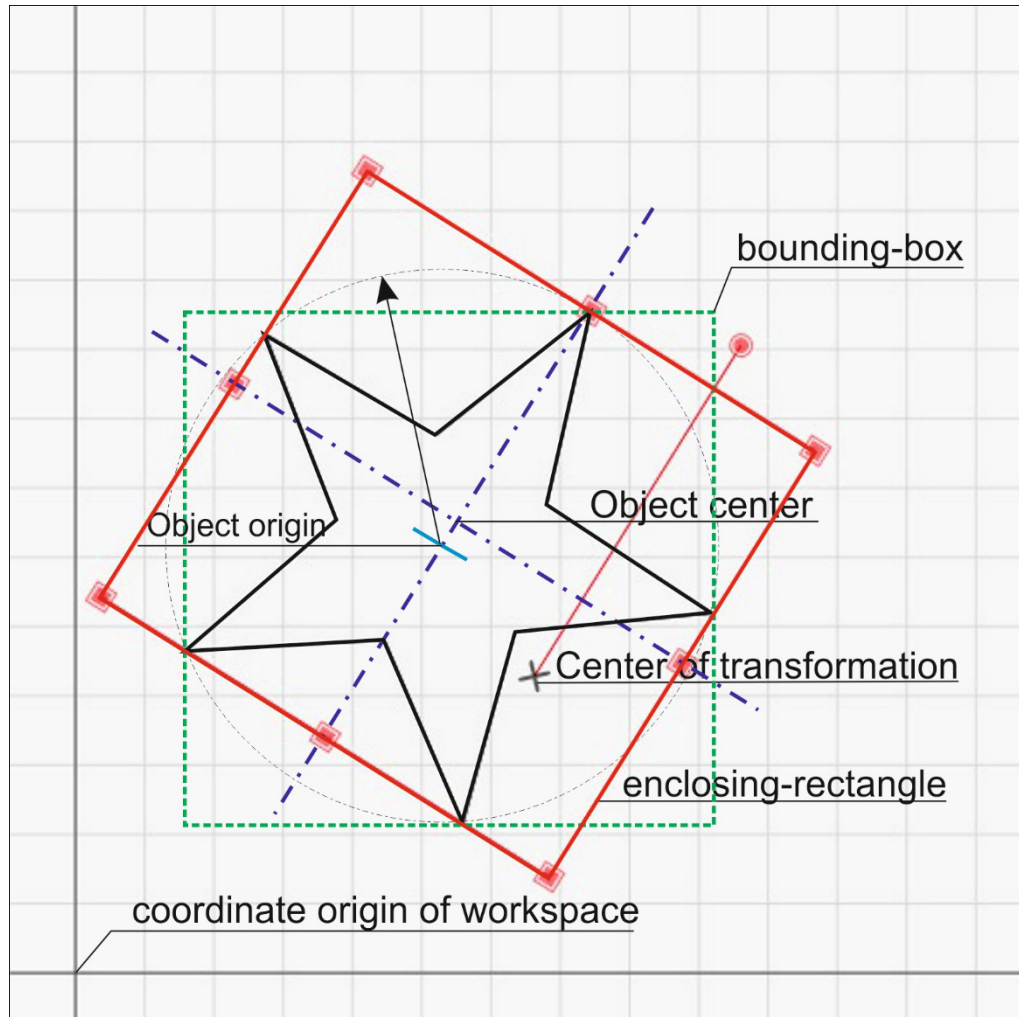
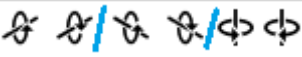


Fig. 7.28: RG-ABO

## Transformation details

The following transformation operations are available:

| Setting     | Explanation  |
|-------------|--|
| Mode        | <p><b>Absolute:</b> Transform to ... (can only be applied at the <i>Object</i> hierarchy level)<br/>Relative: Transform by ...</p>   |
| Offset [mm] | <p>In <b>Absolute mode:</b> Shows / defines the offset (and thus the position) on the X-Y-Z axes from the object origin to the coordinate origin of the workspace.<br/><b>In Relative mode:</b> Shifts the selection by the entered value in the X-Y-Z-direction.<br/>Applicable to containers, objects, or individual layers, paths, path element or groups of thumbs.</p>  |
| Size        | <p>In <b>Absolute mode:</b> Shows / Defines the absolute size of an object or of the surrounding rectangle.<br/>Use the <b>[Lock / Unlock]</b> toggle button to fix the side ratio.<br/>Note that size and scale values are intertwined.</p>   |
| Scale [%]   | <p>In <b>Absolute mode:</b> Shows / Defines the scale factor as a percent relative to the original size of the object. The centre point of the transformation is the transformation centre, which usually coincides with the object centre.<br/><b>In Relative mode:</b> Shows / Defines the scale factor as a percent by which the current selection is scaled relative to the current size.<br/>Can be applied to containers, objects, layers (exception: text levels), paths.<br/>Multiple selections are possible in principle, but only in the same hierarchy level. By default, the transformation centre is at the centre point of the shared, enclosing bounding box.<br/>Use the <b>[Lock / Unlock]</b> toggle button to fix the side ratio.<br/>Note that size and scale values are intertwined.</p> |
| Flip        | <p>Toggle buttons to flip / unflip the selection in direction of the respective coordinate axis.<br/>X direction / Y direction / Z direction</p>   |

| Setting  | Explanation   |
|--|---|
| <b>Rotation [°]</b>  | Shows / Defines the angle in degrees by which the current selection is rotated around the transformation centre.<br>In <b>Absolute mode</b> , the angle is specified relative to the respective coordinate axes.<br>In <b>Relative mode</b> , the angle is specified relative to the current orientation.<br>Can be applied to containers, objects, layers (exception: text levels), paths.<br>Multiple selections are possible in principle, but only in the same hierarchy level.<br>By default, the transformation centre is at the centre point of the shared, enclosing bounding box.<br>The <b>[Reset]</b> buttons reset the respective absolute transformation to the original object position / size / orientation. |
| Fixed rotation angle<br> | Buttons for the fixed rotation per spatial axis by 90 degrees each, clockwise / anti-clockwise around the centre of transformation.<br>Orientation of the rotational axis through the transformation centre:<br>Parallel to: X-axis / Y-axis / Z-axis   |
| Center [mm]  | The coordinates of the transformation centre of an object or of a multiple selection (displayed by an "x" on the "rotating handle")<br>The <b>[Reset]</b> button resets the transformation centre to the object centre.   |

Tab. 7.23: RG-035

The **[Reset]** button actively resets the respective transformation to absolute zero in case of offset, scaling and rotation, both in absolute and relative mode.

The **[x]** buttons in "Relative" mode set values to zero.

### Command buttons

Click **[Checkmark]** to apply the transformation.

Click on **[Apply to copy]** to copy the object and transform it at the same time.

### 7.2.6.2 Edit Mode

**Edit mode** must be activated to be able to edit vector-based layout objects or parts thereof, such as individual thumbs.

To access **Edit mode**, go to **Edit vectors** in the context menu of the object.

Alternatively, you can directly select the layout element in the tree directory to switch directly to **Edit mode**.

In **Edit mode**, outlines are displayed but not fillings. View options such as the display of jump vectors, vector tips and sharp corners are ignored in this mode.

### 7.2.6.3 Automated vector optimisation

#### 7.2.6.3.1 Overview

Many imported layout files are not optimally prepared for laser processing. RAYGUIDE thus offers a broad range of optimisation functions:

- Rearrange the vector sequence.
- Optimise the processing result.
- Adapt the geometry to the real situation if necessary.

To obtain an impression of how the layout object will be processed, use the "Display vector tips" and "Display vector jumps" view options. You may also navigate through the object tree and follow the highlighted thumbs in the viewport.

Some optimisation functions require a tolerance parameter. The corresponding parameters are mentioned with each optimisation function and explained in the section on the associated settings at the end of this chapter.

Right-click an item of the object tree to open the context menu and select **Vector optimizations**.

The table provides an overview of all functions, and at which geometry level you can use them. The following sections explain each function in more detail and provide examples. The examples show the situation before and after applying the function.

| Function                  |                            | Available at level |       |      |              | See ...  |
|---------------------------|----------------------------|--------------------|-------|------|--------------|--|
|                           |                            | Object             | Level | Path | Path element |  |
| Sort                      | Minimize jump distance     | ✓                  | ✓     |      |              | <i>page 178, Sorting to minimise jump distance</i>       |
|                           | By direction               | ✓                  | ✓     |      |              | <i>page 179, Sort by direction</i>                       |
| Close paths               |                            | ✓                  | ✓     | ✓    |              | <i>page 180, Close paths</i>                             |
| Close gaps                |                            | ✓                  | ✓     |      |              | <i>page 180, Closing gaps</i>                            |
| [Change orientation]      |                            | ✓                  | ✓     |      |              |  |
| Set z-coordinates to zero |                            | ✓                  | ✓     | ✓    | ✓            | <i>page 180, Setting z-coordinates to zero</i>           |
| Split path                |                            |                    |       |      | ✓            | <i>page 181, Split path</i>                              |
| Split commands            |                            | ✓                  | ✓     | ✓    | ✓            | <i>page 181, Splitting elements</i>                      |
| Define as start of path   |                            |                    |       |      | ✓            | <i>page 181, Define as start of path</i>                 |
| Merge / Join              | Layers                     | ✓                  |       |      |              | <i>page 182, Merge / Join layers</i>                     |
|                           | Touching paths             | ✓                  | ✓     | ✓    |              | <i>page 182, Merge / Join touching paths</i>             |
|                           | Polylines                  | ✓                  | ✓     | ✓    |              | <i>page 182, Merge / Join polylines</i>                  |
|                           | Straight lines             | ✓                  | ✓     | ✓    |              | <i>page 182, Merge / Join straight lines</i>             |
|                           | Similar circular arcs      | ✓                  | ✓     | ✓    |              | <i>page 183, Merge / Join similar arcs</i>               |
|                           | Selected points with lines |                    |       | ✓    | ✓            | <i>page 183, Merge / Join selected points with lines</i> |
| Remove                    | Drills                     | ✓                  | ✓     | ✓    |              | <i>page 184, Remove drills</i>                           |
|                           | Duplicates                 | ✓                  | ✓     | ✓    | ✓            | <i>page 184, Remove duplicates</i>                       |
|                           | Straight points            | ✓                  | ✓     | ✓    | ✓            | <i>page 185, Remove straight points</i>                  |
|                           | Empty layers               | ✓                  |       |      |              | <i>page 185, Remove empty layers</i>                     |
|                           | Empty paths                | ✓                  | ✓     |      |              | <i>page 185, Remove empty paths</i>                      |

| Function |  | Available at level |       |      |              | See ...  |
|----------|--|--------------------|-------|------|--------------|--|
|          |  | Object             | Level | Path | Path element |  |
| Replace  | Lines / Polylines by ... <ul style="list-style-type: none"> <li>■ Rearranged polylines,</li> <li>■ Circular arcs,</li> <li>■ Quadratic curves,</li> <li>■ Cubic curves</li> </ul>      | ✓                  | ✓     | ✓    | ✓            | <i>page 186, Lines / Polylines</i>               |
|          | Circular arcs by ... <ul style="list-style-type: none"> <li>■ Lines,</li> <li>■ Polylines,</li> <li>■ Elliptical arcs,</li> <li>■ Quadratic curves,</li> <li>■ Cubic curves</li> </ul> | ✓                  | ✓     | ✓    | ✓            | <i>page 190, Circular / Elliptical arcs</i>      |
|          | Elliptical arcs by ... <ul style="list-style-type: none"> <li>■ Lines,</li> <li>■ Polylines,</li> <li>■ Circular arcs,</li> <li>■ Quadratic curves,</li> <li>■ Cubic curves</li> </ul> | ✓                  | ✓     | ✓    | ✓            | <i>page 190, Circular / Elliptical arcs</i>      |
|          | Quadratic curves by ... <ul style="list-style-type: none"> <li>■ Lines,</li> <li>■ Polylines,</li> <li>■ Circular arcs,</li> <li>■ Cubic curves</li> </ul>                             | ✓                  | ✓     | ✓    | ✓            | <i>page 193, Quadratic curves / Cubic curves</i> |



| Function                   |   | Available at level |       |      |              | See ...   |
|----------------------------|---|--------------------|-------|------|--------------|---|
|                            |   | Object             | Level | Path | Path element |   |
|                            | Cubic curves by ... <ul style="list-style-type: none"> <li>■ Lines,</li> <li>■ Polylines,</li> <li>■ Circular arcs,</li> <li>■ Quadratic curves.</li> </ul> | ✓                  | ✓     | ✓    | ✓            | <i>page 193, Quadratic curves / Cubic curves</i>            |
|                            | Straight curves by lines  | ✓                  | ✓     | ✓    |              | <i>page 195, Replacing straight curves with lines</i>       |
|                            | Circles by Drills   | ✓                  | ✓     | ✓    |              | <i>page 195, Replace arcs by drills / drills by circles</i> |
|                            | Drills by Circles   | ✓                  | ✓     | ✓    |              | <i>page 195, Replace arcs by drills / drills by circles</i> |
|                            | All commands by polylines   | ✓                  | ✓     | ✓    |              | <i>page 196, Replace all commands by polylines</i>          |
|                            | All commands by drills  | ✓                  | ✓     |      |              | <i>page 197, Replace all commands by drill holes</i>        |
|                            | All commands by paths   | ✓                  | ✓     | ✓    | ✓            | <i>page 198, Replace all commands by paths</i>              |
| Double points in polylines |   | ✓                  | ✓     | ✓    | ✓            | <i>page 198, Doubling points in polylines</i>               |

Tab. 7.24: RG-036

### 7.2.6.3.2 Sorting

#### 7.2.6.3.2.1 Sorting to minimise jump distance

This function rearranges all paths and, if necessary, the graphic command order to avoid unnecessary jumps. This may also imply that a path succession gets reversed. If a subsequent path has a start point matching its predecessor's end point, the paths are joined after sorting.

The function should be executed before all other optimisation functions, because other functions work better if the elements are already sorted.

Context menu: *Vector optimizations > Sort > Minimize jump distance*

Hierarchy levels: Object, level

Related tolerance value: Min. point distance (for sorting) [mm]

Example:

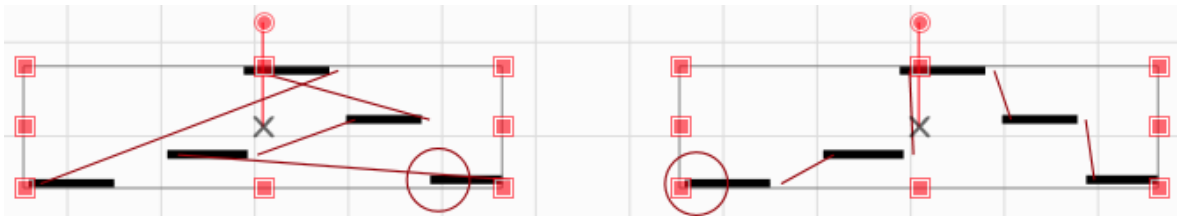


Fig. 7.29: RG-ABP

### 7.2.6.3.2.2 Sort by direction

This function rearranges all paths by considering a belt angle to optimise MOTF execution. Enter an angle that is opposite to the direction of belt movement through the scan field.

Context menu: *Vector optimizations > Sort > By direction*

Hierarchy levels: Object, level

Example:

Three lines of text processed line by line by default

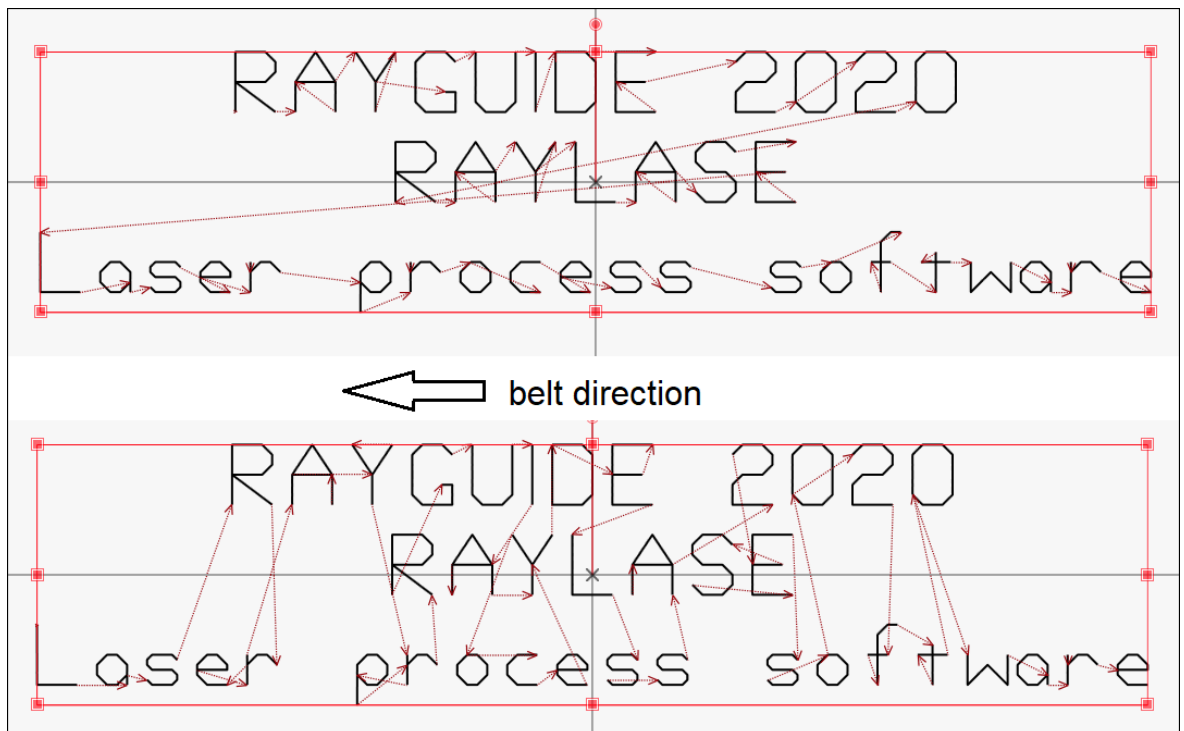


Fig. 7.30: RG-ADN

### 7.2.6.3.3 Close paths

This function closes open paths by connecting the end point of the last graphic command to the path coordinate with a single graphic command.

Context menu: *Vector optimizations > Close paths*

Hierarchy levels: Object, level, path

Example:

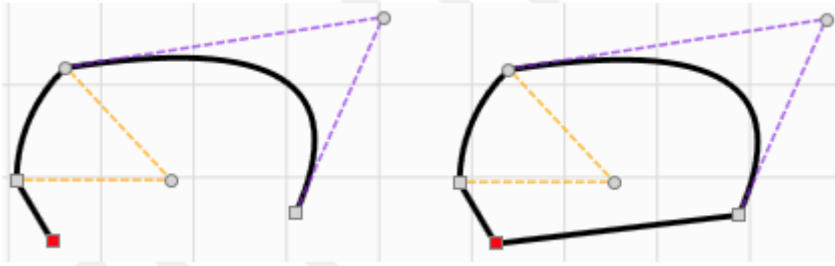


Fig. 7.31: RG-ABQ

### 7.2.6.3.4 Closing gaps

This function closes gaps between adjacent open paths by inserting a line between the paths and joining the paths. The corresponding *tolerance value* sets the maximum size of the gap that can be closed by this routine.

This routine does not identify gaps, which might appear on a T-crossing.

Context menu: *Vector optimizations > Close gaps*

Hierarchy levels: Object, level

Related tolerance value: Min. point distance

Example:



Fig. 7.32: RG-ABR

Because the "circular" looking path is closed, it is not joined with its predecessor and the gap remains open.

### 7.2.6.3.5 Setting z-coordinates to zero

This function will reset all Z-coordinates to zero. Thus you can convert a 3D vector geometry into a 2D geometry. Also, the function is useful if, by mistake, coordinates have been generated with a Z-value unequal to zero.

Context menu: *Vector optimizations > Set z-coordinates to zero*

Hierarchy levels: All

### 7.2.6.3.6 Split path

This function splits a path into two. The selected graphic command becomes the first graphic command of the new path.

Context menu: *Vector optimizations > Split path*

Hierarchy levels: Path element

### 7.2.6.3.7 Splitting elements

This function splits polylines, circular arcs, quadratic and cubic curves into two graphic commands of the same type, preserving the original shape.

If points of a polyline are selected (not the path the polyline belongs to), the polyline is split at these points.

If the path of the polyline is also selected, the polyline is split into two polylines - the selected polyline points are ignored.

Context menu: *Vector optimizations > Split commands*

Hierarchy levels: All

Example:

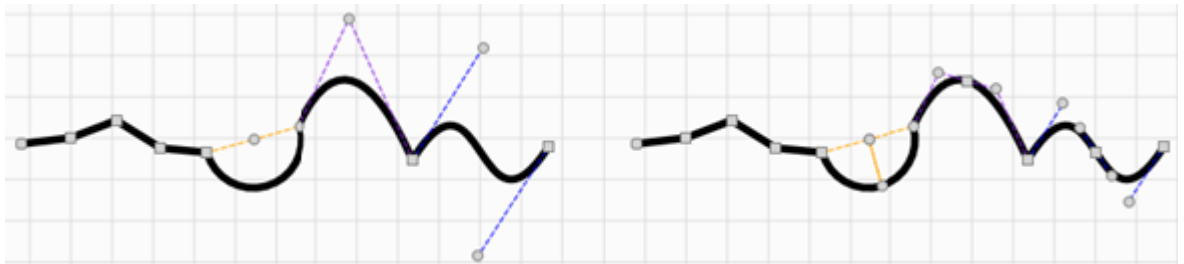


Fig. 7.33: RG-ABS

### 7.2.6.3.8 Define as start of path

Select a contour point that will be the new starting point of the path and then use this function to redefine the starting point of the path.

Context menu: *Vector optimizations > Define as start of path*

Hierarchy levels: Path element, transition points (red)

### 7.2.6.3.9 Merge / Join

#### 7.2.6.3.9.1 Merge / Join layers

This function combines all layers of a vector graphic in one layer.

Context menu: *Vector optimizations > Merge / Join > Layers*

Hierarchy levels: Objects

#### 7.2.6.3.9.2 Merge / Join touching paths

This function merges two adjacent paths if the end coordinates of one path and the start coordinates of the next path are within a given tolerance. Compared to the "close gaps" function, the subsequent path start is adapted and no additional line graphic command is added.

Context menu: *Vector optimizations > Merge / Join > Touching paths*

Hierarchy levels: Object, level, path

Related tolerance value: Min. point distance

#### 7.2.6.3.9.3 Merge / Join polylines

This function joins two polylines if both polyline graphic commands follow the same path.

Context menu: *Vector optimizations > Merge / Join > Polylines*

Hierarchy levels: Object, level, path

#### 7.2.6.3.9.4 Merge / Join straight lines

This function joins two adjacent straight lines within a path if they are collinear.

Context menu: *Vector optimizations > Merge / Join > Straight lines*

Hierarchy levels: Object, level, path

Related tolerance value: Collinear distance

### 7.2.6.3.9.5 Merge / Join similar arcs

The function merges two adjacent circular arcs in one path if their centre points (almost) coincide, and they have the same radius.

Context menu: *Vector optimizations > Merge / Join > Similar circular arcs*  
 Hierarchy levels: Object, layer, path, path element – multiple selection  
 Related tolerance value: Min. point distance (for evaluating the centre points)

Example:

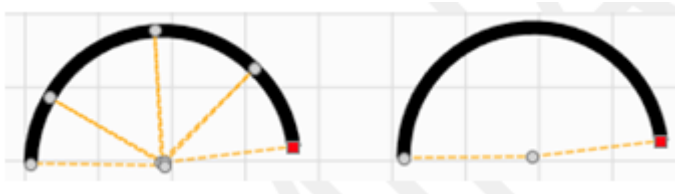


Fig. 7.34: RG-ABT

### 7.2.6.3.9.6 Merge / Join selected points with lines

This function joins two selected points with a line, which represents a new path.

If more than two points are selected, the sequence in which the points are connected is undefined.

Context menu: *Vector optimizations > Merge / Join > Selected points with lines*  
 Hierarchy levels: Path, path element

Example:

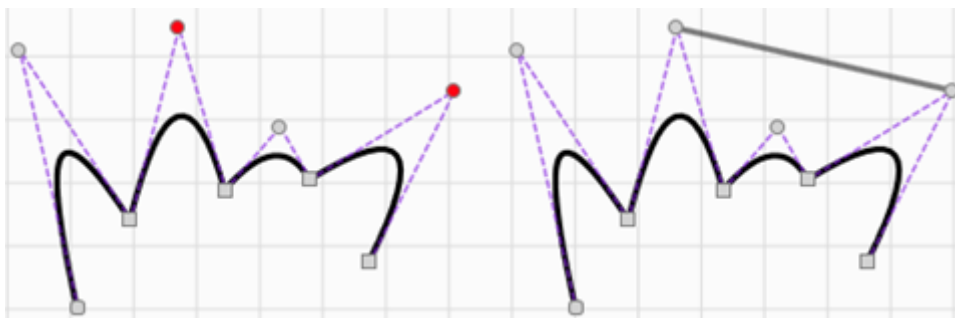


Fig. 7.35: RG-ABU

### 7.2.6.3.10 Remove

#### 7.2.6.3.10.1 Remove drills

This function removes all drills (*Laser on* command) from the selected graphic command. This can affect single drill as well as *Laser on* action commands within a path sequence.

Context menu: *Vector optimizations > [Delete] > Drills*  
 Hierarchy levels: Object, level, path

Example:

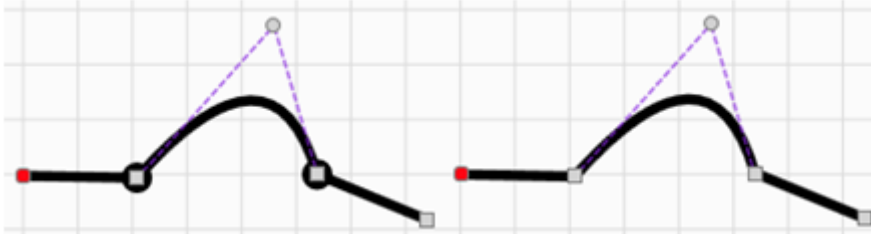


Fig. 7.36: RG-ABV

#### 7.2.6.3.10.2 Remove duplicates

This function removes adjacent duplicate thumbs and adjacent loops in polylines if the thumbs have a distance less than the *min. point distance*.

**NOTE:** This function is not able to detect two separate paths which are completely or partially identical.

Context menu: *Vector optimizations > [Delete] > Duplicates*  
 Hierarchy levels: All  
 Related tolerance value: Min. point distance

Example:

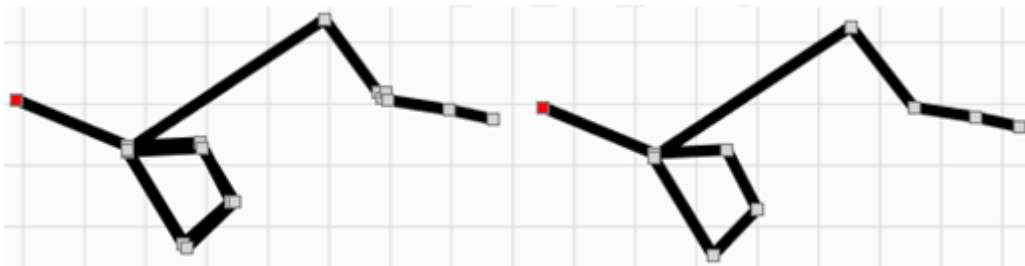


Fig. 7.37: RG-ABW



### 7.2.6.3.10.3 Remove straight points

This function removes all points within a polyline that lie on a “nearly straight line”. The user can set the tolerance of what is considered a “nearly straight line”.

Context menu: *Vector optimizations > Remove > Straight points*

Hierarchy levels: All

Related tolerance value: Collinear distance

Example:

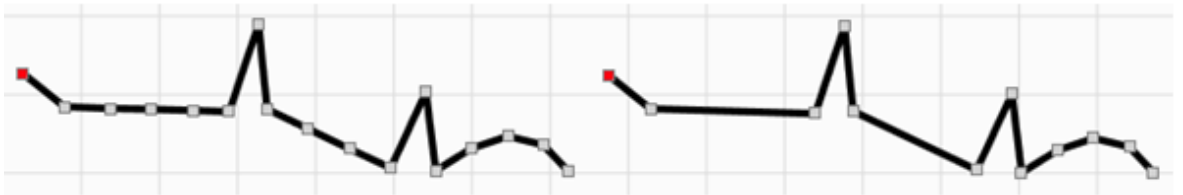


Fig. 7.38: RG-ABX

### 7.2.6.3.10.4 Remove empty layers

This function removes all layers which contain no paths.

Context menu: *Vector optimizations > Remove > Empty layers*

Hierarchy levels: Object

### 7.2.6.3.10.5 Remove empty paths

This function removes all paths which contain no path elements.

Context menu: *Vector optimizations > Remove > Empty paths*

Hierarchy levels: Object, level

### 7.2.6.3.11 Replace

Replace functions are used to convert one type of graphic command to another.

Available sub-functions are listed in the preceding table.

Some of the sub-functions require explanation:

#### 7.2.6.3.11.1 Lines / Polylines

##### Replacing lines / polylines with rearranged polylines

This function can split one polyline graphic command into several polyline graphic commands. The user must select the section(s) of the polyline (a section must always contain more than one polyline point) that will become a new polyline graphic command.

**NOTE:** This function works opposite to the "Join polylines" function.

The example shows a single polyline graphic command describing an elliptical arc where two sections are selected (row of red thumbs).

After the function was applied, the elliptical arc is represented by five polyline graphic commands.

Context menu: *Vector optimizations > Replace > Lines / Polylines by > Rearranged polylines*

Hierarchy levels: Polyline graphic command

Example:

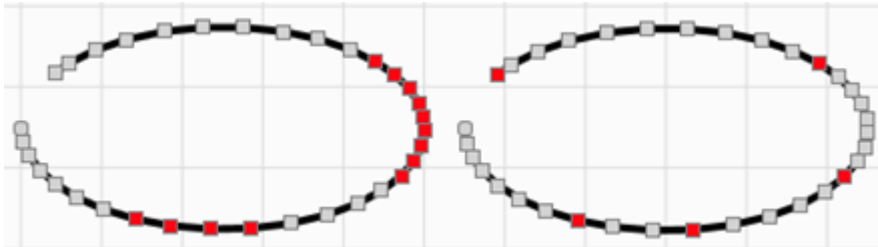


Fig. 7.39: RG-ABY

## Replacing lines / polylines by circular arcs

This function converts either complete polylines (a) or a selected section of points of a polyline (b) by circle arcs approximating the polyline shape.

Use case a) The complete polyline describes a closed circle / ellipse. In this case, you can use this function directly for the following hierarchy levels: Object, level, path.

Use case b) A section of the polyline describes an arc. In this case, you need to select all thumbs that belong to the arc section and apply the function to this section only. Multiple-selection of sections is not advisable.

Context menu: *Vector optimizations > Replace > Lines / Polylines by > Circular arcs*

Hierarchy levels: All / Polyline graphic command

Example a)

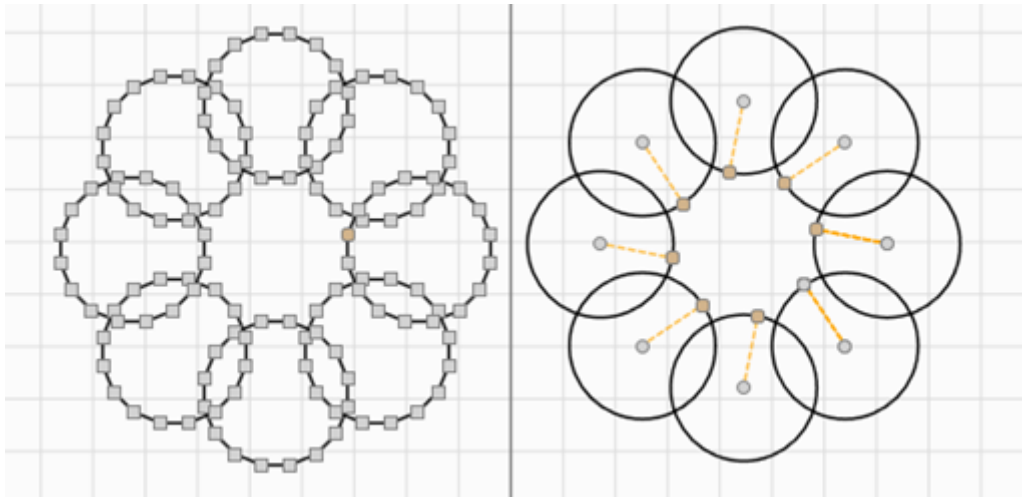


Fig. 7.40: RG-ABZ

Example b)



Fig. 7.41: RG-ACA

### Replacing lines / polylines with quadratic curves

This function replaces each single-line segment of a polyline by a quadratic curve, preserving the polyline's shape.

Context menu: *Vector optimizations > Replace > Lines / Polylines by > Quadratic curves*

Hierarchy levels: All

Example:

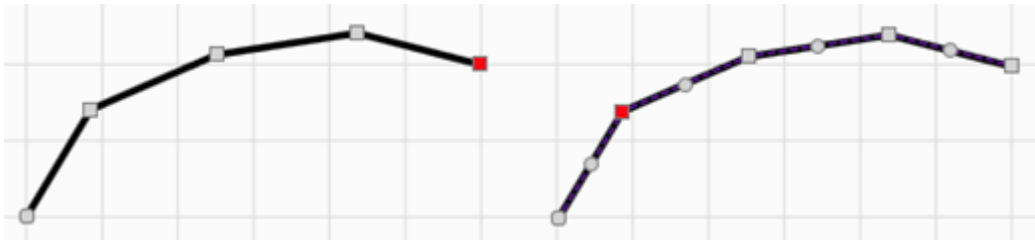


Fig. 7.42: RG-ACB

### Replacing lines / polylines with cubic curves

This function replaces each single-line segment of a polyline by a cubic curve, preserving the polyline's shape.

Context menu: *Vector optimizations > Replace > Lines / Polylines by > Cubic curves*

Hierarchy levels: All

Example:

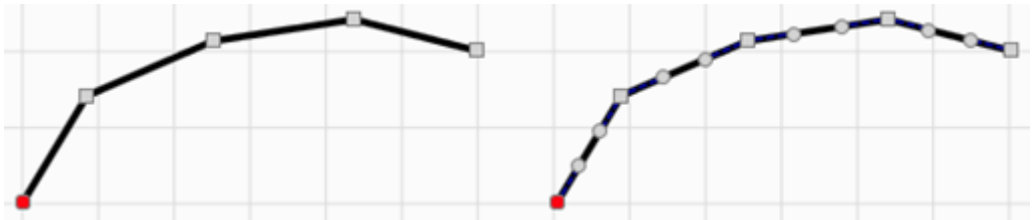


Fig. 7.43: RG-ACC

### 7.2.6.3.11.2 Circular / Elliptical arcs

#### Replacing circular / elliptical arcs with polylines

This function replaces a circular or elliptical arc with a polyline approximating the original shape.

This is done in two steps:

In the first step, the circular arc is replaced by a polyline with the number of points set in the *Number of points* tolerance parameter.

In the second step, all superfluous points are removed from the straight lines using the *Collinearity distance* parameter.

With carefully chosen parameters, the result is a polyline with enough points to approximate the circular arc smoothly even in areas with strong curvature.

**NOTE:** If you select too few points, the adjustment to the arc shape is not very precise, regardless of the value you set for the collinearity distance.

Context menu: *Vector optimizations > Replace > Circular arcs by > Polylines*

Hierarchy levels: All

Related tolerance values: Number of points, collinear distance

Example:

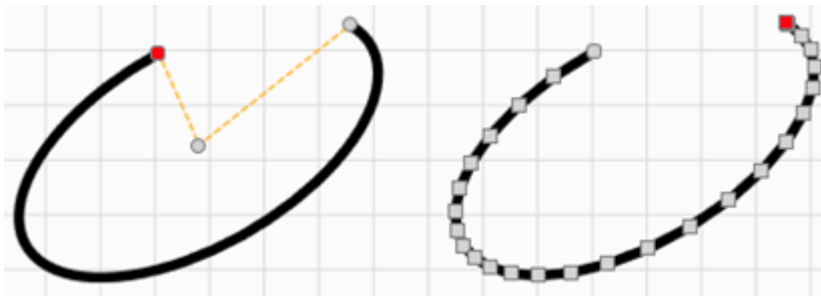


Fig. 7.44: RG-ACD

### Replacing circular / elliptical arcs with elliptical / circular arcs

This function replaces a circular arc by an elliptical arc or an elliptical arc by a circular arc.

In the first case, an elliptical arc is created with both semi axes having the same radius as the original circular arc, preserving the original circular arc's shape.

In the second case, a circular arc is created with the same start and end points as the original elliptical arc and a radius that is a type of average value of the ellipse's semi axes. Therefore, the shape cannot be preserved.

Context menu:

- Circular arcs
- Elliptical arcs

Hierarchy levels:

*Vector optimizations > Replace > Circular arcs by > Elliptical arcs*

*Vector optimizations > Replace > Elliptical arcs by > Circular arcs*

All

Example:



Fig. 7.45: RG-ACE

## Replacing circular / elliptical arcs with quadratic curves

This function replaces a circular or elliptical arc by a set of quadratic curves approximating the original shape. A full circle or ellipse is replaced by eight quadratic curves, smaller arcs are replaced by a suitable smaller number of quadratic curves.

Context menu:

- Circular arcs                      *Vector optimizations > Replace > Circular arcs by > Quadratic curves*
- Elliptical arcs                    *Vector optimizations > Replace > Elliptical arcs by > Quadratic curves*

Hierarchy levels:                    All

Example:

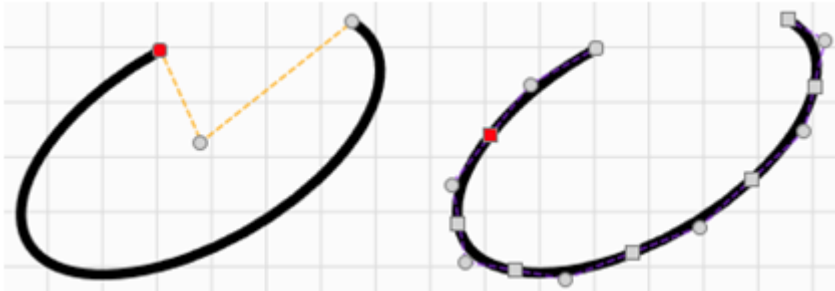


Fig. 7.46: RG-ACF

## Replacing circular / elliptical arcs with cubic curves

This function replaces a circular or elliptical arc by a set of cubic curves approximating the original shape. A full circle or ellipse is replaced by four cubic curves, smaller arcs are replaced by a suitable smaller number of cubic curves.

Context menu:

- Circular arcs                      *Vector optimizations > Replace > Circular arcs by > Cubic curves*
- Elliptical arcs                    *Vector optimizations > Replace > Elliptical arcs by > Cubic curves*

Hierarchy levels:                    All

Example:

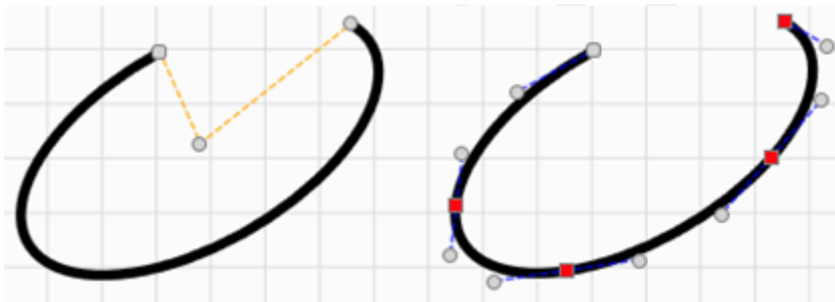


Fig. 7.47: RG-ACG



### 7.2.6.3.11.3 Quadratic curves / Cubic curves

#### Replacing quadratic / cubic curves with lines

This function replaces a quadratic or cubic curve by a single line connecting the original start and endpoint.

Context menu:

- Quadratic curves      *Vector optimizations > Replace > Quadratic curves by > Lines*
- Cubic curves          *Vector optimizations > Replace > Cubic curves by > Quadratic curves*

Hierarchy levels:      All

Example:



Fig. 7.48: RG-ACH

#### Replacing quadratic / cubic curves with polylines

This function replaces a quadratic or cubic curve by a polyline approximating the original shape.

The conversion logic is similar to replacing a circular / elliptical arc by a polyline.

Context menu:

- Quadratic curves      *Vector optimizations > Replace > Quadratic curves by > Polylines*
- Cubic curves          *Vector optimizations > Replace > Cubic curves by > Polylines*

Hierarchy levels:      All

Example:

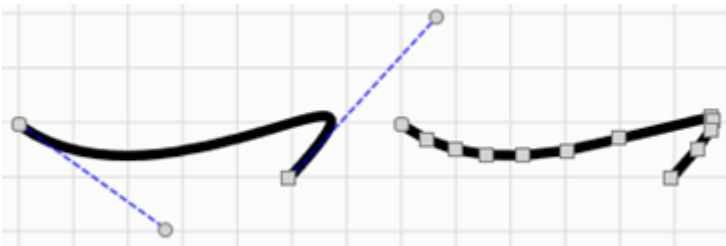


Fig. 7.49: RG-ACI

## Replacing quadratic / cubic curves with circular arcs

This function replaces each quadratic or cubic curve by an arc approximating the original shape.

Since this conversion is performed via the intermediate step of a polyline, the tolerance values *number of points* and *collinearity distance* are taken into account.

As shown in the example: If a rather small collinearity distance is selected, the centre points of all arcs are close together and can be optimised further.

Context menu:

■ Quadratic curves      *Vector optimizations > Replace > Quadratic curves by > Circular arcs*

■ Cubic curves          *Vector optimizations > Replace > Cubic curves by > Circular arcs*

Hierarchy levels:      All

Example:

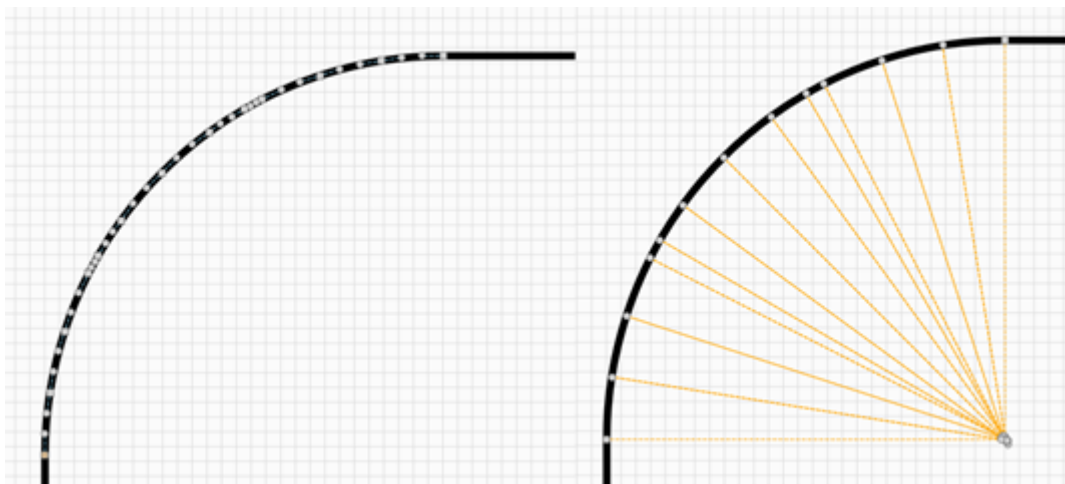


Fig. 7.50: RG-ACJ

#### 7.2.6.3.11.4 Replacing straight curves with lines

This function replaces quadratic or cubic curves with lines, but only if the control points are on the line defined by the curves' start and end points; i. e. the curve has no curvature, it is straight.

How much the control points may differ from the line can be adjusted by the *collinearity distance*.

Context menu: *Vector optimizations > Replace > Straight curves by lines*

Available for the following Object, level, path hierarchy levels:

Related tolerance values: Collinear distance

Example:



Fig. 7.51: RG-ACK

#### 7.2.6.3.11.5 Replace arcs by drills / drills by circles

This function replaces "small" arcs (circles) with drill holes (laser-on command) or vice-versa. The arcs do not necessarily need to describe an angle of 360°.

In the reverse case, i.e. when drill holes are converted to circles (360° arc), the radius of the resulting circles corresponds to the respective tolerance value.

Context menu:

- Arcs *Vector optimizations > Replace > Circles by Drills*
- Drills *Vector optimizations > Replace > Drills by Circles*

Hierarchy levels: Object, level, path

Related specifications: Radius for replacing arcs

Example:

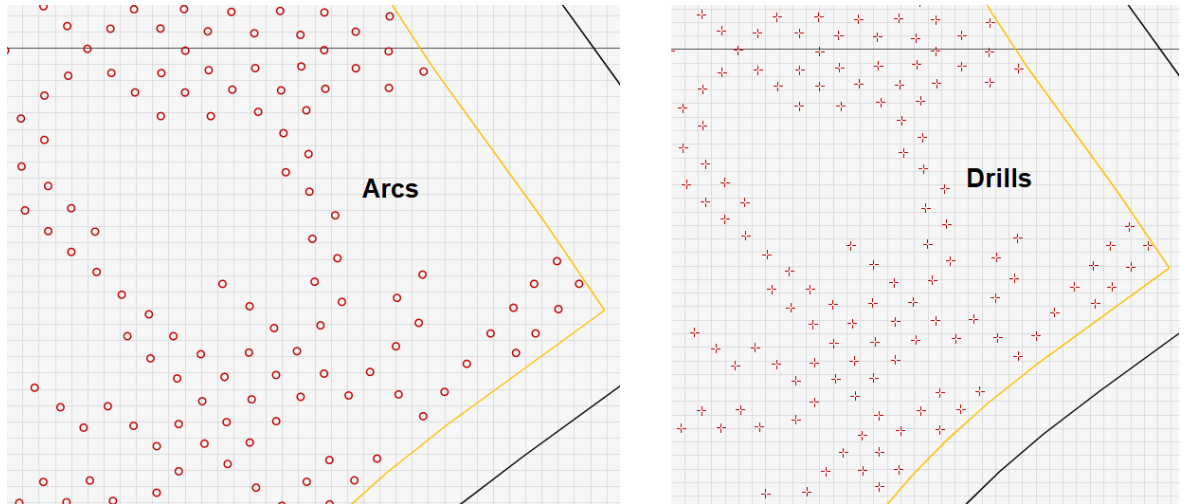


Fig. 7.52: RG-ADZ

#### 7.2.6.3.11.6 Replace all commands by polylines

This function replaces all graphic commands (if not already a polyline) with polylines as described in the above sections (see page 190, *Circular / Elliptical arcs*).

|                           |   |
|---------------------------|---|
| Context menu:             | <i>Vector optimizations &gt; Replace &gt; All commands by polylines</i> |
| Hierarchy levels:         | Object, level, path   |
| Related tolerance values: | Number of points, collinear distance                                    |

### 7.2.6.3.11.7 Replace all commands by drill holes

This function replaces all graphic commands with drill holes that are arranged along the contour lines.

Context menu: *Vector optimizations > Replace > All commands by drills*

Hierarchy levels: Object, level

Related specifications: Spacing [mm], Force corners, Drill mode, Pulse / Time

**NOTE:** You can also directly apply this optimisation as a job optimisation during job execution. This means, for example, that dynamically changing text content can also be converted.

Example a)

With "Force corners" option:

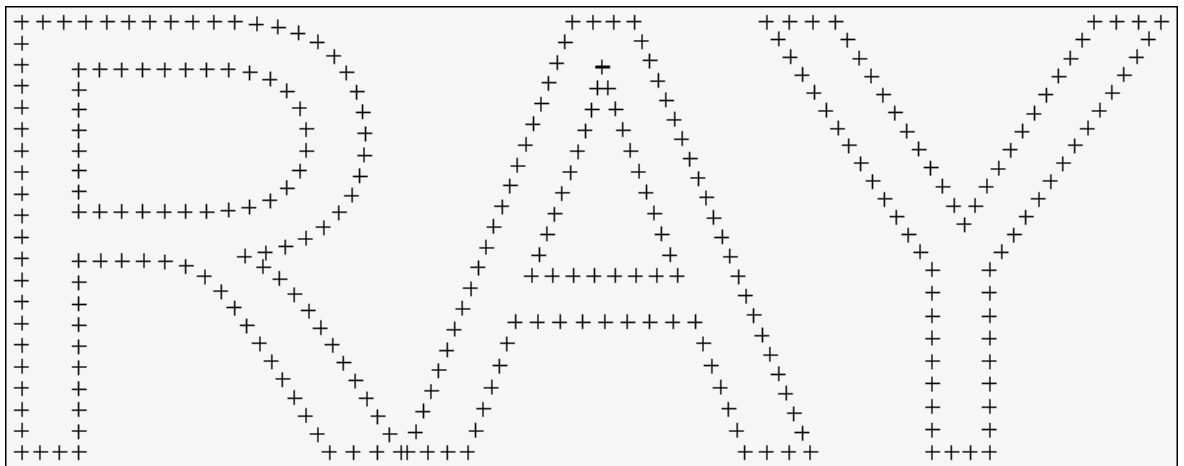


Fig. 7.53: RG-AFF

Example b)

Without "Force corners" option:

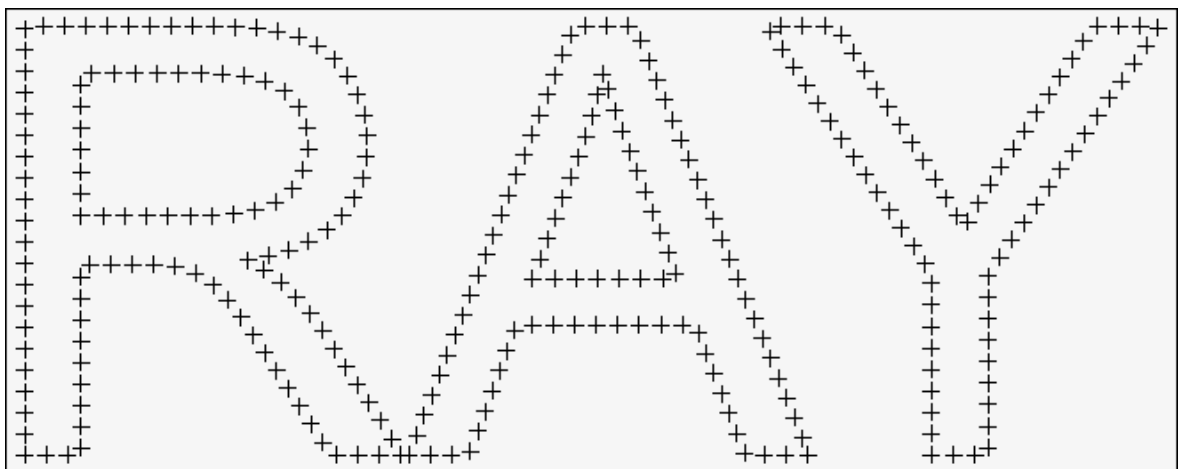


Fig. 7.54: RG-AFG

#### 7.2.6.3.11.8 Replace all commands by paths

If a path contains several graphic commands, each individual or selected graphic command is subdivided into its own path. The processing direction could then be inverted for each path created in this way.

Context menu: *Vector optimizations > Replace > All commands by paths*

Hierarchy levels: All

#### 7.2.6.3.12 Doubling points in polylines

This function inserts an additional point between two existing polyline points.

Context menu: *Vector optimizations > Double points in polylines*

Hierarchy levels: All

Example:

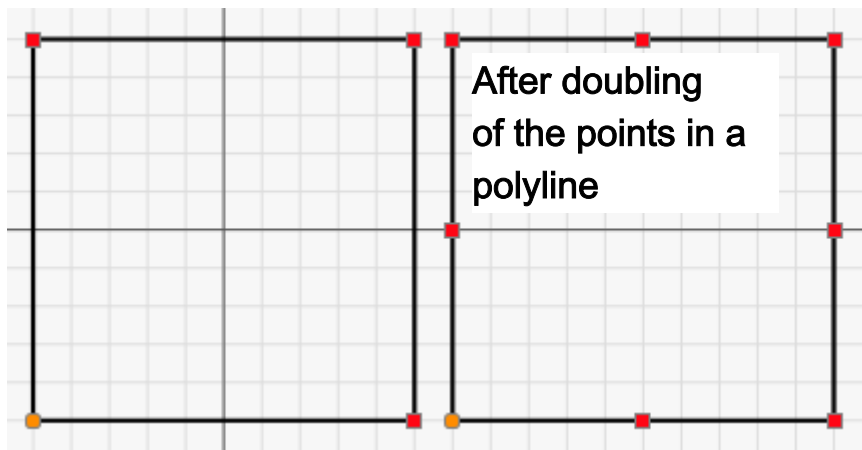


Fig. 7.55: RG-ACL

### 7.2.6.3.13 Related settings

Select

**System > Preferences [F3] > User (current user) > Vector optimizations.**

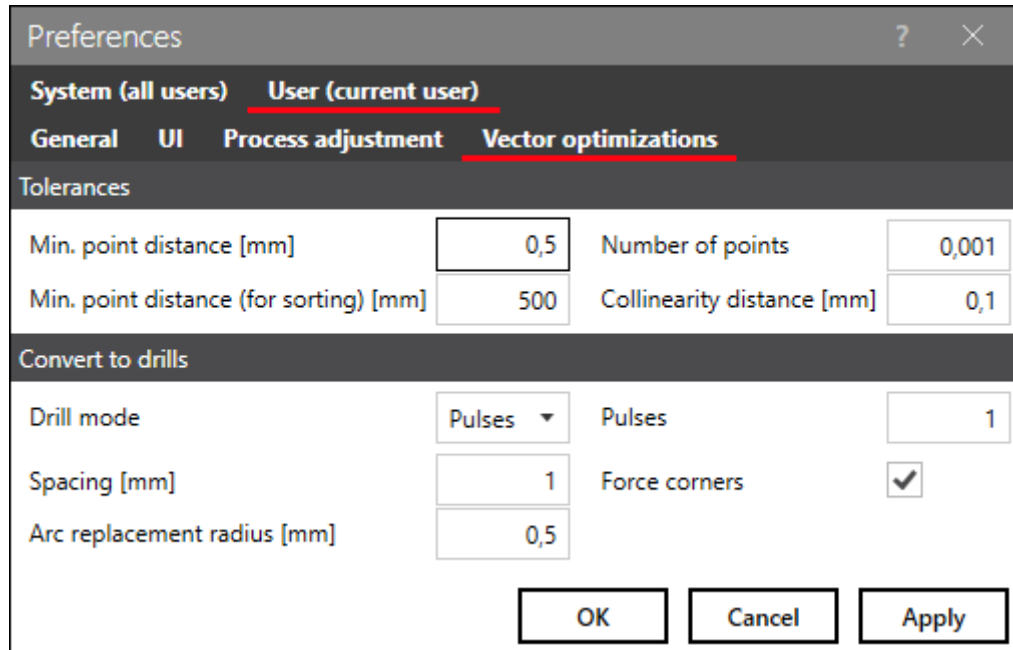


Fig. 7.56: RG-AFH

| Setting                                | Explanation   |
|--|---|
| <b>Tolerances</b>                      |   |
| Min. point distance [mm]               | The distance two points must have to be considered as the same point.<br>Example: 0.5 means that two points at a distance of less than 0.5 mm are interpreted as the same point.  |
| Number of points                       | You can convert each graphic command into a polyline. This is done in two steps:<br>The first step creates a polyline containing the number of points given here.<br>In the second step, the number of points that are entirely or almost entirely in a straight line is reduced using the collinearity distance tolerance value. |
| Min. point distance (for sorting) [mm] | Same as tolerance described above but for using the <i>Sort</i> function.   |
| Collinearity distance [mm]             | Parameter to decide whether a point lies on the same line defined by its two predecessor points. If its distance to that line is less than the specified value (e.g. 0.1 mm), the point is considered to lie on the line.   |

| Setting                        | Explanation   |
|--------------------------------|---|
| <b>Convert to drills</b>       |   |
| Drill mode                     | <ul style="list-style-type: none"> <li>■ <i>Pulse</i>: The dwell time per drill point is defined on the basis of the number of pulses and the frequency defined in the pen and the resulting pulse period.</li> <li>■ <i>Time</i>: The dwell duration per drill point is defined directly as the target value.</li> </ul> |
| Pulse / Time                   | Number of laser pulses or duration [ms]   |
| Spacing [mm]                   | Distance between drill holes along the contour lines  |
| Force corners                  | If active, a drill hole is placed at each corner point of the contour in order to illustrate it more accurately.  |
| Radius for replacing arcs [mm] | <p>Circular arcs with a radius less than / equal to this value would be replaced by drill holes if optimised accordingly.</p> <p>If the reverse conversion from drill holes to arcs is selected, the arcs will have this radius.</p>  |

Tab. 7.25: RG-037

#### 7.2.6.4 Manual Vector Editing

In edit mode, you can manipulate an object's vector directly in the layout as displayed in the viewport.

Edit mode always works per object. The view options (e. g. display of jumps) and fillings are turned off while in edit mode.

You can start edit mode in the object's context menu or select the object's layer or path in the object tree. When entering edit mode, all points (transition points and control points) are displayed and coloured.

When a sub-unit of an object, e.g., a layer, path or graphic command, is selected in the job tree, its thumbs are highlighted to be able to more easily see its position in the viewport.

##### Colour code

Red = Polyline or graphic command transition points

Blue = Starting point of the path

Orange = Control point

- Transition points:

These are points between the graphic commands or between the line segments of a polyline. They are displayed as square dots, which are also called "thumbs".

- Control points:

These are points to define the arc centre or quadratic / cubic curves, to name some examples. Control points are visible as round dots.



## Selecting points

- With the mouse:
  - First click in the empty area so that no thumbs are selected. Then select individual thumbs by clicking the mouse.
  - Multiple selection: Press **[Ctrl]** or **[Shift]** or drag the mouse cursor around the points.
  - To deselect, press the **[Ctrl]+[Alt]** keys.
- In tree directory:
  - All points of the selected command become active.
  - Polyline: Open the point list to select a partial sequence.
  - Keep **[Ctrl]** pressed to add other items to your selection.

**NOTE:** The selected thumbs are always filled, while the remaining thumbs are displayed with a coloured frame.

Example:

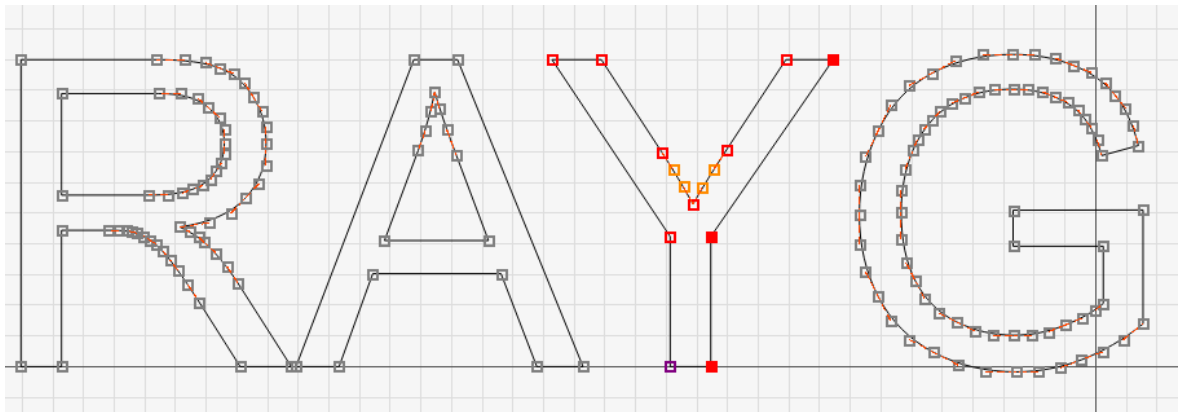


Fig. 7.57: RG-AEA

How to move a point or edit its position:

- With the mouse: Keep the left mouse icon pressed and shift the point to the desired position. To move a complete path, you need to double-click on one of the thumbs of the path (all points are shown filled) and then apply and move one of the thumbs with the mouse.

**NOTE:** The contour points as well as the thumbs have "magnetic" properties to be able to connect 2 points (e.g. start and end point of a path) exactly.

The range of magnetic attraction has a radius of 15 pixels by default and can be set here:  
**System > Settings > User (current user) > UI > Magnetic range**

**NOTE:** The cursor icon changing from arrow to hand indicates that the selection can be moved.

**NOTE on circular arcs:** During manual editing, the circular arc has 3 points on the inset (start and end points and a point on the arc). The centre point is displayed but cannot be moved separately. All 3 thumbs must be selected to move the arc as a whole.

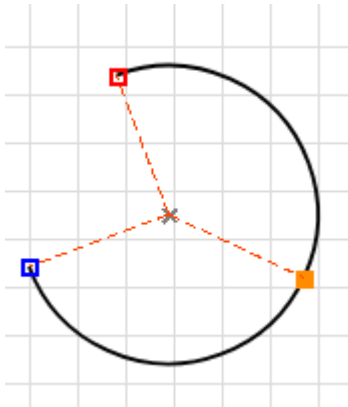


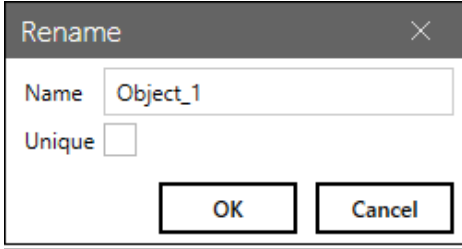
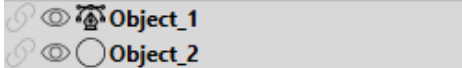
Fig. 7.58: RG-AEK

- With the arrow keys: You can use the arrow keys on the keyboard to move points horizontally / vertically. Usable for single or multiple selection of points.
- Apply relative transformations, see page 168, *Object transformation*.
- To adapt a graphic element position-specifically, you can also edit its point coordinates directly in the command settings dialog.

### 7.2.6.5 More Object-related Operations in the Context Menu

The context menu is always available when you right-click on an item or on a selection of items.

The table below lists all possible functions, however, which context functions are offered depends on the object selection and whether you open the context menu in the viewport of the jobtree.

| Function                   | Explanation  | Available in viewport and / or tree | Available for ...  |
|----------------------------|--|-------------------------------------|--------------------|
| Properties                 | Opens the <i>properties</i> dialog of the respective element.  | Tree                                | All                |
| Edit vectors / Finish edit | Starts or ends the edit mode of a free-shaped vector graphic.  | Tree / Viewport                     | Free-shaped object |
| Rename                     | <p>1. A marking object selected in the tree:<br/>Opens the name field for editing.</p> <p>2. Several marking objects selected:<br/>Opens the following dialog field:</p>   <ul style="list-style-type: none"> <li>■ "Unique" not active:<br/>All selected objects are renamed with the same name</li> <li>■ "Unique" active:<br/>A unique suffix is added to all selected objects in addition to the new name</li> </ul> | Tree                                | Object             |
| Save as template...        | Saves an object as a template for this object type. See <i>page 218, Templates</i> .   | Tree / Viewport                     | Object             |

| Function                  | Explanation   | Available in viewport and / or tree | Available for ...                        |
|---------------------------|---|-------------------------------------|--|
| Export as...              | Allows the export of the selected layout object to another file format, such as DXF.  | Tree                                | Object                                   |
| Change pen...             | Allows selection of another pen from the Job - Pen - Set.   | Tree                                | Object / Layer / Path / Path element(s)  |
| Unify pens...             | Reduces the pens used by the selected item(s) to a single pen, so that all subordinate paths use the same pen. This pen is selected by the user.  | Tree                                | Object / Level / Path                    |
| Edit pens...              | Opens the pen settings dialog. Useful to edit pen values of items using different pens. The value field will display "Multiple" if the respective pens have different values. After editing the pen values, choose a reasonable pen saving option. For details, refer to <i>page 220, Process Parameters (Pens)</i> . | Tree                                | Object / Level / Path                    |
| Edit laser-on commands... | Opens the dialog with the properties of the "Laser on" command to edit the properties of several commands in one operation. For example, all laser-on commands in a layer can be set to the same duration.  | Tree                                | Object / Layer / Path multiple selection |
| [Cut]                     | Copies the item to the clipboard and removes the original <b>[Ctrl-]+[X]</b> .  | Tree / Viewport                     | Container / Object / Layer / Path        |
| Copy                      | Copies the item to the clipboard but keeps the original <b>[Ctrl]+[C]</b> .   | Tree / Viewport                     | Container / Object / Layer / Path        |
| [Delete]                  | Deletes the selected elements.  | Tree / Viewport                     | Container / Object / Layer / Path        |

| Function          | Explanation   | Available in viewport and / or tree | Available for ...                 |
|-------------------|---|-------------------------------------|-----------------------------------|
| [Paste]           | Pastes the item from the clipboard to the position in the tree / viewport.  | Tree / Viewport                     | Container / Object / Layer / Path |
| Center XY         | Positions the object in the centre of the workspace of the XY coordinate plane.   | Tree / Viewport                     | Container / Object                |
| Align             | Option to align a multi-selection of objects relative to each other. The alignment refers to the object bounding box of the selection.<br><br>Horizontally you can align the objects <i>left / centre / right</i> ; vertically you can align the objects <i>top / centre / bottom</i> .   | Tree / Viewport                     | Object multiple selection         |
| To vector graphic | Converts a pre-formed vector object into a free-shaped vector object, built on the hierarchy structure.   | Tree / Viewport                     | Pre-formed object                 |
| Explode           | Option to split a container into its "individual pieces". Each child is created as a separate object in the job tree.<br><br>Sub-options (for nested) containers: <ul style="list-style-type: none"> <li>■ Recursive:<br/>All containers including containers in a container are dismantled.</li> <li>■ Non-recursive:<br/>Only the container selected in the job tree is dismantled</li> </ul> | Tree                                | Container objects                 |
| Group / Ungroup   | Puts the selected objects into a new group container / dissolves the selected group container.  | Tree / Viewport                     | Object multiple selection         |

| Function                        | Explanation  | Available in viewport and / or tree | Available for ... |
|---------------------------------|--|-------------------------------------|-------------------|
| Move to combined vector graphic | <p>Combines two or more selected elements (free-formed or pre-formed) to a single vector object. The resulting object always is a free-shaped vector graphic. Existing layers are preserved. A separate layer is created for each of the previous pre-formed objects.</p> <p><b>NOTE:</b> When you move graphic elements <b>manually</b> (e. g. by dragging in the objects list) into another object which has already undergone transformations, the element is transformed in the same way as the target. In contrast, when using the <b>Move to combined vector graphic</b> command, the element is <b>not</b> transformed but remains unchanged. In fact, the new combined object starts as a new object free of transformations.</p> <p><b>NOTES:</b></p> <ul style="list-style-type: none"> <li>■ The resulting object always uses job pen 1, independent of what pens have been used before.</li> <li>■ If the filling is active for one or more selected objects, the filling algorithm applies to the combined layout and the filling types get stacked.</li> <li>■ If text objects are in the selection, their contents are converted into special text levels so the text attributes are retained. (For the text level, see <i>page 134, Vector Graphic</i>)</li> </ul> | Tree                                | Object            |

| Function                           | Explanation  | Available in viewport and / or tree | Available for ...     |
|------------------------------------|--|-------------------------------------|-----------------------|
| Add layer / Add path / Add command | Adds a subordinate element to the higher-level item, e. g. a path to a layer.  | Tree                                | Object / Level / Path |
| Extract layers as new objects      | All layers of the selected object are copied and created as separate objects, which in turn are combined in a group container.   | Tree                                | Free-shaped object    |
| Extract into combined object       | <p>You can select sub-entities, for example, layers or paths, and extract them into a single new vector object which contains the selection.</p> <p>Multi-selection is possible.</p> <p>The combined selection of layer / paths is possible, however, the path must not be part of an already selected layer.</p> <p>Cross-selection over different objects is possible.</p> <p>Each selected path element gets its own layer in the newly created object.</p> | Tree                                | Layer / Path          |

| Function                        | Explanation  | Available in viewport and / or tree | Available for ... |
|---------------------------------|--|-------------------------------------|-------------------|
| Extract into individual objects | <p>You can select sub-entities for example, layers or paths and extract them into new vector objects. A new graphic object is created for each selected element.</p> <p>Multi-selection is possible.</p> <p>The combined selection of layer / paths is possible, however, the path must not be part of an already selected layer.</p> <p>Cross-selection over different objects is possible.</p> <p>Each selected path element gets its own layer in the newly created object.</p> | Tree                                | Layer / Path      |
| Split                           | <p>Splits the corresponding object above the selected element, creating a second vector object containing all elements from the selection and below. Depending on whether the selected element is a graphic command, a path or a layer, the new vector object is completed with the usual hierarchy.</p> <p>Only one graphic element must be selected.</p>   | Tree                                | Layer / Path      |
| [Reverse order]                 | Reverses the order of path elements in a path, i. e. swaps the path processing direction.  | Tree                                | Path              |
| Delete without closing          | Deletes a graphic command without closing / bridging the gap. The resuming graphic commands after the deleted graphic command create a new path.   | Tree                                | Graphic command   |
| Set as path start               | <p>Defines the selected thumb as the new location of the path.</p> <p><b>NOTE:</b> Can only be used with closed paths</p>  | Viewport in edit mode               | Thumb of a path   |



| Function                           | Explanation   | Available in viewport and / or tree | Available for ... |
|------------------------------------|---|-------------------------------------|-------------------|
| Set starting point for measurement | Defines the selected thumb as the location of a distance measurement. Current (displays the coordinate of the defined measurement location)   | Viewport in edit mode               | Thumb of a path   |
| Measure distance to point          | Defines the selected thumb as the end point of a distance measurement (coordinate of the selected measurement end point).   | Viewport in edit mode               | Thumb of a path   |
| Show ruler                         | The measuring ruler is displayed starting with the last defined "location" (or at 0/0 if none has been defined yet). After releasing the ruler again by left-clicking with the mouse, the measured distance is written to the Notification panel. | Viewport in edit mode               | Thumb of a path   |

Tab. 7.26: RG-038

## 7.2.7 Automation Objects

Automation objects are primarily used to create interactions - with the operator or with external control devices.

Automation objects can be added directly by dragging them to the desired flow position in the job tree. When dragged into the viewport they are added after the current selected object.

If you click the icon, the settings dialog opens. The object is added after the earlier active object, once you click **[OK]**.

### Common Settings of Automation Objects

| Setting        | Explanation  |
|----------------|--|
| Short label    | A name for this object that is easy to remember            |
| Enable binning | To open the detailed port and signal configuration         |
| I/O controller | The scan controller card which receives the signal         |
| I/O port       | Port of the scan controller card which receives the signal |

Tab. 7.27: RG-039

There are five automation objects:

### 7.2.7.1 Wait for External Start



Button

This object causes the execution to wait for a trigger signal – for the primary start and for each execution loop. Thus, it is often the first object in the job. It can also be used as a pause within a job.

**NOTE:** The job has the “active” status even when waiting.

**NOTE:** The input for the trigger signal on the SP-ICE-3 scan controller (pin: START\_MARK) is sensitive to edges.

Specific settings are:

| Setting        | Explanation  |
|----------------|--|
| I/O controller | Select the controller card that receives the trigger signal. Currently, only SP-ICE-3 scan controllers can be selected.                                  |
| Timeout [ms]   | Select a time other than zero to provoke an error message if the start signal is not registered on the selected scan controller within this time period. |

Tab. 7.28: RG-040

### 7.2.7.2 Waiting for port



Button optional,  
see page 113,  
Objects Overview

This object ensures that execution stops or only continues if a state defined in the automation object is present at the selected input (port).

**NOTE:** The job has the "active" status even when waiting.

Specific settings are:

| Setting        | Explanation  |
|----------------|--|
| I/O controller | Select the scan controller that provides the port where the I/O signal is expected. Currently, only SP-ICE-3 scan controllers can be selected as I/O controller.   |
| I/O port       | Configured input port to be used at the selected scan controller.<br><i>See page 45, Scan Controller Configuration</i><br><b>NOTE:</b> In case the IO port bit area has been changed after adding the automation object to the job, a warning will be shown in the Write port dialog, and at the same time a dialog will be offered with a direct option to refresh the port bit area. |
| Port value     | Set the bit pattern that must be received for this object to consider the wait condition fulfilled and continue job execution.<br><b>NOTE:</b> The condition may also be fulfilled before it is the object's turn.   |
| Timeout [ms]   | Select a time other than zero to provoke an error message if the bit state is not registered on the selected scan controller port within this time period.   |

Tab. 7.29: RG-089

### 7.2.7.3 Delay



Button

Inserts the waiting period before the next object is executed.

Specific settings are:

| Setting         | Explanation   |
|-----------------|---|
| Delay           | Duration of the delay in [ms]   |
| Scan controller | Defines the target scan controller with which the object is executed. |

Tab. 7.30: RG-041

#### 7.2.7.4 Dialog



Button

Makes a dialog box pop up in the viewport, for example, to ask for process continuation. The message box offers two different choices:

- **[OK]** button to continue execution
- **[Cancel]** button to abort execution

**NOTE:** The dialog object is executed in the "On host" execution mode only, which is to say that the dialog is displayed in the GUI accordingly.

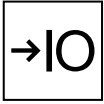
The job execution pauses as long as there is no reply to the message.

Specific settings are:

| Setting          | Explanation  |
|------------------|--|
| Title            | Heading of the message box   |
| Message          | Suitable message text  |
| OK label         | Suitable text to indicate continuing the execution   |
| Cancel label     | Suitable text to indicate aborting the execution   |
| Is modal         | When activated, the dialog blocks the remaining execution of the RAYGUIDE.   |
| <b>Variables</b> |  |
| Prompt for value | When activated, the content entered in the dialog is transferred to the variables defined below.   |
| Name             | Enter a unique name for the variable here.<br><b>NOTES:</b> The field can only be used if the request <i>Value</i> option is activated.<br>The variable can be used to transmit content to text / barcode objects. |

Tab. 7.31: RG-042

### 7.2.7.5 Write Port



Button

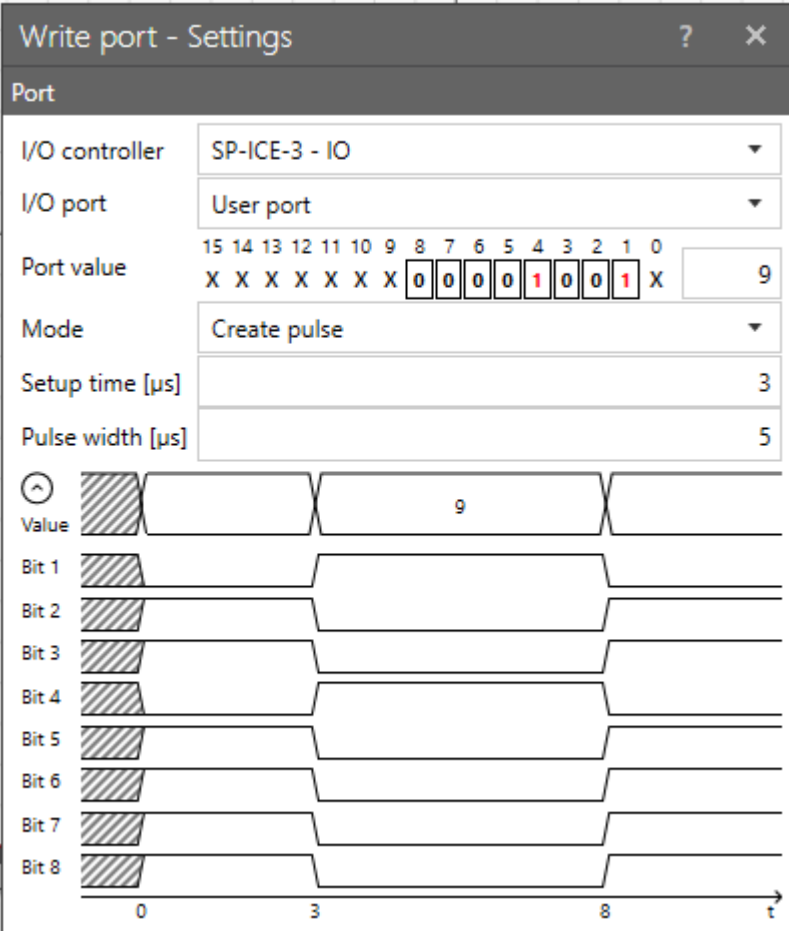
Used to define a bit pattern which is set on a specific I/O port of the scan controller.

Typical use cases:

- Another control device is polling this information.
- Triggering a specific device that responds to a trigger edge, e.g., the START\_MARK input of another SP-ICE-3 scan controller.

**IMPORTANT:** The I/O settings remain like this until they are reset by another write port object, unless the "Pulse" option is used.

| Setting                | Explanation   |
|------------------------|---|
| I/O controller         | Defines the target I/O controller card with which the object is executed. Currently, only SP-ICE-3 scan controllers can be selected as I/O controller.  |
| I/O port               | Configured output port to be used at the selected scan controller.<br><i>See page 45, Scan Controller Configuration</i><br><b>NOTE:</b> In case the IO port bit area has been changed after adding the automation object to the job, a warning will be shown in the Write port dialog, and at the same time a dialog will be offered with a direct option to refresh the port bit area. |
| Port value             | Define the bits (port pins) to be activated.  |
| Mode                   | Select one of the available modes: <ul style="list-style-type: none"> <li>■ Write value</li> <li>■ Create edge</li> <li>■ Create pulse</li> </ul>   |
| Setup time [ $\mu$ s]  | Defines the time in [ $\mu$ s] that the complementary bit value is set in advance to generate a signal edge or a pulse  |
| Pulse width [ $\mu$ s] | Defines the time in [ $\mu$ s] that the value is held before the second signal edge to create a pulse   |

| Setting        | Explanation   |
|----------------|---|
| Timing Diagram | <p>Shows live how the time values affect the signal sequence.<br/>Use expander to view the signal sequence of each bit.</p>  <p><b>NOTE:</b> The polarity of the logical edge / pulse does not have to be the same as the electrical polarity of the signal. This depends on the high / low configuration of the port.</p> |

Tab. 7.32: RG-043

### 7.2.7.6

#### Arming / Disarming laser



Button

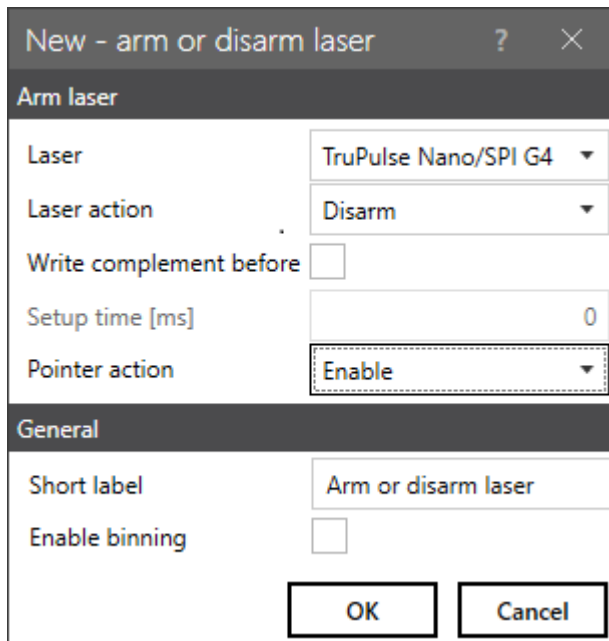
The automation object can be used in any flow position to switch the laser status between "armed" and "disarmed".

In addition, the visible laser source can be switched on and off.

**NOTE:** Most lasers do not permit laser emission while the laser source is active. For this reason, we recommend activating the laser source only if the laser is "disarmed".

Application example: This switch may be necessary, for example, to return a laser that is in the error state to the operating state.

Use example of the laser source: Lets you define a job that runs in stand-alone mode for preview purposes.



| New - arm or disarm laser   |                          |
|---|--------------------------|
| <b>Arm laser</b>  |                          |
| Laser   | TruPulse Nano/SPI G4     |
| Laser action  | Disarm                   |
| Write complement before   | <input type="checkbox"/> |
| Setup time [ms]   | 0                        |
| Pointer action  | Enable                   |
| <b>General</b>  |                          |
| Short label   | Arm or disarm laser      |
| Enable binning  | <input type="checkbox"/> |
| <input type="button" value="OK"/> <input type="button" value="Cancel"/> |                          |

Fig. 7.59: RG-AED

| Setting                 | Explanation   |
|-------------------------|---|
| Laser                   | Select the corresponding, configured laser.   |
| Laser action            | Select whether, at this point in the job flow, the laser is to be <i>armed</i> , <i>disarmed</i> , <i>disarmed and power set to zero</i> , or if <i>no action</i> is to be performed. |
| Write complement before | Define whether an action that is complementary to the defined action (arm, disarm) is to be performed for the laser to ensure a signal edge.  |
| Setup time [ $\mu$ s]   | Enter a time in [ $\mu$ s] for which the complement status is set in advance.   |
| Pointer action          | Select whether, at this laser in the job flow, the laser source is to be <i>activated</i> , <i>deactivated</i> or if <i>no action</i> is to be performed.                             |

Tab. 7.33: RG-078

### 7.2.7.7 Send Enhanced Command



The automation object can be used to send an extended command to the deflection unit in any sequence position, e.g. to switch the tuning and therefore the dynamic behaviour of the deflection unit.

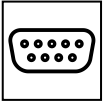
Button optional,  
see page 113,  
Objects Overview

| Setting   | Explanation   |
|---|---|
| Scan head   | Select the corresponding configured deflection unit.  |
| Axes  | Select the axes to receive the command.<br><b>NOTE:</b> Currently, only the X/Y-axes are available as a bundle to receive enhance commands.         |
| Command   | Select the type of command.<br><b>NOTE:</b> Currently, the only available command is the command to set an available tuning of the deflection unit. |
| *Tuning   | Select an available tuning of the chosen deflection unit.<br>The selection lists the tunings by name.   |
| *Delay  | Enter the time required for the deflection unit to switch to another tuning set.  |
| <b>*NOTE:</b> The appearance of these fields depends on the selection of the command. |   |

Tab. 7.34: RG-079



### 7.2.7.8 Write to Serial Port



Send a command line to a preconfigured serial port, see *page 45, Scan Controller Configuration*.

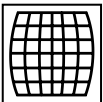
Specific settings are:

Button optional,  
see *page 113,*  
*Objects Overview*

| Setting           | Explanation  |
|-------------------|--|
| Serial Controller | Select the target serial port controller. A possible selection can be the serial port of the PC or the serial port of a SP-ICE-3 scan controller.  |
| Serial Port       | Port name to be used   |
| Add message       | Opens a field where a command line can be entered. The text can be copied for multiple messages with individual responses.   |
| Expected response | Activate if a response is expected. The expected string must be entered. If the response is the expected string, the execution continues. If not, you get a timeout warning.<br><br>See the documentation of the recipient device for available commands and response. |
| Delay             | Set a time delay between a response and sending the next command line.   |

Tab. 7.35: RG-044

### 7.2.7.9 Setting the correction file index



If configured accordingly (see *page 67, General*), this automation object can be used to define, and thus change, the correction file used on the control card. The definition is created by specifying the index of the correction file.

Button optional,  
see *page 113,*  
*Objects Overview*

| Setting         | Explanation  |
|-----------------|--|
| Scan controller | Selects the control card on which the index for the correction file is to be set.    |
| Index           | Defines the index of the correction file that is to be set by the automation object. |

Tab. 7.36: RG-084

## 7.2.8 Templates

Templates can be stored so that job elements with specific settings can be reused at any time. Templates can be used for all job elements (1st tab) – this also includes containers and automation objects – or exclusively on fill patterns (2nd tab).

### Job element templates

Select an object (in the viewport or in the job tree) and select *Save as template* from the context menu. In the dialog, the following settings are made:

| Setting   | Explanation   |
|---|---|
| Name  | An appropriate name for this job element  |
| Use as default  | <p>This sets this template with your specific settings as the default for this object type and is thus the starting point for all newly added objects of this object type.</p> <p>Importable layout objects, for example, bitmaps or vector graphics, do not allow a default template definition.</p> <p>There can only be <b>one</b> default template for each object type. If no template is set as default, the system provides the default.</p> <p>The default object is indicated by a checkmark in the object menu list as well as in the template panel.</p> <p><b>NOTE:</b> The currently assigned pen is not saved as part of a default object template.</p> |
| Include filling   | Includes the object's filling as part of the template.  |
| Include transformation  | Includes the transformations which have been made for this object so far. This is useful to always apply the template in a specific position of the workspace.  |
| <b>NOTE:</b> The object's assigned pen is <b>only</b> stored as the pen number, <b>not</b> with the pen's properties. |   |

Tab. 7.37: RG-045

### Fill templates

To store a fill pattern as template, use the **[Save]** button on the fill tab in the object properties menu.

Click the **[Load]** button for a list of all available fill templates that can be used directly.

### Template panel

The template user interface panel contains all saved templates. They are divided into two tabs, so you can manage / apply them from here.

The **[Create]** button adds the job element to the active job.

The **[Single check]** button applies the filling to all selected layout objects. All previous fill patterns are replaced.

The **[Double check]** button applies the fill to the selected layout objects in addition to any existing fill pattern.

The **[Delete]** button removes the template entry.

## 7.3 Process Parameters (Pens)

### 7.3.1 About Pens

A pen is a collection of process parameters, telling the laser system (laser and deflection unit) **how** to process a specific job, a specific object, or even a single graphic element.

The name "pen" reflects a hand-held pen used for writing or drawing. Just like a normal writing implement (pencil, ballpoint pen, felt-tip pen, marker, etc.) creates a different effect on the drawing paper, each RAYGUIDE pen also processes your graphic object in a different way. This means that the pen settings essentially define the result of the application.

Pens are clustered in pen sets. RAYGUIDE administrates pen sets as a kind of library, called library pen sets. The library pen sets can be seen as templates. Every job is provided with a pen set that is assigned to the job and called base pen set.

- The base pen set is always a duplicate of the default library pen set and can be edited as part of the job without any impact on the stored template.
- The base pen set is connected to its job. It is saved within the job file and shows up wherever and whenever the job is loaded.

Once you load a job, the possible scenarios are:

- The job's base pen set has the same name as a library pen set. The pens of both pen sets may or may not be equal. In any case, only the current settings of the loaded job's base pen set apply.
- The job's base pen set comes from another RAYGUIDE system, and no library pen set of the same name exists. In this case, the pen set is shown as "Unlinked".

If a pen of the default library pen set is modified, the change has no direct effects on the job's base pen set, unless you refresh the base pen set in the job settings menu. In the job settings menu, you can also switch from the default pen set to another library pen set.

It has been specified that pens and layout elements are managed separately. However, every layout element is linked at least to one pen. A newly created graphic object uses the default pen of the base pen set when created.

The pens of the base pen set are listed and maintained in the Pen panel. See *page 223, Pen Panel*.

## 7.3.2 Pen Set Configuration

Open the pen sets configuration dialog from the RAYGUIDE menu: **System > Library pen sets > Configure....**

You can access all pen sets in the library, add new pen sets to the library, add pens to a pen set, edit pen parameters, rename pens, etc.

The **Configure...** option under **System > Library pen sets** lists all available pen sets. One pen set is intended to be the default pen set, indicated by a checkmark in front. Right-click on another pen set in the list if you want to use this pen set as default. The "owners" of the respective pen sets are also displayed here.

Click on a listed library pen set to access it directly.

RAYGUIDE distinguishes two types of library pen sets:

- **System pen sets** are available to all users listed on the System tab
- **User-specifically created pen sets** are available only to their respective owners and are listed on the User (current user) tab






Available library pen sets are available via a drop-down list.


After installation RAYGUIDE comes with one sample library pen set, called the system pen set. The system pen set is the only pen set that cannot be removed.

In a library pen set, all pens starting from pen no. 1 derive their parameter values from master pen no. 0. The master pen no. 0 cannot be deleted.

### Toolbar

All functions of the pen panel's toolbar apply to the selected pens. To select a pen in a pen set, click the pen entry. The pen is now highlighted in grey. Use **[Ctrl]** to select multiple pens.

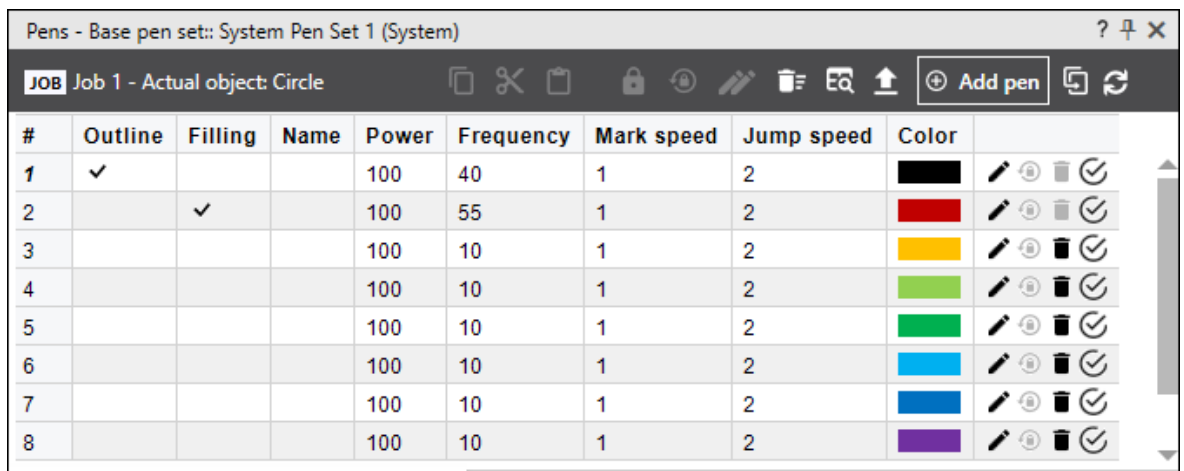
| Tool  | Function  |
|---|---|
| <p><b>[Copy],</b><br/><b>[Cut],</b><br/><b>[Paste],</b><br/><b>Special paste]</b></p>  | <p>A pen selection can be copied or cut out and saved in the clipboard and pasted into another pen set – and thus also in another library pen set or the base pen set of an open job.</p> <p>When you paste pens from the clipboard into a pen set, the target pen set probably already contains pens with the same number. If so, a confirmation dialog is displayed:</p> <ul style="list-style-type: none"> <li>■ <i>Replace</i>: Replaces all pen parameters.</li> <li>■ <i>Merge</i>: Replace only pen parameters that are not protected (protected parameters are shown in italics and bold).</li> <li>■ <i>Copy as new</i>: Add the pens as new pens, while they get subsequent pen numbers in the target pen set.</li> </ul> <p>Click <b>[Skip]</b> to do nothing and proceed to the next pen. Mark <i>Repeat for all conflicts</i> to select the same option for all pens in the clipboard.</p> <p>If multiple pens are in the clipboard, the confirmation dialog is repeated for each pen.</p> <p>When using the “special paste” option, the pen from the clipboard will replace master pen #0 instead of the respective pen number.</p> |
| <p><b>[Lock / Unlock],</b><br/><b>[Reset]</b></p>                                    | <p>Use <b>[Lock / Unlock]</b> to ensure that <b>all</b> parameters are protected against overwriting in case of a pen paste-in.</p> <p>Use <b>[Reset]</b> to remove <b>all</b> previous parameter changes (reset to master pen values) and at the same time unlock <b>all</b> pen parameters.</p>   |
| <p><b>[Edit selected pens]</b></p>   | <p>This option allows you to edit parameters of multiple pens at the same time. The pen form opens and parameter fields where several pens contain different parameters are indicated by <i>Multiple</i>.</p> <p>Editing the parameters affects all selected pens and the linked layout objects. Untouched parameters remain as before.</p>   |
| <p><b>[Delete]</b></p>   | <p>Deletes the selected pen.</p>  |
| <p><b>[Factory reset of system pen set]</b></p>                                      | <p>This option sets all values in all pens to default values and creates the default number of pens in the set.</p>   |

| Tool  | Function   |
|---|--|
| <b>[Edit name]</b>  | Releases the name field of the library pen set for processing.               |
| <b>[Set as default]</b>   | Defines the current library pen set as the default pen set.                  |
| <b>[Add pen]</b>  | Adds an additional pen with the default parameters to a pen set.             |
| <b>[X]</b>  | Deletes the respective library pen set.                                      |
| <br>(located right lower corner of the dialog) | Add a new library pen set.<br>Any new library pen set always has eight pens. |

Tab. 7.38: RG-046

Otherwise, the pen list in the pen configuration menu behaves similar to the pen list in the Pen panel, which is described in the following chapter.

### 7.3.3 Pen Panel



The screenshot shows a software window titled "Pens - Base pen set:: System Pen Set 1 (System)". The window contains a toolbar with icons for copy, paste, lock, refresh, edit, delete, zoom, and an "Add pen" button. Below the toolbar is a table with 10 columns: #, Outline, Filling, Name, Power, Frequency, Mark speed, Jump speed, Color, and a set of control icons (edit, delete, refresh). The table lists 8 pens with various parameters and colors.

| # | Outline | Filling | Name | Power | Frequency | Mark speed | Jump speed | Color       | Control Icons         |
|---|---------|---------|------|-------|-----------|------------|------------|-------------|-----------------------|
| 1 | ✓       |         |      | 100   | 40        | 1          | 2          | Black       | edit, delete, refresh |
| 2 |         | ✓       |      | 100   | 55        | 1          | 2          | Red         | edit, delete, refresh |
| 3 |         |         |      | 100   | 10        | 1          | 2          | Yellow      | edit, delete, refresh |
| 4 |         |         |      | 100   | 10        | 1          | 2          | Light Green | edit, delete, refresh |
| 5 |         |         |      | 100   | 10        | 1          | 2          | Green       | edit, delete, refresh |
| 6 |         |         |      | 100   | 10        | 1          | 2          | Cyan        | edit, delete, refresh |
| 7 |         |         |      | 100   | 10        | 1          | 2          | Blue        | edit, delete, refresh |
| 8 |         |         |      | 100   | 10        | 1          | 2          | Purple      | edit, delete, refresh |

Fig. 7.60: RG-ACM

This is the location to edit, add, and manage the pens used in the current job.

**ATTENTION:** A pen number occurs only once within a pen set. Therefore, you can assign a name for each pen to be able to distinguish it better from other pens sharing the same pen number.


An \* (asterisk) indicates that this pen differs from its reference pen. The **[Reset]** button is activated, in case you want to reset the pen back to the original parameters.

The list shows:








- Default Pen – this pen is used for all newly added layout objects. Will be highlighted in bold.
- Indication columns – there are two columns (O = outline, F = filling) indicating whether a pen is linked with at least one layout object. If you have selected a layout object, the column shows checkmarks at the linked pens. If no layout object is selected, all linked pens are indicated by a dash.
- Parameter columns – in the default view, only the major values of the pen are shown. How to edit the columns, see *page 227, Customize Pen Panel View*.
- To edit a value directly in the column, double-click on the cell to open it for editing. A double click in any cell with predefined content switches the selection to the next possible content in the sequence.
- Pen color – the pen color can be changed. Right-click on the color block to display a wide color range for selecting a new color.

### 7.3.3.1 Pen Panel Tool Bar

All functions of the pen panel's toolbar apply to the selected pens. To select a pen in a pen set, click the pen entry. The pen is now highlighted in grey. Use **[Ctrl]** to select multiple pens.

| Tool   | Function  |
|--|---|
| <p><b>[Copy],</b><br/><b>[Cut],</b><br/><b>[Paste]</b></p>  | <p>A pen selection can be copied or cut out and saved in the clipboard and pasted into another pen set – and thus also in another library pen set or the base pen set of an open job.</p> <p>When you paste pens from the clipboard into a pen set, the target pen set probably already contains pens with the same number. If so, a confirmation dialog is displayed:</p> <ul style="list-style-type: none"> <li>■ <i>Replace</i>: Replaces all pen parameters.</li> <li>■ <i>Merge</i>: Replace only pen parameters that are not protected (protected parameters are shown in italics and bold).</li> <li>■ <i>Copy as new</i>: Add the pens as new pens, while they get subsequent pen numbers in the target pen set.</li> </ul> <p>Click <b>[Skip]</b> to do nothing and proceed to the next pen. Mark <i>Repeat for all conflicts</i> to select the same option for all pens in the clipboard.</p> <p>If multiple pens are in the clipboard, the confirmation dialog is repeated for each pen.</p> |



| Tool  | Function   |
|---|--|
| <p><b>[Lock / Unlock],</b><br/><b>[Reset]</b></p>  | <p>Use <b>[Lock / Unlock]</b> to ensure that <b>all</b> parameters are protected against overwriting in case of a pen paste-in.</p> <p>Use <b>[Reset]</b> to remove <b>all</b> previous parameter changes (reset to master pen values) and at the same time unlock <b>all</b> pen parameters.</p>  |
| <p><b>[Edit selected pens]</b></p>                 | <p>This option allows you to edit parameters of multiple pens at the same time. The pen form opens and parameter fields where several pens contain different parameters are indicated by <i>Multiple</i>.</p> <p>Editing the parameters affects all selected pens and the linked layout objects. Untouched parameters remain as before.</p>  |
| <p><b>[Delete]</b></p>                             | <p>Deletes the selected pen(s), unless one of them is linked to a layout object.</p>   |
| <p><b>[Highlight pen]</b></p>                    | <p>Highlights the selected pen in the job tree (blue colour). Thus, you can easily detect all layout elements linked to this pen – sometimes, the colour signature in the viewport may not be sufficient.</p> <p><b>NOTE:</b> Expand the job tree fully to notice the highlighting.</p>  |
| <p><b>[Forward current pen values]</b></p>       | <p>Sends the current pen values to recalculate the object and job statistics. In the process, the "expected execution time" is also updated.</p>   |
| <p><b>[Transfers the pen set]</b></p>            | <p>Transfers the pen set of the current job to the pen library. Four different options are available for selection:</p> <p>The job pen set:</p> <ul style="list-style-type: none"> <li>■ Created as a new system pen set</li> <li>■ Created as a new user pen set</li> </ul> <p><b>NOTE:</b> For newly created pen sets, there is also the option of renumbering the pens, for instance to avoid gaps in numbering.</p> <ul style="list-style-type: none"> <li>■ Overwrite the pen set currently defined as the default</li> <li>■ Overwrite the corresponding base pen set</li> </ul> |
| <p><b>[Update pen list]</b></p>                  | <p>This function is used to update the pens of the job with the values of the corresponding base pen set.</p>  |

Tab. 7.39: JRG-047

## Editing pens

Newly generated pens probably do not have the appropriate parameters for your application. So it is necessary to edit the pen parameters.

You can edit pens...

- In the pen configuration, after selecting the desired library pen set.
- In the Pen panel, listing the Job / Objects / Container pens used in the current job.
- Via the Edit pens tab of the object.
- Via the Settings tab of the individual layout elements, use the pen number assigned to the object by clicking the **[Edit]** button.
- Via the Fill tab, use the **[Edit]** button right next to the pen number assigned to the fill

After editing a pen, select the appropriate saving option. See the pen saving options in the table in the following chapter.

**NOTE:** The option *Apply to object pen* is only available when coming from any Container / Object / Geometry element / Filling via the Properties dialog.

## Object pens

The object pen is a special type of pen that is not owned by the job. While a job pen can be shared with other objects, the object pen is owned by a single object only.

Containers are also treated as objects and therefore also may use object pens.

Another feature of the object pen is that the object pen takes over all parameters from the respective job pen (= same pen number); only the protected parameters are excluded from this.

An object pen may be useful if the object shares its major parameters (for example, speed, laser power, ...) with another object, but will additionally require an individual property, for example, special wobble settings.

The number of an object pen is marked with an asterisk (\*) in the drop-down list of pens. This list is located on the Pen tab in the associated object settings.

If an object is selected in the job tree or in the viewport, the Pen panel will list only pens (job pens and object pens) used by that object.

An edited pen typically contains valuable process parameters which may be applied to upcoming jobs as well. We therefore strongly recommend storing edited pens in an appropriately named library pen set.

**NOTE:** The pen panel always indicates if the listed pens are job-related pens or object-related pens.

### 7.3.3.2 Customize Pen Panel View

In order to display all desired values of the pens in the column overview, you can select the values to be displayed yourself. The related context menu offers you all the necessary options.

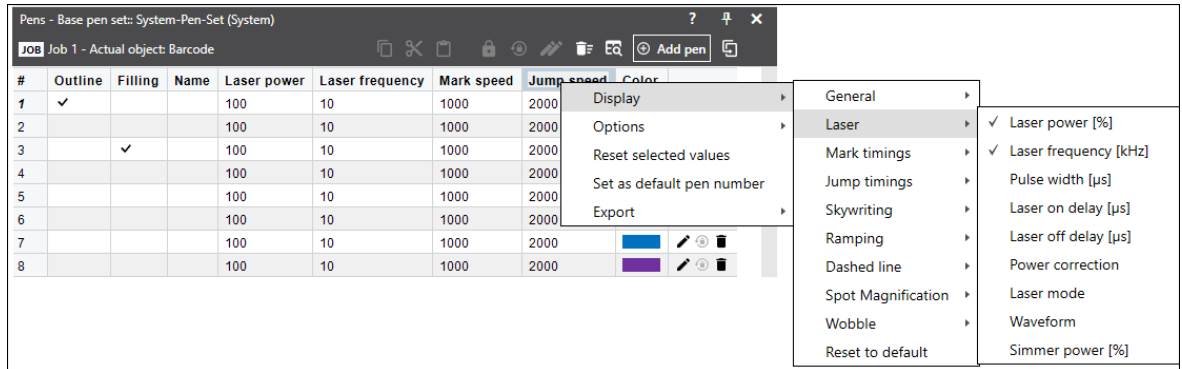


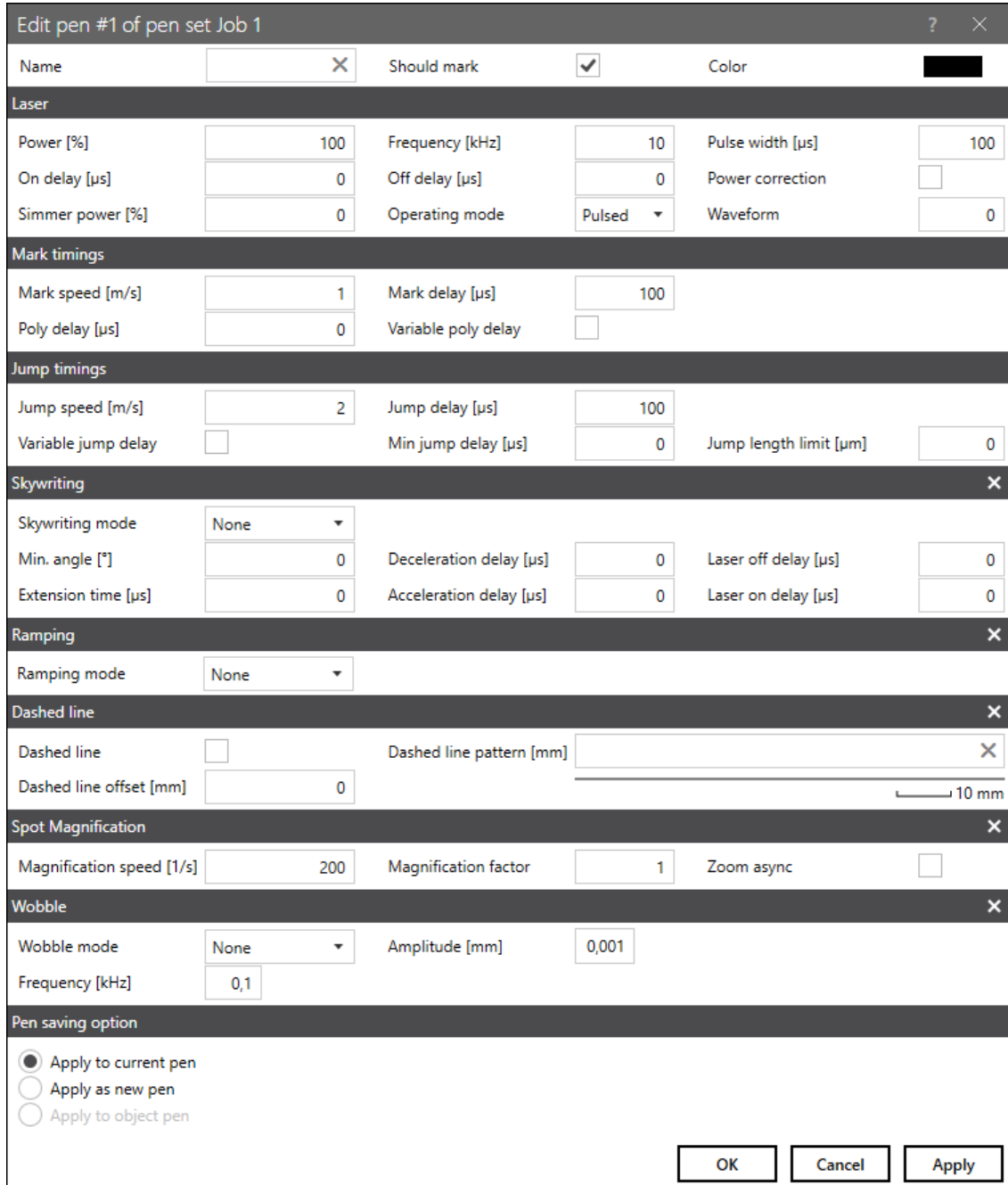
Fig. 7.61: RG-ADV

| Setting                   | Explanation  |
|---------------------------|--|
| Display                   | Under <i>Display</i> you will find all pen values grouped in sub-selections. Check the ones you want to display or uncheck them if you no longer want to display them.   |
| Options                   | The <i>Short header</i> option reduces the column header to an acronym to reduce the column width, while the tool tip continues to display all the information. The <i>Enum as index</i> option lists the enumeration number instead of the text of the drop-down list. This also serves to reduce the column width. |
| [Refresh]                 | You can select one or more cells (keep <b>[Ctrl]</b> pressed) and reset these values to the default pen values.  |
| Set as default pen number | Define the default pen to be used for all new graphic objects.   |
| [Export]                  | This option allows you to export selected (referring to the column view) or all pen values to a CSV table.   |

Tab. 7.40: RG-075

## 7.3.4 Pen Properties

Pen parameters are specified in a dialog. The pen settings dialog covers all possible process parameters, regardless of your system's actual capabilities.



The dialog box is titled "Edit pen #1 of pen set Job 1" and contains the following sections and parameters:

- Name:** [Text field with X icon]
- Should mark:**
- Color:** [Black color swatch]
- Laser:**
  - Power [%]: 100
  - Frequency [kHz]: 10
  - Pulse width [μs]: 100
  - On delay [μs]: 0
  - Off delay [μs]: 0
  - Power correction:
  - Simmer power [%]: 0
  - Operating mode: Pulsed (dropdown)
  - Waveform: 0
- Mark timings:**
  - Mark speed [m/s]: 1
  - Mark delay [μs]: 100
  - Poly delay [μs]: 0
  - Variable poly delay:
- Jump timings:**
  - Jump speed [m/s]: 2
  - Jump delay [μs]: 100
  - Variable jump delay:
  - Min jump delay [μs]: 0
  - Jump length limit [μm]: 0
- Skywriting:**
  - Skywriting mode: None (dropdown)
  - Min. angle [°]: 0
  - Deceleration delay [μs]: 0
  - Laser off delay [μs]: 0
  - Extension time [μs]: 0
  - Acceleration delay [μs]: 0
  - Laser on delay [μs]: 0
- Ramping:**
  - Ramping mode: None (dropdown)
- Dashed line:**
  - Dashed line:
  - Dashed line pattern [mm]: [Text field]
  - Dashed line offset [mm]: 0
- Spot Magnification:**
  - Magnification speed [1/s]: 200
  - Magnification factor: 1
  - Zoom async:
- Wobble:**
  - Wobble mode: None (dropdown)
  - Amplitude [mm]: 0,001
  - Frequency [kHz]: 0,1
- Pen saving option:**
  - Apply to current pen
  - Apply as new pen
  - Apply to object pen

Buttons: OK, Cancel, Apply

Fig. 7.62: RG-ACN

In the pen settings dialog, a red-coloured label indicates which parameter fields were edited since the dialog was opened.

Edited pen parameters are displayed in italics and bold (dirty flag indication). These parameters are protected against overwriting in case the pen itself gets overwritten or "refreshed". To reset these parameters to the original value, use **[Reset]**.

The Edit Pens dialog can be reached using the **[Edit pen]** button from a pen set list (configuration menu of stored pen sets / base pen set in the Pen panel), via the Edit pens tab of a layout object, or by using the **[Edit pen]** shortcut button next to the assign pen drop-down lists.

| Setting                            | Explanation  |
|------------------------------------|--|
| Pen*                               | Select a pen to be edited.<br><b>NOTE:</b> Tooltips indicate whether the pen is a job pen or an object pen.  |
| Name                               | Optional name of this pen.   |
| Should mark                        | Check this if objects / elements assigned to this pen shall actually be marked. Deselect the option to unmark objects that should not be assigned. (The selection is set to active by default.)  |
| Color                              | Select an on-screen colour for a better overview of which graphic element uses which pen.  |
| <b>Laser</b>                       |  |
| Laser power [%]                    | Laser power in [%]. The percentage does always refer to a 100% scale. The range limitation in the laser configuration will not restrict this value entry, but will report warnings when the respective job validation is activated. See <i>page 285, Running a Job</i> .<br><br>Can also be defined in absolute units, i. e. in [watts], with the appropriate preselection. Refer to <b>System &gt; Preferences &gt; User &gt; UI</b> .<br><br>The scale factor for conversion from [%] to [watts] is defined in the laser configuration, see <i>page 55, Laser Controller Configuration</i> . |
| Laser frequency [kHz]              | Value in [kHz]. Defines the pulse rate of the LM signal.   |
| Laser on delay [µs]                | Values in [µs] to synchronise the laser activity with the mirror position at the start and end of a laser path. Can also be set with a negative sign.  |
| Laser off delay [µs]               |  |
| Optical pulse width [index]/[ns]** | Select the index for the APD mode.<br><br>Depending on whether you have set up the additional serial connection to the laser, values for the respective pulse duration are displayed in addition to the index. See <i>page 63, IPG laser type YLPN-APD</i> .<br><br><b>NOTE:</b> An APD mode change always means that the laser emission must be switched off briefly. For this reason, avoid making the change within a laser path.   |

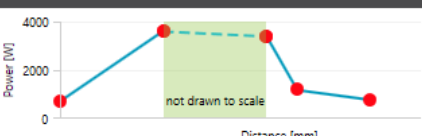
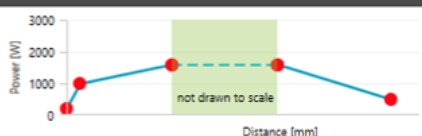
| Setting   | Explanation  |
|---|--|
| Optical pulse width [ns]**  | Specification of the optical pulse width for <b>JPT MOPA Laser</b> in [ns].<br><b>NOTE:</b> Observe the valid value range according to the specifications of the laser manufacturer.   |
| Beam profile index**  | Select the index for the beam profile of the nLight AFX laser.<br><b>NOTE:</b> A beam profile change always means that the laser emission must be switched off briefly. For this reason, avoid making the change within a laser path.  |
| Power correction  | Select to activate SP-ICE-3 function for speed-based power correction.   |
| Operating mode**  | Choose between the <i>Pulsed</i> or <i>CW (continuous wave line)</i> operating modes.  |
| Waveform**  | Number of the pulse form, which then defines the pulse width.  |
| Simmer power [%]**  | Value in [%] that translates into the 0-10 volt range for the simmer voltage.  |
| Secondary power [%]***  | Power value of the laser in [%] for a possible secondary laser source, such as for ring mode when using an IPG YLS AMB or Coherent Highlight ARM laser.<br>Can also be defined in absolute units, for instance in [watts], with the appropriate preselection. See <b>System &gt; Settings &gt; User &gt; UI</b> .<br>The scale factor for conversion from [%] to [watts] is defined in the laser configuration, see <i>page 55, Laser Controller Configuration</i> . |
| <p><b>*NOTE:</b> This option is only available when opening the pens tab in the properties dialog of a selectable job element.</p> <p><b>**NOTE:</b> The availability of these pen parameters depends on the configured lasers and on the settings under <b>System &gt; Preferences &gt; System (all users) &gt; Visibility &gt; Pen</b>.</p> <p><b>***NOTE:</b> This parameter is an alternative to the simmer power parameter and is only available if an analogue laser with a second power channel has been configured.</p> |  |

| Setting                      | Explanation  |
|------------------------------|--|
| <b>Mark timings</b>          |  |
| Mark speed                   | Speed in [m/s] of the laser spot on the material.<br>If desired, it can also be defined in [mm/s] by corresponding preselection. Refer to <b>System &gt; Preferences &gt; User &gt; UI</b> .                   |
| Mark delay [ $\mu$ s]        | Value in [ $\mu$ s]. The value relates to the dynamics of the deflection unit. Value will apply after a mark vector, prior to a jump vector.   |
| Poly delay [ $\mu$ s]        | Value in [ $\mu$ s]. The value relates to the dynamics of the deflection unit. The delay will apply at the transition point of two consecutive mark vectors.   |
| Variable poly delay          | Select this option to activate the SP-ICE-3 <b>Variable poly delay</b> function to shorten the effective value for a polygon delay depending on the heading angle.   |
| <b>Jump timings</b>          |  |
| Jump speed                   | Relative speed in [m/s] or [mm/s] when the deflection unit changes position without laser emission.  |
| Jump delay [ $\mu$ s]        | Value in [ $\mu$ s]. The value relates to the dynamics of the deflection unit. The delay will apply after a position jump.   |
| Variable jump delay          | Trim the effective jump delay dependent on the length of the jump vector. This is useful to adapt the jump delay automatically in cases where jumps are short and the deflection unit cannot reach full speed. |
| Min. jump delay [ $\mu$ s]   | When using a variable jump delay, enter a value for the minimum delay, independent of the jump length.   |
| Jump length limit [ $\mu$ m] | When using a variable jump delay, enter a value for a jump length limit. If exceeded, the main jump delay value is used.   |

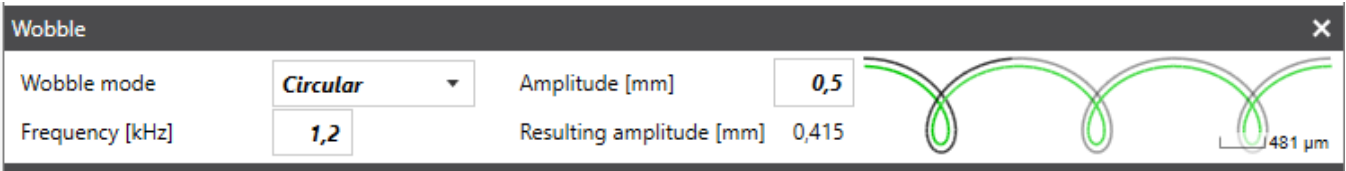
| Setting                         | Explanation   |
|---------------------------------|---|
| <b>Skywriting</b>               |   |
| Skywriting mode                 | <p>Select the suitable Skywriting mode:</p> <ul style="list-style-type: none"> <li>■ <i>None</i> = Skywriting not active</li> <li>■ <i>Force at ends</i> = Skywriting is always performed at each vector start and end independent of the heading angle between the jump-to-mark or mark-to-jump transition. The heading angle (CoH) is only taken into account at the mark-to-mark transition.</li> <li>■ <i>Min. angle</i> = The CoH angle is taken into account for all transitions (jump-to-mark, mark-to-mark, mark-to-jump).</li> </ul> <p>"CoH" stands for "Change of heading angle"</p> |
| Min. Angle [°]                  | Enter a heading angle, which if exceeded determines whether Skywriting will be applied between two consecutive marking vectors.   |
| Extension time [μs]             | Time used to calculate the length of the acceleration / deceleration vectors in consideration of the mark speed of the related mark vectors.  |
| Deceleration delay [μs]         | Delay in [μs] which appears after the deceleration vector, prior to the "u-turn" jump.  |
| Acceleration delay [μs]         | Delay in [μs] which appears after the "u-turn" jump, prior to the acceleration vector.  |
| Skywriting Laser off delay [μs] | Delay in [μs] to synchronise the laser emission on transition from mark-to-deceleration vector.   |
| Skywriting Laser on delay [μs]  | Delay in [μs] to synchronise the laser emission on transition from acceleration-to-mark vector.   |



| Setting   | Explanation   |
|---|---|
| <p><b>Ramping</b></p> <p>Defines a linear laser power ramp that is applied to every path of the layout that is linked to this pen.</p> <p><b>RULE:</b> The ramp always applies per path element. Therefore, the ramp needs to be defined in the pen that is assigned to the path level. Any new power value or other ramps due to a pen change within the path will be ignored.</p> <p><b>NOTES:</b></p> <ul style="list-style-type: none"> <li>■ The overall length of both ramps can be validated to not exceed the length of the affected path. See <i>page 285, Running a Job</i>.</li> <li>■ For drill objects, use only time-based ramping.</li> <li>■ Not applicable for bitmaps.</li> </ul> |   |
| Ramping mode  | <p>Select <i>No ramp</i> if you do not want to create a ramp.</p> <p>Select <i>Time</i> if the ramp segment X-axis is to be defined by time intervals (unit = [ms]).</p> <p>Select <i>Distance</i> if the ramp segment X-axis is to be defined by length (unit = [mm]).</p> <p>If you select <i>Time</i> or <i>Distance</i>, the fields for entering the ramp values for start and end segment ramps are displayed.</p> |
| Displayed channel   | <p>Selection of whether to define and display the power ramp for the primary or secondary power channel.</p> <p><b>NOTE:</b> This selection is only available if the laser in use has a second power channel configured.</p>  |

| Setting                              | Explanation  |          |                                       |       |  |   |                                  |     |                                       |   |                                  |      |                                       |    |                                  |      |                                       |
|--------------------------------------|--|----------|---------------------------------------|-------|--|---|----------------------------------|-----|---------------------------------------|---|----------------------------------|------|---------------------------------------|----|----------------------------------|------|---------------------------------------|
| <p>Start segments / End segments</p> | <p>The "coordinates" to define the ramp slopes are entered "Xcoordinate –blank-Ycoordinate-semicolon" ...and so on.</p> <p>Alternatively, you can enter the coordinates via a table. Click on the [<b>Table</b>] button to open the Edit ramping dialog.</p> <p>X-coordinate = time in [ms] or distance in [mm]<br/>                     Y-coordinate = power in [%] or [watts]</p> <p>To <i>ramp-up-to / ramp-down-from</i> the power defined as the pen power, you can use "*" as a variable.</p> <p>In case you do not refer to the pen power, the middle segment can also have a slope that depends on the length of the middle segments.</p> <p><b>RULES:</b></p> <ul style="list-style-type: none"> <li>■ You must also define the Y-coordinate for X=0.</li> <li>■ For the ramp end segments, the values have to be defined inversely, meaning going backwards from the end of the path.</li> </ul>   |          |                                       |       |  |   |                                  |     |                                       |   |                                  |      |                                       |    |                                  |      |                                       |
|                                      | <p>Example:</p> <div style="border: 1px solid black; padding: 5px;"> <p><b>Ramping</b></p> <p>Ramping mode: <i>Distance</i>    Shown channel: <i>Main</i></p> <p>Start segments: <i>0 700;10 3600</i></p> <p>End segments: <i>0 800;7 1200;10 3400</i></p>  </div> <div style="border: 1px solid black; padding: 5px; margin-top: 5px;"> <p><b>Ramping</b></p> <p>Ramping mode: <i>Distance</i>    Shown channel: <i>Secondary</i></p> <p>Secondary start segments: <i>0 200;2 1000;15 1600</i></p> <p>Secondary end segments: <i>0 500;16 1600</i></p>  </div> <div style="border: 1px solid black; padding: 5px; margin-top: 5px;"> <p><b>Edit ramping start segment</b></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Distance</th> <th></th> <th>Power</th> <th></th> </tr> </thead> <tbody> <tr> <td>0</td> <td><input checked="" type="radio"/></td> <td>200</td> <td><input type="radio"/> Pen laser power</td> </tr> <tr> <td>2</td> <td><input checked="" type="radio"/></td> <td>1000</td> <td><input type="radio"/> Pen laser power</td> </tr> <tr style="background-color: #e0e0ff;"> <td>15</td> <td><input checked="" type="radio"/></td> <td>1600</td> <td><input type="radio"/> Pen laser power</td> </tr> </tbody> </table> <p style="text-align: right;"> <input type="button" value="OK"/>    <input type="button" value="Cancel"/> </p> </div> | Distance |                                       | Power |  | 0 | <input checked="" type="radio"/> | 200 | <input type="radio"/> Pen laser power | 2 | <input checked="" type="radio"/> | 1000 | <input type="radio"/> Pen laser power | 15 | <input checked="" type="radio"/> | 1600 | <input type="radio"/> Pen laser power |
| Distance                             |  | Power    |                                       |       |  |   |                                  |     |                                       |   |                                  |      |                                       |    |                                  |      |                                       |
| 0                                    | <input checked="" type="radio"/>   | 200      | <input type="radio"/> Pen laser power |       |  |   |                                  |     |                                       |   |                                  |      |                                       |    |                                  |      |                                       |
| 2                                    | <input checked="" type="radio"/>   | 1000     | <input type="radio"/> Pen laser power |       |  |   |                                  |     |                                       |   |                                  |      |                                       |    |                                  |      |                                       |
| 15                                   | <input checked="" type="radio"/>   | 1600     | <input type="radio"/> Pen laser power |       |  |   |                                  |     |                                       |   |                                  |      |                                       |    |                                  |      |                                       |

| Setting   | Explanation  |
|---|--|
| <p><b>Dashed line</b></p> <p>Feature to modulate the laser emission (on / off) along a path while the process speed is kept constant (without any jump / mark delays, similar to a bitmap line)</p> <p><b>RULE:</b> At the beginning of a new path, the pattern starts anew. Accordingly, the pattern from the previous path is not continued.</p> <p><b>NOTES:</b></p> <p>Not applicable to drill points and bitmaps.</p> <p>The pattern is displayed in the viewport, but is not visible when in edit mode.</p> |  |
| Dashed line   | Activate to use the dashed line feature.   |
| Dashed line pattern [mm]  | <p>Define the dashed-line pattern by entering length values for laser on / off.</p> <p>Enter at least two numbers.</p> <p>The first value defines the dash length that the pattern starts with.</p> <p>Separate values for dash / gap with blanks.</p> <p>You can also create a pattern that consists of more than two parameters.</p> <p>Example: 2 3 2 1 creates repeated patterns of 2 mm line, 3 mm gap, 2 mm line, 1 mm gap.</p> <p>The preview below displays the pattern according to the values.</p> |
| Dashed line offset  | Enter the value in [mm] by which you want to shift the dashed line pattern in relation to the vector start.  |

| Setting   | Explanation  |
|---|--|
| <p><b>Magnification</b></p> <p>Used to increase the diameter of the laser spot.</p> <p>Magnification is only applied when a deflection unit of the RAYLASE AXIALSCAN, AS FIBER or AM-MODULE type is used. Either SL2 or RL3 must be selected as the protocol. Also, the correction file must support the 4th dimension (labelled, for example, 3D+M).</p> <p>The magnification factor is transmitted to the control card as the 4th dimension of a vector coordinate. The correction file translates this values to the defocusing (AXIALSCAN, AS FIBER) or zoom function (AM-MODULE) or to even zoom, followed by defocusing.</p> <p><b>NOTE:</b> RAYGUIDE visualises the magnification factor in the viewport by drawing the affected contours n-times thicker.</p> |  |
| Speed   | <p>Defines a time ramp in [1/s] over which the spot magnification is achieved.</p> <p><b>NOTE:</b> This value must never be 0.</p>   |
| Factor / Spot size [mm]   | <p>Magnification factor.</p> <p>Default: 1 = No magnification</p> <p>Alternatively, the absolute spot size in [mm] can be defined. To do so, the global unit must be set accordingly (see <i>page 96, UI</i>) and the conversion factor defined (see <i>page 67, General</i>).</p>                                 |
| Zoom async  | <p>Deactivate if the magnification is to be achieved immediately without a designed time ramp.</p> <p><b>NOTE:</b> With this option deactivated, the laser is briefly switched off during the transition from no magnification to magnification.</p>   |
| <p><b>Wobble</b></p> <p>The wobble function imparts additional complex harmonic motion to the laser beam in the X-Y plane, when the laser is active.</p> <p>To understand the mathematical correlation of the Wobble parameters, please refer to the manual for SP-ICE-3, chapter 9.2.2.</p> <p>On the right side of the input fields, a preview of the resulting wobble shape is displayed while making the entries because the wobble shape is not shown in the viewport.</p>   |  |
|   |  |
| Wobble mode   | <p>Select <i>No wobble</i> if you do not want to use the wobble function at all.</p> <p>Select <i>Circular</i> if you want a circular wobble shape.</p> <p>Select <i>Eight</i> if you want a figure-of-eight wobble shape.</p> <p>Select <i>Custom</i> if you want to define a Lissajous-figured wobble shape.</p> |
| Frequency   | Set a frequency in [kHz] at which the wobble shape is repeated.  |

| Setting                  | Explanation   |
|--------------------------|---|
| Amplitude [mm]           | Set an amplitude in [mm] to define the size of the wobble shape.  |
| Resulting amplitude [mm] | <p>Specification of the amplitude that is achieved as a result of the dynamics of the deflection unit.</p> <p>The resulting wobble geometry is marked in the plot:</p> <ul style="list-style-type: none"> <li>■ Green: If it is within the "allowed" range of values.</li> <li>■ Red: If it is outside the "allowed" range of values.</li> </ul> <p>The "allowed" value range roughly defines when the deflection unit is overstressed, and thus possibly damaged.</p> <p><b>NOTE:</b> For the display, the tracking error value of the deflection unit used in the active job is used. If deflection units with different tracking error values are used in a job, the largest value is taken. For deflection units with multi-tuning, the tracking error value from the tuning set as active is used.</p> |
| Phase [°]                | Only for Lissajous-figured shapes. Set a phase offset for each of the two sinus functions.  |
| <b>Pen saving option</b> |   |
| Apply to current pen     | Changes will apply to the current selected job pen.   |
| Apply as new pen         | A new job pen with the current values is created and added to the pen set.  |
| Apply to object pen      | <p>The values are stored in a new so-called "object pen" that belongs to a single object.</p> <p>This option is only available if the pen settings dialog was opened via an object dialog (Object settings dialog, Pen tab)!</p>  |

Tab. 7.41: RG-048

**IMPORTANT:** Modifying a pen changes the processing parameters of all objects (and layers, etc.) to which this pen is assigned. When in doubt, it may be advisable to select the **Apply as new pen** or the **Apply to object pen** options to avoid unwanted effects.

## Related presets

For some pen settings, you can preset the visibility in the dialog. Those presets act “global” on all used pens.

**CAUTION:** Hiding the display of a pen feature does not disable the related functionality. Therefore, before hiding the display of a pen feature, make sure that no part of the feature is used.

Select **System > Preferences** from the menu to open the Settings dialog. Go to the System (all users) tab and to the Visibility sub-tab, Pen section.

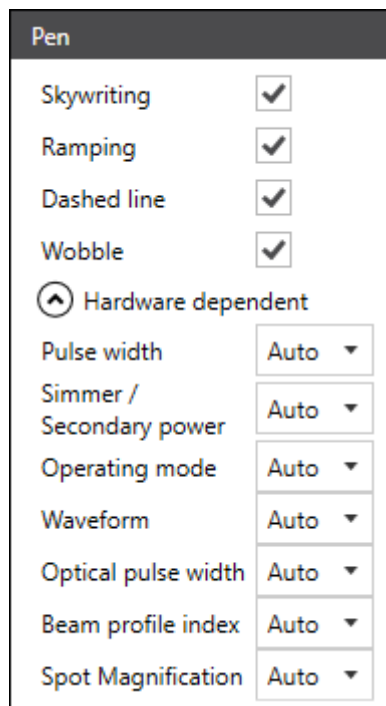


Fig. 7.63: RG-ACO

| Setting     | Explanation   |
|-------------|---|
| Skywriting  | Select if this option shall be available in pen settings. |
| Ramping     | Select if this option shall be available in pen settings. |
| Dashed line | Select if this option shall be available in pen settings. |
| Wobble      | Select if this option shall be available in pen settings. |

| Setting   | Explanation   |
|---|---|
| <b>Hardware-dependent</b>   |   |
| The fields listed under the expander are only displayed in "auto" mode if the laser used has this setting option. |   |
| Pulse width   | Select if the laser pulse width is to be shown in the pen settings. You can select from the options <i>Show</i> , <i>Hide</i> and <i>Auto</i> .<br>If <i>Auto</i> is selected, the parameter is only displayed in the Pen dialog if the pulse width definition is set to <i>manual</i> in one of the configured lasers.   |
| Simmer / Secondary power  | Select if this laser parameter is to be shown in the pen settings. You can select from the options <i>Show</i> , <i>Hide</i> and <i>Auto</i> .<br>If <i>Auto</i> is selected, the parameter is only displayed in the Pen dialog if a corresponding laser has been configured.<br><b>NOTE:</b> If you are using a TruPulse Nano / SPI G4 laser, the parameter for the simmer voltage would be displayed, while if a laser with two power channels is used, the parameter for the secondary laser power would be displayed. |
| Operating mode  | Select if this laser parameter is to be shown in the pen settings. You can select from the options <i>Show</i> , <i>Hide</i> and <i>Auto</i> .<br>If <i>Auto</i> is selected, the parameter is only displayed in the Pen dialog if a corresponding laser (e.g. TruPulse Nano / SPI G4) has been configured.   |
| Waveform  | Select if this laser parameter is to be shown in the pen settings. You can select from the options <i>Show</i> , <i>Hide</i> and <i>Auto</i> .<br>If <i>Auto</i> is selected, the parameter is only displayed in the Pen dialog if a corresponding laser (e.g. TruPulse Nano / SPI G4) has been configured.   |
| Optical pulse width   | Select if this option shall be available in pen settings. You can select from the options <i>Show</i> , <i>Hide</i> and <i>Auto</i> .<br>If <i>Auto</i> is selected, the parameter is only displayed in the Pen dialog if a corresponding laser (e.g. IPG YLP APD) has been configured.   |
| Beam profile index  | Select if this option shall be available in pen settings. You can select from the options <i>Show</i> , <i>Hide</i> and <i>Auto</i> .<br>If <i>Auto</i> is selected, the parameter is only displayed in the Pen dialog if a corresponding laser (nLightAFX) has been configured.  |
| Spot Magnification  | Select if this setting should be available in pen settings. You can select from the options <i>Show</i> , <i>Hide</i> and <i>Auto</i> .<br>The setting is available / visible if one of the configured deflection units has at least four axes, according to its correction file.   |

Tab. 7.42: RG-049

## 7.3.5 Pen Assignment

### Assigning a pen set to a job

Each job has a base pen set which corresponds to the stored default pen set (see *page 220, About Pens*).

To assign a different pen set than the default pen set, open the job settings dialog (**Job > Settings**). In the Base pen set drop-down list, select the desired pen set.

**NOTE:** If the job already contains layout objects that are linked to pen numbers, the links to the specific pen numbers persist when the pen set is changed. However, after the change to the pen set, each pen number points to a pen with different pen parameters.

### Assigning a pen to an object, a layer, a path, or a command

By default, a newly created object (as well as its layers and paths) in the layout uses the default pen (e. g. #1) of the job's base pen set. After this, it is possible to assign another pen to this object or layout element.

The pen for a graphic object is assigned by one of the following methods:

- On the "Properties" tab of the layout object, in the "General" area. For layers and paths, pens are assigned via the respective settings dialogs. Next to the Pen selection, there is always a button for direct navigation to the Pen dialog, where the respective Pen parameters can be edited as necessary.
- By selecting the graphic element, either in the job tree or in the viewport (multi-selection possible) and then using the **[Assign pen to selection]** button in the line of the desired pen in the pen panel.

**NOTE:** If a pen on a lower hierarchy level was changed, the new pen assignment is protected from future pen assignments at higher levels.

To change the pen inside a path:

- Add a "set pen" command between existing graphic commands
- Select the outline area in the viewport, for example by dragging the mouse, and right-click on the highlighted selection in the job tree. In the context menu that opens, click on the **Change pen...** option and select the desired pen number in the drop-down list.

A different pen may be required than for an outline (by default, RAYGUIDE fillings assigns the same pen as for the outline) for filling graphic elements. Therefore, via the Filling tab, you can also change the pen used to process the filling. A manual change of the filling pen causes a change protection against pen changes of the outline pen.



## 7.4 Pen parameter finder

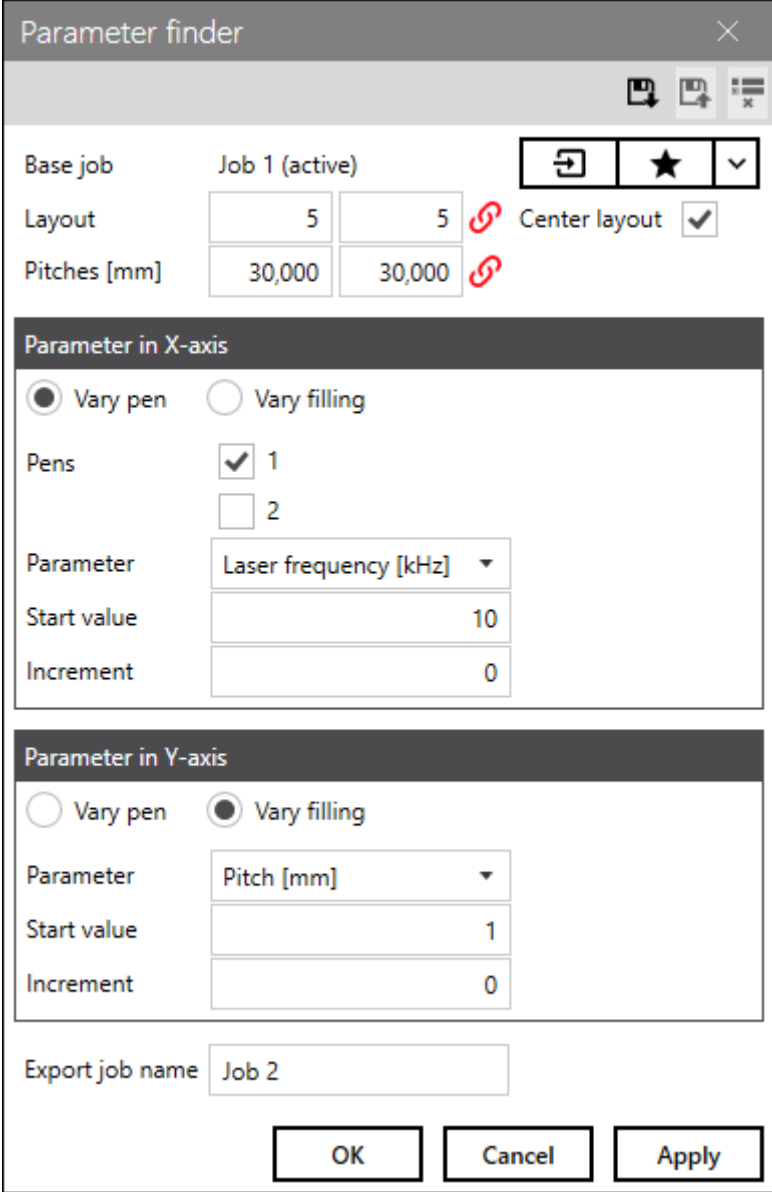
The pen parameter finder is designed to help you find the appropriate settings for your laser application. It essentially creates a matrix of layout objects, allowing you to select two parameters, each of which changes in X-axis and Y-axis tilting directions according to your specification.

These parameters are essentially values from the pens and certain values for fillings.

After executing the resulting job, you can use the process results to decide which parameters provide the best process result and save them for further use, for example, in the pen library or as a fill template.

Start the Parameter finder via the main menu: **Tools > Parameter finder > Pen**

The dialog of the pen parameter finder offers the following setting options:



Parameter finder

Base job Job 1 (active)

Layout 5 5 Center layout

Pitches [mm] 30,000 30,000

Parameter in X-axis

Vary pen  Vary filling

Pens  1  2

Parameter Laser frequency [kHz]

Start value 10

Increment 0

Parameter in Y-axis

Vary pen  Vary filling

Parameter Pitch [mm]



Start value 1

Increment 0

Export job name Job 2

OK Cancel Apply

Fig. 7.64: AEV

| Setting   | Explanation   |
|---|---|
|  | The buttons allow you to save the settings defined in the dialog, load already saved settings or delete a saved setting.  |
| Base job  | <p>Select the job that contains the layout object(s) you want to use for the parameter search.</p> <p>You can either use an already open job or load an already saved job.</p> <p>In case you load an already saved job for this, it will be additionally loaded into the drawing area and displayed.</p> |
| Panel layout  | Define how many times you want the layout object arranged along the X- and Y-axes.  |
| Pitches [mm]  | Define the distances between the layout objects (or layout object groups) along the X- and Y-axes in [mm].  |
|  | Button for interleaving the values (layout, distances) for both axis directions.  |
| Center layout   | <p>Select the option if you want the layout defined here to be centred in the job as a whole.</p> <p><b>NOTE:</b> This option is active by default.</p>   |
| <b>Parameter in X-axis / Parameter in Y-axis</b>                                  |   |
| Vary pen / Vary filling<br>Select pen   | <p>Define whether the parameter you want to vary should be a pen parameter or a fill parameter.</p> <p>In addition, if the base object(s) uses / use multiple pens, the pen whose parameters are varied must be selected. Multiple pen selection per direction is not recommended.</p>                    |

| Setting         | Explanation  |
|-----------------|--|
| Parameter       | <p>Define the parameter that varies per duplication.<br/>The following pen parameters are available for selection:</p> <ul style="list-style-type: none"> <li>■ Laser power [%]</li> <li>■ Laser frequency [kHz]</li> <li>■ Laser pulse width [<math>\mu</math>s]</li> <li>■ Marking speed [m/s]</li> <li>■ Jump speed [m/s]</li> <li>■ Marking delay [<math>\mu</math>s]</li> <li>■ Jump delay [<math>\mu</math>s]</li> <li>■ Poly delay [<math>\mu</math>s]</li> <li>■ Laser-on delay [<math>\mu</math>s]</li> <li>■ Laser-off delay [<math>\mu</math>s]</li> <li>■ Skywriting: Time for extension vector [<math>\mu</math>s]</li> <li>■ Laser: Secondary power [%]</li> </ul> |
|                 | <p>The following fill parameter are available for selection:</p> <ul style="list-style-type: none"> <li>■ Distance (...between fill lines)</li> <li>■ Offset (...of the filling to the contour)</li> </ul> <p><b>NOTE:</b> If, for example, there are several fills in the base object, the start value and the step size will be the same for all fills, regardless of the fact that the values in the base object may be different.</p>  |
| Start value     | <p>Define the start value for the respective parameter. The unit of the start value always corresponds to the unit of the respective parameter.</p> <p><b>NOTE:</b> By default, the value corresponds to the value from the previously defined pen.</p>  |
| Increment       | <p>Define the step size by which the parameter should change per duplication. The unit of the step size always corresponds to the unit of the respective parameter.</p>  |
| Export job name | <p>Specify the name under which the layout of the Parameter finder is to be created in the drawing area for the further steps.</p>   |

Tab. 7.43: RG-088

### 7.4.1 How to use the pen parameter finder

1. Create / choose a representative job layout for this task.
2. Start the pen parameter finder and define all necessary settings.
3. Click on "OK" or "Apply" to create the corresponding export job.

**NOTES:**

- Each object in the export job is named according to the index in the XY layout, where the index is zero-based.
  - The layout with the start values is always found at the bottom left in the XY arrangement.
  - Each duplication uses so-called object pens. The object pens are named according to the object.
  - If the base job contains several job elements, these are grouped in the export job per duplication.
4. All other rules and options for job execution apply to the export job.

**RECOMMENDATION:** Run these jobs statically only (without MOTF) and only per individual scan field.

5. After the job execution, you can evaluate the process results. If necessary, perform the steps again with new settings in the Parameter finder.
6. Once you have found the appropriate parameters, you can simply "copy-and-paste" the corresponding pen values to a library pen set or to a job pen set.

For fill parameters, simply save the fill of the corresponding layout as a fill template.

7. You can also save the export job for reuse like any other RAYGUIDE job.

**NOTE:** Not all parameters relevant for the process result are in the pens or the filling. Other parameters such as the action time for drill points or the pixel resolution for raster graphics are part of the object properties. These, in turn, can be defined as required per row or column of a layout in the compound (multiple selection) using the "edit common properties" option (see page 158, *Edit common object properties*).

## 7.5 Job Organization

### 7.5.1 Organizing Process Order and Affiliations

#### Process order

The sequence of objects and graphic elements in the job tree is also the order of processing. After layout creation, the sequence of graphic objects often is not optimal. The sequence of objects / elements can therefore be reorganised: If, for example, an object, graphic element or group of objects is to be edited before others for a specific reason, it can be moved in the sequence. The graphic layout itself is not altered by re-organising.

To move elements to another place in the job tree, select one or more elements and drag them to the desired position in the job tree. A horizontal line indicates a possible new position.

#### Affiliations

The affiliation of an item to a higher-level element, for example, of a path to a layer, can be changed. For example, you may group paths to another / new layer for a specific reason. The graphic layout itself is not altered by re-organising affiliations.

In the same way, you can pick a layer and shift it into another free-shaped vector object. Paths can also be shifted from one object into another. Only graphic commands cannot be transferred this way.

When shifting items from one object to another, the following rules apply.

**RULE:** If you shift an element (layer, path) from one object to another, the shifted element assumes the transformation of the new object.

**RULE:** The pen assignment of the target pen assigned to the target object is used for the newly affiliated element, **unless** a pen was explicitly assigned to that element before.

## 7.5.2 Containers

Containers build a kind or new job object, in which all inserted objects get treated collectively. An example: A transformation applied to a container will transform the entire contents.

The most simple container type is the Group container.

Matrix copy and polar copy containers also multiply their inserted objects as defined by the container settings. These reproduction objects, called children (subordinate objects), act like clones of the inserted master objects and cannot be picked or edited by themselves. In the viewport, subordinate objects are displayed a bit lighter than the master objects.

**NOTE:** As soon as you pull an object outside a container, it will lose all properties of the container.

You can add a container the same way as any other job object.

### **Add / Remove objects to / from a container:**

Case A: The objects you want to include in the container are already listed in the job tree.

- Select the objects with the mouse and drag them to the container object.
- To remove an object from a container, drag the object out of the container or delete the object.

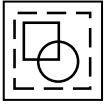
Case B: You start with the container object.

- If you now add a new object and would like to have it in the container, drag it directly to the container item in the tree.
- When you drag the new object into the viewport, it will be inserted after the container object in the job tree.

**NOTE:** To edit a container as a whole by transformation, it must be selected in the job tree.

There are four types of containers:

### 7.5.2.1 Group container



Button

A group of objects / items. The purpose of a group container is to treat all objects / items as a whole, for example, to define binning conditions or the number of iterations, or to transform / shift all objects / items together.

Therefore, you always pick up the group as a whole in the viewport.

To pick single elements, select them in the job tree.

To group the objects, select all objects by cursor selection in the viewport or in the job tree. Open the context menu and select "Group".

To ungroup, select the group container and select "ungroup" in the context menu.

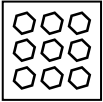
The container and thus the groups can also have their own transformation, which transforms the objects in the container. If the group is ungrouped, this transformation is transferred to the objects that were in the group.

| Setting  | Explanation   |
|--|---|
| <b>Settings</b>  |   |
| Iterations   | How often this group of objects shall be processed.   |
| <b>General</b>   |   |
| Short label  | A name for this container that is easy to remember.   |
| Description  | A description of the container useful for you.  |
| Enable binning   | The settings for conditional execution of the container as a whole correspond to those of a marking object, see <i>page 153, Common Properties of Marking Objects</i> .   |
| Single output  | Processes all container copies as a single, combined vector object.<br>This can speed up the processing if the container contains a huge number of subordinate objects (children).<br><b>NOTES:</b> <ul style="list-style-type: none"> <li>■ This option is especially recommended for MOTF applications in which many small layout elements (such as drilled holes) occur, since this avoids reset jumps.</li> <li>■ If this option is set, automation objects in the container are ignored.</li> <li>■ For text/code objects with variable content, the content is then no longer varied per copy.</li> <li>■ If containers are stacked inside each other, this option should not be used.</li> </ul> |
| <b>Edit Pens (tab)</b>   |   |
| This tab provides access to pen editing.   |   |
| After editing, you may save the pen as "object pen". This allows editing specific pen parameters which only affect container elements without affecting the actual job pens. |   |

Tab. 7.44: RG-050



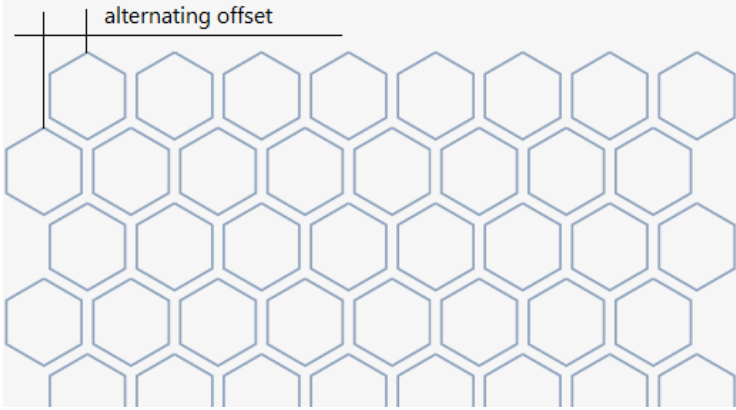
### 7.5.2.2 Matrix copy container



Button

A matrix copy can be used to multiply layout elements throughout the workspace in ordered rows / columns.

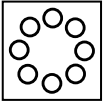
| Setting          | Explanation   |
|------------------|---|
| <b>Settings</b>  |   |
| Number of copies | Number of copies in X, Y, Z directions<br>Use the <b>[Lock / Unlock]</b> toggle button to define the same values for the X and Y directions.                  |
| Pitches [mm]     | Distance the copies are spread in X, Y, Z direction.<br>Use the <b>[Lock / Unlock]</b> toggle button to define the same distances for the X and Y directions. |
| Bidirectional    | Option to alternate the processing direction per row / column.  |
| Centered         | The original centre position of the master object (or the centre of gravity in case of multiple master objects) will become centre of the container.          |

| Setting                  | Explanation   |
|--------------------------|---|
| Alternation offset       | <p>Offset in [mm] by which the first and each subsequent odd row is shifted.</p> <p>With the help of this offset, honeycomb-like patterns can also be created, for example.</p>    |
| Explicit cell order      | <p>If activated, you can freely specify the sequence in which the copies will be processed. To do so, enter all copy positions to be processed with their coordinate index in the <i>Custom list of cells</i> line.</p> <p><b>NOTES:</b></p> <ul style="list-style-type: none"> <li>■ The specifications for the starting corner position and processing direction are hidden.</li> <li>■ The coordinate index starts in the lower left corner at 0.0.</li> </ul> |
| Starting corner location | Corner of the matrix layout at which the execution starts.  |
| Processing direction     | Sequence of processing directions.  |
| Ignore                   | Specification of the copy indices that should not be executed.  |
| Custom list of cells     | Specify the copy indices (cells) in the desired order. Only the index positions listed here are executed and displayed.   |

| Setting  | Explanation   |
|--|---|
| <b>General</b>   |   |
| Short label  | A name for this container that is easy to remember.   |
| Description  | A description of the container useful for you.  |
| Enable binning   | The settings for conditional execution of the container as a whole correspond to those of a marking object, see <i>page 153, Common Properties of Marking Objects</i> .   |
| Single output  | Processes all container copies as a single, combined vector object.<br>This can speed up the processing if the container contains a huge number of subordinate objects (children).<br><b>NOTES:</b> <ul style="list-style-type: none"> <li>■ This option is especially recommended for MOTF applications in which many small layout elements (such as drilled holes) occur, since this avoids reset jumps.</li> <li>■ If this option is set, automation objects in the container are ignored.</li> <li>■ For text/code objects with variable content, the content is then no longer varied per copy.</li> <li>■ If containers are stacked inside each other, this option should not be used.</li> </ul> |
| <b>Edit Pens (tab)</b>   |   |
| This tab provides access to pen editing.   |   |
| After editing, you may save the pen as "object pen". This allows editing specific pen parameters which only affect container elements without affecting the actual job pens. |   |

Tab. 7.45: RG-051

### 7.5.2.3 Polar copy container



Using a polar copy, you can multiply layout elements in a circular arrangement. The centre of the circular arrangement is the original centre of the master object. Basically, the orientation of the layout copies corresponds to the orientation of the master object.

Button optional,  
see page 113,  
Objects Overview

| Setting                 | Explanation  |
|-------------------------|--|
| <b>Settings</b>         |  |
| Number of copies        | Number of copies that are evenly spread across the defined sector of a circular arc. The master object is part of this number.   |
| Radius [mm]             | Radius of the circular arc   |
| Start angle [°]         | Defines the starting angle of the circular arc sector and thus the position of the first object.   |
| End angle [°]           | Defines the end angle of the circular arc sector and thus the position of last object.<br>If start angle and end angle define a 360-degree sector, the copies are evenly distributed along the full circumference. |
| Direction               | Processing direction of the copies along the circular arc.   |
| Align children rotation | All copies are rotated so that their vertical axes are tangential to the arc.  |
| <b>General</b>          |  |
| Short label             | A name for this container that is easy to remember.  |

| Setting   | Explanation  |
|---|--|
| Description   | A description of the container useful for you.   |
| Enable binning  | The settings for conditional execution of the container as a whole correspond to those of a marking object, see <i>page 153, Common Properties of Marking Objects</i> .  |
| Single output   | <p>Processes all container copies as a single, combined vector object.</p> <p>This can speed up the processing if the container contains a huge number of subordinate objects (children).</p> <p><b>NOTES:</b></p> <ul style="list-style-type: none"> <li>■ This option is especially recommended for MOTF applications in which many small layout elements (such as drilled holes) occur, since this avoids reset jumps.</li> <li>■ If this option is set, automation objects in the container are ignored.</li> <li>■ For text/code objects with variable content, the content is then no longer varied per copy.</li> <li>■ If containers are stacked inside each other, this option should not be used.</li> </ul> |
| <p><b>Edit Pens (tab)</b></p> <p>This tab provides access to pen editing.</p> <p>After editing, you may save the pen as "object pen". This allows editing specific pen parameters which only affect container elements without affecting the actual job pens.</p> |  |

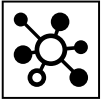
Tab. 7.46: RG-052

### Remark for copy container

- Scaling transforms the contained objects themselves **and** the distances between the objects.
- It is possible to nest containers in other containers.
- You can also add an automation object to the container, which will be executed per copy.
- If a text or code object whose contents usually change with each execution (e.g. incremental number) is located in a container, this change takes place for each child object.

A possible use case for the matrix container is to place drills in a regular fashion.


### 7.5.2.4 Cluster container



Button optional,  
see page 113,  
Objects Overview

The cluster container is similar to the matrix copy container, but with some special properties:

- The arrangement of the copies is not fixed in rows and columns, but is defined per copy with the offset plus angle. This position is also referred to below as the “nest position”.
- Each copy can be defined as a template so that changes (such as to the contour) to the template are transferred to all other copies.
- If you enable “Binning”, you can define a separate execution condition for each nest position.

| Setting  | Explanation   |
|--|---|
| <b>Properties</b>  |   |
| <b>Copies</b>  | List of all copies.<br>The area can be expanded and collapsed using an expander.  |
| Activate   | Select whether the nest position is to be executed or not. <ul style="list-style-type: none"> <li>■ The option is selected by default.</li> <li>■ Nest positions deactivated here are hidden in the workspace.</li> </ul>   |
| Set template   | Select which nest position to use as a template for editing the geometry.   |
| XYZ offset [mm]  | Offset to nest position relative to the position of the original object in the processing field. <p><b>NOTES:</b></p> <ul style="list-style-type: none"> <li>■ As soon as a marking object is located in the cluster container, it is only displayed in the workspace at the defined nest positions.</li> <li>■ No marking object has to be in the container to define the nest positions.</li> </ul> |
| Rotation [°]   | Specification of the angle in degrees by which the nest is rotated compared to the original.  |
| Binning  | The column shows the available bit range that the selected input port of the control card provides for binning.   |
| <b>[Load]</b><br> | You also have the option of loading the values for offset and rotation from a CSV table. <p><b>NOTE:</b> The table must contain values for all four parameters (four columns).</p>  |
| <b>General</b>   |   |

| Setting   | Explanation  |
|---|--|
| Short label   | A name for this container that is easy to remember.  |
| Description   | A description of the container useful for you.   |
| Enable binning  | <p>Only starts processing of the individual nest positions if a specified condition is fulfilled.</p> <p>The dialog has been extended to include other inputs:</p> <ul style="list-style-type: none"> <li>■ I/O controller: Select the control card where the I/O signals will arrive.</li> <li>■ I/O port: Select the preconfigured I/O port of the respective control card (see <i>page 51, I/O Port Configuration</i>).</li> <li>■ The condition itself is defined above for each nest position.</li> <li>■ The "Ahead of time evaluation" option is set by default. It ensures that the condition (bit pattern) is checked in advance so no time is lost during the process.</li> </ul> <p><b>NOTE:</b> Deactivate this option if the condition is not set until it is time to process the object. This may be the case after a preceding wait condition, for example.</p> |
| Single output   | <p>Processes all container copies as a single, combined vector object.</p> <p>This can speed up the processing if the container contains a huge number of subordinate objects (children).</p> <p><b>NOTES:</b></p> <ul style="list-style-type: none"> <li>■ This option is especially recommended for MOTF applications in which many small layout elements (such as drilled holes) occur, since this avoids reset jumps.</li> <li>■ If this option is set, automation objects in the container are ignored.</li> <li>■ For text/code objects with variable content, the content is then no longer varied per copy.</li> <li>■ If containers are stacked inside each other, this option should not be used.</li> </ul>   |
| <p><b>Edit Pens (tab)</b></p> <p>This tab provides access to pen editing.</p> <p>After editing, you may save the pen as "object pen". This allows editing specific pen parameters which only affect container elements without affecting the actual job pens.</p> |  |

Tab. 7.47: RG-092

**NOTE:** In contrast to the other copy containers, only the defined nest positions are displayed in the cluster container.

### Example of display of the graphic objects in the cluster container

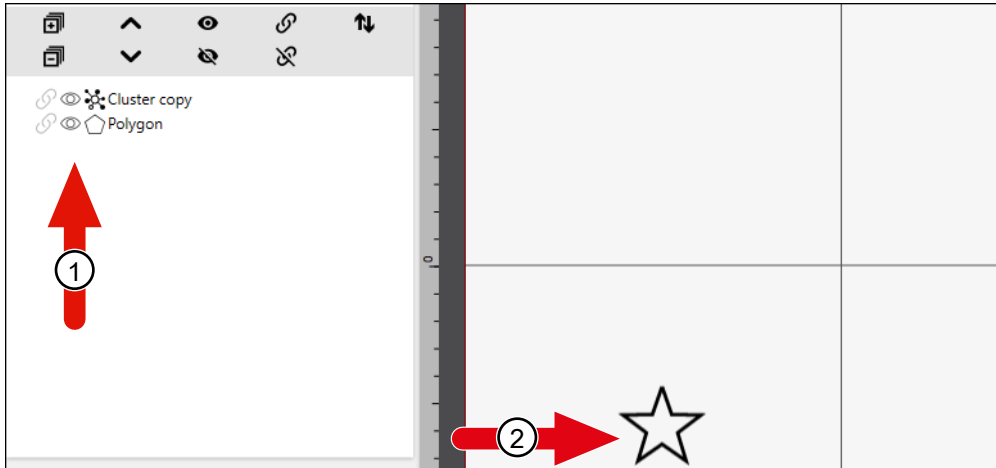


Fig. 7.65: RG-AFC

- 1 Original job object NOT in cluster container
- 2 Original position is displayed

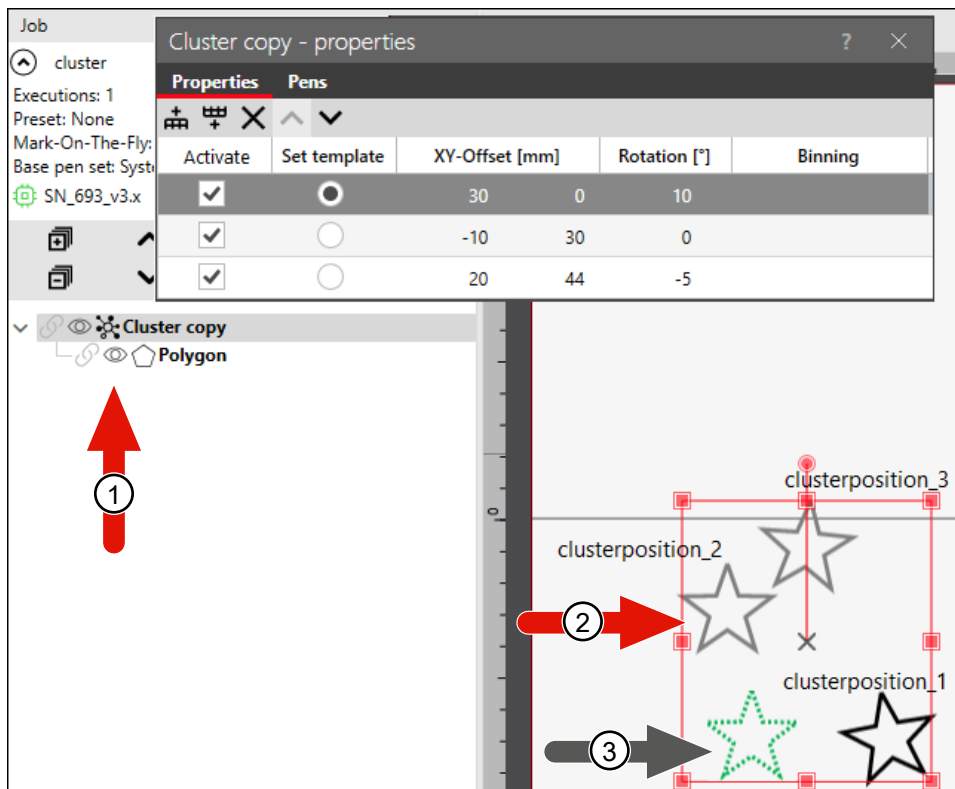
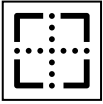


Fig. 7.66: RG-AFD

- 1 Original job object IN cluster container
- 2 Display of the object in the defined nest positions
- 3 Original position is NOT displayed



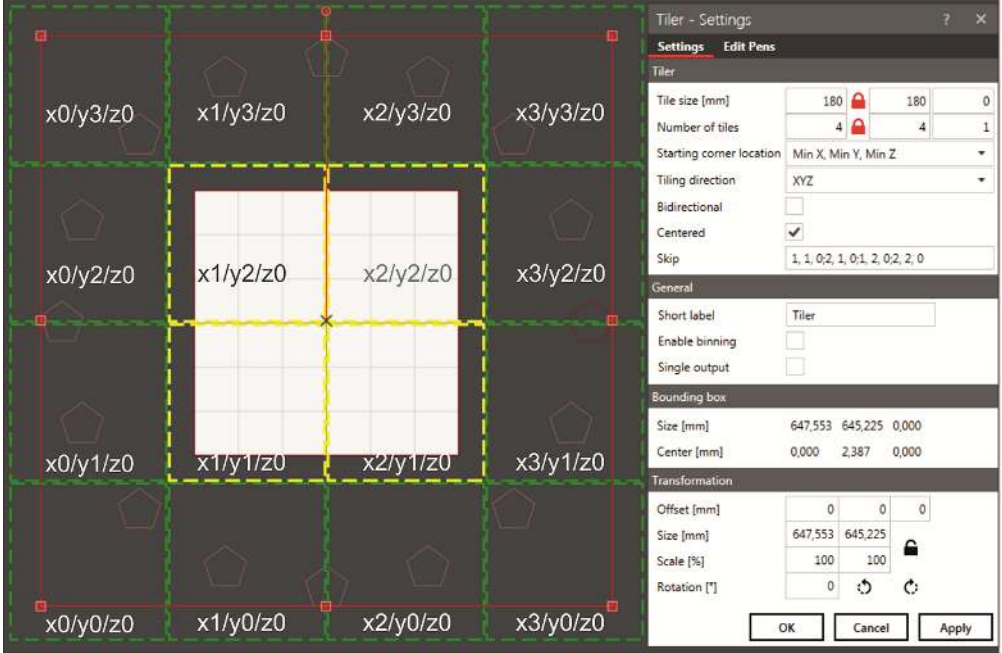
### 7.5.2.5 Tiler container



Using the tiler container, you can process layout objects that are larger than the available workspace.

Button optional,  
see page 113,  
Objects Overview

| Setting                  | Explanation   |
|--------------------------|---|
| <b>Settings</b>          |   |
| Tile size [mm]           | Define the size of the tile pieces in X / Y / Z direction in [mm].<br>Use the <b>[Lock / Unlock]</b> toggle button to use the same segment size in X and Y direction.   |
| Number of tiles          | Define the number of tile pieces in X / Y / Z direction.  |
| Starting corner location | Select the corner of the container layout bounding box to set the start of processing the tile pieces.<br>If the <i>Centred</i> option is not checked, it also defines which of the tile pieces is in the centre of the workspace.  |
| Tiling directions        | Processing sequence along the axis directions.  |
| Bidirectional            | Option to alternate the processing direction per row / column.  |
| Centered                 | The tiling grid is centred at the origin of the workspace. Otherwise, the tiling grid would be positioned so that the first segment is centred at the origin of the workspace.  |
| Explicit cell order      | If activated, you can freely specify the sequence in which the segments will be processed. To do so, enter all segment positions to be processed with their coordinate index in the <i>Custom list of cells</i> line.<br><b>NOTES:</b> <ul style="list-style-type: none"> <li>■ The specifications for the starting corner position and processing direction are hidden.</li> <li>■ The coordinate index starts in the lower left corner at 0.0.</li> </ul> |
| Starting corner location | Corner of the segment layout at which the execution starts.   |
| Processing direction     | Sequence of processing directions.  |
| Ignore                   | Specification of the copy indices that should not be executed.  |

| Setting              | Explanation  |
|----------------------|--|
| Skip                 | <p>Enter the X-,Y-,Z-coordinate of the segment tiles to be ignored (skipped), as they probably do not contain markable vectors.<br/>Use a semicolon to separate the entry of tile coordinates.<br/>The ignored tiles are highlighted in yellow by default.</p> <p>By default, the tile coordinates start counting at "0" in the lower left corner:</p>  |
| Custom list of cells | Specify the segment indices (cells) in the desired order. Only the index segments listed here are executed.  |
| <b>General</b>       |  |
| Short label          | A name for this container that is easy to remember.  |
| Description          | A description of the container useful for you.   |
| Enable binning       | The settings for conditional execution of the container as a whole correspond to those of a marking object, see page 153, <i>Common Properties of Marking Objects</i> .  |

Tab. 7.48: RG-068

## Remarks

The tiler creates a kind of tiling grid to divide the layout objects into pieces that fit into the available workspace.

The position and size of the tiling grid is defined by the tile size, the number of tiles and optionally by the *Centred* option.

The starting corner location also affects the position of the tiling grid if the *Centred* option is not used.

Sample views of tiling grids:

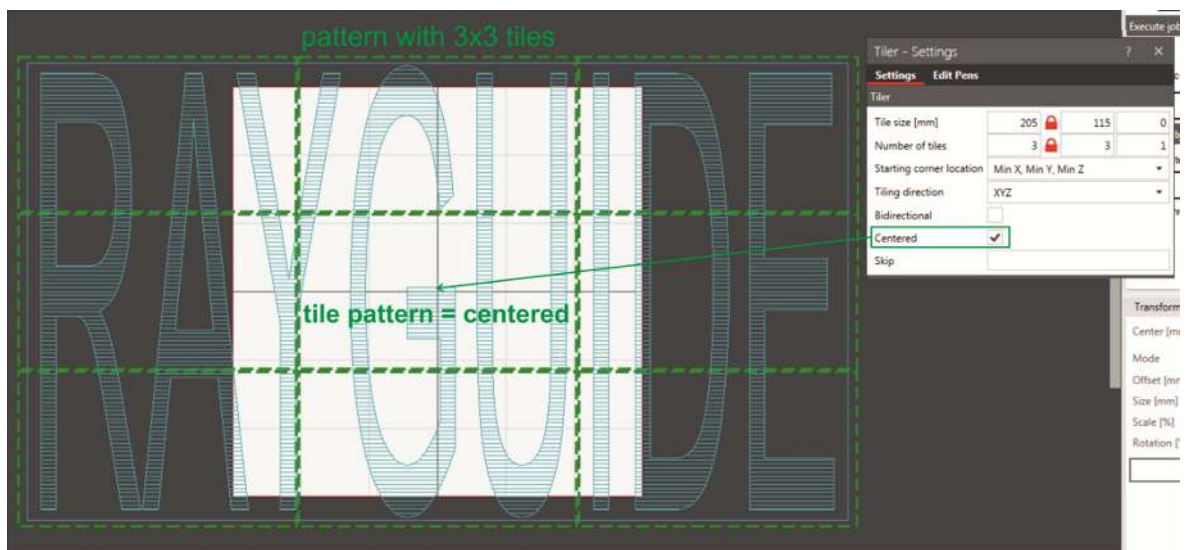


Fig. 7.67: RG-ADJ

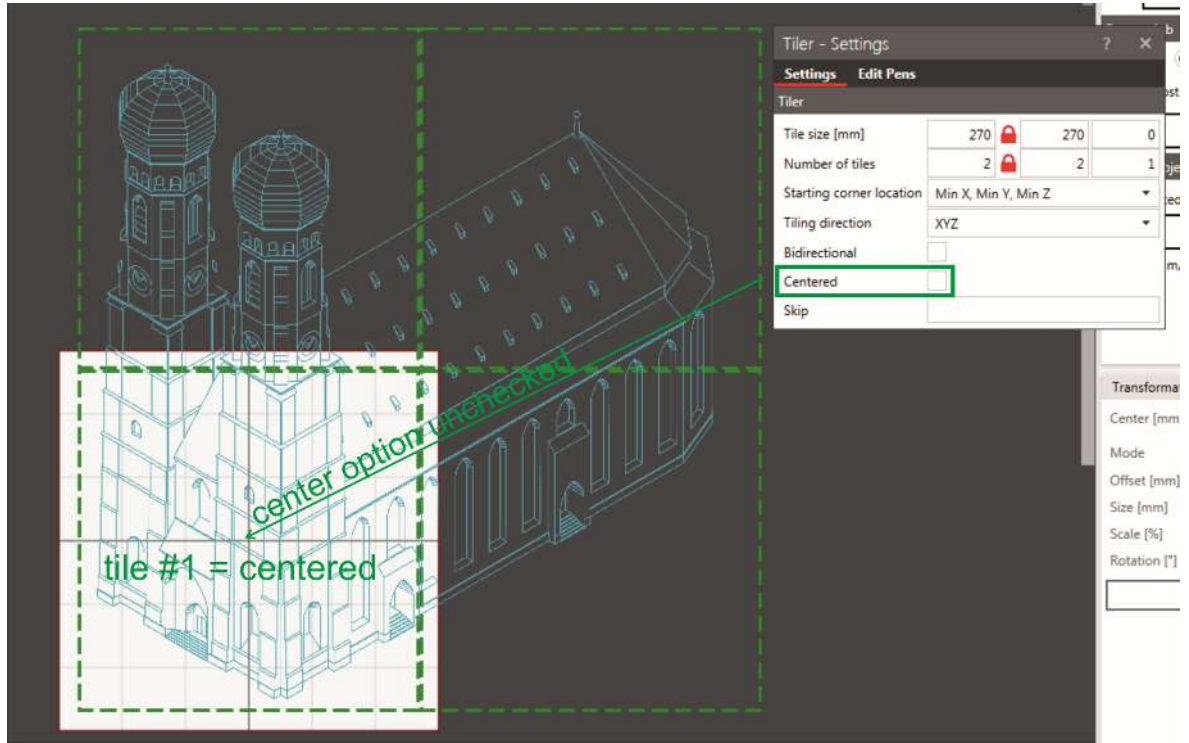


Fig. 7.68: RG-ADK

The tile pieces themselves are processed one after the other. The sequence of processing is determined by setting the starting corner location and the tiling direction.

Examples:

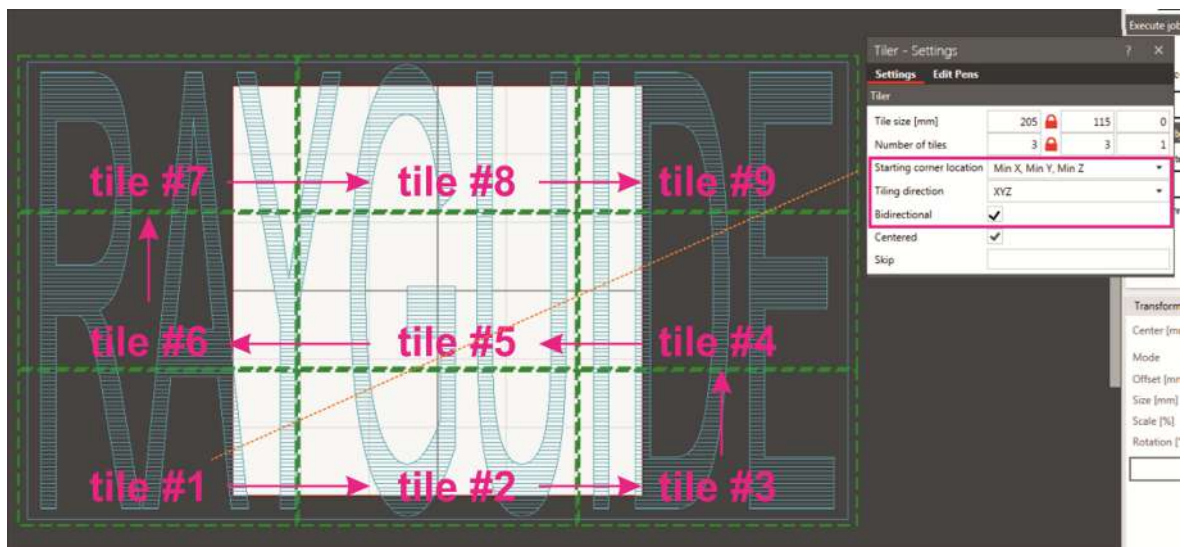


Fig. 7.69: RG-ADL

The tile pieces are processed centred to the workspace.

Recommendations:

- The layout objects to be tiled should be designed, composed and centred before being placed in the tiler container.
- Every transformation of the tiler container applies to its layout content, but not to the tile pattern.
- To synchronise the processing with an external control unit if necessary (e.g. to control motor axes), it is recommended to enter a "**Wait for start signal**" object at the beginning and a "**Write IO port**" object at the end in the tiler container.

### 7.5.2.6 z-offset container



Button optional,  
see page 113,  
Objects Overview

By using the z-offset container, you can execute the layout objects in multiple focal planes to generate deep engravings, for example.

To make it possible to mark in different focal planes, an appropriate deflection unit (e.g. RAYLASE FOCUSHIFTER, AXIALSCAN, AS FIBER) and a correction file with a z-volume are required.

| Setting        | Explanation   |
|----------------|---|
| Count          | Defines the number of focal planes in which the layout objects located in the container are executed.   |
| Delta z [mm]   | The value defines the distance between the focal planes.<br>Negative algebraic signs indicate the focal plane is offset downward and positive algebraic signs indicate it is offset upward. |
| + [Plus sign]  | Adds a new line with shifts to define a new number of focal planes with a new offset value.   |
| <b>General</b> |   |
| Short label    | A name for this container that is easy to remember.   |
| Description    | A description of the container useful for you.  |
| Enable binning | The settings for conditional execution of the container as a whole correspond to those of a marking object, see page 153, <i>Common Properties of Marking Objects</i> .                     |

Tab. 7.49: RG-081

**NOTE:** If multiple layout objects are located in the container, all objects are initially executed once per focal plane before the focal plane is changed and the objects are executed again.

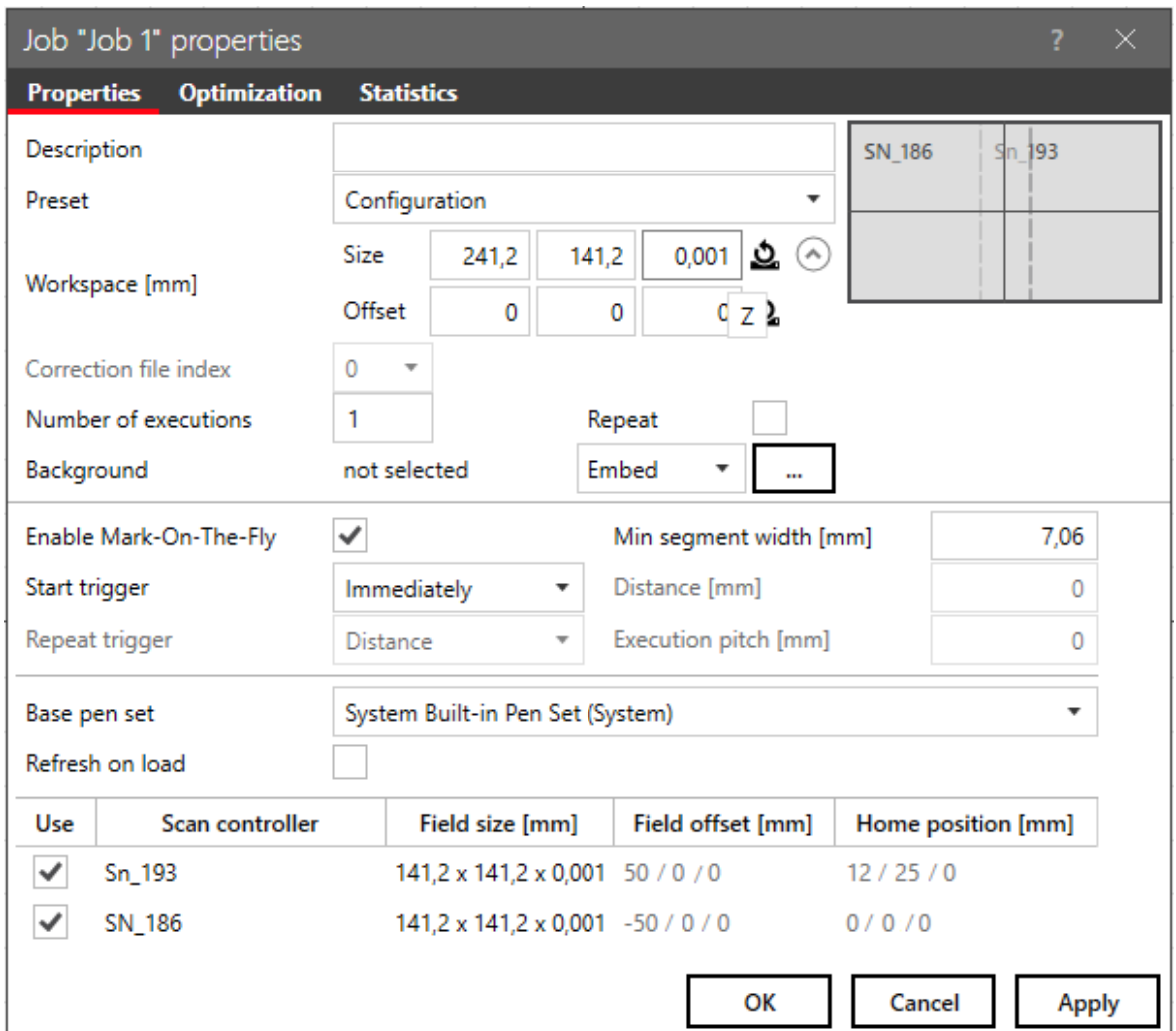
**NOTE:** When you enter automation objects in the z-offset container, they will also be executed for each focal plane.

## 7.6 Dialog job settings

The Job settings dialog provides specific settings per job, and hosts the job statistics overview.

### 7.6.1 Job Properties

Select **Job > Properties** from the menu or double-click any of the job information on the Job panel. The following dialog is displayed:



Job "Job 1" properties

**Properties** Optimization Statistics

Description

Preset Configuration

Workspace [mm] Size 241,2 141,2 0,001 Offset 0 0 0

Correction file index 0

Number of executions 1 Repeat

Background not selected Embed ...

Enable Mark-On-The-Fly  Min segment width [mm] 7,06

Start trigger Immediately Distance [mm] 0

Repeat trigger Distance Execution pitch [mm] 0

Base pen set System Built-in Pen Set (System)

Refresh on load

| Use                                 | Scan controller | Field size [mm]       | Field offset [mm] | Home position [mm] |
|-------------------------------------|-----------------|-----------------------|-------------------|--------------------|
| <input checked="" type="checkbox"/> | Sn_193          | 141,2 x 141,2 x 0,001 | 50 / 0 / 0        | 12 / 25 / 0        |
| <input checked="" type="checkbox"/> | SN_186          | 141,2 x 141,2 x 0,001 | -50 / 0 / 0       | 0 / 0 / 0          |

OK Cancel Apply

Fig. 7.70: RG-ACP

The following settings always apply to the job currently edited and are stored with it.

| Setting               | Explanation  |
|-----------------------|--|
| Description           | Optional label for this setting  |
| Preset                | <p>Select one of the previously stored job preferences (see <i>page 104, Job Presets</i>) displayed in the drop-down list.</p> <p>If a workspace configuration is marked as "Default", it is automatically preselected.</p> <p>If you don't want to use any of the stored workspace configurations, select <i>None</i>.</p> <p><b>NOTE:</b> If a stored workspace configuration with Mark-On-The-Fly (MOTF) settings is selected, the MOTF setting fields are filled accordingly.</p> <p><b>NOTE:</b> If you change a job preset that is already in use, you can apply these changes using the <b>[Reload]</b> button for the current job. However, please note that parameters that you have changed directly in this dialog will be reset to the default parameters.</p> <p>See also <i>page 104, Job Presets</i>.</p> |
| Workspace             | <p>The workspace size of the loaded configuration or the field size provided by the correction file.</p> <p>The expander additionally displays the "Offset" area. The default values come from the FC3 correction file, through which the zero layer is defined primarily in correction files with a Z-range.</p> <p>Enter different workspace dimensions if required.</p>   |
| Correction file index | <p>Define the index of the correction file that is to be active when the execution of the job begins.</p> <p><b>NOTE:</b> The option is only usable if at least one deflection unit has been assigned two correction files in the configuration. See <i>page 67, General</i>.</p>  |
| Number of executions  | Execute the job a specific number of times.  |
| Repeat                | Execute the job in an indefinite loop (most likely in combination with a "Wait for start signal" object).  |

| Setting                | Explanation   |
|------------------------|---|
| Background             | <p>Option for inserting an image as a background picture in the workspace. Valid formats are: JPG, JPEG, BMP, PNG, GIF, EXIF.</p> <p>Select:</p> <ul style="list-style-type: none"> <li>■ <i>Embed</i> if the image is to be saved as part of the job.</li> <li>■ <i>Link</i> if you only want to link the image file to the job locally.</li> </ul> <p><b>NOTE:</b> The image is scaled to the size of the workspace in both dimensions.</p> <p><b>NOTE:</b> The opacity of the background image can be set using the opacity slider, which is part of the toolbar. See <i>page 23, Toolbar</i>.</p> |
| Enable Mark-On-The-Fly | For explanations and settings for Mark-On-the-Fly (MOTF), see <i>page 268, MOTF Jobs</i> .  |
| Start trigger          |   |
| Distance               |   |
| Repeat trigger         |   |
| Execution pitch [mm]   |   |
| Base pen set           | Drop-down list for the base pen set for this job. For details of pens, see <i>page 223, Pen Panel</i> .   |
| Refresh on load        | Select this option (tick the box) so that the values of the job pen set are automatically updated with the values of the base pen set when the job is reloaded.   |
| Use                    | <p>List of used / available control cards for this job.</p> <p>If no workspace configuration was loaded, you can edit the selection.</p> <p>If a workspace configuration was loaded, the list is "read only".</p> <p>The list also shows the size of the scan fields per control card and, if applicable, the field offset defined in the job settings as well as a possibly defined end position.</p>  |

Tab. 7.50: RG-053



## 7.6.2 Optimizations

On the following tab, you can define a selection of optimisations that are performed by RAYGUIDE in the background and before the actual execution on the scan controller.

The parameters displayed on this tab can also be set via a selected setting.

After you have defined a new job pre-setting or edited an existing one, you will see the pre-setting and its workspace setup as soon as you start a new job or change the used preset in the job settings.

| Setting   | Explanation  |
|---|--|
| <b>General</b>  |  |
| Merge vector graphics   | For details, see <i>page 111, Optimizations</i> .      |
| Join layers   |  |
| <b>Mark-On-The-Fly Segmentation</b>   |  |
| Segmentation mode   | For details, see <i>page 274, MOTF Optimizations</i> . |
| Max. Width [mm]   |  |
| Time [s]  |  |
| <b>Sort</b>   |  |
| Minimize jump distance  | For details, see <i>page 111, Optimizations</i> .      |
| By direction  | For details, see <i>page 274, MOTF Optimizations</i> . |
| <b>Replace all commands by drill holes</b>  |  |
| If this option is activated, contour lines are automatically replaced with drill holes when the job is executed. The following fields are then available for required specifications. |  |
| Spacing [mm]  | For details, see <i>page 111, Optimizations</i> .      |
| Force corners   |  |
| Drill mode  |  |
| Pulse / Time  |  |

Tab. 7.51: RG-074

### 7.6.3 Job Statistics

The job statistics provide an overview of the job contents in regards to the processing time and accumulate the overall lengths of mark vectors and jump vectors.

If multiple scan controllers are assigned to the job, each scan controller is displayed with its respective associated contents.

| Total number of markable objects |   |
|----------------------------------|---|
| Total mark length [mm]           | <p>Accumulated length of all mark vectors of all layout objects, split into contour and filling.</p> <p><b>NOTES:</b></p> <ul style="list-style-type: none"> <li>■ If the job contains bitmaps processed in <i>Sprint</i> mode, the bitmap lines are added to the total mark length.</li> <li>■ The gaps in a dashed line are not subtracted from the mark vector length.</li> <li>■ Possible wobble geometry is not taken into account.</li> </ul> |
| Total jump length [mm]           | Accumulated length of all jump vectors of all layout objects, split into contour and filling. Also contains jumps between the individual marking objects.   |
| Execution time [m:s:ms]          | <p>Accumulated calculated process time considering speed and delay values of all layout objects, split into contour and filling.</p> <p><b>NOTE:</b> The execution time does not include the time consumed by extra Skywriting vector extensions.</p> <p><b>NOTE:</b> The execution time does not take into account if the job execution is split between several control cards.</p>  |
| Number of paths                  | Accumulated number of paths, split per contour and filling.   |
| Number of commands               | Accumulated number of commands, excluding "set pen" commands, split into contour and filling.   |
| Number of points                 | <p>Accumulated number of graphic command points, split into contour and filling.</p> <p><b>NOTES:</b></p> <ul style="list-style-type: none"> <li>■ "Supporting points" are excluded</li> <li>■ Path start points are excluded</li> </ul> <p>This is useful to get an idea at how many points a poly delay can take effect.</p>  |
| Number of scan lines             | Accumulated number of bitmap scan lines.  |
| Number of slices                 | The number of slices always pertains to the total height of the solid. In solids with a negative form, however, the number of slice to be executed will usually be far lower.   |

Tab. 7.52: RG-054

## 7.6.4 Job variables

Using the job variables, you can specify fixed contents that can then be used by text and / or code objects as required.

All dynamically created variables of a job are listed here (e.g. via **Dialog** automation object or in **text/code objects**).

Use the **[Refresh]** button to update the dynamically created variable contents.

Compared to the option of the data source to link a file, several but recurring contents can be defined here.

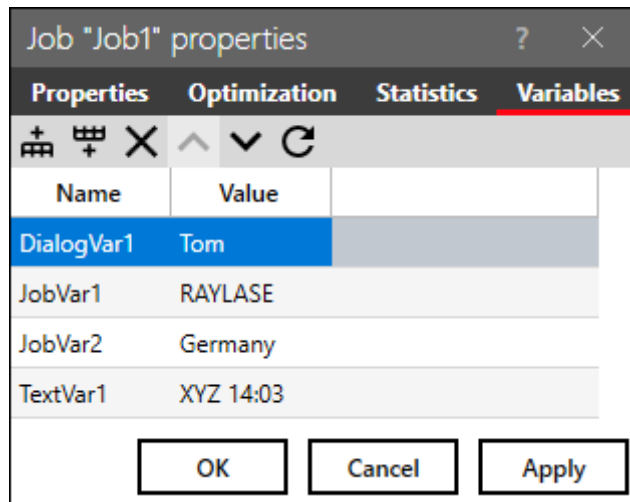


Fig. 7.71: AEX

## 7.7 MOTF Jobs

MOTF stands for Marking-On-The-Fly and means to process objects that are continuously moving through the workspace, instead of resting still. A conveyor belt typically transports the material to be processed to and through the workspace area of the deflection unit. The movement has to be linear (in most cases along coordinate axes), i. e. no curvatures are allowed.

To track the movement of the target material, the scan controller is fed by an encoder. The encoder provides a defined number of signal-edges (called ticks) per turn. By counting the edges per time, the scan controller knows the speed of the target material passing by.

The SP-ICE-3 scan controller offers a second encoder (compensation encoder) input to compensate for slight deviations in the movement of the target material perpendicular to the main movement direction.

Each MOTF job also needs to know when to start the vector execution to meet the right position on the target material. That is why RAYGUIDE offers different trigger options.

**NOTE:** For MOTF versions, trigger signals must be connected to the correspondingly configured pin of the SP-ICE-3 scan controller named "**Part sensor**". This requires a specific port configuration on the SP-ICE-3. Refer to the SP-ICE-3 scan controller manual for more detailed information on the correct port configuration.

To prepare for the execution of an MOTF job, some configuration settings are required:

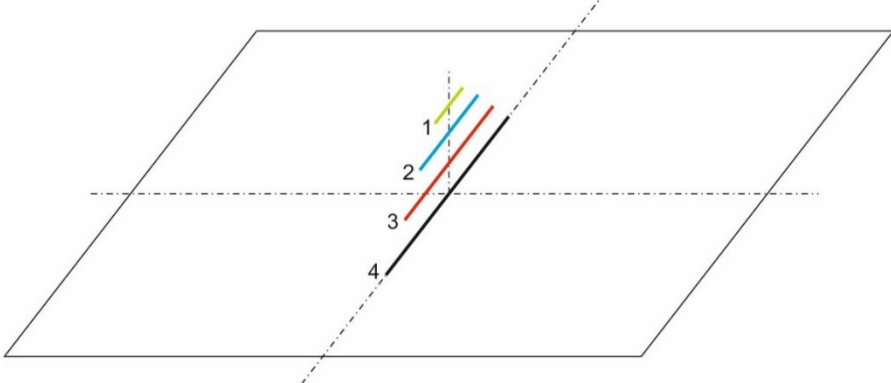
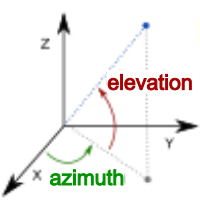
- Controller scan controller configuration – for the basic hardware setup
- **System > Preferences > Workspace > Configuration** – for frequently used MOTF trigger settings.
- Optional: Job settings – if no workspace configuration has been stored to use MOTF defaults.

## 7.7.1 MOTF Settings in Controller Card Configuration

Configure the technical details of the MOTF setup:

- Open the controller scan controller configuration and go to the MOTF tab.
- It is also recommended to consult the scan controller's manual.

| Setting  | Explanation   |
|--|---|
| <b>Base <i>Mark-On-The-Fly</i> configuration</b> |   |
| Part distance [mm]                               | The distance in [mm] between a workpiece and the trigger reference position (usually the workspace origin) when a part detection sensor transmits a detection signal.<br>Knowing this distance and the speed of movement, the scan controller can determine the exact moment when to start processing the vector list in the scan field.<br>The SP-ICE-3 control card has a part sensor buffer. Thus, it is irrelevant whether consecutive parts pass the trigger position before the first part has reached the scan field to get processed. |
| Enable compensation decoder                      | When enabled, a settings dialog is displayed which is similar to the one for the main encoder.  |
| <b><i>Debounce part sensor</i></b>               | Enable this option to debounce the sensor, i.e. to ignore any unwanted signals (often signal glitches) for a certain time.  |
| <b><i>Debounce time [μs]</i></b>                 | Debounce time in [μs]   |
| Suppress part sensor                             | Enable to avoid pick up any trigger edge for a certain distance, i. e. if other fiducials pass the trigger sensor while waiting for the next target object.   |
| Suppression distance [mm]                        | Distance in [mm] over which signals are suppressed  |
| Part sensor response time [μs]                   | Time in [μs] between a part's actual detection at the sensor and the arrival of the sensor signal at the scan controller. Refer to the part sensor specification to see the translation time, for example, of an optical recognition into an output signal.   |
| Reset jump speed [m/s]                           | Definition of the relative jump speed of so-called reset jumps. These jumps are made when the MOTF tracking is ended or paused or when the system jumps to the next assumed layout position.  |
| Margin   | Distance in [mm] to offset the earliest possible marking position from the field border towards the field origin.<br><b>NOTE:</b> Any value greater than zero will lead to a shorter processing time of the layout within the remaining field distance.   |
| Main encoder ID                                  | Assigns input port 0 and port 1 to the main encoder or to the compensation encoder. By default, the main encoder uses ID=0  |
| Belt offset [mm]                                 | Specify if the conveyor belt moves with an offset to the workspace origin.  |

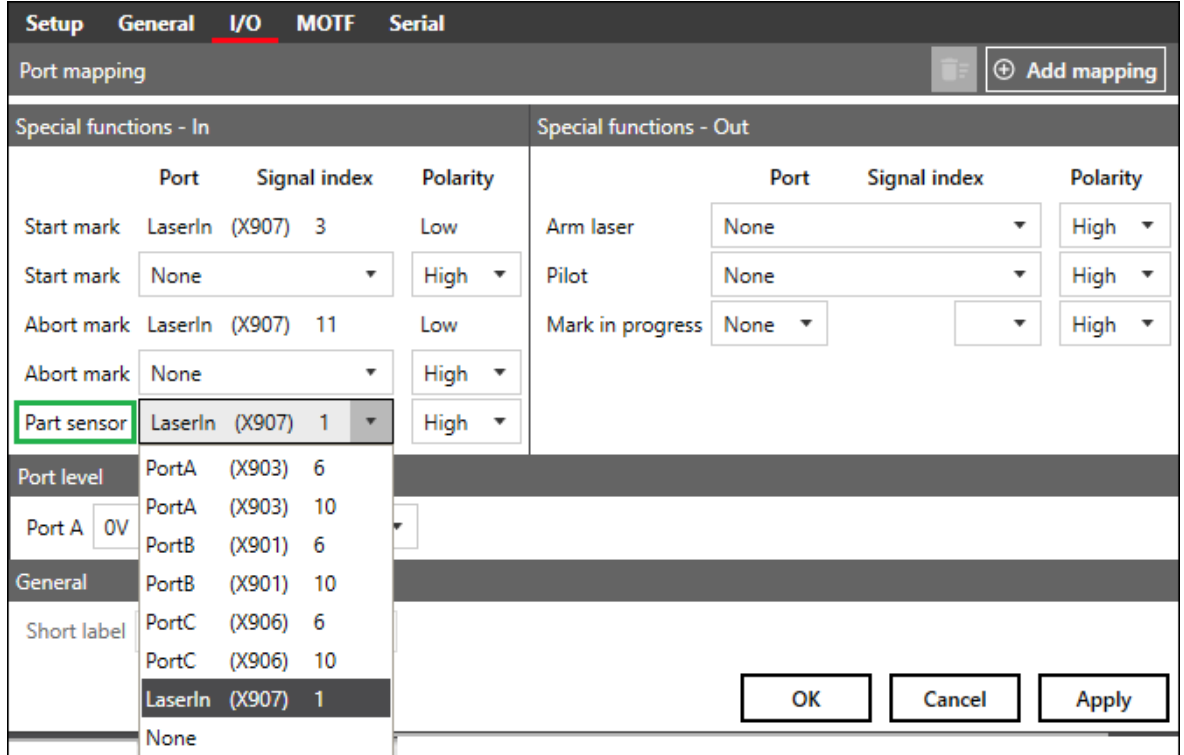
| Setting   | Explanation   |
|---|---|
| <b>Main encoder (also for compensation encoder, if enabled)</b> |   |
| Distance per count [ $\mu\text{s}/\text{tick}$ ]                | <p>The encoder delivers a certain number of signal edges per turn. By knowing this number (refer to the encoder specification) and the circumference of the encoder wheel, you can calculate the distance the conveyor belt is moving per signal-edge = "a count". Alternatively, read the current encoder position (<b>[Refresh]</b>), move the conveyor belt a certain distance, and read the new encoder position. Take the difference between the two encoder positions to calculate the "distance per count impulses".</p> <p>To fine-tune the calculated values, we suggest the following: Define a marking job with four lines of different lengths, orientated vertically to the belt movement direction, all placed in the field centre, one above the other. The shortest line should be first, the longest line last in the marking order.</p>  <p>Run the job and see if the four lines are marked in the same place (one above the other) and straight vertically. If the lines are separated and tilted, there is over-compensation or an under-compensation of the belt movement. Change the "Distance count impulse" value accordingly and repeat the test until the results are good.</p> |
| Invert direction  | Use if the encoder position value is decreasing instead of increasing although the conveyor belt moves in the desired direction.  |
| Azimuth [ $^{\circ}$ ], Elevation [ $^{\circ}$ ]                | <p>The two angle specifications indicate how the conveyor runs relative to the coordinate system of the workspace in your application.</p> <p>In most applications, the conveyor moves in the working plane, so the vertical angle is <math>0^{\circ}</math>, and the horizontal angle is <math>0^{\circ}/180^{\circ}</math> (belt moves along the X axis) <math>90^{\circ}/270^{\circ}</math> (belt moves along the Y axis).</p>    |

| Setting   | Explanation   |
|---|---|
| Enable index  | Some encoder types provide an index signal, used to reset the counter. Check with your encoder manual, if applicable.   |
| Enable simulation                                       | Enable to simulate a real encoder setup. Useful to evaluate if the job can be processed in an available scan field / time. If processing fails, the SP-ICE-3 scan controller sends an "out of field" exception.   |
| Simulation speed [m/s]                                  | Assumed belt speed in [m/s].  |
| Simulation acceleration [ $\mu\text{m}/\mu\text{s}^2$ ] | Assumed acceleration, if required.  |
| Position [tick]   | To determine the current encoder position counter value. With <b>[Refresh]</b> the current counter value is displayed, with <b>[Reset]</b> the value is reset.  |
| <b>Status</b>   |   |
| Pending parts   | Display the number of pending parts of the part sensor buffer. Use <b>[Refresh]</b> to update the status information.<br><b>NOTE:</b> The part sensor buffer count does not get cleared in case of an abort event. It is cleared every time you start an execution. |

Tab. 7.53: RG-055

When using a trigger sensor as part sensor, it is necessary to configure the input port to which the trigger sensor is wired.

Open the controller scan controller configuration and go to the I/O tab, section: *Special functions – In*



| Special functions - In |                |              |          | Special functions - Out |      |              |          |
|------------------------|----------------|--------------|----------|-------------------------|------|--------------|----------|
|                        | Port           | Signal index | Polarity |                         | Port | Signal index | Polarity |
| Start mark             | LaserIn (X907) | 3            | Low      | Arm laser               | None |              | High     |
| Start mark             | None           |              | High     | Pilot                   | None |              | High     |
| Abort mark             | LaserIn (X907) | 11           | Low      | Mark in progress        | None |              | High     |
| Abort mark             | None           |              | High     |                         |      |              |          |
| <b>Part sensor</b>     | LaserIn (X907) | 1            | High     |                         |      |              |          |
| Port level             | PortA (X903)   | 6            |          |                         |      |              |          |
| Port A                 | PortA (X903)   | 10           |          |                         |      |              |          |
|                        | PortB (X901)   | 6            |          |                         |      |              |          |
| General                | PortB (X901)   | 10           |          |                         |      |              |          |
| Short label            | PortC (X906)   | 6            |          |                         |      |              |          |
|                        | PortC (X906)   | 10           |          |                         |      |              |          |
|                        | LaserIn (X907) | 1            |          |                         |      |              |          |
|                        | None           |              |          |                         |      |              |          |

Buttons: OK, Cancel, Apply

Fig. 7.72: RG-ADG

### Remarks

- If the deflection unit moves instead of the one conveyor belt in your hardware setup, then the settings apply analogously.
- When running MOTF jobs in a multiple-scan controller scenario, the settings must be made for each scan controller.

**RULE:** It is recommended to run MOTF jobs in *On card* execution mode to ensure immediate response / processing to trigger signals. See page 285, *Running a Job*.



## 7.7.2 MOTF settings in job settings / presets

In many cases, similar if not the same trigger options are used when creating multiple MOTF jobs. Therefore, it is advisable to define them via a job preset.

Select **Job > Presets** to open the job preset dialog. Go to the MOTF tab.

Click **System > Preferences** from the menu to open the dialog. Go to the **System (all users)** tab and to the **Workspace** sub-tab.

| Setting                    | Explanation  |
|----------------------------|--|
| Enable Mark-On-The-Fly     | Required for a job preset for MOTF jobs. The MOTF trigger options are released.  |
| Minimum segment width [mm] | <p>This value defines how far a layout protrudes into the scan field due to the belt movement before processing begins.</p> <p>The value is 5% of the field size by default.</p> <p>In addition, within the segment, reset jumps are omitted.</p> <p><b>NOTES:</b></p> <ul style="list-style-type: none"> <li>■ This value is of particular significance when a group of individual paths (such as parallel fill lines) or rows of drilled points wander into the scan field due to the belt movement.</li> <li>■ This value is also used for MOTF processing of bitmaps.</li> </ul> <p>Otherwise, the smallest unit that would move into the processing field and after which a reset jump would occur would be a single bitmap line.</p> |
| Start trigger              | <p>Start the <b>first</b> marking after the job was set to the "in execution" status.</p> <p><i>Immediately:</i> Processing starts immediately as soon as you start the job execution.</p> <p><i>Distance:</i> Processing waits until the belt has travelled a certain distance.</p> <p><i>Part sensor:</i> Processing starts on the "part sensor" trigger signal (and consider the part distance).</p>  |
| Distance                   | <p>Activated when <i>Start trigger</i> is set as <i>Distance</i>.</p> <p>Enter the distance in [mm]. The first marking must wait until the job execution has started.</p>  |

| Setting              | Explanation  |
|----------------------|--|
| Repeat trigger       | <p>Define how consecutive parts get triggered:</p> <ul style="list-style-type: none"> <li>■ The job is repeated equidistantly. The distance is defined as execution pitch.</li> <li>■ The part sensor detects the parts as they pass by.</li> </ul> <p><b>NOTE:</b> The SP-ICE-3 control card has a part sensor buffer. Thus, trigger events can be buffered while a part moves from the sensor into the workspace, allowing to place the part sensor in any distance from the workspace centre.</p> |
| Execution pitch [mm] | Activated when the repeat trigger is set to distance. Defines the distance at which the repeated job layout is to be executed.   |

Tab. 7.54: RG-056

### 7.7.3 MOTF Optimizations

**INTRODUCTION:** Note that the following optimizations always consider each path, or more precisely their bounding box, as the smallest unit of a graphic object that can be analysed.

| Setting   | Explanation  |
|---|--|
| <b>Mark-On-The-Fly Segmentation</b>   |  |
| This option allows MOTF processing of geometries that are significantly longer than the dimensions of the scan field. |  |
| Select Segmentation mode  | <p><b>By distance</b></p> <ul style="list-style-type: none"> <li>■ Uses the "Max. Width [mm]" parameter</li> <li>■ With this option, the width of all paths are checked in the belt direction. Only paths that are wider than the "maximum width" value will then be divided <u>into segments of equal width</u>, which are then processed one after the other.</li> </ul> <p><b>By time</b></p> <ul style="list-style-type: none"> <li>■ Uses the "Max. Width [mm]" and "Time [s]" parameters</li> <li>■ With this option, the entire job geometry is divided into segments, which each have <u>the same time requirements</u> for processing. The segments are then processed one after the other in the belt direction.</li> <li>■ In this case, the "Max. Width" value for defining an upper limit to prevent the geometry from being split into segments that are wider than the field size, for instance, due to the time specification.</li> <li>■ The corresponding value for "Time" indicates how much time the segments may take to process (the segments are divided according to this value).</li> </ul> |

| Setting                | Explanation  |
|------------------------|--|
| <b>Sort</b>            |  |
| Minimize jump distance | For details, see <i>page 111, Optimizations</i> .  |
| By direction & Range   | <p>Activate this option to sort all paths (including filling lines) of a graphic object taking the belt movement direction into account, so as to achieve maximum possible belt speed.</p> <p>(For instance if the belt moves the target objects from the right side into the scan field, the paths for processing are sorted according to their position from left to right.)</p> <p><b>CAUTION:</b> Sorting is done per marking object and level. That means it may be necessary to merge several marking objects into one marking object with one level with the optimizations under General.</p> <p>The <b>Range [mm]</b> value defines the width of a virtual segment. Within each virtual segment, the order of primary path processing is opposite to the belt direction, while the secondary order is perpendicular to the belt direction and reverses on alternating segments.</p> <p><b>APPLICATION NOTE:</b> Finding the optimal value for the range depends on the internal path distribution and the overall shape. If the graphic object is rather narrow but long in band direction (e.g. single-line text), a rather small range value is recommended.</p> <p>If, on the other hand, the graphic object has a more square contour and plenty of paths that run perpendicular to the belt direction, a larger range value is recommended in order to avoid too many perpendicular jumps. A reasonable limit for the value is 25% of the field size.</p> |

Tab. 7.55: RG-070

The following images show the jumps to visualise the path process order before and after splitting (with uniform distance) and sorting.

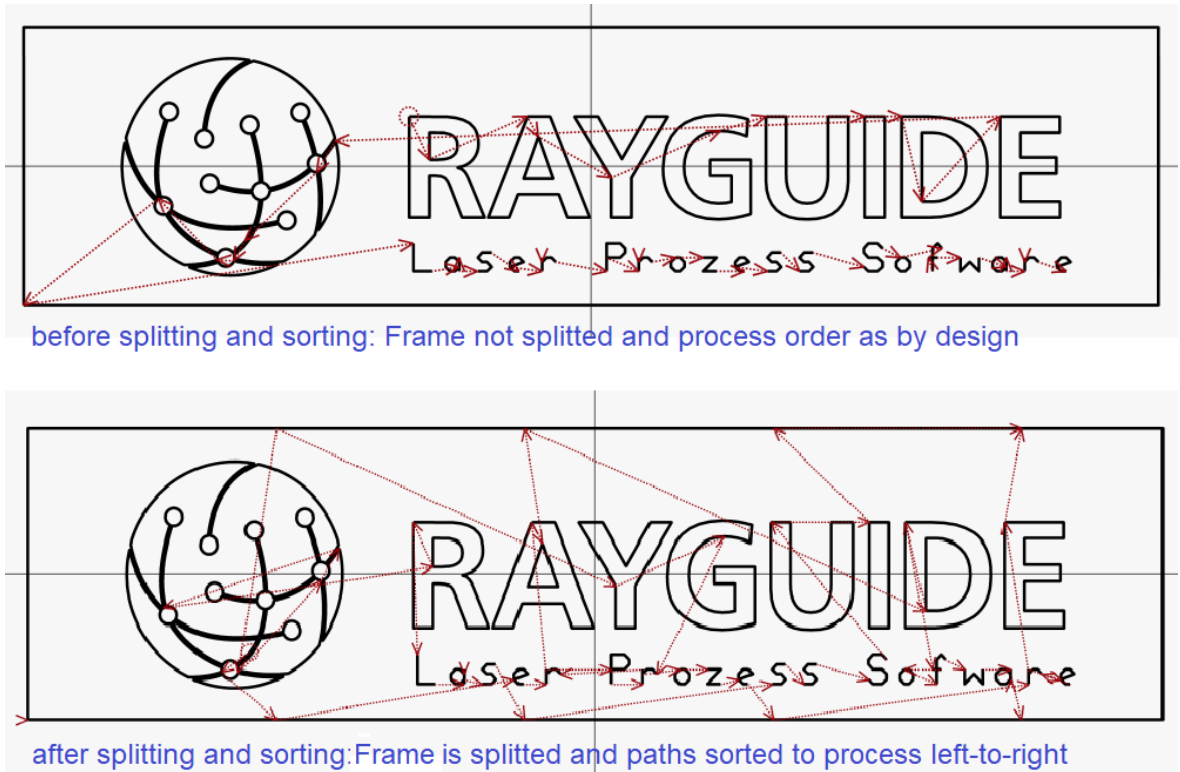


Fig. 7.73: RG-ADR

### Speed optimization

The rule of thumb applies: The maximum belt speed results from the field size divided by the execution time. If the marks are distributed at equal intervals, the repetition distance is used for calculation instead of the field size.

When using the optimization options the maximum possible speed value can be increased. To determine the optimal values, you can try different optimization values and use the simulated encoder for evaluation, or if the geometry has to be split, use the MOTF parameter finder (see page 277, MOTF parameter finder).

**NOTE:** To visualise how the optimization works, a good option is to import the API log file and view the jumps, since all the optimizations previously took place at the executor level.

## 7.7.4 MOTF parameter finder

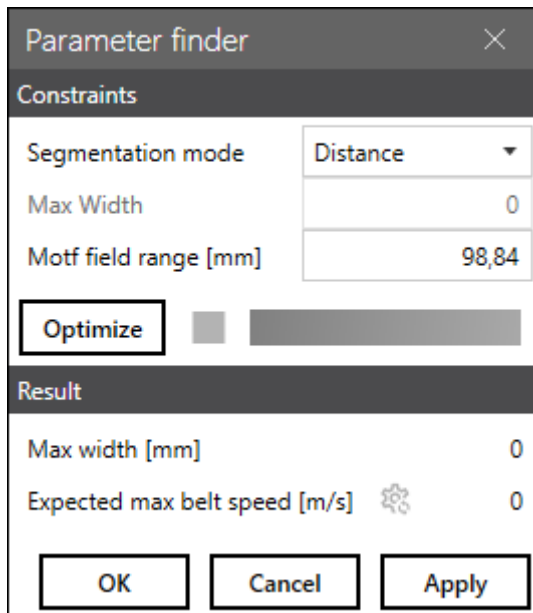
You can use the finder to help you find the optimal parameters for splitting the job geometry for MOTF processing.

### NOTES:

- The values determined here are a mathematically calculated estimate. The real usable values may differ slightly.
- The finder only determines values that are needed if the job geometry is split. The minimum segment width value is not one of them.
- The MOTF parameter finder accesses the value of the current field size. If the field size is changed, the parameters need to be recalculated.
- The MOTF parameter finder can only be applied to jobs that have the “Mark-On-The-Fly” flag set in the job properties.
- For jobs with repeated execution by distance, this circumstance is taken into account. For jobs where repeated execution is triggered by the part sensor input, this circumstance cannot be taken into account in the calculation because the time or distance between job repetitions is unpredictable.



To start the MOTF parameter finder, go to **Tools > Parameter finder > MOTF**.

The following dialog appears:



| Constraints  |                          |
|--|--------------------------|
| Segmentation mode  | Distance                 |
| Max Width  | 0                        |
| Motf field range [mm]  | 98,84                    |
| Optimize   | <input type="checkbox"/> |
| Result   |                          |
| Max width [mm]   | 0                        |
| Expected max belt speed [m/s]  | 0                        |
| <input type="button" value="OK"/> <input type="button" value="Cancel"/> <input type="button" value="Apply"/> |                          |

Fig. 7.74: RG-AFB

| Setting                           | Explanation  |
|-----------------------------------|--|
| <b>Constraints</b>                |  |
| Segmentation mode                 | Specify the desired method for splitting.<br>You can choose between distance or time. For details, see <i>page 274, MOTF Optimizations</i> .   |
| Max. Width [mm]                   | In the "by time" splitting method, this value is an upper limit because the segments may not be infinitely wide.   |
| MOTF field range                  | Define the area or path length in the scan field that is available for MOTF processing here.<br>By default, the value is 70% of the field size, but it can also be smaller or larger if required. 70% is a good starting point according to previous experience.   |
| <b>[Optimize]</b>                 | Starts the calculation of the optimal parameters for splitting.<br>The process bar shows the progress of the calculation.<br>Use the <b>[Cancel]</b> button to cancel the calculation if necessary.  |
| <b>Result</b>                     |  |
| Max. Width [mm] / <b>Time</b> [s] | Specifies the optimal values for the "maximum width" or the "time", depending on the splitting method.   |
| Expected max belt speed [m/s]     | Specification of the maximum belt speed calculated during the MOTF parameter search that can be achieved with the set specifications and splitting.<br>Tolerances of up to $\pm 2\%$ are to be expected with this value.<br> Use the  symbol to transfer the calculated max. belt speed to the simulation encoder of the control card. |
| <b>[OK] / [Apply]</b>             | Transfers the set splitting method and the calculated splitting parameter to the job properties, Optimization tab.   |

Tab. 7.56: 073

### 7.7.5 MOTF workspace

It is possible to define a much larger workspace along the axis direction of the belt movement. See *page 104, Job Presets*.

Use case: The graphic object(s) can be placed outside the field (in the direction in which the material to be marked is fed) to have more "way" left inside the scan field for processing.

**NOTE:** If the job validation for geometry is active, you must position all markable objects inside a defined workspace to avoid warnings.

## 7.7.6 Trigger Reference

This chapter explains considerations to better understand when marking effectively starts.

In general, RAYGUIDE starts processing markable objects as soon as possible, but taking into account various rules.

**GENERAL RULE:** Wait until the first path element has been completely "moved" into the field before you start processing, unless the layout is positioned in such a way that the first path is already completely located in the available scan field. Each subsequent path is marked at the latest when its MOTF-corrected position is also completely moved into the available scan field.

For this, the path, more precisely its bounding box, must lie completely within the scan field. This avoids an out-of-field exception for cases processing paths that would be marked faster than moving their vectors into the scan field.

What does this mean for the three different settings for the **start trigger**?

### 7.7.6.1 Immediately

The processing of the first listed markable object is started immediately, under consideration of the previously mentioned general rule.

### 7.7.6.2 Part Sensor

The processing of the first listed markable object starts after the trigger event has been recognised by the part sensor and the part distance has moved along, but considering the previously mentioned general rule.

The layout object's position in the workspace must be the relative position of the layout object to the trigger reference of the target material / workpiece.

- A common option is to use the workspace origin as a reference.
- It is important to enter the "part distance" value in the MOTF configuration of the scan controller, measured relative to this reference.

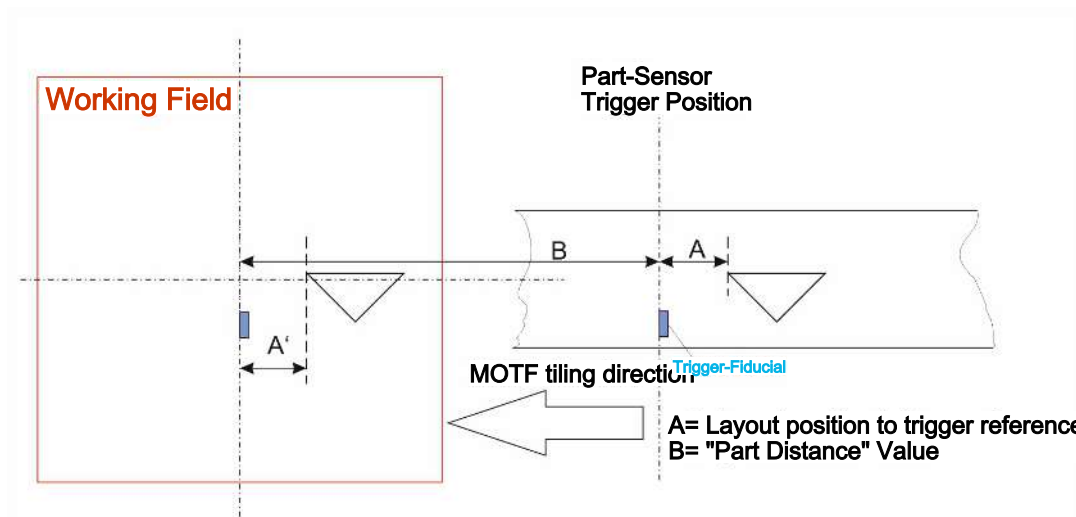


Fig. 7.75: RG-ADD

### 7.7.6.3 Wait Distance

The processing of the first listed markable object starts after the defined wait distance has elapsed, but considering the previously mentioned general rule.



## 7.8 Job Execution

### 7.8.1 Preview

When starting a preview, the deflection unit projects the geometry of the selected layout object(s) with a visible pilot laser onto the target material. Therefore, the laser source itself or the system must provide a visible pilot laser. The preview option must be set in the respective laser configuration.

#### 7.8.1.1 Pilot laser calibration

In most cases, the wavelengths of the visible laser source and the processing laser are different. This will result in a slight deviation of the deflection caused by different diffraction. Thus, it is recommended to calibrate the laser source.

To calibrate the laser source, go to the device calibration of the respective deflection unit, "Preview" section. For details, refer to *page 71, Deflection Unit Calibration*.

#### Workflow

- First, mark a square with a suitable pen on a suitable material.
- Start the preview of the square. Use the arrow buttons to superimpose (by rotating, shifting, scaling) the previewed square with the marked square. Below the buttons are fields where you can define the delta values by which the preview changes with each click of the button.
- You may transfer the hot laser calibration values as initial pointer calibration in advance, using the arrow button between the two calibration sections.
- Save the laser source calibration: Click the **[Apply]** or **[OK]** button to open the laser dialog.
- If the deflection unit is a 3-axis or 4-axis unit, you can set a separate head bias to focus the laser source beam precisely on the target material.  
During previews, a fairly high scanning speed is often required. You can disable the 3rd / 4th axis when a preview is performed to avoid stressing these axes.

For information on field transformations, refer to *page 71, Deflection Unit Calibration*.

### 7.8.1.2 Running a Preview

Go to the Execution panel.

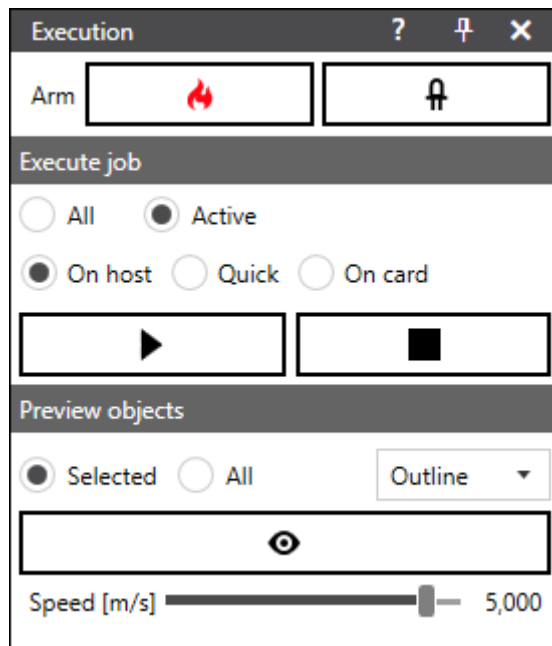


Fig. 7.76: RG-ACQ

You can choose to display only **selected** graphic objects or graphic objects (or a **selection** of layers or paths) or **all** graphic objects via the preview using the pilot laser.

The drop-down list offers you four options to select the previewed content(s) / shape(s):

- *Everything*: This also includes fillings and, for bitmaps, each bitmap line
- *Contour*: All contour vectors, but no fillings, bitmaps as rectangles
- *Rectangle*: A bounding box rectangle around the selected objects
- *Envelope*: Only enclosing contours of the single selected objects

Example:

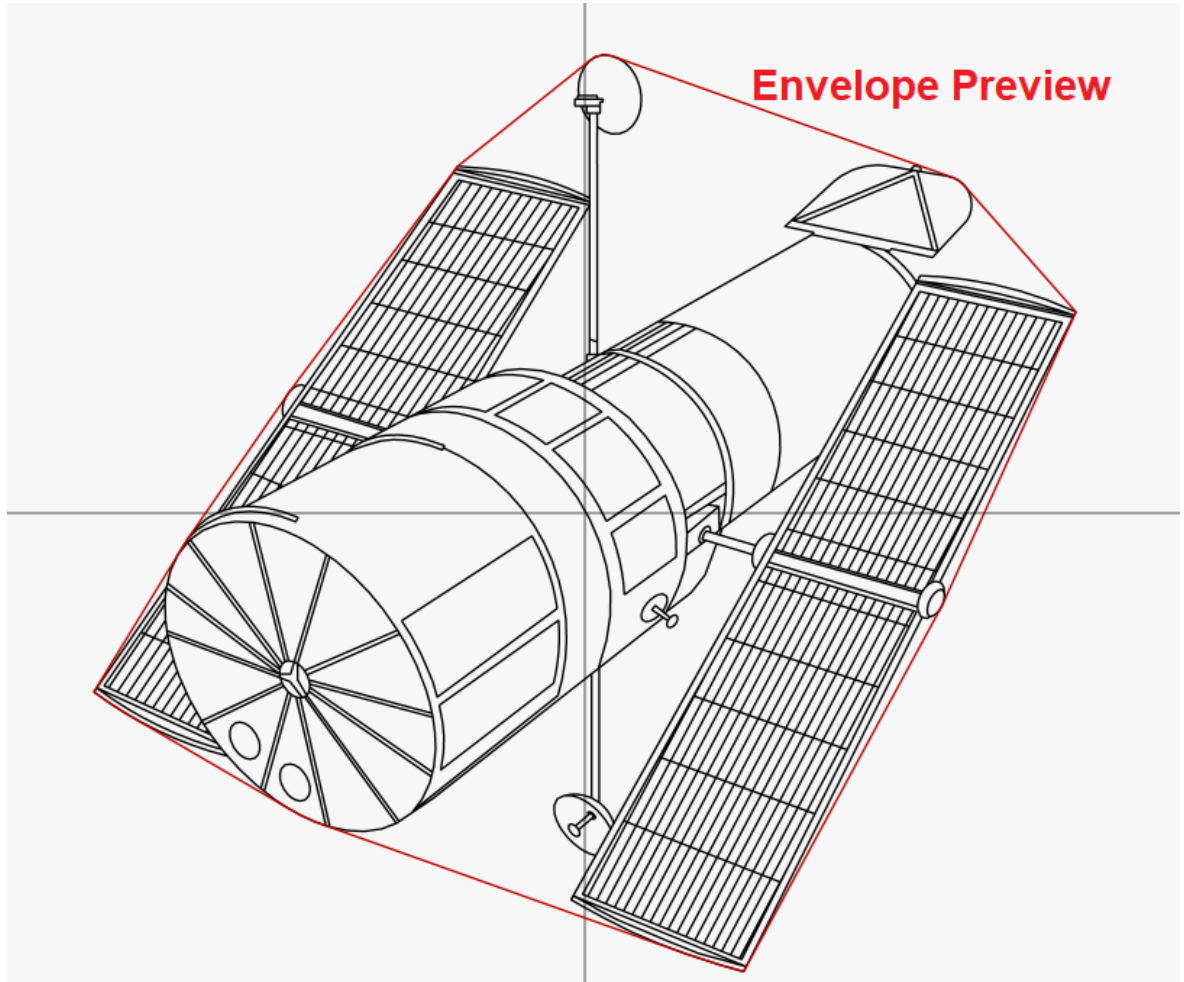


Fig. 7.77: RG-ADO

- **Thumb:** Positions the preview point on the selected thumb position and tracks it live while the thumb position is being processed (only functions in edit mode with a single selected thumb).

This option can also be used when "Drawing" vector graphics. Here, the preview point always shows the end point of the graphic command added last.

**NOTE:** If you change to the object level in the tree while the thumb preview is active, the preview automatically changes to the rectangle preview variant.

When you start a preview, RAYGUIDE "disarms" the laser and turns on the pilot laser. When the preview is finished, the laser is re-armed.

You can also switch on the pilot laser without doing a preview. This means that only one of the two toggle buttons, **[Arm]** and **[Pointer]** can be active at the same time.

To activate the laser source, click on the **[Pointer]** toggle button. The button switches to red:



Fig. 7.78: RG-ACR

Then click on the **[Preview]** toggle button. It also turns red:



Fig. 7.79: RG-ACS

The preview runs continuously until the button is clicked again. The scanning speed for the preview can be adjusted with the speed slider. The speed slider provides the speed values in a logarithmic scale.

The speed range for the preview can be adjusted to meet the specifications of your deflection unit in the **System > Preferences > System (all users) > Process adjustment** menu.

When the preview is stopped using the **[Preview]** toggle button, the preview only ends after the current object has been run through. If you want to stop the preview immediately, click on **[Abort]**.

### Live editing during preview

It is possible to select more / less / other objects, edit and transform the objects, even down to the layer / path / command level, while the preview is running. The changes are always shown with the next preview cycle.

## 7.8.2 Running a Job

The execution of laser processing jobs is controlled from the Execution panel (on the right side of the viewport by default):

**NOTE:** Once you start running a laser processing job, the top and bottom lines of the frame turn red. This ensures that anyone can immediately recognise that a laser process is active with just one glance at the RAYGUIDE user interface.

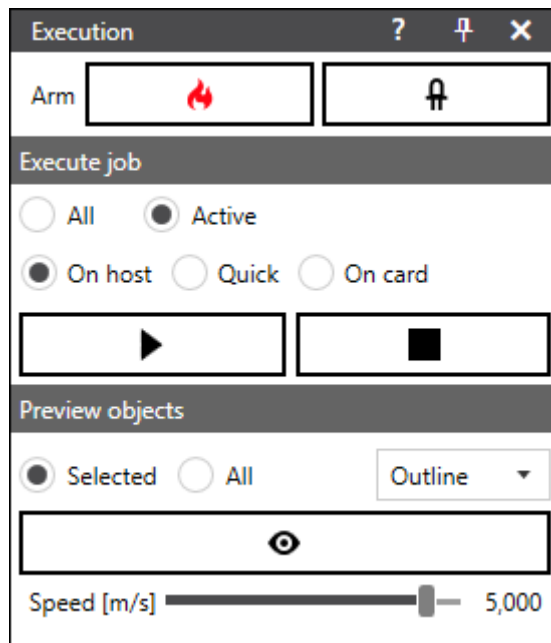


Fig. 7.80: RG-ACT

### Job validation

Job validation is a tool to help you preventing mistakes, for example, positioning a layout object partially outside the available workspace. Job validation is performed ahead of the actual job execution. You can select if and what type of job validation is to be performed. Select **System > Preferences** from the menu, go to the User (current user) tab and to the General tab, Job validation section.

| Setting                | Explanation  |
|------------------------|--|
| <b>Job validation</b>  |  |
| Geometry               | Checks that no layout object is partially or completely outside the defined scan field or workspace.                                       |
| Laser pen properties   | Checks that the defined laser limits (e.g., pulse width, power) are not exceeded in any of the pens used.                                  |
| Scanner pen properties | Checks that the defined scanning speed limit is not exceeded by any of the pens used.  |
| Ramping pen properties | Useful only if a used pen uses the ramping feature. RAYGUIDE checks that the total ramp length exceeds the length of the respective paths. |

Tab. 7.57: RG-059

If any of the active job validation checks finds an issue, a pop-up message indicates the possible error cause.

### Job access during execution

The currently processed job is in read-only status. You can review the statistics or the used pen parameters, but you cannot edit them. All other open jobs can be edited in the meantime.

### Stopping a job

A job that was started will terminate when all job tasks are performed.

If you want to stop the job execution on purpose (for example, because the job is running in an infinite loop), click the **[Abort]** button. This will immediately terminate **all** active processing, and the deflection unit resets to the 0/0 position.

In case of executing multiple jobs in parallel, each job has its own entry in the process monitor and can be stopped individually. See *page 292, Process Monitor*.

When you launch the job execution again, the job starts from the beginning.

### 7.8.2.1 Arm Status

To execute a job with working laser emission, the laser must be armed.

This does not necessarily imply that an electric arming signal is sent to the laser. However, the *Arm laser on startup* status of the SP-ICE-3 scan controller must be set to TRUE to provide any laser control signals at all. If the laser is not armed, no signals are transferred from the controller scan controller to the laser.

In the Execution section of the panel, click on the **[Arm / Disarm]** toggle button to change the laser arm status. The red symbol on the button indicates that the laser is armed.



Fig. 7.81: RG-ACU

Disarming the laser can be useful to prevent accidental laser emission.

In the system settings (**Preferences > System > General** tab), you can define that the laser should always be automatically armed when the RAYGUIDE application is started.

**NOTE:** The toggle buttons **[Arm / Disarm]** and **[Pointer]** are also presented at other locations in the user interface, such as in the laser diagnosis.

**NOTE:** The display of the buttons does not respond to the switching of the laser status or laser source by means of the automation object (see page 215, *Arming / Disarming laser*).

### 7.8.2.2 Execution Modes

In the Mark job section of the Execution panel, you can choose between three modes of execution:

- **On host:** Execute the complete job with its job settings. After clicking the **[Execute]** button, RAYGUIDE starts sending the data to the scan controller for execution. To reduce the idle time during the data transmission, RAYGUIDE streams the data.
- **Quick:** Use the "selected" toggle button to execute selected layout objects only or, if not toggled, all layout objects. To execute the job, click on **[Execute]** – here you can select between "Execute" (= default setting) and "Repeat".

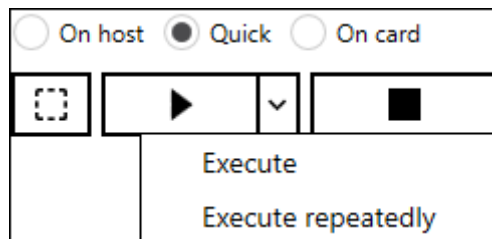


Fig. 7.82: RG-ADB

#### NOTES:

- Job settings such as job repeat loops are ignored.
- No MOTF correction is used.
- Object binning conditions are ignored.
- Automation objects are not executed.
- Text and code are not incremented in a repeat loop.
- **On card:** Use this mode to ensure that there is no idle time when a trigger signal is received, i.e., in MOTF applications. First, use the **[Upload]** button to send the job(s) to the scan controller's RAM memory. When all data are transferred, the **[Run]** button can be used again. Click **[Run]** to execute the job.

**NOTE:** If you have a job scenario that permits the use of the "All" job option, click the **[Run]** button once to set all jobs to execution.

**NOTE:** If you close the RAYGUIDE application after downloading, the job lists are still stored on the card. If you have already started the job execution and close the RAYGUIDE application afterwards, you can choose if the job execution is to be continued. In this case, you must a) abort the job execution and b) re-initialise the scan controller when you re-open RAYGUIDE in order to obtain access to the scan controller.



### 7.8.2.3 Execution with Enabled Shortcuts

The buttons on the Execution panel are also available as keyboard shortcuts.

Press **[F10]** to activate the mode of execution by keyboard shortcuts. A small pop-up dialog is displayed with the known button.

You can access the functions by clicking the buttons with the mouse, or activate them with the keys indicated on the buttons.

**NOTE:** The execution mode can only be selected with the mouse.

| Key        | Function                          |
|------------|-----------------------------------|
| <b>[A]</b> | Arm Laser ON / OFF                |
| <b>[D]</b> | Upload (on-card mode only)        |
| <b>[E]</b> | Pointer ON / OFF                  |
| <b>[M]</b> | Mark (all)                        |
| <b>[R]</b> | Repeat ON / OFF (quick mark only) |
| <b>[S]</b> | Mark selected (quick mark only)   |
| <b>[P]</b> | Preview ON / OFF                  |
| <b>[X]</b> | [Abort]                           |

Tab. 7.58: RG-057

### 7.8.2.4 Considerations and Rules Regarding Multiple Jobs

Two cases are considered for the execution of multiple jobs:

- Prerequisite: All open jobs are assigned to a specific scan controller, and all job elements of a job are assigned to the same card.

This allows the *All* option to be used in the execution user interface panel in order to execute all jobs in parallel on the assigned scan controller. Available execution modes: *On host* or *On card*

- Prerequisite: All open jobs are assigned to the same scan controller.

This allows the second job to be sent for "Execution" while the first job is still running, and so on. RAYGUIDE then queues the jobs and processes them one after the other.

### 7.8.2.5 Considerations and Rules Regarding Multiple Card Scenarios

In general, RAYGUIDE handles the described multiple scan controller scenarios in the same way, regardless of whether the multi field mode setup is defined for unified, intersected, or individual fields, even though these setups support different purposes in the installation design.

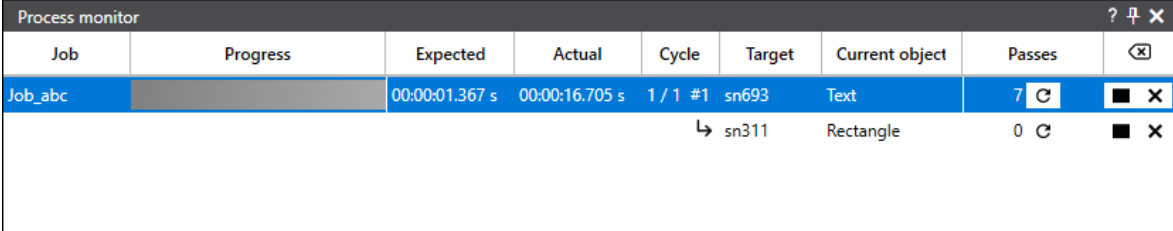
| Execution                  | Explanation  |
|----------------------------|--|
| <b>On host</b>             |  |
| Using an automation object | <p>The automation object is only executed on the assigned scan controller.</p> <ul style="list-style-type: none"> <li>■ <i>Example 1: Wait for start signal</i><br/>All scan controllers wait to continue executing until the trigger signal is received on the assigned scan controller.</li> <li>■ <i>Example 2: Writing IO port</i><br/>Only the assigned scan controller sets the I/O port. All other scan controllers wait until the port is set before continuing with their objects.<br/>If you want all involved scan controllers to write something to the I/O port, you have to duplicate the automation object per scan controller and assign it accordingly.</li> </ul> <p>In any case, further execution is synchronised by the automation object: This means that the automation object is not executed until each scan controller has completed the previous process tasks.</p> |
| Incrementing content       | <p>This case requires special attention when multi-field mode is applied to <i>individual fields</i>:</p> <p><b>RULE:</b> RAYGUIDE increments the content per involved scan controller.</p> <ul style="list-style-type: none"> <li>■ <i>Example:</i> You have three scan controllers assigned and process a text object with incrementing serial number:<br/>At the first job iteration, scan controller #1 will mark 1, scan controller #2 will mark 2, scan controller #3 will mark 3.<br/>At the second job iteration, scan controller #1 will mark 4, scan controller #2 will mark 5, scan controller #3 will mark 6.</li> </ul> <p>If you want to have all scan controllers process the same iteration content, set the value of the "batch parameter" according to the number of assigned scan controllers.</p>  |
| Job Loop                   | <p>The following job repetition starts synchronised again: The executing device waits until each scan controller has finished its task in the previous job repetition.</p>   |
| Abort execution            | <p>If an abort occurs on any of the involved scan controllers, all scan controllers stop processing.</p>   |

| Execution                  | Explanation   |
|----------------------------|---|
| <b>On card</b>             |   |
| Using an automation object | <p>RAYGUIDE clones the scan controller-related automation object for each scan controller involved.</p> <p><b>NOTE:</b> Automation objects that do not refer to any scan controller are ignored. An exception to this is the "Time delay" object</p> <p>In order for RAYGUIDE to do this, the corresponding necessary ports must be configured for each scan controller involved – with identical IDs / descriptions for the ports.</p> |
| Job Loop                   | As there is no crosslink between the scan controllers, the loop execution of the scan controllers involved is not synchronised.   |
| Abort execution            | As there is no crosslink between the scan controllers, only the scan controller at which the abort occurs stops the execution.  |

Tab. 7.59: RG-058

### 7.8.3 Process Monitor

The process monitor is on a UI panel below the viewport. It offers useful information about when the job execution was started. Example:



| Job     | Progress  | Expected       | Actual         | Cycle    | Target | Current object | Passes |
|---------|---|----------------|----------------|----------|--------|----------------|--------|
| Job_abc | <div style="width: 100%; background-color: grey;"></div>  | 00:00:01.367 s | 00:00:16.705 s | 1 / 1 #1 | sn693  | Text           | 7      |
|         | <div style="width: 100%; background-color: white;"></div> |                |                | ↳ sn311  |        | Rectangle      | 0      |

Fig. 7.83: RG-ACV

The Process Monitor lists all jobs that are running while RAYGUIDE is open, unless you delete a single entry or all entries manually.

If the same job is executed several times in a row, the existing entry is updated and the counter in the Cycle column is incremented. The job last started always appears at the top of the list.

The process monitor list provides the following information:

| Info     | Explanation   |
|----------|---|
| Job      | Name of the job   |
| Progress | <p>A dynamic status bar to view the current state of progress.</p> <p>If the job is interrupted for some reason (intentional or after an error), the progress bar stops, too.</p> <p>If the job is to be repeated for a number of times, the progress bar reflects the overall progress.</p> <p>If the job is to be executed in an endless loop:<br/>           The progress bar restarts with each loop if the time span for job execution is more than five seconds.<br/>           The progress bar stops when the first cycle is completed if the job execution time is shorter than five seconds.<br/>           However, the timer will continue counting.</p> <p>Colour code:</p> <ul style="list-style-type: none"> <li>■ Grey bar: The job is executed again</li> <li>■ Green bar: The job has been completely executed</li> <li>■ Red bar: The job was aborted by the user or due to an error message.</li> </ul> <p>If a job is processed by multiple control cards, the progress still refers to the entire job status as such.</p> |

| Info                          | Explanation   |
|-------------------------------|---|
| Expected                      | <p>Calculated process time for the complete job in one iteration. Even if the job is processed by multiple control cards which share the work, the cumulated process time is shown here.</p> <p><b>NOTE:</b> When the job is repeated a defined number of times, the total time is displayed. However, when the job is executed in a repetition loop, the duration of the individual repetition is displayed.</p> |
| Actual                        | <p>Actual process time</p> <p><b>NOTE:</b> The timer for the current time also runs when waiting for an event (for example, "Waiting for signal start") and stops when the process is completed or aborted.</p>   |
| Cycle                         | <p>Counter for displaying the performed job executions / the number of specified job executions.</p> <p>The pound sign is followed by the number of started job executions.</p> <p><b>NOTE:</b> Both counters only work in execution types "On host" and "Quick".</p> <p><b>NOTE:</b> The "Start execution counter" is only reset when the entry is deleted in the process monitor.</p>                           |
| Target                        | <p>Display all scan controllers linked to the current job itemised according to their labels.</p>   |
| Current object                | <p>Display the current or last processed object per involved scan controller.</p> <p><b>NOTE:</b> The object name is only displayed if the execution is in the <i>On host</i> or <i>Quick</i> mode.</p> <p><b>NOTE:</b> When a tiler container is used, the tile coordinate is shown.</p>   |
| Passes                        | <p>Display of object executions.</p> <p><b>NOTE:</b> The display of object pass counter only operates for objects with a sequence using infinite number of passes.</p> <p>The display can be activated during the execution using the <b>[Refresh]</b> button or it happens at the latest when the infinite execution is aborted.</p> <p><b>NOTE:</b> The terminated pass is not counted.</p>                     |
| <b>[Abort]</b>                | <p>Button to abort a specific job, in case several jobs are executed in parallel.</p>   |
| <b>[Clear]* / [Clear all]</b> | <p>Clear individual / all entry(ies) from the process monitor list.</p>   |
| <b>*NOTE:</b> Per target      |   |

Tab. 7.60: RG-060

### 7.8.4 Automated Error Handling

This function is intended for the more detailed communication to an external control unit of possible malfunctions registered on the scan controller. Possible error sources can be the scan controller itself, as well as connected devices such as the laser or the deflection unit. To use this function, the job must be executed by the RAYGUIDE application, i.e., this function cannot be used when executed in stand-alone mode without an additional connection between the RAYGUIDE GUI and the scan controller.

**NOTE:** An error reaction only takes place if a job is being actively executed. This also includes an active preview.

Click **System > Error handling** from the menu to open the Troubleshooting dialog.

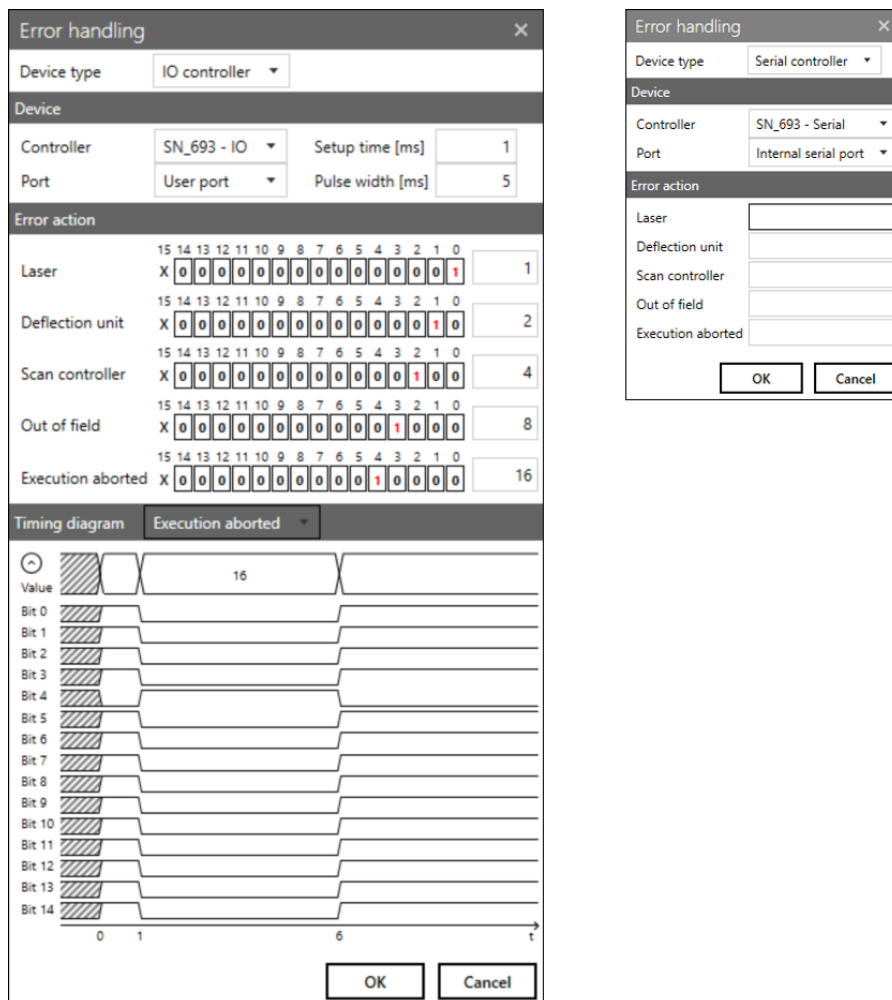


Fig. 7.84: RG-ADW

| Setting   | Explanation   |
|---|---|
| Device Type   | Select which of the available communication interfaces is to be used.<br>Currently, the I/O interface or a serial interface is available.   |
| Controller  | Specify the scan controller on which the interface is physically located.   |
| Port  | Select the desired and preconfigured port on the selected scan controller.  |
| Setup time [ $\mu$ s]<br>Pulse width [ $\mu$ s]<br>Timing Diagram | Both values can be defined if you select an I/O interface for communication.<br>The timing diagram is used to display the signal sequence according to the defined bit pattern and the timing.<br>The same principles apply as for the <i>Write I/O port</i> automation object. See <i>page 210, Automation Objects</i> .   |
| Error Action  | Define a different signal pattern or command line for each individual error reason: <ul style="list-style-type: none"> <li>■ <i>Laser</i>: Reacts when the connected laser source reports a malfunction.</li> </ul> <p><b>NOTE:</b> Some lasers may report various error conditions, but they are combined into one error condition on the SP-ICE-3 scan controller.</p> <ul style="list-style-type: none"> <li>■ <i>Deflection unit</i>: Reacts when the scan head monitoring is set active and the number of consecutive errors is exceeded. For details, see <i>page 49, General</i>.</li> <li>■ <i>Scan controller</i>: Reacts when the scan controller outputs an exception, apart from the special exceptions mentioned below.</li> <li>■ <i>Outside the field</i>: Reacts when the card notifies vectors for processing that exceed the field size. (Separated scan controller exception) Can usually occur during an MOTF job execution.</li> <li>■ <i>Execution aborted</i>: Reacts when either the user presses an abort button or when an external stop signal is detected on the scan controller (Separated card exception).</li> </ul> |

Tab. 7.61: RG-077

### 7.8.5 Setting up the stand-alone card operation

You can transfer one or more jobs from the RAYGUIDE application to the scan controller memory. All job information is stored in a list on the scan controller and remains stored even if the scan controller is powered down.

When the scan controller has all the necessary job information and is in *Stand-Alone mode*, the card independently executes the jobs without being connected to the RAYGUIDE software or being monitored by it.

External signals are sent to the scan controller via the input I / Os – for start / stop processing as well as for job selection. Typically, these signals are generated by a PLC.

**NOTE:** To define the stand-alone configuration and transfer jobs, the scan controller must be in "connected" status.



### Defining a list with jobs for stand-alone mode

Select **System > Stand-Alone** from the menu or press [Ctrl+F12].

The following dialog is displayed:

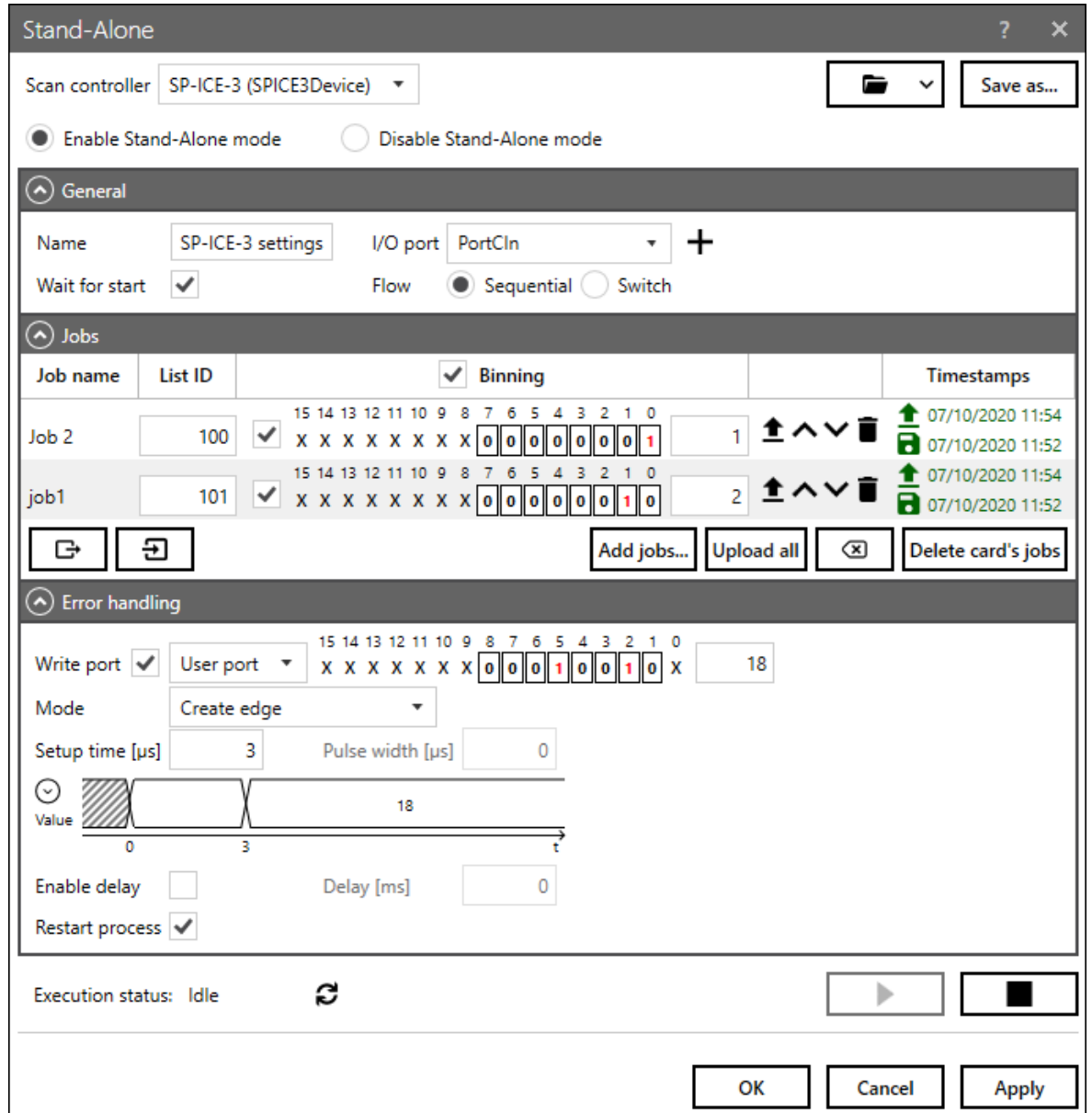


Fig. 7.85: RG-ACW


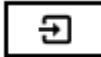

The stand-alone mode dialog offers all options to prepare the scan controller for stand-alone operation. All functions are explained in the table below, followed by generic workflow instructions.



Also, the stand-alone mode dialog provides an option to save / load all settings for a stand-alone operation in a so-called "stand-alone configuration". A stand-alone configuration can be useful to back up the work or to apply the settings to further scan controllers.

## Settings

| Setting  | Explanation  |
|--|--|
| Scan controller                                    | Select the scan controller for the stand-alone configuration.  |
| Enable Stand-Alone mode / Disable Stand-Alone mode | Select "Enable Stand-Alone mode" to release the stand-alone configuration section in the dialog and define your stand-alone configuration.<br>Press <b>[Apply]</b> or <b>[OK]</b> to transmit the stand-alone configuration to the selected scan controller.<br>Choose "Disable Stand-Alone mode" and press <b>[Apply]</b> or <b>[OK]</b> to leave <i>stand-alone mode</i> . The scan controller is enabled for operation via the RAYGUIDE user interface or the API application.  |
| <b>General</b>                                     |  |
| Name   | The name of the stand-alone configuration.   |
| I/O port   | Select the corresponding I/O port at which the bit information defining the job selection are expected. This technique is called "binning".<br>An input port may also have to be defined in the scan controller configuration. Use the <b>[+]</b> shortcut button to open the respective scan controller configuration dialog directly and add an I/O port. For details on scan controller I/O port definitions, refer to <i>page 45, Scan Controller Configuration, I/O tab</i> . |
| Wait for external start                            | Determine that the processing of the jobs can only start after a start signal was detected on the respective scan controller.<br><b>NOTE:</b> Without a wait condition, the jobs run in an infinite loop as soon as stand-alone mode was activated.  |

| Setting              | Explanation  |
|----------------------|--|
| Flow                 | <p>Choose <i>Sequential</i> if the jobs are to be executed as arranged in the list. Individual binning conditions are optional.</p> <p>Choose <i>Switch</i> if the jobs have individual binning conditions. The job sequence is then determined by the conditions. To set individual binning conditions, activate <i>Binning</i> in the Jobs section (see below) and set the available bit range to the specific signal pattern.</p> <p>The main difference between the sequential and switch options is:</p> <p>Sequential: More lists can be executed per loop.</p> <p>Switch: The list that matches the binning conditions is executed. Each binning condition must be unique (i.e. it occurs only once).</p> |
| <b>Jobs</b>          |  |
| List ID              | <p>ID of the job in the job list. IDs can be edited if required.</p> <p>The list ID number is allocated by RAYGUIDE.</p> <p>If you want to change the list ID number, note that only numbers above 100 are allowed.</p>  |
| Binning              | <p>Enable <i>Binning</i> to define the binning conditions per job.</p> <p>The top binning tab enables / disables the binning per job.</p> <p>If <i>Flow</i> is set to <i>Single job</i>, each job must have a binning condition, and the binning condition must be unique.</p> <p>If <i>Flow</i> is set to <i>Sequential</i>, each job can, but does not have to, have a binning condition.</p> <p>The binning condition can be set by toggling individual bits (0/1), or by entering the corresponding numerical value.</p> <p>Alternatively, you can import the binning conditions from a *.csv table.</p>   |
| Individual job icons | <ul style="list-style-type: none"> <li>■ Upload a single job.</li> <li>■ Press the arrow pointing up or down to change the order of the jobs in the list.</li> <li>■ Click <b>[Delete]</b> to immediately remove a single job entry from the stand-alone mode dialog.</li> </ul>   |

| Setting   | Explanation   |
|---|---|
| Timestamps  | <ul style="list-style-type: none"> <li>■ The lower entry shows the timestamp, when the job file was saved (shown as soon as the job is added to the dialog).</li> <li>■ The upper entry shows the timestamp when the job was uploaded to the scan controller (shown as soon as the job is added to the dialog).</li> <li>■ As soon as the save timestamp of the job file is more recent than the upload timestamp, it is highlighted in orange, indicating that a more recent version of the job file is available. Download the job file again to work with the latest version of the job file.<br/><b>NOTE:</b> This can only work if you always save the job to the same folder location.</li> </ul> |
| <br>Export CSV   | Create a csv table listing the jobs you have added for stand-alone mode: Job (including path and file name) / List ID / Binning checkbox / condition / Upload timestamp / Save timestamp / Last change timestamp.   |
| <br>Import CSV  | Import the job list in CSV format, mainly to load the data entered in the CSV table for binning.<br><br><b>NOTE:</b> It is recommended to generate the table using the export function before importing, to enter the values for the binning conditions, and only then to import. This ensures that the format will be correct.   |
| <b>[Add jobs...]</b>  | Open a browser window to select one or multiple jobs to be added to the stand-alone mode list.  |
| <b>[Upload all]</b>   | Transmit all listed jobs to the scan controller.  |
| <br><b>[Delete card's jobs]</b>  | Immediately clear all listed jobs of the actual stand-alone configuration from the dialog and also delete the job lists from corresponding scan controller after pressing <b>[Apply]</b> .  |
| <b>Error handling</b><br>In case a list execution aborts, a specific behaviour can be defined.<br>An error event can be caused by a laser or deflection unit error, by a scan controller exception, or by an intended stop signal from the scan controller that is received by the scan controller. |   |

| Setting   | Explanation   |
|---|---|
| Write on port   | Select a specific output port and define a bit pattern to be communicated.<br>The output port must be defined in advance in the scan controller configuration. See <i>page 45, Scan Controller Configuration</i> for details on scan controller I/O port definitions. |
| Mode & Timing   | Same options as for the write port object. See <i>page 213, Write Port</i> .  |
| Enable delay & Delay [ms]   | Define the delay time to wait before the next trigger is accepted after an error event.<br><b>NOTE:</b> The delay timer starts after the I/O port pulse, if this has been defined.  |
| Restart process   | After an error, the whole stand-alone mode returns to the initial wait condition.<br>This is important so that operation can continue after an abort without the need to reboot the scan controller.<br><b>NOTE:</b> This option is active by default.                |
| <b>Stand-Alone mode</b>   |   |
|  | Start the execution of stand-alone mode.<br>The status display changes from <i>Idle</i> to <i>In progress</i> .   |
|  | Stop the execution of stand-alone mode.<br>The status display changes from <i>In progress</i> to <i>Idle</i> .  |

Tab. 7.62: RG-061

**Flow recommendation for the job execution in stand-alone mode.**

To prepare a stand-alone execution, follow these steps in the Stand-alone mode dialog:

1. Select the scan controller.
2. Enable "Stand-Alone mode".
3. Add all job files to the dialog that you may want to execute during stand-alone mode (multiple selection of job files is possible).
4. Re-order the job sequence if necessary.
5. Upload all jobs.
6. Verify the time stamps to ensure that all jobs are up-to-date.
7. Define flow control, binning conditions, error handling.  
It is highly recommended to enable "**Wait for signal start**" and "**Restart process**".
8. Press **[Apply]** > Now the scan controller is ready to operate in stand-alone mode.  
**NOTE:** Indicated by an orange icon in front of the scan controller entry in the job overview. Also, the execution panel is blocked.  
This action will also save the complete stand-alone configuration under its entered name.
9. Press **[Run]** to initialise the execution on the scan controller, for example, for testing.

The execution status changes from *Idle* to *In progress*.

Alternatively, close the RAYGUIDE application. As soon as you reboot the scan controller, the stand-alone configuration is automatically activated.

To use an already existing stand-alone configuration, for example, to prepare another scan controller, proceed with the following workflow:

1. Select the scan controller.
2. Enable "Stand-Alone mode".
3. *Load* the stand-alone configuration.
4. Add / remove jobs or change the configuration, if desired.
5. Upload all jobs.
6. Press **[Apply]**.

### Editing the configuration while stand-alone mode is active

You can only edit the currently displayed stand-alone configuration while the Stand-alone mode is active and the execution has the *Idle* status: We therefore recommend **[stopping]** processing. To apply the changes, do not forget to press the **[Apply]** button.

If you edit a stand-alone configuration while the stand-alone mode has already been started (status = in progress) and you press **[Apply]** or **[OK]**, a dialog appears offering you three different options:

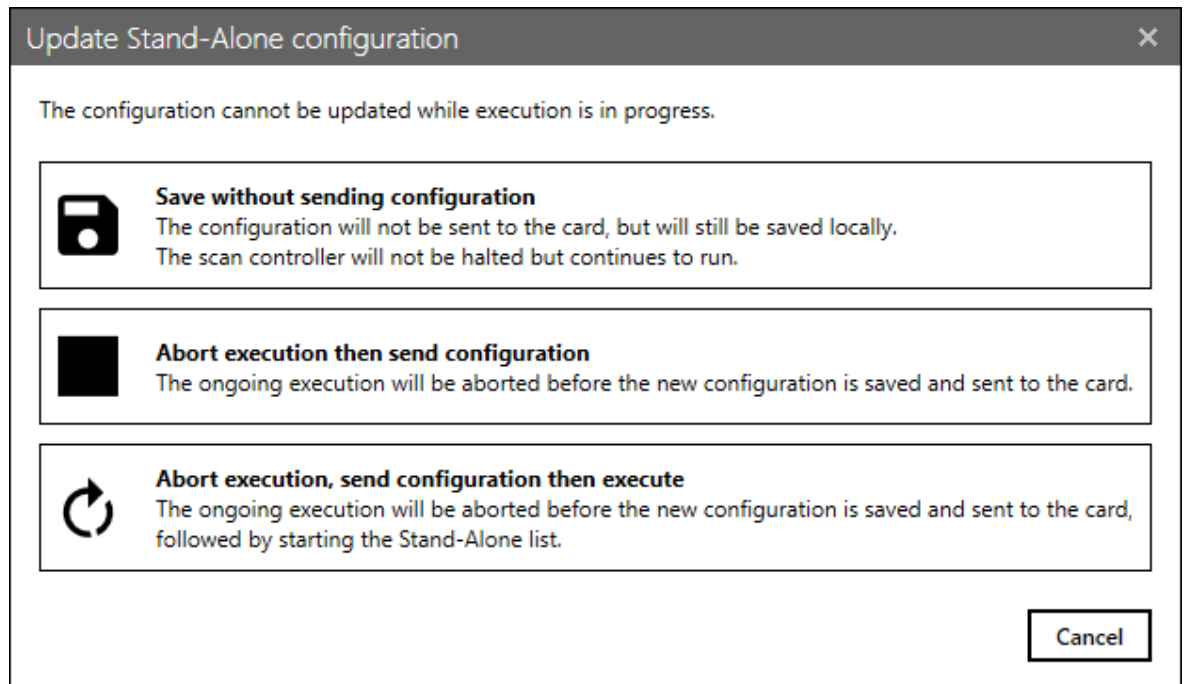


Fig. 7.86: RG-ADE

If you press **[Apply]** to confirm the stand-alone configuration, but there are jobs which are out-of-date or not even uploaded to the scan controller, the following dialog reminds you and prompts to upload these jobs before running the stand-alone configuration.

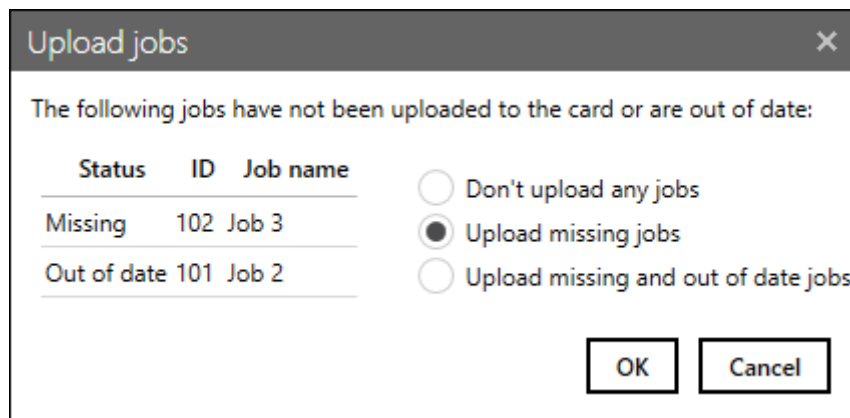


Fig. 7.87: RG-ADF

### Terminating stand-alone mode

A scan controller operating in stand-alone mode is inaccessible by any other application (indicated by the orange scan controller button in the job overview). Therefore, you must first deactivate stand-alone mode to release the scan controller for RAYGUIDE.

1. Open the stand-alone mode dialog.
2. Press the **[Stop]** button to abort the execution of the stand-alone "master list".
3. Enable "Stand-Alone mode".
4. Click **[Apply]** or **[OK]**.

Job execution is stopped even if the current job execution status was *In progress*, and the stand-alone mode is disabled in the same step.

Now the scan controller is "released" and can be operated again via the RAYGUIDE application (indicated in the job overview by the button of a green card).



## 7.8.6 Process Adjustment

Process adjustment allows global and timely adjustments of process parameters and / or a layout transformation, without the need to edit the job itself.

Process adjustment is available via a separate GUI panel. By default, the Process adjustment panel is located on the right side of the user interface, behind the Transformation tab.

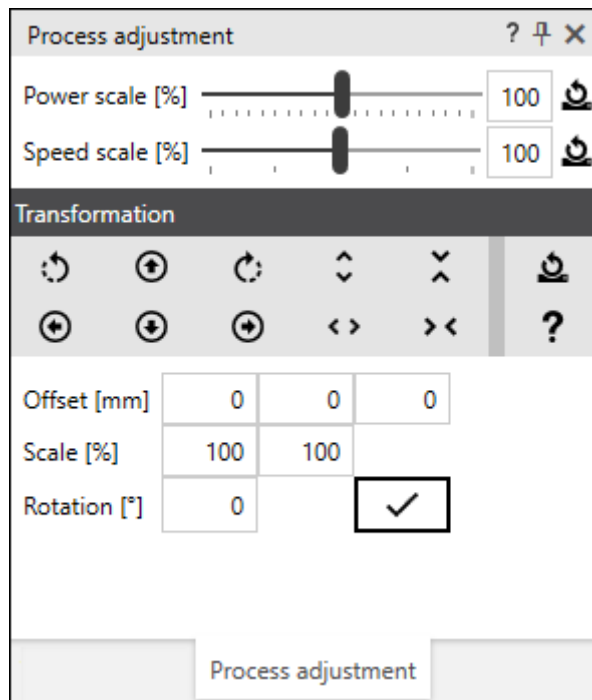


Fig. 7.88: RG-ACX

The process adjustment settings apply to the active job and its scan controller(s). If a job has several scan controllers integrated, an additional selection option appears in the user interface panel:

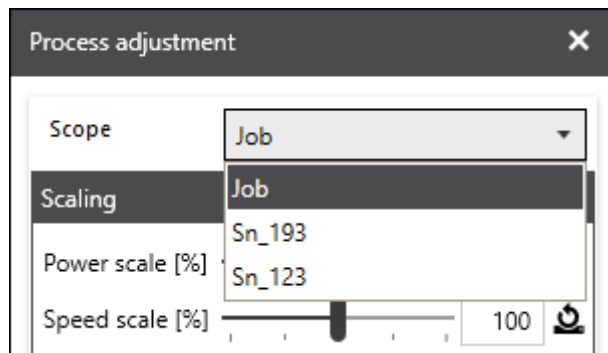


Fig. 7.89: AEW

Via *Scope* you define whether all scan controllers involved in the job get the parameters for the process adjustment or only one explicitly selected scan controller.

**NOTE:** If you select *Job*, the process transformation is automatically converted for the individual scan controllers according to the job preset used in the job and its scan field arrangement.







**CAUTION:** In this case, the boundary overlap should be non-zero in the job settings so that layouts are not cut exactly at the field edge and there is still room for a resulting offset.

**NOTES:**

- The process adjustment takes effect immediately (even for jobs that are in execution) and is only reset according to the specifications as described in *page 83, General*.
- The process adjustment is also effective if the job is executed in the *On scan controller* mode or in the stand-alone mode.

Process adjustment can be useful if the layout positioning, the laser power, or the process speed need to be corrected while the job is looping or between job iterations.

The following settings are available:

| Setting   | Explanation  |
|---|--|
| <b>Process adjustment</b>   |  |
| Value ranges can be limited, see below.   |  |
| Power scale [%]   | By default, you can decrease the laser power to 0% or increase it up to 200%.<br><b>NOTE:</b> The power scale is relative to laser power defined for the respective pen. Logically, the total laser power can never exceed 100%.   |
| Speed scale [%]   | By default, you can decrease the process speed to 0% or increase it up to 200%.<br><b>NOTE:</b> The speed scale is relative to mark / jump speed defined for the respective pen.   |
| <b>Transformation</b>   |  |
| The behaviour of the transformation buttons can be preset:                          |  |
|    | Rotate entire job layout: clockwise / anticlockwise.   |
|   | Move the entire job layout in axis direction: up / down / left / right.  |
|  | Enlarge (scale) the entire job layout in X- or Y-axis direction in [%].  |
|  | Shrink (scale) the entire job layout in X- or Y-axis direction in [%].   |
|  | Reset all transformations.   |
|  | Update all displayed process transformation values with the values currently stored on the control card.   |
| Input fields for the process transformation (Offset [mm], Scale [%], Rotation [°])  | The values can either result from the above buttons or you can enter the value directly.<br>If the value is entered directly, then press the <b>[Check]</b> button to apply the value(s).<br><b>NOTE:</b> Compared to the buttons, an offset in the z-direction can also be defined. |

Tab. 7.63: RG-062

### Related preset: Power and speed limits

It is possible to limit the range of the power value of the laser and speed adjustments in advance.

Select **System > Preferences** from the menu to open the Settings dialog. Go to the System (all users) tab and to the Process adjustment sub-tab.

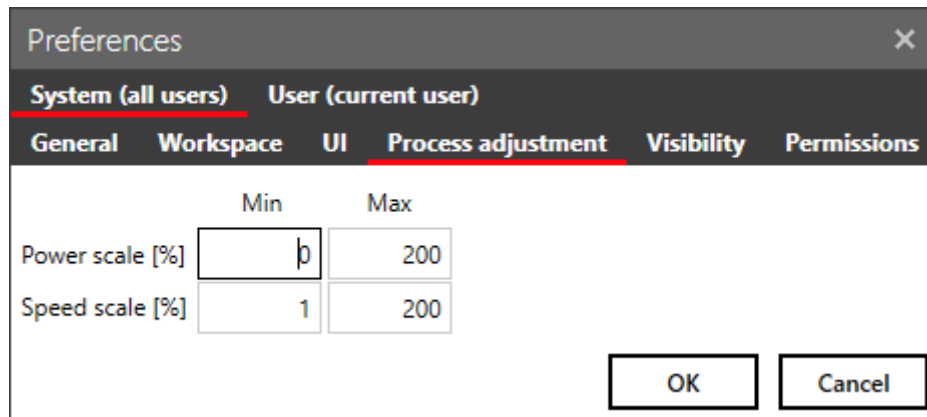


Fig. 7.90: RG-ACY

| Setting                 | Explanation  |
|-------------------------|--|
| Power scale [%] Min/Max | Restricts the range in which the adjustment of the laser power in [%] can be set.<br>Check the laser power settings for the used pens and the capacity of the laser source to define suitable limitations.   |
| Speed scale [%] Min/Max | Restricts the range in which the adjustment of the process speed in [%] can be set.<br>Check the mark / jump speed settings for the used pens and the threshold of the deflection unit to define suitable limitations.<br>Any settings shall take the laser capabilities into account. |

Tab. 7.64: RG-063

### Related preset: Transformation deltas

It is possible to define the delta of the respective transformation per button click as a preference.

Select **System > Preferences** from the menu to open the Settings dialog. Go to the Current user tab and to the Process adjustment sub-tab.

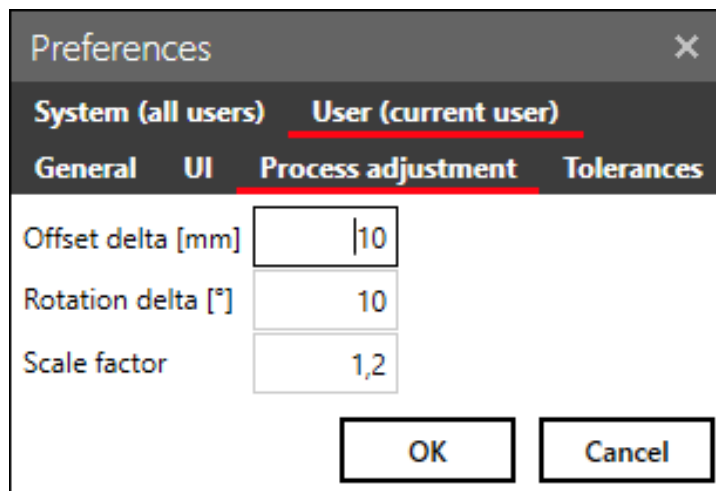


Fig. 7.91: RG-ACZ

| Setting            | Explanation   |
|--------------------|---|
| Offset delta [mm]  | Defines how many [mm] an object is offset when clicking a <b>[Move]</b> button on the Process adjustment panel.           |
| Rotation delta [°] | Defines how many degrees an object is rotated when clicking the <b>[Rotation]</b> button on the Process adjustment panel. |
| Scale factor       | Scale factor in [%] when clicking the <b>[Size]</b> buttons on the Process adjustment panel.                              |

Tab. 7.65: RG-064

### Reset options

**IMPORTANT:** There is no automatic reset of the values set here as they are stored in the scan controller! Make sure to reset the changes when they are no longer needed, for example when a new job starts.

It is possible to force a reset at each start of the software:

- Click **System > Preferences** in the menu to open the Settings dialog. Go to the System (all users) and to the General sub-tab, Initialisation section.
- Select event for the transformation and scaling settings when they will be automatically reset:
  - At software startup
  - At start of processing (execution)
  - Never

## 8 RAYLASE PLUG-INS

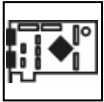
RAYLASE offers specially developed plug-ins for various purposes.

During the installation process of RAYGUIDE, you will also be offered a chance to install these plug-ins.

The associated library files are stored in the subfolder `\RAYGUIDE\Bin\PlugIns\`.

**NOTE:** All plug-ins are optional. In the installation routine, they must be selected to be installed and then available in the GUI.

### 8.1 SP-ICE-3 Log Import



Button

The SP-ICE-3 log object inserts all the graphic content of a SP-ICE-3 log file as a layout object. A log file can be created for each SP-ICE-3 scan controller. It contains all the communication to the scan controller, including all vectors contained in the jobs that were downloaded to the scan controller for laser processing.

Re-importing the graphic content in that way can be helpful to find the reason for unwanted process results (error analysis).

In order to have a log file, logging has to be enabled. See [page 334, Error Handling and Log Files](#) for more information on log files.

To create a log file that contains only data of the current job, it is recommended to reset the log file before executing the job. See [page 45, Setup](#).

To display the vector content of a log file in the viewport, click the button of the log importer on the object panel. The dialog with the log file import settings opens. Alternatively, you can drag the log file directly from the folder to the RAYGUIDE viewport or to the job tree. In this case, the default import settings are used.

Note that the log file content is displayed in the viewport as **one** graphic object, similar to a DXF or PLT file object, providing the same layout hierarchy.

### Essential settings

| Setting               | Description  |
|-----------------------|--|
| Path                  | Path and file name of the log file. Use the file selection button to load a file. The default path is <i>C:\ProgramData\RAYLASE\RAYGUIDE\Logs\</i> .   |
| Start path, Count     | If you want only a specific part of the layout to be imported, enter the number of the first desired path of the layout, and then the quantity of subsequent paths.  |
| Start time / End time | These fields can be used to limit the time span of the log file, which is displayed graphically after the import.<br>The entry is made in the same format as the entry in the log file. However, the year is left out:<br>MM-DD HH:MM:SS:FFF |
| Only executed lists   | This option allows you to limit the displayed content to only what the deflection unit really executed compared to all content that has been sent to the scan controller.  |
| Offset wait distance  | When loading a log file from a MOTF execution, this option is recommended to display the paths as they were placed in the original job layout. Even split paths appear stitched together.  |
| Center                | Check to place the layout centred in the workspace.  |
| Overwrite pens        | Will use the pen attribute of the log source. In case of SP-ICE-3 log, however, only the pen attribute dashed line is taken into account.  |

Tab. 8.1: RG-065

### Additional settings

- Common settings for all marking objects; refer to *page 153, Common Properties of Marking Objects*.
- For transformations; refer to *page 168, Object Transformation*.

## 8.2 weldMARK job importer plug-in

This paid plug-in allows loading of certain version 3.6 weldMARK jobs in RAYGUIDE. Please contact your RAYLASE sales representative if you would like to use this plug-in.

## 8.3 Solar wafer

The aim of this plug-in is to import and optimise vector graphics used specially for wafer processing.

Above all, it is possible to save process time by converting lines consisting of many individual short vector strokes into a single line with a stroke-pattern property.

### 8.3.1 Solar wafer importer



Button

#### Vector optimisation

This job element imports the vector graphic and replaces multiple vectors arranged in a dashed line fashion with a single dashed line. Only horizontal or vertical dashed lines are recognised. Any remaining vectors are appended after the dashed line vectors. The lines are processed bidirectionally.

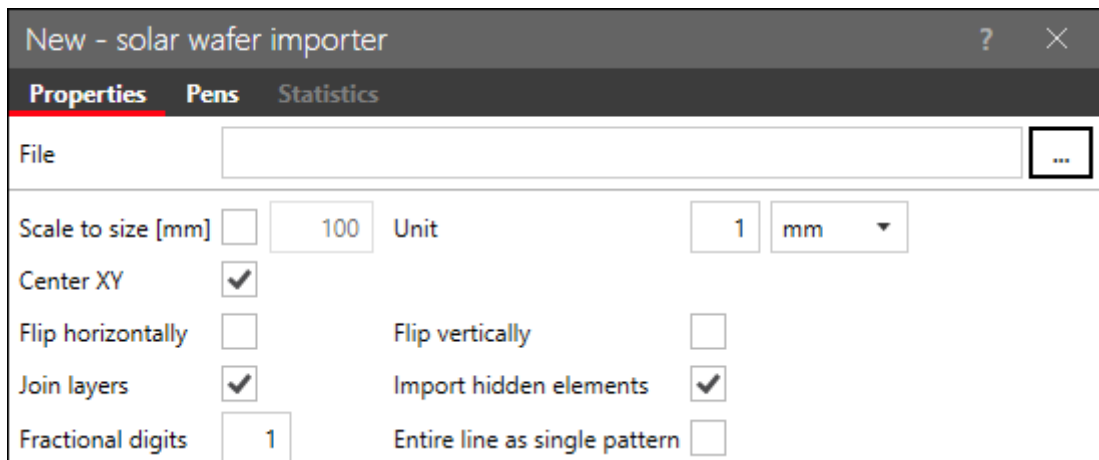


Fig. 8.1: AEZ

| Setting         | Explanation  |
|-----------------|--|
| File            | Opens a file browser to navigate to the graphic file you want to import.<br>After selecting the file, click <b>[Open]</b> in the browser and the preview displays the file content.<br>Supported file formats are: DXF, PLT, SVG, DWG, CGM, HPGL, GBR, CSV, TXT. |
| Scaling to size | Activate to scale the size of the imported graphic to the specified size in [mm].  |



| Setting                       | Explanation   |
|-------------------------------|---|
| Unit                          | <p>Defines the unit of the imported vectors. Select from [mm], [<math>\mu\text{m}</math>] and [inch].</p> <ul style="list-style-type: none"> <li>■ Value = 1: Normal case (without scaling).</li> <li>■ Value <math>\neq</math> 1: also applies a scaling factor.</li> </ul> <p><b>NOTE:</b> Can only be used when <i>Scaling to size</i> is not used.</p>  |
| Center xy                     | Incorporates the vector graphic centred on the XY axes of the workspace.  |
| Flip horizontally             | Flips the vector graphic horizontally during import.  |
| Flip vertically               | Flips the vector graphic vertically during import.  |
| Join layer                    | Merges multiple layers to one layer.  |
| Import hidden elements        | Some file formats (e.g. DXF files) can contain layers marked as hidden. These layers are ignored during import by default. Use this option if to import them anyway.  |
| Fractional digits             | <p>Defines the accuracy of checks as to whether individual vector strokes are in the same horizontal or vertical line or not.</p> <p>The fewer decimal places related to [<math>\mu\text{m}</math>] are considered, the more tolerant the algorithm is to positional inaccuracies of the vector coordinates.</p>  |
| Entire line as single pattern | <p>When active, a completely horizontal or vertical arrangement of lines is evaluated as a stroke-line pattern during import and therefore converted into a single straight line with a stroke-pattern property (in the pen).</p> <p>This means that patterns with strokes or gaps of unequal length can also be converted.</p> <p><b>NOTE:</b> Using this option may result in a larger required number of pens to illustrate all horizontal lines of the wafer.</p> |

Tab. 8.2: 092

**NOTE on pen use**

Pen 1 is used for solid lines and starting with pen 2, as many pens are created as dashed line patterns exist.

All marking parameters except for the dash line related ones are copied from the default pen (default 1) to the other pens. That is why only pen 1 should be modified when the process parameters for the wafer are adjusted. Please note that the values are applied automatically during execution, but are not visible in the pen dialogs.

Skywriting is not automatically activated, which is why it must be actively defined by the user in pen 1.

### 8.3.2

## Solar wafer designer



Button

This job element can be used to create the wafer array directly in RAYGUIDE. The major benefit compared to the import is that the design pattern can be defined directly by entering just a few parameters. This avoids the prior DXF generation and rounding issues during import and allows easy adaptation of design changes.

**CAUTION:** Please note that, for the solar wafer, the marking and jump speeds must be set to the same value in the assigned pen.

| New - solar wafer designer  |                          |                     |            |
|---|--------------------------|---------------------|------------|
| Properties  |                          |                     |            |
| Wafer   |                          |                     |            |
| Size [mm]   | 208,8                    | Total lines         | 175        |
| Bus bar pattern   |                          |                     |            |
| Size [mm]   | 3,100                    | 11,000              | Columns 12 |
| Margin [mm]   | 6,500                    | 12,000              | Rows 8     |
| Dashed line   |                          |                     |            |
| Pattern [mm]  | 0,8 0,2                  |                     | X          |
| Forward shift [mm]  | 0                        | Backward shift [mm] | 0          |
| Dash pattern must be defined in settings and cannot be shown or altered within pen. |                          |                     |            |
| Deflection unit settings  |                          |                     |            |
| Jerk limited control  | <input type="checkbox"/> | Max current [A]     | 5          |

Fig. 8.2: RG-ADP

| Setting                  | Explanation  |
|--------------------------|--|
| <b>Wafer</b>             |  |
| Size                     | Size of the wafer square in [mm].<br><b>IMPORTANT NOTE:</b> Do not perform any object transformations (e.g. like scaling) of the object after its creation, as this can lead to incorrect positioning of the dashes in the dashed lines.   |
| Total Lines              | Number of horizontal dashed lines evenly spread over the wafer size.   |
| <b>"Bus bar" pattern</b> |  |
| Size                     | X and Y dimensions of "the bus "bars in [mm].  |
| Margin                   | Distance between the bounding box of the "bus bar" pattern and the wafer contour in [mm].  |
| Columns / Rows           | Number of columns and rows of the "Bus bars".  |
| <b>Dashed line</b>       |  |
| Pattern                  | The dashed line pattern is defined by entering length values for laser on / off. Enter at least two numbers.<br>The first value defines a dash to start the pattern.<br>Separate values for dash / gap with blanks.<br><b>IMPORTANT NOTE:</b> You can edit the dashed pattern any time after creating the object. However, it must be edited in the Object settings dialog and not in the associated pen settings. |
| Forward shift            | Distance in [mm].<br>Shifts the dashed pattern for all lines that are marked from left to right.   |
| Backward shift           | Distance in [mm].<br>Shifts the dashed pattern for all lines that are marked from right to left.   |

| Setting                         | Explanation  |
|---------------------------------|--|
| <b>Deflection unit settings</b> |  |
| Jerk limited control            | <p>The jerk-limited control enables optimal acceleration and takes into account a maximum jerk value, leading to smooth command signals.</p> <p>In particular, this improves the behaviour at the reversal points between the lines while reducing the load on the galvanometer scanner. The reduced jerk in the command improves the accuracy in the process. (When the jerk-limited control is used, a reduced tracking error is activated for the deflection unit to ensure that there are only advantages compared to the standard operation.)</p> <p><b>NOTE:</b> When the jerk-limited control is used, the (red) bounding box around the acceleration paths is enlarged, even if they themselves are not displayed graphically.</p> |
| Max. current [A]                | <p>Input of the maximum permissible current for the galvanometer scanners, between 3 A and 9 A. In this optimisation, the specification of the current value sets the focus between the increase in accuracy and the increase in dynamics.</p> <p><b>RULE:</b> The lower the current value, the higher the accuracy, with extension of the acceleration time. The inverse applies for a high current.</p>  |

Tab. 8.3: RG-071

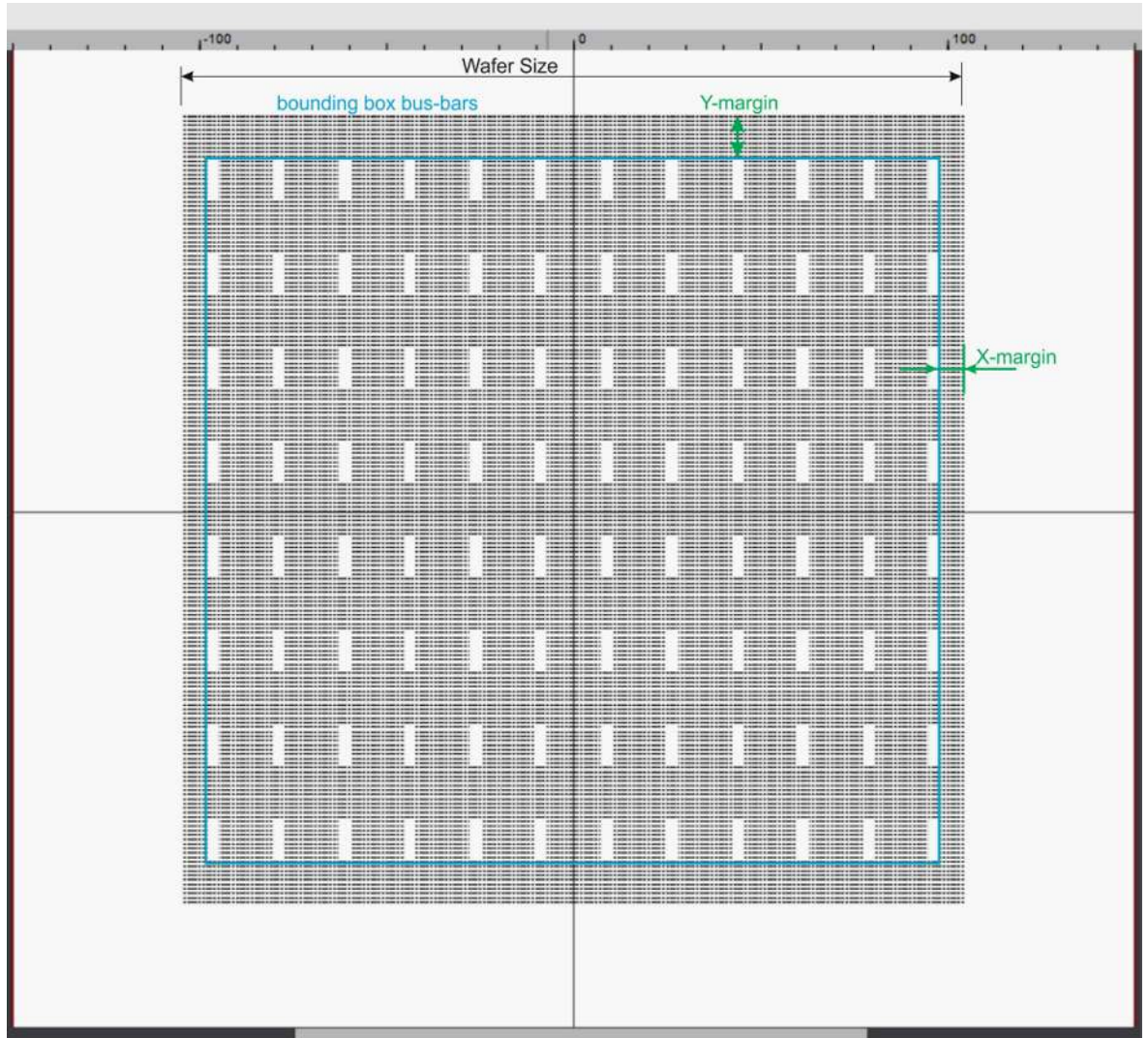


Fig. 8.3: RG-ADQ

## 8.4 Remote Interface

### 8.4.1 General

The remote interface is an interface for remote control of the RAYGUIDE user interface based on API events. It makes it possible to define a TCP/IP socket through which command lines can be received to open/modify/execute a RAYGUIDE job e.g. from a PLC.

If required, the range of functions can be extended by the user via the RAYGUIDE API. In this case, it must be compiled and updated by the user. Instructions on how to do this can be found in the RAYGUIDE SDK manual chapter 3.5.

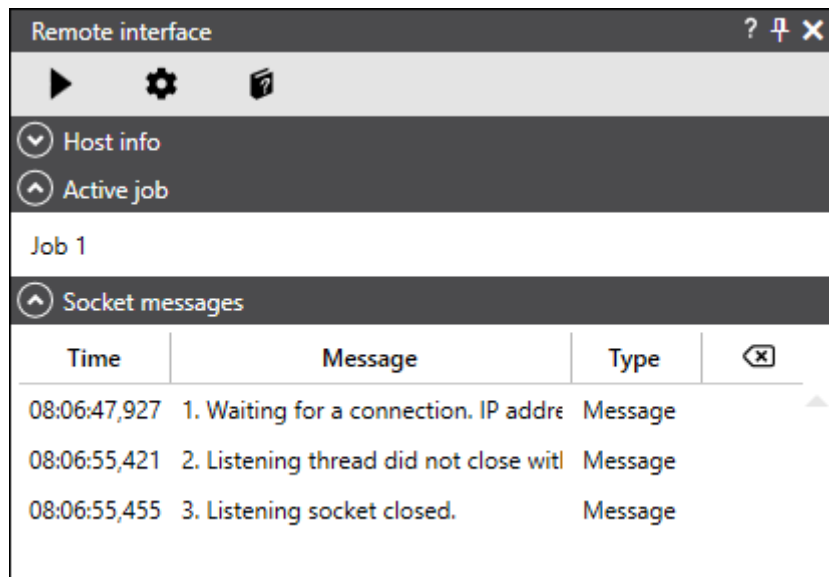



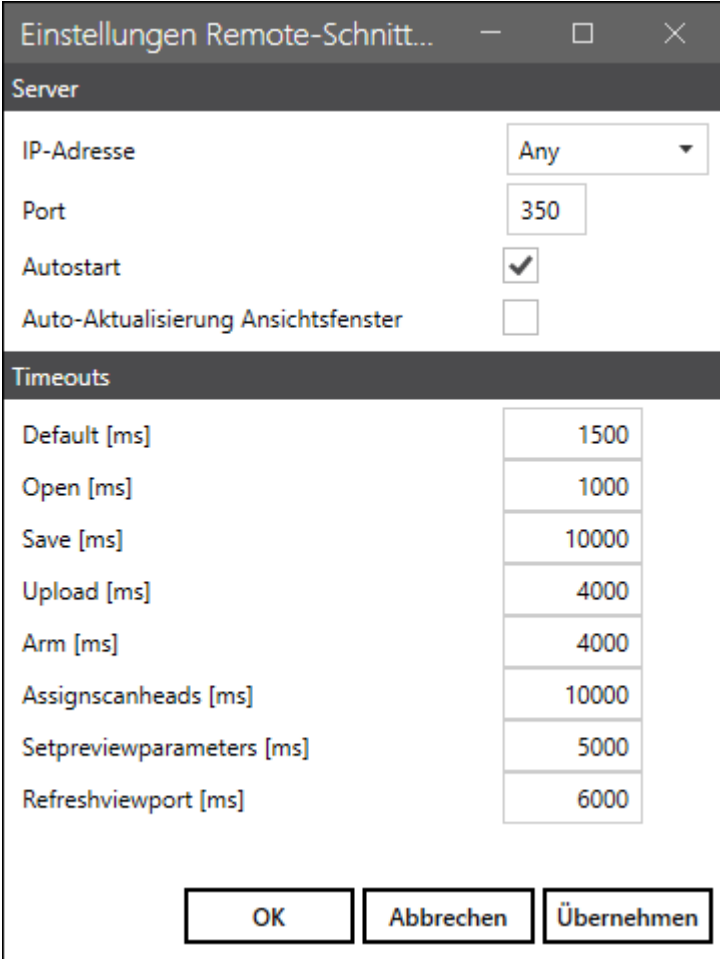


Fig. 8.4: AEB

**NOTE:** All areas can be expanded and collapsed via the expander button.

| Setting   | Explanation   |
|---|---|
|  /  | Button for manually starting the remote server <ul style="list-style-type: none"> <li>■ (is then ready to respond to remote commands)</li> <li>■ or stopping it.</li> </ul> |
|    | Button for opening the remote interface settings:   |

| Setting | Explanation   |
|---------|---|
|         |  |

#### ■ **Server**

##### – *IP address:*

The IP address on which the socket server receives commands is set to "Any" by default. A specific IP address does not need to be defined here. If you wish to specify a discrete IP address, all relevant IP addresses are available to you for selection.


##### – *Auto start:*

If this option is set, when the RAYGUIDE application is restarted, the remote server is also always started immediately so that there is an immediate reaction to the commands from the remote client.

##### – *Auto update viewport:*

If this setting is activated, the entire view area is re-rendered each time a marking object is changed. Depending on the scope of the job, this can take a lot of time.

If this function is deactivated, you can use the "refreshViewport" command to re-render all changes once.

| Setting   | Explanation   |
|---|---|
| <p>■ <b>Timeouts</b></p> <p>List of all times that, depending on the command, produce a timeout error message when the time is exceeded.</p>  |   |
|    | <p>Button to open a list of all available commands</p> <p><b>NOTE:</b> Each command is terminated with "eol" (end of line).</p> |
| <p><b>Host information</b></p> <p>List of all network adapters in the UP status and all associated IP addresses of the host PC.</p>   |   |
| <p><b>Active job</b></p> <p>Shows the job name of the currently active job.</p>   |   |
| <p><b>Socket messages</b></p> <p>Lists all incoming commands either as confirmed or with an error message.</p> <p><b>*NOTE:</b> The labels are case-sensitive.</p> <p><b>**NOTE:</b> These commands have a specific timeout value. It can, if necessary, be adapted in the RemoteInterface.json file. For all other commands, the timeout is set to 500 ms.</p> |   |

Tab. 8.4: RG-080

**TIP:** To test the remote connection commands, a client tool (RemoteClient.exe) is also provided, which can be found in the folder `\RAYGUIDE\tools`.

**NOTES** on the sequence: First enter the appropriate IP address on the server side (RAYGUIDE GUI). Click on "Start Listening" to prepare the server to begin receiving commands. Then establish the connection on the client side using the "connect" command. The connection is now ready for using the commands described above.

**NOTE:** If the client application was closed while the server was still "listening", "listening" needs to be ended on the server side when the client application is to be restarted and started again before a connection can be re-established there using the "Connect" command.



## 8.4.2 List of available commands

| List of available commands   |  |
|--|--|
| abort, eol   | Command for aborting an active job execution.  |
| Arm, eol **  | Command for arming the laser.  |
| assignScanHeads;<br><scanControllerShortLabel>,<br><scanHead1ShortLabel>,<br><scanHead2ShortLabel>,<br>eol */ ** | Command for assigning the deflection unit to the control card.<br><b>NOTE:</b> By means of assigning the deflection unit to the scan controller, a deflection unit can be specifically selected, however with different correction files and different calibrations. |
| blockGui, eol  | Command to lock the RAYGUIDE GUI so that no operations can take place simultaneously via the GUI during remote control.  |
| close, eol **  | Command for closing an active job.<br><b>NOTE:</b> The closing command automatically implies that the job will first be saved in order to prevent changes from being lost.   |
| closeAll, eol **   | Command to close all currently open jobs at the same time.<br><b>NOTE:</b> The closing command automatically implies that all open jobs will first be saved in order to prevent changes from being lost.   |
| disablePointer, eol  | Deactivates the pointer.   |
| disableEvent, <eventName>,<br>eol  | Command to deactivate the event feedback activated by enableEvent.   |
| disarm, eol  | Command for disarming the laser.   |
| enablePointer, eol   | Activates the pointer.   |

| List of available commands         |   |
|------------------------------------|---|
| enableEvent, <eventName>, eol      | <p>Command to respond to events in the form of messages to the remote client.</p> <p>Available events (names):</p> <ul style="list-style-type: none"> <li>■ <b>BarcodeContentEvent</b><br/>Message contains the content of the first barcode object of the job; sent at the start of job execution:<br/>EVT,BarcodeContentEvent,&lt;jobname&gt;,&lt;data&gt;</li> <li>■ <b>ExecutionErrorEvent</b><br/>Message about a failed execution; sent immediately upon error event:<br/>EVT,ExecutionErrorEvent,&lt;jobname&gt;,&lt;type&gt;<br/>Possible error types are: Aborted, Executor, Laser, OutOfField, ScanController, ScanHead</li> <li>■ <b>JobFinishedEvent</b><br/>Message is sent as soon as the execution is finished:<br/>EVT,JobFinishedEvent,&lt;jobname&gt;,&lt;scancontroller (for OnCard otherwise empty)&gt;</li> <li>■ <b>JobStartedEvent</b><br/>Message is sent as soon as the execution is finished:<br/>EVT,JobStartedEvent,&lt;jobname&gt;,&lt;scancontroller (for OnCard otherwise empty)&gt;</li> <li>■ <b>JobValidationEvent</b><br/>Message is sent as soon as job validation fails, e.g. because geometries are not in the processing field:<br/>EVT,JobValidation,&lt;jobname&gt;,&lt;Validation type&gt;</li> </ul> |
| upload, eol **                     | Command for uploading the active job onto the control card.   |
| executor, <type>, eol              | Command for selecting the execution type: host (On PC) / quick (test run) / scan controller (on scan controller)  |
| executorMode, <executionMode>, eol | Command to select the execution mode: all (all jobs) / active (active job)  |
| getExecutionstatistic, eol         | <p>Command to read out the execution statistics according to the Process monitor panel</p> <p>An example of a response:</p> <pre>{ "job": "Job 1", "scancontroller": "SN_693", "singlecontroller": true, "expected": 157.2796, "actual": 11979.0, "finished": false, "aborted": true, "cycle": 1, "starts": 1, "passes": "96" }</pre>   |

| List of available commands  |   |
|---|---|
| getJobElements, eol   | Generates a character string with a list of short labels of all job elements of the active job. The character string is generated in the JSON format. For more details, see the API Handbook, class RequestJobElementsEvent.  |
| getJobPens, eol   | Generates a character string with a list of all data of all pens used in the active job. The character string is generated in the JSON format. For more details, see the API Handbook, class RequestJobPensEvent.   |
| getPenNumbers, <jobElementLabel>, eol *   | Generates a character string with a list of the pen numbers of all pens that are used in the job element with the transferred short label. The short label is case-sensitive. The character string is generated in the JSON format. For more details, see the API Handbook, class RequestPenNumbersEvent.                                   |
| getPens, <jobElementLabel>, eol *   | Generates a character string with a list of all data of all pens that are used in the job element with the transferred short label. The short label is case-sensitive. The character string is generated in the JSON format. For more details, see the API Handbook, class RequestPensEvent.  |
| modifyJobVariable, <variableName>, <newValue>, eol *  | Command for changing the content of a job variable that is already defined. See also <i>page 267, Job variables</i> .   |
| modifyText, <jobElementLabel>, <nexttext>, eol *  | Command for changing the content of a text or code element.<br><job element label> corresponds to the name of the job element in the tree directory.<br><next text> Definition of the new text content.   |
| modifyTransformation, <job element label>, <rotation>, <scaleX>, <scaleY>, <scaleZ>, <offsetX>, <offsetY>, <offsetZ>, <mode>, eol * | Command with which individual layout objects can be transformed.<br><b>NOTE:</b> The rotation must be specified in [rad], the scaling in [absolute factor] and the offset in [ $\mu\text{m}$ ].<br><b>NOTE:</b> The transformation mode can be optionally be transferred with the <i>mode</i> variables:<br>abs (absolute) / rel (relative) |
| open, <path>, eol **  | Command to open a job in a certain folder.  |
| renderAsBitmap, <Path>, <imageSize>, eol  | Command to save the workspace of the current job locally as an image. The following parameters must be specified: <ul style="list-style-type: none"> <li>■ Storage location (path) with file name and file format</li> <li>■ Image size in number of pixels (referring to the longer side)</li> </ul>                                       |
| run, eol  | Command for starting the job execution task.<br><b>NOTE:</b> Returns ACK as soon as the job execution has actually started.   |

| List of available commands   |   |
|--|---|
| refreshViewport  | <p>Command for re-rendering all job elements displayed in the viewport. Changes to position or text content become visible.</p> <p>Only useful if automatic rendering has been deactivated.</p>   |
| resetIncrement,<br><jobelementname>, eol   | <p>Command to reset the increment counter of a text or code object.</p> <p>The command can also transfer a list of job elements in order to handle several elements at one time.</p>  |
| Save, <path>, eol *  | <p>Command to save the job after a change (e.g. new text content or object transformation), as otherwise a prompt will appear when the job is closed.</p> <p>&lt;path&gt; defines the file path for the storage procedure.</p>  |
| setActiveJob, <job label>, eol   | <p>Command to define the current job or to change it. If you loaded multiple job one after the other, the job loaded last is the active job.</p>  |
| SetParameter,<br><ParameterName>, <Value>,<br>eol  | <p>This command can be used to set remote interface settings (e.g. auto-refresh of the active / inactive viewport ).</p> <p>All timeout parameters can also be adjusted.</p>  |
| setPen, <PenNumber>,<br><Property1>,<br><Property1Value>,<br><Property2>,<br><Property2Value>, eol | <p>Command to change pen parameters.</p> <p>With <i>Property1</i> to <i>PropertyN</i> the pen parameter to be changed is specified. The following parameters are available for selection:</p> <ul style="list-style-type: none"> <li>■ BeamProfileID</li> <li>■ JumpDelay [<math>\mu</math>s]</li> <li>■ JumpSpeed [m/s]</li> <li>■ LaserFrequency [kHz]</li> <li>■ LaserPower [%/100] e.g. 50% &gt; 0.5 regardless of the GUI unit</li> <li>■ LmWidth [<math>\mu</math>s]</li> <li>■ MarkDelay [<math>\mu</math>s]</li> <li>■ MarkSpeed [m/s]</li> <li>■ SecondaryPower [%/100]</li> </ul> <p>With <i>Property1Value</i> to <i>PropertyNValue</i> the values belonging to the respective parameter are transferred. The values must be in the units noted above.</p> |

| List of available commands   |  |
|--|--|
| setLaseronProperties, <job<br>lement>, <mode>, <value>   | <p>Command to define the parameters of drills:</p> <ul style="list-style-type: none"> <li>■ You can use the mode variable to define whether to specify a number of pulses (pulse) or a dwell time (time).</li> <li>■ Value: integer value</li> </ul>   |
| SetPreviewParameters<br><previewAll>,<br><previewMode>,<br><previewSpeed>, eol                                   | <p>Command to make the various settings for a preview.</p> <p>PreviewAll = True: All objects are shown in the preview.<br/>PreviewAll = False: Only selected objects are shown in the preview.</p> <p>PreviewMode = Mode Index 0 to 4<br/>0 = All; 1 = Inset; 2 = Rectangle; 3 = Envelope; 4 = Point</p> <p>Unit for the variable previewSpeed = [m/s] Permissible value range = 0.05 m/s to 10 m/s</p>  |
| SetScanheadBias, <Scanhead<br>name>,<br><axis index>,<br><axis offset>,<br>[<calibration file index>,<br><mode>] | <p>Command to primarily provide the optical axes for laser focus, zoom, sensor, RDM with an offset.</p> <p><b>CAUTION:</b> This offset is managed by the control card and is not automatically reset.</p> <p>Observe the notes on offsetting on the <i>page 71, Deflection Unit Calibration</i>.</p> <ul style="list-style-type: none"> <li>■ Scanhead name: Abbreviation of deflection unit</li> <li>■ Axis index: 2 = z , 3 = zoom, 4 = sensor, 5 = AUX</li> <li>■ Axis offset: Offset in [µm]</li> <li>■ Optional: <ul style="list-style-type: none"> <li>– Calibration file index (0 ... 3, 0 = standard)</li> <li>– Mode: laser / pointer (laser = standard)</li> </ul> </li> </ul> |

| List of available commands   |   |
|--|---|
| setTransformation, jobelement,<br><job element name1>,<br><Property1>,<br><Property1Value>,<br><Property2>,<br><Property2Value>, jobelement,<br><job element name2>,<br><Property1>,<br><Property1Value>,<br><Property2>,<br><Property2Value>, eol | <p>Command for transforming <b>several objects</b> with a single command.</p> <p>With <i>job element name1</i> to <i>job element nameN</i> the job elements that are to be transformed are named.</p> <p>With <i>Property1</i> to <i>PropertyN</i> the transformation parameters to be changed per object are specified. The following parameters are available for selection:</p> <ul style="list-style-type: none"> <li>■ rotation [rad]</li> <li>■ scaleX [factor]</li> <li>■ scaleY [factor]</li> <li>■ scaleZ [factor]</li> <li>■ offsetX [<math>\mu\text{m}</math>]</li> <li>■ offsetY [<math>\mu\text{m}</math>]</li> <li>■ offsetZ [<math>\mu\text{m}</math>]</li> <li>■ mode               <ul style="list-style-type: none"> <li>– Possible values: abs (absolute) / rel (relative)</li> <li>– Standard, is absolute if not specified</li> </ul> </li> </ul> <p>With <i>Property1Value</i> to <i>PropertyNValue</i> the values belonging to the respective transformation parameter are transferred. The values must be in the units noted above.</p> <p><b>EXAMPLE:</b> settransformation,jobelement,Rectangle,scalex,1.5,mode,rel,jobelement,Circle,offsetx,3000,mode,rel</p> |
| StartPreview, eol  | Starts the preview with the pointer (for details on the preview, see <i>page 282, Running a Preview</i> ).  |
| StopPreview, eol   | Ends the preview with the pointer.  |
| transform, <rotation>,<br><scaleX>, <scaleY>, scaleZ>,<br><offsetX> <offsetY>,<br><offsetZ>, <scope>, <mode>,<br>eol   | <p>Command for setting the process transformation.</p> <p><b>NOTE:</b> The rotation must be specified in [rad], the scaling in [absolute factor] and the offset in [<math>\mu\text{m}</math>].</p> <p><b>NOTES:</b></p> <ul style="list-style-type: none"> <li>■ The scope of the process transformation can be optionally be transferred with the <i>scope</i> variables: (Only makes sense for jobs that use a multifield):<br/>             Job (for the job as a whole) / CardLabel (short name of the control card)</li> <li>■ The transformation mode can be optionally be transferred with the <i>mode</i> variables:<br/>             abs (absolute) / rel (relative)</li> </ul> <p>Details on process transformation, see <i>page 305, Process Adjustment</i>.</p>   |

| List of available commands            |   |
|---------------------------------------|---|
| unblockGui, eol                       | <p>Command to unlock the GUI.</p> <p><b>NOTE:</b> This command should always be used at the end of a program run.</p>   |
| wait, <eventName>, <timeoutTime>, eol | <p>Command to define a waiting time in [ms] an event can take.</p> <p>These events can be:</p> <ul style="list-style-type: none"> <li>■ JobFinishEvent; (= job is finished)</li> <li>■ WorkspaceRefreshEvent (= the display of the job in the GUI is completed after e.g. job changes)</li> </ul> <p><b>NOTE:</b> NOTES: The command returns an ACK when the event is received. If the event is not received in the specified time, a "Wait_Error" is returned.</p> |

Tab. 8.5: RG-097

### 8.4.3 Overview of feedback

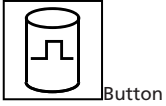
| Return messages                              |
|--|
| ACK  |
| EVT  |
| DISCONNECTED                                 |
| ABORT_ERROR                                  |
| ARM_LASER_ERROR                              |
| ASSIGNING_SCANHEADS_ERROR                    |
| BLOCK_GUI_ERROR                              |
| CLOSE_JOB_ERROR                              |
| CLOSE_JOBS_ERROR                             |
| DISABLE_POINTER_ERROR                        |
| DISARM_LASER_ERROR                           |
| ENABLE_POINTER_ERROR                         |
| FILE_NOT_EXISTS_ERROR                        |
| FILE_OPEN_ERROR                              |
| INVALID_FILEPATH_ERROR                       |
| MODIFY_TRANSFORMATION_ERROR                  |
| MODIFY_TRANSFORMATION_ERROR_NO_ELEMENT_FOUND |
| OBSOLETE_COMMAND                             |
| PARAMETER_COUNT_ERROR                        |
| PARSE_ERROR                                  |
| RENDER_AS_BITMAP_ERROR                       |
| RUN_ERROR                                    |
| SAVE_ACTIVE_JOB_ERROR                        |



| Return messages                            |
|--|
| SET_ACTIVE_JOB_ERROR                       |
| SET_EXECUTOR_TYPE_ERROR                    |
| SET_PREVIEW_PARAMETERS_ERROR               |
| SET_PROCESS_TRANSFORMATION_ERROR           |
| SET_TEXT_ERROR                             |
| START_PREVIEW_ERROR                        |
| STOP_PREVIEW_ERROR                         |
| UNBLOCK_GUI_ERROR                          |
| UNKNOWN_COMMAND_ERROR                      |
| UPLOAD_JOB_ERROR                           |
| WAIT_ERROR                                 |
| SET_EXECUTOR_MODE_ERROR                    |
| SETPENSEVENT_ERROR                         |
| SETPENSEVENT_JOBELEMENT_NOT_FOUND_ERROR    |
| SETPENSEVENT_NO_DATA_ERROR                 |
| SETPENSEVENT_WRONG_PEN_ERROR               |
| EXECUTION_STATISTIC_NO_DATA_ERROR          |
| GET_TRANSFORMATION_ERROR                   |
| GET_TRANSFORMATION_ERROR_NO_JOB            |
| GET_TRANSFORMATION_ERROR_NO_ELEMENT_FOUND  |
| SET_TRANSFORMATION_ERROR                   |
| SET_TRANSFORMATION_ERROR_INVALID_DATA      |
| SET_TRANSFORMATION_ELEMENT_NOT_FOUND_ERROR |

Tab. 8.6: RG-096

## 8.5 Electrode tab designer



Button

This plug-in makes a special job element available. The job element can be used to create a geometry for cutting electrode tabs from battery foils. Especially when the size or spacing of the tabs changes incrementally. In addition, the height can be defined where the geometry is split between two pens, which is cut partly on bare foil material and partly on coated foil material.

The panel allows the following parameters to be entered in order to design the geometry accordingly.

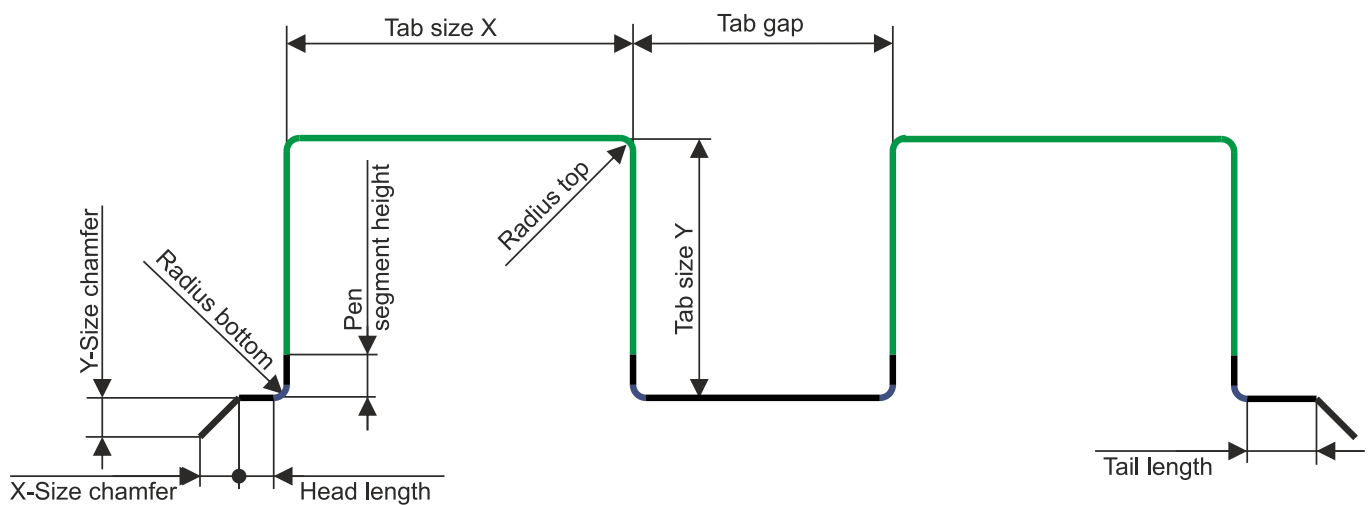


Fig. 8.5: AEY

| Setting                | Explanation  |
|------------------------|--|
| Tab size               | Dimension of the tab in width (X) and height (Y) in [mm].                                    |
| Tab sizes, incremental | Value in [mm] by which the size changes with each additional tab in width (X) or height (Y). |
| Tab gap                | Distance between two tabs in [mm].   |
| Tab gaps, incremental  | Value in [mm] by which the gap between two tabs increases with each additional tab.          |
| Radius, top            | Indication of the radius of curvature in [mm] at the upper edge of the tab.                  |
| Radius, bottom         | Indication of the rounding radius in [mm] at the transition from tab to connecting line.     |
| Start length           | Length of the connecting line in [mm] before the first tab.                                  |
| End length             | Length of the connecting line in [mm] after the last tab.                                    |
| Number of tabs         | Specification of how many tabs are drawn.  |
| Pen segment height     | Specification from which height in [mm] the geometry is divided between two pens.            |

| <b>Setting</b>    | <b>Explanation</b>   |
|-------------------|--|
| Cutting direction | Select how the geometry is to be cut: <ul style="list-style-type: none"><li>■ <i>From left to right</i> or</li><li>■ <i>From right to left</i>.</li></ul>  |
| Chamfer [mm]      | Specification of the X-and Y-dimensions of an angular chamfer.<br><b>NOTES:</b> <ul style="list-style-type: none"><li>■ A downward sloping chamfer requires a negative value for the Y-dimension.</li><li>■ The X-dimension of the chamfer is added to the start and end length.</li><li>■ Only one chamfer is created at the start and end of all tabs.</li></ul> |

Tab. 8.7: RG-090

## 9 CUSTOMER PLUG-INS

The RAYGUIDE software and its UI can be extended by plug-ins defined by the customer.

There are two types of custom plug-ins:

- API plug-ins: Allows you to add custom developed / programmed job elements or devices to the RAYGUIDE application.
- Embed the control elements for actuating external / third-party components into the "Custom UI panel".

### API plug-ins

Examples:

- Job elements: Use the RAYGUIDE API to create the job elements you want, such as graphics, containers, and automation objects.
- Devices: You can implement another device – such as a laser, a deflection unit, an I/O controller, or even a scan controller – to configure and use it through the RAYGUIDE user interface.

### Custom user interface panel

The custom user interface panel is activated from the menu: **View > Panels > Custom UI**. This user interface panel is empty by default.

Any external control element based on WPF (Windows Presentation Foundation) can be embedded.

Examples of custom user interface panel usage:

- Viewing a camera stream of the actual marking process.
- Controlling the movement of a conveyor belt

The RAYGUIDE software development kit (SDK) provides sample codes and the RAYGUIDE SDK manual contains a detailed description on how to apply a customer plug-in.

## 10 EMBEDDING THE RAYGUIDE UI

This feature allows you to embed either the complete user interface or selected user interface elements, for example, the panels, into your machine HMI.

This saves you from having to program your own controls to access the RAYGUIDE functionality (as opposed to working with customer plug-ins).

**NOTE:** Dialogs cannot be embedded without calling their event.

How to embed the user interface with the Microsoft WPF tool is described in detail in the RAYGUIDE SDK manual.

# 11 ERROR HANDLING AND LOG FILES

## 11.1 Error Messages

RAYGUIDE can generate error messages. These messages are displayed in window spanning bars in the RAYGUIDE user interface. They have to be acknowledged before continuing.

An error message contains an expandable stack trace with detailed information. The entire text can be copied and pasted, for example, into an email message to support@raylase.de.

Other error messages are generated by the scan controller and sent to the RAYGUIDE user interface.

For example, an "Out of Field" exception is generated when the conveyor moves the target material too fast in the MOTF process.

### Contact support

Each RAYGUIDE exception window also provides a shortcut to send an email to support. All required log files (including the batch error message), the system configuration and the currently opened RAYGUIDE job file are automatically attached to this email. If you do not want the current job to be transferred, please delete the corresponding email attachment.

By default, the mail recipient is empty. You can define a default recipient by editing the corresponding entry in the branding.json file. You can find this file in the folder:

*C:\Programdata\RAYLASE\RAYGUIDE\Configuration*

## 11.2 Log Files

There are three types of log files. The log files are saved under the following default path:  
**C:\ProgramData\RAYLASE\RAYGUIDE\Logs.**

| Log file                  | Explanation  |
|---------------------------|--|
| RAYGUIDE.log              | Contains information about the environment (hardware, licences, plug-ins, authorisations) and the program procedure (job, exceptions)  |
| RAYGUIDENotifications.log | All notifications are recorded here (status information, measurement results).   |
| SP-ICE-3.log              | <p>All commands transferred to the control card are recorded here (vector positions, process parameters).</p> <p>The log file can be read back into the application with the "SP-ICE-3 Log Importer" plug-in and the content displayed with respect to the vectors, see <i>page 310, SP-ICE-3 Log Import</i>.</p> <p>If more than one scan controller is applied, each has its own log file. The name of the log file of each card is the same as the respective control card label.</p> <p><b>NOTE:</b> If several control cards are used, it is recommended to use a label that makes it easier for you to assign them in the system (e.g. serial number).</p> |

Tab. 11.1: 097

It is recommended to have logging enabled.

1. Open the configuration of the control card via **System > Devices > Scan controller**.
2. Tick the box next to Generate log file.

With the **[Reset]** button, the file can be reset to empty.

The path to the log files can also be seen (default location or other) and opened here. Log files can be read in a text editor.

### NOTES:

- The log files are always created new when the software is started or when the maximum size of 10 MB is reached. The 10 latest files are kept as ZIP files in an archive sub-folder.
- The log files of a multi-point calibration are included in the RAYGUIDE log file.
- In case of an error, the log files can also be sent to RAYLASE support. Always include the software version in your bug reports (can be accessed via **Help > About**).

## 11.3 Notification Panel

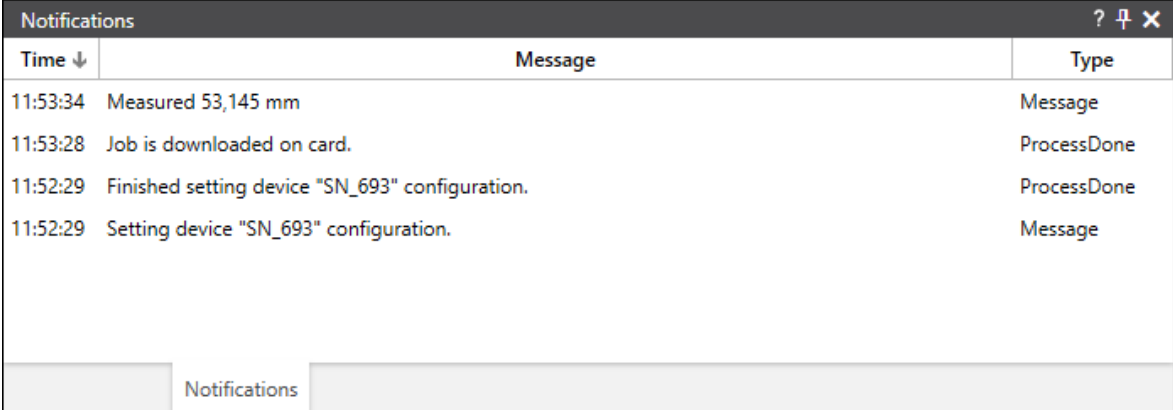
In the list displayed on the Notification user interface panel, RAYGUIDE tracks status information that can also be useful for debugging, such as when a control card has failed to connect. In general, all SP-ICE-3 error messages are listed here.

This list will also trace all measured values generated with the measurement tool.

To delete the display in the user interface panel, click the right mouse button. The context menu then offers you the function to copy and delete.

It is recommended to sort the list by descending date to always have the latest notification at the top.

The notification history is recorded in a separate log file, see *page 335, Log Files*.



| Time ↓   | Message   | Type        |
|----------|---|-------------|
| 11:53:34 | Measured 53,145 mm                              | Message     |
| 11:53:28 | Job is downloaded on card.                      | ProcessDone |
| 11:52:29 | Finished setting device "SN_693" configuration. | ProcessDone |
| 11:52:29 | Setting device "SN_693" configuration.          | Message     |

Fig. 11.1: RG-AEC



# 12 TROUBLESHOOTING

## **There is no laser radiation, but the deflection unit is "working".**

- a) Check if the laser is armed.
- b) Check laser configuration, especially the hot power target setting.
- c) Check the cabling.
- d) Check whether the laser has output an error.

## **Bitmap or vector object in job tree but no graphic in viewport**

An object was just added by dragging it into the tree, but no source file was selected.

## **An individual object is not processed.**

- a) The *Mark* tab in the object settings is disabled.
- b) The *Should mark* tab is disabled in associated pen.
- c) The object has a binning condition set which has not been met.

## **Job does not get processed.**

Check that RAYGUIDE is currently connected to the scan controller. A first indication can be given by the colour index of the symbol in front of the SP-ICE-3 entry in the job overview.

If the scan controller has been disabled or if there has been a power loss while using RAYGUIDE, we recommend restoring the connection. Then, re-toggle the **[Arm / Disarm]** button in the execution panel.

## **The layout of the panels is so jumbled as to be unusable or not present at all.**

Navigate to **View > Panel layout** and use **[Reset]** to return to the standard panel configuration.

## **Layout objects cannot be edited in the drawing area.**

- a) Check your RAYGUIDE permission role and your allowed operations.
- b) Check whether the working area, the job tree or the individual object was proactively "locked" to prevent editing.

**The laser emits power but the deflection unit does not move the laser beam.**

- a) Check whether the deflection unit is supplied with power and correctly connected to the scan controller.
- b) Check whether a deflection unit has been configured and assigned to the scan controller.
- c) Check the operating status of the deflection unit on the status tab of the deflection unit dialog.

**Directly after starting an execution, an "Rpc" error message indicating that marking was aborted is output.**

Use the SP-ICE-3 configuration. Tool, "SFR" tab (special function register) to check if the "Abort Mark State" is permanent = 1. This would mean that the scan controller is set permanently to "Abort", for example because an I/O pin was wrongly configured for abort, or the signal is short circuited.

**The buttons or panels for a RAYGUIDE plug-in (solar wafer SP-ICE-3 log importer, remote interface) are not available in the GUI.**

The corresponding plug-in was not selected during initial installation of the RAYGUIDE software or during the last software update.

**A single marking object in the container is not selected in the drawing area.**

The bounding box of individual objects does not appear in the drawing area after one or more marking objects are dragged into a group or copy container and then selected in the object tree. The reason for this is that the *Single output* option is enabled in the container.

# 13 FREQUENTLY ASKED QUESTIONS

**Q:** Can I load a job that was created on another installation?

**A:** Yes. All job-relevant information, including workspace configuration and pen set configuration, is delivered with the job file. You only need to link the job to your local scan controller and any other connected hardware devices.

Bitmap elements must be stored in the job before they can be transferred to another RAYGUIDE installation.

**Q:** What if I need to replace my scan controller?

**A:** You open the scan controller dialog and start the search for the IP address. As soon as the IP address of the scan controller is found, the connection to the scan controller is established. The previous configuration data for the deflection unit including its correction file, field calibration, and laser configuration, are transferred to the newly installed scan controller when you press **[Apply]**.

**Q:** What do I need to consider when updating RAYGUIDE?

**A:** All configurations of your hardware devices, the RAYGUIDE settings, pens, etc. remain unchanged when you update RAYGUIDE.

**Q:** Can I use the RAYGUIDE user interface when working with a RAYGUIDE SDK license?

**A:** Yes, but only in demo mode. However, in this mode you can still configure and calibrate the system using the GUI dialogs. You can also load and check jobs generated by API commands.

**Q:** Can a job created with the RAYGUIDE user interface be edited by another RAYGUIDE API application?

**A:** Yes, you can load and modify this job and process this job through your custom API application, as the job is not bound to a specific license.

**Q:** I use an activation license, but I need to replace my PC or change the operating system. What do I need to consider?

**A:** The activation license is bound to certain attributes of your computer. Changing the operating system may unbind it. We therefore strongly recommend that you contact our support before changing your PC or operating system.

# 14 GLOSSARY

## Acceleration time [ $\mu\text{s}$ ]

Time required by the optical axes (e.g. deflection mirrors) to accelerate / decelerate to the desired speed. This parameter is required for processing bitmaps in "sprint mode", where an acceleration / deceleration vector is added to each bitmap line.

## Binning

Binning is an option to execute a job or job element, depending on the pattern of an I/O port that is most likely set by a PLC.

## BoundingBox

The bounding box is a rectangle that encloses the layout object and is always vertically oriented. It is only used internally by the RAYGUIDE application and therefore, unlike the "Enclosing Rectangle", it is not displayed in the viewport.

## Centre of Transformation (CoT)

The point around which an object or container is scaled and / or rotated during an object transformation.

## Change of Heading (CoH) angle

The angle between two consecutive vectors that describes the change in direction.

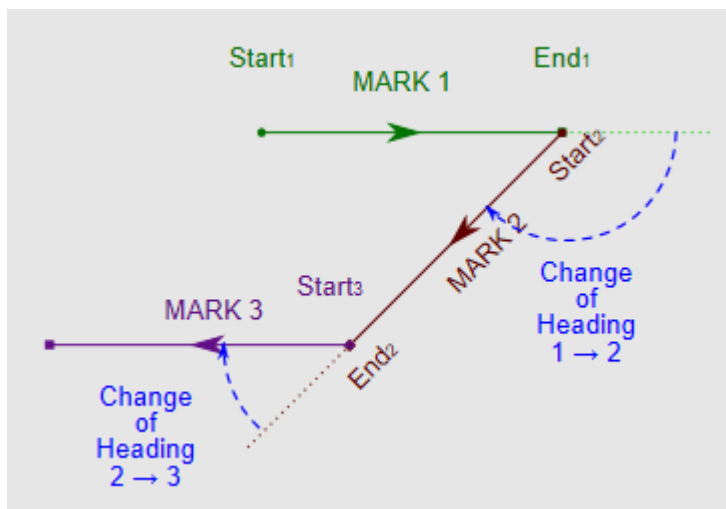


Fig. 14.1: RG-ADX

**Graphic command**

A graphic command is a graphical element that supports the scan controller library as per the graphic command definition. The SP-ICE-3 scan controller supports vector, arc, ellipse and Bezier curve geometry elements.

**Container**

A container is a special type of object plug-in with the goal of assigning certain behaviours to the objects inserted there. In the simplest case, all objects should have the same number of executions, for example. Or the aim may be to multiply the objects contained therein in a defined manner.

Containers can contain both layout and automation objects, or other containers (nested structure). Each container has its own transformation matrix that transforms all layout objects contained in the container.

**Deflection unit / scan head / scanner**

An opto-mechanical unit that uses so-called optical axes (mirrors and lenses) to deflect and focus the laser beam.

**Device**

The term "device" refers to a physical component within the laser cell, such as a deflection unit, laser, or serial port. In future, other types of "devices" may be added.

**Enclosing rectangle**

Compared to the bounding box, the enclosing rectangle always rotates together with its layout object. Its dimensions determine the size specified for the layout object.

**Field domain**

Positions defined in the field domain refer to the scan field coordinate system. The coordinates are translated into the scanner domain on the SP-ICE-3 scan controller using a field transformation and correction file. RAYGUIDE manages the coordination of layouts exclusively in the field domain.

**Free-shaped vector object (as compared to preshaped vector object)**

A "free-shaped" vector object is generally created by importing graphic files and always has the hierarchy structure Object > Layer > Path > Path element. It is "free-shaped" because it can contain very complex polylines and its individual thumbs can be freely edited.

**Gate pre-run / hold time**

Gate pre-run and gate hold time specify how long the gate signal is activated before marking starts and is kept active after marking ends.

**Gate signal**

Signal that generally modulates the laser emission. When using the SP-ICE-3 scan controller, you can configure the polarity of the signal (high-active vs. low-active) according to the requirements of the connected laser source. This setting is part of the RAYGUIDE laser configuration.

**Job**

A collection of editable objects that the RAYGUIDE application can load / save with the *RG* file extension. These objects can be layout objects and automation objects. Each job content is translated by the user application into one or more command lists that the scan controller can process further.

**Laser-on delay / Laser-off delay**

This delay defines the time by which the laser trigger pulse is delayed in relation to the mirror position at the beginning / end of a marking vector.

**Laser trigger delay**

This value defines the time by which the optical pulse is delayed compared to the trigger pulse of the LM signal.

**Level**

Defines a group of paths. Subunit of a free-shaped vector object.

**Panel layout**

Sum of all graphical job elements.

**Licence**

A permission distributed by the owner of the software to use the software. It can be distributed as activation file or as hardware dongle.

**LM signal**

Signal used to trigger laser pulses. Its pulse rate is defined via the laser frequency pen value. The pulse width of the signal is defined either in the laser configuration or also in the pen. When using the SP-ICE-3 scan controller, you can configure the polarity of the LM signal (high-active vs. low-active) according to the requirements of the connected laser source.

**Log file**

Files that track all graphic and action commands sent, for example, by the application to the scan controller. In this way, all actions performed by the RAYGUIDE application can be tracked.

**Spot magnification**

Option to increase the laser spot size by using either the zoom feature or the defocus feature of a 4- or 3-axis deflection unit. Requires a special FC3 correction file.

**Mark / Jump delay**

The delay applies after a mark / jump vector. It is needed to stabilise the optical axes (mirrors) after deceleration to avoid deflections. The optimal value is established by means of process tests. As an initial value, we recommend setting it to 120% of the acceleration time.

**MOTF**

"Mark-On-The-Fly" application in which the parts or the material(s) to be processed move through the scan field.

**Motor axis**

A motor axis refers to the axes of a stepper or servo motor device.

**Object**

Basic elements of a laser processing job.

**Path**

Single or a chain of graphic commands that define a continuous line. The line can be opened or closed (start and end points are equal). Subunit of a layer.

**Pen**

A series of parameters used to define the behaviour of the laser and deflection unit during layout processing.

**PLC**

Programmable Logic Controller.

**Position dependent power correction file**

A correction file containing a table of power gain values in relation to the field position. It is managed by the SP-ICE-3 scan controller. The file is created using the Multi Point Editor application. The file extension is *PC3*.

**Poly delay**

Delay applied for each vector connection so that the deflection unit can follow sharp corners. When using a variable poly delay, the delay time is adjusted according to the change of heading angle.

**Power calibration file**

A file that can be created using the *SPICE3PowerCalibrator.exe* software tool to linearise the emitted laser power with respect to the power control value.

**Power ramp**

Feature for linear modulation of the laser power at the beginning / end of a path by a defined length or time. It is implemented by the SP-ICE-3 scan controller.

**Pre-formed vector object (compared to free-Shaped vector object)**

A vector object defined by its geometric properties, for example *Line, Rectangle, Polygon, Circle, Ellipse, Spiral*.

**Protocol (electric decoding vs. language)**

The protocol defines how the scan controller communicates with the deflection unit.

One aspect is the electronic decoding of the signal. This determines how many axes can be controlled per cable.

Another aspect is the data format, so that both sides can interpret the command language.

**Jolt**

"Jolt" is the change in acceleration over time. If, for example, a directional change of almost 180° occurs in a geometry, the scan movement must be fully inverted, which leads to abrupt deceleration with subsequent maximum acceleration. This could cause the deflection mirrors to oscillate, which in turn would result in marking inaccuracies. This jolt-limiting control would counteract this.

**RAYBOARD PRODUCT INSTALLER**

Central and free software tool for easy installation, update or modification of RAYLASE software products.

Available for download from the RAYLASE website.

**Scan controller / card**

Special printed circuit board for actuating the laser and deflection unit by hardware signals.

Can provide additional Inputs / Outputs. The RAYLASE product is the SP-ICE-3 scan controller.

**Scan field**

Area in which the deflection unit can image the laser beam. Defined by the loaded correction file.



**Scanner domain**

The coordinates from the field domain translated into units that can "implement" the respective received optical axis. This conversion is also done in the SP-ICE-3 scan controller with the help of the correction file. An example: A three-dimensional coordinate in the field domain is translated into deflection angles for X- and Y-mirrors and a position in bits for the Z-lens.

**Skywriting**

Feature that adds an additional acceleration / deceleration vector at the beginning / end of a marking vector to improve marking precision and power input at vector transitions. Is implemented by the SP-ICE-3 scan controller and applied depending on the heading angle.

**System**

Means the entire RAYGUIDE software application.

**Tracking error [ $\mu$ s]**

Time the respective optical axes need to respond to a new position command. The value is used, for example, for compensating for the different tracking error values or for speed-dependent power correction.

**Sequence**

In the RAYGUIDE software, repeated sequences of a geometry with the same set of parameters (pens) are called sequences.

**Tracking error compensation**

Functionality of the SP-ICE-3 scan controller to account for the different dynamic behaviour of the X and Y mirrors compared to the Z lens(es).

**Tuning**

A property of a deflection unit that defines the dynamic behaviour of the unit. Digital deflection units may have more than one tuning and the ability to switch between them. The equipment of the deflection unit in terms of tuning is defined in the deflection unit ordering process.

**Velocity based power control**

Feature for automatic adaptation of the laser power to the actual speed of the deflector mirrors during acceleration / deceleration. Is done by the SP-ICE-3 scan controller. To do this, the SP-ICE-3 scan controller resorts to the tracking error values, therefore its correct value is important.

**Wobble**

A defined oscillation of the X and Y mirrors to create a circle or Lissajous shape along a vector. Mainly used in welding applications or to create wider line thicknesses in the marking result.

**Working distance [mm]**

Vertical distance between the lower edge of the base plate of the deflection unit and the focal plane.

**Workspace**

The workspace defined by the user.

- It can be limited to a smaller area than the scan field.
- It can represent an intersection area or a combined area of several scan fields.
- It can represent the virtual field introduced by MOTF or an XY-motor table.

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APPLICATION SOFTWARE

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APPLICATION SOFTWARE

Original manual

# RAYGUIDE

## CLICK & TEACH

### **RAYGUIDE CLICK & TEACH**

USER MANUAL

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# 1 INTRODUCTION

## 1.1 About CLICK & TEACH

RAYGUIDE CLICK & TEACH, in the following often abbreviated as C&T, is an extension of the RAYGUIDE laser software. C&T uses cameras mounted on the optical axis of deflection units to display an image of the actual workspace in the viewport of RAYGUIDE.

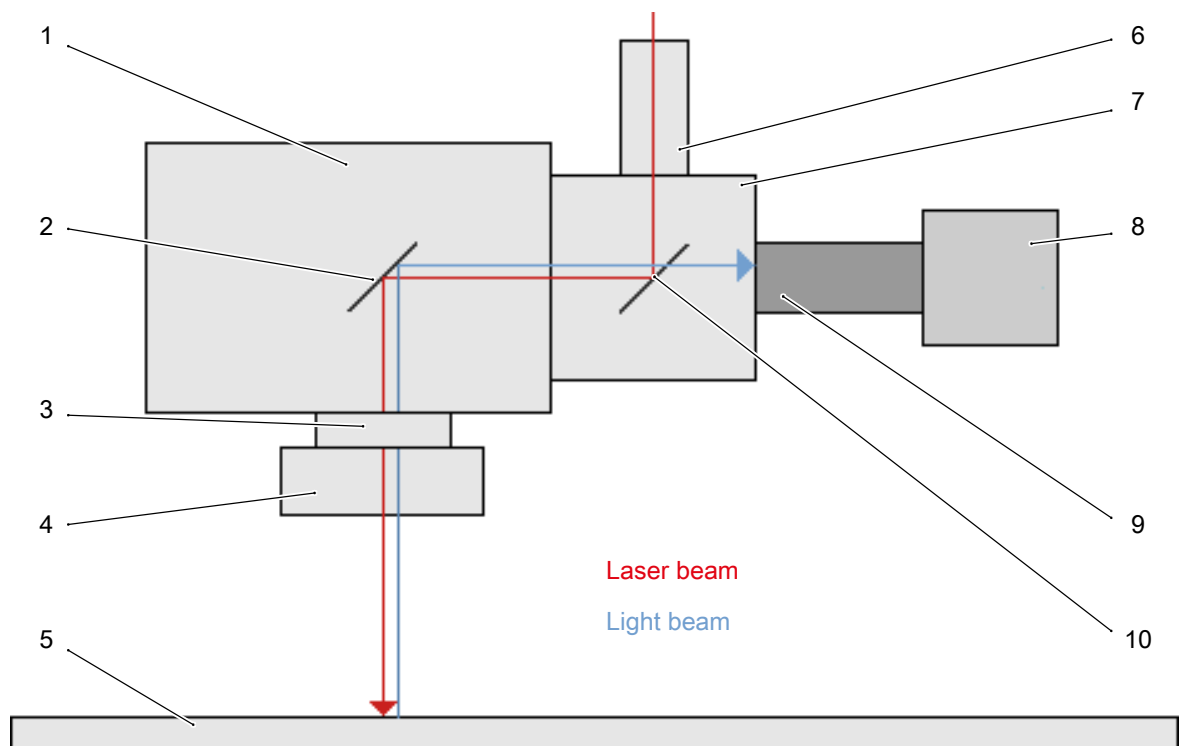


Fig. 1.1: CT-AAA

- |   |                   |    |                  |
|---|-------------------|----|------------------|
| 1 | Deflection unit   | 6  | Collimator       |
| 2 | Deflection mirror | 7  | Camera adapter   |
| 3 | Spacer ring       | 8  | Camera           |
| 4 | F-Theta-lens      | 9  | Camera lens      |
| 5 | Working area      | 10 | Dichroic element |

In this way it is possible to trace the contours of real objects with the graphic features of the RAYGUIDE software and to easily generate laser jobs. Existing objects in a job can be easily superimposed with the positions of real objects.

The camera image generally shows only a small section of the workspace. The overall image is created from individual tiles.

## 1.2 About this manual

This manual describes the functionality, installation and operation of the C&T supplementary application of the RAYGUIDE software when used with the Graphical User Interface (GUI).

The manual section dealing with the C&T supplementary application is contained in the PDF edition of the RAYGUIDE manual. It is not issued as a separate document.

**NOTE:** Consequently, the same rights apply as for the main manual of the RAYGUIDE application and the same rules also apply to the warranty and support.

### Conventions

- Emphasized phrases are printed in **bold**.
- Important notes and remarks are introduced with **NOTE:**, **RULE:**, etc.
- Folder and file names are printed in *italics*.
- The names of windows, dialogs and tabs are given as normal text: On the Settings tab.
- Menu options to be selected are marked in bold and italics: Select ***File > Save as...***
- The names of dialog options (function buttons, checkboxes) are specified in italics: Select the *Manual* calibration mode.
- Buttons are bold and in italics and shown in brackets: Click on ***[Start calibration]***.
- Buttons labelled with graphic icons are described by words.

Example:  is the ***[Search]*** button.

- References to other pages in the manual are indicated by italics: See *page 22, Setup*.
- Links to web addresses are underlined: Visit [RAYLASE](http://RAYLASE).

## 1.3 Compatibility

The C&T supplementary application is compatible with the RAYGUIDE laser software.

Please note that currently only the cameras of the GO-PGE series from JAI and the cameras of the Genie-Nano-GigE series from Teledyne DALSA are supported. C&T was successfully tested with the models GO-5100M-PGE, GO-2400M-PGE and Nano M2420 Mono.

The basic operating procedures can be simulated with the camera emulator.

**NOTE:** We recommend primarily operating the camera via a peer-to-peer network connection and advise against using an internal company network in light of the data volume.

## 1.4 PC requirements

To operate the RAYGUIDE software with the supplementary CLICK & TEACH feature, the PC must meet the following requirements:

- A Windows 10 / Windows 11 operating system with a 64-bit platform
- A working memory of at least 16 GB
- It is highly recommended that the network card for the connection have an INTEL chip as this type of network card was demonstrated to enable trouble-free connection to the camera. Support is not guaranteed if other network cards are used.

**NOTE:** We recommend using two monitors in order to transfer overlapping dialogs to a second monitor, thus making full use of the viewport.

## 1.5 Scope of delivery

The scope of delivery of the CLICK & TEACH installation includes the camera plug-ins for general communication to the respective camera type as well as the panel for the CLICK & TEACH application.

The required and tested hardware drivers for the supported camera models are also provided.

## 2 INSTALLATION

### 2.1 Hardware

In addition to the components necessary for operation of RAYGUIDE (deflection unit, laser, control card, etc.), the following components are also required for C&T:

- For 2-axis deflection units: suitable camera adapter plus camera lens
- For pre-focused deflection units: RAYLASE monitoring module RAYSPECTOR with associated correction file for controlling the optical axis in RAYSPECTOR
- Camera (see *page 7, Compatibility*)
- Illumination equipment for illuminating the processing field

**NOTE:** The illumination equipment (consisting of illumination controller and lamps) can be purchased from RAYLASE on request. However, they can also be provided by the customer. Talk to your RAYLASE sales representative if required.

**NOTE:** Agree on the optomechanical coupling of the camera and the components required for this with your RAYLASE sales employee to ensure compatibility with the laser and camera.

**NOTE:** In principle, it is possible to retrofit existing laser systems for camera integration. Depending on the situation, manufacturer service for the deflection unit may be required. Contact your RAYLASE sales employee if needed.

**NOTE (ADJUSTMENT):** The dichroic element of the RAYLASE camera adapter must be adjusted after mounting and fastening the fibre collimator of the laser to couple the beam precisely with the deflection unit. Note the RAYLASE manuals *Standard Camera Adapter* and *High Power Camera Adapter*. When using preadjusted High Power welding modules with a collimator, it is not necessary to adjust the *High Power camera adapter*.

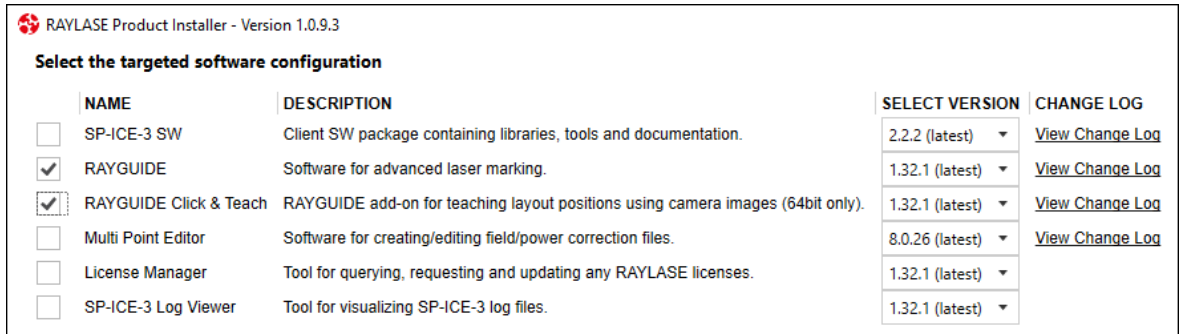
## 2.2 Software

### 2.2.1 CLICK & TEACH software installation

For the installation of all RAYLASE software products (therefore also the *RAYGUIDE Click & Teach* additional option), RAYLASE provides the so-called RAYBOARD PRODUCT INSTALLER (RLPI) free of charge as a central tool on its website.

Using the “Select the targeted software configuration” menu item, select the right version of *RAYGUIDE Click & Teach*.

**IMPORTANT:** The version of *RAYGUIDE Click & Teach* must correspond to the *RAYGUIDE* version.



| RAYLASE Product Installer - Version 1.0.9.3 |                        |   |                   |                                 |
|---|------------------------|---|-------------------|---------------------------------|
| Select the targeted software configuration  |                        |   |                   |                                 |
| <input type="checkbox"/>                    | NAME                   | DESCRIPTION   | SELECT VERSION    | CHANGE LOG                      |
| <input type="checkbox"/>                    | SP-ICE-3 SW            | Client SW package containing libraries, tools and documentation.                | 2.2.2 (latest) ▾  | <a href="#">View Change Log</a> |
| <input checked="" type="checkbox"/>         | RAYGUIDE               | Software for advanced laser marking.  | 1.32.1 (latest) ▾ | <a href="#">View Change Log</a> |
| <input checked="" type="checkbox"/>         | RAYGUIDE Click & Teach | RAYGUIDE add-on for teaching layout positions using camera images (64bit only). | 1.32.1 (latest) ▾ | <a href="#">View Change Log</a> |
| <input type="checkbox"/>                    | Multi Point Editor     | Software for creating/editing field/power correction files.                     | 8.0.26 (latest) ▾ | <a href="#">View Change Log</a> |
| <input type="checkbox"/>                    | License Manager        | Tool for querying, requesting and updating any RAYLASE licenses.                | 1.32.1 (latest) ▾ |                                 |
| <input type="checkbox"/>                    | SP-ICE-3 Log Viewer    | Tool for visualizing SP-ICE-3 log files.  | 1.32.1 (latest) ▾ |                                 |

Fig. 2.1: CT-AAB

**IMPORTANT:** The *RAYGUIDE Click & Teach* additional option can only work together with the actual RAYGUIDE application. For this reason, it is essential to also select installation of the RAYGUIDE application, or else it must already be installed.

The direct link to the change log lets you review the latest changes relative to the predecessor version. The RLPI then downloads the *RAYGUIDE Click & Teach* installation file and displays the installation options.

The following installation options are presented for RAYGUIDE CLICK & TEACH:

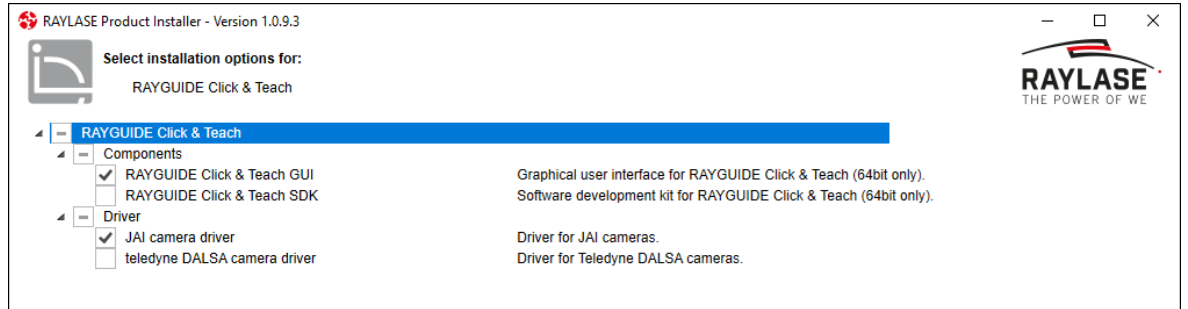


Fig. 2.2: CT-AAC

1. Select whether you would like to install the *GUI* and/or the *SDK components* of *RAYGUIDE Click & Teach*.
2. Select the camera variant in order to install the appropriate camera driver.

**NOTE:** When installing or upgrading the camera drivers with other setup files, RAYLASE will not be able to provide support in case of faults.

After selecting the installation options, you need to consent to the license agreement; then the *RAYGUIDE Click & Teach* application will be installed.

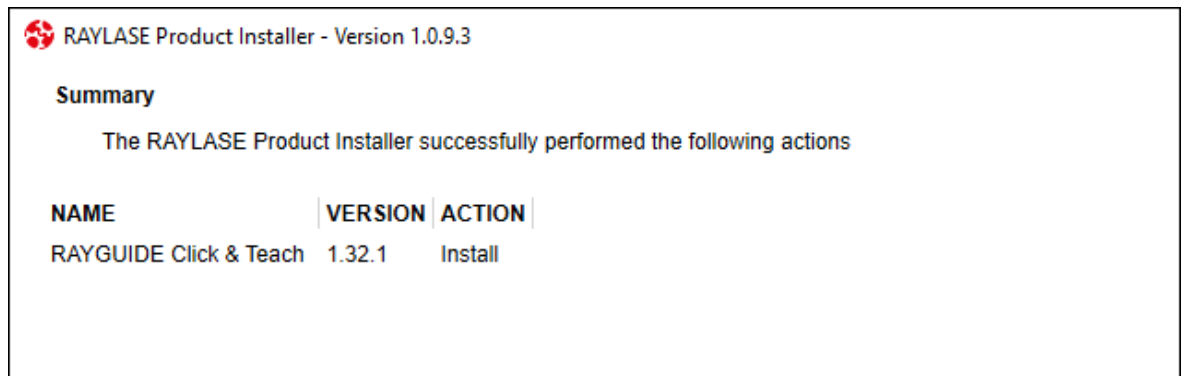


Fig. 2.3: CT-AAD

## 2.2.2 Licenses

In order to be able to use the CLICK & TEACH supplementary application, your RAYGUIDE licenses requires an additional "license product". This license product can be ordered during the initial order of the RAYGUIDE or can be purchased later.

For this purpose, your existing RAYGUIDE license is extended with a file upload.

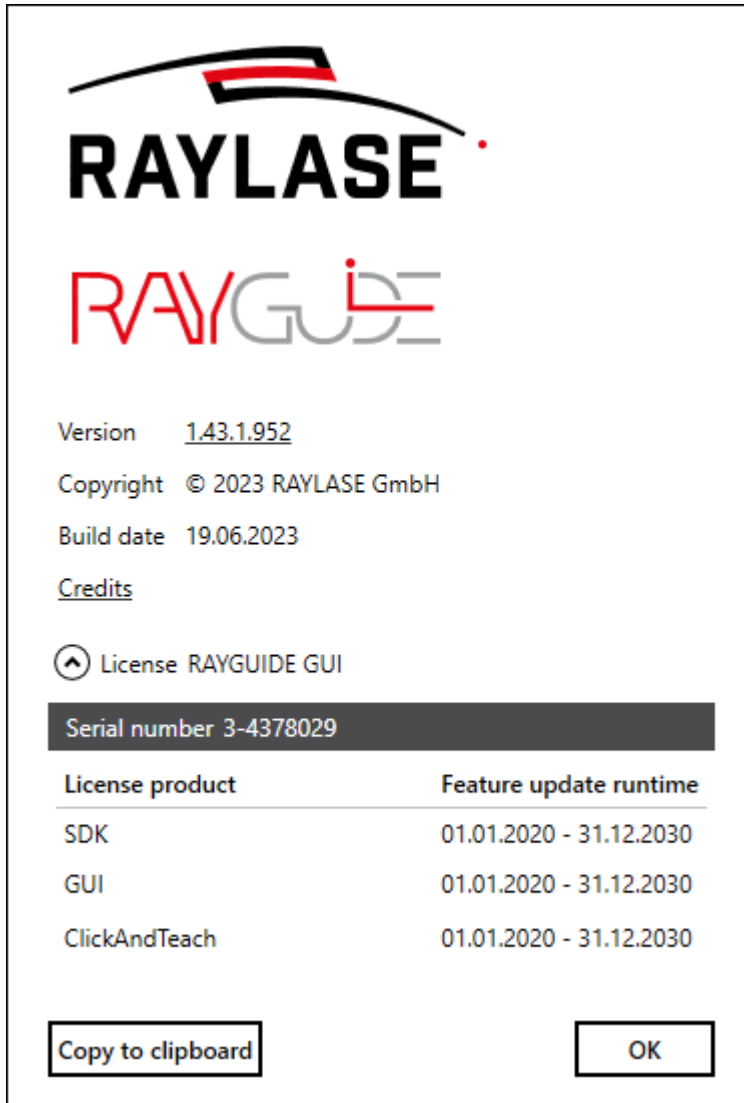
**NOTE:** Only the serial number of the existing RAYGUIDE license is needed.

### Viewing license products

Select **Help > About RAYGUIDE** to view the existing license products.

If the CLICK & TEACH entry is listed as a license product, the CLICK & TEACH supplementary application is activated.

Example:



Version 1.43.1.952

Copyright © 2023 RAYLASE GmbH

Build date 19.06.2023

Credits

⤴ License RAYGUIDE GUI

Serial number 3-4378029

| License product | Feature update runtime  |
|-----------------|-------------------------|
| SDK             | 01.01.2020 - 31.12.2030 |
| GUI             | 01.01.2020 - 31.12.2030 |
| ClickAndTeach   | 01.01.2020 - 31.12.2030 |

Copy to clipboard      OK

Fig. 2.4: CT-AAE

### 2.2.3 Software updates

If you update your RAYGUIDE application by loading new versions, the appropriate CLICK & TEACH installation must also be performed as well. This is necessary to ensure compatibility between the main application and the supplementary application.

The camera drivers can be selected during an update but do not have to be. This is the case unless it is noted explicitly that the drivers are updated with the new version.

## 2.3 IMPORTANT: System preparation

Before the application using C&T, it must be ensured that the deflection unit and laser of your system have already been configured and the scan field has been calibrated.

The way the scan field is calibrated relative to the laser is decided by your accuracy requirements.

You can find the options RAYGUIDE offers in the

- RAYGUIDE GUI manual, chapter 5.3.2 or
- in the MULTI POINT EDITOR manual.

In addition, entries for the process transformation are taken into account by automatically displaying the background image with a distortion, and a superimposed traced or positioned outline is again displayed without distortion when marking.

It is advisable to already have a pen in the library pen set marked as "Default", which you can later use to mark your material for the camera calibration with good contrast and a sharp result.



## 3 CLICK & TEACH COMPONENTS

From the user's point of view, C&T essentially consists of two components that are completely integrated in the RAYGUIDE software:

- Camera (as a device) with associated device dialog for configuration and calibration.  
See page 20, *Setting up the camera as a device in RAYGUIDE* page 14, *Camera setup*.
- CLICK & TEACH panel for using the camera.  
See page 48, *CLICK & TEACH panel*.

Optional illumination control can also be purchased from RAYLASE and then used. The following components are available in the software for this purpose:

- The illumination controller (device) with corresponding device dialog for configuration.  
See page 61, *Illumination controller*.
- The *Illumination* panel to set the illumination intensity directly from the user GUI.  
See page 66, *Illumination panel*.

To add the required panels to the RAYGUIDE GUI, select these under the **View > Panels > Plugins > CLICK & TEACH** menu item and, if applicable, **Illumination**:

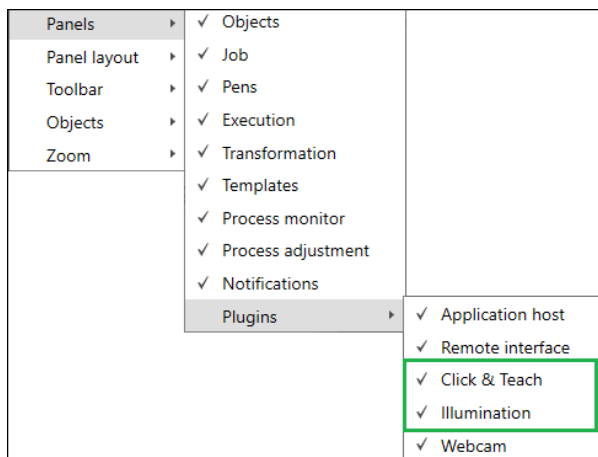


Fig. 3.1: CT-AAF

## 4 CAMERA SETUP

Before beginning to set up the camera, ensure that all mechanical components are correctly aligned and that the camera is mounted on the deflection unit using the adapter and is connected to the network card with the Ethernet cable.

The matching correction file must be loaded for the deflection unit and the F-Theta lens used (see page 9, *CLICK & TEACH software installation*). When using a pre-focused deflection unit plus RAYSPECTOR, a correction file must be loaded which supports the so-called sensor axis. Focus the camera objective in such a way that a sharp image is displayed.

### 4.1 Configuration of the network connection with the camera

Use the configuration tools of the camera manufacturer to perform the basic setup of the camera. Set the necessary network parameters for your network card and give the camera a valid IP address.

### 4.1.1 JAI cameras

JAI makes the *eBUS Player for JAI* program available for configuring your cameras. The *eBUS Player* enables more extensive settings than the Settings dialog (see page 13, *CLICK & TEACH components*), which can only be used to adjust the most important parameters.

The steps necessary for configuring the IP address are described below:

1. Start the *eBUS Player* and click on the **[Select / Connect]** button. You will find the executable file in a standard driver installation under  
*C:\Program Files\JAI\eBUS SDK\Binaries\eBUSPlayerJAI64.exe.*

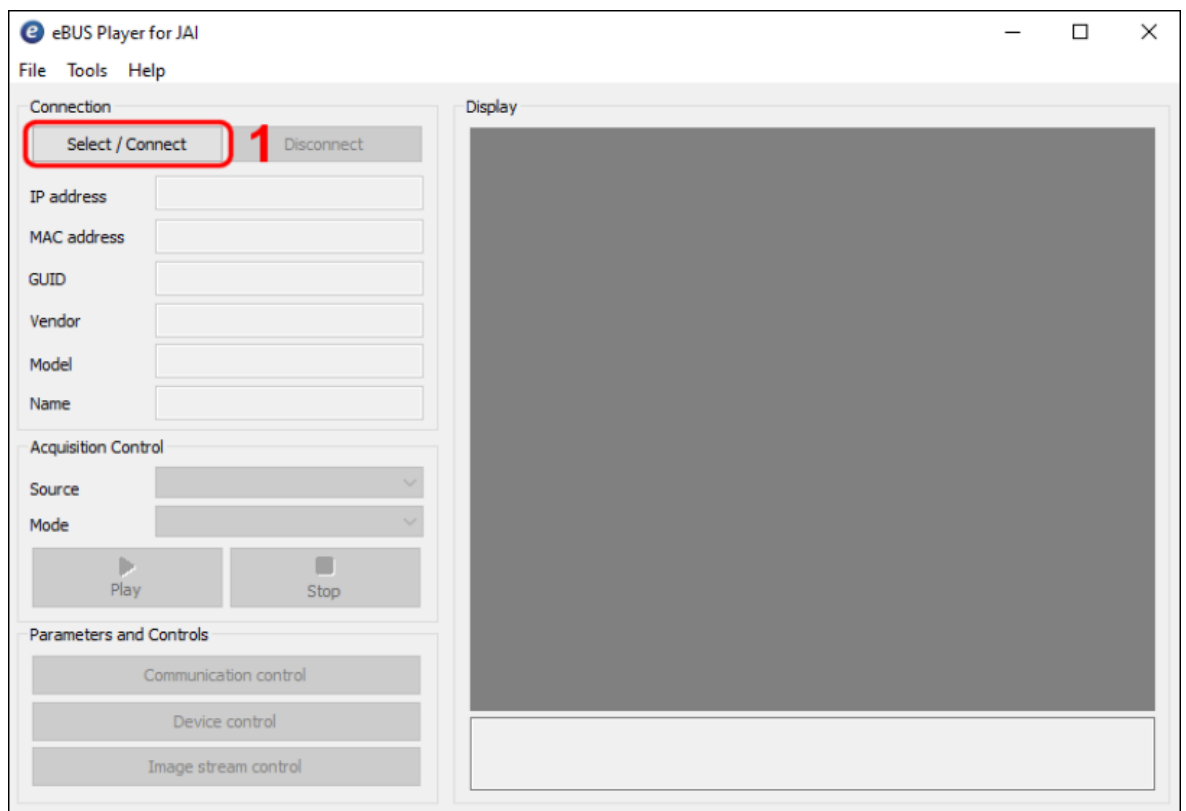


Fig. 4.1: CT-AAG

2. In the Device Selection dialog, all network adapters that are known to your PC are listed on the left side. Since your camera does not yet have an IP address, it cannot be reached at this time. Activate *Show unreachable Network Devices*:
3. The camera (in the example: GO-5100M-PGE) appears below the network adapter it is connected to. Click on the entry to display the Interface Information and Device Information.

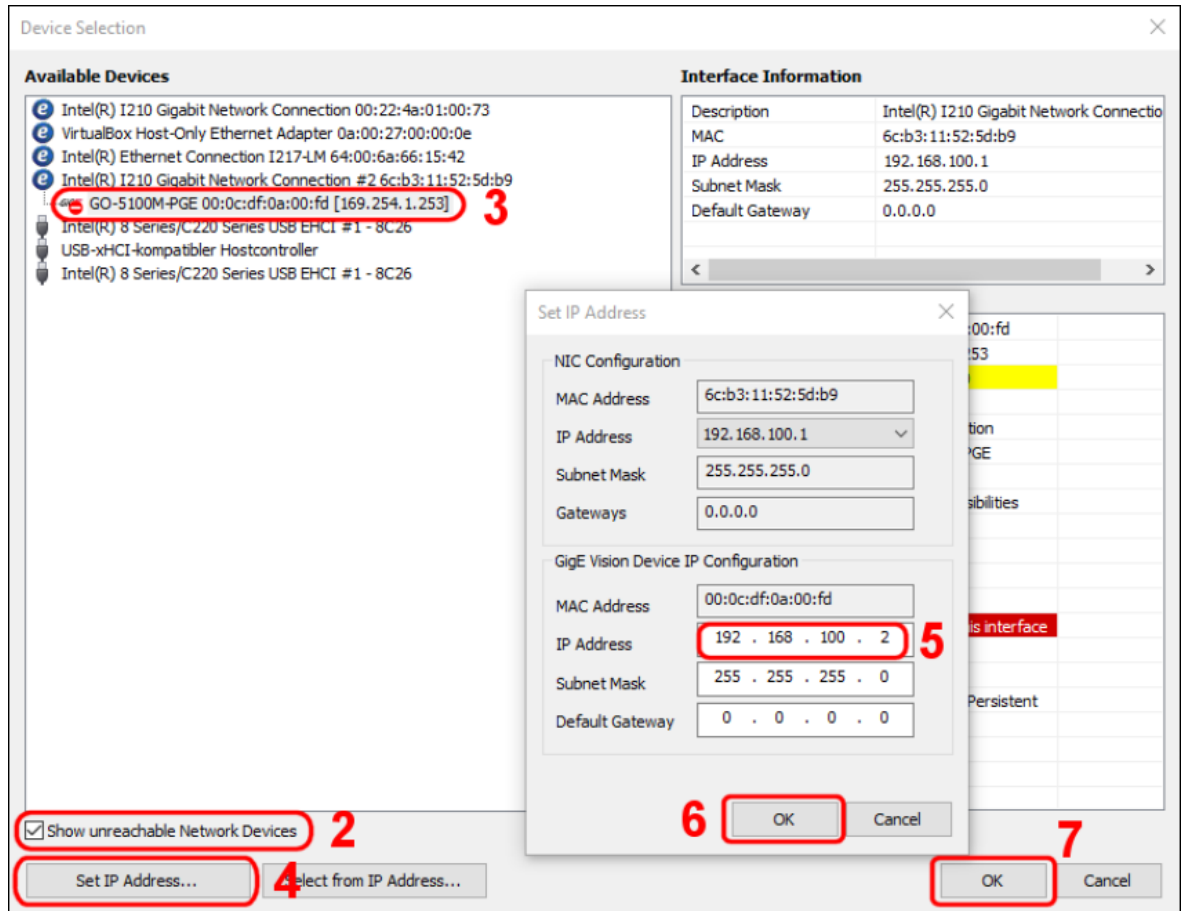


Fig. 4.2: CT-AAH

4. Click on **[Set IP Address...]** to open the dialog for configuring the IP address.
5. Enter an IP address that is still free in your network.
6. The red warning symbol in the device list disappears when you close the Device Selection dialog.
7. Close the Device Selection dialog by clicking on **[OK]**.
8. Click on **[Play]** to display a live image. First, however, the IP configuration is completed. Click on **[Device control]**:

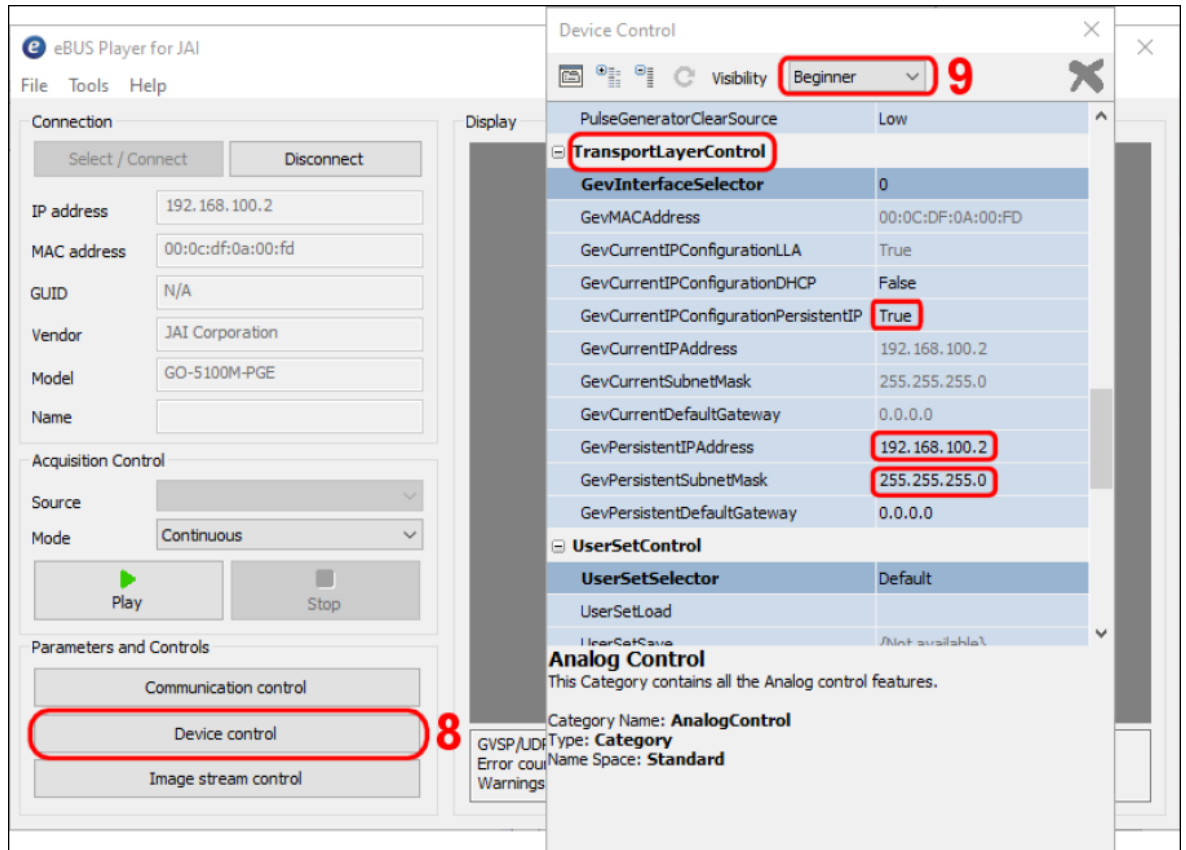


Fig. 4.3: CT-AAI

9. In the Device Control dialog, select the visibility level *Beginner* to reduce the parameter list.
10. In the TransportLayerControl area, you can set how the camera should be supplied with an IP address in the future. If there is a DHCP server in your network, the camera can obtain the address from there. For this purpose, set the GetCurrentIPConfigurationDHCP element to *True*. In this case, the camera is connected directly to a network card installed in the computer so that the IP address should be fixed.

## 4.1.2 TeledyneDALSA cameras

Teledyne DALSA makes several programs available for configuring its cameras.

### 4.1.2.1 Sopera Network Configuration Tool

Use the Sopera Network Configuration Tool to set the IP address.

You will find the executable file in a standard driver installation under:

*C:\Program Files\Teledyne DALSA\Network Interface\Bin\CorNetConfigApp.exe*

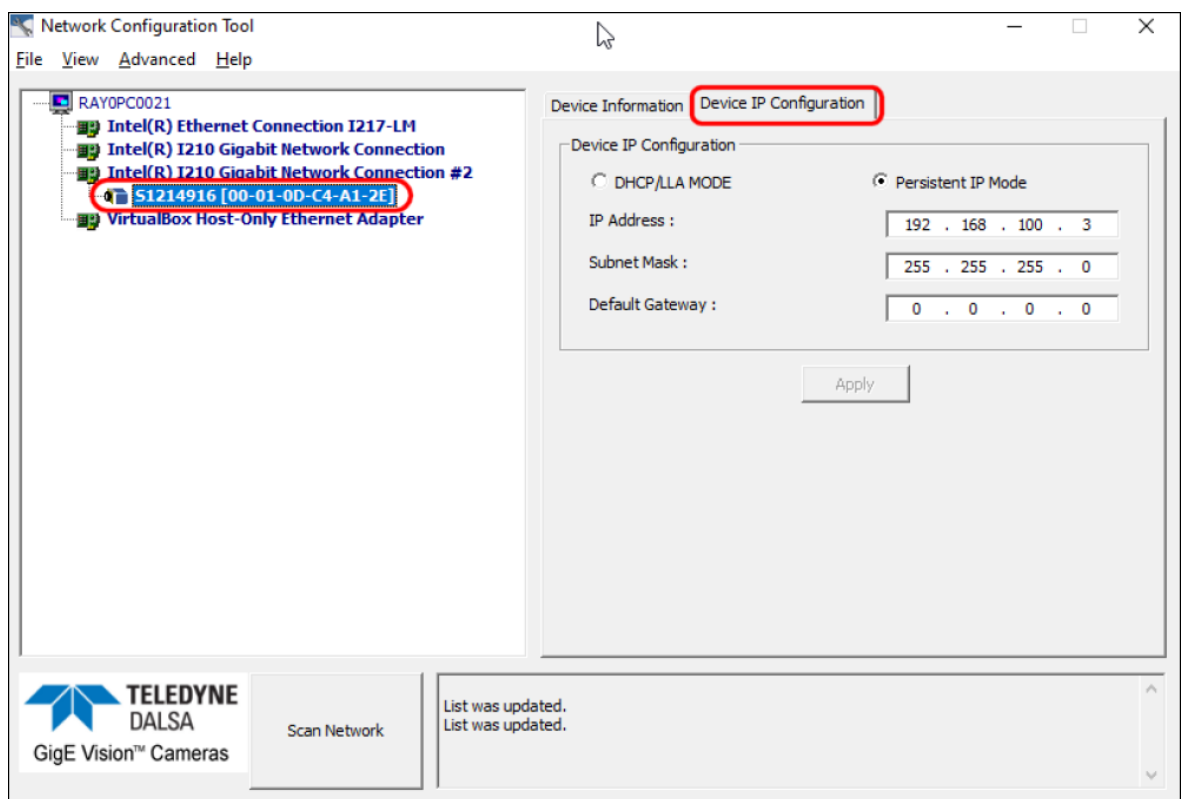


Fig. 4.4: CT-AAJ

1. Select the camera in the list of network adapters.
2. Change to the Device IP Configuration tab and enter the desired IP configuration.

### 4.1.2.2 Sopera CamExpert

Use the Sopera CamExpert to set camera parameters such as exposure time, to test the basic camera function (image recording should be possible) or to change camera parameters that are not offered in the Configuration dialog.

You will find the executable file in a standard driver installation under:

*C:\Program Files\Teledyne DALSA\Sopera\CamExpert\camexpert.exe.*

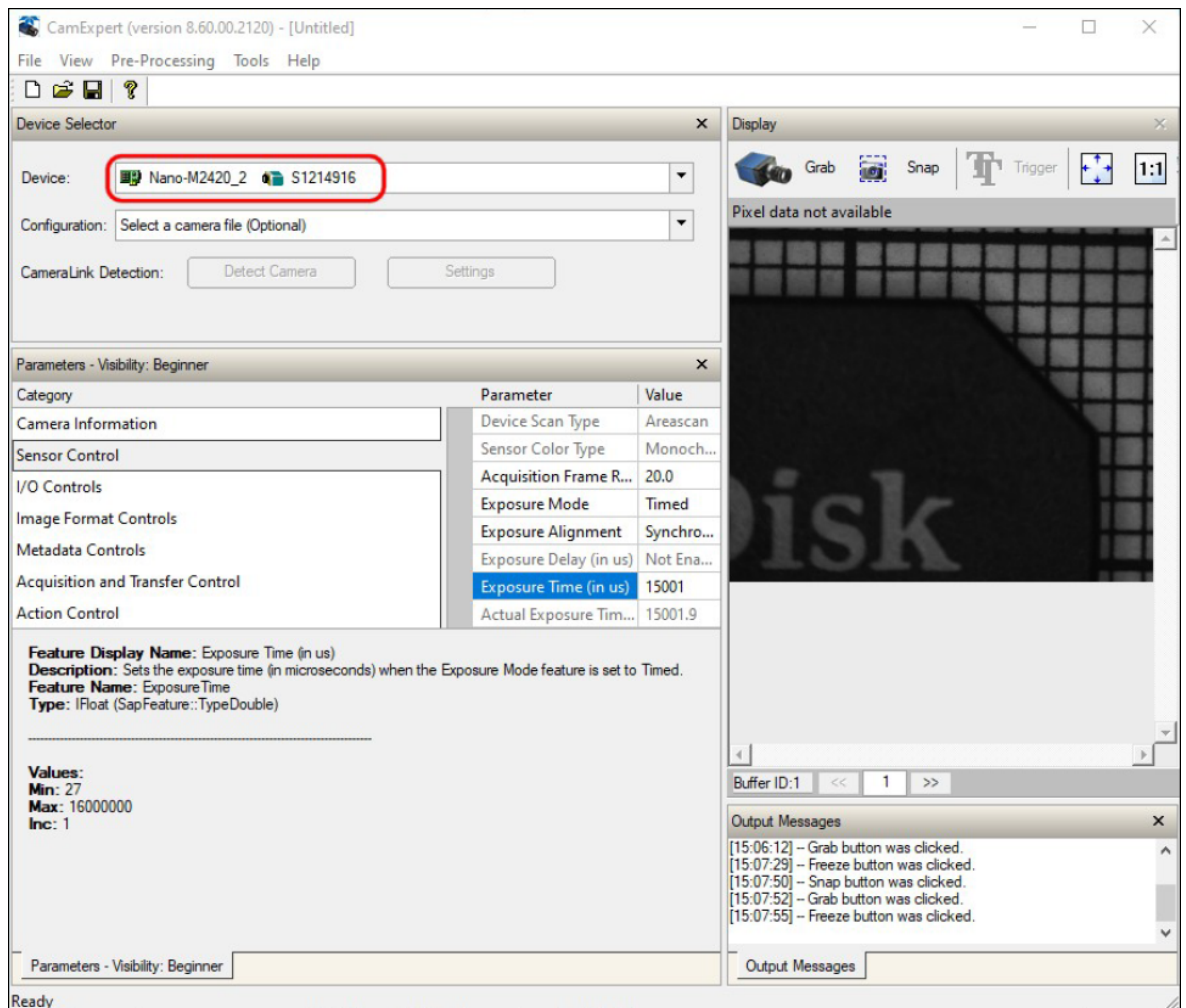


Fig. 4.5: CT-AAK

1. Select your camera in the *Device* drop-down list in the Device Selector area.
2. Enter the desired camera parameters.

## 4.2 Setting up the camera as a device in RAYGUIDE

### 4.2.1 Adding the camera as a device

The camera is added to RAYGUIDE via the Device Configuration dialog. Select **System > Devices > Configure....**

Configuration window with example content:

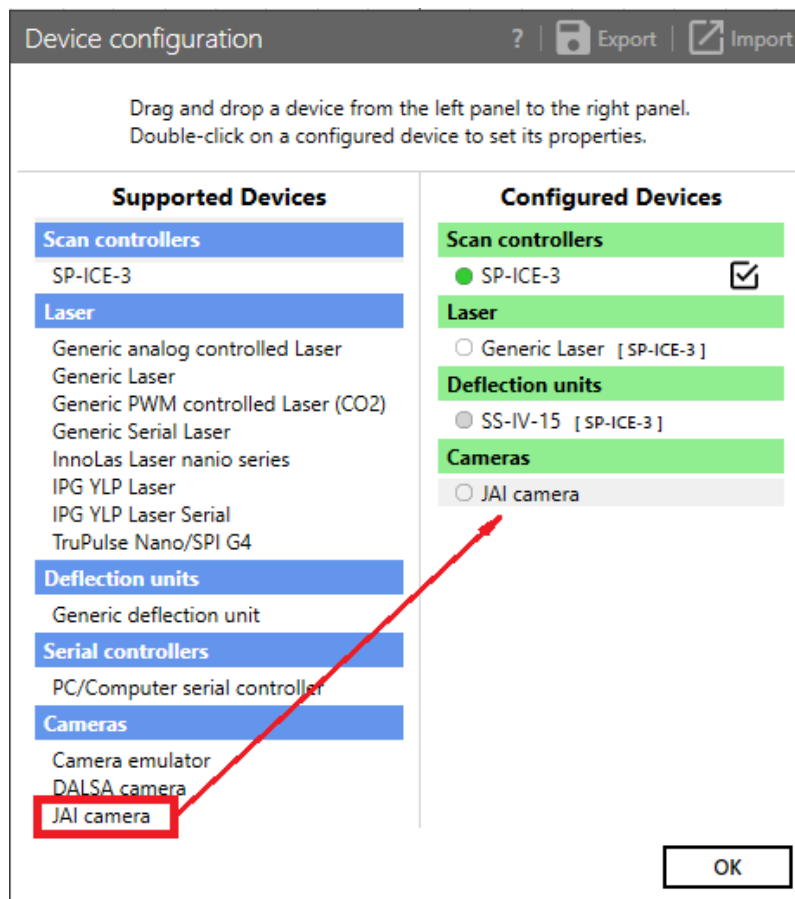


Fig. 4.6: CT-AAL

If the C&T extension is installed and a valid license is available, the existing camera plug-ins appear in the **Supported Devices** window area on the left side.

Use the mouse to drag the desired camera from the **Supported Devices** window area to the **Configured Devices** area.



## 4.2.2 Camera dialog

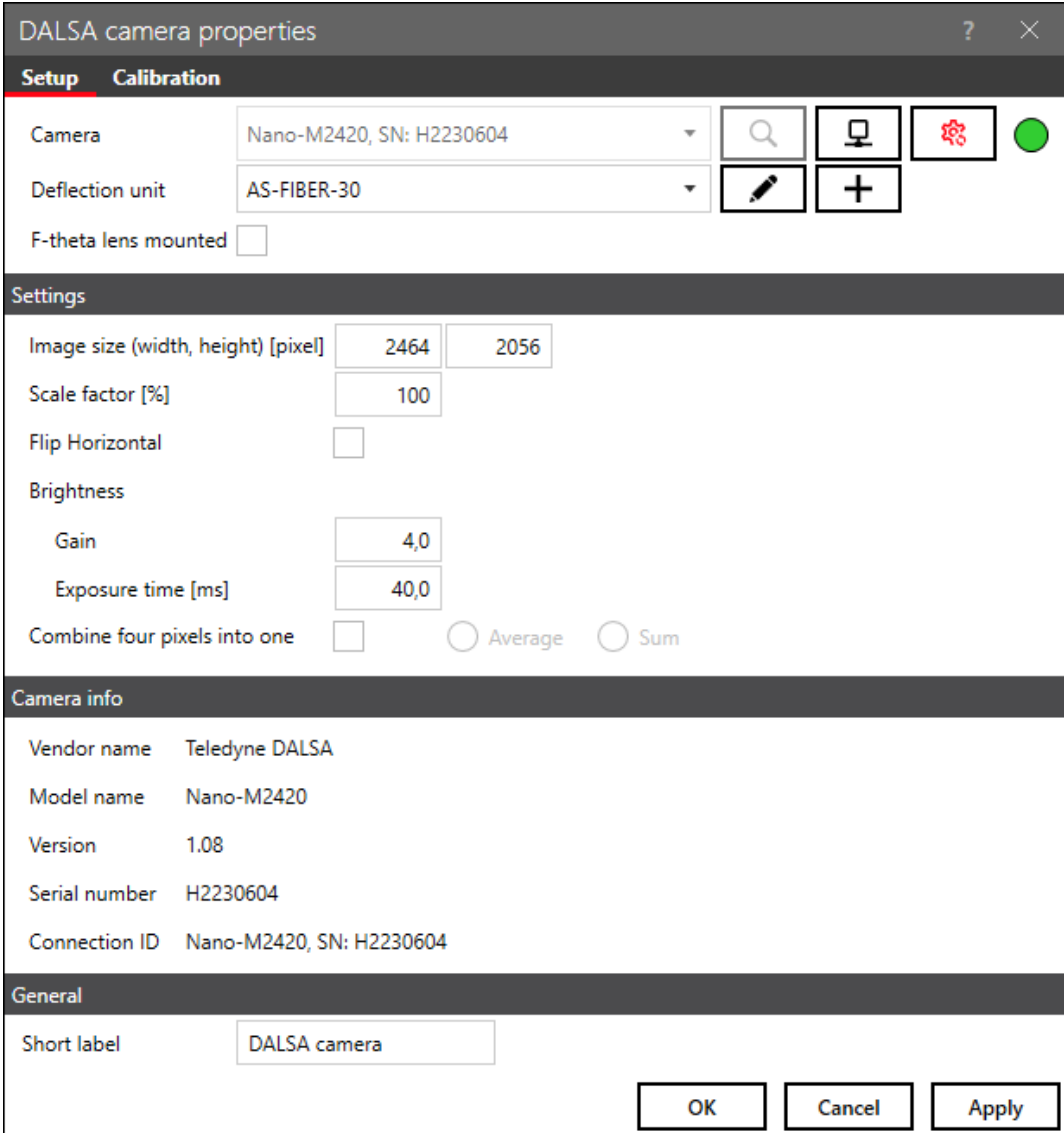
For each connected camera there is a Settings dialog that is executed as a RAYGUIDE device plug-in.

**NOTE:** The camera dialog is the same for the available camera models.

Open the camera dialog e.g. by double-clicking on the corresponding entry in the device configuration, or use the context menu of the camera and select **Properties**.

Alternative navigation: **System > Devices > Cameras > (Device name)**

### Setup tab

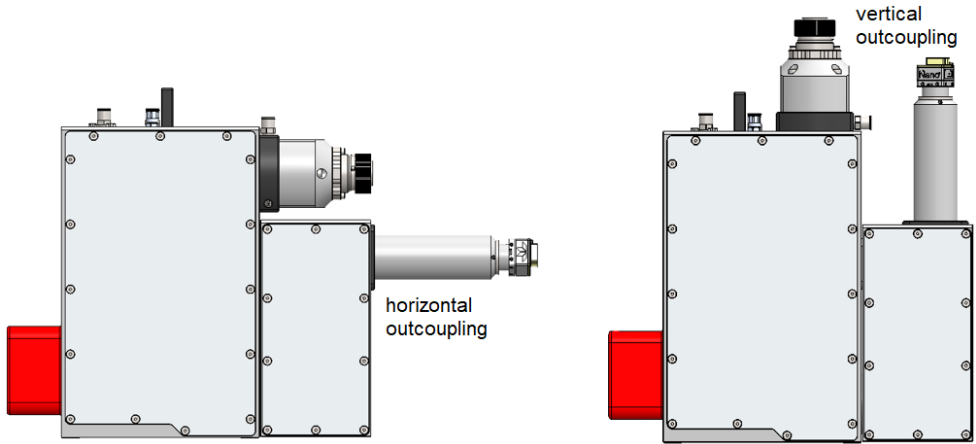


The screenshot shows the 'DALSA camera properties' dialog box with the 'Setup' tab selected. The dialog is divided into several sections:

- Setup / Calibration:**
  - Camera: Nano-M2420, SN: H2230604
  - Deflection unit: AS-FIBER-30
  - F-theta lens mounted:
- Settings:**
  - Image size (width, height) [pixel]: 2464, 2056
  - Scale factor [%]: 100
  - Flip Horizontal:
  - Brightness:
    - Gain: 4,0
    - Exposure time [ms]: 40,0
  - Combine four pixels into one:  (Average),  Sum
- Camera info:**
  - Vendor name: Teledyne DALSA
  - Model name: Nano-M2420
  - Version: 1.08
  - Serial number: H2230604
  - Connection ID: Nano-M2420, SN: H2230604
- General:**
  - Short label: DALSA camera

Buttons at the bottom: OK, Cancel, Apply.

Fig. 4.7: CT-AAM

| Setting  | Explanation   |
|--|---|
| <b>Setup</b>   |   |
| For defining several camera parameters, such as the exposure time. |   |
| Camera   | Selection of the desired camera if multiple cameras are found on the system.  |
| Deflection unit  | Selection of the deflection unit at which the corresponding camera is has an optomechanic docking point.  |
| F-Theta-lens mounted   | Specify whether your deflection unit has an F-Theta lens or not.<br><b>NOTE:</b> This information is important for calculation of the distortion (see page 44, Equalization calibration).   |
| <b>Settings</b>  |   |
| Image size (width x height) [pixels]                               | The size of the produced tiles can be reduced here. It may be helpful to reduce the unavoidable image distortions at the expense of the time required for tiling.   |
| Scale factor [%]   | The resolution of a tile or the overall image after it is taken is reduced by this factor to save memory and increase performance.  |
| Flipping horizontal  | <p>When a camera is attached to a RAYSPECTOR module in combination with an AS FIBER, the light for the camera can be decoupled vertically or horizontally:</p>  <p>If it is vertically decoupled, the camera image must be flipped.</p> |

| Setting  | Explanation  |
|--|--|
| Brightness   | <p>The brightness of the camera images is influenced by the following settings:</p> <ul style="list-style-type: none"> <li>■ Gain:<br/>The cameras permit the electrical amplification of the detected incident light to lighten the camera image.<br/><b>NOTE:</b> Increasing the amplification may result in more noise in the image.</li> <li>■ Exposure time [ms]<br/>The cameras permit the setting of the exposure time to be set for an individual image. A longer exposure time makes the camera image lighter.<br/><b>NOTE:</b> Increasing the exposure time makes the shots and therefore the tiling slower.</li> </ul> <p>A good compromise between amplification and exposure time is therefore crucial.</p> |
| Combining four pixels into one   | <p>The cameras permit so-called "binning".</p> <p>In this process, pixels are combined. This reduces image noise at the expense of the resolution. Optionally, the grey values of the pixels can be summed or their average calculated to calculate the result image point.</p>  |
| <b>Camera info</b>   |  |
| Information on the manufacturer, model, version, serial number and connection ID |  |
| <b>General</b>   |  |
| Short label  | Enter the name under which the camera is to be listed in the device list.  |

Tab. 4.1: CT-001

### Calibration tab

**NOTE:** The buttons on the Calibration tab can only be used if the C&T panel is activated. Otherwise, they are greyed out.

DALSA camera properties ? ×

Setup   Calibration

Sensor axis offset [%]  |

Calibration valid for focus level [mm]

Calibration job pen

Calibration of the camera image size

Standard measure [mm]

Field of view (width, height) [mm]   
  

Field of pixel (width, height) [µm]

Center calibration

Offset (x, y) [mm]

Wavelength calibration

Upper left corner (x, y) [mm]

Lower right corner (x, y) [mm]

Scale factor (x, y)

Equalization calibration

Tile position

Top left

Top middle

Top right

Middle left

Bottom middle

Middle right

Bottom left

Bottom right

Cross positions [%]

|  |              |   |   |
|--|--------------|---|---|
|  | Top left     | <input style="width: 50px;" type="text" value="11,02"/> | <input style="width: 50px;" type="text" value="14,63"/> |
|  | Top right    | <input style="width: 50px;" type="text" value="83,44"/> | <input style="width: 50px;" type="text" value="13,78"/> |
|  | Bottom left  | <input style="width: 50px;" type="text" value="17,65"/> | <input style="width: 50px;" type="text" value="85,31"/> |
|  | Bottom right | <input style="width: 50px;" type="text" value="89,46"/> | <input style="width: 50px;" type="text" value="85,09"/> |

Fig. 4.8: CT-AAN

| Setting  | Explanation  |
|--|--|
| <b>Calibration</b>   |  |
| For setting and/or determining the calibration parameters. |  |
| Sensor axis offset [%]                                     | The slider can be used to adjust the focus of the camera for the reference position (at the working distance).<br><b>CAUTION:</b> A positive value will shift the focus "downwards".<br><b>NOTE:</b> The input field and slider are greyed out if the correction file has no z-range.  |
| Calibration for focal plane [mm]                           | For systems that work with a correction file including the z-range, the camera must be calibrated in different focal planes to be able to record images in different focal planes. A minimum of 2 focal planes should be calibrated. The data between the calibrated planes are interpolated. For this reason, it is advisable to calibrate the uppermost and lowermost planes.<br><b>NOTE:</b> If no z-area is defined in the correction file, these fields are greyed out. |
| Calibration job pen  | Selection of the pen for marking the calibration jobs.<br><b>NOTE:</b> The pen number refers to the library pen set defined as the "Default". After the job is created, this pen can still be edited if necessary.   |
| <b>Calibration of the camera image size</b>                |  |
| Standard measure [mm]                                      | The distance between the two scale markings used for the calibration of the camera image size in the real world.   |
| Field of view (width, height) [pixels]                     | The image size is the result of the image size calibration and indicates how large the area recorded by the camera is in reality.  |
| Field of pixel (width, height) [ $\mu\text{m}$ ]           | Indicates how large the area is in reality that is recorded by a single pixel.   |
| <b>Center calibration</b>                                  |  |
| Offset (x,y) [mm]  | For design reasons, there is a deviation between the point to which the laser points and the centre point of the camera image. This offset relative to the coordinate axis is determined by means of centre point calibration and is then compensated for accordingly during tiling.   |
| <b>Wavelength calibration</b>                              |  |
| Upper left corner (x,y) [mm]                               | At this position, a cross is generated in the calibration job that, on account of the different wavelengths of visible and laser light, appears in a slightly different position in the camera image. This difference is used to calculate the scaling factors for the wavelength correction.  |
| Lower right corner (x,y) [mm]                              | The second cross position is located at the diagonally opposite side only for the purpose of better accuracy of calculation.   |
| Scale factor (x,y)   | The result of the wavelength correction indicates a factor that must be applied to the mirror positions to compensate for the different angles of refraction of visible and laser light.   |
| <b>Equalization calibration</b>                            |  |

| Setting         | Explanation   |
|-----------------|---|
| Tile position   | Selection of the eight tile positions to be processed, in each of which four cross positions must be taught.<br>The colour of the labelling changes during the calibration process when the respective tile position has been taught. |
| Cross positions | Display of the X/Y-coordinates as a percentage of the camera image width and height for each of the four cross positions. Valid for the currently selected tile position.   |

Tab. 4.2: CT-002

### 4.2.3 Connecting / assigning the camera

Select **System > Devices > Cameras > (Device name)** from the menu to open the Settings dialog. Select the **Setup** tab to set up the camera connection.

1. Click on **[Search]** to search for existing cameras.
2. Select the desired camera in the drop-down list and click on **[Connect / Disconnect]** to establish a connection or interrupt a connection. An active connection is indicated by a green traffic light.

As soon as a connection is established, several parameters, such as the image size or the current exposure time, are read out of the camera.

3. Assign the associated deflection unit to the camera.
4. Specify whether your system is equipped with F-Theta lens. This specification is relevant for the equalization of the camera images.

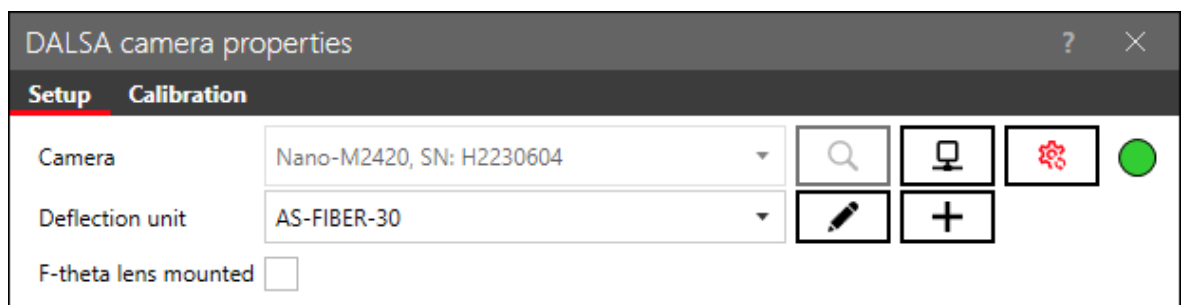
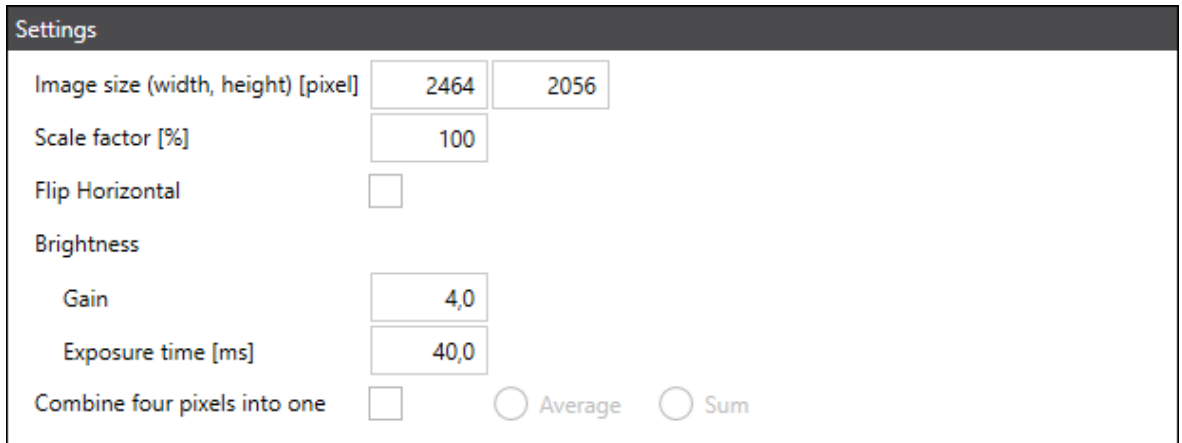


Fig. 4.9: CT-AAO

5. Edit the parameters in the Settings area.

**NOTE:** To adapt additional camera parameters, use the configuration program from the camera manufacturer.



| Settings                           |   |
|------------------------------------|---|
| Image size (width, height) [pixel] | <input type="text" value="2464"/> <input type="text" value="2056"/> |
| Scale factor [%]                   | <input type="text" value="100"/>                                    |
| Flip Horizontal                    | <input type="checkbox"/>  |
| Brightness                         |   |
| Gain                               | <input type="text" value="4,0"/>                                    |
| Exposure time [ms]                 | <input type="text" value="40,0"/>                                   |
| Combine four pixels into one       | <input type="checkbox"/>  |
|                                    | <input checked="" type="radio"/> Average <input type="radio"/> Sum  |

Fig. 4.10: CT-AAP

The *scale factor* has special significance. A complete image of the workspace consists of many (e.g. ten by ten) image tiles. If, for example, a camera generates images with 2000 pixels along the width, the overall image has a width of 20,000 pixels. This can in turn affect the performance in terms of time and is also not always necessary. Therefore, select the scaling factor so that the images have enough resolution for your needs, but no higher than necessary so as not to make handling too difficult.

**NOTE:** Calibration requires a high accuracy, which is why the images are always shown with the full resolution in this case.

6. Close the dialog with **[OK]** to apply the changes. Click **View > Panels > CLICK & TEACH** from the menu to open the C&T panel.

## 4.3 Aligning camera and adjusting focus

This step ensures that the camera images are focused or “clear” and displayed orthogonally aligned to the workspace.

**NOTE:** Changing the field alignment does not require a new alignment of the camera, but the live image rotation should be adjusted.

In preparation, we recommend marking the calibration job with a suitable pen on suitable material. The parallel lines contained in the calibration job then serve as a reference for the alignment of the camera.

To do this, select the Calibration tab in the Camera dialog, select the pen and then click on **[Create 1.. calibration job]**.

**NOTE on the calibration job and field transformation:** If an angle for the rotation is specified in the field transformation (see RAYGUIDE manual, chapter 5.3.2), each rotation is counterbalanced by CLICK & TEACH. The calibration job is then displayed rotated inversely in the viewport.

**NOTE on calibration jobs and RAYGUIDE workspace:** The workspace can be one composed of several scan fields in the RAYGUIDE software. It can be smaller or larger than the scan field and may have an offset relative to the scan field.

CLICK & TEACH always automatically positions the calibration job centred to the scan field and not centred to the workspace, because each coaxial working camera always acts per scan field.

If the geometries are within an area of the scan field that cannot or should not be targeted by the laser, the job will have to be adjusted manually (scaling would not be permissible since this would destroy the dimensions of the scale).

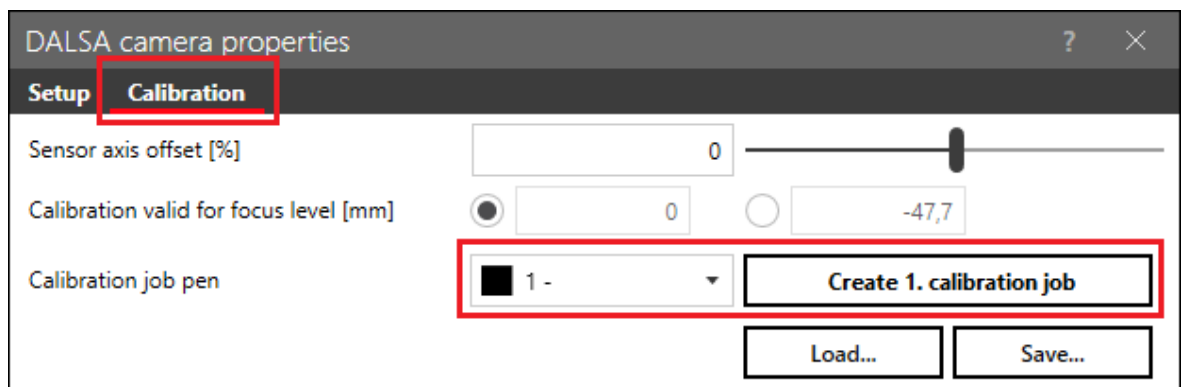


Fig. 4.11: Generating a calibration job



Only the middle part is of interest here, which contains two texts and horizontal lines. The cross positions are described in the actual camera calibration routine.

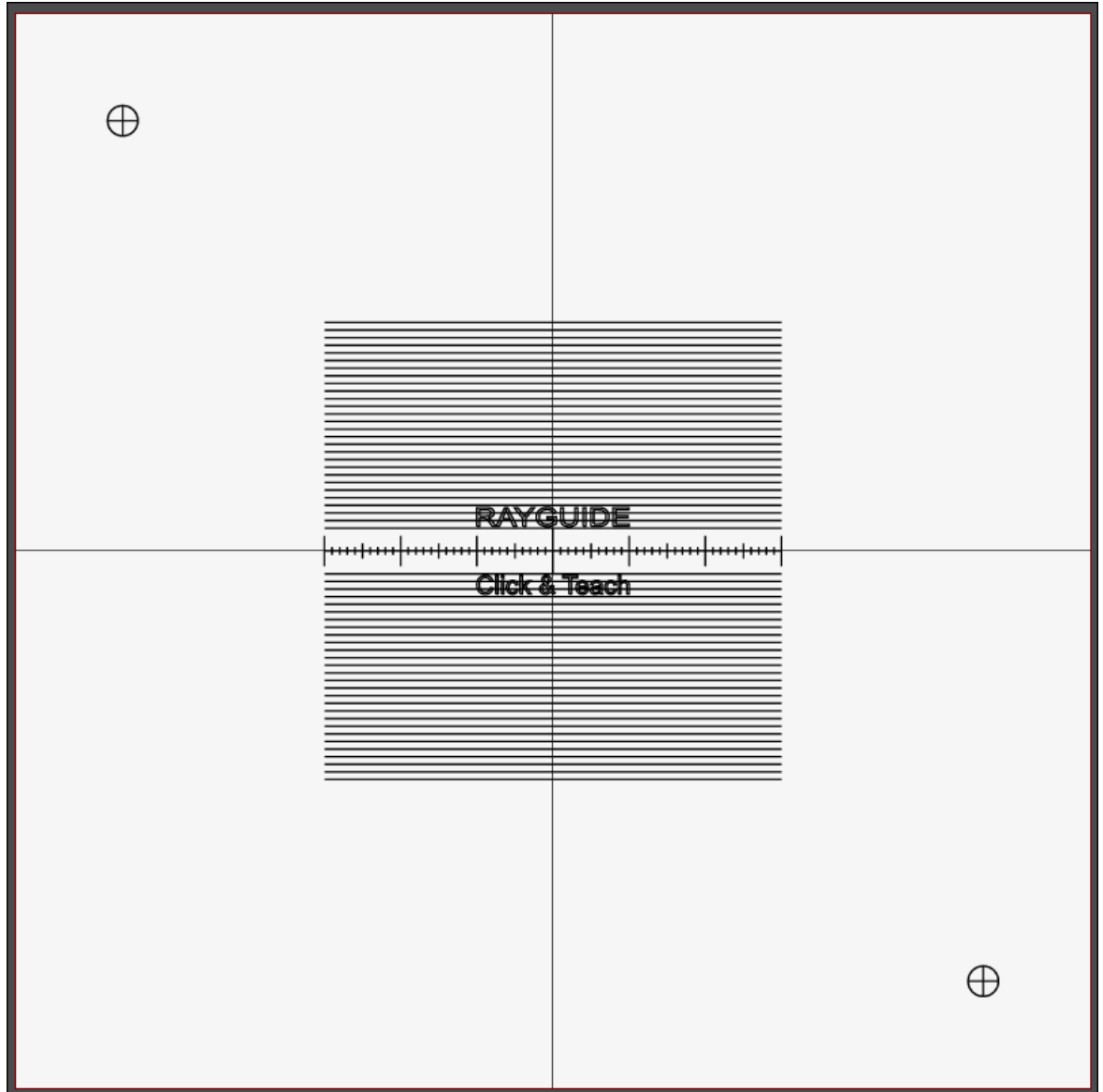


Fig. 4.12: Calibration job for aligning the camera

Execute the calibration job like a normal RAYGUIDE job and activate the live image of the camera by clicking on the camera icon in the C&T panel:

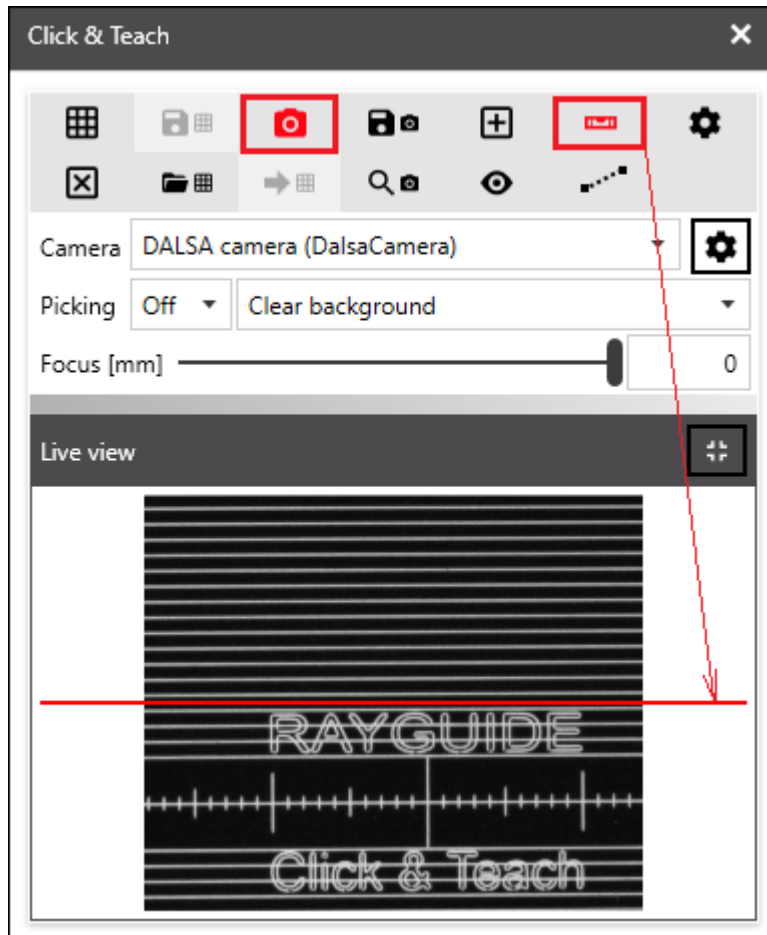


Fig. 4.13: Live image button in C&T panel

In addition, activate the display of the adjustment line in the live image (see [page 50, Buttons](#)). Using the mouse wheel, you can move the line up or down to be positioned where the horizontal lines of the marking are visible.

The live image can also be enlarged if required, for details see [page 58, Live image](#).

Now turn the camera lens or camera mount in such a manner that the texts are not upside down and not sideways, and the horizontal lines are parallel to the displayed horizontal adjustment lines. For details, see the next chapter.

### 4.3.1 Procedure for deflection units with camera adapter

This procedure applies, for example, to 2-axis deflection units or the FOCUSSHIFTER 14 MVC with corresponding camera lens:

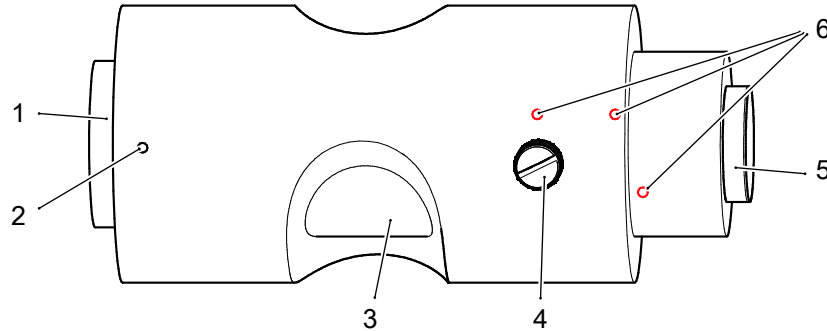


Fig. 4.14: CT-AAQ

- |   |                                   |   |   |
|---|-----------------------------------|---|---|
| 1 | Connection thread for camera lens | 4 | Knurled screw (for focus adjustment)        |
| 2 | Grub screws (for rotation)        | 5 | Connection thread for camera (C-mount)      |
| 3 | Inner cylinder                    | 6 | Locking screws (thread-locked, do not open) |

1. Screw the connection thread of the camera lens (1) into the camera adapter all the way to the stop. Tighten the camera lens only lightly at the stop.
2. Screw the camera all the way onto the connection thread (5). Tighten the camera only very lightly at the stop. Tightening the camera too tightly will damage the thread and will lead to the destruction of the camera or the camera lens.
3. Open the knurled screw (4), adjust the focus\* roughly and tighten the knurled screw again.
4. Slightly loosen the three grub screws (2) and rotate the entire camera lens until the marked lines seen in the live image appear horizontally. While the grub screws are open, the focus must not be changed, or else there will be a risk of mechanical damage.
5. Lightly tighten one of the grub screws (2) again to prevent accidental turning.
6. Adjust the focus\* exactly and secure this setting by lightly tightening the knurled screw (4).

**NOTE\*:** With the RAYLASE FOCUSSHIFTER, there is the option to set the focus position as desired in the focus area (defined by the correction file). However, since the FOCUSSHIFTER does not have dynamic focus tracking, only a single focus position can be adjusted. Later calibration of the camera image must then take place in this focus position.

### 4.3.2 Procedure for AS FIBER with RAYSPECTOR

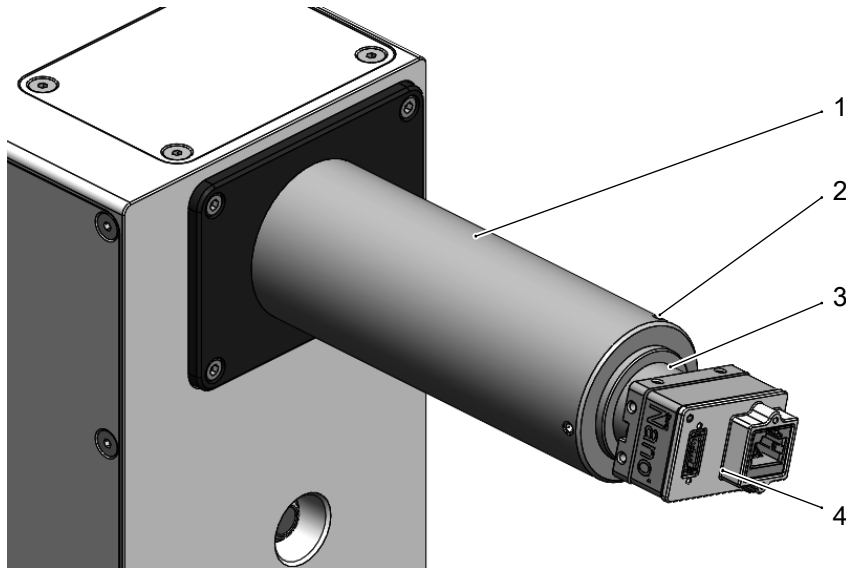


Fig. 4.15: CT-AAR

- |   |                       |   |                                      |
|---|-----------------------|---|--------------------------------------|
| 1 | Spacer tube           | 3 | Mounting option for camera (C-Mount) |
| 2 | Screws on spacer tube | 4 | Camera                               |

1. Screw the camera with the connection thread into the camera mount (C-mount) up to the stop. Tighten the camera only lightly at the stop.
2. Slightly open the three screws on the spacer tube so that you can rotate the camera mount.
3. Turn the camera into position until the marked lines visible in the live image appear horizontally.
4. Fix this position by carefully tightening the three screws again. **NOTE:** Make sure that there is no tension in the cables to the camera.

## 4.4 Calibrating the camera image

For an optimal result when assembling the image tiles, it must be known how large the area of the processing field is that is shown in a single image tile. Also, the centre point of the camera image before calibration is never identical with the point onto which the mirrors would direct the laser beam. This deviation must be compensated for. The laser generally has a different wavelength than the visible light that generates the camera image and is therefore deflected differently by the optics. This chromatic aberration is taken into account with a calibration step.

Furthermore, the F-theta lens installed in the beam path as well as the pure deflection via the deflection mirrors cause distortion of the camera images. The distortion is greater the more the mirrors are deflected. These distortions can also be largely compensated for by a calibration step.

### Starting calibration

1. Select **System > Devices > Camera > (Device name)** to open the Camera dialog.
2. Select the **Calibration** tab.

### 4.4.1 Focus calibration

When using the camera with a RAYSPECTOR module that is coupled to an AS-FIBER deflection unit, the sensor Z-axis in RAYSPECTOR, in combination with the fitting correction file, is set at the factory such that the camera is in focus at the working distance. It can still be necessary to adjust the focal plane slightly.

**CAUTION:** This step must be performed once prior to calibration.



Fig. 4.16: CT-AAS

In this case, use the slider.

Note that a positive sensor axis offset corrects the focus "downward", while a negative sensor axis offset corrects the focus "upward".

**NOTES:**

- If multiple focal planes are used for the camera calibration below, the focus calibration only needs to be performed for one focal plane.
- The sensor axis offset is also displayed on the Calibration tab in the dialog of the corresponding deflection unit.
- If the camera is used in a 2-axis unit with an F-Theta lens and the corresponding correction file, this point is not applicable.

## 4.4.2 Manual calibration of the (actual) camera

The calibration is performed in five simple steps using two marked calibration job.

**NOTE:** The marking must always take place in the focal plane of the system.

- With 2-axis deflection units, the marking must always be made at the working distance = focal plane.
- For the AS FIBER and using a 3D correction file, it is intended to mark and calibrate in two focal planes (top edge and bottom edge) of the focus range (3D volume).
- With a FOCUSHIFTER MVC (with camera observation), a single but freely selectable focus position can be defined.

A total of two different calibration jobs are needed for the different calibration steps. However, these can be marked (one after the other) on the same material.

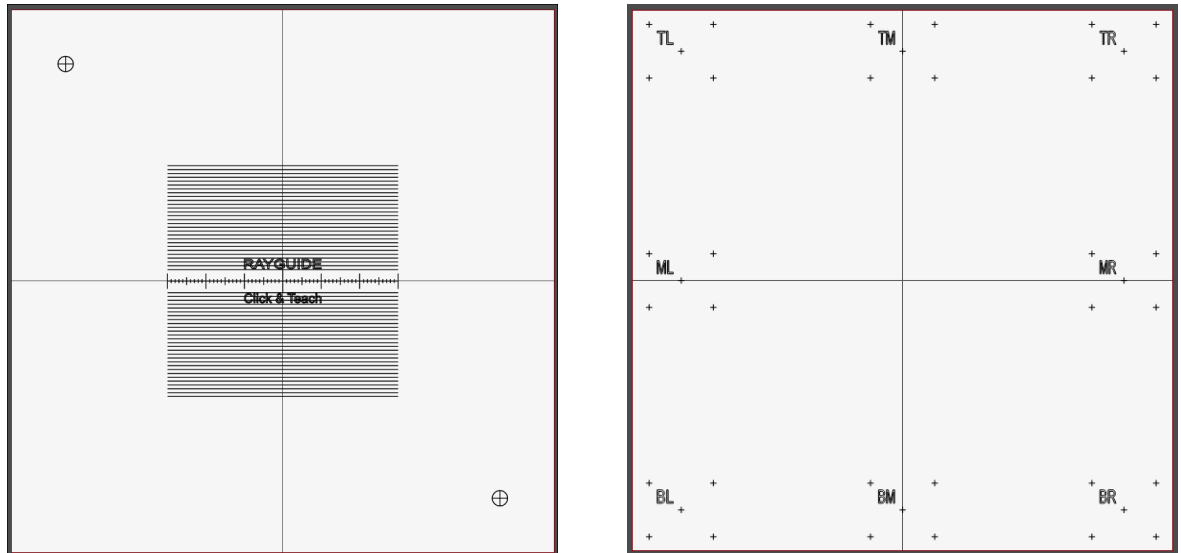


Fig. 4.17: CT-AAT

### 4.4.2.1 Generating calibration reference

Usually, a laser processing job of the two calibration jobs on a paper or foil suitable for the laser wavelength serves as a reference.

**NOTE:** Make sure that the material to be marked does not shift or curl during calibration.

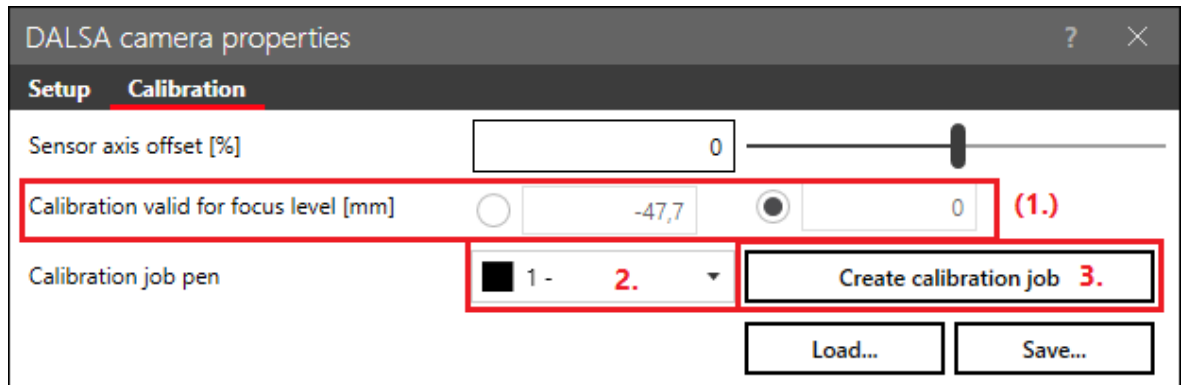


Fig. 4.18: CT-AAU

#### 1. Optional: Defining focal plane for camera calibration

##### ■ AS FIBER with RAYSPECTOR

If the workspace used should have an extension in the Z direction, the calibration steps described below must always be carried out at least twice:

- At the highest point (z-position = 0 mm)
- And again, if possible, at the lowest point (depends on the values in the correction file).

The obtained calibration data are then automatically interpolated (linearly) for the intermediate z-positions.

**NOTE:** The value for the lower focal plane is always specified as per the correction file. If a marking is not possible in this focal plane because of the system design, an alternative value can be entered.

##### ■ FOCUSHIFTER MVC

Enter the position of the camera focus that you have adjusted so calibration takes place in this focus position.

#### **NOTE on the calibration job and field transformation:**

If an angle for the rotation is specified in the field transformation (see RAYGUIDE manual, chapter 5.3.2), each rotation is counterbalanced by CLICK & TEACH. The calibration job is then displayed rotated inversely in the viewport.



2. Select a pen (process parameter) that is suitable for marking on your material. The pens listed here come from the standard pen set of the pen library.
3. Click on the **[Create 1. calibration job]** button to create the job. This is then executed like a regular laser processing job in RAYGUIDE.

**NOTE:** The crosses with circle for wavelength correction are automatically positioned at 80% of the field size in two corners. If necessary, the position can be changed manually before creating the job.

**NOTE on calibration jobs and RAYGUIDE workspace:**

The workspace can be one composed of several scan fields in the RAYGUIDE software. It can be smaller or larger than the scan field and may have an offset relative to the scan field.

If the workspace is smaller than the scan field and remains centred, the first of the two calibration jobs automatically fits into the workspace. The second optional calibration job always covers the entire scan field.

CLICK & TEACH always automatically positions the calibration job centred to the scan field and not centred to the workspace, because each coaxial working camera always acts per scan field.

If the graphic elements of a job are within an area of the scan field that cannot or should not be targeted by the laser, the job will have to be adjusted manually (scaling would not be permissible since this would destroy the dimensions of the scale).

**NOTE on the calibration job and field alignment:**

Before the calibration job is generated, the field alignment must be defined, as its alignment is determined in the RAYGUIDE viewport.

4. Perform the job with the RAYGUIDE software.

### 4.4.2.2 Calibration of the camera image size

Determine the area of the processing field that a single tile displays. For this purpose, you must inform the system about how large a known comparative measure appears to be in the camera image:

1. Click on **[Show centre tile]** in the **Calibration of the camera image size** area.

| Calibration of the camera image size |                 |                            |                          |   |
|--------------------------------------|-----------------|----------------------------|--------------------------|---|
| Standard measure [mm]                | 30,0            | <b>Show center tile</b> 1. |                          |   |
| Field of view (width, height) [mm]   | 32,108          | 26,792                     | <b>Start calibration</b> | <input type="button" value="X"/> <input type="button" value="✓"/> |
| Field of pixel (width, height) [µm]  | 13,031 x 13,031 |                            |                          |   |

Fig. 4.19: CT-AAV

This step positions the mirrors of the deflection unit to the zero point and the associated camera image of an image tile is displayed in the workspace of RAYGUIDE in its full format:

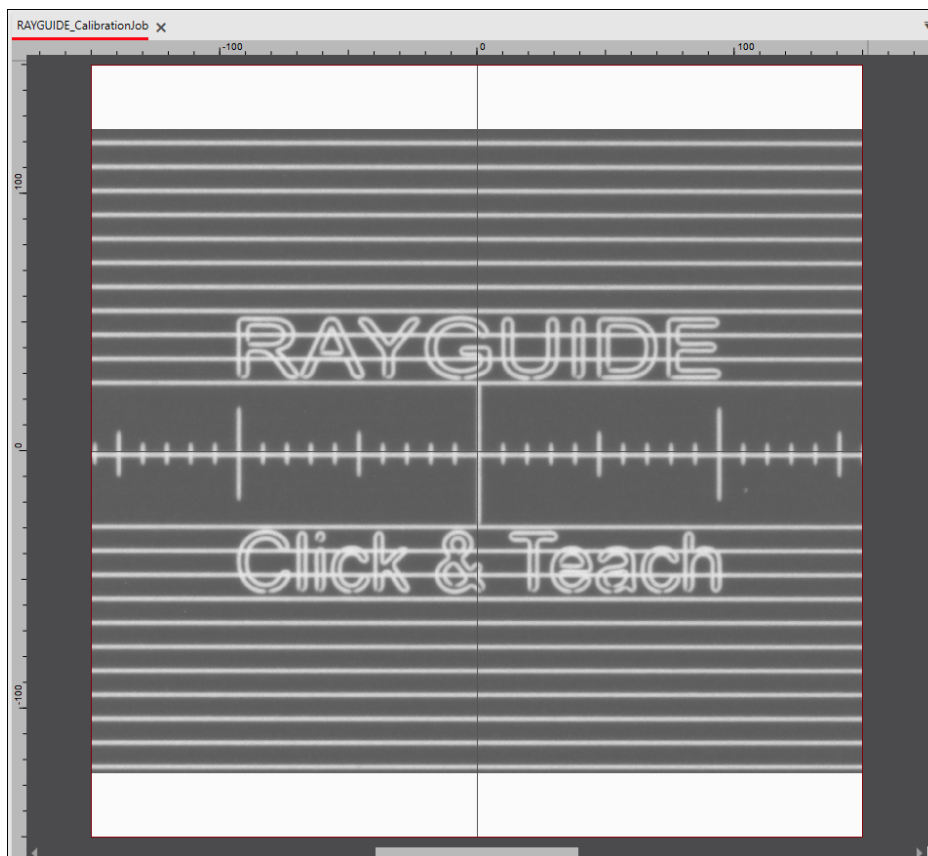


Fig. 4.20: CT-AAW

You can see the scale of the marked job. Each scale line is 1 mm from its neighbour in the real world. Select two scale lines that are far out on the edges but still fully visible, and count the distance between these two elements. In the example, the two outermost scale lines that are just barely visible are 30 mm apart.

**NOTE:** The measurement becomes more accurate as the distance between the two selected scale line increases.

2. Enter the distance between the two selected markings in the *Standard measure* field.

It is essential that this value corresponds to the distance between the markings that was selected in step 1 and measured in step 4.

| Calibration of the camera image size |    |   |  |
|--------------------------------------|----|---|--|
| Standard measure [mm]                | 2. | <input type="text" value="30,0"/>                                       | <input type="button" value="Show center tile"/>  |
| Field of view (width, height) [mm]   |    | <input type="text" value="32,108"/> <input type="text" value="26,792"/> | <input type="button" value="Start calibration"/> <input type="button" value="X"/> <input type="button" value="✓"/> |
| Field of pixel (width, height) [µm]  |    | 13,031 x 13,031   | 3. 4.  |

Fig. 4.21: CT-AAX

3. Click on **[Start calibration]**.

In the workspace, you can see two blue vertical guidelines. Move those to a position directly over the two selected scale lines. To increase the accuracy, you can zoom into the workspace.

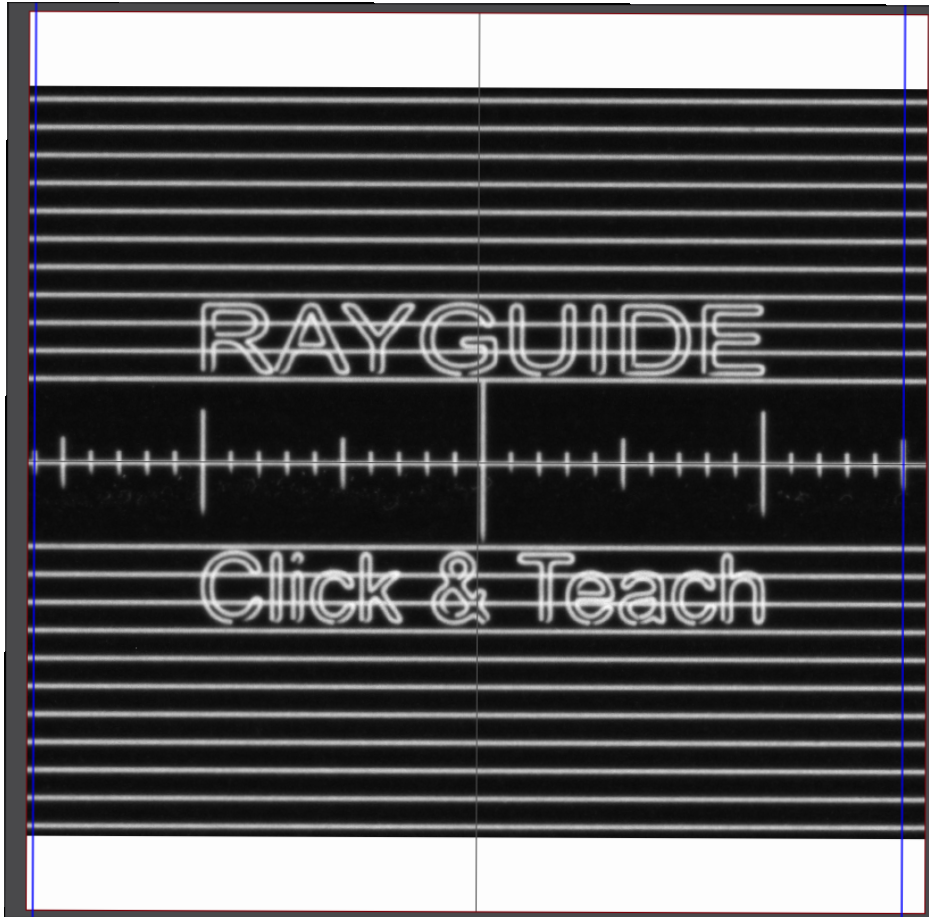


Fig. 4.22: CT-AAY

4. When the two guidelines are precisely positioned, click on the **[✓]** button to complete this calibration step. The system now knows the size of the area in the workspace that a single image tile or a camera pixel displays. The result is displayed in the *Field of View* and respectively *Field of Pixel* fields.

### 4.4.2.3 Calibration of the centre point

For design reasons, there is a natural deviation between the point to which the laser points and the centre point of the camera image. This offset is determined by centre point calibration and can be compensated for during tiling.

1. Click on the **[Start calibration]** button in the **Calibration of the centre point** area:

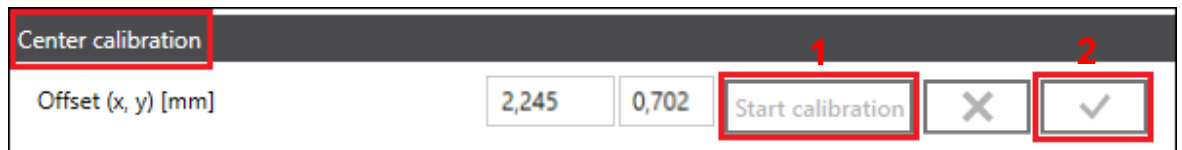


Fig. 4.23: CT-AAZ

In the same manner as for the calibration of the camera resolution, the camera image is displayed in the workspace of the RAYGUIDE as a background image, but this time with a vertical and a horizontal guideline. Move the blue lines in such a way that their point of intersection is directly over the centre point of the marked calibration reference:

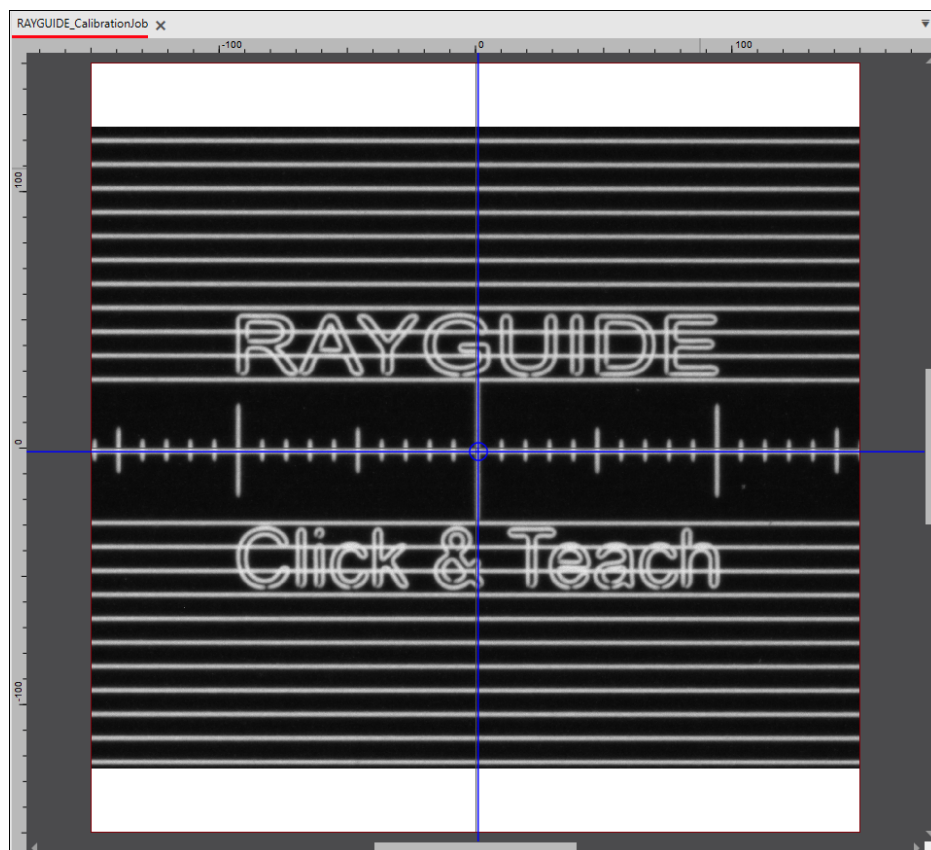


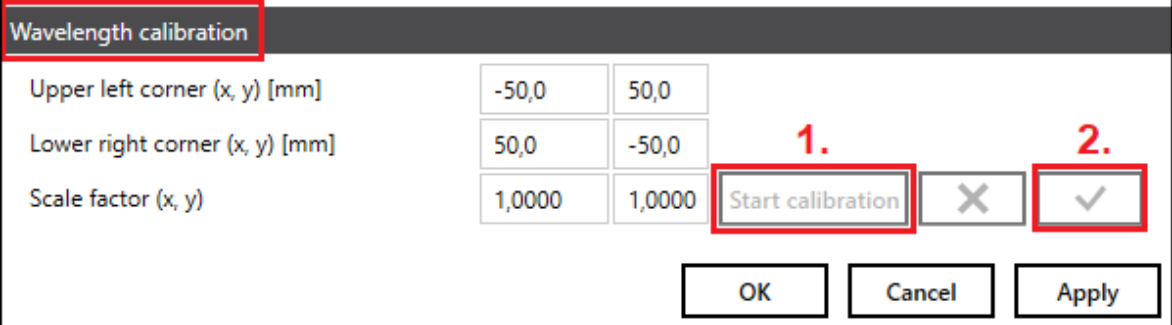
Fig. 4.24: CT-ABA

2. Click on the **[✓]** button to complete this calibration step.

#### 4.4.2.4 Wavelength calibration

Next comes a calibration step to compensate for chromatic aberration due to different wavelengths from laser to the camera observation wavelength.

1. Click on **[Start calibration]** in the **Wavelength calibration** area.



| Wavelength calibration         |                  |
|--------------------------------|------------------|
| Upper left corner (x, y) [mm]  | -50,0    50,0    |
| Lower right corner (x, y) [mm] | 50,0    -50,0    |
| Scale factor (x, y)            | 1,0000    1,0000 |

1. Start calibration    2. X    2. ✓

OK    Cancel    Apply

Fig. 4.25: CT-ABB

The camera is first aligned with the top left corner and the image is shown in the workspace.

2. The circled cross that the calibration job marked there should be visible. Move the two blue guidelines to the position where their point of intersection coincides with the centre point of the marked cross, and click on .

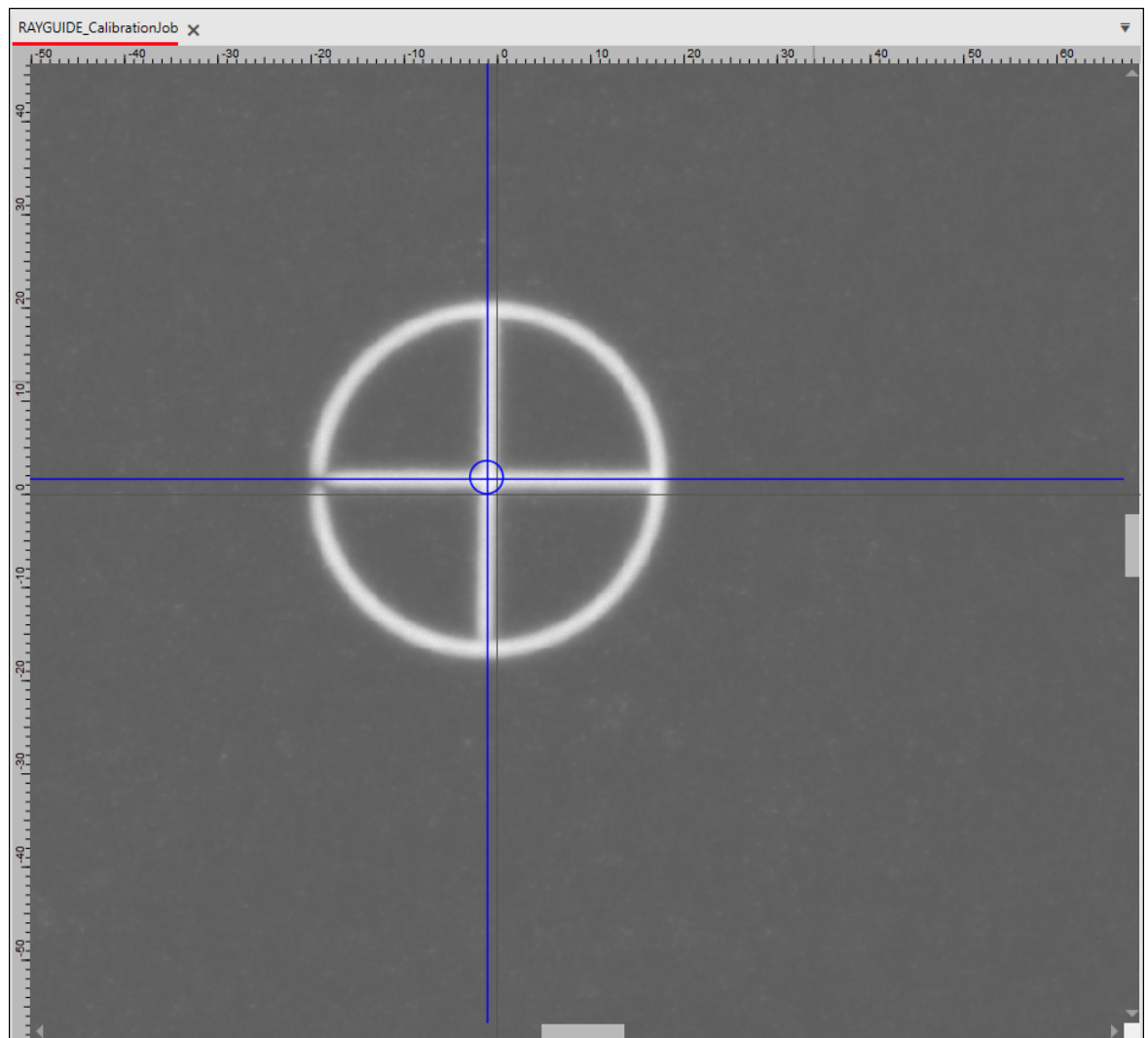


Fig. 4.26: CT-ABC

3. The camera jumps to the position of the lower right corner, where the second circled cross was marked. Again, align the guidelines with the cross and click the  button a second time to complete this calibration step.

The result is two scaling factors that compensate for the wavelength difference during tiling.

#### 4.4.2.5 Equalization calibration

The images recorded by the camera naturally show distortions in the beam path via the deflection mirrors and, if applicable, the F-Theta lens, which are particularly strong if there are image tiles at the field border. This is accompanied by positional deviations if the centre of an image tile does not correspond to the “point to be taught”.

This effect is to be corrected by means of equalization calibration. For this purpose, the calibration job contains a 5-cross pattern type in all four corners as well as in all coordinate directions.

**Equalization calibration**

1)

Create 2. calibration job

Tile position

2)

Top left

Top middle

Top right

Middle left

Bottom middle

Middle right

Bottom left

Bottom right

| Cross positions [%] | Middle |       |  |
|---------------------|--------|-------|--|
| Middle              | 50,00  | 50,00 |  |
| Top left            | 17,15  | 13,94 |  |
| Top right           | 90,12  | 13,96 |  |
| Bottom left         | 10,81  | 85,27 |  |
| Bottom right        | 83,71  | 85,67 |  |

3)

Start calibration

4)

✕

✓

OK

Cancel

Apply

Fig. 4.27: CT-ABD

The value table shows the X/Y-coordinates as a percentage of the camera image width and height of the five crosshair positions for the selected tile position.

1. Before you can start with this calibration step, click on the **[Create 2. calibration job]** button to create the required pattern type as an additional RAYGUIDE job. Also mark this pattern type on your calibration material.



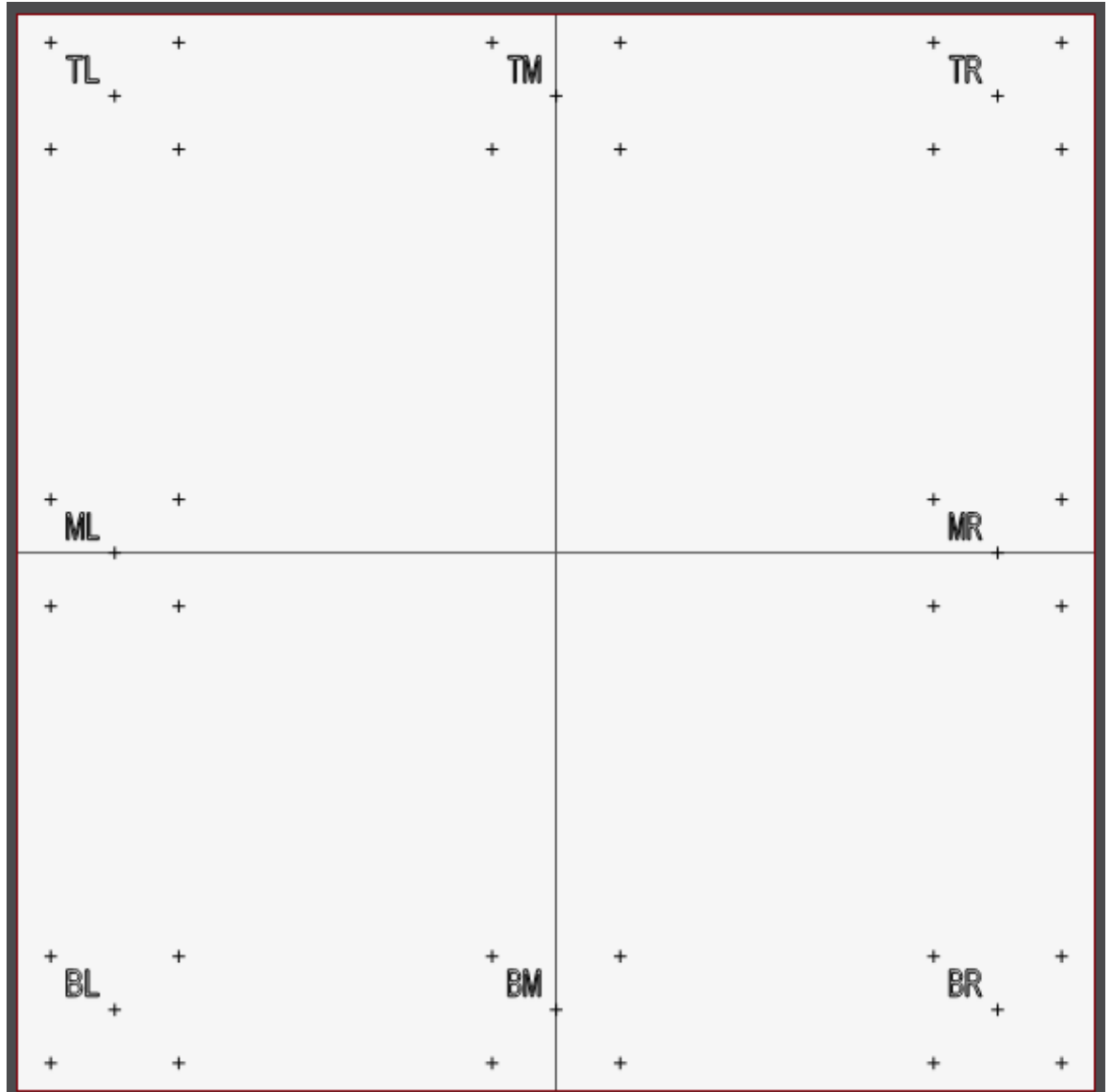


Fig. 4.28: CT-ABE

2. Select one of the eight tile positions.

The order in which you process the eight different tile positions is arbitrary.

**NOTES:**

At the beginning, all unprocessed calibration positions are coloured orange in the dialog. As soon as a calibration position has learned all five cross positions, the colour changes to black.

If you leave out a calibration position, no equalization correction will be able to take place in this area of the scan field.

3. Then also start this calibration step also by clicking the **[Start calibration]** button. An image tile of the selected tile position is displayed in full screen mode in the viewport.

Each tile position has five cross positions (one cross in the centre and one cross in each of the four corners). These must then be aligned with the blue auxiliary line crosses (“crosshairs”).

**NOTE:** It is advisable to zoom into the respective cross position with as high a resolution as possible in order to match the positions as accurately as possible.

At the beginning, the crosshairs are not congruent with the reference cross. You can see all the lines of all five crosshairs.

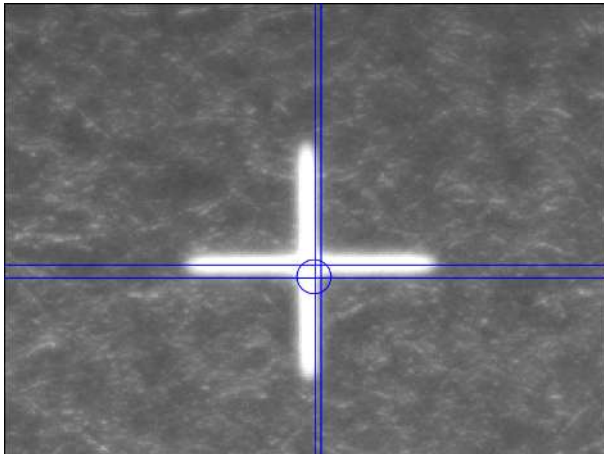


Fig. 4.29: CT-ABF

As soon as you start moving the crosshairs, you only see the relevant crosshairs.

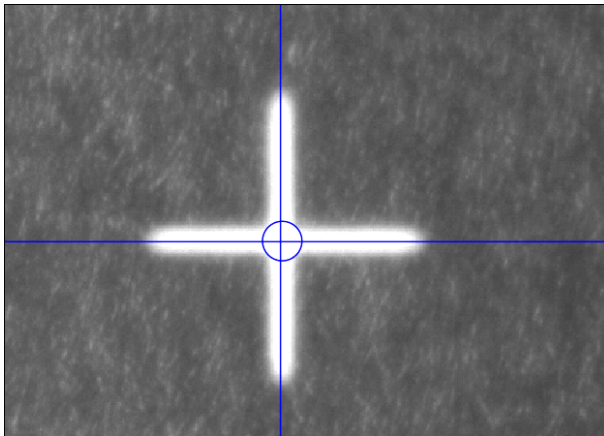
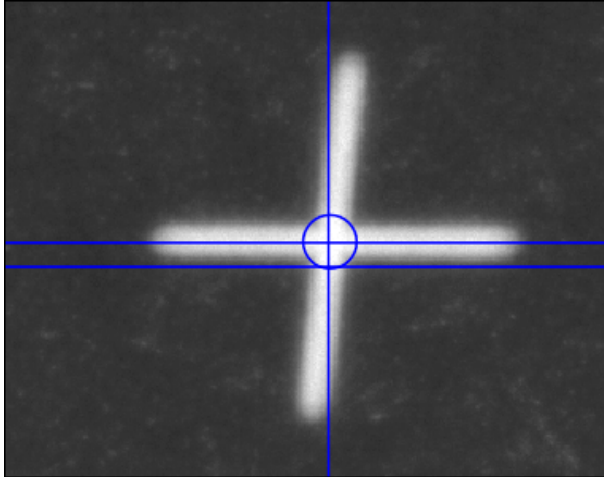


Fig. 4.30: CT-ABG

Once you have positioned the crosshairs so they are congruent and “let then go”, you can see all the crosshair lines again.



CT-ABH

Finally, all five crosshairs are adjusted. This tile position can be taught in with a click on the  button so that the position values of the crosshairs are included in the calibration calculation.

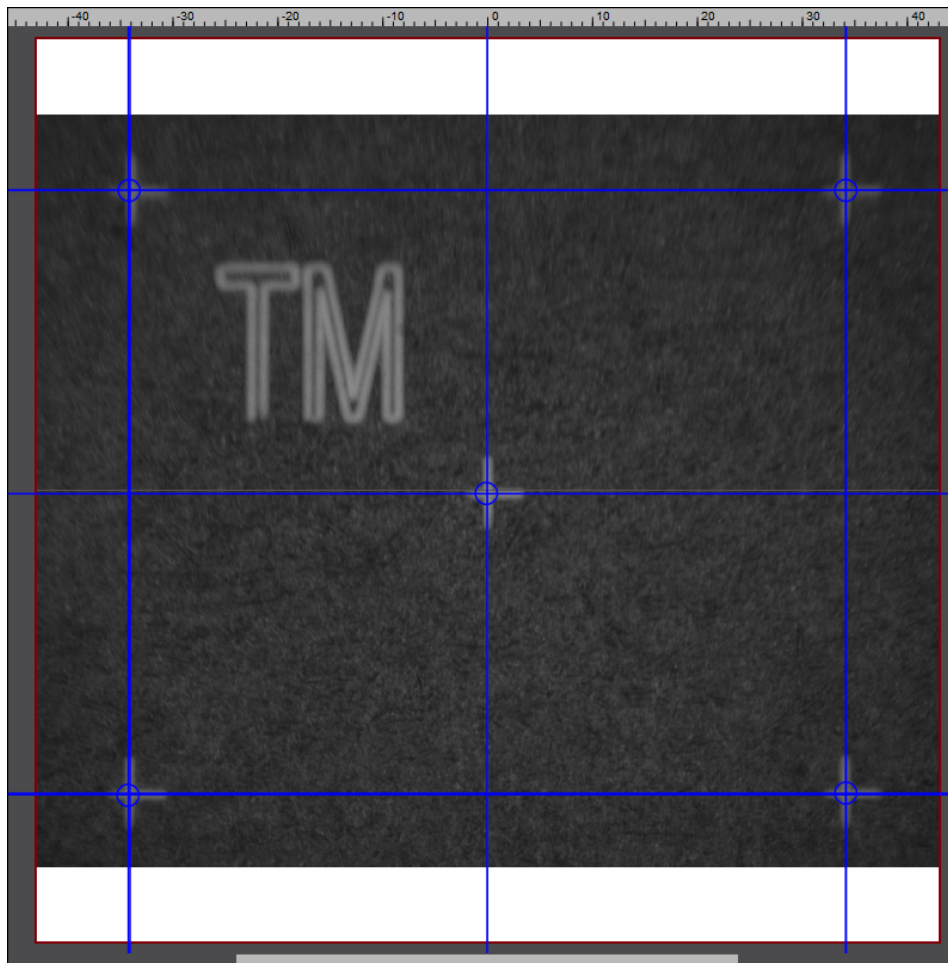


Fig. 4.31: CT-ABI

## 5 CLICK & TEACH PANEL

In the RAYGUIDE menu, select **View > Panels > CLICK & TEACH** to display the C&T panel. It can be shown or hidden, as desired, and is located in the same area as the panels for transformation and process adjustment (the standard position is on the right side of the screen). The panel can also be detached from this anchoring position. For example, it can be slid onto a second monitor and enlarged there to display the live image in full format.



Fig. 5.1: CT-ABJ

- |   |                                  |   |                             |
|---|----------------------------------|---|-----------------------------|
| 1 | Buttons                          | 5 | Progress bar                |
| 2 | Camera selection                 | 6 | Live image                  |
| 3 | Picking                          | 7 | Grey value gradient display |
| 4 | Focal plane of slider (optional) |   |                             |

**NOTE:** If the correction file used for the deflection unit provides a 3D working volume, this focal plane slider can be used to adjust the camera focus within the available working volume. The displayed z-value pertains to the coordinate axis in the field domain.

The C&T panel is subdivided into several areas, which are described below in detail.

### See also

- page 49, *Camera selection*
- page 50, *Buttons*
- page 53, *Picking*
- page 55, *CLICK & TEACH settings*
- page 58, *Live image*

## 5.1 Camera selection

Multiple deflection units can be equipped with cameras. Select the camera to be controlled in the *Camera* drop-down list.

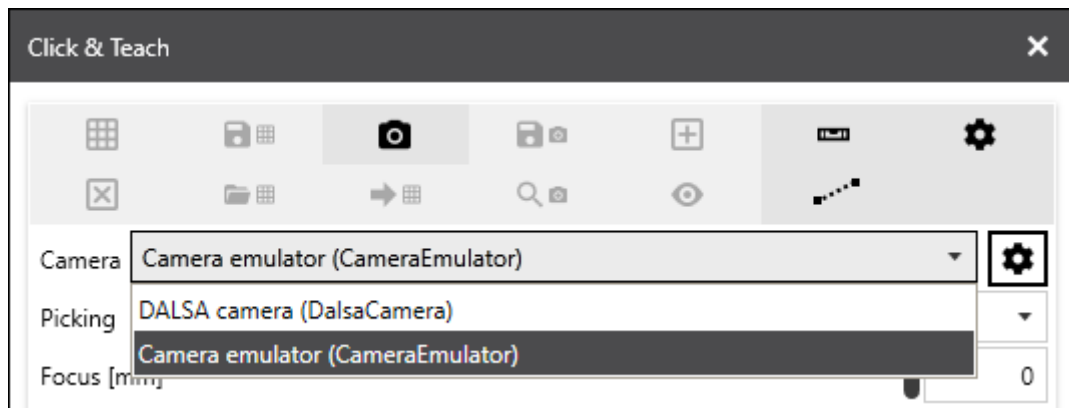


Fig. 5.2: CT-ABK

The name of the camera consists of the short designation of the camera and the camera type. With the button next to the camera selection, you can directly open the associated camera device dialog.

Communication is only possible with the camera selected here. This refers not only to picking and tiling, but also to calibration: if the camera is not selected in the panel, all buttons for calibration are greyed out in the **Calibration** tab of the camera dialog.

## 5.2 Buttons

### Icon buttons

The following icon buttons are offered in the C&T panel and explained in the following table:

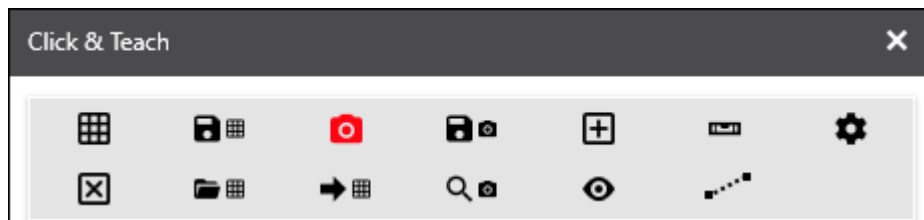















Fig. 5.3: CT-ABL

| Button / buttons  | Referenced as                    | Function  |
|---|----------------------------------|---|
|  | <b>[Tile workspace]</b>          | <p>Toggle button for tiling the entire workspace.</p> <p>The button appears red when the tiling process is running. Clicking the button again cancels the tiling process.</p> <p><b>NOTE:</b> If <b>[Tile workspace]</b> is clicked while the left shift key on the keyboard is pressed, all tiles are stored as PNG files in the <i>ClickAndTeach</i> subdirectory of the <i>Temp</i> directory.</p> <p><b>NOTE:</b> If the workspace is smaller than the scan field, only this area is tiled. If the workspace extends beyond the scan field, tiling only takes place up to the border of the scan field.</p> |
|  | <b>[Save current background]</b> | <p>Saves the current tiled scan field background to a file.</p> <p>Two variants are always saved:</p> <ul style="list-style-type: none"> <li>■ A <i>Without field rotation</i> variant (for reloading via CLICK &amp; TEACH) and</li> <li>■ an <i>Including field variation</i> variant if this image is to be used as the background image for RAYGUIDE jobs. These variants can be identified by the supplement to the file name.</li> </ul>  |
|  | <b>[Show / hide live image]</b>  | <p>Switches the live image on and off.</p> <p>The frame rate is 10 images per second.</p>   |
|  | <b>[Save live image]</b>         | <p>Saves the current live image in a file.</p>  |

| Button / buttons  | Referenced as                        | Function  |
|---|--------------------------------------|---|
|    | <b>[Adjustment line]</b>             | Shows / hides the adjustment line in the live image.<br>The adjustment line is used to support camera alignment, see <i>page 28, Aligning camera and adjusting focus</i> .<br><b>NOTE:</b> The position of the adjustment line can be moved up and down with the mouse wheel. |
|    | <b>[Settings]</b>                    | Opens the dialog with the C&T settings, see <i>page 55, CLICK &amp; TEACH settings</i> .  |
|    | <b>[Crosshairs on / off]</b>         | Switches the crosshairs on and off. The crosshairs mark the location on which the laser is positioned.<br><b>NOTE:</b> The size; thickness and colour of the crosshairs can be changed in the settings.   |
|   | <b>[Clear background]</b>            | Deletes the background of the workspace.  |
|  | <b>[Load background]</b>             | Loads the background of the workspace from a file.  |
|  | <b>[Load background loaded last]</b> | Reloads the background loaded last without opening a file selection dialog.   |
|  | <b>[Zoom in live image]</b>          | Zooms the viewport to the position of the live image. The selected option in the <i>Pick</i> drop-down list is taken into account: If, for example, the <i>3 x 3 tiles option</i> is selected, then this area is zoomed to this size.   |

| Button / buttons  | Referenced as                        | Function   |
|---|--------------------------------------|--|
|    | <b>[Preview]</b>                     | <p>Starts a special marking preview.</p> <p>The live image is switched on and crosshairs are displayed in it, which represent the position of the laser point. The current job geometry is then traced so that the crosshairs in the live image move along the geometry. This makes it possible to verify that the job geometry exactly matches the desired part contour.</p> <p><b>NOTES:</b></p> <ul style="list-style-type: none"> <li>■ Whether all or only selected geometry elements are run in the job can be defined in the <b>Execution</b> panel in the Preview area.</li> <li>■ The scanning speed used here can be defined in the CLICK &amp; TEACH settings.</li> <li>■ By default, the selected geometry is approached once completely.</li> <li>■ A running preview can always be stopped via the <b>[Abort]</b> button in the <b>Execution</b> panel. If you want the preview to repeat automatically, this can also be set in the CLICK &amp; TEACH settings.</li> <li>■ When running the preview, the wave length calibration must be taken into account. This is done by automatically applying the factors for the wavelength correction that were determined during camera calibration to the scaling of the current process transformation. After the preview is closed, the old scaling is restored.</li> </ul> |
|  | <b>[Display grey value gradient]</b> | <p>Displays a dotted line with two “thumb points” in the live image.</p> <p>The position of the line in the live image can be freely selected via the position of the thumb points.</p> <ul style="list-style-type: none"> <li>■ Blue thumb point = Start</li> <li>■ Red thumb point = End</li> </ul> <p>For this purpose, an area appears below the live image in which the grey value gradient is displayed along this line.</p>   |

Tab. 5.1: CT-003

**NOTE:** The opacity of the background images recorded via the camera can be adjusted with a slider. For details, see RAYGUIDE manual, chapter 4.3.



## 5.3 Picking

Apart from tiling the overall scan field, it is also possible to separately tile selected areas of the scan field by clicking on the desired position with the mouse pointer.

The picking tool is defined via two presets, which can be selected via two drop-down lists:

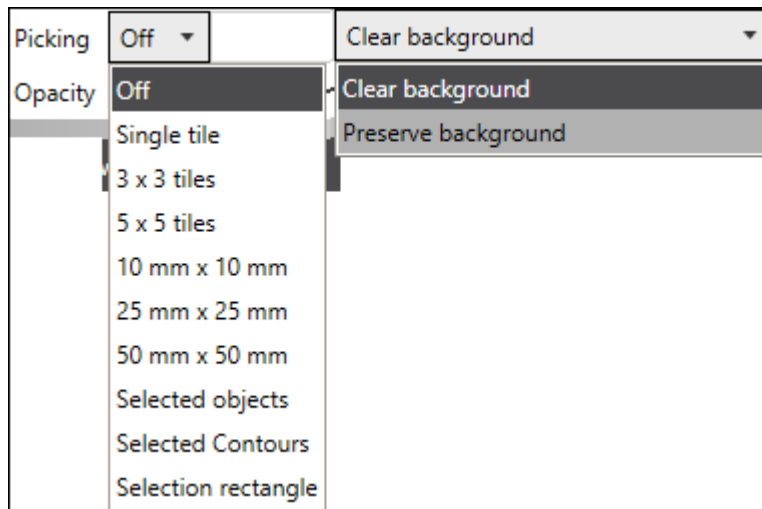


Fig. 5.4: CT-ABM

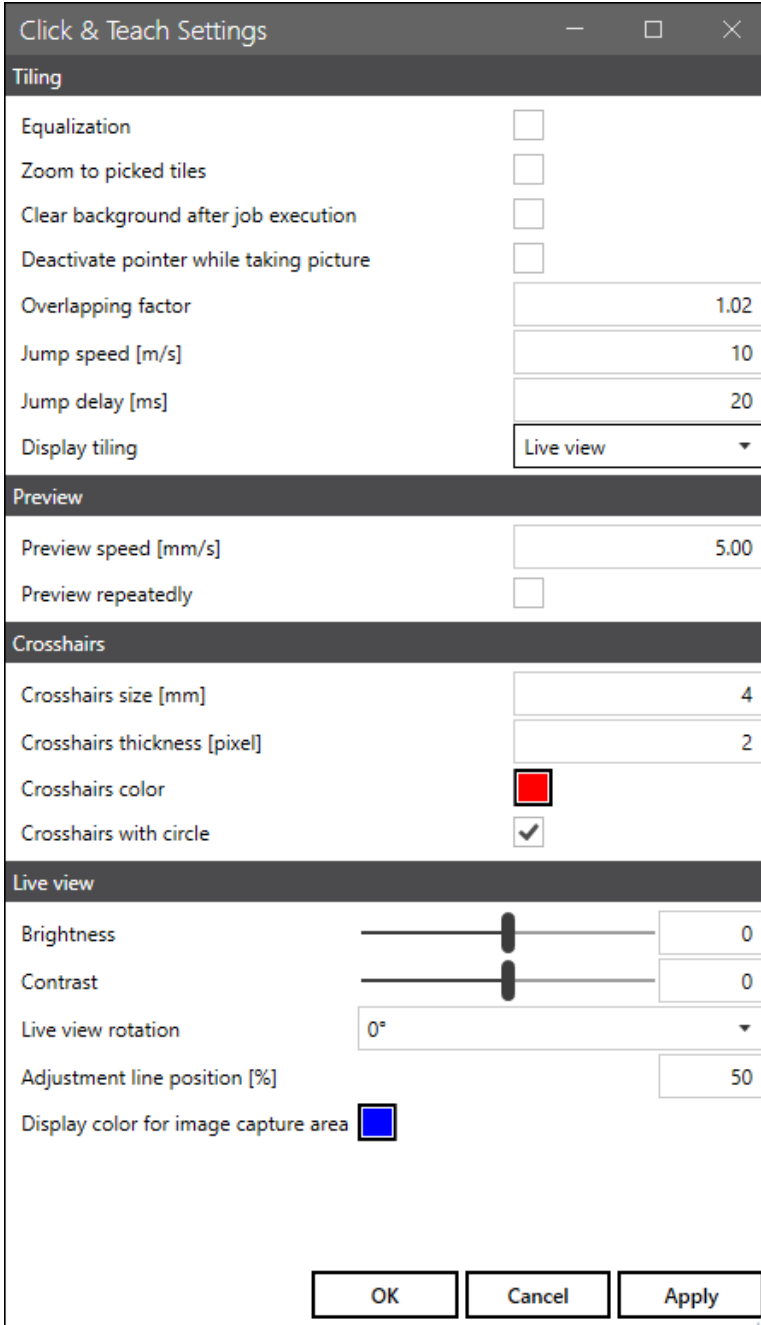
| Setting  | Explanation   |
|--|---|
| <b>Left drop-down list</b>                                     |   |
| Select the size of the area to be tiled or switch off picking. |   |
| Individual tile  | A single camera image is recorded in which the mouse pointer indicates the mirror positions.  |
| Tile area  | An area consisting of multiple camera images is recorded, where the mouse pointer indicates the mirror positions of the middle tile.<br>The area consists of 3x3, 5x5, 10x10, 25x25 or 50x50 tiles.   |
| Size in millimetres  | Assign a minimum size to the tiled surface.<br>Protruding areas that result from the tile size are not cut off.   |
| Selected objects   | Selected objects are completely tiled (rectangular). The location where picking occurs in the workspace is unimportant.   |
| Selected contours  | Tiles are generated along the selected outline. The selection of the outline can be a whole object, a layer, or a path. The location where picking occurs in the workspace is unimportant.  |
| Selection rectangle  | Use the cursor to drag open a rectangle on the workspace. The opened rectangle is tiled when the mouse is released.<br><b>NOTE:</b> An uneven number of tiles is always generated in the horizontal and vertical directions. Protruding areas that result from the tile size are not cut off. |
| <b>Right drop-down list</b>                                    |   |
| Two setting options for the background of the workspace.       |   |
| Clear background   | Existing C&T background images are deleted before new C&T image tiles are displayed.  |
| Preserve background  | Existing C&T background images are retained and new C&T image tiles are added or laid over the existing image tiles.  |

Tab. 5.2: CT-004

As is the case when tiling the entire scan field, all image tiles are also stored as PNG files during picking in the *ClickAndTeach* subdirectory of the *Temp* directory of the user if the left shift key on the keyboard is pressed while the mouse is clicked.

## 5.4 CLICK & TEACH settings

Under **Settings**, various configuration parameters can be set for different C&T functions:



| Section    | Parameter                               | Value / Option                      |
|------------|---|-------------------------------------|
| Tiling     | Equalization                            | <input type="checkbox"/>            |
|            | Zoom to picked tiles                    | <input type="checkbox"/>            |
|            | Clear background after job execution    | <input type="checkbox"/>            |
|            | Deactivate pointer while taking picture | <input type="checkbox"/>            |
|            | Overlapping factor                      | 1.02                                |
|            | Jump speed [m/s]                        | 10                                  |
|            | Jump delay [ms]                         | 20                                  |
|            | Display tiling                          | Live view                           |
| Preview    | Preview speed [mm/s]                    | 5.00                                |
|            | Preview repeatedly                      | <input type="checkbox"/>            |
| Crosshairs | Crosshairs size [mm]                    | 4                                   |
|            | Crosshairs thickness [pixel]            | 2                                   |
|            | Crosshairs color                        | Red                                 |
|            | Crosshairs with circle                  | <input checked="" type="checkbox"/> |
| Live view  | Brightness                              | 0                                   |
|            | Contrast                                | 0                                   |
|            | Live view rotation                      | 0°                                  |
|            | Adjustment line position [%]            | 50                                  |
|            | Display color for image capture area    | Blue                                |

Buttons: OK, Cancel, Apply

Fig. 5.5: CT-ABN

| Setting                                 | Explanation   |
|---|---|
| <b>Tiling</b>                           |   |
| Equalization                            | <p>Activates / deactivates the equalization, which can be achieved in the last calibration step of the camera.</p> <p><b>NOTE:</b> The integration of the equalization takes some additional computing time and is not always mandatory, therefore it can be used as an option.</p>                   |
| Zoom to the picked tiles                | <p>If activated, the workspace is automatically zoomed so that the picked tile(s) is / are displayed in full format.</p> <p>This can also be achieved by clicking on <b>[Zoom into live image]</b>.</p>   |
| Clear background after job execution    | <p>If activated: After the job has been executed, background images generated by CLICK &amp; TEACH are automatically deleted.</p>   |
| Deactivate pointer while taking picture | <p>If activated: To avoid interference in the image due to reflections of the pointer beam on the material, the pointer is switched off as soon as the camera records an image. The pointer can be switched on again after the image has been recorded.</p>   |
| Overlapping factor                      | <p>Due to unavoidable rounding errors, a one-pixel gap may arise between two individual image tiles. To avoid this, the tiles may overlap slightly. A value of 2 means, for example, that twice as many tiles will be generated, which will then overlap by 50% each.</p> <p>Default value: 1.02.</p> |
| Jump speed [m/s]                        | <p>Speed with which the mirrors jump from one tile position to the next.</p> <p>Default value: 10 m/s.</p>  |
| Jump delay [ms]                         | <p>The time the system waits after the mirrors have reached the desired positions before the image is taken.</p> <p>This can be useful if the camera can determine the exposure time and / or gain automatically and requires some time for this.</p> <p>Default value: 0 ms.</p>                     |
| Display tiling                          | <p>Select where you want to see the progress when tiling sections:</p> <ul style="list-style-type: none"> <li>■ In live image window</li> <li>■ Directly in the workspace (viewport)</li> </ul> <p>You can also deselect this display completely if you want.</p>                                     |

| Setting  | Explanation   |
|--|---|
| <b>Preview</b>                                 |   |
| Preview speed<br>[mm/s]                        | Defines the value for the C&T preview speed.  |
| Preview repeatedly                             | Switches the special C&T preview into an automatic repeat loop.<br>The repeat loop can be cancelled by clicking the <b>[Preview]</b> toggle button again or the general RAYGUIDE <b>[Abort]</b> button.   |
| <b>Crosshairs</b>                              |   |
| Crosshairs size [%]                            | The length of the crosshair bars is indicated as a percentage of the tile size.   |
| Crosshairs thickness [pixels]                  | The thickness of the crosshair bars is indicated in pixels.   |
| Crosshairs colour                              | Selection of the colour used to display the crosshairs.   |
| Crosshairs with circle                         | Selection of whether the crosshairs are surrounded by a circle.   |
| <b>Live image</b>                              |   |
| Brightness                                     | Slider to increase or decrease the brightness of the live image and all future image tiles. This does not influence image tiles that have already been recorded.<br><b>NOTE:</b> This setting does not change the camera settings, but is digital post-processing of the images.  |
| Contrast                                       | Slider to increase or decrease the contrast of the live image and all future image tiles. This does not influence image tiles that have already been recorded.<br><b>NOTE:</b> This setting does not change the camera settings, but is digital post-processing of the images.  |
| Live view rotation                             | The live image can be rotated in 90° steps.   |
| Adjustment line position [%]                   | Specification of the position of the adjustment lines in the live image in [%] of the live image height.<br>The position can be moved directly using the [+]/[-] buttons or the mouse wheel.  |
| Display colour for the image recording section | Selection of the colour used to display the areas in the view port where the camera records background images.<br>These camera recordings are controlled by the <i>Acquire and save image</i> automation object (see page 69, <i>Acquire and save image</i> )<br><b>NOTE:</b> To display the areas, select the automation object in the job tree. |

Tab. 5.3: CT-005

## 5.5 Live image

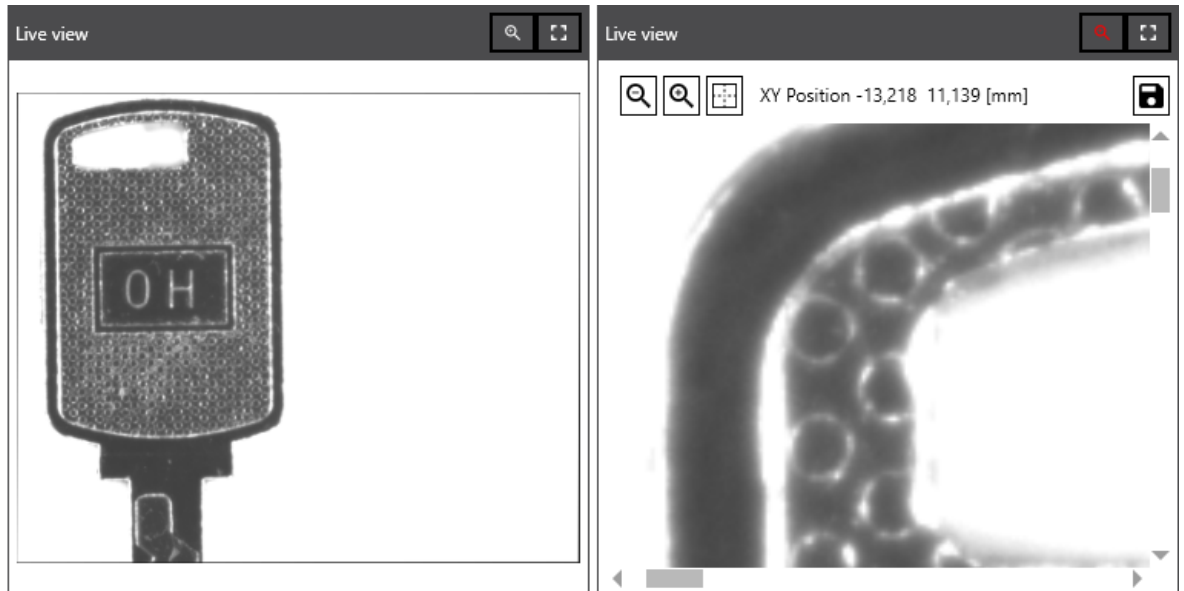







Fig. 5.6: CT-ABO

The live image is shown and hidden using the **[Show / hide live image]** button and can be stored using the **[Store live image]** button.

Other options for the live image are:

| Setting   | Explanation   |
|---|---|
|  | Enlarges the live image so that it takes up the entire area of the C&T panel and switches to so-called "full screen mode". <b>NOTE:</b> Any displayed adjustment lines or position lines of the grey value gradient are switched off.   |
|  | Adjusts the live image to the normal size in the C&T panel.   |
|  | Toggle button for activating / deactivating the zoom function even when the live image has the normal size.   |
|  | The three buttons serve to zoom into or out of the live image or to fit it back in.<br>In addition, the absolute cursor position in the workspace is displayed with X/Y-coordinates.<br><b>NOTE:</b> The zoom functions are only available in full screen mode of the live image. |
|  | Saves the current view of the live image.   |

Tab. 5.4: CT-006

The live image can be rotated in 90° steps. This allows it to be adjusted to a possible field alignment other than 0°.

**NOTE:** Note that the live image is not shown in the full camera resolution but is scaled down to the value set in the Scale factor field in the camera settings (see page 26, *Connecting / assigning the camera*).

## 5.6 Example of tiling

The following figure shows a tiling of a complete scan field with a marked line grid pattern type and with the full image size of the camera model used of 1936 x 1216 pixels:

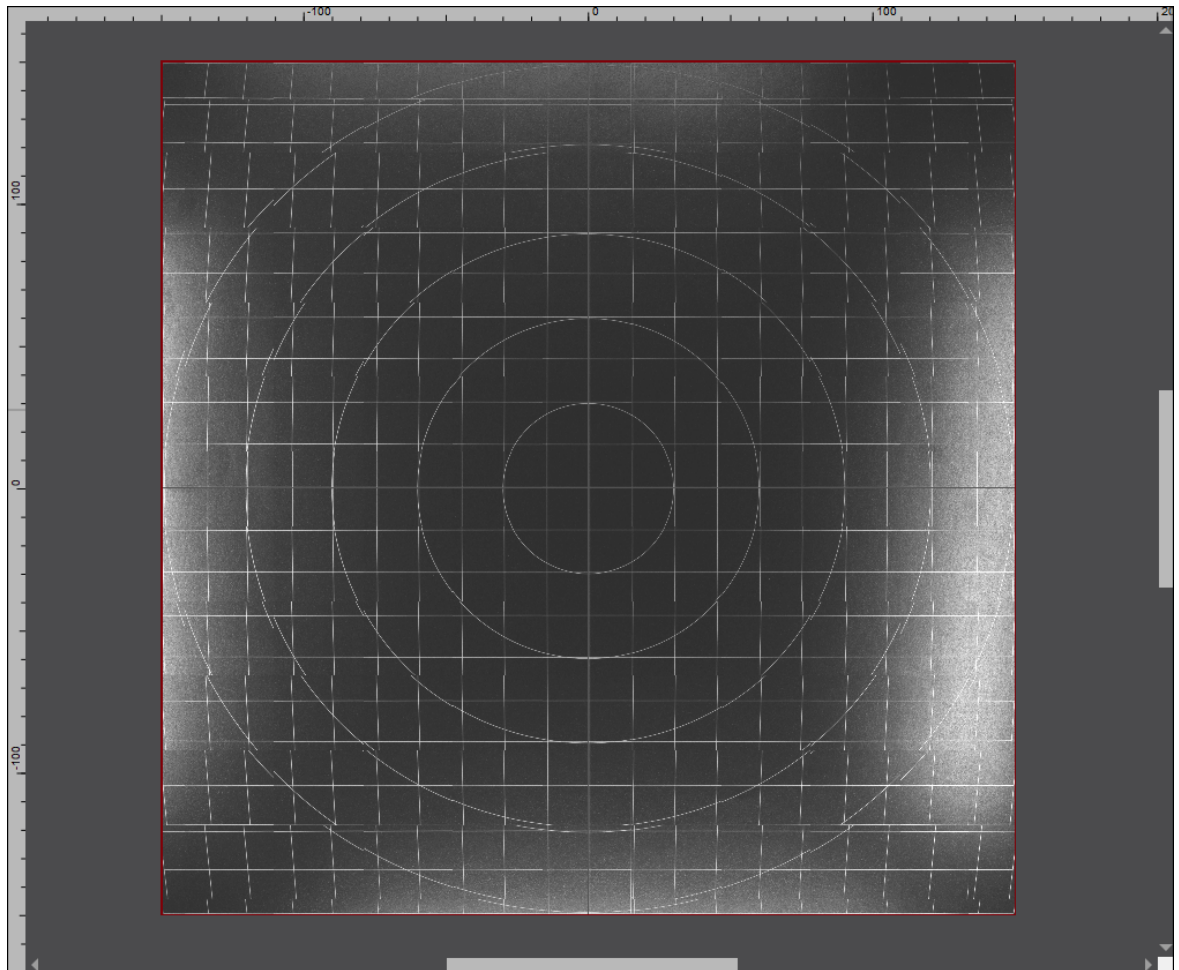


Fig. 5.7: CT-ABP

With 2-axis deflection units, the distortions can be caused by the F-Theta lens units, or with pre-focusing deflection units such as the AS FIBER, by the so-called geometric distortion.

However, if you pick individual contour points directly, this distortion effect is not so relevant. However, it can cause inaccuracies, especially when teaching positions in the area of the field border.

It is therefore advisable to carry out the equalization calibration and to activate equalization when tiling (see page 55, *CLICK & TEACH settings*).

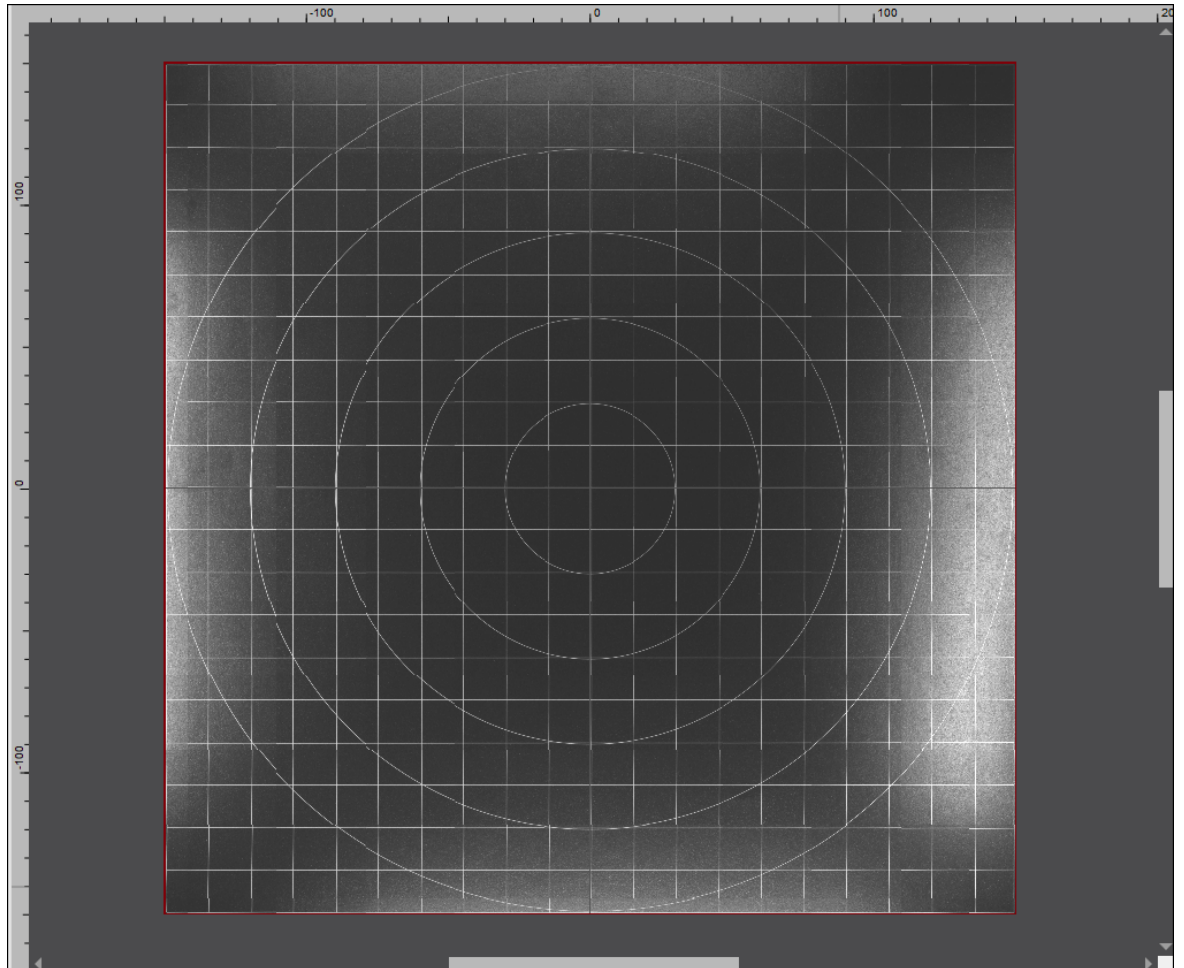


Fig. 5.8: CT-ABQ

**NOTE:** Another way to minimise distortion is to reduce the image size (see Camera dialog, **Settings** tab). More and smaller tiles are then created, which of course makes tiling take much longer.



## 6 ILLUMINATION

### 6.1 Illumination controller

RAYLASE offers you the option of using a 1-, 4- or 8-channel illumination controller from Gardasoft Vision Ltd. to light up your scan field. The illumination controller communicates via Ethernet with your computer or the RAYGUIDE application.



Fig. 6.1: CT-ABR (source: <http://www.gardasoft.com>)

**NOTE:** The illumination controller from GARDASOFT can also be addressed directly via a web interface if required. We recommend that you obtain the necessary documentation and software tools directly via the official website of GARDASOFT: [www.gardasoft.com](http://www.gardasoft.com).

First add the illumination controller as a device to the RAYGUIDE device configuration:

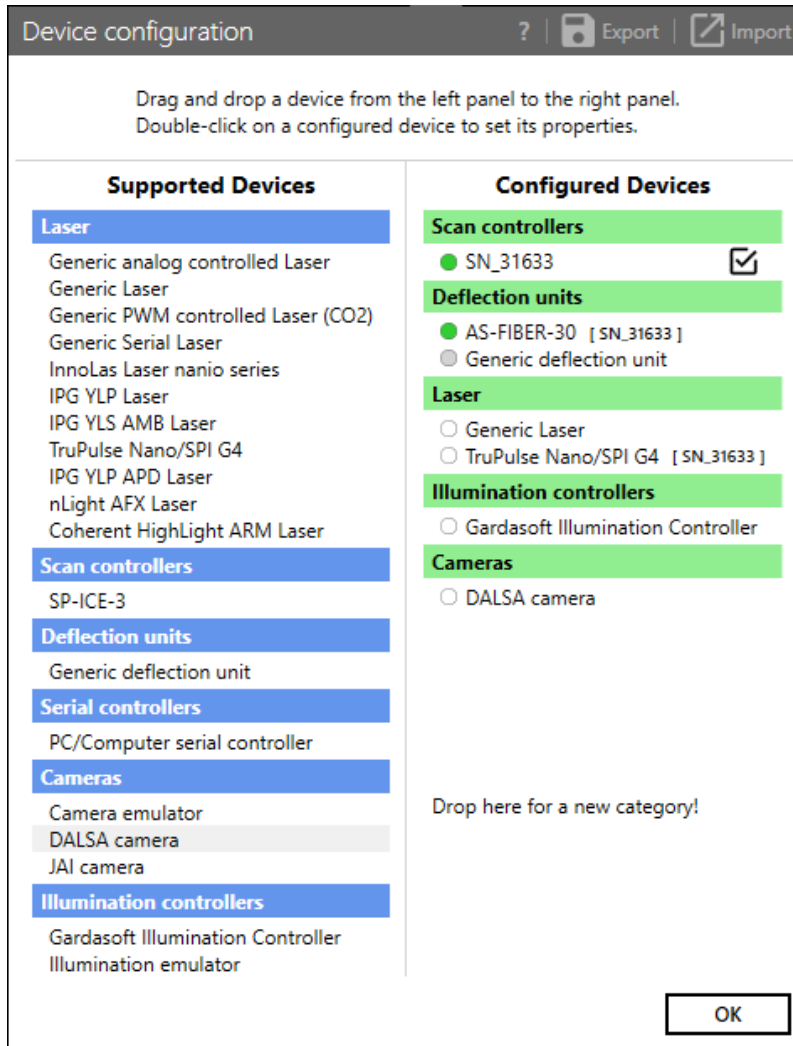
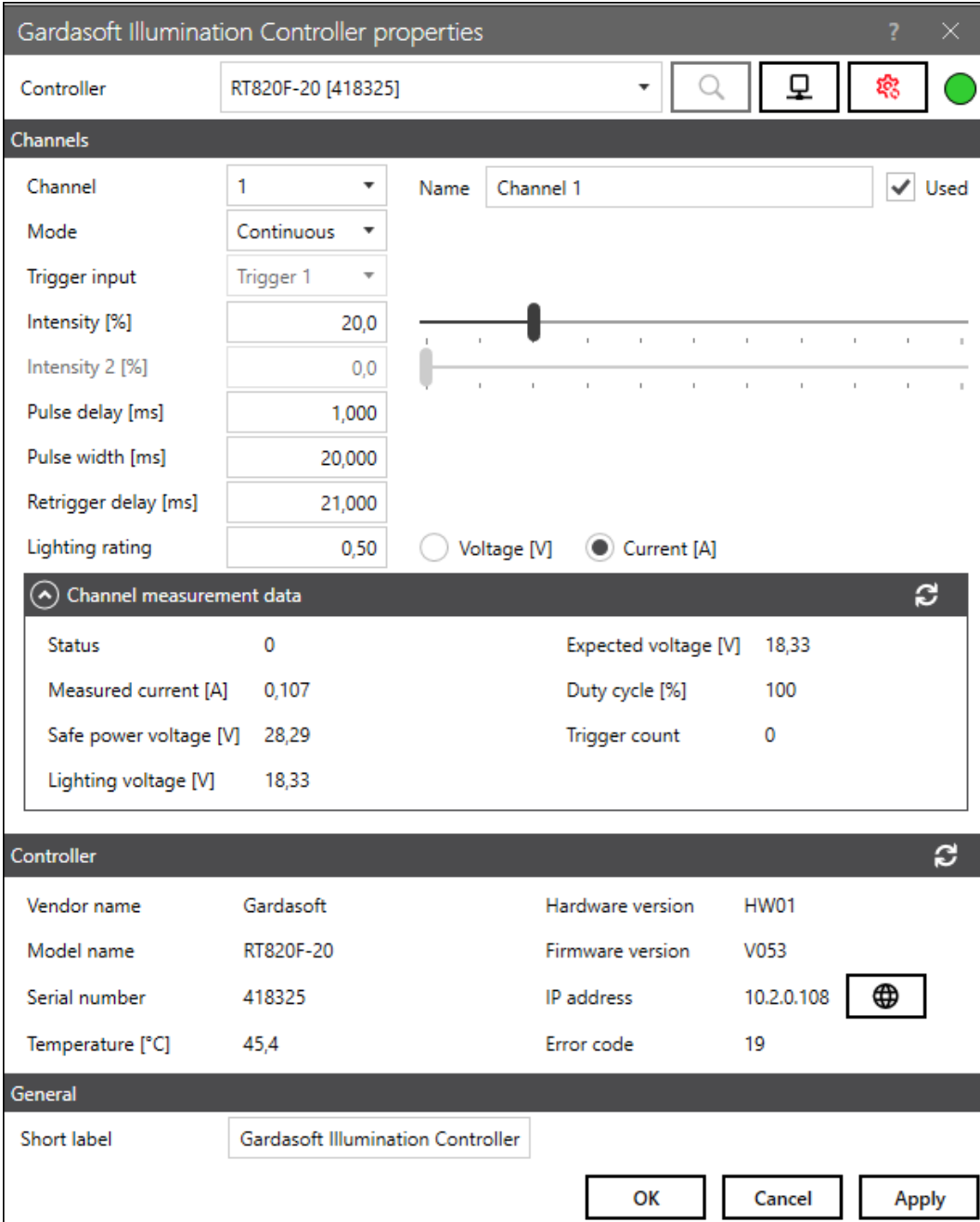


Fig. 6.2: CT-ABS

Open the Properties dialog by double-clicking on the new device entry (alternatively right-click and then select Properties):



**Gardasoft Illumination Controller properties**

Controller: RT820F-20 [418325]

**Channels**

Channel: 1 Name: Channel 1  Used

Mode: Continuous

Trigger input: Trigger 1

Intensity [%]: 20,0

Intensity 2 [%]: 0,0

Pulse delay [ms]: 1,000

Pulse width [ms]: 20,000

Retrigger delay [ms]: 21,000

Lighting rating: 0,50  Voltage [V]  Current [A]

**Channel measurement data**

|                        |       |                      |       |
|------------------------|-------|----------------------|-------|
| Status                 | 0     | Expected voltage [V] | 18,33 |
| Measured current [A]   | 0,107 | Duty cycle [%]       | 100   |
| Safe power voltage [V] | 28,29 | Trigger count        | 0     |
| Lighting voltage [V]   | 18,33 |                      |       |

**Controller**

|                  |           |                  |            |
|------------------|-----------|------------------|------------|
| Vendor name      | Gardasoft | Hardware version | HW01       |
| Model name       | RT820F-20 | Firmware version | V053       |
| Serial number    | 418325    | IP address       | 10.2.0.108 |
| Temperature [°C] | 45,4      | Error code       | 19         |

**General**

Short label: Gardasoft Illumination Controller

OK Cancel Apply

Fig. 6.3: CT-ABT

| Setting         | Explanation   |
|-----------------|---|
| Controller      | <p>Name and [serial number] of the illumination controller</p> <p>Click on the <b>[Search]</b> button to search for illumination controllers available in the network. The illumination controllers available in the network are listed with their model name and serial number. Identify the illumination controller by its serial number and select it.</p> <p>Then click on <b>[Connect / Disconnect]</b> to establish / disconnect the connection to the illumination controller. An active controller connection is indicated by a green traffic light.</p> <p>Use the <b>[Auto connect at startup]</b> shift key to define whether the illumination controller should be connected when starting RAYGUIDE.</p> <p>The button is activated by default. If you disconnect from the controller and do not want it to reconnect automatically the next time you start the program, you must disable this button.</p> <p><b>NOTE:</b> Even with auto connect active, it can take a few seconds until the connection to the illumination controller is established after the RAYGUIDE program starts.</p> |
| <b>Channels</b> |   |
| Channel         | <p>Select the channel number you want to edit.</p> <p>Depending on the model of the GARDASOFT illumination controller, you have 1, 4 or 8 channels at your disposal.</p> <p>All the following setting options apply per channel.</p>  |
| Mode            | <p>There are three modes to choose from:</p> <ul style="list-style-type: none"> <li>■ <b>Continuous:</b> The current for the illumination elements is constant and continuous (mode to be used by default).</li> <li>■ <b>Pulse:</b> A single pulse is emitted as specified in the settings when a trigger signal is received at the controller.</li> <li>■ <b>Switch:</b> This mode uses a trigger signal on the controller to switch the current on and off.</li> <li>■ <b>Selected:</b> This mode uses a trigger signal to switch between intensity value 1 and intensity value 2.</li> </ul> <p>The following applies: Intensity value 1 &gt; intensity value 2.</p>  |
| Trigger input   | Define which trigger input on the illumination controller is used for this channel.   |
| Intensity [%]   | Define the default value for the illumination intensity of the illumination element connected to the respective channel.  |
| Intensity 2 [%] | Define a second intensity value to be switched to in <i>Selected</i> mode.  |

| Setting   | Explanation  |
|---|--|
| Pulse delay [ms]  | Amount of time waited in <i>Pulse</i> mode after the trigger signal until the current for the pulse is switched on.  |
| Pulse width [ms]  | Amount of time until the current in <i>Pulse</i> mode is switched on.  |
| Retrigger delay [ms]  | Defines the minimum time allowed between two consecutive trigger signals. If a following trigger signal comes earlier, it is ignored.  |
| Lighting rating   | Defines the voltage or current value that causes 100% intensity for the connected illumination elements.<br><b>NOTE:</b> This value, as well as the information on whether the illumination elements are voltage or current controlled, must be taken from their technical data. |
| Voltage / current   | Select whether the light intensity is controlled by current or voltage at the controller.  |
| Measurement data channel<br>Use the expander to view available measurement data from the illumination controller. |  |
| <b>Controller</b>   |  |
| <b>NOTE:</b> Use the <b>[Refresh]</b> button to update the displayed information                                  |  |
| Illumination controller information   | Display of the most important information about the connected illumination controller such as <ul style="list-style-type: none"> <li>■ Model name</li> <li>■ Serial number</li> <li>■ Hardware or software version</li> <li>■ Temperature</li> </ul> Error code                  |
| <b>General</b>  |  |
| Short label   | Enter the name under which the illumination controller is to be listed in the device list.   |

**NOTE:** The illumination elements connected to the illumination controller light up as soon as the illumination controller receives its supply voltage. With which intensity depends on whether default values have already been set up in RAYGUIDE for this controller, or if it still has the factory settings.

The illumination elements go out as soon as either the connection to the illumination controller is disconnected (which can also be done by exiting the RAYGUIDE application) or when the power supply is shut off. As soon as the RAYGUIDE application starts and the connection with the illumination controller is established, the values stored in the unit configuration are set.

## 6.2 Illumination panel

**NOTE:** The default values of the illumination intensity of the illumination elements are set in the device configuration of the illumination controller (see chapter *page 61, Illumination controller*).

If the default values for the illumination intensity of the illumination elements need to be adjusted often, it is recommended to do this via the ***Illumination*** panel. In this panel, the intensity of the connected illumination elements can be set directly.

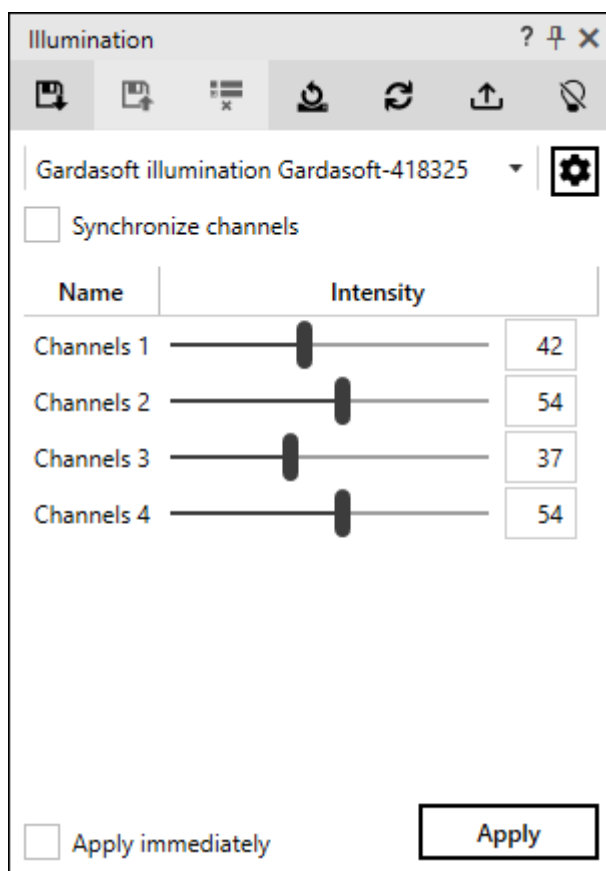







Fig. 6.4: CT-ABU

| Setting   | Explanation  |
|---|--|
|  | The buttons allow you to save the settings defined in the dialog, load already saved settings or delete a saved setting. |
|  | Button to reset the settings to the basic setting as defined in the device configuration.                                |

| Setting   | Explanation  |
|---|--|
|    | <p>Button to read back the last values commanded to the illumination controller from the illumination controller and to set the sliders to the corresponding position.</p> <p><b>NOTE:</b> This option is useful if another instance has written the illumination intensities to the controller.</p> |
|    | <p>Button for transferring the intensity values set in the panel to the device configuration.</p>  |
|    | <p>Toggle button for</p> <ul style="list-style-type: none"> <li>■ Directly switching off (intensity = zero) or</li> <li>■ Switching back on (intensity = last set value) all illumination elements</li> </ul>  |
| <p>Selection of illumination controller</p> <p>The <b>[Device dialog]</b> button enables direct opening of the device configuration of the selected illumination controller.</p>  |  |
| Synchronise channels  | Select this option if you want to set all channels to the same intensity.  |
| <p>Intensity slide regulator per channel with value field for setting the desired intensity</p> <p>The <b>Name</b> column shows the names – which can be freely defined in the Device dialog of the illumination controller – per channel.</p> <p><b>NOTE:</b> Only the channels that have been marked as “used” in the device configuration are displayed.</p> |  |
| Apply immediately   | Automatically writes the intensity values to the illumination controller as soon as the values have been changed.  |
| <b>[Apply]</b>  | Button to send the set intensity values directly to the illumination controller.   |



Tab. 6.1: CT-008

## 7 WEBCAM

This plug-in allows the integration of live images from a webcam into the RAYGUIDE GUI. Images from the laser chamber interior are often not visible to the user. With the help of the webcam, you can get a direct view of the laser process in the laser chamber.



Fig. 7.1: CT-ABV

| Setting   | Explanation   |
|---|---|
|  | Click on the <b>[Search]</b> button to search for available webcams.<br>When the search is complete, select one of the available webcams. |
|  | Click on the <b>[Camera]</b> button to start / stop streaming from the live image.  |

Tab. 7.1: CT-009



## 8 AUTOMATIONS

The two automation objects of the CLICK & TEACH extension are integrated in the Objects panel in the Automation objects category.

### 8.1 Acquire and save image



Button

This automation object is used to automatically record and save images of the workpiece in a job sequence with or without the contour superimposed in the GUI. One can use the images this way to check whether the laser contour still superimpose with the part contour as desired.

This automation object can be inserted at any point in the job sequence.

It acts like all other automation objects in RAYGUIDE (see RAYGUIDE manual, chapter 7.2.7).


#### **NOTE on the automation object in a RAYGUIDE duplication container**



In principle, this automation object can be placed in a duplication container. This means that the recording section can be copied to various positions via the workspace according to the rules of the container.

The following rules must be observed:

- In addition to this automation object, there must always be at least one marker object in the container.
- As this automation object uses a camera that is assigned to a deflection unit, the section that the container creates with its copies must *only be in one scan field*.

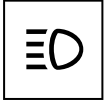
This rule must be observed when setting up *multi-scan field workspaces!*

| Setting  | Explanation   |
|--|---|
| Camera   | Select the camera device that will be used to make recordings from the list of available cameras.   |
| <b>Region of interest</b>  |   |
| <br>Centre (x, y, z) [mm] | Use the <b>[Pick]</b> button to drag the mouse cursor to the desired image area in the viewport. The centre and size are then entered automatically.<br>Display of the position of the area to be recorded by the camera.<br>If the image is to be recorded in a focus position other than z=0, enter the corresponding Z-coordinate. |

| Setting   | Explanation   |
|---|---|
| Size (width, height) [mm]<br>        | Display of the dimensions of the area to be recorded by the camera.<br>The selected area is visualised with a blue rectangle in the view window.<br>Use the <b>[Reset]</b> symbol to reset the area to the size of a single image tile.           |
| Reduce camera field of view to ...x... pixels   | Set this option if only the selected recording section is to be retrieved by the camera to save data transfer time.<br>The values show how many pixels the selected section requires.   |
| <b>Location</b>   |   |
| File name   | Enter any file name you want for the recordings.  |
| Edition   | Display the file name which consists of the file name and time stamp.<br>The file format is *.png by default.   |
| <b>Settings</b>   |   |
| Overlay workspace   | Select: <ul style="list-style-type: none"> <li>■ Whether the contours located in the recording area of the workspace are to be saved in the image</li> <li>■ Or if only the background images recorded with the camera should be saved</li> </ul> |
| Stroke thickness  | Specification of the line width for the contour lines in the result image.  |
| Line colour   | Select a colour for all contour lines or whether the contour lines are displayed with your respective pen colour.   |
| <b>Preview</b>  |   |
|                                    | Use the <b>[Update]</b> button to display the preview again.  |
| <b>General</b>  |   |
| <b>NOTE:</b> The generally valid properties of automation objects can be found in the RAYGUIDE manual, chapter 7.2.7. |   |

Tab. 8.1: CT-010

## 8.2 Set illumination



Button

With the help of this automation object, the illumination elements connected to the illumination controller can be automatically set to a certain intensity in a job sequence.

This automation object can be inserted at any point in the job sequence.

It acts like all other automation objects in RAYGUIDE (see RAYGUIDE manual, chapter 7.2.7).

The following properties of the automation object can be set:

| Setting   | Explanation   |
|---|---|
| Controller  | Selection of an illumination controller   |
| Synchronise channels  | Select this option if you want to set all channels to the same intensity.                                     |
| <b>Channel</b>  |   |
| Use the <b>tab</b> to determine whether this channel or its intensity value should be set or whether it remains unchanged when the automation object is executed. |   |
| Intensity slide regulator per channel with value field for setting the desired intensity  |   |
| The <b>Name</b> column shows the names – which can be freely defined in the Device dialog of the illumination controller – per channel.                           |   |
| <b>NOTE:</b> Only the channels that have been marked as “used” in the device configuration are displayed.   |   |
| Delay [ms]  | The time to wait after setting the intensity values since the illumination elements need some time to adjust. |
| <b>General</b>  |   |
| <b>NOTE:</b> The generally valid properties of automation objects can be found in the RAYGUIDE manual, chapter 7.2.7.   |   |

Tab. 8.2: CT-011

## 9 CAMERA EMULATOR

The camera emulator is available for testing, presentation and training purposes. It can be used to simulate the operation of most C&T functions, such as calibration and picking / tiling, without having to connect an actual camera.

If a deflection unit with a pilot laser is available, the functionality of C&T can be demonstrated clearly even without a real laser.

Instead of having to record images, the emulator already contains a large image from which, depending on the mirror position, areas can be shown as "live" images or image tiles. As with real cameras, the emulator is designed as a RAYGUIDE plug-in. To work with an emulated camera, first add it as a device:

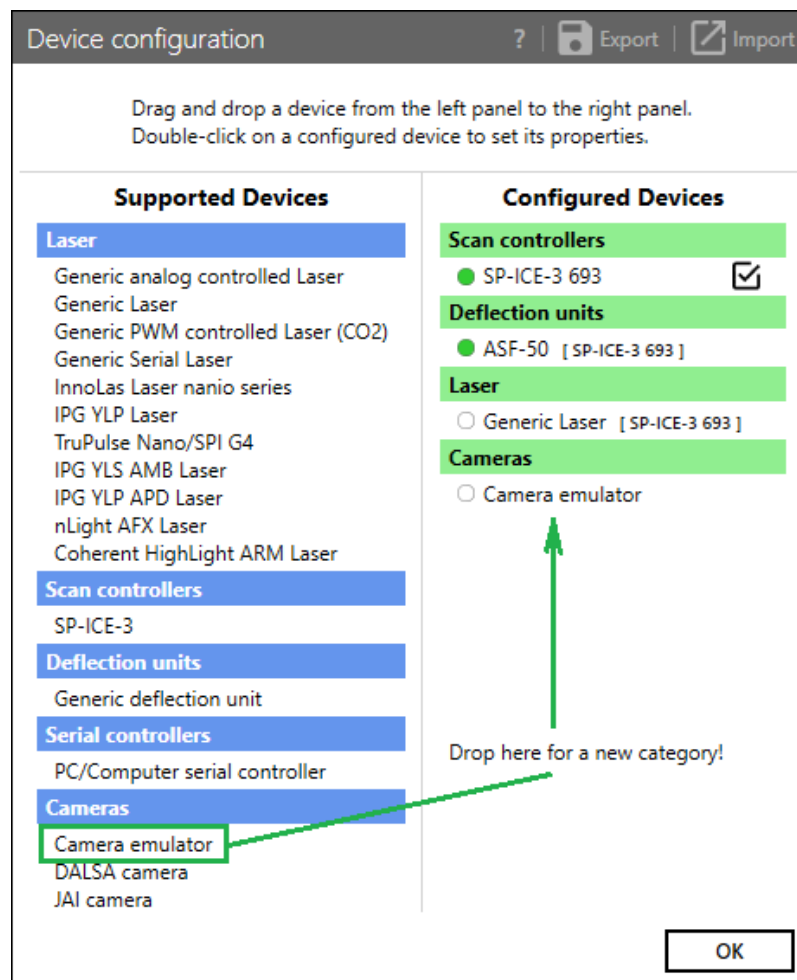
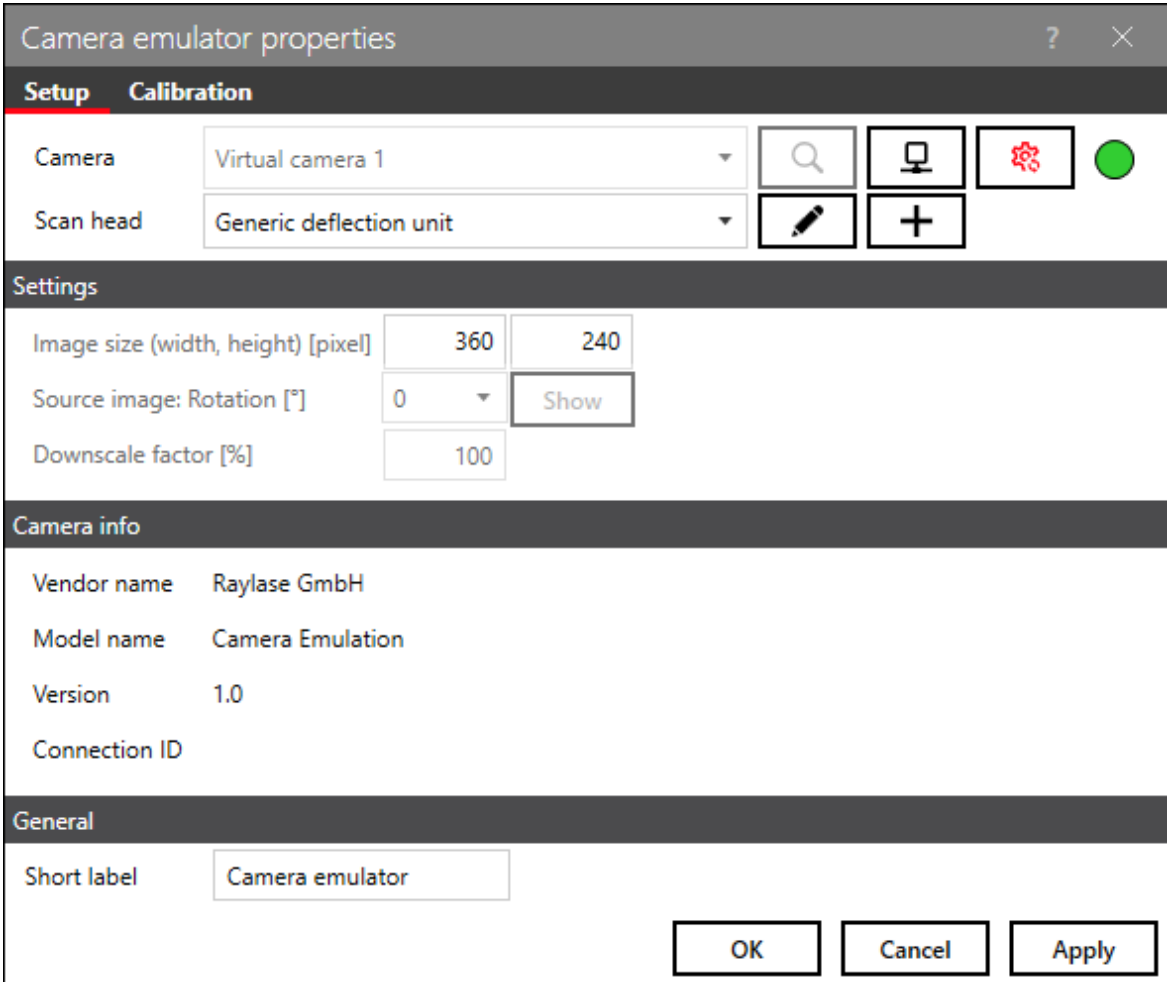


Fig. 9.1: CT-ABW

In the next step, select one of the four available emulated cameras and activate the connection.

Just as with a real camera, a deflection unit must be assigned to the emulated camera.



Camera emulator properties

**Setup** Calibration

Camera: Virtual camera 1

Scan head: Generic deflection unit

Settings

Image size (width, height) [pixel]: 360 240

Source image: Rotation [°]: 0 Show

Downscale factor [%]: 100

Camera info

Vendor name: Raylase GmbH

Model name: Camera Emulation

Version: 1.0

Connection ID:

General

Short label: Camera emulator

OK Cancel Apply

Fig. 9.2: CT-ABX

| Setting                             | Explanation  |
|-------------------------------------|--|
| <b>Settings</b>                     |  |
| Image size (width, height) [pixels] | Setting of the image size.<br>The maximum size of the camera image is limited to 360 x 240 pixels. For real cameras, it can be useful to reduce the size since the unavoidable distortions become smaller as a result. The emulator always generates an undistorted image, making a reduction in size unnecessary. |
| Source image rotation [°]           | If a rotation is set in the deflection unit, it can be compensated here to achieve a vertically oriented image.  |
| <b>[Show]</b>                       | Clicking on <b>[Show]</b> shows the background image in the workspace. This can be useful for the calibration of the emulator; see <i>page 77, Manual calibration</i> .  |
| Downscale factor [%]                | Adjustment of the downscale factor.<br>The source image of 3000 x 3000 pixels is small enough so that the scaling factor can be set to 100% without reductions in performance.   |

Tab. 9.1: CT-012

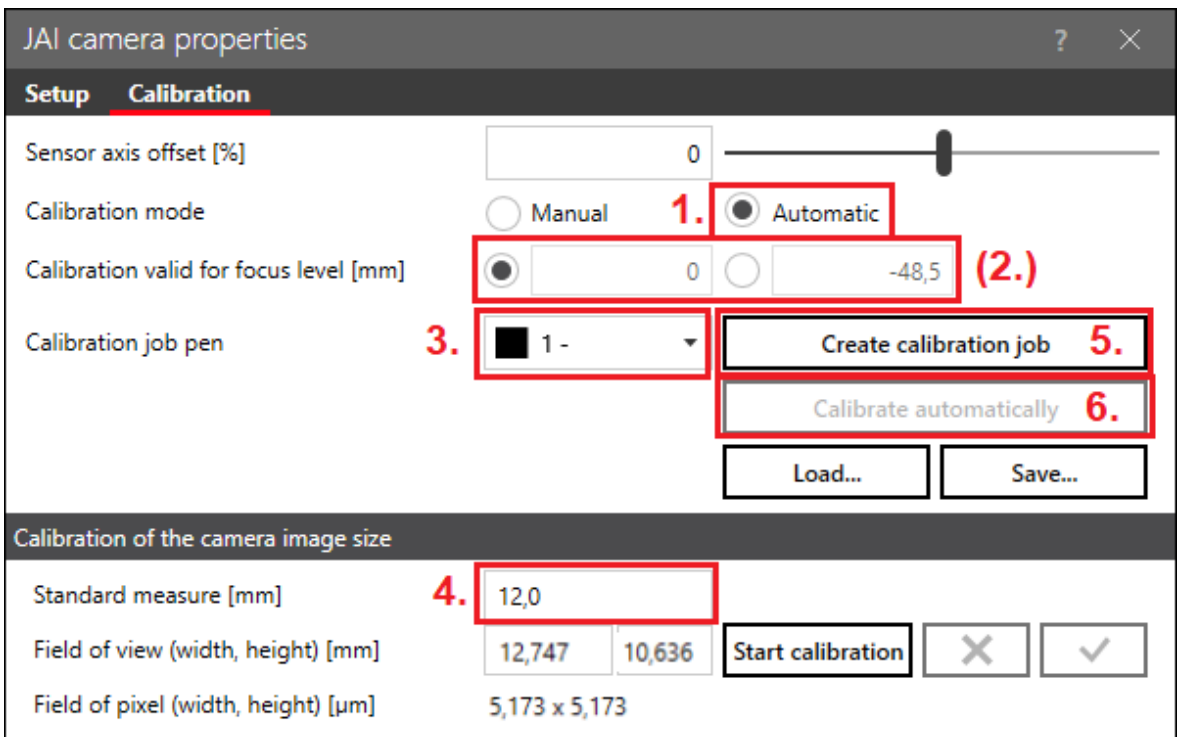
Afterwards, the emulated camera is ready for simulation within the scope of its possible options.

## 9.1 Calibration

### 9.1.1 Automatic calibration

The automatic calibration simplifies the calibration process through the use of image processing algorithms.

**NOTE:** This option is only available for the emulated camera.



JAI camera properties

Setup **Calibration**

Sensor axis offset [%]

Calibration mode  Manual **1.**  Automatic

Calibration valid for focus level [mm]     **(2.)**

Calibration job pen **3.**   **5.**

**6.**

Calibration of the camera image size

Standard measure [mm] **4.**

Field of view (width, height) [mm]

Field of pixel (width, height) [µm] 5,173 x 5,173

Fig. 9.3: CT-ABY

1. Set the calibration model to *automatic*.
2. Optional: **Defining focal plate for camera calibration**

If the workspace used has an extension in the z direction, the calibration described below must be performed at least twice: at the highest point (z-position = 0 mm) and again at the lowest point if possible (depends on the values in the correction file). The obtained calibration data are then automatically interpolated (linearly) for the intermediate z-positions.

**NOTE:** The value for the lower focal plane is always specified as per the correction file. If a marking is not possible in this focal plane because of the system design, an alternative value can be entered.

3. Select a pen that achieves good results on the surface to be marked.

**ATTENTION:** A good marking result is required for pattern recognition to be successful. The laser parameters must have been determined in advance on the basis of simple marking tests. Image recognition requires good illumination with sufficient contrast.

4. In the *Measure* field, enter the approximate width of the area in the workspace that is displayed by the camera. This value determines the size of the checkerboard pattern that the calibration job will contain and that will later need to be recognised during image processing.
5. Generate the calibration job and carry it out. It consists of several sensibly arranged squares that are to be detected by the image detection feature.
6. Perform the automatic calibration. While it is running, the calibration step that was just executed is logged in the status bar of the RAYGUIDE software at the bottom right.

Then a dialog appears that displays either the success of or the failure of image recognition. If calibration was successful, the determined values are automatically entered in the corresponding fields of the Settings dialog. The dialog is closed by clicking on **[OK]**.

If calibration fails, try to improve the illumination or to adjust the laser parameters. You can also see the results of image processing directly as images by pressing the left shift key and clicking on **[Calibrate automatically]**. In this case, RAYGUIDE places five PNG files into the *temp* directory of the user (enter *%temp%* into the address line of Windows Explorer to open it). These files all begin with *ClickAndTeach* and mark identified checkerboard patterns with a grey border.

Because the size of the source image from which the areas are displayed and the dimensions of the processing field are known, the automatic calibration always functions perfectly because the calibration parameters can simply be calculated. It is not necessary to create a calibration job.

Switch to the automatic calibration mode and click on **[Automatic calibration]**.

**NOTE:** Automatic centre point calibration only works with the integrated source image since the centre point shift is known (12 pixels in the x direction and 24 pixels in the negative y direction at 3000 x 3000 pixels overall size). When using a separate source image, you need to perform the centre point calibration manually.



## 9.1.2 Manual calibration

For demonstration purposes or when using your own source image, the calibration can be performed manually. The procedure is slightly different than for a real camera because the creation of the calibration job is replaced by the manual measurement of suitable distance markers in the source image.

Problem: The integrated source image has a size of 3000 x 3000 pixels and contains scales on the x- and y-axes, where the individual "millimetre" markings are spaced 10 pixels apart:

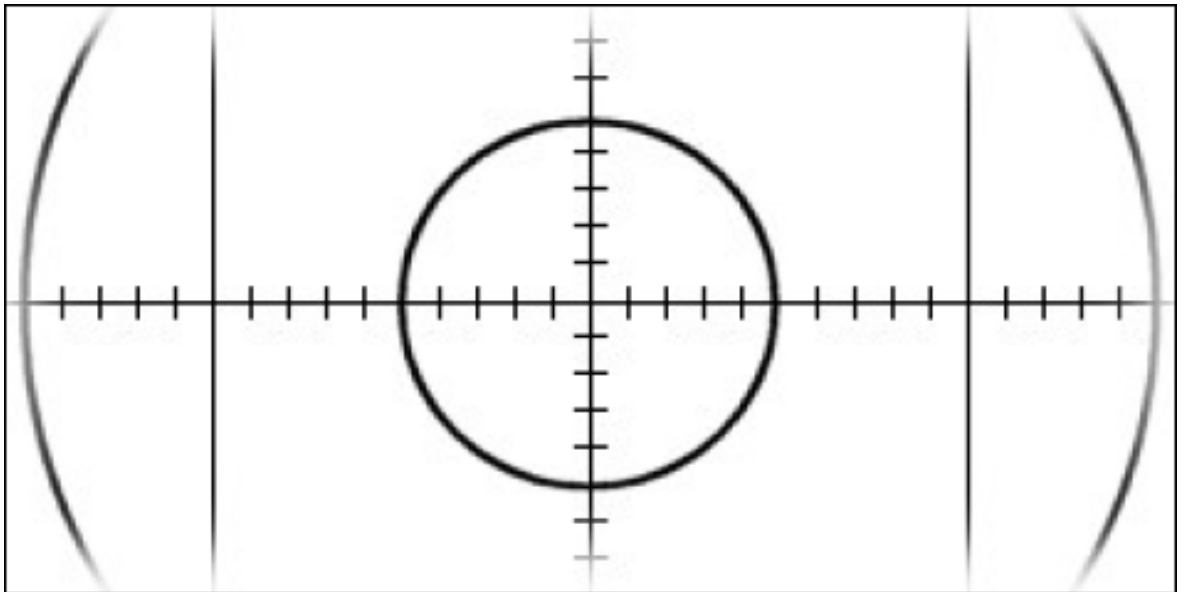


Fig. 9.4: CT-ABZ

The source image is now always shown in the background of the processing field with its full width and height. The width of the processing field is always 3000 pixels. In a processing field of 300 mm x 300 mm, 10 pixels are equivalent to exactly one millimetre. However, this is not the case for processing fields of different sizes, in which case a suitable reference size needs to be determined before the actual calibration is performed.

The necessary steps for manual calibration are described below:

1. Click on **[Start calibration]** in the Calibration area of the camera image size. The centre of the imaging field is enlarged in the workspace:

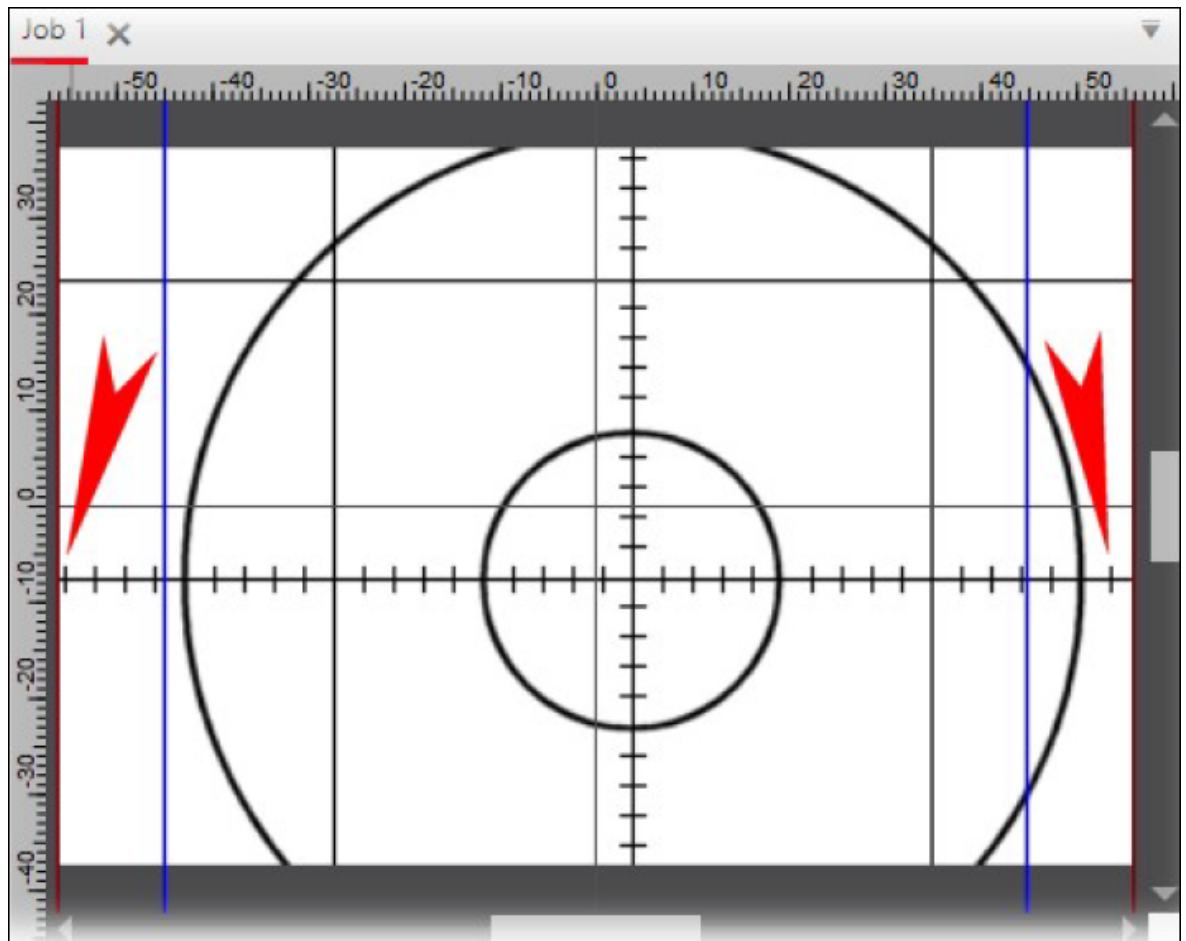


Fig. 9.5: CT-ACA

2. Find two points in the image that are as far apart as possible and that can be easily found again. In the example, the "millimetre" markings identified with red arrows at -19 and +16 are convenient points. The question now is how far apart these points are in the real world. With a 300 mm field, it would be exactly 35 mm. In this example, however, we use a field of 112 mm x 112 mm. With a pixel distance of 35 \* 10 pixels, one could now convert the true distance according to the formula  $112 \text{ mm} / 3000 \text{ pixels} * 350 \text{ pixels} = 13.067 \text{ mm}$ . This distance can also be measured. To do so, terminate the calibration procedure by clicking on **[Cancel calibration]**. Display the overall image in the background by clicking on **[Show]** under Settings:

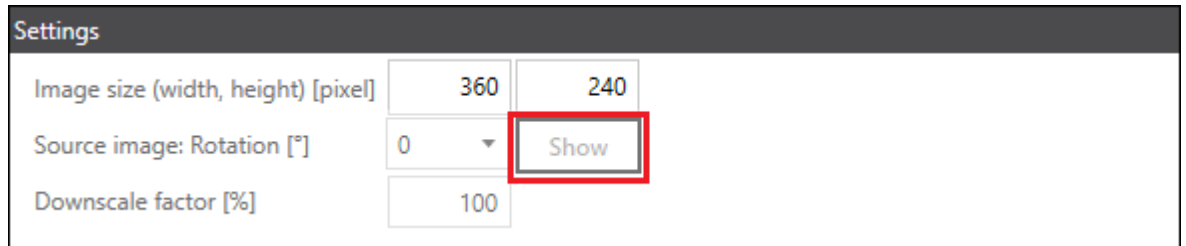


Fig. 9.6: CT-ACB

- Zoom into the image until both markings are easy to see. Measure the distance using the *Measure distance* tool of RAYGUIDE:

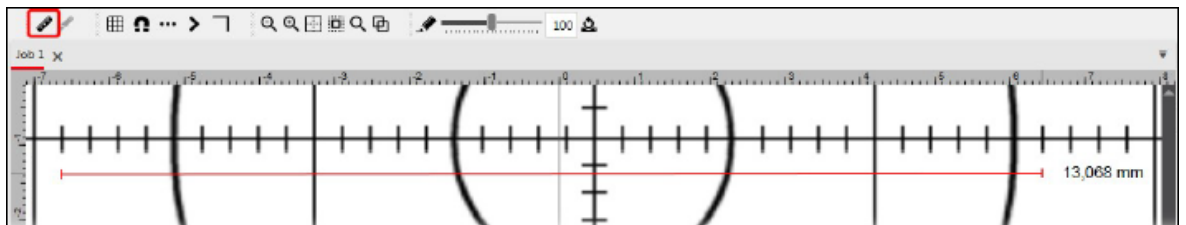


Fig. 9.7: CT-ACC

- Enter the value (recommendation: calculated value) into the *Measure* field:

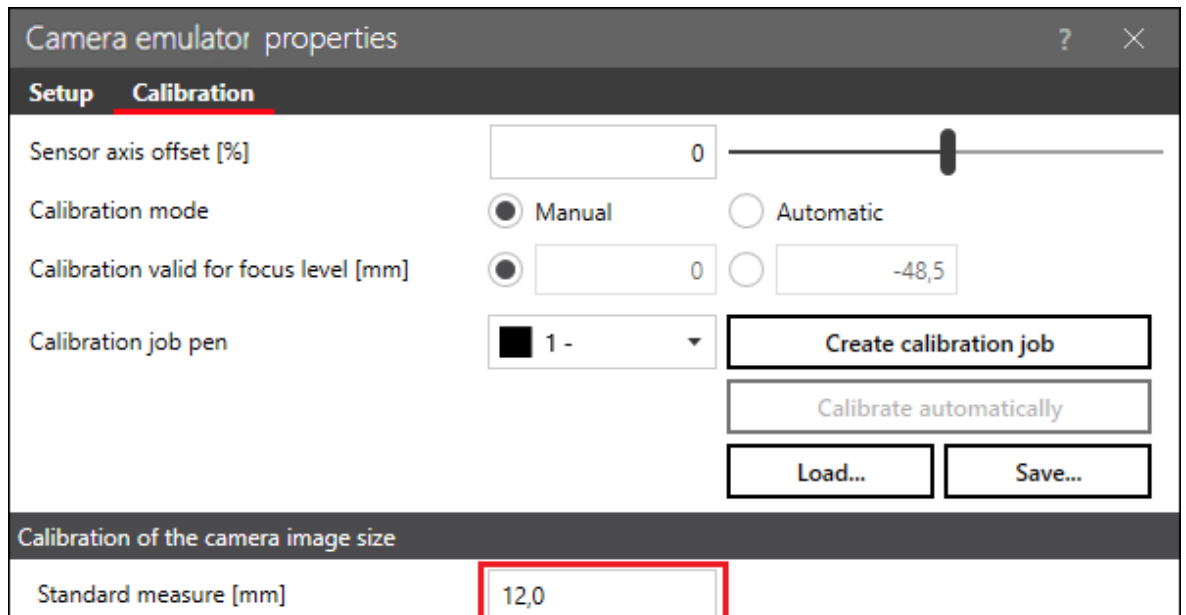


Fig. 9.8: CT-ACD

- Proceed with the calibration as described in *page 38, Calibration of the camera image size*. The integrated background image intentionally has an offset of 6 pixels in the x direction and 12 pixels in the negative y direction in order to be able to demonstrate the calibration of the centre point.

## 9.2 Changing the background image

The integrated background image, which is used by the emulator as a template, can be replaced by another image if desired. To do this, simply copy your PNG image to the folder C:\ProgramData\RAYLASE\RAYGUIDE\Configurations\.

The file name must have the exact same name as the connected virtual camera, i.e. *Virtual Camera 1.png*, *Virtual Camera 2.png*, *Virtual Camera 3.png* or *Virtual Camera 4.png*.

The fastest way to open the directory is by simply entering *%programdata%* in the address line of Windows Explorer.

**CAUTION:** The autocalibration of the centre point only works with the integrated background image since the deviation from the actual centre point is only known for this image.

# 10 TROUBLESHOOTING

## The camera does not output a live image

1. Check that the camera provides a live image in the camera manufacturer's software application.

### A. JAI camera

- Start the eBUS Player application (see also *page 15, JAI cameras*).
- Connect to the camera.
- Start the live image with the **[Play]** button.

### B. Teledyne DALSA camera

- Start the CamExpert application (see also *page 19, Spera CamExpert*)
- Connect to the camera.
- Start the live image with the **[Grab]** button.

2. If the camera does not output a live image in the respective software tool of the camera manufacturer, it may be because a camera parameter has been adjusted.

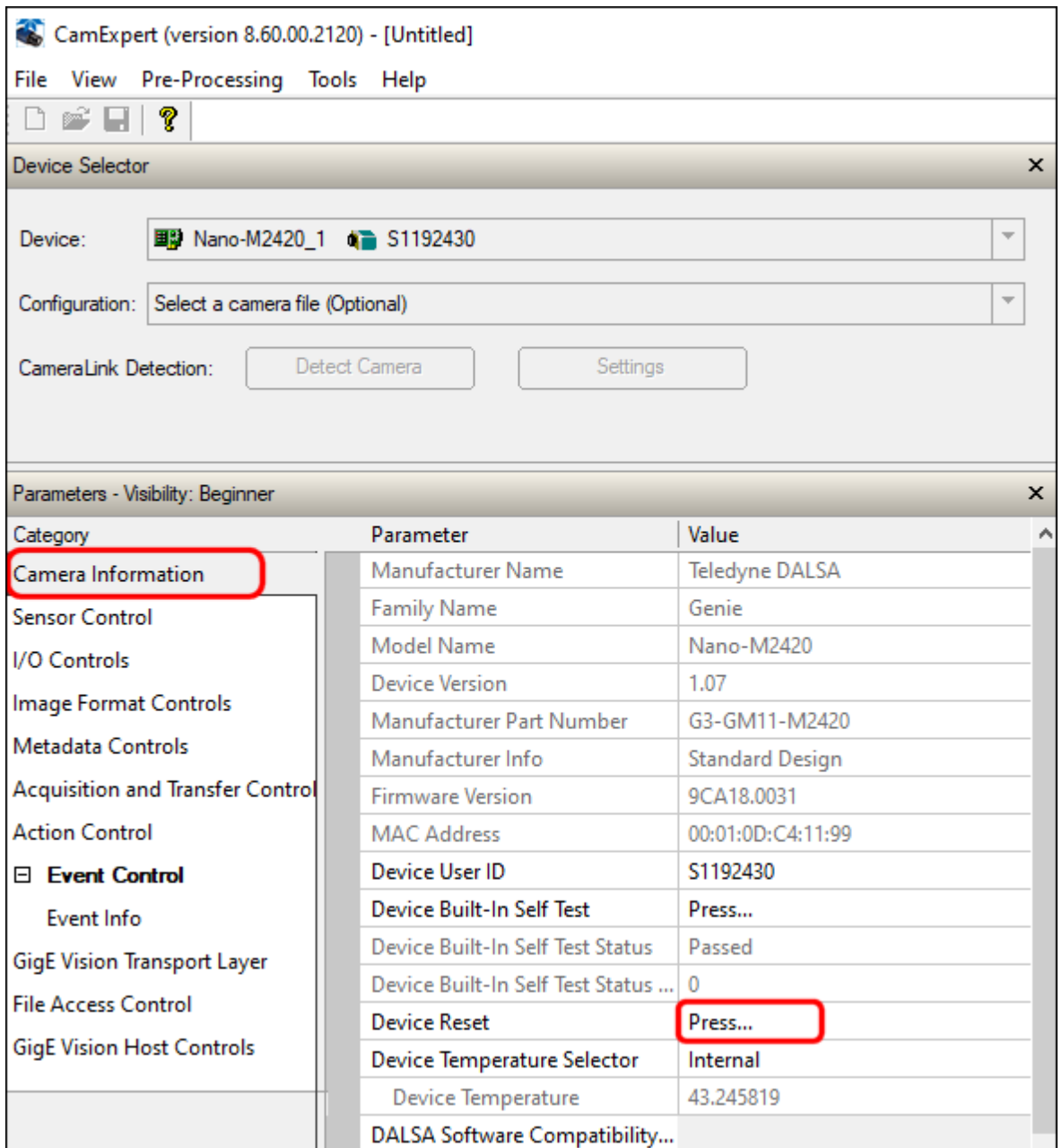
To restore the camera to an operational state, proceed as follows:

### A. JAI camera

- Start the eBUS Player application.
- Connect to the camera.
- Load the appropriate recovery file via the **File > Open** menu item from the folder:  
`C:\ProgramData\RAYLASE\RAYGUIDE\Resources\Camera\`

### B. Teledyne DALSA camera

- Start the CamExpert application.
- Connect to the camera.
- In the *Camera Information* category, press the **[Press...]** button under the *Device Reset* parameter:



The screenshot shows the CamExpert application interface. The main window is titled "CamExpert (version 8.60.00.2120) - [Untitled]". Below the title bar is a menu bar with "File", "View", "Pre-Processing", "Tools", and "Help". A toolbar contains icons for file operations and help. Two windows are open:

**Device Selector** window:

- Device: Nano-M2420\_1 S1192430
- Configuration: Select a camera file (Optional)
- CameraLink Detection: Detect Camera, Settings

**Parameters - Visibility: Beginner** window:

| Category           | Parameter                            | Value             |
|--------------------|--------------------------------------|-------------------|
| Camera Information | Manufacturer Name                    | Teledyne DALSA    |
|                    | Family Name                          | Genie             |
|                    | Model Name                           | Nano-M2420        |
|                    | Device Version                       | 1.07              |
|                    | Manufacturer Part Number             | G3-GM11-M2420     |
|                    | Manufacturer Info                    | Standard Design   |
|                    | Firmware Version                     | 9CA18.0031        |
|                    | MAC Address                          | 00:01:0D:C4:11:99 |
|                    | Device User ID                       | S1192430          |
|                    | Device Built-In Self Test            | Press...          |
|                    | Device Built-In Self Test Status     | Passed            |
|                    | Device Built-In Self Test Status ... | 0                 |
|                    | Device Reset                         | Press...          |
|                    | Device Temperature Selector          | Internal          |
|                    | Device Temperature                   | 43.245819         |
|                    | DALSA Software Compatibility...      |                   |

Fig. 10.1: CT-ACE

**C&T panel is not visible.**

Activate the C&T panel via the menu point *View > Panels > CLICK & TEACH*.

**The C&T panel cannot be activated.**

Check whether the RAYGUIDE license has the necessary product code.

**Desired camera does not appear in the drop-down list of the C&T panel.**

- Check whether the camera was added to the Device Configuration dialog.
- Check whether the camera is connected in the Settings dialog.

**The buttons for calibration are greyed out in the Settings dialog.**

- If necessary, repeat the camera calibration or load a saved calibration.
- In the Camera dialog, Setup tab, check whether the camera is assigned to a deflection unit.

**Tiling button is greyed out in the C&T panel.**

- Calibrate the camera.
- Check in the camera device configuration dialog if the desired camera has a deflection unit associated.

**The tiles do not join up properly in the centre of the image (the outer areas are normal because there is no distortion).**

Calibrate the camera image size.

**The middle of the processing field is not displayed in the centre of the RAYGUIDE window.**

Calibrate the centre point.

**Marked objects in the tiled image are displayed with increasing deviations toward the edges of the workspace.**

Perform a wavelength correction.

**Images that are recorded in a focal position other than the zero position exhibit "gaps" between the tiles.**

The camera was only calibrated in one focal plane. A corresponding second camera calibration must be made in another focal position. (See *page 35, Manual calibration of the (actual) camera*)

- If necessary, briefly disconnect the network connection to the corresponding camera in the device configuration and reconnect.
- In the eBUS Player application, check whether a live image is available there and check the network settings.





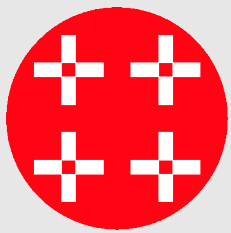
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# Multi Point Editor

**MULTI POINT EDITOR**

USER MANUAL

This manual has been created by RAYLASE for its customers and employees.

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Information correct at: 2022/12

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# 1 OVERVIEW

The Multi Point Editor is a Windows based utility, which allows the user to open, view, edit and save field correction files (.gcd or .fc3 files) and power correction files (.pc3). Optionally, the contents can be copied into the clipboard, from where they can be pasted into other applications, such as spreadsheet programs, for further analysis.

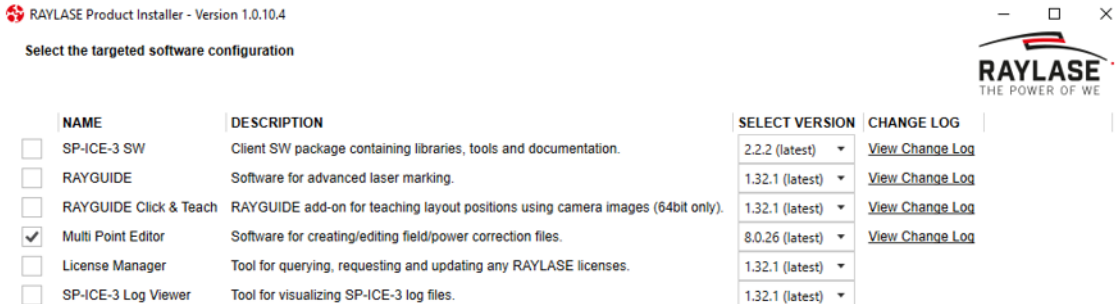
## NOTE:

The manual version 1.1.16 applies to the Multi Point Editor software from version 8.0.28 on.

# 2 INSTALLATION AND LICENSE

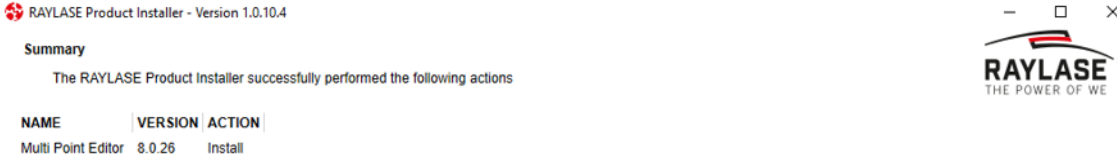
**NOTE:** Once using the RAYGUIDE application software, the Multi Point Editor feature is embedded per default and does not need to be installed additionally.

1. First install the RAYLASE PRODUCT INSTALLER (RLPI, free of charge):  
<https://www.raylase.de/en/products/software/product-installer.html>
2. In the window "Select the targeted software configuration", select **Multi Point Editor** with the appropriate version.  
"View Change Log" shows an overview of the latest changes compared to the previous version.



| NAME   | DESCRIPTION   | SELECT VERSION  | CHANGE LOG                      |
|--|---|-----------------|---------------------------------|
| <input type="checkbox"/> SP-ICE-3 SW                   | Client SW package containing libraries, tools and documentation.                | 2.2.2 (latest)  | <a href="#">View Change Log</a> |
| <input type="checkbox"/> RAYGUIDE                      | Software for advanced laser marking.  | 1.32.1 (latest) | <a href="#">View Change Log</a> |
| <input type="checkbox"/> RAYGUIDE Click & Teach        | RAYGUIDE add-on for teaching layout positions using camera images (64bit only). | 1.32.1 (latest) | <a href="#">View Change Log</a> |
| <input checked="" type="checkbox"/> Multi Point Editor | Software for creating/editing field/power correction files.                     | 8.0.26 (latest) | <a href="#">View Change Log</a> |
| <input type="checkbox"/> License Manager               | Tool for querying, requesting and updating any RAYLASE licenses.                | 1.32.1 (latest) |                                 |
| <input type="checkbox"/> SP-ICE-3 Log Viewer           | Tool for visualizing SP-ICE-3 log files.  | 1.32.1 (latest) |                                 |

3. After you have agreed to the license agreement, the installation starts directly.



| NAME               | VERSION | ACTION  |
|--------------------|---------|---------|
| Multi Point Editor | 8.0.26  | Install |

Since the Multi Point Editor Application is a freeware, you do not need to purchase any license to use the software.

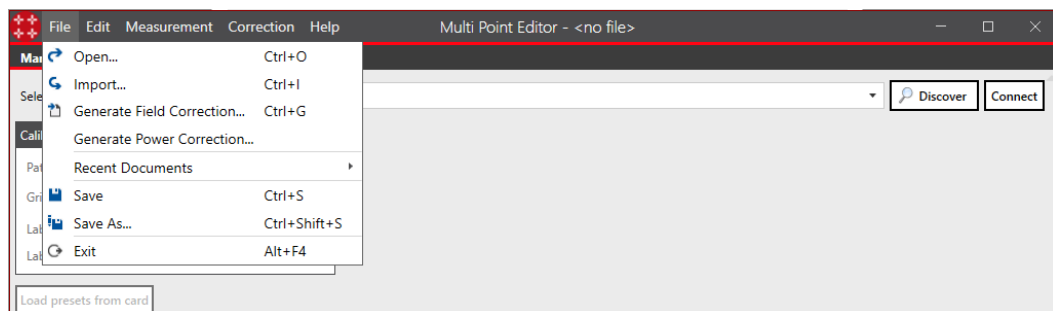
## 3 FILE OPERATIONS

### 3.1 Loading field and power corrections

The user has two options to load corrections:

- First, the user can open an existing \*.gcd, \*.fc3 or \*.pc3 file via File > Open. For gcd files, if in the same directory the description file with a \*.txt extension exists, then it will be loaded as well and important parameters such as the field size are extracted. If no such \*.txt file exists, the user will have to manually set the field size.
- Second, the user can import a \*.txz file via File > Import. This is a text-based description of the corrections, which the application will parse.

Additionally all supported files can be opened from the explorer via drag and drop or *Open with...* from the context menu.



### 3.2 Saving field and power corrections

The user can save the field or power correction value either to the same file, and thus overwriting the previous contents, or alternatively save the corrections to a new file. In this case, the application will write a new description file (with a \*.txt extension, only for \*.gcd).

Furthermore, the application does not create backup files. The user, thus, must either save to a new file, or manually create backups if so desired.

If the resulting field with the applied correction exceeds the field size, you will be notified that the correction values will be clipped to match the field size.

If “Create backup” is enabled in the settings (Edit > Settings), a copy of the correction file will be created at the provided backup path. An index will be appended to the filename, if the target file already exists.

### 3.3 Generating field corrections (3D)

| Generate Fieldcorrection  |          |      |       |
|---|----------|------|-------|
|   | X        | Y    | Z     |
| Field Size [mm]   | 300      | 300  | 99,14 |
| Layers  | 257      | 257  | 17    |
| X2Y [mm]  | 37       |      |       |
| Y2Z0 [mm]   | 371,26   |      |       |
| O2X [mm]  | 120,85   |      |       |
| Max Angle [°]   | 22,5     | 22,5 |       |
| Focal Length [mm]   | 126,3598 |      |       |
| Max Lens Travel [mm]  | 11       |      |       |
| Aperture [mm]   | 20       |      |       |
| Working Distance [mm]   | 500      |      |       |
| Z Offset [mm]   | 49,57    |      |       |
| <input type="button" value="Open Config..."/> <input type="button" value="OK"/> <input type="button" value="Cancel"/> |          |      |       |

You can generate a field correction file for a 3D scan head. Therefore you can either import a scan head configuration file (\*.cfg), or type in the data yourself.

In addition you have to supply the number of desired layers for each dimension, e.g. 257\*257\*17 for \*.fc3 or 65\*65\*1 for \*.gcd.

### 3.4 Generate Power Correction

| Generate Power Correction   |                          |     |     |
|---|--------------------------|-----|-----|
|   | X                        | Y   | Z   |
| Dimensions  | 257                      | 257 | 1   |
| Field Size [mm]   | 100                      | 100 | 100 |
| No power outside circular/subfield                                      | <input type="checkbox"/> |     |     |
| <input type="button" value="OK"/> <input type="button" value="Cancel"/> |                          |     |     |

To generate an empty Power Correction file (\*.pc3) select File > Generate Fs.

After defining the dimensions and the field size a new power correction file will be generated. All correction values of the new file will be 1 (100%).

If a sub field is used and "No power outside subfield" is checked, only the cells within the sub field are set to 1. The rest is set to 0.

To manipulate the table, use the Measurement > New Table Dialog to create a new Measurement Table (see chapter 5.4.3).



## 3.5 Import Corrections

Correction can be imported from \*.txz files. The following parameters are read from the header (not case sensitive):

- Head parameters:
  - Aperture
  - FocalLength
  - MaxLensTravel
  - XYMaxGalvoAngles
  - ObjToX
  - XToY
  - Yrad
  - Workingdistance
- FocusShifter ( 0 or 1)  
If set to 1, the corrections for the z axis will be shifted, so that the middle of the z-axis is in the middle of the lens translator ( 32768 bit )
- 4D ( 0 or 1)  
Activates the import of the 4th dimension (for zoom)
- ExtensionAxis (0 or 1)  
If set to 1, only the data for the Z axis is read, and will be merged as extension axis to the existing correction. That means that before importing the extension axis, a field correction must be loaded

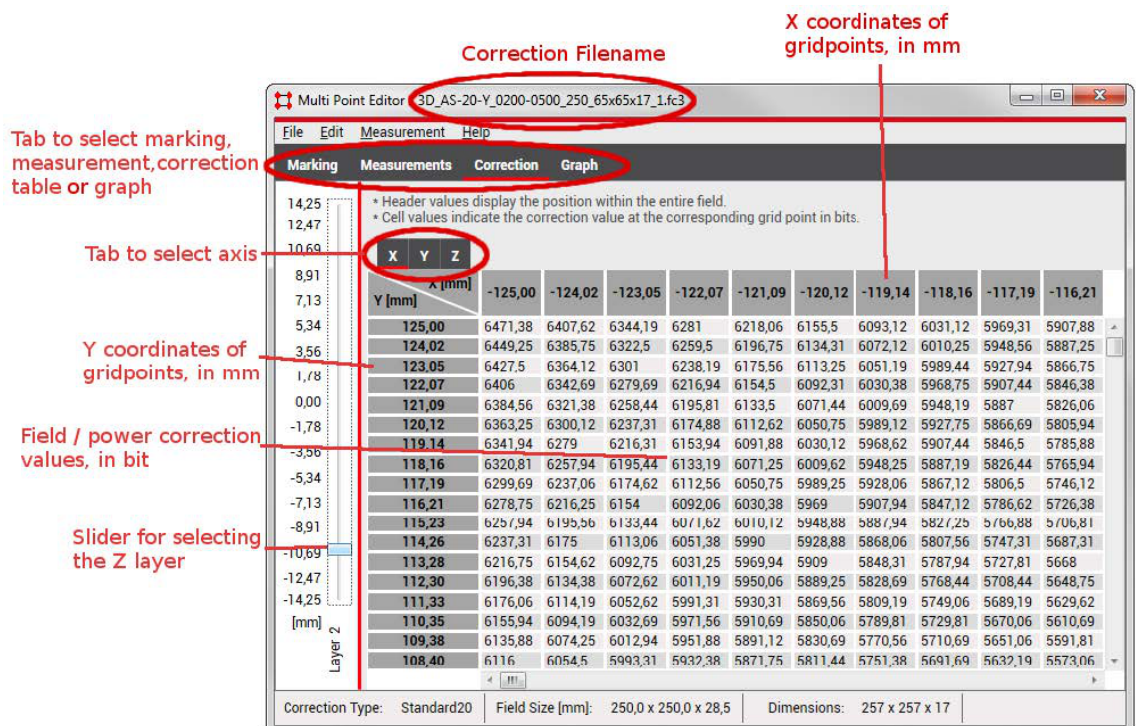
The last line of the header must be "start".

The data is expected in the following order:

POSITION X, TILT ANGLE X, POSITION Y, TILT ANGLE Y, POSITION Z, LENS 1 SPACING (EDGE), LENS 1 SPACING (CENTRE), LENS 2 SPACING (EDGE), LENS 2 SPACING (CENTRE), SPOT, corrected SPOT

# 4 FIELD CORRECTIONS ANALYSIS

## 4.1 Viewing field corrections



The application's main view consists of the following components:

- The title shows the filename if one has been loaded. A star (\*) indicates whether the data has been modified, i.e. is dirty.
- Tabs in the top-left: the tabs *Measurements* (not for .pc3) and *Corrections* select whether the data grid is showing the multi point measurements or field correction values, respectively. The tab *Graph* shows a visualization of the data.
- Below are tabs providing a choice of which axis should be displayed in the data grid.
- Measurement data grid: the user can enter the position where the grid point was marked, in millimetres.
- Field correction data grid: For each grid point, the field correction values are displayed in units of bit. The data is framed by the grid point's coordinates for X in the top header and Y in the left-most column, respectively. All units are in millimetres. The grid point coordinates are derived from the field size.
- Power correction data grid: for each grid point the power correction values are displayed as a factor from 0 to 4, meaning the power supplied by the laser has to be multiplied by the factor to get a consistent power distribution.
- Footer: the status bar displays the correction type, such as Standard16 – which is the

proper type for regular 2 or 3 axis scan heads using conventional galvanometer technology. Furthermore, the field size and dimensions are shown.

- If the correction file consists of multiple layer, e.g. a \*.fc3 file, a slider for layer choosing appears on the left side of the window
- If the correction file consists of multiple magnifications, an additional slider selecting the magnitude appears on the left side of the window
- The number of axes to select depends on the correction file, the maximum of supported axes is 5: X, Y, Z, ZoomZ, SensorZ (Auxiliary axis for e.g. Camera)
- The unit of the displayed corrections can be selected in the settings (Edit > Settings), the resulting range is:

|            | 16 bit | 20 bit  | Percent |
|------------|--------|---------|---------|
| <b>Min</b> | -32768 | -524288 | -50     |
| <b>Max</b> | 35767  | 524287  | 50      |

## 4.2 Copying data to clipboard

The entire field correction data for all three axes can be copied to the clipboard. The data can then be pasted into other applications, for example a spreadsheet program, for further analysis, or for example to create a 3D plot.

In order to ease further processing, the data can be copied into the clipboard in two different formats:

- List Format

In order to choose the list formatting go to Edit and make sure that the menu item “Format copied corrections as list” is checked.

Description:

Each grid point produces one line, which consists of the grid point’s X and Y coordinates, then the correction values for X, Y and Z.

Example:

Row/Column 0/0 represents the bottom-left corner

| Row | Column | Field X | Field Y | Field Z |
|-----|--------|---------|---------|---------|
| 0   | 0      | 2407    | 296     | 0       |
| 0   | 1      | 2283    | 330     | 0       |
| 0   | 2      | 2162    | 363     | 0       |
| ... |        |         |         |         |

- Table Format

In order to choose the table formatting go to Edit and make sure that the menu item “Format copied corrections as list” is unchecked.

- Description:
- Each axis produces a section, which itself consists of the corresponding field correction

## 4 FIELD CORRECTIONS ANALYSIS



values arranged in rows and columns. The data is thus organized in the same fashion as seen in the data grid.

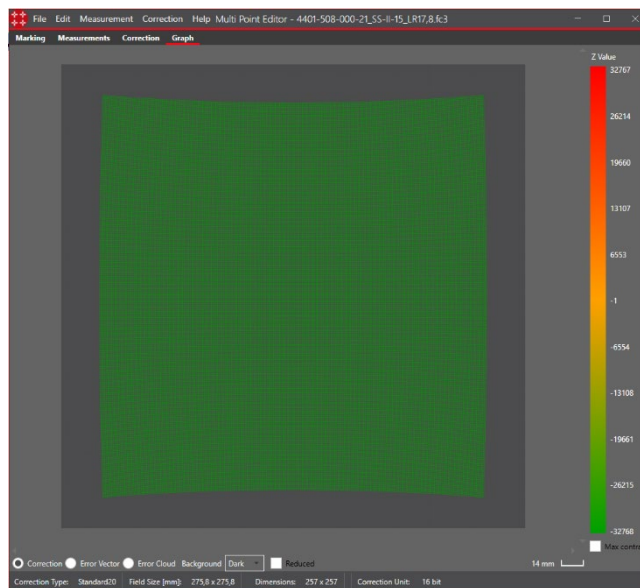
Example:

|                                      |      |      |      |      |      |      |      |      |      |     |     |
|--------------------------------------|------|------|------|------|------|------|------|------|------|-----|-----|
| Top-Left item represents -X / +Y     |      |      |      |      |      |      |      |      |      |     |     |
| Top-Right item represents +X / +Y    |      |      |      |      |      |      |      |      |      |     |     |
| Bottom-Left item represents -X / -Y  |      |      |      |      |      |      |      |      |      |     |     |
| Bottom-Right item represents -X / -Y |      |      |      |      |      |      |      |      |      |     |     |
| X Correction                         |      |      |      |      |      |      |      |      |      |     |     |
| 2407                                 | 2283 | 2162 | 2046 | 1934 | 1827 | 1723 | 1624 | 1528 | 1435 | ... |     |
| 2316                                 | 2194 | 2076 | 1962 | 1853 | 1748 | 1647 | 1550 | 1457 | 1368 | ... |     |
| 2227                                 | 2107 | 1992 | 1881 | 1774 | 1671 | 1573 | 1479 | 1388 | 1301 | ... |     |
| ...                                  |      |      |      |      |      |      |      |      |      |     |     |
| Y Correction                         |      |      |      |      |      |      |      |      |      |     |     |
| -296                                 | -330 | -363 | -394 | -424 | -454 | -482 | -510 | -536 | -561 | ... |     |
| -227                                 | -260 | -292 | -323 | -353 | -381 | -409 | -435 | -461 | -485 | ... |     |
| -164                                 | -196 | -227 | -257 | -286 | -314 | -340 | -366 | -391 | -415 | ... |     |
| ...                                  |      |      |      |      |      |      |      |      |      |     |     |
| Z Correction                         |      |      |      |      |      |      |      |      |      |     |     |
| 0                                    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0   | ... |
| 0                                    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0   | ... |
| 0                                    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0   | ... |
| ...                                  |      |      |      |      |      |      |      |      |      |     |     |

## 4.3 Graphical visualization

On the Graph tab, a visual representation of the correction file is displayed. You can zoom using the mouse wheel and browse through the layers via the slider on the left side.

### 4.3.1 Field correction



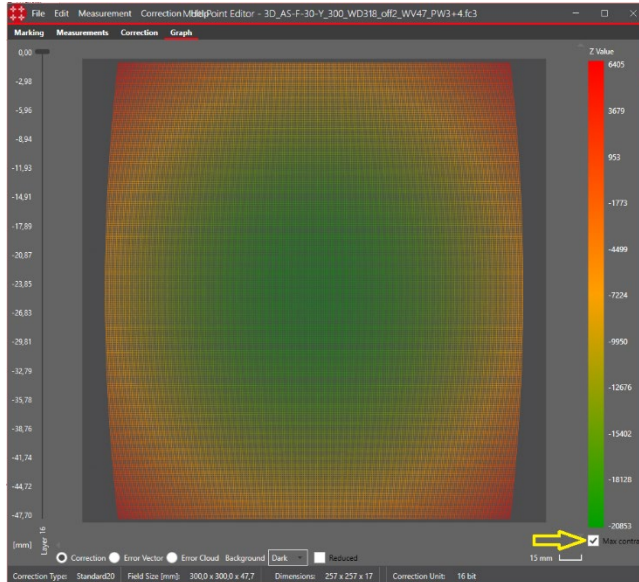
Colours from green (minimum) to red (maximum). Depending on the selected correction unit, the range is:

|            | 16 bit | 20 bit  | Percent |
|------------|--------|---------|---------|
| <b>Min</b> | -32768 | -524288 | -50     |
| <b>Max</b> | 35767  | 524287  | 50      |

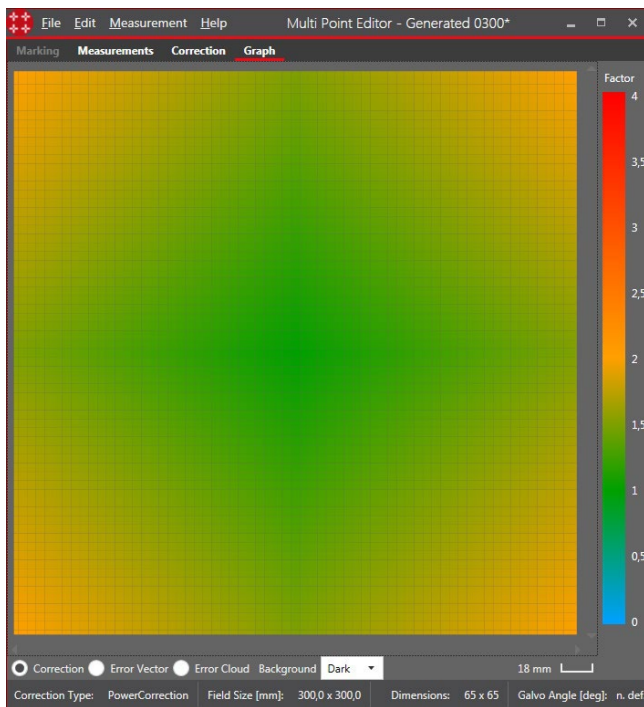
If a zoom or camera axis is present, the source for the displayed colour can be chosen.

## 4 FIELD CORRECTIONS ANALYSIS

Using the max contrast feature adapts the colour range to the actual Z range. Green will be used for the lowest and red for the highest Z value.



### 4.3.2 Power correction



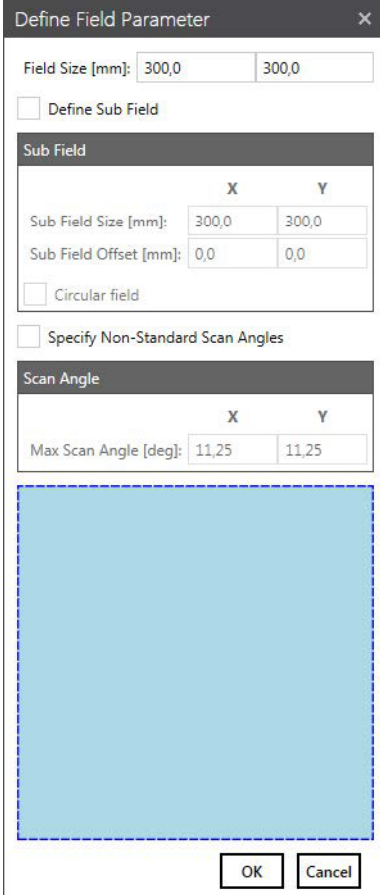
Colours from green (correction factor = 0) to red (correction factor = 4)

# 5 FIELD CORRECTION

## 5.1 Setting standard field size

When the user opens a correction file (\*.gcd) the application tries to load the corresponding description file (\*.txt), which if available must exist in the same directory as the gcd. The description file contains parameters to calculate the field size. In case of the \*.fc3 file, the description file is obsolete, as the information is contained in the \*.fc3 file.

In case the description file is missing, the user can manually set the field size via Edit > Change Field



| Field Size [mm]: |       |
|------------------|-------|
| 300,0            | 300,0 |

Define Sub Field

| Sub Field              |       |       |
|------------------------|-------|-------|
|                        | X     | Y     |
| Sub Field Size [mm]:   | 300,0 | 300,0 |
| Sub Field Offset [mm]: | 0,0   | 0,0   |

Circular field

Specify Non-Standard Scan Angles

| Scan Angle            |       |       |
|-----------------------|-------|-------|
|                       | X     | Y     |
| Max Scan Angle [deg]: | 11,25 | 11,25 |

OK Cancel

## 5.2 Defining custom field

Customers who wish not to use the entire field can define a smaller section – in the following referred to as “sub field”. The sub field does not need to be centred, but could be offset providing it is fully contained within the regular beam field.

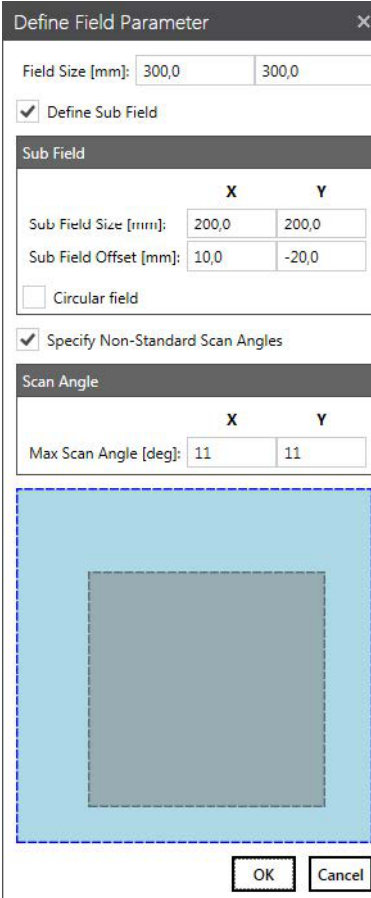
Open the “Define Field Parameter” dialog via Edit > Change Field

The field size refers to the size the scan head is capable of covering, and is the one used to generate the field correction file. This value must match the value extracted from the correction’s description file – if existent.

To define a custom field check “Define Sub Field” and enter the desired sub field size. If the sub field is shifted relative to centre then enter the appropriate values. Otherwise, leave them at 0.

Customers who operate with a custom scan head have to enter the maximum scan angle of each galvanometer.

Check “Specify Non-Standard Scan Angles” and then enter the mechanical maximum scan angles.



|                        | X     | Y     |
|------------------------|-------|-------|
| Field Size [mm]:       | 300,0 | 300,0 |
| Sub Field Size [mm]:   | 200,0 | 200,0 |
| Sub Field Offset [mm]: | 10,0  | -20,0 |
| Max Scan Angle [deg]:  | 11    | 11    |



**NOTE:**

These sub field parameters merely affect the measurement locations used by this tool. The correction points outside the sub field will also be updated, but as the correction values will be extrapolated, the accuracy may suffer.

If the sub field changes for any reasons then you will need to recalibrate, i.e.:

- Mark a new correction pattern at the desired region
- Launch the Multi Point Editor
- Load the correction file
- Define the custom field
- Enter the actual coordinates of the marked gridpoints
- Apply the measurements
- Save the correction file
- Send the updated correction file to the controller card

The sub field definition is getting saved, and will be loaded when opening a correction file with die same field size.

## 5.3 Circular sub field

The sub field can be either rectangular or circular. Setting the “circular field” option in the “Define field parameter” dialog changes the shape of the sub field to an ellipse defined by the size and the offset of the sub field. Furthermore, the size of the circle can exceed the size of the original field. This can be useful for a circular field which is covered by multiple deflection units.

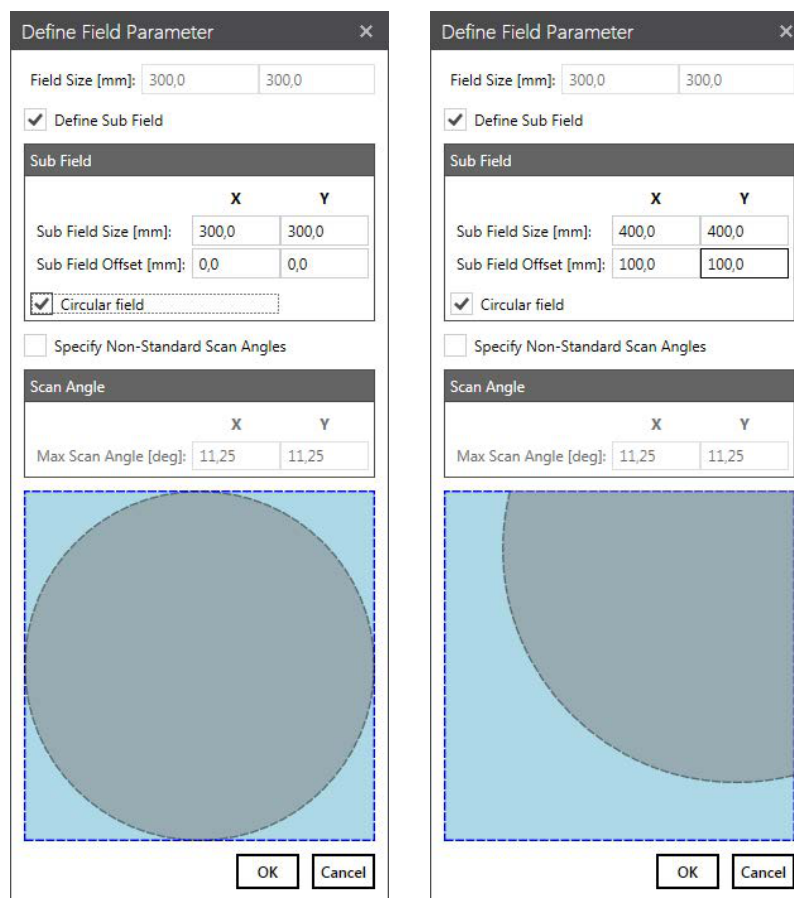


Fig. 1: Circle within main field / Circle exceeding main field.

As the measurement table is still rectangular, not all values have to be filled. All cells that corresponds to grid points outside the circle are crossed out and will be extrapolated.

| X   | Y       |        |                 |                |      |       |        |
|-----|---------|--------|-----------------|----------------|------|-------|--------|
|     |         | X [mm] | -2:             | -1:            | 0:   | 1:    | 2:     |
|     |         | Y [mm] | -150,00         | -75,00         | 0,00 | 75,00 | 150,00 |
| 2:  | 150,00  |        | <del>-150</del> | <del>-75</del> | 0    | 75    | 150    |
| 1:  | 75,00   |        | <del>-150</del> | <del>-75</del> | 0    | 75    | 150    |
| 0:  | 0,00    |        | -150            | -75            | 0    | 75    | 150    |
| -1: | -75,00  |        | <del>-150</del> | <del>-75</del> | 0    | 75    | 150    |
| -2: | -150,00 |        | <del>-150</del> | <del>-75</del> | 0    | 75    | 150    |

Fig. 2: Sample for circle field using 5x5 points

## 5 FIELD CORRECTION

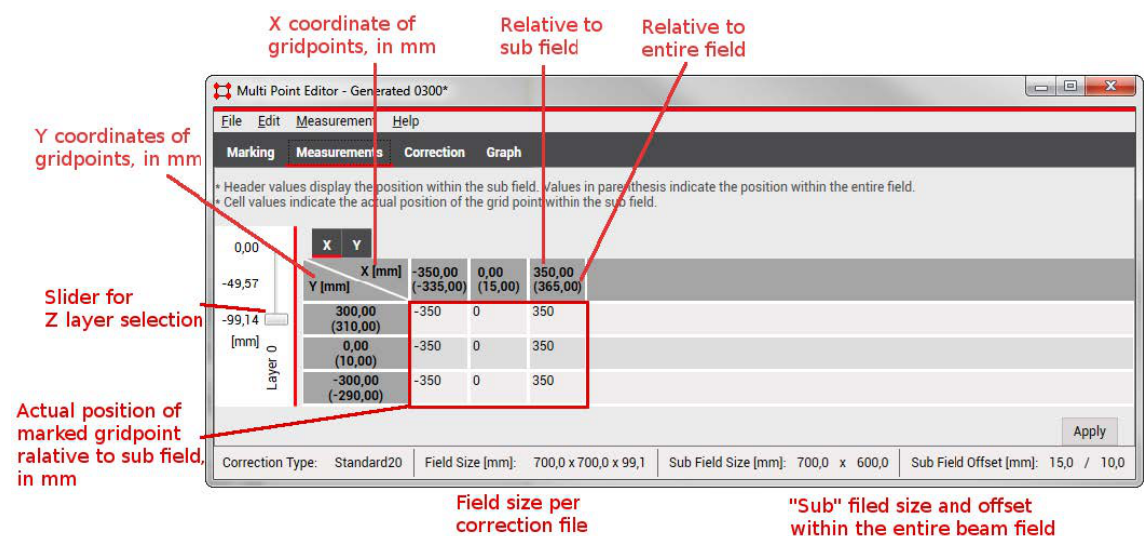
| X           | Y         |                          |                         |                       |                       |                     |                      |
|-------------|-----------|--------------------------|-------------------------|-----------------------|-----------------------|---------------------|----------------------|
| X [mm]      | Y [mm]    | -4: -200,00<br>(-100,00) | -3: -150,00<br>(-50,00) | -2: -100,00<br>(0,00) | -1: -50,00<br>(50,00) | 0: 0,00<br>(100,00) | 1: 50,00<br>(150,00) |
| 1: 50,00    | (150,00)  | -200                     | -150                    | -100                  | -50                   | 0                   | 50                   |
| 0: 0,00     | (100,00)  | -200                     | -150                    | -100                  | -50                   | 0                   | 50                   |
| -1: -50,00  | (50,00)   | -200                     | -150                    | -100                  | -50                   | 0                   | 50                   |
| -2: -100,00 | (0,00)    | -200                     | -150                    | -100                  | -50                   | 0                   | 50                   |
| -3: -150,00 | (-50,00)  | -200                     | -150                    | -100                  | -50                   | 0                   | 50                   |
| -4: -200,00 | (-100,00) | -200                     | -150                    | -100                  | -50                   | 0                   | 50                   |

Fig. 3: Sample for quarter circle field using 9x9 points

The table shows only the cells of the subfield being inside the original field. As a good portion of the circle is outside the original field, the table is reduced from 9x9 to 6x6 points.

## 5.4 Entering errors

### 5.4.1 Field correction



Multi Point Editor - Generated 0300\*

File Edit Measurements Help

Marking Measurements Correction Graph

\* Header values display the position within the sub field. Values in parenthesis indicate the position within the entire field.  
\* Cell values indicate the actual position of the grid point within the sub field.

| X                    | Y      |                      |                 |                    |
|----------------------|--------|----------------------|-----------------|--------------------|
| X [mm]               | Y [mm] | -350,00<br>(-335,00) | 0,00<br>(15,00) | 350,00<br>(365,00) |
| 300,00<br>(310,00)   |        | -350                 | 0               | 350                |
| 0,00<br>(10,00)      |        | -350                 | 0               | 350                |
| -300,00<br>(-290,00) |        | -350                 | 0               | 350                |

Correction Type: Standard20 Field Size [mm]: 700,0 x 700,0 x 99,1 Sub Field Size [mm]: 700,0 x 600,0 Sub Field Offset [mm]: 15,0 / 10,0

By selecting the “Measurements” tab the user is presented a table which allows entering the actual mark positions for X and Y.

Unless the user has defined a custom beam field, i.e. a sub field, then two coordinates are shown for every expected grid point:

The coordinate on the top shows the expected position relative to the sub field. For example, if you have a 700mm x 600mm sub field then the left/right and bottom/top extreme grid points are located at +/- 350mm and +/- 300mm, respectively.

The second coordinate (beneath in parenthesis) shows the expected position relative to the entire beam field. For example, if the sub field is shifted by 15mm and 10mm in X and Y, then for the aforementioned sub field the corner grid points are expected to be located at -335/+365mm (X) and -290/310mm (Y).

## 5 FIELD CORRECTION

\* Header values display the position within the sub field. Values in parenthesis in

\* Cell values indicate the actual position of the grid point within the sub field.

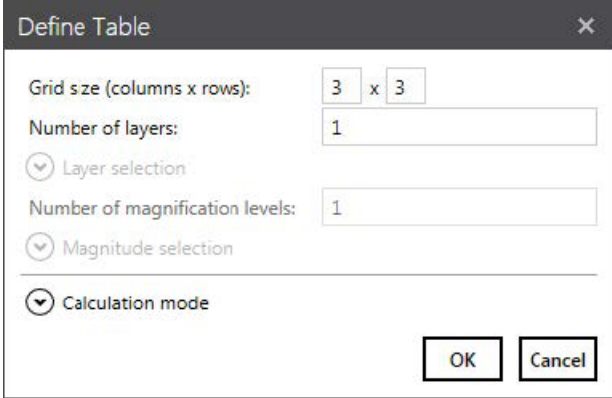
| X           | Y         |             |         |           |
|-------------|-----------|-------------|---------|-----------|
| X [mm]      |           | -1: -100,00 | 0: 0,00 | 1: 100,00 |
| Y [mm]      |           | (-90,00)    | (10,00) | (110,00)  |
| 1: 100,00   | (80,00)   | -100        | 0       | 100       |
| 0: 0,00     | (-20,00)  | -100        | 0       | 100       |
| -1: -100,00 | (-120,00) | -100        | 0       | 100       |

- The recommended procedure to fine-adjust the field is by marking a grid that coincides with the field correction's grid points. For RAYLASE products the default grid consists of 65 x 65 (\*.gcd) or 257 x 257 (\*.fc3) rows and columns. Thus, for \*.gcd the dimensions of each cell are the field size divided by 64 (65 minus 1). For example, for a 160mm field each cell is 2.5mm x 2.5mm large.

Once the grid has been marked, the actual cross points must be measured and their coordinates must be entered into the corresponding X and Y tab.

If the measurements are not done by automation but done by hand, then it will tend to be rather laborious. For this reason, it is possible to set the error table to a subset and make the data entry much more manageable.

By selecting Measurement > New Table the user can resize the error table to fit their needs:



It is recommended to use a grid which has its grid points on the grid points of the correction file. This can be achieved with the following number of columns/rows: 3, 5, 9, 17, 33, 65, 129, 257.

Be sure to select the *Error Interpolation* as *Calculation Mode*. For the *Absolute Interpolation* see chapter 5.14 Setting Field Correction directly.

## 5 FIELD CORRECTION



In case of multi-layer corrections (\*.fc3), the number of layers can also be defined.

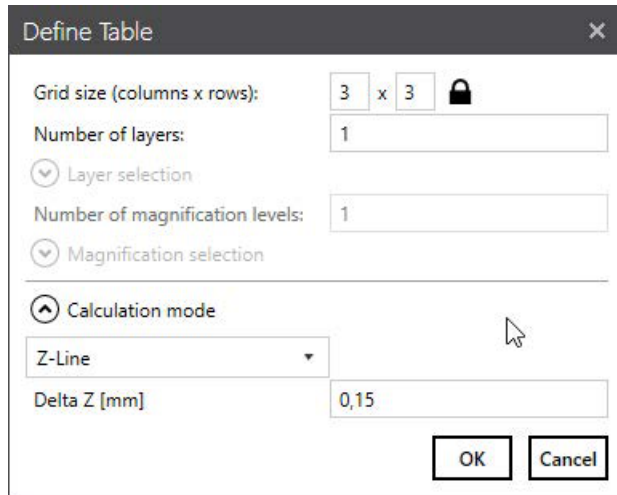
The "Define Table" dialog box is shown with the following settings:

- Grid size (columns x rows): 3 x 3
- Number of layers: 3
- Layer selection: A dropdown menu is open, showing a list of layers from 0 to 16. The selected layer is 1 (-92,94 mm). Other visible layers include 0 (-99,14 mm), 2 (-86,75 mm), 3 (-80,55 mm), 4 (-74,36 mm), 5 (-68,16 mm), 6 (-61,96 mm), 7 (-55,77 mm), 8 (-49,57 mm), 9 (-43,37 mm), 10 (-37,18 mm), 11 (-30,98 mm), 12 (-24,79 mm), 13 (-18,59 mm), 14 (-12,39 mm), 15 (-6,20 mm), and 16 (0,00 mm).
- Position levels: 1
- Buttons: OK and Cancel

Furthermore, the specific layers for the measurement can be chosen. For example the Z field size is from 0 to -99mm. If you choose to measure three layers, the default selection of the layers will be equidistant, in this example the layers  $z=0\text{mm}$ ,  $z=-50\text{mm}$  and  $z=-99\text{mm}$ . With the Layers selection boxes, you can define any three layers to be measured. But keep in mind that the accuracy may suffer, especially if the top and the bottom layer is not included.

5.4.2 **Z-Axis Correction**

To calibrate the Z-Axis, chose Z-Line for the calculation mode in the new table dialog. The Delta Z value defines the multiplier for the calibration values to enter. It is provided as mm on the lens translator module.



| Z           |         |      |        |  |
|-------------|---------|------|--------|--|
| X [mm]      | -1:     | 0:   | 1:     |  |
| Y[mm]       | -150,00 | 0,00 | 150,00 |  |
| 1: 150,00   | 2       | 1    | 0      |  |
| 0: 0,00     | 1       | 0    | -1     |  |
| -1: -150,00 | 0       | -1   | -2     |  |

The values will be multiplied by Delta Z, then interpolated to fit the dimensions of the correction file and finally added to the Z correction values.

If you marked the z calibration pattern, the values represent the lines starting from the center lined. E.g. the line 2 left from the center is -2, the line 3 right of the center is 3 and the center line is 0.

See chapter 6.3 for how to mark a z calibration pattern.

## 5 FIELD CORRECTION

### 5.4.3 Power correction

For the power correction, the approach is similar to the field correction. Instead of measuring the distances, you type in the desired scaling factors from 0 to 4.

In the following example, the power of the left and right border will be scale by 1.3 to 1.5 and the rest of the field will be scaled by 1.1.

| X [mm]<br>Y[mm] | -2:<br>-150,00 | -1:<br>-75,00 | 0:<br>0,00 | 1:<br>75,00 | 2:<br>150,00 |
|-----------------|----------------|---------------|------------|-------------|--------------|
| 2: 150,00       | 1,5            | 1,4           | 1,3        | 1,4         | 1,5          |
| 1: 75,00        | 1,4            | 1,3           | 1,2        | 1,3         | 1,4          |
| 0: 0,00         | 1,3            | 1,2           | 1          | 1,2         | 1,3          |
| -1: -75,00      | 1,4            | 1,3           | 1,2        | 1,3         | 1,4          |
| -2: -150,00     | 1,5            | 1,4           | 1,3        | 1,4         | 1,5          |

### 5.4.4 Missing cells

Cells in the measurement table can be ignored for the error analysis. This can be useful if the grid point cannot be marked or evaluated at this position. In order to mask the cells, right click on the selected cells in the table and choose "Toggle ignored cells". It will cross out the cells in red and the values will be ignored during analysis.

| X          | Y      |        |      |       |       |
|------------|--------|--------|------|-------|-------|
| X [mm]     | -2:    | -1:    | 0:   | 1:    | 2:    |
| Y[mm]      | -50,00 | -25,00 | 0,00 | 25,00 | 50,00 |
| 2: 50,00   | -50    | -25    | 0    | 25    | 50    |
| 1: 25,00   | -50    | -25    | 0    | 25    | 50    |
| 0: 0,00    | -50    | -25    | 0    | 25    | 50    |
| -1: -25,00 | -50    | -25    | 0    | 25    | 50    |
| -2: -50,00 | -50    | -25    | 0    | 25    | 50    |

Toggle ignored cells

| X          | Y              |                |      |       |       |
|------------|----------------|----------------|------|-------|-------|
| X [mm]     | -2:            | -1:            | 0:   | 1:    | 2:    |
| Y[mm]      | -50,00         | -25,00         | 0,00 | 25,00 | 50,00 |
| 2: 50,00   | <del>-50</del> | <del>-25</del> | 0    | 25    | 50    |
| 1: 25,00   | <del>-50</del> | <del>-25</del> | 0    | 25    | 50    |
| 0: 0,00    | -50            | -25            | 0    | 25    | 50    |
| -1: -25,00 | -50            | -25            | 0    | 25    | 50    |
| -2: -50,00 | -50            | -25            | 0    | 25    | 50    |

Cells will also be ignored, if a circular sub field is used, and the cell is outside the circle. These cells are crossed out in orange and cannot be toggled.

Both methods can be combined, but each row and column must have a least one value.

| X          | Y              |                |      |       |               |
|------------|----------------|----------------|------|-------|---------------|
| X [mm]     | -2:            | -1:            | 0:   | 1:    | 2:            |
| Y[mm]      | -50,00         | -25,00         | 0,00 | 25,00 | 50,00         |
| 2: 50,00   | <del>-50</del> | <del>-25</del> | 0    | 25    | <del>50</del> |
| 1: 25,00   | <del>-50</del> | <del>-25</del> | 0    | 25    | <del>50</del> |
| 0: 0,00    | -50            | -25            | 0    | 25    | 50            |
| -1: -25,00 | <del>-50</del> | <del>-25</del> | 0    | 25    | <del>50</del> |
| -2: -50,00 | <del>-50</del> | <del>-25</del> | 0    | 25    | <del>50</del> |

| X          | Y              |                |      |       |               |
|------------|----------------|----------------|------|-------|---------------|
| X [mm]     | -2:            | -1:            | 0:   | 1:    | 2:            |
| Y[mm]      | -50,00         | -25,00         | 0,00 | 25,00 | 50,00         |
| 2: 50,00   | <del>-50</del> | <del>-25</del> | 0    | 25    | <del>50</del> |
| 1: 25,00   | <del>-50</del> | <del>-25</del> | 0    | 25    | <del>50</del> |
| 0: 0,00    | -50            | -25            | 0    | 25    | 50            |
| -1: -25,00 | <del>-50</del> | <del>-25</del> | 0    | 25    | <del>50</del> |
| -2: -50,00 | <del>-50</del> | <del>-25</del> | 0    | 25    | <del>50</del> |

Fig. 4 Ignored by circular sub field / Ignored by circular sub field and mask

Cells within the field should only be ignored scarcely (e.g automated measuring failed, sensor on position to measure). If too many cells are missing, the calibration result will suffer.

## 5.5 Loading measurements

### 5.5.1 Measurement table types

The measurement table supports the following types:

- Error: This is the default type. The values define the actual position [ $\mu\text{m}$ ] of the laser.
- Edit: Direct input mode. Correction values will be replaced by the provided values [ $^{\circ}/\mu\text{m}$ ]. Currently only z axes are supported.
- Offset: Values [bit] will be added to the correction values.
- Scale: Correction values will be multiplied by the provide scale. Used by power calibration.

### 5.5.2 Loading whole table

The measurements table can be loaded from a text file, which can be generated with a text editor, or by any customer-supplied external program or by the Multi Point Editor itself (if the user previously saved the measurement table).

Choose Measurement > Load Table in order to select the text file that should be loaded.

This text file must comply with the following format:

- Lines that should be ignored must begin with '#' or be blank
- All other lines are treated as valid data
- The coordinates in each valid line must be separated by tab, space or ';' (semicolon)
- The coordinates must obey the US-English numbering style, i.e. '.' (dot) as the decimal point
- If the header line contains "layer" the first column will be interpreted as layer. If it contains magnitude and layer, the first column is magnitude, the second layer.

Example:

```
# Multipoint FieldCorrection File
# The data contained herein describes the actual positions where the laser fired
# All units (except for row and column etc) are in microns

# Each line lists one data point consisting of
# [Magnitude/Layer/]Row/Column: the position where the data point is expected expressed as [magnitude/layer/]row/column
# ActualX/Y/Z: the position where the laser truly fired
# Empty lines and lines that begin with '#' are ignored
# The fields can be separated by <space>, <tab> or semicolon
# The floating point values must use '.' as the decimal point

; Type: Error
; FieldSize: 250000      250000
; SubFieldSize: 100000 100000
; SubFieldOffset: 40000 50000
; IsCircularField: True

; Magnitude [] Layer [] Row [] Column [] ActualX [um] ActualY [um] ActualZ [um]
```



## 5 FIELD CORRECTION

|   |   |   |   |        |        |   |   |   |
|---|---|---|---|--------|--------|---|---|---|
| 0 | 0 | 0 | 0 | -49000 | -49500 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0      | -51000 | 0 | 0 | 0 |
| 0 | 0 | 0 | 2 | 50010  | -50000 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | -50000 | 0      | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0      | 0      | 0 | 0 | 0 |
| 0 | 0 | 1 | 2 | 50000  | 0      | 0 | 0 | 0 |
| 0 | 0 | 2 | 0 | -53000 | 50000  | 0 | 0 | 0 |
| 0 | 0 | 2 | 1 | 0      | 51000  | 0 | 0 | 0 |
| 0 | 0 | 2 | 2 | 51000  | 50500  | 0 | 0 | 0 |

Like shown in the example, the type can be defined by “;Type: actualType”. The type can be Error, Edit, Offset or scale. If no type is provided, it defaults to Error.

If the definition of the sub field is provided like shown in the example, it will be automatically loaded. Loading of table for a correction file with a different size than the one provided by the field size line will result in an exception to prevent misuse. If the field size is not provided, no validation is done.

For multiple layers, if specific layers are chosen, they can be saved as *Selected layers*: followed by the layer numbers starting with 0 for the bottom layer.

Multi-layer example:

```
; Selected layers: 0      4      16
```

| ; Layer [] | Row [] | Column [] | ActualX [um] | ActualY [um] | ActualZ [um] |
|------------|--------|-----------|--------------|--------------|--------------|
| 0          | 0      | 0         | -70040       | -70490       | 10020        |
| 0          | 0      | 1         | -35180       | -70490       | 10025        |

The same logic applies to selected magnitudes.

Missing cells are visualized by a red stroke and will be ignored when applying the table. They can be filled manually by using the context menu and choosing “Toggle ignored cells” (see 5.4.4 Missing cells).

### 5.5.3 Loading table layer

Instead of loading the whole table, a single layer can be loaded with Measurement > Load Table Layer. This will only overwrite the data of the active layer of the measurement table.

The file format is the same, but it can only contain a single layer and the number of rows and columns must be the same as the current measurement table.

### 5.5.4 Importing List

In case the measured points are not a grid, a list of measured points defined by expected and actual position can be imported.

Unit of measure is  $\mu\text{m}$  and decimal point is ‘.’, as explained in 5.5.2 Loading whole table. Lines starting with ‘;’ or ‘#’ are skipped. Supported formats are:

- <expected X>, <expected Y>, <expected Z>, <actual X>, <actual Y>
- <expected X>, <expected Y>, <expected Z>, <actual X>, <actual Y>, <actual Z>
- <layer>, <expected X>, <expected Y>, <expected Z>, <actual X>, <actual Y>, <actual Z>
- <magnification>, <layer>, <expected X>, <expected Y>, <expected Z>, <actual X>, <actual Y>, <actual Z>

Indices of magnification and layer can be provided optionally. Currently only X/Y errors can be imported, meaning actual Z has to be equal to expected Z, if provided.

A new measurement table is created with the same number of X/Y points as the field correction. Number of layers and magnitudes are used as provided by the imported data.

For each point of the measurement table, the nearest three points of the imported points are determined. The error at this position is then defined by a plane fitted through the measured deviation of these three points.

## 5.6 Saving measurements

The measurement table can be saved to a text file either to archive the measurement data or for further analysis by an external program.

Choose Measurement > Save Table.

## 5.7 Evaluating measurements

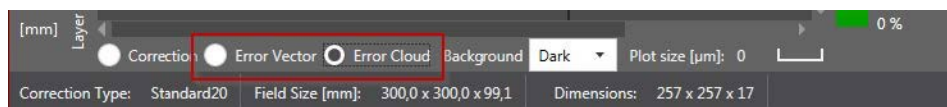
There are two plotting modes available to visualize the measured data. To show the graphs, click on the *Show Graph* button, located next to the *Apply* button in the measurements tab.

| X           | Y                                   |
|-------------|-------------------------------------|
| X [mm]      | -1: -150,00    0: 0,00    1: 150,00 |
| Y [mm]      | -150,00    0,00    150,00           |
| 1: 150,00   | -150    0    150                    |
| 0: 0,00     | -150    0    150                    |
| -1: -150,00 | -150    0    150                    |

Average correction [µm]: 0,00    Maximal correction [µm]: 0,00   

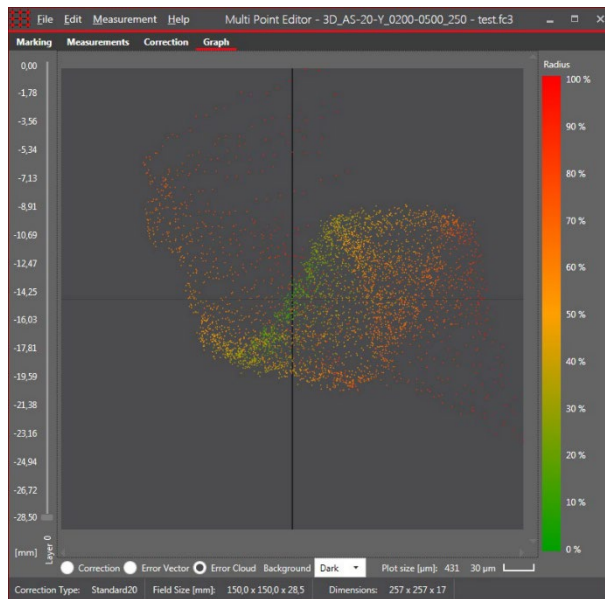
Correction Type: Standard20    Field Size [mm]: 300,0 x 300,0 x 99,1    Dimensions:

The type of the graph can be selected in the lower left corner.



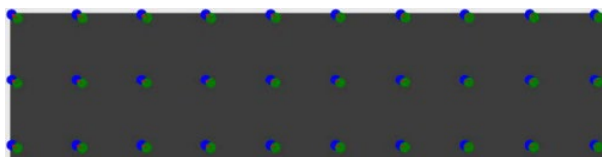
### 5.7.1 Error Cloud

- The error cloud displays the necessary XY correction of each measured point. The color is defined by the distance of the measured point to the center, meaning the color changes from green (center) to red (corner). The scale of the plot is shown as *Plot size [ $\mu\text{m}$ ]* in the lower right corner.



### 5.7.2 Error Vector

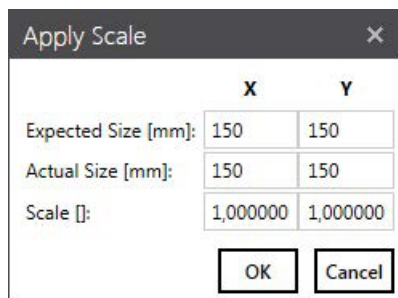
The error vector graph shows the measured and the expected location.



The measured points are green, the expected points blue. The resulting correction is displayed as a red arrow.

## 5.8 Applying scale

In order to quickly resize the field size, the user can apply a scale factor to the entire field correction table. Since the scaling is applied to the field correction table, only minute scale errors should be entered. Larger scaling should be implemented by scaling every vector sent to the card.

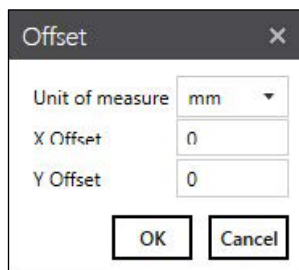
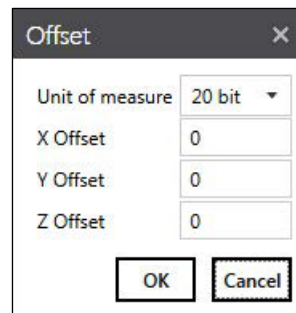


|                     | X        | Y        |
|---------------------|----------|----------|
| Expected Size [mm]: | 150      | 150      |
| Actual Size [mm]:   | 150      | 150      |
| Scale []:           | 1,000000 | 1,000000 |

## 5.9 Apply offset

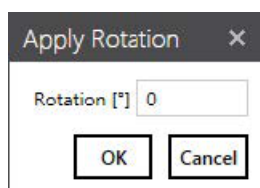
To apply a constant offset to the X, Y or Z correction values, you can use the *Correction > Apply Offset* dialog. The same offset will be applied to all layers.

Unit of measure controls if the offset is applied in field coordinates (mm) or control value (20 bit).

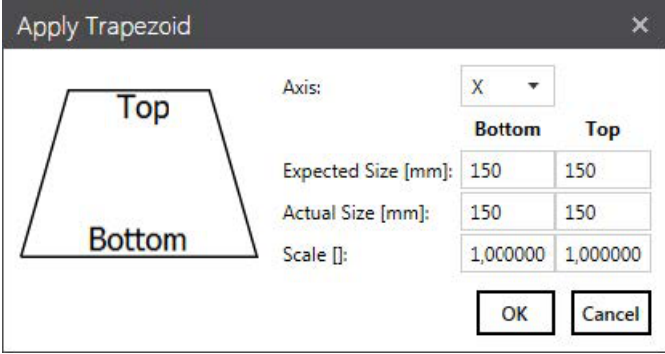
## 5.10 Apply rotation

To apply a rotation to the correction, choose the *Correction > Apply Rotation* dialog. The corrections will be rotated by the specified value in positive direction (counter clock wise). It should only be used for compensating small (single digit) rotations.

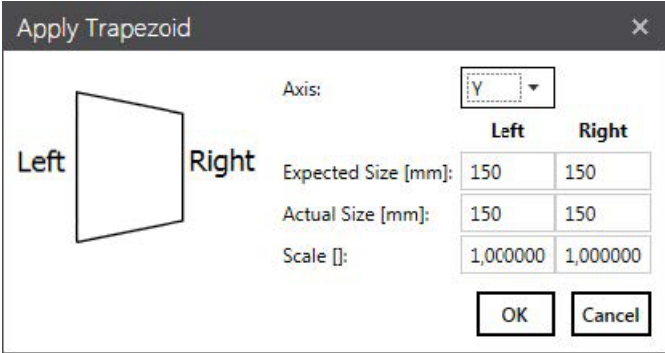


## 5.11 Apply trapezoid

To compensate a trapezoid shaped distortion, select *Correction > Apply Trapezoid*. After the axis to compensate is chosen, the measured sizes can be set. For the X Axis, the top and the bottom side has to be measured and for the Y axis the left and the right side like shown on the picture.



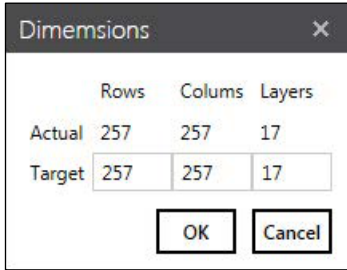
| Axis:               | X        |          |
|---------------------|----------|----------|
|                     | Bottom   | Top      |
| Expected Size [mm]: | 150      | 150      |
| Actual Size [mm]:   | 150      | 150      |
| Scale []:           | 1,000000 | 1,000000 |



| Axis:               | Y        |          |
|---------------------|----------|----------|
|                     | Left     | Right    |
| Expected Size [mm]: | 150      | 150      |
| Actual Size [mm]:   | 150      | 150      |
| Scale []:           | 1,000000 | 1,000000 |

## 5.12 Interpolate correction

Choose *Edit > Change Dimensions* to change the size of the corrections matrix. The missing values will be interpolated (non-linear).



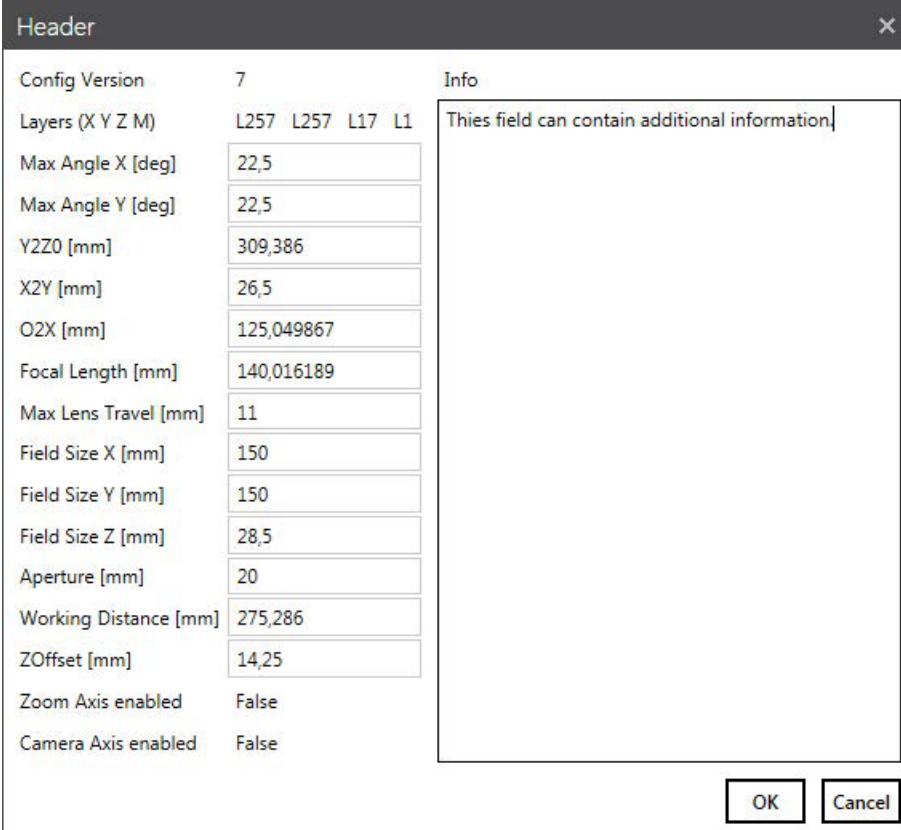
|        | Rows | Columns | Layers |
|--------|------|---------|--------|
| Actual | 257  | 257     | 17     |
| Target | 257  | 257     | 17     |

## 5.13 Edit Header

The Change Header option is only available for \*.fc3 files. In the header are multiple optical parameters and some informational parameters stored.

For example, RAYGUIDE is using the following parameters: field size, z offset, max lens travel, working distance and aperture.

Some parameters cannot be changed and are only for information like the dimensions of the correction and the enabled axes.



| Header                |                  | Info  |
|-----------------------|------------------|---|
| Config Version        | 7                | This field can contain additional information |
| Layers (X Y Z M)      | L257 L257 L17 L1 |   |
| Max Angle X [deg]     | 22,5             |   |
| Max Angle Y [deg]     | 22,5             |   |
| Y2Z0 [mm]             | 309,386          |   |
| X2Y [mm]              | 26,5             |   |
| O2X [mm]              | 125,049867       |   |
| Focal Length [mm]     | 140,016189       |   |
| Max Lens Travel [mm]  | 11               |   |
| Field Size X [mm]     | 150              |   |
| Field Size Y [mm]     | 150              |   |
| Field Size Z [mm]     | 28,5             |   |
| Aperture [mm]         | 20               |   |
| Working Distance [mm] | 275,286          |   |
| ZOffset [mm]          | 14,25            |   |
| Zoom Axis enabled     | False            |   |
| Camera Axis enabled   | False            |   |

OK Cancel

## 5.14 Setting Field Correction directly

To set the Field Correction directly, go to *Measurement > New Table* and select the *Absolut Interpolation* mode. Tick the axes to be updated (currently only the Z-Axis is supported) and set the Max Lens Travel to the correct value if the Z-Axis is getting updated.

The measurements table can be defined the same way explained in 5.4.1 (*Measurement > New Table*).

## 5 FIELD CORRECTION



**Define Table** ✕

Grid size (columns x rows):  x

Number of layers:

Layer selection

Number of magnification levels:

Magnitude selection

---

Calculation mode

▾

Edit Axes:  X  Y  Z

Max Lens Travel[mm]:

The Values are now displayed in millimetres and can be edited directly. By applying the changes, the values will be interpolated to fit the size of the correction table and replace the original correction values of the chosen axis.

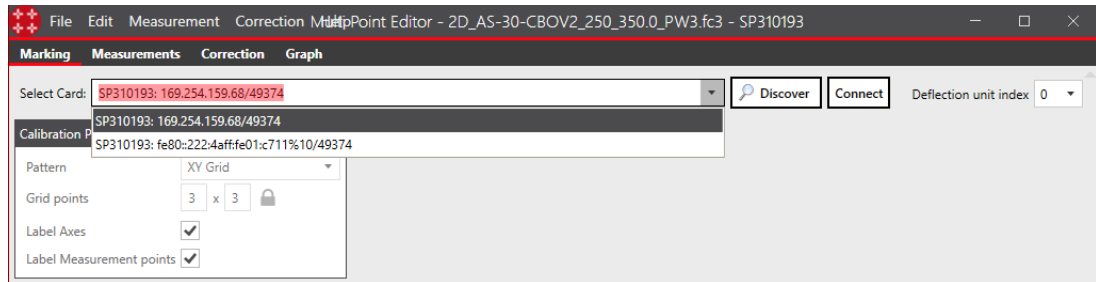
\* Header values display the position within the sub field. Values in parenthesis indicate the position within the entire field.  
 \* Cell values indicate the actual position of the grid point within the sub field.

| <b>Z</b>     |               |               |               |               |               |             |              |              |              |              |
|--------------|---------------|---------------|---------------|---------------|---------------|-------------|--------------|--------------|--------------|--------------|
|              | <b>X [mm]</b> | <b>-4:</b>    | <b>-3:</b>    | <b>-2:</b>    | <b>-1:</b>    | <b>0:</b>   | <b>1:</b>    | <b>2:</b>    | <b>3:</b>    | <b>4:</b>    |
| <b>Y[mm]</b> |               | <b>-75,00</b> | <b>-56,25</b> | <b>-37,50</b> | <b>-18,75</b> | <b>0,00</b> | <b>18,75</b> | <b>37,50</b> | <b>56,25</b> | <b>75,00</b> |
| <b>4:</b>    | <b>75,00</b>  | 10,956        | 9,85          | 9,014         | 8,493         | 8,316       | 8,493        | 9,014        | 9,85         | 10,956       |
| <b>3:</b>    | <b>56,25</b>  | 9,765         | 8,577         | 7,677         | 7,114         | 6,923       | 7,114        | 7,677        | 8,577        | 9,765        |
| <b>2:</b>    | <b>37,50</b>  | 8,359         | 7,606         | 6,655         | 6,059         | 5,856       | 6,059        | 6,655        | 7,606        | 8,359        |
| <b>1:</b>    | <b>18,75</b>  | 8,291         | 6,997         | 6,012         | 5,395         | 5,185       | 5,395        | 6,012        | 6,997        | 8,291        |
| <b>0:</b>    | <b>0,00</b>   | 8,398         | 6,789         | 5,793         | 5,168         | 4,956       | 5,168        | 5,793        | 6,789        | 8,098        |
| <b>-1:</b>   | <b>-18,75</b> | 8,291         | 6,997         | 6,012         | 5,395         | 5,185       | 5,396        | 6,012        | 6,997        | 8,291        |
| <b>-2:</b>   | <b>-37,50</b> | 8,359         | 7,606         | 6,655         | 6,059         | 5,856       | 6,059        | 6,655        | 7,606        | 8,359        |
| <b>-3:</b>   | <b>-56,25</b> | 9,765         | 8,577         | 7,677         | 7,114         | 6,923       | 7,114        | 7,677        | 8,577        | 9,765        |
| <b>-4:</b>   | <b>-75,00</b> | 10,956        | 9,85          | 9,014         | 8,493         | 8,316       | 8,493        | 9,014        | 9,85         | 10,956       |

# 6 MARKING OF CALIBRATION PATTERN

## 6.1 SP-ICE-3 Connection

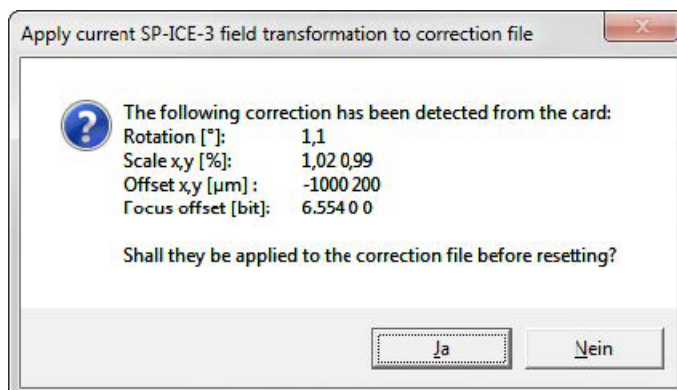
To connect to your SP-ICE-3 card, go to the *Marking* tab and press the *Discover* button. All cards installed in your pc or connected to your LAN will be listed. Choose your card and press *Connect*. The address of the card will be saved and restored in further sessions.



After the connection has been established, the active correction file will be sent to the card. If the correction file is changed or an other correction file is loaded, it will be sent to the card again. Please note that only the saved files can be sent. Any unsaved changes will not be sent to the card.

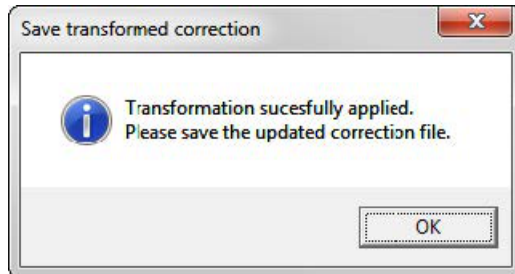
**NOTE:** In case your card is controlling 2 deflection units (dual mode) you can additionally select the deflection unit index in order to address field corrections for the second correction file as well. When you start the MPE from RAYGUIDE, this selection is made automatically when you select either the first or second deflection unit.

The SP-ICE-3 field transformation set by another application can be read back and applied to the correction file. If the transformation is not identity matrix, you will be asked if you want to update the correction file.





If the correction file was updated, it has to be saved, for being able to send it to the card.



After skipping or applying the transformation, it will be reset on the card.

## 6.2 XY-Axes Calibration patterns

There are five different pattern for calibration the XY coordinates.

As recommended in chapter 5.4.1 Field correction, the measurement grid should have its grid points on the grid points of the correction file. This can be achieved with the following number of columns/rows: 3, 5, 9, 17, 33, 65, 129, 257.

### 6.2.1 XY Grid

The XY Grid is the best choice for manual measurement. It will mark a grid with the specified amount of grid points. For convenience, the axis and the grid points can be labelled.

| Calibration Pattern      |                                     | 4..4  | 4..3  | 4..2  | 4..1  | Y    | 4.0  | 4.1  | 4.2  | 4.3  | 4.4 |
|--------------------------|-------------------------------------|-------|-------|-------|-------|------|------|------|------|------|-----|
| Pattern                  | XY Grid                             | 3..4  | 3..3  | 3..2  | 3..1  | 3.0  | 3.1  | 3.2  | 3.3  | 3.4  |     |
| Grid points              | 9 x 9                               | 2..4  | 2..3  | 2..2  | 2..1  | 2.0  | 2.1  | 2.2  | 2.3  | 2.4  |     |
| Label Axes               | <input checked="" type="checkbox"/> | 1..4  | 1..3  | 1..2  | 1..1  | 1.0  | 1.1  | 1.2  | 1.3  | 1.4  |     |
| Label Measurement points | <input checked="" type="checkbox"/> | 0..4  | 0..3  | 0..2  | 0..1  | 0.0  | 0.1  | 0.2  | 0.3  | 0.4  | X   |
| 3D Mode                  | Single Layer                        | -1..4 | -1..3 | -1..2 | -1..1 | -1.0 | -1.1 | -1.2 | -1.3 | -1.4 |     |
| Z position [mm]          | 0,00                                | -2..4 | -2..3 | -2..2 | -2..1 | -2.0 | -2.1 | -2.2 | -2.3 | -2.4 |     |
| Load presets from card   |                                     | -3..4 | -3..3 | -3..2 | -3..1 | -3.0 | -3.1 | -3.2 | -3.3 | -3.4 |     |
| Scanner                  |                                     | -4..4 | -4..3 | -4..2 | -4..1 | -4.0 | -4.1 | -4.2 | -4.3 | -4.4 |     |
| Jump Speed [m/s]         | 2                                   |       |       |       |       |      |      |      |      |      |     |
| Jump Delay [µs]          | 500                                 |       |       |       |       |      |      |      |      |      |     |
| Mark Speed [m/s]         | 1                                   |       |       |       |       |      |      |      |      |      |     |
| Mark Delay [µs]          | 100                                 |       |       |       |       |      |      |      |      |      |     |
| Poly Delay [µs]          | 50                                  |       |       |       |       |      |      |      |      |      |     |
| Laser                    |                                     |       |       |       |       |      |      |      |      |      |     |
| LM Frequency [kHz]       | 10,0                                |       |       |       |       |      |      |      |      |      |     |
| LM Width [µs]            | 100                                 |       |       |       |       |      |      |      |      |      |     |
| LaserOn Delay [µs]       | 0                                   |       |       |       |       |      |      |      |      |      |     |
| LaserOff Delay [µs]      | 0                                   |       |       |       |       |      |      |      |      |      |     |
| Power [%]                | 50,0                                |       |       |       |       |      |      |      |      |      |     |

### 6.2.2 XY Drill

- The XY Drill pattern is similar to the XY Grid pattern, but instead of marking a grid, the

## 6 MARKING OF CALIBRATION PATTERN



grid points will be drilled with the specified pulse count. The *Highlight center* will drill four additional point to identify the center. They are placed on half way between the center and the adjacent points. The mark delay will be inserted after each drill.

The screenshot displays the software interface for setting up a calibration pattern. It is divided into three main sections: Calibration Pattern, Scanner, and Laser.

**Calibration Pattern**

|                          |                                     |
|--------------------------|-------------------------------------|
| Pattern                  | XY Drill                            |
| Grid points              | 9 x 9                               |
| Pulses                   | 10                                  |
| Label Axes               | <input checked="" type="checkbox"/> |
| Label Measurement points | <input type="checkbox"/>            |
| Highlight center         | <input checked="" type="checkbox"/> |
| 3D Mode                  | Single Layer                        |
| Z position [mm]          | 0,00                                |

Load presets from card

**Scanner**

|                  |     |
|------------------|-----|
| Jump Speed [m/s] | 2   |
| Jump Delay [μs]  | 500 |
| Mark Speed [m/s] | 1   |
| Mark Delay [μs]  | 100 |
| Poly Delay [μs]  | 50  |

**Laser**

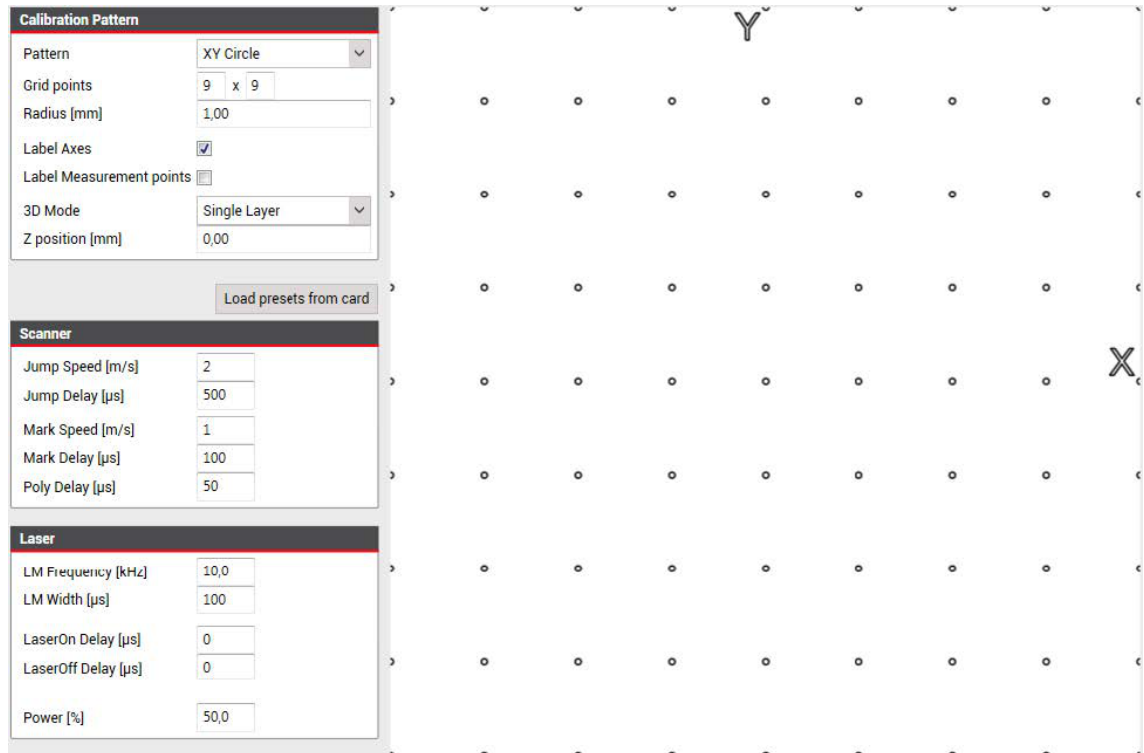
|                     |      |
|---------------------|------|
| LM Frequency [kHz]  | 10,0 |
| LM Width [μs]       | 100  |
| LaserOn Delay [μs]  | 0    |
| LaserOff Delay [μs] | 0    |
| Power [%]           | 50,0 |

The right side of the interface shows a 9x9 grid of points. The grid is labeled with 'Y' at the top and 'X' on the right side. The center point is highlighted with a larger dot, and four additional points are placed around it to identify the center.

## 6.2.3

**XY Circle**

The circle pattern marks a circle with a defined radius at each grid point.

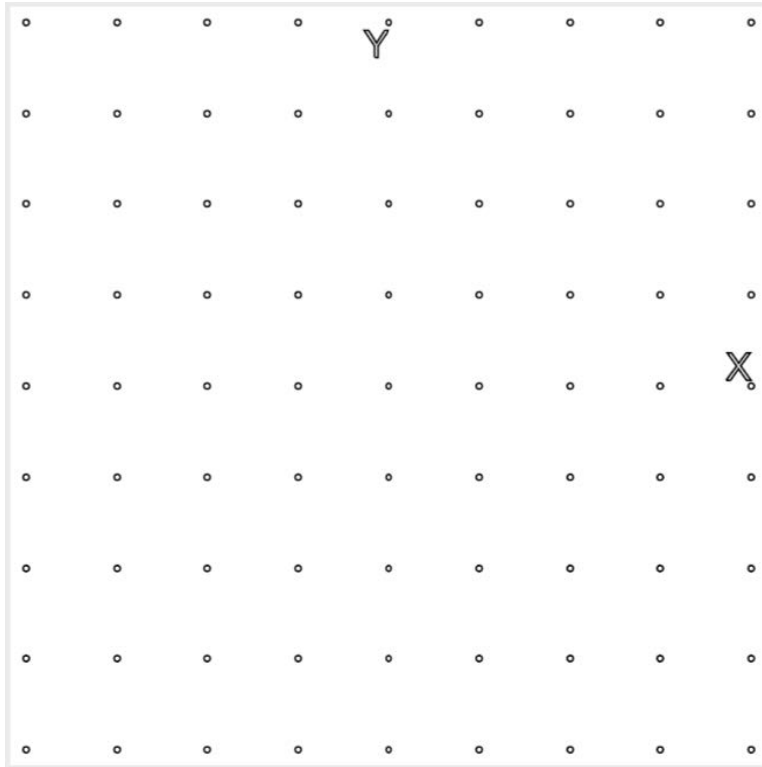


As a circle can't be marked at the edge of the field, it will be cut off. To avoid the circles being cut off, a sub field can be defined.

## 6 MARKING OF CALIBRATION PATTERN



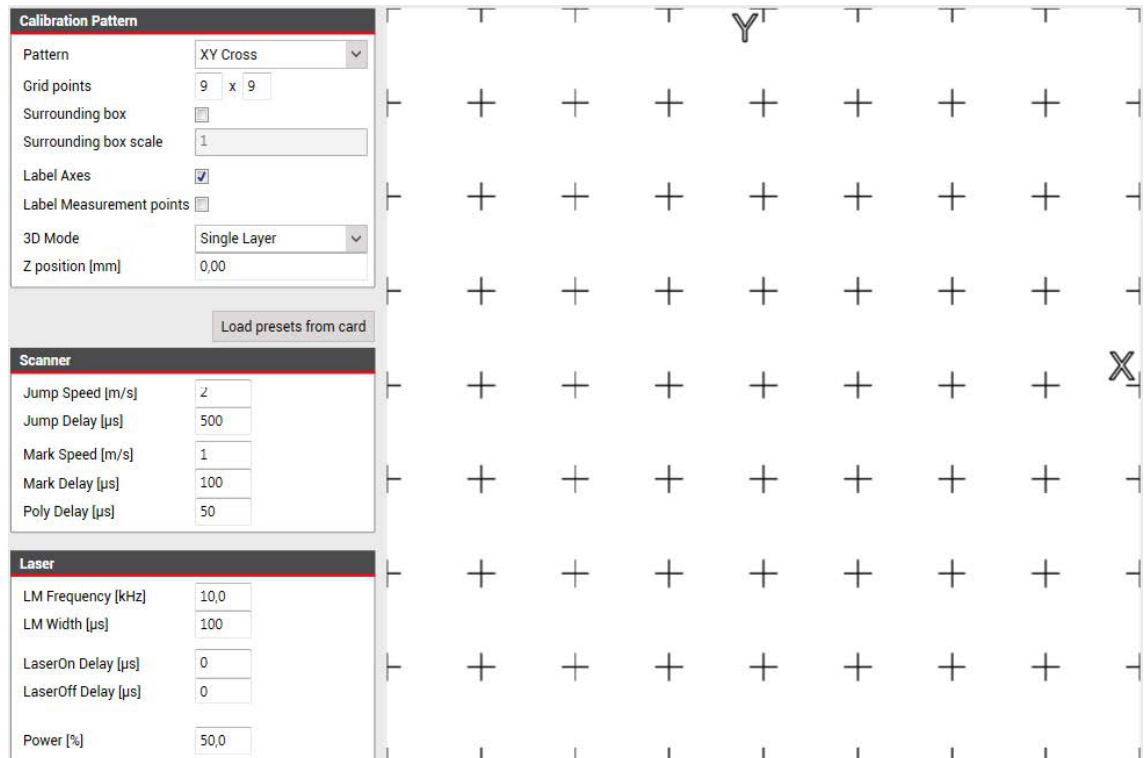
The following picture shows the same pattern for a sub field of 240 mm instead of the original 250 mm of the correction file.



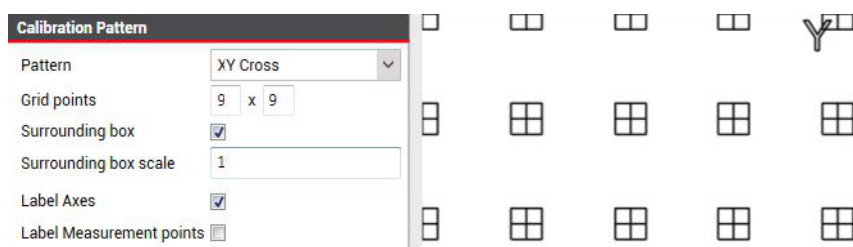
## 6 MARKING OF CALIBRATION PATTERN

### 6.2.4 XY Cross

The cross pattern marks a cross at each grid point.



Optionally the cross can be surrounded by a box.

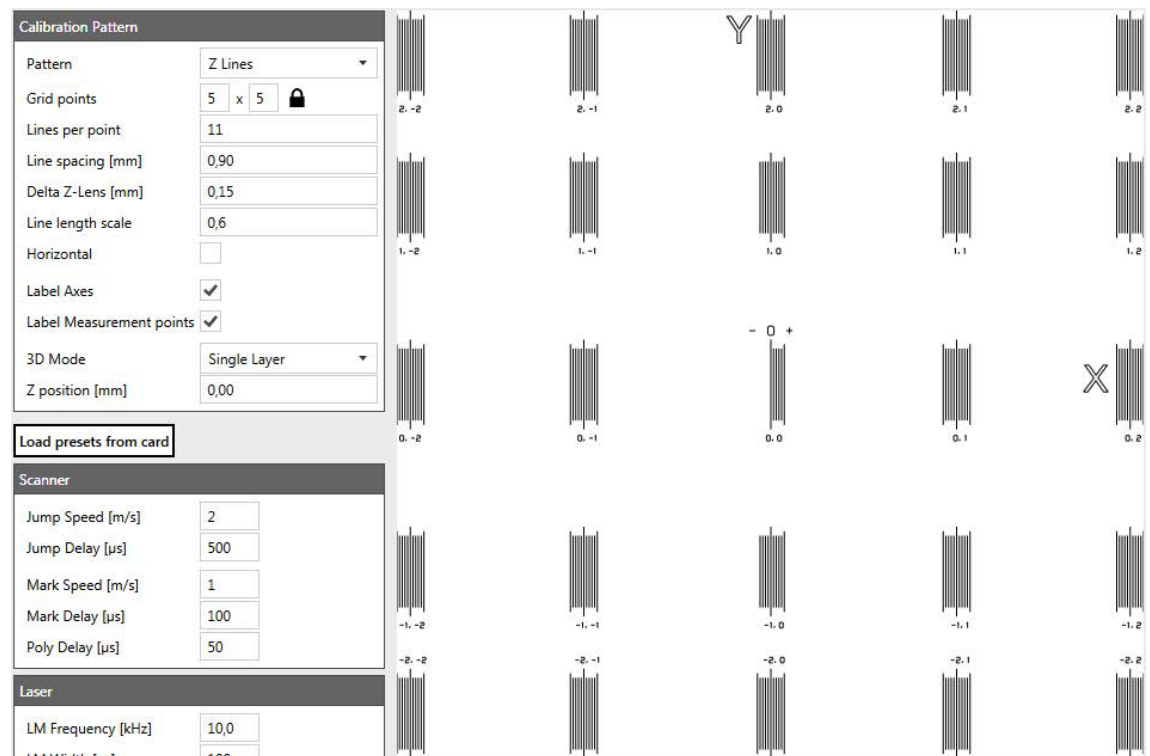


Like explained in the circle pattern, this pattern will be cut of at the edge of the field. Choose a sub field to avoid this behaviour.

## 6.3 Z-Axis calibration pattern

The Z-Axis calibration pattern will mark several lines at each grid point. Each line subtracts or adds the offset defined by *Delta Z* in mm to the z-axis. The max lens travel is depending on the deflection unit, and can be viewed at Edit > Change Header. For most lens translators, it's 11mm. The distance between the lines is set via the Line spacing. If the control value for the z axis is outside the markable range, the line will not be marked. This problem can be compensated by moving the position of the lens in the lens translator. For values smaller than the minimum (-524288), move the lens towards the laser, for values larger than the maximum (524287) towards the scanner.

By varying the offset, the best z correction values can be determined. The most focused line defines the offset. See chapter 5.4.2 for how to apply the measured values.



The screenshot displays the 'Calibration Pattern' configuration window on the left and a grid of marked lines on the right. The configuration window includes the following settings:

- Pattern:** Z Lines
- Grid points:** 5 x 5
- Lines per point:** 11
- Line spacing [mm]:** 0,90
- Delta Z-Lens [mm]:** 0,15
- Line length scale:** 0,6
- Horizontal:**
- Label Axes:**
- Label Measurement points:**
- 3D Mode:** Single Layer
- Z position [mm]:** 0,00

Below the configuration window is a 'Load presets from card' button. The 'Scanner' section includes:

- Jump Speed [m/s]:** 2
- Jump Delay [µs]:** 500
- Mark Speed [m/s]:** 1
- Mark Delay [µs]:** 100
- Poly Delay [µs]:** 50

The 'Laser' section includes:

- LM Frequency [kHz]:** 10,0
- LM Width [mm]:** 100

The grid on the right shows a 5x5 arrangement of vertical line patterns. The columns are labeled with Z-axis coordinates: -2, -1, 0, 1, 2. The rows are labeled with X-axis coordinates: -2, -1, 0, 1, 2. A 'Y' label is positioned above the 0 column, and an 'X' label is positioned to the right of the 0 row. The patterns consist of 11 vertical lines at each grid point, with varying lengths and positions corresponding to the Delta Z-Lens setting.

The length of the marked line can be influenced by the line length scale. A scale of one results in the largest lines still fitting into the scan field.

Horizontal marks the lines horizontally instead of vertically.

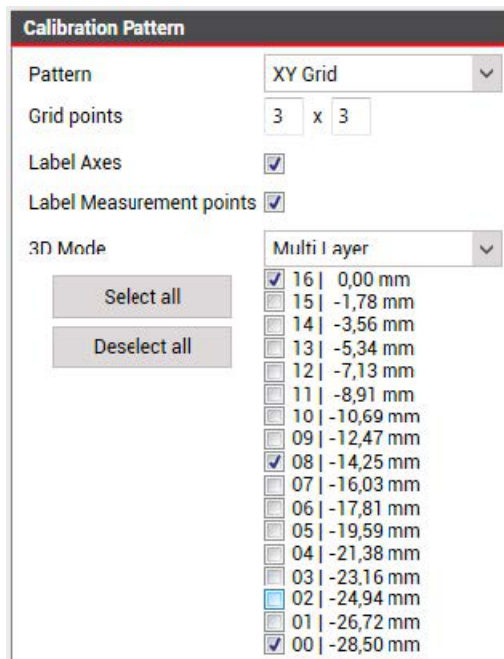
## 6.4 3D Mode

There are two approaches for calibration a \*.fc3 correction file with multiple layers.

For the *Single layer* mode, only a single layer is measured and the resulting corrections will be applied to all layers. The desired z position can be set without restriction. This mode can be useful if the distortion is the same for every z height.

If the distortion is different for multiple z heights, the *Multi Layer* mode should be used. In this mode, the measurements will be done on several layers and the resulting corrections will be interpolated in-between the layers. For a good result, at least the most top and bottom layers should be included. Otherwise the calibration data has to be extrapolated which could result in a loss of accuracy. The desired layers can be chosen by clicking on the corresponding check-boxes.

Please note that it is not possible to apply the corrections to a single layer only. If only one layer is checked in the multi-layer mode, the correction will still be applied to all layers.



## 6.5 Setting marking parameters

The object depending marking parameters can be set in the scanner and laser boxes. For loading the values the cards has used last, the *Load presets from card* button can be pressed.

| Scanner             |       |
|---------------------|-------|
| Jump Speed [m/s]    | 5,5   |
| Jump Delay [µs]     | 100   |
| Mark Speed [m/s]    | 1,5   |
| Mark Delay [µs]     | 200   |
| Poly Delay [µs]     | 100   |
| Laser               |       |
| LM Frequency [kHz]  | 10,0  |
| LM Width [µs]       | 100   |
| LaserOn Delay [µs]  | 150   |
| LaserOff Delay [µs] | 150   |
| Power [%]           | 100,0 |

All system parameters like the laser polarity etc must be set via the SP-ICE-3 config tool. If the card has already been used since the last reboot or the config is stored on the card, the system should already be configured.

## 6.6 Mark pattern

Depending on the type of laser, the laser has to be armed before the start of engraving. If the *Arm Laser* button (fire symbol) is black, the laser is not armed and the pilot (if available) is active. If the button is pressed, it will turn red, arm the laser and deactivate the pilot. By pressing the button again, the laser will be disarmed.

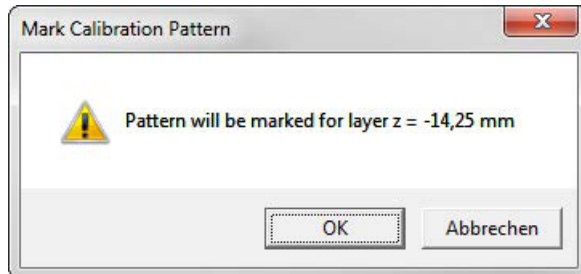


Fig. 5: Update Arm Mark Abort

Pressing the *Mark* button (play symbol) will mark the patterns.



For each pattern, a message with the z position will be shown.



While the marking is in progress, the *Laser Active* sign in the status bar is red.



As soon as the marking is finished, the sign will turn green.



## 6.7 Create new measurement table

After the marking is done, a new measurement table, with the configuration used for marking, can be created by clicking the *New Measurement Table* button.

See chapter 5.4 for how to enter the measured errors.

# 7 COMMAND LINE

## 7.1 Correction file generation

For fc3, gcd or pc3 generation via script, a command line interface has been implemented.

The generated file will be saved in the same path as the input file and, despite of the ending, will be named same.

If a file with the same name is already existing, it will be overwritten without asking.

In case of the correction values exceeding the field, they will be clipped automatically.

### 7.1.1 Fc3 generation

For fc3 generation the following arguments are expected in this order:

- fc3
- txz filename (with path)
- optional config file name: default values are :  
XYMaxGalvoAngles = 22.5, MaxLensTravel = 11  
In case of focus shifter, MaxLensTravel is calculated as  $1048575 / \text{taxiscalfactor}$ .
- optional rows, default value = 257
- optional columns, default value = 257
- optional layers, default value = 17

### 7.1.2 Gcd generation

For gcd generation the following arguments are expected in this order:

- gcd
- txz filename (with path)
- optional config file name: default values are :  
XYMaxGalvoAngles = 22.5, MaxLensTravel = 11

### 7.1.3 Pc3 generation

For pc3 generation the following arguments are expected in this order:

- pc3
- txz filename (with path)
- optional rows, default value = 257
- optional columns, default value = 257
- optional layers, default value = 17

## 7.2 Apply measurement table

The measurement table can be applied to a correction file with or without sub field.

### 7.2.1 Without sub field

The following arguments are expected in this order:

- applyError
- correction file name (\*.gcd, \*.fc3 or \*.pc3)
- measurement table file name (see 5.11 for file format)
- optional new correction file name

If the new name is not set, the original file will be overwritten.

Sample including new file name (quotes are only necessary if path contains whitespaces):

```
MultiPointEditor.exe applyError "correction.fc3" "measurements.mtf" "newFileName.fc3"
```

### 7.2.2 With sub field

The following arguments are expected in this order:

- applyErrorSubfield
- correction file name (\*.gcd or \*.fc3)
- measurement table file name (see 5.11 for file format)
- sub field size X [ $\mu\text{m}$ ]
- sub field size Y [ $\mu\text{m}$ ]
- sub field offset X [ $\mu\text{m}$ ]
- sub field offset Y [ $\mu\text{m}$ ]
- optional new correction file name

If the new name is not set, the original file will be overwritten.

## 7.3 Apply bit error

A table with error in bit can be applied to the correction file. The values will be interpolated to match the dimensions of the correction file and then be added to the correction values.

Expected format:

```
; Layer Row Column OffsetX [bit] OffsetY [bit] OffsetZ [bit] Offset4 [bit] Offset5 [bit]
0      0      0      0      0      0      0      297.886
0      0      1      0      0      0      0      500
```

The following arguments are expected in this order:

- applybiterror
- correction file name (\*.gcd, \*.fc3 or \*.pc3)
- bit error table file name
- optional new correction file name

If the new name is not set, the original file will be overwritten.

## 7.4 Logging

A log file is stored at

%programdata%\RAYLASE\Multi Point Editor\Logs\MultiPointEditorConsole.log.

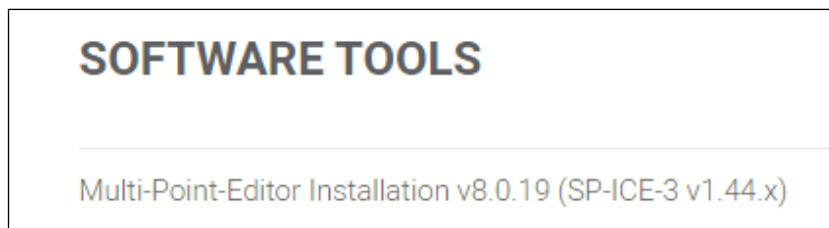
It contains the parameters the program got called with and, if occurred, the error messages.

# 8 COMPATIBILITY NOTES

The herein described methods apply to the following component(s):

- Multi Point Editor version 7.0.3 and later
- All RAYLASE standard and UHSS scan heads
- SP-ICE-3 v1.31 and later (only for the marking part)

Note the compatible SP-ICE-3 Firmware Version as mentioned in the downloaded file name, for example:



# 9 DOCUMENT CHANGE HISTORY

| Rev    | Date       | Valid from MPE version | Description   |
|--------|------------|------------------------|---|
| 1.1.14 | 2021-09-01 | 8.0.19                 | Transfer from Application Note to User Manual, new layout;<br>New: chap. Installation and License, Compatibility note;<br>Removed: List of compatible SP-ICE-3 versions |
| 1.1.15 | 2022-10    | 8.0.26                 | Chapter 2: Installation and License (RLPI)  |

# 10 KNOWN ISSUES

- Changing amount of magnification levels is not supported



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# TEC-IT Barcode Software

## Barcode Overview

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Version 11

## Reference

5 March 2021

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# 1 Disclaimer

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## 3 Introduction

### 3.1 Scope of this Document

This document describes barcode symbologies supported by TEC-IT software in a non-product-specific way. Please use this document as add-on or in-depth reference when dealing with barcode related questions in the following TEC-IT products:

|                            |  |
|----------------------------|--|
| ▶ <b>TBarCode OCX</b>      | A Microsoft® ActiveX® compliant barcode control          |
| ▶ <b>TBarCode .NET</b>     | A .NET barcode library                                   |
| ▶ <b>TBarCode Library</b>  | Barcode DLL for Microsoft® Windows® (and UNIX®)          |
| ▶ <b>Barcode Studio</b>    | A stand-alone barcode designer for Microsoft® Windows®   |
| ▶ <b>TBarCode/X</b>        | Barcode generators (SDK) for Linux® and UNIX®            |
| ▶ <b>TFORMer Designer</b>  | Full-featured label and report design                    |
| ▶ <b>TFORMer Runtime</b>   | Label and reporting engine for various operating systems |
| ▶ <b>TFORMer Server</b>    | Industrial output management                             |
| ▶ <b>TBarCode/Embedded</b> | Barcode-enabled print and spool appliance                |
| ▶ <b>TBarCode/SAPwin</b>   | Barcode DLL for SAP® R/3®                                |
| ▶ <b>TBarCode/Direct</b>   | Smart PostScript® compatible bar-coding for SAP® R/3®    |

### 3.2 Barcode Types

The reason for the many different types of barcodes is that barcodes are used in many different operational areas. Thus, it is possible to select the most suitable barcode type to meet the requirements of a particular industry.

#### 3.2.1 Linear 1D Barcodes



Figure 1: Linear Barcode Sample

Linear barcodes are known under names like Code 39, Code 128, UPC, EAN, 2of5...

Linear barcodes encode the information in one way (=one dimension), so they are also called one-dimensional barcodes (1D). The information is stored in the relationship of the widths of the bars (spaces) to each other.

In most of these symbologies the height of the bars is not relevant, except for some height-modulated Postal Codes (e.g. Australia Post 4-State or USPS Intelligent Mail® Barcode / IM® Barcode).

#### 3.2.2 2D Barcodes (Stacked)



Figure 2: 2D-Stacked Barcode Sample

Two-dimensional barcodes are known under names like PDF417, or Codablock F.

Such stacked or multi-row barcodes store information in two dimensions. Several stacked linear barcodes are used to encode the information.

### 3.2.3 2D Barcodes (Matrix Codes)



Figure 3: 2D Barcode Sample

Two-dimensional barcodes like MaxiCode, Data Matrix or QR Code® encode information in two dimensions. Compared to stacked symbologies the information is not stored by using different bar (space) widths. Instead, the position of black (or white) dots is relevant.

### 3.2.4 Composite Codes



Figure 4: Composite Barcode Sample

Composite codes like GS1 DataBar Composite Symbology are combining linear with 2D (stacked) symbologies. The advantage of such codes is that the linear code component encodes the most important information. The 2D component is used for additional data. This separation ensures better migration (e.g. with respect to scanning hardware) between linear and 2D technology.

### 3.3 Barcode Glossary

As follows, you will find a short explanation about technical terms which are used in the barcode technology.






|                           |   |   |
|---------------------------|---|---|
| Bar                       | A bar is represented by the dark or black elements in a barcode.  |    |
| Space                     | The white or lighter elements in a barcode are called spaces.   |   |
| Barcode density           | The density of the barcode refers to how much space is required for the needed characters (characters per Inch or centimeter)   |   |
| Element                   | Represents both a bar and a space.  |   |
| Module                    | A module is the smallest element of a barcode. The width of the single bars and spaces is a (mostly integer) multiples of the basic width of the module.  |   |
| Module width              | The width of the barcode's smallest element in millimeter, in inches or in so-called mils (one mil = 1/1000 inch).<br>The module width is usually abbreviated with the letter X.  |   |
| X Dimension               | The width of the barcode's smallest element (see Module width).   |   |
| Quiet zone                | An area free of any printing or marks that precedes the start character of a barcode and follows the stop character.<br>The required minimal size of the quiet zone depends on the barcode type. As a rule, the quiet zone should be ten times the dimension of the module width or at least 1/4 inch (6.5 mm). |    |
| Human Readable Text       | This term refers to the entire encoded information of a barcode shown in readable form. It is usually printed below the code. For 2D codes, no human readable text is used.   |   |
| Discrete Codes            | Each character begins and ends with a bar. The spacing between characters is not part of the code.  |   |
| Continuous Code           | The spaces between the characters are also part of the code. An example of a continuous code is the Code 2/5 Interleaved.   |   |
| Start and Stop Characters | Distinct characters used at the beginning and end of each barcode symbol that provide the scanner with start and stop reading instructions as well as scanning direction.   |   |
| Self-checking Code        | Self-checking code uses the same pattern for each character. For example, there can be five elements, two of them are wide and three are narrow. Any deviation from this pattern would result in an error.  |   |
| Check Digit               | One or more characters included within the barcode, which are used to perform a mathematical check to ensure the accuracy of the scanned data. Check digits are mandatory with certain codes or are even built into the symbology (as for Code-128)   |   |
| Bearer Bars               | These are bars printed above and below the symbol. The bearer bars are eliminating partial reads (as drawn in the example on the right). Sometimes bearer bars surround the complete symbol (e.g. ITF-14).  |  |
| Substitution Error        | Due to reading errors, a character is replaced by another during scanning. Substitution errors can be excluded by adding a check digit.   |  |
| Synchronizing Bars        | These bars are synchronizing the barcode reader. E.g. UPC-A and EAN-13 have synchronizing bars at the beginning, in the middle and at the end of the symbol.  |   |
| No-Read                   | A failure to decode, resulting in no output.  |   |
| Misread                   | The data output of a reader/decoder does not agree with the data encoded in the barcode field. This yields to substitution errors.  |   |

Table 1: Barcode Glossary



## 4 Important Barcode Parameters

In this chapter, you will find an explanation about the most important barcode parameters.

### 4.1 Barcode Symbology

The symbology determines the format and the capabilities of the barcode. Check out chapter 6 for a list of supported barcode symbologies. It depends on your application which symbology you should use. For help, deciding the right symbology, you can contact TEC-IT Support.

### 4.2 Module Width

#### 4.2.1 Introduction

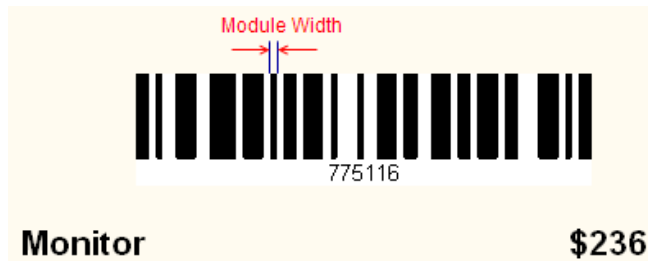


Figure 5: Module Width

The module width (or X dimension) is the width of the smallest bar (or space) in the barcode. The minimal module width depends on the used symbology. In most specifications, the recommended module width is at least 0.19 mms.

The default setting in TEC-IT software adapts the module width according to the bounding rectangle of the barcode. The module width is computed automatically by dividing the width of the object by the number of required modules. This depends on the number of data characters to be encoded. The module width decreases as the data content increases.

When adjusting the module width to a fixed value, the resulting barcode can be wider than the bounding rectangle. To avoid clipping, ensure that the entire barcode can be displayed with the maximum data content and enlarge the barcode object if required.

#### 4.2.2 Optimize the Module Width

Printing tolerances can lead to problems when decoding a barcode. A remedy for this problem is to optimize the module width with respect to available printing resolutions.

Assume you want to print a barcode with a resolution of 300 dpi then one pixel equals 0.003333 inch (or 0.08466 mm) in such a case. To avoid raster errors, you should select a module width that is an integer multiple of the pixel width (e.g. for 300 dpi a multiple of 0.08466 mm).

- ▶ 200 dpi: 2 modules á one pixel (0.127 mm) = 0.254 mm
- ▶ 202 dpi: 2 modules á one pixel (0.1257 mm) = 0.251 mm
- ▶ 300 dpi: 3 modules á one pixel (0.08467 mm) = 0,254 mm
- ▶ 600 dpi: 5 modules á one pixel (0.04233 mm) = 0,212 mm
- ▶ For printer resolutions > 300 dpi, module width optimization may not be required.

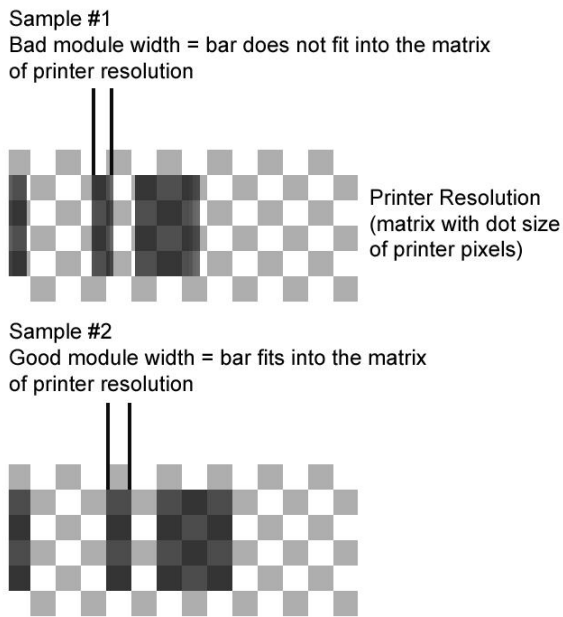


Figure 6: Raster Optimization

### 4.2.3 Module Width and Reading Distance

The actual reading distance for barcodes depends on two factors: the scanner hardware and the module width of the barcode.

There is no scanner, which can read all barcodes (ranging from high-density codes to barcodes with wide tracking) from all distances. Each barcode scanner has an optimum reading distance for barcodes with a certain module width. The manufacturer of the barcode scanner usually specifies the correlation between the module width and the reading distance. The following table shows such an exemplary specification.

Thus, depending on the module width the optimum reading distance for a specific scanner can be identified. On the other hand, if the reading distance is given by the application, the required module width for printing the barcodes may be adjusted.

| Module Width<br>(1 mil = 1/1000 mm) | Depth of Field<br>(Reading Distance) |
|-------------------------------------|--------------------------------------|
| 5 mil                               | 7.6 to 15.2 cm / 3 to 6"             |
| 7.5 mil                             | 5.1 to 40.6 cm / 2 to 16"            |
| 10 mil                              | 3.8 to 55.9 cm / 1.5 to 22"          |
| 13 mil                              | 2.5 to 76.2 cm / 1 to 30"            |
| 20 mil                              | 2.5 to 106.7 cm / 1 to 42"           |
| 55 mil                              | 5.1 to 203.2 cm / 2 to 80"           |

Table 2: Example for Scanner Specification

### 4.3 Bar Width Reduction (Pixel Shaving)

Another word for bar width reduction (BWR) is "bar width correction" (BWC) or "pixel shaving".

Bar width reduction is a common issue with printing bar codes. So called "dot gain" is part of every printing process and leads to enlargement of bars (while the gaps are reduced). Depending on the printing process, you must compensate these aberrations with the appropriate bar width reduction.

Sample values for dot gain (to compensate) are approximately 100 $\mu$ m with flexographic printing, 50 $\mu$ m with intaglio printing and 30 $\mu$ m with offset printing. The smaller the bar codes, the more precise you must work. Depending on the bar code orientation to the printing direction, the printing accuracy and printing process may change.

Bar width reduction may be applied also for laser printers (e.g. with too high toner saturation) or inkjet printers.

TEC-IT Software allows fine-tuning of the bar width reduction in percent, mm ( $\mu$ m), mils and inch.

#### 4.4 Quiet Zone

A quiet zone (an area free of any printing or marks) should be maintained directly before and after the barcode symbol. The quiet zone helps the scanner to determine the barcode correctly.

As a rule, the quiet zone should be ten times the dimension of the module width or at least 1/4 inch (6.5 mm); the exact value depends on the barcode symbology.



Figure 7: Quiet Zone

#### 4.5 Print Ratio and Ratio Format

The print ratio (the bar/width ratio) is the width relationship of all elements of a barcode – with respect to the smallest element. TEC-IT Software allows fine-tuning of the print ratio by supporting three parameters:

- Print ratio  
The read/write property *Ratio* is used to adjust the print ratio. The value of this property has to comply with the ratio format.
- Format of ratio  
The read-only property *RatioHint* shows the format (syntax) of the print ratio setting. It is intended as a hint for the programmer or user.
- Default print ratio  
The read-only property *RatioDefault* contains the default print ratio for the selected barcode symbology. In most cases the default ratio is the best choice for printing the barcode.



Figure 8: Print Ratio

Example:

The picture above shows a barcode with 4 different bar widths and 4 different space widths. Because TEC-IT software maintains the print ratio of bars and spaces separately, the ratio format is composed as follows: 1B:2B:3B:4B:1S:2S:3S:4S.

The first four values (1B:2B:3B:4B) refer to the 4 different widths of the **B**ars, the second four values (1S:2S:3S:4S) refer to the 4 different widths of the **S**paces. The numbers in the ratio hint (e.g. 1B stands for the smallest bar, 2B for the bar with the next larger width and so on) are only used to denote the order – they have no meaning with respect to the ratio itself.

Now set a new print ratio value. This string must be formatted according to the ratio format, but without the letters: A value of “1:3:5:7.3:1:3:5:7.3” for the *Ratio* indicates that the width of the widest bar (4B) is 7.3 times the width of the smallest bar (7.3:1).

| Ratio Format Specifier | Description   |
|------------------------|---|
| nB                     | The ratio of bar-width n with respect to the width of the smallest bar (bar-width 1)  |
| nS                     | The ratio of space-width n with respect to space-width 1 (smallest space)   |
| 1T                     | This is specific to the symbology “Plessey Bidirectional”. It denotes the ratio of the width of the terminator bar 1 to bar-width 1 |
| nC                     | This is specific to the symbology “Pharmacode”. It denotes the ratio of the width of color-bar n to the width of the smallest bar   |

Table 3: Print Ratio Adjustment

## 4.6 Format

Format acts like a “mask” for formatting the barcode data prior to encoding it. Placeholders in the format string can be mixed with constant data characters to build a final data string. With this feature, it is possible to:

- Select subsets in Code 128, GS1-128 (even within the code!)
- Insert control characters into the barcode
- Select the required start/stop character for CODABAR
- Change the position of the check digit
- Set the MaxiCode values “date”, “preamble”, “service class”, “postal code” and “country code” directly in the barcode data (with special escape sequences).

| Placeholder character | Description  |
|-----------------------|--|
| #                     | Stands for the next data character of the input data (property <i>Text</i> )   |
| &                     | Stands for all remaining data characters in the input data (property <i>Text</i> )   |
| ^                     | Stands for the next check digit (use only if check digits will be computed!) <ul style="list-style-type: none"> <li>▪ TBarCode 6 (or earlier) computes the check digit for all characters in the input data.</li> <li>▪ TBarCode 7 (or later) only uses input data left of the check digit placeholder for check digit computation (see examples below!).</li> </ul> |
| A                     | Switch to Subset A (used in: Code 128, GS1-128)<br>Start- or stop character A (only in: CODABAR)   |
| B                     | Switch to Subset B (used in: Code 128, GS1-128)<br>Start- or stop character B (only in: CODABAR)   |
| C                     | Switch to Subset C (used in: Code 128, GS1-128)<br>Start- or stop character C (only in: CODABAR)   |
| C                     | Enable compatibility mode for CAPTIVA/IBML document scanning software (used in Data Matrix only)   |
| D                     | Start- or stop character D (only in: CODABAR),<br>Only for <i>Pharmacode</i> : encode the Pharmacode directly (bar by bar)<br>Only for <i>Data Matrix</i> : use an alternative error correction algorithm for symbols of size 144x144.   |
| E                     | Translate the Escape Sequences that the input data contains.   |
| J                     | Only for Japanese Postal codes: the Address B data field can be automatically compressed, i.e. Japanese characters are converted into ASCII characters by a defined rule.  |

| Placeholder character | Description   |
|-----------------------|---|
| S                     | Only for MaxiCode: enables setting the values of Date, Preamble, Service Class, Postal- and Country-Code directly in the barcode data (only in conjunction with escape sequences).  |
| <                     | Adds quiet zone markers at the left (“<”) and/or at the right (“>”) side of the barcode. These markers are supported by the following barcode types: <ul style="list-style-type: none"> <li>▪ EAN 8 and add-on variants (both sides)</li> <li>▪ EAN 13 and add-on variants (only right side)</li> <li>▪ UPC-A with 2 and 5 digit add-on (only right side)</li> <li>▪ UPC-E with 2 and 5 digit add-on (only right side)</li> <li>▪ ISBN (only right side)</li> </ul> |
| >                     |   |

Table 4: Format Placeholders

### 4.6.1 Format Examples

| Input data | Barcode type | Format string | Data used for encoding | Notes   |
|------------|--------------|---------------|------------------------|---|
| 123        | Irrelevant   |               | 123                    |   |
| 123        | Irrelevant   | 5&            | 5123                   |   |
| 123        | Irrelevant   | &6            | 1236                   |   |
| 123        | Irrelevant   | q#w#e#        | q1w2e3                 |   |
| 123        | Irrelevant   | #q&           | 1q23                   |   |
| 123        | Irrelevant   | &^            | 123c                   |   |
| 123        | Irrelevant   | ^&            | c123                   | This format string may be used for TBarCode 6 (or earlier). – Newer versions always return 0 in this case.  |
| 12345      | Irrelevant   | #####^#       | 1234c5                 | When using Modulo 10 for check digit calculation, c will be <ul style="list-style-type: none"> <li>▪ Mod-10 (12345) = 5 for TBarCode 6 (or earlier).</li> <li>▪ Mod-10 (1234) = 0 for TBarCode 7 (or later).</li> </ul> |
| Hello      | Code 128     | A&            | Hello                  |   |
| Hello      | Code 128     | A##B&         | Hello                  |   |
| Hello4711  | Code 128     | A##B&         | Hello4711              |   |
| Hello4711  | Code 128     | A##B###C&     | Hello4711              |   |
| 1234567890 | GS1-128      | #####^#####   | 12345767890            | 7 is the check digit computed when using Modulo 10. The check digit computation uses only the digits 12345 (67890 are ignored because this data comes after the ^)  |

Table 5: Format Examples

red characters represented in subset A  
gray characters represented in subset B  
green characters represented in subset C  
c represents the place of the check digit

### 4.7 Escape Sequences (Encoding Binary Data)

If you want to use non-printable or special characters in a barcode, you have to use escape sequences. An escape sequence always start with a backslash (“\”) followed by the sequence itself.

- ▶ You have to activate the decoding of escape sequences in the barcode properties – per default the translation of escape sequences is turned off.
- ▶ With activated escape sequences you must use “\” in the input data to encode a single backslash „\” in the barcode.

| Escape sequence      | Description  | Valid for Barcode Symbology   |
|----------------------|--|---|
| <b>\a</b>            | Bell (alert)   | All   |
| <b>\b</b>            | Backspace  |   |
| <b>\f</b>            | Form feed  |   |
| <b>\n</b>            | New Line   |   |
| <b>\r</b>            | Carriage Return  |   |
| <b>\t</b>            | Horizontal Tab   |   |
| <b>\v</b>            | Vertical Tab   |   |
| <b>\\</b>            | The backslash \ itself   |   |
| <b>\0</b>            | Zero Byte (if subsequent char is non-numeric)<br>Available in TBarCode V10+  |   |
| <b>\000</b>          | ASCII-character in octal notation:<br>ooo ... up to 3 octal digits (0..7)<br>First digit is always zero.   |   |
| <b>\ddd</b>          | ASCII-character in decimal notation:<br>ddd ... up to decimal digits (0..9)<br>First digit must not be zero.   |   |
| <b>\xhh</b>          | For encoding bytes or ASCII-characters in hexadecimal notation<br>hh ... hexadecimal digits (0..F)   |   |
| <b>\Crrggbb</b>      | Color selection  | See Pharmacode  |
| <b>\Ce</b>           | Reset the color to default   |   |
| <b>\F</b>            | FNC1 (Function Number Character 1) used as field separator   | GS-128, Codablock-F<br>MicroPDF417: a special FNC1 code word is inserted when using emulation mode for GS1-128 or Code-128<br>Data Matrix: a special FNC1 code word is inserted |
| <b>\F</b>            | Inserts a Gs (Group Separator) or ASCII 1DHex.<br>Do not encode the \x1d directly!   | PDF417, MaxiCode and in QR Code<br>QR Code: When using format UCC/EAN/GS1 Gs is inserted in Byte Mode, a % is inserted in alphanumeric mode.                                    |
| <b>\Ennnnnn</b>      | <b>Extended Channel Interpretation (ECI).</b><br>nnnnnn ... 6 digit ECI number with leading zeros<br>Used for defining the character set (code page) for the subsequent encoded data – see C.1 ECI | MaxiCode, Data Matrix, QR Code, PDF417, MicroPDF417, Aztec Code   |
| <b>\EB, \EE</b>      | Special ECI identifiers for nesting ECIs.<br><b>\EB (ECI Begin)</b> opens a nesting level,<br><b>\EE (ECI End)</b> closes it.  | QR Code   |
| <b>\G</b>            | <b>Global Language Identifier (GLI)</b> , similar to ECI (see <b>\E</b> ).   | PDF417  |
| <b>\S</b>            | Symbol separator character for C128 emulation  |   |
| <b>\&lt;FNCx&gt;</b> | Function sequence. Currently <b>FNC1</b> , <b>FNC2</b> , <b>FNC3</b> , and <b>FNC4</b> are implemented. <b>\&lt;FNC1&gt;</b> is equal to <b>\F</b> .   |   |
| <b>\x11</b>          | DC1  | Code93, Code93Ext   |
| <b>\x12</b>          | DC2  | Code93, Code93Ext   |
| <b>\x13</b>          | DC3  | Code93, Code93Ext   |
| <b>\x14</b>          | DC4  | Code93, Code93Ext   |
| <b>\x1e</b>          | Rs (Record Separator), ASCII 1EHex   | PDF417, QR Code, Data Matrix, MaxiCode (Mode 3,4 SCM)   |
| <b>\x1d</b>          | Gs (Group Separator), ASCII 1DHex  | PDF417, QR Code, Data Matrix, MaxiCode (Mode 3,4 SCM)   |
| <b>\x04</b>          | Eot (End of Transmission), ASCII 04Hex   | PDF417, QR Code, Data Matrix, MaxiCode (Mode 3,4 SCM)   |

Table 6: Implemented Escape Sequences

## 4.8 Check Digits

The method for the check digit(s) calculation depends on the respective barcode type. In order to make TEC-IT products as user-friendly as possible, a standard method for each barcode type is supplied (where applicable).

- ▶ Per default, the input can take place with and without a check digit. In the latter case, the check digit is calculated automatically and added to the barcode data.  
Example (EAN13): If you enter 12 digits (= utilizable data), the 13th digit (= the check digit) is computed and added automatically. If you enter 13 digits, the check digit is verified only.

| Check digit enumeration     | Enumeration value | Check digit calculation methods   |
|-----------------------------|-------------------|---|
| eCDNone                     | 0                 | No check digit will be computed   |
| eCDStandard                 | 1                 | Standard check digit of the selected barcode type is used                                       |
| eCDMod10                    | 2                 | Modulo 10 (usually used with Interleaved 2of5)  |
| eCDMod43                    | 3                 | Modulo 43 (suggested for Code39 and LOGMARS, consist of 1 digit)                                |
| eCD2Mod47                   | 4                 | Modulo 47 (2 digits)  |
| eCDDPLeit                   | 5                 | Method for DP Leitcode  |
| eCDDPIdent                  | 6                 | Method for DP Identcode   |
| eCD1Code11                  | 7                 | Method for Code11 (1 digit)   |
| eCD2Code11                  | 8                 | Method for Code11 (2 digits)  |
| eCDPostnet                  | 9                 | Method for USPS POSTNET   |
| eCDMSI1                     | 10                | Method for MSI (1 digit)  |
| eCDMSI2                     | 11                | Method for MSI (2 digits)   |
| eCDPlessey                  | 12                | Method for Plessey  |
| eCDEAN8                     | 13                | Method for EAN 8  |
| eCDEAN13                    | 14                | Method for EAN 13   |
| eCDUPCA                     | 15                | Method for UPC A  |
| eCDUPCE                     | 16                | Method for UPC E  |
| eCDEAN128                   | 17                | EAN 128 internal method (Modulo 103)  |
| eCDCCode128                 | 18                | Code 128 internal method (Modulo 103)   |
| eCDRM4SCC                   | 19                | Method for Royal Mail 4 State   |
| eCDPZN                      | 20                | Modulo 11 method for PZN  |
| eCDMod11W7                  | 21                | Modulo 11 (weighting = 7)   |
| eCDEAN14                    | 22                | Method for EAN 14   |
| eCDMod10Kor                 | 23                | Method for Korean Postal Authority - Modulo 10  |
| eCDMod10Pla                 | 24                | Method for Planet - Modulo 10   |
| eCDMod10ItIPst25            | 25                | Method for Italian Postal 2/5 (Modulo 10 based)   |
| eCDMod36                    | 26                | Modulo 36 (ISO/IES 7064) for DPD Barcode  |
| eCDMod16                    | 27                | Modulo 16 for Codabar Barcode   |
| eCDMod10Luhn                | 28                | Modulo 10 with Luhn Algorithm   |
| eCDVIN                      | 29                | Method for VIN (North America)  |
| eCDMod10LuhnRev             | 30                | Modulo 10 with Reverse Luhn Algorithm   |
| eCDMod23PPSN                | 31                | Modulo 23 for PPSN  |
| eCDMod10IMPpackage          | 32                | Modulo 10 for Intelligent Mail Package Barcode  |
| eCDMod11W10                 | 33                | Modulo 11 (using maximum weight 10)   |
| eCDUPU/<br>eCDSwedishPostal | 34                | Modulo 11 method for UPU (Universal Postal Union)<br>Method for Swedish Postal Shipment Item ID |
| eCDMod11W9                  | 35                | Modulo 11 (using maximum weight 9)  |

Table 7: Check Digit Methods and Enumerators

## 5 Application Identifiers (AI)

### 5.1 Introduction

Some barcode symbologies (e.g. GS1-128) use Application Identifiers (AIs) in order to provide information about the structure of the encoded data. Application Identifiers are mostly used in industry-specific barcode symbologies.

An Application Identifier (AI) is a prefix (built from 2 to 4 characters) used to identify the meaning and the format of the data that follows. AIs have been defined by GS1 (formerly UCC/EAN) for identification, traceability data, dates, quantity, measurements, locations, and many other types of information.

The data presented can be alphanumeric or numeric and with fixed or variable data lengths. The symbology character FNC1 is used as field separator in connection with variable length data fields.

- ▶ Use FNC1 only with variable length data fields
- ▶ Do not use FNC1 after the last data field.

Depending on the barcode symbology, you are able to concatenate multiple AIs and encode more data fields into one symbol. If an AI is of variable length type, you have to separate the next data field with FNC1. FNC1 is specified in the barcode data with the escape sequence “\F” (see section 4.7).

- ▶ For encoding the FNC1, you have to activate *Translate Escape Sequences*.
- ▶ Do not encode the brackets, which are usually used to denote an Application Identifier. TEC-IT software generates the brackets automatically for the human readable text. The brackets are not encoded in the barcode itself.

For more information (e.g. a list of all available AIs), please follow the links below:

- <https://www.gs1.org/barcodes/technical/genspecs>
- <https://www.gs1.org/productssolutions/barcodes/technical/genspecs/index.html>
- <https://en.wikipedia.org/wiki/GS1-128>

You find additional links in our support area as well:

- <https://www.tec-it.com/support/links/barcode.aspx>

### 5.2 Examples

#### 5.2.1 Batch Number

A batch number is encoded with AI 10. The format of AI 10 is “n2 + an..20”. This means the AI has two digits (10) followed by variable length data with maximum 20 characters.

| Description          | Value                               |
|----------------------|-------------------------------------|
| Data (Text property) | 10 + Production Number = 1012345678 |
| Human readable text  | (10)12345678                        |
| Encoded data         | 1012345678                          |

#### 5.2.2 Multiple AIs within one Barcode

Two data fields should be encoded in one barcode. Following fields are used:



| Description                   | Value  |
|-------------------------------|--|
| Item number AI (01) – format  | n2 + n14   |
| Batch number AI (10) – format | n2 + an1...20  |
| Data (Text property)          | 01+Global Trade Item Number+10+Batch Number = 01123456789012311012345678 |
| Human readable text           | (01)12345678901231(10)12345678   |
| Encoded data                  | 01123456789012311012345678   |

▶ Because AI 01 is a fixed length data field, no FNC1 (field separator) is used.

| Description                    | Value  |
|--------------------------------|--|
| Batch number AI (10) – format  | n2 + an1...20  |
| Serial number AI (21) – format | n2 + an1...20  |
| Data (Text property)           | 10+Batch Number+F+21+Serial Number = 10L12345678\F21S12345 |
| Human readable text            | (10)L12345678(21)S12345                                    |
| Encoded data                   | 10L12345678FNC121S12345                                    |

▶ The field separator FNC1 (encoded by the sequence „\F“) has to be used because the batch number (AI 10) is a variable length data field.

### 5.2.3 GS1-128 with embedded Check Digit

Sometimes it is required to calculate a check digit only for a partial content of a barcode. A good example is the AI 01 (GTIN) in combination with other data fields within a GS1-128 symbol.

| Description              | Value         |
|--------------------------|---------------|
| AI for GTIN              | 01            |
| AI for Date              | 11            |
| GTIN without check digit | 1234567890123 |
| Production Date          | 060606        |

In our example, the GTIN contains no check digit (e.g. when created based on the EAN-13 number). The check digit has to be generated only for the first 13 digits of the supplied data and not for the full data content.

Since **TBarCode Version 7+**, you can use the format property to solve this problem:

| Description             | Value                                 |
|-------------------------|---------------------------------------|
| Format property:        | 01#####^11#####                       |
| Data (Text property):   | 1234567890123060606                   |
| Check Digit Method:     | EAN-14 (Mod-10)                       |
| Calculated Check Digit: | CD = Mod-10 of (1234567890123) = 1    |
| Result:                 | 01 + 1234567890123 + CD + 11 + 060606 |
| Encoded data:           | 011234567890123111060606              |

### 5.3 GS1 DataBar Expanded / GS1 DataBar Expanded Stacked

The mentioned symbologies use an internal data compression algorithm for specific Application Identifiers. Compression means that the barcode can encode more data or can be made smaller. This optimization takes effect if the AIs are applied in the following predefined order.

### 5.3.1 AIs with a Fixed Length

#### 5.3.1.1 AI(01) and Weight

AI (01) must begin with an indicator digit of 9 for variable units

| Combinations        | Description                                       | Max. Weight |
|---------------------|---|-------------|
| AI (01) + AI (3103) | Weight in kg with 3 decimal places (n.nnn kg)     | 32.767      |
| AI (01) + AI (3202) | Weight in pound with 2 decimal places (n.nn lbs)  | 999.99      |
| AI (01) + AI (3203) | Weight in pound with 3 decimal places (n.nnn lbs) | 22.767      |

Table 8: Fixed length AIs in RSS Expanded / Expanded Stacked Codes

#### 5.3.1.2 AI(01), Weight and Date

Two or three data elements will be used for the barcode:

| Combinations                         | Description                                 | Addition |
|--------------------------------------|---|----------|
| AI (01)                              | <b>Must start with 9</b> for variable units |          |
| + AI (310n) or AI (320n)             | For declaration of the Weight               | n = 0..9 |
| + AI (11), AI (13), AI (15), AI (17) | For the Date                                |          |

Table 9: AIs in GS1 DataBar Expanded / Expanded Stacked Codes

If the date is not required, this order of AIs still leads to a better barcode representation.

### 5.3.2 AIs with Variable Lengths

#### 5.3.2.1 AI (01) and Price

| Combinations          | Description                                 | Addition |
|-----------------------|---|----------|
| AI (01)               | <b>Must start with 9</b> for variable units |          |
| + AI (392x)           | For the price                               | x = 0..3 |
| <b>or</b> + AI (393x) | For the price in the ISO currency format    | x = 0..3 |

Table 10: Variable length AIs in RSS Expanded / Expanded Stacked Codes

#### 5.3.2.2 AI (01)

▶ If AI(01) is needed in the barcode, please ensure it is the first AI encoded (for optimal data representation).

## 5.4 GS1 Composite Symbology

The GS1 (EAN.UCC) Composite Symbology was designed to hold primary data (like the GTIN or Shipping Container Code) in the linear symbol and additional data in the 2D Composite Component. For specific AI combinations in the 2D add-on symbol, it is possible to perform a data compression (as shown below). This leads to a higher data density (= smaller barcode or more encode able characters).

### 5.4.1 Compressed Sequences of AIs

The following AI-sequences can be compressed for higher data efficiency:

| Combinations      | Description                    |
|-------------------|--------------------------------|
| AI (11) + AI (10) | Date and Lot-Number            |
| AI (17) + AI (10) | Expiration Date und Lot-Number |

Table 11: AIs in Composite Codes

#### 5.4.2 AI (90)

AI (90) and the following data (which starts with an upper-case letter or a digit) may be used for encoding of FACT IDs. Compression takes place only if AI(90) is the first data element of the sequence.



## 6 Barcode Symbologies

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This chapter describes all supported barcode types. For each barcode, the following values are specified:

- **Symbology Number**  
This number is used in some TEC-IT products to specify the barcode symbology. Developers are usually specifying the barcode type via an enumeration, which is documented in the respective developer documentation.
- **Valid characters**  
Lists the available characters or character sets which can be encoded with the symbology.
- **Quiet zone**  
This is the recommended quiet zone for the barcode symbology in question. Please note that the quiet zone often depends on your individual application.
- **Module width**  
The recommended minimal module width of the barcode. This value may be adapted to your special requirements.
- **Standard print ratio**  
This setting describes the print ratio used by TEC-IT software if no custom ratios are adjusted. For most applications, you can use this default value.
- **Ratio format**  
This value serves as a hint for specifying user defined print ratios.
- **Default check digit**  
Describes, which check digit method is used by default for the barcode symbology in question. For 2D codes check digits are not applicable, these codes are using an error correction scheme.
- **Possible check digits**  
Provides information whether additional or user defined check digits methods may be adjusted
- **Size**  
Describes the requirements with respect to the symbol size (if available)
- **Print control<sup>1</sup>**  
Control character sequence used by TBarCode/SAPwin (Barcode DLL for SAP®).

### 6.1 Linear Symbologies (1D Codes)

#### 6.1.1 Bookland

The Bookland barcode encodes the ISBN number in EAN-13 format followed by a 5-digit supplemental code. The barcode data always consists of the digits '978' (the EAN article identifier), followed by a 9-digit number and one check digit. You can use the EAN-13 with 5-digits add-on for encoding. The 5-digit add-on barcode is used to encode the book price. For more information, refer to section 6.1.39

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<sup>1</sup> Listed for the most common bar code types. See user manual for the complete list of print controls.



## 6.1.2 Codabar (Rationalized Version)

|                        |   |  |
|------------------------|---|--|
| Symbology number:      | 18  |  |
| Valid characters:      | "0".."9", "-", "\$", ":", "/", ".", "+", "A", "B", "C", "D" |  |
| Quiet zone:            | left/right: 10X   |  |
| Module width:          | X = 0.19 mm   |  |
| Standard print ratio:  | 1:3:1:3   |  |
| Ratio format:          | 1B:2B:1S:2S   |  |
| Default check digit:   | None (eCDNone)  |  |
| Possible check digits: | User supplied (e.g. Modulo 16)                              |  |
| Symbol size:           | +/- 0.066mm Module width Deviation                          |  |
| Print control:         | C=CODA  |  |

This code was invented 1972 by Monarch Marking Systems for retail purposes. In 1977 the American Blood Commission defined Codabar 2 as standard symbology for blood banks (=ABC Codabar).

The characters "A", "B", "C", and "D" are useable as start or stop characters only. The barcode uses 2 element-widths and 4 different start/stop-characters (A, B, C, and D). These start/stop characters can be utilized for additional information – e.g. "B1234B". The print ratio should be in the following range: 1:2 -1:3 (Pr >= 2.25:1). Since the symbology is "self-checking", there is no established check sum method.

The symbology is also known as Code 2 of 7, NW-7, ABC Codabar, USD-4, Monarch, Code-27, Ames code, or Rationalized Codabar.

The "rationalized version" uses 2 different element widths in spite of the original symbology, which used 18 different element widths (Standard Codabar).


- ▶ Use the format property to determine the Start and Stop characters (see section 9.3).
- ▶ FedEx is using a special variant of the Codabar barcode. The format of the encoded number is as follows: XXXX-XXXX-XXXY with a 4-digit ID at the end. The first 12 digits contain the tracking number. The barcode starts with „C“ (start-character) and ends with „D“ (stop-character).

## 6.1.3 Code 11

|                        |  |  |
|------------------------|--|--|
| Symbology number:      | 1  |  |
| Valid characters:      | "0".."9", "-"  |  |
| Quiet zone:            | left/right: 10X  |  |
| Module width:          | X= 0.191 mm  |  |
| Standard print ratio:  | 1:2.24:3.48:1:2.24   |  |
| Ratio format:          | 1B:2B:3B:1S:2S   |  |
| Default check digit:   | None (eCDNone)   |  |
| Possible check digits: | 1 check digit (eCD1Code11) – or<br>2 check digits (eCD2Code11) |  |
| Symbol size:           | --   |  |

This symbology is mainly used in telecommunications for marking equipment and components. It was invented in 1977 by INTERMEC. It is similar to Code 2 of 5 Matrix. The symbology is not self-checking therefore two check digits are recommended. Code 11 is a high-density code, but requires also a high-density output device (mainly because of the print ratio utilized).

## 6.1.4 Code 128

|                        |   |   |
|------------------------|---|---|
| Symbology number:      | 20  |  <p>Alphanumeric</p> |
| Valid characters:      | ASCII-characters between 0..127                             |   |
| Quiet zone:            | left/right: 10X, min. ¼ inch                                |   |
| Module width:          | X >= 0.19 mm  |   |
| Standard print ratio:  | 1:2:3:4:1:2:3:4   |   |
| Ratio format:          | 1B:2B:3B:4B:1S:2S:3S:4S                                     |   |
| Default check digit:   | Automatic (symbology specific).<br>Modulo 103 (eCDCCode128) |   |
| Possible check digits: | Modulo 10, EAN-14   |   |
| Symbol size:           | --  |   |
| Print control:         | C=128   |   |

Code 128 is heavily used in all areas. It is a modern high-density symbology and was invented 1981 by Computer Identics.

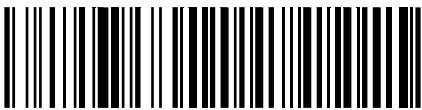
TEC-IT software analyzes input data and chooses the best suitable barcode representation with the highest data density. This is done by so-called "subset switching". 3 different internal characters (=subsets) sets are used:

- Code128A = Upper Case + Non-Printable Characters (ASCII 0-31)
- Code128B = Upper / Lower Case + All Printable Characters
- Code128C = Numeric with doubled density

Code128 uses a built-in check digit (Modulo 103). This check digit is part of the code and cannot be omitted. It is never printed in the human readable text. Scanners are checking it when reading a code but do not deliver the check digit to connected systems.


In conjunction with the symbology character "FNC1", this code is also known as GS1-128 barcode – see section 6.1.24.

## 6.1.5 Code 128 Subset A

|                        |   |  |
|------------------------|---|--|
| Symbology number:      | 59  |  <p>ABab123+/-</p> |
| Valid characters:      | ASCII-characters between 0..127                             |  |
| Quiet zone:            | left/right: 10X, min. ¼ inch                                |  |
| Module width:          | X >= 0.19 mm  |  |
| Standard print ratio:  | 1:2:3:4:1:2:3:4   |  |
| Ratio format:          | 1B:2B:3B:4B:1S:2S:3S:4S                                     |  |
| Default check digit:   | Automatic (symbology specific).<br>Modulo 103 (eCDCCode128) |  |
| Possible check digits: | Modulo 10, EAN-14   |  |
| Symbol size:           | --  |  |
| Print control:         | C=128A  |  |


This is a variant of Code128, which uses character set (subset) A. It is suitable for encoding upper case characters + ASCII control sequences. It switches to other Code128 subsets when required.

### 6.1.6 Code 128 Subset B

|                        |   |  |
|------------------------|---|--|
| Symbology number:      | 60  |  <p>ABab123+/-</p> |
| Valid characters:      | ASCII-characters between 0..127                             |  |
| Quiet zone:            | left/right: 10X, min. ¼ inch                                |  |
| Module width:          | X >= 0.19 mm  |  |
| Standard print ratio:  | 1:2:3:4:1:2:3:4   |  |
| Ratio format:          | 1B:2B:3B:4B:1S:2S:3S:4S                                     |  |
| Default check digit:   | Automatic (symbology specific).<br>Modulo 103 (eCDCCode128) |  |
| Possible check digits: | Modulo 10, EAN-14   |  |
| Symbol size:           | --  |  |
| Print control:         | C=128B  |  |


This is a variant of Code128, which uses character set (subset) B. It is suitable for encoding lower & upper case letters. It switches to other Code128 subsets when required.

### 6.1.7 Code 128 Subset C

|                        |   |   |
|------------------------|---|---|
| Symbology number:      | 61  |  <p>ABab123+/-</p> |
| Valid characters:      | ASCII-characters between 0..127                             |   |
| Quiet zone:            | left/right: 10X, min. ¼ inch                                |   |
| Module width:          | X >= 0.19 mm  |   |
| Standard print ratio:  | 1:2:3:4:1:2:3:4   |   |
| Ratio format:          | 1B:2B:3B:4B:1S:2S:3S:4S                                     |   |
| Default check digit:   | Automatic (symbology specific).<br>Modulo 103 (eCDCCode128) |   |
| Possible check digits: | Modulo 10, EAN-14   |   |
| Symbol size:           | --  |   |
| Print control:         | C=128C  |   |


This is a variant of Code128, which uses character set (subset) C. It is suitable for encoding digits. It switches to other Code128 subsets when required.

### 6.1.8 Code 2 of 5 Standard (Code 2 of 5 Matrix)

|                        |                              |  |
|------------------------|------------------------------|--|
| Symbology number:      | 2                            |  <p>12345</p> |
| Valid characters:      | "0".."9"                     |  |
| Quiet zone:            | left/right: 10X, min. ¼ inch |  |
| Module width:          | X >= 0.19 mm                 |  |
| Standard print ratio:  | 1:3:4.5:1:3                  |  |
| Ratio format:          | 1B:2B:3B:1S:2S               |  |
| Default check digit:   | None (eCDNone)               |  |
| Possible check digits: | Modulo 10 (eCDMod10)         |  |
| Symbol size:           | --                           |  |
| Print control:         | C=25M                        |  |


This is a self-checking code. It is used for industrial applications, article numbering, photo development, ticketing.

### 6.1.9 Code 2 of 5 Data Logic

|                        |                              |  |
|------------------------|------------------------------|--|
| Symbology number:      | 6                            |  |
| Valid characters:      | "0".."9"                     |  |
| Quiet zone:            | left/right: 10X, min. ¼ inch |  |
| Module width:          | --                           |  |
| Standard print ratio:  | 1:3:1:3                      |  |
| Ratio format:          | 1B:2B:1S:2S                  |  |
| Default check digit:   | None (eCDNone)               |  |
| Possible check digits: | Modulo 10 (eCDMod10)         |  |
| Symbol size:           | --                           |  |
|                        |                              |  |

This symbology is proprietary variant of Code 2 of 5 Standard.


### 6.1.10 Code 2 of 5 IATA

|                        |                              |   |
|------------------------|------------------------------|---|
| Symbology number:      | 4                            |  |
| Valid characters:      | "0".."9"                     |   |
| Quiet zone:            | left/right: 10X, min. ¼ inch |   |
| Module width:          | X $\geq$ 0.19 mm             |   |
| Standard print ratio:  | 1:3:1                        |   |
| Ratio format:          | 1B:2B:1S                     |   |
| Default check digit:   | None (eCDNone)               |   |
| Possible check digits: | Modulo 10 (eCDMod10)         |   |
| Symbol size:           | --                           |   |
| Print control:         | C=25A                        |   |

This is a self-checking code. Start/stop-characters are identical to Code 2 of 5 Industry. It supports distance reading (> 1m) and can be printed with very simple printing techniques.

It is used for baggage handling in air-transport applications (International Air Transport Agency = IATA).

### 6.1.11 Code 2 of 5 Industrial

|                        |                              |  |
|------------------------|------------------------------|--|
| Symbology number:      | 7                            |  |
| Valid characters:      | "0".."9"                     |  |
| Quiet zone:            | left/right: 10X, min. ¼ inch |  |
| Module width:          | X $\geq$ 0.19 mm             |  |
| Standard print ratio:  | 1:3:1                        |  |
| Ratio format:          | 1B:2B:1S                     |  |
| Default check digit:   | None (eCDNone)               |  |
| Possible check digits: | Modulo 10 (eCDMod10)         |  |
| Symbol size:           | --                           |  |
| Print control:         | C=25I                        |  |



### 6.1.12 Code 2 of 5 Interleaved

|                        |                              |               |
|------------------------|------------------------------|---------------|
| Symbology number:      | 3                            | <p>012345</p> |
| Valid characters:      | "0".."9"                     |               |
| Quiet zone:            | left/right: 10X, min. ¼ inch |               |
| Module width:          | X $\geq$ 0.19 mm             |               |
| Standard print ratio:  | 1:3:1:3                      |               |
| Ratio format:          | 1B:2B:1S:2S                  |               |
| Default check digit:   | None (eCDNone)               |               |
| Possible check digits: | Modulo 10 (eCDMod10)         |               |
| Symbol size:           | --                           |               |
| Print control:         | C=25L                        |               |

Code 2 of 5 Interleaved is in widespread use (article-numbering, industrial applications).

This self-checking code offers high data capacity due to encoding pairs of numbers (the first digit is encoded in the bars, the second in the spaces). Thus, this symbology can encode only an even number of digits. If the number of digits is odd, a leading zero will be inserted automatically.

### 6.1.13 Code 2 of 7

This symbology is identical with Codabar 2 Widths and is known as NW-7 or USD-4. See section 6.1.2

### 6.1.14 Code 25

Uniform Symbology Specification ITF 2-5. Identical to Code 2 of 5 Interleaved. Another alias is USS ITF 2-5.

### 6.1.15 Code 39 (3of9)

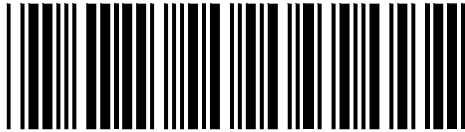
|                        |   |               |
|------------------------|---|---------------|
| Symbology number:      | 8   | <p>TEC-IT</p> |
| Valid characters:      | "0".."9", "A".."Z", "-", ".", Space, "*", "\$", "/", "+", "%"   |               |
| Quiet zone:            | left/right: 10X, min. ¼ inch  |               |
| Module width:          | X $\geq$ 0.19 mm  |               |
| Standard print ratio:  | 1:3:1:3   |               |
| Ratio format:          | 1B:2B:1S:2S   |               |
| Default check digit:   | None (eCDNone)  |               |
| Possible check digits: | Modulo 43 (eCDMod43), Modulo 11 Weight 7 (eCDMod11W7)   |               |
| Symbol size:           | H $\geq$ 15% of L (H $\geq$ 6.3 mm!)<br>H: Height of the barcode without human readable text<br>L: width of the barcode |               |
| Print control:         | C=39  |               |

Code 39 is in heavy use in industry, organizations and commerce. It was developed 1974 by INTERMEC and were standardized by ANSI MH 10.8 M-1983 and MIL-STD-1189.

▶ The start- and stop characters "\*" (asterisk) are created automatically and must not be included in the input data. They are not displayed in the human readable text.

Code 39 is a self-checking code. Code concatenation is possible (if the first encoded character is a space, the scanner concatenates subsequent barcodes). Distance reading is possible (> 1m).


### 6.1.16 Code 32

|                        |   |  |
|------------------------|---|--|
| Symbology number:      | 93  |  <p>A012345676</p> |
| Valid characters:      | "0" - "9"                                 |  |
| Quiet zone:            | left/right: 10X, min. ¼ inch              |  |
| Module width:          | 0,25 <= X <= 0.254 mm                     |  |
| Standard print ratio:  | 1:2.5:1:2.5                               |  |
| Ratio format:          | 1B:2B:1S:2S                               |  |
| Default check digit:   | Module 10 Luhn Reversed (eCDMod10LuhnRev) |  |
| Possible check digits: | Module 10 Luhn Reversed (eCDMod10LuhnRev) |  |
| Symbol size:           | --  |  |

It is used by the Italian Pharma Industry. The code is also called *Italian Pharmacode*.

The Code 32 number, consisting of 9 digits, is converted to an equivalent Code 39 Barcode of 6 characters. An "A", which is not encoded, prepends the letter the human readable text.


### 6.1.17 Code 39 Extended

|                        |   |  |
|------------------------|---|--|
| Symbology number:      | 9   |  <p>Tec</p> |
| Valid characters:      | ASCII-characters between 0..127   |  |
| Quiet zone:            | left/right: 10X, min. ¼ inch  |  |
| Module width:          | X >= 0.19 mm  |  |
| Standard print ratio:  | 1:3:1:3   |  |
| Ratio format:          | 1B:2B:1S:2S   |  |
| Default check digit:   | None (eCDNone)  |  |
| Possible check digits: | Modulo 43 (eCDMod43), Modulo 11 Weight 7 (eCDMod11W7)   |  |
| Symbol size:           | H>=15% of L (H>=6.3 mm!)<br>H: Height of the barcode without human readable text<br>L: width of the barcode |  |
| Print control:         | C=39E   |  |

Code 39 Extended is rarely used because Code 128 offers much better compression. Code 39 Extended uses the same symbology as Code 39 but encodes also lower-case letters and special characters („+A“ results in a lower case „a“ when scanned). Scanner must be configured correctly for decoding Code39 Extended.


► The start- and stop characters "\*" (asterisk) are created automatically and must not be included in the input data. They are not displayed in the human readable text.

### 6.1.18 Code 93

|                       |  |   |
|-----------------------|--|---|
| Symbology number:     | 25   |  <p>ABC123-/+</p> |
| Valid characters:     | "0".."9", "A".."Z", "-", ".", Space, "\$", "/", "+", "%" |   |
| Quiet zone:           | left/right: 10X, min. ¼ inch                             |   |
| Module width:         | X >= 0.19 mm   |   |
| Standard print ratio: | 1:2:3:4:1:2:3:4  |   |
| Ratio format:         | 1B:2B:3B:4B:1S:2S:3S:4S                                  |   |
| Default check digit:  | Automatic (symbology specific).<br>Modulo 47 (eCD2Mod47) |   |
| Symbol size:          | --   |   |
| Print control:        | C=93   |   |

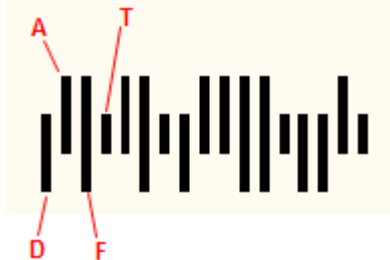
Code 93 was invented 1982 by [INTERMEC](#) to achieve better information densities (compared to Code 39). Code concatenation is possible (if the first encoded character is a space, the scanner concatenates subsequent barcodes).

### 6.1.19 Code 93 Extended

|                       |  |  |
|-----------------------|--|--|
| Symbology number:     | 62   |  <p>ABab12-/+</p> |
| Valid characters:     | ASCII-characters between 0..127                          |  |
| Quiet zone:           | left/right: 10X, min. ¼ inch                             |  |
| Module width:         | X >= 0.19 mm   |  |
| Standard print ratio: | 1:2:3:4:1:2:3:4  |  |
| Ratio format:         | 1B:2B:3B:4B:1S:2S:3S:4S                                  |  |
| Default check digit:  | Automatic (symbology specific).<br>Modulo 47 (eCD2Mod47) |  |
| Symbol size:          | --   |  |
| Print control:        | C=93E  |  |

Based upon Code 93 but encodes the complete ASCII character set. One of the four available control characters is used to shift into the ASCII-character table.

### 6.1.20 DAFT Code

|                       |  |  |
|-----------------------|--|--|
| Symbology number:     | 93                                       |  |
| Valid characters:     | "D", "A", "F", "T" or "d", "a", "f", "t" |  |
| Quiet zone:           | left/right: 2 mm                         |  |
| Module width:         | --                                       |  |
| Standard print ratio: | 1:1                                      |  |
| Ratio format:         | 1B:1S                                    |  |
| Default check digit:  | None                                     |  |
| Symbol size:          | --                                       |  |

DAFT Code is no symbology. It is a technique to generate arbitrary postal codes (like for instance the Australia Post Codes or the Royal Mail 4 State code).

Each input character stands for a specific bar type and there are 4 different bar types:

- "D" or "d": Descender
- "A" or "a": Ascender
- "F" or "f": Full
- "T" or "t": Transmitter

### 6.1.21 DOD LOGMARS

DOD LOGMARS stands for Department of Defense LOGMARS. Same as LOGMARS (see section 6.1.46).

### 6.1.22 DUN-14

The DUN-14 (Distribution Unit Number) is not a barcode type. It is a numbering system for shipping containers. The DUN-14 uses the ITF-14 or the EAN-14 barcode symbols. Modern installations always use the EAN-14 (EAN-128) to encode the DUN-14.

The DUN-14 encodes the following data:


- The first digit represents the number of units in the container: 1=6 units, 2=10 units, 3=12 units, 4=20 units, 5=24 units. (The digits 6, 7, and 8 are standing for other numbers of units.)
- The next 12 digits are representing the product number. In general, this is the EAN-13 number without check digit.
- The last digit is the check digit.

### 6.1.23 DUNS

This is not a barcode standard. DUNS is a nine-digit number assigned and maintained by Dun and Bradstreet to identify unique business establishments. DUNS numbers are assigned worldwide and include US, Canadian, and international organizations.

### 6.1.24 EAN-128 (GS1-128)

The EAN-128 code was renamed to GS1-128. It is the same as the UCC-128 and sometimes referenced as UCC/EAN-128 in this document.


|                        |   |   |
|------------------------|---|---|
| Symbology number:      | 16  | <br>EAN128 |
| Valid characters:      | ASCII-characters between 0..127<br>(maximum: 48 characters) |   |
| Quiet zone:            | left/right: 10X, min. ¼ in                                  |   |
| Module width:          | see Code128   |   |
| Standard print ratio:  | see Code128   |   |
| Ratio format:          | see Code128   |   |
| Default check digit:   | Automatic (symbology specific).<br>Modulo 103 (eCDEAN128)   |   |
| Possible check digits: | Modulo 10, EAN-14   |   |
| Symbol size:           | the maximum physical width is 165 mm                        |   |
| Print control:         | C=G128 / C=E128   |   |

The GS1-128 code is based upon Code-128. It has an FNC1 character at the 1st position (after the start code). This allows scanners and data processing software to differentiate GS1-128 from other symbologies.

The GS1-128 code is in wide spread use (retail, logistics, food and beverage, etc.). It is used for marking transport-units in supply chains. Besides the article-number, it encodes quantities, weights, prices, dates, and other information in a structured way. This is supported by the use of so-called Application Identifiers (AIs) – see chapter 5. Within the GS1 system, these Application Identifiers (AIs) prefix the encoded data.

- Please note: The TEC-IT barcode software automatically inserts the FNC1 character at the beginning and computes the internal check digit (Modulo 103).

### 6.1.25 EAN-13


|                        |                                      |   |
|------------------------|--------------------------------------|---|
| Symbology number:      | 13                                   |  |
| Valid characters:      | "0".."9", 12 digits + 1 check digit  |   |
| Quiet zone:            | left: 11X, right: 7X                 |   |
| Module width:          | X=0.33mm                             |   |
| Standard print ratio:  | 1:2:3:4:1:2:3:4                      |   |
| Ratio format:          | 1B:2B:3B:4B:1S:2S:3S:4S              |   |
| Default check digit:   | EAN-13 (eCDEAN13)                    |   |
| Possible check digits: | User supplied                        |   |
| Symbol size:           | Standardized symbol sizes (see EAN). |   |
| Print control:         | C=E13                                |   |

This code is reserved for the International Article Number<sup>2</sup> administered by the standards organization GS1. The numbers encoded into EAN bar codes are known as Global Trade Item Numbers, for EAN-13, they are called GTIN-13.

EAN 13 is used for identifying articles or products uniquely (often sold at retail point of sale). Encoded are a 2-digit country code, 5-digits manufacturer code and a 5-digits products code. JAN and IAN are identical to EAN-13.


The check digit is calculated automatically if it not specified in the input data (that is when only 12 digits are used for creating the code).

### 6.1.26 EAN-13 with 2 Digits Add-On

|                        |                                      |   |
|------------------------|--------------------------------------|---|
| Symbology number:      | 14                                   |  |
| Valid characters:      | "0".."9", 14 digits + 1 check digit  |   |
| Quiet zone:            | left: 7-10X, right: 5X               |   |
| Module width:          | X=0.33mm                             |   |
| Standard print ratio:  | 1:2:3:4:1:2:3:4                      |   |
| Ratio format:          | 1B:2B:3B:4B:1S:2S:3S:4S              |   |
| Default check digit:   | EAN-13 (eCDEAN13)                    |   |
| Possible check digits: | User supplied                        |   |
| Symbol size:           | Standardized symbol sizes (see EAN). |   |

This symbology extends EAN-13 with two add-on digits (see also EAN-8 with 2 Digits Add-On). The check digit will be calculated automatically if not specified in the input data (e.g. 978020137968612).


### 6.1.27 EAN-13 with 5 Digits Add-On

|                        |                                      |   |
|------------------------|--------------------------------------|---|
| Symbology number:      | 15                                   |  |
| Valid characters:      | "0".."9", 17 digits + 1 check digit  |   |
| Quiet zone:            | left: 7-10X, right: 5X               |   |
| Module width:          | X=0.33mm                             |   |
| Standard print ratio:  | 1:2:3:4:1:2:3:4                      |   |
| Ratio format:          | 1B:2B:3B:4B:1S:2S:3S:4S              |   |
| Default check digit:   | EAN-13 (eCDEAN13)                    |   |
| Possible check digits: | User supplied                        |   |
| Symbol size:           | Standardized symbol sizes (see EAN). |   |

This symbology extends EAN-13 with five add-on digits (see also EAN-8 with 5 Digits Add-On). The check digit will be calculated automatically if not specified in the input data (e.g. 978020137968612345).

<sup>2</sup> Formerly European Article Number (EAN)

### 6.1.28 EAN-14

|                        |   |   |
|------------------------|---|---|
| Symbology number:      | 72  |  |
| Valid characters:      | ASCII-characters between 0..127,<br>13 digits + 1 check digit |   |
| Quiet zone:            | see GS1-128, ITF-14   |   |
| Module width:          | see GS1-128, ITF-14   |   |
| Standard print ratio:  | see GS1-128, ITF-14   |   |
| Ratio format:          | see GS1-128, ITF-14   |   |
| Default check digit:   | EAN-14 (eCDEAN14)   |   |
| Possible check digits: | User supplied   |   |
| Symbol size:           | see GS1-128, ITF-14   |   |

EAN-14 is used to encode the GTIN (Global Trade Item Number) for numbering trade items. Within the GS1 system, you can use 2 symbologies for encoding the GTIN:


- GS1-128 (UCC/EAN-128)
- ITF-14.

EAN-14 uses GS1-128 with Application identifier (AI) 01. The AI is prefixed automatically; it must not be part of the input data. The check digit is calculated automatically if not specified in the input data (that is when only 13 digits are used).

### 6.1.29 EAN-18

Same as SSCC-18 (see section 6.1.58).

### 6.1.30 EAN-8


|                        |                                     |   |
|------------------------|-------------------------------------|---|
| Symbology number:      | 10                                  |  |
| Valid characters:      | "0".."9", 7 digits + 1 check digit  |   |
| Quiet zone:            | left/right: 7X                      |   |
| Module width:          | X=0.33mm                            |   |
| Standard print ratio:  | 1:2:3:4:1:2:3:4                     |   |
| Ratio format:          | 1B:2B:3B:4B:1S:2S:3S:4S             |   |
| Default check digit:   | EAN-8 (eCDEAN8)                     |   |
| Possible check digits: | User supplied                       |   |
| Symbol size:           | Standardized symbol sizes. See EAN. |   |
| Print control:         | C=E8                                |   |

This symbology is derived from the longer EAN-13 bar code and encodes the GTIN-8, which is another set of product identifiers from the GS1 system.

EAN 8 is used for marking small articles with restricted space. It encodes a unique article number, which consists of a GS1 prefix, an item reference (no company prefix) and a checksum digit.

The check digit is calculated automatically if not specified in the input data (that is when only seven digits are used for creating the code).


### 6.1.31 EAN-8 with 2 Digits Add-On

|                        |                                     |   |
|------------------------|-------------------------------------|---|
| Symbology number:      | 11                                  |  |
| Valid characters:      | "0".."9", 9 digits + 1 check digit  |   |
| Quiet zone:            | left: 7-10X, right: 5X              |   |
| Module width:          | X=0.33mm                            |   |
| Standard print ratio:  | 1:2:3:4:1:2:3:4                     |   |
| Ratio format:          | 1B:2B:3B:4B:1S:2S:3S:4S             |   |
| Default check digit:   | EAN-8 (eCDEAN8)                     |   |
| Possible check digits: | User supplied                       |   |
| Symbol size:           | Standardized symbol sizes. See EAN. |   |
| Print control:         | C=E8+2                              |   |

This symbology extends EAN-8 with two add-on digits which are mainly used for encoding the price or the weight. The check digit will be calculated automatically if it not specified in the input data (e.g. 9031101712).

This symbology is also used for bar-coding paperbacks or newspapers. In this case, a 2(3) digits country code and a 4(5) article code are encoded.

### 6.1.32 EAN-8 with 5 Digits Add-On

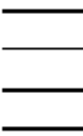
|                        |                                     |   |
|------------------------|-------------------------------------|---|
| Symbology number:      | 12                                  |  |
| Valid characters:      | "0".."9", 12 digits + 1 check digit |   |
| Quiet zone:            | left: 7-10X, right: 5X              |   |
| Module width:          | X=0.33mm                            |   |
| Standard print ratio:  | 1:2:3:4:1:2:3:4                     |   |
| Ratio format:          | 1B:2B:3B:4B:1S:2S:3S:4S             |   |
| Default check digit:   | EAN-8 (eCDEAN8)                     |   |
| Possible check digits: | User supplied                       |   |
| Symbol size:           | Standardized symbol sizes. See EAN. |   |
| Print control:         | C=E8+5                              |   |

This symbology extends EAN-8 with five add-on digits which are mainly used for encoding the price or the weight. The check digit will be calculated automatically if it not specified in the input data (e.g. 072527272077).

### 6.1.33 FIN Code (Fahrzeug-Identifizierungsnummer)

This code is identical to the **VIN Code (Vehicle Identification Number)**.

### 6.1.34 Flattermarken


|                       |                                  |  |
|-----------------------|----------------------------------|--|
| Symbology number:     | 28                               |  |
| Valid characters:     | "0".."9"                         |  |
| Quiet zone:           | Application dependent            |  |
| Module width:         | 2-3 mm                           |  |
| Standard print ratio: | 1:1                              |  |
| Ratio format:         | 1B:1S                            |  |
| Default check digit:  | None (eCDNone)                   |  |
| Symbol size:          | Symbol height between 5 and 10mm |  |
| Print control:        | C=FLM                            |  |

This is a special "barcode" used for recognizing the correct sequence of pages in print shops.





### 6.1.39 ISBN Code (ISBN 13)

|                        |  |  |
|------------------------|--|--|
| Symbology number:      | 69 (without add-on) or 23 (with add-on)                          |  |
| Valid characters:      | "0".."9", 12 digits + 1 check digit + optionally 5 add-on digits |  |
| Quiet zone:            | See EAN13 / EAN13 + 5 Digits                                     |  |
| Module width:          | See EAN13 / EAN13 + 5 Digits                                     |  |
| Standard print ratio:  | See EAN13 / EAN13 + 5 Digits                                     |  |
| Ratio format:          | See EAN13 / EAN13 + 5 Digits                                     |  |
| Default check digit:   | EAN-13 (eCDEAN13)  |  |
| Possible check digits: | User supplied  |  |
| Symbol size:           | See EAN13 / EAN13 + 5 Digits                                     |  |
| Print control:         | C=ISBN   |  |

ISBN is the abbreviation of International Standard Book Number. It uses the symbology EAN-13 and can be optionally extended with 5 Add-On Digits. The add-on is used for additional pricing information. For more information, please refer to <https://www.isbn.org>.

The EAN-13 barcode for a book is generated from the ISBN number assigned to it. When encoding ISBN in an EAN-13 barcode, the ISBN number is preceded by the number 978 and the ISBN check digit is not used (the rightmost digit of the ISBN). When the ISBN number is encoded in the EAN-13 barcode in this way, it is often called Bookland. A 5-digit add-on barcode is optional and can contain the price of the book.

▶ ISBN codes with 10 digits are automatically converted to the newer ISBN with 13 digits!

#### 6.1.39.1 Example

You got the ISBN Number 1-56592-843-1 and a value for the second small barcode (as for the price) of 90000.

Therefore choose the **symbology EAN 13 + 5 Digits** encode the following data: 97815659284390000. The check digit is calculated automatically (5).

#### 6.1.39.2 ISBN Additional Data

The smaller barcode, which is on the right side of the ISBN code, is a 5-digit additional code and can be used for additional information (e.g. like pricing).

Example:

| Price     | Encoded |
|-----------|---------|
| \$10.95   | 51095   |
| \$3.00    | 50300   |
| \$99.99 + | 59999   |

Table 12: ISBN Sample

The preceding digit "5" (therefore also called EAN-5) marks the price encoded in US Dollar. Bookstores recommend EAN-5. If there is no price, the value 90000 will be encoded instead (EAN-9). This value is used when no additional information is available.

▶ For scanner in US bookstores ISBN, EAN codes are not readable without the 5-digit add-on (which is called EAN-5 or EAN-9, depending on the first number encoded in the add-on).

| First Digit | Description    |
|-------------|----------------|
| 5           | \$ US          |
| 6           | \$ Canada      |
| 4           | \$ New Zealand |
| 3           | \$ Australia   |
| 0 & 1       | British pounds |

Table 13: ISBN Encoding – Country and Currency

| Values      | Description   |
|-------------|---|
| 59999       | Price for \$100 and more  |
| 90000-98999 | For internal purposes (BISG recommend 90000 if no price is given) |
| 99000-99999 | Reserved for the industry market                                  |
| 99990-99999 | Reserved for Nat'l Ass'n College Stores (NACS)                    |
| 99990       | NACS used books   |
| 99991       | NACS copies   |


Table 14: ISBN Encoding – Price Samples

### 6.1.40 ISBT-128

This is the International Standard for the transfer of information associated with tissue transplantation and Blood Transfusion. It provides a globally unique donation numbering system, internationally standardized product definitions, and standard data structures for bar-coding and electronic data interchange.

It uses (but is not limited to) Code128B. For more information, please refer to <https://iccbba.org>.

### 6.1.41 ISMN


|                        |                                     |  |
|------------------------|-------------------------------------|--|
| Symbology number:      | 24                                  |  |
| Valid characters:      | "0".."9", 12 digits + 1 check digit |  |
| Quiet zone:            | See EAN13                           |  |
| Module width:          | See EAN13                           |  |
| Standard print ratio:  | See EAN13                           |  |
| Ratio format:          | See EAN13                           |  |
| Default check digit:   | EAN-13 (eCDEAN13)                   |  |
| Possible check digits: | User supplied                       |  |
| Symbol size:           | See EAN13                           |  |

ISMN stands for International Standard Music Number. The ISMN is a standardized international code, which identifies printed music.

The digits 9790 precede the ISMN. The ISMN (=EAN-13) check digit is calculated and appended automatically!

For more information, please refer <https://www.ismn-international.org/>.

## 6.1.42 ISSN

|                        |  |  |
|------------------------|--|--|
| Symbology number:      | 26 (without add-on) or 27 (with add-on)                          |  |
| Valid characters:      | "0".."9", 12 digits + 1 check digit + optionally 2 add-on digits |  |
| Quiet zone:            | See EAN13 / EAN13 + 2 Digits                                     |  |
| Module width:          | See EAN13 / EAN13 + 2 Digits                                     |  |
| Standard print ratio:  | See EAN13 / EAN13 + 2 Digits                                     |  |
| Ratio format:          | See EAN13 / EAN13 + 2 Digits                                     |  |
| Default check digit:   | EAN-13 (eCDEAN13)  |  |
| Possible check digits: | User supplied  |  |
| Symbol size:           | See EAN13 / EAN13 + 2 Digits                                     |  |


ISSN stands for International Standard Serial Number. The ISSN is a standardized international code, which identifies any serial publication independently of its country of origin, its language or alphabet, or its frequency, medium, etc.

The digits 977 precede the ISSN. The check digit of an 8-digit ISSN code (the last of the 8 digits) must be omitted! A two-digit price code, usually "00", is added to the end. Finally, the EAN-13 check digit (calculated automatically by TEC-IT software) is added.

Optionally the issue number can be appended as 2-digit add-on.

For more information, please refer to <https://www.issn.org/>.

## 6.1.43 ITF-14

|                       |  |  |
|-----------------------|--|--|
| Symbology number:     | 89   |  |
| Valid characters:     | 13 digits + 1 check digit  |  |
| Quiet zone:           | left/right: 10X  |  |
| Module width:         | 0.051 – 1.02 mm (nominal size)   |  |
| Standard print ratio: | 1:2.5:1:2.5  |  |
| Ratio format:         | 1B:2B:1S:2S  |  |
| Default check digit:  | Mod-10 (eCDMod10)  |  |
| Symbol size:          | 152.43 x 41.60 mm at nominal size (including Quiet Zone and Bearer Bars) |  |
| Print control:        | C=I14  |  |

ITF-14 encodes the GTIN-14, this is a 14-digit number used to identify trade items at various packaging levels (also referred as GTIN).

ITF-14 bases on the Code 2 of 5 Interleaved symbology. It encodes 14 digits (13 usable digits + 1 modulo 10 check digit). The check digit method complies with the EAN-14 method.

ITF-14 uses "Bearer Bars", these are horizontal or surrounding bars, to prevent misreads.

- ▶ Symbol size and Bearer Bars are depending on printing method and scanning environment – for details please follow the GS1 specification.
- ▶ When using vertical Bearer Bars, they must have at least a distance of 10 modules to the bar code. This is why you have to adjust a minimum of 12 modules for the quiet zone to see a vertical Bearer Bar in TEC-IT Software.


## 6.1.44 JAN

JAN is the abbreviation for Japanese Article Number. This code uses **EAN-13** symbology. The first two digits have to be either 45 or 49 for identifying Japan.

### 6.1.45 LAETUS-Code


Same as the Pharmacode One-Track (see section 6.1.51).

### 6.1.46 LOGMARS

|                        |  |   |
|------------------------|--|---|
| Symbology number:      | 50   |  <p>AB12\$+</p> |
| Valid characters:      | "0".."9", "A".."Z", "+", "-", "*", "/", ".", "\$", Space   |   |
| Quiet zone:            | left/right: 10X, min. ¼ inch   |   |
| Module width:          | X>=0.19 mm   |   |
| Standard print ratio:  | 1:3:1:3  |   |
| Ratio format:          | 1B:2B:1S:2S  |   |
| Default check digit:   | None (eCDNone)   |   |
| Possible check digits: | Modulo 43 (eCDMod43), Modulo 11 Weight 7 (eCDMod11W7)  |   |
| Symbol size:           | H>=15% of L (H>=6.3 mm!)<br>H: Height of barcode symbol without human readable text<br>L: Width of barcode |   |


This is a special variant of Code 39 used by the U.S. Department of Defense. This standard defines acceptable ranges for a number of variables, include density, ratio, bar height, and size of the human-readable interpretation line. The modulo-43 check digit, which is optional for Code 39, is defined and recommended in the specification.

### 6.1.47 MSI

|                        |   |   |
|------------------------|---|---|
| Symbology number:      | 47                                      |  <p>012345674</p> |
| Valid characters:      | "0".."9"                                |   |
| Quiet zone:            | left/right: 12X                         |   |
| Module width:          | --                                      |   |
| Standard print ratio:  | 1:2:1:2                                 |   |
| Ratio format:          | 1B:2B:1S:2S                             |   |
| Default check Digit:   | MSI 1 digit (eCDMS11)                   |   |
| Possible check digits: | User supplied and MSI 2 digit (eCDMS12) |   |
| Symbol size:           | 14 digits incl. check digits            |   |
| Print control:         | C=MSI                                   |   |

The MSI-Code is a variant of the Plessey-Code. MSI uses various check digit calculation methods - TEC-IT implemented the two most common used. Please contact TEC-IT if you need a different one.

### 6.1.48 NTIN Code

|                       |  |   |
|-----------------------|--|---|
| Symbology number:     | 125  |  |
| Valid characters:     | depending on field numeric or alphanumeric |   |
| Quiet zone:           | left/right/ top/bottom: 1X                 |   |
| Module width:         | --   |   |
| Standard print ratio: | 1:1  |   |
| Ratio format:         | 1B:1S                                      |   |
| Default check digit:  | None (eCDNone)                             |   |
| Symbol size:          | see Notes                                  |   |

The content of the NTIN Code is specified by GS1. It was developed in order to get unique pharmaceutical product codes on an international level. It embeds the already existing national coding systems, like PZN in Germany.

The NTIN Code bases on the Data Matrix symbology with GS1 format. It splits into following fields (with AI(xx) as the GS1 Application Identifier number):


- product code (=NTIN, AI(01), mandatory)
- serial number (AI(21), optional)
- batch number (AI(10), optional)
- expiry date (AI(17), optional)

The <FNC1> character separates the fields if needed. Each field is prefixed with the according GS1 Application Identifier.

The product code consists of following parts:

- Leading “0” to gain 14 digits
- GS1 prefix that defines the agency that is responsible for the product code (e.g. “**4150**” for PZN)
- Registered Product Number (e.g. the PZN8 in Germany - see Pharma Zentralnummer (PZN))
- NTIN check digit

### 6.1.49 NVE-18 (Nummer der Versandeinheit)

|                       |  |  |
|-----------------------|--|--|
| Symbology number:     | 75   |  |
| Valid characters:     | “0”..”9”   |  |
| Check digit method:   | Modulo10   |  |
| Default check digit:  | Modulo10   |  |
| Quiet zone:           | left/right: 10X, min. ¼ inch   |  |
| Module width:         | X >= 0.19 mm   |  |
| Standard print ratio: | 1:2:3:4:1:2:3:4  |  |
| Ratio format:         | 1B:2B:3B:4B:1S:2S:3S:4S  |  |
| Default check digit:  | Automatic (symbology specific).<br>Modulo 10 (eCDMod10) and Modulo 103 (eCDEAN128) |  |
| Symbol size:          | --   |  |

NVE stands for “Nummer der Versandeinheit” (a German term for tracking number). This code uses an EAN-128 symbology with a prefixed Application Identifier (AI) 00. The AI “00” is inserted automatically and must not be included in the input data. It is similar to SSCC-18.


### 6.1.50 NW-7

This symbology is identical with **Codabar 2 Widths** and is known as Code 2 of 7.

The Japanese version of the Codabar 2 Widths barcode is called NW7. Another name for this symbology is Code 2 of 7 – see section 6.1.2

The following symbols can be encoded in NW7: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, -, \$, /, ., +

### 6.1.51 Pharmacode One-Track

|                       |                    |   |
|-----------------------|--------------------|---|
| Symbology number:     | 51                 |  |
| Valid characters:     | "0".."9" or binary |   |
| Quiet zone:           | left/right: 6 mm   |   |
| Module width:         | 2-3 mm             |   |
| Standard print ratio: | 1:3:2:4:2:3        |   |
| Ratio format:         | 1B:2B:1C:2C:1S:2S  |   |
| Default check digit:  | None (eCDNone)     |   |
| Symbol size:          | 5-10 mm height     |   |


LAETUS® invented this code. It is used in pharmaceutical areas. Pharmacode supports colored bars. The data for the bars/spaces is encoded directly in the property *Text*.

- "0" is used for a narrow bar (the width of these bars are enlarged after a color change, according to ratio 1C)
- "1" is used for a wide bar (the width of these bars are enlarged after a color change, according to ratio 2C)
- "b" is used for a narrow bar
- "c" is used for a wide bar

When using colored bars, the color is specified by the escape sequence `\Crrggbb` (where *rrggbb* is an RGB value; each letter stands for a hexadecimal digit (0-f); *rr* stands for the red, *gg* for the green, and *bb* for the blue value part). The sequence `\Cx` resets the color to default. The barcode *Format* must be set to *D* and *EscapeSequences* must be activated.

The data for the barcode in the example above is as follows (the color escape sequence is not displayed in the human readable text): 111\C2a3282111.

### 6.1.52 Pharmacode Two-Track

|                       |                             |  |
|-----------------------|-----------------------------|--|
| Symbology number:     | 53                          |  |
| Valid characters:     | numeric [0..9] and generic; |  |
| Quiet zone:           | left/right: 6 mm            |  |
| Module width:         | --                          |  |
| Standard print ratio: | 1:1                         |  |
| Ratio format:         | 1B:1S                       |  |
| Default check digit:  | None (eCDNone)              |  |
| Symbol size:          | see Notes                   |  |


This code was invented and specified by LAETUS®. Pharmacode assigns numeric values to the bars. It is used for medicine packing in pharmaceutically area; for small labels. Usually Pharmacode is printed without a human readable text.

The dimensions are:

- 2-track bar width: 1 mm
- space bars: 1 mm
- bar height above/below: 4-6 mm
- height of the long bar: 8-12 mm

It offers a high printing tolerance and is readable very fast (200 readings per second).

### 6.1.53 Pharmacy Product Number Code (PPN Code)

|                       |  |   |
|-----------------------|--|---|
| Symbology number:     | 124  |  |
| Valid characters:     | depending on field numeric or alphanumeric |   |
| Quiet zone:           | left/right/ top/bottom: 1X                 |   |
| Module width:         | --   |   |
| Standard print ratio: | 1:1  |   |
| Ratio format:         | 1B:1S                                      |   |
| Default check digit:  | None (eCDNone)                             |   |
| Symbol size:          | see Notes                                  |   |

The content of the Pharmacy Product Number Code is specified by the IFA. It was developed in order to get unique pharmaceutical product codes on an international level. It embeds the already existing national coding systems, like PZN in Germany.

The PPN Code bases on the Data Matrix symbology with format Macro 06. It splits into following fields:

- product code (=PPN, mandatory)
- NTIN (optional)
- serial number (optional)
- batch number (optional)
- expiry date (optional)

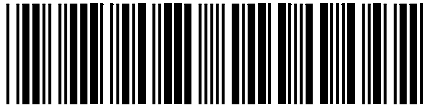
The group separator character <GS> (ASCII 29) separates the fields. Each field is prefixed with a unique field ID.

The product code consists of following three parts:

- **Product Registration Agency Code**  
It defines the agency that is responsible for the product codes. E.g. "11" is assigned to German PZN (see Pharma Zentralnummer (PZN))
- **Registered Product Number**  
(e.g. the PZN8 in Germany)
- 2 check digits

## 6.1.54 Pharma Zentralnummer (PZN)

### 6.1.54.1 PZN7: 6 Digits + 1 Check Digit (valid until 2012/12/31)

|                        |                                    |  |
|------------------------|------------------------------------|--|
| Symbology number:      | 52                                 |  <p>PZN -1234562</p> |
| Valid characters:      | "0".."9", 6 digits + 1 check digit |  |
| Quiet zone:            | see Code 39                        |  |
| Module width:          | see Code 39                        |  |
| Standard print ratio:  | see Code 39                        |  |
| Ratio format:          | see Code 39                        |  |
| Default check digit:   | PZN check digit (eCDPZN)           |  |
| Possible check digits: | User supplied                      |  |
| Symbol size:           | see Code 39                        |  |

### 6.1.54.2 PZN8: 7 Digits + 1 Check Digit (valid from 2013/01/01)

|                        |                                    |   |
|------------------------|------------------------------------|---|
| Symbology number:      | 113                                |  <p>PZN -12345678</p> |
| Valid characters:      | "0".."9", 7 digits + 1 check digit |   |
| Quiet zone:            | see Code 39                        |   |
| Module width:          | see Code 39                        |   |
| Standard print ratio:  | see Code 39                        |   |
| Ratio format:          | see Code 39                        |   |
| Default check digit:   | PZN check digit (eCDPZN)           |   |
| Possible check digits: | User supplied                      |   |
| Symbol size:           | see Code 39                        |   |

PZN uses Code 39 as the base symbology. It uses a special check digit and the human readable text always contains the prefix "PZN-", which is not encoded in the barcode data.

*PZN7* is valid until the end of 2012 and will be replaced by *PZN8* with the beginning of year 2013. *PZN7* numbers will stay valid but are going to be extended to eight digits by a leading "0".

## 6.1.55 Plessey Code

|                        |                                 |  |
|------------------------|---------------------------------|--|
| Symbology number:      | 46                              |  <p>ABC123B3</p> |
| Valid characters:      | numeric [0..9] A, B, C, D, E, F |  |
| Quiet zone:            | left/right: 12X                 |  |
| Module width:          | --                              |  |
| Standard print ratio:  | 1:2:1:2                         |  |
| Ratio format:          | 1B:2B:1S:2S                     |  |
| Default check digit:   | Plessey (eCDPlessey)            |  |
| Possible check digits: | User supplied                   |  |
| Symbol size:           | --                              |  |

Plessey code is in use primarily in libraries. It is a pulse-width modulated code and was developed by Plessey Company Limited in UK. The basic encoding principle in Plessey Code was used by MSE Data Corporation to construct its MSI barcode.

The check digit is calculated with a polynomial CRC algorithm and is always part of the symbology.

## 6.1.56 Rational Codabar


Is the same as Codabar – see section 6.1.2.

## 6.1.57 SCC-14

Shipping Container Code – see DUN-14.



### 6.1.58 SSCC-18


|                       |  |  |
|-----------------------|--|--|
| Symbology number:     | 48   |  |
| Valid characters:     | "0".."9", 17 digits + 1 check digit  |  |
| Quiet zone:           | see EAN 128, sometimes ¼ inch  |  |
| Module width:         | see EAN 128  |  |
| Standard print ratio: | 1:2:3:4:1:2:3:4  |  |
| Ratio format:         | 1B:2B:3B:4B:1S:2S:3S:4S  |  |
| Default check digit:  | Automatic (symbology specific).<br>Modulo 10 (eCDMod10) and Modulo 103 (eCDEAN128) |  |
| Symbol size:          | see GS1-128  |  |
| Print control:        | C=SSCC18   |  |

SSCC-18 is used for encoding the Serial Shipping Container Code. It is used for the unique identification of trade items worldwide. SSCC-18 bases on the GS1-128 symbology with Application Identifier (AI) 00. The check digit is encoded automatically if 17 digits are used for the input data.

The structure of the SSCC-18 is as follows:


- The first two digits represent the Application Identifier (AI). The AI is always '00'.
- The next digit is the Packaging Identifier.
- The Packaging Identifier is followed by the ILN (the International Location Number) of the manufacturer (7 digits).
- The next 9 digits represent the Carton Serial Number.
- The last digit is the check digit.

### 6.1.59 Telepen Alpha

|                       |                                 |  |
|-----------------------|---------------------------------|--|
| Symbology number:     | 32                              |  |
| Valid characters:     | ASCII characters between 0..127 |  |
| Quiet zone:           | n/a                             |  |
| Standard print ratio: | 1:3:1:3                         |  |
| Ratio format:         | 1B:2B:1S:2S                     |  |
| Default check digit:  | None (eCDNone)                  |  |
| Symbol size:          | --                              |  |

Telepen Alpha is the alphanumeric variant of Telepen.

### 6.1.60 Telepen

|                       |   |   |
|-----------------------|---|---|
| Symbology number:     | 87  |  |
| Valid characters:     | pairs of digits, pairs of one digit with an 'X' |   |
| Quiet zone:           | n/a   |   |
| Standard print ratio: | 1:3:1:3   |   |
| Ratio format:         | 1B:2B:1S:2S                                     |   |
| Default check digit:  | None (eCDNone)                                  |   |
| Symbol size:          | --  |   |

Telepen can encode pairs of characters only. A pair must consist of 2 digits or of one digit and the letter 'X'.


### 6.1.61 UCC-128

Same as the EAN-128 (see section 6.1.24).

### 6.1.62 UPC 12 Digits

Same as the UPC-A (see section 6.1.63).

### 6.1.63 UPC Version A

|                        |  |   |
|------------------------|--|---|
| Symbology number:      | 34   |  |
| Valid characters:      | "0".."9", 11 digits + 1 check digit                        |   |
| Quiet zone:            | 9X   |   |
| Module width:          | 0,33 mm  |   |
| Standard print ratio:  | 1:2:3:4:1:2:3:4  |   |
| Ratio format:          | 1B:2B:3B:4B:1S:2S:3S:4S                                    |   |
| Default check digit:   | UPC-A (eCDUPCA)  |   |
| Possible check digits: | User supplied  |   |
| Symbol size:           | H=26.26mm; B=37.29mm; variations allowed (see UPC-A spec). |   |
| Print control:         | C=UA   |   |


UPC A is used in the United States for marking of products in retail applications (similar to EAN).

The numbers encoded into UPC bar codes are known as Global Trade Item Numbers, for UPC-A they are called GTIN-12.

UPC-A is mainly used for scanning of trade items at the point of sale. The article number is maintained by [GS1 US](http://GS1US.com) and identifies manufacturer and product uniquely.

The code (11 digits + 1 check digit) is built from one system-digit, five digits manufacturer code and five digits product code. The check digit is calculated automatically if not specified in the input data (that is when only 11 digits are used for the code).

### 6.1.64 UPC Version A, 2 Digits Add-On

|                        |                                     |  |
|------------------------|-------------------------------------|--|
| Symbology number:      | 35                                  |  |
| Valid characters:      | "0".."9", 13 digits + 1 check digit |  |
| Quiet zone:            | left: 9-12X, right: 5X              |  |
| Module width:          | see UPC-A                           |  |
| Standard print ratio:  | see UPC-A                           |  |
| Ratio format:          | see UPC-A                           |  |
| Default check digit:   | UPC-A (eCDUPCA)                     |  |
| Possible check digits: | User supplied                       |  |
| Symbol size:           | see UPC-A                           |  |
| Print control:         | C=UA+2                              |  |

It is identical to UPC-A, but with 2 add-on digits. The check digit will be calculated automatically if it is not specified in the input data (e.g. 7252727207012). The check digit is not displayed in the human readable text.

### 6.1.65 UPC Version A, 5 Digits Add-On

|                        |                                     |  |
|------------------------|-------------------------------------|--|
| Symbology number:      | 36                                  |  |
| Valid characters:      | "0".."9", 16 digits + 1 check digit |  |
| Quiet zone:            | left: 9-12X, right: 5X              |  |
| Module width:          | see UPC-A                           |  |
| Standard print ratio:  | see UPC-A                           |  |
| Ratio format:          | see UPC-A                           |  |
| Default check digit:   | UPC-A (eCDUPCA)                     |  |
| Possible check digits: | User supplied                       |  |
| Symbol size:           | see UPC-A                           |  |
| Print control:         | C=UA+5                              |  |

It is identical to UPC-A, but with two add-on digits. The check digit will be calculated automatically if it is not specified in the input data (e.g. 72527272070712345). The check digit is not displayed in the human readable text.

### 6.1.66 UPC Version E

|                        |                                    |  |
|------------------------|------------------------------------|--|
| Symbology number:      | 37                                 |  |
| Valid characters:      | "0".."9", 7 digits + 1 check digit |  |
| Quiet zone:            | left: 9X, right: 7X                |  |
| Module width:          | --                                 |  |
| Standard print ratio:  | 1:2:3:4:1:2:3:4                    |  |
| Ratio format:          | 1B:2B:3B:4B:1S:2S:3S:4S            |  |
| Default check digit:   | UPC-E (eCDUPCE)                    |  |
| Possible check digits: | User supplied                      |  |
| Symbol size:           | --                                 |  |
| Print control:         | C=UCE                              |  |

UPC-E is used for product marking and article bar coding. The code must begin with "0" or "1". The check digit is computed automatically if it is not specified in the input data (that is when only seven digits are used for creating the code).

### 6.1.67 UPC Version E, 2 Digits Add-On

|                        |                                    |  |
|------------------------|------------------------------------|--|
| Symbology number:      | 38                                 |  |
| Valid Digits:          | "0".."9", 9 digits + 1 check digit |  |
| Quiet zone:            | left: 9-12X, right: 5X             |  |
| Module width:          | see UPC-E                          |  |
| Default check digit:   | see UPC-E                          |  |
| Ratio format:          | see UPC-E                          |  |
| Check digit method:    | UPC-E (eCDUPCE)                    |  |
| Possible check digits: | User supplied                      |  |
| Symbol size:           | --                                 |  |
| Print control:         | C=UCE+2                            |  |

This code is identical to UPC Version E, but with two add-on digits. The check digit will be calculated automatically if not specified in the input data (e.g. 0123456512). The check digit is not displayed in the human readable text.

### 6.1.68 UPC Version E, 5 Digits Add-On

|                        |                                     |  |
|------------------------|-------------------------------------|--|
| Symbology number:      | 39                                  |  |
| Valid Digits:          | "0".."9", 12 digits + 1 check digit |  |
| Quiet zone:            | left: 9-12X, right: 5X              |  |
| Module width:          | see UPC-E                           |  |
| Standard print ratio:  | see UPC-E                           |  |
| Ratio format:          | see UPC-E                           |  |
| Default check digit:   | UPC-E (eCDUPCE)                     |  |
| Possible check digits: | User supplied                       |  |
| Symbol size:           | --                                  |  |
| Print control:         | C=UCE+5                             |  |

This code is identical to UPC Version E, but with two add-on digits. The check digit will be calculated automatically if not specified in the input data (e.g. 0123456512345). The check digit is not displayed in the human readable text.

### 6.1.69 UPC SCS (Shipping Container Symbols)

UPC SCS stands for Shipping Container Symbol. ITF-14 is based on Code 2 of 5 interleaved as barcode symbology, but is rendered with bearer bars.

#### Shipping Container Symbol



Figure 10: UPC Shipping Container Symbol (SCS)

The UPC Shipping Container Symbol (SCS) is very similar in structure to the Universal Product Code (UPC). Both employ a unique GS1/UCC company prefix (assigned by GS1) and a 1 to 5-digit item number (assigned by the manufacturer, depending on the number of digits in the company-prefix). Each employs a check digit at the end of the code.

The SCS also has a packaging indicator field preceding the UCC company prefix. Its symbology is called Interleaved 2 of 5 (I-2/5) and uses a series of wide and narrow bands and spaces to represent digits and is surrounded on two or four sides by a frame called a bearer.

The packaging indicator (historically called an assortment indicator) can be any single digit (except 8, which is reserved for future use):

| Packaging Indicator | Description  |
|---------------------|--|
| 0                   | Is always used when the UPC code on the case and on the individual items inside the case are different or when both a UPC Version A symbol and a UPC Shipping Container Symbol (I-2/5) must appear on the same carton (for products where the shipping container also acts as the package for the consumer product). |
| 1                   | Is used traditionally when the UPC code on the case and on the individual items inside the case are the same.  |
| 1-7                 | Can be used to signify a range of packaging levels   |
| 8                   | Reserved for future use  |
| 9                   | Is used only to signify a variable content shipment. The 9 indicates to the scanner that a mandatory variable content add-on symbol follows the primary symbol.  |

Table 15: Shipping Container Symbol Packaging Indicator

### 6.1.70 USD-4

This symbology is identical with **Codabar 2 Widths** and is known as Code 2 of 7 and as NW-7.

### 6.1.71 USS ITF 2-5

Uniform Symbology Specification ITF 2-5. Identical to Code 2 of 5 Interleaved. Another alias is Code 25.


### 6.1.72 USS Code 128

USS Code 128 stands for Uniform Symbology Specification Code 128. It is identical to Code 128.

### 6.1.73 USS Code 39

USS Code 39 stands for Uniform Symbology Specification Code 39. It is identical to Code 39.

### 6.1.74 VIN Code (Vehicle Identification Number)


|                        |   |   |
|------------------------|---|---|
| Symbology number:      | 73  |  <p>VB1YYY1JX3M386752</p> |
| Valid characters:      | "0".."9", "A".."Z" (without "I", "O", and "Q")  |   |
| Quiet zone:            | left/right: 10X, min. ¼ inch  |   |
| Module width:          | X >= 0.19 mm  |   |
| Standard print ratio:  | 1:3:1:3   |   |
| Ratio format:          | 1B:2B:1S:2S   |   |
| Default check digit:   | None (eCDNone)  |   |
| Possible check digits: | VIN (eCDVin)  |   |
| Symbol size:           | H >= 15% of L (H >= 6.3 mm!)<br>H: Height of the barcode without human readable text<br>L: width of the barcode |   |

VIN Code is used for vehicle identification. It bases on Code 39, but does not contain start and stop characters. The set of valid characters consists of digits and upper case letters. The letters "I", "O", and "Q" are not allowed because they could be easily mixed up with the digits "0", and "1".

VIN Code is implemented differently in Europe and North America. Both kinds are compatible but the North American version is defined more strictly. Therefore, the check digit calculation method is only valid for the North American implementation of the code.

## 6.2 Postal Codes (Linear/1D)


### 6.2.1 Australia Post 4-State Standard Customer Barcode

|                       |                                    |  |
|-----------------------|------------------------------------|--|
| Symbology number:     | 63                                 |  |
| Valid characters:     | "0".."9", 8 digits                 |  |
| Quiet-zone:           | left/right: 6 mm, top/bottom: 2 mm |  |
| Module width:         | --                                 |  |
| Standard print ratio: | 1:1                                |  |
| Ratio format:         | 1B:1S                              |  |
| Default check digit:  | Automatic (symbology specific).    |  |
| Size:                 | see Notes                          |  |
| Print control:        | see Notes                          |  |
| Print control:        | C=APC37                            |  |

The Australia Post for marking shipments uses this barcode. Special code variants are available for redirections, replies and so on. The barcode height is between 4.2mm and 5.8mm. The module width should be adjusted to 0.47 mms. Usual no readable text is displayed. The length will depend on the use of additional bars (code variants Customer 2 and Customer 3).


Due to its number of bars (37) Australia Post Customer is also called *Australia Post 37-CUST*.

### 6.2.2 Australia Post 4-State Customer Barcode 2

|                       |  |  |
|-----------------------|--|--|
| Symbology number:     | 64                                       |  |
| Valid characters:     | "0".."9", "A".."Z", "a".."z", Space, "#" |  |
| Quiet zone:           | left/right: 6 mm, top/bottom: 2 mm       |  |
| Module width:         | --                                       |  |
| Standard print ratio: | 1:1                                      |  |
| Ratio format:         | 1B:1S                                    |  |
| Default check digit:  | Automatic (symbology specific).          |  |
| Symbol size:          | see Australia Post Standard Customer     |  |


This is the same barcode as the Australia Post Standard Customer Barcode, but with additional five characters for customer specific data. The first eight characters must be digits. This symbology is also called *Australia Post 52-CUST* (Due to its 52 bars).

### 6.2.3 Australia Post 4-State Customer Barcode 3

|                       |  |  |
|-----------------------|--|--|
| Symbology number:     | 65                                       |  |
| Valid characters:     | "0".."9", "A".."Z", "a".."z", Space, "#" |  |
| Quiet zone:           | left/right: 6 mm, top/bottom: 2 mm       |  |
| Module width:         | --                                       |  |
| Standard print ratio: | 1:1                                      |  |
| Ratio format:         | 1B:1S                                    |  |
| Default check digit:  | Automatic (symbology specific).          |  |
| Symbol size:          | see Australia Post Standard Customer     |  |


This is the same barcode as the Australia Post Standard Customer Barcode, but with additional 10 characters for customer specific data. The first 8 characters must be digits. This symbology is also called *Australia Post 67-CUST* (Due to its 67 bars).

### 6.2.4 Australia Post Redirection


|                   |                                    |  |
|-------------------|------------------------------------|--|
| Symbology number: | 68                                 |  |
| Valid characters: | "0".."9", 8 digits                 |  |
| Quiet zone:       | left/right: 6 mm, top/bottom: 2 mm |  |
| Module width:     | --                                 |  |

|                       |                                      |
|-----------------------|--------------------------------------|
| Standard print ratio: | 1:1                                  |
| Ratio format:         | 1B:1S                                |
| Default check digit:  | Automatic (symbology specific).      |
| Symbol size:          | see Australia Post Standard Customer |


### 6.2.5 Australia Post Reply Paid

|                       |                                      |  |
|-----------------------|--------------------------------------|--|
| Symbology number:     | 66                                   |  |
| Valid characters:     | "0".."9", 8 digits                   |  |
| Quiet zone:           | left/right: 6 mm, top/bottom: 2 mm   |  |
| Module width:         | --                                   |  |
| Standard print ratio: | 1:1                                  |  |
| Ratio format:         | 1B:1S                                |  |
| Default check digit:  | Automatic (symbology specific).      |  |
| Symbol size:          | see Australia Post Standard Customer |  |

### 6.2.6 Australia Post Routing

|                       |                                      |  |
|-----------------------|--------------------------------------|--|
| Symbology number:     | 67                                   |  |
| Valid characters:     | "0".."9", 8 digits                   |  |
| Quiet zone:           | left/right: 6 mm, top/bottom: 2 mm   |  |
| Module width:         | --                                   |  |
| Standard print ratio: | 1:1                                  |  |
| Ratio format:         | 1B:1S                                |  |
| Default check digit:  | Automatic (symbology specific).      |  |
| Symbol size:          | see Australia Post Standard Customer |  |


### 6.2.7 Brazilian CEPNet / Brazilian Postal Code

|                       |   |  |
|-----------------------|---|--|
| Symbology number:     | 54  |  |
| Valid characters:     | "0".."9", 8 digits + 1 check digit          |  |
| Quiet zone:           | vertical: 1/25 inch<br>horizontal: 1/8 inch |  |
| Module width:         | --  |  |
| Standard print ratio: | 1:1   |  |
| Ratio format:         | 1B:1S                                       |  |
| Default check digit:  | POSTNET (eCDPostNet)                        |  |
| Symbol size:          | 8 digits, 1 check digit                     |  |

This code is used by the Brazilian Postal Services. An 8 digit ZIP-code is encoded. The check digit is calculated automatically. It cannot be specified in the input data.


The barcode height should be adjusted to 3.2 mms; the module width to 0.423 mms; usually no plain text is displayed. The encoding is based on US Postal codes.

## 6.2.8 Deutsche Post Identcode

|                       |   |  |
|-----------------------|---|--|
| Symbology number:     | 22  |  |
| Valid characters:     | "0".."9", 11 digits + 1 check digit                           |  |
| Quiet zone:           | left/right: 10X, min. ¼ inch                                  |  |
| Module width:         | --  |  |
| Standard print ratio: | 1:3:1:3   |  |
| Ratio format:         | 1B:2B:1S:2S   |  |
| Default check digit:  | Automatic (symbology specific).<br>DP Identcode (eCDDPIIdent) |  |
| Symbol size:          | --  |  |


Deutsche Post uses this symbology. The code is a Code 2 of 5 interleaved enhanced with a special check digit calculation.

## 6.2.9 Deutsche Post Leitcode

|                       |  |  |
|-----------------------|--|--|
| Symbology number:     | 21   |  |
| Valid characters:     | "0".."9", 13 digits + 1 check digit                        |  |
| Quiet zone:           | left/right: 10X, min. ¼ inch                               |  |
| Module width:         | --   |  |
| Standard print ratio: | 1:3:1:3  |  |
| Ratio format:         | 1B:2B:1S:2S  |  |
| Default check digit:  | Automatic (symbology specific).<br>DP Leitcode (eCDDPLeit) |  |
| Symbol size:          | --   |  |

Deutsche Post uses this symbology. The code is a Code 2 of 5 Interleaved enhanced with a special check digit calculation. It is used for encoding the ZIP-Code, Street and number of the shipment.

## 6.2.10 DPD Code

|                       |   |  |
|-----------------------|---|--|
| Symbology number:     | 96  |  |
| Valid characters:     | ASCII-characters between 32..127                            |  |
| Quiet zone:           | left/right: 10X, min. ¼ inch                                |  |
| Module width:         | X >= 0.19 mm  |  |
| Standard print ratio: | 1:2:3:4:1:2:3:4   |  |
| Ratio format:         | 1B:2B:3B:4B:1S:2S:3S:4S                                     |  |
| Default check digit:  | Automatic (symbology specific).<br>Modulo 103 (eCDCCode128) |  |
| Symbol size:          | --  |  |

DPD Code is used by DPD (*Deutscher Paket Dienst*). It bases on Code 128 and is limited to 28 encoded characters. The encoded data and the human readable text differ slightly.

The barcode data is specified as follows

I P P P P P P P T T T T T T T T T T T T T T T T S S S C C C

Whereas the human readable text is defined as:

P P P P P P P P T T T T T T T T T T T T T T T T S S S C C C C D

With:


| Character | Description                                      | Data Type    | Length |
|-----------|--|--------------|--------|
| I         | Identifier (in <b>barcode data only</b> )        | Alphanumeric | 1      |
| P         | Destination postal code                          | Alphanumeric | 7      |
| X         | Depot number (first part of the tracking number) | Alphanumeric | 4      |



|   |   |              |    |
|---|---|--------------|----|
| L | Serial number (second part of the tracking number)          | Numeric      | 10 |
| S | Service Code  | Numeric      | 3  |
| C | Destination Country Code                                    | Numeric      | 3  |
| D | Check digit modulo 36 (in <b>human readable text only</b> ) | Alphanumeric | 1  |


Table 16: DPD Format

### 6.2.11 Italian Postal Code 2 of 5

|                       |                              |  |
|-----------------------|------------------------------|--|
| Symbology number:     | 94                           |  |
| Valid characters:     | "0".."9"                     |  |
| Quiet zone:           | left/right: 10X, min. ¼ inch |  |
| Module width:         | X>= 0.19 mm                  |  |
| Standard print ratio: | 1:2.5:1:2.5                  |  |
| Ratio format:         | 1B:2B:1S:2S                  |  |
| Default check digit:  | None (eCDMod10ItIPst25)      |  |
| Symbol size:          | --                           |  |

Italian Postal Code 2 of 5 is based upon Code 2 of 5 Interleaved, but it is limited to 12 digits (11 usable digits + 1 modulo 10 check digit).

### 6.2.12 Japanese Postal Code

|                       |   |  |
|-----------------------|---|--|
| Symbology number:     | 76  |  |
| Valid characters:     | "0".."9", "A".."Z", "-",<br>7 digits (ZIP code) + additional data |  |
| Quiet zone:           | left/right/top/bottom: 2 mm                                       |  |
| Module width:         | --  |  |
| Standard print ratio: | 1:1   |  |
| Ratio format:         | 1B:1S   |  |
| Default check digit:  | Automatic (symbology specific).                                   |  |
| Symbol size:          | --  |  |

This code is used by the Japanese Postal system. You can encode 7 digits followed by block and street number (uppercase alphanumeric). The special compaction mode of Japanese characters can be enabled on demand– see below.

#### 6.2.12.1 Direct Encoding Mode

| Description                | Value                                      |
|----------------------------|--|
| Format Property            | "" (default=empty)                         |
| Postal code                | 2730102 (no hyphen '-')                    |
| Address B                  | 3-20-5B604                                 |
| Barcode text               | Postal code + Address B (no space between) |
| Barcode text               | 27301023-20-5B604                          |
| Encoded data in the symbol | 27301023-20-5B604                          |

#### 6.2.12.2 Japanese Extraction Mode

**Format** parameter "J" triggers data extraction from the Japanese Address B field.

| Description     | Value                                  |
|-----------------|--|
| Format Property | "J" (= Enable Japanese Compaction)     |
| Postal code     | 273-0102 (can contain '-')             |
| Address B       | 東3丁目 - 20 - 5 郵便・ A&b□一ホB604号          |
| Barcode text    | Postal code + Address B                |
| Barcode text    | 273-0102 東3丁目 - 20 - 5 郵便・ A&b□一ホB604号 |

|                            |                                      |
|----------------------------|--------------------------------------|
| Encoded data in the symbol | 27301023-20-5B604 (after compaction) |
| Encoding                   | SHIFT JIS (CP932)                    |


- ▶ In **TBarCode DLL** you have two possibilities:
  - Provide the data in UNICODE with *BCSetTextW(..)* and use *BCSetCodepage (Shift JIS)*<sup>3</sup>.
  - Provide the data in Shift JIS with *BCSetTextA(..)* and use *BCSetEncodingMode (LowByte)*.
- ▶ In **TBarCode OCX** and **TBarCode .NET** you set *CodePage* = Japanese Shift JIS.

### 6.2.12.3 Standard Dimensions

To draw the barcode according to the specification please follow these steps:

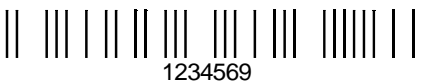
- ▶ Set the module width to 0.577mm (DLL-function: *BCSetModWidth* (pBC, "577"))
- ▶ Set the height of the „Bounding Rectangle“ in the draw function to 3.5 mm
- ▶ Switch off the display of the human readable text

### 6.2.13 KIX – Dutch Postal Code

|                       |                              |  |
|-----------------------|------------------------------|--|
| Symbology number:     | 90                           |  <p>2500GG30250</p> |
| Valid characters:     | "0".."9", "A".."Z", "a".."z" |  |
| Quiet zone:           | left/right/top/bottom: 2 mm  |  |
| Module width:         | 0.38-0.63 mm                 |  |
| Standard print ratio: | 1:1                          |  |
| Ratio format:         | 1B:1S                        |  |
| Default check digit:  | None (eCDNone)               |  |
| Symbol size:          | --                           |  |


This code is used by the Dutch Postal system.

### 6.2.14 Korean Postal Authority

|                       |   |   |
|-----------------------|---|---|
| Symbology number:     | 77  |  <p>1234569</p> |
| Valid characters:     | "0".."9", 6 digits + 1 check digit                        |   |
| Check digit method:   | Check digit included in the code                          |   |
| Quiet zone:           | 10X (not exactly specified)                               |   |
| Module width:         | --  |   |
| Standard print ratio: | 1:3:4   |   |
| Ratio format:         | 1B:1S:2S  |   |
| Default check digit:  | Automatic (symbology specific).<br>Modulo10 (eCDMod10Kor) |   |
| Symbol size:          | --  |   |

This code is used by the Korean Postal system. Encoded are a 6-digit ZIP and one check digit.

#### 6.2.14.1 Example


| Description                | Value   |
|----------------------------|---|
| Post number                | 305-600   |
| Barcode Text property      | 305600 (no hyphen, 6 digits)  |
| Encoded data in the symbol | 0065036   |
|                            | The check digit (7 <sup>th</sup> digit marked red) is calculated automatically.<br> |

<sup>3</sup> Shift JIS will be the default code page for Japanese Postal in TBarCode SDK 10.2.6 and later.

Parameters: width = 70, height = 4 mm, module width = 0.417 mm


▶ Hint: Is scanned from right to left, so the data is encoded in the reverse order. The check digit is added at the right side, so it is the first digit read by a scanner.

### 6.2.15 Planet 12 (Deprecated)

|                        |   |  |
|------------------------|---|--|
| Symbology number:      | 82  | <br>123456789014 |
| Valid characters:      | "0".."9", 11 digits + 1 check digit           |  |
| Quiet zone:            | left/right: 1/25 inch<br>top/bottom: 1/8 inch |  |
| Module width:          | --  |  |
| Standard print ratio:  | 1:1   |  |
| Ratio format:          | 1B:1S   |  |
| Default check digit:   | Modulo 10 Planet (eCDMod10Pla)                |  |
| Possible check digits: | User supplied                                 |  |
| Symbol size:           | 11 digits + 1 check digit                     |  |


This code was developed for the United States Postal Services. It is a 3-of-5 variant of the POSTNET barcode. It was fully superseded by Intelligent Mail® Barcode (6.2.25) by January 28, 2013.

### 6.2.16 Planet 14 (Deprecated)

|                        |   |  |
|------------------------|---|--|
| Symbology number:      | 83  | <br>12345678901239 |
| Valid characters:      | "0".."9", 13 digits + 1 check digit           |  |
| Quiet zone:            | left/right: 1/25 inch<br>top/bottom: 1/8 inch |  |
| Module width:          | --  |  |
| Standard print ratio:  | 1:1   |  |
| Ratio format:          | 1B:1S   |  |
| Default check digit:   | Modulo 10 Planet (eCDMod10Pla)                |  |
| Possible check digits: | User supplied                                 |  |
| Symbol size:           | 13 digits + 1 check digit                     |  |

This code was developed for the United States Postal Services. It is a 3-of-5 variant of the POSTNET barcode. It was fully superseded by Intelligent Mail® Barcode (6.2.25) by January 28, 2013.

### 6.2.17 Royal Mail 4 State (RM4SCC)

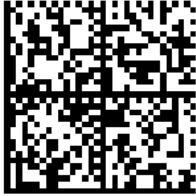
|                        |                                    |   |
|------------------------|------------------------------------|---|
| Symbology number:      | 70                                 | <br>12345678 |
| Valid characters:      | "0".."9", "A".."Z"                 |   |
| Quiet zone:            | left/right: 2 mm                   |   |
| Module width:          | --                                 |   |
| Standard print ratio:  | 1:1                                |   |
| Ratio format:          | 1B:1S                              |   |
| Default check digit:   | Automatic (symbology specific).    |   |
| Possible check digits: | User supplied                      |   |
| Symbol size:           | max. 9 digits without check digits |   |
| Print control:         | C=RM                               |   |

This code is a height-modulated code using 4 different vertical bars. It is used in mass-mailing applications (Cleanmail, Mailsort) of the Royal Mail, United Kingdom and Singapore (called SinPost barcode). Encoded are ZIPs.

### 6.2.18 Royal Mail Complex Mail Data Mark (CMDM) Mailmark® Barcode

Royal Mail CMDM Mailmark is just an old name of the Royal Mail Mailmark 2D barcode.

### 6.2.19 Royal Mail Mailmark® 2D Barcode

|                       |   |   |
|-----------------------|---|---|
| Symbology number:     | 119   |  |
| Valid characters:     | "0".."9", "A".."Z", " " (Space), 45 chars fixed length + variable customer part |   |
| Quiet zone:           | left/right/ top/bottom: 4X  |   |
| Module width:         | 0.5 – 0.7 mm  |   |
| Standard print ratio: | 1:1   |   |
| Ratio format:         | 1B:1S   |   |
| Default check digit:  | Automatic (symbology specific).   |   |
| Symbol size:          | 12 x 12 mm, 16 x 16 mm, 8 x 24 mm   |   |

The *Mailmark 2D* is based upon Data Matrix ECC200 (ISO/IEC 16022, version 2006) and is used by the Royal Mail for postal services. In addition, the Mailmark™ 2D barcode uses a specific format and data structure defined by the Royal Mail for their purposes.

A Mailmark™ 2D barcode can be any of the following Data Matrix formats:

- Format 7 (24 x 24 modules), total capacity 51 characters, 6 characters for customer use.
- Format 9 (32 x 32 modules), total capacity 90 characters, 45 characters for customer use.
- Format 29 (16 x 48 modules), total capacity 70 characters, 25 characters for customer use.

#### 6.2.19.1 Data Structure

The Mailmark™ 2D barcode is differentiated from other Data Matrix symbols by the first 6 characters of the data within the barcode:

- UPU identifier – 1 Characters (J),
- Country ID – 3 Characters (e.g. GBA, or GB<SPACE>),
- Product type ID – 1 Character,
- Version ID – 1 Character

Each field within any CMDM is of a fixed and defined length. The length in total (except customer part) is *45 characters*. Missing or optional attributes must be filled with the *SPACE* character.

► For more information, we refer to the [Royal Mail Mailmark® barcode definition document](#).

Sample data content (Format 9, 45 characters Mailmark™ data + 41 characters customer data):

JGB 010100000700009001B707RH1A 0SN35XX ABCDEFGHIJ1234567890ABCDEFGHIJ1234567890A

#### 6.2.19.2 Customer Content


Each format has a reserved space for customers and/or mailing houses to place information. The amount of space depends on the barcode type and characters/encoding used.

#### 6.2.19.3 Encoding

All data within the Royal Mail defined portion of the code shall comply with the C40 character set (upper case alphanumeric, numeric and SPACE characters) and C40 encoding scheme of Data Matrix. The customer content field does not need to comply with this encoding.

► TBarCode uses the proper encoding if you select the "eBC\_2D\_Mailmark" symbology.

### 6.2.20 Royal Mail Mailmark® 4-state Barcode

|                       |   |  |
|-----------------------|---|--|
| Symbology number:     | 121   |  |
| Valid characters:     | "0".."9", "A".."Z", " " (Space)                 |  |
| Quiet zone:           | left/right/ top/bottom: 2 mm                    |  |
| Module width:         | 0.38 – 0.63 mm                                  |  |
| Standard print ratio: | 1:1   |  |
| Ratio format:         | 1B:1S   |  |
| Default check digit:  | Automatic (symbology specific).                 |  |
| Symbol size:          | depending on variant either 22 or 26 characters |  |

This code is a height-modulated code using four different vertical bars. It is defined and used by the Royal Mail for postal services.

Following variants of Mailmark 4-state are used:

- Variant C (22 characters, 66 modules), available to customers who consolidate mailings.
- Variant L (26 characters, 78 modules), available to all customers.

Each field within any Mailmark 4-state is of a fixed and defined length. The length in total must be either *22 (for variant C) or 26 characters (for variant L)*. Missing or optional attributes must be filled with the *SPACE* character.

► For more information we refer to the [Royal Mail Mailmark® barcode definition document](#)


### 6.2.21 Singapore Post 4-State Customer Code (SinPost)

Singaporean Postcode – identical with Royal Mail 4 State (RM4SCC).

### 6.2.22 Singapore Post

The Singapore Post 4 State Customer Code is the same as the RM4SCC.

### 6.2.23 Swedish Postal Shipment Item ID


|                       |  |  |
|-----------------------|--|--|
| Symbology number:     | 118  |  <p style="text-align: center;">EM 10 002 799 5 SE</p> |
| Valid characters:     | 2 letters + 8 digits + 1 digit check digit + "SE". |  |
| Quiet zone:           | left/right: 10X                                    |  |
| Module width:         | X >= 0.28mm  |  |
| Standard print ratio: | 1:2:3:4:1:2:3:4                                    |  |
| Ratio format:         | 1B:2B:3B:4B:1S:2S:3S:4S                            |  |
| Default check digit:  | UPU check digit (Universal Postal Union) (eCDUPU)  |  |
| Symbol size:          | H >= 9mm (for details see Swedish Postal spec).    |  |

This Code bases upon Code 128 and is used on Swedish Postal labels. The code consists of:

- 2-digit letter prefix
- 8-digit serial number
- 1-digit check digit (mod 11)
- "SE" as application identifier

The check digit is calculated according to weighted modulo 11 method for Universal Postal Union (for 8 digits).

### 6.2.24 UPU S10 – Generic Postal Code


|                       |   |  |
|-----------------------|---|--|
| Symbology number:     | 120   |  |
| Valid characters:     | 2 letters + 8 digits + 1 digit check digit + 2 letters. |  |
| Quiet zone:           | left/right: 10X   |  |
| Module width:         | X >= 0.28mm   |  |
| Standard print ratio: | 1:2:3:4:1:2:3:4   |  |
| Ratio format:         | 1B:2B:3B:4B:1S:2S:3S:4S                                 |  |
| Default check digit:  | UPU check digit (Universal Postal Union) (eCDUPU)       |  |
| Symbol size:          | H >= 9mm.   |  |

This Code bases upon Code 128 and is used on Postal labels in various countries. The code consists of:

- 2-digit letter prefix
- 8-digit serial number
- 1-digit check digit (mod 11)
- 2-digit country code

The check digit is calculated according to weighted modulo 11 method for Universal Postal Union (for eight digits).

### 6.2.25 USPS Intelligent Mail® Barcode or IM® Barcode

|                       |  |  |
|-----------------------|--|--|
| Symbology number:     | 85   |  |
| Valid characters:     | "0".."9", 20 digits + 0, 5, 9, or 11-digit ZIP Code. |  |
| Quiet zone:           | vertical: 1/25 inch<br>horizontal: 1/8 inch          |  |
| Module width:         | --   |  |
| Standard print ratio: | 1:1  |  |
| Ratio format:         | 1B:1S  |  |
| Default check digit:  | Automatic (symbology specific).                      |  |
| Symbol size:          | Up to 31 digits                                      |  |
| Print control:        | C=IMB  |  |


This symbology is also known as

- OneCode 4CB
- USPS 4CB
- 4-CB
- 4-State Customer Barcode
- USPS OneCode Solution Barcode.

The following data is encoded:

- Barcode ID (1st digit: 0-9; 2nd digit: 0-4)
- Special services (range: 000-999)
- Customer ID (range: 000000-999999)
- Sequence number (range: 00000000-99999999)
- Delivery point ZIP code (0, 5, 9, or 11-digit ZIP code)

### 6.2.26 USPS Intelligent Mail® Package Barcode

|                        |   |  |
|------------------------|---|--|
| Symbology number:      | 117   | <br>9102 8052 1368 3062 5229 20 |
| Valid characters:      | "0".."9" + FNC1, Routing Information: 0, 8, or 12 digits + Tracking Information: 22 to 26 digits. |  |
| Quiet zone:            | vertical: 1/25 inch<br>horizontal: 1/8 inch   |  |
| Module width:          | --  |  |
| Standard print ratio:  | 1:1   |  |
| Ratio format:          | 1B:1S   |  |
| Default check digit:   | Modulo 10 (USPS IM Package)<br>(eCDMod10IMPackage)  |  |
| Possible check digits: | User supplied   |  |
| Symbol size:           | 22 to 34 digits   |  |

The barcode data consists of Routing Information and Tracking Information. The Routing Information is optional. It is not printed in the human visible text and consists of:

- Postal Code Application Identifier (AI): always **420**
- Destination ZIP Code (5 or 9 digits)


The tracking information is mandatory. It is printed in the human readable text 3 types of tracking information exist: commercial mailer constructs, online constructs, and retail constructs.

- Commercial Mailer Constructs:
  - Channel Application Identifier (**92** or **93**)
  - Service Type Code (3 digits)
  - Mailer Identifier (6 or 9 digits)
  - Serial Number (if Mailer Identifier has 9 digits: 7 or 11 digits, otherwise: 10 or 14 digits)
  - Check Digit
- Online Constructs:
  - Channel Application Identifier (**94**)
  - Service Type Code (3 digits)
  - Source Identifier (2 digits)
  - Mailer Identifier (6 or 9 digits)
  - Serial Number (5 or 8 digits)
  - Check Digit
- Retail Constructs:
  - Channel Application Identifier (**95**)
  - Service Type Code (3 digits)
  - Channel Identifier (1 digit)
  - Device ID (6 digits)
  - Julian Date (4 digits)
  - Serial Number (5 digits)
  - Check Digit

## 6.2.27 USPS Postnet (Deprecated)

The subsequent listed USPS® Postnet bar codes were retired effective January 28, 2013. Mailers must use a Basic or Full-Service Intelligent Mail® bar code (see section 6.2.25).

### 6.2.27.1 USPS Postnet 5


|                       |   |  |
|-----------------------|---|--|
| Symbology number:     | 40  |  |
| Valid characters:     | "0".."9", 5 digits + 1 check digit          |  |
| Quiet zone:           | vertical: 1/25 inch<br>horizontal: 1/8 inch |  |
| Module width:         | --  |  |
| Standard print ratio: | 1:1   |  |
| Ratio format:         | 1B:1S                                       |  |
| Default check digit:  | POSTNET (eCDPostNet)                        |  |
| Symbol size:          | 5 digits, 1 check digit                     |  |
| Print control:        | C=PSN5                                      |  |

The United States Postal Services used this code for mass-mailing applications. Encoded are a 5 digit ZIP-code. The check digit is calculated automatically (not specified in the input data).

The barcode height should be adjusted to 3.2 mms; the module width to 0.423 mms; usually no plain text is displayed.


The newer USPS Intelligent Mail® Barcode or IM® Barcode (4-State Customer Barcode) additionally includes a 20 digits tracking code.

### 6.2.27.2 USPS POSTNET 6

|                        |   |  |
|------------------------|---|--|
| Symbology number:      | 41  |  |
| Valid characters:      | "0".."9", 5 digits + 1 check digit          |  |
| Quiet zone:            | vertical: 1/25 inch<br>horizontal: 1/8 inch |  |
| Module width:          | --  |  |
| Standard print ratio:  | 1:1   |  |
| Ratio format:          | 1B:1S                                       |  |
| Default check digit:   | POSTNET (eCDPostNet)                        |  |
| Possible check digits: | User supplied                               |  |
| Symbol size:           | 5 digits, 1 check digit                     |  |

Same as POSTNET 5, but the check digit can be specified (the sixth digit).

### 6.2.27.3 USPS POSTNET 9

|                       |   |  |
|-----------------------|---|--|
| Symbology number:     | 42  |  |
| Valid characters:     | "0".."9", 9 + 1 check digit                 |  |
| Quiet zone:           | vertical: 1/25 inch<br>horizontal: 1/8 inch |  |
| Module width:         | --  |  |
| Standard print ratio: | 1:1   |  |
| Ratio format:         | 1B:1S                                       |  |
| Default check digit:  | POSTNET (eCDPostNet)                        |  |
| Symbol size:          | 9 digits, 1 check digit                     |  |
| Print control:        | C=PSN9                                      |  |


The United States Postal Services used this code for mass-mailing applications. Encoded are a 5-digit ZIP-code and four additional digits. The check digit is computed automatically; it cannot be specified in the input data.



The barcode height should be adjusted to 3.2 mms; the module width to 0.423 mms; usually no plain text is displayed.


The newer USPS Intelligent Mail® Barcode or IM® Barcode (4-State Customer Barcode) additionally includes a 20 digits tracking code.

### 6.2.27.4 USPS POSTNET 10

|                        |   |  |
|------------------------|---|--|
| Symbology number:      | 43  |  |
| Valid characters:      | "0".."9", 9 digits + 1 check digit          |  |
| Quiet zone:            | vertical: 1/25 inch<br>horizontal: 1/8 inch |  |
| Module width:          | --  |  |
| Standard print ratio:  | 1:1   |  |
| Ratio format:          | 1B:1S                                       |  |
| Default check digit:   | POSTNET (eCDPostNet)                        |  |
| Possible check digits: | User supplied                               |  |
| Symbol size:           | 9 digits, 1 check digit                     |  |

Same as POSTNET 9, but the check digit can be specified (the 10<sup>th</sup> digit).

### 6.2.27.5 USPS POSTNET 11


|                       |   |  |
|-----------------------|---|--|
| Symbology number:     | 44  |  |
| Valid characters:     | "0".."9", 11 digits + 1 check digit         |  |
| Quiet zone:           | vertical: 1/25 inch<br>horizontal: 1/8 inch |  |
| Module width:         | --  |  |
| Standard print ratio: | 1:1   |  |
| Ratio format:         | 1B:1S                                       |  |
| Default check digit:  | POSTNET (eCDPostNet)                        |  |
| Symbol size:          | 11 digits, 1 check digit                    |  |
| Print control:        | C=PSN11                                     |  |

The United States Postal Services used this code for mass-mailing applications. Encoded are a 5-digit ZIP-code and 4 to 9 additional digits. The check digit is calculated automatically. It cannot be specified in the input data.

The barcode height should be adjusted to 3.2 mms; the module width to 0.423 mms; usually no plain text is displayed.

The newer USPS Intelligent Mail® Barcode or IM® Barcode (4-State Customer Barcode) additionally includes a 20 digits tracking code.


### 6.2.27.6 USPS POSTNET 12

|                        |   |  |
|------------------------|---|--|
| Symbology number:      | 45  |  |
| Valid characters:      | "0".."9", 11 digits + 1 check digit         |  |
| Quiet zone:            | vertical: 1/25 inch<br>horizontal: 1/8 inch |  |
| Module width:          | --  |  |
| Standard print ratio:  | 1:1   |  |
| Ratio format:          | 1B:1S                                       |  |
| Default check digit:   | POSTNET (eCDPostNet)                        |  |
| Possible check digits: | User supplied                               |  |
| Symbol size:           | 11 digits, 1 check digit                    |  |

Same as POSTNET 11, but the check digit can be specified (the 12<sup>th</sup> digit).

## 6.3 2D Symbologies

### 6.3.1 Aztec Code

|                      |                                 |   |
|----------------------|---------------------------------|---|
| Symbology number:    | 92                              |  |
| Valid characters:    | ASCII 0-127 + ISO 8859-1        |   |
| Quiet zone:          | left/right/ top/bottom: 0X      |   |
| Module width:        | --                              |   |
| Print ratio:         | 1:1                             |   |
| Ratio format:        | 1B:1S                           |   |
| Default check digit: | Automatic (symbology specific). |   |
| Size:                | --                              |   |
| Print control:       | C=AZT                           |   |

Aztec Code can encode from small to large amounts of data with user-selected percentages of error correction. The symbol size adjusts automatically depending on the amount of input data.

The input data is always analyzed and the appropriate encoding mode is chosen automatically. Mode switching is done as required to produce the most efficient encoding.

#### 6.3.1.1 Character Set

The default interpretation is ISO-8859-1 (Latin-1), which corresponds to ECI 000003.

The special FNC1 character is supported.

#### 6.3.1.2 Layers and Core Type

1 to 4 layers, producing symbols from 15x15 through 27x27 pixels, may surround the compact Aztec code core. The full core version supports up to 32 layers (that are up to 151x151 pixels).

The core type and the number of layers are controlled by the size parameter.

| Size Enumeration | Size Pixel             | Core Type              | Layers                 |
|------------------|------------------------|------------------------|------------------------|
| 0                | Automatically selected | Automatically selected | Automatically selected |
| 1                | 15x15                  | Compact                | 1                      |
| 2                | 19x19                  | Compact                | 2                      |
| 3                | 23x23                  | Compact                | 3                      |
| 4                | 27x27                  | Compact                | 4                      |
| 5                | 31x31                  | Full                   | 4                      |
| 6                | 37x37                  | Full                   | 5                      |
| 7                | 41x41                  | Full                   | 6                      |
| ...              | ...                    | Full                   | ...                    |
| 33               | 151x151                | Full                   | 32                     |

Table 17: Aztec Code Symbol Sizes

The full core 1-3 layer versions are not supported; instead, the compact version is used.

#### 6.3.1.3 The Maximum Data Capacity of Aztec Code

The Aztec Code specification defines the following:

|                      |   |
|----------------------|---|
| Numerical data only: | 3832                                      |
| Bytes:               | 1914                                      |
| Text characters:     | 3067 (only uppercase letters used [A..Z]) |

If you mix the character types the maximum data capacity cannot be predicted exactly (due to internal compression and character set switching - this is by design).

If you use a combination of digits and text (lower & uppercase letters), the maximum data capacity would be about 2500 characters - but this can vary due to your input data. If you want to encode large data amounts we recommend using only capital letters or multiple symbols (structured append).

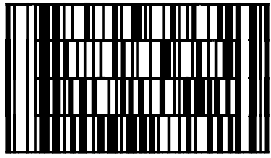
### 6.3.1.4 Format

Beside the default format for general purposes, Aztec Code supports GS1 and Industry formats.

The GS1 format adds a leading FNC1 in front of the encoded data to signal usage within the GS1 system. The FNC1 is not transmitted but has an influence to the symbology identifier.

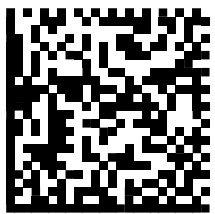
If industry format is used, the internal data representation in the bar code will be *<format specifier> + FNC1 + <bar code data>*. In that case the bar code reader transmits "jz2" (symbology identifier for industry standards) followed by the *<format specifier>* and the data.

### 6.3.2 Codablock F

|                      |  |  |
|----------------------|--|--|
| Symbology number:    | 74                                     |  |
| Valid characters:    | ASCII 0-127 + ISO 8859-1               |  |
| Quiet zone:          | left/right/ top/bottom: 10X            |  |
| Module width:        | X>=0.19mm                              |  |
| Print ratio:         | 1:2:3:4:1:2:3:4                        |  |
| Ratio format:        | 1B:2B:3B:4B:1S:2S:3S:4S                |  |
| Default check digit: | Automatic (symbology specific).        |  |
| Size:                | 2 - 44 rows; 4 - 62 characters per row |  |
| Print control:       | C=CBF                                  |  |

Codablock F is de facto a "stacked" Code128 symbology. It is based upon Code 128 - each row is a single Code 128 symbol extended with row indicator information and additional check digits. The UCC/EAN/GS1 format indicator is supported.

### 6.3.3 Data Matrix

|                      |   |   |
|----------------------|---|---|
| Symbology number:    | 71  |  |
| Valid characters:    | Alphanumeric (ASCII 0.. 255) and/or bytes |   |
| Quiet zone:          | left/right/ top/bottom: 1X                |   |
| Module width:        | --  |   |
| Print ratio:         | 1:1                                       |   |
| Ratio format:        | 1B:1S                                     |   |
| Default check digit: | Automatic (symbology specific).           |   |
| Size:                | .001 till 14.0 square inch                |   |
| Print control:       | C=DMX                                     |   |

Data Matrix is used for encoding large amounts of data and is ideal for marking small objects. The symbol size adjusts automatically depending on the amount of input data.

It was developed by RVSI Acuity CiMatrix for the Space Shuttle Program and then enhanced by the NASA and the Symbology Research Center.

It is the de-facto standard symbology in the following areas:

- Automotive
- Aviation (SPEC2000)
- Pharmaceutical areas

TEC-IT's Data Matrix implementation complies to

- ECC200
- ANSI/AIM BC11
- ISO/IEC 16022
- Department of Defense UID, MIL-STD-130L
- all other specifications that require ECC200.

### 6.3.3.1 Encoding Modes

The input data is always analyzed and the appropriate encoding mode is chosen automatically. Mode switching is done as required to produce the most efficient encoding. Supported encoding modes are

- BASE256
- C40
- TEXT
- ASCII

### 6.3.3.2 Data Capacity

The data capacity depends on the format of the encoded data:

| Format       | Data Capacity |
|--------------|---------------|
| Numeric      | 3116          |
| Alphanumeric | 2355          |
| Binary       | 1556          |

Table 18: Data Matrix Data Capacity

The maximum data capacity for binary data is equal to **1556 bytes** using a Matrix of 144x144 dots. With a dot size of 0.35 mm minimum, you get a symbol size of 50.4 \* 50.4 mm.

- The maximum data capacity for a matrix of 120x120 dots = 1048 Bytes.
- The maximum data capacity for a matrix of 96x96 dots = 694 Bytes.

In practice, with a hand-held scanner, you can scan sizes up to 96x96 dots without problems. Symbol sizes of 120x120 dots are ok if you are using (very) good scanners. However – TEC-IT recommends splitting up the 1 KB input data into 2 or more symbols.

### 6.3.3.3 Code Format

The following code formats are supported by TEC-IT software:

- Default/Standard
- UCC/EAN/GS1 (FNC1 is added at 1<sup>st</sup> position; this format is used for the “GS1 Data Matrix”)
- Industry (a peculiar industry format, which adds FNC1 at 2<sup>nd</sup> position)
- Macro 05 (the data is prefixed with “[ ]>” + RS + “05” + GS and suffixed with RS + EOT)
- Macro 06 (the data is prefixed with “[ ]>” + RS + “06” + GS and suffixed with RS + EOT)
- Reader Programming (the barcode data is used to program the barcode reader)

### 6.3.3.4 Compatibility Options

The internal encoding mode switching is highly optimized and should be supported by all bar code readers on the market. In case of problems with document scanning solutions (like CAPTIVA, IBML and other), we provide a compatibility mode (available from TBarCode V10.0.2).

▶ To turn on this compatibility mode, enter "C" into the format property (Data Matrix only).

### 6.3.3.5 DMRE – Data Matrix Rectangular Extension

The original Data Matrix specification includes 24 square formats but only six rectangular formats with a data capacity in the lower range.

Specifically small surfaces benefit from rectangular formats resulting in a demand for rectangular versions with a higher data volume. This led to the Data Matrix Rectangular Extension (DMRE), which was adopted by AIM in 2014 and later specified in DIN 16587.

The DMRE adds new rectangular versions with a higher capacity. In 2017, ISO published a DMRE working draft (ISO/IEC 21471) which adds even more rectangular formats, but it does not adopt all formats from the DIN standard.

| DMRE (Data Matrix Rectangular Extension) <sup>4</sup>          |                            |
|--|----------------------------|
| 8 x 48   | 24 x 48                    |
| 8 x 64   | 24 x 64                    |
| 12 x 64  | 26 x 32 *                  |
| 16 x 64  | 26 x 40                    |
| 24 x 32 *  | 26 x 48                    |
| 24 x 36 *  | 26 x 64                    |
| Additional DMRE sizes defined by ISO/IEC 21471                 |                            |
| 8 x 80   | 20 x 36                    |
| 8 x 96   | 20 x 44                    |
| 8 x 120  | 20 x 64                    |
| 8 x 144  | <del>22 x 40</del> removed |
| 12 x 88  | 22 x 48                    |
| * Those sizes are not included in the ISO 21471 draft/standard |                            |

Table 19: Data Matrix DMRE Sizes

The rectangular sizes are selected via the symbol size property.

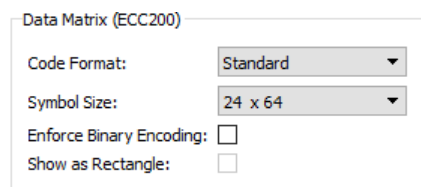


Figure 11: Data Matrix Symbol Size Property



Figure 12: Data Matrix DMRE 24x64

### 6.3.3.6 GS1 Data Matrix

For creating a GS1 Data Matrix, set the code format to GS1/UCC/EAN (adds FNC1 on 1<sup>st</sup> position).

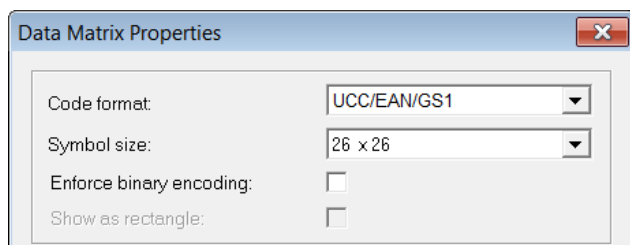


Figure 13: GS1 Data Matrix Code Format

GS1 Data Matrix utilizes Application Identifiers (see chapter 5) and FNC1 for variable length AI's.

More information: [Overview and technical introduction to the use of GS1 Data Matrix](#)

<sup>4</sup> See AIM-D Standard "DMRE 1.01", DIN 16587 DMRE

### 6.3.3.7 Deutsche Post Premiumadress Data Matrix

In order to generate a Data Matrix for Deutsche Post *Premiumadress* use the property settings below and follow the example.

- Enforce binary encoding (BASE256 mode)
- Data Matrix Size 22x22 (standard)
- Data Matrix Size 26x26 (enlarged)
- Module width 0.423 mm

- ▶ Make sure that the property "Translate Escape Sequences" is activated!
- ▶ The hexadecimal data must be converted in a **TBarCode** escape format. Before each hexadecimal digit pair, you have to set a "x"!
- ▶ By using **TBarCode** select the Encoding mode "No conversion (Lower bytes only)" - see "Advanced settings".

The following example refers to the product **TBarCode**. If you want to generate a Data Matrix with **TFormer** or **Barcode Studio**, the workflow is just the same.

Example:

Original data:

```
444541080D02540BE3FF0052232D242D00006500000010100015A31
```

Encoded data:

```
\x44\x45\x41\x08\x0D\x02\x54\x0B\xE3\xFF\x00\x52\x23\x2D\x24\x2D\x00\x00\x65\x00\x00\x00\x01\x01\x00\x01\x5A\x31
```

Tab *Barcode*

| Description                    | Value  |
|--------------------------------|--|
| Barcode type:                  | Data Matrix. The standard symbol size is 22x22 (see Figure 14). To adjust the symbol size, please click on the <i>Adjust</i> button. |
| Barcode data (112 characters): | \x44\x45\x41\x08\x0D\x02\x54\x0B\xE3\xFF\x00\x52\x23\x2D\x24\x2D\x00\x00\x65\x00\x00\x00\x01\x01\x00\x01\x5A\x31                     |
| Translate escape sequences     | Make sure that this checkbox is activated.   |

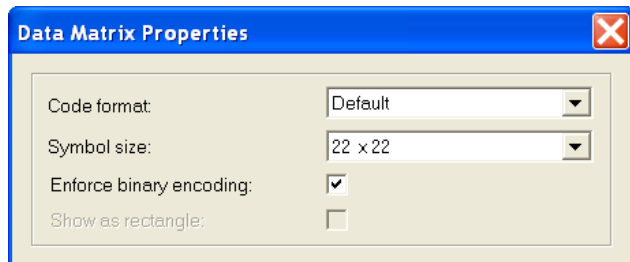


Figure 14: Data Matrix Properties

Tab *Appearance*

| Description                          | Value   |
|--------------------------------------|---|
| Barcode size and module width.       | Use the entry Custom – Specify module with from the drop down menu. |
| Module width [1/1000 mm]             | Use the value 423.  |
| Display error if barcode is clipped. | Make sure that you have activated this checkbox.                    |

### 6.3.3.8 DP PostMatrix

Deutsche Post PostMatrix bases on Data Matrix standard, which is used by Deutsche Post in their RESPONSEPLUS service. It adds two additional lines at the left side of the matrix code.

You can enable the DP PostMatrix by adjusting the following code format:

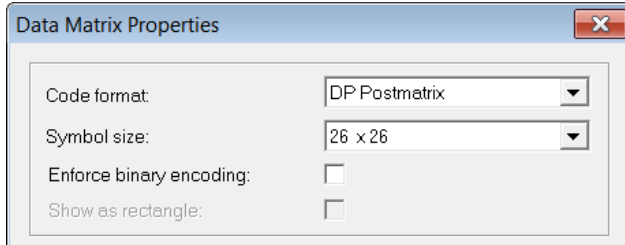


Figure 15: Data Matrix DP PostMatrix Code format

The logical size of the symbol is limited to 22x22 and 26x26 dots. The module width (dot size) has to be in a range between 0,423 and 0,508mm.

More information:

- <https://www.deutschepost.de/de/r/responseplus.html>

#### Deutsche Post Werbeantwort PostMatrix

In order to generate a PostMatrix code for Deutsche Post Werbeantwort use the property settings below and follow the example.

- Code format DP PostMatrix
- PostMatrix Size 22x22 (standard) or PostMatrix Size 26x26 (enlarged)
- No Binary encoding mode (!)
- Module width 0.423 mm

The following example refers to the product **TBarCode**. If you want to generate a Data Matrix with **TFormer** or **Barcode Studio**, the workflow is just the same.

#### Example:

Original data:

| DEAW00A01Z690WA52345678000010205001099~JOB4711~850

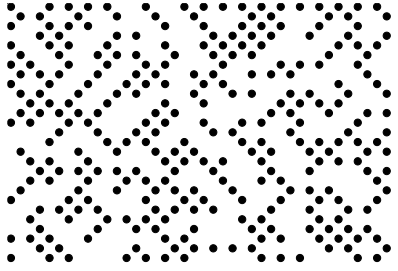
#### Barcode Properties

| Common        | Value       |
|---------------|-------------|
| Barcode type: | Data Matrix |

| Data Matrix              | Value         |
|--------------------------|---------------|
| Code format:             | DP PostMatrix |
| Symbol size:             | 26x26         |
| Enforce binary encoding: | Disabled (!)  |

### 6.3.4 DotCode

|                      |   |  |
|----------------------|---|--|
| Symbology number:    | 115                                       |  |
| Valid characters:    | Alphanumeric (ASCII 0.. 255) and/or bytes |  |
| Quiet zone:          | left/right/ top/bottom: 3X                |  |
| Module width:        | --  |  |
| Print ratio:         | 1:1                                       |  |
| Ratio format:        | 1B:1S                                     |  |
| Default check digit: | Automatic (symbology specific).           |  |
| Size:                | --  |  |

DotCode is 2D dot code symbology designed to be reliably readable when printed by high-speed inkjet or laser dot technologies.

The encoding modes of DotCode bases on the Code128 data encoding (with modes A, B, and C) extended by a so-called Binary Mode.

The default interpretation for DotCode data is ECI 000003 representing the Latin-I character set.

The DotCode symbology does not have absolute capacity limits, but a maximum symbol size of 124x124 dots is recommended.

#### 6.3.4.1 Code Format

The following code format is supported by TEC-IT software:

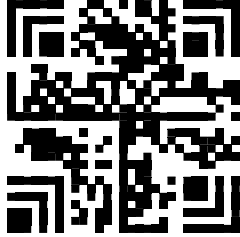
- Auto Discriminate  
If the data starts with two digits, barcode has GS1 format, otherwise generic format is used.
- Generic Format  
The barcode data does not fulfill any special format, if it starts with 2 digits, FNC1 is inserted.
- UCC/EAN/GS1  
The internal data must start with 2 digits and be formatted with GS1 Application Identifiers.
- Industry (a peculiar industry format, which adds FNC1 at 2nd position)
- Macro 05 (the data is prefixed with “[ ]>” + RS + “05” + GS and suffixed with RS + EOT)
- Macro 06 (the data is prefixed with “[ ]>” + RS + “06” + GS and suffixed with RS + EOT)
- Macro 12 (the data is prefixed with “[ ]>” + RS + “12” + GS and suffixed with RS + EOT)
- Custom Macro (the data is prefixed with “[ ]>” + RS and suffixed with RS + EOT; the rest of the format specifier has to be encoded by the user)
- Reader Programming (the barcode data is used to program the barcode reader)

The following unprintable characters are used with the Macro 05/06 modes:

- RS (Record Separator): 0x1e
- GS (Group Separator): 0x1d
- EOT (End of Transmission): 0x04.



### 6.3.5 Han Xin Code

|                      |   |   |
|----------------------|---|---|
| Symbology number:    | 116   |  |
| Valid characters:    | Alphanumeric (ASCII 0.. 255) and/or bytes, Chinese Characters (GB18030) |   |
| Quiet zone:          | left/right/ top/bottom: 3X  |   |
| Module width:        | --  |   |
| Print ratio:         | 1:1   |   |
| Ratio format:        | 1B:1S   |   |
| Default check digit: | Automatic (symbology specific).   |   |
| Size:                | --  |   |

Han Xin Code is a 2D matrix symbology, which is used for encoding large amounts of data and provides a special support for encoding Chinese characters (character set GB18030).

#### 6.3.5.1 Data Capacity

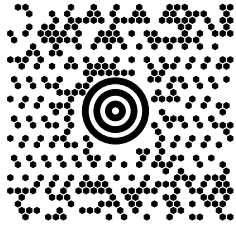
The data capacity depends on the format of the encoded data:

| Format                          | Data Capacity |
|---------------------------------|---------------|
| Numeric                         | 7827          |
| Alphanumeric                    | 4350          |
| Binary                          | 3261          |
| Common Chinese in Region 1 or 2 | 2174          |
| 2-byte Chinese                  | 1739          |
| 4-byte Chinese                  | 1044          |

Table 20: Han Xin Code Data Capacity

The maximum data capacity for binary data is equal to **3261 bytes** using a Matrix of 189x189 dots. For compaction of Chinese characters, adjust the Codepage to GB18030.

### 6.3.6 MaxiCode

|                      |   |   |
|----------------------|---|---|
| Symbology number:    | 57  |  |
| Valid characters:    | Alphanumeric (ASCII 0.. 255) and/or bytes |   |
| Default Mode:        | Mode-4 (standard symbol)                  |   |
| Quiet zone:          | left/right/ top/bottom: 1X                |   |
| Module width:        | --  |   |
| Print ratio:         | n/a                                       |   |
| Ratio format:        | n/a                                       |   |
| Default check digit: | Automatic (symbology specific).           |   |
| Size:                | Fix: 1.11 x 1.054 inch                    |   |
| Print control:       | C=MXC                                     |   |

MaxiCode is in use (and was invented) by UPS®.

MaxiCode represents data by drawing hexagonal items, which are arranged around a circular center (a so called "Bull's Eye"). Different encoding modes for including postal information (SCM) can be adjusted: UPS Modes are Mode 2 (US Carrier) and Mode 3 (International Carrier).

The printing size is usually set to a fixed value. If you want to change the size of the symbol, adjust a custom module width (default is 0.870 mm).

#### 6.3.6.1 Data Capacity

The data capacity depends on the format of the encoded data:

| Format       | Data Capacity | Characters          |
|--------------|---------------|---------------------|
| Numeric      | 138           | 0-9                 |
| Alphanumeric | 93            | 0-9 A-Z (uppercase) |

Table 21: Maxi Code Data Capacity

The maximum data capacity of one symbol is 93 alphanumeric characters. By using the UPS® MaxiCode compression software, you can extend this value to about 100 characters. The actual quantity of the utilizable data depends on the selected mode, how often special characters are used, whether numeric sequences are used (which can be compressed) and the level of error correction.

With **Structured Append**, you can divide larger quantities of data into several MaxiCode symbols – the scanner joins them when being read.

### 6.3.6.2 Modes

The internal data structure is regulated by different "modes". For standard purposes, data can be encoded with two different error correction levels:

- Mode 4 - SEC / Standard Error Correction
- Mode 5 - EEC = Enhanced E.C.).

The modes for "Structured Carrier Message" (SCM) were defined by the parcel transport service UPS®. If you want to use MaxiCode for UPS, please use these SCM modes.

- Mode 2 - SCM numeric
- Mode 3 - SCM alphanumeric

### 6.3.6.3 MaxiCode & UPS®

In order to generate a MaxiCode symbol for UPS®, follow the steps below. The following sample uses the properties of the barcode software component **TBarCode OCX**.

#### Select MaxiCode Mode

- ▶ Please use mode 2 or 3 (SCM) depending on your postal code. UPS MaxiCode compression works only for these SCM modes.

If you want to encode a numeric Postcode (USA) set the mode to "SCM numeric" (Property *MaxiCode.Mode = 2*). If you want to use letters in the Postcode (e.g. "D12345" for German PLZ) choose mode SCM alphanumeric (Property *MaxiCode.Mode = 3*).

#### Adjust SCM Fields

- Check "Use preamble" (property *MaxiCode.Preamble*)
- Enter the date into the field preamble date (property *MaxiCode.Date*, refer to "Message Header / Transportation Data" in the UPS® manual)
- Enter Service Class (property *MaxiCode.ServiceClass*), Country Code (property *MaxiCode.CountryCode*) and Postal Code (property *MaxiCode.PostalCode*) into the according text boxes. (refer to Postal Code, Country Code, Class of Service in the UPS® manual)

Alternatively, you can pass the values for the SCM fields as shown in following section "Setting SCM Parameters in the Barcode Data itself"

#### Adjust Data String

- All other UPS® fields must be entered in 'Encoded data' (property *Text*) separated by **Gs**. At the end of the text, **Rs** and **Eot** must be added.

Example: the text could look like this:

```
1Z12345677GsUSPNGs123556Gs089GsGs1/1\Gs0GsYGsGsSALT LAKE CITYGsUTRsEot
```

- Then replace all control characters (**Gs**, **Rs**, **Eot**) with their hexadecimal encoding (**\nn**):  
**Gs** → \x1d  
**Rs** → \x1e  
**Eot** → \x04.
- Please refer to Escape Sequences for an overview of available escape sequences.

The text should now look like:

```
1Z12345677\x1dUSPN\x1d123556\x1d089\x1d\x1d1/1\x1d10\x1dY\x1d\x1dSALT LAKE  
CITY\x1dUT\x1e\x04
```

- This corresponds to the UPS® Data fields: → Tracking Number, SCAC, UPS Account Number, Julian Day of Collection, placeholder for Shipment ID Number, Package n/x, Package Weight, Address Validation, Place Holder for Ship To Street Address, Ship To City, Ship To State, End Of Transmission.
- At last, check *Translate escape sequences* (property *EscapeSequences*). This is necessary to translate the hexadecimal codes (e.g. \x1d) into the special characters “**Rs**”, “**Gs**” and “**Eot**”.

#### Setting SCM Parameters in the Barcode Data itself

The parameters for SCM (Structured Carrier Message - used for UPS®) can be set directly in the barcode data string. This allows complete control of all necessary parameters in one step.

Enable extracting of SCM data:

- Set the *Format* property of **TBarCode** to "S"
- Set the *EscapeSequences* property to True.

The values for the properties postal code, country code, service class, preamble and date are then extracted from the barcode data (*Text* property). Values from the text string overdrive the belonging properties in the barcode component.

The *Text* property should contain the whole data string according to UPS standard (see following picture) including preamble, date, postal code, country code, and service class.

Special characters and separators must be replaced by escape sequences (also refer to Escape Sequences).

```
Gs → \x1d  
Rs → \x1e  
Eot → \x04.
```

**Example 1**

A typical international data string would appear as follows:  
 ]>Rs01Gs96841706672Gs840Gs066Gs1Z12345677GsUPS  
 NGs123556Gs089Gs1/1Gs10GsYGsGsSALT LAKE  
 CITYGsUTRsEot

Most of the information is easily identified and can be separated into its component data elements as shown below:

|                         |  |
|-------------------------|--|
| <b>]&gt;Rs</b>          | Message Header                             |
| <b>01Gs96</b>           | Transportation Data<br>Format Header       |
| <b>841706672Gs</b>      | Postal Code                                |
| <b>840Gs</b>            | Country Code                               |
| <b>066Gs</b>            | Class of Service                           |
| <b>1Z12345677Gs</b>     | Tracking Number                            |
| <b>UPSNGs</b>           | SCAC                                       |
| <b>123556Gs</b>         | UPS Account Number                         |
| <b>089Gs</b>            | Julian Day Of Collection                   |
| <b>Gs</b>               | Place holder for<br>Shipment ID Number     |
| <b>1/1Gs</b>            | Package n/x                                |
| <b>10Gs</b>             | Package Weight                             |
| <b>YGs</b>              | Address Validation                         |
| <b>Gs</b>               | Place holder for Ship<br>To Street Address |
| <b>SALT LAKE CITYGs</b> | Ship To City                               |
| <b>UTRs</b>             | Ship To State                              |
| <b>Eot</b>              | End of Transmission                        |

There are additional characters contained in the data string

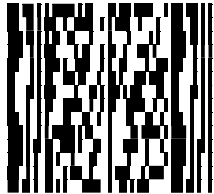
- **]>Rs** is the message header
- **Gs** is used to separate field in a message
- **Rs** is used to separate format types
- **Eot** is the end of transmission character

Notice that in example 1, the Shipment ID Number and Ship to Street Address are blank data elements that are separated with a Gs.

The class of service and shipper number fields in the 1Z number have been omitted in the MaxiCode tracking number field to avoid duplication within the symbol.

Figure 16: MaxiCode UPS Encoding


**6.3.7 MicroPDF417**

|                             |  |   |
|-----------------------------|--|---|
| Symbology number:           | 84   |  |
| Valid characters:           | Alphanumeric and/or bytes                            |   |
| Quiet zone:                 | left/right: 1X                                       |   |
| Module width:               | --   |   |
| Print ratio:                | 1:2:3:4:5:6:1:2:3:4:5:6                              |   |
| Ratio format:               | 1B:2B:3B:4B:5B:6B:1S:2S:3S:4S:5S:6S                  |   |
| Default check digit:        | Automatic (symbology specific).                      |   |
| Size:                       | --   |   |
| Print control:              | C=MPDF   |   |
| TBarCode/X control sequence |  |   |
| For V1.x:                   | <i>\$_tbcs b84 dThis is a MicroPDF417\$_tbce</i>     |   |
| For V2.x:                   | <i>\$_tbcs -b84 -d"This is a MicroPDF417"\$_tbce</i> |   |

This stacked 2D symbology is used to encode large quantities of data.

The input data is always analyzed and the appropriate encoding mode is chosen automatically. Mode switching is done as required to produce the most efficient encoding.

### 6.3.8 Micro QR Code

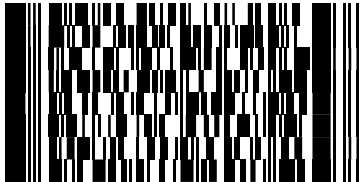
|                      |  |   |
|----------------------|--|---|
| Symbology number:    | 97   |  |
| Valid characters:    | Alphanumeric and/or bytes, Kanji character set |   |
| Quiet zone:          | left/right/ top/bottom: 2X or 4X               |   |
| Module width:        | --   |   |
| Print ratio:         | 1:1  |   |
| Ratio format:        | 1B:1S  |   |
| Default check digit: | Automatic (symbology specific).                |   |
| Size:                | --   |   |
| Print control:       | C=MQR  |   |

This 2D symbology is a small variant of QR Code® with a reduced number of overhead modules and a restricted range of sizes. It was developed for fast readability (QR = Quick Response) by Denso. The symbol size adjusts automatically depending on input data.

Micro QR Code has 4 different symbol sizes (M1-M4). The smallest version (=size) M1 is restricted to numeric data and error detection, M2 may contain also alphanumeric values, and M3 and M4 may use the whole range of the QR Code character sets (bytes, Kanji).

The maximum amount of data is 35 numeric, 21 alphanumeric, 15 byte, or 9 Kanji characters, in conjunction with the lowest error correction level.

### 6.3.9 PDF417

|                      |   |   |
|----------------------|---|---|
| Symbology number:    | 55  |  |
| Valid characters:    | Alphanumeric (ASCII 0.. 255)                  |   |
| Quiet zone:          | left/right: 2X                                |   |
| Module width:        | --  |   |
| Print ratio:         | 1:2:3:4:5:6:7:8:1:2:3:4:5:6                   |   |
| Ratio format:        | 1B:2B:3B:4B:5B:6B:7B:8B:<br>1S:2S:3S:4S:5S:6S |   |
| Default check digit: | Automatic (symbology specific).               |   |
| Size:                | X >= 0.19 mm                                  |   |
| Print control:       | C=PDF   |   |

Symbol Technologies invented this (stacked) 2D symbology. It is used to encode large quantities of data. It is the de-facto 2D standard symbology in the automotive industry.

The symbol is divided into rows and columns. TEC-IT software adjusts the size automatically depending on the amount of input data. A data density of up to 900 characters per square inch is possible.

The input data is always analyzed and the appropriate encoding mode is chosen automatically. Mode switching is done as required to produce the most efficient encoding.

#### 6.3.9.1 Data Capacity

The data capacity depends on the format of the encoded data. The following limits can only be reached with error correction level 0.

| Format       | Data Capacity   | Characters              |
|--------------|-----------------|-------------------------|
| Numeric      | 2710 characters | 0-9                     |
| Alphanumeric | 1850 characters | 0-9 A-Z (uppercase)     |
| Binary       | 1108 bytes      | Default encoding: CP437 |

Table 22: PDF417 Data Capacity

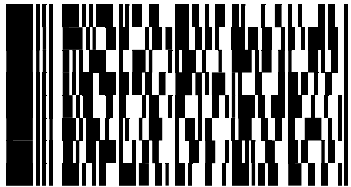
If you mix the character types the maximum data capacity cannot be predicted exactly (due to internal compression and character set switching - this is by design).

If you use a combination of digits and text (lower & uppercase letters) the maximum data capacity would be about 1100 to 1200 characters - but this can vary due to your input data. If you want to encode large data amounts we recommend using only capital letters or multiple symbols (structured append).

### 6.3.9.2 How to optimize PDF417 for FAX?

Adjust the resolution of the generated barcode to 200 dpi (FAX devices are usually using 200 dpi). Follow the instructions in chapter **A.4 Optimize Barcode for the Output Device Resolution**. Make sure the row-height of the PDF417 is at least 3 times the module width.

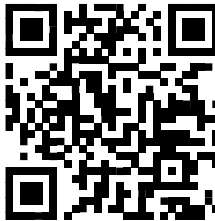
### 6.3.10 PDF417 Truncated

|                      |   |   |
|----------------------|---|---|
| Symbology number:    | 56  |  |
| Valid characters:    | Alphanumeric (ASCII 0.. 255) and/or bytes     |   |
| Quiet zone:          | left/right: 2X                                |   |
| Module width:        | --  |   |
| Print ratio:         | 1:2:3:4:5:6:7:8:1:2:3:4:5:6                   |   |
| Ratio format:        | 1B:2B:3B:4B:5B:6B:7B:8B:<br>1S:2S:3S:4S:5S:6S |   |
| Default check digit: | Automatic (symbology specific).               |   |
| Size:                | --  |   |

This (stacked) 2D symbology is used to encode large quantities of data.

The symbol is divided into rows and columns. TEC-IT software adjusts the size automatically depending on the amount of input data. A data-density of up to 900 characters per square inch is possible.

### 6.3.11 QR Code® (Model 2)

|                      |  |   |
|----------------------|--|---|
| Symbology number:    | 58   |  |
| Valid characters:    | Alphanumeric and/or bytes, Kanji character set |   |
| Quiet zone:          | left/right/ top/bottom: 4X                     |   |
| Module width:        | --   |   |
| Print ratio:         | 1:1  |   |
| Ratio format:        | 1B:1S  |   |
| Default check digit: | Automatic (symbology specific).                |   |
| Size:                | --   |   |
| Print control:       | C=QRC  |   |

Based upon standard: *AIM International ITS/97-001 and ISO/IEC 18004:2015*

This 2D symbology is used to encode large quantities of data and was developed for fast readability (QR = Quick Response Code) by Denso. The symbol size adjusts automatically depending on input data. Special industry formats are supported.

The default interpretation for QR Code '97 is ECI 000020 representing the JIS8 and Shift JIS character sets. For Latin-1 refer to QR Code 2005 / 2015 (see section 6.3.11.4).

#### 6.3.11.1 Kanji and Chinese Compaction

This symbology supports the compaction of Kanji characters and (in newer specifications) also the compaction of Chinese characters. The compaction of Kanji or Chinese characters can be activated

in TEC-IT software – when used, it must be ensured that the input data complies with the Shift JIS X 02 (Japanese) or the GB 2312 (Simplified Chinese) character set.

### 6.3.11.2 QR-Code Capacity

The data capacity depends on the format of the encoded data:

| Format       | Data Capacity   | Characters                                    |
|--------------|-----------------|---|
| Numeric      | 7089 characters | 0-9   |
| Alphanumeric | 4296 characters | 0–9 A–Z (upper-case) space \$ % * + - , . / : |
| Binary       | 2953 bytes      | Default encoding: ISO 8859-1 (QR Code 2005)   |
| Kanji        | 1817 characters | Shift JIS X 0208                              |

Table 23: QR Code Data Capacity

Maximum data capacity for binary data is **2953 bytes** using a matrix of 177x177 dots. As an example the symbol version 22 (104x104 dots) can encode approximately 1 KB of data using a low error correction level. The resulting symbol size is about = 37x37 mm when a dot-size of 0.35 mm is used.

The input data is always analyzed and the appropriate encoding mode is chosen automatically. Mode switching is done as required to produce the most efficient encoding.

### 6.3.11.3 QR Code Creation Speed

QR Code is a quite complex symbology and may take a lot of CPU-time when encoding a very large amount of data. You could speed up the encoding process by

- ▶ Set the symbol size to a constant value (property *“QRCode.Version”*) if the symbol should have always the same size and capacity.
- ▶ Set the error correction level to "low" (*“QRCode.ECLevel”*) if your requirements do not need this feature. Changing this setting could affect readability.
- ▶ Minimize computing steps: set the configuration properties of **TBarCode** only one time at startup of your program, and do only change the text property for each barcode.
- ▶ Not recommended: You may set the QR Code mask pattern to a constant value (changing this setting could affect readability).

### 6.3.11.4 Codepages (Character Set)

QR Code was originally developed for Japanese bar code applications. The supported character set of QR Code Model 2 consists of:

- JIS X 0208 - [https://en.wikipedia.org/wiki/JIS\\_X\\_0208](https://en.wikipedia.org/wiki/JIS_X_0208)
- JIS X 0201 - [https://en.wikipedia.org/wiki/JIS\\_X\\_0201](https://en.wikipedia.org/wiki/JIS_X_0201)

SHIFT JIS / CP932 contains both of these character sets and is the Multi Byte character set used by **TBarCode** for QR Code.

CP932 table: [https://en.wikipedia.org/wiki/Code\\_page\\_932\\_\(Microsoft\\_Windows\)](https://en.wikipedia.org/wiki/Code_page_932_(Microsoft_Windows))

Note: The ISO/IEC 18004:2015 standard for “QR Code” (former called “QR-Code 2005”) defines ISO-8859-1 (Latin-1) as default character set in Byte mode!

- Latin-1 - [https://en.wikipedia.org/wiki/ISO/IEC\\_8859-1](https://en.wikipedia.org/wiki/ISO/IEC_8859-1)

Therefore, QR Code (JIS / '97 version) uses Shift-JIS and QR Code defined by ISO uses Latin-1 as default character set. QR Code (ISO), former called QR-Code 2005, is available in TBarCode V10 and later.

### 6.3.11.5 Encoding Special Latin-1 Characters

If you want to encode special Latin-1 characters such as the “ß” (sharp s), you come to the problem that the SHIFT JIS table does not contain the “ß” (sharp s) character. Therefore, with QR Code JIS version you cannot encode these special Latin-1 characters in the default encoding.

- ▶ Encoding the full Latin-1 character set is supported in QR Code® (ISO), former QR-Code 2005, which is defined by ISO/IEC 18004:2015.

#### *Using UTF-8*

One possibility to encode “sharp s” would be to switch to ISO-8859-1 (Latin-1) or UTF-8 encoding.

#### *Disadvantage*

Using other code pages / character sets than the default character set of a 2D bar code can lead to problems on the decoding stage. Barcode readers try to decode the QR Code data by using the default character set, which is SHIFT JIS for QR-Code (JIS) and ISO-8859-1 (Latin-1) for QR-Code (ISO). Only with barcode reader apps for mobile applications, there is also UTF-8 support.

#### *Workarounds*

You could use UTF-8 in closed applications. If the data is transmitted in binary form (e.g. a serial bar code reader or an image scanner will transmit the data as sequence of Bytes), you can decode the bar code data as UTF-8 format by the software, which receives the data.

You may also have luck with intelligent image decoding software (e.g. ZXing) which tries to find out if Latin-1, UTF-8 or Shift JIS is used by auto detection (also, Smartphone reader apps will do that). If you do not have a closed application or do not have control about the bar code decoder, this workaround cannot be used.

#### *Note about ECI sequences*

Theoretically, QR-Code can encode data in a user selectable character set. By design of QR-Code, so-called “Extended Channel Interpretation” code words may indicate the character set used for the subsequent data. ECI is part of QR-Code specification and is supported by TBarCode Escape Sequences. The problem is that many bar code decoders ignore ECI and so they are useless.

If you want to use UTF-8 without ECI's you could try to indicate UTF-8 format by prefixing the data with an UTF-8 byte order mark at the start (EF BB BF). However, there is no standard for this and you have to verify if your bar code reader / decoding software recognizes this marker.

*More information in our FAQ*

<https://www.tec-it.com/en/support/faq/tbarcode/barcode-dll.aspx>





### 6.3.12 QR Code® (ISO), former QR-Code 2005

|                      |   |  |
|----------------------|---|--|
| Symbology number:    | 112                                       |  |
| Valid characters:    | Alphanumeric and/or bytes, ISO-IEC 8859-1 |  |
| Quiet zone:          | left/right/ top/bottom: 4X                |  |
| Module width:        | --  |  |
| Print ratio:         | 1:1                                       |  |
| Ratio format:        | 1B:1S                                     |  |
| Default check digit: | Automatic (symbology specific).           |  |
| Size:                | --  |  |
| Print control:       | C=QR2                                     |  |

Based upon standard: *ISO/IEC 18004:2015*

QR Code (ISO standard) is closely similar to QR Code (JIS) and, in its QR Code format, differs only in the addition of the facility for symbols to appear in a mirror image orientation, for reflectance reversal (light symbols on dark backgrounds) and the option for specifying alternative character sets to the default.

The default interpretation for QR Code (ISO) is ECI 000003 representing the *ISO/IEC 8859-1* character set.

QR Code (ISO) is the form of the symbology recommended for new and open systems applications.

### 6.3.13 Swiss QR Code

|                       |  |  |
|-----------------------|--|--|
| Symbology number:     | 126  |  |
| Valid characters:     | depending on the field numeric, alphanumeric, decimal, or ISO-IEC 8859-1 |  |
| Quiet zone:           | left/right/ top/bottom: minimum 1,6 mm, requested 5 mm                   |  |
| Module width:         | minimal 0.4 mm   |  |
| Standard print ratio: | 1:1  |  |
| Ratio format:         | 1B:1S  |  |
| Default check digit:  | Automatic (symbology specific).  |  |
| Symbol size:          | --   |  |
| Print control:        | --   |  |

The Swiss QR Code is part of the so-called *QR-Rechnung*, defined by *SIX Interbank Clearing AG*. It contains the needed information to initiate customer credit transfers via barcode scanner.

The Swiss QR Code bases on the QR Code symbology, extended with a black Swiss Cross drawn in the center of the code.

The content description can be found in <https://www.paymentstandards.ch/dam/downloads/ig-qr-bill-de.pdf>.

## 6.4 HIBC – Health Industry Bar Code

HIBC bar codes are commonly used by the health industry. HIBC standards do not really describe unique symbologies, but a family of data structures. These data structures may be represented by several symbologies.

There are two categories of HIBC:

- Label Identification Code (LIC) – specified by the Supplier Labeling Standard
- Provider Applications Standard (PAS)

### 6.4.1 Supplier Labeling Standard (SLS) Formats

The Supplier Labeling Standard is used for all **HIBC LIC** bar codes. For a full specification, please refer to the document *Health Industry Bar Code: Supplier Labeling Standard (HIBC SLS) ANSI/HIBC 2.6 – 2016*. It consists of a Primary and a Secondary data structure, which may be encoded together in one barcode or split into two single symbols.

The **Primary Data Structure** is specified as follows

```
+IIIIIP*UL
```

With:

| Character | Description   | Data Type                                 | Length |
|-----------|---|---|--------|
| +         | HIBC Supplier Labeling Flag '+'   | "+"                                       | 1      |
| I         | Label Identification Code (LIC)   | Alphanumeric, first character is a letter | 4      |
| P*        | PCN (Labelers Product or Catalog)   | Alphanumeric                              | 1 - 18 |
| U         | Unit of Measure ID  | Numeric                                   | 1      |
| C         | Check Digit (mod 43) – also used as Link Character in the Secondary Data Structure. |   | 1      |

Table 24: HIBC LIC - Primary Format

The **Secondary Data Structure** is defined as

```
+R*Q*D*B*LA*C
```

With:

| Character | Description  | Data Type                                 | Length               |
|-----------|--|---|----------------------|
| +         | HIBC Supplier Labeling Flag '+'  | "+"                                       | 1                    |
| R*        | Quantity/Date Reference Identifier   | "\$"; "\$+"; "\$\$"; "\$\$+", or 5 digits | 1, 2, 3, or 5 digits |
| Q*        | Quantity Field<br>(used by legacy versions 2.2 and 2.4 of the SLS only)    | Numeric                                   | 0, 3, or 6           |
| D*        | Date Field   | Numeric                                   | 0, or 4-9            |
| B*        | Lot/Batch/Serial Number  | Alphanumeric                              | 0-18                 |
| L         | Link Character – conforms to the check digit in the Primary Data Structure |   | 1                    |
| A*        | Additional Supplemental Data   | (see below)                               |                      |
| C         | Check Digit (mod 43)   |   | 1                    |

Table 25: HIBC LIC - Secondary Format

The **Combined Data Structure** (Primary and Secondary data structure in one piece) is defined as

```
+IIIIIP*U/R*Q*D*B*A*C
```

When the fields are as described above and a separator character (“/”) is inserted between the Primary and the Secondary data structure.

The Additional Supplemental Data section may either be empty or consist of one or more of following fields:

| Identifier | Description  | Data Type                      | Length   |
|------------|--|--------------------------------|----------|
| “/S”       | Serial Number when Lot number is used. <ul style="list-style-type: none"> <li>The Secondary Data Structure contains the lot number.</li> </ul>                             | Alphanumeric                   | 2 + 1-18 |
| “/16D”     | Date of Manufacture  | YYYYMMDD<br>(Year, Month, Day) | 4 + 8    |
| “/14D”     | Expiry Date formatted as YYYYMMDD <ul style="list-style-type: none"> <li>The Secondary Data Structure may also contain the expiry date, but not in this format.</li> </ul> | YYYYMMDD<br>(Year, Month, Day) | 4 + 8    |
| “/Q”       | Quantity <ul style="list-style-type: none"> <li>In legacy versions of the LIC standard, the quantity was located in the Secondary Data Structure.</li> </ul>               | Numeric                        | 2 + 1-5  |

### 6.4.2 Provider Application Standard Formats

The Provider Applications Standard is used for all **HIBC PAS** bar codes. For a full specification, please refer to the document *Health Industry Bar Code: Provider Applications Standard ANSI/HIBC 1.3 – 2010*. It may consist of a Single or Split Data Field Format. The split format may be encoded together in one bar code or split into two single symbols.

The **Single Data Structure** is specified as follows

+ / F\*G\*DDDDDC<sub>1</sub>

With:

| Character      | Description  | Data Type    | Length |
|----------------|--|--------------|--------|
| + /            | HIBC Provider Applications Standard Flag   | “+ /”        | 2      |
| F*             | „Where“ Flag   | Alpha        | 1 or 3 |
| G*             | „What“ Flag  | Alpha        | 1 or 3 |
| D              | Application Data   | Alphanumeric | 1-15   |
| C <sub>1</sub> | Check Digit (mod 43) - equal to the "Link Character" of the Second Data Structure. |              | 1      |

Table 26: HIBC PAS – Single/First Data Structure

The **Multiple (or Combined) Data Structure** is defined as

+ / F\*G<sub>1</sub>\*D<sub>1</sub>D<sub>1</sub>/G<sub>2</sub>\*D<sub>2</sub>D<sub>2</sub>C

| Character        | Description   | Data Type    | Length |
|------------------|---|--------------|--------|
| + /              | HIBC Provider Applications Standard Flag                    | “+ /”        | 2      |
| F*               | „Where“ Flag  | Alpha        | 1 or 3 |
| G <sub>1</sub> * | „What“ Flag for D <sub>1</sub>                              | Alpha        | 1 or 3 |
| D <sub>1</sub>   | First Application Data                                      | Alphanumeric | 1-15   |
| /                | Separator Character between First and Second Data Structure | “/”          | 1      |
| G <sub>2</sub> * | „What“ Flag for D <sub>2</sub>                              | Alpha        | 1 or 3 |
| D <sub>2</sub>   | Second Application Data                                     | Alphanumeric | 1-15   |
| C                | Check Digit (mod 43)  |              | 1      |

Table 27: HIBC PAS – Combined Data Structure

As the Multiple (or Combined) Data structure may contain more than two data fields, the secondary part (between / and D<sub>2</sub>) may be repeated.

The legacy versions of the PAS (V1.2) also knew the **Split Data** structure, which consists of the **First Data Structure** and the **Second Data Structure**. The **First Data Structure**, which is specified as follows:

+ / 1 F \* G \* D D D D C<sub>1</sub>

It is much the same as the Single Data Structure but has "1" as prefix.

The **Second Data Structure** is defined as


+ / 2 D D D D C<sub>1</sub> C<sub>2</sub>

| Character      | Description  | Data Type    | Length |
|----------------|--|--------------|--------|
| +/             | HIBC Provider Applications Standard Flag   | "+"          | 2      |
| 2              | "2" indicates that this is the second data structure                               | "2"          | 1      |
| D              | Application Data   | Alphanumeric | 1-15   |
| C <sub>1</sub> | Check Digit (mod 43) - conforms to the check digit in the First Data Structure.    |              | 1      |
| C <sub>2</sub> | Check Digit (mod 43) - equal to the "Link Character" of the Second Data Structure. |              | 1      |

Table 28: HIBC PAS – Second Data Structure



In following, you find a list of the bar code symbologies that are able to encode HIBC.

### 6.4.3 HIBC LIC 128

|   |  |
|---|--|
| <p>Symbology number: 98</p> <p>Valid characters: "0".."9", "A".."Z", "-", ".", Space, "*", "\$", "!", "+", "%"</p> <p>Quiet zone: left/right: 10X, min. ¼ inch</p> <p>Module width: X &gt;= 0.19 mm</p> <p>Standard print ratio: 1:2:3:4:1:2:3:4</p> <p>Ratio format: 1B:2B:3B:4B:1S:2S:3S:4S</p> <p>Default check digit: Modulo 43 (eCDMod43)</p> <p>Symbol size: --</p> |  |
|---|--|

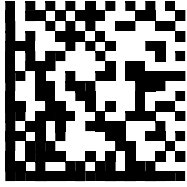
HIBC LIC 128 bases on the symbology Code 128. The data format corresponds to the HIBC LIC Format described above. An additional modulo-43 check digit is required.

### 6.4.4 HIBC LIC 39

|  |   |
|--|---|
| <p>Symbology number: 99</p> <p>Valid characters: "0".."9", "A".."Z", "-", ".", Space, "*", "\$", "!", "+", "%"</p> <p>Quiet zone: left/right: 10X, min. ¼ inch</p> <p>Module width: X &gt;= 0.19 mm</p> <p>Standard print ratio: 1:3:1:3</p> <p>Ratio format: 1B:2B:1S:2S</p> <p>Default check digit: Modulo 43 (eCDMod43)</p> <p>Symbol size: H &gt;= 15% of L (H &gt;= 6.3 mm!)<br/>H: Height of the barcode without human readable text<br/>L: width of the barcode</p> |   |
|--|---|

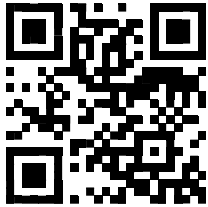
HIBC LIC 39 bases on the symbology Code 39. The data format corresponds to the HIBC LIC Format described above. An additional modulo-43 check digit is required.

### 6.4.5 HIBC LIC Data Matrix

|                      |   |   |
|----------------------|---|---|
| Symbology number:    | 102   |  |
| Valid characters:    | "0".."9", "A".."Z", "-", ".", Space, "*", "\$", "/", "+", "%" |   |
| Quiet zone:          | left/right/ top/bottom: 1X                                    |   |
| Module width:        | --  |   |
| Print ratio:         | 1:1   |   |
| Ratio format:        | 1B:1S   |   |
| Default check digit: | Modulo 43 (eCDMod43)  |   |
| Size:                | .001 till 14.0 square inch                                    |   |

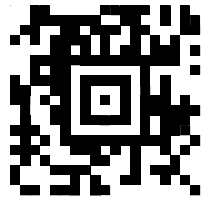
HIBC LIC Data Matrix bases on the 2D symbology Data Matrix. The data format corresponds to the HIBC LIC Format described above. An additional modulo-43 check digit is required.

### 6.4.6 HIBC LIC QR Code

|                      |   |   |
|----------------------|---|---|
| Symbology number:    | 104   |  |
| Valid characters:    | "0".."9", "A".."Z", "-", ".", Space, "*", "\$", "/", "+", "%" |   |
| Quiet zone:          | left/right/ top/bottom: 4X                                    |   |
| Module width:        | --  |   |
| Print ratio:         | 1:1   |   |
| Ratio format:        | 1B:1S   |   |
| Default check digit: | Modulo 43 (eCDMod43)  |   |
| Size:                | --  |   |

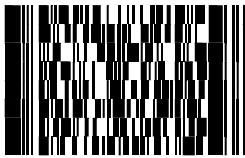
HIBC LIC QR Code bases on the 2D symbology QR Code. The data format corresponds to the HIBC LIC Format described above. An additional modulo-43 check digit is required.

### 6.4.7 HIBC LIC Aztec Code

|                      |   |   |
|----------------------|---|---|
| Symbology number:    | 124   |  |
| Valid characters:    | "0".."9", "A".."Z", "-", ".", Space, "*", "\$", "/", "+", "%" |   |
| Quiet zone:          | left/right/ top/bottom: 0X                                    |   |
| Module width:        | --  |   |
| Print ratio:         | 1:1   |   |
| Ratio format:        | 1B:1S   |   |
| Default check digit: | Modulo 43 (eCDMod43)  |   |
| Size:                | --  |   |


HIBC LIC Aztec Code bases on the 2D symbology Aztec Code. The data format corresponds to the HIBC LIC Format described above. An additional modulo-43 check digit is required.

### 6.4.8 HIBC LIC PDF417

|                      |   |   |
|----------------------|---|---|
| Symbology number:    | 106   |  |
| Valid characters:    | "0".."9", "A".."Z", "-", ".", Space, "*", "\$", "/", "+", "%" |   |
| Quiet zone:          | left/right: 2X  |   |
| Module width:        | --  |   |
| Print ratio:         | 1:2:3:4:5:6:7:8:1:2:3:4:5:6                                   |   |
| Ratio format:        | 1B:2B:3B:4B:5B:6B:7B:8B:<br>1S:2S:3S:4S:5S:6S                 |   |
| Default check digit: | Modulo 43 (eCDMod43)  |   |
| Size:                | X >= 0.19 mm  |   |

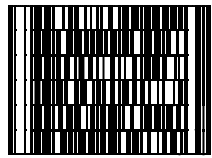
HIBC LIC PDF417 bases on the 2D symbology PDF417. The data format corresponds to the HIBC LIC Format described above. An additional modulo-43 check digit is required.

### 6.4.9 HIBC LIC MicroPDF417

|                      |   |   |
|----------------------|---|---|
| Symbology number:    | 108   |  |
| Valid characters:    | "0".."9", "A".."Z", "-", ".", Space, "*", "\$", "/", "+", "%" |   |
| Quiet zone:          | left/right: 1X  |   |
| Module width:        | --  |   |
| Print ratio:         | 1:2:3:4:5:6:1:2:3:4:5:6                                       |   |
| Ratio format:        | 1B:2B:3B:4B:5B:6B:1S:2S:3S:4S:5S:6S                           |   |
| Default check digit: | Modulo 43 (eCDMod43)  |   |
| Size:                | --  |   |


HIBC LIC MicroPDF417 bases on the 2D symbology MicroPDF417. The data format corresponds to the HIBC LIC Format described above. An additional modulo-43 check digit is required.

### 6.4.10 HIBC LIC Codablock F

|                      |   |   |
|----------------------|---|---|
| Symbology number:    | 110   |  |
| Valid characters:    | "0".."9", "A".."Z", "-", ".", Space, "*", "\$", "/", "+", "%" |   |
| Quiet zone:          | left/right/ top/bottom: 10X                                   |   |
| Module width:        | X >= 0.19mm   |   |
| Print ratio:         | 1:2:3:4:1:2:3:4   |   |
| Ratio format:        | 1B:2B:3B:4B:1S:2S:3S:4S                                       |   |
| Default check digit: | Modulo 43 (eCDMod43)  |   |
| Size:                | 2 - 44 rows; 4 - 62 characters per row                        |   |


HIBC LIC Codablock F bases on the stacked symbology Codablock F. The data format corresponds to the HIBC LIC Format described above. An additional modulo-43 check digit is required.

### 6.4.11 HIBC PAS 128

|                       |   |  |
|-----------------------|---|--|
| Symbology number:     | 100   |  <p>*+/EU9C83416F/Z34H159\$*</p> |
| Valid characters:     | "0".."9", "A".."Z", "-", ".", Space, "*", "\$", "/", "+", "%" |  |
| Quiet zone:           | left/right: 10X, min. ¼ inch                                  |  |
| Module width:         | X >= 0.19 mm  |  |
| Standard print ratio: | 1:2:3:4:1:2:3:4   |  |
| Ratio format:         | 1B:2B:3B:4B:1S:2S:3S:4S                                       |  |
| Default check digit:  | Modulo 43 (eCDMod43)  |  |
| Symbol size:          | --  |  |

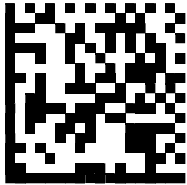
HIBC PAS 128 bases on the symbology Code 128. The data format corresponds to the HIBC PAS Format described above. An additional modulo-43 check digit is required.

### 6.4.12 HIBC PAS 39

|                       |   |  |
|-----------------------|---|--|
| Symbology number:     | 101   |  |
| Valid characters:     | "0".."9", "A".."Z", "-", ".", Space, "*", "\$", "/", "+", "%"   |  |
| Quiet zone:           | left/right: 10X, min. ¼ inch  |  |
| Module width:         | X >= 0.19 mm  |  |
| Standard print ratio: | 1:3:1:3   |  |
| Ratio format:         | 1B:2B:1S:2S   |  |
| Default check digit:  | Modulo 43 (eCDMod43)  |  |
| Symbol size:          | H>=15% of L (H>=6.3 mm!)<br>H: Height of the barcode without human readable text<br>L: width of the barcode |  |

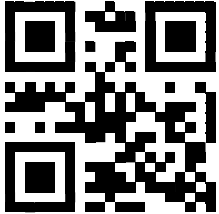
HIBC PAS 39 bases on the symbology Code 39. The data format corresponds to the HIBC PAS Format described above. An additional modulo-43 check digit is required.

### 6.4.13 HIBC PAS Data Matrix

|                      |   |  |
|----------------------|---|--|
| Symbology number:    | 103   |  |
| Valid characters:    | "0".."9", "A".."Z", "-", ".", Space, "*", "\$", "/", "+", "%" |  |
| Quiet zone:          | left/right/ top/bottom: 1X                                    |  |
| Module width:        | --  |  |
| Print ratio:         | 1:1   |  |
| Ratio format:        | 1B:1S   |  |
| Default check digit: | Modulo 43 (eCDMod43)  |  |
| Size:                | .001 till 14.0 square inch                                    |  |

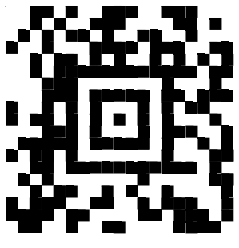
HIBC PAS Data Matrix bases on the 2D symbology Data Matrix. The data format corresponds to the HIBC PAS Format described above. An additional modulo-43 check digit is required.

### 6.4.14 HIBC PAS QR Code

|                      |   |   |
|----------------------|---|---|
| Symbology number:    | 105   |  |
| Valid characters:    | "0".."9", "A".."Z", "-", ".", Space, "*", "\$", "/", "+", "%" |   |
| Quiet zone:          | left/right/ top/bottom: 4X                                    |   |
| Module width:        | --  |   |
| Print ratio:         | 1:1   |   |
| Ratio format:        | 1B:1S   |   |
| Default check digit: | Modulo 43 (eCDMod43)  |   |
| Size:                | --  |   |

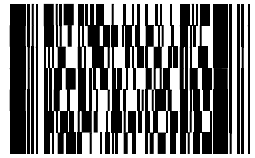
HIBC PAS QR Code bases on the 2D symbology QR Code. The data format corresponds to the HIBC PAS Format described above. An additional modulo-43 check digit is required.

### 6.4.15 HIBC PAS Aztec Code

|                      |   |   |
|----------------------|---|---|
| Symbology number:    | 105   |  |
| Valid characters:    | "0".."9", "A".."Z", "-", ".", Space, "*", "\$", "/", "+", "%" |   |
| Quiet zone:          | left/right/ top/bottom: 0X                                    |   |
| Module width:        | --  |   |
| Print ratio:         | 1:1   |   |
| Ratio format:        | 1B:1S   |   |
| Default check digit: | Modulo 43 (eCDMod43)  |   |
| Size:                | --  |   |

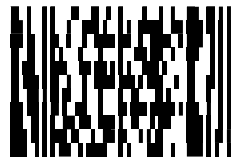
HIBC PAS Aztec Code bases on the 2D symbology Aztec Code. The data format corresponds to the HIBC PAS Format described above. An additional modulo-43 check digit is required.

### 6.4.16 HIBC PAS PDF417

|                      |   |   |
|----------------------|---|---|
| Symbology number:    | 107   |  |
| Valid characters:    | "0".."9", "A".."Z", "-", ".", Space, "*", "\$", "/", "+", "%" |   |
| Quiet zone:          | left/right: 2X  |   |
| Module width:        | --  |   |
| Print ratio:         | 1:2:3:4:5:6:7:8:1:2:3:4:5:6                                   |   |
| Ratio format:        | 1B:2B:3B:4B:5B:6B:7B:8B:<br>1S:2S:3S:4S:5S:6S                 |   |
| Default check digit: | Modulo 43 (eCDMod43)  |   |
| Size:                | X >= 0.19 mm  |   |

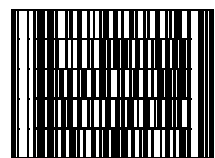
HIBC PAS PDF417 bases on the 2D symbology PDF417. The data format corresponds to the HIBC PAS Format described above. An additional modulo-43 check digit is required.

### 6.4.17 HIBC PAS MicroPDF417

|                      |   |   |
|----------------------|---|---|
| Symbology number:    | 109   |  |
| Valid characters:    | "0".."9", "A".."Z", "-", ".", Space, "*", "\$", "/", "+", "%" |   |
| Quiet zone:          | left/right: 1X  |   |
| Module width:        | --  |   |
| Print ratio:         | 1:2:3:4:5:6:1:2:3:4:5:6                                       |   |
| Ratio format:        | 1B:2B:3B:4B:5B:6B:1S:2S:3S:4S:5S:6S                           |   |
| Default check digit: | Modulo 43 (eCDMod43)  |   |
| Size:                | --  |   |

HIBC PAS MicroPDF417 bases on the 2D symbology MicroPDF417. The data format corresponds to the HIBC PAS Format described above. An additional modulo-43 check digit is required.

### 6.4.18 HIBC PAS Codablock F

|                      |   |   |
|----------------------|---|---|
| Symbology number:    | 111   |  |
| Valid characters:    | "0".."9", "A".."Z", "-", ".", Space, "*", "\$", "/", "+", "%" |   |
| Quiet zone:          | left/right/ top/bottom: 10X                                   |   |
| Module width:        | X >= 0.19mm   |   |
| Print ratio:         | 1:2:3:4:1:2:3:4   |   |
| Ratio format:        | 1B:2B:3B:4B:1S:2S:3S:4S                                       |   |
| Default check digit: | Modulo 43 (eCDMod43)  |   |
| Size:                | 2 - 44 rows; 4 - 62 characters per row                        |   |

HIBC PAS Codablock F bases on the stacked symbology Codablock F. The data format corresponds to the HIBC PAS Format described above. An additional modulo-43 check digit is required.



## 6.5 GS1 DataBar Symbologies (RSS Codes)

The sample control sequences refer to the following TEC-IT products only: **TBarCode/X** and **TBarCode Embedded** (SEH ISD 300).

### 6.5.1 GS1 DataBar (RSS-14)

|                        |   |                           |
|------------------------|---|---------------------------|
| Symbology number (:    | 29  | <p>(01)01234567890128</p> |
| Valid characters:      | "0".."9"  |                           |
| Quiet zone:            | none required (1X recommended)                            |                           |
| Module width:          | --  |                           |
| Print ratio:           | 1:2:3:4:5:6:7:8:9:1:2:3:4:5:6:7:8:9                       |                           |
| Ratio format:          | 1B:2B:3B:4B:5B:6B:7B:8B:9B:<br>1S:2S:3S:4S:5S:6S:7S:8S:9S |                           |
| Default check digit:   | EAN 14 (eCDEAN14)   |                           |
| Possible check digits: | User supplied   |                           |
| Symbol size:           | 13 digits, 1 check digit, AI 01 is encoded automatically  |                           |
| Print control:         | C=R   |                           |

GS1 DataBar is used to encode the GTIN (Global Trade Item Number) with Application identifier (AI) "01". The GTIN consists of a packaging indicator (0..9) followed by a 12 digit number (taken from the EAN-13 article number system) followed by a check digit. The check digit on the 14<sup>th</sup> position is computed automatically if not provided in the input data.


The height of the symbol should be at least 33X in order to support omnidirectional scanning (X = module width). TEC-IT software prefixes the barcode data with the AI "01" automatically - do not provide the AI 01 with your input data.

### 6.5.2 GS1 DataBar Truncated (RSS-14 Truncated)

|                        |   |                           |
|------------------------|---|---------------------------|
| Symbology number:      | 78  | <p>(01)01234567890128</p> |
| Valid characters:      | "0".."9"  |                           |
| Quiet zone:            | none required (1X recommended)                            |                           |
| Module width:          | --  |                           |
| Print ratio:           | 1:2:3:4:5:6:7:8:9:1:2:3:4:5:6:7:8:9                       |                           |
| Ratio format:          | 1B:2B:3B:4B:5B:6B:7B:8B:9B:<br>1S:2S:3S:4S:5S:6S:7S:8S:9S |                           |
| Default check digit:   | EAN 14 (eCDEAN14)   |                           |
| Possible check digits: | User supplied   |                           |
| Symbol size:           | 13 digits, 1 check digit, AI 01 is encoded automatically  |                           |
| Print control:         | C=RT  |                           |


This symbology is similar to GS1 DataBar but the height should be at least 13X. Omni-directional scanning may not be possible.

### 6.5.3 GS1 DataBar Limited (RSS Limited)

|                        |   |  |
|------------------------|---|--|
| Symbology number:      | 30  |  |
| Valid characters:      | "0".."9"  |  |
| Quiet zone:            | 1X left, 5X right   |  |
| Module width:          | --  |  |
| Print ratio:           | 1:2:3:4:5:6:7:8:9:1:2:3:4:5:6:7:8:9                       |  |
| Ratio format:          | 1B:2B:3B:4B:5B:6B:7B:8B:9B:<br>1S:2S:3S:4S:5S:6S:7S:8S:9S |  |
| Default check digit:   | EAN 14 (eCDEAN14)   |  |
| Possible check digits: | User supplied   |  |
| Symbol size:           | 13 digits, 1 check digit                                  |  |
| Print control:         | C=RL  |  |

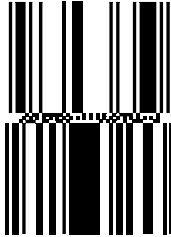
This symbology is similar to GS1 DataBar, but it is smaller and limited to a packaging indicator (first digit) 0 or 1.

### 6.5.4 GS1 DataBar Stacked (RSS-14 Stacked)

|                        |   |  |
|------------------------|---|--|
| Symbology number:      | 79  |  |
| Valid characters:      | "0".."9", 13 digits + 1 check digit                       |  |
| Quiet zone:            | none required (1X recommended)                            |  |
| Module width:          | --  |  |
| Print ratio:           | 1:2:3:4:5:6:7:8:9:1:2:3:4:5:6:7:8:9                       |  |
| Ratio format:          | 1B:2B:3B:4B:5B:6B:7B:8B:9B:<br>1S:2S:3S:4S:5S:6S:7S:8S:9S |  |
| Default check digit:   | EAN 14 (eCDEAN14)   |  |
| Possible check digits: | User supplied   |  |
| Size:                  | --  |  |
| Print control:         | C=RS  |  |


This symbology is similar to GS1 DataBar, but it is split into two rows to make the symbol smaller. It is used for pharmaceutical packaging. Omni-directional scanning is not possible.

### 6.5.5 GS1 DataBar Stacked Omni directional (RSS-14 Stacked Omni directional)

|                        |   |   |
|------------------------|---|---|
| Symbology number:      | 80  |  |
| Valid characters:      | "0".."9", 13 digits + 1 check digit                       |   |
| Quiet zone:            | none required (1X recommended)                            |   |
| Module width:          | --  |   |
| Print ratio:           | 1:2:3:4:5:6:7:8:9:1:2:3:4:5:6:7:8:9                       |   |
| Ratio format:          | 1B:2B:3B:4B:5B:6B:7B:8B:9B:<br>1S:2S:3S:4S:5S:6S:7S:8S:9S |   |
| Default check digit:   | EAN 14 (eCDEAN14)   |   |
| Possible check digits: | User supplied   |   |
| Size:                  | --  |   |
| Print control:         | C=RO  |   |

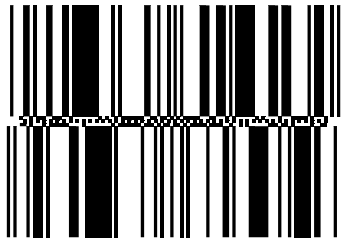
This symbology is similar to the GS1 DataBar Stacked and supports omnidirectional scanning.

## 6.5.6 GS1 DataBar Expanded (RSS Expanded)

|                        |   |   |
|------------------------|---|---|
| Symbology number:      | 31  |  <p>ABab+</p> |
| Valid characters:      | "A".."Z", "a".."z", "0".."9" + ISO 646 character set      |   |
| Quiet zone:            | none required (1X recommended)                            |   |
| Module width:          | --  |   |
| Print ratio:           | 1:2:3:4:5:6:7:8:9:1:2:3:4:5:6:7:8:9                       |   |
| Ratio format:          | 1B:2B:3B:4B:5B:6B:7B:8B:9B:<br>1S:2S:3S:4S:5S:6S:7S:8S:9S |   |
| Default check digit:   | None (eCDNone).   |   |
| Possible check digits: | Modulo 10 (eCDMod10). EAN-14 (eCDEAN14)                   |   |
| Size:                  | Numeric: 74 digits<br>Alphanumeric: 41 characters         |   |
| Print control:         | C=RE  |   |

This is a variable length symbology. It encodes up to 74 numeric or 41 alphabetic characters. Data should be encoded with Application Identifiers (AIs). Omni-directional scanning is possible.

## 6.5.7 GS1 DataBar Expanded Stacked (RSS Expanded Stacked)

|                        |   |  |
|------------------------|---|--|
| Symbology number:      | 81  |  |
| Valid characters:      | "A".."Z", "a".."z", "0".."9" + ISO 646 char set           |  |
| Quiet zone:            | none required (1X recommended)                            |  |
| Module width:          | --  |  |
| Print ratio:           | 1:2:3:4:5:6:7:8:9:1:2:3:4:5:6:7:8:9                       |  |
| Ratio format:          | 1B:2B:3B:4B:5B:6B:7B:8B:9B:<br>1S:2S:3S:4S:5S:6S:7S:8S:9S |  |
| Default check digit:   | None (eCDNone).   |  |
| Possible check digits: | Modulo 10 (eCDMod10). EAN-14 (eCDEAN14)                   |  |
| Size:                  | --  |  |
| Print control:         | C=RX  |  |

This is the stacked version of GS1 DataBar Expanded. The number of data segments per row can vary between 4 and 22. The default number of data segments is four.

## 6.6 GS1 Composite Symbologies

### 6.6.1 Data Input

- ▶ Please note: For all Composite Symbologies the vertical bar "|" character is used to separate the data of the linear symbol and the 2D composite component.
- ▶ Example: 1234567890123|TEC-IT

### 6.6.2 Data Capacity of GS1 Composite Symbols

#### 6.6.2.1 Linear Component

- GS1-128: up to 48 digits
- EAN/UPC: 8, 12 or 13 digits
- GS1 DataBar: 16 digits (2 digits AI01 + 14 digits GTIN)
- GS1 DataBar Expanded: up to 74 digits

### 6.6.2.2 2D Component


- CC-A up to 56 digits
- CC-B up to 338 digits
- CC-C up to 2361 digits

The maximum data capacity of the 2D component depends on the number of data columns, which also depends on the type of the linear component.

For instance, GS1 DataBar Stacked allows a 2D component with 2-data columns (CC-A or CC-B). In this case the maximum capacity of a CC-A would be 52 digits with special AI combination at the beginning of the data (AI 11/17 + 10), otherwise the capacity would be 48 digits.


With the other variants having 4 data columns (GS1 DataBar, GS1 DataBar Expanded,...) the maximum data capacity is a little bit higher = 56 digits.

### 6.6.3 GS1 DataBar Composite Symbology

|                          |   |   |
|--------------------------|---|---|
| Symbology number:        | 29  |  <p>(01)12345678901231</p> |
| Valid characters RSS-14: | "0".."9", 13 digits + 1 check digit                       |   |
| Valid characters CC-A/B: | ISO 646 character set, up to 338 characters               |   |
| Standard print ratio:    | 1:2:3:4:5:6:7:8:9:1:2:3:4:5:6:7:8:9                       |   |
| Ratio format:            | 1B:2B:3B:4B:5B:6B:7B:8B:9B:<br>1S:2S:3S:4S:5S:6S:7S:8S:9S |   |
| Default check digit:     | EAN 14 (eCDEAN14)   |   |
| Possible check digits:   | User supplied   |   |
| Encoded data:            | 1234567890123 TEC-IT                                      |   |


This is a GS1 DataBar barcode with an attached 2D component (CC-A or CC-B). The leading Application Identifier (AI) 01 (for the GTIN) is prefixed automatically by TEC-IT software and must not occur in the input data. The 2D component can encode additional information like lot number, quantity, expiration date ...

### 6.6.4 GS1 DataBar Truncated Composite Symbology

|                          |   |   |
|--------------------------|---|---|
| Symbology number:        | 78  |  <p>(01)12345678901231</p> |
| Valid characters RSS-14: | "0".."9", 13 digits + 1 check digit                       |   |
| Valid characters CC-A/B: | ISO 646 character set, up to 338 characters               |   |
| Standard print ratio:    | 1:2:3:4:5:6:7:8:9:1:2:3:4:5:6:7:8:9                       |   |
| Ratio format:            | 1B:2B:3B:4B:5B:6B:7B:8B:9B:<br>1S:2S:3S:4S:5S:6S:7S:8S:9S |   |
| Default check digit:     | EAN 14 (eCDEAN14)   |   |
| Possible check digits:   | User supplied   |   |
| Encoded data:            | 1234567890123 TEC-IT                                      |   |


This is a GS1 DataBar Truncated barcode with an attached 2D component (CC-A or CC-B).

### 6.6.5 GS1 DataBar Limited Composite Symbology

|                            |   |   |
|----------------------------|---|---|
| Symbology number:          | 30  |  <p>(01)12345678901231</p> |
| Valid characters RSS Lim.: | "0".."9", 13 digits + 1 check digit                       |   |
| Valid characters CC-A/B:   | ISO 646 character set, up to 338 characters               |   |
| Standard print ratio:      | 1:2:3:4:5:6:7:8:9:1:2:3:4:5:6:7:8:9                       |   |
| Ratio format:              | 1B:2B:3B:4B:5B:6B:7B:8B:9B:<br>1S:2S:3S:4S:5S:6S:7S:8S:9S |   |
| Default check digit:       | EAN 14 (eCDEAN14)   |   |
| Possible check digits:     | User supplied   |   |
| Encoded data:              | 1234567890123 TEC-IT                                      |   |

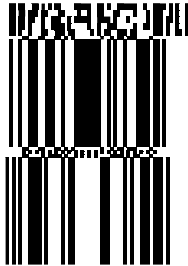
This is a GS1 DataBar Limited barcode with an attached 2D component (CC-A or CC-B).

### 6.6.6 GS1 DataBar Stacked Composite Symbology

|                          |   |   |
|--------------------------|---|---|
| Symbology number:        | 79  |  |
| Valid characters RSS-14: | "0".."9", 13 digits + 1 check digit                       |   |
| Valid characters CC-A/B: | ISO 646 character set, up to 338 characters               |   |
| Standard print ratio:    | 1:2:3:4:5:6:7:8:9:1:2:3:4:5:6:7:8:9                       |   |
| Ratio format:            | 1B:2B:3B:4B:5B:6B:7B:8B:9B:<br>1S:2S:3S:4S:5S:6S:7S:8S:9S |   |
| Default check digit:     | EAN 14 (eCDEAN14)   |   |
| Possible check digits:   | User supplied   |   |
| Encoded data:            | 1234567890123 TEC-IT                                      |   |


This is a GS1 DataBar Stacked barcode with an attached 2D component (CC-A or CC-B).

### 6.6.7 GS1 DataBar Stacked Omni directional Composite Symbology

|                          |   |   |
|--------------------------|---|---|
| Symbology number:        | 80  |  |
| Valid characters RSS-14: | "0".."9", 13 digits + 1 check digit                       |   |
| Valid characters CC-A/B: | ISO 646 character set, up to 338 characters               |   |
| Standard print ratio:    | 1:2:3:4:5:6:7:8:9:1:2:3:4:5:6:7:8:9                       |   |
| Ratio format:            | 1B:2B:3B:4B:5B:6B:7B:8B:9B:<br>1S:2S:3S:4S:5S:6S:7S:8S:9S |   |
| Default check digit:     | EAN 14 (eCDEAN14)   |   |
| Possible check digits:   | User supplied   |   |
| Encoded data:            | 1234567890123 TEC-IT                                      |   |

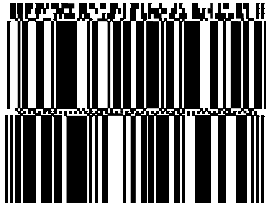
This is a GS1 DataBar Stacked Omni directional barcode with an attached 2D component (CC-A or CC-B).

### 6.6.8 GS1 DataBar Expanded Composite Symbology

|  |   |
|--|---|
| Symbology number: 31<br>Valid characters RSS Exp.: ASCII characters between 0..127<br>Valid characters CC-A/B: ISO 646 character set, up to 338 characters<br>Standard print ratio: 1:2:3:4:5:6:7:8:9:1:2:3:4:5:6:7:8:9<br>Ratio format: 1B:2B:3B:4B:5B:6B:7B:8B:9B:1S:2S:3S:4S:5S:6S:7S:8S:9S<br>Default check digit: None (eCDNone).<br>Possible check digits: Modulo 10 (eCDMod10). EAN-14 (eCDEAN14) |  <p>1234567890123</p> |
| Encoded data: 1234567890123 TEC-IT   |   |


This is a GS1 DataBar Expanded barcode with an attached 2D component (CC-A or CC-B).

### 6.6.9 GS1 DataBar Expanded Stacked Composite Symbology

|  |  |
|--|--|
| Symbology number: 81<br>Valid characters RSS ES: ASCII characters between 0..127<br>Valid characters CC-A/B: ISO 646 character set, up to 338 characters<br>Standard print ratio: 1:2:3:4:5:6:7:8:9:1:2:3:4:5:6:7:8:9<br>Ratio format: 1B:2B:3B:4B:5B:6B:7B:8B:9B:1S:2S:3S:4S:5S:6S:7S:8S:9S<br>Default check digit: None (eCDNone).<br>Possible check digits: Modulo 10 (eCDMod10). EAN-14 (eCDEAN14) |  |
| Encoded data: ABCabc123+ TEC-IT  |  |

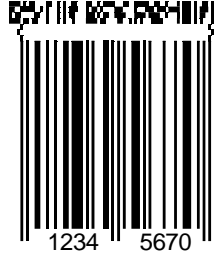
This is a GS1 DataBar Expanded Stacked barcode with an attached 2D component (CC-A or CC-B).

### 6.6.10 GS1-128 Composite Symbology

|   |  |
|---|--|
| Symbology number: 16<br>Valid characters EAN 128: ASCII-characters between 0..127<br>Valid characters CC-A/B/C: ISO 646 character set, up to 2361 characters<br>Standard print ratio: 1:2:3:4:1:2:3:4<br>Ratio format: 1B:2B:3B:4B1S:2S:3S:4S<br>Default check digit: None (eCDNone).<br>Possible check digits: Modulo 10 (eCDMod10). EAN-14 (eCDEAN14) |  <p>1234567890</p> |
| Encoded data: 1234567890 TEC-IT   |  |


This is a GS1-128 barcode with an attached 2D component (CC-A, CC-B or CC-C).

### 6.6.11 EAN-8 Composite Symbology

|                          |   |   |
|--------------------------|---|---|
| Symbology number:        | 10  |  |
| Valid characters EAN 8:  | "0".."9", 7 digits + 1 check digit          |   |
| Valid characters CC-A/B: | ISO 646 character set, up to 338 characters |   |
| Standard print ratio:    | 1:2:3:4:1:2:3:4                             |   |
| Ratio format:            | 1B:2B:3B:4B:1S:2S:3S:4S                     |   |
| Default check digit:     | EAN-8 (eCDEAN8)                             |   |
| Possible check digits:   | User supplied                               | 1234 5670   |
| Encoded data:            | 1234567 TEC-IT                              |   |


This is an EAN-8 barcode with an attached 2D component (CC-A or CC-B).

### 6.6.12 EAN-13 Composite Symbology

|                          |   |   |
|--------------------------|---|---|
| Symbology number:        | 13  |  |
| Valid characters EAN 13: | "0".."9", 12 digits + 1 check digit         |   |
| Valid characters CC-A/B: | ISO 646 character set, up to 338 characters |   |
| Standard print ratio:    | 1:2:3:4:1:2:3:4                             |   |
| Ratio format:            | 1B:2B:3B:4B:1S:2S:3S:4S                     |   |
| Default check digit:     | EAN-13 (eCDEAN13)                           |   |
| Possible check digits:   | User supplied                               | 1 234567 890128   |
| Encoded data:            | 123456789012 TEC-IT                         |   |


This is an EAN-13 barcode with an attached 2D component (CC-A or CC-B).

### 6.6.13 UPC-A Composite Symbology

|                          |   |   |
|--------------------------|---|---|
| Symbology number:        | 34  |  |
| Valid characters UPC-A:  | "0".."9", 11 digits + 1 check digit         |   |
| Valid characters CC-A/B: | ISO 646 character set, up to 338 characters |   |
| Standard print ratio:    | 1:2:3:4:1:2:3:4                             |   |
| Ratio format:            | 1B:2B:3B:4B:1S:2S:3S:4S                     |   |
| Default check digit:     | UPC-A (eCDUPCA)                             |   |
| Possible check digits:   | User supplied                               | 1 23456 78901 2   |
| Encoded data:            | 12345678901 TEC-IT                          |   |

This is an UPC-A barcode with an attached 2D component (CC-A or CC-B).

### 6.6.14 UPC-E Composite Symbology

|                          |   |   |
|--------------------------|---|---|
| Symbology number:        | 37  |  |
| Valid characters UPC-A:  | "0".."9", 7 digits + 1 check digit          |   |
| Valid characters CC-A/B: | ISO 646 character set, up to 338 characters |   |
| Standard print ratio:    | 1:2:3:4:1:2:3:4                             |   |
| Ratio format:            | 1B:2B:3B:4B:1S:2S:3S:4S                     |   |
| Default check digit:     | UPC-E (eCDUPCE)                             |   |
| Possible check digits:   | User supplied                               | 1 234567 0  |
| Encoded data:            | 1234567 TEC-IT                              |   |

This is an UPC-E barcode with an attached 2D component (CC-A or CC-B).

## 7 Image Parameters

### 7.1 Image Types

The barcode can be converted to a bitmap or vector format (see TBarCode API *BCSaveImage*, *SaveImage*, *Barcode.Draw*, *BCSaveImageToBuffer*, *ConvertToStream*, etc).

The following image types with the corresponding compression options (parameter *nQuality*) are available<sup>5</sup>.

Please keep in mind that unreadable barcodes may be produced when creating a bitmap with low resolution (see section **A.4 Optimize Barcode for the Output Device Resolution**).

#### 7.1.1 Image Formats

| Image Format | Enumeration (def. value)        | Note   |
|--------------|---------------------------------|--|
| BMP          | eIMBmp (0)                      | BMP bitmap format  |
| EMF          | eIMEmf (1)                      | Enhanced Metafile vector format (Windows only)                         |
| EPS (Bitmap) | eIMEpsDeprecated (2)            | EPS with low-resolution bitmap (no longer available).                  |
| GIF          | eIMGif (3)                      | GIF bitmap format, supported since <b>TBarCode 7</b>                   |
| JPG          | eIMJpg (4)                      | JPG bitmap format  |
| PCX          | eIMPcx (5)                      | PCX bitmap format  |
| PNG          | eIMPng (6)                      | PNG bitmap format  |
| TIF          | eIMTif (7)                      | TIF bitmap format  |
| EPS (Vector) | eIMEps (8)<br>eIMPEpsVector (8) | EPS / PostScript vector based format                                   |
| PCL          | eIMPcl (9)                      | PCL 5 (vector based format)  |
| SVG          | eIMSvg (10)                     | SVG vector based format, supported since <b>TBarCode SDK 11.2</b>      |
| AI           | eIMAi (11)                      | Adobe Illustrator® V7 format, supported since <b>TBarCode SDK 11.2</b> |

Table 29: Supported Image Types

#### 7.1.2 Compression Modes

| Image format | Compression / Quality   | Remark   |
|--------------|---|--|
| BMP          | 0..1, 0 = uncompressed, 1 = compressed  |  |
| EMF          | No compression is used.   |  |
| EPS          | Bitmap EPS: unused<br>Vector EPS: adjust font substitution.                         | With vector EPS files, you can choose between using Windows fonts (0) and only PostScript compatible fonts (1).  |
| JPG          | 0..100, 0=highest compression, worst quality, 100 =lowest compression, best quality | Value of 100 suggested, especially for high data density   |
| PCX          | Not used  | In <i>ConvertToStream</i> and <i>ConvertToStreamEx</i> not supported   |
| PNG          | PNGALLFILTERS (0)   | Use best filter for each row (highest compression)   |
|              | PNGINTERLACE (1)  | Interlace filter   |
|              | PNGNOFILTER (2)   | No filter will be used (fastest runtime)   |
|              | PNGSUBFILTER (4)  | Difference filter with adjacent pixel  |
|              | PNGUPFILTER (6)   | Difference filter with pixel from the previous row   |
|              | PNGAVGFILTER (8)  | Average filter   |
|              |   | To save an image in compressed mode and additional as interlaced file, you have to make a bit wise or operation with the defined constants (or simple adding the numbers).<br>Example: to save a file with maximum compression and interlaced, the quality parameter is calculated as follows: |

<sup>5</sup> Depending on the API not all image types are available for streaming – see API reference for more information.



|     | PNGPAETHFILTER (10)  | Path filter | PNGALLFILTERS  <br>PNGINTERLACE           |
|-----|--|-------------|---|
| TIF | 0.. No compression<br>1.. LZW *<br>2.. Pack Bits compression<br>3.. Group 3 1D compression (CCITT Modified Huffman RLE)<br>4.. Group 4 2D compression (CCITT Group 4 FAX) *<br>5.. CCITT Group 3 compression (= CCITT Group 4 FAX) *<br>7.. JPEG * |             | * is supported with TBarCode 7 and higher |
| EPS | No compression is used.  |             |   |
| PCL | No compression is used.  |             |   |
| SVG | No compression is used.  |             |   |
| AI  | No compression is used.  |             |   |

Table 30: Supported Image Compression Modes

## 8 Character Encoding

### 8.1 UNICODE ↔ Code Pages

Due to internationalization and localization, strings are often encoded in the UNICODE character set, because it makes it possible to represent characters from many different languages and scripts. However, barcode symbologies are usually able to process only a relatively small set of characters. Whereas most of them are only capable of encoding a fix character set with a fix character encoding – these symbologies are not affected by the encoding topic, some others (particularly 2D symbologies) are able to switch between several code pages.

Because even these barcodes types cannot display all character sets at the same time (unlike UNICODE), **TBarCode** offers the possibility to let the user decide how the input data should be interpreted (see the properties *EncodingMode* and *CodePage*).

### 8.2 Default Code Pages

Different barcode symbologies use different default character encodings (=code pages).

| Symbology   | Default Encoding / Default Code Page  |
|---|---|
| 1D Codes  | ASCII 0-127   |
| Code-128  | ASCII 0-127 + Latin-1 (via FNC4)  |
| PDF417<br>MicroPDF417   | ASCII Extended (Code Page 437)  |
| QR Code (AIM '97)<br>Micro QR-Code<br>Japanese Postal   | Shift-JIS (Code Page 932)   |
| Aztec Code<br>Codablock-F<br>Data Matrix<br>DotCode<br>Han Xin Code<br>MaxiCode<br>QR Code 2005<br>QR Code (ISO/IEC 18004:2015) | Latin-1 / ISO 8859-1 / Windows 28591<br><br>TBarCode V8 and earlier: ANSI / Windows-1251 (Code Page 1252) |

Table 31: Default Code Pages

### 8.3 Code Page Switching

If a code page different from the standard code page should be used, the decoding application or the barcode reader must be told how the data is to be interpreted. Either the code page is exactly defined by the application (for example, mobile tagging), or the code page must be communicated separately to the bar code reader. This is usually done with ECI codes (Extended Character Interpretation) which have to be added to the barcode data (see also section 4.7 *Escape Sequences (Encoding Binary Data)*).

- ▶ Be aware that not all readers are able to handle ECI codes and decode the barcode data in a correct manner. Many of the scanners just ignore the ECIs; others pass them un-translated to the addressee and let it do the work.

## 9 Frequently Asked Questions

---

### 9.1 How to add the Leading and Trailing '\*' for Code 39?

No action is required. The asterisks '\*' are added automatically to the barcode.

### 9.2 How to add the Check Digit to Code 39?

Simply select Modulo 43 (or another method) as check digit Method. The automatically computed check digit is appended at the end of the barcode.

### 9.3 How to add the Leading and Trailing 'A' (or B, C, D) for CODABAR?

Enter A&A in the format string (property "*Format*" – see section 4.6).

### 9.4 How to use a Specific Subset in Code 128?

Use the corresponding barcode types Code128A, 128B or 128C. The whole code will then be generated in the corresponding subset. If this is not possible with the current data, the software will change subsets as required. If you want to change the subset within the barcode enter A or B or C in the "*Format*" (see section 4.6).

### 9.5 How to use the Compressed Mode of Code 128?

Use the barcode type Code128 and make sure "*Format*" is empty.

### 9.6 How to generate a PDF417 symbol with an Aspect Ratio of 3:2?

In order to generate a PDF417 which utilizes the standard aspect ratio of 3:2 there are two possible methods:

#### 9.6.1 Set a Row:Col Ratio of 11:1

```
Set Cols = 2  
Set Rows = Cols * 11
```

#### 9.6.2 Maintain a constant Ratio of Row Height / Module Width

Set a row height: module width ratio of 3:1 (default) by setting the module width to 500 (0.5 mm constant value) and PDF417 row height to 1500 (1.5 mm).

### 9.7 How to set a Specific Module Width?

You can adjust the module width (or X Dimension) by setting the property *ModuleWidth* to the desired value.

Per default the barcode adapts automatically to the object width (= to the dimension of the bounding rectangle). After adjusting module width, the resulting barcode width depends on the amount of the encoded data characters and no longer on the width of the bounding rectangle.

- ▶ Keep in mind to choose a suitable size of the bounding rectangle to ensure that the barcode is not clipped.
- ▶ The dimension of the bounding rectangle must be wide enough to hold the largest data content possible. Use the property *MustFit* to check whether a barcode does not fit into the bounding rectangle.
- ▶ The *SizeMode* property (available since TBarCode V7) must be set to Custom Module Width if you want your settings to take effect.

## 9.8 More FAQ

<https://www.tec-it.com/support/faq/barcode/printing-decoding.aspx>

<https://www.tec-it.com/support/faq/tbarcode/barcode-ocx.aspx>



## 10 Contact and Support Information

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## Appendix A: Creating Optimal Barcodes

---

### A.1 General

Generating optimal barcodes means to

1. Determine the optimal barcode size required by the application (see section A.2)
2. Maintain a minimal quiet zone to guarantee the readability of the barcode (see section A.3)
3. Produce the best possible output on the target device (see sections A.4)

The last and most important step, the optimization for the output device, is described in detail in sections A.5 and following. It is described how the optimization is supported by TEC-IT barcode software. Furthermore, it is described what you should consider when printing barcodes directly or when using barcode images. In the last section, the approach for optimizing barcodes is illustrated with some code examples.

### A.2 Barcode Size

Primarily the barcode size is determined by the application where the barcode is used. The scanner hardware and the projected reading distance define an upper and lower limit for the barcode size (see also Barcode Reference, section 4.2.3).

In addition, some barcode specifications provide guidelines for the barcode size. This is either:

- An obligatory size with only little tolerance (most postal barcodes like USPS POSTNET, Australia Post Codes, ...)
- A list of recommended sizes or module widths, e.g. a standard size and a number of magnification factors to choose from (GS1-128, UPC, ITF-14, ...)
- A recommended minimum module width (Code 128, ...)

When using the barcode in an industry or transportation label the required barcode size is usually exactly specified. The label specification provides the required information.

### A.3 Quiet Zone

To guarantee the readability of the barcode a certain quiet zone around the barcode should be maintained. The quiet zone depends on the type of the barcode:

- Linear Barcodes  
As a rule of thumb for linear barcodes the quiet zone should be ten times the module width. For some barcode types, a recommended minimum is explicitly given by the specification.
- 2D Barcodes  
The quiet zone depends on the actual barcode type. A rule of thumb cannot be given but using 10 times the module width could fix possible problems.
- GS1 DataBar Codes  
Due to the technical nature of these barcodes no quiet zones are required. Only for symbologies with an added composite component, you have to maintain a certain quiet zone.





Figure 17: Quiet Zone for Linear Barcode

For more information about quiet zones, please refer to the Barcode Reference, section 4.4.

## A.4 Optimize Barcode for the Output Device Resolution

When printing the barcode (or when creating a barcode image), the most important step is to optimize the module width with respect to the output device resolution. A printer can only print whole dots. Therefore, the bar and the space widths have to be adjusted, so that they exactly fit the printing raster. If this adjustment is skipped, the resulting output may be inaccurate and the readability of the barcode may suffer. Especially for low output resolutions (e.g. screen output or thermo-transfer printing), the optimization is essential. For printers with high resolution the optimization may be negligible. However, it is recommended to optimize the barcode in any case.

Due to optimization, the size of the barcode symbol is modified very slightly.

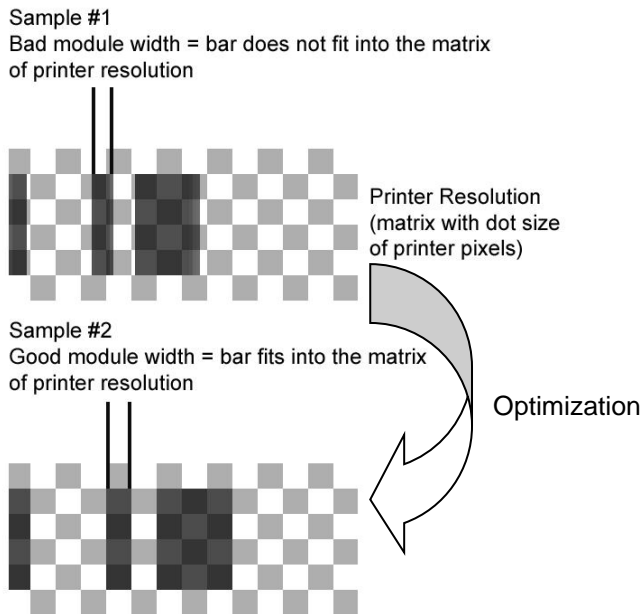


Figure 18: Optimize Barcode for Output Device Resolution

After the optimization the module width is exactly N times the width of a device pixel (for N is an integer greater than 0).

In practice, the optimization can be done using different methods. Section A.5 describes all necessary adjustments, which are required to enable the automatic optimization in TEC-IT software products. Alternative you can also choose an appropriate module width, which fits the printing raster by yourself.

Whenever printing a barcode directly or when using barcode images, you should additionally consider a few rules (see sections A.6 to A.7). Finally, for developers, in section A.9 all programming steps, which are required to optimize a barcode, are explained with a few code examples.

## A.5 Enable Optimization in TEC-IT Software

In TEC-IT software, per default the barcode optimization for a given resolution is turned off. All barcodes are created in the exact size as specified, instead. If you want to turn the optimization on, please do the following:

### A.5.1 Barcode Studio

With the barcode image designer **Barcode Studio**, you have two possibilities to optimize a barcode:

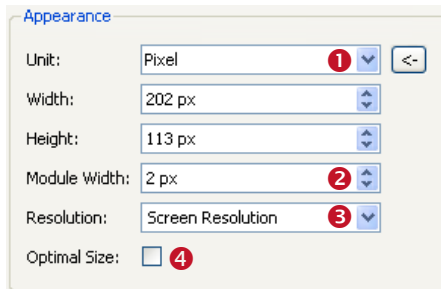


Figure 19: Barcode Optimization in Barcode Studio

The easiest method is to set the check mark in ④. This will automatically optimize the barcode for the given output resolution (see ③).

As an alternative you can also set the scaling unit to “Pixel” (see ①) and then adjust the module width in ②. Since you can only adjust integer values for the unit “pixel”, the barcode must necessarily fit the raster and you will get an optimal barcode for the specified resolution.

### A.5.2 TFORMer

In the barcode label software **TFORMer Designer** you can set *Optimal Resolution* to “True” (see ⑤). This will optimize the barcode for the printer on which the document is actually printed.

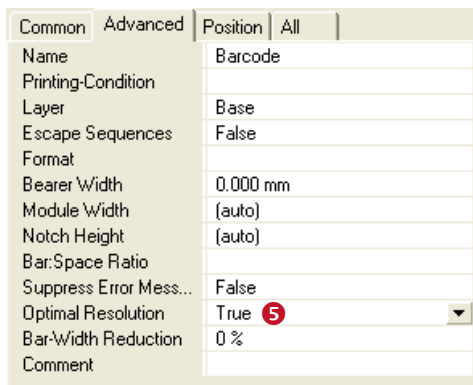


Figure 20: Barcode Optimization in TFORMer Designer

### A.5.3 TBarCode

In the barcode generator SDK **TBarCode**, you have two different adjustments for optimization: Either you can generate the smallest possible barcode optimized for the selected decoder type and for the specified resolution (see Figure 21).

Alternatively, for any custom sized barcodes, you can turn on the optimization by setting the *OptResolution* property to “true” (see Figure 22).



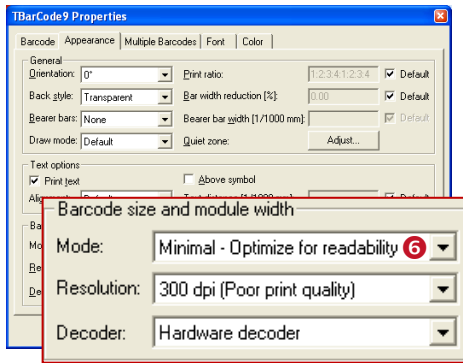


Figure 21: Barcode Optimization in TBarCode OCX (Version 1)

The settings shown in the figure above are available in the properties dialog of the barcode control. The “Minimal” mode **6** creates all barcodes with the recommended minimum module widths. For the decoder type “Hardware decoder” (e.g. suitable for barcode scanners) this would produce linear and stacked barcodes with a module width of approximately 0.254 mm (= 10 mils) and 2D barcodes like QR Code or Data Matrix with a module width of about 0.5 mm ( $\cong$  20 mils).

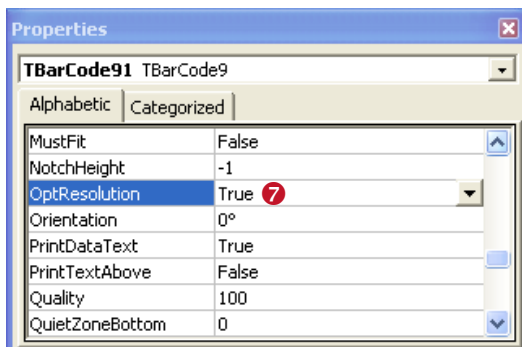


Figure 22: Barcode Optimization in TBarCode OCX (Version 2)

In the application specific property window (and not in the properties page as shown in Figure 21) you will find the property *OptResolution* **7**. When set to “true” the barcode will be optimized for its predefined size.

#### A.5.4 Application Notes for “Optimal Resolution”

Please note: When enabling the switch “optimal resolution” (see **4**, **5** and **7**) the barcode will always be reduced to the next smaller size, in which it can be printed in optimal quality.

Under unfortunate circumstances this size reduction might cause the module width to drop below a given minimal module width. Therefore, it is recommended to enlarge the bounding rectangle of the barcode to the maximum available area whenever possible. This way you will get the largest possible optimized barcodes on the printout.

However, instead of using *OptResolution* the following approach may sometimes be even more suitable:

- Experienced users can adjust the module width of the barcode manually. E.g. in **TFORMer** you can specify the module width in mm. When doing this you have to take care that the adjusted module width is suitable for the printer resolution.  
Example: printer resolution = 600 dpi  
→ One dot has  $1/600$  inch  $\cong$  0.00167 inches  $\cong$  0.0423 mm  
→ For this printer you could use  $N * 0.0423$  mm (for N is an integer greater than 0) as module width  
(Hint: You can also use **Barcode Studio** to do the necessary module width calculations!)

- For creating images software developers should use *BCGetOptimalBitmapSize()* instead of *OptResolution*. Using this function, you have more control over the output.

## A.6 Printing Barcodes Directly

By default, TEC-IT software uses the whole available space (the bounding rectangle) to render a barcode. This means that the software computes the module width based on the available space and on the data to be encoded.

For printing with high resolutions such as 600 dpi, this approach is OK. Even if the resulting quality of the barcode is not optimal with respect to the printer resolution, the inaccuracies are usually so small, that they do not lead to a noticeable loss in the barcode quality. To get a sense for the occurring deviations you could check the output quality for your settings with **Barcode Studio**.

On the other hand, if the printer resolution is low (equal or smaller to 300 dpi) or the data density is very high – or to be more precisely if the module width in device pixels is very small, the loss of quality may be noticeable. Therefore, you should always optimize the barcode quality in such circumstances. In order to do so, you can either adjust the module width, so that it exactly fits the printing raster, or you can set the *OptResolution* flag to “true”.

## A.7 Barcode Images

When using barcode images, you should always generate them in optimal quality, meaning that all spaces and all bars should be represented with a whole number of image pixels. Images are (in principle) device independent. Therefore, this should always be possible.

Consider the following:

- ▶ Whenever possible use the property *OptResolution* to adapt the module width to the resolution (pixel raster) of the image. Developers also have the possibility to use the function *BCGetOptimalBitmapSize()*. Given the requested size of the barcode (in device pixels), it will optimize the width and the height of the barcode.
- ▶ Use lossless image formats (like PNG instead of JPG). Do not use any compression reducing the picture quality.
- ▶ Avoid any post processing like scaling/resizing with image editing software! Each post-processing step means a potential loss of the barcode quality.

However, when using the images (e.g. when embedding them in a layout) and, in a further consequence, when printing them you have to be aware that

- depending on the size of your source image and
- depending on the required size on your printout and
- depending on the resolution of the printer

the original barcode image will be scaled with a particular scaling factor.

This scaling occurs when the image is rastered for the printer resolution. It may negatively influence the barcode quality of the printout. Therefore, you should ideally always create the barcode image in the same resolution in which it will be printed. Consequently, any scaling between the image and the printout is avoided. If scaling is inevitable for any reason, you should take care that after the scaling the barcode can be rendered with whole device pixels on the target printer.

In section A.7.3 a general approach how to optimize a barcode image for a specific printer resolution is described. However, before going into detail we want to explain a few general principles for using barcode images.

### A.7.1 Embedding Barcode Images

In general, barcode images are used in order to embed a barcode into arbitrary layouts (e.g. on a HTML page, in a desktop publishing program, in a report generator, etc.).

Therefore, you usually specify a rectangular region on the layout in which the image will be inserted. This rectangular region defines the size (in device independent units like mm) in which the barcode will be printed. (Only exception: In HTML, you specify the actual printout size indirectly via screen pixels. Nonetheless this pixel size can be translated to a specific target size on your printout – for details see section A.7.2.)

Now, the basic principle is that the printout will always have exactly the same size as specified in the layout. The size of the embedded source image actually does not have any influence on the printout size. However, the quality of the printout will vary depending on different source image dimensions!

Therefore, you should ideally always

- ▶ Create the image exactly in the same resolution as used for printing (printer resolution).
- ▶ If you do not know in which resolution the barcode image will be printed, use a sufficiently high resolution, so that the image is likely to be printed in an aspect ratio of 1:1 or that it is being down-scaled for printing (down-scaling a large image usually produces better results on the printout than up-scaling a smaller image).

### A.7.2 Barcode Images in HTML

As already stated above, the basic idea for generating high quality barcode printouts is to generate detailed barcode images, which are optimized for a specific printer resolution. This approach can also be used for HTML. The high-resolution images are only scaled down for display in the browser window. Internally the images keep their high resolution. Thus, the browser can generate more accurate printouts compared to using source images in a low screen resolution.

To specify the dimension in which the barcode will be displayed on the HTML page you can use the image attributes “width” and “height”. These attributes specify the display size of images on the screen. Within the HTML code, this would look like:

```

```

The screen size of the barcode image does not only specify the size in which the barcode is displayed in the browser window, it also specifies the size in which the barcode will be drawn on the printout. For translation, you need to know:

- ▶ All images, which are displayed in the web browser, are assumed to have a resolution of 96 dpi. Based on that resolution the size on the printout is calculated. This calculation is independent of the printer resolution.

Example:

If a barcode image is displayed with 200 pixels, it will appear on your printout with a size of about 53 mm (200 pixels / 96 dpi  $\cong$  2.083 inches  $\cong$  52.91 mm).

This means: In order to make sure that the barcode has the correct size on the printout you have to calculate the pixel size that is required for 96 dpi. Therefore divide the size (of the high-resolution image) by the printer resolution and then multiply it by 96 dpi. This value must be used as “width” (or as “height”) attribute for the image.

Example:

Image width = 900 pixel  
Printer resolution = 600 dpi

900 / 600 \* 96 = 144 pixel

```

```

Please note:

- ▶ When using such high-resolution images you have to increase the font size for the barcode to make the text look normal.
- ▶ Linear barcodes:  
To avoid large file sizes you can use a higher resolution in the horizontal dimension of the barcode image only. Please note: This approach will produce distorted fonts. So switch off the font in the barcode and print the text separately using HTML.
- ▶ Instead of generating the barcode image for a dedicated printer resolution, you can also produce the barcode with twice or triple the resolution as displayed in the browser window. This will produce a good approximation. With more detailed source images, the rasterizing errors are reduced and the printing quality is increased.

### A.7.3 Optimizing Barcode Images with Respect to the Printer Resolution

Below we will describe a general approach for optimizing barcode images with respect to the printer resolution. It can be used for all images, which are going to be printed. This optimization is only possible if you know the resolution of the target printer.

For optimization, the following steps are required:

1. Specify the intended size of the barcode on the printout.  
Please keep in mind that due to the optimization the final barcode size will vary!  
e.g.: barcode width = 5 cm
2. Based on that size calculate the image size (in pixels) for the required printer resolution.  
e.g.: printer resolution = 600 dpi  
→ 5 cm / 2.54  $\cong$  1.97 inches  
→ Calculated image width = 1.97 \* 600  $\cong$  1181 pixels
3. Now check if the barcode fits the pixel raster of the image, or if it has to be optimized.  
We assume our (linear) barcode uses 101 modules<sup>6</sup>.  
→ Module width (in pixel) = 1181 / 101  $\cong$  11.7  
→ This module width cannot be represented with whole device pixels! The image has to be optimized!
4. Optimize the image.  
In order that all bars and spaces can be represented with whole device pixels, we have to use an integer value for the module width. Therefore, the calculated pixel size has to be rounded up or down.  
→ In our case, we will round the module width down to 11 pixels (instead of 11.7).  
Therefore, the barcode will become a little smaller.  
→ The actual image width is now 11 \* 101 = 1111 pixels.
5. Based on that pixel size the actual barcode size on the printout can be calculated.  
→ 1111 / 600  $\cong$  1.85 inches  $\cong$  4.7 cm
6. For HTML only:  
To print the barcode in the correct size, we have to calculate the width of the displayed barcode in screen pixels:  
→ Therefore divide the image size by the printer resolution and multiply it by 96 dpi.  
→ 1111 / 600 \* 96 = 177.76 pixel  
→ In the HTML image tag you would specify a width of 178 pixels!

For code examples, see sections A.9.1 and A.9.2!

<sup>6</sup> The module count is the number of modules, which is required for drawing the barcode. Example: If the barcode consists of a bar, followed by a space and then followed by two bars (making one big bar) we would count 4 modules. The module count can be retrieved using *CountModules* for linear barcodes and *2DXCols* for 2D barcodes.

Additional considerations:

- ▶ If you do not know the resolution of the target printer, it is a good approximation to use a sufficiently high image resolution (e.g. 600 dpi). In any case the barcode image should be optimized with respect to the image pixels (see step 4!).
- ▶ If you want to save space and therefore intend to create smaller images (e.g. for web applications) you can do that. In this case you should take care, that after upscaling to the printer resolution, the barcode can be printed with whole printer dots (see also the example in section A.9.3).

Remark:

Another method to get optimal printouts would be to generate all barcode images with exactly one pixel module width. Such images have an optimal barcode quality and can be up-scaled to any required size. Since you do not know if the printer driver uses anti-aliasing (and produces half tones) when upscaling an image, or if you want to get a readable barcode text, the optimization as described above is recommended.

## A.8 Barcode Vector Graphics

In TEC-IT software, you do not only have the possibility to use bitmap images, but also vector graphics images. Vector graphics have the advantage, that they do not contain any rastered data, but only structural information about the barcode (positions and sizes of all bars). Therefore:

- ▶ All vector graphics can be arbitrarily scaled without gaining any loss of quality.
- ▶ The file size is usually rather small (it is independent of the barcode dimensions).
- ▶ However, during printing also vector graphics will eventually be rastered. Therefore, the module width of the barcode should ideally always be a whole multiple of the dot size of your printer. If the module width does not fit the printing raster, there will be inaccuracies on the printout.

As a vector based file format TEC-IT supports the Encapsulated PostScript® format (or short EPS format). Considering the advantages as stated above it is usually a good idea to use the EPS format instead of bitmap files wherever possible. However, please note that this format is only supported by a few applications!

## A.9 Code Examples for Barcode Optimization

For your understanding, the following examples show the barcode optimization by code. The first four examples do the optimization by programmatic adaption of the module width. The last sample shows the usage of the function *BCGetOptimalBitmapSize*.

### A.9.1 Linear Barcodes

In this example, a linear barcode will be optimized for output. We assume the following specification:

Barcode width = 60 mm  
Barcode height = 30 mm  
Resolution of the output device = 200 dpi (dots per inch)

Based on this specification we first calculate the projected barcode size in target device pixels. This size (actually only the width) is then adjusted so that each bar and each space of the barcode exactly matches the output raster. This is achieved by making sure that the width of one module is a multiple of one device pixel. A similar height adjustment is not necessary because the scanning process is usually not affected by the height of the barcode.

First, we calculate the barcode width in device pixels:

Therefore we convert the width (which is given in mm) to inches. Then we multiply the result by the resolution (dots per inch) of the output device.

$$60 / 25.4 * 200 \cong 472.44 \text{ dots (or pixels)}$$

Then we calculate the module width and adopt it, so that all bars and spaces can be displayed with whole pixels:

```
// 1) Specify the barcode type, the barcode data, etc.
//
//   Do your barcode adjustments here!

// 2) Specify the favored barcode size.
//   To optimize the output quality we will do all calculations in device pixels.
//   Therefore, the given size (in this case in mm) must be converted to device pixels
//   with respect to the resolution of the output device.
LONG   ldpi           = 200;
LONG   lBarcodeWidth = (LONG)ConvertMMToPixel (60.0f, ldpi); // 60 mm --> 472.44 pix
LONG   lBarcodeHeight = (LONG)ConvertMMToPixel (30.0f, ldpi); // 30 mm --> 236.22 pix

// 3) Get the horizontal module count.
//   This function returns the number of modules that was calculated for the given
//   barcode. This is usually an integer! For non-integer values the optimization
//   will not work!
DOUBLE dCountModules = ::BCGetCountModules ( pBC );
DOUBLE dModuleWidth;

// avoid division by zero
if( dCountModules > 0.0)
{
    // 4) Calculate the current module width:
    //   --> Divide the barcode width by the horizontal module count.
    dModuleWidth = (DOUBLE)lBarcodeWidth/dCountModules;

    // 5) Optimize the module width:
    //   For an optimal barcode, the module width must be a multiple of one device pixel!
    //   Thus, all decimal places have to be eliminated.
    //   In this case the value is rounded up with the ceil-function.
    dModuleWidth = ceil ( dModuleWidth );

    // 6) Now that you have found the optimal module width
    //   calculate the width of the complete barcode in target device pixels.
    lBarcodeWidth = (LONG)(dCountModules * dModuleWidth);
}

// 7) The optimized barcode width can now be used to draw the barcode or to save
//   the barcode as an image. In this sample, the barcode will be saved as an image.
::BCSaveImage ( pBC, "C:\\ MyBarcode.BMP", eIMBmp,
               lBarcodeWidth, lBarcodeHeight, ldpi, ldpi );
```

## A.9.2 2D Barcodes

For 2D barcodes, we have to do both a vertical and a horizontal size adjustment.

Barcode width = 60 mm

Barcode height = 30 mm (assuming a rectangular 2D barcode like PDF417)

Resolution of the output device = 200 dpi

The following code example shows the complete calculation, which is necessary for optimizing a 2D barcode for the given output, device resolution:

```
// 1) Specify the barcode type, the barcode data, etc.
//
//   Do your barcode adjustments here!

// 2) Specify the favored barcode size.
//   For optimizing the output quality, we will do all calculations in device pixels.
//   Therefore, the given size (in this case in mm) must be converted to device pixels
```

```

// with respect to the resolution of the output device.
LONG   ldpi           = 200;
LONG   lBarcodeWidth = (LONG)ConvertMMToPixel (60.0f, ldpi); // 60 mm --> 472.44 pix
LONG   lBarcodeHeight = (LONG)ConvertMMToPixel (30.0f, ldpi); // 30 mm --> 236.22 pix

// 3) Get the horizontal and vertical module count7.
// This function returns the number of modules that was calculated for the given
// barcode. This is usually an integer! For non-integer values the optimization
// will not work!
LONG   lCols = ::BCGet2D_XCols ( pBC );
LONG   lRows = ::BCGet2D_XRows ( pBC );

// avoid division by zero
if( lCols > 0 && lRows > 0 )
{
    // 4) Optimize the barcode width and height:
    // For an optimal barcode, the module width must be a multiple of one device pixel!
    // Thus, all decimal places have to be eliminated.
    // In this case the value is rounded up with the ceil-function.
    // Then the module width/height is again multiplied by the module count.
    lBarcodeWidth = (LONG)ceil((DOUBLE)lBarcodeWidth / (DOUBLE)lCols) * lCols;
    lBarcodeHeight = (LONG)ceil((DOUBLE)lBarcodeHeight / (DOUBLE)lRows) * lRows;
}

// 5) The optimized barcode width and height can now be used to draw the barcode or to
// save the barcode as an image. In this sample, the barcode will be saved as an image.
::BCSaveImage ( pBC, "C:\\\\MyBarcode.BMP", eIMBmp,
               lBarcodeWidth, lBarcodeHeight, ldpi, ldpi );

```

### A.9.3 Prepare a Barcode with a specific Module Width for a Web Page

In the following example, we want to create a barcode image with a module width of 15 mils. The printer resolution is assumed 600 dpi.

Therefore, the module width is  $0.015 * 600 = 9$  device pixels.

Furthermore, we want to generate a rather small image. Therefore we will use just 3 (instead of 9) pixels as module width. This means the barcode image is actually optimized for a resolution of 200 dpi. For printing with 600 dpi, the image will be scaled by 3 ( $3 * 3 = 9$  device pixels). That is perfect.

In order to prepare the image, we have to do the following steps:

#### Step 1: Create the Image

First, we calculate the horizontal size of the barcode image in pixels. Therefore, we multiply the number of barcode modules with the intended module width (in pixel):

```

' the number of modules in the barcode
CntModules = tbc.CountModules8

' one module will be 3 pixels in the generated image
BitmapWidth = 3 * CntModules

' the height of the barcode image is half an inch
BitmapHeight = 100

' convert to bitmap stream
ImgByteArray = ConvertToStream (eIMPng, BitmapWidth, BitmapHeight, ...)

```

#### Step 2: Scale the Image

Now we calculate the desired display size in the browser, so that the barcode will finally be printed in the correct size on the printout. HTML assumes a screen resolution of 96 dpi. The image was optimized for 200 dpi. Thus, we have to scale the image for display in the browser by  $96 / 200$ .

<sup>7</sup> In TBarCode SDK V10+ you can use DLL function BCGetOptimalBitmapSize()

<sup>8</sup> In TBarCode SDK V10+ you can use COM method GetOptimalBitmapSize()

```

DispWidth = BitmapWidth * 96 / 200
DispHeight = BitmapHeight * 96 / 200

" width="<%=DispWidth%>" height="<%=DispHeight%>"

```

This procedure works for web applications (*ConvertToStream* method) as well as for storing image files (*SaveImage* method).

#### A.9.4 Create a 2D Barcode Image with the Module Width specified in Pixels

To get a precise image you can adjust the size of the image in pixels according to the required horizontal and vertical size of the barcode. By using the properties *2DXCols* (number of columns in modules) and *2DXRows* (number of rows in modules) the size of the image can be optimized:

```

Dim nScale As Long
Dim nXSize As Long
Dim nYSize As Long

' 1) Initialize the barcode
TBarcode111.Text = "Somedata"
TBarcode111.BarCode = TBarcode11Lib.eBC_MicroPDF417

' 2) Use 5 pixels per module
nScale = 5
nXSize = TBarcode111.Get2DXCols * nScale
nYSize = TBarcode111.Get2DXRows * nScale

' 3) Save the barcode using the optimized size
' (Please note: The resolution specified by the last two parameters is only stored as
' Information in the image attributes (if supported by the image type).
' It has no influence on the pixel size of the generated image.)
TBarcode111.SaveImage "C:/MyBarcode.bmp", TBarcode11Lib.eIMBmp, nXSize, nYSize, 72, 72

```

#### A.9.5 Optimize an Image using BCGetOptimalBitmapSize

The following code snippet shows you how to use the function *GetOptimalBitmapSize()*.

```

Dim lWidth As Long
Dim lHeight As Long

' 1) Initialize the barcode
TBarcode111.Text = "Somedata"
TBarcode111.BarCode = TBarcode11Lib.eBC_Code128
TBarcode111.Width = 200
TBarcode111.Height = 70

' 2) Optimize the pixel size of the barcode image
TBarcode111.GetOptimalBitmapSize 1, 1, lWidth, lHeight

' 3) Save the barcode using the optimized image width and height
' (Please note: The resolution specified by the last two parameters is only stored as
' Information in the image attributes (if supported by the image type).
' It has no influence on the pixel size of the generated image.)
TBarcode111.SaveImage "C:\temp\Doc1.bmp", TBarcode11Lib.eIMBmp, lWidth, lHeight, 72, 72

```



## Appendix B: Barcode Quiet Zones

The information contained in this chapter is subject to be changed without notification. We are sorry, but we cannot guarantee that all information is error-free. TEC-IT Datenverarbeitung GmbH is not liable for any damages or lost profits if somebody relies on the information in this chapter.

We recommend the following quiet zones to be used with the listed bar code symbologies. Please consider that quiet zones often depend on a specific label format, so please hold on to your specification (if you have one).

The “X” stands for module width (narrow bar width).

### B.1 Linear Symbologies

| No. | Barcode Symbology                                | Vertical quiet zone |        | Horizontal quiet zone |               |
|-----|--|---------------------|--------|-----------------------|---------------|
|     |  | top                 | bottom | left                  | right         |
| 63  | Australia Post 4-State Standard Customer Barcode | 2 mm                |        | 6 mm                  |               |
| 64  | Australia Post 4-State Customer Barcode 2        |                     |        |                       |               |
| 65  | Australia Post 4-State Customer Barcode 3        |                     |        |                       |               |
| 68  | Australia Post Redirection                       |                     |        |                       |               |
| 66  | Australia Post Reply Paid                        |                     |        |                       |               |
| 67  | Australia Post Routing                           |                     |        |                       |               |
| 18  | Codabar  | –                   |        | 10X                   |               |
| 2   | Code 2 of 5 Standard / Code 2 of 5 Matrix        | –                   |        | 10X, min. ¼ inch      |               |
| 6   | Code 2 of 5 Data Logic                           |                     |        |                       |               |
| 4   | Code 2 of 5 IATA                                 |                     |        |                       |               |
| 7   | Code 2 of 5 Industrial                           |                     |        |                       |               |
| 3   | Code 2 of 5 Interleaved                          |                     |        |                       |               |
| 1   | Code 11  | –                   |        | 10X                   |               |
| 8   | Code 39  | –                   |        | 10X, min. ¼ inch      |               |
| 9   | Code 39 Extended                                 | –                   |        | 10X, min. ¼ inch      |               |
| 25  | Code 93  | –                   |        | 10X, min. ¼ inch      |               |
| 62  | Code 93 Extended                                 | –                   |        | 10X, min. ¼ inch      |               |
| 20  | Code 128   | –                   |        | 10X, min. ¼ inch      |               |
| 59  | Code 128 Subset A                                |                     |        |                       |               |
| 60  | Code 128 Subset B                                |                     |        |                       |               |
| 61  | Code 128 Subset C                                |                     |        |                       |               |
| 22  | Deutsche Post Identcode                          | see Code 39         |        |                       |               |
| 21  | Deutsche Post Leitcode                           |                     |        |                       |               |
| 10  | EAN-8 <sup>9</sup>                               | –                   |        | 7X                    |               |
| 11  | EAN-8 with 2 digits add-on <sup>9</sup>          |                     |        | add-on:<br>7-10X      | add-on:<br>5X |
| 12  | EAN-8 with 5 digits add-on <sup>9</sup>          |                     |        |                       |               |
| 13  | EAN-13 <sup>9</sup>                              | –                   |        | 11X                   | 7X            |
| 14  | EAN-13 with 2 digits add-on <sup>9</sup>         |                     |        | add-on:<br>7-10X      | add-on:<br>5X |
| 15  | EAN-13 with 5 digits add-on <sup>9</sup>         |                     |        |                       |               |
| 72  | EAN-14   | see EAN-128         |        |                       |               |
| 16  | GS1-128 (EAN-128)                                | –                   |        | 10X, min. ¼ inch      |               |

<sup>9</sup> In TEC-IT software, the quiet zones for this symbology are included in the barcode generation algorithm. You need no extra adjustments.

|     |  |  |      |                                    |               |
|-----|--|--|------|------------------------------------|---------------|
| 28  | Flattermarken                                | depends on the application                           |      |                                    |               |
| 69  | ISBN Code                                    | see EAN-13 P5  |      |                                    |               |
| 89  | ITF-14                                       | 10X  |      |                                    |               |
| 76  | Japanese Postal                              | 2 mm   | 2 mm | 2 mm                               | 2 mm          |
| 77  | Korean Post Authority                        | –  |      | not exactly specified, but use 10X |               |
| 50  | LOGMARS                                      | see Code 39  |      |                                    |               |
| 47  | MSI  | see Plessey  |      |                                    |               |
| 75  | NVE-18                                       | see EAN-128  |      |                                    |               |
| 51  | Pharmacode One-Track                         | –  |      | 6 mm                               |               |
| 53  | Pharmacode Two-Track                         |  |      |                                    |               |
| 82  | Planet 12                                    | see USPS POSTNET                                     |      |                                    |               |
| 83  | Planet 14                                    |  |      |                                    |               |
| 46  | Plessey Code                                 | –  |      | 12X                                |               |
| 52  | PZN (Pharma Zentralnummer)                   | see Code 39  |      |                                    |               |
| 70  | Royal Mail 4 State (RM4SCC)                  | –  |      | 2 mm                               |               |
| 29  | GS1 DataBar (RSS-14)                         | –  |      | no quiet zone required             |               |
| 78  | GS1 DataBar Truncated (RSS-14 Truncated)     |  |      |                                    |               |
| 31  | GS1 DataBar Expanded (RSS Expanded)          |  |      |                                    |               |
| 30  | GS1 DataBar Limited (RSS Limited)            |  |      |                                    |               |
| 48  | SSCC-18                                      | see EAN-128<br>(for some label specs it says ¼ inch) |      |                                    |               |
| 118 | Swedish Postal Shipment ID                   | –  |      | 10X                                |               |
| 32  | Telepen Alpha                                | –  |      | –                                  |               |
| 33  | UCC / EAN-128 (GS1-128)                      | –  |      | 10X, min. ¼ inch                   |               |
| 17  | UPC 12                                       | –  |      | 9X                                 |               |
| 34  | UPC version A <sup>10</sup>                  | –  |      | 9X                                 |               |
| 35  | UPC version A, 2 digits add-on <sup>10</sup> |  |      | add-on:<br>9-12X                   | add-on:<br>5X |
| 36  | UPC version A, 5 digits add-on <sup>10</sup> |  |      |                                    |               |
| 37  | UPC version E <sup>10</sup>                  |  |      | 9X                                 | 7X            |
| 38  | UPC version E, 2 digits add-on <sup>10</sup> |  |      | add-on:<br>9-12X                   | add-on:<br>5X |
| 39  | UPC version E, 5 digits add-on <sup>10</sup> |  |      |                                    |               |
| 40  | USPS POSTNET 5                               | 1/25 inch  |      | 1/8 inch                           |               |
| 41  | USPS POSTNET 6                               |  |      |                                    |               |
| 42  | USPS POSTNET 9                               |  |      |                                    |               |
| 43  | USPS POSTNET 10                              |  |      |                                    |               |
| 44  | USPS POSTNET 11                              |  |      |                                    |               |
| 45  | USPS POSTNET 12                              |  |      |                                    |               |

Table 32: Quiet Zones (Linear Symbolologies)

## B.2 2D Symbolologies

| No. | Barcode Symbology | Vertical quiet zone |        | Horizontal quiet zone |       |
|-----|-------------------|---------------------|--------|-----------------------|-------|
|     |                   | top                 | bottom | left                  | right |
| 92  | Aztec Code        | –                   |        | –                     |       |
| 74  | Codablock F       | 10X                 |        | 10x                   |       |
| 71  | Data Matrix       | 1 cell (1X)         |        | 1 cell (1X)           |       |
| 115 | DotCode           | 3 cells (3X)        |        | 3 cells (3X)          |       |

<sup>10</sup> In TEC-IT software, the quiet zones for this symbology are included in the barcode generation algorithm. You need no extra adjustments.

|     |   |              |              |
|-----|---|--------------|--------------|
| 116 | Han Xin Code  | 3 cells (3X) | 3 cells (3X) |
| 57  | MaxiCode  | 1 cell (1X)  | 1 cell (1X)  |
| 84  | MicroPDF417   | –            | 1X           |
| 97  | Micro QR Code   | 4 cells (4X) | 4 cells (4X) |
| 55  | PDF417  | 2X           | 2X           |
| 56  | PDF417 Truncated  |              |              |
| 58  | QR Code®  | 4 cells (4X) | 4 cells (4X) |
| 79  | GS1 DataBar Stacked<br>(RSS-14 Stacked)                                   | –            | –            |
| 80  | GS1 DataBar Stacked Omni directional<br>(RSS-14 Stacked Omni directional) |              |              |
| 81  | GS1 DataBar Expanded Stacked<br>(RSS Expanded Stacked)                    |              |              |

Table 33: Quiet Zones (2D Symbolologies)



## Appendix C: Extended Channel Interpretation (ECI)

### C.1 ECI Overview

Here a short overview about the available ECI specifiers for defining the encoding of subsequent bar code data (see also section 4.7.)

| ECI Number                              | Description  |
|---|--|
| ECI 000000 (equates to original GLI 0): | The lower half of the character set (decimal value 0 to 127) equates to ISO/IEC 646: 1991 IRV (equivalent to ANSI X3.4), the upper half (decimal value 128 to 255) equates to Code Page PC437.<br>ISO/IEC 15438 Bar code symbology specification-PDF417: Default character set to 1994 specification with GLI rules.   |
| ECI 000001 (equates to original GLI 1): | The lower half of the character set (decimal value 0 to 127) equates to ISO/IEC 646: 1991 IRV (equivalent to ANSI X3.4) and characters 128 to 255 being identical to those values of ISO 8859-1.<br>ISO/IEC 15438 Bar code symbology specification-PDF417: Latin 1 character set to 1994 specification with GLI rules. |
| ECI 000002                              | PC437 (code table equivalent to ECI 000000, without the reset-to-GLI 0 logic).   |
| ECI 000003                              | ISO 8859-1 (code table equivalent to ECI 000001, without the reset-to-GLI 0 logic).  |
| ECI 000004                              | ISO 8859-2 Latin-2 Central European  |
| ECI 000005                              | ISO 8859-3 Latin-3 South European  |
| ECI 000006                              | ISO 8859-4 Latin-4 North European  |
| ECI 000007                              | ISO 8859-5 Latin/Cyrillic  |
| ECI 000008                              | ISO 8859-6 Latin/Arabic  |
| ECI 000009                              | ISO 8859-7 Latin/Greek   |
| ECI 000010                              | ISO 8859-8 Latin/Hebrew  |
| ECI 000011                              | ISO 8859-9 Latin-5 Turkish   |
| ECI 000012                              | ISO 8859-10 Latin-6 Nordic   |
| ECI 000013                              | ISO 8859-11 Latin/Thai   |
| ECI 000015                              | ISO 8859-13 Latin-7 Baltic Rim   |
| ECI 000016                              | ISO 8859-14 Latin-8 Celtic   |
| ECI 000017                              | ISO 8859-15 Latin-9  |
| ECI 000018                              | ISO 8859-16 Latin-10 South-Eastern European  |
| ECI 000020                              | Shift JIS (JIS X 0208 Annex 1 + JIS X 0201)  |
| ECI 000021                              | Windows 1250 Latin 2 (Central Europe) 2001-02-12   |
| ECI 000022                              | Windows 1251 Cyrillic 2001-02-12   |
| ECI 000023                              | Windows 1252 Latin 1 2001-02-12  |
| ECI 000024                              | Windows 1256 Arabic  |
| ECI 000025                              | ISO/IEC 10646 UCS-2 (High order octet first)   |
| ECI 000026                              | ISO/IEC 10646 UTF-8  |

Table 34: ECI Numbers

▶ Character set overview: [https://en.wikipedia.org/wiki/ISO/IEC\\_8859-1](https://en.wikipedia.org/wiki/ISO/IEC_8859-1)