APPLICATION SOFTWARE

Original manual

RAYGUIDE

USER MANUAL

Document: MN_RAYGUIDE

Status of the information: V2.10 [2025-02-18]

CONTENTS

1 INTRODUCTION

1.1 About RAYGUIDE

RAYGUIDE is a software package for laser material processing. The powerful and flexible user interface makes designing and importing text, barcode and graphic elements simple, enabling the execution of sophisticated and extensive laser processing projects.

RAYGUIDE features two user interfaces:

- The graphical user interface (GUI). It makes it possible for users to manage complex laser processing jobs directly and without programming knowledge.
- The RAYGUIDE software development kit (SDK), a programmable interface based on the Microsoft .NET environment. This makes it possible to integrate the entire functionality of RAYGUIDE into a customized system application completely in line with customer needs.

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 control card. An emulated control card is also available.
- Support of multiple SP-ICE-3 control cards.
- 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 customized 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 serialization of barcodes and text.
- Sophisticated pen concept for maximum flexibility and assignment of process parameters.
- Parameter finders for quick determination of optimum application parameters.
- Definition of multi-slope power ramps plus ramp visualization.
- Support of MOTF processes, including various trigger and automated path sorting options.
- Support of combined workspaces when working with multiple control cards.
- Predefinition of laser processing jobs for control cards 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 protecting the area around the device from hazards caused by laser radiation. OEM customers must ensure compliance with all local and national regulations.

⚠ WARNING
Avoid unsafe laser operation Always switch on the PC before switching on the laser system. This prevents the laser from behaving in an uncontrolled and unforeseen manner when the PC is switched on. Check your application carefully before using the laser system. Damaged software can block the entire system and lead to uncontrolled operation of the laser or deflection unit. Safety instructions for these components can be found in the manuals for the laser system and deflection unit.

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, dialogs 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 dialog options (function buttons, checkboxes) are specified in italics: Select *Fixed*, if you ...
- Buttons are bold and in italics and shown in brackets: Click on ***[Apply]***.
- Buttons labeled 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 379, Glossary*.

1.6.1 Version reference

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

Manual version	RAYGUIDE version
V2.10	v2.18.0

1.7 Legal Information

Copyright

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

RAYLASE GmbH
Argelsrieder Feld 2+4
D-82234 Wessling
www.raylase.de

Phone:	+49 8153 9999 699
Fax:	+49 8153 9999 296
E-mail:	info@raylase.de

Customer Service

RAYLASE customer service will 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 a.m. to 5:00 p.m.
	UTC+1 (April to October: UTC+2)
Phone:	+49 8153 9999 297
E-mail:	support@raylase.de

2 INSTALLATION AND STARTUP

Requirements

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

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

  NOTE: Linux operating systems are not supported
- Minimum hardware requirements:
  - Microsoft .NET Framework Version 4.8 or higher
  - 8 GB RAM
  - 300 MB of free disk space

Control card

A control card is required for operation of a complete laser system.

NOTES:

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

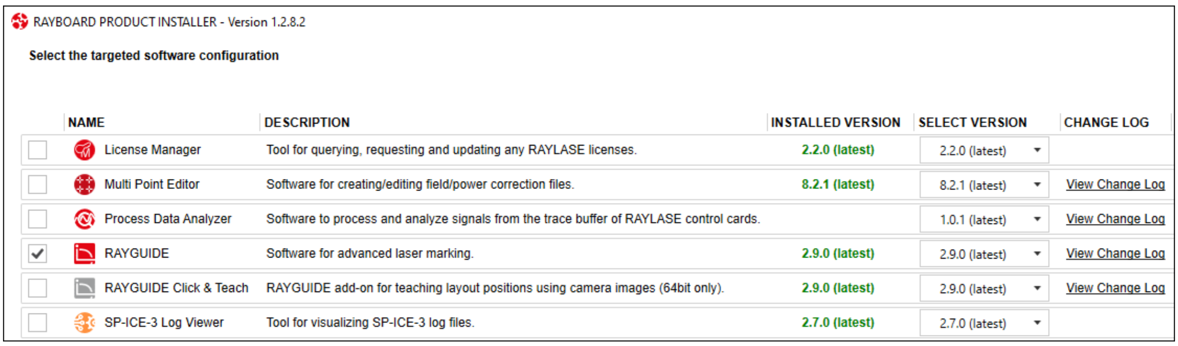


Fig. 2.1: S-AAA

You can use the direct link to the change log to get an overview of the latest changes to the previous version. The RBPI then downloads the RAYGUIDE installation file and displays the installation options.

The following installation options are available for RAYGUIDE:

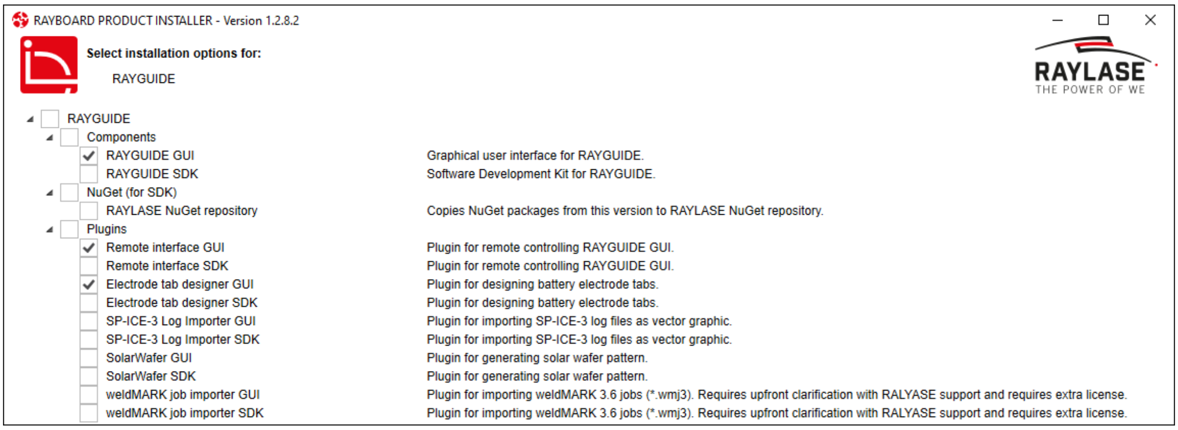


Fig. 2.2: RG-AES

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 343, 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.

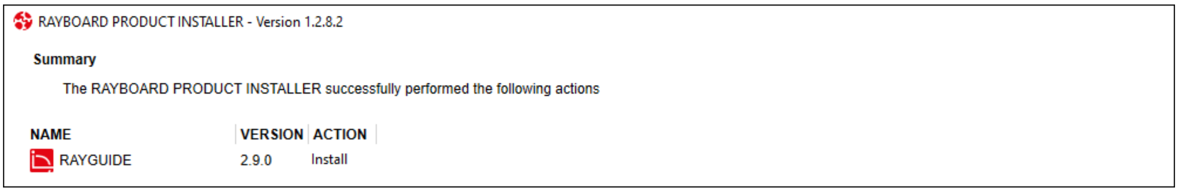


Fig. 2.3: S-AAB

The installation process creates the following folders by default:

- *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 license management is also installed.

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

Fig. 2.4: S-AAC

Starting software

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

Fig. 2.5: S-AAC

NOTE: When RAYGUIDE **is started for the first time**, the main GUI is displayed but no devices are configured and are therefore not available for use. For details on device configuration, see *page 42, 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 customized laser processing applications, which are 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 > License > Generate license request...***, and send the generated file to RAYLASE (license@raylase.de). RAYLASE will return an activation file which can be imported by selecting ***Help > License > Activate license***.

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 expiration of the runtime, it is possible that new features will not automatically be 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 license products

If you want to add additional license products to your existing license, please get in touch with your sales contact. We only need the serial number of your license. You can then import the license extension file (*.WibuCmRaU) via ***Help* > *License* > *Activate license***.

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 use the RAYBOARD PRODUCT INSTALLER for this purpose 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

4.1.1 User interface

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

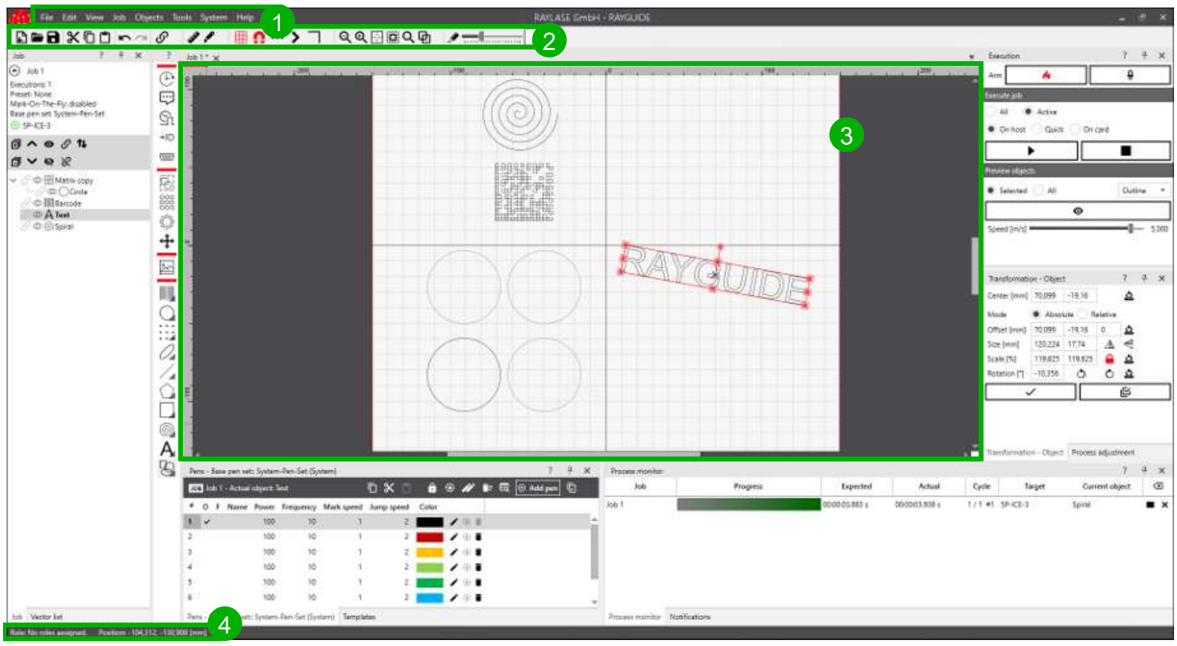


Fig. 4.1: RG-AAI

Menu

① The main menu provides access to all important functions. For details, see *page 23, Menu*.

Toolbar

② The buttons in the toolbar offer shortcuts to program functions. For details, see *page 24, 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 32, 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 panels. They can be presented and moved to various places of the GUI. For details, see *page 35, Panels*.

Dialogs

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

Online help

All dialogs and panels have 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.

Table. 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

Table. 4.2: RG-002

4.1.2 Simplified user interface

Users who find the standard user interface too complex can change the overall view and the pen dialog to a simplified view.

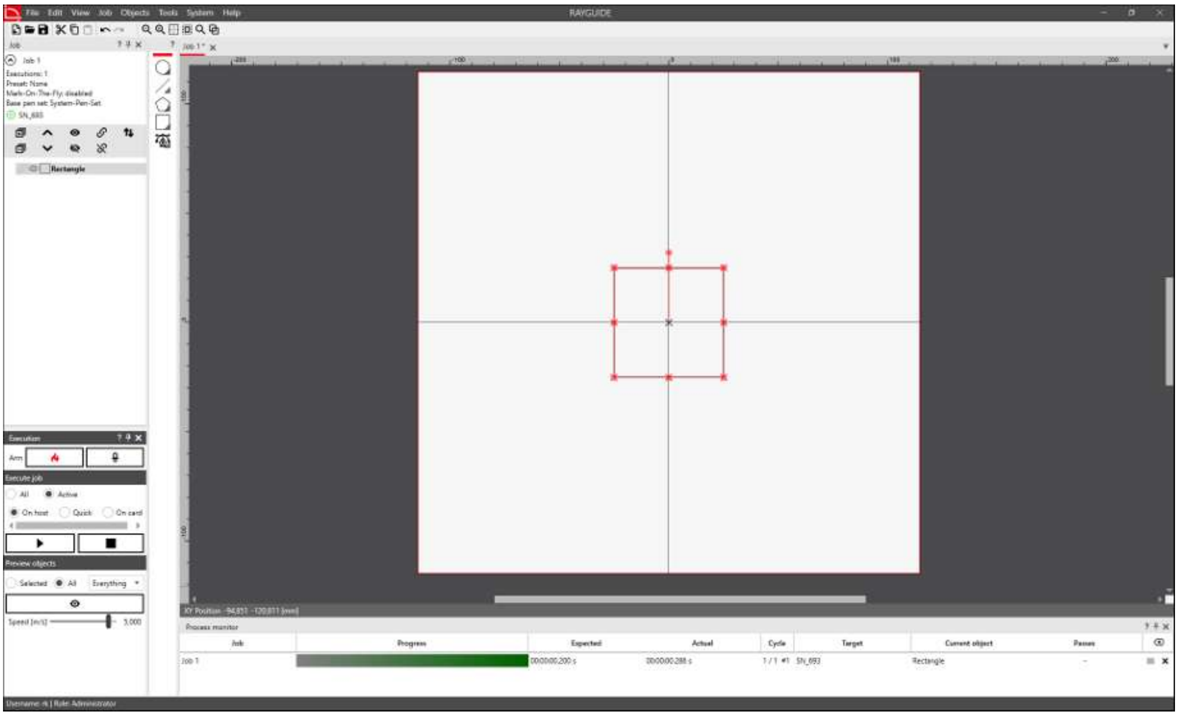


Fig. 4.2: RG-AFL

For the procedure, see *page 29, View Options*.

4.2 Menu

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

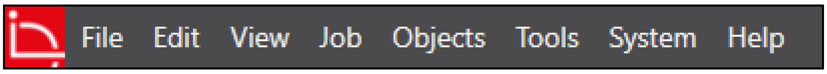


Fig. 4.3: RG-AAJ

Some standard functions of the software require no further explanation.

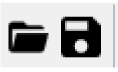
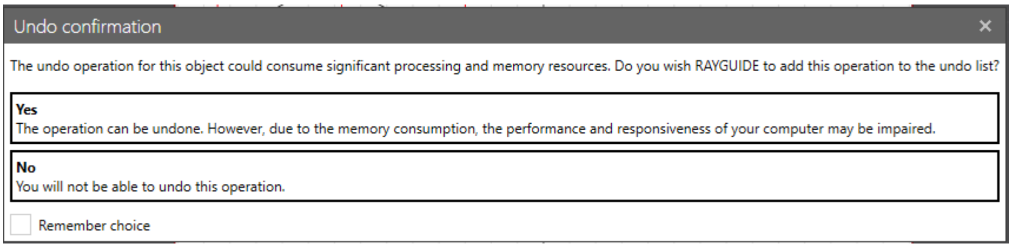
- The ***File*** menu refers to common job file tasks. RAYGUIDE job files will be saved with the file extension *.rg. The menu also offers the option of importing layout objects and exporting jobs to other file formats such as DXF.

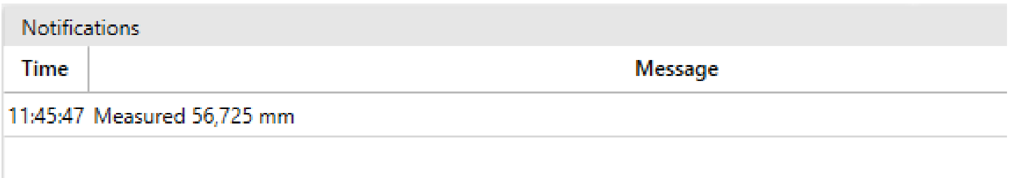
  NOTE: Bitmap elements are not included in the export, while text elements are exported as vector graphics.
- The ***[Edit]*** menu contains common operations that can be applied to the selected objects. This menu also contains the "Click to modify" object transformations. For details, see *page 24, Toolbar*.
- The ***View*** menu is described in *page 29, 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 125, Graphic job design*). In addition, available templates are listed for each object type (see *page 243, Templates*).
- The ***Tools*** menu provides access to the “Distance measurement”, “Split object” and “Parameter finder” tools (see *page 268, Pen parameter finder* and *page 305, 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 108, 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 license management. You can also launch an email with all relevant information automatically attached and send it to your support contact. For more information, see *page 373, Error messages*.

Applicable keyboard shortcuts are shown behind most menu options.

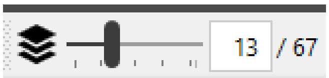
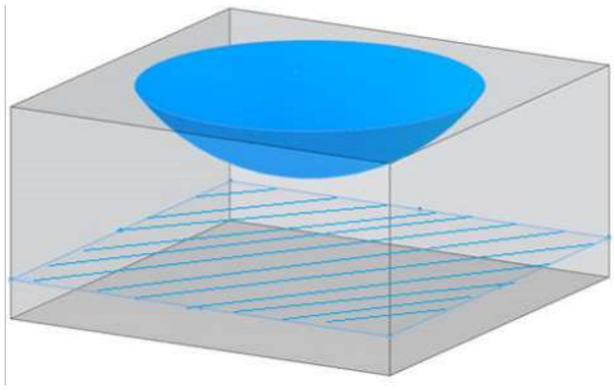
4.3 Toolbar

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

Tool	Explanation
Jobs	
	Adds a blank job document.
	Opens / Saves a job document.
[Cut], Copy, [Paste]	
	Cuts, copies and pastes selected items.
Undo, Redo	
	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). 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. That is why the software may prompt you with the following query.  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. The saved selection can be found again via ***Preferences > User (current user) > UI*** (see*page 105, UI*).
	Lock / Unlock workspace. This option locks all (current and new) layout objects in the viewport against mouse operation. Applies to all open jobs.

Tool	Explanation
Extras	
	Tool to **measure** distances. Click once on the start point of the distance to be measured, 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. Keep ***[Shift]*** pressed to measure horizontal / vertical only. Keep ***[Ctrl]*** pressed to stay in measurement mode, e. g. for subsequent measures. The cursor icon indicates the measurement mode by switching from “arrow” to “crosshairs”. After each measurement, the distance is: ■ Temporarily shown in the status bar ■ Noted in the notifications panel:  To measure an exact distance from one thumb to another thumb, please refer to the context menu of the thumb. For details, see *page 225, More Object-related Operations in the Context Menu*.
	**Splits** the selected objects. Any selected object can be split into two parts. 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 ***[Shift]*** to get a horizontal / vertical line.) The object will be split now. **NOTE:** All objects that are content based (e.g. text, codes) produce vector-based parts after splitting. **NOTE:** Fillings of split objects lose their fill attribute, and are created as part of the object geometry in a new layer of their own. **NOTE:** Containers as a whole cannot be split with this tool. However, multiple objects can be selected.

Tool	Explanation
	Pen parameter finder, see *page 268, Pen parameter finder*.
	MOTF parameter finder, see *page 305, MOTF parameter finder*.
Zoom 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.	
Display options Toggle buttons to enable / disable the use of the main display options. For details, see *page 29, View Options*.	
	Display grid
	Display guidelines
	Display jumps
	Display vector tips
	Display sharp corners

Tool	Explanation
Stroke width	
	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. Use the slider or enter a value in the input field. Use the ***[Reset]*** button to reset to default.
Slice navigator [1]	
	Use the navigator to select the index of the slice from the solid that can be seen in the viewport. **NOTE:** When using a solid file with a negative form, the slice may be empty as soon as you navigate under the negative form. <u>Example</u>: 
Opacity	
	The sliders can be used to adjust the opacity of the background images.

[1] This toolbar is hidden by default. It can be activated via ***View* > *Toolbar***.

Tool	Explanation
Click-to-fit [1] **NOTE:** With all three variants, after the *Click-to-fit* action the resulting transformation is displayed in the Notifications panel.	
	Shifting and rotating (transformation 1) Adapts the position of the selected objects by manually picking two source points and then picking two target points. The object selection is not scaled.
	Shift, rotate and scale with the same factor for X/Y (transformation 2) Adapts the position and size of the selected objects by manually picking two source points and then picking two target points. The scale factors are the same for both dimensions (X/Y).
	Shift, rotate and scale with different factors for X/Y (transformation 3) Adapts the position and size of the selected objects by manually picking three source points and then picking three target points. The scale factors are independent of each other for both dimensions (X/Y).

Table. 4.3: RG-003

The tool bar is subdivided into groups that can be shown and hidden independently. See *page 29, 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:

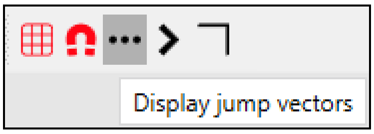


Fig. 4.4: RG-AAK

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	Switches the display of viewport grid lines on or off. The grid spacing automatically adjusts to the zoom level.
Guidelines	Select this menu item to show / hide the guidelines.
Jump vectors	Switches the display of the jump vectors on or off. The display shows all jumps within and between all current layout objects. A limit for the display can be defined in ***System*** **>** ***Preferences*** **>** ***System (all users)*** **>** ***UI***.
Vector tips	Switches the display of vector sequences / directions of all current layout objects on or off. A circle also marks the starting point of the object. A limit for the display can be defined in ***System*** **>** ***Preferences*** **>** ***System (all users)*** **>** ***UI***.
Sharp corners	Switches the highlighting of specific vector transitions in all layout objects on and off. Useful, for example, when the skywriting feature is active to see which vector transitions are effected, depending on its “change of heading angle”. Unintentional u-turns of consecutive vectors can also be highlighted. The angle limit to define a “sharp corner” must be set in ***System*** **>** ***Preferences*** **>** ***System (all users)*** **>** ***UI***.
GUI Appearance	Select here whether the entire GUI (panels, object bar, toolbar) should appear in the standard view or in a predefined, simplified view. **NOTES:** ■ The software has to be restarted one time to change the type of view. ■ If you want to display other GUI elements in addition to the simplified view and save this status as your customized mode and reuse it, see *page 108, Saving / Restoring system settings*.

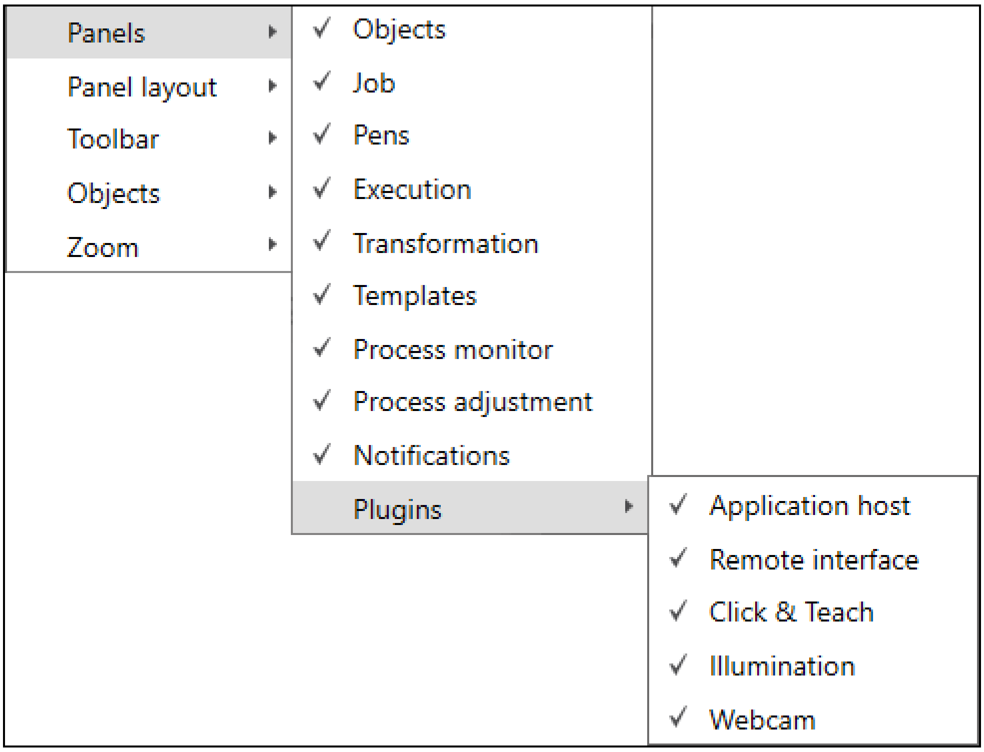
Setting	Explanation
Panels	Switches the display of the various panels on or off. All panels that belong to plug-ins or have been implemented by users are summarized under the ***Plugins*** category. 
Panel layout	Offers a sub-menu to store / load panel arrangements per user. You also find options to ***[Reset]*** 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.
Zoom	Provides a sub-menu for using the various zoom functions.

Table. 4.4: RG-004

Related presets

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

Setting	Explanation
System (all users) > UI	
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 [pixels]	Radius (in pixel) of the circle that highlights path starts and sharp corners
User (current user) > UI	
Jump vectors in pen color	Displays the jumps in the color of the pen that also defines the jump parameters – if the display option “show jumps” is activated.

Table. 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.

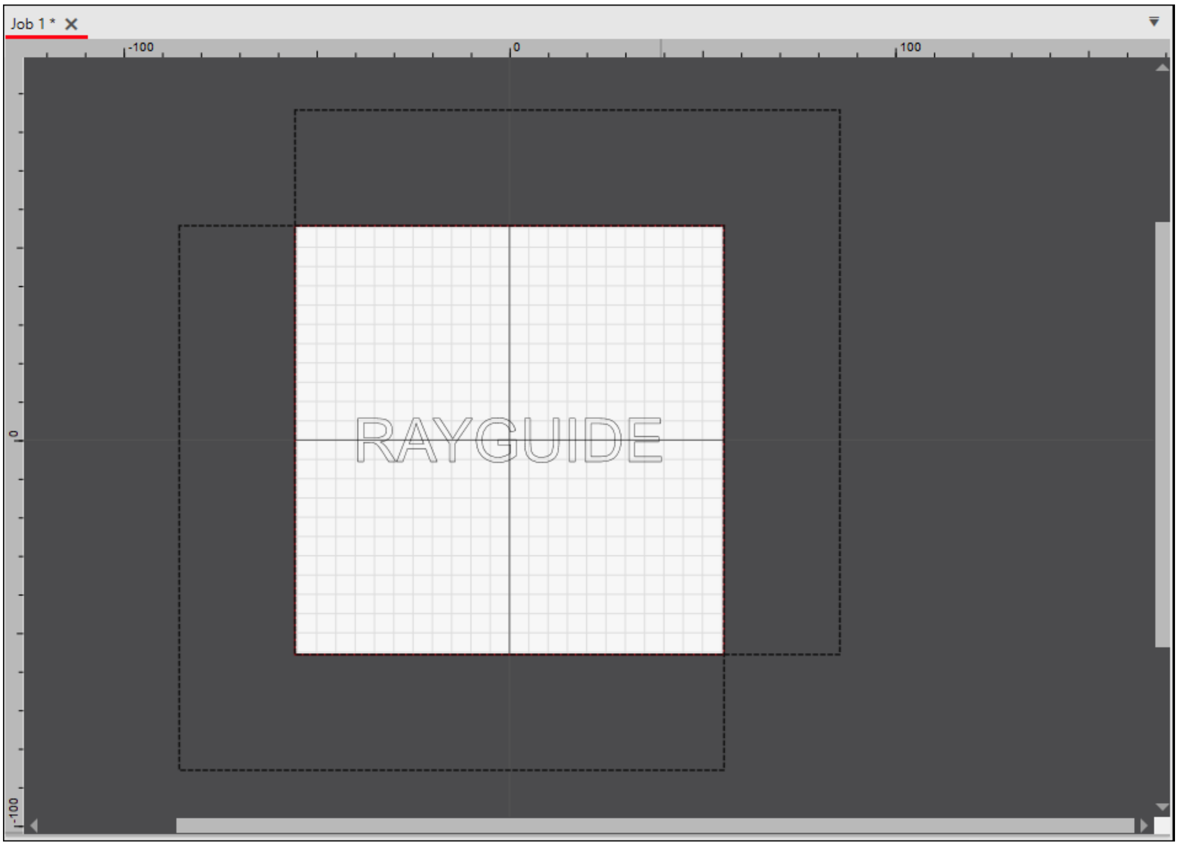


Fig. 4.5: RG-AAL

As an example you see two 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 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.
- 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.

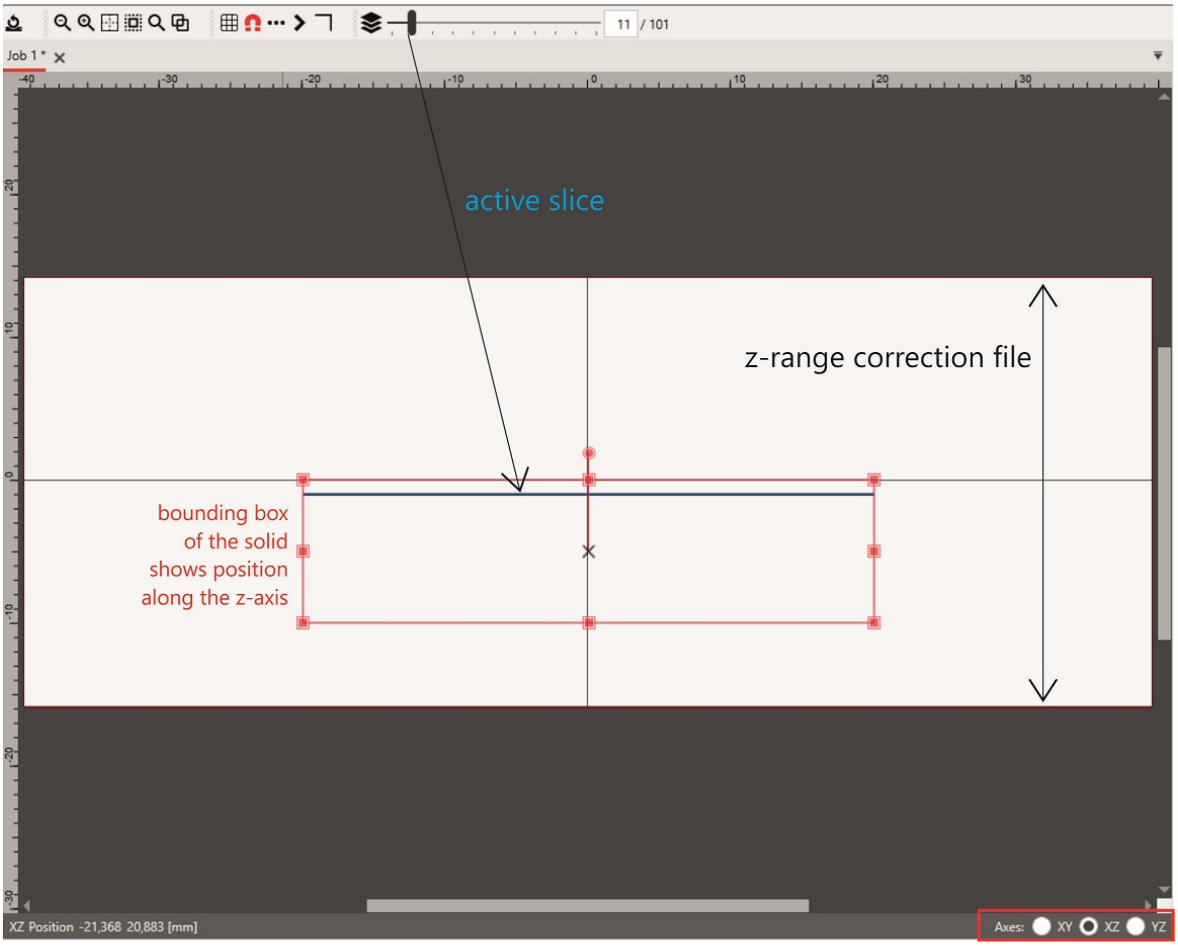


Fig. 4.6: RG-AEM

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.

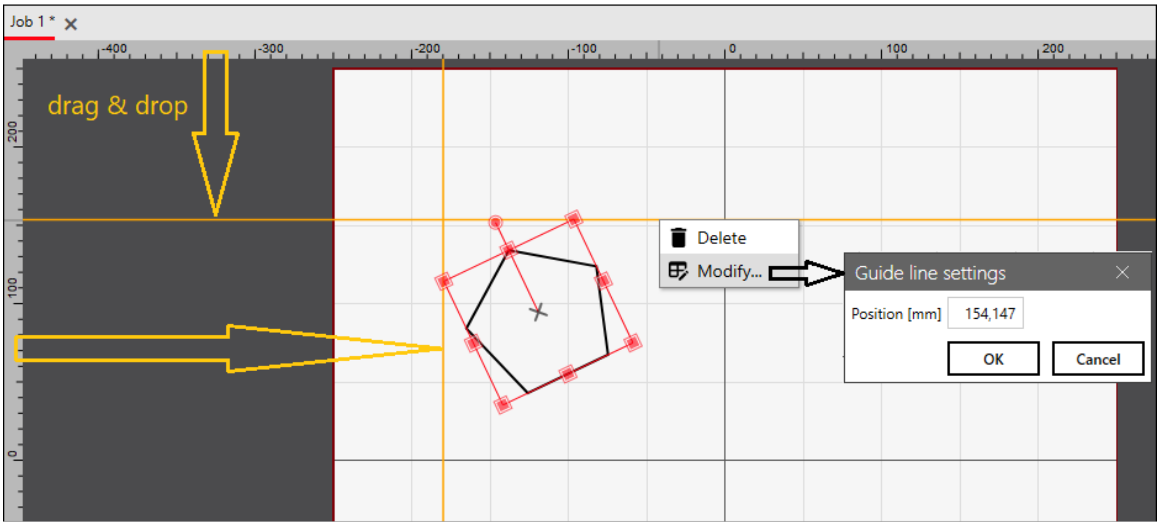


Fig. 4.7: RG-ADH

- 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 behavior” of guidelines, press the ***[Alt Gr]*** key.

4.6 Panels

Program functions are available on a variety of panels.

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

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

Available panels

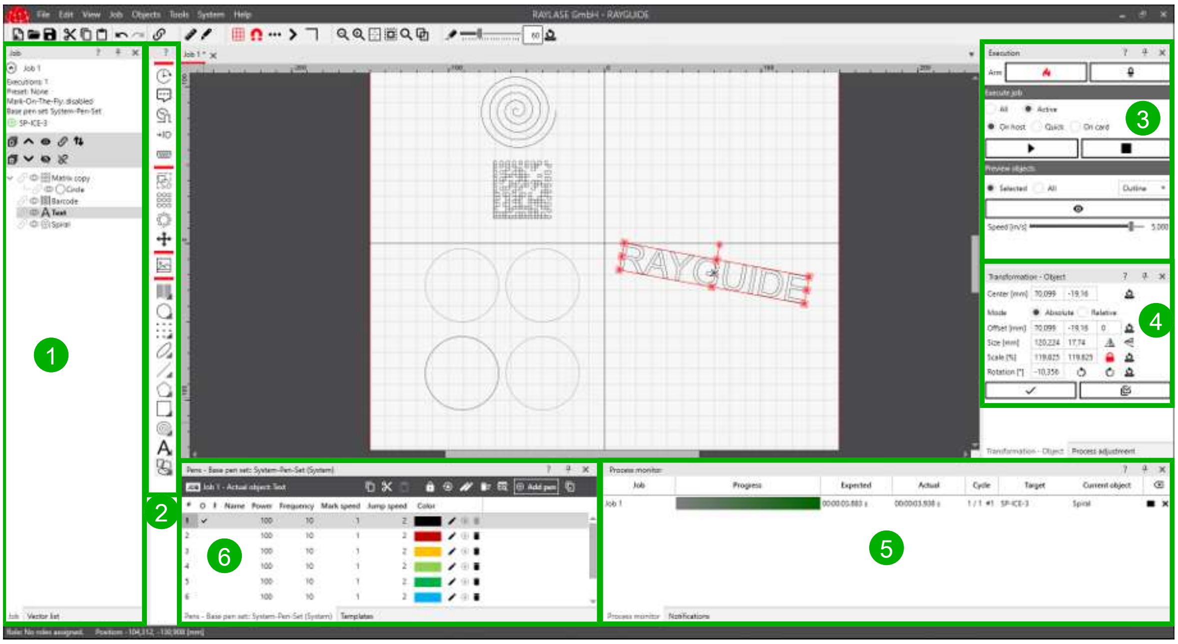


Fig. 4.8: RG-AAM

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 125, Graphic job design*)

or ***Vector list***: List of graphic commands (see *page 125, Graphic job design*)

② ***Objects*** (see *page 125, Graphic job design*)

③ ***Execution*** (see *page 316, Running a Job*)

④ ***Transformation*** (see *page 190, Object Transformation*) or ***Process adjustment*** (see *page 337, Process Adjustment*)

⑤ ***Process monitor*** (see *page 323, Process Monitor*)

⑥ ***Pens*** (see *page 245, Process Parameters (Pens)*) or ***Templates*** (see *page 243, Templates*)

⑦ ***Notifications***: Table which traces the latest RAYGUIDE status information.

In addition, a custom user-defined panel can be activated. This panel hosts controls which could be added by customer-specific plug-ins (see *page 371, 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 show or hide 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.

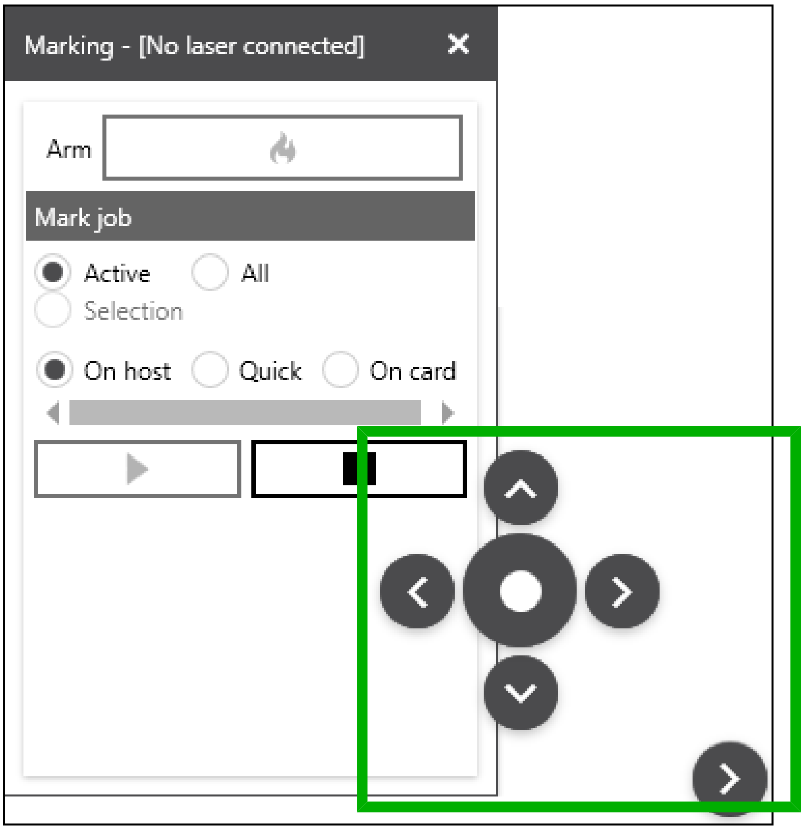


Fig. 4.9: RG-AAN

- To dock the panel beside another panel, drag the mouse point to one of the arrows and release it there.

  The circle in the center 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 button with the pin icon on the panel title bar to minimize the panel to a sidebar (pin bar). Click the tabs of the pin bar to maximize a panel at the previous position.
- Use the ***[x]*** button on the panel 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. That means 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.

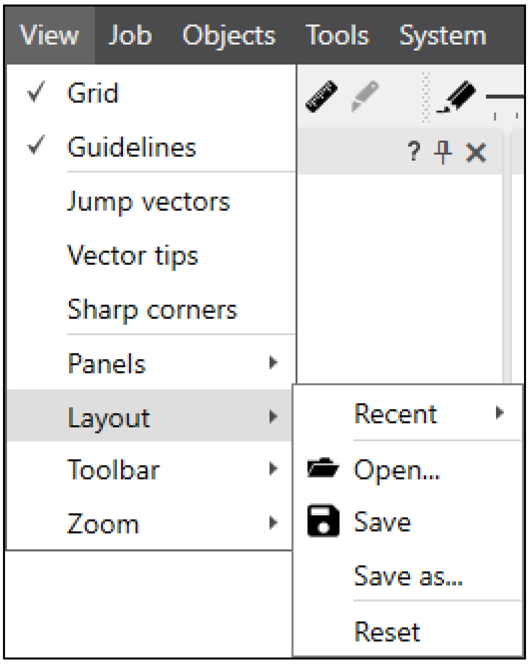


Fig. 4.10: RG-AAO

4.7 Buttons, Icons, Shortcuts

Text Buttons

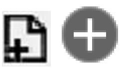
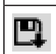
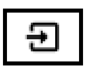
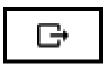
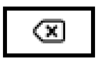
Throughout the GUI and its dialogs, text buttons are used for common functions:

Button	Meaning
OK	Activates the setting changes and closes the dialog.
Apply	Activates the setting changes without closing the dialog.
Cancel	Discards the setting changes and closes the dialog.
Other buttons are labeled appropriately.	

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

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

Button / buttons	Referenced as	Function
	[Stop]	Stops processing.
	[Search]	Searches the network for control cards.
	[Connect] / [Disconnect]	Connects to or disconnects from the control cards (IP address).

Table. 4.7: RG-007

Toggle buttons **Some icon buttons serve as toggle switches. Clicking them activates/deactivates the function. In some cases the icon turns red when activated.**		
	[Auto connect at startup]	Automatically connect to the control card when the program starts.
	[Pointer]	Activates the pilot laser.
	[Arm/Disarm]	Arms and disarms the laser. An armed laser is ready for operation.
	[Preview]	Starts / stops a preview.
	[Show pen]	In pen panel: Activates / deactivates the color highlighting of elements in the tree structure that use the selected pens.
Transformation buttons Buttons used for object transformation on the Process adjustment panel are described separately, see *page 337, Process Adjustment*.		

Table. 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]	**Start** preview
[F10]	Enable marking with keyboard shortcuts
[F11]	Job settings
[Ctrl]+[F11]	Job presets
[Ctrl]+[F12]	Stand-alone mode dialog

Table. 4.9: RG-009

5 DEVICE CONFIGURATION AND CALIBRATION

Before you use RAYGUIDE to define and execute laser processing jobs or other tasks, the system devices must be configured. Four types of devices are available:

- Control cards
- Lasers
- Deflection units and
- System / Serial computer controls

Recommended workflow

The hardware devices must be configured according to their interfaces, properties and optical setup. Carry out all the steps listed below in any order you want.

Add the device to the *Configured Devices* area in the device configuration window.

Step 1 In the menu, select ***System*** > ***Devices*** > ***Configure...***, or press ***[F3]***.

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

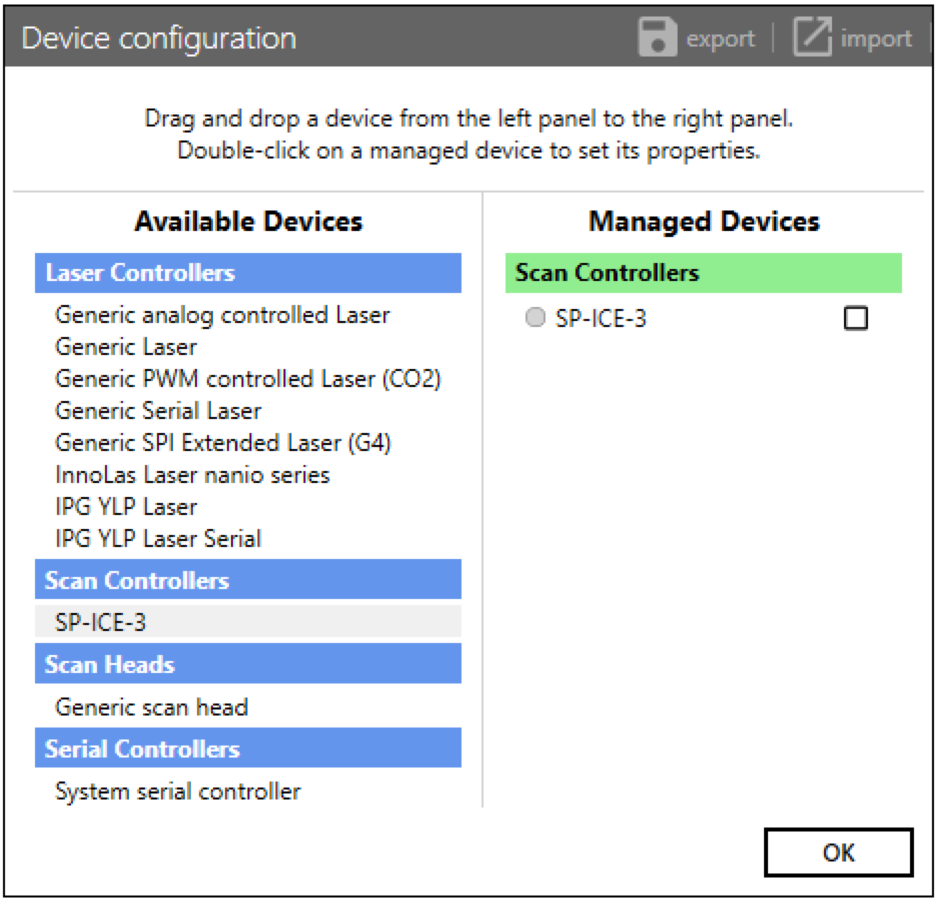


Fig. 5.1: RG-ADT

Configuration window with sample content:

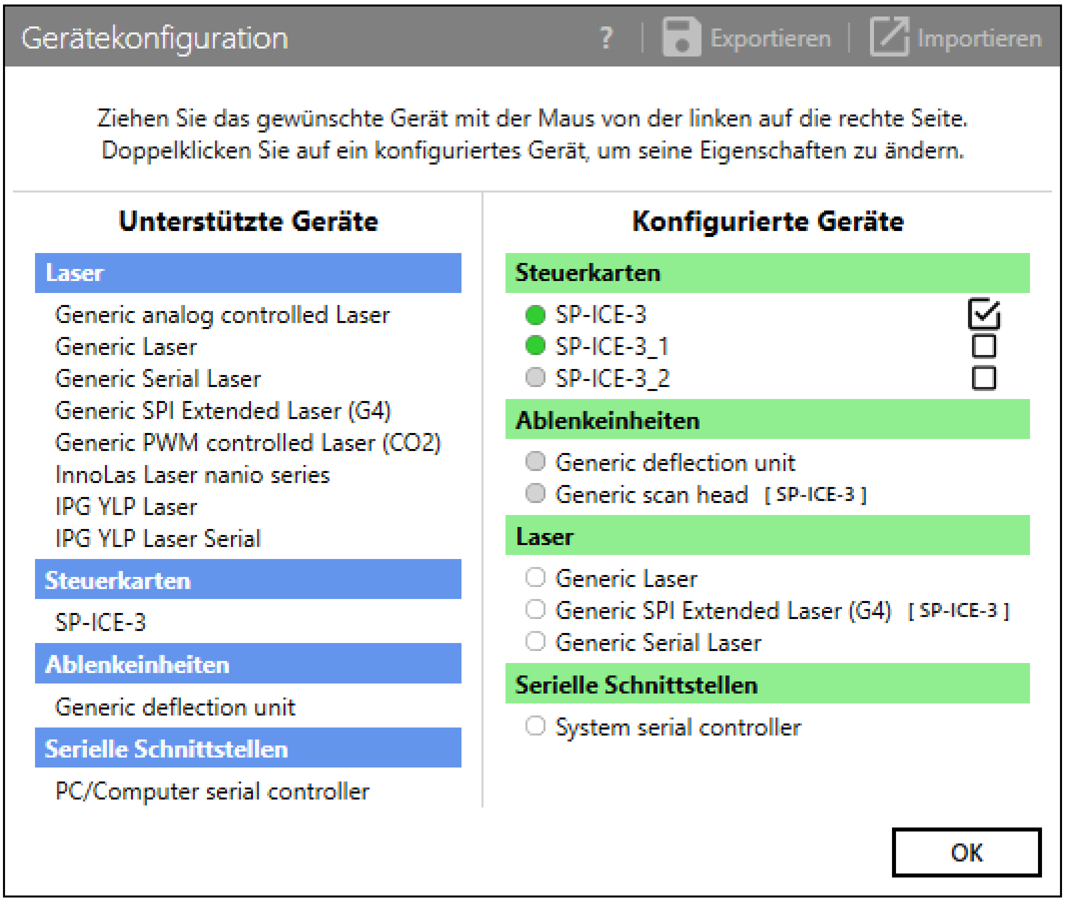


Fig. 5.2: RG-AAP

To add devices such as a control card or a laser, use the mouse to drag the device out of the **Supported Devices** window area into the **Configured Devices** area. You can add a supported device type to the *Configured Devices* area multiple times.

NOTE: We recommend adding at least one control card.

Step 2 Configure the device. Double-click on the device entry to open its configuration dialog box.

The various settings and options in the configuration dialogs are described in the following sections of this manual.

Step 3 The control card must know which devices it should communicate with. That is why you have to assign a laser and a deflection unit to the control card as follows:

- Navigate to the control card configuration dialog and select the appropriate device from the drop-down list for lasers and deflection units. The configuration dialog box of the control card lists all devices that are currently in the Configured devices area.
- Use the ***[Edit]*** button to configure the device (if not already done).

Result: Once the devices have been linked to a control card, the short name of the card is displayed after the device entry in the device configuration overview.

Color coding: For the color coding of the traffic light display, see *page 126, Job Panel*.

The check mark behind the control card indicates that this control card and the devices linked to it are defined as primary devices. If several control cards are used, you can change the definition of the primary devices by moving the check mark.

5.1 Scan Controller Configuration

Open the control card configuration dialog. There are three options here:

- 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***.
- In the menu, select ***System > Devices > Scan controllers > (Device name)***.
- 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.

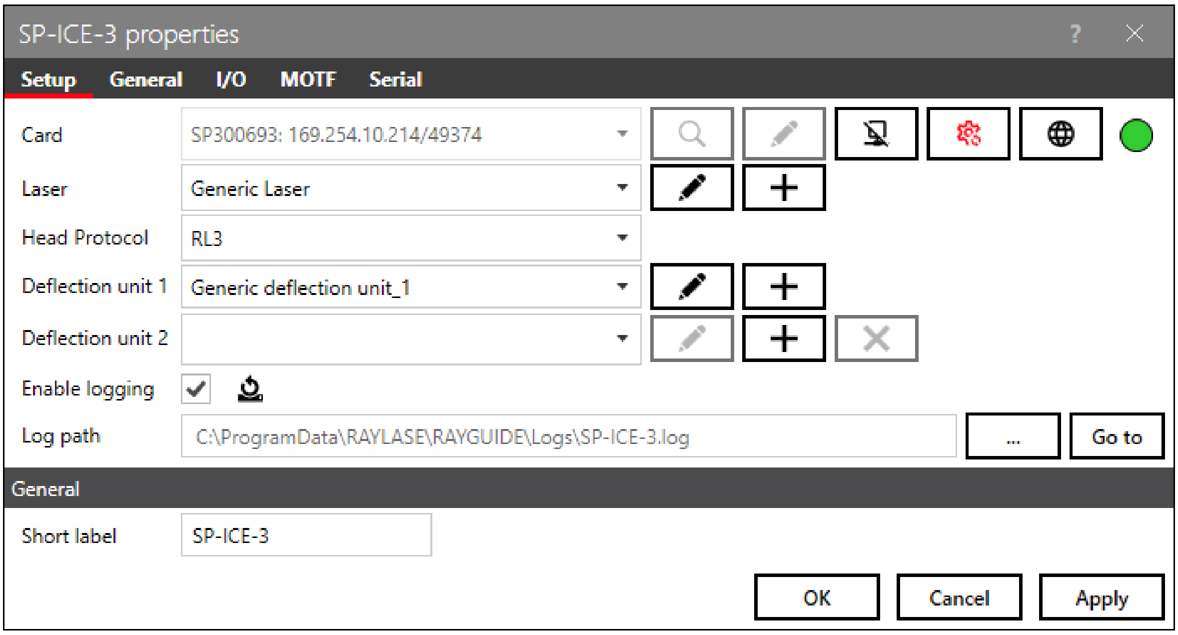


Fig. 5.3: RG-AAQ

Setting	Explanation
Card	Name and IP address of the control card. Click on the ***[Search]*** button to search for available control cards. The control cards available in the network are listed together with their serial numbers and IP addresses. Identify the SP-ICE-3 control card based on its serial number and select it. In most cases, each control card is listed once with its IP4 address and once with its IP6 address. **NOTE:** Which IP address family is selected for the control card does not affect the connection speed of the control card. Alternatively, you can click on the ***[Edit]*** button to add a control card by directly entering your IP address. Click on the ***[Connect] / [Disconnect]*** button to connect or disconnect a control card. An active connection to the control card is indicated by a green “traffic light”. If you are setting up a system with several control cards, repeat this step for each control card and its individual configuration dialog. ***[Auto connect at startup]*** toggle switch specifying whether the control card should be automatically connected when starting RAYGUIDE. If you disconnect from the card and do not want the system to automatically reconnect to the card the next time you start the program, you must deactivate this button. The button is activated by default. Click on ***[Webinterface]*** to access the web interface of the control card. For instance, this interface can be used to update the firmware of the control card. You can find more information in the manual of the SP-ICE-3.
Laser	Select a suitable laser to be controlled by the control card. Click on the ***[Edit]*** button to open the laser dialog. Click on the ***[Add]*** button to add another laser device to the list of configured devices.

Setting	Explanation
Head Protocol	Select a suitable protocol for the deflection unit. This protocol defines the command resolution and the number of controllable axes. ■ XY2: – Log with a resolution of 16 bits – Can control up to 3 axes – Requires an additional XY2-100 adapter card on the SP-ICE-3 – Only “Single head” mode – Supports feedback channel ■ SL2: – Log with a resolution of 20 bits – Can control 2 axes per protocol port/cable. Two SL2-100 connections (and two cables) are required for a deflection unit with 3 or 4 axes – “Dual head” mode possible – Supports feedback channel ■ RL3 – Log with a resolution of 20 bits – Can control 6 axes per control port / cable (a deflection unit with up to 6 axes can be run on a single data connection) – “Dual head” mode possible – Supports feedback channel **NOTE:** The subtype of the protocol is defined by the correction file selected in the deflection unit dialog box.
Scan head 1	Select the type for the first deflection unit. Click on the ***[Edit]*** button to open the dialog for the deflection unit. Click on the ***[Add]*** button to add another deflection unit to the list of configured devices.
Scan head 2	Select the type for the second deflection unit. This only applies if you have selected a protocol that contains “Dual head”. Click on the ***[Edit]*** button to open the dialog for the deflection unit. Click on the ***[Add]*** button to add another deflection unit to the list of configured devices.

Setting	Explanation
Enable logging	Activates the SP-ICE-3 API log. The log file records all SP-ICE-3 API commands sent to this control card. This is decisive for error analysis. See *page 373, Error Handling and Log Files*. Click on ***[Reset]*** to reset the log file.
Log path	Path to the log file. Click on ***[...]*** to select a path, or click on ***[Go to]*** to open the corresponding folder.
Short label	A name for this control card that is easy to remember. Naming the control card according to its function or assignment in the system is recommended so that it can be easily identified later.

Table. 5.1: RG-010

5.1.2 General

Basic information about the scan controller.

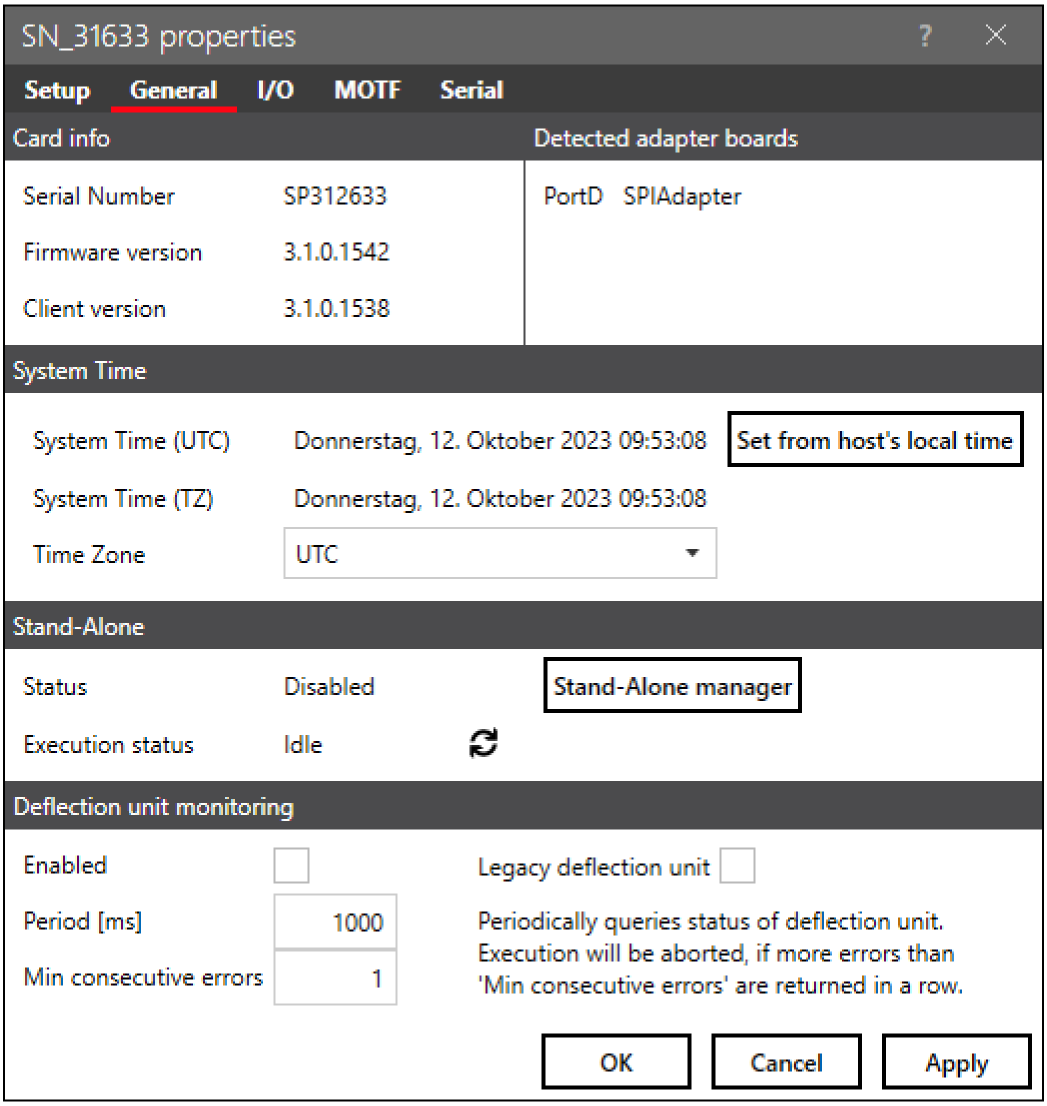


Fig. 5.4: RG-AAR

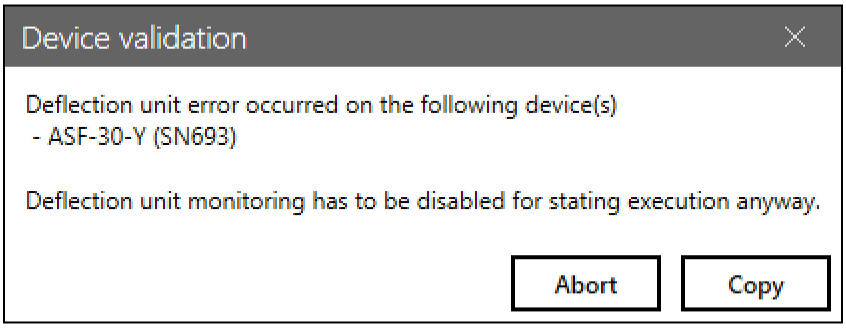
Setting	Explanation
Card Info	Display of the major control card information such as its serial number and firmware version.
Detected adapter boards	Displays the IO ports and connected adapter cards (if detected). **NOTE:** For details on the adapter cards, see the manual of the SP-ICE-3 control card.
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. The ***[Preferences]*** button takes you directly to the dialog of the stand-alone configuration.
Deflection Unit Monitoring	**NOTE:** 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”. The cause for the termination can also be communicated to external devices using the "Error handling" option. See *page 326, Automated Error Handling*. **NOTE:** If monitoring is activated, the status is also checked separately before the execution of each job. If it is faulty, job execution is not started and the following validation message appears: 
Enabled	Activates the control card to monitor the status of the connected deflection unit by querying its head status word.
Legacy deflection unit	Select this option to also be able to use the monitoring for deflection units that do not support the so-called "Enhanced Protocol". For instance, this includes deflection units of the *MS-II* or *SS-IIE* series.
Period	Time interval, in which the card is querying the status word. **NOTE:** 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.

Table. 5.2: RG-076

5.1.3 I/O Port Configuration

Used to configure the I/O ports ***SP-ICE-3*** of the control card.

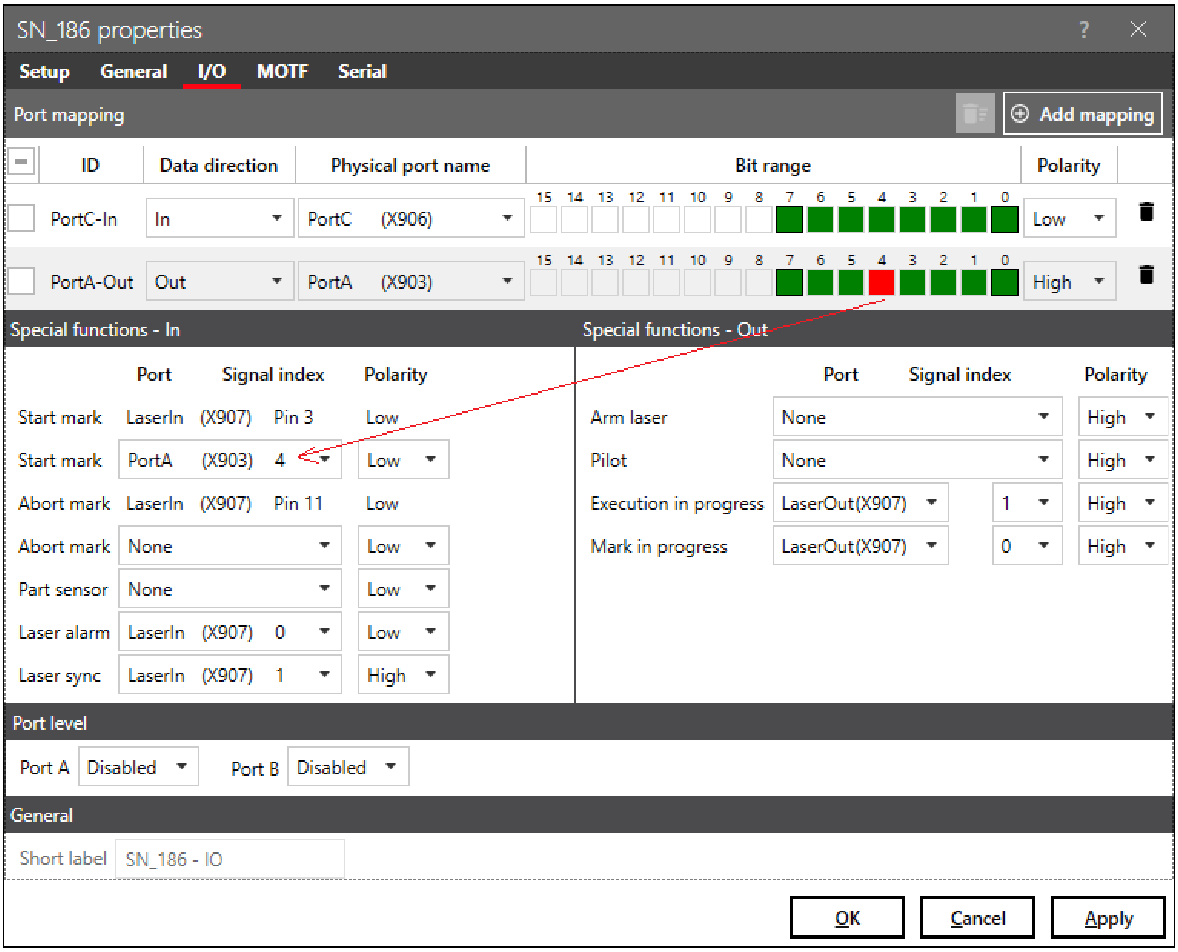


Fig. 5.5: RG-AAS

Setting	Explanation
Port mapping	
Click on ***[Add mapping]*** 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. **CAUTION:** Existing references to this port, for example in automation objects, are cleared when the ID is changed.

Setting	Explanation
Data direction	Select ***In*** if the port receives signals from another device, or ***Out*** if the port provides signals for other devices. **NOTE:** Some I/O ports of the SP-ICE-3 control card can be split into an input and an output section.
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 control card.
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. Color code: ■ Green: Marks the selected bit range. To resolve the range, click on the outermost marked box. ■ Gray: This bit has already been assigned elsewhere. ■ Red: This bit was assigned twice!
Polarity	Use the polarity to define whether a logic "1" is applied at 0 V=Low or 5 V=High.
[Delete]	Click on the ***[Delete]*** button to delete the corresponding port configuration.
Special functions In / Out	
In ■ Start mark ■ Abort mark ■ Part sensor ■ Laser alarm ■ Laser Sync	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. **NOTE**: The SP-ICE-3 control card provides two dedicated pins on the *Laser In* (X907) port for the input of the start / stop signal, which then do not require any configuration. Define the signal polarity in the second drop-down list. **NOTE:** If you set the I/O pins for the Start mark, Abort mark, Part sensor, Laser alarm, Laser Sync inputs to “High Active” but do not connect anything (= floating state), you 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.
Out ■ Arm Laser ■ Pilot ■ Mark in progress ■ Marking active	

Setting	Explanation
Port level	
Port A / Port B	Select the value of the port level to be 0 V, 3,3 V or 5 V.
General	
Short label	Enter a name to identify which ports are associated with which control card.

Table. 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 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, meaning it 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. That means 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 328, Setting up the stand-alone card operation* and *page 171, 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 bet 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

Use this tab to configure the necessary settings if your application requires “Mark-On-The-Fly”.

For details, see *page 295, 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.

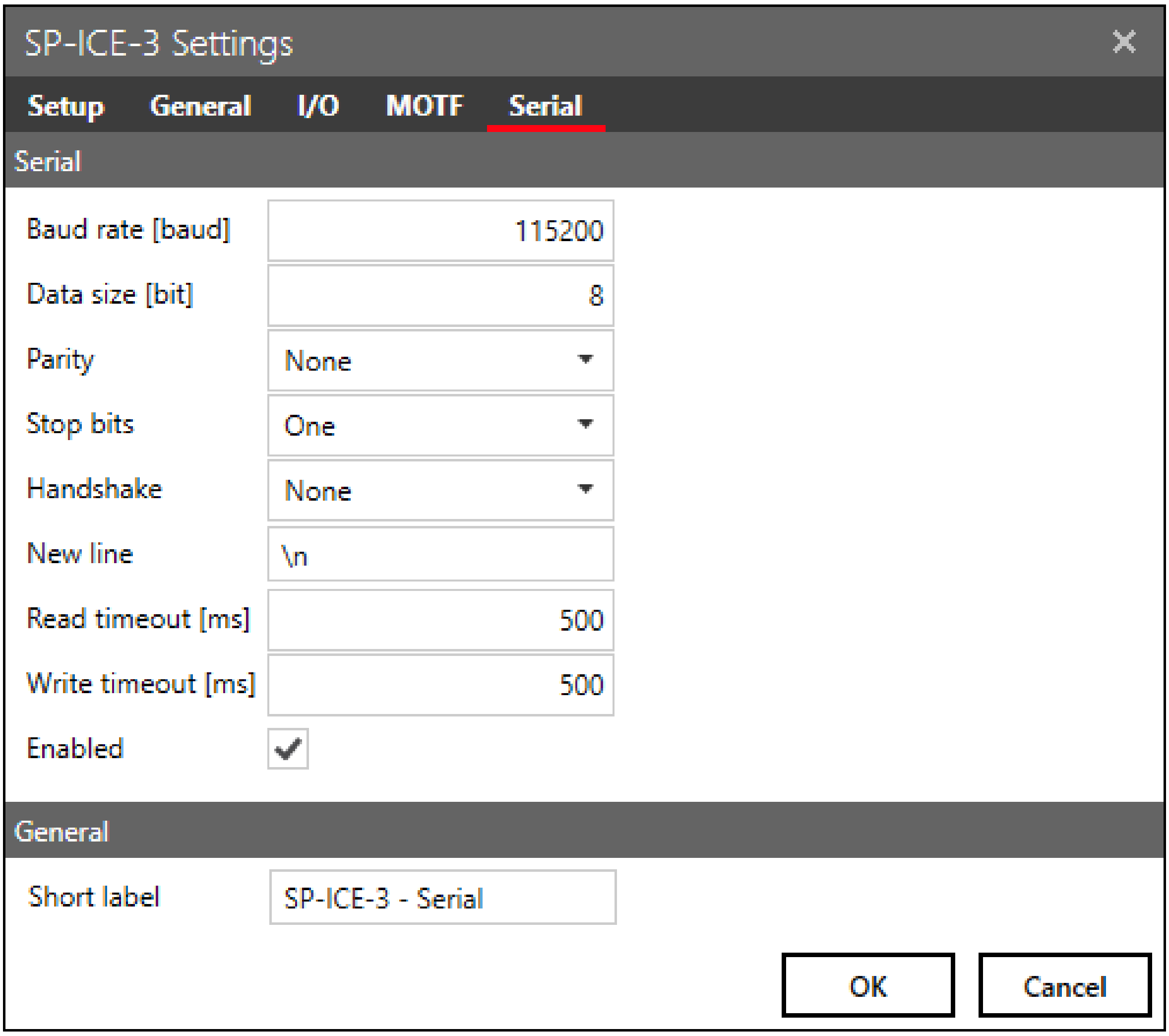


Fig. 5.6: RG-AAT

5.2 Laser Controller Configuration

Open the configuration dialog box for laser control. There are three options here:

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

NOTE: Some laser types offer special control options and therefore 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
nLight SFX	Second laser power
Coherent Highlight ARM	Second laser power, automatic IO configuration of the control card

Table. 5.4: RG-082

The configuration dialog for lasers shown below includes all conceivable (generic) settings.

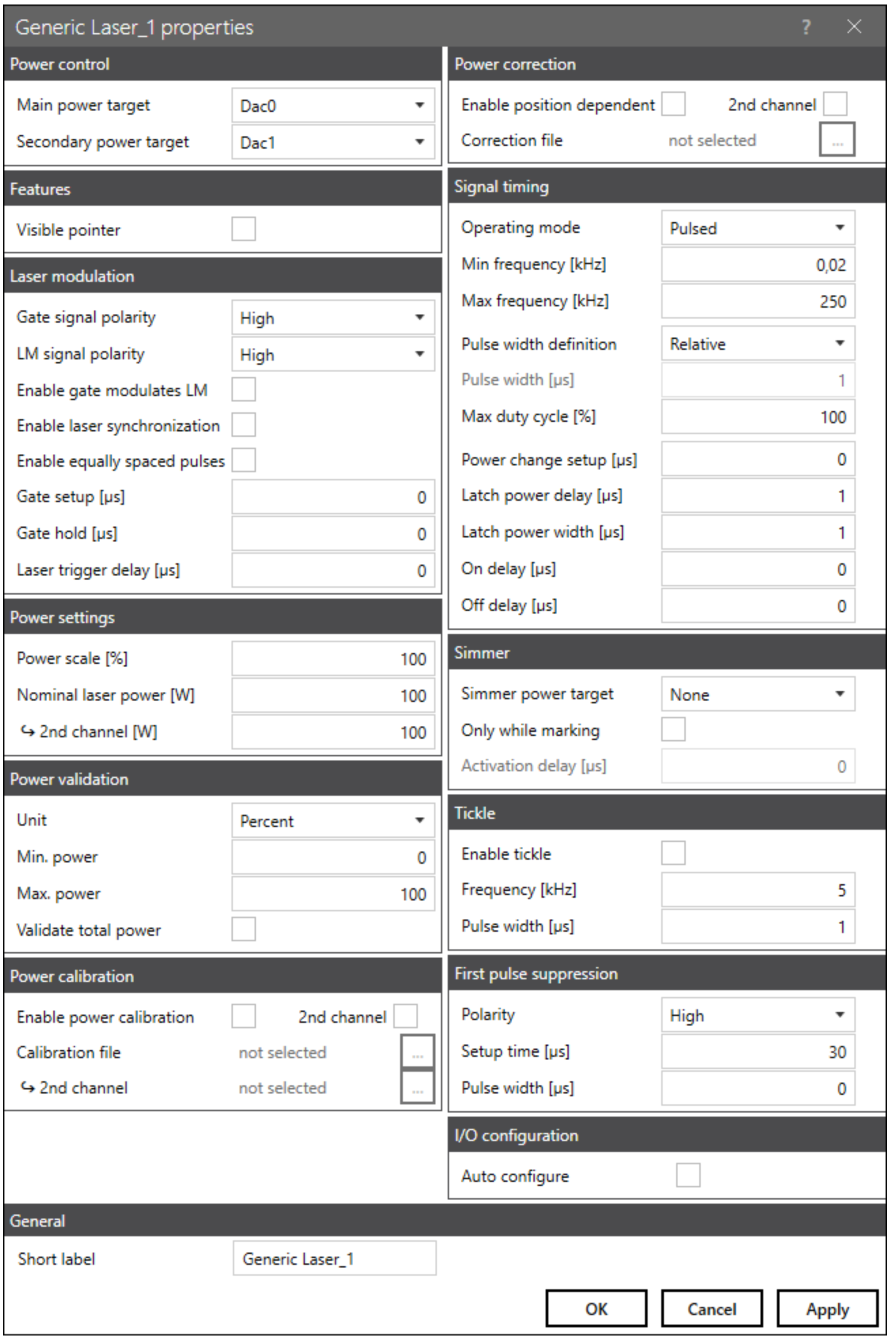
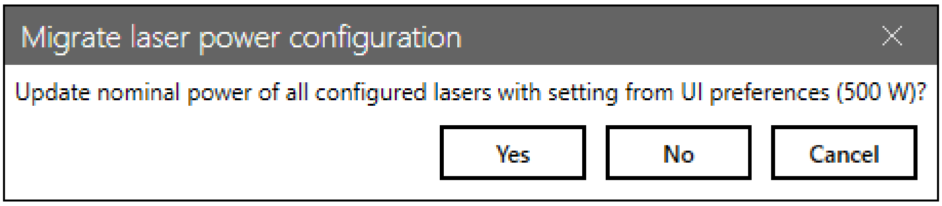


Fig. 5.7: RG-AAU

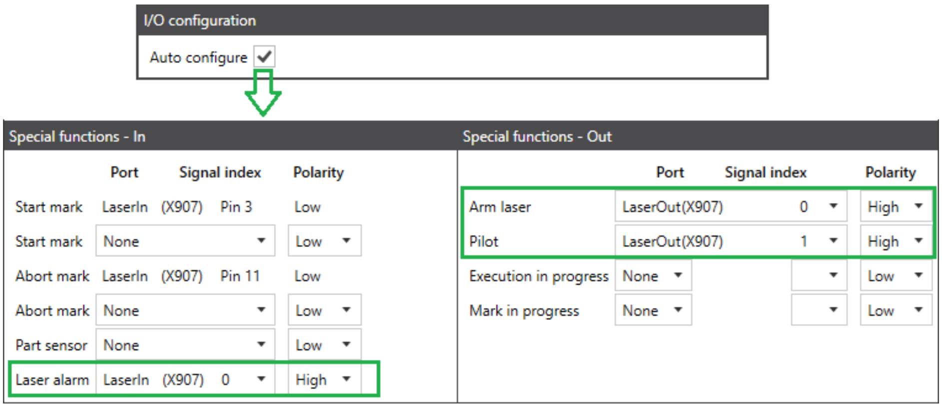
Setting	Explanation
Power control	
Hot power target	Defines the signal type through which the (primary) laser source receives power data (DAC0, DAC1 / Digital1bit, Digital2bit, Digital8bit, Digital16bit / LmWidth, LmFrequency). Depending on the “available” laser selected, there is already a default setting. For instance, select DAC for analog-controlled lasers or LmWidth for standard CO2 lasers.
Secondary power target	Define the power signal type for a possible second analog power setting here. Only Dac0 or Dac1 are available for selection.
Features	
Visible pointer	Defines whether the corresponding laser is equipped with a pilot laser so that the preview function can be offered.
Laser modulation	
Gate Signal polarity	The polarity of the gate signal can be set to low- or high-active according to the interface description of the laser.
LM signal polarity	The polarity of the laser modulation signal can be set to low- or high-active according to the interface description of the laser. On the laser side, this signal is often referred to as “trigger”, PWM (pulse width modulation) or PRR (pulse repetition rate).
Enable gate modulates LM	Only required if the dotted line function is used with lasers that do not use a switching signal input (e.g. CO2 lasers).
Enable laser synchronization	For lasers that have an internal pulse sequence to adjust the vector position to the laser timing
Enable equally spaced pulses	Causes the frequency to be modulated in relation to the actual marking speed. This achieves equidistant laser pulses, even with changes in speed caused by acceleration / deceleration of the deflection mirrors. **NOTE:** This function is based on the value of the drag delay of the deflection unit. That means this value must be specified correctly.
Gate setup [µs]	Time period in which the gate signal precedes the actual start of marking. That means positive lead times extend the period for which the gate signal is set. That means negative lead times shorten the period for which the gate signal is set.

Setting	Explanation
Gate hold [µs]	Time period in which the gate signal lags behind the actual end of marking. That means positive lag times extend the period for which the gate signal is set. That means negative lag times shorten the period for which the gate signal is set.
Laser trigger delay [µs]	Time in which the optical pulse is generated after the trigger edge has been received by the laser. The value must be provided by the laser manufacturer.
Power settings	
Power scale [%]	Global power scale in [%] <u>Example</u>: If an analog-controlled laser requires the power range to be regulated over a voltage range of 0 V to 5 V, you can scale the output power to 50%.
Nominal laser power [W]	Specification of the maximum laser power in [watt], which corresponds to 100%. **CAUTION**: It may be the case that this specification was previously made under ***System > Preferences > User (current user) > User interface > Units*** . The value can be adopted automatically in this case. For instance, the following message would appear: 
↪ 2nd channel [W] [2]	Specify the maximum laser power in [watt] for the possible second laser channel, which corresponds to 100%.
Power validation	
Unit	Select the unit for validating the laser power of the pens used. **NOTE:** The selection of the unit does not determine the unit in which the power is specified in the pens, see *page 105, UI*.
Validate total power	Define whether the combined power from primary and secondary power should be validated. This ensures that the total power does not exceed the specification of the deflection unit.
Min. power Max. power	Fields for defining the laser power limits that can be used to validate the pen values. For instance, some lasers can be slightly unstable if they operate in a power range that is too low.

2 **NOTE:** Certain settings for the laser are only possible or necessary if a second power channel is used.

Setting	Explanation
Enable power calibration	
Enable power calibration / 2nd channel [2]	Define whether you want to apply power calibration (also optional for the second power channel).
Calibration file	Use Windows Explorer to navigate to the desired laser calibration file and load it. You also have the option of selecting a calibration file for the second power channel. **NOTE:** The calibration file is generated using the *SPICE3PowerCalibrator.exe* program, which is part of the SP-ICE-3 software tools.
Power correction	
Enable position dependent / 2nd channel [2]	Define whether you want to apply a field position-dependent power correction in order to influence the laser power depending on the current scan field position (also optional for the second power channel).
Correction file	Use Windows Explorer to navigate to the desired laser calibration file (*.pc3) and load it. **NOTE:** The power correction file is created using the MULTI POINT EDITOR application. If you use the second power channel, it can contain correction data for both channels.
Signal timing	
Operating mode	Select whether the laser should only work in pulsed or continuous line mode or whether it should be possible to select the mode in the pen. **NOTE**: Depending on your choice, the limits for the pulse frequencies can be defined below. The pens offer respective fields for the pulse frequency and selection of the operating mode.
Min. frequency [kHz]	Minimum frequency at which the laser can operate
Max. frequency [kHz]	Maximum frequency at which the laser can operate

Setting	Explanation
Pulse width definition	*Fixed:* The pulse width of the laser modulation signal is set to a fixed value. The value can be entered in the next field. Please refer to the relevant laser manual for the expected standard pulse width. *Relative:* The ratio of pulse width to pulse duration is variable because it depends on the frequency and laser power [in percent] defined by the pen. Usually used by CO2 lasers with the “LMWidth” power signal type. *Manual:* Select this option if the pulse width has to be set individually for each pen. **NOTE:** The pulse width value influences the control pulse, but not necessarily the optical pulse.
Pulse width [µs]	Fixed value for the pulse width of the provided LM signal
Max. duty cycle [%]	Defines the maximum ratio of pulse duration to pulse period that the laser accepts.
Power change setup [µs]	Time required by the laser to change the output power. The value is provided by the manufacturer of the laser or calculated with application tests.
Latch power delay [µs]	Time at which the signal for setting the power value is set according to the power command.
Latch power width [µs]	Pulse width of the signal for setting the power value
On delay [µm]	Specification of a delay time when switching on that is added individually per laser source to the switch-on delay specified in the pen. **NOTE:** May be necessary when using several lasers because even the same laser models from the same manufacturer have slightly different reaction behavior.
Off delay [µm]	Specification of a delay time when switching off that is added individually per laser source to the switch-off delay specified in the pen.
Simmer	
Simmer power target	Define the power signal type for the simmer voltage here. **NOTES:** ■ Dac1 is used here as standard. ■ This specification primarily has to be made for TruPulse nano / SPI G4 laser types.
Only while marking	Activate if the simmer voltage should only be set during marking.
Activation delay [µs]	Time during which the simmer voltage must be set before marking.

Setting	Explanation
Tickle	
Enable tickle	Enables the use of the tickle signal. Please refer to the laser manual for more information on whether your laser requires this signal.
Frequency	Frequency of the laser tickle signal as per the laser manual
Pulse width [µs]	Pulse width of the laser tickle signal as per the laser manual
First pulse suppression	
Polarity	The polarity of the FPS signal of the laser can be set to low- or high-active according to the interface description of the laser.
Setup time [µs]	Defines the period of time with which the FPS pulse must precede the first optical pulse.
Pulse width [µs]	Defines the pulse width of the FPS signal as per the description of the laser interface.
I/O configuration	
Auto configure	When activated, the *pins on port X907 of the control card* are automatically set:
	Coherent Highlight ARM laser The freely configurable pins are configured for the *Laser alarm*, *Pointer* and *Arm* signals. 

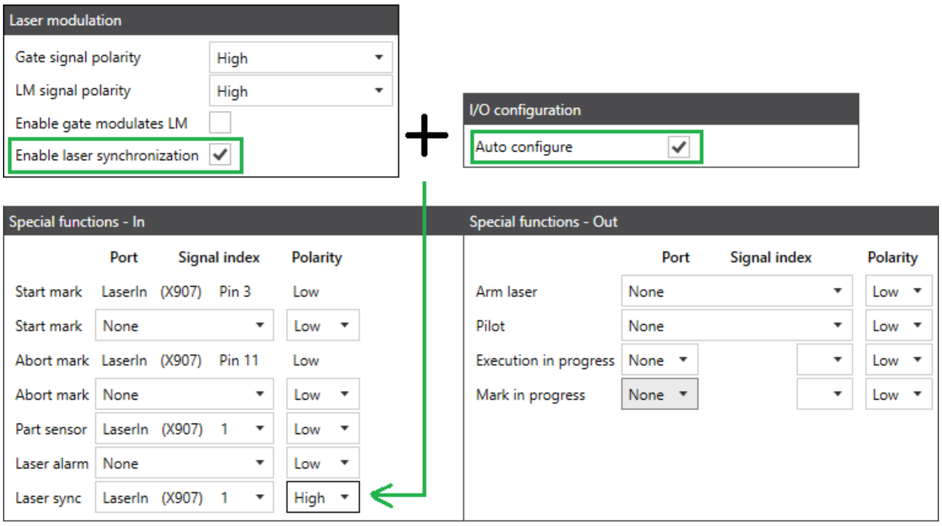
Setting	**Explanation**
	Lasers that support the *Laser Sync* signal The pin for *Laser triggered* is set automatically if the "Enable laser synchronization"option is selected at the same time. The polarity for the input signal is "High" by default. Use the laser manual to check whether this signal polarity applies to your laser model.  **NOTE:** If you want to use this auto configuration, the corresponding inputs must be wired.
General	
Short label	Assign a name with which the laser is listed in the GUI, e.g. manufacturer, type.

Table. 5.5: RG-013

5.2.1 Advanced configuration of lasers with serial interface

Some lasers can exchange additional data or receive commands, usually through an additional serial interface.

Depending on the laser, you can either use the serial PC interfaces (after prior configuration, see *page 84, Configuring the PC / computer serial interface*) or the serial interface of the SP-ICE-3 control card (port X802).

CAUTION: The functions that communicate via the serial port of the PC are only effective in *On host* or *Quick* job execution mode.

This applies, for example, to setting the laser power and pen frequency of the InnoLas Nanio Air laser.

Another laser that also uses serial communication via a PC port is the IPG YLPN APD laser. Serial communication is optional here to query the available optical pulse width values:

The laser configuration contains the option for enabling the interface for serial communication and selecting the serial port.

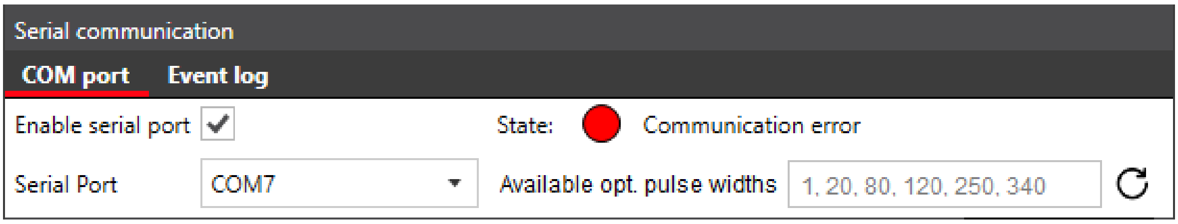


Fig. 5.8: RG-AEF

The traffic light indicates the laser operating status:

Red:	Laser is not responding (for instance because it is not connected or not switched on)
Yellow:	Laser still warming up
Green:	Laser is ready for operation

You can view the exchanged commands in the event log in a second tab. These are also written in the RAYGUIDE log.

5.2.1.1 IPG laser type YLPN APD

The values for the pulse width of the optical laser pulses can be set with this laser type (depending on the laser, these are set up individually in advance by IPG).

The APD mode is transmitted from the control card and adapter board to the laser through the IO connection. That means an additional **connection via the serial interface is optional**.

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

CAUTION: To allow the laser to execute the signal sequence for switching the adjustable pulse duration via the IO interface of the IPG compatible adapter of the SP-ICE-3 control card, jumper W3 of the adapter board must connect contacts 2 and 3. This applies no matter which IPG interface type is used. For details, see SP-ICE-3 manual, chapter 4.3.4.

The pulse width values for the indices can be queried and read in via the serial interface. This allows the values to be displayed in the pens.

NOTE: With 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 saved in the *Device.json* file, but can be queried again manually using the ***[Refresh]*** button if the laser source has been replaced.

5.2.1.2 InnoLas laser type Nanio Air / Blizz

With this laser type, information on the operating status of the laser can be queried by the serial interface, for instance to avoid starting a job while the laser is still in its warm-up phase.

The status of the laser is queried automatically whenever a job has to be executed.

If the laser is not in an operational state, a corresponding device validation message appears in the GUI:

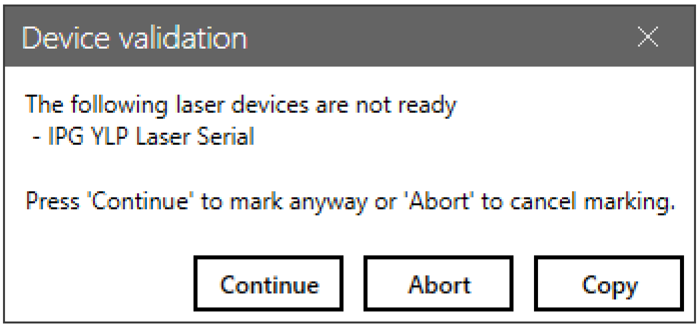


Fig. 5.9: AEE

5.2.1.3 Lumentum Picoblade 3

This laser type communicates exclusively via the serial port of the SP-ICE-3 control card.

Serial commands are used to arm or disarm the laser. This communication path can also be used to acknowledge error messages.

5.2.2 Additional laser-specific options

5.2.2.1 nLight AFX / SFX laser

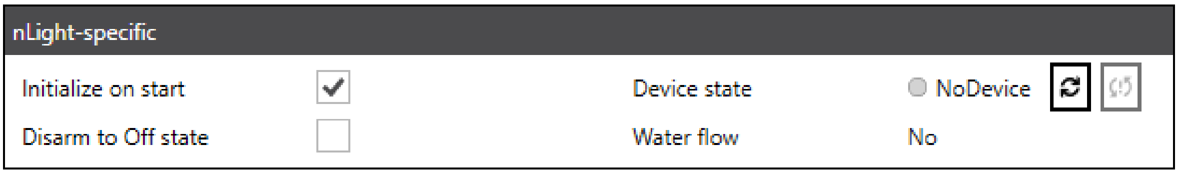


Fig. 5.10: RG-AFN

nLight-specific	
Initialize on start	If activated, RAYGUIDE automatically switches the nLight laser to the standby or emission state when the application starts. If not activated, the nLight laser is only set to the emission state when the laser is manually armed.
Disarm to Off state	If activated, the nLight laser switches to the *Off state* during disarming. If not activated, the nLight laser switches to the *Ready state*. **NOTES:** ■ For the nLight laser, the interlock may only be opened in the *Off state*; otherwise, an error message will be output and the laser will be forced to switch into the *Off state*. ■ Independently of this, a preview with the pointer is possible both in the *Ready state* and in the *Off state*.
Device status	*Off / Ready / Emission / Error* Indicates one of four possible states of the laser source. For further details on the status, please see the notes in the manual of the laser source. The different statuses are also shown in the job panel, see *page 126, Job Panel*.
Status water flow	*Yes / No* Indicates whether the laser source is water-cooled.
	Can be used to manually reset the error status of the laser source. **NOTE:** Only enabled if the laser source has an active error.

Table. 5.6: RG-083

5.3 Deflection Unit Configuration

Open the deflection unit configuration dialog window for laser control. There are three options here:

- In the Device configuration menu, double-click on the entry for the deflection unit (right side) or select the Properties option in the context menu.
- In the configuration dialog of the control card, click on the ***[Edit]*** button next to the corresponding device.
- In the menu, select ***System*** **>** ***Devices*** **>** ***Deflection units*** **>** ***(Device)***.

The configuration window for the deflection unit consists of three tabs: ***General***, ***Calibration***, ***Deflection unit status***.

NOTE: If you are using a deflection unit with different correction files and / or field sizes, it is advisable to make your work easier by “cloning” the existing deflection unit, therefore creating a second deflection unit to which you can assign a different correction file and also a different calibration.

CAUTION: If you use several deflection units with the same optical setup and therefore also with the same correction file, duplicating the original correction file and adding a suffix to the file name for each deflection unit is strongly recommended so as not to confuse the correction files.

5.3.1 General

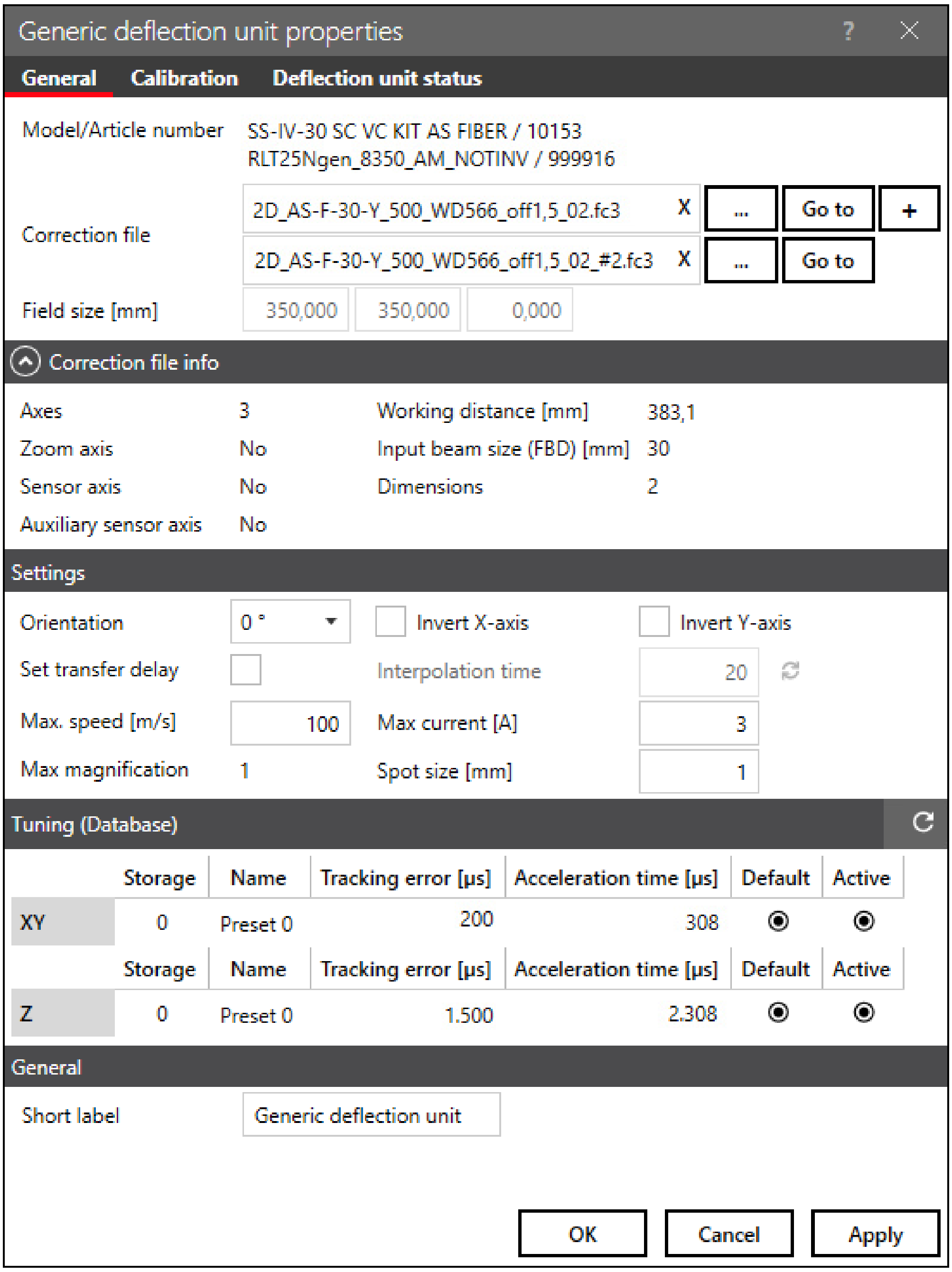


Fig. 5.11: RG-AAV

Setting	Explanation
Model / Article Number	The data is automatically read from the deflection unit. The deflection unit must be physically connected to make it possible to read this data from the deflection unit. The correct protocol must also have already been set in the General tab of the control card configuration dialog.
Correction file	A correction file must be selected. RAYLASE provides suitable correction files for the optical setup of the customer. Correction files should be saved in the following folder and also loaded from there: C:\ProgramData*RAYLASE*\CorrectionFiles\\ The correction file must have the *FC3* or *GCD* format. To ensure that the correction file is immediately updated on the control card, click on the ***[Apply]*** button after selecting the correction file – this is especially important if you intend to continue with field calibration right away. ***[...]*** opens the folder where the correction files are stored in order to select a correction file. ***[Go to]*** opens the folder where the correction files are stored, but without further action. ***[+]*** adds another row to select an additional correction file as an option that can be loaded and used on the same control card. A maximum of 4 correction files can be loaded for one (single) deflection unit. **CAUTION:** The additional correction file can only be loaded if: ■ It corresponds to the same optical setup as the first correction file ■ The file name is not absolutely identical ■ The number of four correction files is limited to correction files that support a maximum of three optical axes. **NOTE:** For how the assignment is made to determine when which correction file is used, see *page 114, Setup*, *page 242, Setting the correction file index* and *page 289, Job Properties*.
Correction file info	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. Use the expander to display the information.

Setting	Explanation
Orientation	Defines the directions of the XY coordinate system of the RAYGUIDE GUI relative to the current alignment of the deflection nit. The directions of the layout in the RAYGUIDE viewport should correctly reflect the workspace of the deflection unit. Can be adjusted to 0°, 90°, 180°, 270°. If you have any doubts, run a marking test to determine the correct setting. According to RAYLASE conventions, an orientation of 0 degrees means that the +X-axis points in the direction where the laser enters the deflection unit. For units in which the laser enters from above (e.g. AS FIBER), the standard +X-axis points towards the front of the device.
Invert Axis	Check boxes for the X- and Y-axes to invert the individual coordinate axes.
Set transfer delay	Activate this option if you have not already defined a transfer delay for the control card. The transfer delay is made up of a value depending on the protocol and the interpolation time of the deflection unit. The interpolation time is either read out automatically by the deflection unit or can be entered manually. The ***[Refresh]*** button can be used to repeat the query of the interpolation time at any time. **NOTES:** ■ The transfer delay will affect the timing between the laser and deflection position. ■ The option exists from RAYGUIDE version v.1.17.
Speed limit [m/s]	Defines an optional speed limit for the deflection unit. Default setting is 100 m/s. This setting does not override the speed set in the pens, but can be used for job validation. See *page 316, Running a Job*.
Max. current [A]	Defines an optional upper limit for current consumption of the galvanometer drives of the deflection unit. Default setting is 6A. The value is used exclusively for job validation of the wobble parameters in the pens used (see *page 102, General*).
Max. magnification [3]	Displays the maximum value for the spot magnification factor (according to the loaded correction file).
Spot size [mm] [3]	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 size. (See *page 105, UI*)

3 These fields are only available if the loaded correction file supports spot magnification.

Setting	Explanation
Tuning The data in the section below can be read either from an internal database or from the connected deflection unit. Click on the [Refresh data] button to update the tuning list and the associated dynamic data, for instance if another deflection unit has been connected. **NOTE:** In order to automatically obtain the data, the article number of the axis displayed at the top of the window is required. If an older deflection unit that does not support the extended protocol is connected, the values must be entered manually. The dynamic data for the X- and Y-axes is always identical and is therefore listed together.	
Storage	The memory location number (counting always starts at zero) is the fine adjustment internal ID.
Name	The name assigned to the tuning can be overwritten. That means that you can enter a suitable name for each tuning that best describes the associated dynamic behavior in your application. This name is also displayed to select the desired tuning in the *"Send Enhanced Command"* automation object.
Tracking error [µs]	The value is either read from an internal database as per the part number specified for the axes or, if the head is equipped with DICON2.5 electronics, it is read from the deflection unit. **NOTE:** If necessary, the value can be corrected or entered manually (for instance if the deflection unit cannot provide information such as the article number of the axes). Use the right mouse button > Reset to Default to reset the settings to the original values. Information on the value: Time interval required by the respective optical axis to follow a new position command. The value depends on the inertia of the optical axis (resulting from the substrate material and diameter) and the so-called tuning. If in doubt, the values can be found in the data sheet or in the manual for the deflection unit.

Setting	Explanation
Acceleration time [µs]	The value is linked to the tracking delay value by default. **NOTE:** If necessary, the value can be corrected or entered manually (for instance if the deflection unit cannot provide information such as the article number of the axes). Use the right mouse button > Reset to Default to reset the settings to the original values. Information on the value: Time [microseconds] the respective optical axis needs to reach the desired speed specified in the pen. This value is only used when marking bitmaps.
Default | Active	Select which of the available tunings should be set. ■ Standard = tuning that is loaded when the deflection unit is started up. ■ Active = tuning that is active unless the *"Send Enhanced Command"* automation object is used to manually set another tuning.
Short label	A name for this deflection unit that is easy to remember. You can enter the field size as part of the name, for example.

Table. 5.7: RG-014

5.3.2 Deflection Unit Calibration

5.3.2.1 Overview

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.
- Assign the deflection unit to the control card in the control card dialog.
- Assign 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 control card, 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 pilot laser. This calibration data is therefore applied during a preview.

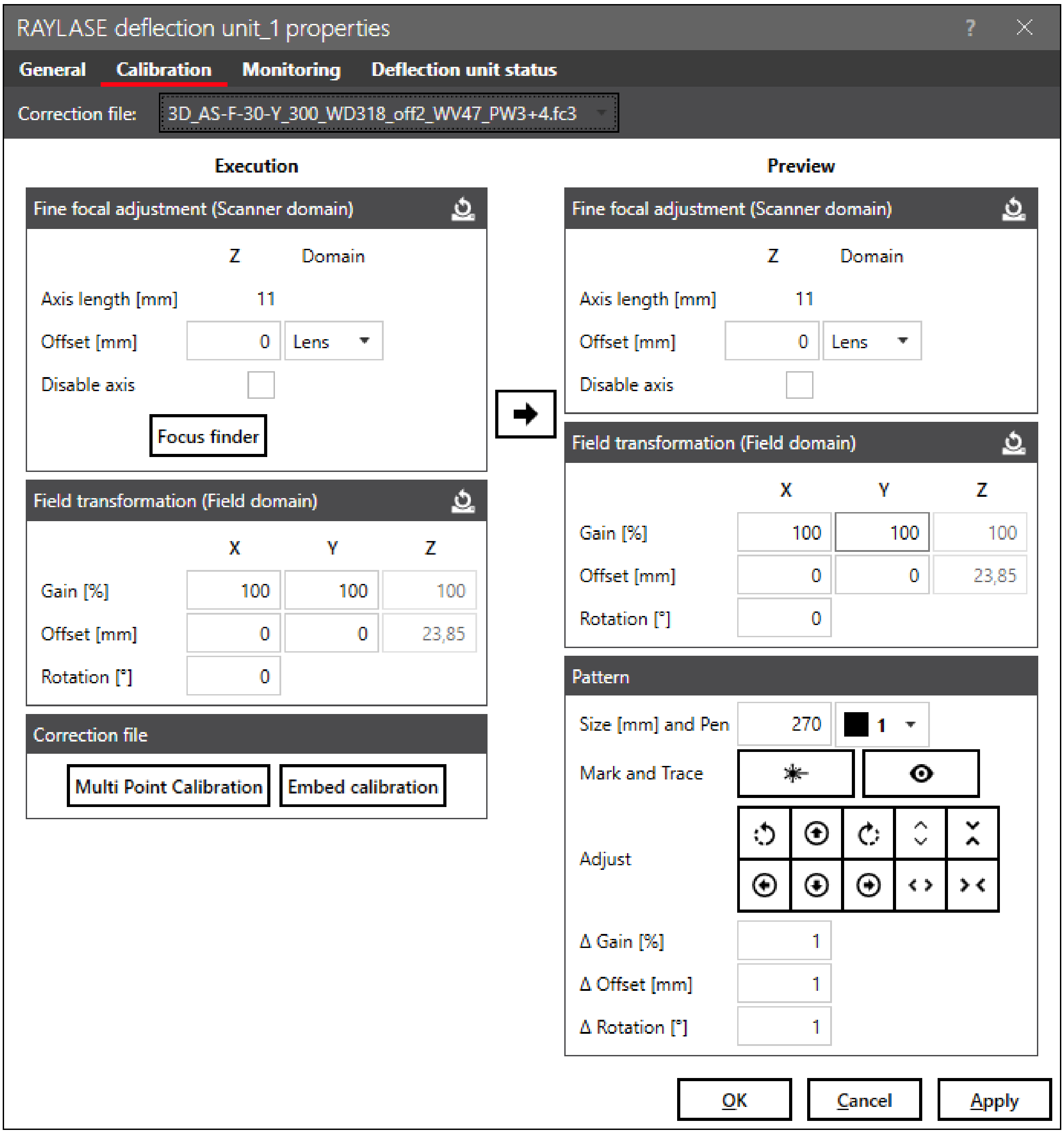


Fig. 5.12: RG-AAW

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

Setting	Explanation
Fine focal adjustment (Scanner domain) This option is only available if the correction file controls the pre-focusing optics, e.g. for deflection units of the AXIALSCAN type. Depending on the choice of **domain**, the offset for the focusing optics can be specified either in the *Lens offset* or in the *Focus range*. This setting is used to adjust the focus position throughout the entire system. Other additional optical axes, such as those used by the RAYSPECTOR can be adjusted directly in their focus position here.	
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.
[Focus finder]	This button opens a dialog to define and execute a special marking pattern. This marking pattern can be used to determine the current focus position and calculate the z-axis offset from this position. For details, see *page 79, Focus finder*.
Field transformation (Field domain) **NOTE:** Transformation values for offset and rotation as well as scaling above 100% reduce the available workspace according to the correction file. **NOTE:** These transformations are applied to the vectors to be marked and do not edit the correction file.	
Gain [%]	Can be defined separately for X- and Y-axes. Reduces or increases the length of the vectors mapped by the deflection unit until they are true to size with the defined geometry. 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.
Offset [mm]	Moves the projected coordinate system relative to another coordinate system (e.g. to align it with a machine coordinate system or another scan field). Editable for X- and Y-axes.

Setting	Explanation
Rotation [°]	Rotates the projected coordinate system relative to another coordinate system (e.g. to align it with a machine coordinate system or another scan field).
Correction file Multi-point calibration always applied to the selected correction file.	
[Multi Point Calibration]	Opens the MULTI POINT EDITOR (MPE). 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. You can use pens for marking as defined in the default library pen set. 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. Detailed information on functions and operation of the MPE can be found in the separate manual for the MULTI POINT EDITOR that is attached to the PDF.
[Embed calibration]	This button transfers the field calibration values and axis offset values directly into the correction file and resets the transformation values accordingly.

Table. 5.8: RG-015

In the Preview section, the geometric correction of the preview is set up. This may be necessary as the pilot laser 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 312, Preview*.

Setting	Explanation
Fine focal adjustment (Scanner domain) The same principles apply as in the Laser section. Pilot-laser 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 pilot laser spot.	
Field transformation (Field domain) The same principles apply as in the Laser section. See the table above for details. To start calibration of the pilot laser, the values from the Execution section can be transferred into the Preview section with the arrow button.	
Pattern 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 center.
Mark and Trace	First, mark the square using ***[Mark]***. Then, trace the shape of the square with the pilot laser using ***[Trace]***.
Adjust	Use ***[Gain]***, ***[Shift]*** and ***[Rotate]*** 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. Specify the delta values in the corresponding units for gain / offset / rotation.

Table. 5.9: RG-016

5.3.2.2 Focus finder

The focus finder has two tasks that help you to globally set the focus for your pre-focusing deflection unit.

1. A pattern is defined and marked which contains parallel lines in different focus positions.

   To make it easier to identify the current focus position or focus deviation, a power ramp is also used to get the following example image after marking:

Example:

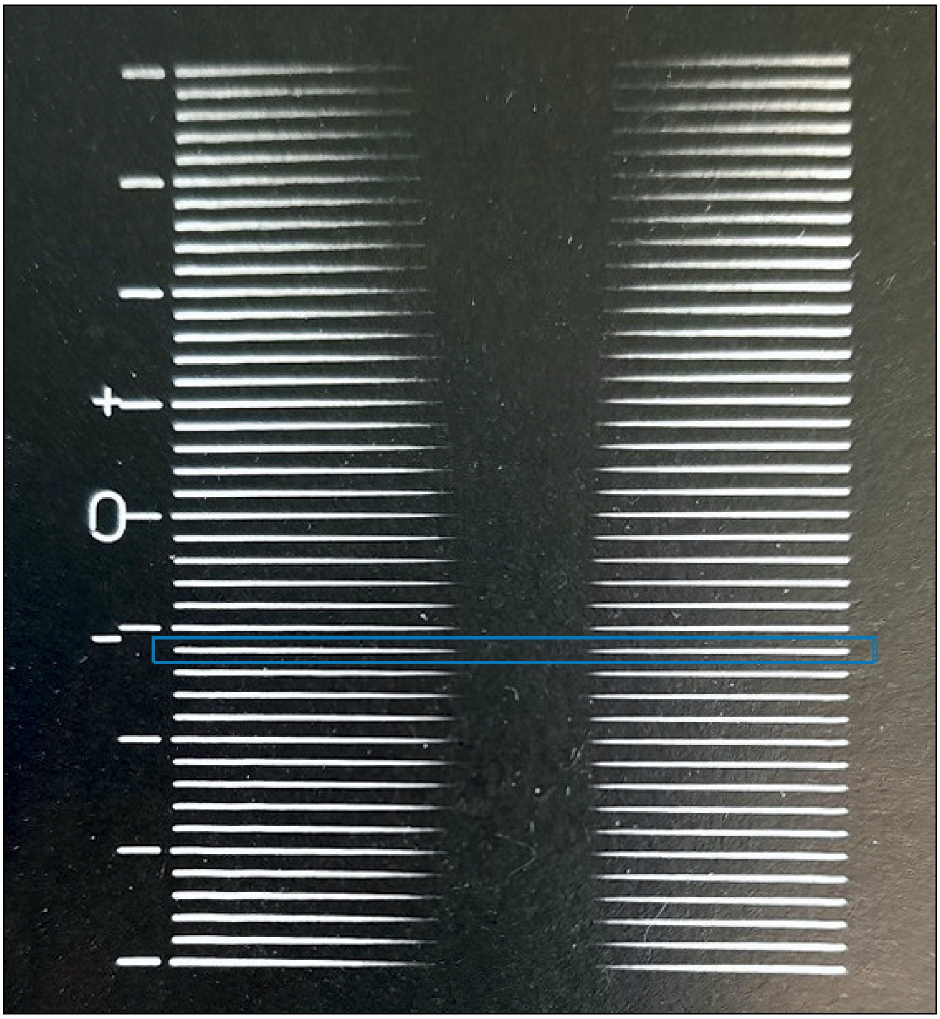
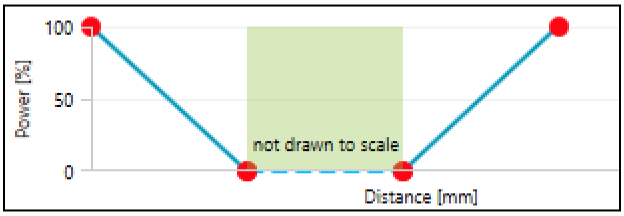


Fig. 5.13: RG-AFO

2. By entering the ordinal number of the line with the best focus, the required offset of the z-lens is calculated automatically (decimal numbers are also permitted).

Setting	Explanation
Pattern	
Position X / Y / Z [mm]	Specify the position in the scan field at which the pattern is positioned.
Z Range [mm]	Specify the range in [mm] of focus stroke in which you expect the focus. The lines are then arranged by half the range in the focus above and in the other half in the focus below Z=0.
Line count	Specify how many lines with different focus positions the pattern should contain.
Line length	Enter the length of the parallel lines in [mm].
Line separation [mm]	Enter the distance between the parallel lines in [mm].
Pen Select a pen from the standard pen set.	
Laser	Additional information derived from the pen to set the marking result of the pattern. For details on the parameters, see *page 253, Pen Properties*. The ramp should be defined here so that it reduces the power at the start and increases it again at the end of the line: 
Mark timings	
Ramping	
Execute	
[Activate pilot laser]	Use the toggle button to activate / deactivate the pilot laser.
[Arm Laser]	Use the toggle button to arm or disarm the laser.
[Execute]	Use the button to mark the pattern.
Calculate z axis offset	
Line number in focus	Enter the number of the line of the pattern here that has the optimal focus. If you have the impression that two neighboring lines are equally in focus, you can also enter a decimal point value.
[Apply]	Click on the button to calculate the offset. The calculated value is applied as the offset for the z-axis in the Calibration tab.
Offset [mm]	Display of the resulting z-axis offset.

5.3.3 Extended monitoring of the deflection unit

In this tab, you can define the properties for extended monitoring of the deflection unit, which, in contrast to monitoring of the deflection unit of the control card (see *page 50, General*) is executed directly by the RAYGUIDE application. The RAYGUIDE applications then also assumes the resulting actions in the event of an error.

USER NOTE: This type of monitoring of the deflection unit by RAYGUIDE is only recommended when other types of operating data should be monitored in addition to the status. If only the status should be monitored, monitoring by the control card is preferable (see *page 50, General*).

NOTE: The actions in the event of an error are to be defined in the preferences, see *page 90, General*. Monitoring only takes place if at least one action is defined.

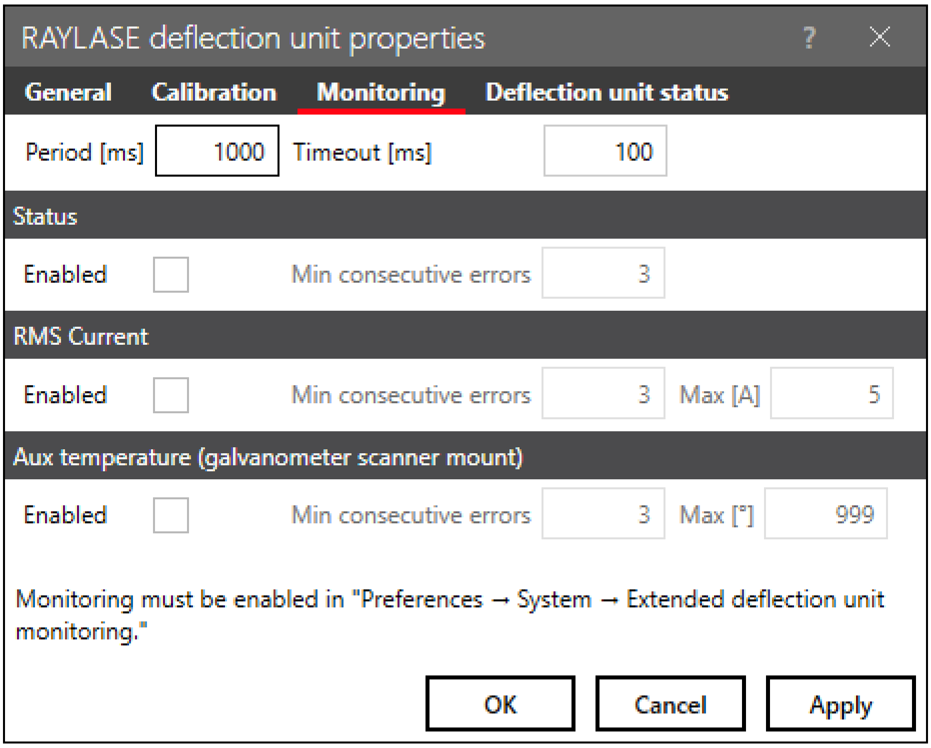


Fig. 5.14: RG-AFP

Settings	
Period [ms]	Defines the query interval.
Timeout [ms]	Select a time to trigger an error message if the query takes longer than this time.
Status	
Enabled	If activated, the status word of the deflection unit is checked. This check is initiated if the deflection unit is not ready for use or is in an error state.
Min. consecutive errors	Number of consecutive errors that are tolerated before the status is declared faulty.
RMS current This option can only be used with deflection units whose firmware has at least rev. 6972 or higher so that this value can be read out by the deflection unit.	
Enabled	If activated, the RMS current of the deflection unit is queried and checked against the maximum.
Min. consecutive errors	Number of consecutive value overshoots that are tolerated before the status is declared faulty.
Max [A]	Specification of the maximum permissible RMS current **NOTE:** For the limit values for the RMS current, please refer to the manual for your deflection unit or contact support@raylase.de.
Max [°] This option can only be used for deflection units of the SS-IVHL series because only these deflection units are equipped with temperature sensors on the galvanometer holders.	
Enabled	If activated, the temperature value measured by sensors on the holder of the galvanometer scanner is queried and checked against the maximum.
Min. consecutive errors	Number of consecutive value overshoots that are tolerated before the status is declared faulty.
Aux temperature (galvanometer scanner bracket)	Specification of the maximum permitted temperature

5.3.4 Deflection Unit Status Information

If you use a digital deflection unit (e.g. SUPERSCAN IV) and a fitting protocol has been 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 manual.

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

The current mirror position can be read here, too.

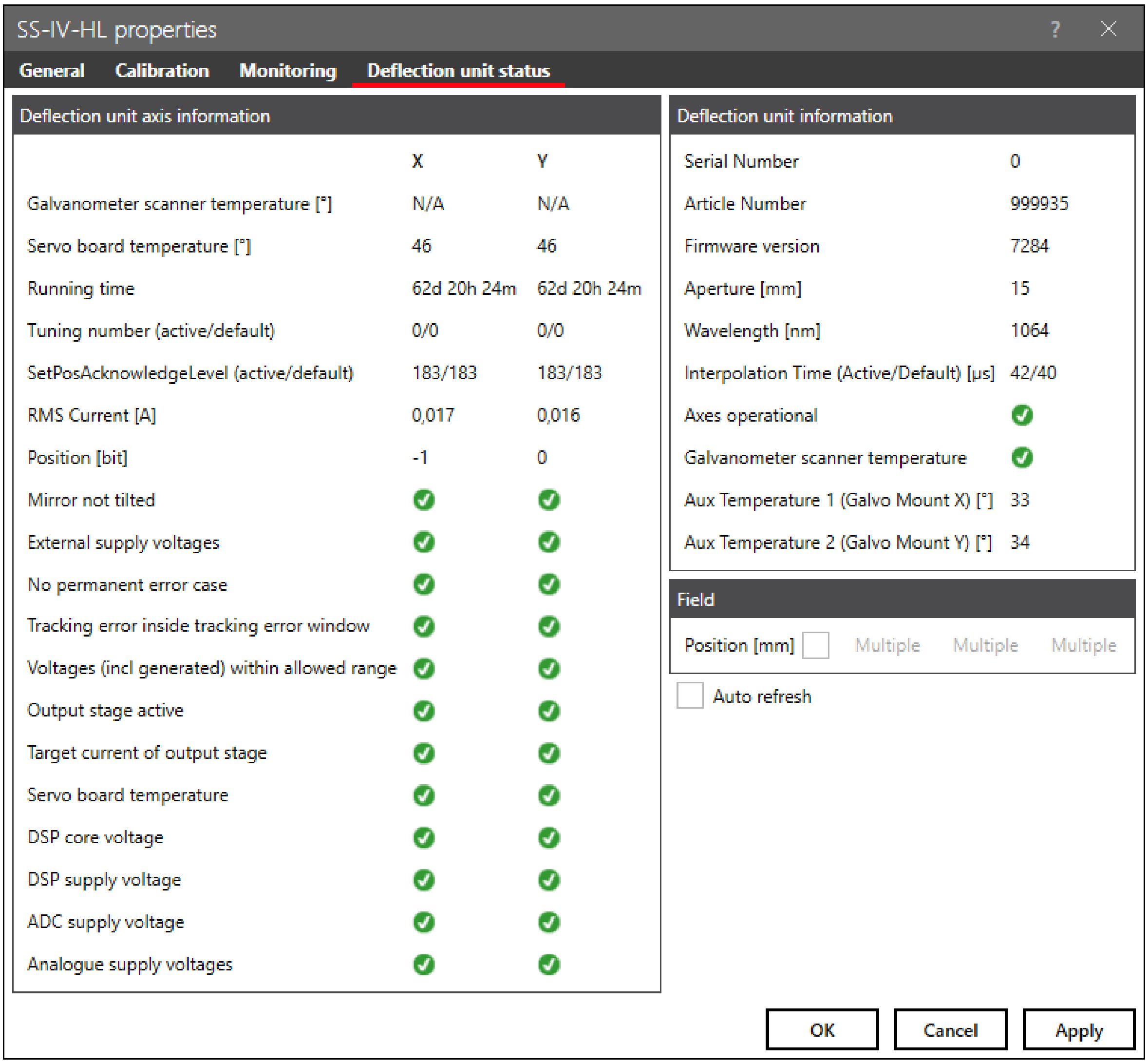


Fig. 5.15: RG-ADM

5.4 Configuring the PC / computer serial interface

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

- In Device configuration menu, double-click on an entry for the serial interfaces 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.

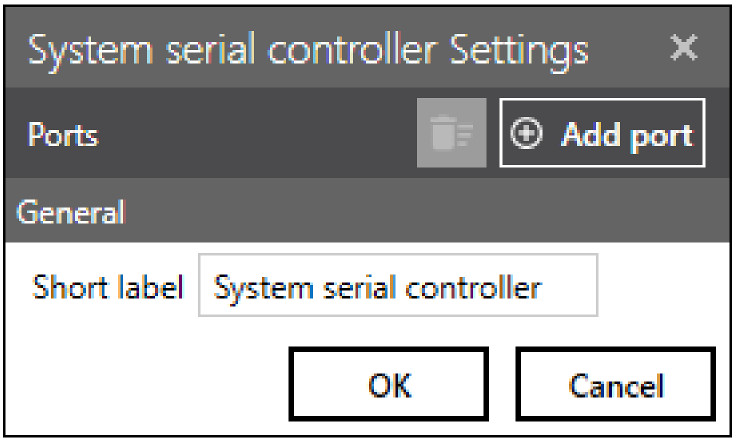


Fig. 5.16: RG-AAX

Setting	Explanation
Ports	Click on ***[Add port]*** 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.
General	
Short label	A name for this PC serial port that is easy to remember.

Table. 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, saving the current configuration as a backup file (*JSON* format) is recommended.

In the device configuration window

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

System replication

A configuration backup file is also helpful if you move to another computer or if you want to replicate your complete system. Replication means having one or more laser processing systems (control card, 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 control card using a unique IP address. This is a manual process, even if a configuration backup is used:

1. Search for the control card (IP address).
2. Select the control card.
3. Connect to the control card.

Cloning devices

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

- If you use multiple control cards 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 control card configuration, but you must connect the cloned control card configuration to a different physical control card.

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 diagnostics tool can only be used to control the laser in order to measure its power output, for instance to generate a laser calibration file.

In the menu, select ***System* > *Devices* > *Laser diagnostics...*** to open the laser diagnostic file:

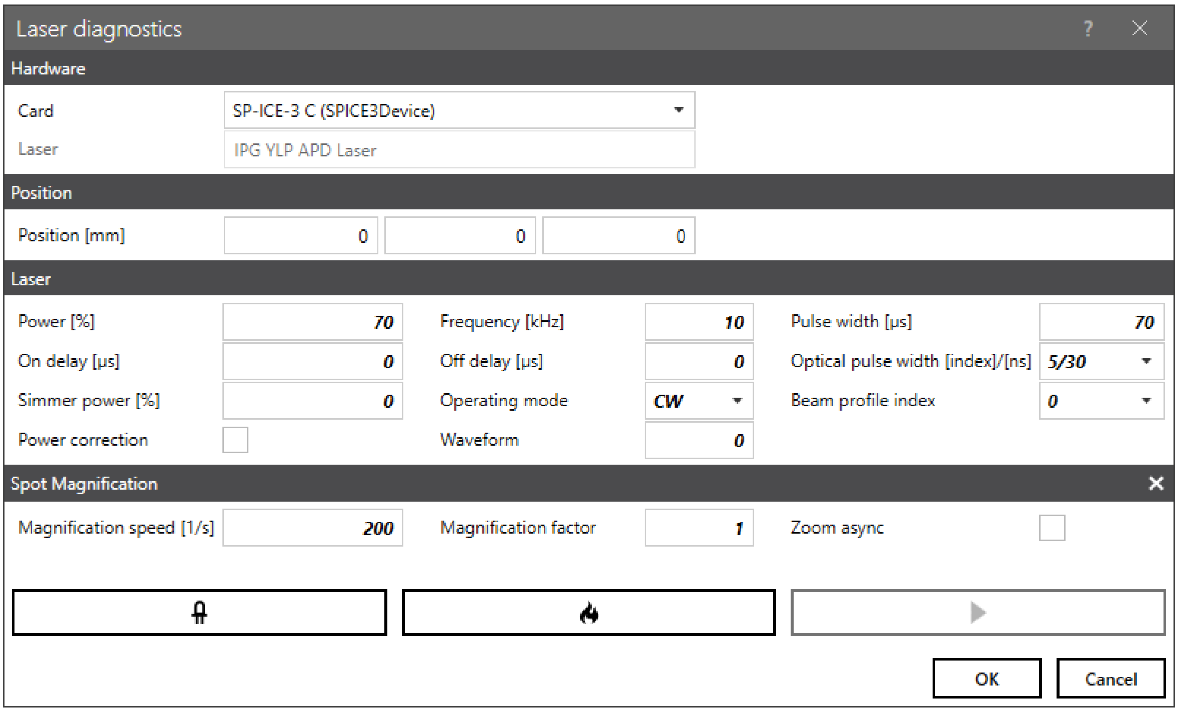


Fig. 5.17: RG-AAY

⚠ WARNING

Laser operation

Observe all relevant precautionary measures for safe laser operation.

Safety instructions can be found in the laser system and deflection unit manuals (scan head).

Proceed as follows to perform measurement:

1. Select the control card with the connected laser. Make sure that the laser is switched on.
2. Enter 2- or 3-dimensional coordinates as the target for the laser beam. Make sure that there is a suitable target object in the corresponding position, for instance 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. Also see *page 253, Pen Properties*.
4. Arm the laser if you have not already done so.

   Click on the ***[Arm / Disarm]*** button.

   An armed laser is indicated by a red fire symbol on the button.
5. Click on the ***[Laser on / off]*** button to start laser emission. The laser now emits until the button is pushed again.
6. Close the dialog by clicking on ***[OK]*** or ***[Abort]***. *OK* saves the settings until the function is used again.

6 PREFERENCES

The RAYGUIDE software can be configured with respect to user interface properties, process behavior, 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.

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.

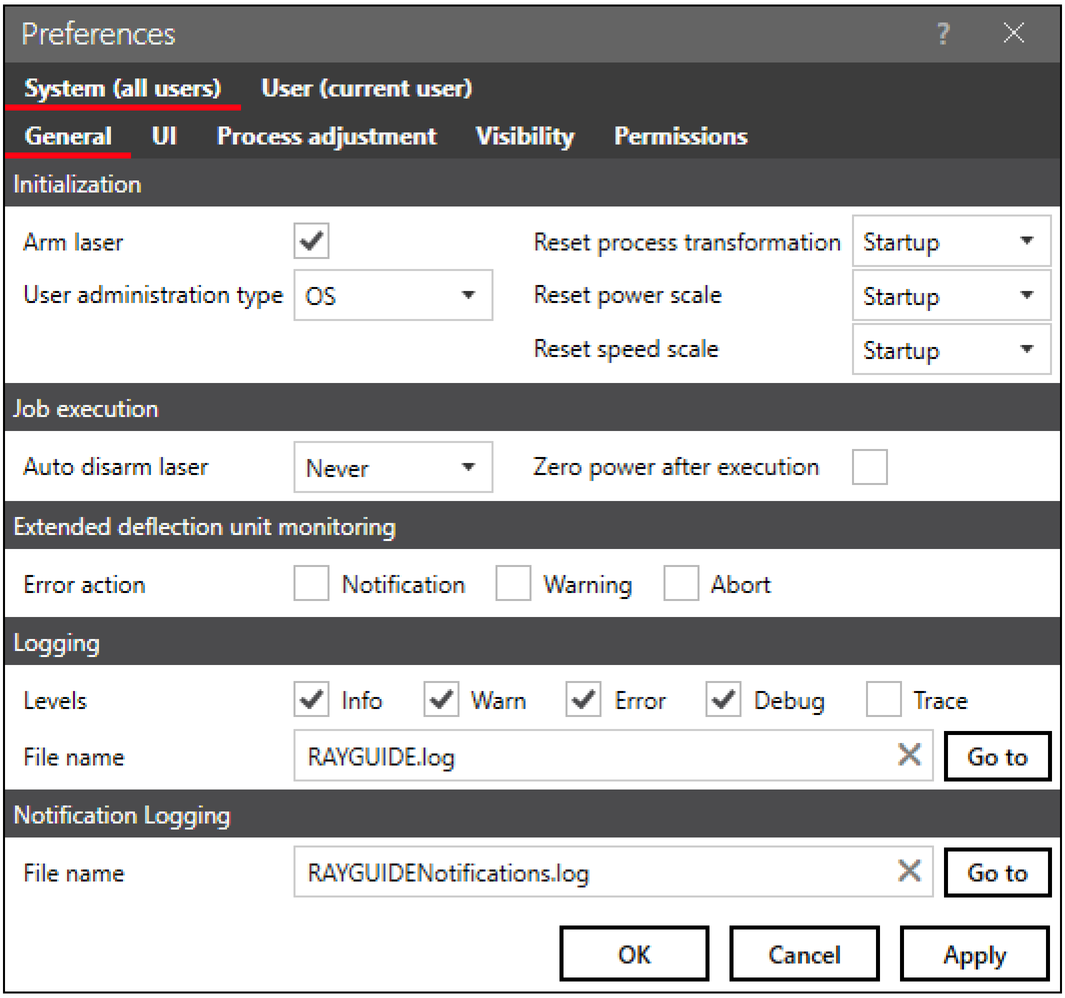
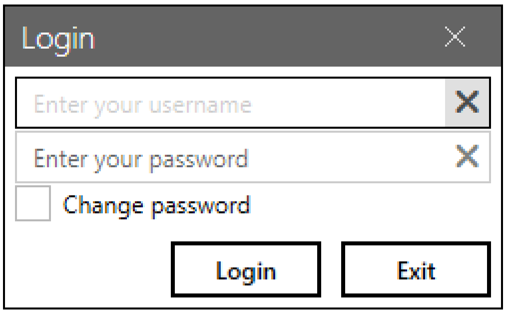
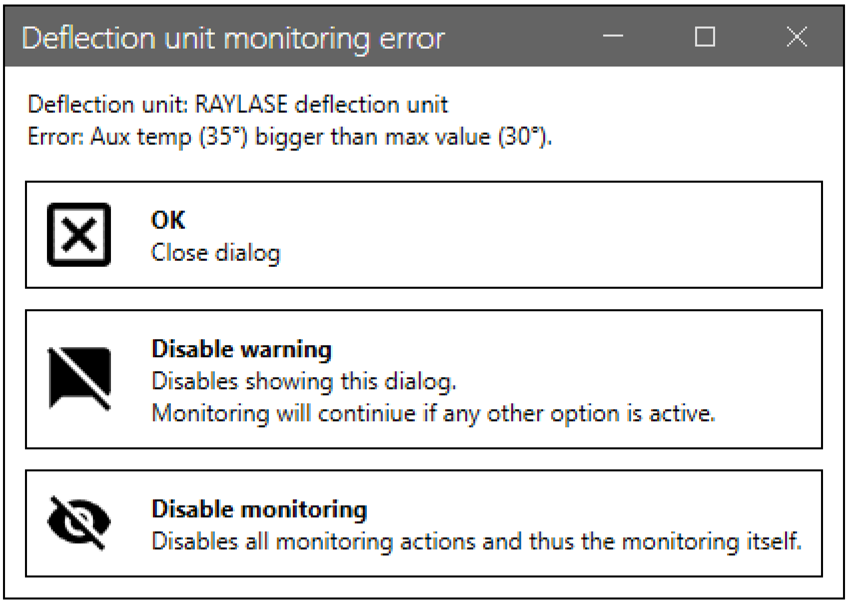


Fig. 6.1: RG-AAZ

Setting	Explanation
Initialization	
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	Specify which user management you want to use to set up the authorizations: ■ *Operating system:* Users have to be created as users in the operating system in order to be assigned a role. ■ *Local:* The administrator creates users in directly in a RAYGUIDE user list and assigns them to a role there. This allows the authorization role to be changed without logging out of the operating system. **NOTES:** ■ Local users have to log in with user name and password each time the RAYGUIDE application starts. ■ The default user with the administrator role is called “#rayguide#”. ■ The selection list contains all previously created users. The last user that logged in is selected by default. ■ The initial password for all (newly) created users is “raylase” until the user changes it to an customized password. The password can also be left *blank*.  Additional specifications are made under ***System > Permissions > Users / Groups***. **CAUTION:** After changing the user administration variant, the RAYGUIDE application must be restarted.

Setting	Explanation
Reset process transformation, Reset power scale, Reset speed scale	Select when to reset all process transformations and scale settings for the laser power value and / or speeds made on the ***Process adjustment*** panel: ■ For *Startup* ■ For *Execution* ■ *Never*
Job execution	
Auto disarm laser	Select an event for which the laser is to be automatically disarmed: ■ *Never* ■ *Abort* 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. ■ *Error* If an error is reported, the laser is disarmed at the same time. ■ *Abort or Error* Selection for both cases
Zero power after execution	If this option is set, the power value is set to 0% after execution of each job. Otherwise, the power value at the output of the control card stays at the last commanded power value.

Setting	Explanation
Extended monitoring deflection unit	
Error Action	Select at least one action in response to an error (for definition see *page 81, Extended monitoring of the deflection unit*). Multi-selection is possible. ■ *Message*: A message appears in the Notifications panel (see chapter 11.3) If the remote interface (see section 8.3) is used, an event message is also sent to the remote client. ■ *Warning:* The RAYGUIDE application shows a warning message:  ■ *Abort:* Any job execution that may be in progress is aborted. **NOTE:** The extended monitoring of the deflection unit does not work in stand-alone mode of the control card.
Logging 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. By default, all but *Trace* is checked. Trace data is very detailed and creates huge log files. The *Trace* option should only be selected if this data is requested by RAYLASE support.
File name	Name of the log file. Click on ***[Go to]*** to open the respective folder.

Setting	Explanation
Notification logging All messages from the Notifications panel are logged here (status messages, measurement results).	
File name	Name of the log file Click on ***[Go to]*** to open the respective folder.

Table. 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.

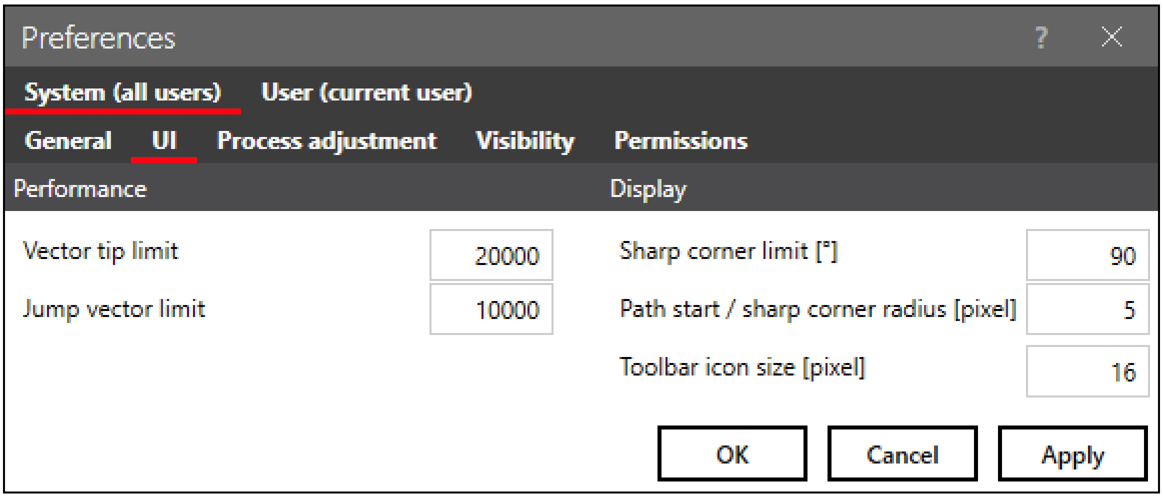


Fig. 6.2: RG-ABB

Setting	Explanation
UI	
Performance	
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.

Setting	Explanation
Display	
Sharp corner limit [°]	See *page 29, View Options*.
Path start / sharp corner radius [pixels]	See *page 29, 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.

Table. 6.2: RG-020

6.1.3 Process Adjustment

You define limits for the two sliders here in the Process adjustment panel, see *page 337, 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 scanning scan speed is also defined in this tab. For more details on the preview, see *page 312, Preview*.

6.1.4 Visibility

You may display or hide parts of the user interface 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.

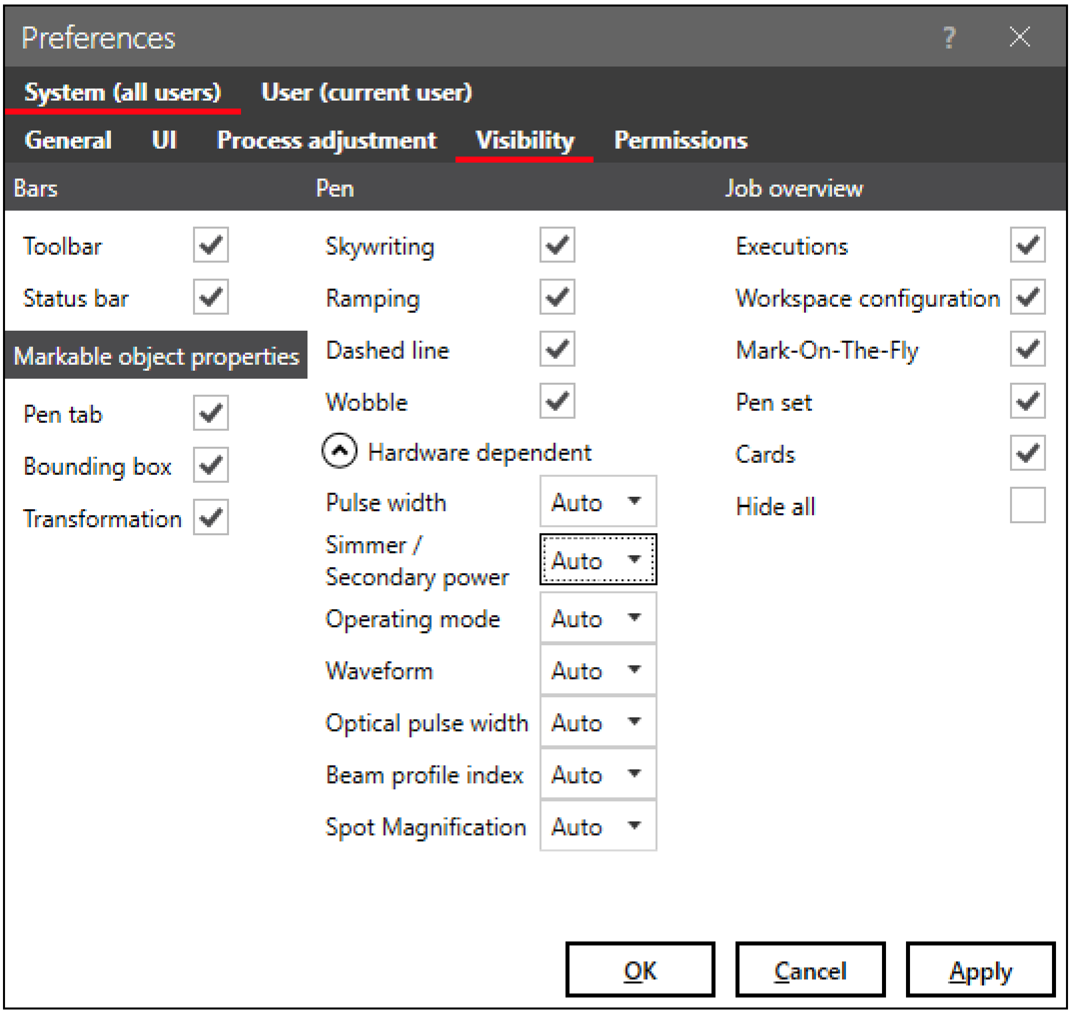


Fig. 6.3: RG-ABC

Make your selection in the following categories:

- Bars: Enables / Disables the display of the toolbar and the status bar.

  The status bar is the gray bar at the bottom of the user interface. It shows current status information such as permission roles, cursor position, etc.
- Markable objects properties: Enables / Disables the display of certain tabs or areas in the properties dialog of (markable) objects.
  - Pen tab: Enables / Disables the tab for editing pens in the object dialog
  - BoundingBox: Enables / Disables the display for the dimensions of the bounding box on the first tab in the object dialog.
  - Transformation Enables / Disables the display for object transformation on the first tab in the object dialog.
- Pen-related settings can be used to adapt the pen dialog according to your needs. For a description, see *page 253, Pen Properties*.
- Job overview information to be displayed: For a description, see *page 111, 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 90, 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

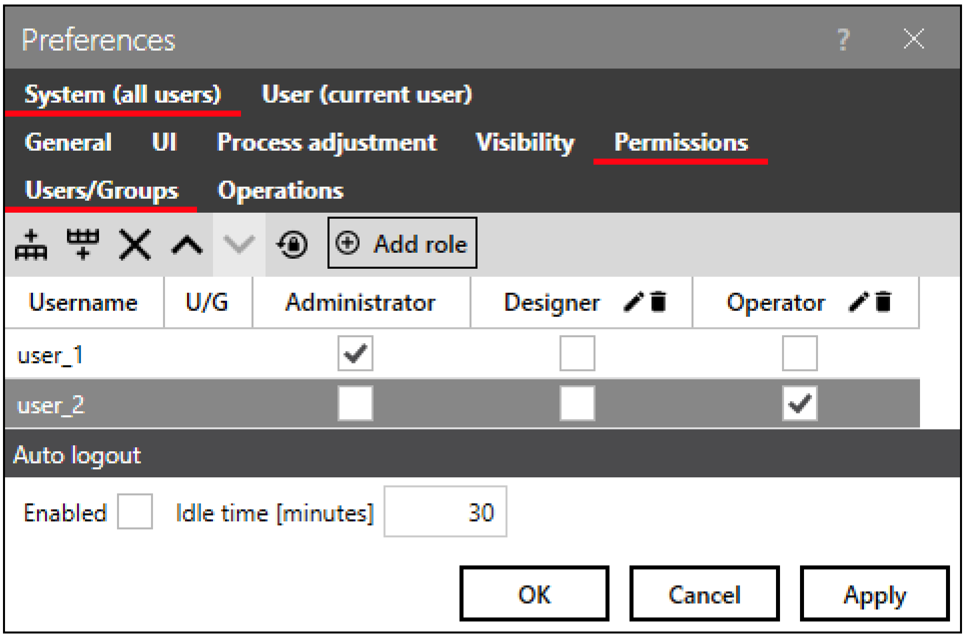


Fig. 6.4: RG-ABD

Setting	Explanation
	Add a new entry (line) above / below to create a new user. 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). **NOTE**: At least one user with administrator rights must be created.
	Deletes the user entry.
	Moves the line up / down.

Setting	Explanation
	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). ■ A Windows dialog opens in which you have to enter the login name of the user. Several names can be entered (separated by a semicolon). ■ Click on ***[Check name]***. If the user or the user group is found, confirm with ***[OK]***. **NOTE:** 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.
[Add role]	Button for adding a new column for another role.

Table. 6.3: RG-094

6.1.5.2 Variant: User management local

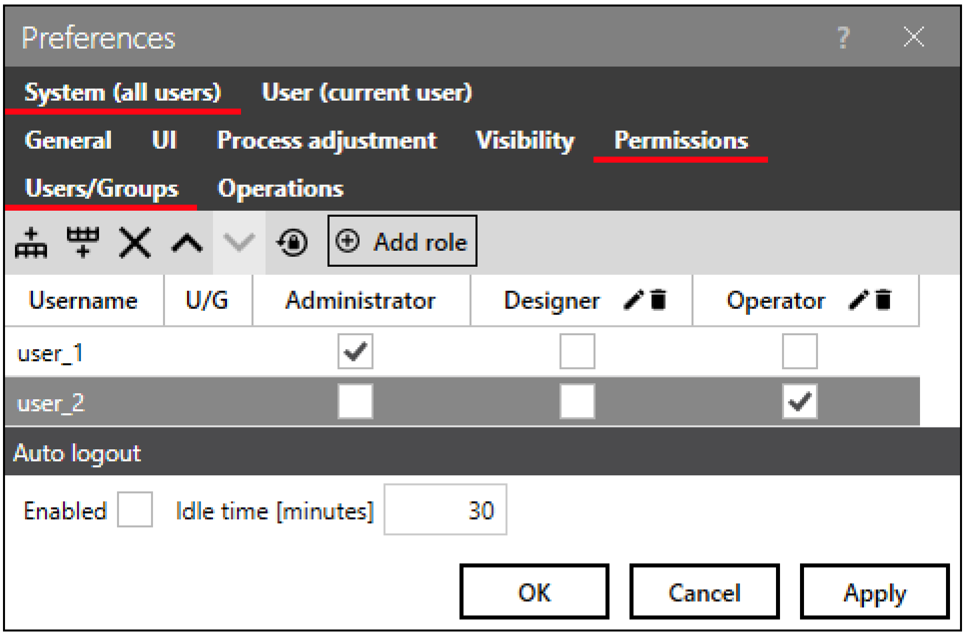


Fig. 6.5: RG-AFE

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. 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").
[Add role]	Button for adding a new column for another role.
List of all created local users and their role assignment (multiple assignment possible)	
Auto logout	
Enabled & Idle time [minutes]	If activated, inactive users with the Administrator role are automatically logged off after the idle time in [minutes] has expired.

Table. 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.

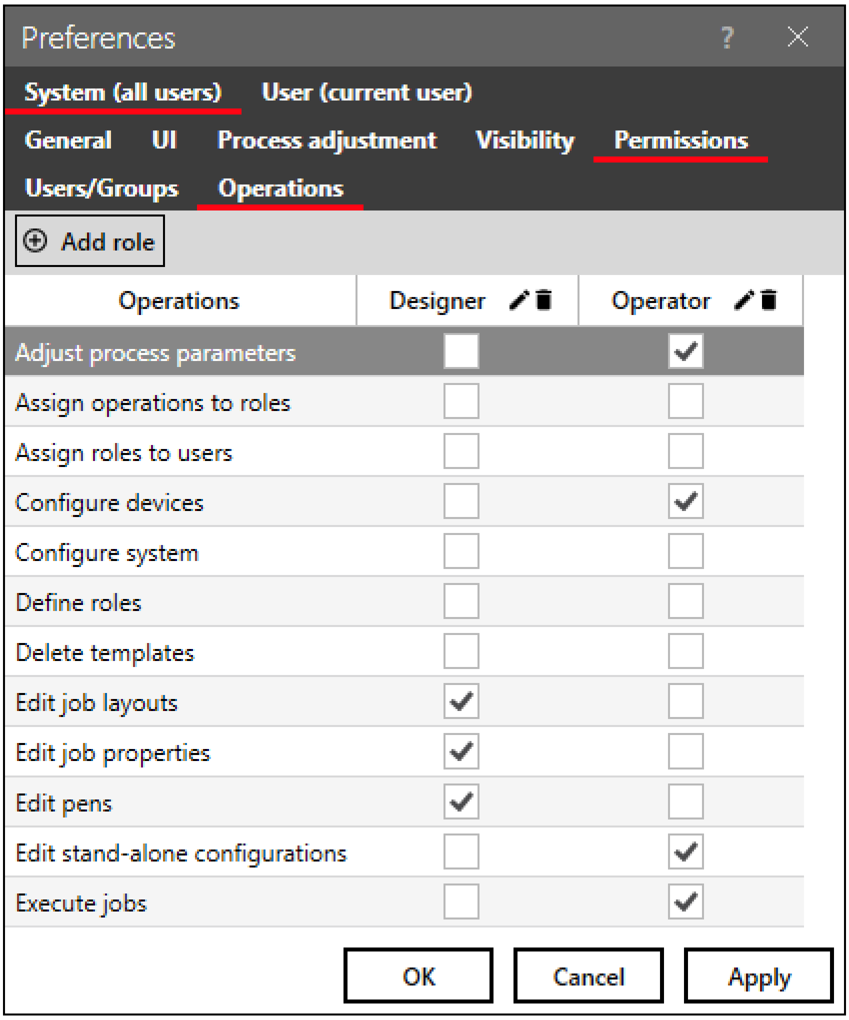


Fig. 6.6: RG-ABE

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 operations by default, meaning you cannot withdraw any operations 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.

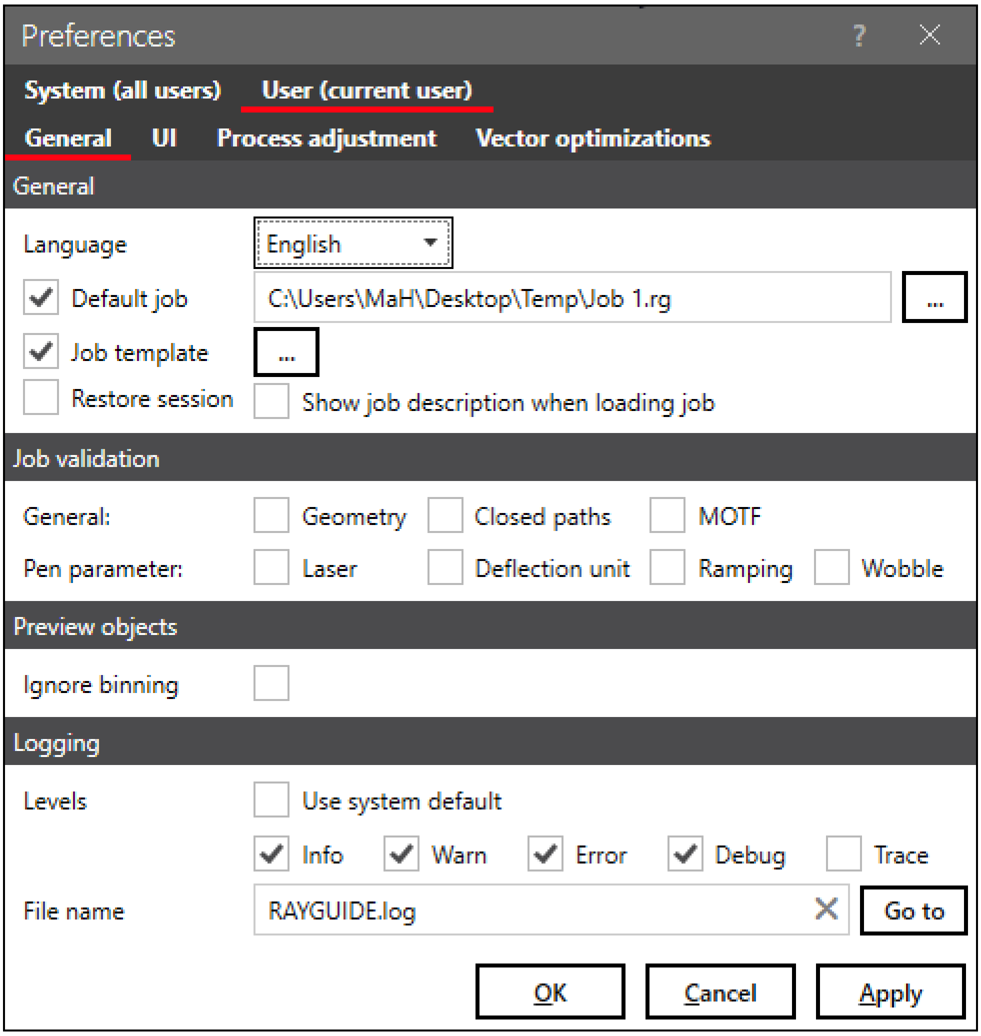


Fig. 6.7: RG-ABF

<table>
<tr><th>Setting</th><th>Explanation</th></tr>
<tr><td colspan="2">General</td></tr>
<tr><td>Language</td><td>Select from the list of available GUI languages. Currently available languages: English, German, Chinese, French, Spanish, Italian, Japanese.</td></tr>
<tr><td>Default job</td><td>Activate the option and select a job file that is loaded by default when the RAYGUIDE application is started.
Deactivate this option if you want an empty job to be displayed when you start RAYGUIDE.</td></tr>
<tr><td>Job template</td><td>Activate the option and select a job file if you want a predefined job content when starting a new job.
Deactivate the option if you want to have a blank job when you create a new job.
Use case: Use case: Each job must start with a "Wait condition" and end with a "Set I/O output" object.</td></tr>
<tr><td>Restore session</td><td>Activate this option if all currently open and saved jobs should be automatically reloaded when the RAYGUIDE application is restarted.</td></tr>
<tr><td>Show job description when loading job</td><td>Activate this option if you want the content of the job description to be displayed when the job is loaded.
This allows you to indicate any points that are relevant to job execution.</td></tr>
<tr><td colspan="2">Job validation</td></tr>
<tr><td colspan="2">Check the box if you want jobs to be validated with respect to the following aspects before execution (all validations are enabled by default):</td></tr>
<tr><td colspan="2">General
■ Whether the layout fits into the workspace / scan field
  NOTES:
  – In case on a MOTF job, validation is performed only for the configured
  – If a tiler container is used, it is also checked whether the layout fits into the tile pattern.
  – Job validation also will consider field calibration and process transformation, however, it does not consider vector extension by skywriting or any wobble geometry.
■ Whether the job contains marking objects with open paths or whether all paths are closed.
■ 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.</td></tr>
</table>

Setting	Explanation
Pen parameters ■ Whether the laser-related pen values exceed a limit (e.g. the power range as defined in the laser dialog). ■ Whether the scan head-related pen values exceed a limit (e.g. the speed limit as defined in the deflection unit dialog). ■ Whether the pen settings with regard to ramping, in particular the accumulated ramp length, will exceed the length of the respective path. ■ Whether the pen settings with respect to the wobble parameters would exceed the maximum current consumption of the galvanometer motor (see *page 69, General*). **NOTE:** 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 83, Deflection Unit Status Information*). **NOTE:** Job validation is not available in stand-alone mode. For more information, see *page 316, Running a Job*.	
Preview objects	
Ignore binning	Setting to display all objects in a preview, regardless of possible binning conditions.
Logger 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. **NOTE:** The *Trace* 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 Click on ***[Go to]*** to open the respective folder.

Table. 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.

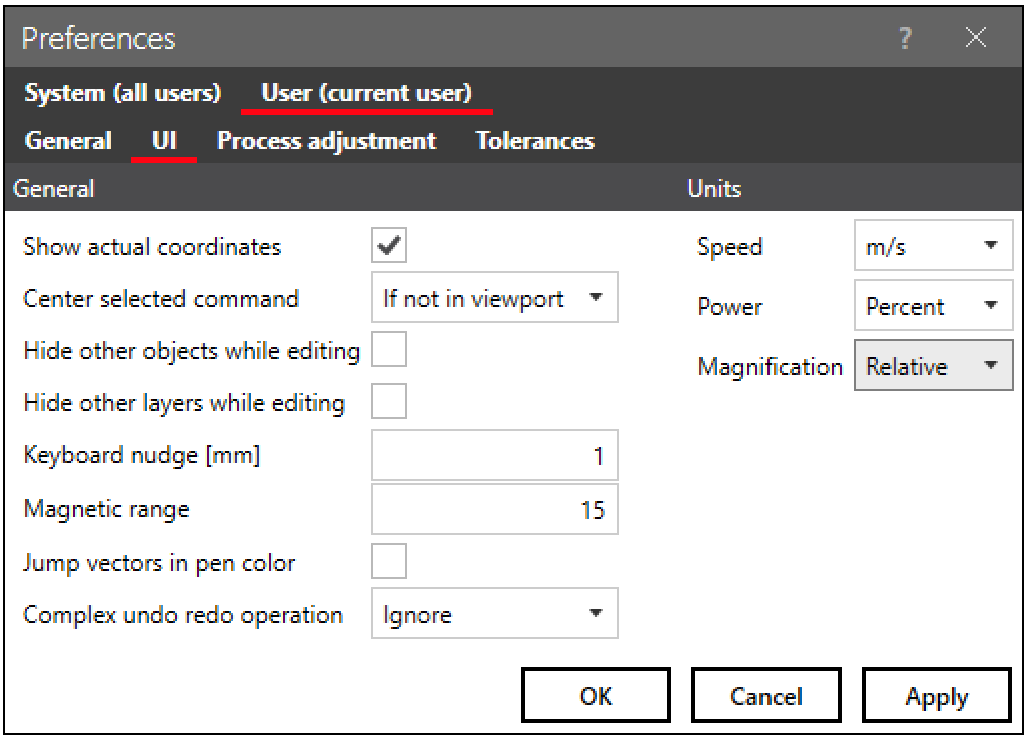


Fig. 6.8: ABG

Setting	Explanation
General	
Show actual coordinates	Check if you want to show the coordinates of a graphic element **including** 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 center of the viewport. Check one of the following settings: ■ *Never* ■ *Always* ■ *If not in Viewport:* Only if the selected graphic element is not already visible in the current image section of the viewport.
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).

<table>
<tr><th>Setting</th><th>Explanation</th></tr>
<tr><td>Keyboard nudge [mm]</td><td>Sets how many selected objects or graphic elements are moved with one keyboard stroke (arrow keys) in [mm].</td></tr>
<tr><td>Jump vectors in pen color</td><td>When the display option “show jumps” is activated:
Displays the jumps in the color of the pen which also defines the jump parameters.</td></tr>
<tr><td>Magnetic range [pixels]</td><td>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.</td></tr>
<tr><td>Complex undo redo operation</td><td>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.
This function defines how complex undo / redo operations are handled.</td></tr>
<tr><td colspan="2">Units
If you change the units, you must restart the software to apply the change to all forms and dialogs.</td></tr>
<tr><td>Speed</td><td>Select the global speed unit:
■ [m/s]
■ [mm/s]</td></tr>
<tr><td>Power</td><td>Select the global unit for the laser power: [%] or [watts].
The translation from [%] to [watts] is now defined in the laser configuration (see page 56, Laser Controller Configuration).</td></tr>
<tr><td>Magnification</td><td>Select the global unit for spot magnification:
■ Relative (factor) or
■ Absolute (diameter in [mm]).
The conversion factor for this is defined in the configuration of the deflection unit (see page 69, General)</td></tr>
</table>

Table. 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 337, Process Adjustment*.

6.2.4 Vector optimizations

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

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 optimization*** sub-tab.

For detailed information on the application cases, see *page 196, Automated vector optimization*.

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*"

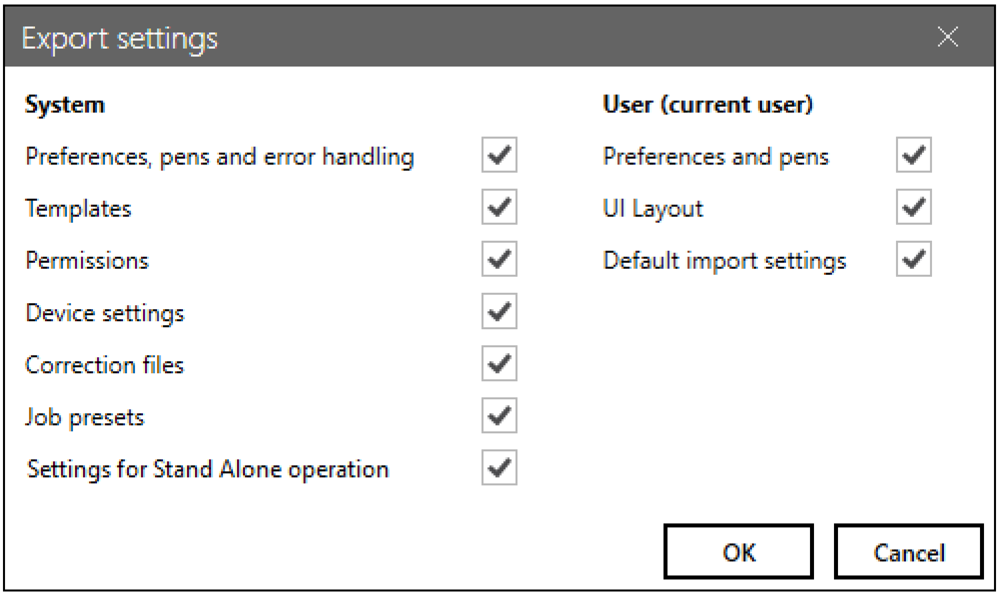


Fig. 6.9: RG-AFI

Setting	Explanation
System	
Preferences, pens and error handling	Contains all settings that were made according to *page 90, General* to *page 96, Visibility*. All system pen sets and the settings for automatic error handling are also included (see *page 326, Automated Error Handling*).
Templates	Contains all templates generated for objects and fillings, see *page 243, Templates*.

Setting	Explanation
Permissions	Contains the created users and their rights.
Device settings	Contains all configured devices, see *page 42, Device Configuration and Calibration*. **NOTE:** 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 *page 114, Job Presets*.
Stand-alone settings	Contains all configurations that have been set up for stand-alone mode, but without the linked job files.
User (current user)	
Preferences and pens	Contains all settings that were made according to *page 90, General* to *page 96, Visibility*. 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.

Table. 6.7: RG-095

6.3.2 Importing settings

The settings from the backup are displayed during import.

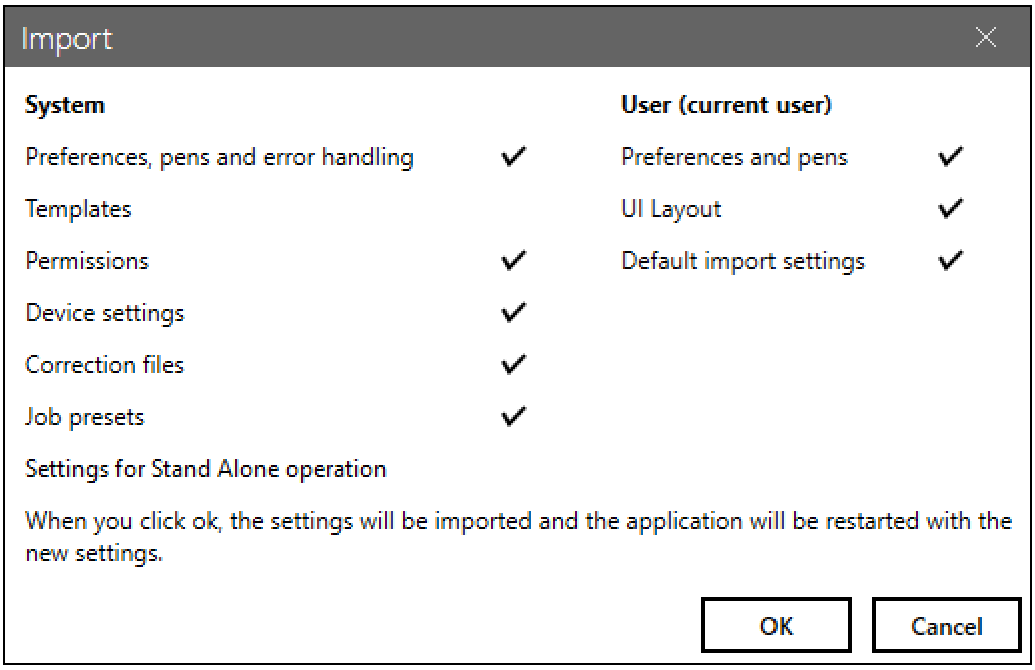


Fig. 6.10: RG-AFJ

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*** in the menu or the ***[Add]*** button in the main toolbar. 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:

Example:

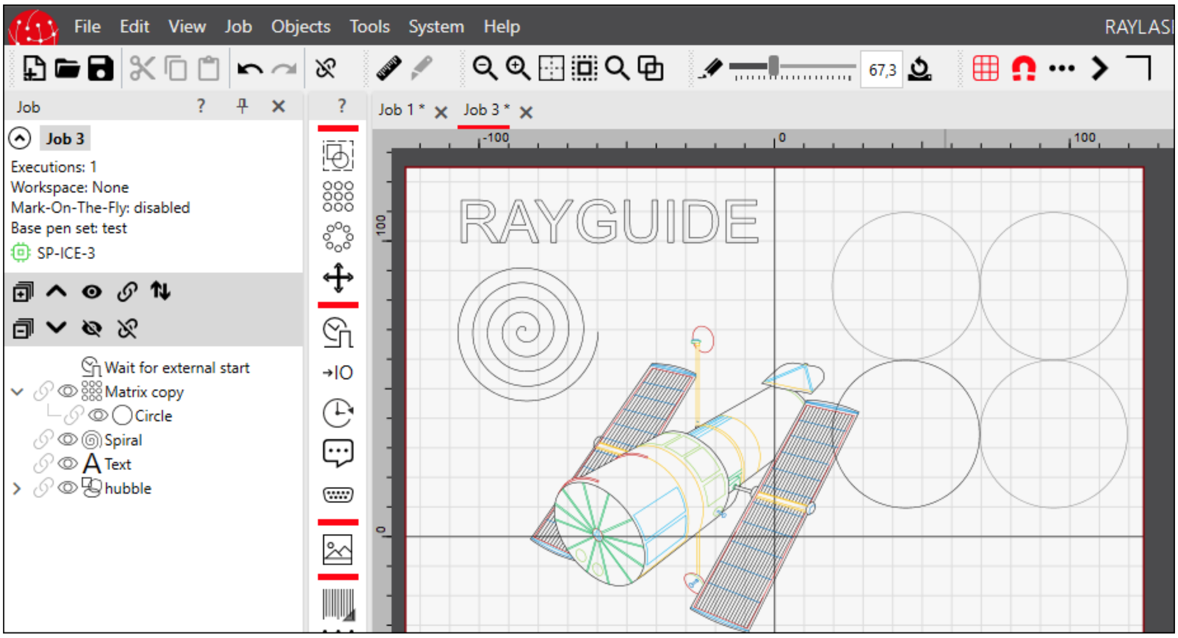


Fig. 7.1: ABH

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

On top, important job settings and the control cards linked to the job 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 125, 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 system, that job refers to a different control card and possibly to other hardware devices. Therefore, RAYGUIDE prompts you to reference the missing devices to available devices in the current RAYGUIDE system. Suitable devices are listed in the respective drop-down lists.

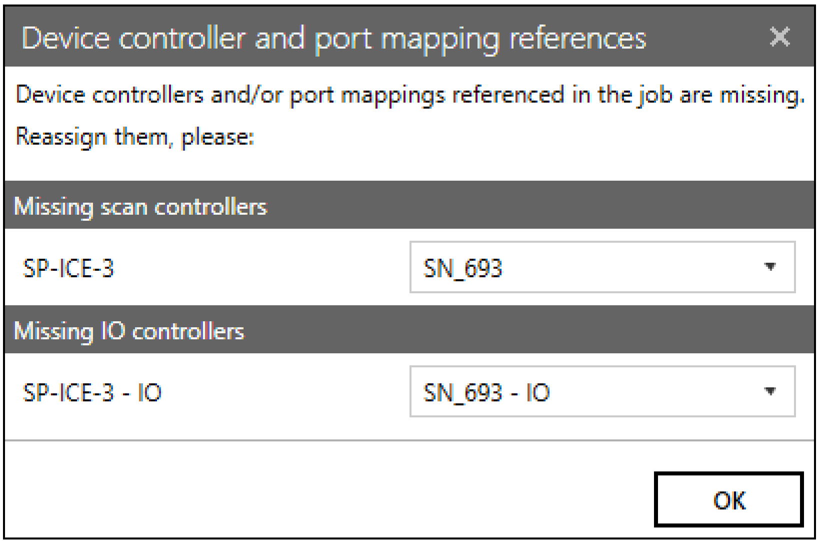


Fig. 7.2: RG-ADC

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 save the default settings for jobs, such as configuration of the workspace, frequently used MOTF settings and automated job optimizations.

In the menu, select ***Job > Presets***, or press ***[Ctrl]+[F11]*** to open the ***Job presets*** dialog box.

As a user, you can define several configurations as default settings:

- Click on ***[Add]*** and enter the name for the new default setting.
- Click on ***[Edit name]*** to change the name of an existing default setting.
- Click on ***[Delete]*** to delete an existing default setting.
- Click on ***[Duplicate]*** to create a copy of an existing default setting. The duplicate is given a corresponding suffix.
- Select *Default* (set check mark) if you would like each new job to use this default setting definition.

7.1.2.1 Setup

The workspace configuration is defined in this tab.

Application cases

- If you are using several control cards and therefore also several scan fields.
- If you want to limit the usable workspace relative to the available scan field.
- If you want to enlarge the workspace beyond the scan field for MOTF applications.

Appearance in the viewport

The defined workspace itself can be made clearly visible by activating the grid line display. Brighter areas also indicate areas that can in principle be reached by the deflection units, especially if the selected multiple field mode is taken into account.

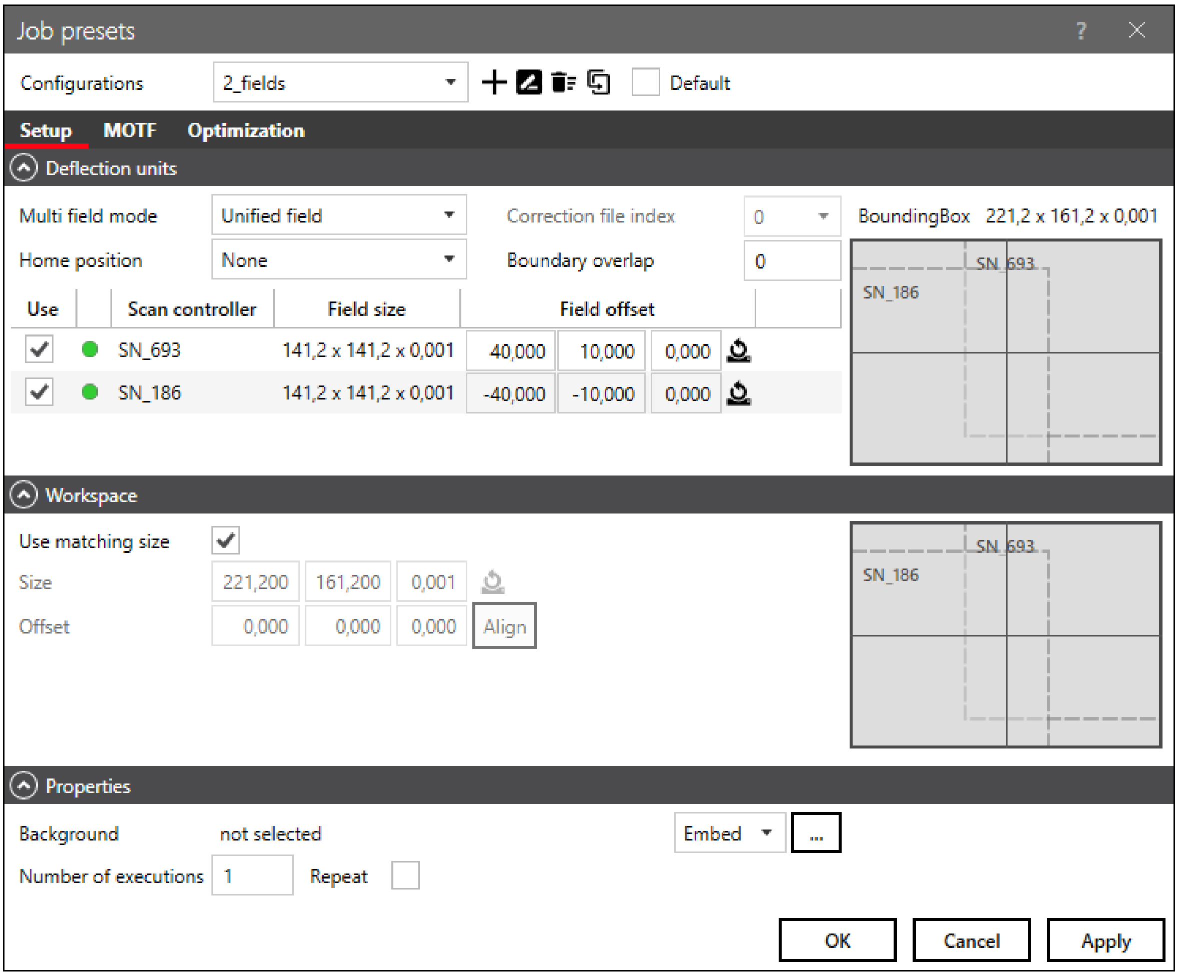
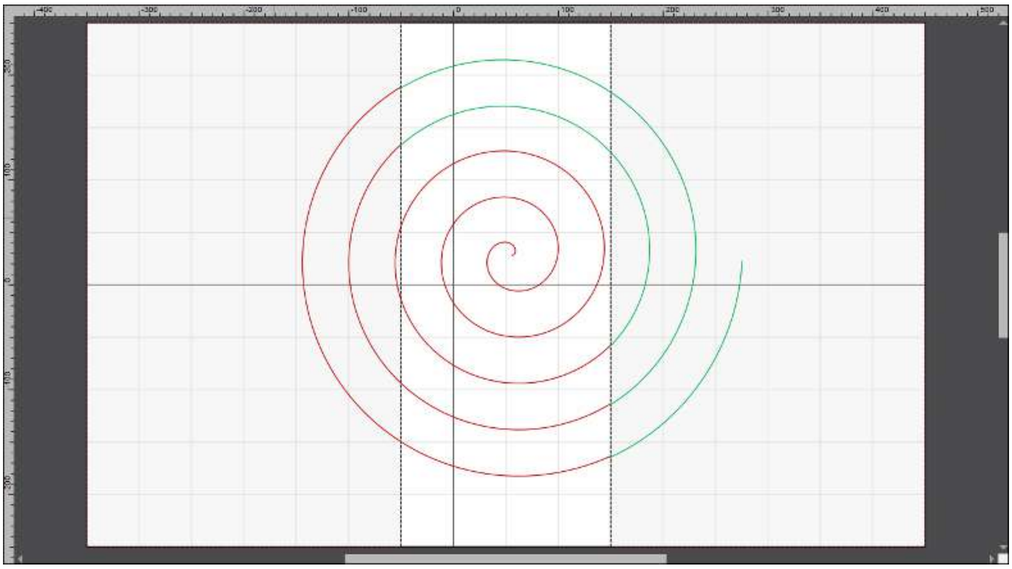
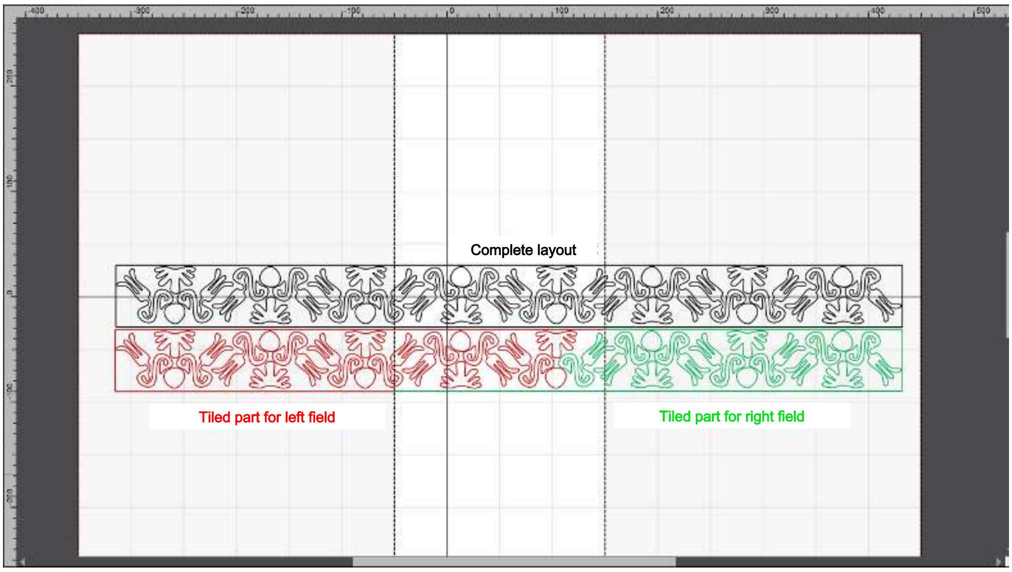
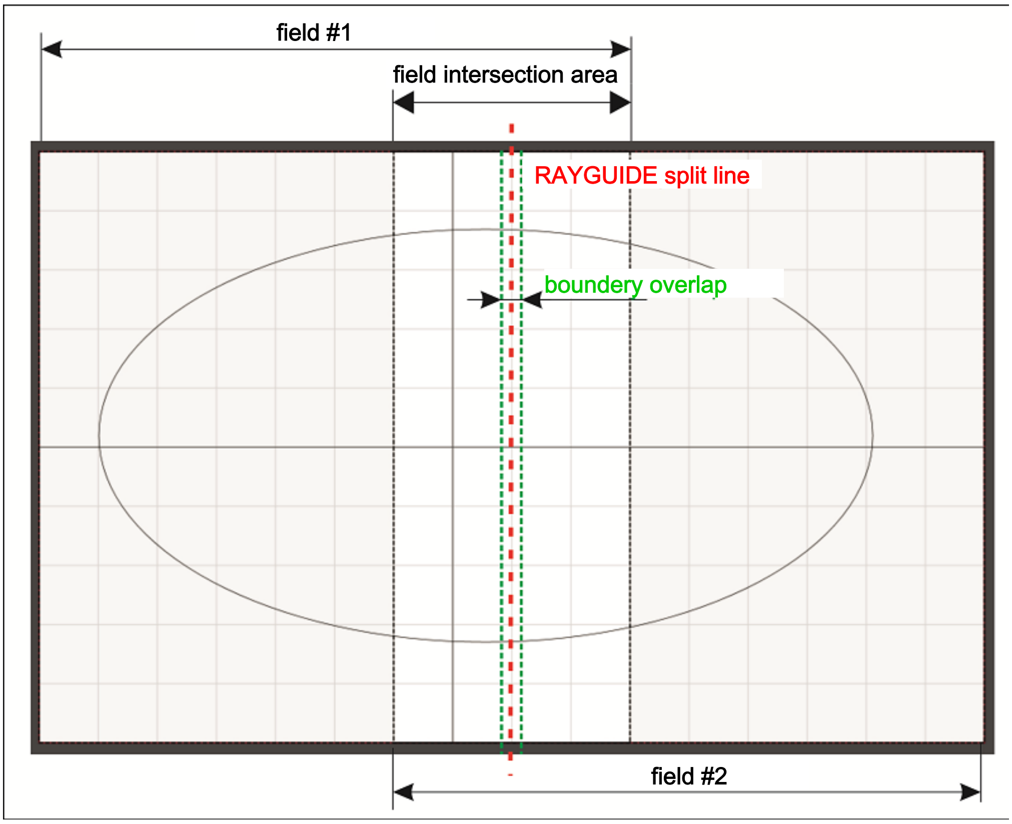
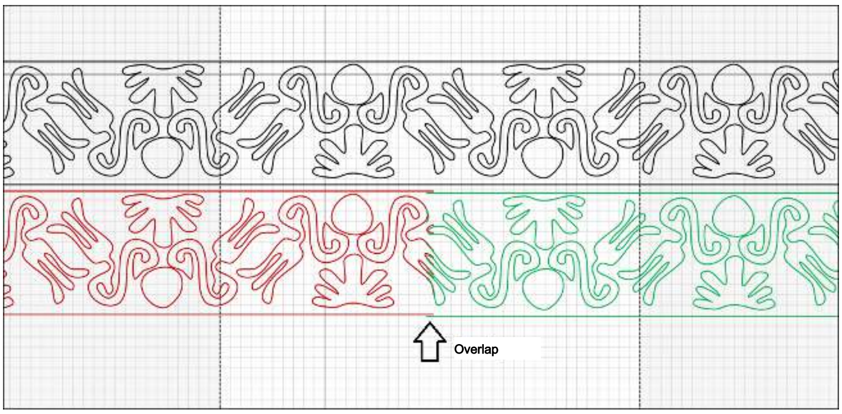


Fig. 7.3: RG-ABA

Setting	Explanation
Deflection units	
Multi field mode	If more than one control card is connected, the controlled deflection units and their scan fields can interact in a variety of ways. *Individual fields*: 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. **NOTE**: The field offset is not applicable in this mode and is ignored by the software.
	Unified field: All scan fields are used together to cover a combined workspace where layout objects can be positioned. **NOTES:** ■ 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 **Manual** option and then the desired control card. ■ 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 **Boundary overlap** value. Depending on the boundary overlap, two cases can be distinguished: 1. Boundary overlap = 0 [mm] 2. Boundary overlap ≠ 0 [mm]

Setting	Explanation
	Case a) Boundary overlap= 0 [mm] 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. Example:  

Setting	Explanation
	Case b): Boundary overlap ≠ 0 [mm] If the value of the boundary overlap ≠ 0, 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. Example:  

Setting	Explanation
	Intersection field: 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. **NOTE:** 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.
Home position	Select if the deflection unit should "jump" to a specific position at the end of all job elements. The choices are: ■ *None* ■ *Defined position*: Specify the coordinates in the list per control card. ■ *Start position of the job*: Position where the first marking path starts.
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	Define the index of the correction file that is to be active when the execution of the job begins. **NOTE:** The option is only usable if at least one deflection unit has been assigned two correction files in the configuration. See *page 69, General*.
List control cards	The table shows the connected control cards. Check the ones to be used in this configuration. 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. If necessary, enter the desired coordinates for the end position per control card.

Setting	Explanation
Workspace	
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: ***Use case 1:*** 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. ***Use case 2:*** Visualize a part of the virtual field for MOTF applications so the user can position the layout objects accordingly. In this case, the workspace size may well exceed the size of the scan field.	
Use matching size	Set the tab to force that the workspace size matches the scan field size. 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 ***[Align]*** to use one of the predefined layouts.
Properties	
Background	Option for inserting an image as a background picture in the workspace. Valid formats are: JPG, JPEG, BMP, PNG, GIF, EXIF. Select: ■ *Embed* if the image is to be saved as part of the job. ■ *Link* if you only want to link the image file to the job locally. **NOTE**: The image is scaled to the size of the workspace in both dimensions. **NOTE**: The opacity of the background image can be set using the opacity slider, which is part of the toolbar. See *page 24, Toolbar*.
Number of executions	Specify the job repetitions for jobs with this preset.
Repeat	Activate the option if jobs with this preset are to be executed in an endless loop.

Table. 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 *page 295, MOTF Jobs*.
Start trigger	
Distance	
Repeat trigger	
Execution pitch [mm]	

Table. 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.

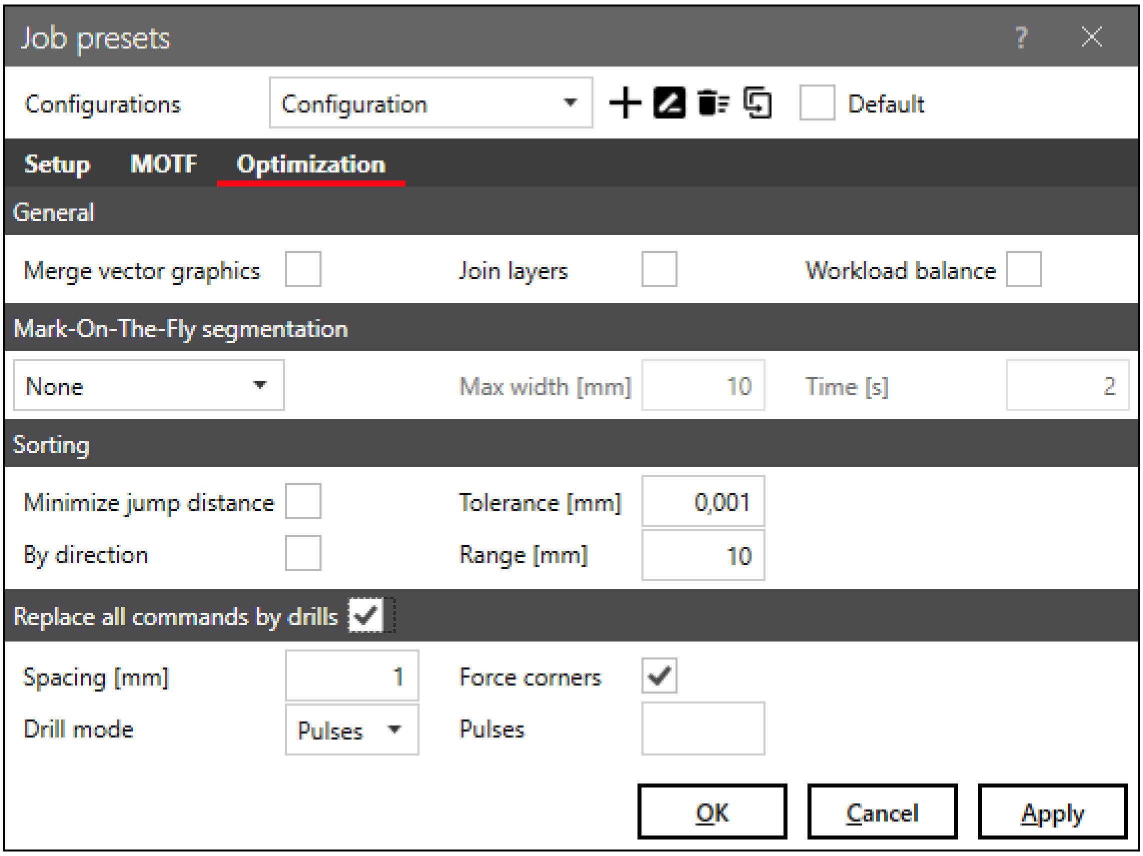


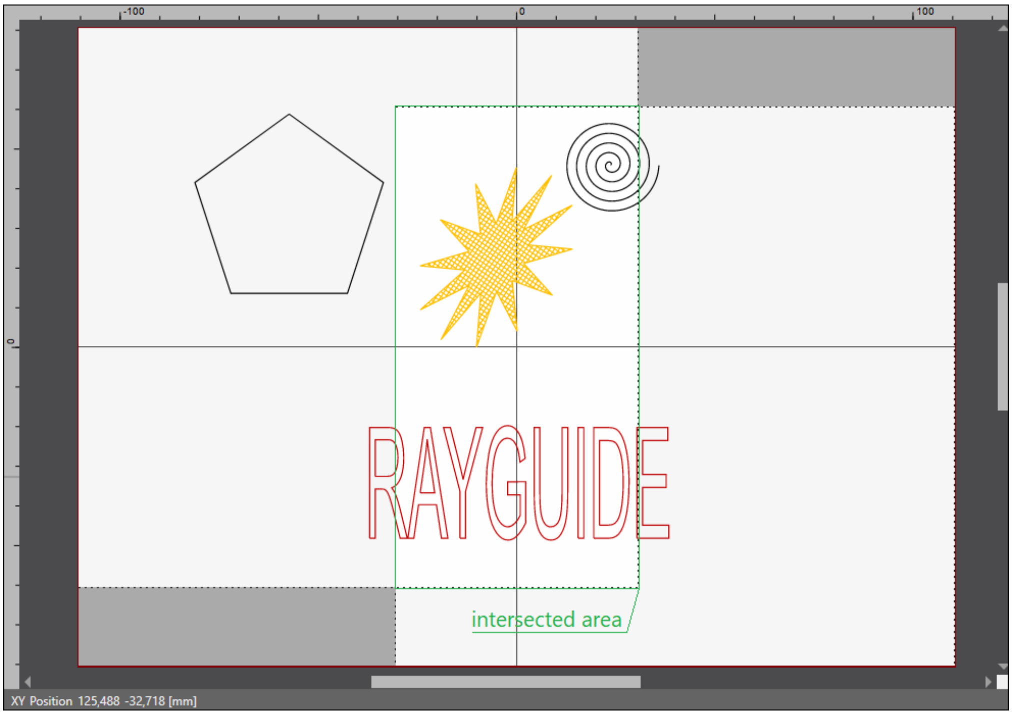
Fig. 7.4: RG-AFA

Setting	Explanation
General	
Merge vector graphics	Merges all vector graphics to one graphic object. When merging, the following rules must be observed: If objects vary in their main settings (such as *sequences* or *binning*), 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. **RECOMMENDATION:** 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 *"Sort by direction"* option sorts the paths per individual object and layer.
Join layers	Activate this option if, for example, you want to ensure that concatenated paths are merged in advance. **RECOMMENDATION:** Use this option if your job encompasses objects with multiple layers and the job with the MOTF condition is to be executed since the *"Sort by direction"* option sorts the paths per individual object and layer.

<table>
<tr><th>Setting</th><th>Explanation</th></tr>
<tr><td>Workload balance</td><td>This option is relevant for jobs that use a workspace consisting of several scan fields.

With this option, all paths (contour paths such as paths of fillings) are automatically assigned to the control cards so that all participating control cards and their deflection units are utilized as equally as possible. This can lead to significant savings in process time.

The extent of this saving depends on the number and processing time of the paths that could in principle be executed by more than one deflection unit (i.e. paths that lie completely in the overlap area).

<u>Example:</u>

</td></tr>
<tr><td colspan="2">Mark-On-The-Fly</td></tr>
<tr><td>Segmentation mode</td><td rowspan="3">See page 302, MOTF Optimizations.</td></tr>
<tr><td>Max. Width [mm]</td></tr>
<tr><td>Time [s]</td></tr>
</table>

Setting	Explanation
Sort	
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 302, MOTF Optimizations*.
Replace all commands by drill holes 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 *page 221, Related settings*
Force corners	
Drill mode	
Pulse / Time	

Table. 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 layouts 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 135, Basic Marking Objects* and *page 136, Extended Marking Objects*.

Essential types of graphic objects:

- Vector graphic: 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 of layers, paths, path elements, and the vector coordinates.

  Text and code objects are also made of vectors 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 image contrast.
- Helix: A three-dimensional spiral spring for deep cutting of holes.
- 3D model: Surface model of a 3D body whose volume is to be engraved into the material.
- Graphic content of a SP-ICE-3 log file.

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

- Automation objects – see *page 234, Automation Objects*.
- Containers – see *page 273, 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 doubleclick in this area.

Below the Job overview, the assigned control cards are shown.

For each control card, icons are used to display the devices connected to the control card in line with the configuration (e.g. deflection unit, laser, camera, etc., RAYDIME METER).

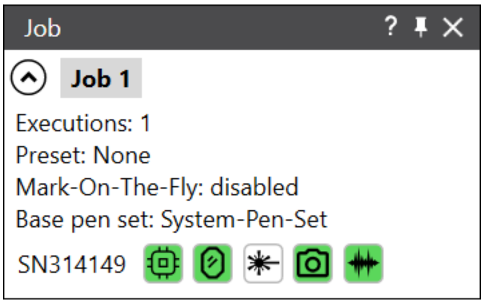


Fig. 7.5: RG-AGL

The color of the icons also provides information about the status, which is also noted in the tooltip:

Control card	Deflection unit	Laser	Camera	RAYDIME METER
Not connected (no answer)	Not connected (no answer)	Not connected (no answer)	Not connected (no answer)	Not connected (no answer)
-	-	Status information not possible [4]	-	-
-	Connection lost	Not ready / Off status [5]	-	Connected, but measuring laser not active
Stand-alone operation	Error condition monitoring	-	-	-
-	-	Emission status [5]	-	-
Ready for use	Ready for use	Ready for use	Ready for use	Ready for use
Connected, but not initialized	Device error (status)	Laser alarm (not all lasers)	-	-

Table. 7.4: RG-107

4 Only exception: nLight Laser.

5 Only applies for nLight laser.

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
Tree controls	
	Use the buttons for ***[Expand] / [Collapse]*** to expand or collapse all freely shaped marking objects in a single step across all Hierarchy levels.
	Use the ***[Up] / [Down]*** arrow keys to navigate step-by-step through the job elements and their individual thumbs. **NOTE:** Collapsed hierarchy elements are automatically expanded. 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 ***[Hide / Unhide all]*** buttons to hide / show all current graphic objects in the viewport. This option has priority over the single object settings.
	Use the ***[Lock / Unlock all]*** buttons to lock all current graphic objects in the viewport against mouse modifications in the viewport. This option has priority over the single object settings. **NOTE:** Locked objects are always displayed with less intensity.
	Use the ***[Reverse order]*** button to reverse the order of all current job elements.

Table. 7.5: 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-shaped 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

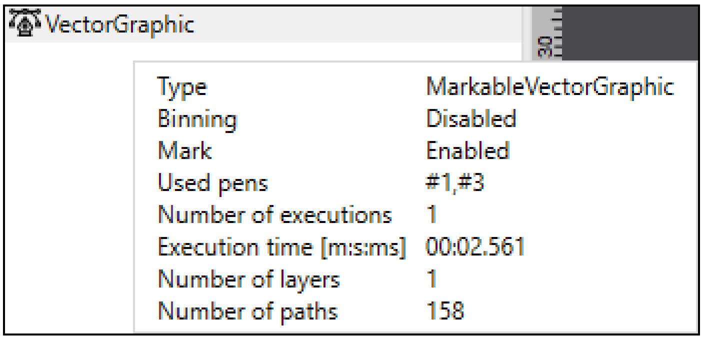


Fig. 7.6: RG-AFK

Example 2

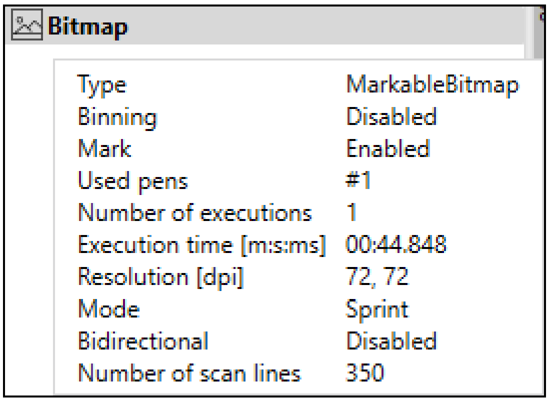


Fig. 7.7: RG-AFL

Example 3

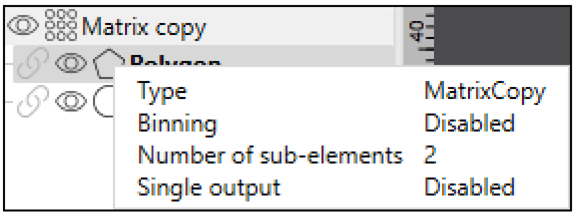


Fig. 7.8: RG-AFM

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. The appearance of the panel 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, fillings and statistics (if available).

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

  The object is created and shown in the job tree and in the viewport (in the center 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, click on the ***[Apply]*** button.

  The object is created and shown in the job tree and in the viewport (in the center of the workspace if no offset has been defined).
- With the left mouse button pressed, 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 pressed, 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 center 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 243, Templates*) the settings of a newly added layout object will match the template. In addition, fillings and transformations 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:

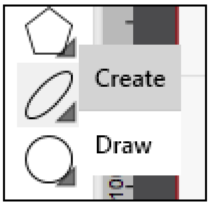


Fig. 7.9: RG-ADI

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. **NOTE:** 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. Press ***[Ctrl]*** to fix the X/Y ratio. 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. Press ***[Ctrl]*** 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. Press ***[Ctrl]*** to fix the X/Y ratio. When drawing, the general default settings of the object are still used (see object-specific settings).

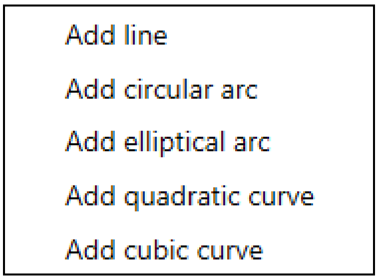
Drawing of objects	
Vector graphic, SP-ICE-3 protocol	First, define the start position of a path by clicking on the corresponding positions (a single blue point appears). Right-click on the point to open the context menu for drawing paths:  The path can now be compiled using basic graphic commands: Line, circular arc, elliptical arc, quadratic curve and cubic curve. Keep ***[Ctrl]*** pressed as long as you want a chain of the same graphic commands. Keep ***[Shift]*** pressed to draw vertically / horizontally only. **RULE:** Each new graphic command is always appended at the end of the path.

Table. 7.6: 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 ***[Properties]*** dialog of the ellipsoid:

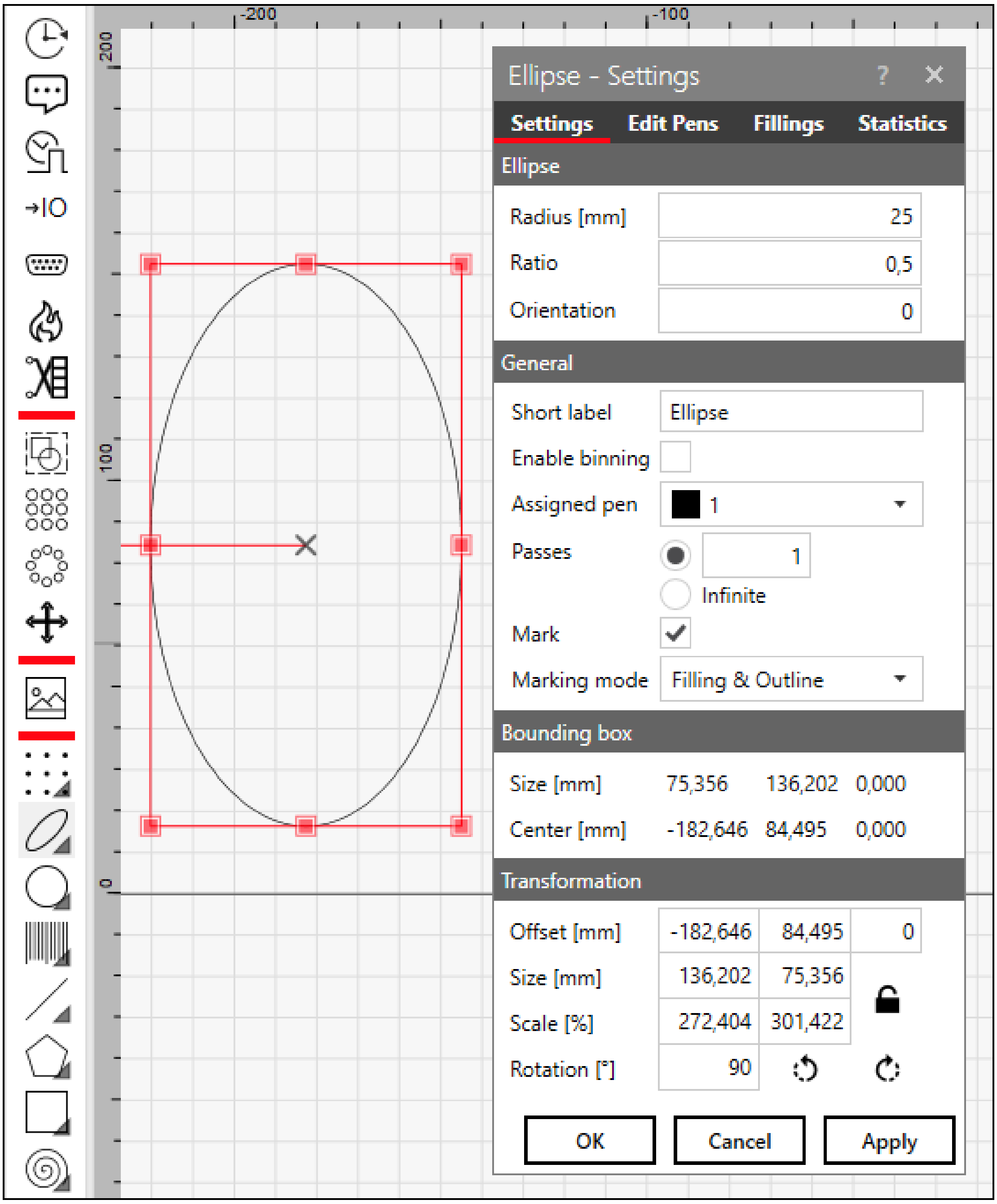


Fig. 7.10: ABI

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 253, Pen Properties*.

  NOTE: This tab can be or become hidden if necessary. For details, see *page 96, Visibility*.
- Fillings (optional)
  Layout objects that contain closed contours / paths can also fill these areas with a line patterns, so-called fillings.
  For more information on fillings, see*page 178, Object Fillings*.

Transformations

Every layout object carries transformation information:

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

For more information on transformations, see *page 190, 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 293, 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 The chord length controls how smooth the spiral is rounded by defining the length of the polyline segments.

Table. 7.7: RG-023

Additional settings

Additional settings include:

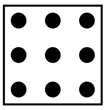
- For general settings for all marking objects; see *page 171, Common Properties of Marking Objects*.
- For transformations, see *page 190, Object Transformation*.

7.2.3 Extended Marking Objects

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

- Drills (see *page 136, Drill*)
- Texts (see*page 137, Text*)
- Barcodes (see *page 143, Barcode*)
- Vector graphics (see *page 148, Vector Graphic*)
- Bitmaps (see *page 164, 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
Drill	
Mode	*Pulse*: 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. *Time*: The dwell duration per drill point is defined directly as the target value.
Pulses / Time	Number of laser pulses or duration [ms]
Import A table of X-Y coordinates can be imported (*CSV, TXT*), defining a drill pattern. Click on the ***[Import]*** button to select a file. The ***[Reset]*** button dismisses the pattern and returns to a single drill point mode. **NOTE:** The first line of the import file must already contain coordinates (no text / headlines). 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 273, Containers*.	
Unit	Unit to be applied to the coordinates being imported.

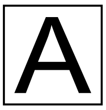
Table. 7.8: RG-024

Additional settings

Additional settings include:

- For general settings for all marking objects; see *page 171, Common Properties of Marking Objects*.
- For transformations, see *page 190, Object Transformation*.

7.2.3.2 Text



Button

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

Essential settings

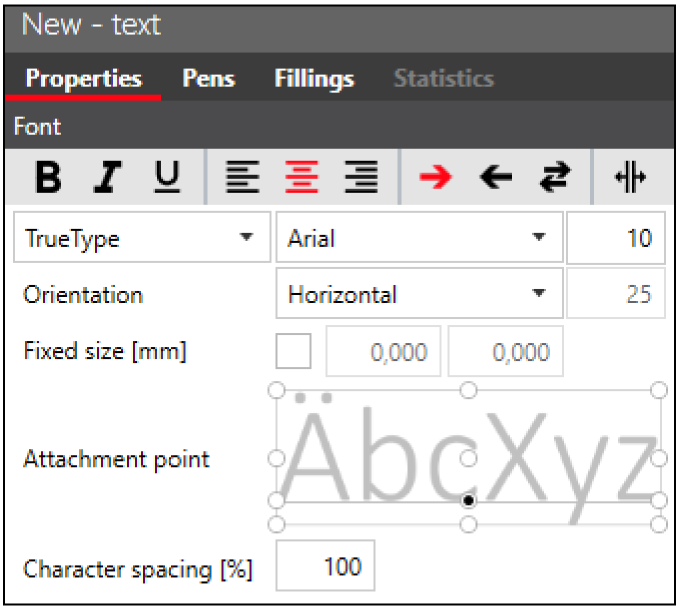
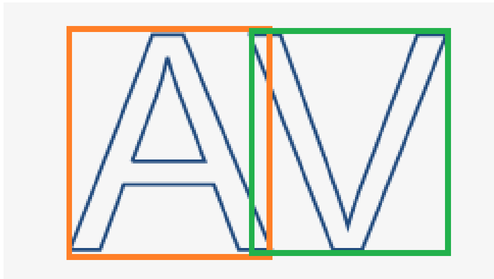
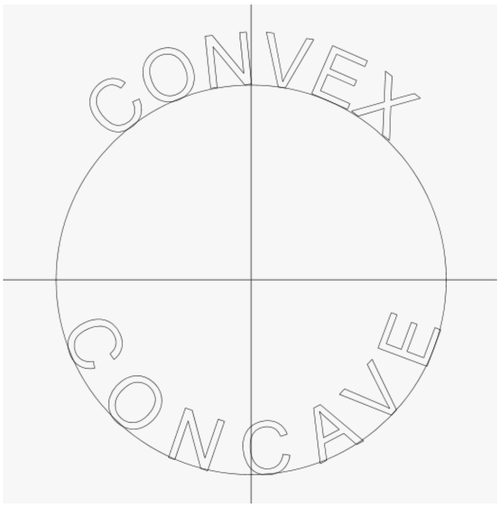


Fig. 7.11: RG-ADU

Setting	Description
Text style icons	
B *I* U	Use the well-known buttons to define a **bold**, *italic*, underlined text style. **NOTE:** The underlined style is not available for circular text. Each style will always apply to the entire text content.
Multiline adjustment icons	
	Use the well-known buttons to define whether multi-line text is left-, center- or right-aligned.
Process direction icons	
	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	
Textsetting icon		
	Use the button to actively prevent font-specific ligatures as well as undercuts.	
	<u>Example ligature:</u>  	<u>Example undercut:</u> 
Font		
Type	True Type fonts are defined by a contour. All True Type fonts installed on the PC are available. The line fonts are 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	Defines the layout of the text characters: ■ *Horizontal:* The characters are arranged next to each other (= default setting). ■ *Stacked:* The characters are arranged one below the other. ■ *Convex:* The characters are arranged on the outside of a circular path. ■ *Concave:* The characters are arranged on the inside of a circular path.
	 
Radius [mm]	Specification of the radius in [mm] for concave / convex text layout.

Setting	Description
Fixed size [mm]	Specify a fixed frame size into which the text content must fit, independent of the number of characters and text size. **NOTE:** If you only want to fix the text length, but the text height should be a function of the font height, enter the fixed text length as an X value for the frame and "zero" for the Y value. **NOTE:** This option can only be used with horizontally arranged text.
Fixed angle [°]	Specify a fixed angle in which the radially arranged text content should fit, regardless of the number of characters. **NOTE:** This option can only be used with concave or convex text.
Attachment point	Click on one of the fixation points: ■ *Left / Center / Right point:* The text is enlarged from this point. ■ *Upper / Basic / Lower point:* The text is fixed for all character heights on this line. If the text varies in length, its fixation point is also adjusted.
Character spacing [%]	Spacing of characters in percent. Values greater than 100% increase the spacing predefined by the font, values less than 100% decrease the spacing.
Data	
Source	Select a source for the text:
	String: Use the text as entered from the text field below.
	File: 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: ■ *Start*: The number of the line in the source file to start with. ■ *Increment*: Delta of lines after the batch has been processed. ■ *Batch*: The increment is only applied after n executions. ■ *File*: To select the data source file (TXT, CSV format) ■ *Current iteration*: Displays the current increment status. ■ *Auto reset:* – *Never* – *[Execute]* > Resets the iteration value every time a job is executed. – *Load* > Resets the iteration value whenever a job is loaded. ■ *"Wrap around" checkbox:* Enable this checkbox if you want to continue with the first line of the source file when the end of the source file is reached. ■ *"Cache" checkbox:* 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.
	Date: Select one of various date format presets. Custom and sortable formats can be manually edited in the Format field.

Setting	Description
	Increment: Creates a number that will be incremented as follows. ■ *Start*: Number to start with. ■ *Increment*: Delta in counter after the batch has been processed. ■ *Batch*: The increment is only applied after n executions. ■ *Digits*: How many leading zeros are added to the number. ■ *Current iteration*: Displays the current increment status. ■ *Auto reset:* – *Never* – *[Execute]*: Resets the iteration value every time a job is executed. – *Load*: Resets the iteration value whenever a job is loaded.
	Custom: Text-, number characters and date / time items can be combined. Click on the ***[Placeholder]*** drop-down list to display a list with predefined placeholders for different formats. You may combine them according to your needs. In addition, the content of variables can be inserted by means of syntax ***% (NameVariable)***. The content of variables can be assigned via pop-up dialogs (dynamic – see *page 236, Dialog*), via the job settings (static – see *page 294, Job variables*) or via a text- / code object (dynamic). **NOTES:** ■ The assignment of the variable content must be done in the job sequence before the variable is inserted. ■ The variable name is case sensitive. ■ The variable and its content are also listed on the Variables tab of the job properties (see *page 294, Job variables*). Optional fields in case the custom string contains an incrementing number: ■ *Start*: Number to start with. ■ *Increment*: Delta in counter after the batch has been processed. ■ *Batch*: The increment is only applied after n executions. ■ *Digits*: How many leading zeros are added to the number. ■ *Current iteration*: Displays the current increment status. ■ *Auto reset:* – *Never* – *[Execute]* > Resets the iteration value every time a job is executed. – *Load* > Resets the iteration value whenever a job is loaded. **NOTE:** The date separator character corresponds to the local format in the operating system.
Content	Field for the definition of content. For dynamic data sources, the placeholders or even date formats are displayed here.

Setting	Description
	NOTE: 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 marks each edited content with a timestamp.
Resulting content	In this line you see the resulting text that appears after you have pressed the **[*Apply*]** button.
Save content to variable	Select if the previously defined content is to be assigned by the text object as variable content. In the field next to it, specify the name of the variable.

Table. 7.9: RG-025

NOTE: Variable text content features are not supported when a job is executed at the control card level.

Additional settings

Additional settings include:

- For general settings for all marking objects; see *page 171, Common Properties of Marking Objects*.
- For transformations, see *page 190, 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
Barcode	
Type	List of all available standard code types. The last three code types used are shown in extra list on top. 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. Some of the generic settings are explained below.	
Subset	Some codes are grouped to certain types. The specific code is defined here, for example: Type = Postal > SubType = AustralianPstRouting See the code library manual for details.
Narrow wide ratio	Defines the ratio of narrow gaps / bars to the wide gaps / bars. The range of values extends from 2 to 3. **NOTE:** This parameter is only available 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. The parameter can be used to compensate the laser spot width for very narrow code bars. **NOTE:** This parameter is only available for some barcodes.
Code format	Format that is available for some code types.

Setting	Description
Size mode	■ For 2D code types: Choose if you want to fix the size of the 2D code or the size of a code cell. ■ For 1D code types *Code128* and *Code\Code39*, you can select between: – Width: The code width remains fixed regardless of the content (according to the value in the *Size* field). The width of the bars is adjusted accordingly. – Height: The code width remains fixed regardless of the content (according to the value in the “Size” field). The bar width can remain constant and the code width varies with the content. **NOTE:** Any text displaying in the code content is included in the height specification.
Module width scaling	Specification in [%] by which the modules (bars) can be scaled in width. **NOTE:** This value is only available for the two 1D codes that can be defined with a fixed height.
Cell size [mm]	Enter the size of code cells in [mm]. Usable only for 2D codes
Size	Enter the size of the complete code in [mm]. For other codes than 2D, the size value refers to the X-dimension.
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. 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. Specifying the values for the ASCII characters primarily in HEX format and not in decimal format is recommended. Some typical examples are: ■ GS (Group Separator) = \x1d ■ RS (Record Separator) = \x1e ■ EOT (End of Transmission) = \x4

Setting	Description
Show text	This option is only available for 1D barcodes. 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.
Data	
Source	Select a source for the text. ***String***: Use the text as entered from the text field below. ***File***: 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: ■ *Start*: The number of the line in the source file to start with. ■ *Increment*: Delta of lines after the batch has been processed. ■ *Batch*: The increment is only applied after n executions. ■ *File*: To select the data source file (TXT, CSV format) ■ *Current iteration*: Displays the current increment status. ■ *Auto reset:* – *Never* – *[Execute]* > Resets the iteration value every time a job is executed. – *Load* > Resets the iteration value whenever a job is loaded. ■ *"Wrap around" checkbox:* Enable this checkbox if you want to continue with the first line of the source file when the end of the source file is reached. ■ *"Cache" checkbox:* 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. ***Date***: Select one of various date format presets. Custom and sortable formats can be manually edited in the Format field. ***Increment***: Creates a number that will be incremented as follows. ■ *Start*: Number to start with. ■ *Increment*: Delta in counter after the batch has been processed. ■ *Batch*: The increment is only applied after n executions. ■ *Digits*: How many leading zeros are added to the number. ■ *Current iteration*: Displays the current increment status. ■ *Auto reset:* – *Never* – *[Execute]*: Resets the iteration value every time a job is executed. – *Load*: Resets the iteration value whenever a job is loaded. ***Custom***: Text, number characters and date / time items can be combined. Click the ***[Placeholder]*** drop-down list to display a list with predefined placeholders for several formats. You may combine them according to your needs.

Setting	Description
	In addition, the content of variables can be inserted by means of syntax ***%(NameVariable)***. The content of variables can be assigned via pop-up dialogs (dynamic – see *page 236, Dialog*), via the job settings (static – *page 294, Job variables*) or via a text- / code object (dynamic). **NOTES on variables:** ■ The assignment of the variable content must be done in the job sequence before the variable is inserted. ■ The variable name is case sensitive. ■ The variable and its content are also listed on the Variables tab of the job properties (see *page 294, Job variables*). Optional fields in case the custom string contains an incrementing number: ■ *Start*: Number to start with. ■ *Increment*: Delta in counter after the batch has been processed. ■ *Batch*: The increment is only applied after n executions. ■ *Digits*: How many leading zeros are added to the number. ■ *Current iteration*: Displays the current increment status. ■ *Auto reset:* – *Never* – *[Execute]* > Resets the iteration value every time a job is executed. – *Load* > Resets the iteration value whenever a job is loaded. **NOTE:** The date separator character corresponds to the local format in the operating system.

Setting	Description
Content	Field for the definition of content. For dynamic data sources, the placeholders or even date formats are displayed here. **NOTE:** 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 **[*Apply*]** button.
Head Protocol	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 marks each edited content with a timestamp.
Save content to variable	Select if the previously defined content is to be assigned by the text object as variable content. In the field next to it, specify the name of the variable.
Statistics	*Characters* = Displays the number of characters from the defined content, as the code size depends on it. *Cells* = Displays the number of cells per code row / column (available only for 2D codes)

Table. 7.10: RG-026

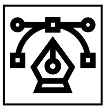
NOTE: Variable code content features are not supported when a job is executed at the control card level.

Additional settings

Additional settings include:

- For general settings for all marking objects; see *page 171, Common Properties of Marking Objects*.
- For transformations, see *page 190, 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.

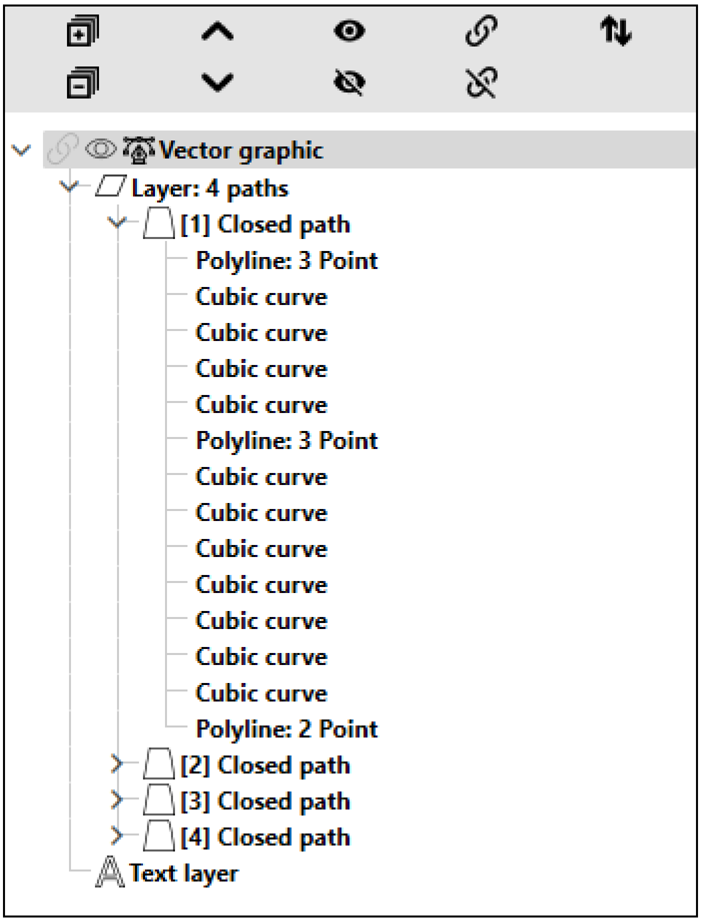


Fig. 7.12: RG-ADA

- layer : 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 137, 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 contour (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	
Graphic commands	
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 center 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.
Action commands (control the laser behavior in a path)	
Laser on	Switches the laser on for a defined amount of time. Similar to a drill object.
Change pen	Selects another pen to switch to different process parameters.

Table. 7.11: 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 also displayed as read-only information.

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

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

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

Setting	Explanation
Tree Icon	Common layer text layer
Index	When adding layers: Number of the layer within an object
Name	Optional name of a layer
Sequences	The sequence “inherits” the layer from the object structure level. The process runs defined in the sequence cannot be changed in the layers-structure level, 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. **NOTE:** If you merge multiple layers with different settings, you obtain 2 layers: One layer that contains all paths to be marked, and one that contains all paths that are not to be marked.
Tab Fillings	
The layer itself can be filled with the default fill options. **NOTE:** Only closed areas of paths are considered by the fill routine. **NOTE:** 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 layers symbol is now grayed out.	

Table. 7.12: RG-027

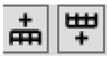
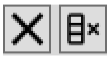
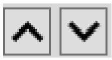
The following table explains all settings for **paths**.

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

Setting	Explanation
Tab Fillings	
A closed path itself can be filled with the standard fill options. Open paths can either use the inset fill with a counted number of contour lines or the filling ends at virtual closing lines. **NOTE:** The path filling routine does not consider closed areas that arise in combination with other paths. **NOTE:** 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 grayed out.	

Table. 7.13: 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
Polyline	
	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.
Arc	
Angle [°]	Angle in degrees. Positive values turn anti-clockwise, negative values turn clockwise.
Center [mm]	Coordinates of the virtual center point of the arc. The radius results from the distance between start and center.
Ellipse	
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 center point.

Setting	Explanation
Quadratic curve	
Control point [mm]	Coordinates to define the point positions. This curve is defined using one control point.
End point [mm]	
Cubic curve	
Control point 1 [mm]	Coordinates to define the point positions. This curve is defined using two control points.
Control point 2 [mm]	
End point [mm]	
Laser on 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 *Pulse* to enter the number of laser pulses to apply at this point. Select *Time* to enter the duration of laser application at this point.
Pulses or Time	Number of pulses or time in µs
Set pen	
Pen number	Pen (from the base pen set of the job) to be used for the succeeding graphic commands. Use the ***[Edit]*** button to edit the pen settings.

Table. 7.14: RG-029

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

Import, conversion or creation of vector graphics

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 importing 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:

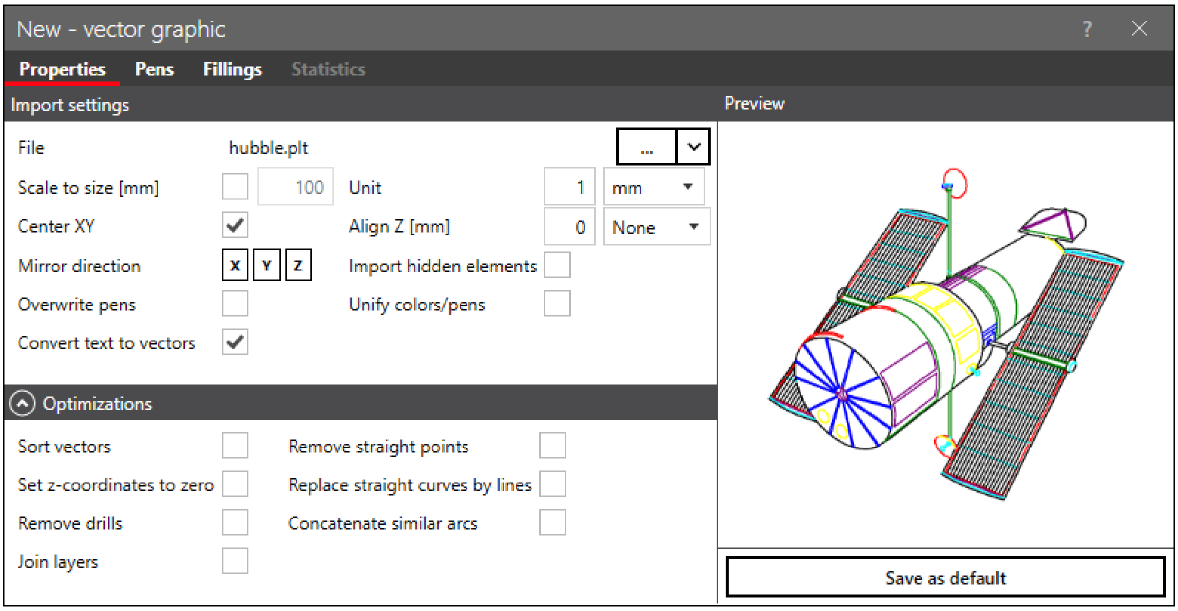


Fig. 7.13: RG-ADS

Setting	Description
Import settings	
File	Opens a file browser to navigate to the graphic file you want to import. After selecting the file, click on ***[Open]*** in the browser and the preview displays the file content. If files were already imported, these are made available in the drop-down list for renewed selection. Supported file formats are: *DXF, PLT, SVG, DWG, CGM, HPGL, GBR, CSV* [6], *TXT* [6]. Valid separators are: Space, semicolon and “\\t”. An empty line acts as a separator between a path and another, subsequent path in the vector graphic.
Scale to size	Activate to scale the size of the imported graphic to the specified size in [mm].

[6] **NOTE:** You can import a contour created as a polyline defined as a coordinate table: X / Y / (Z) / pen number.

Setting	Description
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], [µm] and [inch]. A value ≠ 1 would additionally add a scale factor to it. Only applicable if *Scale to size* is not used.
Center XY	Incorporates the vector graphic centered on the XY axes of the workspace.
Align Z [mm]	Specification of the Z position in [mm], according to which either the upper side, center 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 you want 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 color and the dashed line pattern setting) by the pens defined in the imported file.
Unify colors/pens	Assigns the job default pen to all layout elements of the imported graphic. This unifies all original multiple colors to one color = one pen.
Convert text to vectors	If the vector graphics file contains text-based elements, these will be converted to vector-based layers during import. If this option is not active, text-based elements are displayed as so-called "text layers" after import. **NOTE:** This option is active by default.
Optimizations Optimization functions applied in the import process.	
Sort vectors	Optimizes the vector order to reduce jumps and to get a time-optimized 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	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. A corresponding tolerance value can be set in the system settings: ***System > Preferences > User (current user)***, ***Tolerances tab***, collinear distance.

Setting	Description
Straight curves by lines	Converts graphic elements that are straight into straight line graphic commands. The corresponding tolerance value that determines how close the curve shape equals a straight line is defined under ***System > Preferences > User (current user)***, ***Tolerances tab***, *collinear distance*.
Concatenate similar arcs	Combines multiple arcs to one arc if they appear to have the same radius and the same center coordinate. To determine whether the center points are the same, a corresponding tolerance value can be defined: ***System > Preferences > User (current user)***, ***Tolerances tab***, ***Location***.
[Save as default]	Button to save the created settings as default settings for future imports of vector graphics.

Table. 7.15: 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:

- For general settings for all marking objects, see *page 171, Common Properties of Marking Objects*.
- For transformations, see *page 190, 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 with the following basic 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, see *page 131, Draw an Object from the Panel*.

7.2.3.5 Dynamic vector graphic

Button optional, see *page 125, 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 148, 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 importing 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**
Import settings	
Primarily the same import settings are available to you here that are also available for the regular vector graphic; see *page 148, Vector Graphic*.	
Automatic reload	Select if the vector graphic is to be re-imported from the referenced source file every time the job execution is repeated.
Optimizations Optimization functions applied in the import process.	
The same optimization functions are available to you here that are also available for the regular vector graphic, see *page 148, Vector Graphic*.	

Table. 7.16: 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, 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.

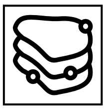
Dynamic vector graphics within a copy container

In general, the graphic is reloaded per copy during execution, provided that the container option *Execute as single vector graphic* 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 in RAYGUIDE, unless the referenced graphic file is also located in the same directory path.

7.2.3.6 Extruded vector graphic



Button optional, see *page 125, Objects Overview*

The extruded vector graphic is characterized by the fact that

- It is repeated in a number of focus positions
- The start and end position of the paths shifts slightly at each focus position

This procedure is used for deep cutting of glass, for example, to prevent a vertical groove from forming at the point where the path is cut.

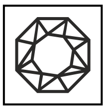
NOTES:

- The extruded vector graphic can generally contain several paths as well as fillings. However, the paths and fill lines should always be closed.
- You can also convert text or any simple marking object (e.g. circle, polygon, rectangle, ellipse) into an extruded vector graphic (see *page 225, More Object-related Operations in the Context Menu*)

Setting	Explanation
Import settings	
Primarily the same import settings are available to you here that are also available for the regular vector graphic; see *page 148, Vector Graphic*.	
Optimizations	
Primarily the same optimizations are available to you here that are also available for the regular vector graphic; see *page 148, Vector Graphic*.	
Extrusion	
Number of slices	Specify the number of focus positions in which the graphic should be executed.
ΔZ [µm]	Specify the focus offset per focus position in [µm]. This value is always positive.
Start point offset [mm]	Specify by how many [mm] the start/end point of the paths shifts in the processing direction at each next focus position. **NOTE:** Negative values cause a shift in the opposite direction to the processing direction.
Processing direction	Specify whether the focus should change from top to bottom or from bottom to top per slice.

Table. 7.17: RG-117

7.2.3.7 Solid



Button optional, see *page 125, Objects Overview*

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 FOCUSSHIFTER, AXIALSCAN, AS FIBER) 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:

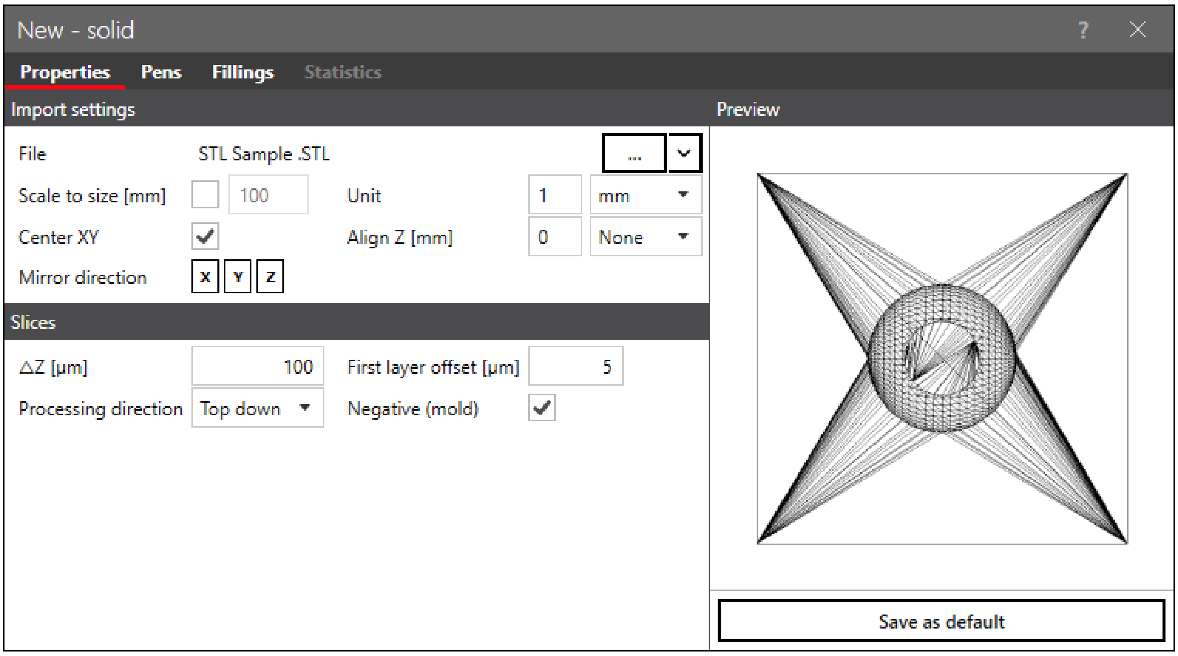


Fig. 7.14: RG-AEN

Setting	Explanation
Import settings	
File	Opens a file browser to navigate to the file of the solid you want to import. After selecting the file, click ***[Open]*** in the browser. The preview displays the file content. If files were already imported, these are made available in the drop-down list for renewed selection. Supported file formats are: *.STL (stereolithography file)
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 imported vectors. This is usually the value = 1 and the unit in which the layout was created. Select from [mm], [µm] and [inch]. A value ≠ 1 would additionally add a scale factor to it. Only applicable if *Scale to size* is not used.
Center XY	Incorporates the solid object centered 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, center position or underside of the solid aligns itself when importing.
Mirror direction	Activate the toggle buttons for the X / Y / Z direction if the solid is to be mirrored accordingly when imported.
[Save as default]	Button to save the created settings as default settings for future imports of body objects. **NOTE:** For solid objects, the standard also contains the settings for the slices.

Table. 7.18: RG-085

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

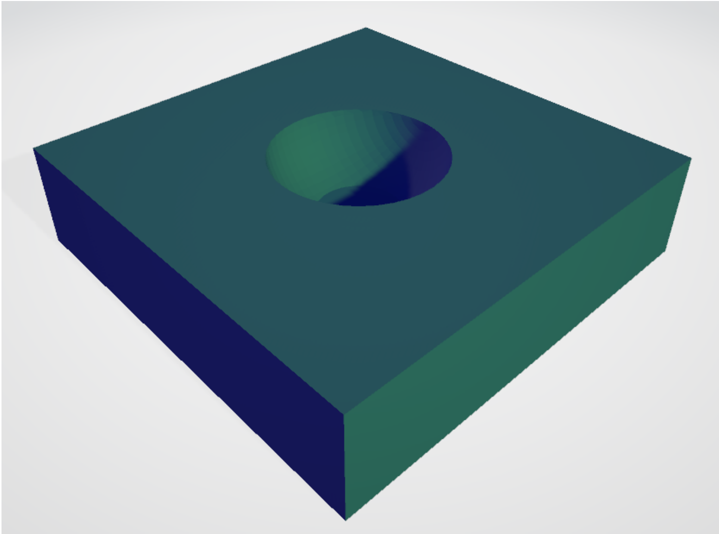
Setting	Explanation
Slices	
ΔZ [µm]	The distance between the slices in [µm]. Depending on the process direction, the value is specified either from the upper edge or the lower edge of the solid.
First layer offset [µm]	The distance between the absolute highest point of the solid and the first slice shown in the navigator (see *page 24, Toolbar*). **NOTE:** 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).
Negative (mold)	Define whether the STL file being imported contains the solid as a negative form. This selection determines which areas of the slices are filled, for example for the engraving process. <u>Example of an STL file with a negative form for deep engraving:</u> 
Number of slices	Shows the number of slices resulting from the object height and ΔZ. **NOTE:** This display is only available in the object settings, not in the import dialog.

Table. 7.19: 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.

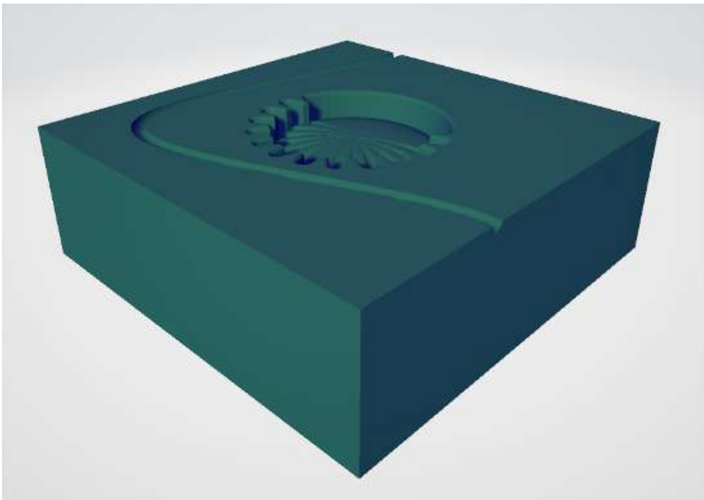
If negative forms are used, note the following:

The number of slices is not based only on the depth of the negative form, but also on the total component height. That means 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:



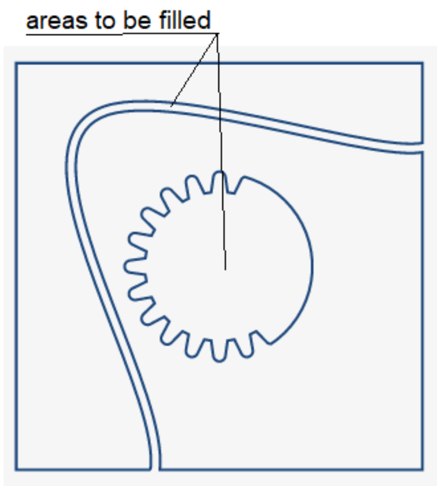


Fig. 7.15: RG-AEO

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 178, 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:

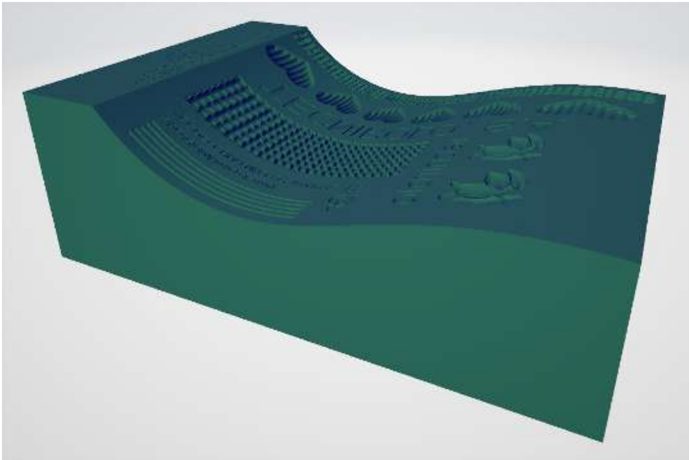


Fig. 7.16: RG-AEP

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.

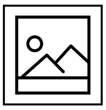
NOTE on solid and execution options:

- The *Test run* execution 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.

7.2.3.8 Bitmap



Button

A bitmap graphic is a two-dimensional array of pixels, representing an image. It is always imported from a file. The grayscale 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:

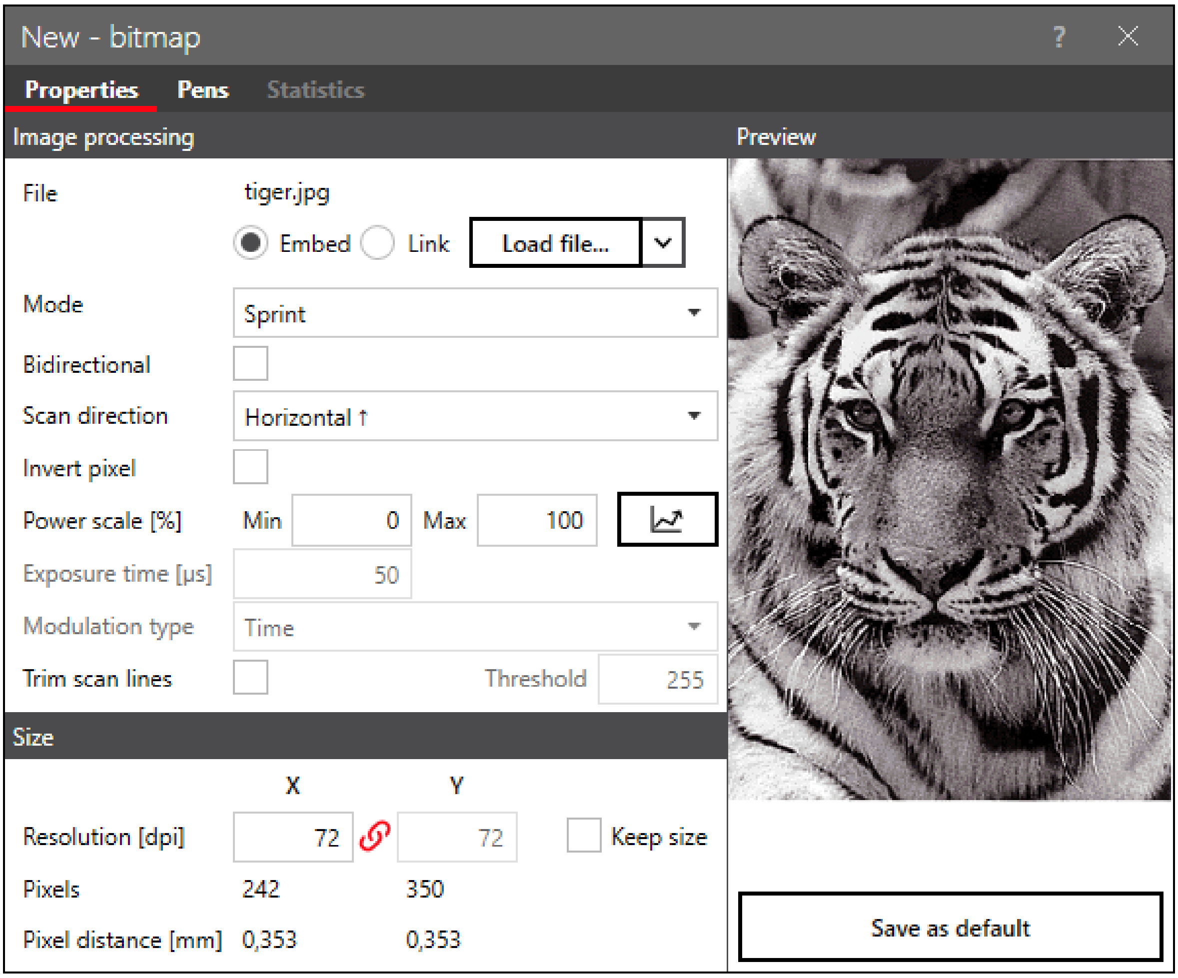


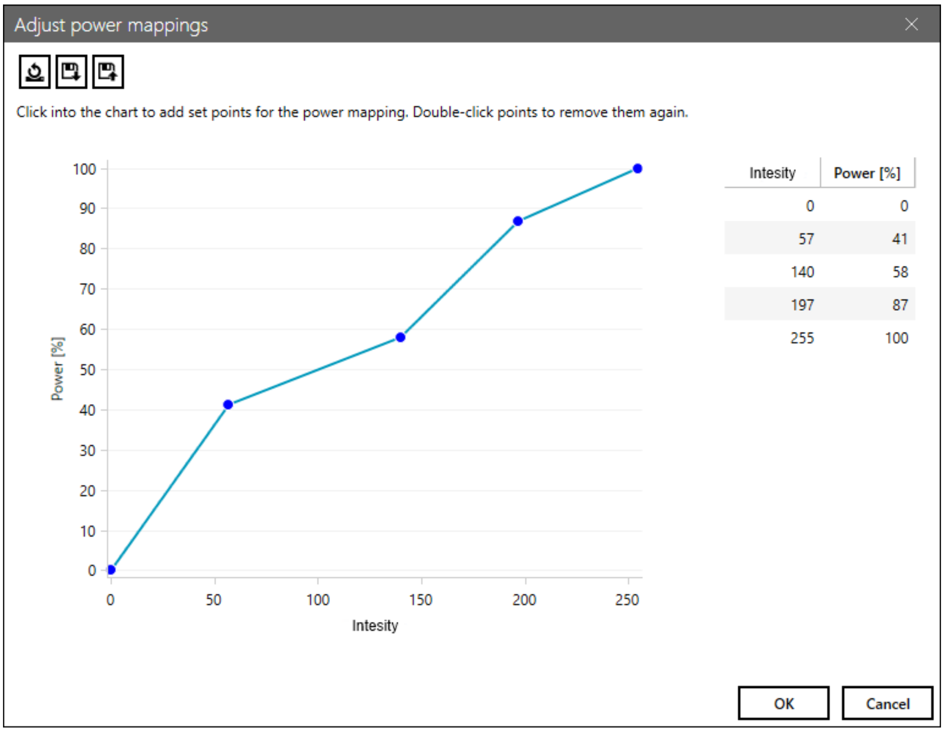
Fig. 7.17: RG-AEQ

Setting	Description
Image processing	
File	***[Load file...]*** opens a file browser to select a bitmap file. Choose the *Insert* option to embed the file content into the job file (important if you want to send the job file to another user). Choose *Link to File* to store only the file path in the job file. Supported file formats are: *JPG, BMP, EXIF, GIF, PNG, JPEG*.
Mode	■ *Sprint***:** The laser beam moves in lines with continuous speed and emits **one** laser pulse per pixel. The grayscale value of the pixel modulates the laser power, resulting in the desired degree of contrast. The grayscale value has a resolution of 16 bit. **APPLICATION NOTE:** 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. ■ *PointAndShoot*: 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 grayscale value, in order to reach the desired degree of contrast. **NOTE**: "White" pixels are automatically skipped.
Bidirectional	Enables alternating marking directions of the bitmap lines.
Scan direction	Sets the main processing direction: ■ Horizontal ↑ : Starts at the bottom and goes up row by row. ■ Horizontal ↓ : Starts at the top and goes down row by row. ■ Vertical → : Starts at the left and goes to the right row by row. ■ Vertical ← : Starts at the right and goes to the left row by row. **APPLICATION NOTE:** 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.
Invert pixel	Inverts the grayscale value of each pixel.

<table>
<tr><th>Setting</th><th>Description</th></tr>
<tr><td>Power scale [%] Min/Max</td><td>Scales the laser power per pixel grayscale value in a linear fashion between the minimum and maximum power.

<u>Example</u>:

If 80% laser power already results in a completely black pixel, any excess would probably cause laser burns and cost valuable 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.</td></tr>
<tr><td>[Non-linear power mapping]</td><td>Opens the settings dialog that allows for flexible configuration of the conversion from intensity to laser power. This makes it possible to react more flexibly to the color change from material to laser power:



Click on the graph with the mouse to insert a new support point. This will then also appear in the table.

■ Drag the support point with the mouse for a reassignment of laser power to intensity, or
■ Use the table to make the assignment very precisely.

NOTES:
■ The upper and lower power limits for the support points are max/min values of the power range.
■ Any count of support points can be inserted.</td></tr>
</table>

Setting	Description
Exposure time [µs]	Only relevant for PointAndShoot mode. Maximum duration [µs] that the laser emits on a pixel. The actual time is modulated by the grayscale value of the pixel.
Modulation type	Time**:** The grayscale value of the pixel modulates the emission time, resulting in the desired degree of contrast. Power**:** The grayscale value of the pixel modulates the laser power, resulting in the desired degree of contrast.
Trim scan lines / Threshold	Bitmaps are always imported as rectangular objects. However, the lines of the bitmap do not necessarily begin or end with visible pixels. 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). 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.
Size	
Resolution [dpi]	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. The X-Y ratio can be locked / unlocked with the ***[Lock / Unlock]*** button. *Keep size* forces the resulting image dimensions to remain at the original size, regardless of the specified resolution.
Pixels 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.
[Save as default]	Click on ***[Save as default]*** to save the created settings as default settings for future imports of raster graphics.

Table. 7.20: RG-031

Additional settings

Additional settings include:

- For general settings for all marking objects, see *page 171, Common Properties of Marking Objects*.
- For pen settings and details on object-related process parameters, see *page 253, Pen Properties*.

NOTE on display: Bitmaps are always displayed in grayscale, with the opacity of the pixels corresponding to their grayscale 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:

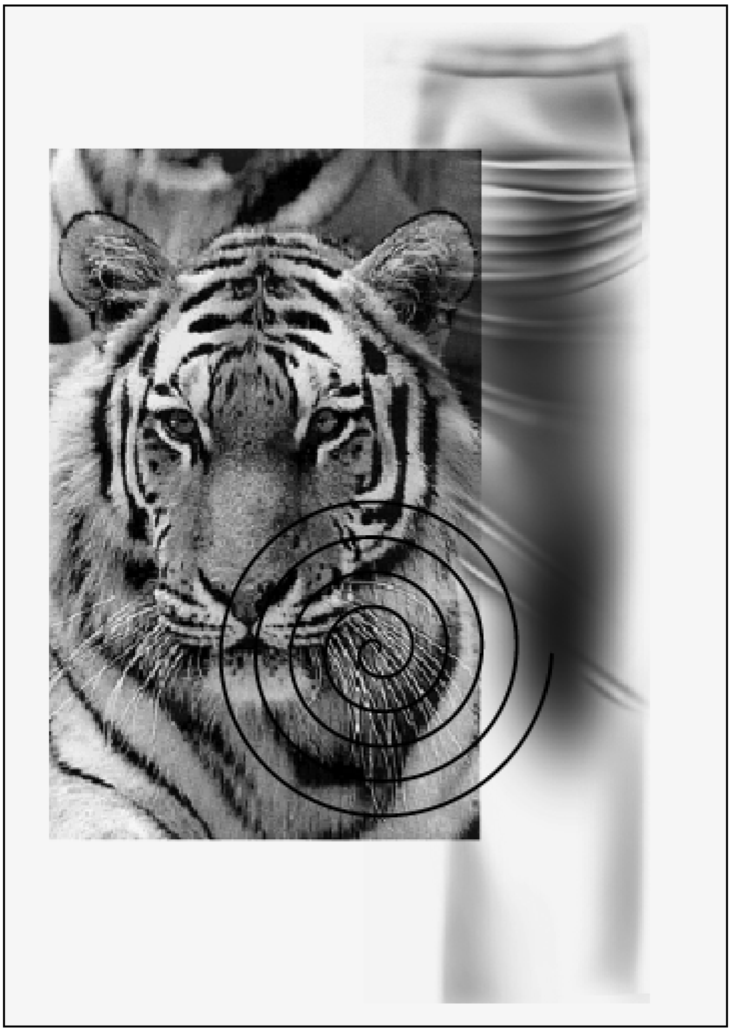
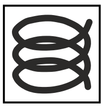


Fig. 7.18: RG-AEL

7.2.3.9 Helix



Button (optional)
See *page 125, Objects Overview*.

A helix is a 3-dimensional winding circular or elliptical path similar to a spring. This requires the use of a corresponding deflection unit (e.g. FOCUSSHIFTER, AXIALSCAN, AS FIBER) and the corresponding configuration with a 3-dimensional correction file.

Setting	Description
Radius [mm]	Radius of the circular path (or ellipse main axis) in [mm].
Ratio	Ratio of the Y-dimension relative to the X-dimension of an ellipse.
Z-dimension	Depending on the sign, the helix goes up or down (negative sign).
Turns	Number of windings that are evenly distributed over the Z dimension.
Flat ends	Select whether you also want to add a flat winding at the top and bottom end of the helix (i.e. without a slope). These two extra turns are added to the specified number of windings.
Turn direction	Choose whether the helix rotates clockwise or counterclockwise.

Table. 7.21: RG-108

7.2.4 Common Properties of Marking Objects

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

Setting	Explanation
General	
Short label	Appropriate name for the object, according to its content / purpose. For imported files, the file name is used by default.
Enable binning	Starts object processing only if a specified condition is fulfilled. The dialog has been extended to include other inputs: ■ *I/O controller*: Select the control card where the I/O signals will arrive. ■ *I/O port*: Select the preconfigured I/O port of the respective control card (see *page 46, Scan Controller Configuration*, I/O section). ■ *Binning value*: Set the bit pattern to be received to process this object. You can also use the masking technique. For details, see *page 46, Scan Controller Configuration*, Port masking section. ■ 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.
Sequences	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. 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 ***[Abort]*** button or with an external stop signal at the control card. However, this results in the fact that subsequent objects or sequences will never be executed. The number of executions is also passed on to all lower-level structure levels and cannot be changed there. The number of execution loops and the pens used in the process are referred to as sequences. The "+" can be used to add more sequences, which are executed one after the other.
	NOTE: The colored depiction of the pens always corresponds to the 1st sequence. **NOTE:** 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 loops. Below the table, additional explanations are presented on the basis of various examples.

Setting	Explanation
Execute	Select whether the object is to be processed. This option is available in markable objects as well as in containers and automation objects.
Marking mode	Use the available options to select whether contour and / or filling are to be executed and in which order to each other. 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. **REQUIREMENT:** The filling must have been used on the same structure level 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. 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. **NOTE:** This setting is only relevant if the complete graphic object can in principle be executed by several control cards.
BoundingBox	
Size, Center	Read-only values, showing the size of an imaginary orthogonal rectangle surrounding the whole object. **NOTE:** The information on the bounding box can be or become hidden if necessary. For details, see *page 96, Visibility*.

Table. 7.22: RG-032

An additional group of general settings are object transformations; see *page 190, 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 contour.

Legend:

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

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

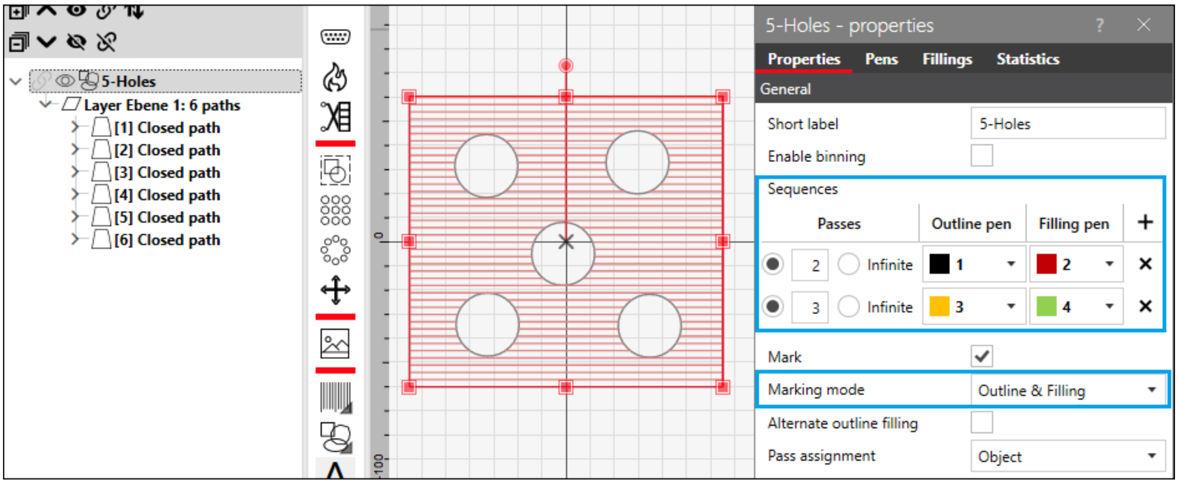


Fig. 7.19: RG-AEG

Executed order:

[2 x complete contours with pen 1 > 2 x filling with pen 2] > [3 x complete contour with pen 3 > 3 x filling with pen 4]

Example 2: Here, in contrast to example 1, the option to alternate between the filling and contour is enabled.

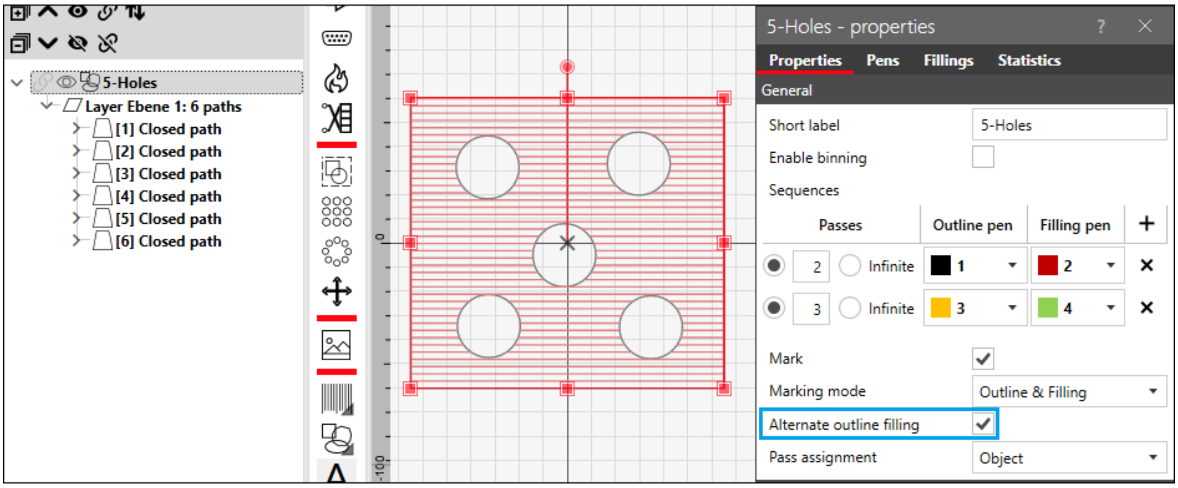


Fig. 7.20: RG-AEH

Executed order:

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

[{1 x complete contour with pen 3 > 1 x filling with pen 4} > {1 x complete contour with pen 3 > 1 x filling with pen 4} > {1 x complete contour 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 level.

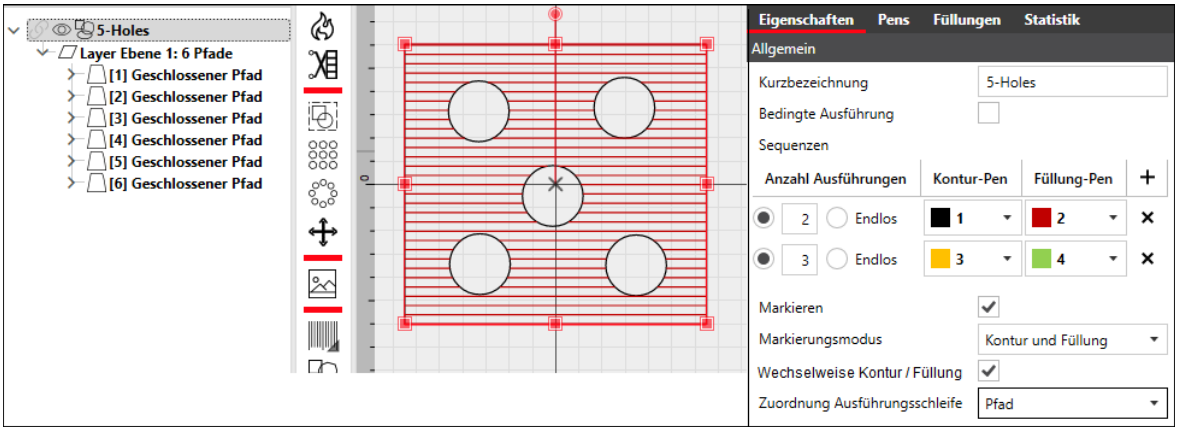


Fig. 7.21: RG-AEI

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 contour and filling. The reason for this in this example is that the filling is on the object level, while the sequence was assigned to the path level.

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

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

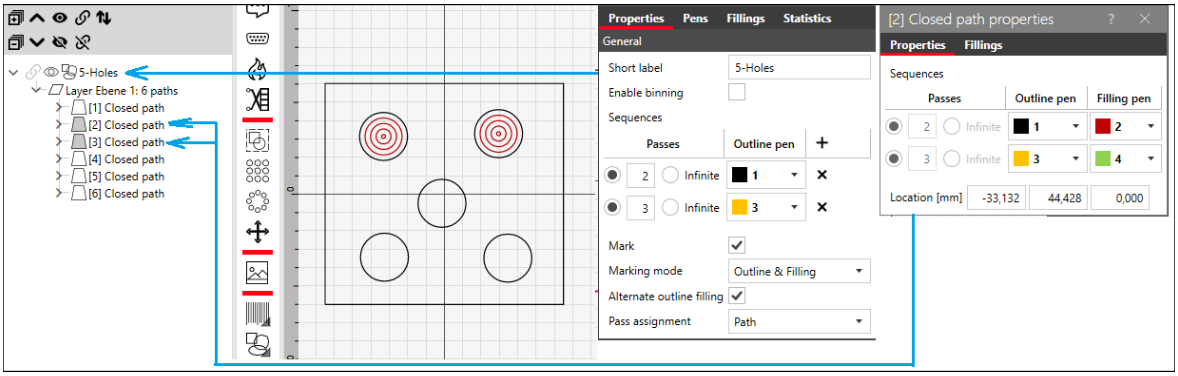


Fig. 7.22: RG-AEJ

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.

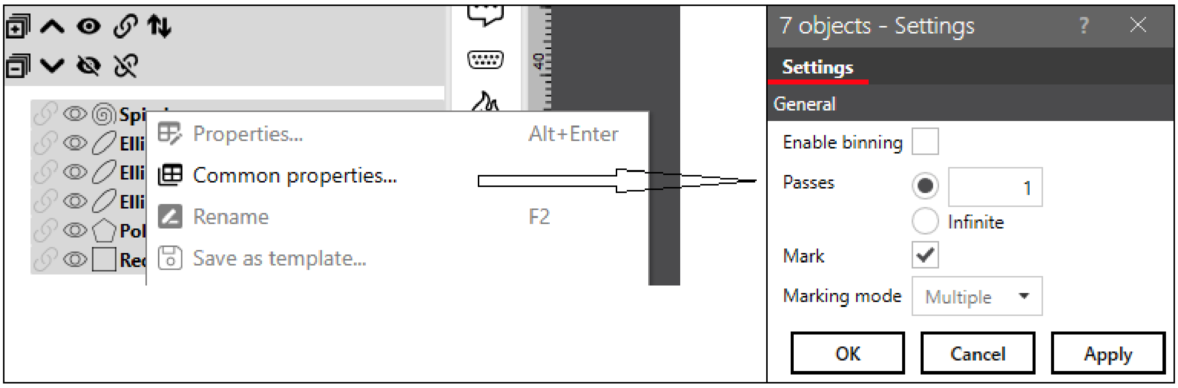


Fig. 7.23: RG-ADY

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 free-shaped vector object can also be filled. Please note the rules mentioned in the tables, see *page 148, Vector Graphic*.

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

Example:

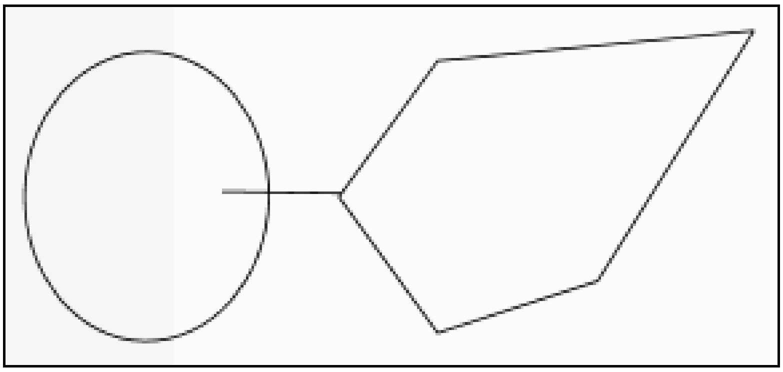


Fig. 7.24: RG-ABJ

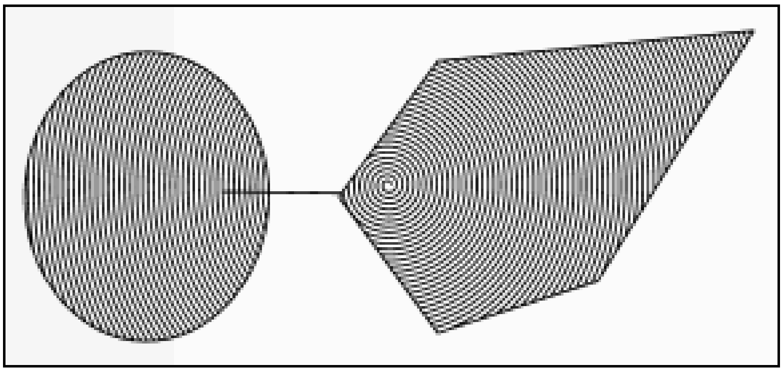


Fig. 7.25: RG-ABK

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:

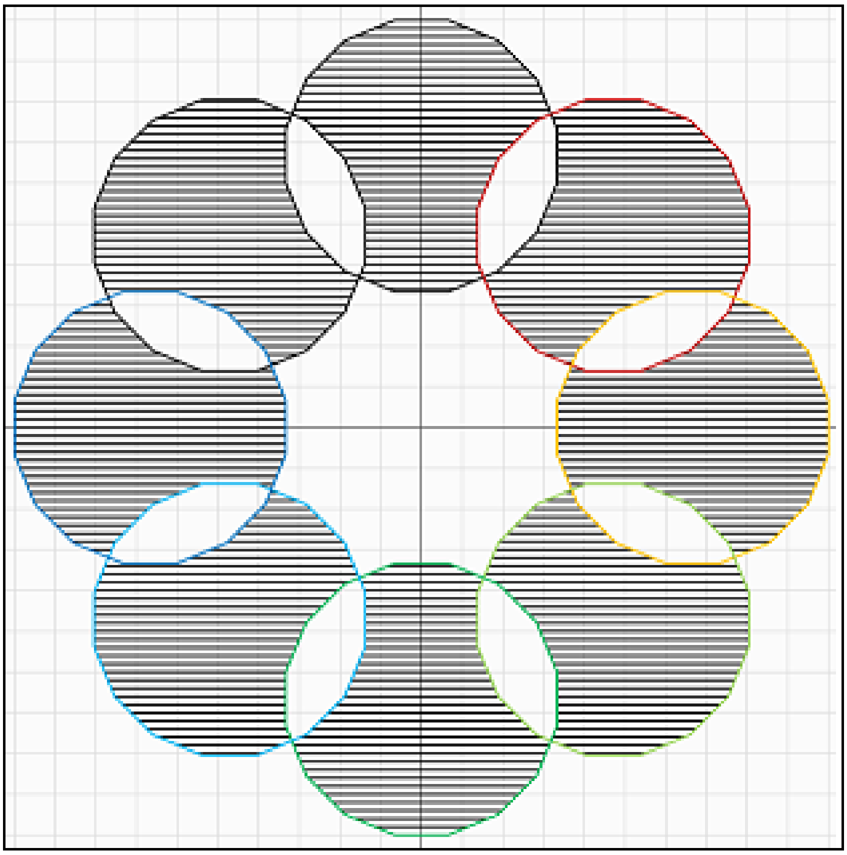


Fig. 7.26: RG-ABL

7.2.5.1 Variants of fillings

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. 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. 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.
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.

Table. 7.23: 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).

7.2.5.2 General settings for fillings

Each filling pattern type has its own settings dialog:

Setting	Explanation
Pitch [mm]	Distance between fill lines
Invert [7]	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 [7]	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. **NOTE:** 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 optimized automatically to save process time. Select if you want the filling to be processed with the minimum number of required jumps to save process time.

[7] **NOTE:** Not available for spiral filling and special code fillings.

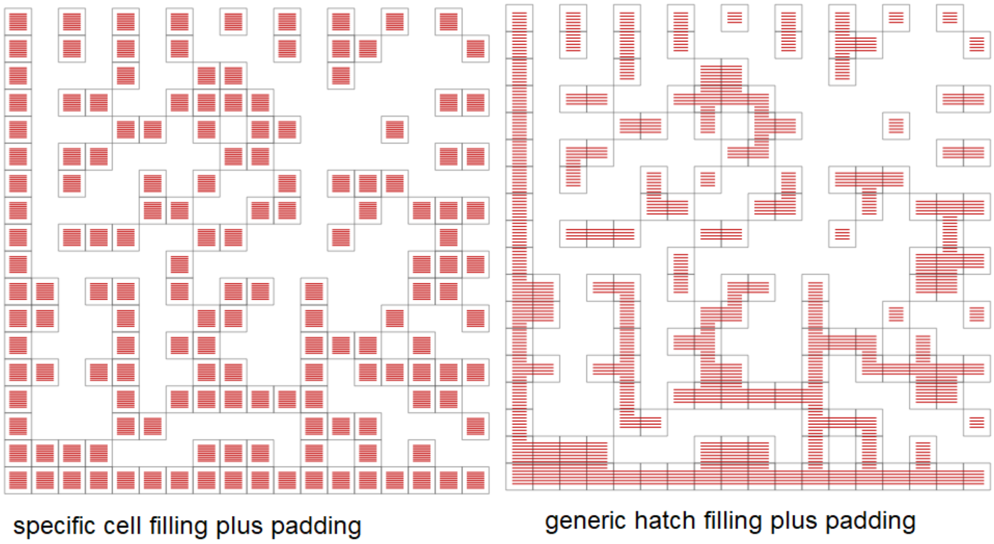
Setting	Explanation
Padding [mm]	Creates a non-filled frame between filling and respective filling outline. Positive values generate a distance toward the inside (from the contour to the filling), while values with a negative sign generate a distance toward the outside. **NOTE:** For 2D codes, connected cells are filled together. The parameter operates differently depending on whether a specific cell filling or a generic filling is used: 

Table. 7.24: RG-034

7.2.5.3 Special parameters for hatching filling

Setting	Explanation
Angle [°]	Angle of fill lines related to the object’s own coordinate system. **NOTE:** 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.
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	Select to define a cross hatch filling style. Equal spacing is used for both directions and the cross angle is fixed to 90 degrees. 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. If you require a different cross angle, simply add a second hatch filling and adjust the angles accordingly.
Direction	*Unidirectional* / *Bidirectional* / *Meander* Bidirectional provokes alternating marking directions of the fill lines. The meander is equally bidirectional, but the u-turn jumps are marked.

Table. 7.25: RG-109

7.2.5.4 Special parameters for contour filling

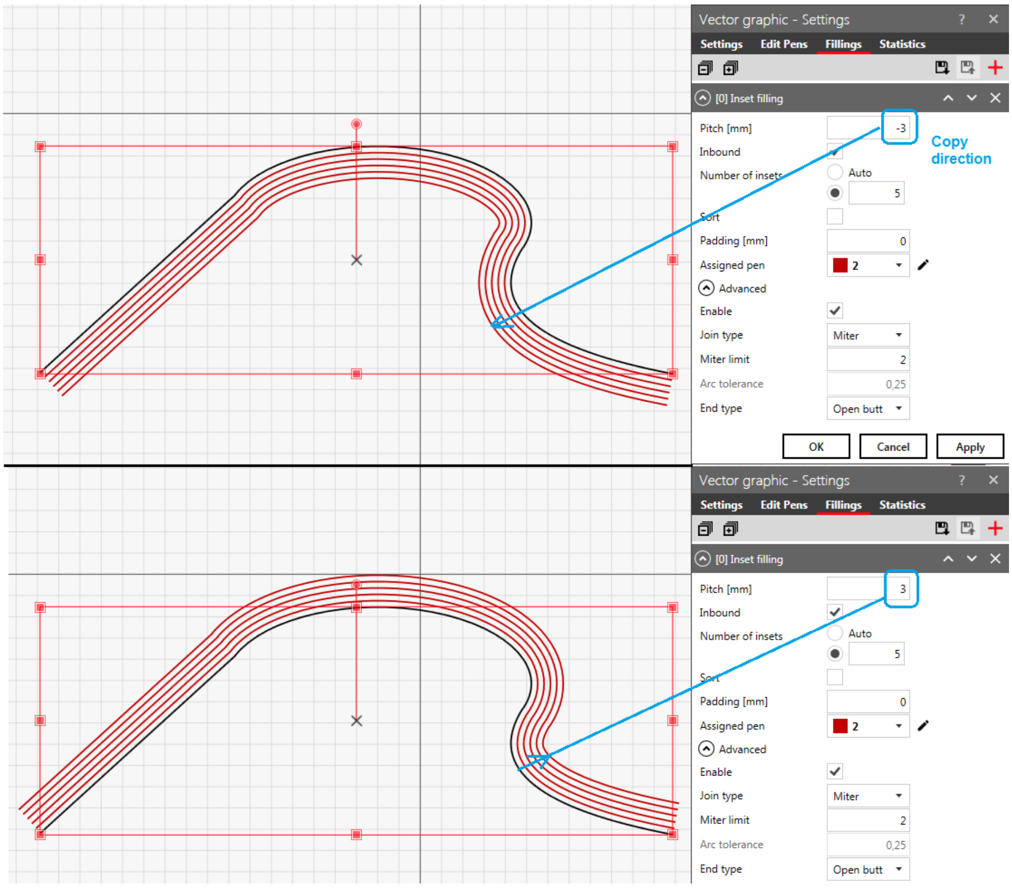
Setting	Explanation
Inbound	Select the checkbox (tick the box) if you want to process the filling from the inside to the outside (standard setting). Deselect it if you want to process the filling from the outside to the inside.
Number of insets	■ *Auto*: Closed contours get filled completely. ■ *Defined number:* 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. Example:  **NOTE:** To design a contour copy as in the example, the advanced fill option **End type** must be set to **Open butt**.

Table. 7.26: RG-110

7.2.5.5 Special parameters for spiral filling

Setting	Explanation
Angle [°]	Inside starting angle of the spiral line.
Offset [mm]	Shifts the center of the spiral relative to the center of the object bounding box
Chord length [mm]	Length of the polyline segment that represents the spiral shape

Table. 7.27: RG-111

7.2.5.6 Special parameters for filling with drill points

Setting	Explanation
Distance X / Y	Distance at which the drill points will be arranged in the X and Y directions.
Mode	*Pulse:* 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. *Time:* The dwell duration per drill point is defined directly as the target value.
Pulses / Time	Number of laser pulses or duration [ms].

Table. 7.28: RG-112

7.2.5.7 Special parameters for circular filling of code cells

Setting	Explanation
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.

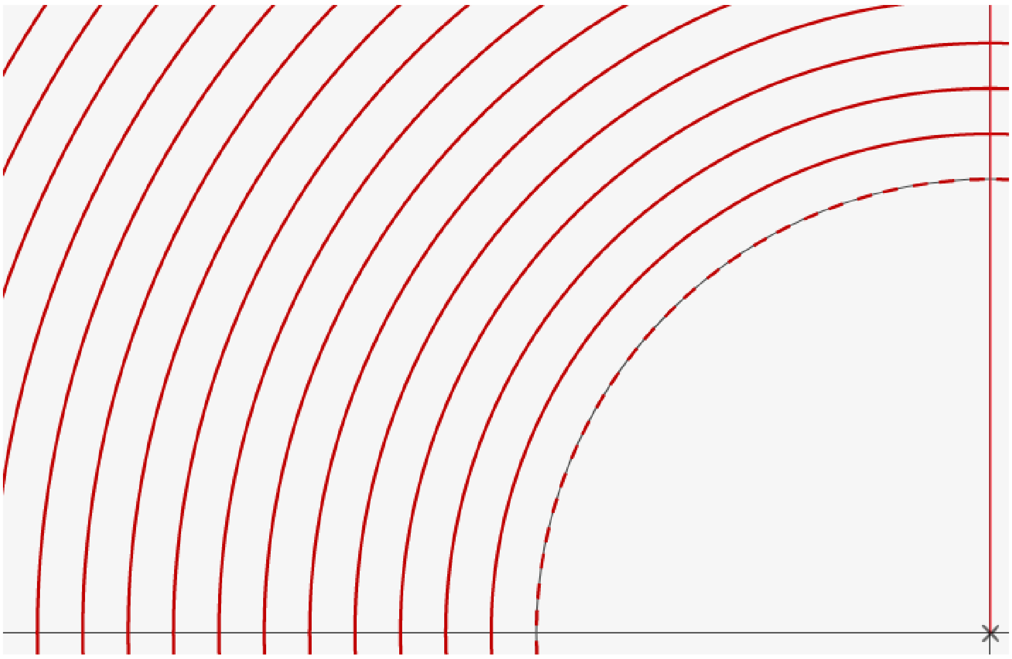
Table. 7.29: RG-113

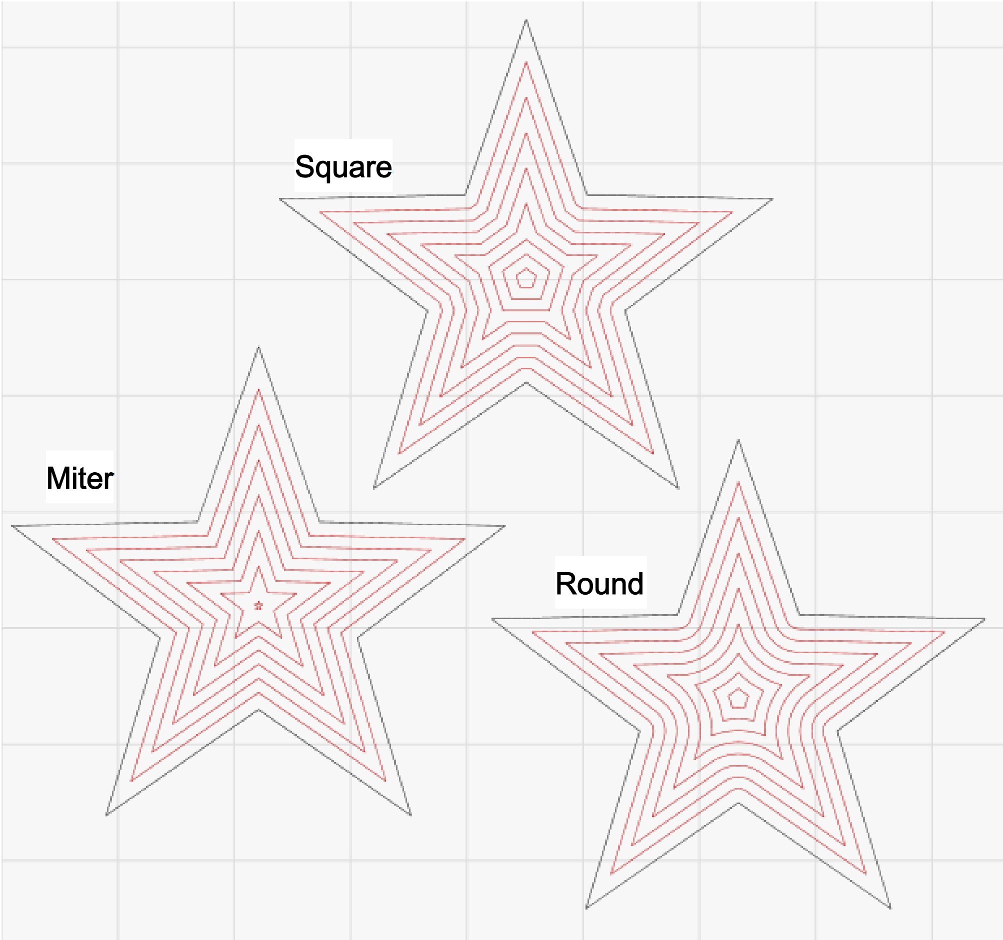
7.2.5.8 Special parameters for fillings per vector graphic

Setting	Explanation
[Load file…]	Opens a file browser to select and load the vector graphic file that should represent the fill pattern.
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], [µm] and [inch]. A value ≠ 1 would additionally add a scale factor to it. Only applicable if *Scale to size* is not used.
Center XY	Activate this option to center the fill graphic relative to the graphic to be filled.
[Embed]	Clicking on the button embeds the fill graphic directly into the job file. This also makes it available for other RAYGUIDE applications. **CAUTION:** After embedding, the import options such as centering to each other are no longer available.
Number of points	For vector graphics as fill patterns, all curve commands and arcs contained inside them are automatically converted into polygons. ■ The first step creates a polyline containing the number of points given here. ■ 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.
Collinearity distance [mm]	Parameter for deciding 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.
Offset [mm]	Offset of the center of the fill graphic to the center of the graphic to be filled.
Rotation [°]	Rotation of the fill graphic relative to the graphic to be filled.

Table. 7.30: RG-114

7.2.5.9 Advanced settings for fillings

Setting	Explanation
Click ***[Expander]*** 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 the “Contour” filling pattern. Some of the relevant settings are listed below.	
Activate	Select whether this fill profile is to be executed or not. **NOTE:** This option is active by default. Can be used if an object has several fill profiles but not all are to be executed.
Clipping zone	Specification in [mm] for a zone around the contour in which fill lines are trimmed or omitted completely. **NOTE:** This parameter does not change the position of the fill lines compared to the value padding. Application example: 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 may become a stroke line: 

Setting	Explanation
Join type	Varies the way the filling lines meet on inner corners: Miter vs. Round vs. Square 

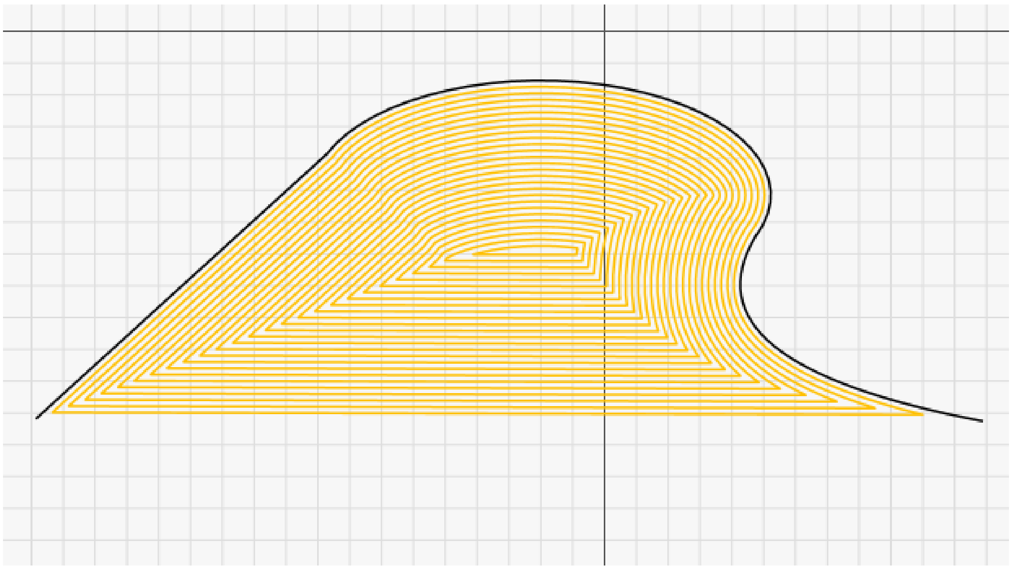
Setting	Explanation
End type	■ *Open butt*: Is used for contour copy of open paths ■ *Closed polygon*: Closes an open path with a virtual line as a fill border Example: 

Table. 7.31: RG-115

7.2.5.10 Fill dialog buttons

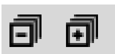
Type	Explanation
	Click on the buttons for ***[Expand] / [Collapse]*** to expand or collapse the various sections of fillings in the dialog box.
	Click on the ***[Up] / [Down]*** arrow key to change the order (corresponds to the processing sequence) for a multiple-fill pattern.
	Use the ***[Save]***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

Table. 7.32: 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 element or vector position.

Types of transformations

- The object offset and thus the position of the object center in relation to the workspace origin.
- The size and scale 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 center.

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 for performing transformations is the Transformation panel (by default, on the right side of the screen). Here, all transformation options are available.

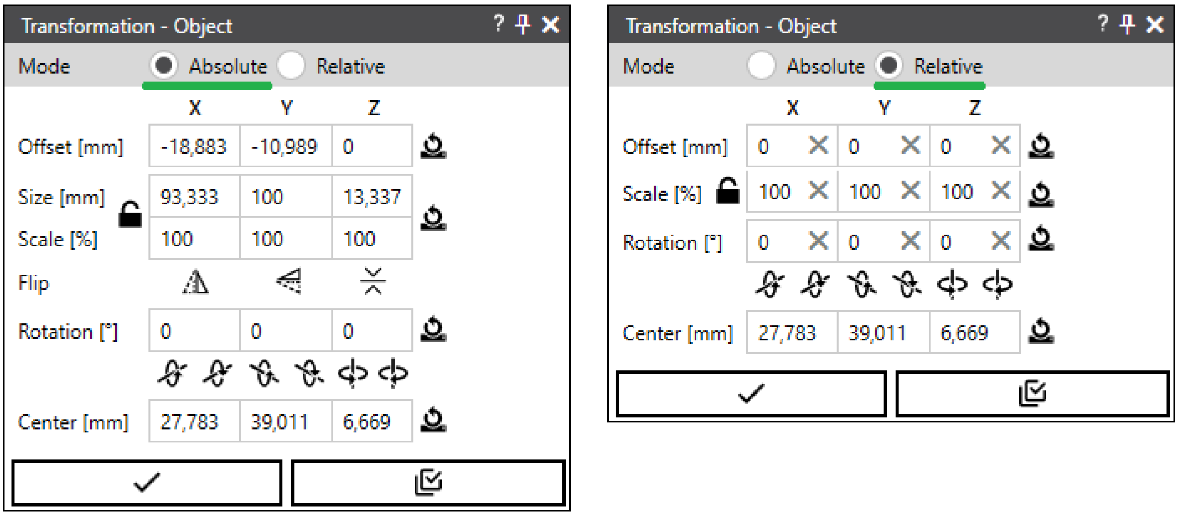


Fig. 7.27: RG-ABM

Object settings dialog

The settings in this dialog reflect the settings provided in the Transformation panel.

To open an object settings dialog, go to the Settings tab, Transformation section.

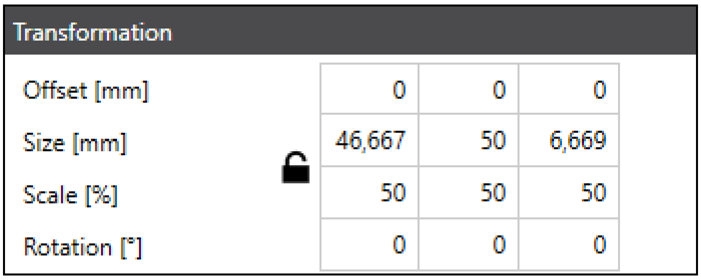


Fig. 7.28: RG-ABN

The table shows the current offset and the dimensions of the object, and thus its scale 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 and to the layers, paths, and path elements of an object, 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 center 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 center: Center 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 center of the object, with the exception of polygons and spirals, for example.
- Transformations center: By default, the transformation center is the object center. Transformations of scale and rotation relate to the transformation center. The absolute position of the transformation center is available in the panel under “Center point”. The position can be shifted with the mouse and reset to the object center using the ***[Reset]*** button next to the “Center point” coordinates.

The following example figure shows the essential items regarding transformations:

Example:

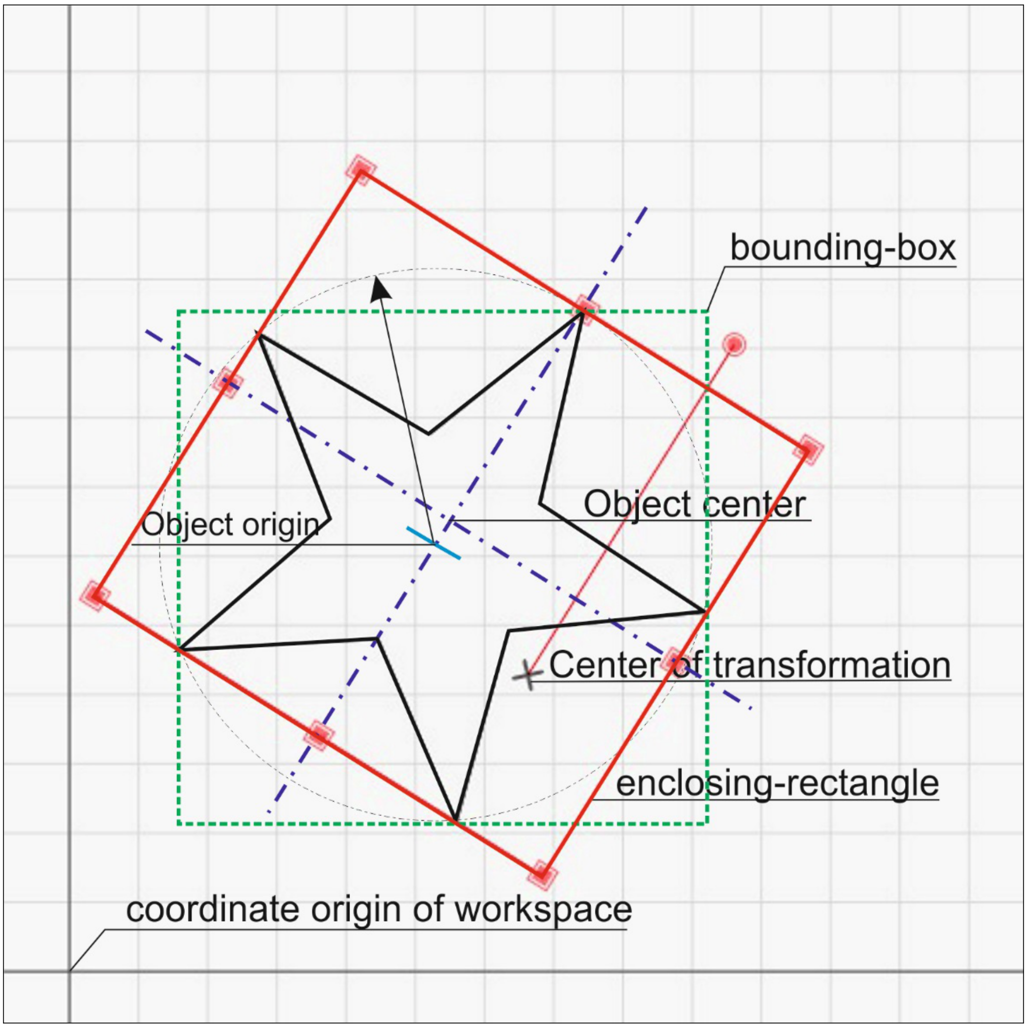


Fig. 7.29: RG-ABO

Transformation details

The following transformation operations are available:

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

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

Table. 7.33: 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 on the ***[Checkmark]*** button to apply the transformation.

Click on the ***[Apply to copy]*** button 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**, contours 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 optimization

7.2.6.3.1 Overview

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

- Rearrange the vector sequence.
- Optimize 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 optimization functions require a tolerance parameter. The corresponding parameters are mentioned with each optimization 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	Layer	Path	Path element	
Sort	Minimize jump distance	✓	✓			*page 200, Sorting to minimize jump distance*
	By direction	✓	✓			*page 201, Sorting by direction*
	Layers by name (ascendend / descendent)	✓				*page 201, Sorting layers by names*
Close paths		✓	✓	✓		*page 202, Close paths*
Close gaps		✓	✓			*page 202, Closing gaps*
[Change orientation]		✓	✓			
Set z-coordinates to zero		✓	✓	✓	✓	*page 202, Setting z-coordinates to zero*
Split path					✓	*page 203, Split path*
Split commands		✓	✓	✓	✓	*page 203, Splitting elements*
Define as start of path					✓	*page 203, Defining as start of path*
Merge / Join	Layers	✓				*page 204, Merging / Joining layers*
	Touching paths	✓	✓	✓		*page 204, Merging / Joining touching paths*
	Polylines	✓	✓	✓		*page 204, Merging / Joining polylines*
	Straight lines	✓	✓	✓		*page 204, Merging / Joining straight lines*
	Similar circular arcs	✓	✓	✓		*page 205, Merging / Joining similar arcs*
	Selected points with lines			✓	✓	*page 205, Merging / Joining selected points with lines*

Function		Available at level				See …
		Object	Layer	Path	Path element	
Remove	Drills	✓	✓	✓		*page 206, Removing drills*
	Duplicates	✓	✓	✓	✓	*page 206, Removing duplicates*
	Straight points	✓	✓	✓	✓	*page 207, Removing straight points*
	Empty layers	✓				*page 207, Removing empty layers*
	Empty paths	✓	✓			*page 207, Removing empty paths*
Replace	Lines / Polylines by … ■ Rearranged polylines, ■ Circular arcs, ■ Quadratic curves, ■ Cubic curves	✓	✓	✓	✓	*page 208, Lines / Polylines*
	Circular arcs by … ■ Lines, ■ Polylines, ■ Elliptical arcs, ■ Quadratic curves, ■ Cubic curves	✓	✓	✓	✓	*page 212, Circular / Elliptical arcs*
	Elliptical arcs by … ■ Lines, ■ Polylines, ■ Circular arcs, ■ Quadratic curves, ■ Cubic curves	✓	✓	✓	✓	*page 212, Circular / Elliptical arcs*

Function		Available at level				See ...
		Object	Layer	Path	Path element	
	Quadratic curves by ... ■ Lines, ■ Polylines, ■ Circular arcs, ■ Cubic curves	✓	✓	✓	✓	*page 215, Quadratic curves / Cubic curves*
	Cubic curves by ... ■ Lines, ■ Polylines, ■ Circular arcs, ■ Quadratic curves.	✓	✓	✓	✓	*page 215, Quadratic curves / Cubic curves*
	Straight curves by lines	✓	✓	✓		*page 217, Replacing straight curves with lines*
	Circles by Drills	✓	✓	✓		*page 218, Replacing arcs with drills / drills with circles*
	Drills by Circles	✓	✓	✓		*page 218, Replacing arcs with drills / drills with circles*
	All commands by polylines	✓	✓	✓		*page 218, Replacing all commands with polylines*
	All commands by drills	✓	✓			*page 219, Replacing all commands with drill holes*
	All commands by paths	✓	✓	✓	✓	*page 220, Replacing all commands with paths*
Double points in polylines		✓	✓	✓	✓	*page 220, Doubling points in polylines*

Table. 7.34: RG-036

7.2.6.3.2 Sorting

7.2.6.3.2.1 Sorting to minimize 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 optimization functions, because other functions work better if the elements are already sorted.

Context menu:	*Vector optimizations* > *Sort* > *Minimize jump distance*
Hierarchy levels:	Object, layer
Related tolerance value:	Min. point distance (for sorting) [mm]

Example:

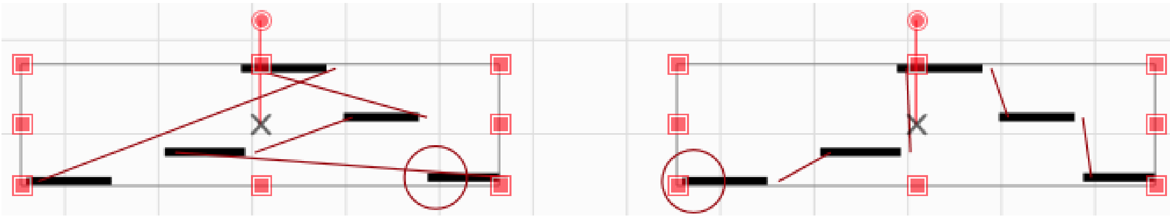


Fig. 7.30: RG-ABP

7.2.6.3.2.2 Sorting by direction

This function rearranges all paths by considering a belt angle to optimize 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, layer

Example: Three lines of text processed line by line by default

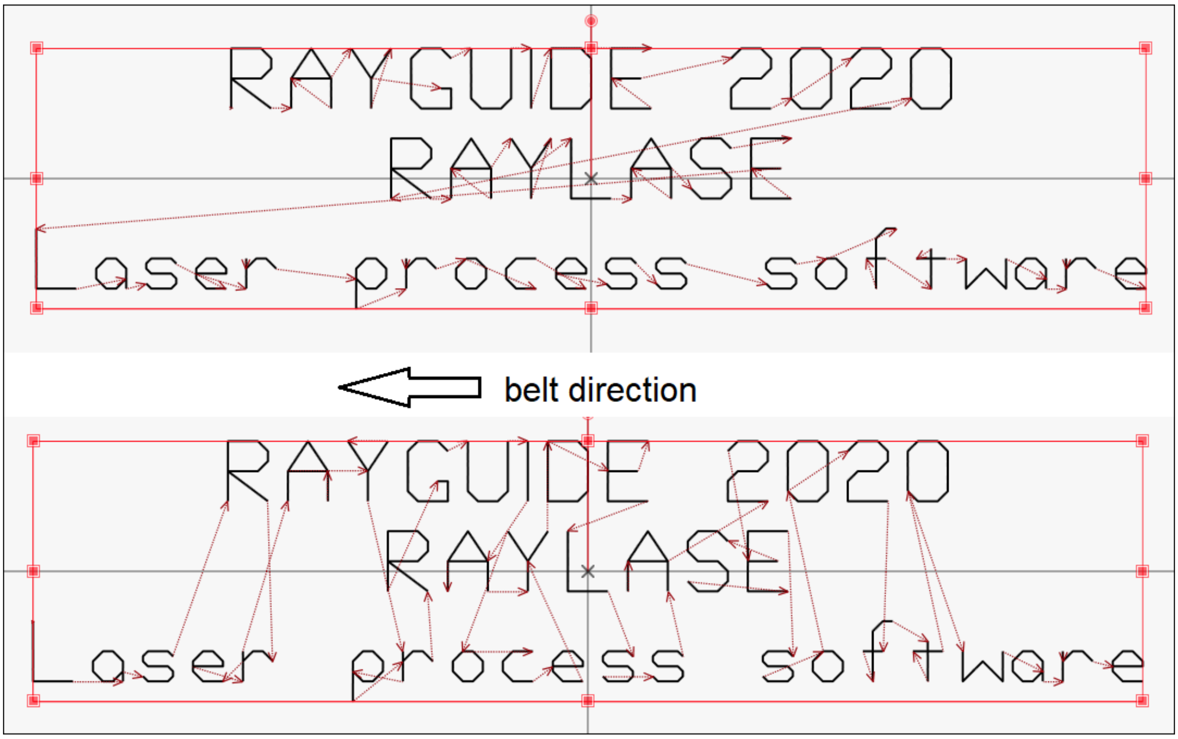


Fig. 7.31: RG-ADN

7.2.6.3.2.3 Sorting layers by names

This function sorts the order of the layers alphabetically by name, either ascending or descending.

Context menu:	*Vector optimizations* > *Sort* > *Layers by name (ascendend / descendent)*
Hierarchy levels:	Object

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 line graphic command.

Context menu:	*Vector optimizations* > *Close paths*
Hierarchy levels:	Object, layer, path

Example:

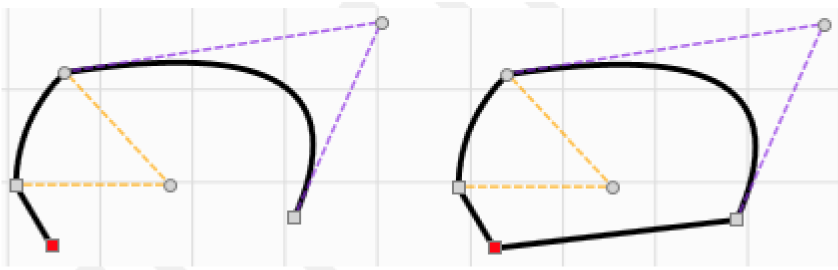


Fig. 7.32: RG-ABQ

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 that might appear on a T-crossing.

Context menu:	*Vector optimizations* > *Close gaps*
Hierarchy levels:	Object, layer
Related tolerance value:	Min. point distance

Example:

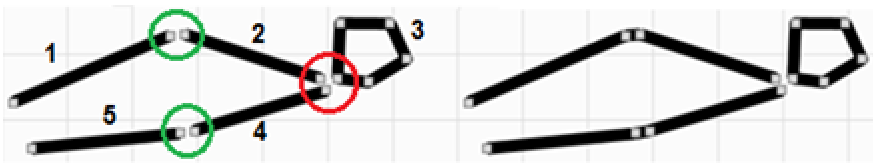


Fig. 7.33: RG-ABR

Because the “circular” 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. You can convert a 3D vector geometry into a 2D geometry in this way. 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:

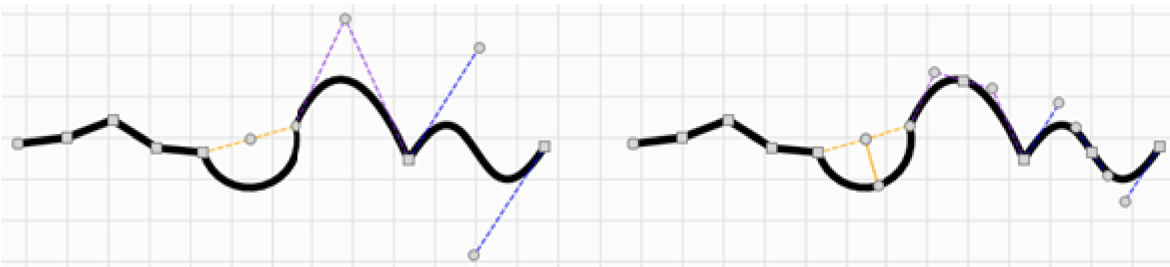


Fig. 7.34: RG-ABS

7.2.6.3.8 Defining as start of path

Select a thumb 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 Merging / Joining

7.2.6.3.9.1 Merging / Joining 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 Merging / Joining 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, layer, path
Related tolerance value:	Min. point distance

7.2.6.3.9.3 Merging / Joining 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, layer, path

7.2.6.3.9.4 Merging / Joining 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, layer, path
Related tolerance value:	Collinear distance

7.2.6.3.9.5 Merging / Joining similar arcs

The function merges two adjacent circular arcs in one path if their center 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 center points)

Example:

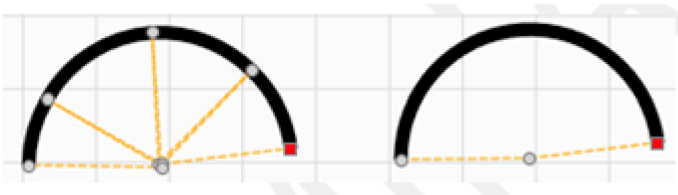


Fig. 7.35: RG-ABT

7.2.6.3.9.6 Merging / Joining 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:

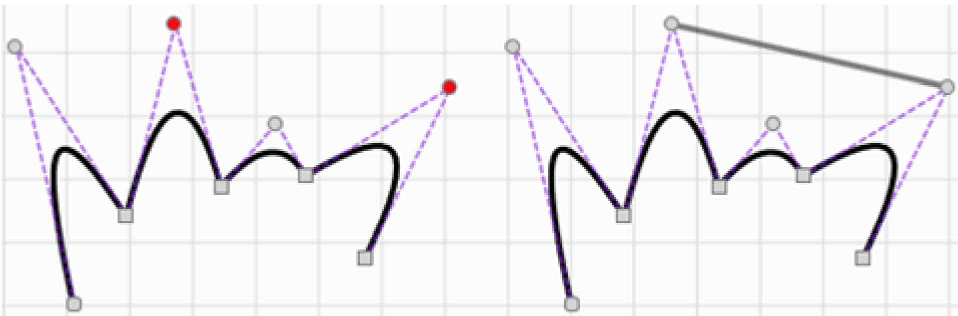


Fig. 7.36: RG-ABU

7.2.6.3.10 Removing

7.2.6.3.10.1 Removing drills

This function removes all drills (*Laser on* command) from the selected graphic element. 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, layer, path

Example:

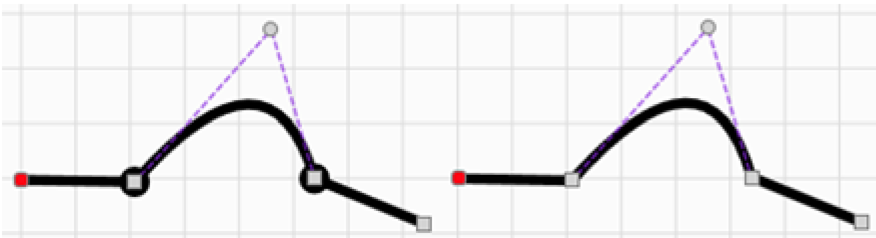


Fig. 7.37: RG-ABV

7.2.6.3.10.2 Removing 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:

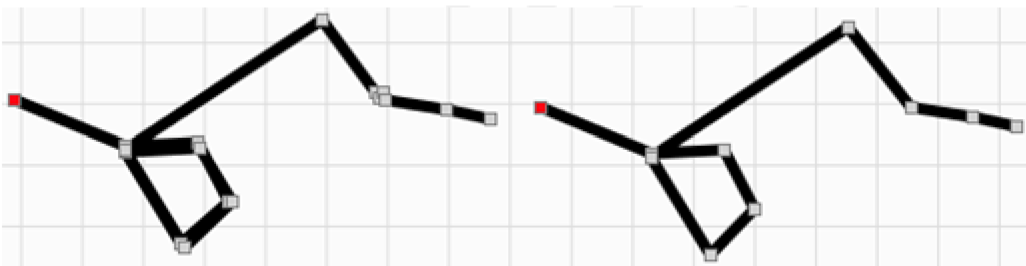


Fig. 7.38: RG-ABW

7.2.6.3.10.3 Removing 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:

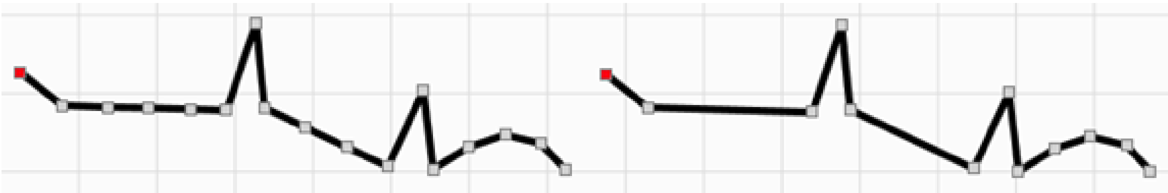


Fig. 7.39: RG-ABX

7.2.6.3.10.4 Removing 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 Removing empty paths

This function removes all paths which contain no path elements.

Context menu:	*Vector optimizations* > *Remove* > *Empty paths*
Hierarchy levels:	Object, layer

7.2.6.3.11 Replacing

Replacing 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:

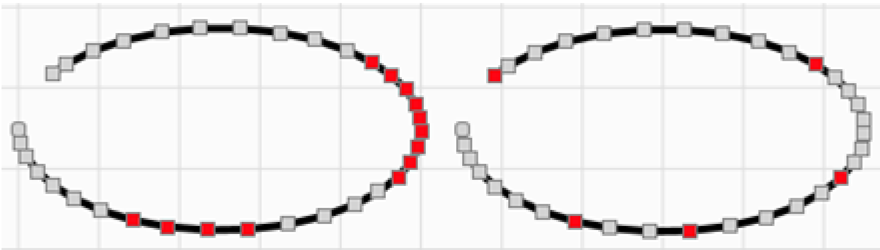


Fig. 7.40: RG-ABY

Replacing lines / polylines with circular arcs

This function converts either complete polylines (a) or a selected section of points of a polyline (b) with circular 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 Hierarchy levels: Object, layer, 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)

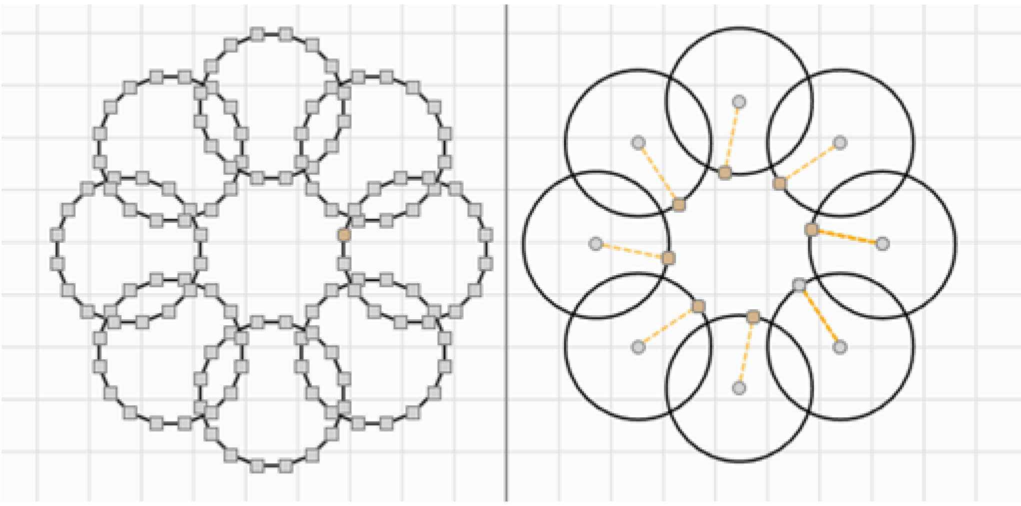


Fig. 7.41: RG-ABZ

Example b)

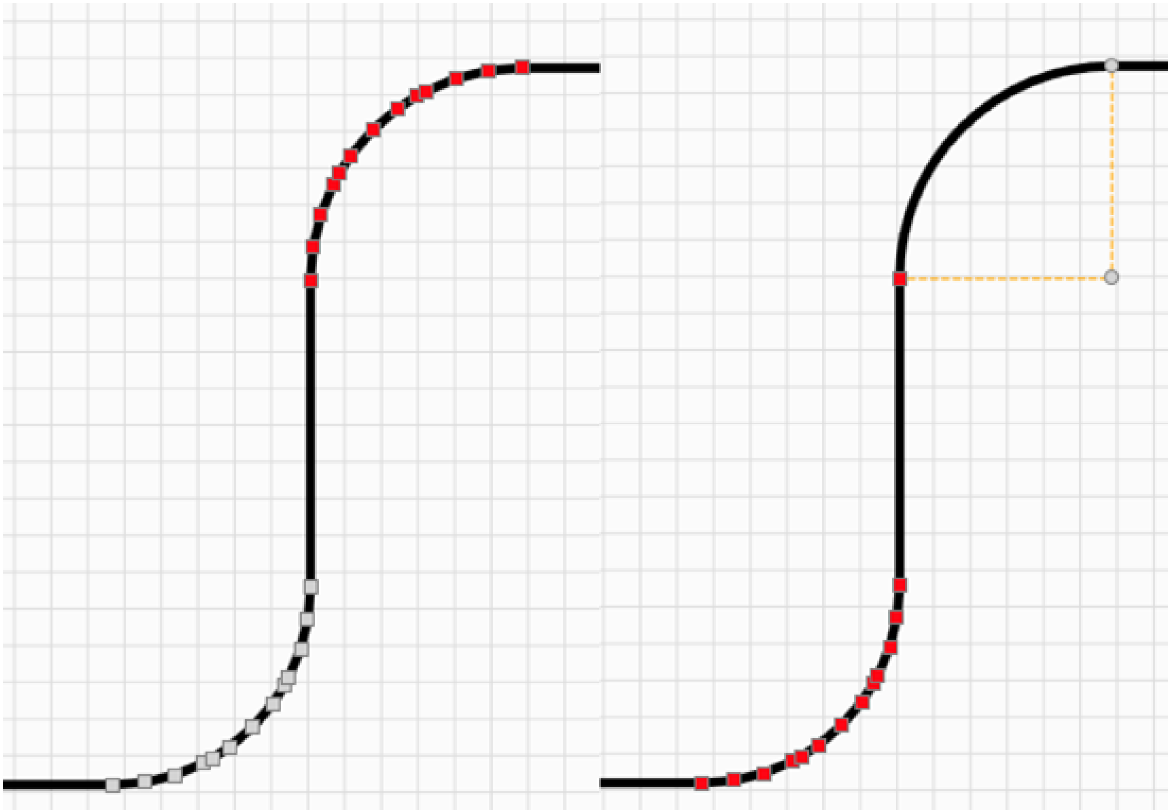


Fig. 7.42: RG-ACA

Replacing lines / polylines with quadratic curves

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

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

Example:

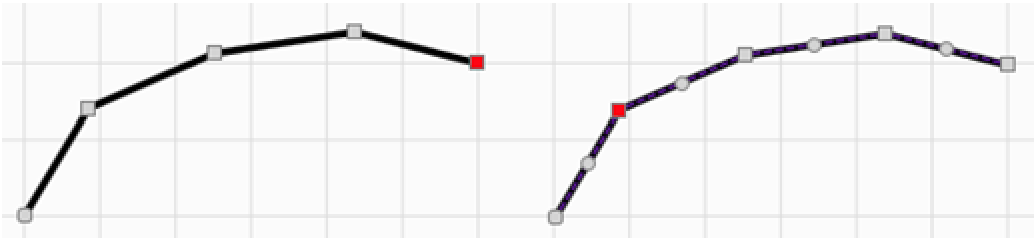


Fig. 7.43: RG-ACB

Replacing lines / polylines with cubic curves

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

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

Example:

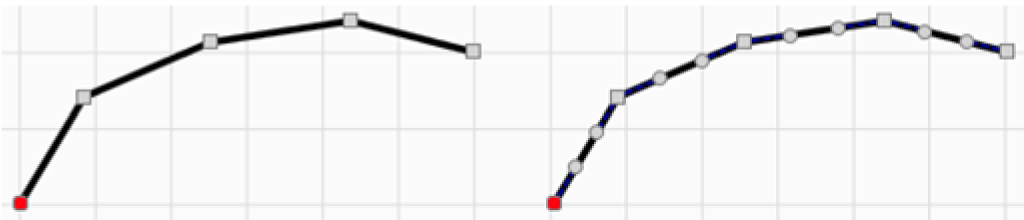


Fig. 7.44: RG-ACC

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 with 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:

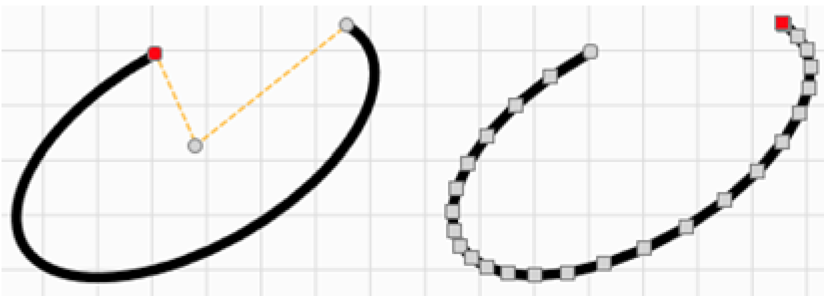


Fig. 7.45: RG-ACD

Replacing circular / elliptical arcs with elliptical / circular arcs

This function replaces a circular arc with an elliptical arc or an elliptical arc with 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 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 semi axes. Therefore, the shape cannot be preserved.

Context menu:

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

Hierarchy levels: All

Example:

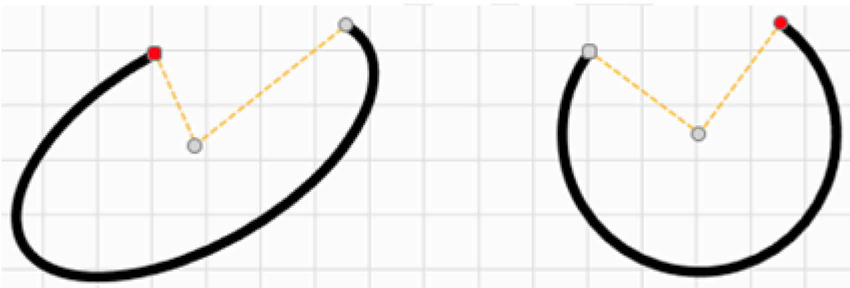


Fig. 7.46: RG-ACE

Replacing circular / elliptical arcs with quadratic curves

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

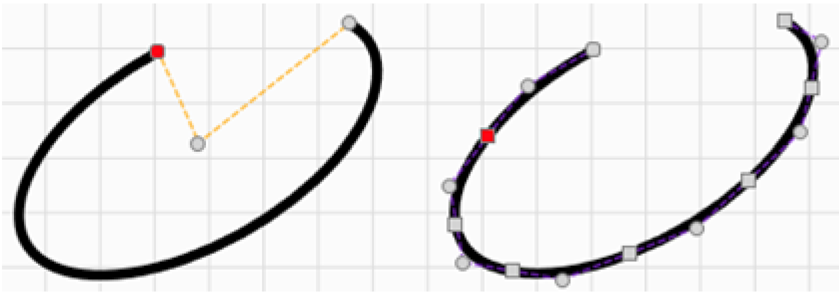


Fig. 7.47: RG-ACF

Replacing circular / elliptical arcs with cubic curves

This function replaces a circular or elliptical arc with a set of cubic curves approximating the original shape. A full circle or ellipse is replaced with 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:

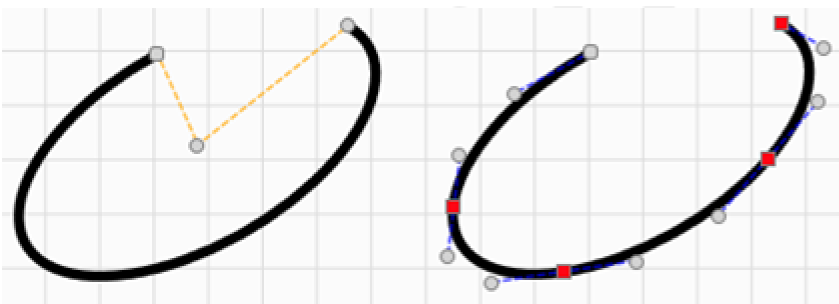


Fig. 7.48: RG-ACG

7.2.6.3.11.3 Quadratic curves / Cubic curves

Replacing quadratic / cubic curves with lines

This function replaces a quadratic or cubic curve with a single line connecting the original start and end point.

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:

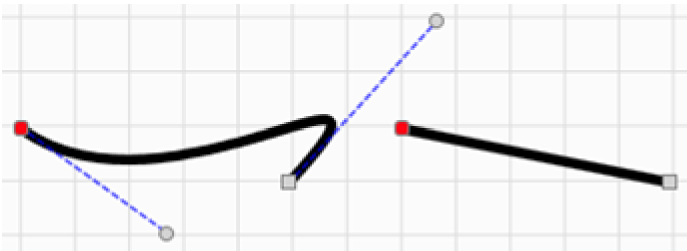


Fig. 7.49: RG-ACH

Replacing quadratic / cubic curves with polylines

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

The conversion logic is similar to replacing a circular / elliptical arc with 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:

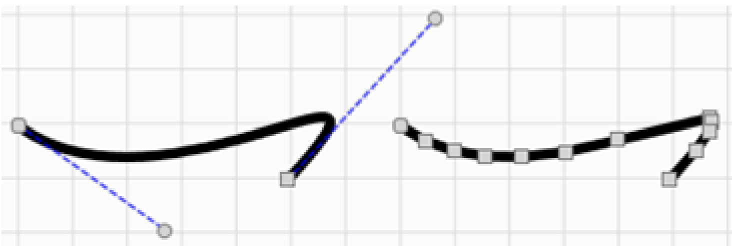


Fig. 7.50: RG-ACI

Replacing quadratic / cubic curves with circular arcs

This function replaces each quadratic or cubic curve with 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 center points of all arcs are close together and can be optimized 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:

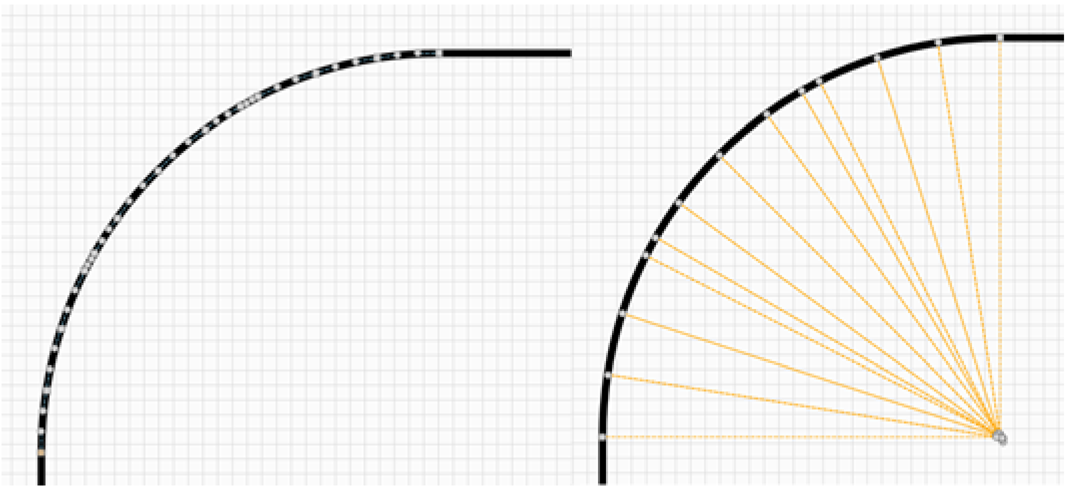


Fig. 7.51: RG-ACJ

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 start and end points of the curve; 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*
Hierarchy levels:	Object, layer, path
Related tolerance values:	Collinear distance

Example:

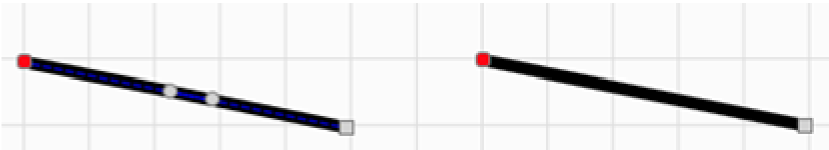


Fig. 7.52: RG-ACK

7.2.6.3.11.5 Replacing arcs with drills / drills with 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, layer, path

Related specifications: Radius for replacing arcs

Example:

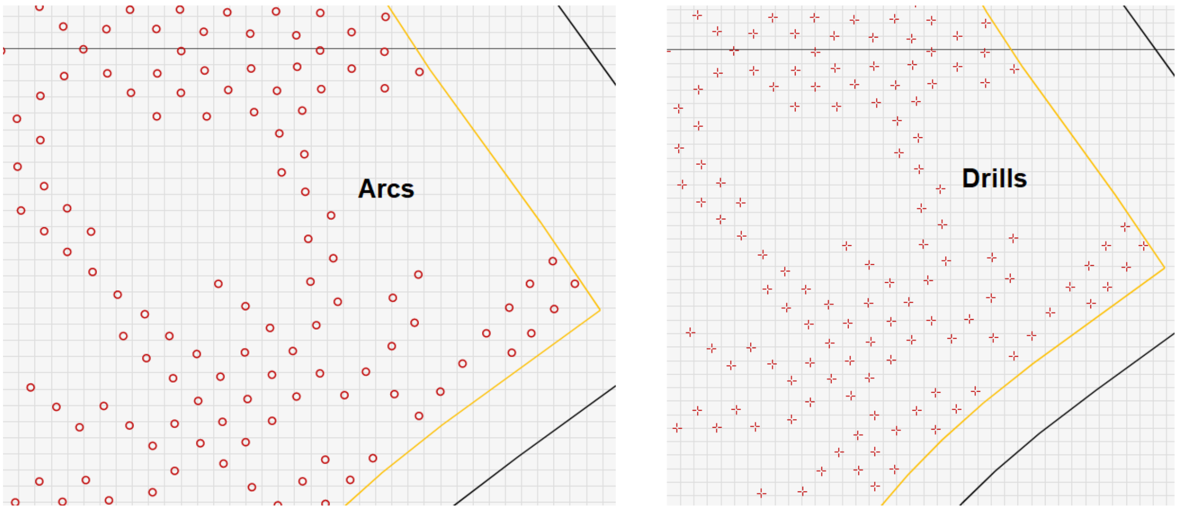


Fig. 7.53: RG-ADZ

7.2.6.3.11.6 Replacing all commands with polylines

This function replaces all graphic commands (if not already a polyline) with polylines as described in the above sections (see *page 212, Circular / Elliptical arcs*).

Context menu:	*Vector optimizations* > *Replace* > *All commands by polylines*
Hierarchy levels:	Object, layer, path
Related tolerance values:	Number of points, collinear distance

7.2.6.3.11.7 Replacing all commands with 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, layer
Related specifications:	Spacing [mm], Force corners, Drill mode, Pulse / Time

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

Example a) With "Force corners" option:

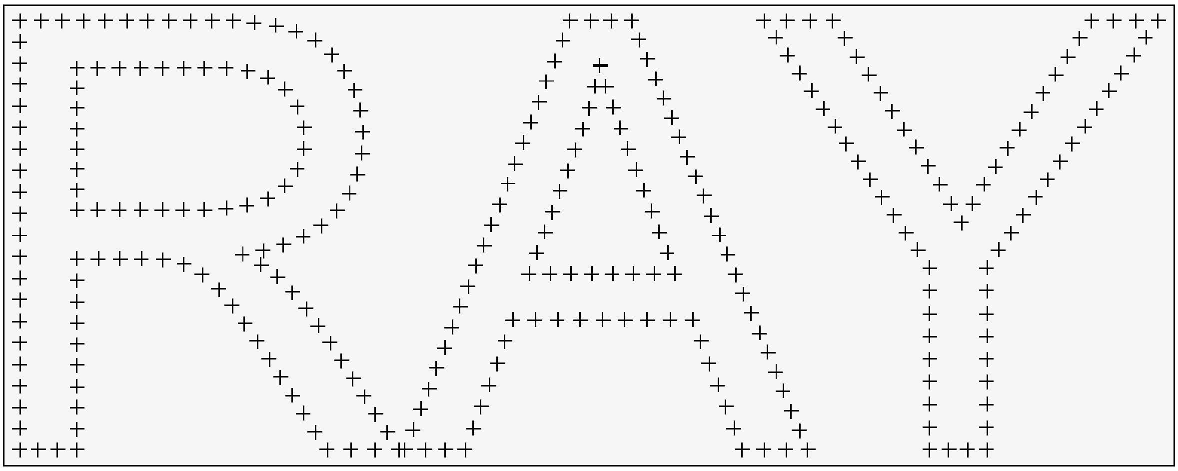


Fig. 7.54: RG-AFF

Example b) Without "Force corners" option:

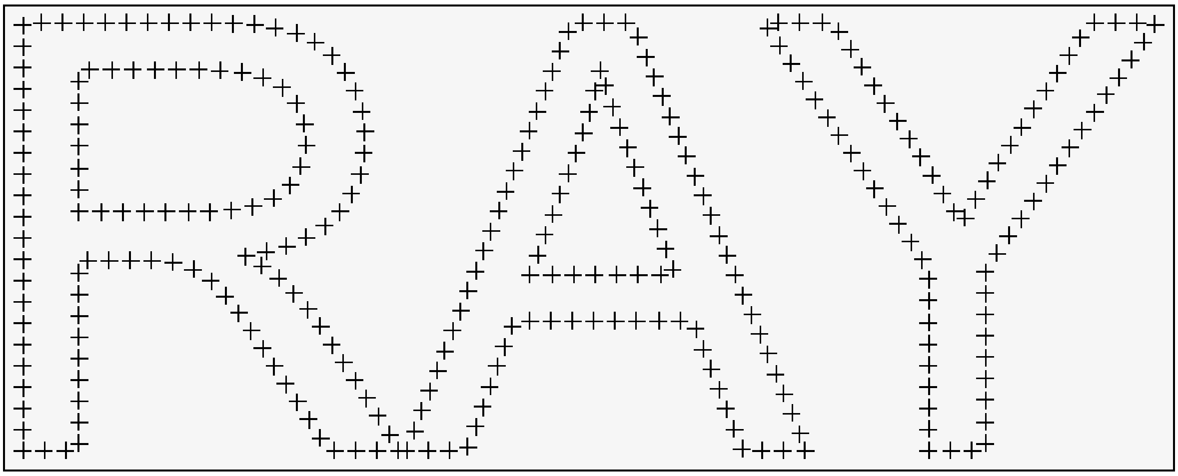


Fig. 7.55: RG-AFG

7.2.6.3.11.8 Replacing all commands with 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:

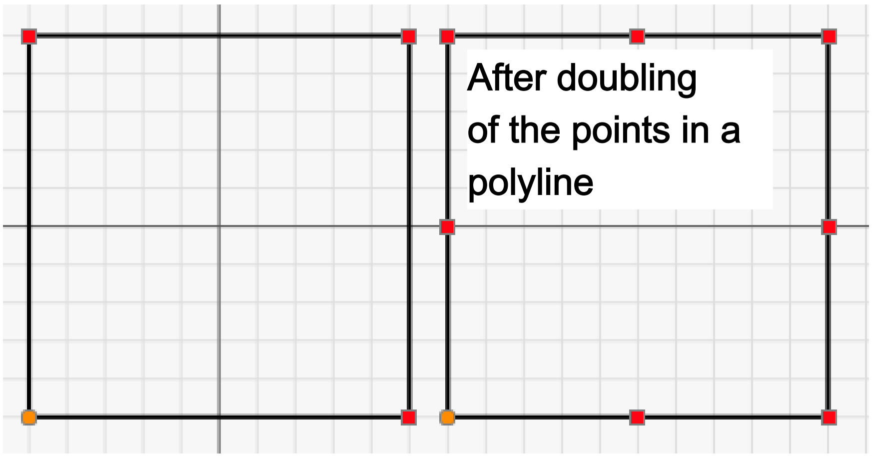


Fig. 7.56: RG-ACL

7.2.6.3.13 Related settings

Select

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

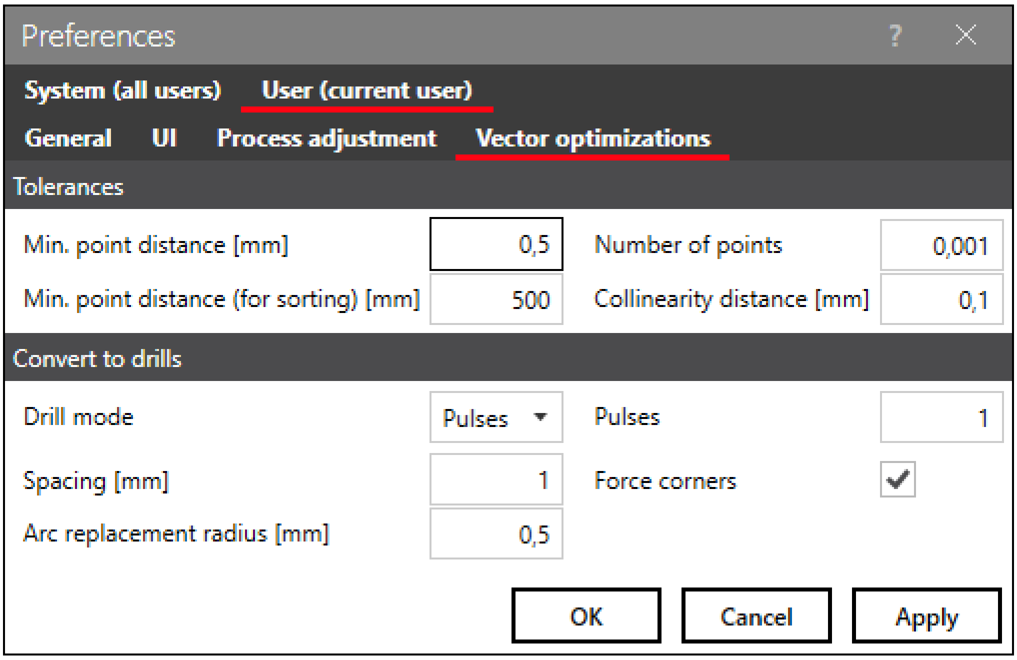


Fig. 7.57: RG-AFH

Setting	Explanation
Tolerances	
Min. point distance [mm]	The distance that must exist between two points to be considered the same point. 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: The first step creates a polyline containing the number of points given here. 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 *Sort* 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
Convert to drills	
Drill mode	■ *Pulse:* 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. ■ *Time:* The dwell duration per drill point is defined directly as the target value.
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]	Circular arcs with a radius less than/equal to this value would be replaced with drill holes if optimized accordingly. If the reverse conversion from drill holes to arcs is selected, the arcs will have this radius.

Table. 7.35: RG-037

7.2.6.4 Manual Vector Editing

In edit mode, you can edit a vector of an object 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 context menu or select the object layer or path in the object tree. When entering edit mode, all points (transition points and control points) are displayed and colored.

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.

Color 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 center or quadratic / cubic curves, to name some examples. Control points are visible as round dots.

7.2.6.4.1 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 the 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 of the path are displayed with a colored frame.

Example:

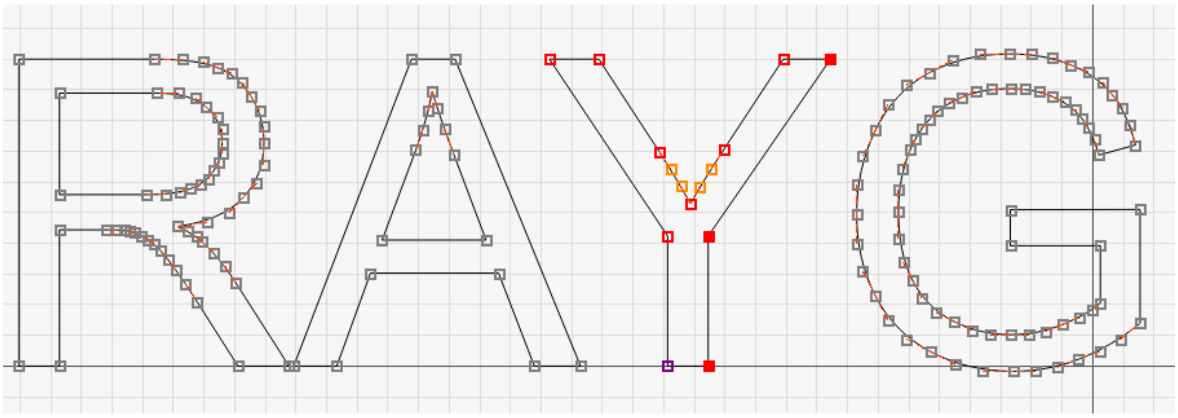


Fig. 7.58: RG-AEA

7.2.6.4.2 How to move a point / edit its position

- With the mouse:

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

  NOTE: The thumbs as well as the control points 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 > Preferences > 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 center point is displayed but cannot be moved separately. All 3 thumbs must be selected to move the arc as a whole.

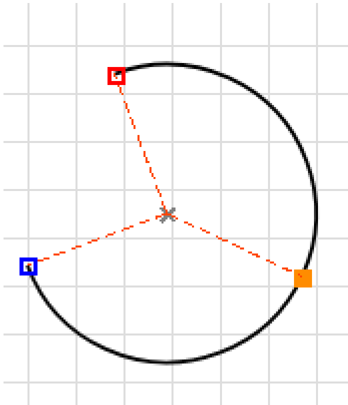


Fig. 7.59: RG-AEK

- With the arrow keys:

  You can use the arrow keys on the keyboard to move points horizontally / vertically. Can be used for single or multiple selection of points.
- Apply relative transformations, see *page 190, Object transformation*.
- About the context menu:

  Using the context menu of the points, you can position individual points as well as the associated path, layer or the entire graphic object with the *Move* menu item.

  To do this, enter the absolute target position for the selected point, for instance. Alternatively, you can also offset the selection made by a desired relative distance.

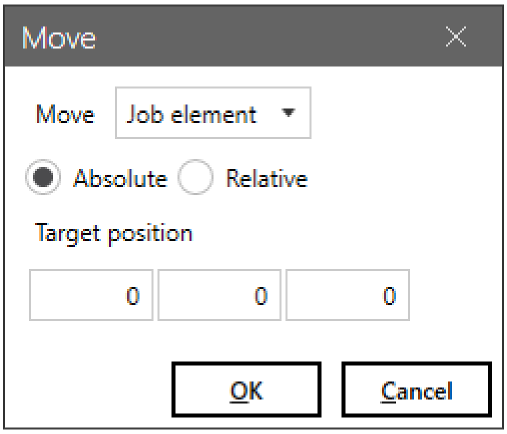
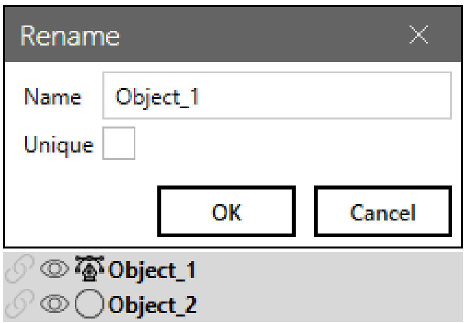


Fig. 7.60: RG-AGO

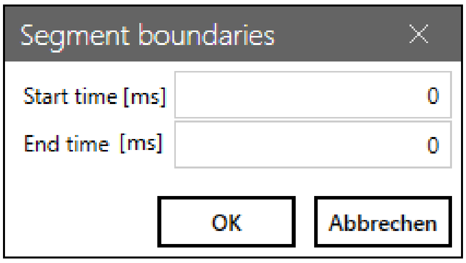
- To adapt a graphic element specific to the position, you can also edit its point coordinates directly in the command settings dialog.

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 *properties* 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	1. A marking object selected in the tree: Opens the name field for editing. 2. Several marking objects selected: Opens the following dialog field:  ■ “Unique” not active: All selected objects are renamed with the same name ■ “Unique” active: A unique suffix is added to all selected objects in addition to the new name	Tree	Object
Save as template...	Saves an object as a template for this object type. See *page 243, Templates*.	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, see *page 245, Process Parameters (Pens)*.	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 ***[Ctrl-]+[X]***.	Tree / Viewport	Container / Object / Layer / Path
Copy	Copies the item to the clipboard but keeps the original ***[Ctrl]+[C]***.	Tree / Viewport	Container / Object / Layer / Path

Function	**Explanation**	**Available in viewport and / or tree**	**Available for ...**
Copy segment	Copies a section of the path to the clipboard. The path section is defined by a start time and end time relative to the beginning of the path. The segment can then be inserted as a new marking object in the same or a new job using ***[Ctrl]+[V]***.  **NOTE:** This option is mostly used for repair welding, where the time value of the defect can be determined using coaxial sensors.	Tree	Path
Delete	Deletes the selected elements.	Tree / Viewport	Container / Object / Layer / Path
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 center 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. Horizontally you can align the objects *left/center/right*; vertically you can align the objects *top/center/ bottom*.	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

Function	Explanation	Available in viewport and / or tree	Available for ...
Explode	Option to split a container into its "individual pieces". Each child is created as a separate object in the job tree. Sub-options (for nested) containers: ■ Recursive: All containers including containers in a container are dismantled. ■ Non-recursive: Only the container selected in the job tree is dismantled	Tree	Container objects
Group / Ungroup	Puts the selected objects into a new group container / dissolves the selected group container.	Tree / Viewport	Object multiple selection
Move to combined vector graphic	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. **NOTE:** When you move graphic elements **manually** (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 ***Move to combined vector graphic*** command, the element is **not** transformed but remains unchanged. In fact, the new combined object starts as a new object free of transformations. **NOTES:** ■ The resulting object always uses job pen 1, independent of what pens have been used before.	Tree	Object

Function	Explanation	Available in viewport and / or tree	Available for ...
	■ 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. ■ 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 *page 148, Vector Graphic*)		
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

Function	Explanation	Available in viewport and / or tree	Available for ...
Convert to extruded vector graphic	Converts a vector-based marking object into an extruded vector graphic object. For details on the extruded vector graphic, see *page 158, Extruded vector graphic*.	Tree	Objects (Only useful if the object only contains closed paths)
Convert filling	This action “vectorizes” fillings, meaning each filling is created as a separate layer in the object. This allows the associated paths to be edited individually. **NOTE:** The conversion is applied to all fillings of the object, regardless of the hierarchy level at which this filling was created.	Tree	Objects of the vector graphic type

Function	Explanation	Available in viewport and / or tree	Available for ...
Extract into combined object	You can select sub-entities, for example, layers or paths, and extract them into a single new vector object which contains the selection. Multi-selection is possible. The combined selection of layer / paths is possible, however, the path must not be part of an already selected layer. Cross-selection over different objects is possible. Each selected path element gets its own layer in the newly created object.	Tree	Layer / Path
Extract into individual objects	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. Multi-selection is possible. The combined selection of layer / paths is possible, however, the path must not be part of an already selected layer. Cross-selection over different objects is possible. Each selected path element gets its own layer in the newly created object.	Tree	Layer / Path

Function	**Explanation**	**Available in viewport and / or tree**	**Available for ...**
Split	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. Only one command must be selected.	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
Define as start of path	Defines the selected thumb as the new location of the path. **NOTE:** Can only be used with closed paths	Viewport in edit mode	Thumb of a path
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

Function	Explanation	Available in viewport and / or tree	Available for ...
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

Table. 7.36: 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]***.

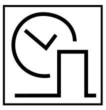
Common Settings of Automation Objects

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 control card which receives the signal
I/O port	Port of the control card which receives the signal

Table. 7.37: 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. That means 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 control card (pin: START_MARK) is sensitive to edges.

Specific settings are:

Setting	Explanation
I/O controller	Select the control card that receives the trigger signal. Currently, only SP-ICE-3 control cards 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 control card within this time period.

Table. 7.38: RG-040

7.2.7.2 Waiting for port

Button optional, see *page 125, 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).

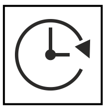
NOTE: The job has the “active” status even when waiting.

Specific settings are:

Setting	Explanation
I/O controller	Select the control card that provides the port where the I/O signal is expected. Currently, only SP-ICE-3 control cards can be selected as I/O controllers.
I/O port	Configured input port to be used at the selected control card. See *page 46, Scan Controller Configuration* **NOTE:** 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. **NOTE:** 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 expected bit state is not registered on the selected control card port within this time period.

Table. 7.39: RG-089

7.2.7.3 Delay



Button

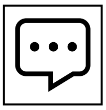
Inserts a waiting time before the next object is executed.

Specific settings are:

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

Table. 7.40: RG-041

7.2.7.4 Dialog


Button

Makes a pop-up dialog in the viewport, for example, to ask if the process should be continued.
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 PC” 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.
Variables	
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. **NOTES:** The field can only be used if the request *Value* option is activated. The variable can be used to transmit content to text / barcode objects.

Table. 7.41: RG-042

7.2.7.5 Write Port

→IO

Button

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

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 control card.

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 control card with which the object is executed. Currently, only SP-ICE-3 control cards can be selected as I/O controller.
I/O port	Configured output port to be used at the selected control card. See *page 46, Scan Controller Configuration* **NOTE:** 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 / mask	Define the bits (port pins) to be activated or the bits to be toggled.
Mode	Select one of the available modes: ■ *Write value* ■ *Create edge* ■ *Create pulse* ■ *Toggle*: Changes the polarity of the masked bits.
Setup time [µs]	Defines the time in [µs] that the complementary bit value is set in advance to generate a signal edge or a pulse
Pulse width [µs]	Defines the time in [µs] that the value is held before the second signal edge to create a pulse

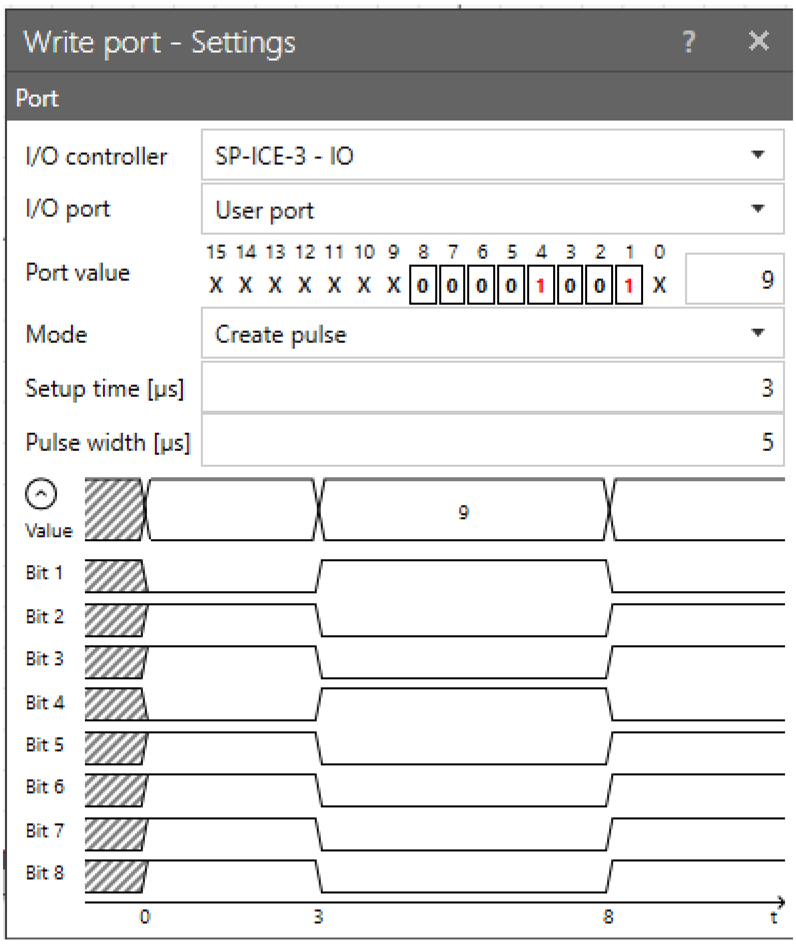
Setting	Explanation
Timing Diagram	Shows live how the time values affect the signal sequence. Use expander to view the signal sequence of each bit.  **NOTE:** The polarity of the logical edge / pulse does not have to be the same as the electrical polarity of the signal. This depends on the high / low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

Table. 7.42: RG-043

7.2.7.6 Arming / Disarming laser

Button

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

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

NOTE: Most lasers do not permit laser emission while the pilot laser is active. For this reason, we recommend activating the pilot laser 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.

Application example with pilot laser:

Lets you define a job that runs in stand-alone mode for preview purposes.

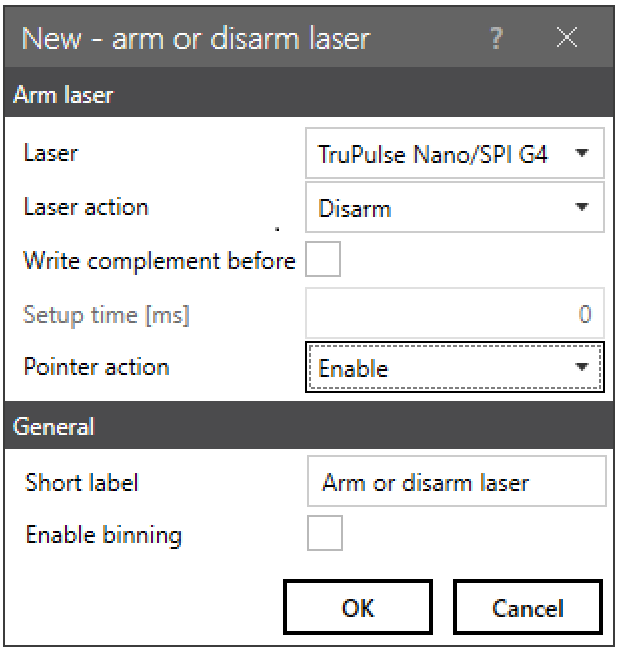
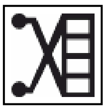


Fig. 7.61: RG-AED

Setting	Explanation
Laser	Select the corresponding configured laser.
Laser action	Select whether, at this point in the job sequence, the laser is to be *armed, disarmed, disarmed and power set to zero*, or if *no action* 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 [µs]	Enter a time in [µs] for which the complement status is set in advance.
Pointer action	Select whether, at this laser in the job sequence, the pilot laser is to be *activated, deactivated* or if *no action* is to be performed.

Table. 7.43: RG-078

7.2.7.7 Send Enhanced Command



Button optional, see *page 125, Objects Overview*

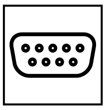
The automation object can be used to send an extended command to the deflection unit in any sequence position, e.g. to switch the tuning and therefore the dynamic behavior of the deflection unit.

Setting	Explanation
Deflection unit	Select the corresponding configured deflection unit.
Axes	Select the axes to receive the command. **NOTE:** Currently, only the X/Y-axes are available as a bundle to receive enhance commands.
Command	Select the type of command. **NOTE:** Currently, the only available command is the command to set an available tuning of the deflection unit.
Tuning [8]	Select an available tuning of the chosen deflection unit. The selection lists the tunings by name.
Delay [8]	Enter the time required for the deflection unit to switch to another tuning set.

Table. 7.44: RG-079

[8] **NOTE:** The appearance of these fields depends on the selection of the command.

7.2.7.8 Write to Serial Port



Button optional, see *page 125, Objects Overview*

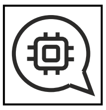
Send a command line to a preconfigured serial port, see *page 46, Scan Controller Configuration*.

Specific settings are:

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 control card.
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. See the documentation of the recipient device for available commands and response.
Delay	Set a time delay between a response and sending of the next command line.

Table. 7.45: RG-044

7.2.7.9 Sending control card command



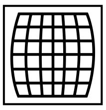
Button optional, see *page 125, Objects Overview*

You can use this automation object to send a command to the control card at any position in the sequence.

Only one command is currently available.

Setting	Explanation
Command	Only the command for setting a so-called trace label is currently available for selection.
Trace label	A Trace label is a kind of marking in the job list of the control card. Other programs, for instance the RAYBOARD PROCESS DATA ANALYZER can use Trace label to trigger recordings. Enter the number of the label for this position in the job process.

7.2.7.10 Setting the correction file index



Button optional, see *page 125, Objects Overview*

If configured accordingly (see *page 69, 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.

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.

Table. 7.46: 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 setting are made:

Setting	Explanation
Name	An appropriate name for this job element
Use as default	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. Importable layout objects, for example, bitmaps or vector graphics, do not allow a default template definition. There can only be **one** default template for each object type. If no template is set as default, the system provides the default. The default object is indicated by a checkmark in the object menu list as well as in the template panel. **NOTE:** The currently assigned pen is not saved as part of a default object template.
Include filling	Includes the object 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.
NOTE: The object pen is **only** stored as the pen number, **not** with the pen properties.	

Table. 7.47: RG-045

Fill templates

To store a fill pattern as template, use the ***[Save]*** button on the filling tab in the object properties menu.
Click on the ***[Load]*** button for a list of all available fill templates that can be used directly.

Template panel

The template 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 filling 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 the 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 base pen set of the job 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 base pen set of the loaded job apply.
- The base pen set of the job 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 base pen set of the job, 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 248, 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 the 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
- **Specific pen sets created by users** 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 toolbar apply to the selected pens. To select a pen in a pen set, click the pen entry. The pen is now highlighted in gray. Use ***[Ctrl]*** to select multiple pens.

Tool	Function
[Copy] ***[Cut]*** ***[Paste]*** ***[Special paste]***	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. 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: ■ *Replace*: Replaces all pen parameters. ■ *Merge*: Replace only pen parameters that are not protected (protected parameters are shown in italics and bold). ■ *Copy as new*: Add the pens as new pens, while they get subsequent pen numbers in the target pen set. Click on ***[Skip]*** to do nothing and proceed to the next pen. Mark *Repeat for all conflicts* to select the same option for all pens in the clipboard. If multiple pens are in the clipboard, the confirmation dialog is repeated for each pen. When using the “special paste” option, the pen from the clipboard will replace master pen #0 instead of the respective pen number.
[Lock / Unlock] ***[Reset]***	Use ***[Lock / Unlock]*** to ensure that **all** parameters are protected against overwriting if a pen is pasted in. Use ***[Reset]*** to remove **all** previous parameter changes (reset to master pen values) and at the same time unlock **all** pen parameters.
[Edit selected pens]	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 *Multiple*. Editing the parameters affects all selected pens and the linked layout objects. Untouched parameters remain as before.
[Delete]	Deletes the selected pen.
[Factory reset of system pen set]	This option sets all values in all pens to default values and creates the default number of pens in the set.

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

Table. 7.48: 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

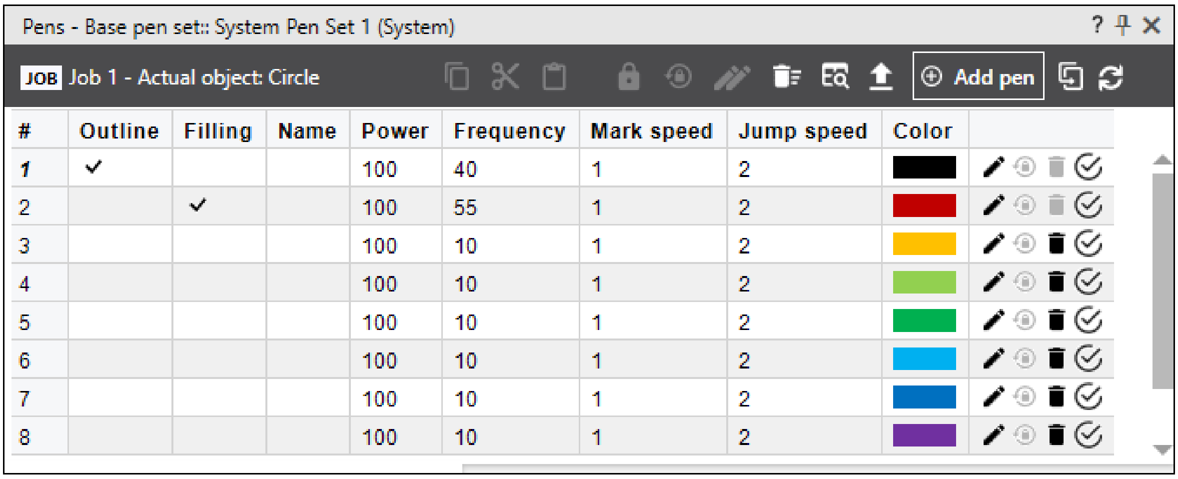


Fig. 7.62: RG-ACM

This where you can edit, add and manage the pens used in the current job.

CAUTION: A pen number only is only used once within a pen set. That means you can assign a name to each pen to better distinguish it from other pens that have the same pen number.

An * (asterisk) indicates that this pen differs from its reference pen. The ***[Reset]*** button is activated so that you can reset the pen to the original parameters if required.

The list contains:

- Standard pen – This pen is used for all newly added layout objects. It is displayed in bold.
- Display columns – There are two columns (O = outline, F = filling) that show whether a pen is linked to at least one layout object. If you have selected a layout object, you will see a checkmark next to the pens linked to the object in these columns. If no layout object is selected, all linked pens are marked with a dash.
- Parameter columns – In the standard view, only the main values of the pen are displayed. To edit the columns, see *page 252, Customize Pen Panel View*.
- To edit a value directly in the column, double-click on the cell to open it for editing. If you double-click on cells with predefined content, the selection is switched to the next possible content in the sequence.
- Pen color — The pen color can be changed. Right-click on the color field to display an extensive color palette for selecting a new color.

7.3.3.1 Pen Panel Tool Bar

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

Tool	Function
[Copy] ***[Cut]],*** ***[Paste]*** 	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. 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: ■ *Replace*: Replaces all pen parameters. ■ *Merge*: Replace only pen parameters that are not protected (protected parameters are shown in italics and bold). ■ *Copy as new*: Add the pens as new pens, while they get subsequent pen numbers in the target pen set. Click on ***[Skip]*** to do nothing and proceed to the next pen. Mark *Repeat for all conflicts* to select the same option for all pens in the clipboard. If multiple pens are in the clipboard, the confirmation dialog is repeated for each pen.

Tool	Function
[Lock / Unlock] ***[Reset]***	Use ***[Lock / Unlock]*** to ensure that **all** parameters are protected against overwriting if a pen is pasted in. Use ***[Reset]*** to remove **all** previous parameter changes (reset to master pen values) and at the same time unlock **all** pen parameters.
[Edit selected pens]	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 *Multiple*. Editing the parameters affects all selected pens and the linked layout objects. Untouched parameters remain as before.
[Delete]	Deletes the selected pen(s), unless one of them is linked to a layout object.
[Highlight pen]	Highlights the selected pen in the job tree (in blue). That means you can easily detect all layout elements linked to this pen – sometimes, the color signature in the viewport may not be sufficient. **NOTE**: Expand the job tree fully to see the highlighting.
[Forward current pen values]	Sends the current pen values to recalculate the object and job statistics. In the process, the "expected execution time" is also updated.
[Transfers the pen set]	Transfers the pen set of the current job to the pen library. Four different options are available for selection: The job pen set: ■ Created as a new system pen set ■ Created as a new user pen set **NOTE:** For newly created pen sets, there is also the option of renumbering the pens, for instance to avoid gaps in numbering. ■ Overwrite the pen set currently defined as the default ■ Overwrite the corresponding base pen set
[Update pen list]	This function is used to update the pens of the job with the values of the corresponding base pen set.

Table. 7.49: RG-047

Editing pens

Newly generated pens probably do not have the appropriate parameters for your application. That is why 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 on the ***[Edit]*** button.
- Via the Filling tab, use the ***[Edit]*** button right next to the pen number assigned to the filling

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

NOTE: The *Save as object pen* option is only available if you have selected the “Edit pens” tab through the Properties dialog of any Container / Object / Geometry element / Filling.

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 most important parameters (for example, speed, laser power, etc.) with another object, but will also 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.

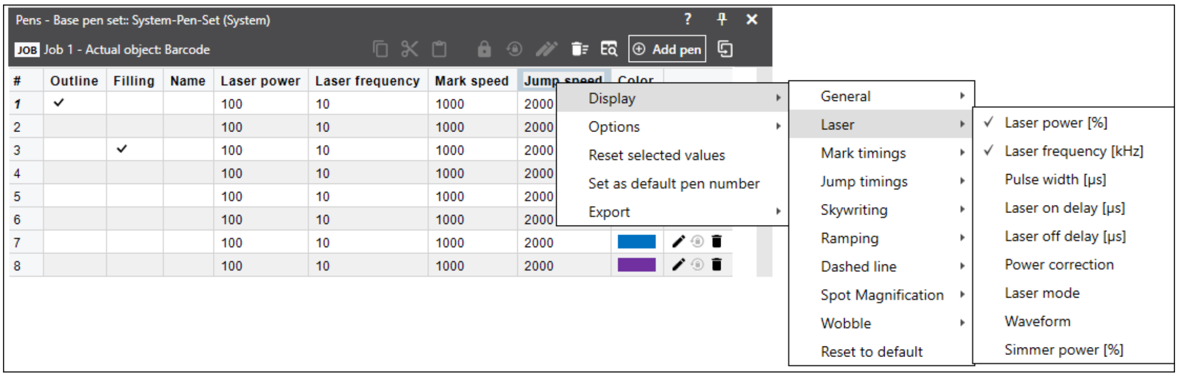


Fig. 7.63: RG-ADV

Setting	Explanation
Display	Under *Display* 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 *Short header* option reduces the column header to an acronym to reduce the column width, while the tool tip continues to display all the information. The *Enum as index* 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 ***[Ctrl]*** 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.

Table. 7.50: 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 the actual capabilities of your system.

Fig. 7.64: RG-ACN

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

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

The Edit pens dialog can be reached in different ways: 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]*** button next to the drop-down list for assigning pens.

Setting	Explanation
Pen [9]	Select a pen to be edited. **NOTE:** 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 should 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 color for a better overview of which graphic element uses which pen.
Laser	
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 *page 316, Running a Job*. Can also be defined in absolute units, i. e. in [watts], with the appropriate preselection. See ***System*** **>** ***Preferences*** **>** ***User*** **>** ***UI***. The scale factor for conversion from [%] to [watts] is defined in the laser configuration, see *page 56, Laser Controller Configuration*.
Frequency [kHz]	Value in [kHz]. Defines the pulse rate of the LM signal.
Laser on delay [µs]	Values in [µs] to synchronize 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]	

[9] **NOTE:** This option is only available when the pens tab in the properties dialog of a marked job element is opened.

[10] **NOTE:** The availability of these pen parameters depends on the configured lasers and on the settings under ***System*** **>** ***Preferences*** **>** ***System (all users)*** **>** ***Visibility*** **>** ***Pen***.

Setting	Explanation
Optical pulse width [index]/[ns] [10]	Select the index for the APD mode. 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 *page 65, IPG laser type YLPN APD* . **NOTE:** 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.
Optical pulse width [ns] [10]	Specification of the optical pulse width for **JPT MOPA Laser** in [ns]. **NOTE:** Observe the valid value range according to the specifications of the laser manufacturer.
Beam profile index [10]	Select the index for the beam profile of the nLight AFX laser. **NOTE:** 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 [10]	Choose between the *Pulsed* or *CW (continuous wave line)* operating modes.
Waveform [10]	Number of the pulse form, which then defines the pulse width.
Simmer power [%] [10]	Value in [%] that translates into the 0-10 volt range for the simmer voltage.
Secondary power [%] [11]	Laser power in [%] for a possible secondary laser source, such as for ring mode when using an IPG YLS AMB or Coherent Highlight ARM laser. Can also be defined in absolute units, for instance in [watts], with the appropriate preselection. See ***System> Settings > User > UI***. The scale factor for conversion from [%] to [watts] is defined in the laser configuration, see *page 56, Laser Controller Configuration*.

[11] **NOTE:** This parameter is an alternative to the simmer power parameter and is only available if an analog laser with a second power channel has been configured.

Setting	Explanation
Mark timings	
Mark speed	Speed in [m/s] of the laser spot on the material. If desired, it can also be defined in [mm/s] by corresponding preselection. See ***System* > *Preferences* > *User* > *UI***.
Mark delay [µs]	Value in [µs]. The value relates to the dynamics of the deflection unit. Value will apply after a marking vector, prior to a jump vector.
Poly delay [µs]	Value in [µs]. The value relates to the dynamics of the deflection unit. The delay will apply at the transition point of two consecutive marking vectors.
Variable poly delay	Select this option to activate the SP-ICE-3 *Variable poly delay* function to shorten the effective value for a polygon delay depending on the change of heading angle.
Jump timings	
Jump speed	Relative speed in [m/s] or [mm/s] when the deflection unit changes position without laser emission.
Jump delay [µs]	Value in [µs]. 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 [µs]	When using a variable jump delay, enter a value for the minimum delay, independent of the jump length.
Jump lenght limit [µm]	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
Skywriting	
Skywriting mode	Select the suitable Skywriting mode: ■ *No skywriting* Skywriting is not active ■ *Force at start and end* Skywriting at is always performed at each vector start and end independent of the change of heading angle between the jump-to-mark or mark-to-jump transition. The change of heading angle (CoH) is only taken into account at the mark-to-mark transition. ■ *Minimum angle* The CoH angle is taken into account for all transitions (jump-to-mark, mark-to-mark, mark-to-jump).
Min. Angle [°]	Enter a change of heading angle which if exceeded determines whether Skywriting will be applied between two consecutive vectors.
Extension time [µs]	Time used to calculate the length of the acceleration/deceleration vectors in consideration of the marking 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 synchronize the laser emission on transition from mark-to-deceleration vector.
Skywriting Laser on delay [µs]	Delay in [µs] to synchronize the laser emission on transition from acceleration-to-mark vector.

Setting	Explanation
Ramping Defines a linear laser power ramp that is applied to every path of the layout that is linked to this pen. **RULE:** The ramp always applies per path element. That means 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. **NOTES:** ■ The overall length of both ramps can be validated to not exceed the length of the affected path. See *page 316, Running a Job*. ■ For drill objects, use only time-based ramping. ■ Not applicable for bitmaps.	
Ramping	Select *No ramp* if you do not want to create a ramp. Select *Time* if the ramp segment X-axis is to be defined by time intervals (unit = [ms]). Select *Distance* if the ramp segment X-axis is to be defined by length (unit = [mm]). If you select *Time* or *Distance*, the fields for entering the ramp values for start and end segment ramps are displayed.
Displayed channel	Selection of whether to define and display the power ramp for the primary or secondary power channel. **NOTE:** This selection is only available if the laser in use has a second power channel configured.
Start segments / End segments	To define the start and end segments of the ramp, use the ***[Edit table]*** button. This opens the editing menu. By selecting the ***displayed channel***, you determine whether the ramp applies to the primary or secondary power channel (you define whether the laser has a secondary power channel in the laser configuration). **NOTE:** The ramp graphic displayed in the pen menu is for viewing purposes only (double-click on the graphic to open the editing menu). The individual values of the support points are displayed when the mouse pointer is moved over them. Editing menu: The support points of the ramp can be added directly to the graph with a mouse click. As soon as the mouse pointer changes from an arrow to a hand, the support points can be moved with the mouse. By default, the first or last support point is inserted 50 ms (or a distance converted to the marking speed) before or after the point at which the power has its constant value. Each support point is also created as a row in the respective table. Here you can also specify or adjust the values (time/distance and power) discretely. If you want to assign the power of the pen to a support point, use the corresponding checkbox.

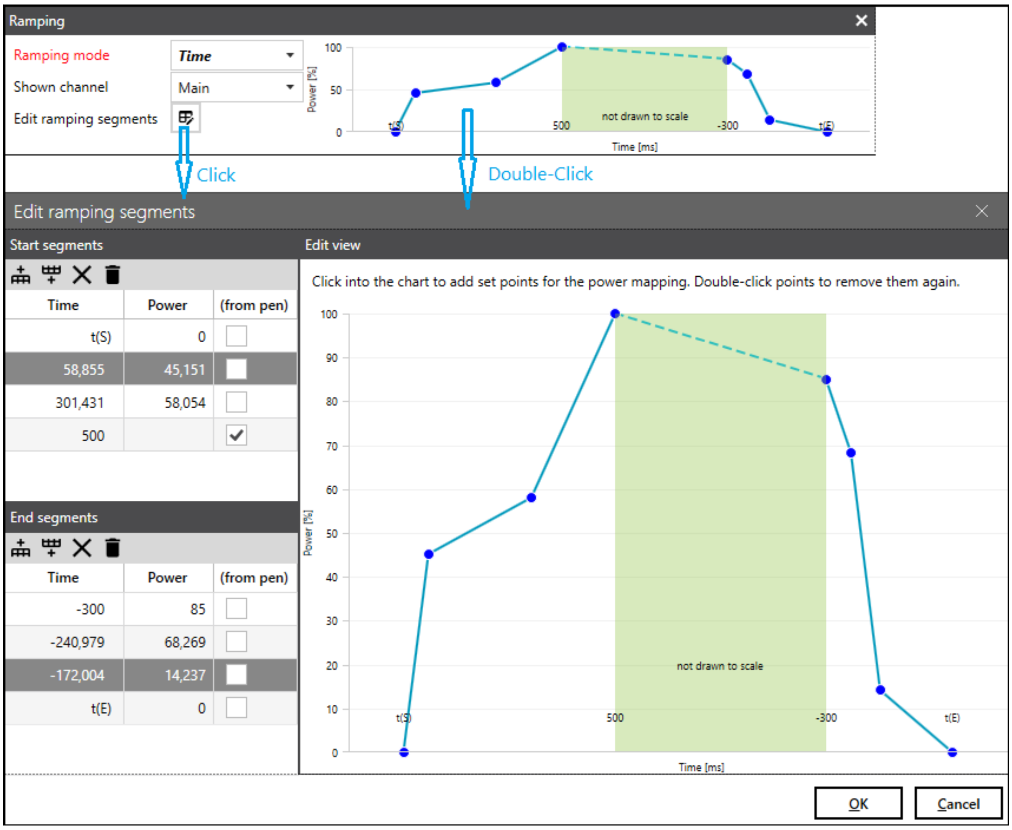
<table>
<tr><th>Setting</th><th>Explanation</th></tr>
<tr><td></td><td>
t(S) is the start point of the start segment and t(E) is the end point of the end segment. Accordingly, the time/distance values of the end segment have a negative sign, as they are defined backwards from the end point.

NOTES:

- If the power at the end of the start segment is not equal to the power at the beginning of the end segment, this generates a change in power throughout the entire remaining path length. How steep this power curve is effective depends on the length of the path, which can always be of different lengths.
- When switching between time-based and distance-based ramps, the conversion is carried out automatically using the marking speed specified in the pen.

[X] deletes the selected row and the associated support point.

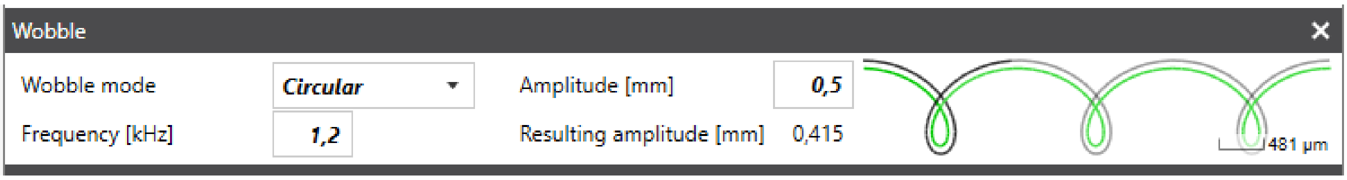
[Litter bin] deletes the entire ramp segment.
</td></tr>
<tr><td></td><td>
Example:



</td></tr>
</table>

Setting	Explanation
Dashed line 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) **RULE:** At the beginning of a new path, the pattern starts anew. Accordingly, the pattern from the previous path is not continued. **NOTES:** Not applicable to drill points and bitmaps. The pattern is displayed in the viewport, but is not visible when in edit mode.	
Dashed line	Activate this option to use the dashed line feature.
Dashed line pattern [mm]	Define the dashed-line pattern by entering length values for laser on / off. Enter at least two numbers. The first value defines the dash length that the pattern starts with. Separate values for dash / gap with blanks. You can also create a pattern that consists of more than two parameters. <u>Example:</u> 2 3 2 1 creates repeated patterns of 2 mm line, 3 mm gap, 2 mm line, 1 mm gap. The preview below displays the pattern according to the values.
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
Magnification Used to increase the diameter of the laser spot. 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 (labeled, for example, 3D+M). 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. **NOTE:** RAYGUIDE visualizes the magnification factor in the viewport by drawing the affected contours n-times thicker.	
Speed	Defines a time ramp in [1/s] over which the spot magnification is achieved. **NOTE:** This value must never be 0.
Factor / Spot size [mm]	Magnification factor. Default: 1 = No magnification Alternatively, the absolute spot size in [mm] can be defined. To do so, the global unit must be set accordingly (see *page 105, UI*) and the conversion factor defined (see *page 69, General*).
Zoom async	Deactivate if the magnification is to be achieved immediately without a designed time ramp. **NOTE:** With this option deactivated, the laser is briefly switched off during the transition from no magnification to magnification.

<table>
<tr><th>Setting</th><th>Explanation</th></tr>
<tr><td colspan="2">Wobble
The wobble function imparts additional complex harmonic motion to the laser beam in the XY plane when the laser is active.
To understand the mathematical correlation of the wobble parameters, please refer to the manual for SP-ICE-3, chapter 9.2.2.
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.

</td></tr>
<tr><td>Wobble mode</td><td>Select No wobble if you do not want to use the wobble function at all.
Select Circular if you want a circular wobble shape.
Select Eight if you want a figure-of-eight wobble shape.
Select Custom if you want to define a Lissajous-figured wobble shape.</td></tr>
<tr><td>Frequency</td><td>Set a frequency in [kHz] at which the wobble shape is repeated.</td></tr>
<tr><td>Amplitude [mm]</td><td>Set an amplitude in [mm] to define the size of the wobble shape.</td></tr>
<tr><td>Resulting amplitude [mm]</td><td>Specification of the amplitude that is achieved as a result of the dynamics of the deflection unit.
The resulting wobble geometry is marked in the plot:
■ Green: If it is within the "allowed" range of values.
■ Red: If it is outside the "allowed" range of values.
The "allowed" value range roughly defines when the deflection unit is overstressed, and thus possibly damaged.
NOTES:
■ 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.
■ When moving the mouse over the label, the resulting speed range of the laser spot along the actual wobble trajectory is also displayed.</td></tr>
<tr><td>Phase [°]</td><td>Only for Lissajous-figured shapes. Set a phase offset for each of the two sinus functions.</td></tr>
</table>

Setting	Explanation
Pen saving option	
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	The values are stored in a new so-called "object pen" that belongs to a single object. This option is only available if the pen settings dialog was opened via an object dialog (Object settings dialog, Pen tab).

Table. 7.51: 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 “globally” on all used pens.

CAUTION: Hiding the display of a pen feature does not disable the related functionality. That is why, before hiding the display of a pen feature, you should 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.

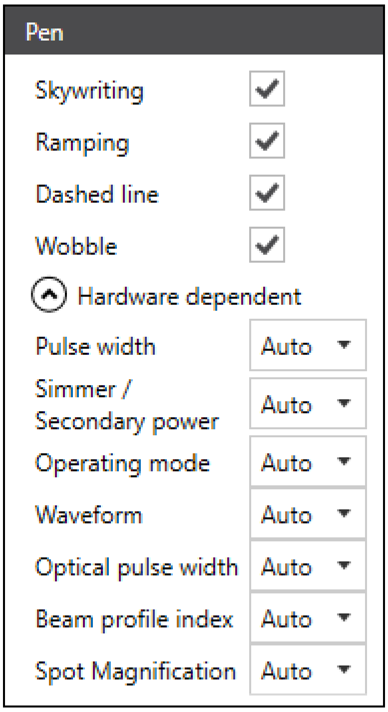


Fig. 7.65: RG-ACO

Setting	Explanation
Skywriting	Select if this option should be available in the pen settings.
Ramping	Select if this option should be available in the pen settings.
Dashed line	Select if this option should be available in the pen settings.
Wobble	Select if this option should be available in the pen settings.
Hardware-dependent 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 Show, Hide and Auto options. If *Auto* is selected, the parameter is only displayed in the Pen dialog if the pulse width definition is set to *manual* 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 *Show, Hide* and *Auto* options. If *Auto* is selected, the parameter is only displayed in the Pen dialog if a corresponding laser has been configured. **NOTE:** 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 *Show, Hide* and *Auto* options. If *Auto* 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 *Show, Hide* and *Auto* options. If *Auto* 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 should be available in the pen settings. You can select from the *Show, Hide* and *Auto* options. If *Auto* is selected, the parameter is only displayed in the Pen dialog if a corresponding laser (e.g. IPG YLP APD) has been configured.

Setting	Explanation
Beam profile index	Select if this option should be available in the pen settings. You can select from the *Show, Hide* and *Auto* options. If *Auto* is selected, the parameter is only displayed in the Pen dialog if a corresponding laser (nLightAFX) has been configured.
Spot Magnification	Select if this option should be available in the pen settings. You can select from the Show, Hide and Auto options. The setting is available / visible if one of the configured deflection units has at least four axes, according to its correction file.

Table. 7.52: 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 245, 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 are maintained 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 base pen set of the job. 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.
- You can do this 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 contour area in the viewport, for example by dragging with 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 a contour (by default, RAYGUIDE fillings assigns the same pen as for the contour) for filling graphic elements. That means you can also change the pen used to process the filling in the Filling tab. A manual change of the filling pen results in a protection function against pen changes of the contour 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:

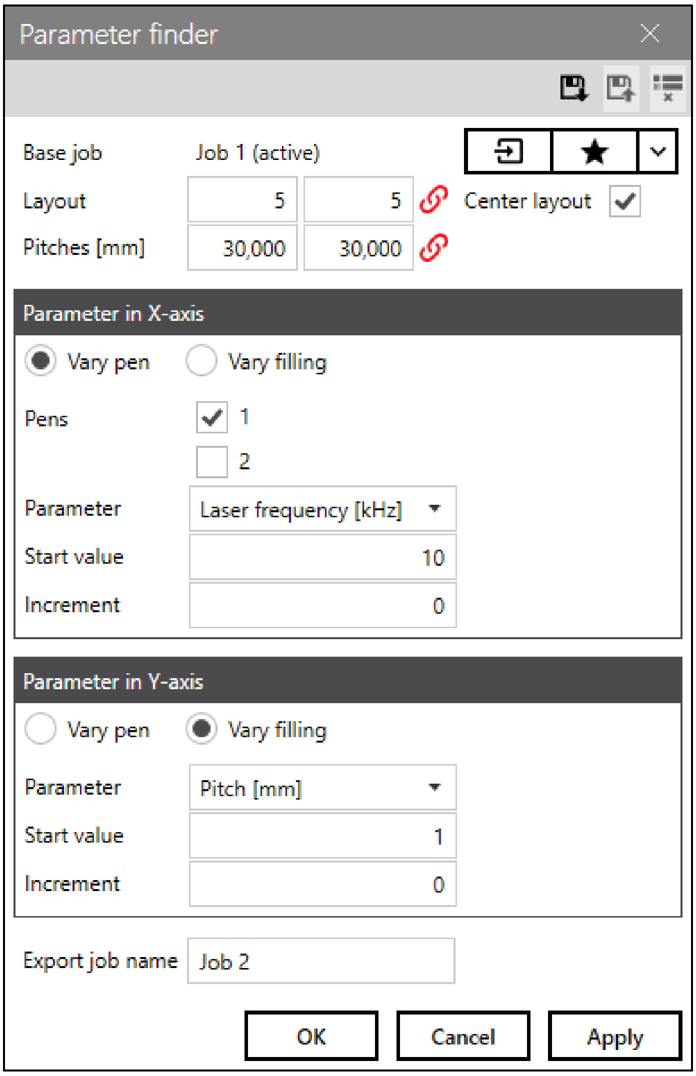


Fig. 7.66: RG-AEV

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	Select the job that contains the layout object(s) you want to use for the parameter search. You can either use an already open job or load an already saved job. In case you load an already saved job for this, it will be additionally loaded into the drawing area and displayed.
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	Select the option if you want the layout defined here to be centered in the job as a whole. **NOTE:** This option is active by default.
Parameter in X-axis / Parameter in Y-axis	
Vary pen **/** Vary filling Select pen	Define whether the parameter you want to vary should be a pen parameter or a fill parameter. 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.

Setting	Explanation
Parameter	Define the parameter that varies per duplication. The following pen parameters are available for selection: ■ Laser power [%] ■ Laser frequency [kHz] ■ Laser pulse width [µs] ■ Marking speed [m/s] ■ Jump speed [m/s] ■ Marking delay [µs] ■ Jump delay [µs] ■ Polygon delay [µs] ■ Laser-on delay [µs] ■ Laser-off delay [µs] ■ Skywriting: Time for extension vector [µs] ■ Laser: Secondary power [%]
	The following fill parameter are available for selection: ■ Distance (...between fill lines) ■ Offset (...of the filling to the contour) **NOTE:** If, for example, there are several fillings 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.
Start value	Define the start value for the respective parameter. The unit of the start value always corresponds to the unit of the respective parameter. **NOTE:** By default, the value corresponds to the value from the previously defined pen.
Increment	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.
Export job name	Specify the name under which the layout of the parameter finder is to be created in the drawing area for the further steps.

Table. 7.53: 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, whereby 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 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 filling 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 177, 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. That is why it could make sense to reorganize the sequence of objects / elements: 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-organizing.

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-organizing 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.

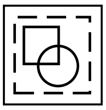
Case B: You start with the container object.

- 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 execution conditions or the number of iterations, or to transform / shift all objects / items together.

That is why 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.

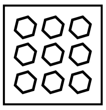
The container and thus the groups can also have their own transformation, which transforms the objects in the container. If the group is ungrouped, this transformation is transferred to the objects that were in the group.

Setting	Explanation
Settings	
Iterations	How often this group of objects should be processed.
General	
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 171, Common Properties of Marking Objects*.
Single output	Processes all container copies as a single, combined vector object. This can speed up the processing if the container contains a huge number of subordinate objects (children). **NOTES:** ■ This option is especially recommended for MOTF applications in which many small layout elements (such as drilled holes) occur, since this avoids reset jumps. ■ If this option is set, automation objects in the container are ignored. ■ For text/code objects with variable content, the content is then no longer varied per copy. ■ If containers are stacked inside each other, this option should not be used.

Setting	Explanation
Edit Pens (tab)	
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.	

Table. 7.54: RG-050

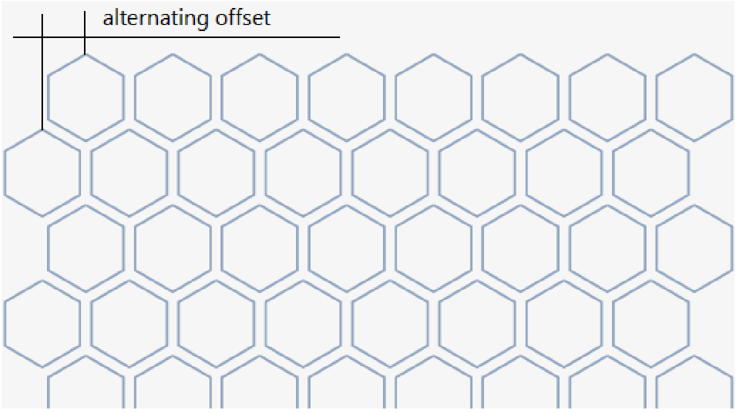
7.5.2.2 Matrix copy container



Button

A matrix copy can be used to multiply layout elements throughout the workspace in ordered rows / columns.

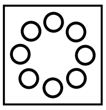
Setting	Explanation
Settings	
Number of copies	Number of copies in X, Y, Z directions Use the ***[Lock / Unlock]*** toggle button to define the same values for the X and Y directions.
Pitches [mm]	Distance the copies are spread in X, Y, Z direction. Use the ***[Lock / Unlock]*** toggle button to define the same distances for the X and Y directions.
Bidirectional	Option to alternate the processing direction per row / column.
Centered	The original center position of the master object (or the center of gravity in case of multiple master objects) will become the center of the container.

Setting	Explanation
Alternation offset	Offset in [mm] by which the first and each subsequent odd row is shifted. With the help of this offset, honeycomb-like patterns can also be created, for example. 
Explicit cell order	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 *Custom list of cells* line. **NOTES:** ■ The specifications for the starting corner position and processing direction are hidden. ■ The coordinate index starts in the lower left corner at 0.0.
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
General	
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 171, Common Properties of Marking Objects*.
Single output	Processes all container copies as a single, combined vector object. This can speed up the processing if the container contains a huge number of subordinate objects (children). **NOTES:** ■ This option is especially recommended for MOTF applications in which many small layout elements (such as drilled holes) occur, since this avoids reset jumps. ■ If this option is set, automation objects in the container are ignored. ■ For text/code objects with variable content, the content is then no longer varied per copy. ■ If containers are stacked inside each other, this option should not be used.
Edit Pens (tab) 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.	

Table. 7.55: RG-051

7.5.2.3 Polar copy container



Button optional, see *page 125, Objects Overview*

Using a polar copy, you can multiply layout elements in a circular arrangement. The center of the circular arrangement is the original center of the master object. Basically, the orientation of the layout copies corresponds to the orientation of the master object.

Setting	Explanation
Settings	
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. 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.
General	
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 *page 171, Common Properties of Marking Objects*.
Single output	Processes all container copies as a single, combined vector object. This can speed up the processing if the container contains a huge number of subordinate objects (children). **NOTES:** ■ This option is especially recommended for MOTF applications in which many small layout elements (such as drilled holes) occur, since this avoids reset jumps. ■ If this option is set, automation objects in the container are ignored. ■ For text/code objects with variable content, the content is then no longer varied per copy. ■ If containers are stacked inside each other, this option should not be used.
Edit Pens (tab) 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.	

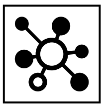
Table. 7.56: RG-052

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 125, 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
Properties	
Copies	List of all copies. The area can be expanded and collapsed using an expander.
Activate	Select whether the nest position is to be executed or not. ■ The option is selected by default. ■ Nest positions deactivated here are hidden in the workspace.
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. **NOTES:** ■ As soon as a marking object is located in the cluster container, it is only displayed in the workspace at the defined nest positions. ■ No marking object has to be in the container to define the nest positions.
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.
[Load] 	You also have the option of loading the values for offset and rotation from a CSV table. **NOTE:** The table must contain values for all four parameters (four columns).
General	
Short label	A name for this container that is easy to remember.
Description	A description of the container useful for you.

<table>
<tr><th>Setting</th><th>Explanation</th></tr>
<tr><td>Enable binning</td><td>Only starts processing of the individual nest positions if a specified condition is fulfilled.
The dialog has been extended to include other inputs:
■ I/O controller: Select the control card where the I/O signals will arrive.
■ I/O port: Select the preconfigured I/O port of the respective control card (see page 52, I/O Port Configuration).
■ The condition itself is defined above for each nest position.
■ 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.
NOTE: 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.</td></tr>
<tr><td>Single output</td><td>Processes all container copies as a single, combined vector object.
This can speed up the processing if the container contains a huge number of subordinate objects (children).
NOTES:
■ This option is especially recommended for MOTF applications in which many small layout elements (such as drilled holes) occur, since this avoids reset jumps.
■ If this option is set, automation objects in the container are ignored.
■ For text/code objects with variable content, the content is then no longer varied per copy.
■ If containers are stacked inside each other, this option should not be used.</td></tr>
<tr><td colspan="2">Edit Pens (tab)
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.</td></tr>
</table>

Table. 7.57: 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

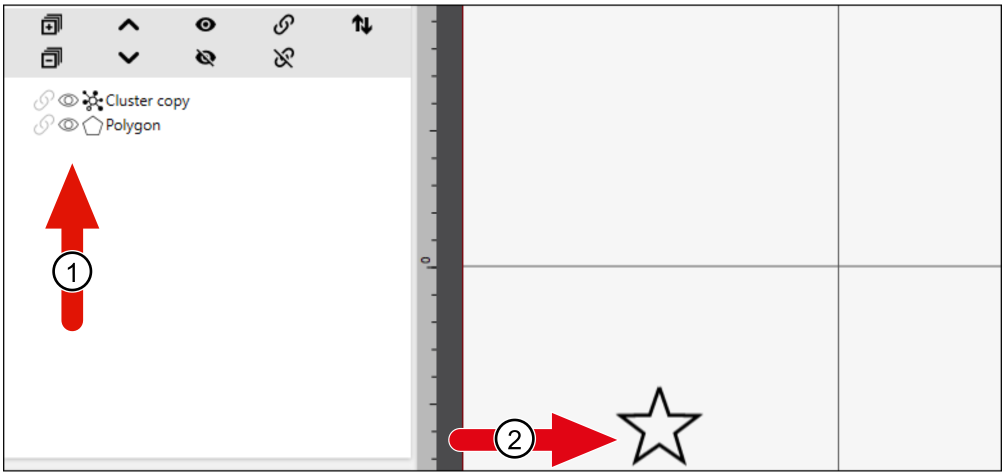


Fig. 7.67: RG-AFC

1 Original job object NOT in cluster container
2 Original position is displayed

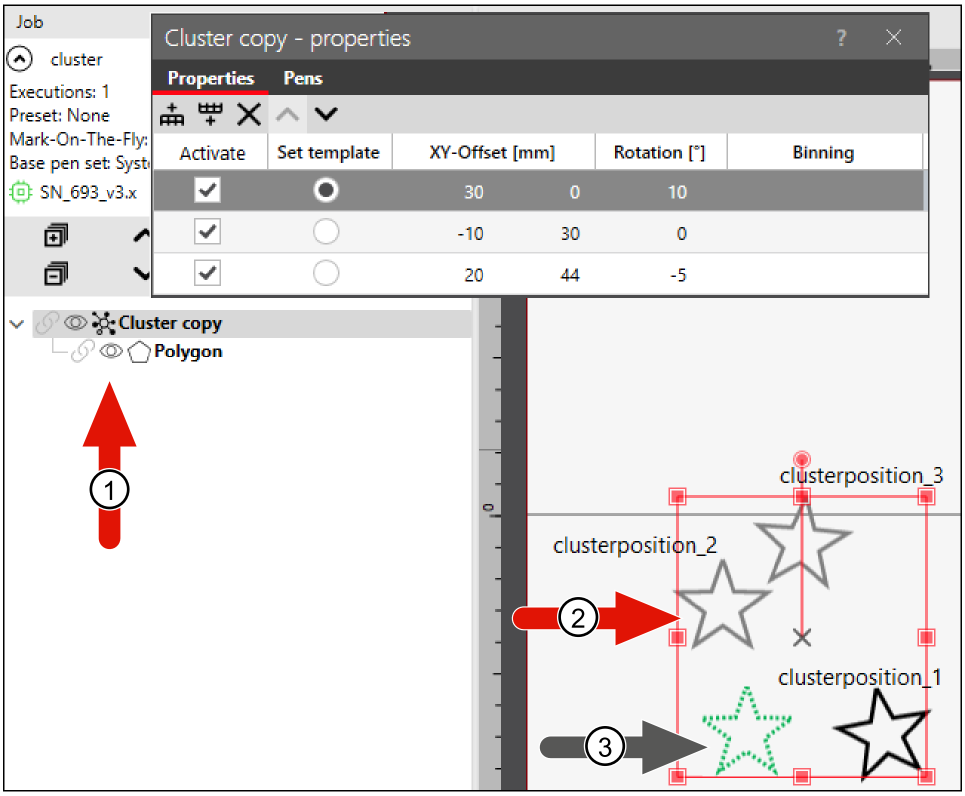
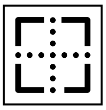


Fig. 7.68: RG-AFD

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



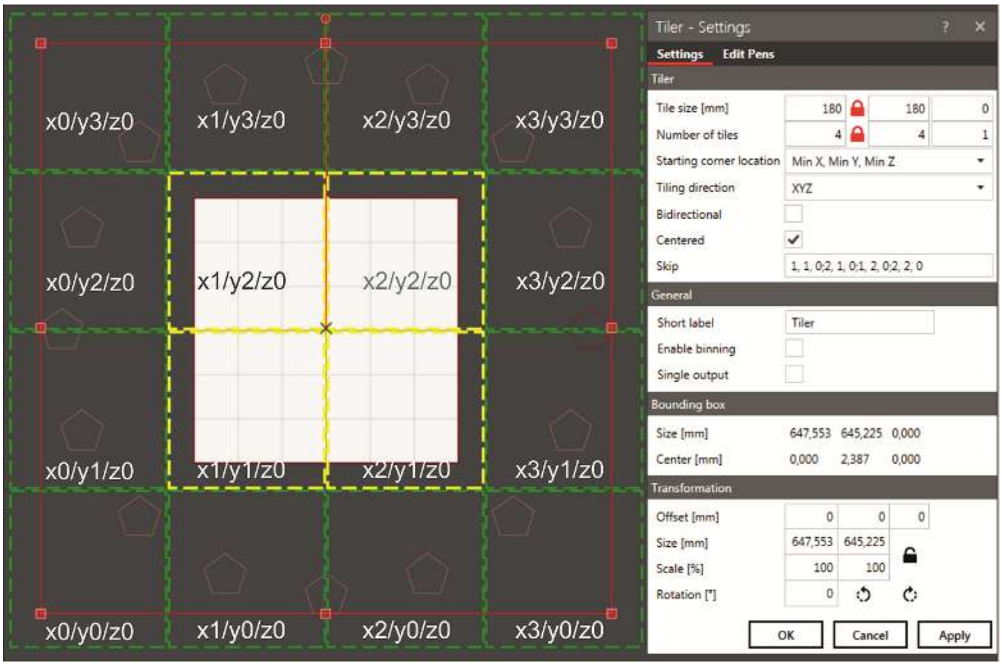
Button optional,
see *page 125, Objects Overview*

Using the tiler container, you can process layout objects that are larger than the available workspace.

Setting	Explanation
Settings	
Tile size [mm]	Define the size of the segment tiles in X / Y / Z direction in [mm]. Use the ***[Lock / Unlock]*** toggle button to use the same segment size in X and Y direction.
Number of tiles	Define the number of segment tiles in X / Y / Z direction.
Starting corner location	Define the starting point of the processing sequence by selecting the corner coordinate of the object frame. If the *Centered* option is not checked, it also defines which of the segment tiles is in the center of the workspace.
Direction	Processing sequence along the axis directions.
Bidirectional	Option to alternate the processing direction per row / column.
Centered	The tiling grid is centered at the origin of the workspace. Otherwise, the tiling grid would be positioned so that the first segment is centered 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 *Custom list of cells* line. **NOTES:** ■ The specifications for the starting corner position and processing direction are hidden. ■ The coordinate index starts in the lower left corner at 0.0.
Starting corner location	Corner of the segment layout at which execution starts.
Processing direction	Sequence of processing directions.
Ignore	Specification of the copy indices that should not be executed.

<table>
<tr><th>Setting</th><th>Explanation</th></tr>
<tr><td>Skip</td><td>Enter the X-,Y-,Z-coordinate of the segment tiles to be ignored (skipped), as they probably do not contain markable vectors.
Use a semicolon to separate the entry of segment tiles coordinates.
The ignored segment tiles are highlighted in yellow by default.

By default, the segment tile coordinates start counting at "0" in the lower left corner:



</td></tr>
<tr><td>Custom list of cells</td><td>Specify the segment indices (cells) in the desired order. Only the index segments listed here are executed.</td></tr>
<tr><td colspan="2">General</td></tr>
<tr><td>Short label</td><td>A name for this container that is easy to remember.</td></tr>
<tr><td>Description</td><td>A description of the container useful for you.</td></tr>
<tr><td>Enable binning</td><td>The settings for conditional execution of the container as a whole correspond to those of a marking object, see page 171, Common Properties of Marking Objects.</td></tr>
</table>

Table. 7.58: 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 size and the number of segment tiles and optionally by the *Centered* option.

The starting corner location also affects the position of the tiling grid if the *Centered* option is not used.

Examples:

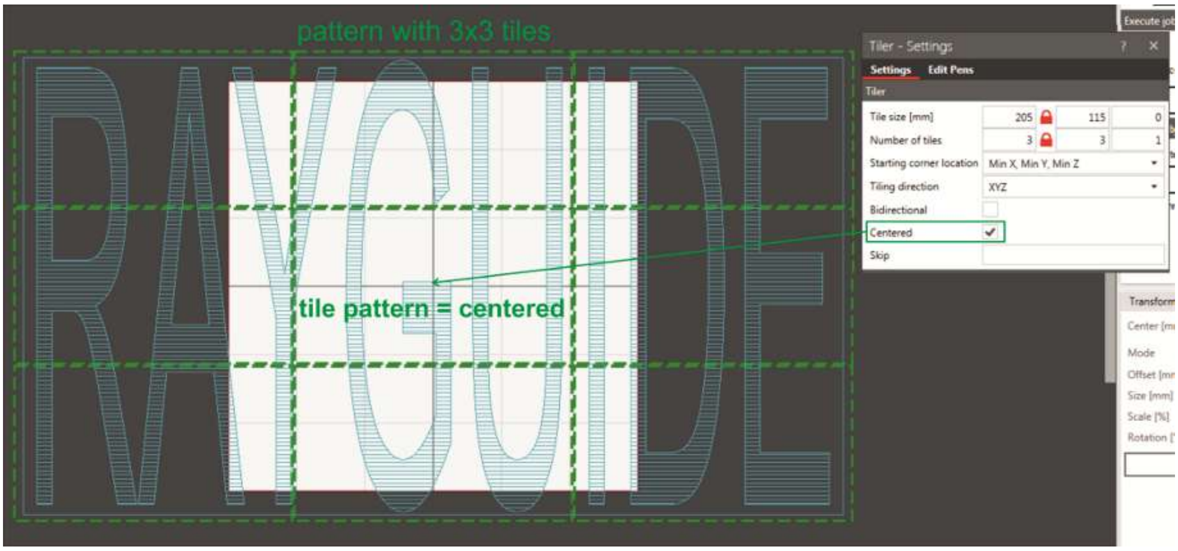


Fig. 7.69: RG-ADJ

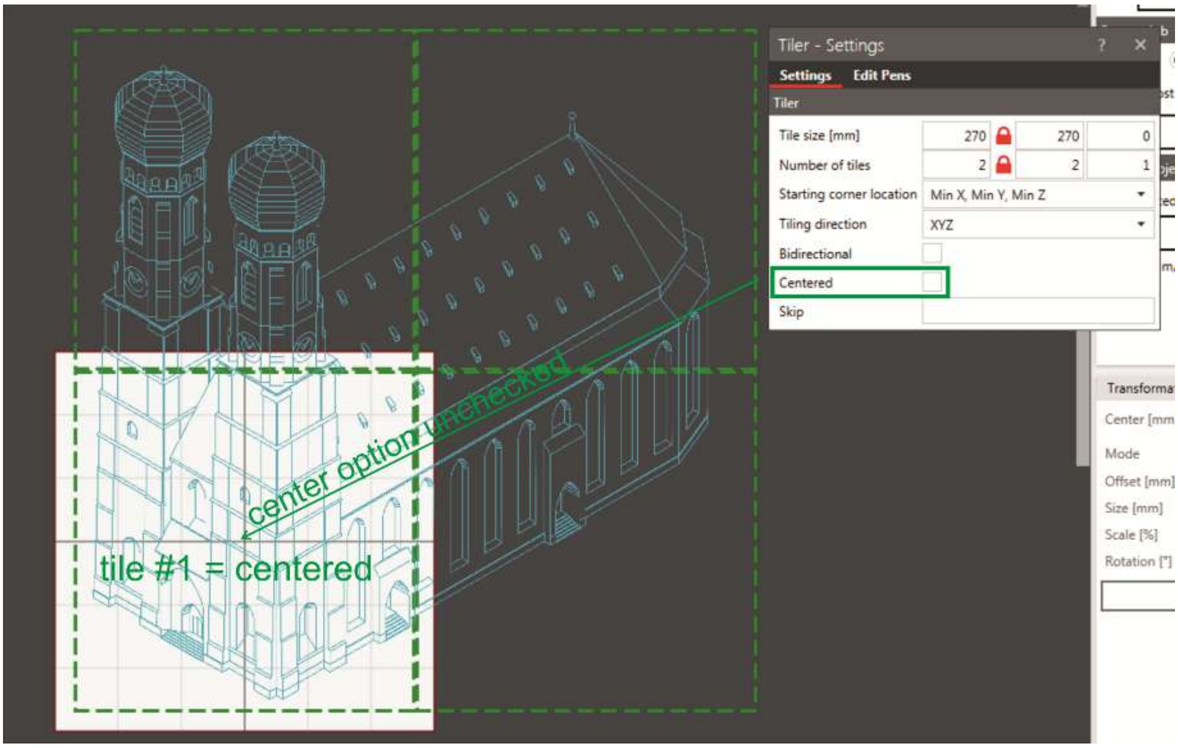


Fig. 7.70: RG-ADK

The segment tiles themselves are processed one after the other. The sequence of processing is determined by setting the starting corner location and the tiling direction.

Examples:

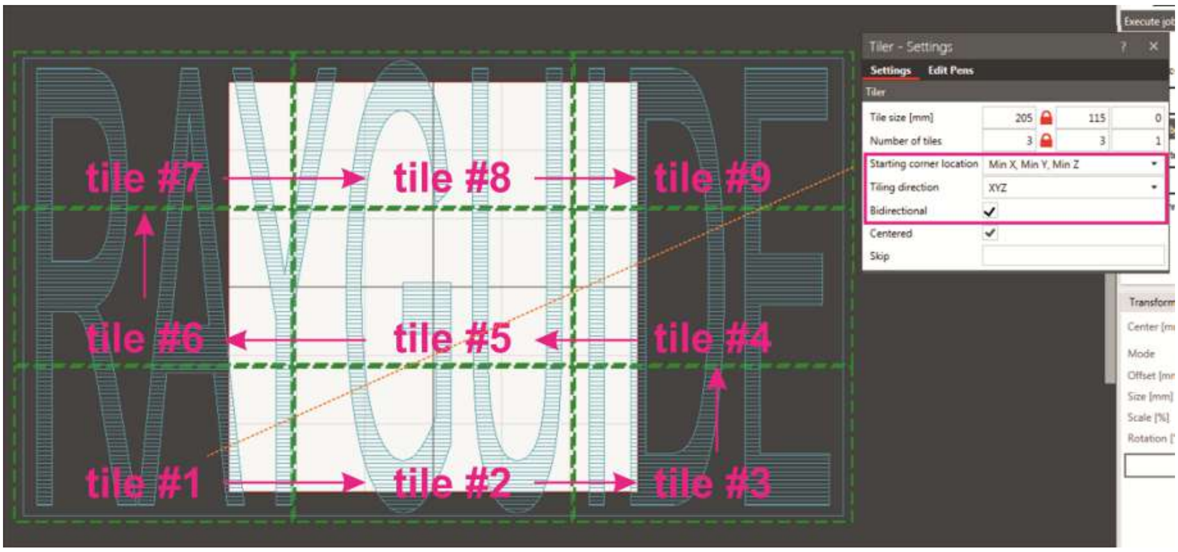


Fig. 7.71: RG-ADL

The segment tiles are processed centered to the workspace.

Recommendations:

- The layout objects to be tiled should be designed, composed and centered 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 synchronize 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 125, 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 FOCUSSHIFTER, 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. 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.
Rotation [°]	Enter the angle in [°] by which the contents of the container should rotate around the center of the container for each z offset. The value is applied equally to all table rows.
General	
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 171, Common Properties of Marking Objects*.

Table. 7.59: 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 Job settings dialog

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:

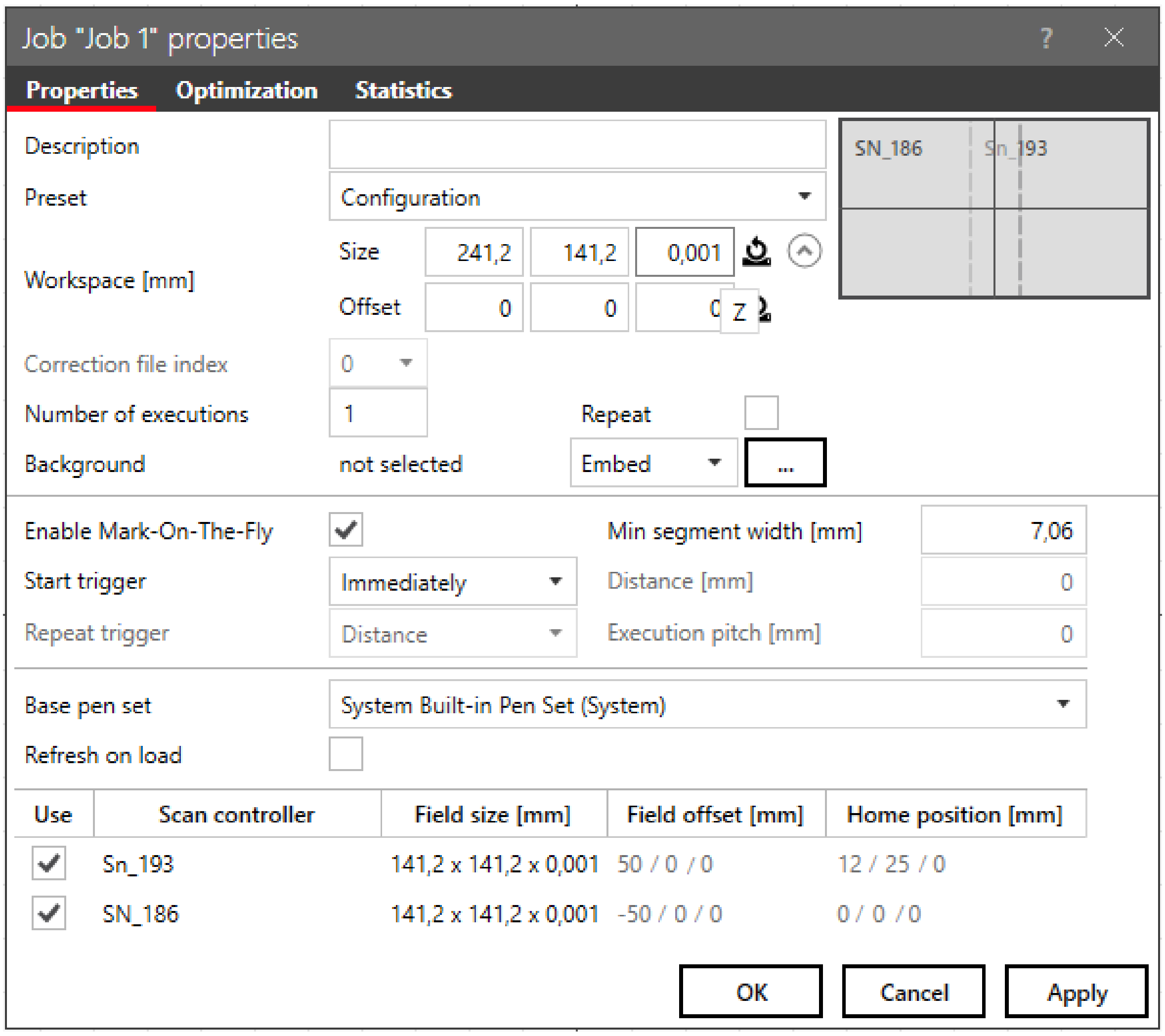


Fig. 7.72: RG-ACP

The following settings always apply to the job currently edited and are stored with it.

Setting	Explanation
Description	Optional label for this setting.
Preset	Select one of the previously stored job preferences (see *page 114, Job Presets*) displayed in the drop-down list. If a workspace configuration is marked as "Default", it is automatically preselected. If you don't want to use any of the stored workspace configurations, select *None*. **NOTE:** If a stored workspace configuration with Mark-On-The-Fly (MOTF) settings is selected, the MOTF setting fields are filled accordingly. **NOTE:** If you change a job preset that is already in use, you can apply these changes using the ***[Reload]*** 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. See also *page 114, Job Presets*.
Workspace	The workspace size of the loaded configuration or the field size provided by the correction file. The expander additionally displays the "Offset" area. The default values come from the FC3 correction file, which primarily defines the zero position for correction files with a Z-range. Enter different workspace dimensions if required.
Correction file index	Define the index of the correction file that is to be active when the execution of the job begins. **NOTE:** The option is only usable if at least one deflection unit has been assigned two correction files in the configuration. See *page 69, General*.
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	Option for inserting an image as a background picture in the workspace. Valid formats are: JPG, JPEG, BMP, PNG, GIF, EXIF. Select: ■ *Embed* if the image is to be saved as part of the job. ■ *Link* if you only want to link the image file to the job locally. **NOTE**: The image is scaled to the size of the workspace in both dimensions. **NOTE**: The opacity of the background image can be set using the opacity slider, which is part of the toolbar. See *page 24, Toolbar*.
Enable Mark-On-The-Fly	For explanations and settings for Mark-On-the-Fly (MOTF), see *page 295, MOTF Jobs*.
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 *page 248, Pen Panel*.
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	List of used / available control cards for this job. If no workspace configuration was loaded, you can edit the selection. If a workspace configuration was loaded, the list is “read only”. 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.

Table. 7.60: RG-053

7.6.2 Optimizations

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

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
General	
Merge vector graphics	For details, see *page 121, Optimizations*.
Join layers	
Workload balance	
Mark-On-The-Fly Segmentation	
Segmentation mode	For details, see *page 302, MOTF Optimizations*.
Max. Width [mm]	
Time [s]	
Sort	
Minimize jump distance	For details, see *page 121, Optimizations*.
By direction	For details, see *page 302, MOTF Optimizations*.
Replace all commands by drill holes 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 *page 121, Optimizations*.
Force corners	
Drill mode	
Pulse / Time	

Table. 7.61: 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]	Accumulated length of all mark vectors of all layout objects, split into contour and filling. **NOTES**: ■ If the job contains bitmaps processed in *Sprint* mode, the bitmap lines are added to the total mark length. ■ The gaps in a dashed line are not subtracted from the mark vector length. ■ Possible wobble geometry is not taken into account.
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]	Accumulated calculated process time considering speed and delay values of all layout objects, split into contour and filling. **NOTE:** The execution time does not include the time consumed by extra Skywriting vector extensions. **NOTE:** The execution time does not take into account if the job execution is split between several control cards.
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	Accumulated number of graphic command points, split into contour and filling. **NOTES**: ■ “Supporting points” are excluded ■ Path start points are excluded This is useful to get an idea at how many points a polygon delay can take effect.
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.

Table. 7.62: 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.

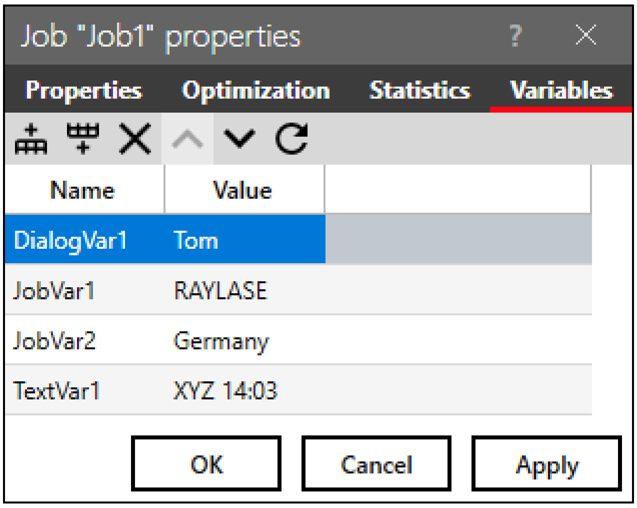


Fig. 7.73: RG-AEX

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 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 control card 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 control card knows the speed of the target material passing by.

The SP-ICE-3 control card 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 control card named "***Part sensor***". This requires a specific port configuration on the SP-ICE-3. Refer to the SP-ICE-3 control card manual for more detailed information on the correct port configuration.

To prepare for execution of an MOTF job, some configuration settings are required:

- Control card 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.

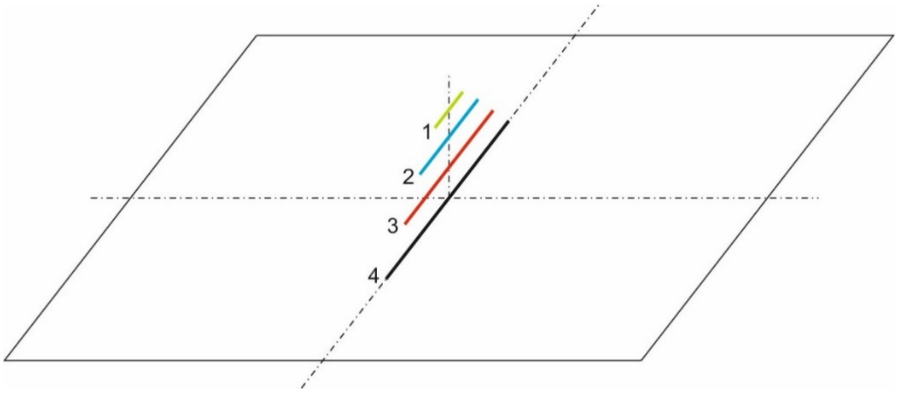
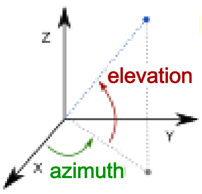
7.7.1 MOTF Settings in Controller Card Configuration

Configure the technical details of the MOTF setup:

- Open the control card configuration and go to the MOTF tab.
- It is also recommended to consult the manual of the control card.

Setting	Explanation
Base *Mark-On-The-Fly* configuration	
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. Knowing this distance and the speed of movement, the control card can determine the exact moment when to start processing the vector list in the scan field. The SP-ICE-3 control card has a part sensor buffer. That means 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.
Debounce part sensor	Enable this option to debounce the sensor, i.e. to ignore any unwanted signals (often signal glitches) for a certain time.
Debounce time [µs]	Debounce time in [µs]
Suppress part sensor	Enable this option to avoid picking up any trigger edges 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 actual detection of the part at the sensor and the arrival of the sensor signal at the control card. For more information on the time required to translate an optical detection into an output signal, for instance, please refer to the specifications for the part sensor.
Jump speed [m/s]	Definition of the relative jump speed of so-called reset jumps. These jumps are made when MOTF tracking is ended or paused or when the system jumps to the next assumed layout position. **NOTE:** Since in conventional MOTF each path is positioned over a belt distance to the other paths, there are no longer any normal jumps between paths in a MOTF marking that use the jump speed(s) of the pens; only the MOTF jump speed is used. Exception: Jumps between paths that are combined into a segment via the minimum segment width.
Margin	Distance in [mm] to offset the earliest possible marking position from the field border towards the field origin. **NOTE:** Any value greater than zero will lead to a shorter processing time of the layout within the remaining field distance.

Setting	Explanation
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.
Endless “Marking-on-the-fly” For details on Endless-MOTF, see *page 309, Endless MOTF*	
Minimum [%]	Lower limit of the range in percent relative to the target speed of the belt / material (as displayed in the Notification panel) in which the marking speed and laser power are readjusted according to the actual belt speed. **NOTE:** The lower limit cannot be less than 1 %
Maximum [%]	Upper limit of the range in percent relative to the target speed of the belt / material (as displayed in the Notification panel) in which the marking speed and laser power are readjusted according to the actual belt speed. **NOTE:** The upper limit cannot exceed 190 %.

Setting	Explanation
***Main encoder* (also for compensation encoder, if activated)**	
Distance per count [µs/ tick]	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 ***[Refresh]*** encoder position, 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”. 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 center, one above the other. The shortest line should be first, the longest line last in the marking order.  Run the job and see if the four lines are marked in the same place (one above the other) and exactly straight in the vertical plane. If the lines are separated and tilted, there is over-compensation or under-compensation of the belt movement. Change the "Distance count impulse" value accordingly and repeat the test until the results are good.
Invert direction	Use if the encoder position value is decreasing instead of increasing although the conveyor belt moves in the desired direction.
Azimuth [°], Elevation [°]  	The two angle specifications indicate how the conveyor runs relative to the coordinate system of the workspace in your application. In most applications, the conveyor moves in the working plane so the vertical angle is 0°, and the horizontal angle is 0°/180°(belt moves along the X axis) 90°/ 270°(belt moves along the Y axis).

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 control card sends an "out of field" exception.
Simulation speed [m/s]	Assumed belt speed in [m/s].
Simulation acceleration [µm/µs²]	Assumed acceleration, if required.
Position [tick]	If the ***[Refresh]*** toggle button is activated, the counter level is constantly updated. The counter is set to zero with the ***[Reset]*** button.
Current speed [m/s]	Display of the determined belt speed via the increments per time (averaged over 1 second).
Status	
Pending parts	Display the number of pending parts of the part sensor buffer. Use ***[Refresh]*** to update the status information. **NOTE:** The part sensor buffer count does not get cleared in case of an abort event. It is cleared every time you start an execution.

Table. 7.63: 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 control card configuration and go to the I/O tab, section: *Special functions – In*

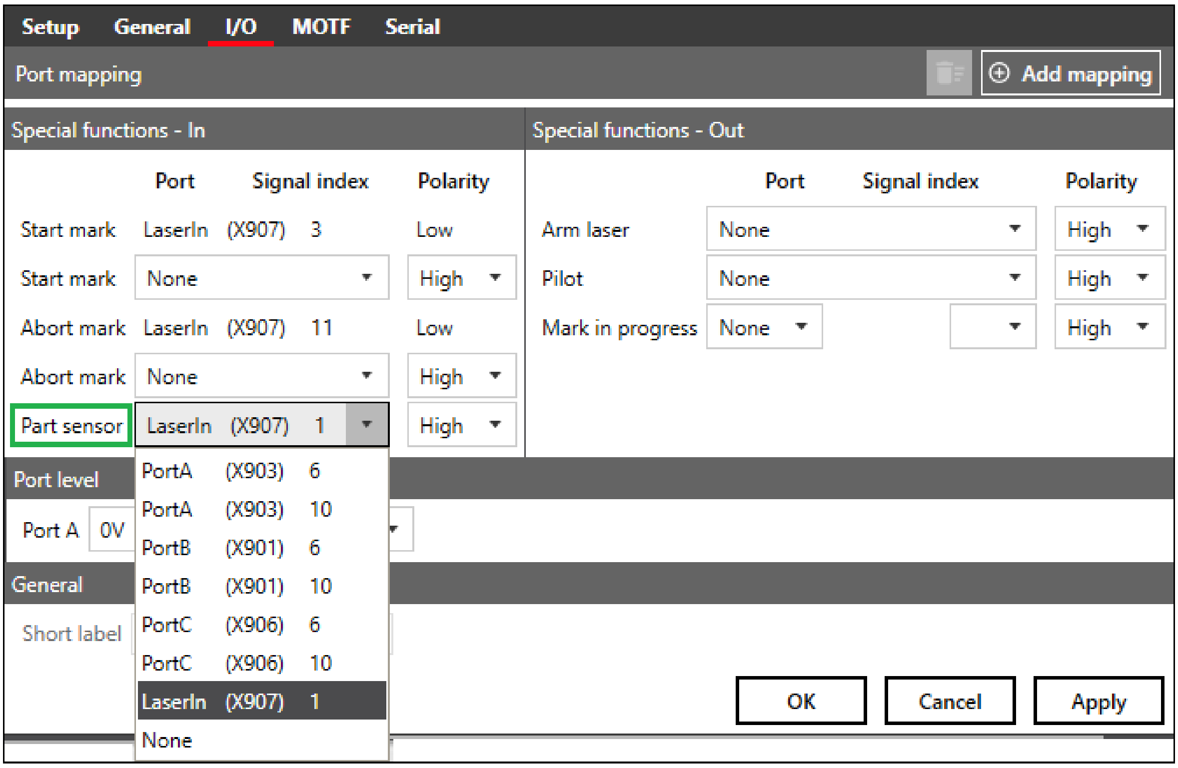


Fig. 7.74: RG-ADG

Remarks

- If the deflection unit moves instead of the one conveyor belt in your hardware setup, then the settings apply in the same way.
- When running MOTF jobs in a scenario with multiple control cards, the settings must be made for each control card.

RULE: It is recommended to run MOTF jobs in *On card* execution mode to ensure immediate response / processing to trigger signals. See *page 316, 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 on ***System*** **>** ***Preferences*** from the menu to open the dialog. Go to the ***System (all users)*** tab and to the ***Workspace*** sub-tab.

Setting	Explanation
Marking-on-the-fly Mode	Select the Marking-on-the-fly variant: ■ *Disabled*: The job is executed without MOTF. ■ *Enabled*: The conventional variant is used. ■ *Endless*: The Endless MOTF variant is used. (For details, see *page 309, Endless MOTF*).
Minimum segment width [mm]	This value defines how far a layout protrudes into the scan field due to the belt movement before processing begins. The value is 5% of the field size by default. In addition, within the segment, reset jumps are omitted. **NOTES:** ■ 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. ■ This value is also used for MOTF processing of bitmaps. 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.
Start trigger	Start the **first** marking after the job was set to the “in process" status. ■ *Immediately*: Processing starts immediately as soon as you start job execution. ■ *Distance***:** Processing waits until the belt has traveled a certain distance. ■ *Part sensor***:** Processing starts on the “part sensor” trigger signal (and considers the part distance).
Distance	Activated when *Start trigger* is set as *Distance.* Enter the distance in [mm]. The first marking must wait until the job execution has started.

Setting	Explanation
Repeat trigger	Define how consecutive parts get triggered: ■ The job is repeated equidistantly. The distance is defined as the execution pitch. ■ The part sensor detects the parts as they pass by. **NOTE**: The SP-ICE-3 control card has a part sensor buffer. That means trigger events can be buffered while a part moves from the sensor into the workspace, making it possible to place the part sensor at any distance from the workspace center.
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.

Table. 7.64: 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 analyzed.

Setting	Explanation
Mark-On-The-Fly Segmentation This option allows MOTF processing of geometries that are significantly longer than the dimensions of the scan field.	
Select Segmentation mode	***By distance*** ■ Uses the "Max. Width [mm]" parameter ■ 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. ***By time*** ■ Uses the "Max. Width [mm]" and "Time [s]" parameters ■ 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. ■ 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. ■ The corresponding value for "Time” indicates how much time the segments may take to process (the segments are divided according to this value).

Setting	Explanation
Sort	
Minimize jump distance	For details, see *page 121, Optimizations*.
By direction & Range	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. (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.) **CAUTION:** Sorting is done per marking object and layer. That means it may be necessary to merge several marking objects into one marking object with one layer with the optimizations under General. The **Range [mm]** 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. **APPLICATION NOTE:** 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 belt direction (e.g. single-line text), a rather small range value is recommended. 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.

Table. 7.65: RG-070

The following images show the jumps to visualize the path process order before and after splitting (with uniform distance) and sorting.

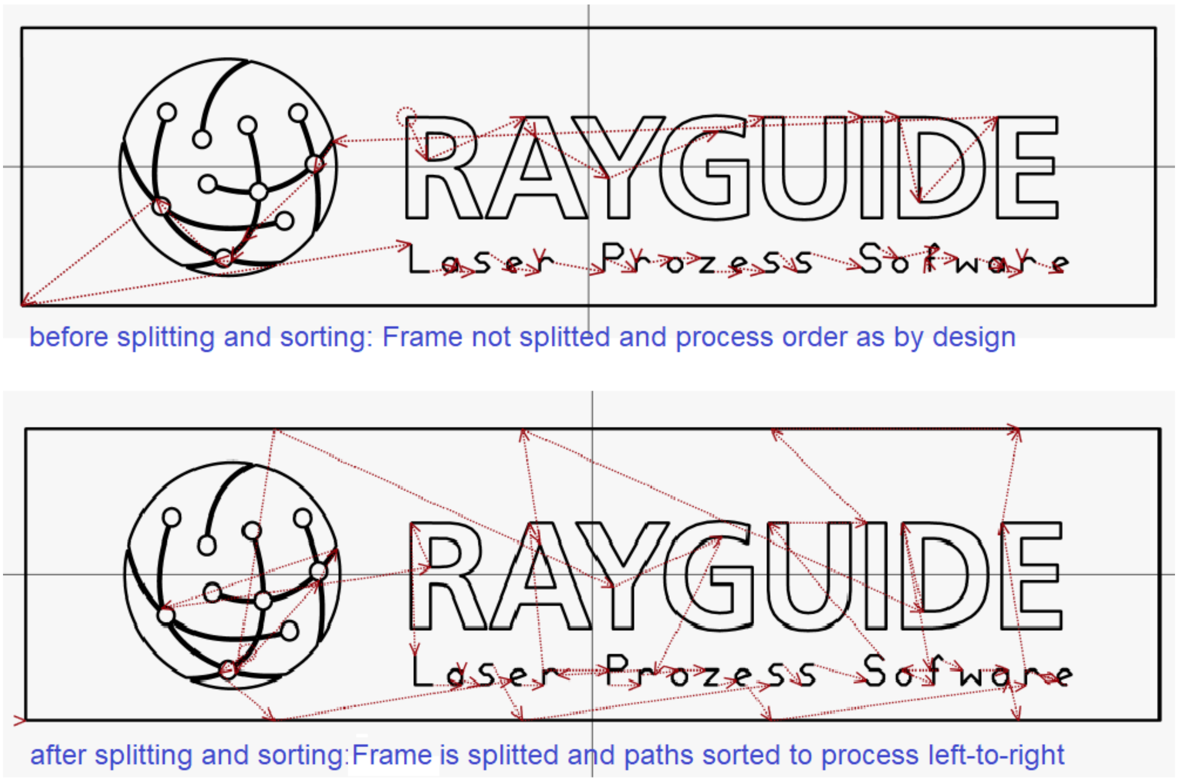


Fig. 7.75: RG-ADR

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 305, MOTF parameter finder*).

NOTE: To visualize 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.
- This circumstance is taken into account for jobs with repeated execution by distance. 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:

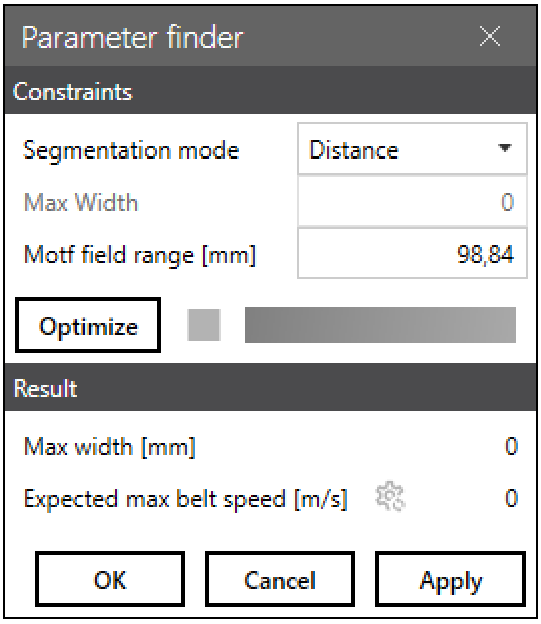


Fig. 7.76: RG-AFB

Setting	Explanation
Constraints	
Segmentation mode	Specify the desired method for splitting. You can choose between distance or time. For details, see *page 302, MOTF Optimizations*.
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. 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.
[Optimize]	Starts the calculation of the optimal parameters for splitting. The process bar shows the progress of the calculation. Use the ***[Cancel]*** button to cancel the calculation if necessary.
Result	
Max. Width [mm] / ***Time*** [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. Tolerances of up to ±2% are to be expected with this value. Use the symbol to transfer the calculated max. belt speed to the simulation encoder of the control card.
[OK] / [Apply]	Transfers the set splitting method and the calculated splitting parameter to the job properties, Optimization tab.

Table. 7.66: 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 114, 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 “space" left inside the scan field for processing.

NOTE: If the job validation for the 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 prevents the “out-of-field” exception message from being issued in cases where paths are processed that are marked faster than their vectors move 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 recognized by the part sensor and the part distance has moved along, but considering the previously mentioned general rule.

The position of the layout object 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 control card measured relative to this reference.

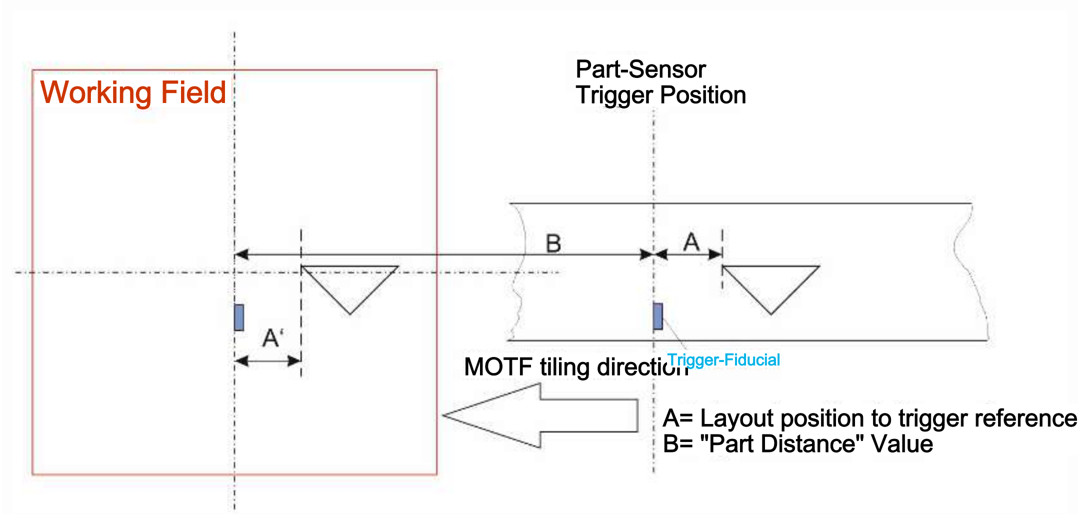


Fig. 7.77: RG-ADD

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.

7.7.7 Endless MOTF

7.7.7.1 Introduction

Endless MOTF is a special way of controlling processing on moving material. Endless MOTF is suitable for continuous markings or cuts where a contour is repeated periodically. A typical application example would be cutting of a battery foil with periodically recurring “tabs”.

Due to the infinite execution, in contrast to conventional MOTF, the sometimes extremely long contour is not split into segments and then joined together.

Instead, the deflection mirrors project a self-contained, “folded” contour, which is then “unfolded” into your desired contour by the belt movement. This prevents unwanted “connection points” as well as interruption of laser emission.

The following **conditions** for the job or job content must be observed:

1. Only one markable job element may be included; its geometry should be repeated periodically on the material.
2. No automation objects or containers may be included
3. The job geometry starts at 90° to the belt axis at the same coordinate as it ends. This is the only way to create a closed geometry in the folded state.
4. The geometry consists of only one path and therefore contains no jumps
5. The pen or pens used do not have active SKYWRITING or power ramps.

7.7.7.2 Execution concept

The main execution of Endless MOTF is performed in a special app on the SP-ICE-3 control card.

The app is not available until firmware version 3.3.2 of the SP-ICE-3 control card.

NOTES for using the app:

- The app has to be activated using the SP-ICE-3 configuration tool.
- The number of permitted connections to the control card must be set to at least 2 or -1 (corresponds to infinite) using the SP-ICE-3 configuration tool.

For details, see the manual of the SP-ICE-3 control card.

This Endless MOTF app “folds” the geometry and calculates the scanning speeds. For each Endless MOTF job, there is exactly one resulting belt speed (target speed) at which the laser power and the marking speed are maintained in line with the specification in the pens.

As it will not be possible to transport the belt / material at exactly this speed in reality, the app records the actual belt speed and regulates the marking speed and laser power accordingly.

However, this regulation only takes place in a range that is defined in the MOTF configuration of the control card. See section *page 296, MOTF Settings in Controller Card Configuration*.

If an actual belt speed is detected that is outside the control range, execution is aborted or not started at all.

NOTES on the process:

1. Create your job geometry according to the specifications.
2. In the job properties, select the "Marking-on-the-fly" "Endless" mode
3. Check that the horizontal angle that the belt direction has relative to the +X axis is entered in the MOTF configuration of the control card (otherwise the list cannot be loaded on the card).
4. Select “On card” mode in the “Execution” panel and load the job onto the card. After the upload, in the ***Notifications*** panel, you get information about the target speed of the belt in [m/s] from the app:

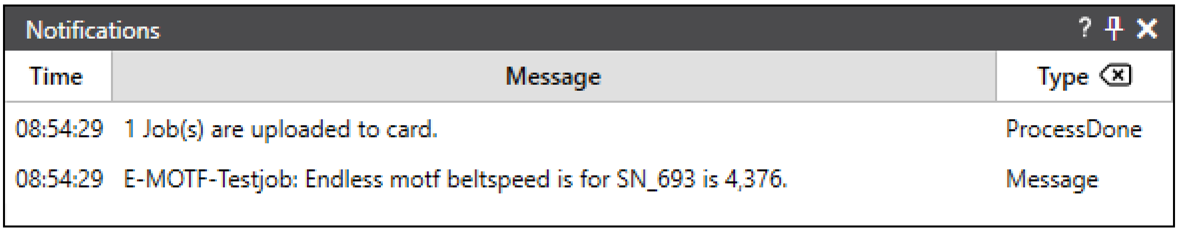


Fig. 7.78: RG-AFQ

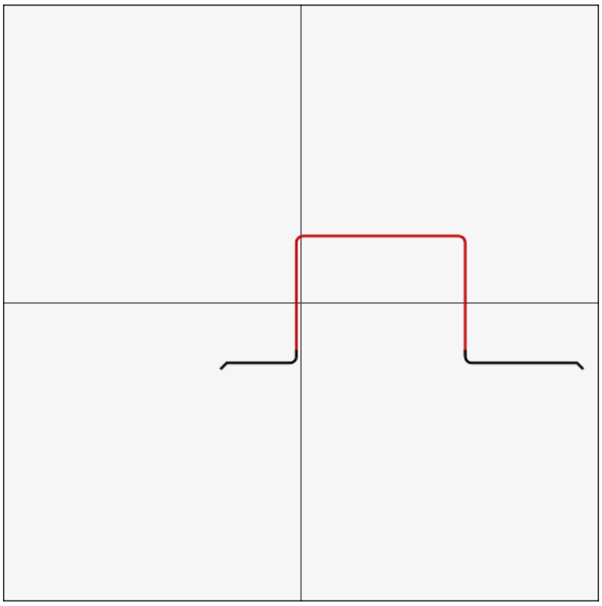
5. Only start execution when the belt speed is at least above the lower limit of the control range.

Additional **NOTES**:

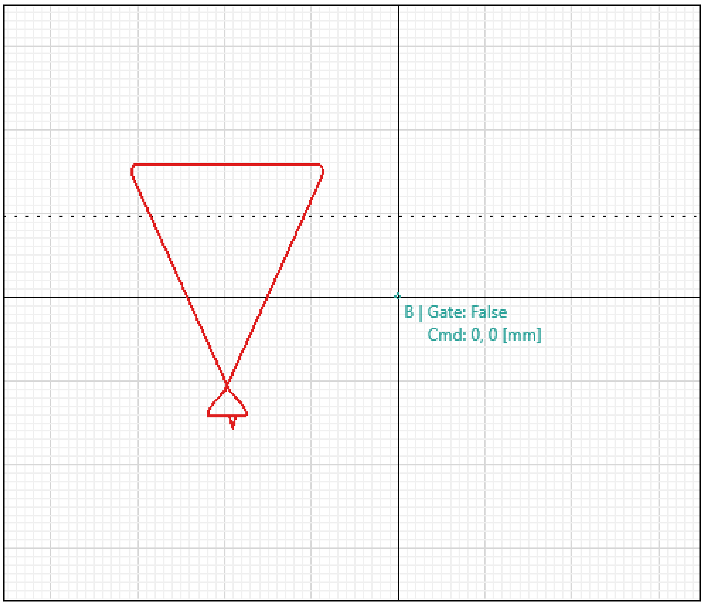
- The execution of Endless MOTF allows for simultaneous use of the compensation encoder.
- The transfer of the job content to the control card is not recorded in the regular card log file.

Example ## Battery tab

a) Original job contour that will be repeated periodically:



b) "Folded" contour that the deflection unit moves along:



c) Result is the "unfolded", repeating contour:

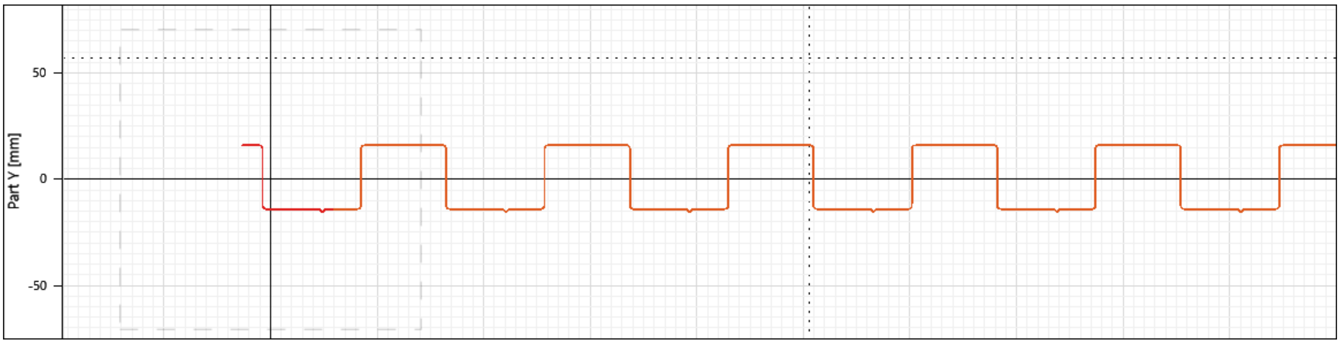


Table. 7.67: RG-101

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 pilot laser and the processing laser are different. This will result in a slight deviation of the deflection caused by different diffraction.

That is why calibrating the pilot laser is recommended.

To calibrate the pilot laser, go to the device calibration of the respective deflection unit, "Preview" section. For details, see *page 74, 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.
- The arrow button between the two calibration sections can be used to transfer the calibration values from the working laser as initial values.
- Save the pilot laser calibration: Click on 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 pilot laser 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 74, Deflection Unit Calibration*.

7.8.1.2 Running a Preview

Go to the Execution panel.

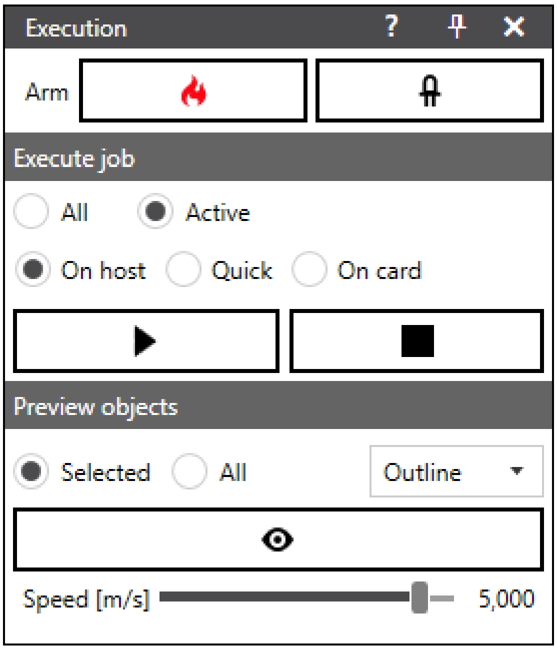


Fig. 7.79: RG-ACQ

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:

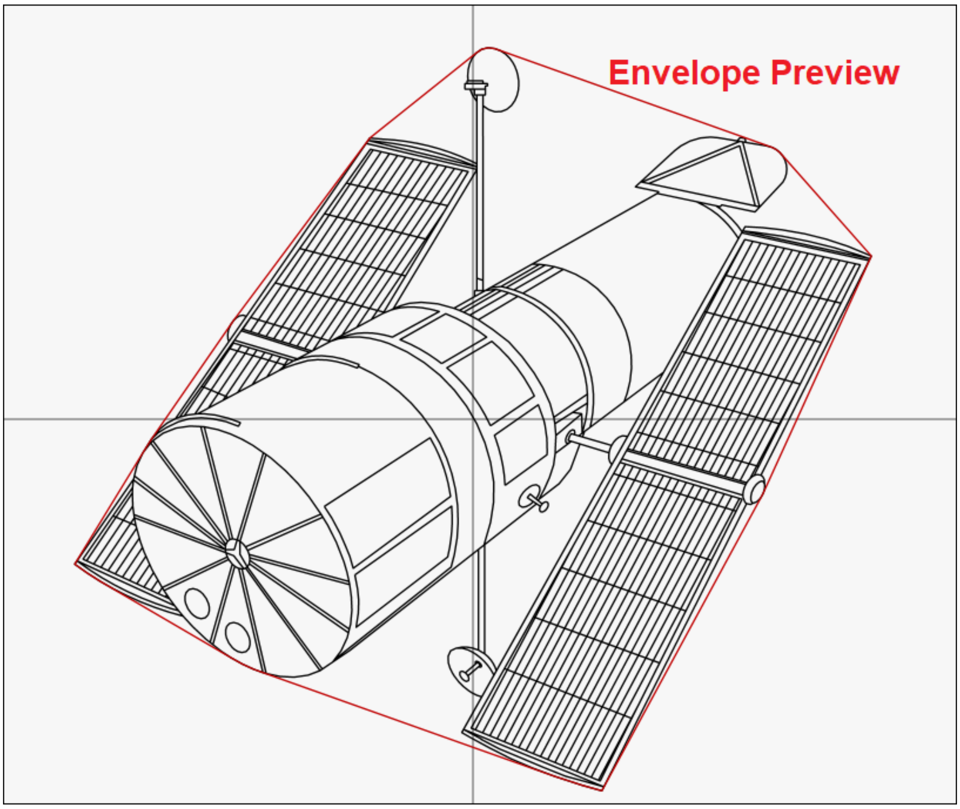


Fig. 7.80: RG-ADO

- *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 pilot laser, click on the ***[Pointer]*** toggle button. The button switches to red:

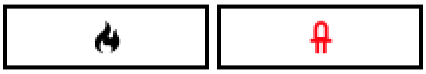


Fig. 7.81: RG-ACR

Then click on the ***[Preview]*** toggle button. It also turns red:

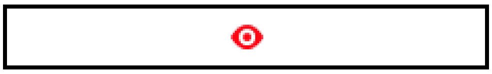


Fig. 7.82: RG-ACS

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. Click on ***[Abort]*** if you want to stop the preview immediately.

Live editing during preview

It is possible to select more / less / other objects, edit and transform the objects, even down to the layers / 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 see that a laser process is active with just one glance at the RAYGUIDE user interface.

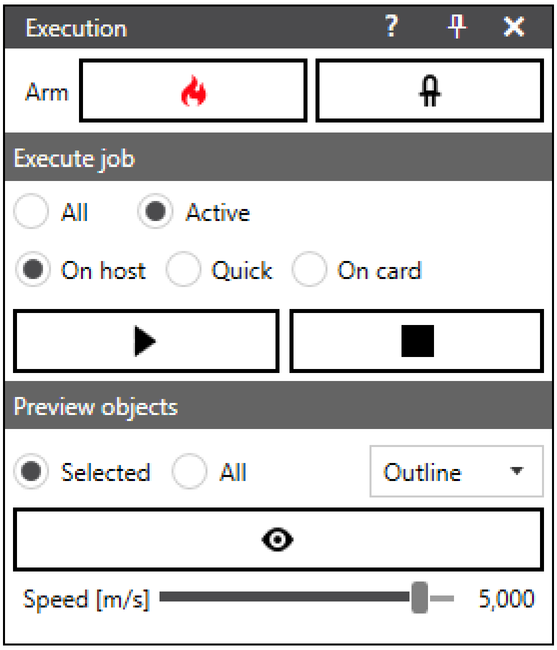


Fig. 7.83: RG-ACT

Job validation

Job validation is a tool to help you prevent 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
Job validation	
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 pen uses the ramping feature. RAYGUIDE checks that the total ramp length exceeds the length of the respective paths.

Table. 7.68: 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 before this time (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.

If multiple jobs are executed in parallel, each job has its own entry in the process monitor and can be stopped individually. See *page 323, 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 control card 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 control card 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.

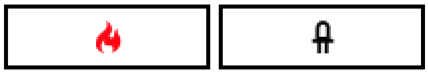


Fig. 7.84: RG-ACU

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 ***[Arm / Disarm]*** toggle buttons 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 pilot laser by means of the automation object (see *page 239, 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 PC:** Execute the complete job with its job settings. After clicking on the ***[Execute]*** button, RAYGUIDE starts sending the data to the control card for execution. To reduce the idle time during data transmission, RAYGUIDE streams the data.
- **Test run:** Use the "Selected" toggle button to execute only the selected layout objects or, if you have not clicked on the button, to execute all layout objects. To execute the job, click on the ***[Execute]*** button – a sub-selection is available here: "Execute" (= default setting) or "*Repeat execution*".

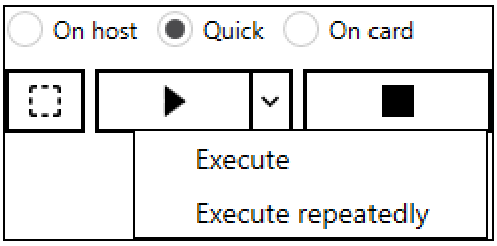


Fig. 7.85: RG-ADB

NOTES:

- Job settings such as job repeat loops are ignored.
- MOTF correction is not used.
- The execution conditions defined for objects are ignored.
- Automation objects are not executed.
- Text and code are not incremented in a repetition 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 control card RAM memory. When all data is transferred, the ***[Run]*** button can be used again.
  Click on ***[Run]*** to execute the job.

NOTE: If you have a job scenario that permits the use of the "All" job option, click on 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 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 job execution and b) re-initialize the control card when you re-open RAYGUIDE in order to get access to the control card.

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
[A]	Arm Laser ON / OFF
[D]	Upload (on-card mode only)
[E]	Pointer ON / OFF
[M]	Mark (all)
[R]	Repeat ON / OFF (quick mark only)
[S]	Mark selected (quick mark only)
[P]	Preview ON / OFF
[X]	[Abort]

Table. 7.69: 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 control card, and all job elements of a job are assigned to the same card.

  This allows the *All* option to be used in the Execution panel in order to execute all jobs in parallel on the assigned control card. Available execution modes: *On PC* or *On card*
- Prerequisite: All open jobs are assigned to the same control card.

  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 control card 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 system design.

<table>
<tr><th>Execution</th><th>Explanation</th></tr>
<tr><td colspan="2">On host</td></tr>
<tr><td>Using an automation object</td><td>The automation object is only executed on the assigned control card.
■ <u>Example 1</u>: Wait for start signal
All control cards wait to continue execution until the trigger signal is received on the assigned control card.
■ <u>Example 2</u>: Writing IO port
Only the assigned control card sets the I/O port. All other control cards wait until the port is set before continuing with their objects.
If you want all involved control cards to write something to the I/O port, you have to duplicate the automation object per control card and assign it accordingly.
In any case, further execution is synchronized by the automation object: This means that the automation object is not executed until each control card has completed the previous process tasks.</td></tr>
<tr><td>Incrementing content</td><td>This case requires special attention when multi-field mode is applied to individual fields:
RULE: RAYGUIDE increments the content per involved control card.
■ <u>Example</u>: You have three control cards assigned and are processing a text object with incrementing serial number:
At the first job iteration, control card 1 will mark 1, control card 2 will mark 2, control card 3 will mark 3.
At the second job iteration, control card 1 will mark 4, control card 2 will mark 5, control card 3 will mark 6.
If you want to have all control cards process the same iteration content, set the value of the “batch parameter” according to the number of assigned control cards.</td></tr>
<tr><td>Job Loop</td><td>The following job repetition starts synchronized: The executing device waits until each control card has finished its task in the previous job repetition.</td></tr>
<tr><td>Abort execution</td><td>If an abort occurs on any of the involved control cards, all control cards stop processing.</td></tr>
</table>

Execution	Explanation
On card	
Using an automation object	RAYGUIDE clones the control card-related automation object for each control card involved. **NOTE**: Automation objects that do not refer to any control card are ignored. An exception to this is the "Time delay" object In order for RAYGUIDE to do this, the necessary ports must be configured for each control card involved – with identical IDs / descriptions for the ports.
Job Loop	As there is no crosslink between the control cards, the loop execution of the control cards involved is not synchronized.
Abort execution	As there is no crosslink between the control cards, only the control card at which the abort occurs stops the execution.

Table. 7.70: RG-058

7.8.3 Process Monitor

The process monitor is a panel under the viewport. It provides useful information after job execution has been started.

Example:

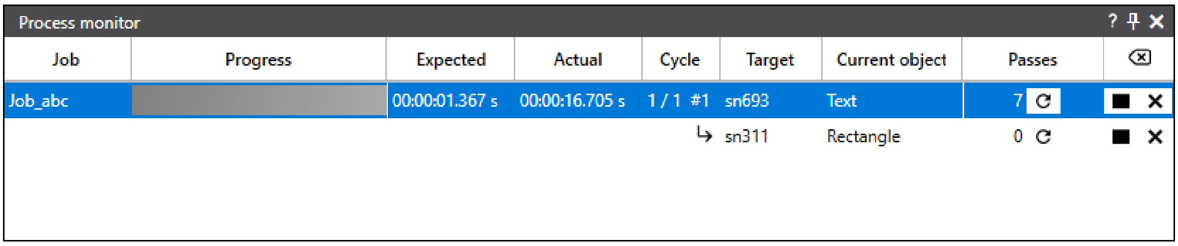


Fig. 7.86: RG-ACV

The process monitor lists all jobs that are executed while RAYGUIDE is open unless you delete a single entry or all entries manually.

If the same job is executed several times in succession, the existing entry is updated and the counter in the cycle column moves up. The last job 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	A dynamic status bar to view the current state of progress. If the job is interrupted for some reason (intentional or after an error), the progress bar stops, too. If the job is to be repeated for a number of times, the progress bar reflects the overall progress. If the job is to be executed in an endless loop: The progress bar restarts with each loop if the time span for job execution is more than five seconds. The progress bar stops when the first cycle is completed if the job execution time is shorter than five seconds. However, the timer will continue counting. Color coding: ■ Gray bar: The job is executed again ■ Green bar: The job has been completely executed ■ Red bar: The job was aborted by the user or due to an error message. If a job is processed by multiple control cards, the progress still refers to the entire job status as such.

Info	Explanation
Expected	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. **NOTE**: 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.
Actual	Actual process time **NOTE**: 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.
Cycle	Counter for displaying the performed job executions / the number of specified job executions. The pound sign is followed by the number of started job executions. **NOTE:** Both counters only work in execution types “On PC” and “Test run". **NOTE:** The "Start execution counter" is only reset when the entry is deleted in the process monitor.
Target	Display all control cards linked to the current job itemized according to their labels.
Current object	Display the current or last processed object per involved control card. **NOTE:** The object name is only displayed if the execution is in the *On PC* or *Test run* mode. **NOTE:** When a tiler container is used, the segment tile coordinate is shown.

Info	Explanation
Iterations	Display of object executions. **NOTE:** The display of object pass counter only works for objects with a sequence using an infinite number of passes. The display can be activated during execution using the ***[Refresh]*** button, or this happens at the latest when the infinite execution is aborted. **NOTE:** The terminated pass is not counted.
[Abort]	Button to abort a specific job, in case several jobs are executed in parallel.
[Clear] [12] / ***[Clear all]***	Clear individual / all entry(ies) from the process monitor list.

Table. 7.71: RG-060

The columns displayed in the Process monitor panel can be adjusted.

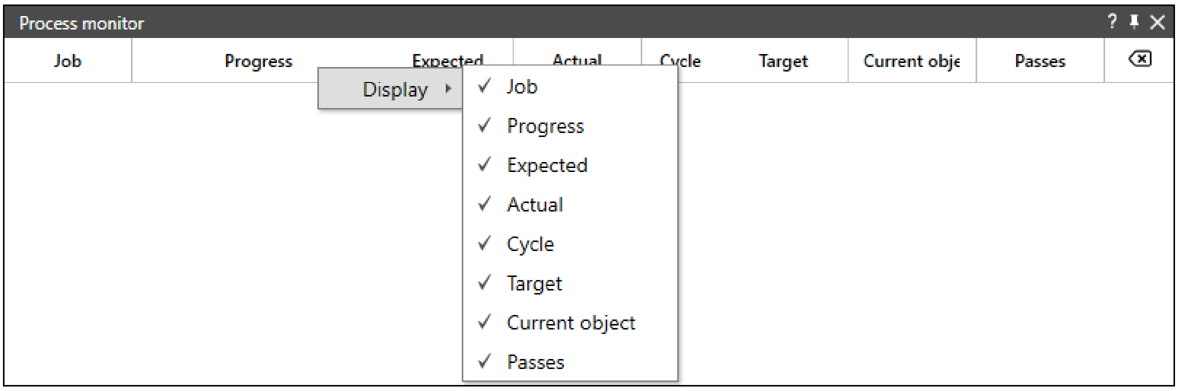


Fig. 7.87: RG-AGM

Right-click in the column header area and the following menu appears. Select or deselect the columns to be displayed in the list.

12 **NOTE:** Per target

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 control card. Possible error sources can be the control card 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 control card.

NOTE: An error reaction only takes place if a job is being actively executed. This also includes an active preview.

Click on ***System > Error handling*** from the menu to open the Error handling dialog.

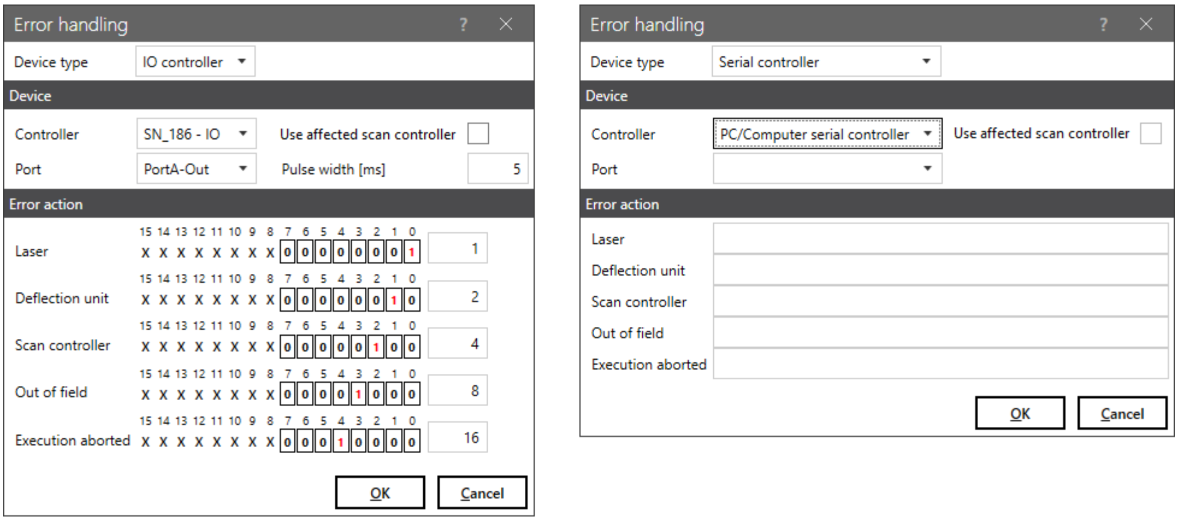


Fig. 7.88: RG-ADW

Setting	Explanation
Device Type	Select which of the available communication interfaces is to be used. Currently, the I/O interface or a serial interface is available.
Controller	Specify the control card on which the interface is physically located.
Use affected control card	If several control cards are used, the error information can only be output on one control card. If this option is set, the error information is output on the control card on which the error was registered.
Port	Select the desired and preconfigured port on the selected control card. **NOTE:** When using the *Use affected control card* option, the IO ports of the affected control cards must all have the same name (same ID).
Pulse width [µs]	If the I/O interface was selected as the device type, enter the pulse width for a signal pulse for event-based errors here.

Setting	Explanation
Error Action	Define a different signal pattern or a command line for each individual error reason (prerequisite: There is an error status for the laser and the deflection unit). This means that the corresponding signal is set to active and is not canceled until the error status has been rectified or cleared. **NOTE on the laser:** The error status must be cleared manually by opening the device dialog of the laser once. **NOTE on the deflection unit:** Here, the error condition is cleared automatically if the deflection unit monitoring no longer evaluates an error condition from the deflection unit. All other errors are event-based, meaning they only result in a signal pulse. **NOTE:** All non-selected bits are set to non-active by default. ■ *Laser:* Reacts when the connected laser source reports a malfunction. **NOTE:** Some lasers may report various error conditions, but they are combined into one error condition on the SP-ICE-3 control card. ■ *Deflection unit:* Reacts when the scan head monitoring is set active and the number of consecutive errors is exceeded. For details, see *page 50, General*. ■ *Control card:* Reacts when the control card outputs an exception, apart from the special exceptions mentioned below. ■ *Outside the field:* Reacts when the card notifies vectors for processing that exceed the field size. (Separated control error condition) Can usually occur during an MOTF job execution. ■ *Execution aborted:* Reacts when either the user presses an abort button or when an external stop signal is detected on the control card (separated control card error condition).

Table. 7.72: 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 control card memory. All job information is stored in a list on the control card and remains stored even if the control card is powered down.

When the control card 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 control card 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 control card must have the “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:

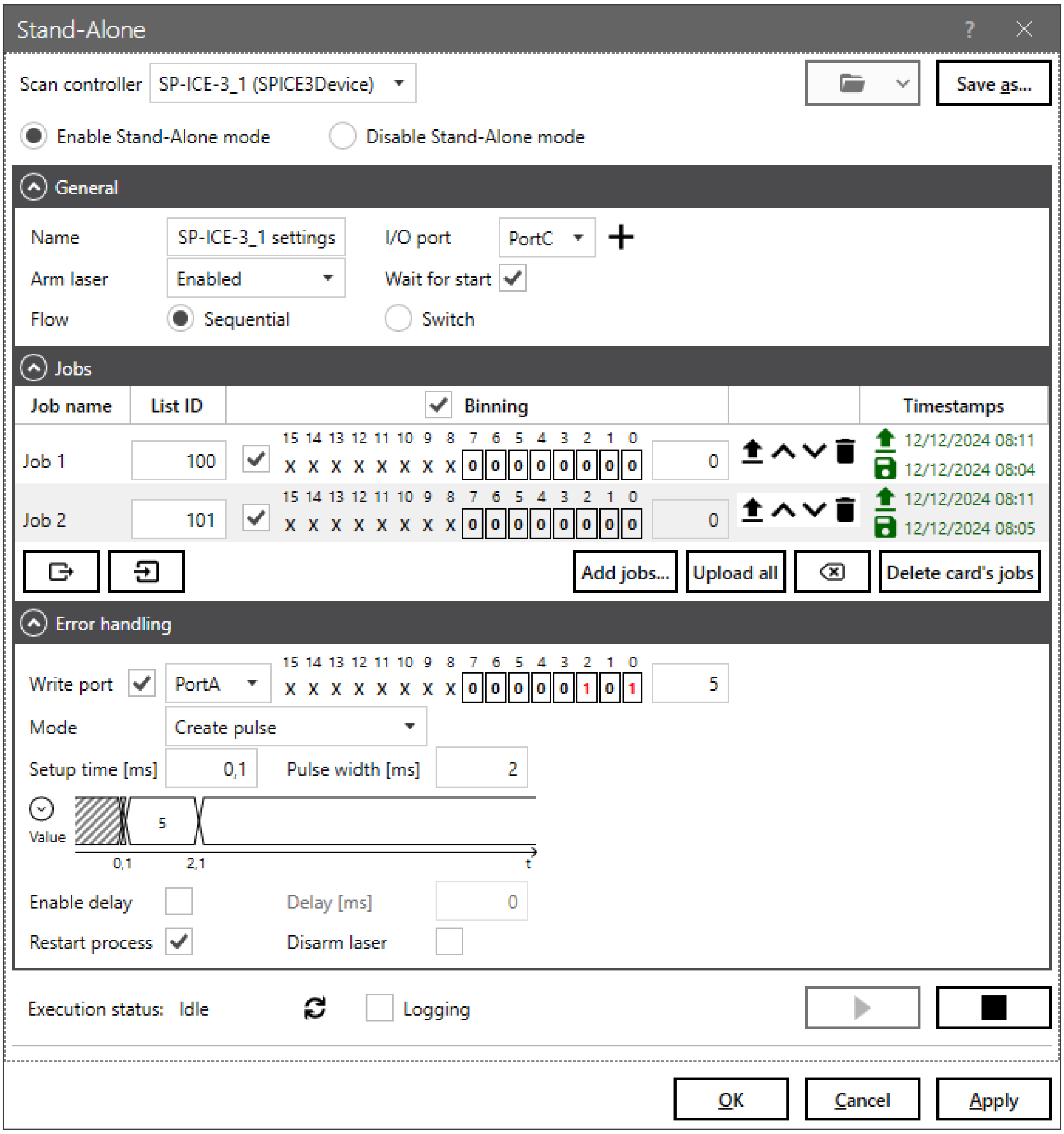


Fig. 7.89: RG-ACW

The stand-alone mode dialog offers all options to prepare the control card 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 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 other control cards.

Settings

Setting	Explanation
Card	Select the control card 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. Press ***[Apply]*** or ***[OK]*** to transmit the stand-alone configuration to the selected control card. Select "Disable Stand-Alone mode" and press ***[Apply]*** or ***[OK]*** to leave *stand-Alone mode*. The control card is enabled for operation via the RAYGUIDE user interface or the API application.
General	
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 is expected. This technique is called "binning". An input port may also have to be defined in the control card configuration. Use the ***[+]*** shortcut button to open the respective control card configuration dialog directly and add an I/O port. For details on control card I/O port definitions, see *page 46, Scan Controller Configuration*, I/O tab.
Arm Laser	In principle, it makes sense for the laser to be armed automatically (in the master list) in stand-alone control card mode. That is why the selection is *Enabled* by default. Alternatively, this option can be deactivated in order to arm the laser only from the job list, for instance. Another alternative is the *double edge*. This is required, for instance, when using a TruPulse nano laser to ensure that possible error statuses have been cleared.

Setting	Explanation
Wait for external start	This option determines that the processing of the jobs can only start after a start signal was detected on the respective control card. **NOTE**: Without a wait condition, the jobs run in an infinite loop as soon as stand-alone mode is activated.
Flow	Choose *Sequential* if the jobs are to be executed as arranged in the list. Individual binning conditions are optional. Choose *Switch* if the jobs have individual binning conditions. The job sequence is then determined by the conditions. To set individual binning conditions, activate the *Binning* option in the Jobs section (see below) and set the available bit range to the specific signal pattern. The main difference between the *Sequential* and *Switch* options is: ■ Sequential: More lists can be executed per loop. ■ Switch: The list that matches the binning conditions is executed. Each binning condition must be unique (i.e. it occurs only once).
Jobs	
List ID	ID of the job in the job list. IDs can be edited if required. The list ID number is allocated by RAYGUIDE. If you want to change the list ID number, note that only numbers above 100 are allowed.
Binning	Enable *Binning* to define the binning conditions per job. The top binning tab enables / disables the binning per job. If *Flow* is set to *Single job*, each job must have a binning condition, and the binning condition must be unique. If *Flow* is set to *Sequential*, each job can, but does not have to, have a binning condition. The binning condition can be set by toggling individual bits (0/1), or by entering the corresponding numerical value. Alternatively, you can import the binning conditions from a *.csv table.

Setting	Explanation
Individual job icons	■ Upload a single job. ■ Press the arrow pointing up or down to change the order of the jobs in the list. ■ Click on ***[Delete]*** to immediately remove a single job entry from the stand-alone mode dialog.
Timestamps	■ The lower entry shows the timestamp from when the job file was saved (shown as soon as the job is added to the dialog). ■ The upper entry shows the timestamp from when the job was uploaded to the control card (shown shortly after uploading). ■ 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. **NOTE**: This can only work if you always save the job to the same folder location.
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.
Import CSV	Import the job list in CSV format, mainly to load the data entered in the CSV table for binning. **NOTE:** 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.
[Add jobs...]	Open a browser window to select one or multiple jobs to be added to the stand-alone mode list.
[Upload all]	Transmit all listed jobs to the control card.
	Immediately clear all listed jobs of the current stand-alone configuration from the dialog and also delete the job lists from corresponding control card after pressing ***[Apply].***
[Delete card`s jobs]	Delete all jobs/lists out of the control card memory that were previously uploaded to the control card.

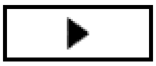
Setting	Explanation
Error handling In case a list execution aborts, a specific behavior can be defined. An error event can be caused by a laser or deflection unit error, by a control card exception, or by an intended stop signal from the control card that is received by the control card.	
Write on port	Select a specific output port and define a bit pattern to be communicated. The output port must be defined in advance in the control card configuration. See *page 46, Scan Controller Configuration* for details on control card I/O port definitions.
Mode & Timing	Same options as for the write port object. See *page 237, Write Port*.
Enable delay & Delay [ms]	Define the delay time to wait before the next trigger is accepted after an error event. **NOTE**: The delay timer starts after the I/O port pulse if this has been defined.
Restart process	After an error, the entire stand-alone mode returns to the initial wait condition. This is important so that operation can continue after an abort without the need to reboot the control card. **NOTE:** This option is active by default.
Disarm laser	Select this option if you want to ensure that the laser is disarmed in the event of an error (including termination).
Stand-Alone execution	
Logging	If activated, the *RAYGUIDE_StandAlone.log* log file is written as soon as execution is started. For details on the log file, see *page 374, Log Files*.
	Start execution of stand-alone mode. The status display changes from *Idle* to *In progress.* **NOTE:** When execution is started, the so-called “master list” is automatically active, even if the actual job execution is still waiting for a trigger signal. This “master list” also automatically arms the laser so that it can emit power immediately after receiving a trigger signal.
	Stop the execution of stand-alone mode. The status display changes from *In progress* to *Idle.*

Table. 7.73: RG-061

Workflow recommendation for job execution in stand-alone mode

To prepare a stand-alone execution, follow these steps in the Stand-alone mode dialog:

1. Select the control card.
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 timestamps to ensure that all jobs are up-to-date.
7. Define workflow control, binning conditions, error handling.
   It is highly recommended to enable “**Wait for signal start**” and "***Restart process***”.
8. Press ***[Apply]*** > Now the control card is ready to operate in stand-alone mode.
   NOTE: Indicated by an orange icon in front of the control card 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 initialize execution on the control card, for example, for testing.

   The execution status changes from *Idle* to *In progress.*

Alternatively, close the RAYGUIDE application. As soon as you reboot the control card, the stand-alone configuration is automatically activated.

To use an already existing stand-alone configuration, for example, to prepare another control card, proceed with the following workflow:

1. Select the control card.
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. Click on ***[Apply].***

Editing the configuration while stand-alone mode is active

You can only edit the currently displayed stand-alone configuration while Stand-alone mode is active and execution has the *Idle* status: We therefore recommend ***[stopping]*** processing. To apply the changes, do not forget to click on 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:

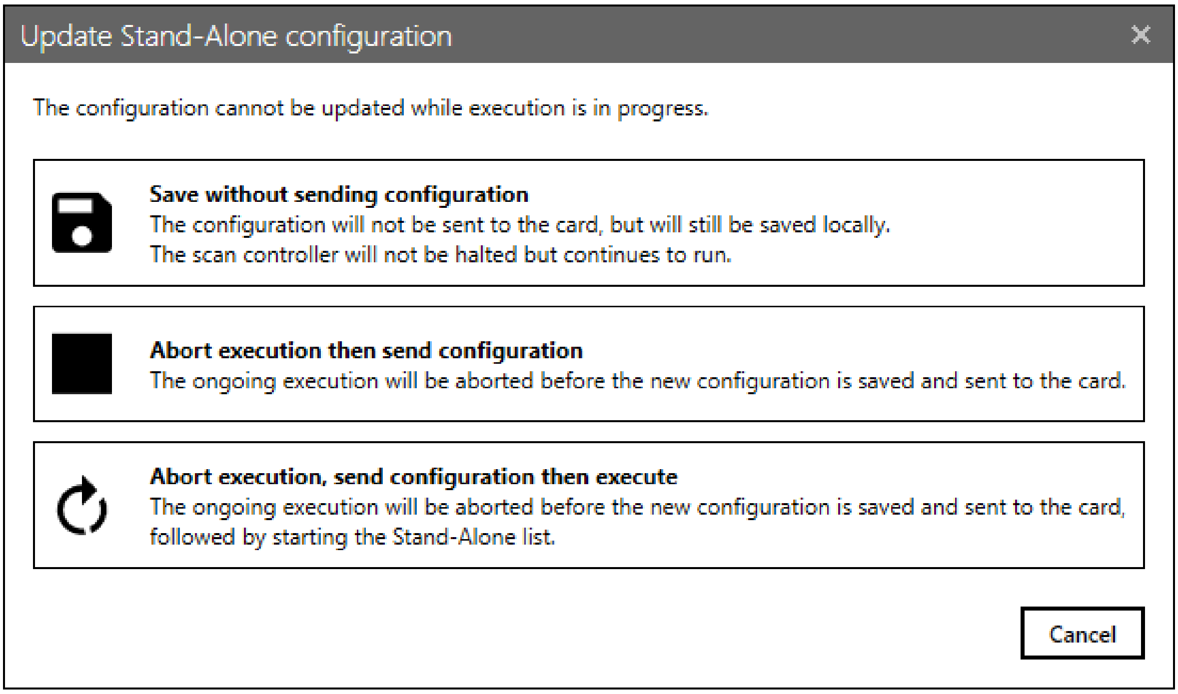


Fig. 7.90: RG-ADE

If you click on ***[Apply]*** to confirm the stand-alone configuration, but there are jobs which are out-of-date or not even uploaded to the control card, the following dialog reminds you and prompts you to upload these jobs before running the stand-alone configuration.

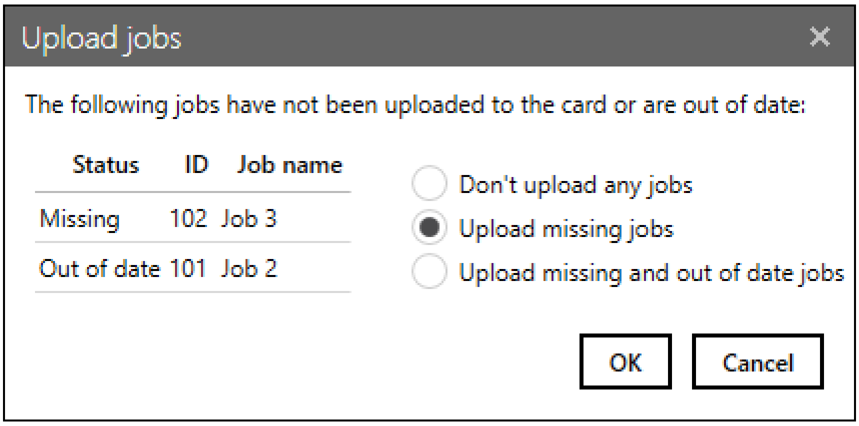


Fig. 7.91: RG-ADF

Terminating stand-alone mode

A control card operating in stand-alone mode is inaccessible by any other application (indicated by the orange control card button in the job overview). That means you must first deactivate stand-alone mode to release the control card for RAYGUIDE.

1. Open the stand-alone mode dialog.
2. Press the ***[Stop]*** button to abort execution of the stand-alone "master list".
3. Enable “Stand-alone mode”.
4. Click on ***[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 control card 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.

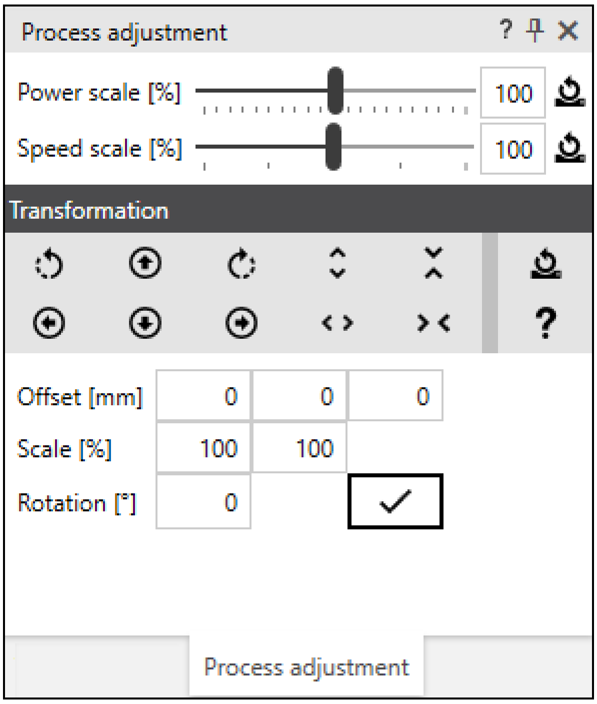


Fig. 7.92: RG-ACX

The process adjustment settings apply to the active job and its control card(s). If a job has several control cards integrated, an additional selection option appears in the panel:

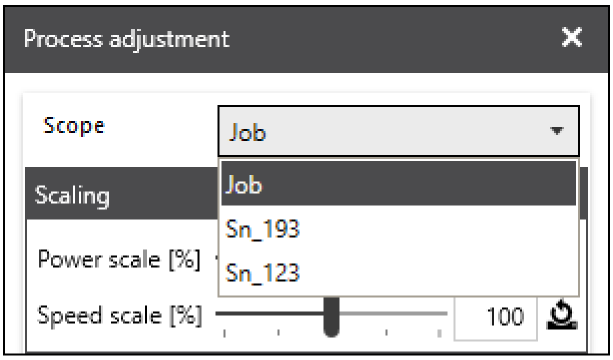


Fig. 7.93: RG-AEW

Via *Scope* you define whether all control cards involved in the job get the parameters for the process adjustment or only one explicitly selected control card.

NOTE: If you select *Job*, the process transformation is automatically converted for the individual control cards 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 process) and is only reset according to the specifications as described in *page 90, General*.
- The process adjustment is also effective if the job is executed in *On card* mode or in 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
Process adjustment 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%. **NOTE**: 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%. **NOTE**: The speed scale is relative to mark / jump speed defined for the respective pen.
Transformation The behavior 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. If the value is entered directly, then press the ***[Check]*** button to apply the value(s). **NOTE:** Compared to the buttons, an offset in the z-direction can also be defined.

Table. 7.74: RG-062

Related preset: Power and speed limits

It is possible to limit the range in which adjustments to the laser power and speed can be made 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.

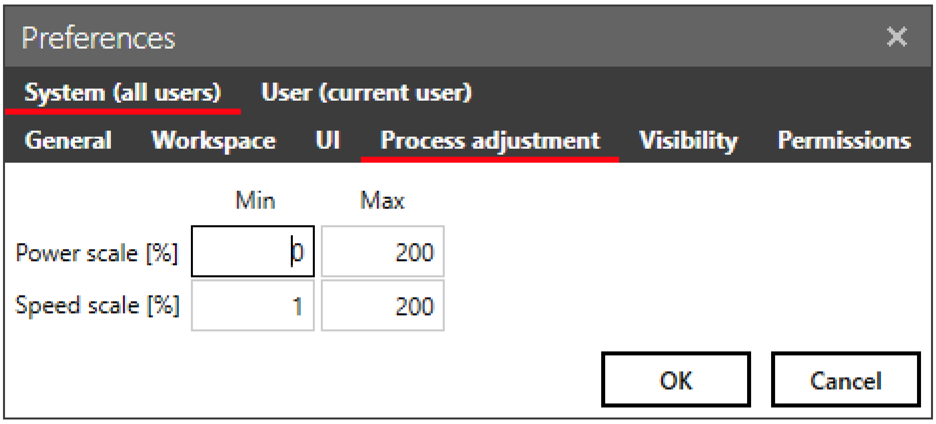


Fig. 7.94: RG-ACY

Setting	Explanation
Power scale [%] Min/Max	Restricts the range in which the adjustment of the laser power in [%] can be set. 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. Check the mark / jump speed settings for the used pens and the threshold of the deflection unit to define suitable limitations. Any settings shall take the laser capabilities into account.

Table. 7.75: 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.

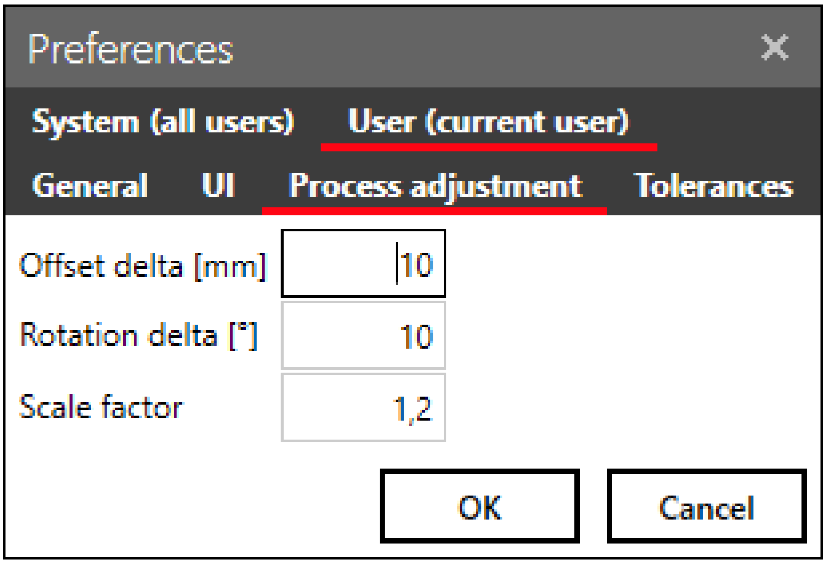


Fig. 7.95: RG-ACZ

Setting	Explanation
Offset delta [mm]	Defines how many [mm] an object is offset when clicking a ***[Move]*** button on the Process adjustment panel.
Rotation delta [°]	Defines how many degrees an object is rotated when clicking the ***[Rotation]*** button on the Process adjustment panel.
Scale factor	Scale factor in [%] when clicking the ***[Size]*** buttons on the Process adjustment panel.

Table. 7.76: RG-064

Reset options

IMPORTANT: There is no automatic reset of the values set here as they are stored in the control card! 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, Initialization section.

- Select event for the transformation and scaling settings an define when they will be automatically reset:
  - *At software startup*
  - *At start of processing (execution)*
  - *Never*

8 RAYLASE PLUG-INS

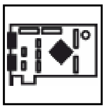
RAYLASE offers specially developed plug-ins for various purposes.

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 for installation so they will then be 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 control card. It contains all the communication to the control card, including all vectors contained in the jobs that were downloaded to the control card 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 373, 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 46, 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 *C:\ProgramData\RAYLASE\RAYGUIDE\Logs*.
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 import. The entry is made in the same format as the entry in the log file. However, the year is left out: 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 control card.
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 in the center of 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.

Table. 8.1: RG-065

Additional settings

- For general settings for all marking objects, see *page 171, Common Properties of Marking Objects*.
- For transformations, see *page 190, Object Transformation*.

8.2 weldMARK job importer plug-in

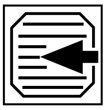
This paid plug-in allows loading of certain version 3.6 weldMARK jobs in RAYGUIDE. Please contact your RAYLASE sales representative if you would like to use this plug-in.

8.3 Solar wafer

The aim of this plug-in is to import and optimize 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 optimization

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 recognized. Any remaining vectors are appended after the dashed line vectors. The lines are processed bidirectionally.

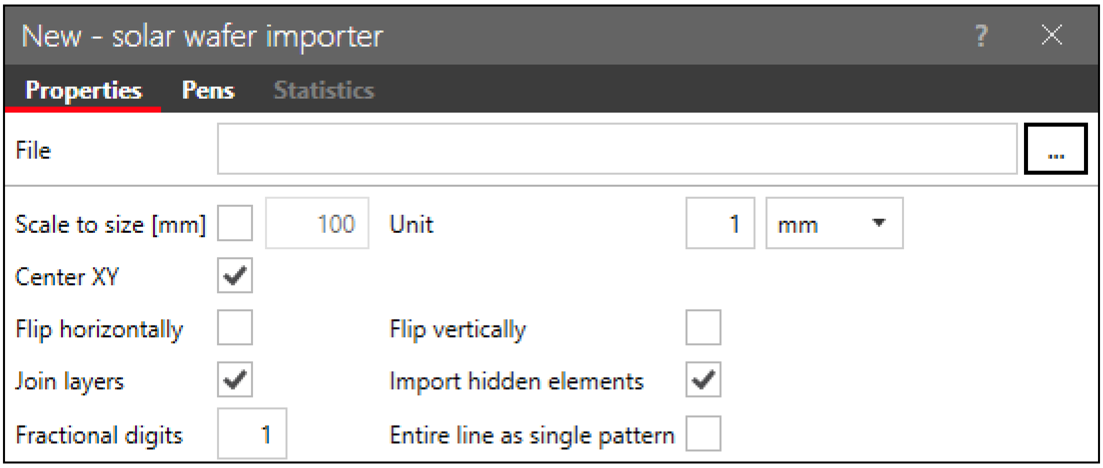


Fig. 8.1: RG-AEZ

Setting	Explanation
File	Opens a file browser to navigate to the graphic file you want to import. After selecting the file, click ***[Open]*** in the browser and the preview displays the file content. Supported file formats are: DXF, PLT, SVG, DWG, CGM, HPGL, GBR, CSV, TXT.
Scale to size	Activate to scale the size of the imported graphic to the specified size in [mm].

Setting	Explanation
Unit	Defines the unit of the imported vectors. Select from [mm], [µm] and [inch]. ■ Value = 1: Normal case (without scaling). ■ Value ≠ 1: also applies a scale factor. **NOTE:** Only applicable if *Scale to size* scaling is not used.
Center XY	Incorporates the vector graphic centered 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 layers	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 you want to import them anyway.
Fractional digits	Defines the accuracy of checks as to whether individual vector strokes are in the same horizontal or vertical line or not. The fewer decimal places related to [µm] are considered, the more tolerant the algorithm is to positional inaccuracies of the vector coordinates.
Entire line as single pattern	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). This means that patterns with strokes or gaps of unequal length can also be converted. **NOTE:** Using this option may result in a larger required number of pens to illustrate all horizontal lines of the wafer.

Table. 8.2: RG-102

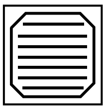
NOTE on pen use

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 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.

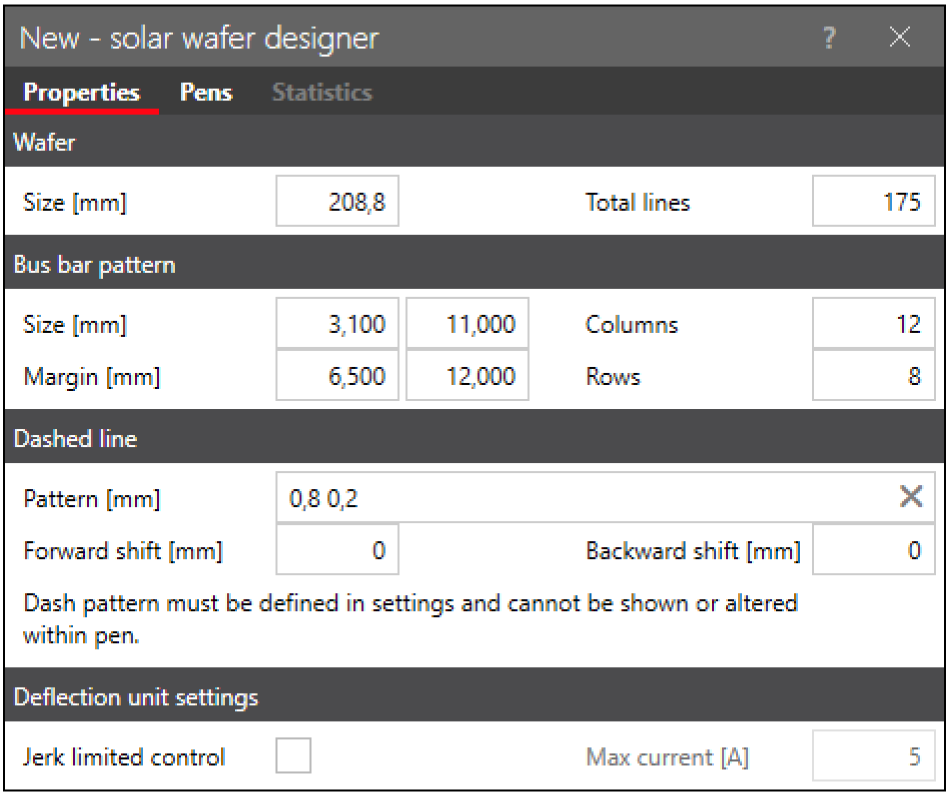


Fig. 8.2: RG-ADP

Setting	Explanation
Wafer	
Size	Size of the wafer square in [mm]. **IMPORTANT NOTE:** Do not perform any object transformations (e.g. 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.
“Bus bar” pattern	
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".
Dashed line	
Pattern	The dashed line pattern is defined by entering length values for laser on / off. Enter at least two numbers. The first value defines a dash to start the pattern. Separate values for dash / gap with blanks. **IMPORTANT NOTE:** 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]. Shifts the dashed pattern for all lines that are marked from left to right.
Backward shift	Distance in [mm]. Shifts the dashed pattern for all lines that are marked from right to left.

Setting	Explanation
Deflection unit settings	
Jerk limited control	The jerk-limited control enables optimal acceleration and takes into account a maximum jerk value, leading to smooth command signals. In particular, this improves the behavior 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.) **NOTE:** 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.
Max. current [A]	Input of the maximum permissible current for the galvanometer scanners, between 3 A and 9 A. In this optimization, the specification of the current value sets the focus between the increase in accuracy and the increase in dynamics. **RULE:** The lower the current value, the higher the accuracy, with extension of the acceleration time. The inverse applies for a high current.

Table. 8.3: RG-071

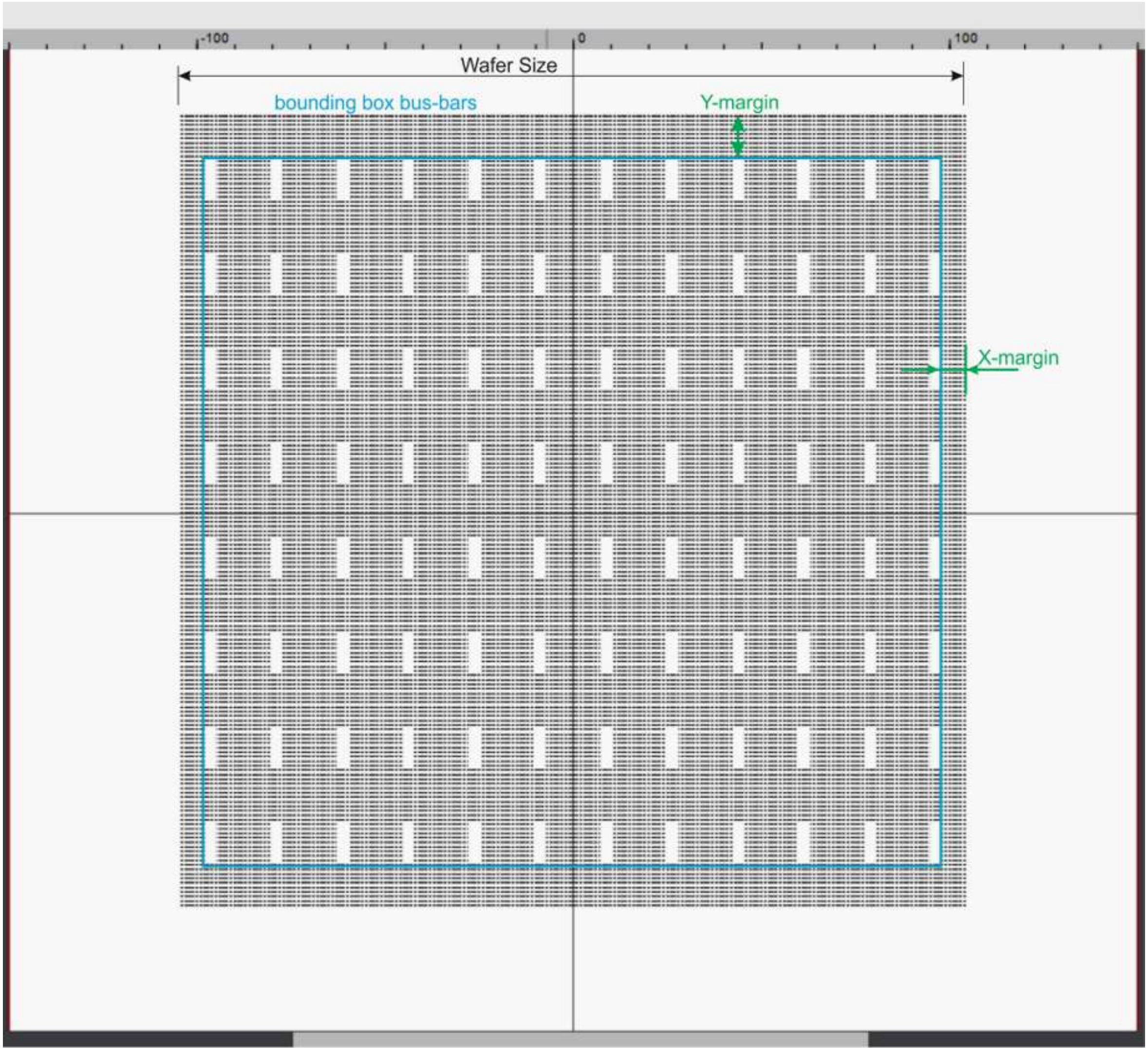
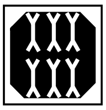


Fig. 8.3: RG-ADQ

8.3.3 TOPCon Solar Wafer Designer



Button

This job element can be used to generate the wafer pattern for a classic design of wafers with TOPCon architecture directly in RAYGUIDE.

The special feature here is that both the number and spacing of the lines per line batch can be freely defined.

All other dimensions, and also the position and size of the bus bars, are fixed.

The size of the wafer is approx. 181 x 181 mm, which corresponds to the M10 format size.

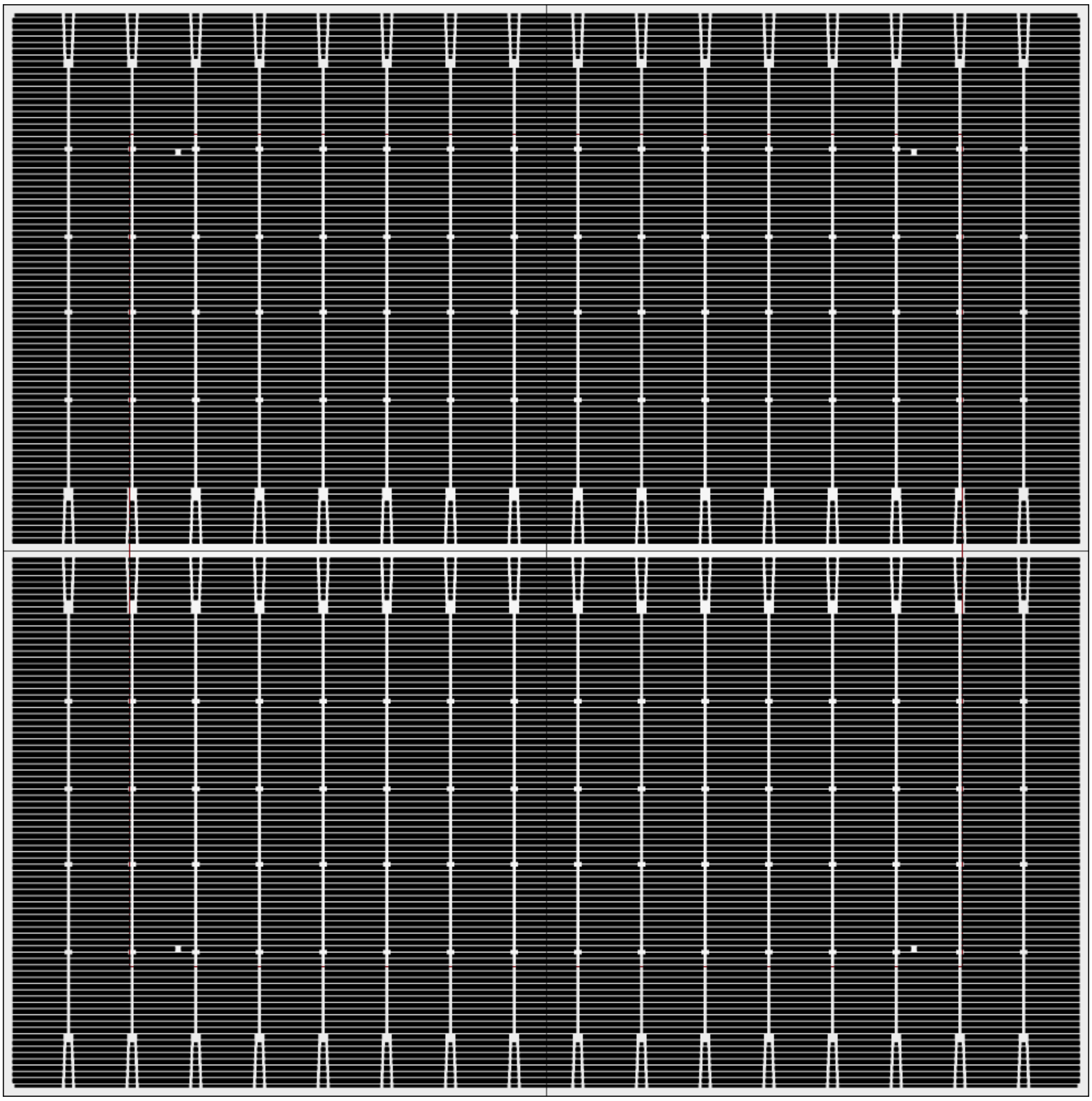


Fig. 8.4: RG-AFU

Setting	Explanation
Batch lines	
Count	Number of lines per batch
Spacing [µm]	Spacing between the lines within the batch in [µm]
Wafer The forward/backward offset can be used to align the bidirectionally marked lines so that they are perfectly aligned with each other in the vertical plane.	
Forward shift	Distance in [mm] Shifts all lines that are marked from left to right.
Backward shift	Distance in [mm] Shifts all lines that are marked from right to left.

Table. 8.4: RG-099

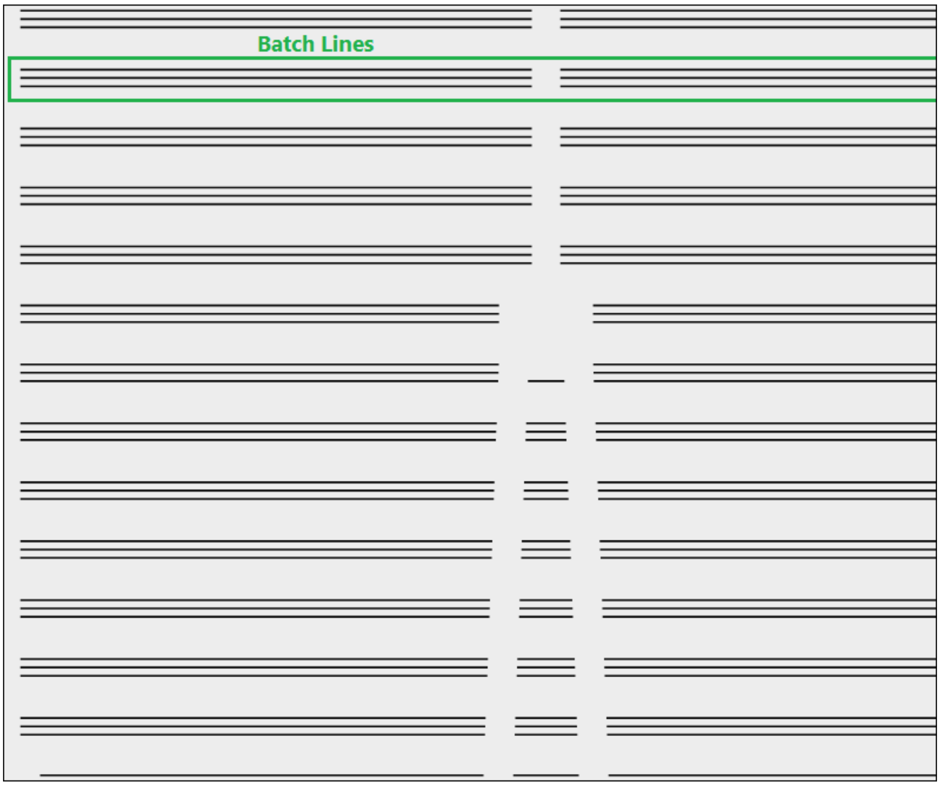


Fig. 8.5: RG-AFV

NOTE: The horizontal lines are always executed continuously with the *Dashed line* option. This means that only the line is switched on or off during the entire laser emission, but no delay times are applied for the deflection unit.

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.

In addition to the plug-in integrated in the RAYGUIDE GUI and the corresponding panel, there is also the option of sending remote command to the ***RAYGUIDE Remote Interface Server App*** and having them executed by this application.

For details, see *page 356, RAYGUIDE Remote Interface Server App*.

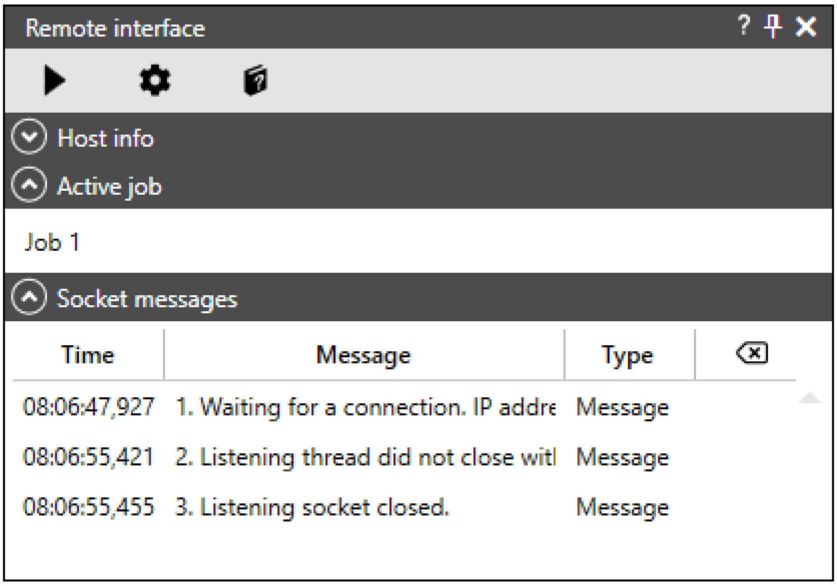
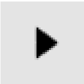
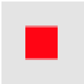
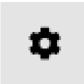
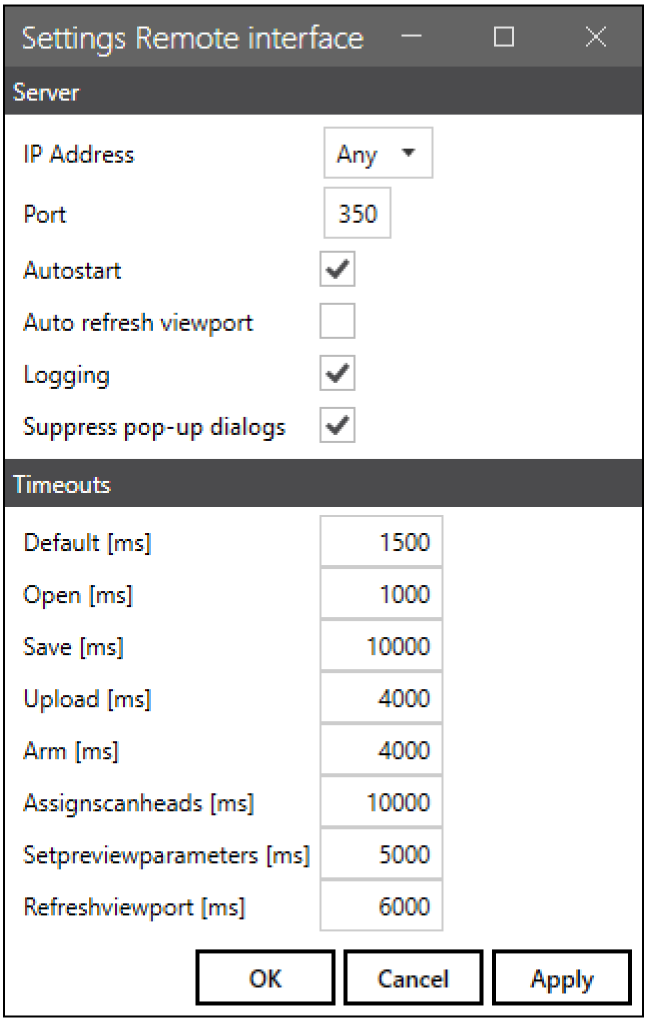


Fig. 8.6: RG-AEB

NOTE: All areas can be expanded and collapsed via the expander button.

Setting	Explanation
 / 	Button for manually starting the remote server ■ (is then ready to respond to remote commands) ■ or stopping it.
	Button for opening the remote interface settings: 

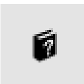
Setting	**Explanation**
■ ***Server*** – *IP address*: The IP address at which the socket server receives commands is set to "Any" by default. A specific IP address does not need to be defined here. If you wish to specify a discrete IP address, all relevant IP addresses are available to you for selection. – *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. – *Logging*: If activated, a log file is created that logs all incoming commands and responses. This file can also be found under: *C:\ProgramData\RAYLASE\RAYGUIDE\Logs\RAYGUIDE_RemoteInterface.log*	
■ ***Timeouts*** List of all times that, depending on the command, produce a timeout error message when the time is exceeded.	
	Button to open a list of all available commands. See *page 358, List of available commands*. **NOTE:** Each command is terminated with "eol" (end of line).
Host information	
List of all network adapters in the UP status and all associated IP addresses of the host PC.	
Active job	
Shows the job name of the currently active job.	
Socket messages	
Shows all incoming commands either as confirmed or with an error message.	

Table. 8.5: 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 is closed while the server is still “listening”, “listening” must be stopped and restarted on the server side when the client application is restarted before a connection can be re-established there using the “connect” command.

8.4.2 RAYGUIDE Remote Interface Server App

The ***RAYGUIDE Remote Interface Server App*** is a stand-alone application that can be executed as an alternative to the RAYGUIDE GUI to load, modify and execute common RAYGUIDE jobs using remote commands.

The main advantage over the RAYGUIDE GUI variant is the much faster execution time of the commands, especially since no vector graphics or similar job elements are graphically re-rendered here, and there is significantly less overhead.

The app can also be minimized to the task bar so that it is almost invisible:

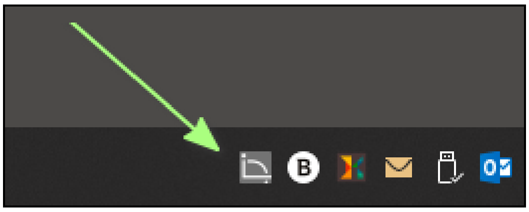


Fig. 8.7: RG-AFW

The GUI of the RAYGUIDE Remote Interface Server App is divided into three tabs.

Tab	Explanation
Client	List of all incoming commands and the response from the server.
System	Information on the RAYGUIDE system configuration that also has to be initialized.
Help	List of all available remote commands with indication of which commands are not available in the app in contrast to the GUI plug-in.

Table. 8.6: RG-100

List of all available remote commands with indication of which commands are not available in the app in contrast to the GUI plug-in.

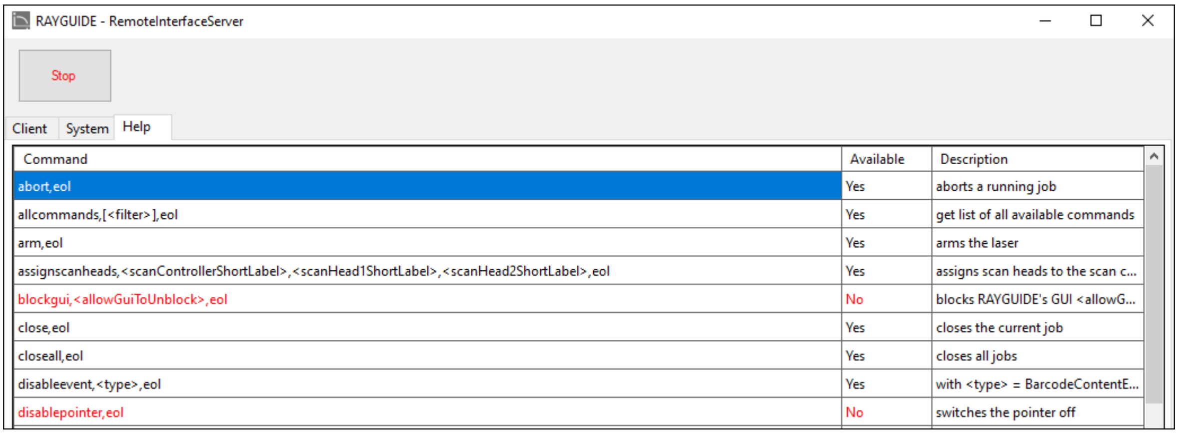


Fig. 8.8: RG-AFX

NOTES:

- After opening the app, it may take a few seconds until the app is ready for connection to the client because the app also loads the entire system configuration, including the correction file, onto the control card.
- Before executing a job, the laser must be armed with the “Arm” command.
- To shut down the app, click on the icon in the task bar and select the “Quit” menu item:

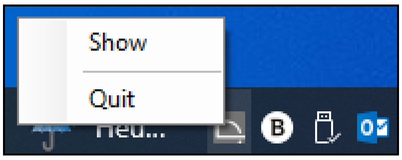


Fig. 8.9: RG-AFY

8.4.3 List of available commands

List of available commands	
abort, eol	Command for aborting an active job execution.
Arm, eol [13]	Command for arming the laser.
assignScanHeads; <scanControllerShortLabel>, <scanHead1ShortLabel>, <scanHead2ShortLabel>, eol [14] / [13]	Command for assigning the deflection unit to the control card. **NOTE:** By assigning the deflection unit to the control card, 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 [13]	Command for closing an active job. **NOTE:** The closing command automatically implies that the job will first be saved in order to prevent changes from being lost.
closeAll, eol [13]	Command to close all currently open jobs at the same time. **NOTE:** 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 pilot laser.
disableEvent, <eventName>, eol	Command to deactivate the event feedback activated by enableEvent.
disarm, eol	Command for disarming the laser.
enablePointer, eol	Activates the pilot laser.

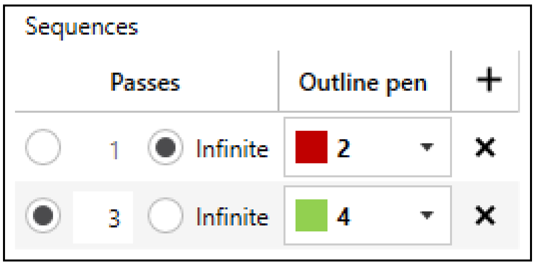
[13] **NOTE:** These commands have a specific timeout value. It can, if necessary, be adapted in the RemoteInterface.json file. For all other commands, the timeout is set to 500 ms.

[14] **NOTE:** The labels are case-sensitive.

List of available commands	
enableEvent, <eventName>, eol	Command to respond to events in the form of messages to the remote client. Available events (names): ■ ***JobStartedEvent*** Message is sent as soon as the execution is finished: EVT,JobStartedEvent,<jobname>,<scancontroller (for OnCard otherwise empty)> ■ ***JobValidationEvent*** Message is sent as soon as job validation fails, e.g. because geometries are not in the processing field: EVT,JobValidation,<jobname>,<Validation type> ■ ***BarcodeContentEvent*** Message contains the content of the first barcode object of the job; sent at the start of job execution: EVT,BarcodeContentEvent,<jobname>,<data> ■ ***ExecutionErrorEvent*** Message about a failed execution; sent immediately upon error event: EVT,ExecutionErrorEvent,<jobname>,<type> Possible error types are: Aborted, Executor, Laser, OutOfField, ScanController, ScanHead ■ ***JobFinishedEvent*** Message is sent as soon as the execution is finished: EVT,JobFinishedEvent,<jobname>,<scancontroller (for OnCard otherwise empty)> ■ ***MonitoringErrorEvent*** A message is sent as soon as a status is received from the extended monitoring function of the deflection unit (see *page 81, Extended monitoring of the deflection unit* and *page 90, General*) that is outside the defined limits, e.g. the temperature at the Aux temperature sensor is too high: EVT,MonitoringErrorEvent,ScanHead,SS-IV-HL,AuxTemp,Aux temp (38°) bigger than max value (37°). ■ ***MessageEvent*** This event ensures that a message is sent to the client in the event of a timeout, for example.
upload, eol [13]	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) / card (on card)
executorMode, <executionMode>, eol	Command to select the execution mode: all (all jobs) / active (active job)

List of available commands	
getDeviceStatus, eol	Command to receive information about the status of all devices currently in use, such as control card, deflection unit, laser, etc. If only the status of a single device is required, enter the Short label of the device after the command, e.g. getDeviceStatus,SP-ICE-3,eol Devices that do not offer status information return "NA" (not available) as the response.
getExecutionstatistic, eol	Command to read out the execution statistics according to the Process monitor panel An example of a response: {"job":"Job 1","scancontroller":"SN_693","singlecontroller":true,"expected":157.2796,"actual":11979.0,"finished":false,"aborted":true,"cycle":1,"starts":1,"passes":"96"}
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 [14]	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 [14]	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.
getJobUploadHash, eol	Returns a unique hash code for the job loaded onto the control card. The command can be used to check whether the job has changed in any way.
modifyJobVariable, <variableName>, <newValue>, eol [14]	Command for changing the content of an job variable that is already defined. See also *page 294, Job variables*.
modifyText, <jobElementLabel>, <nexttext>, eol [14]	Command for changing the content of a text or code element. <job element label> corresponds to the name of the job element in the tree directory. <next text> Definition of the new text content.

List of available commands	
modifyTransformation, <job element label>, <rotation>, <scaleX>, <scaleY>. <scaleZ>, <offsetX>, <offsetY>, <offsetZ>, <mode>, eol [14]	**NOTE:** This command is essentially the same as the *setTransformation* command, which is why it is no longer developed.
open, <path>, eol [13]	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: ■ Storage location (path) with file name and file format ■ Image size in number of pixels (referring to the longer side)
run, eol	Command for starting the job execution task. **NOTE:** Returns ACK as soon as the job execution has actually started.
refreshViewport	Command for re-rendering all job elements displayed in the viewport. Changes to position or text content become visible. Only useful if automatic rendering has been deactivated.
resetIncrement, <jobelementname>, eol	Command to reset the increment counter of a text or code object. The command can also transfer a list of job elements in order to handle several elements at one time.
rdmtriggerspectrumcalibration, eol	Command for triggering spectrum calibration for the RAYDIME METER.
rdmturnonsld, <boolean>	Command for switching the measuring laser (SLD) on or off. The Boolean argument “true” switches the measuring laser on, and the argument “false” switches the measuring laser off.
Save, <path>, eol [14]	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. <path> defines the file path for the storage procedure.
selectjobelements, <job element name> [<job element name 2>…..], eol	Command to select one or more job elements for subsequent commands.

List of available commands	
setActiveJob, <job label>, eol	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.
setGlobalScale, <power scale>, <speed scale>, eol	Command to globally scale the laser power and process speeds (marking like jumps). Both scalings must be defined here as a factor. See *page 95, Process Adjustment* for the valid range of values. **CAUTION:** These scalings are executed by the SP-ICE-3 control card and saved there, but not reset. RAYGUIDE offers you settings for resetting these values for certain events, see *page 90, General*.
SetjobElement, <label>, sequences, <passes(row 1)>, <outline-pen(row 1)>, <filling-pen(row 1)>, <passes(row 2)>, <outline-pen(row 2)>, <filling-pen(row 2)>,…,eol	This command can be used to define the sequences of a marking object. ■ <passes>: Number of runs, can either be an integer or "-1" for infinity. ■ <outline-pen> Number of pen for the contour ■ <filling-pen> The number of the pen for the filling as an option. If there is no filling, this parameter must remain empty. **NOTE:** A maximum of 5 lines can be defined for sequences using the remote command. Previously existing sequences are completely replaced. <u>Example of two sequences without filling:</u> setJobelement,Rectangle,sequences,-1,2,,3,4,,eol Result: 

List of available commands	
setParameter, <ParameterName>, <Value>, eol	This command can be used to set remote interface settings (e.g. auto-refresh of the active / inactive viewport). All timeout parameters can also be adjusted.
setPen, <PenNumber>, <Property1>, <Property1Value>, <Property2>, <Property2Value>, eol	Command to change pen parameters. With *Property1* to *PropertyN* the pen parameter to be changed is specified. The following parameters are available for selection: ■ BeamProfileID ■ JumpDelay [µs] ■ JumpSpeed [m/s] ■ LaserFrequency [kHz] ■ LaserPower [%/100] e.g. 50% > 0.5 regardless of the GUI unit ■ LmWidth [µs] ■ MarkDelay [µs] ■ MarkSpeed [m/s] ■ SecondaryPower [%/100] ■ Magnification factor (can only be used if a suitable correction file is used) ■ Magnification speed ■ Zoom Async With *Property1Value* to *PropertyNValue* the values belonging to the respective parameter are transferred. The values must be in the units noted above.
setLaseronProperties, <job lement>, <mode>, <value>	Command to define the parameters of drills: ■ You can use the mode variable to define whether to specify a number of pulses (pulse) or a dwell time (time). ■ Value: integer value
SetPreviewParameters <previewAll>, <previewMode>, <previewSpeed>, eol	Command to make the various settings for a preview. PreviewAll = True: All objects are shown in the preview. PreviewAll = False: Only selected objects are shown in the preview. PreviewMode = Mode Index 0 to 4 0 = All; 1 = Inset; 2 = Rectangle; 3 = Envelope; 4 = Point Unit for the variable previewSpeed = [m/s] Permissible value range = 0.05 m/s to 10 m/s
setquickexecutionparameters, <selected job elements only (true|false)>,eol	With this command, you decide in *Quick* execution mode whether only selected (= true) or all objects (= false) are executed.
SetScanheadBias, <Scanhead name>, <axis index>,	Command to primarily provide the optical axes for laser focus, zoom, sensor, RDM with an offset.

List of available commands	
<axis offset>, [<calibration file index>, <mode>]	**CAUTION:** This offset is managed by the control card and is not automatically reset. Observe the notes on offsetting on the *page 74, Deflection Unit Calibration*. ■ Scanhead name: Abbreviation of deflection unit ■ Axis index: 2 = z , 3 = zoom, 4 = sensor, 5 = AUX ■ Axis offset: Offset in [µm] ■ Optional: – Calibration file index (0 … 3, 0 = standard) – Mode: laser / pointer (laser = standard)
setTransformation, jobelemet, <job element name1>, <Property1>, <Property1Value>, <Property2>, <Property2Value>, jobelement, <job element name2>, <Property1>, <Property1Value>, <Property2>, <Property2Value>, eol	Command for transforming ***several objects*** with a single command. With *job element name1* to *job element nameN* the job elements that are to be transformed are named. With *Property1* to *PropertyN* the transformation parameters to be changed per object are specified. The following parameters are available for selection: ■ rotationX [rad] ■ rotationY [rad] ■ rotationZ [rad]: Rotation around the Z-axis in the XY plane/top view ■ scaleX [factor] ■ scaleY [factor] ■ scaleZ [factor] ■ offsetX [µm] ■ offsetY [µm] ■ offsetZ [µm] ■ mode – Possible values: abs (absolute) / rel (relative) – Standard, is absolute if not specified With *Property1Value* to *PropertyNValue* the values belonging to the respective transformation parameter are transferred. The values must be in the units noted above. Example**:** settransformation,jobelement,Rectangle,scalex,1.5,mode,rel,jobelement,Circle,offsetx,3000,mode,rel
StartPreview, eol	Starts the preview with the pilot laser (for details on the preview, see *page 313, Running a Preview*).
StopPreview, eol	Ends the preview with the pilot laser.

List of available commands	
transform, <rotation>, <scaleX>, <scaleY>, scaleZ>, <offsetX> <offsetY>, <offsetZ>, <scope>, <mode>, eol	Command for setting the process transformation. **NOTE:** The rotation must be specified in [rad], the scaling in [absolute factor] and the offset in [µm]. **NOTES:** ■ The scope of the process transformation can be optionally be transferred with the *scope* variables: (Only makes sense for jobs that use a multifield): Job (for the job as a whole) / CardLabel (short name of the control card) ■ The transformation mode can be optionally be transferred with the *mode* variables: abs (absolute) / rel (relative) Details on process transformation, see *page 337, Process Adjustment*.
unblockGui, eol	Command to unlock the GUI. **NOTE:** This command should always be used at the end of a program run.
wait, <eventName>, <timeoutTime>, eol	Command to define a waiting time in [ms] an event can take. These events can be: ■ JobFinishEvent; (= job is finished) ■ WorkspaceRefreshEvent (= the display of the job in the GUI is completed after e.g. job changes) **NOTE:** 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.

Table. 8.7: RG-097

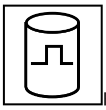
8.4.4 Overview of feedback

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
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

Return messages
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

Table. 8.8: 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.

Two different design variants are available:

- Continuous cut for discrete tabs.
- Only the short, “vertical” cuts are set (primarily used for battery foils of round cells).

8.5.1 Variant 1: Discrete tabs

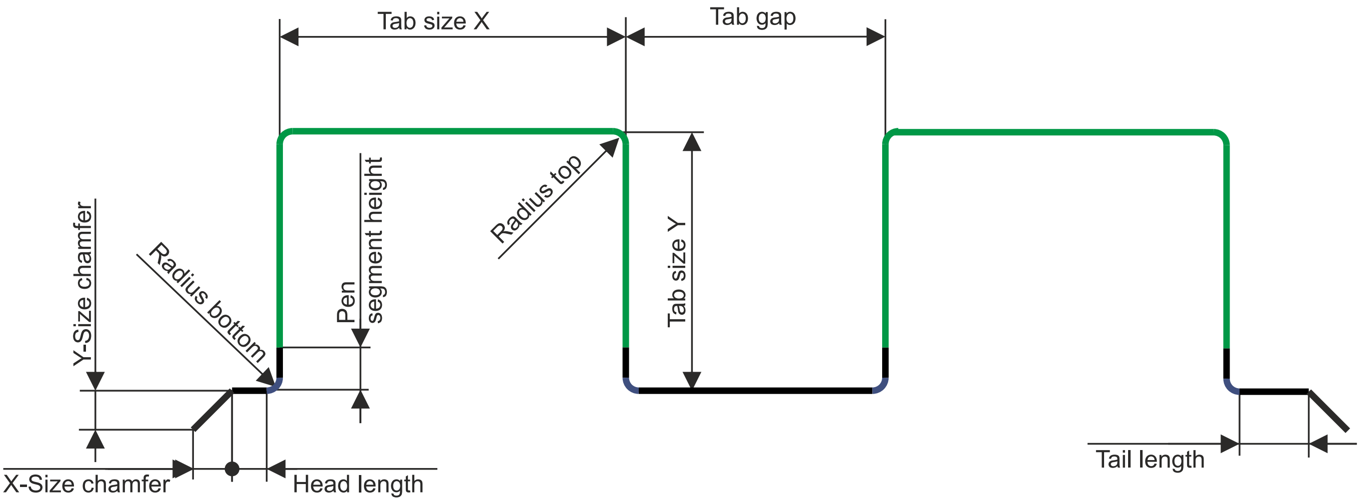


Fig. 8.10: RG-AEY

Setting	Explanation
Tab size [mm]	Dimension of the tab in width (X) and height (Y) in [mm].
Tab size incremental	Value in [mm] by which the size changes with each additional tab in width (X) or height (Y).
Tab gap [mm]	Distance between two tabs in [mm].
Tab gap incremental	Value in [mm] by which the gap between two tabs increases with each additional tab.

Setting	Explanation
Radius top [mm]	Indication of the radius of curvature in [mm] at the upper edge of the tab.
Radius bottom [mm]	Indication of the rounding radius in [mm] at the transition from tab to connecting line.
Head length [mm]	Length of the connecting line in [mm] before the first tab.
Tail length [mm]	Length of the connecting line in [mm] after the last tab.
Number of tabs	Specification of how many tabs are drawn.
Pen segment height [mm]	Specification from which height in [mm] the geometry is divided between two pens.
Cutting direction	Select how the geometry is to be cut: ■ *From left to right* or ■ *From right to left.*
Chamfer [mm]	Specification of the X-and Y-dimensions of an angular chamfer. **NOTES:** ■ A downward sloping chamfer requires a negative value for the Y-dimension. ■ The X-dimension of the chamfer is added to the start and end length. ■ Only one chamfer is created at the start and end of all tabs.

Table. 8.9: RG-090

8.5.2 Variant 2: “Tabless” design

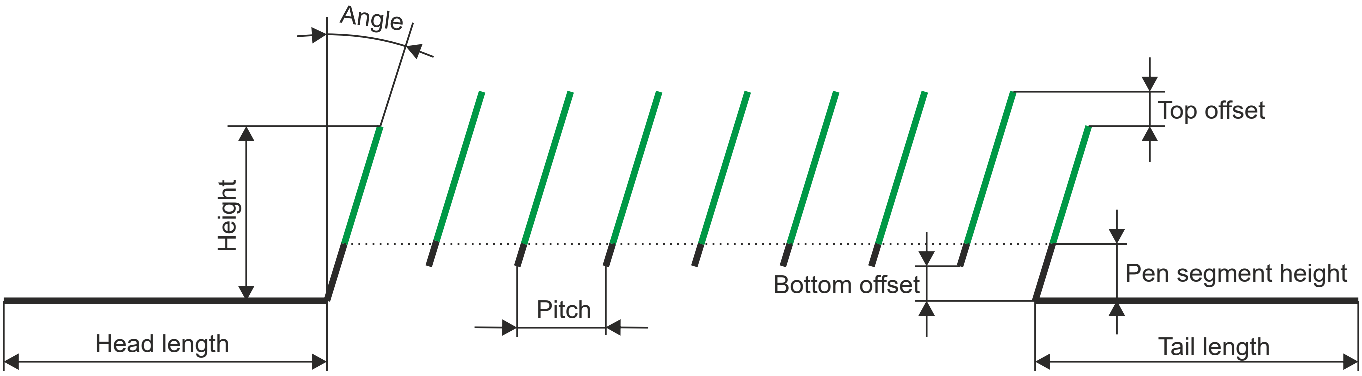


Fig. 8.11: RG-AGN

Setting	Explanation
Height [mm]	Height of the cutting flank, regardless of its angle.
Angle [°]	Angle of the cutting flank relative to the vertical line.
Pitch [mm]	Distance between repetitive cuts in [mm].
Head length [mm]	Length of the connecting line in [mm] before the first cutting flank.
Tail length [mm]	Length of the connecting line in [mm] after the first cutting flank.
number of cuts	Specification of how many cuts are to be made.
Pen segment height [mm]	Specification from which height in [mm] the geometry is divided between two pens.
Cutting direction	Specify whether the cut should go ■ From left to right or ■ From right to left
Vertical direction	Specify whether the vertical cuts should all be upwards, downwards or bi-directional.
Bottom offset [mm]	Specification indicating by how many [mm] the actual short cuts are offset from the horizontal cutting line at the bottom.
Top offset [mm]	Specification indicating by how many [mm] the actual short cuts extend beyond the height specification.

Table. 8.10: RG-116

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 control card – to configure and use it through the RAYGUIDE user interface.

Customized panel

The customized panel is activated from the menu: ***View* > *Panels* > *Custom UI***. This panel is empty by default.

Any external control element based on WPF (Windows Presentation Foundation) can be embedded.

Examples

For use of the user-defined panel:

- 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 control card 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, licenses, plug-ins, authorizations) and the program procedure (job, exceptions)
RAYGUIDE_Notifications.log	This file logs all messages in the Notifications *Notifications* panel such as status messages, measurement results, user logins, monitoring messages, etc.
RAYGUIDE_RemoteInterface.log	This file logs all remote commands received and the corresponding responses.
RAYGUIDE_StandAlone.log	This file logs which user loads which jobs with which content (marking objects and pens used) onto the control card.
SP-ICE-3.log	All commands transferred to the control card are recorded here (vector positions, process parameters). 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 *page 343, SP-ICE-3 Log Import*. If more than one control card is used, each has its own log file. The name of the log file of each card is the same as the respective control card label. **NOTE:** 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).
SP-ICE-3_Extra.log	In addition to the normal API commands, information is written here that is used for queries to the deflection unit, for instance transfer of the correction file and all “Enhanced” commands. The objective of the separate log file is to avoid overloading the actual log file with periodic status queries, for example.

Table. 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 ***[Reset]*** button, all entries can be reset and the file emptied.

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 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 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 374, Log Files*.

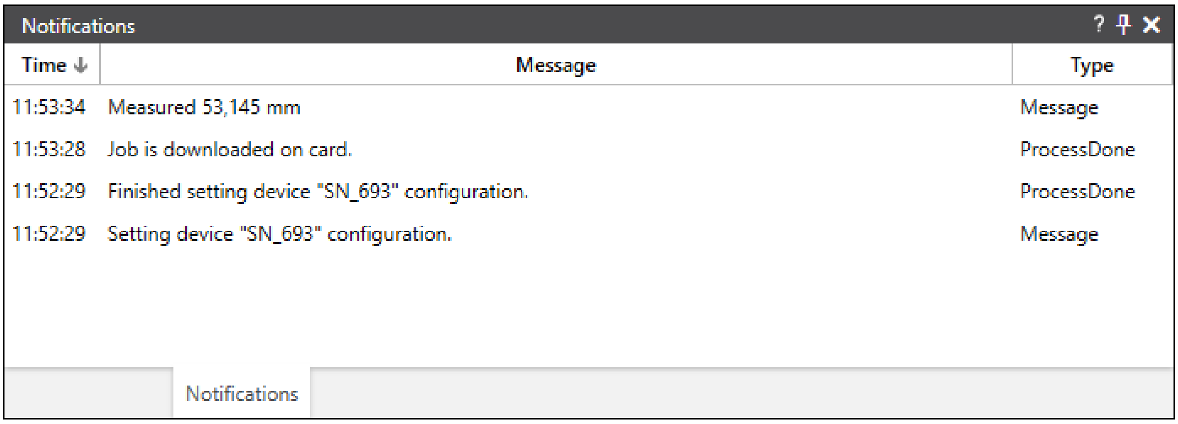


Fig. 11.1: RG-AEC

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 control card. A first indication can be given by the color index of the symbol in front of the SP-ICE-3 entry in the job overview.

If the control card 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 control card.

b) Check whether a deflection unit has been configured and assigned to the control card.

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 control card 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 *Execute as single vector graphic* 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 control card 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 control card?

A: You open the control card dialog and start the search for the IP address. As soon as the IP address of the control card is found, the connection to the control card is established. The previous configuration data for the deflection unit including its correction file, field calibration, and laser configuration, is transferred to the newly installed control card 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 [µs]

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.

Center 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:

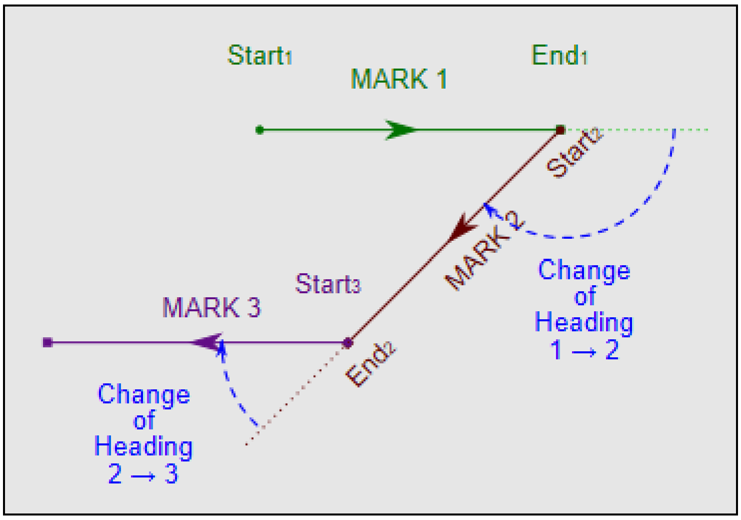


Fig. 14.1: RG-ADX

Graphic command

A graphic command is a graphical element that supports the control card library as per the graphic command definition. The SP-ICE-3 control card supports vector, arc, ellipse and Bezier curve commands.

Container

A container is a special type of object plug-in with the goal of assigning certain behaviors 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

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. Other types of “devices” may be added in the future.

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 control card 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 pre-shaped 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 control card, 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 control card can continue to process.

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.

License

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 control card, 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 control card. 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 stabilize 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 behavior 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 control card. The file is created using the Multi Point Editor application. The file extension is *PC3*.

Polygon delay

Delay applied for each vector connection so that the deflection unit can follow sharp corners. When using a variable polygon 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 linearize 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 control card.

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 control card 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 control card.

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 control card 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 control card and applied depending on the change of heading angle.

System

Means the entire RAYGUIDE software application.

Tracking error [µs]

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 control card to account for the different dynamic behavior of the X and Y mirrors compared to the Z lens(es).

Tuning

A property of a deflection unit that defines the dynamic behavior 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 deflection mirrors during acceleration / deceleration. Is done by the SP-ICE-3 control card. To do this, the SP-ICE-3 control card resorts to the tracking error values, therefore it is important that the value is correct.

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

Original manual

MULTI POINT EDITOR

USER MANUAL

Document: MN_MULTI POINT EDITOR

Status of the information: V2.1 [2025-02-12]

CONTENTS

1 INTRODUCTION

1.1 About MULTI POINT EDITOR

The MULTI POINT EDITOR (MPE) is a Windows based utility, which allows the user to open, view, edit and save field correction files (*.fc3 or *.gcd) and power correction files (*.pc3) in order to adapt them to the individual opto-mechanical situation of each laser system.

The functionality of the MULTI POINT EDITOR can also be used programmatically at API level, but this would require the installation of the RAYGUIDE SDK, as the MULTI POINT EDITOR is also an integral part of the RAYGUIDE Laser Process Software.

The goal of the MPE is mainly to edit the correction data of the axes of a deflection unit, responsible for the XY position of the laser beam as well as the Z-axis of a prefocusing unit or FOCUSSHIFTER to control the focus position. Other possible axes that are controlled by a *.fc3 correction file, such as SensorZ of an RAYSPECTOR, ZoomZ of an AM-MODULE and Aux-axis of a RAYDIME METER are not calibrated by the MPE.

1.2 Compatibility

The MULTI POINT EDITOR software tool is compatible with the RAYLASE SP-ICE-3 scan controller.

Please note that the software can be used without the connected scan controller if only correction values are applied to a correction file.

1.3 Features

- Calibration of the xy correction values of RAYLASE *.fc3 or *.gcd correction files
- Calibration of the Z-correction values for the third optical axis (if available)
- Creation of a correction table for field position dependent power correction
- Direct marking of the calibration pattern (in connection with the use of a SP-ICE-3 control card)
- Definition of a sub field (if only a subarea of the scan field is usable)
- Selection of different calibration patterns
- Direct input of scaling, rotation, offset and trapezoidal deviations
- Import function of measured values
- Various visualization options of the calibration data for validation of the measured values
- Creation of correction files that map the surface of a three-dimensional body
- Calculation of maximum process speed values

1.4 Scope of delivery

A typical bundle delivered to the customer includes the following items:

- MULTI POINT EDITOR software installation file to install all necessary program and library files required for the MULTI POINT EDITOR.
- MULTI POINT EDITOR user manual as PDF file.
- License agreement as PDF file.

1.5 Laser Safety

The user is responsible for safe operation and for protecting the area around the device from hazards caused by laser radiation. OEM customers must ensure compliance with all local and national regulations.

⚠ WARNING

Avoid unsafe laser operation

Always switch on the PC before switching on the laser system. This prevents the laser from behaving in an uncontrolled and unforeseen manner when the PC is switched on. Check your application carefully before using the laser system. Damaged software can block the entire system and lead to uncontrolled operation of the laser or deflection unit.

Safety instructions for these components can be found in the manuals for the laser system and deflection unit.

1.6 About this Manual

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

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 are shown in bold and italics: Select ***File > Save as...***.
- The names of dialog options (function buttons, checkboxes) are specified in italics: Select *Fixed*, if you ...
- Buttons are bold and in italics and shown in brackets: Click on ***[Apply]***.
- Buttons labeled with graphic icons are described in 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.

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.

All rights reserved.

Duplication of this manual or extracts from it – in particular by photocopying, scanning or photographing – and any other form of reproduction is only permitted with the prior written consent of RAYLASE.

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

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Customer Service

RAYLASE customer service will 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 a.m. to 5:00 p.m. UTC+1 (April to October: UTC+2)
Phone:	+49 8153 9999 297
E-mail:	support@raylase.de

2 INSTALLATION AND LICENSE

2.1 Installation process

NOTE: Once using the RAYGUIDE application software, the MULTI POINT EDITOR feature is embedded per default and does not need to be installed additionally.

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

First install (RAYBOARD PRODUCT INSTALLER)

https://www.raylase.de/en/products/software/rayboard/product-installer.html

Here in the “Select the targeted software configuration” menu item, select MULTI POINT EDITOR with the most current version.

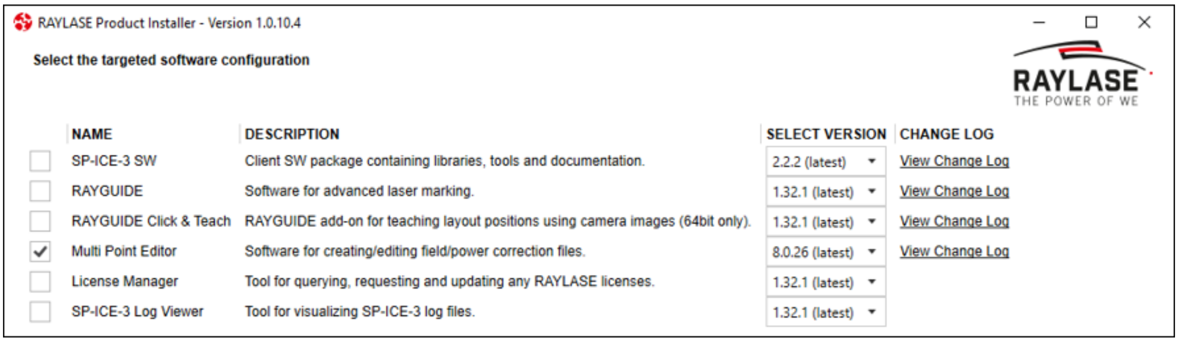


Fig. 2.1: S-AAA

You can use the direct link to the change log to get an overview of the latest changes to the previous version. The RBPI will then download the MULTI POINT EDITOR installation file and the installation options will be displayed.

Accept the license agreement.

After successful installation, you will receive the following information in the RAYBOARD PRODUCT INSTALLER.

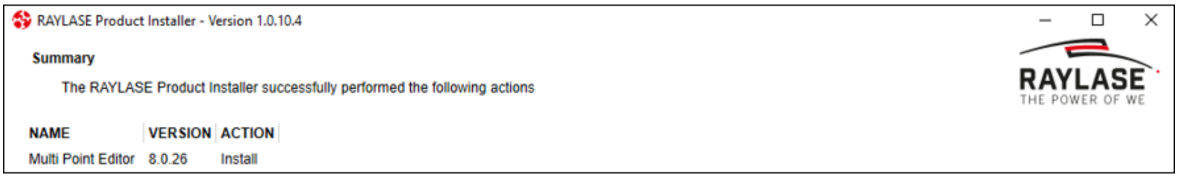


Fig. 2.2: S-AAB

A symbol for starting the MULTI POINT EDITOR application directly on the desktop of the computer is created:

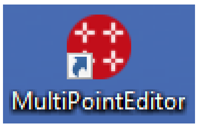


Fig. 2.3: MPE-AAC

Starting software

For instance, use the MULTI POINT EDITOR desktop icon ton start the software.

2.2 License

The MULTI POINT EDITOR is basically a freeware tool. Only the use of the creation of 3D surface correction files requires a MPE Professional license.

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 > License > Generate license request...***, and send the generated file to RAYLASE (license@raylase.de). RAYLASE will return an activation file which can be imported by selecting ***Help > License > Activate license***.

NOTE: The MPE Professional license can also be added to an existing ***RAYGUIDE*** license via push-update, also using the menu option ***Help > License*** > ***Activate license***.

As soon the MPE recognizes the Professional license, it will be mentioned in the top bar.

3 INTRODUCTION TO THE USER INTERFACE

By default, the tab ***Marking*** is shown after the start of the application.

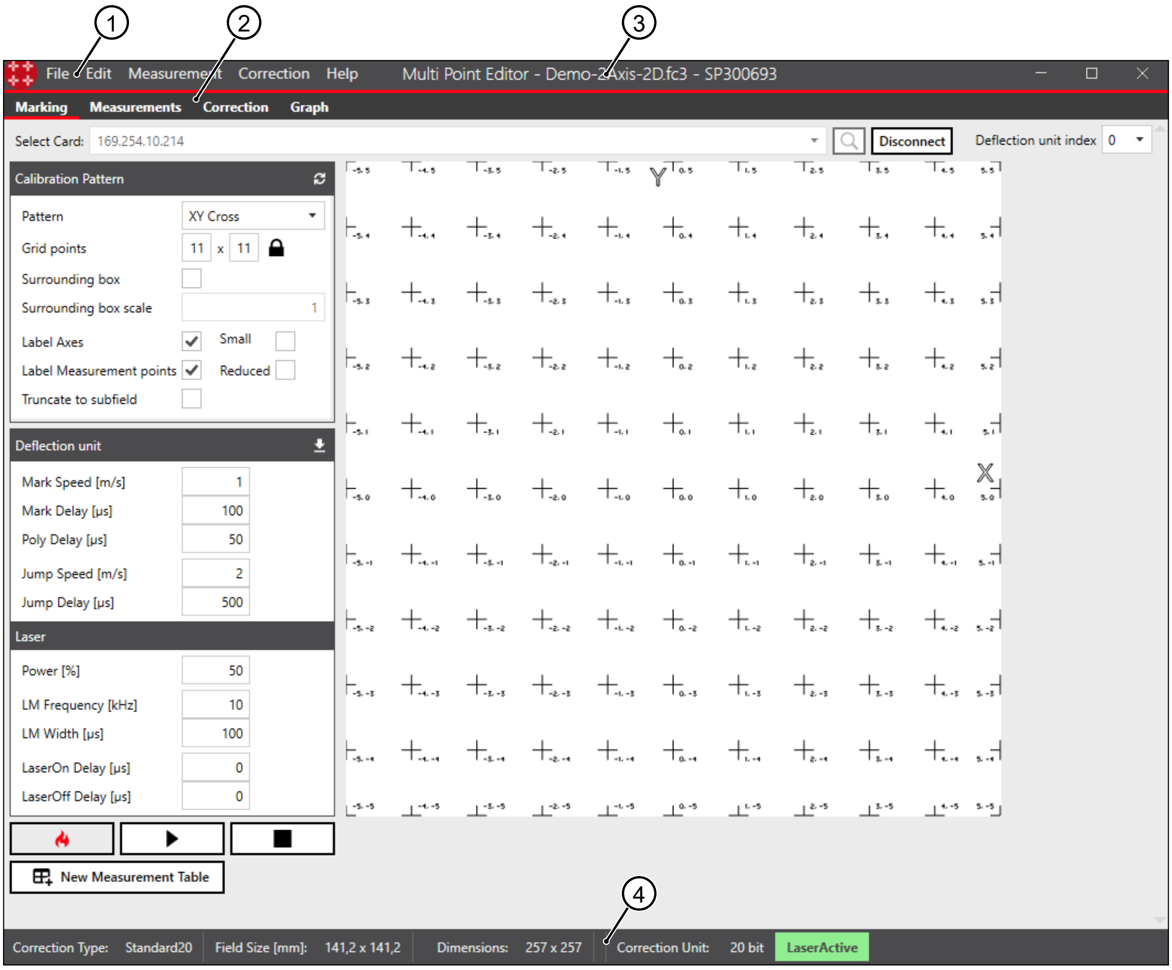


Fig. 3.1: MPE-AAD

1	Menu	2	Main tabs
3	Loaded file name and possible license	4	Info bar

The ***File*** menu refers to common job file tasks. It also provides the option to generate or power correction files (see *page 63, Position dependent power correction file*).

The ***Edit*** menu provides options for changing field size and defining sub fields, changing the resolution of the lookup tables and header information. There is also an option to convert a 3D correction file to a 2D correction file hosted here.

The ***Measurement*** menu provides the option to define the measurement table and to transfer measurements either by loading them in the same table format as defined (see *page 41, Loading measurement values from a file*) or by importing a list of freely defined coordinates (see *page 50, Importing a list of measurement values*).

In the ***Correction*** menu, global field corrections such as scale, offset, rotation, and trapezoid can be applied. An analysis option provides some statistical information as well as options to copy the correction values from the lookup table in either table or list format. The options for creating 3D-Surface correction files are also available from this menu.

The ***Help*** menu provides shortcuts to this manual, log files, and version information.

Applicable keyboard shortcuts are shown after most menu items.

4 GENERAL PREPARATIONS

4.1 Loading a correction file

Go to ***File* > *Open*** and browse for the desired correction file (RAYGUIDE usually stores its correction files usually under *C:\ProgramData\RAYLASE\Correction Files*).

Alternative: you can simply drag & drop the file from the folder into the MPE application window, or simply double-click on the file, and the file will start the MPE application if it is available.

For *.gcd files (used on SP-ICE-1 PCI/e PRO control card):

- If in the same directory the description file with a *.txt extension exists, it will also be loaded as well and important parameters such as the field size will be extracted.
- If no such *.txt file exists, you will need to set the field size manually.

When the MPE is started from the RAYGUIDE application, the associated correction file is automatically selected and loaded.

4.2 Type of field calibration

The MPE offers two basic ways to calibrate a scan field:

1. If the scan field requires global adjustments such as scaling, offset, rotation or trapezoidal distortion correction, these can be done directly. This could also mean a global focus adjustment that defines a bias / offset for the (all available) Z-axes.
2. If you need a very precisely calibrated scan field and also want to correct inhomogeneous distortions, then a true multi-point correction, which includes global adjustments, is the way to go.

Therefore, you will usually choose either option 1 (see *page 15, Global field corrections*) or option 2 (see *page 18, System dependent considerations* and *page 22, Multipoint calibration*).

5 GLOBAL FIELD CORRECTIONS

NOTE: In the case of a 3D correction file, any of the following global corrections will be applied to all Z-layers.

5.1 Apply scale

To scale the marking result globally, you can apply scaling factors for X and Y to the entire field correction table.

It is recommended to mark a square of ¾ field size, to measure the dimensional error.

Go to the menu ***Correction > Apply scale*** to open the following dialog:

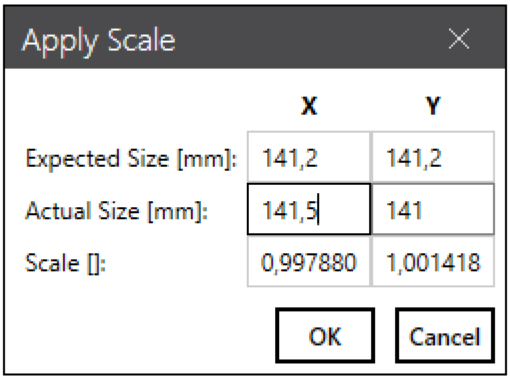


Fig. 5.1: MPE-AAE

Since the scaling is applied to the field correction table, only small scale errors should be applied.

NOTE: Larger scale deviations may result from incorrect working distance adjustments. They should not necessarily be corrected by mechanical adjustment.

5.2 Apply offset

To shift the X- / Y-position of the field center, you can apply an offset to the entire field correction table.

It is recommended to mark a large center cross to evaluate the offset.

In case of a prefocusing deflection unit (AXIALSCAN, AS FIBER, FOCUSSHIFTER) an offset can also be applied to the Z dimension to shift the focus globally.

To access the Z offset field, the units must be selected as either 16 bit, 20 bit or percentage.

Go to the menu ***Correction > Apply offset*** to open the following dialog:

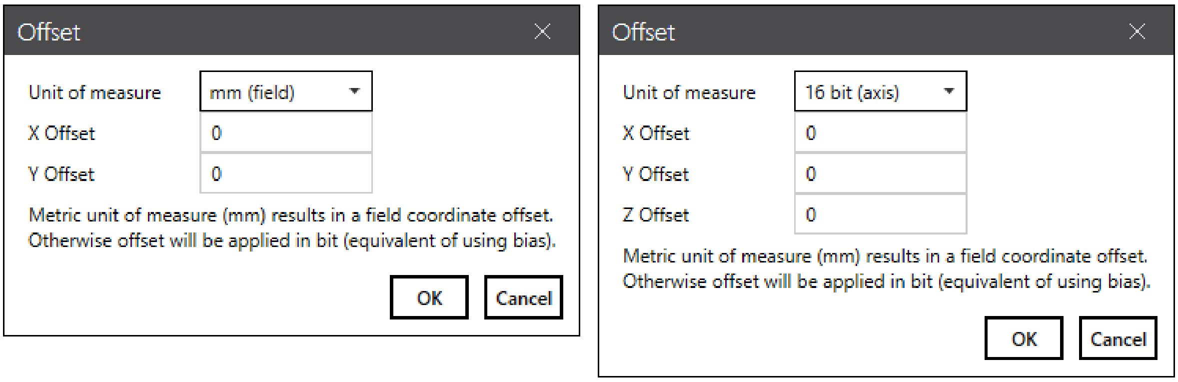


Fig. 5.2: MPE-AAF

Unit of measure controls whether the offset is applied in field coordinates (mm) or control value (20 bit).

5.3 Apply rotation

To rotate the marking result globally, one can apply a rotation to the entire field correction table.

It is recommended that only small (single digit) rotations be compensated.

It is recommended to mark a large center cross, to evaluate the rotation.

Go to the menu ***Correction > Apply rotation*** to open the following dialog:

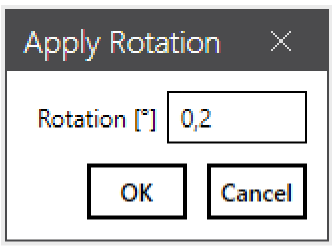


Fig. 5.3: MPE-AAG

5.4 Apply trapezoid

You can use this option to correct a global trapezoidal distortion of the marking result.

It is recommended to mark a square to measure the trapezoidal distortion.

Go to the menu ***Correction*** **>** ***Apply trapezoid*** to open the following dialog:

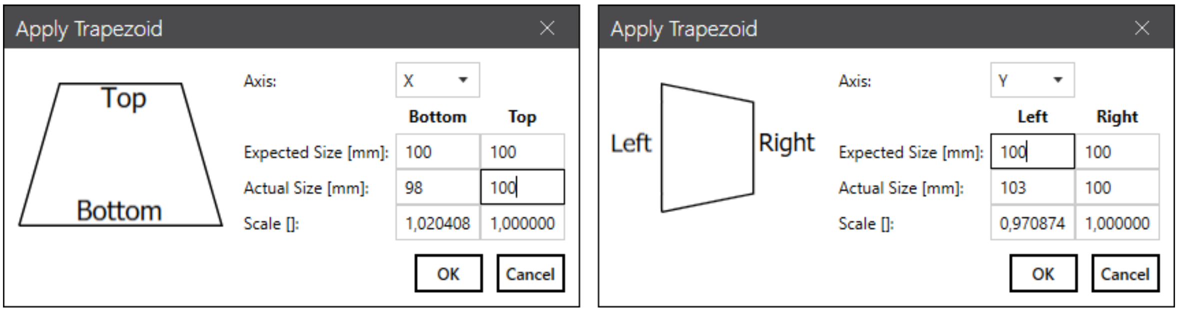


Fig. 5.4: MPE-AAH

After selecting the axis to be compensated, the measured sizes can be set.

NOTE: A trapezoidal distortion can only be corrected along one field axis.

For the X-axis, measure and enter the top and the bottom sides, and for the Y-axis, measure and enter the left and the right side dimensions.

5.5 Apply barrel distortion

Use this option to correct a global barrel distortion of the marking result. It is recommended to mark a square to measure the barrel distortion.

The distortion is usually along a coordinate axis, either the X-axis (width) or the Y-axis (height).

Go to the menu ***Correction*** **>** ***Apply barrel distortion*** to open the following dialog:

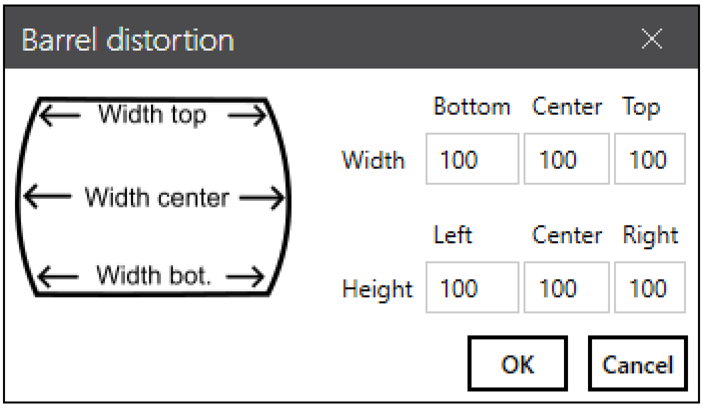


Fig. 5.5: MPE-ABT

6 SYSTEM DEPENDENT CONSIDERATIONS

6.1 Deflection units with f-theta lenses

For all deflection units with f-theta lenses (2-axis deflection unit or FOCUSSHIFTER) only the scan field needs to be calibrated.

6.2 Prefocusing units (AXIALSCAN, AS FIBER)

For prefocusing deflection units, it is recommended that you start with the focus calibration and then continue with the scan field calibration.

6.3 Correction files that provide a 3D volume

If the selected correction file provides a 3D volume, both the focus calibration and the scan field calibration can be performed at multiple focus layers. It is recommended to calibrate at least the top and bottom layers, so that all layers in between are interpolated.

Select *Multi Layer* as *3D Mode*, see *page 24, Definition of calibration job layout, using predefined pattern styles*.

6.4 Correction files with spot magnification

Correction files for the RAYLASE AM-MODULE contain multiple data layers with respect to spot magnification. Similar to a 3D volume correction file, it is recommended to perform the scan field calibration at least at the min and max spot magnification layers, so that all layers in between will be interpolated.

Select *Multi Magnification* as *Magnification Mode*, see *page 24, Definition of calibration job layout, using predefined pattern styles*.

NOTE: It is not recommended to calibrate the focus, as this would only affect the Z axis correction data, but during the process, both axes (Z and ZoomZ) perform a correlated movement.

6.5 Optional field range limitation for calibration (sub field)

Customers who do not want to or are unable to use the entire scan field can define a smaller section – hereafter referred to as “sub field”.

This option can be used for correction files that represent a flat field or a 3D volume. Calibration data for additional axes such as ZoomZ, SensorZ, Aux-axis will also be cropped by a sub field.

NOTE: Only the measurement area is reduced. Correction data outside the sub field is retained.

Go to ***Edit* > *Change field*** to open below dialog:

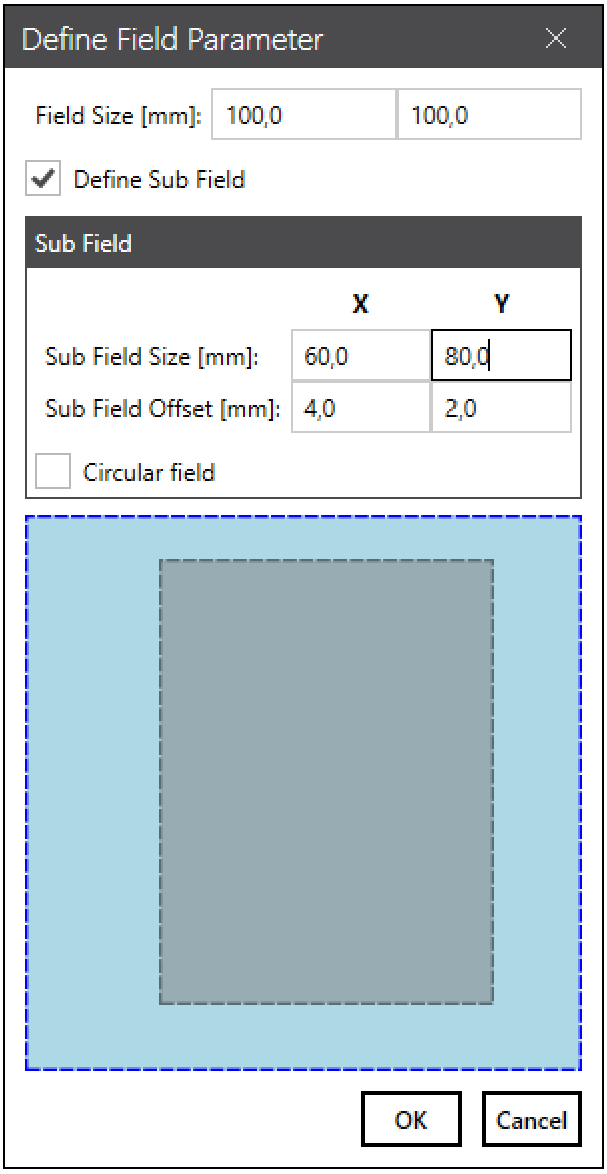
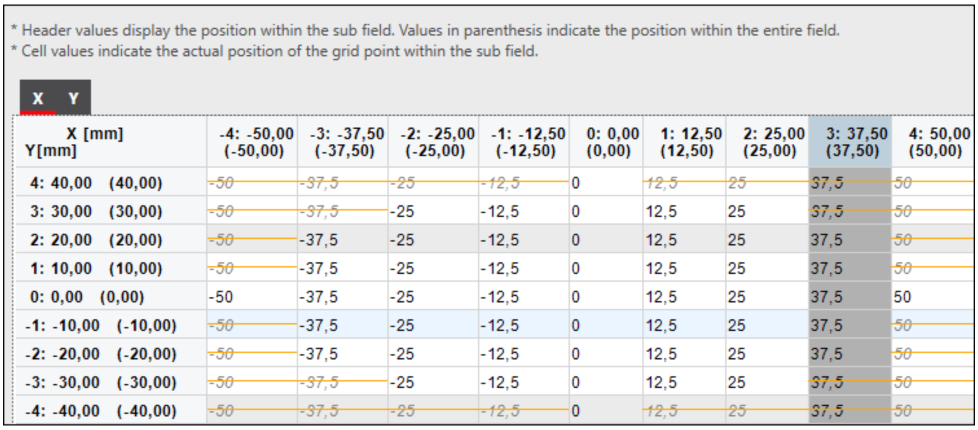


Fig. 6.1: MPE-AAI

Element	Explanation
Define field parameter	
Field size [mm]	Displays the field size per X- and Y-dimension as defined by the loaded correction file.
Define sub field	Select the check box if you want to define a sub field.
Sub field	
Sub field size [mm]	Enter the X- and Y-dimensions of the required sub field.
Sub field offset [mm]	Enter the X- and Y-offsets if the sub field is not centered to scan field.
Circular sub field	Select whether the sub field should be circular instead of rectangular. **NOTE:** The size of the circular sub field defined in this way can exceed the size of the original field. Combined with the offset, this can result in a circular sector. This can be useful for a circular field covered by several deflection units.

Table. 6.1: MPE-001


* 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]	-4: -50,00 (-50,00)	-3: -37,50 (-37,50)	-2: -25,00 (-25,00)	-1: -12,50 (-12,50)	0: 0,00 (0,00)	1: 12,50 (12,50)	2: 25,00 (25,00)	3: 37,50 (37,50)	4: 50,00 (50,00)
4: 40,00 (40,00)	~~-50~~	~~-37,5~~	~~-25~~	~~-12,5~~	0	~~12,5~~	~~25~~	~~37,5~~	~~50~~
3: 30,00 (30,00)	~~-50~~	~~-37,5~~	-25	-12,5	0	12,5	25	~~37,5~~	~~50~~
2: 20,00 (20,00)	~~-50~~	-37,5	-25	-12,5	0	12,5	25	37,5	~~50~~
1: 10,00 (10,00)	~~-50~~	-37,5	-25	-12,5	0	12,5	25	37,5	~~50~~
0: 0,00 (0,00)	-50	-37,5	-25	-12,5	0	12,5	25	37,5	50
-1: -10,00 (-10,00)	~~-50~~	-37,5	-25	-12,5	0	12,5	25	37,5	~~50~~
-2: -20,00 (-20,00)	~~-50~~	-37,5	-25	-12,5	0	12,5	25	37,5	~~50~~
-3: -30,00 (-30,00)	~~-50~~	~~-37,5~~	-25	-12,5	0	12,5	25	~~37,5~~	~~50~~
-4: -40,00 (-40,00)	~~-50~~	~~-37,5~~	~~-25~~	~~-12,5~~	0	~~12,5~~	~~25~~	~~37,5~~	~~50~~

Example 1: Circular sub field

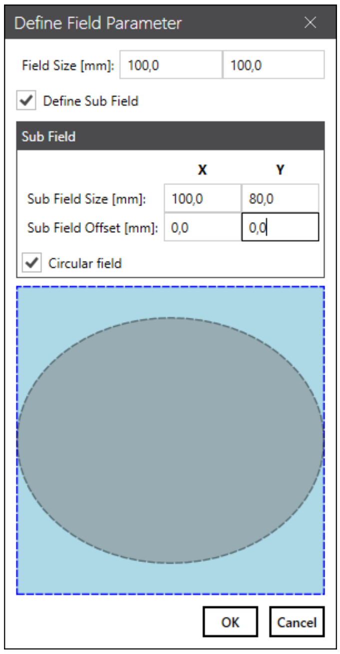
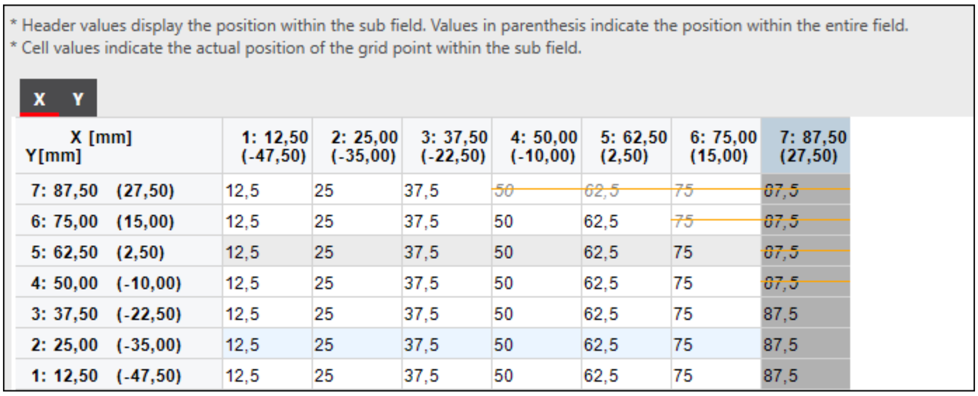


Table. 6.2: MPE-025

Because the measurement table is always rectangular, not all values need to be filled in. All cells corresponding to grid points outside the circle are crossed out and extrapolated.



* 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]	1: 12,50 (-47,50)	2: 25,00 (-35,00)	3: 37,50 (-22,50)	4: 50,00 (-10,00)	5: 62,50 (2,50)	6: 75,00 (15,00)	7: 87,50 (27,50)
7: 87,50 (27,50)	12,5	25	37,5	~~50~~	~~62,5~~	~~75~~	~~87,5~~
6: 75,00 (15,00)	12,5	25	37,5	50	62,5	~~75~~	~~87,5~~
5: 62,50 (2,50)	12,5	25	37,5	50	62,5	75	~~87,5~~
4: 50,00 (-10,00)	12,5	25	37,5	50	62,5	75	~~87,5~~
3: 37,50 (-22,50)	12,5	25	37,5	50	62,5	75	87,5
2: 25,00 (-35,00)	12,5	25	37,5	50	62,5	75	87,5
1: 12,50 (-47,50)	12,5	25	37,5	50	62,5	75	87,5

Example2: Circular sub field

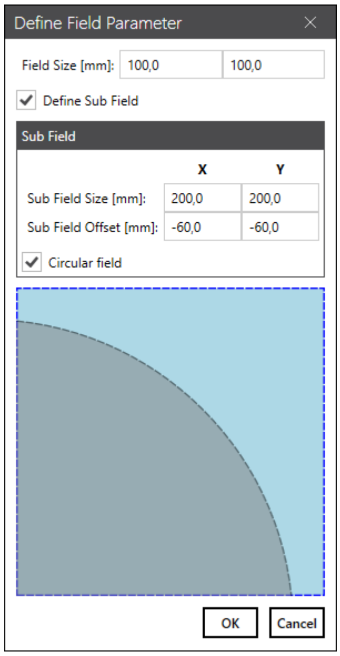


Table. 6.3: MPE-026

The measurement table shows only those cells of the sub field that are inside the original field. Since much of the circle is outside the original field, the table is reduced from 8 x 8 to 7 x 7 points.

NOTES:

- A sub field affects both the marking grid, which is truncated accordingly, and the measurement points which need to be entered.
- Correction points outside the sub field will also be updated, but because the correction values are extrapolated, the accuracy may suffer.
- Correction file data sent to a control card will not be truncated by a sub field definition.

7 MULTIPOINT CALIBRATION

7.1 Marking of the calibration pattern

7.1.1 Preparing the marking pattern "Job"

Using the MPE in combination with RAYLASE SP-ICE-3 control card, you can define and execute a calibration pattern and then measure the grid points afterwards. This requires a connection to an SP-ICE-3 control card. This task is managed in the ***Marking*** tab.

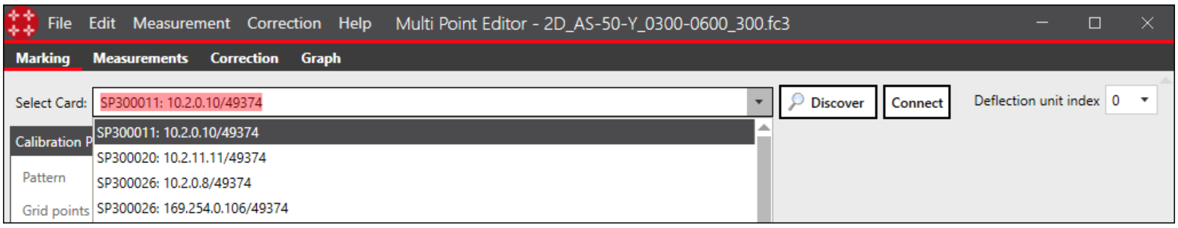


Fig. 7.1: MPE-AAN

The following sections explain all the options on the ***Marking*** tab.

7.1.1.1 Connect to a control card

Card connection	
Selected card	Displays the connected control card with its serial number and IP address. After a detection, all available control cards are listed, and the desired one can be selected.
Discover	Click to start discovering of all available control cards on the network.
[Connect] / [Disconnect]	Press ***[Connect]*** to connect to the selected control card and send the active correction file to the card. Press ***[Disconnect]*** to release the current connection, e.g. for rediscovering or to connect to another card.
Deflection unit index	If the control card uses the *dual scan head mode* to control two deflection units in master-slave mode, the index of the head to be calibrated can be selected. **NOTE:** If index 1 is selected, the same correction file will be stored on the card for both heads. Once both heads have completed their multipoint calibration, the configuration must be set up again.

Card connection

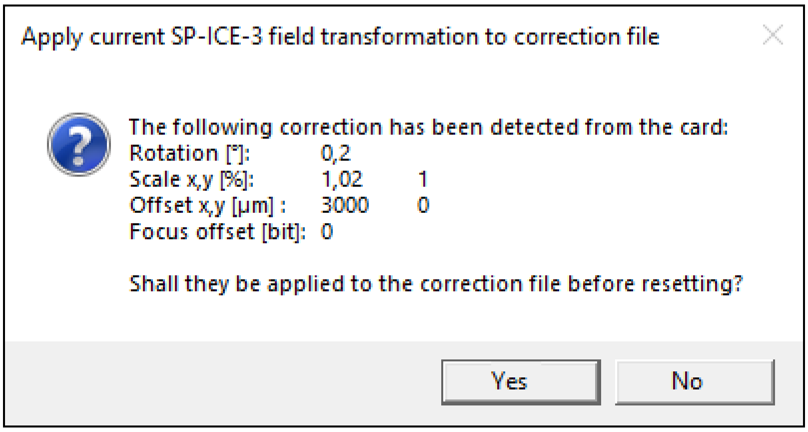
NOTES:

If another correction file is loaded after the control card is connected, the file is automatically uploaded to the card.

In case the MPE is started from the RAYGUIDE application, the connection is already established and the correction file as assigned in RAYGUIDE is selected.

Once the MPE is connected to the card, it reads the actual field transformation values from the scan controller.

This transformation may include gain, offset and rotation correction previously set by another application (e.g. RAYGUIDE). It is displayed in a pop-up dialog:



Select ***[Yes]*** or ***[No]*** if you want to embed or not to embed the transformation in the correction file.

IMPORTANT NOTES:

In any case, the transformation is deleted from the control card, since it would otherwise affect the execution of the pattern. In addition, the process transformation is also deleted.
If you have decided not to embed the values after completing the multipoint correction task, be sure to set the values again.

NOTE: If MPE is started from RAYGUIDE and you decide to embed the transformation, the field transformation values for will also be reset in the RAYGUIDE deflection unit configuration.

Table. 7.1: MPE-022

7.1.1.2 Definition of calibration job layout, using predefined pattern styles

For prefocusing systems, it is recommended to start with the focus calibration, see pattern option “Focus calibration”.

Click the ***[Refresh]*** icon to refresh the marking pattern display.

Calibration Pattern	
Pattern	Scan field multipoint calibration ■ *XY Grid* The XY Grid is the best choice for manual measurements. ■ *XY Drill* Compared to the XY Grid, each grid point is represented by a drill point. ■ *XY Circle* Compared to the XY Grid, each grid point is represented by a small circle. **NOTE:** It is not possible to mark complete circles at the edge of the field. To overcome this limitation, you can define a sub field (see *page 19, Optional field range limitation for calibration (sub field)*) that is one circle diameter smaller than the field. ■ *XY Cross* Compared to the XY Grid, each grid point is represented by a cross. **NOTE:** It is not possible to mark complete crosses at the edge of the field. To overcome this cut-off, you can define a sub field (see *page 19, Optional field range limitation for calibration (sub field)*) that is one cross size smaller than the field.
	Focus calibration (only for correction files for prefocusing deflection units) ■ *Z Lines* Each grid position is represented by a line array, where the focus position is incremented per line to identify the best-in-focus line.
Grid Points	Number of grid points for complete X- and Y-axis range. The fields for X and Y are interlocked. Click the ***lock*** button to unlock the two fields. **Recommendation:** 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 (only if no sub field is set): 3, 5, 9, 17, 33, 65, 129, 257. **Application Note:** Typically, a grid of 9 x 9 points provides sufficient position accuracy.

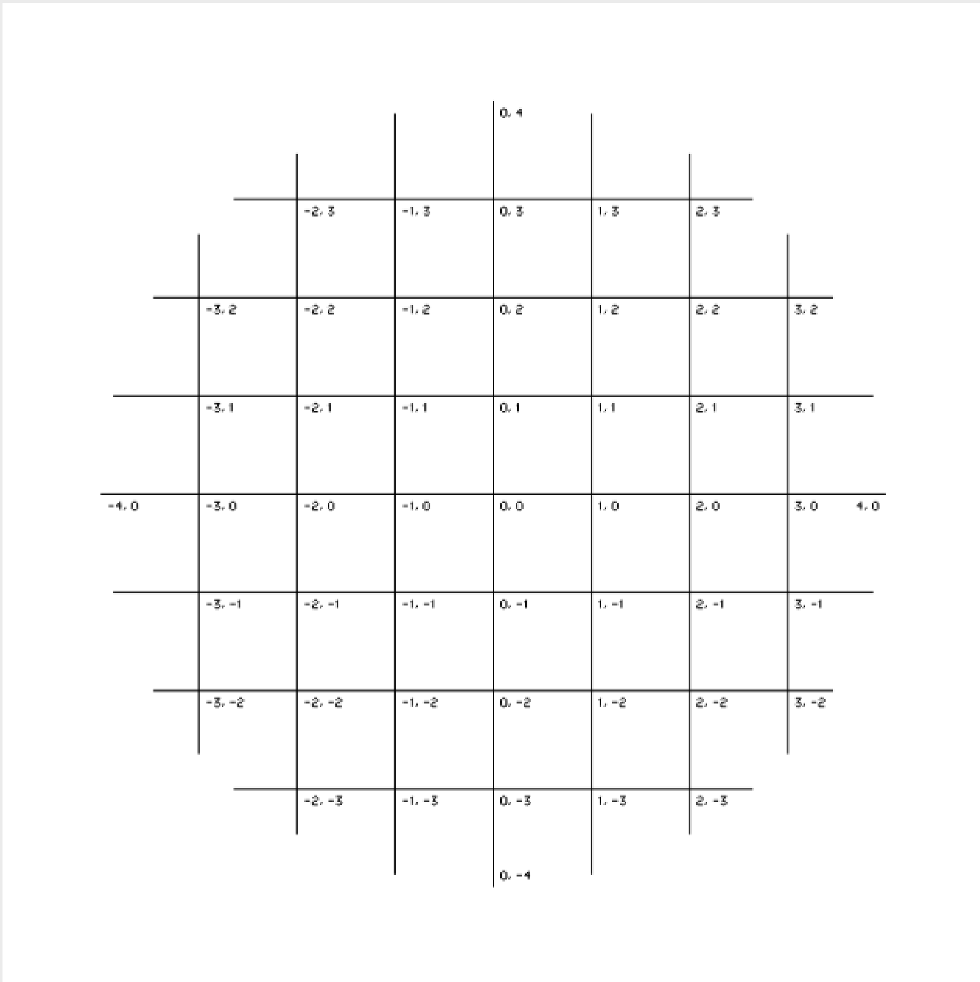
Calibration Pattern	
Pulses [1]	Enter the number of pulses for drill points.
Highlight center [1]	Check to add four more drill points around the center of the grid.
Radius [mm] [2]	Enter the radius of the pattern circles.
Surrounding box [3]	Adds a square around the crosses.
Surrounding box scale [3]	Scales the squares relative to the size of the crosses.
Lines per point [4]	Enter an odd number of lines to be marked at each grid point position. The lines (vertical by default) are arranged symmetrically, with every 5th line drawn slightly longer.
Line spacing [mm] [4]	Enter the line spacing between the parallel Z-lines.
Delta Z [mm] [4]	Select whether the Delta Z value applies to the *Z-lens* or to the *focus*. **NOTES:** ■ When *Z-lens* is selected, the value refers to the range of movement of the axis. A delta value of about 100 µm can cause a noticeable change in the focus position. ■ When *focus* is selected, the value refers to the field domain. The MPE internally converts the value to a lens offset using a special algorithm to control the Z-axis.
Line length scale [4]	Enter the value by which each line is shifted relatively in Z-position, while the center line is marked at the nominal Z-position. The length of the lines can be reduced to avoid possible overlapping of line-groups. The value is 0,66.
Horizontal [4]	Switches the orientation of the lines from vertical to horizontal lines.
Label Axis	Select this check box to additionally mark labels to identify the X- and Y-axes.
Small	Select to force the axis label to fit the label size to the free space between the grid marking instead of overlapping, and to use a single stroke font instead of true type font
Label measurement points	Select to additionally mark the X/Y index at each grid position. **NOTE:** In the same cases, two labels may overlap.
Reduced	Select to limit the number of grid labels to 9 x 9 to avoid overcrowding the pattern being marked.

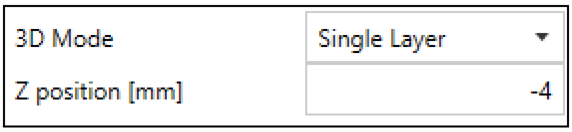
[1] Available only when the pattern *XY Drill* is selected.

[2] Available only when the pattern *XY Circle* is selected.

[3] Available only when the pattern *XY Cross* is selected.

[4] Available only when the pattern *Z Lines* is selected.

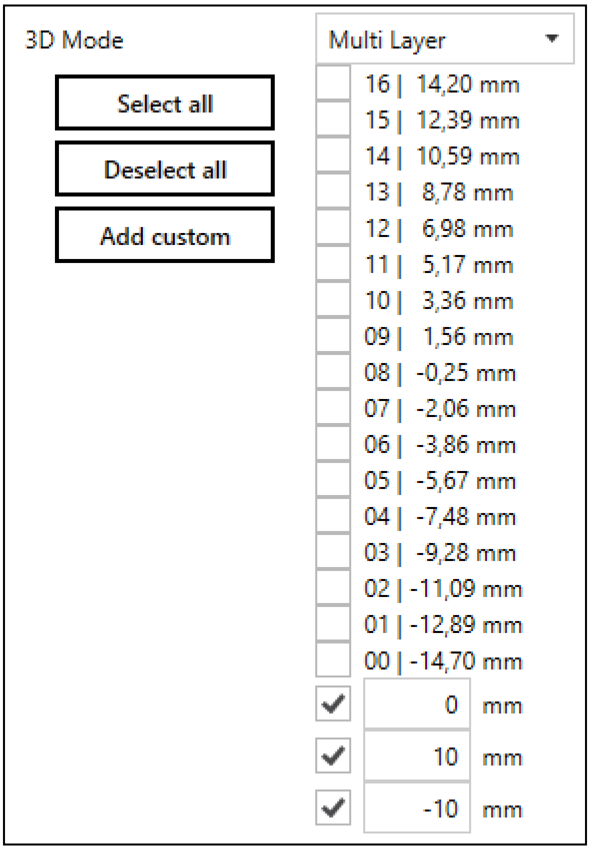
<table>
<tr><th colspan="2">Calibration Pattern</th></tr>
<tr><td>Truncate to sub field</td><td>NOTE:
If a sub field is used, the grid points of the markup are adjusted to fit the rectangular bounding box of the sub field.
If this option is checked, the marking pattern will also be cut off at the sub field edge (see page 19, Optional field range limitation for calibration (sub field)). Useful mainly for circular sub fields:

</td></tr>
</table>

<table>
<tr><th colspan="2">Calibration Pattern</th></tr>
<tr><td>3D Mode [5] /
Magnification Mode [6]</td><td>Select, if the pattern is marked
■ just in a SINGLE Z position / SINGLE magnification level
NOTE: If only a single Z / magnification position is calibrated, the correction values for all other Z layers / magnification-levels will be extrapolated.
■ or in MULTIPLE Z positions / MULTIPLE magnification levels.
NOTE: When calibrating multiple Z positions / magnification levels, the MPE will interpolate the correction values for layers in between.</td></tr>
<tr><td rowspan="2">Z position [mm] [7] /
Magnification Level [7]</td><td>■ SINGLE layer:
Enter the Z position / magnification level relative to the working distance for the pattern to be marked.
■ MULTIPLE layer:
A list of all layers / levels, as defined in the correction file, will appear.
Simply check from the offered indexes which focus layer / magnification level should be used to perform the calibration marking.
If the predefined layers cannot be used to place a material, additional custom Z-layers can be added. Click [Add custom] to add an additional layer and define its Z position.
NOTE: When the pattern has been marked in the first selected Z position / magnification level, a pop-up dialog appears, waiting for your confirmation to continue
■ to mark the pattern again at the next Z position /
■ with the next magnification factor
until all selected Z positions / magnification factors have been processed.</td></tr>
<tr><td><u>Example: 3D CF - Single Layer selection</u>

</td></tr>
</table>

[5] Available only when a 3D correction file is loaded.

[6] Available only when a correction file is loaded, that supports an additional zoom lens.

[7] Depending on the mode selection (3D Mode, Magnification Mode)

<table>
<tr><th colspan="2">Calibration Pattern</th></tr>
<tr><td></td><td>
<u>Example: 3D CF - Multi Layer selection with custom layers</u>
(FOCUSSHIFTER correction file e.g. does not have a Z-Layer for Z = 0 by default)


</td></tr>
</table>

Table. 7.2: MPE-023

Example pattern layouts with 9 x 9 grid points

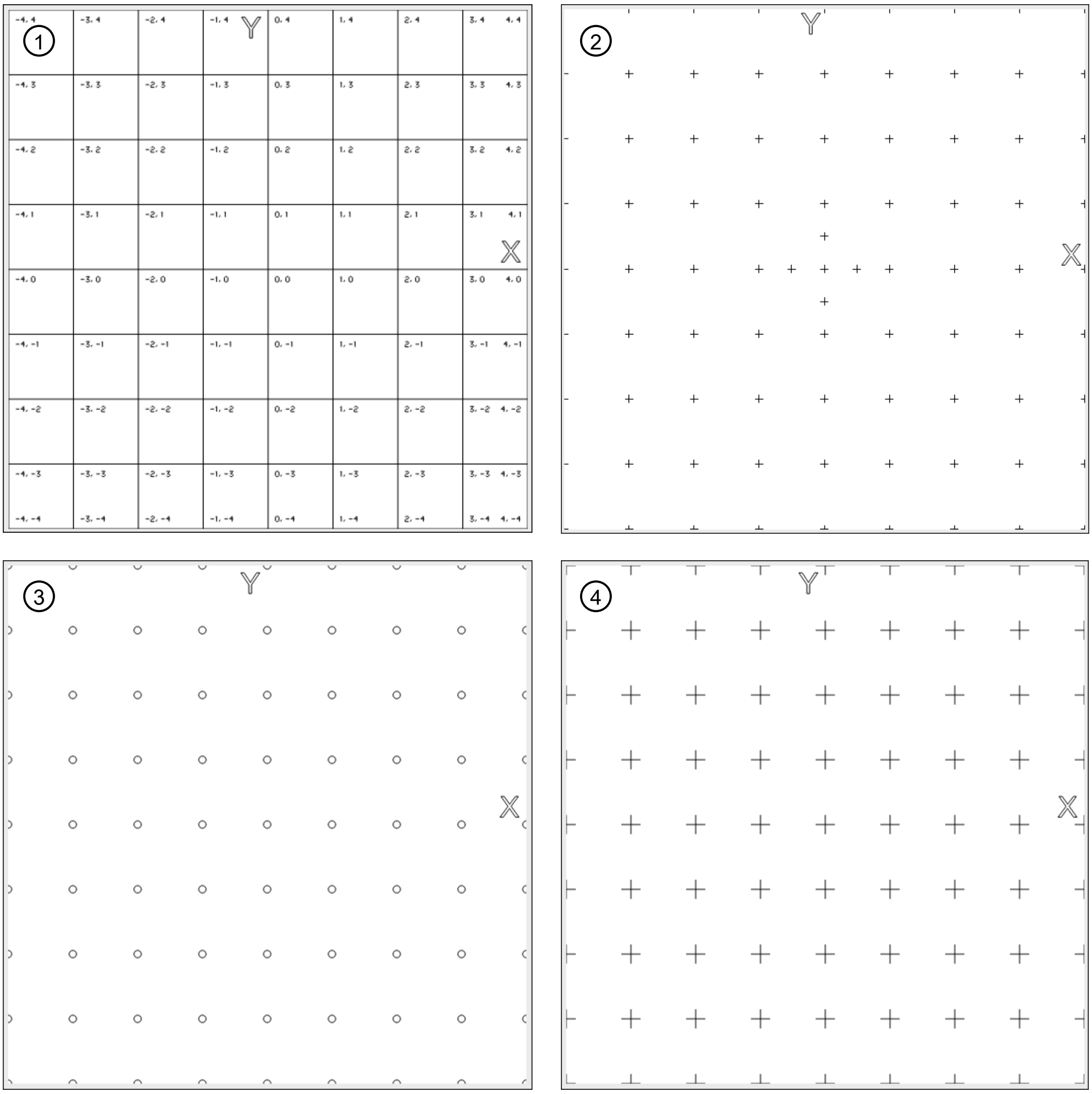


Fig. 7.2: MPE-AAO

1 Grid style (with labels)

2 Drill style (with highlighted center)

3 Circle style

4 Cross style

Z-lines (for focus calibration of prefocusing deflection units)

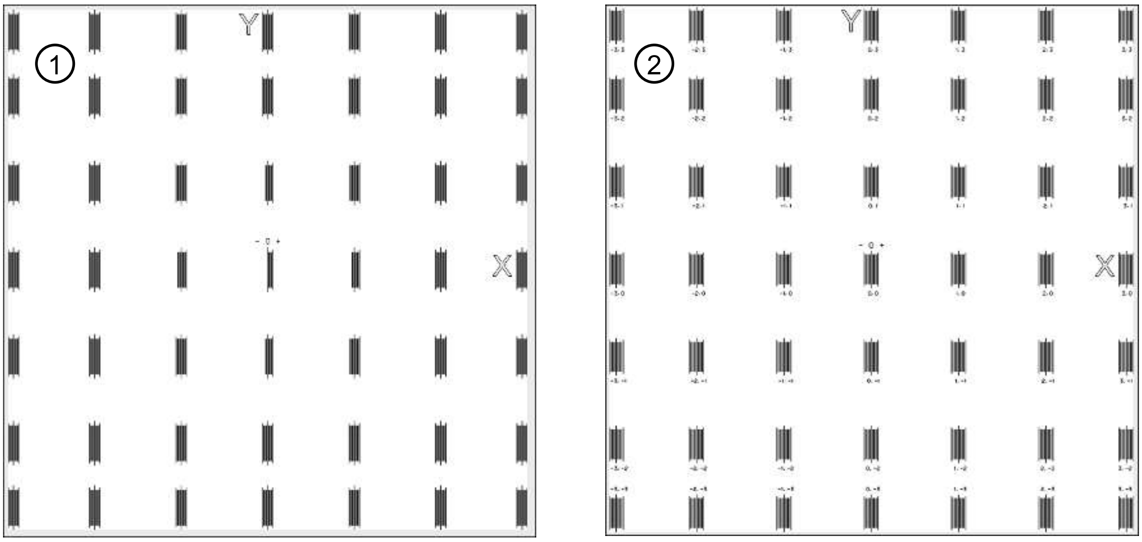


Fig. 7.3: MPE-AAP

1 Z-lines (none-Z-lens-offset CF)

2 Z-lines (predefined Z-lens-offset CF)

- Correction file without Z-lens offset:

  The center positioned line-arrays miss some lines, because the focus positions of those lines would be beyond what the Z-lens can reach.
- Correction file with predefined Z-lens offset:

  Usually every focus position of the pattern can be reached. Therefore, all grid positions show their defined number of lines.

7.1.1.3 Defining the process parameters, used to mark the pattern

Pen	Select a pen to define the process parameters for marking the pattern This option is only available when MPE is started from the RAYGUIDE application.

Table. 7.3: MPE-002

Scanner	
Click the ***[Download]*** button to download the current process parameters for the deflection unit and laser from the connected control card: 	
Mark Speed [m/s]	Speed of the laser spot on the material
Mark delay [µs]	This value is applied after a mark vector, often before a subsequent jump vector. The value refers to the dynamics of the deflection unit.
Poly Delay [µs]	The value refers to the dynamics of the deflection unit. The delay is applied at the transition point between two consecutive mark vectors.
Jump Speed [m/s]	Relative speed, when the deflection unit changes position without laser emission.
Jump Delay [µs]	The delay is applied after a position jump, often before a subsequent mark vector. The value refers to the dynamics of the deflection unit.

Table. 7.4: MPE-003

Laser	
Power [%]	Power value to set emitted laser power. The percentage always refers to a 100 % scale.
LM Frequency [kHz]	Value to define the pulse rate of the laser modulation (LM) signal.
LM Width [µs]	Value to define the pulse width of the laser modulation (LM) signal.
Laser-On Delay [µs]	Values to synchronize the laser activity with the mirror position at the start and end of a laser path. It can also be set with a negative sign.
Laser-Off Delay [µs]	

Table. 7.5: MPE-004

IMPORTANT NOTES when the MPE is not started from the RAYGUIDE application:

The MPE only allows the most important process parameters to be set. All other process parameters must be set using the control card **config tool**.

All system configuration settings, such as the laser configuration, must also to be set using the control card **config tool**.

7.2 Executing the marking pattern "job"

Main controls for execution:

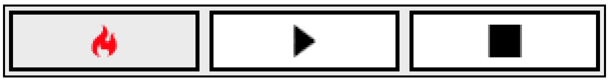


Fig. 7.4: MPE-AAQ

To execute the pattern with the laser, the ***[Arm]***-Button must be turned ***ON*** (red).

Otherwise, the control card won´t request laser emission.

NOTE: When the laser is disarmed, the MPE commands the pointer signal to be on.

To start the execution, press the ***[Play]*** button.

In each case, a pop-up dialog will first display the Z position for the marking.

Example:

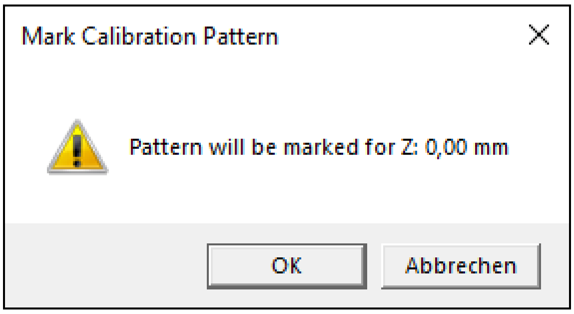


Fig. 7.5: MPE-AAR

NOTE for 3D calibration: If the marking is to be performed in a multi Z level selection, the popup will reappear for each selected Z position until all positions have been processed. In this way, the popup pauses the execution loop to give you time to place the marker material at the new focus position.

Only after confirming this message, the execution will start.

The status bar indicates whether the laser job running:

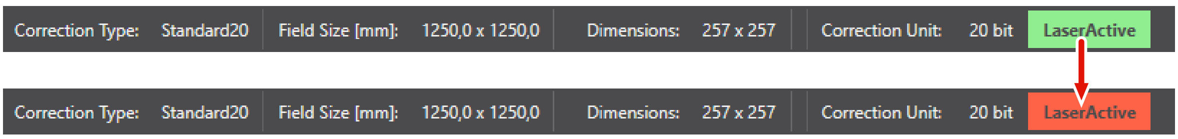


Fig. 7.6: MPE-AAS

Use the ***[Abort]*** button to stop the execution at any time.

7.3 Entering the measurements

7.3.1 Creating a new measurement table

The best practice is to use the ***[New table]*** button right below the execution buttons:

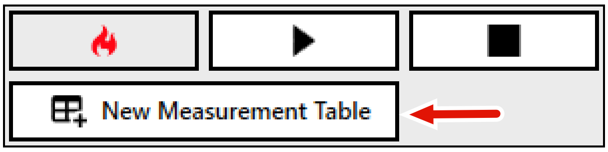


Fig. 7.7: MPE-AAT

This way, the table will already appear with the correct number of cells according to the previously selected grid points, and all cells that are not in the optionally defined sub field will be crossed out.

Alternatively, you can use the menu item ***Measurement > New table***. This can be used when the grid has been marked without using the MPE.

The dialog that appears requires the following information (depending on the correction file):

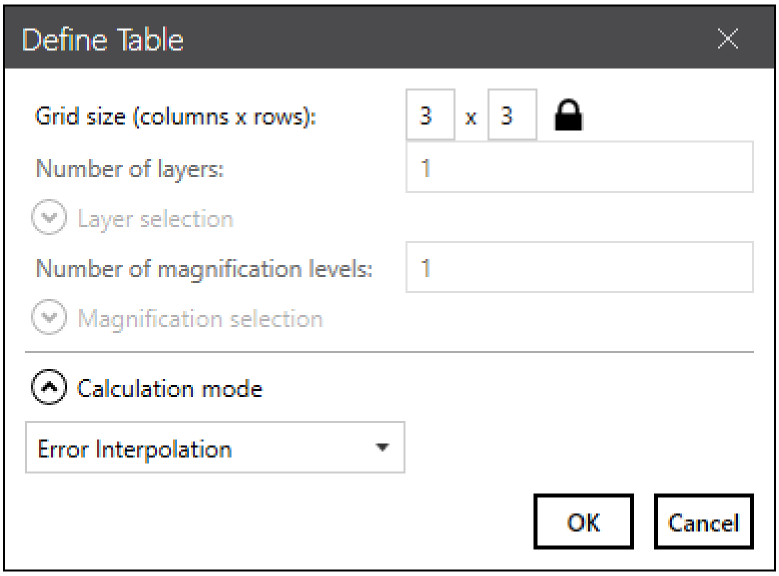


Fig. 7.8: MPE-AAU

Define table	
Grid Size (columns x rows)	It is recommended to use a grid, whose grid points correspond to 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. **NOTE:** The grid size should be the same as the number of grid points which were marked. **APPLICATION NOTE:** A 9 x 9 grid is usually sufficient for position accuracy. Use the [Lock] button to allow different values for columns and rows if necessary.
Number of layers [8]	In the case of a 3D correction file, you can define the number of Z layers in which you have marked and measured pattern to perform the XY field calibration.
Layer selection [8]	Use the expander to view the layer selection: Shows a preselection of the layers (count and Z value) evenly distributed according to the defined number of layers in relation to the available layers of the loaded correction file. If desired, use the drop-down selection to switch to another available layer.
Number of magnification levels [9]	In the case of a correction file that supports a zoom lens (e.g. for RAYLASE AM-MODULE), you can specify the number of marked magnification levels and measured pattern to perform the XY field calibration.
Magnification selection [9]	Use the expander to view the magnification selection: Shows a preselection of the levels (count and magnification factor) evenly distributed according to the defined number of levels in relation to the available levels of the loaded correction file. If desired, use the drop-down selection to change to another available factor

8 Only accessible if the loaded correction file provides a 3D volume.

9 Only accessible if the loaded correction file supports the ***ZoomZ***-axis.

Define table	
Calculation Mode	Depending on the correction task, the following calculation modes are available: ■ *Error Interpolation* Default mode for any standard XY field correction ■ *Absolute interpolation* If you want to set the field correction directly. For more details refer to *page 40, Enter measurements for focus calibration using absolute values*. ■ *Z-Line* Default mode for Z-axis (focus) calibration The Delta Z [mm] can be either related either to – the lens or – the focus.

Table. 7.6: MPE-005

When the settings are complete, press ***[OK]*** and the new table appears on the ***Measurements*** tab.

7.3.2 Tab “Measurements“

7.3.2.1 Enter measurements for scan field calibration

The Measurements table by default is divided into two tabs:

- one for the X-values and
- one for the Y-values of the measured grid points.

The displayed values, as well as the values in the column / row header, show the expected X- and Y-coordinate value of the grid points in [mm].

In the case of a sub field that's offset relative to the actual scan field, the expected grid coordinates in the table shown refer to the center of the sub field. The grid points themselves are always evenly spread over the sub field size along the two coordinate axes.

Example:

Original Measurements table with sub field definition

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]	-4: -50,00 (-35,00)	-3: -37,50 (-22,50)	-2: -25,00 (-10,00)	-1: -12,50 (2,50)	0: 0,00 (15,00)	1: 12,50 (27,50)	2: 25,00 (40,00)	3: 37,50 (52,50)	4: 50,00 (65,00)
4: 60,00 (70,00)	-50	-37,5	-25	-12,5	0	12,5	25	37,5	50
3: 45,00 (55,00)	-50	-37,5	-25	-12,5	0	12,5	25	37,5	50
2: 30,00 (40,00)	-50	-37,5	-25	-12,5	0	12,5	25	37,5	50
1: 15,00 (25,00)	-50	-37,5	-25	-12,5	0	12,5	25	37,5	50
0: 0,00 (10,00)	-50	-37,5	-25	-12,5	0	12,5	25	37,5	50
-1: -15,00 (-5,00)	-50	-37,5	-25	-12,5	0	12,5	25	37,5	50
-2: -30,00 (-20,00)	-50	-37,5	-25	-12,5	0	12,5	25	37,5	50
-3: -45,00 (-35,00)	-50	-37,5	-25	-12,5	0	12,5	25	37,5	50
-4: -60,00 (-50,00)	-50	-37,5	-25	-12,5	0	12,5	25	37,5	50

Fig. 7.9: MPE-AAV

Example:

Original Measurements table with 4 selected Z-layers

Marking | Measurements | Correction | Graph

0,00
-12,47
-23,16
-28,50
[mm] Layer 0

* 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]	-4: -125,00	-3: -93,75	-2: -62,50	-1: -31,25	0: 0,00	1: 31,25	2: 62,50	3: 93,75	4: 125,00
4: 125,00	-100	-75	-50	-25	0	25	50	75	100
3: 93,75	-100	-75	-50	-25	0	25	50	75	100
2: 62,50	-100	-75	-50	-25	0	25	50	75	100
1: 31,25	-100	-75	-50	-25	0	25	50	75	100
0: 0,00	-100	-75	-50	-25	0	25	50	75	100
-1: -31,25	-100	-75	-50	-25	0	25	50	75	100
-2: -62,50	-100	-75	-50	-25	0	25	50	75	100
-3: -93,75	-100	-75	-50	-25	0	25	50	75	100
-4: -125,00	-100	-75	-50	-25	0	25	50	75	100

Average correction [µm]: 0,00 Maximal correction [µm]: 0,00

Fig. 7.10: MPE-AAW

The slider position connects the measurement table e.g. with the focus layer / magnification layer of the correction file. Now move the slider to each available layer and enter the measured values in the X- and Y-table.

TIP about useless cells: If the scan field contains areas that could not be marked, and therefore no measurement data is available for these grid points, you can select the corresponding cells in the table (multiple selection possible), use the context menu *Toggle ignored cells*.

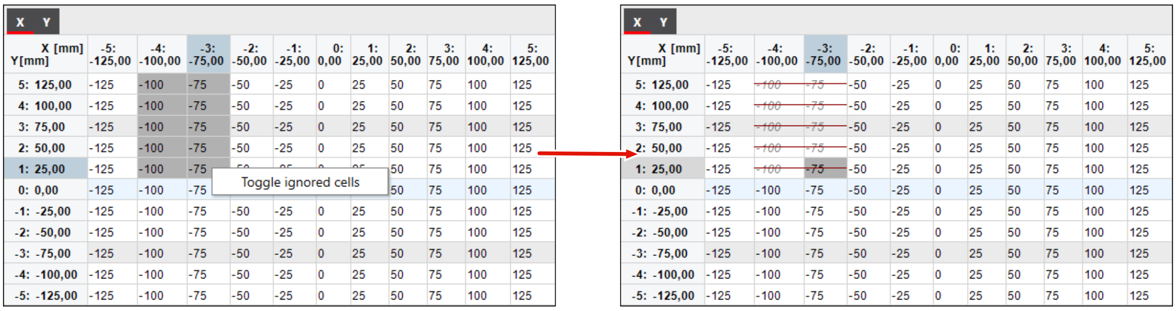


Fig. 7.11: MPE-AAX

The selected cells are then crossed out, just like cells outside a sub field, and are ignored in the error calculation.

NOTE: Note that if too many cells are missing, the calibration result will suffer. This is especially the case if cells are missing at the edge of the sub field, requiring extrapolation..

Below the table, the MPE displays information about the average correction in [µm] and the maximum correction in [µm].

Once all measurement data has been entered, you can use the ***[Show graph]*** option to navigate to the ***Graph*** tab to review the resulting impact of the measurement on the correction file. For more details on the graph, refer to chapter *page 51, Graphical visualization of correction file data*.

Press ***[Apply]*** to calculate the new field correction.

TIP: If you want to save the entered measurement data for further use, e.g. possible re-import or archiving, use the ***Measurement > Save table*** menu.

7.3.2.2 Enter measurements for focus calibration

The Measurements tab only provides one table for the Z-axis.

Different from the field calibration, where you enter the measured grid point coordinate, you have to enter the order number of the "best in focus" line for each grid position. The center line has an order number of zero.

TIP: If the best focus position is not clearly on one line, but between two marked lines, you can also enter a floating point number, e.g. 1,5.

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.

Z

X [mm] Y[mm]	-5: -150,00	-4: -120,00	-3: -90,00	-2: -60,00	-1: -30,00	0: 0,00	1: 30,00	2: 60,00	3: 90,00	4: 120,00	5: 150,00
5: 150,00	1	0	0	0	0	0	0	0	0	0	0
4: 120,00	0	0	0	0	0	0	0	0	0	0	0
3: 90,00	0	0	0	0	0	0	0	0	0	0	0
2: 60,00	0	0	0	0	0	0	0	0	0	0	0
1: 30,00	0	0	-2	0	0	0	0	0	0	0	0
0: 0,00	0	0	0	0	0	0	0	0	0	0	0
-1: -30,00	0	0	0	0	0	0	0	0	0	0	0
-2: -60,00	0	0	0	0	0	0	0	0	0	0	0
-3: -90,00	0	0	0	0	0	0	0	2	0	0	0
-4: -120,00	0	0	0	0	0	0	0	0	2	2	0
-5: -150,00	0	0	0	0	0	0	0	0	0	0	2

Fig. 7.12: MPE-AAY

Move the slider to each layer position and enter the values determined in the tables.

The sign of the order number of the other lines could be noted as follows:

- Left: Vertical line pattern
- Right: Horizontal line pattern

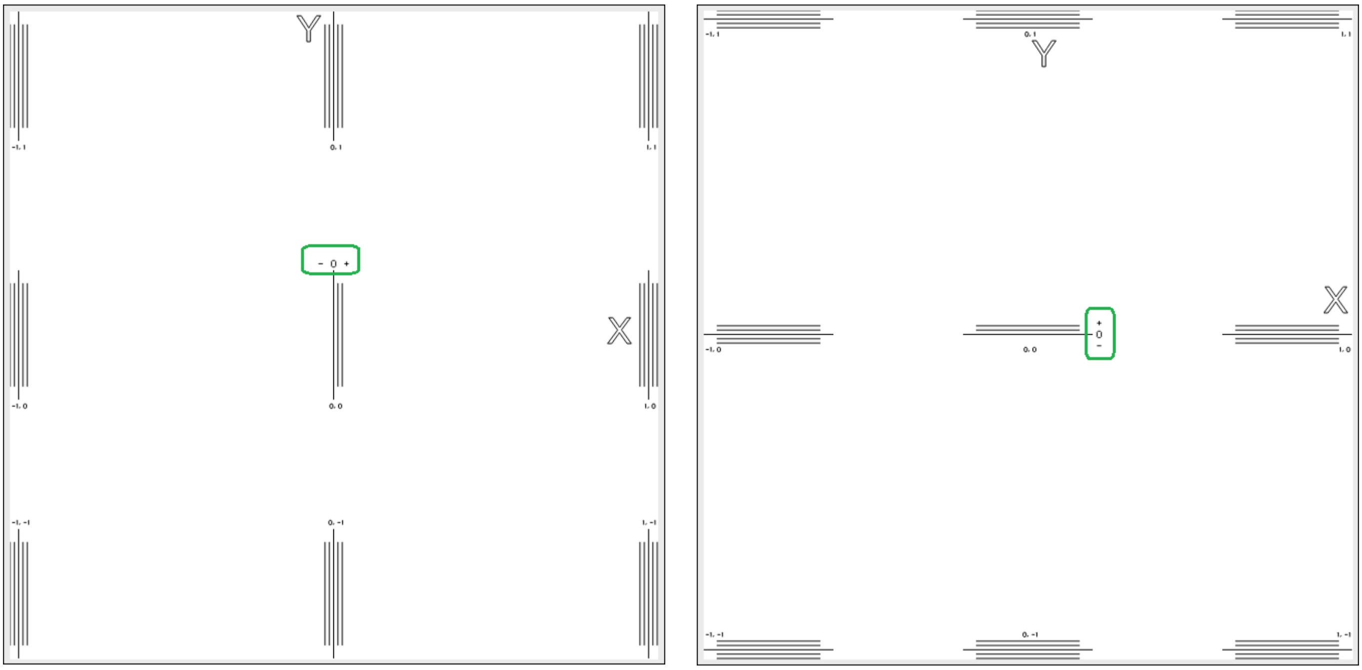
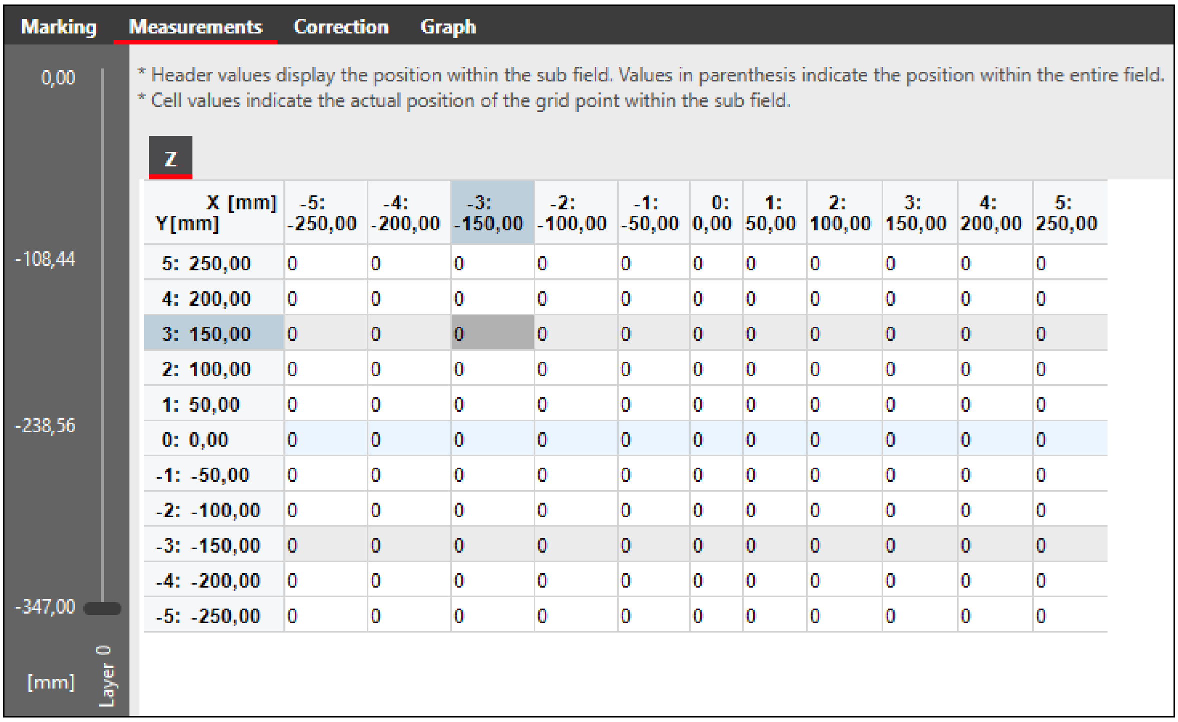


Fig. 7.13: MPE-AAZ

If the focus calibration is to be performed for several focus layers, a layer slider to the left of the table allows you to select the corresponding layer. The layer slider represents your previous done layer selection.



X [mm] Y[mm]	-5: -250,00	-4: -200,00	-3: -150,00	-2: -100,00	-1: -50,00	0: 0,00	1: 50,00	2: 100,00	3: 150,00	4: 200,00	5: 250,00
5: 250,00	0	0	0	0	0	0	0	0	0	0	0
4: 200,00	0	0	0	0	0	0	0	0	0	0	0
3: 150,00	0	0	0	0	0	0	0	0	0	0	0
2: 100,00	0	0	0	0	0	0	0	0	0	0	0
1: 50,00	0	0	0	0	0	0	0	0	0	0	0
0: 0,00	0	0	0	0	0	0	0	0	0	0	0
-1: -50,00	0	0	0	0	0	0	0	0	0	0	0
-2: -100,00	0	0	0	0	0	0	0	0	0	0	0
-3: -150,00	0	0	0	0	0	0	0	0	0	0	0
-4: -200,00	0	0	0	0	0	0	0	0	0	0	0
-5: -250,00	0	0	0	0	0	0	0	0	0	0	0

Fig. 7.14: MPE-ABB

7.3.2.3 Enter measurements for focus calibration using absolute values

As a special approach, you may be able to provide the absolute position of the Z-lens relative to its travel range.

In this case, when defining the measurement table, the calculation mode must be set to “absolute interpolation” and the Z-axis must be selected.

Currently, this mode is only supported for Z-axis.

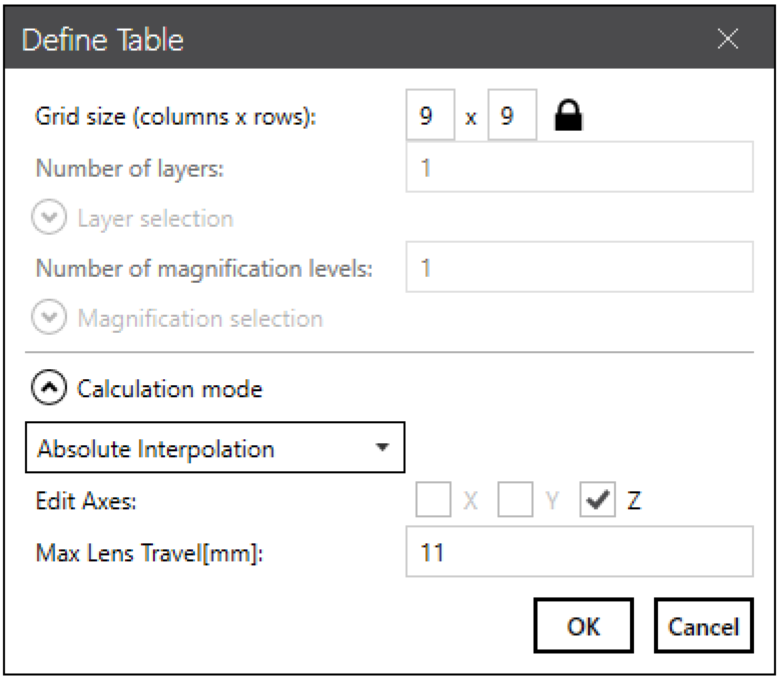


Fig. 7.15: MPE-ABC

The values are now displayed in millimeters and can be edited directly.

When the changes are applied, the values are interpolated to fit the size of the correction table and replace the original correction values of the selected 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.

Z

X [mm] Y[mm]	-4: -75,00	-3: -56,25	-2: -37,50	-1: -18,75	0: 0,00	1: 18,75	2: 37,50	3: 56,25	4: 75,00
4: 75,00	10,956	9,85	9,014	8,493	8,316	8,493	9,014	9,85	10,956
3: 56,25	9,765	8,577	7,677	7,114	6,923	7,114	7,677	8,577	9,765
2: 37,50	8,359	7,606	6,655	6,059	5,856	6,059	6,655	7,606	8,859
1: 18,75	8,291	6,997	6,012	5,395	5,185	5,395	6,012	6,997	8,291
0: 0,00	8,098	6,789	5,793	5,168	4,956	5,168	5,793	6,789	8,098
-1: -18,75	8,291	6,997	6,012	5,395	5,185	5,396	6,012	6,997	8,291
-2: -37,50	8,359	7,606	6,655	6,059	5,856	6,059	6,655	7,606	8,859
-3: -56,25	9,765	8,577	7,677	7,114	6,923	7,114	7,677	8,577	9,765
-4: -75,00	10,956	9,85	9,014	8,493	8,316	8,493	9,014	9,85	10,956

Fig. 7.16: MPE-ABD

7.3.3 Loading measurement values from a file

Loading the measurement from a file can support two main use cases:

- You have saved the previously entered measurements and want to reload them.
- You use a measuring device that automatically measures the marked position and generates a table of values.

The data is entered into a text based file, the application related file name is *.mtf.

The “type= Error” corresponds to the field correction. According to the “Error Interpolation” calculation method these values define the actual marked position.

The “Type = Offset” corresponds to the “Z-Line” calculation mode used when performing the 3rd-axis multi point calibration (see *page 38, Enter measurements for focus calibration*).

If no type is specified, it defaults to Error.

NOTE: The specified field size (in [µm]) must match the field size of the supplied correction file! Otherwise, you will get an exception.

7.3.3.1 Loading the complete measurement data

Go to ***Measurement > Load table*** in order to select the measurement file to load.

This text file must be in the following format:

- Lines to be ignored must begin with '#' or be blank.
- Each row lists one data point.
- All other rows are treated as valid data.
- The coordinates in each valid line must be separated by tab, space, or semicolon.
- The coordinates must follow the US-English numbering style, i.e. '.' (dot) as the decimal point.
- All units (except for row, column etc.) are in microns.

If the header line contains "layer", the first column is interpreted as layer.

If it contains magnification and layer, the first column is magnification, the second is layer.

NOTE: In practice, either the magnification or the layers will have multiple entries, never both.

The header row contains the index of the layer / magnification while the corresponding column contains the count, starting from zero.

If a sub field is defined (`=SubFieldSize`), has an offset (`=SubFieldOffset)`, and if the sub field will be circular (`=IsCircularField`), this information is also mentioned in the header.

NOTE: You may need to save a sample of your specific measurement table to see the format required.

Next are a few examples:

Example 1:

Prefocusing deflection unit, flat field (XY calibration, single layer)

```
# 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
# [Magnification/Layer/]Row/Column: the position where the data point is expected
expressed as [magnification/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:        300000    300000
; Selected layers:
; Selected magnifications:

; Magnification [] Layer [] Row [] Column [] ActualX [um] ActualY [um] ActualZ [um]
0         0         0         0         -150000   -150000   0         0         0
0         0         0         1         -112500   -150000   0         0         0
0         0         0         2         -75000    -150000   0         0         0
0         0         0         3         -37500    -150000   0         0         0
0         0         0         4         0         -150000   0         0         0
0         0         0         5         37500     -150000   0         0         0
0         0         0         6         75000     -150000   0         0         0
0         0         0         7         112500    -150000   0         0         0
0         0         0         8         150000    -150000   0         0         0
0         0         0         0         -150000   -112500   0         0         0
0         0         1         1         -112500   -112500   0         0         0
0         0         1         2         -75000    -112500   0         0         0
0         0         1         3         -37500    -112500   0         0         0
0         0         1         4         0         -112500   0         0         0
0         0         1         5         37500     -112500   0         0         0
0         0         1         6         75000     -112500   0         0         0
0         0         1         7         112500    -112500   0         0         0
0         0         1         8         150000    -112500   0         0         0
0         0         2         0         -150000   -75000    0         0         0
0         0         2         1         -112500   -75000    0         0         0
0         0         2         2         -75000    -75000    0         0         0
```

Table. 7.7: MPE-007

Example 2:

Prefocusing deflection unit, 3D volume (3 focus layers selected for XY calibration)

```
# 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
# [Magnification/Layer/]Row/Column: the position where the data point is expected
expressed as [magnification/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:                   1000000   1000000
; SubFieldSize:                850000    850000
; SubFieldOffset:              0         0
; IsCircularField:             False [10]
```

[10] Example continues on next page.

```
; Selected layers:          0         8         16
; Selected magnifications:

; Magnification [] Layer [] Row [] Column [] ActualX [um] ActualY [um] ActualZ [um]
0         0         0         0         -425000   -425000   0         0         0
0         0         0         1         -318750   -425000   0         0         0
0         0         0         2         -212500   -425000   0         0         0
0         0         0         3         -106250   -425000   0         0         0
0         0         0         4         0         -425000   0         0         0
0         0         0         5         106250    -425000   0         0         0
…
0         1         0         0         -425000   -425000   0         0         0
0         1         0         1         -318750   -425000   0         0         0
0         1         0         2         -212500   -425000   0         0         0
0         1         0         3         -106250   -425000   0         0         0
0         1         0         4         0         -425000   0         0         0
0         1         0         5         106250    -425000   0         0         0
0         1         0         6         212500    -425000   0         0         0
0         1         0         7         318750    -425000   0         0         0
0         1         0         8         425000    -425000   0         0         0
…
0         2         0         0         -425000   -425000   0         0         0
0         2         0         1         -318750   -425000   0         0         0
0         2         0         2         -212500   -425000   0         0         0
0         2         0         3         -106250   -425000   0         0         0
0         2         0         4         0         -425000   0         0         0
0         2         0         5         106250    -425000   0         0         0
0         2         0         6         212500    -425000   0         0         0
0         2         0         7         318750    -425000   0         0         0
```

Table. 7.8: MPE-007

Example 3:

AM-MODULE, flat field (3 magnifications selected for calibration)

```
# 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
# [Magnification/Layer/]Row/Column: the position where the data point is expected
expressed as [magnification/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 [11]
```

[11] Example continues on next page.

```
; Type:                       Error
; FieldSize:                  500000    500000
; Selected layers:
; Selected magnifications:    0         4         8

; Magnification [] Layer [] Row [] Column [] ActualX [um] ActualY [um] ActualZ [um]
0         0         0         0         -250000   -250000   0         0         0
0         0         0         1         -187500   -250000   0         0         0
0         0         0         2         -125000   -250000   0         0         0
0         0         0         3         -62500    -250000   0         0         0
0         0         0         4         0         -250000   0         0         0
0         0         0         5         62500     -250000   0         0         0
0         0         0         6         125000    -250000   0         0         0
…
1         0         0         0         -250000   -250000   0         0         0
1         0         0         1         -187500   -250000   0         0         0
1         0         0         2         -125000   -250000   0         0         0
1         0         0         3         -62500    -250000   0         0         0
1         0         0         4         0         -250000   0         0         0
1         0         0         5         62500     -250000   0         0         0
1         0         0         6         125000    -250000   0         0         0
1         0         0         7         187500    -250000   0         0         0
1         0         0         8         250000    -250000   0         0         0
…
2         0         0         0         -250000   -250000   0         0         0
2         0         0         1         -187500   -250000   0         0         0
2         0         0         2         -125000   -250000   0         0         0
2         0         0         3         -62500    -250000   0         0         0
2         0         0         4         0         -250000   0         0         0
2         0         0         5         62500     -250000
2         0         0         6         125000    -250000   0         0         0
2         0         0         7         187500    -250000   0         0         0
2         0         0         8         250000    -250000   0         0         0
2         0         0         10        -250000   -187500   0         0         0
```

Table. 7.9: MPE-008

Example 4:

AXIALSCAN, flat field (focus calibration)

```
# The fields can be separated by <space>, <tab> or <semicolon>
# The floating point values must use '.' as the decimal point

; Type:                 Offset
; FieldSize:            500000      500000
; SubFieldSize:         450000      450000
; SubFieldOffset:       0           0
; IsCircularField:      False [12]
```

[12] Example continues on next page.

```
; Selected layers:
; Selected magnifications:

; Magnification [] Layer [] Row [] Column [] OffsetX [bit] OffsetY [bit] OffsetZ
[bit]
0           0           0           1           0           0           0
0           0           0           2           0           0           0
0           0           0           3           0           0           0
0           0           0           4           0           0           0
0           0           0           5           0           0           0
0           0           0           6           0           0           0
0           0           0           7           0           0           0
0           0           0           8           0           0           0
0           0           0           9           0           0           0
0           0           1           0           0           0           0
0           0           1           1           0           0           0
0           0           1           2           0           0           14299
0           0           1           3           0           0           0
0           0           1           4           0           0           0
0           0           1           5           0           0           0
0           0           1           6           0           0           0
0           0           1           7           0           0           0
0           0           1           8           0           0           0
0           0           1           9           0           0           0
0           0           2           0           0           0           0
0           0           2           1           0           0           0
0           0           2           2           0           0           0
0           0           2           3           0           0           0
0           0           2           4           0           0           0
0           0           2           5           0           0           0
0           0           2           6           0           0           0
0           0           2           7           0           0           0
0           0           2           8           0           0           42897
```

Table. 7.10: MPE-009

7.3.3.2 Loading a table for a single layer/magnification

Instead of loading the entire measurement table, a single data grid for a (focus) layer or magnification 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 as on *page 42, Loading the complete measurement data*, whereby it must be ensured that the number of rows and columns matches the current measurement table.

7.3.3.3 Importing a list of measurement values

If the measured points are not a uniform grid, a list of measured points defined by expected and actual position can be imported.

Magnification and layer indices can be provided optionally. Currently only X/Y errors can be imported, meaning actual Z must be equal to expected Z if provided.

A new measurement table must be created, taking into account the number of measurements in the prepared list that will be imported next. The number of layers and magnifications will be used as specified in the imported list.

For each point in the measurement table, the nearest three points to the imported points are determined. A plane that is fitted through the measured deviation of these three points then defines the error at that position.

The unit of measurement is [µm] and the decimal point is '.'.

Support format:

<expected X>, <expected Y>, <expected Z>, <actual X>, <actual Y>

NOTE: After loading or importing measurement data, it is still necessary to apply the data and save the calibrated correction file.

8 GRAPHICAL VISUALIZATION OF CORRECTION FILE DATA

When loading a correction file and especially after applying measurements, you may want to visually check the original or modified data.

Use the ***Graph*** tab to view the correction file visualization.

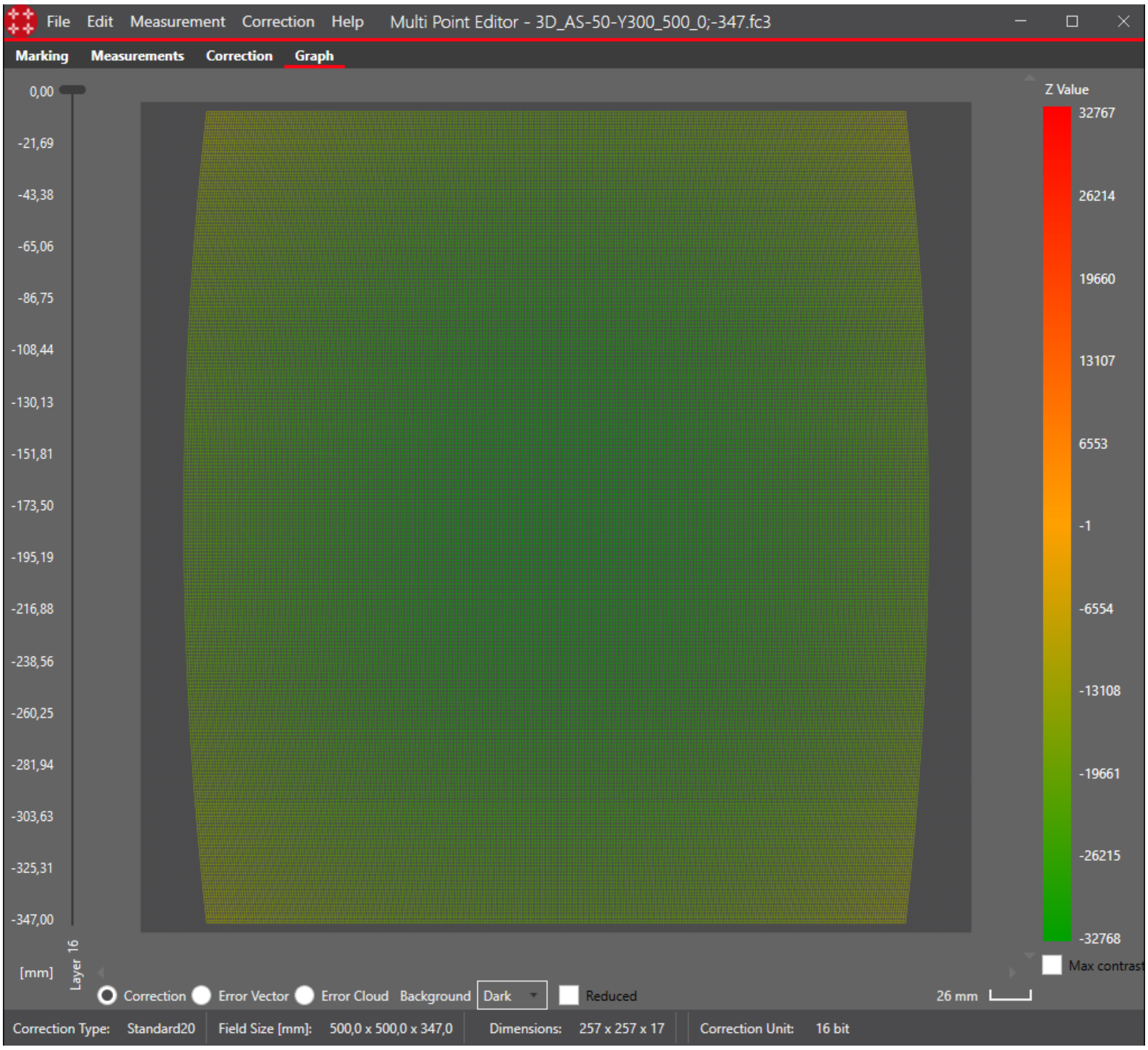


Fig. 8.1: MPE-ABE

NOTE: The background color of the graph can be changed from black to white (dark vs. light) according to the user's preference.

The **color bar** defines the color of the values for the Z-axis over the graph.

The range of values depends on the selected correction unit (refer to *page 75, Settings*):

	16 Bit	20 Bit	Percent
Min. (green)	-32768	-524288	-50
Max. (red)	+32767	+524287	+50

Table. 8.1: MPE-010

The bar can either represent the full range of Z-axis values, or by using the "max contrast" flag, the color range from min to max of the Z-axis will be adjusted to the min/max values of the respective Z-layer.

More than one Z-axis

As soon as a correction file supports more than one Z-axis (linear axis), a selection becomes available (below the checkbox). If the correction file supports an additional Z-axis, select whether the displayed correction data refers to

- Z-axis (focus),
- SensorZ (RAYSPECTOR) or
- Aux-axis (RAYDIME METER).

3D volumes or Zoom-axis

For correction files that support either 3D volumes or a Zoom-axis, a slider is available (to the left of the graph). It can be used to select the layer for which the corresponding correction data should be displayed.

Navigation

Navigating the graph:

- Scroll to zoom in / out,
- Left drag to pan.

Type of data visualization	Description
Correction	Shows the grid of correction values Use the “reduced” flag to change the number of grid lines from original (usually 257 x 257) to 65 x 65
Error vector [13]	The error vector graph shows the measured and the expected locations. The measured points are green and the expected points blue. The resulting correction is shown as a red arrow.
Error cloud [13]	The error cloud displays the necessary XY correction of each measured point. The color is defined by the distance of the measured point from the center, i.e. the color changes from green (center) to red (corner). The scale of the plot is shown as plot size [µm] in the lower right corner. This can be useful for deeper analysis of the nature of the errors (e.g. if the whole field has the same offset, all points would be displayed at the same position).

Table. 8.2: MPE-011

[13] This display option is only useful as long as the deviation between the measured values and the default values can be determined within the MULTI POINT EDITOR. Loading a correction file that has already been edited will no longer provide this information.

9 APPLY MEASUREMENT AND SAVE MODIFIED CORRECTION FILE

After entering the measured values and checking them in the visualization, the values can be applied.

After the values have been applied, a message is displayed informing you of the average and maximum correction:

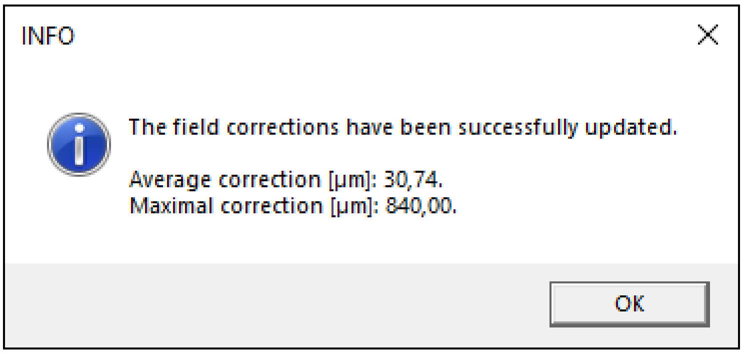


Fig. 9.1: MPE-ABF

Finally, save the modified correction: ***File* > *Save as... Save as...***.

TIP: It is useful to save the file with the same name as the original, but adding information about the type of correction applied and, if necessary, the number of iterations as a suffix.

NOTES:

- If the resulting field with the applied correction exceeds the field size (e.g. because the field was offset), you are notified that the correction values will be clipped to fit the field size.
- Normally, there is no backup of the original correction file, unless you check the option in the MPE settings (***Edit* > *Settings...***).
- An index is appended to the filename, if the target file already exists.
- The standalone application will upload the modified correction when saving (if still connected to the scan controller), and the changes to the correction file will become active. The RAYGUIDE application will also have the modified version in its configuration.

10 GENERATING CORRECTION FILES REPRESENTING A 3D SURFACE

When processing on a 3D surface and the vector data is not available as 3D vectors, there is another way to adapt the focus of the laser beam to the surface. Instead of a correction file representing a 3D volume (cuboid), the correction file, which controls the Z-axes anyway, maps the surface shape.

To do so, the MPE offers two features.

These features require starting with a correction file that provides a 3D volume.

The result is a correction file that represents the outer shell, i.e. a single 2D layer that follows the 3D surface.

NOTE: It is recommended to perform regular field and focus corrections on the 3D volume before starting to create a 3D surface correction file.

10.1 Apply wrapped surface

This option allows you to create 3D correction files that not only represent a 3D surface, but also correct the XY position of the incoming layout coordinates so that the layout wraps onto the surface.

To calculate the correction, only certain types of surfaces are supported:

- cylindrical surface,
- inclined plane.

10.1.1 Mode: Cylinder

Select: ***Apply wrapped surface* > *Mode: Cylinder***

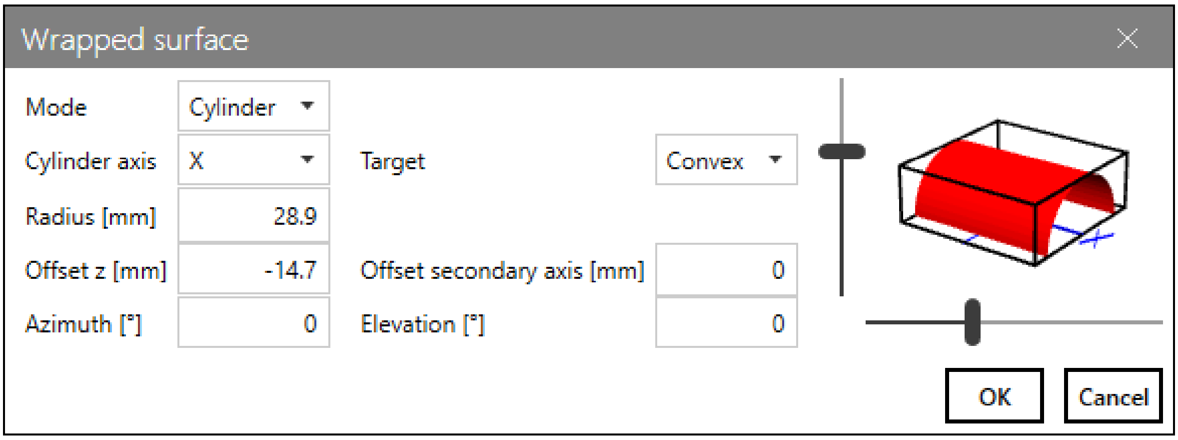


Fig. 10.1: MPE-ABG

Element	Description
Cylinder axis	Specify whether the cylinder axis is placed along the X- or Y-axes.
Target	Select whether the cylinder represents a concave or convex curvature
Radius [mm]	Enter the radius of the cylinder in [mm].
Offset z [mm]	Offset of the cylinder axis relative to the zero plane of the correction file.
Offset secondary axis [mm]	Enter the parallel offset of the cylinder axes to the selected coordinate axes.
Azimuth [°] [14]	Horizontal angle of the cylinder axes relative to the selected coordinate axes.
Elevation [°] [14]	Vertical angle of the cylinder axes relative to the selected coordinate axes.

Table. 10.1: MPE-012

[14] Azimuth and elevation angles are limited to a maximum of ±10 degrees.

10.1.2 Mode: Plane

Select: ***Apply wrapped surface*** **>** ***Mode: Plane***

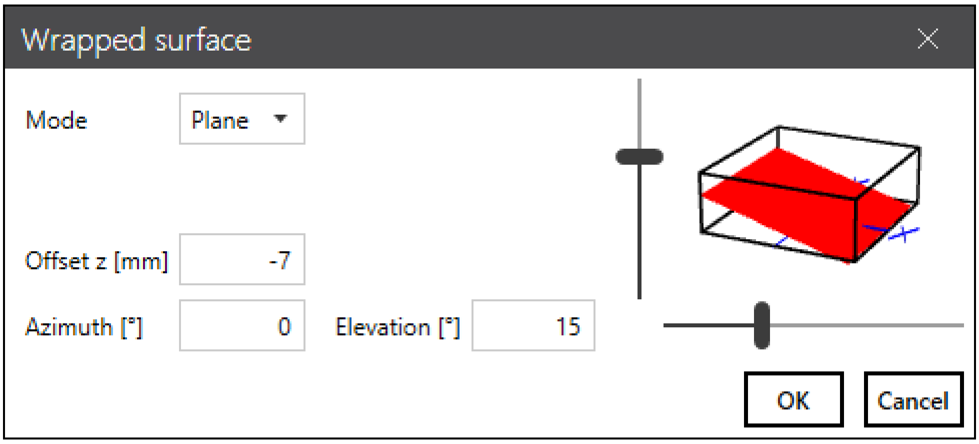


Fig. 10.2: MPE-ABH

Element	Description
Offset z [mm]	Offset of a “flat” plane relative to Z=0.
Azimuth [°] [15]	Horizontal rotation angle of the inclined plane relative to the X-axis.
Elevation [°] [15]	Tilt angle of the inclined plane in vertical perspective.

Table. 10.2: MPE-013

[15] Azimuth and elevation angles are limited to a maximum of ±10 degrees.

10.2 Apply projection

This option allows you to create almost any kind of 3D surface by importing the surface shape from an STL file. With this option, only the Z data of the correction file is matched to the surface, resulting in a projected image of the layout being processed. As an alternative to importing an STL file, you can define a sphere shape by entering its radius and position.

10.2.1 Mode: Sphere

Select: ***Apply projection*** > ***Mode: Sphere***

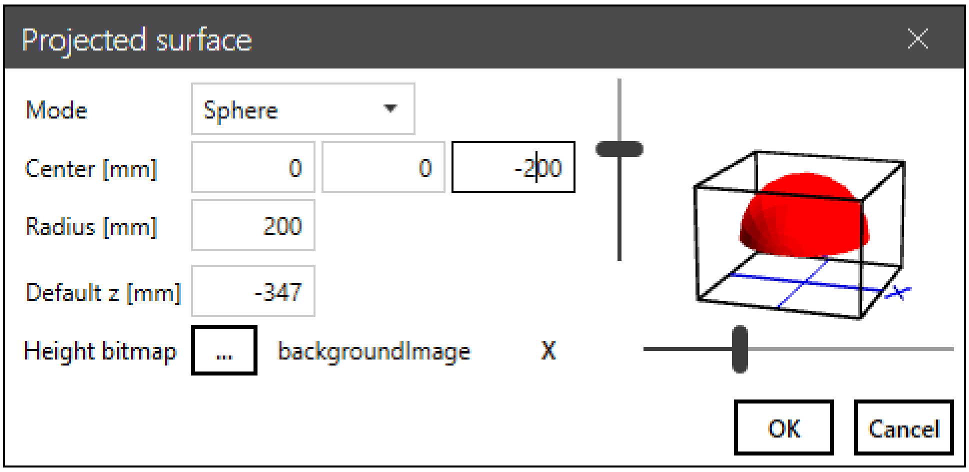


Fig. 10.3: MPE-ABI

Element	Description
Center [mm] (X/Y/Z)	Coordinate of the center of the sphere relative to the origin of working volume.
Radius [mm]	Enter the radius in [mm] of the sphere. A positive radius results in a convex sphere, while a negative radius results in a concave sphere.
Default z [mm]	Defines the Z-position for all XY-positions, that do not meet the surface of the sphere.

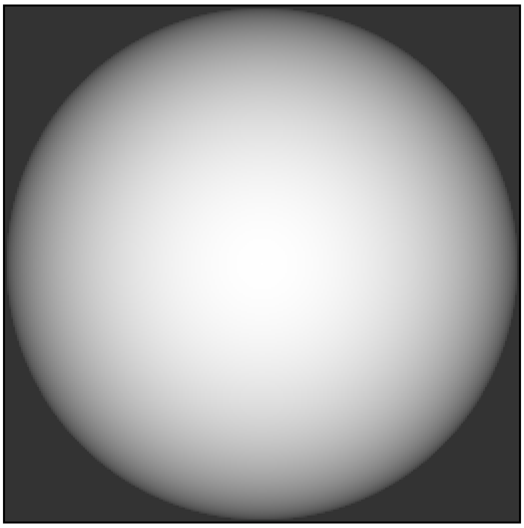
Element	Description
Height bitmap […]	Browse to a folder and specify a file name for a height-representing image. Example:  This image can be e.g. loaded into the background of RAYGUIDE as an orientation for where to place the layout object in order to hit the 3D surface. **NOTE:** The darker the deeper the focus compared to Z = 0.

Table. 10.3: MPE-014

10.2.2 Mode: STL File

Select: ***Apply projection* > *Mode "STL"***

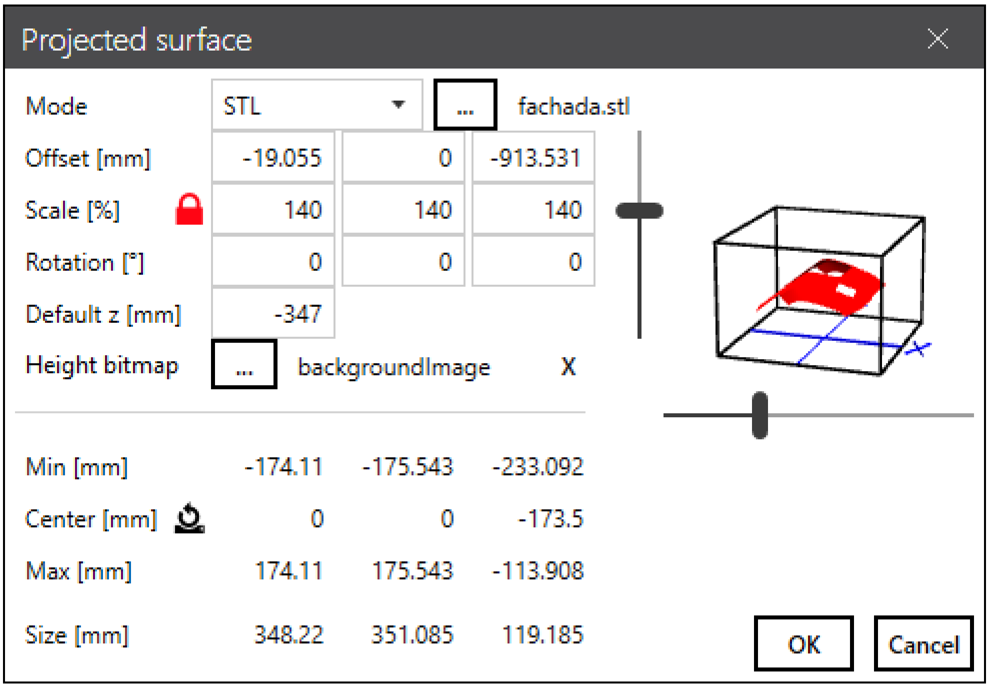


Fig. 10.4: MPE-ABJ

Element	Description
[…] Select file	Browse to the desired STL file and load it.
Offset[mm]	Define the offset from the origin of the STL File to the origin of the working volume given by the correction file.
Scale [%]	Scaling of the STL file dimensions in percent (in X-, Y-, Z-dimension) By default, the dimensions are locked for the same aspect ratio. Unlock if necessary.
Rotation [°]	Enter an angle to rotate the 3D surface relative to the axis of the correction file
Default z]mm]	Defines the Z-position for all XY positions, that do not meet the STL surface.

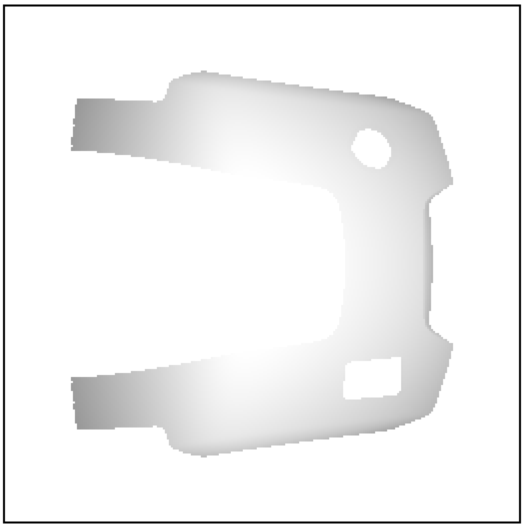
Element	Description
Height bitmap [...]	Browse to a folder and specify a file name for a height-representing image. Example:  This image can be e.g. loaded into the background of RAYGUIDE as an orientation, where to place the layout object in order to hit the 3D surface. NOTE: The darker the deeper the focus compared to Z = 0.
Infos	
Min.[mm] (X/Y/Z)	Shows the minimum position of the surface in each axis direction
Center [mm]	Use the ***[Reset]*** button to center the surface inside the volume. This sets the STL origin to the working volume origin. The values show the actual offset between the two origins.
Max.[mm] (X/Y/Z)	Shows the maximum position of the surface in each axes direction.
Size [mm] (X/Y/Z)	Surface size along the three axis dimensions, including scaling.

Table. 10.4: MPE-015

TIP: To avoid cropping the imported surface, make sure all positions are inside the 3D volume.

Next to the value field, a preview shows the actual position of the surface relative to the working volume. Use the two sliders to adjust the point of view.

11 CORRECTION FILE HEADER

The *.fc3 correction file contains a lot of additional information in what is called the "header". This information includes the metadata, too.

Go to ***Edit > Change header***

The only editable value here is the Z-offset, which can be used to set the reference plane (Z = 0) other than the default defined by RAYLASE.

The *Info field* can be used to enter custom information.

NOTE: The header data is used by the control card, while the metadata is just additional information that specifies more detailed information about the optical setup that the correction file applies to.

Example: AM-MODULE header

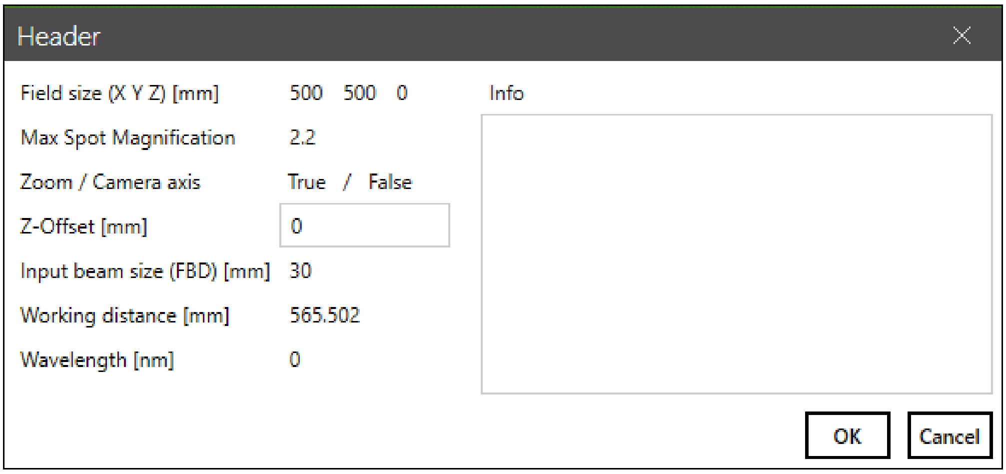


Fig. 11.1: MPE-ABK

Example: Header with additional metadata

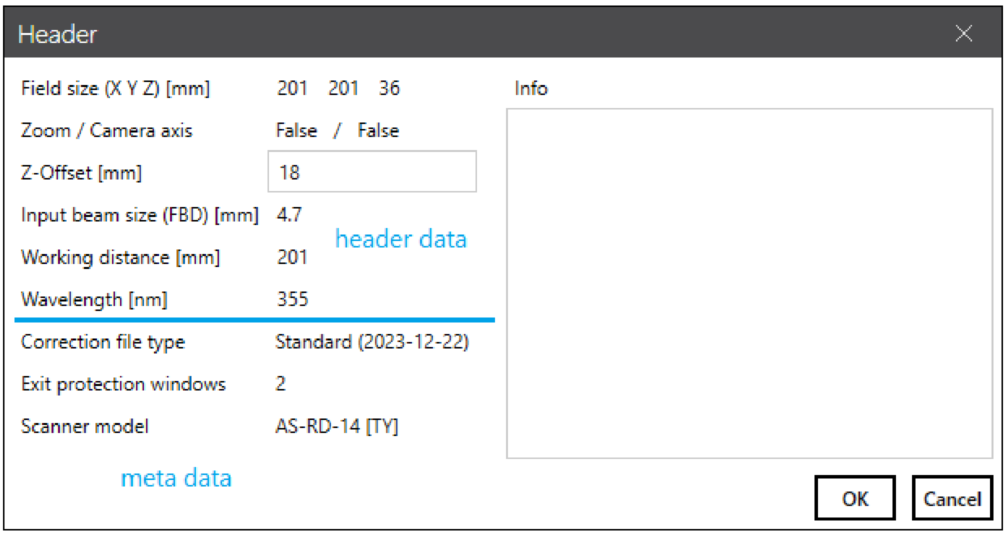


Fig. 11.2: MPE-ABL

12 POSITION DEPENDENT POWER CORRECTION FILE

The MULTI POINT EDITOR software can also be used to create power correction files. These files are uploaded to the control card to adjust the laser power based on the field position.

A common use case would be to compensate for the variation in power density caused by variation in spot size due to deflection angle.

To generate a new power correction file, select ***File* > *Generate power correction*.**

NOTE: The power correction is not part of the field correction. Instead, this method creates a special correction file named *.pc3.

In the following dialog, you have to define the number of grid points and layers (in case of a 3D workspace) as well as the field size (according to the used field correction file).

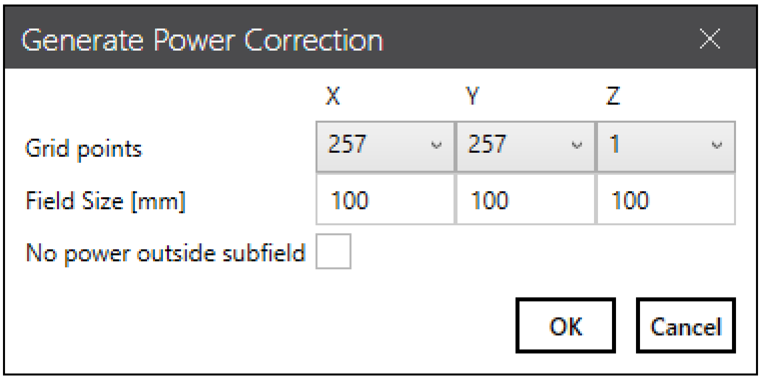


Fig. 12.1: MPE-ABM

In addition, the "No power outside sub field" flag can be checked to force power scaling to zero outside the sub field. This type of power correction is used, for example, to avoid laser power emission when the scanner targets a position outside the defined sub field (see *page 19, Optional field range limitation for calibration (sub field)*.

NOTE: To use the flag, the sub field must first be defined (in a field size that matches the field size of the power correction, or a field correction file with a sub field definition must have been loaded before (refer to *page 19, Optional field range limitation for calibration (sub field)*).

When you click ***[OK]***, the basis for the power correction is created, resulting in a scale factor = 1 for the entire field used.

NOTE: Although you are presented with a measurement table, this 3 x 3 table is not ready for your input.

Next, go to the ***Measurement > New table*** menu to create the table for entering the scaling factors for the power correction required.

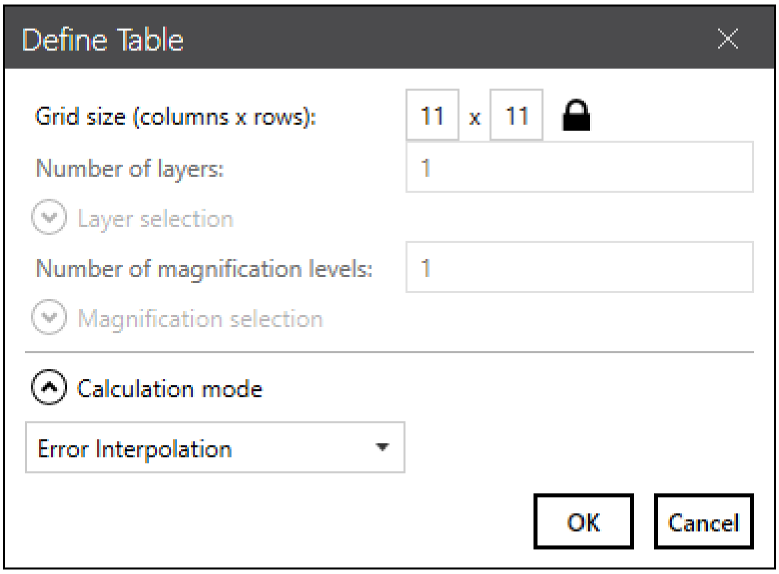
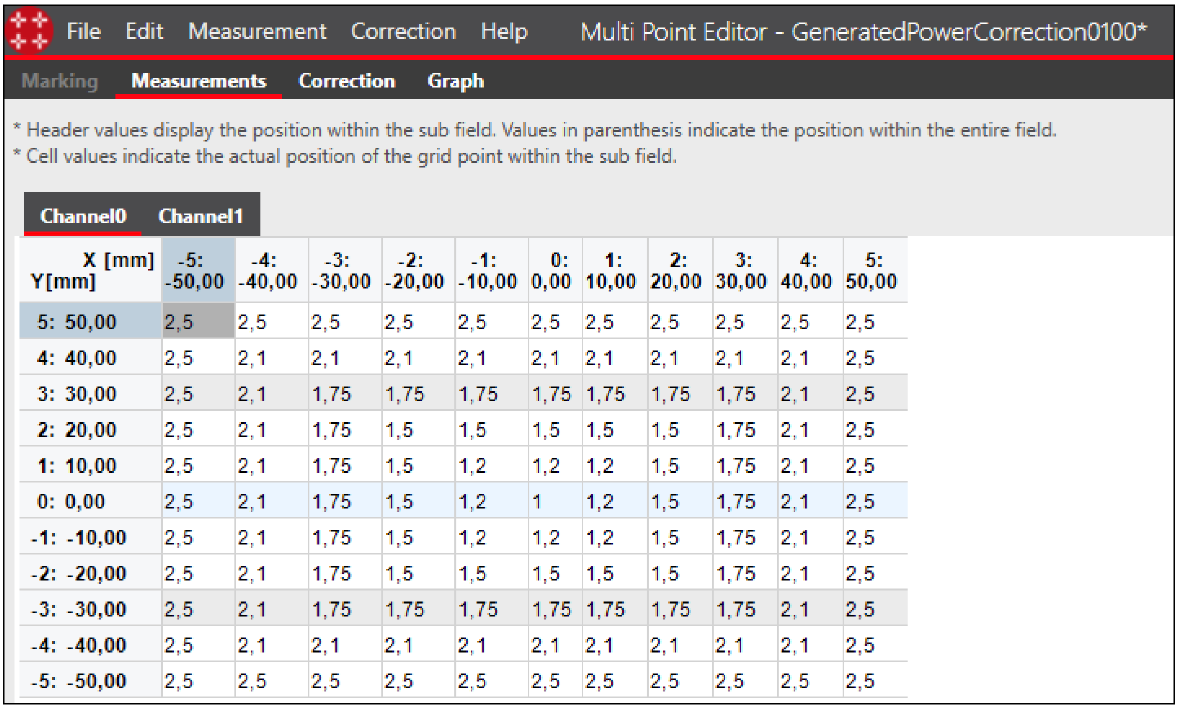


Fig. 12.2: MPE-ABN

The grid with the channel0 tab is used to control the laser power on the main power control card. Channel1 is optional if the laser has defined a secondary power target (usually Dac1).

The range of values to enter can be from factor 0 to factor 4. You can also enter decimal values, the display will just round them to 2 digits.

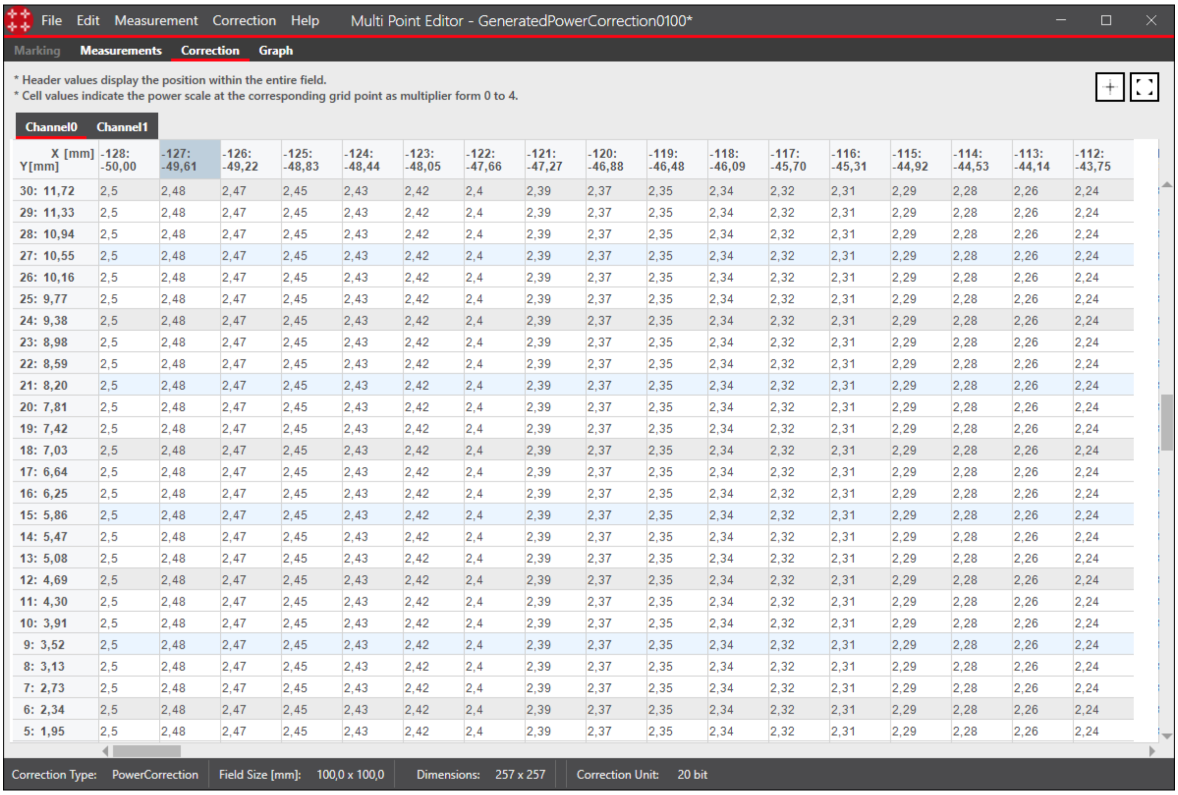


Y[mm] \ X [mm]	-5: -50,00	-4: -40,00	-3: -30,00	-2: -20,00	-1: -10,00	0: 0,00	1: 10,00	2: 20,00	3: 30,00	4: 40,00	5: 50,00
5: 50,00	2,5	2,5	2,5	2,5	2,5	2,5	2,5	2,5	2,5	2,5	2,5
4: 40,00	2,5	2,1	2,1	2,1	2,1	2,1	2,1	2,1	2,1	2,1	2,5
3: 30,00	2,5	2,1	1,75	1,75	1,75	1,75	1,75	1,75	1,75	2,1	2,5
2: 20,00	2,5	2,1	1,75	1,5	1,5	1,5	1,5	1,5	1,75	2,1	2,5
1: 10,00	2,5	2,1	1,75	1,5	1,2	1,2	1,2	1,5	1,75	2,1	2,5
0: 0,00	2,5	2,1	1,75	1,5	1,2	1	1,2	1,5	1,75	2,1	2,5
-1: -10,00	2,5	2,1	1,75	1,5	1,2	1,2	1,2	1,5	1,75	2,1	2,5
-2: -20,00	2,5	2,1	1,75	1,5	1,5	1,5	1,5	1,5	1,75	2,1	2,5
-3: -30,00	2,5	2,1	1,75	1,75	1,75	1,75	1,75	1,75	1,75	2,1	2,5
-4: -40,00	2,5	2,1	2,1	2,1	2,1	2,1	2,1	2,1	2,1	2,1	2,5
-5: -50,00	2,5	2,5	2,5	2,5	2,5	2,5	2,5	2,5	2,5	2,5	2,5

Fig. 12.3: MPE-ABO

On the ***Correction*** tab, you will notice that the scaling factors are again distributed over the array of grid points. Since the number of grid points is likely to be larger than the number of points in the measurement table, the values are interpolated accordingly.

Again, there are two subtabs for channel0 and channel1:



X [mm] Y[mm]	-128: -50,00	-127: -49,61	-126: -49,22	-125: -48,83	-124: -48,44	-123: -48,05	-122: -47,66	-121: -47,27	-120: -46,88	-119: -46,48	-118: -46,09	-117: -45,70	-116: -45,31	-115: -44,92	-114: -44,53	-113: -44,14	-112: -43,75
30: 11,72	2,5	2,48	2,47	2,45	2,43	2,42	2,4	2,39	2,37	2,35	2,34	2,32	2,31	2,29	2,28	2,26	2,24
29: 11,33	2,5	2,48	2,47	2,45	2,43	2,42	2,4	2,39	2,37	2,35	2,34	2,32	2,31	2,29	2,28	2,26	2,24
28: 10,94	2,5	2,48	2,47	2,45	2,43	2,42	2,4	2,39	2,37	2,35	2,34	2,32	2,31	2,29	2,28	2,26	2,24
27: 10,55	2,5	2,48	2,47	2,45	2,43	2,42	2,4	2,39	2,37	2,35	2,34	2,32	2,31	2,29	2,28	2,26	2,24
26: 10,16	2,5	2,48	2,47	2,45	2,43	2,42	2,4	2,39	2,37	2,35	2,34	2,32	2,31	2,29	2,28	2,26	2,24
25: 9,77	2,5	2,48	2,47	2,45	2,43	2,42	2,4	2,39	2,37	2,35	2,34	2,32	2,31	2,29	2,28	2,26	2,24
24: 9,38	2,5	2,48	2,47	2,45	2,43	2,42	2,4	2,39	2,37	2,35	2,34	2,32	2,31	2,29	2,28	2,26	2,24
23: 8,98	2,5	2,48	2,47	2,45	2,43	2,42	2,4	2,39	2,37	2,35	2,34	2,32	2,31	2,29	2,28	2,26	2,24
22: 8,59	2,5	2,48	2,47	2,45	2,43	2,42	2,4	2,39	2,37	2,35	2,34	2,32	2,31	2,29	2,28	2,26	2,24
21: 8,20	2,5	2,48	2,47	2,45	2,43	2,42	2,4	2,39	2,37	2,35	2,34	2,32	2,31	2,29	2,28	2,26	2,24
20: 7,81	2,5	2,48	2,47	2,45	2,43	2,42	2,4	2,39	2,37	2,35	2,34	2,32	2,31	2,29	2,28	2,26	2,24
19: 7,42	2,5	2,48	2,47	2,45	2,43	2,42	2,4	2,39	2,37	2,35	2,34	2,32	2,31	2,29	2,28	2,26	2,24
18: 7,03	2,5	2,48	2,47	2,45	2,43	2,42	2,4	2,39	2,37	2,35	2,34	2,32	2,31	2,29	2,28	2,26	2,24
17: 6,64	2,5	2,48	2,47	2,45	2,43	2,42	2,4	2,39	2,37	2,35	2,34	2,32	2,31	2,29	2,28	2,26	2,24
16: 6,25	2,5	2,48	2,47	2,45	2,43	2,42	2,4	2,39	2,37	2,35	2,34	2,32	2,31	2,29	2,28	2,26	2,24
15: 5,86	2,5	2,48	2,47	2,45	2,43	2,42	2,4	2,39	2,37	2,35	2,34	2,32	2,31	2,29	2,28	2,26	2,24
14: 5,47	2,5	2,48	2,47	2,45	2,43	2,42	2,4	2,39	2,37	2,35	2,34	2,32	2,31	2,29	2,28	2,26	2,24
13: 5,08	2,5	2,48	2,47	2,45	2,43	2,42	2,4	2,39	2,37	2,35	2,34	2,32	2,31	2,29	2,28	2,26	2,24
12: 4,69	2,5	2,48	2,47	2,45	2,43	2,42	2,4	2,39	2,37	2,35	2,34	2,32	2,31	2,29	2,28	2,26	2,24
11: 4,30	2,5	2,48	2,47	2,45	2,43	2,42	2,4	2,39	2,37	2,35	2,34	2,32	2,31	2,29	2,28	2,26	2,24
10: 3,91	2,5	2,48	2,47	2,45	2,43	2,42	2,4	2,39	2,37	2,35	2,34	2,32	2,31	2,29	2,28	2,26	2,24
9: 3,52	2,5	2,48	2,47	2,45	2,43	2,42	2,4	2,39	2,37	2,35	2,34	2,32	2,31	2,29	2,28	2,26	2,24
8: 3,13	2,5	2,48	2,47	2,45	2,43	2,42	2,4	2,39	2,37	2,35	2,34	2,32	2,31	2,29	2,28	2,26	2,24
7: 2,73	2,5	2,48	2,47	2,45	2,43	2,42	2,4	2,39	2,37	2,35	2,34	2,32	2,31	2,29	2,28	2,26	2,24
6: 2,34	2,5	2,48	2,47	2,45	2,43	2,42	2,4	2,39	2,37	2,35	2,34	2,32	2,31	2,29	2,28	2,26	2,24
5: 1,95	2,5	2,48	2,47	2,45	2,43	2,42	2,4	2,39	2,37	2,35	2,34	2,32	2,31	2,29	2,28	2,26	2,24

Fig. 12.4: MPE-ABP

As an alternative to entering the values manually, the values can also be loaded from a file. To load power correction values, the "Type" must be "Scale".

Example:

```
# Multipoint FieldCorrection File
# The data contained herein describes the scale applied to the correction values.
# Scale of 1 equals original value

# Each line lists one data point consisting of
# [Magnification/Layer/]Row/Column: the position where the data point is expected
expressed as [magnification/layer/]row/column
# ScaleX/Y/Z: multiplier
# 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 [16]
```

[16] Example continues on next page.

```
; Type:                        Scale
; FieldSize:                   100000    100000
; Selected layers:
; Selected magnifications:

; Magnification [] Layer [] Row [] Column [] ScaleX [] ScaleY [] ScaleZ []
0        0        0        0        2.5      1        1        1        1
0        0        0        1        2.5      1        1        1        1
0        0        0        2        2.5      1        1        1        1
0        0        0        3        2.5      1        1        1        1
0        0        0        4        2.5      1        1        1        1
0        0        0        5        2.5      1        1        1        1
0        0        0        6        2.5      1        1        1        1
0        0        0        7        2.5      1        1        1        1
0        0        0        8        2.5      1        1        1        1
0        0        0        9        2.5      1        1        1        1
0        0        0        10       2.5      1        1        1        1
0        0        1        0        2.5      1        1        1        1
0        0        1        1        2.1      1        1        1        1
0        0        1        2        2.1      1        1        1        1
0        0        1        3        2.1      1        1        1        1
0        0        1        4        2.1      1        1        1        1
0        0        1        5        2.1      1        1        1        1
0        0        1        6        2.1      1        1        1        1
0        0        1        7        2.1      1        1        1        1
0        0        1        8        2.1      1        1        1        1
0        0        1        9        2.1      1        1        1        1
0        0        1        10       2.5      1        1        1        1
0        0        2        0        2.5      1        1        1        1
0        0        2        1        2.1      1        1        1        1
0        0        2        2        1.75     1        1        1        1
0        0        2        3        1.75     1        1        1        1
```

Table. 12.1: MPE-016

After confirming the entered values with the ***[Apply]*** button, similar to the field correction, the entered values can be visualized in a kind of heat map. Clicking the ***[Show graph]*** button switches directly to the ***Graph*** tab to view the power scaling distributed over the scan field.

Example: (corresponds to the values as shown in the previous table)

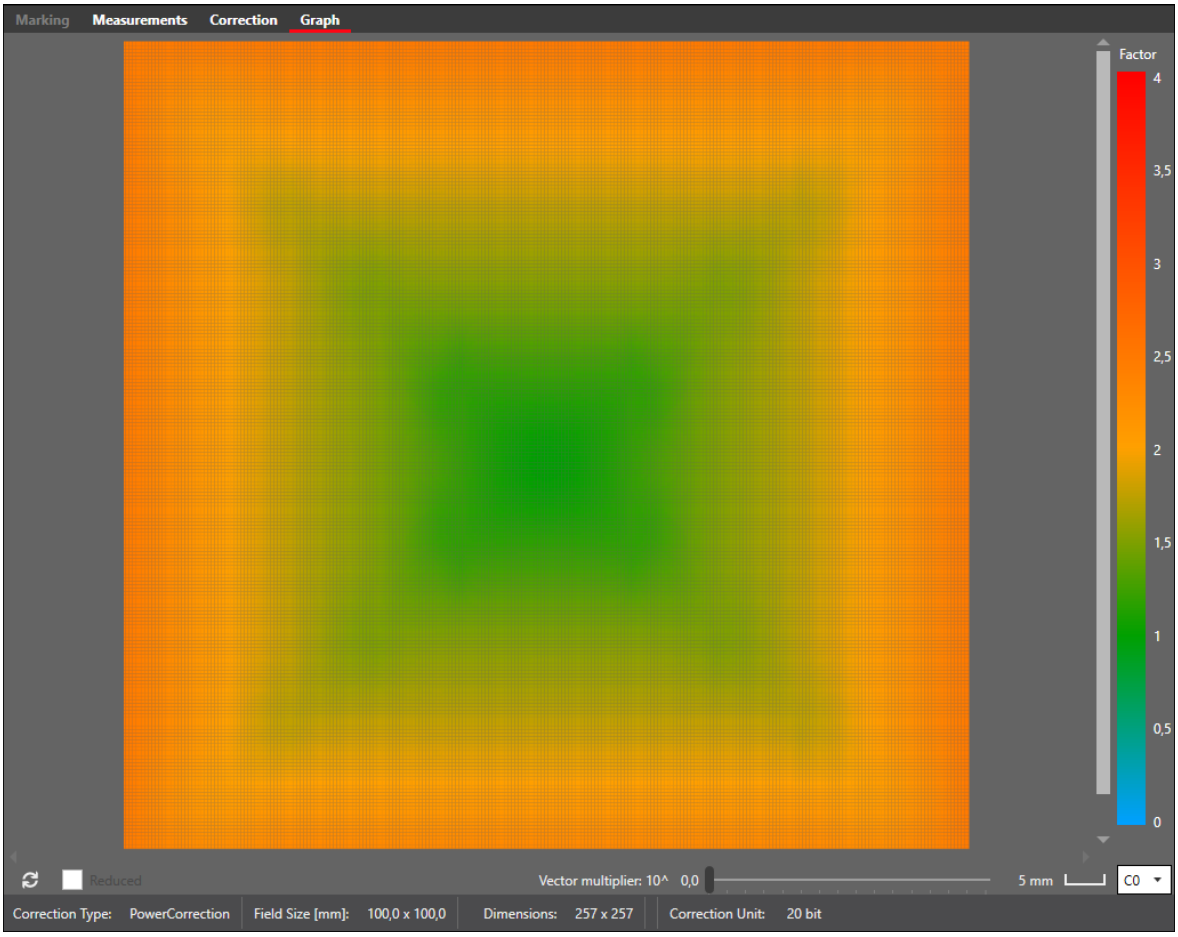


Fig. 12.5: MPE-ABQ

To switch the graph display from channel0 to channel1, use the drop-down menu below the color bar.

Once the power correction is done, you can save the file: ***File > Save / Save as...***

Upload the file to the control card, either directly through API commands or through the RAYGUIDE Laser configuration. The appropriate file type is *.pc3.

13 DETERMINATION OF MAXIMUM PROCESS SPEEDS

On the data sheets of the deflection units, the maximum processing speeds are usually given in [rad/s] and in [mm/s] for the linearly moving Z-axis. These are the speeds at which the lenses move, not, for example, how fast the focus can be moved in the field along the Z-axis.

When working with an AM-MODULE, the magnification speed must also be specified as an application parameter. The speed is given in [1/s], which is the number of magnification change per time.

Information stored in the correction file can be used to convert data sheet values to field domain units. Therefore, the MPE provides a function to analyze and calculate the processing speed.

Go to ***Correction*** **>** ***Analyze***.

The dialog shown below opens and provides the following information and functions:

- Left: Analysis of 3D correction file (example)
- Right: Analysis of an AM-MODULE correction file (example).

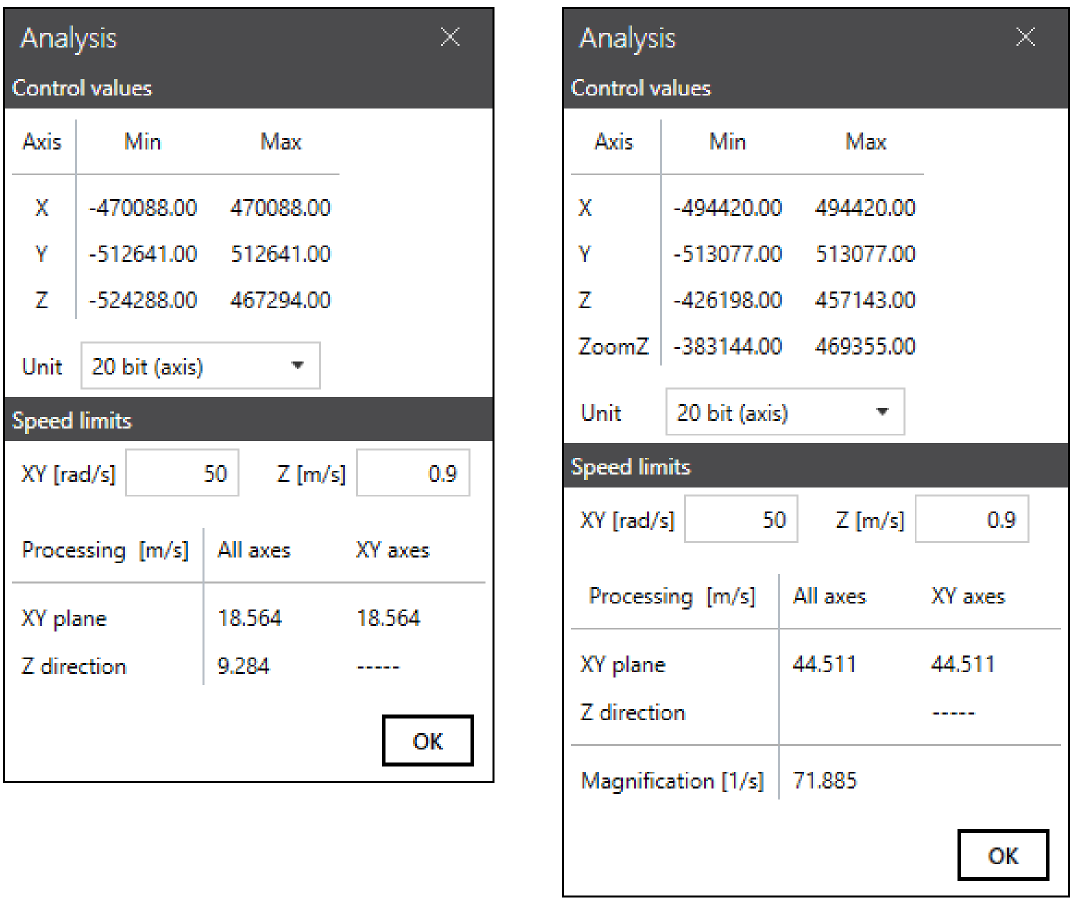


Fig. 13.1: MPE-ABS

13.1 Control values

The table shows the maximum control values used in the correction file per axis depending on the selected units.

You can select the following units:

- 16-bit resolution (valid for XY2-100 protocol),
- 20-bit resolution (valid for SL2-100 or RL3-100 protocol),
- Percent (of axis movement range),
- Percent (margin).

13.2 Speed limits

First, you need to enter the speed limits in [rad/s] as specified in the corresponding deflection unit datasheets.

NOTE: Please be careful to check the value, as it may depend on the aperture size, mirror substrate, and so on.

The Z-axis speed is specified in [mm/s]. The default maximum speed for all common Z-axes is 900 mm/s. If necessary, you can enter a different speed value.

Table explanation	
XY Plane	These values are valid when the scanning trajectory is limited to a XY plane.
Z direction	This value represents the case when the spot moves vertically along the Z direction only.
All axes	This value includes the movement of all axes involved. For example, if the deflection unit is a prefocusing unit, the usually less dynamic Z-axis is also considered to maintain the focus position.
XY axes	This value considers only the movement of the XY mirrors, excluding any possible Z-axis.
Magnification	Value for the maximum possible magnification speed

Table. 13.1: MPE-024

14 COMMAND LINE

14.1 Correction file generation

A command line interface is available to programmatically generate field correction files (*.fc3) or power correction files (*.pc3) using script commands.

The generated file will be saved in the same path as the input file and will have the same name, regardless of the extension. If a file with the same name already exists, it will be overwritten without asking.

If the correction values exceed the field, they are automatically clipped.

14.1.1 Generation of *.fc3 files

For *.fc3 generation the following arguments are expected in this order:

Argument	Default value
fc3	-
txz filename (with path)	-
optional config file name	XYMaxGalvoAngles = 22.5, MaxLensTravel = 11. In case of a focusshifter, MaxLensTravel is calculated as *1048575 / taxiscalfactor.*
optional rows	257
optional columns	257
optional layers	17

Table. 14.1: MPE-027

14.1.2 Generation of *.pc3 files

For *.pc3 generation the following arguments are expected in this order:

Argument	Default value
pc3	-
txz filename (with path)	-
optional rows	257
optional columns	257
optional layers	17

Table. 14.2: MPE-028

14.2 Apply measurement table

The measurement table can be applied to a correction file with or without a sub field.

14.2.1 Without sub field

The following arguments are expected in this order:

Argument	Explanation
applyError	-
correction file name	*.fc3 or *.pc3
measurement table file name	For file format, see *page 41, Loading measurement values from a file*.
optional new correction file name	The original file will be overwritten if the new name is not set. Example including new file name: `MultiPointEditor.exe applyError "correction.fc3" "measurements.mtf" "newFileName.fc3"` Quotes are only necessary if the path contains whitespace.

Table. 14.3: MPE-029

14.2.2 With sub field

The following arguments are expected in this order:

Argument	Explanation
applyErrorSubfield	-
correction file name	*.fc3 or *.pc3
measurement table file name	For file format, see *page 41, Loading measurement values from a file*.
sub field size X [µm]	-
sub field size Y [µm]	-
sub field offset X [µm]	-
sub field offset Y [µm]	-
optional new correction file name	The original file will be overwritten if the new name is not specified.

Table. 14.4: MPE-030

14.3 Apply bit error

A bit error table can be applied to the correction file. The values are interpolated to the dimensions of the correction file and then 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          0          0          0          0          0          500
```

Table. 14.5: MPE-017

The following arguments are expected in this order:

Argument	Explanation
applybiterror	-
correction file name	*.fc3 or *.pc3
bit error table file name	-
optional new correction file name	If the new name is not specified, the original file will be overwritten.

Table. 14.6: MPE-031

14.4 Logging

A log file is created at

%programdata%\RAYLASE\Multi Point Editor\Logs\MultiPointEditorConsole.log

It contains the parameters with which the program was called and any messages.

15 LOG DATA

If MPE is started directly from the RAYGUIDE application, the logging is part of the standard RAYGUIDE logs, see the RAYGUIDE manual.

When the MPE is used as a standalone application, it creates log files in the following path:

C:\ProgramData\RAYLASE\Multi Point Editor\Logs

Two log files are created:

- Application log file: *MultiPointEditor.log*
- SP-ICE-3 log file: *SPICE3Mpe.log*
  It tracks all commands sent to the SP-ICE-3 scan controller.

To navigate to the log files, go to ***Help > Log***

If requested by RAYLASE support, please send these files for troubleshooting to support@raylase.de.

16 SETTINGS

There are two things to define in the ***Settings...*** dialog:

- If and where the backup file of the original correction files is stored.
- Correction display unit: 20 bit / 16 bit / Percent.

To open the dialog, select ***Edit > Settings...***

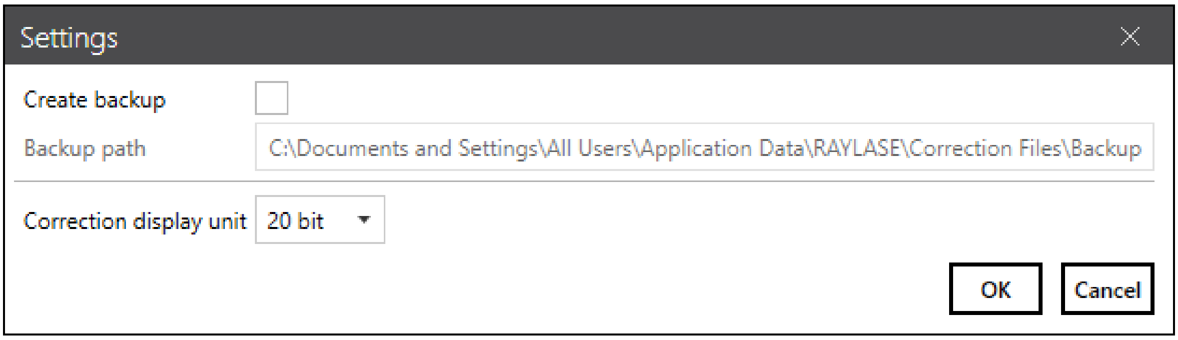


Fig. 16.1: MPE-ABR

17 EXPLANATION OF CORRECTION FILE NAMING

Correction file naming is a continuous improvement process, so you may find it a bit confusing.

The following example should help you to extract the important information from the naming.

Customer specivic correction files may be named differently. The examples below do not cover all possible abbreviations that may be used.

17.1 Correction files for 2-axis deflection units

Correction file name	Explanation
4401-499-000-26_SS-IV-15_LR-20,0-003.fc3	
4401-499-000-26_ SS-IV-15_ LR-20,0-003.fc3	■ Vendor ID F-Theta lens_ ■ SS-IV head model - with 15mm mirror aperture_ ■ Lens ring spec
2407_SS-II-20_4401-508-000-26.fc3	
2407_ SS-II-20_ 4401-508-000-26.fc3	■ RAYLASE list ID_ ■ SS-II to SS-V head model - with 20mm mirror aperture_ ■ Vendor ID F-Theta lens

Table. 17.1: MPE-018

17.2 Correction files for AXIALSCAN, AS FIBER (with or without RAYSPECTOR, RAYDIME METER)

Correction file name	Explanation
2D_AS-F-30-Y_250.0_WD257_off2_PW3+4_SZ2.fc3	
2D_ AS-F-30-Y_ 250.0_ WD257_ off2_ PW3+4_ SZ2.fc3	■ Flat field_ ■ AS FIBER-30mm mirror aperture-YAG wavelength_ ■ 250mm field size_ ■ 257mm working distance_ ■ 2mm Z-Lens offset_ ■ two protective windows_ ■ Support of SensorZ-axis
3D_AS-50-Y_300-1000_WV3917.fc3	
3D_ AS-50-Y_ 300-1000_ WV3917.fc3	■ 3D volume_ ■ AXIALSCAN-50mm mirror aperture-YAG wavelength_ ■ 300mm-1000mm field size_ ■ 3917mm Working Volume
3D_AS-F-30-Y_300_WD318_off2_WV47_PW3+4.fc3	
3D_ AS-F-30-Y_ 300_ WD318_ off2_ WV47_ PW3+4.fc3	■ 3D volume_ ■ AS FIBER-30mm mirror aperture-YAG wavelength_ ■ 300mm field size_ ■ 318mm working distance_ ■ 2mm Z-Lens offset_ ■ 47mm working volume_ ■ two protective windows

Correction file name	Explanation
3D_AS-F-30-633_400_WD447_off5.5_WV10_PW3_SZ2_SZ3.fc3	
3D_	■ 3D volume_
AS-F-30-633_	■ AS FIBER-30mm mirror aperture-633nm special wavelength_
400_	■ 400mm field size_
WD447_	■ 447mm working distance_
off5.5_	■ 5,5mm Z-Lens offset_
WV10_	■ 10mm working volume_
PW3_	■ one protective window_
SZ2_	■ Support of SensorZ-axis_
SZ3.fc3	■ Support of Aux-axis used in RAYDIME METER
2D+M_AS-F-50_370_WD378_off2_def4.0x_NA75_Msq1.1.fc3	
2D+M_	■ Flat field plus magnification_
AS-F-50_	■ AS FIBER-50mm mirror aperture_
370_	■ 370mm field size_
WD378_	■ 378mm working distance_
off2_	■ 2mm Z-Lens Offset_
def4.0x_	■ 4x Defocusing_
NA75_	■ 75mm NA of AS FIBER_
Msq1.1.fc3	■ M^2 of 1.1

Table. 17.2: MPE-019

17.3 Correction files for FOCUSSHIFTER

Correction file name	Explanation
3D_LT-FC3-05-[Y]_4401-301-000-21_MS-14.fc3	
3D_ LT-FC3-05-[Y]_ 4401-301-000-21_ MS-14.fc3	■ 3D volume_ ■ Linear Translator_ ■ FOCUSSHIFTER Compact Size - 3-fold internal beam expansion - 5mm input aperture-YAG wavelength_ ■ Vendor ID F-Theta lens_ ■ MINISCAN - with 14mm mirror aperture
2690_FS-RD-14-Y_017700-025-26.fc3	
2690_ FS-RD-14-Y_ 017700-025-26.fc3	■ MPE List ID_ ■ FOCUSSHIFTER-RAYVOLUTION DRIVE - 14mm mirror aperture – YAG wavelength_ ■ Vendor ID F-Theta lens
2364_FS-L2-05-TY_SS-II-15_4401-481-000-21.gcd	
2364_ FS-L2-05-TY_ SS-II-15_ 4401-481-000-21.gcd	■ MPE List ID_ ■ FOCUSSHIFTER-2-fold beam expansion-5mm input aperture - Triple YAG wavelength_ ■ SS-II to SS-V head models-15mm mirror aperture_ ■ Vendor ID F-Theta lens

Table. 17.3: MPE-020

17.4 Corrections Files for AM MODULE

Correction file name	Explanation
2D_AM-30RD-F085_0500_WD566_off0,5_Z2,2.fc3	
2D_ AM-30RD-F085_ 0500_ WD566_ off0,5_ Z2,2.fc3	■ Flat field_ ■ AM-MODULE-30mm mirror aperture - 85mm focal length collimator_ ■ 500mm field size_ ■ 566mm working distance_ ■ 0,5mm Z-Lens offset_ ■ max. magnification factor = 2.2

Table. 17.4: MPE-021

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TEC-IT Barcode Software

Barcode Overview

Version 11

Reference

5 March 2021

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2.1 Table of Figures

2.2 List of Tables

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:

► **TBarCode OCX**	A Microsoft® ActiveX® compliant barcode control
► **TBarCode .NET**	A .NET barcode library
► **TBarCode Library**	Barcode DLL for Microsoft® Windows® (and UNIX®)
► **Barcode Studio**	A stand-alone barcode designer for Microsoft® Windows®
► **TBarCode/X**	Barcode generators (SDK) for Linux® and UNIX®
► **TFORMer Designer**	Full-featured label and report design
► **TFORMer Runtime**	Label and reporting engine for various operating systems
► **TFORMer Server**	Industrial output management
► **TBarCode/Embedded**	Barcode-enabled print and spool appliance
► **TBarCode/SAPwin**	Barcode DLL for SAP® R/3®
► **TBarCode/Direct**	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

(01)12345678901231

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.

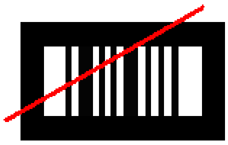
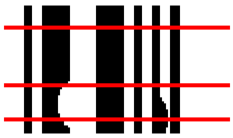
Bar	A bar is represented by the dark or black elements in a barcode.	
Space	The white or lighter elements in a barcode are called spaces.	
Barcode density	The density of the barcode refers to how much space is required for the needed characters (characters per Inch or centimeter)	
Element	Represents 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). 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. 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

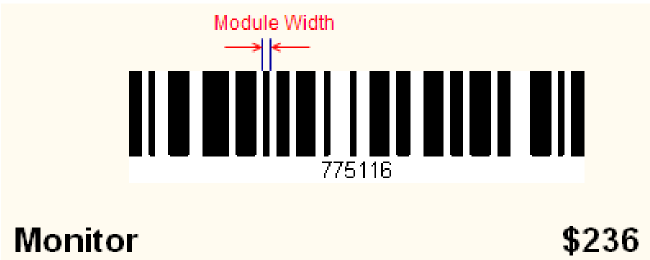


Figure 5: Module Width

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.

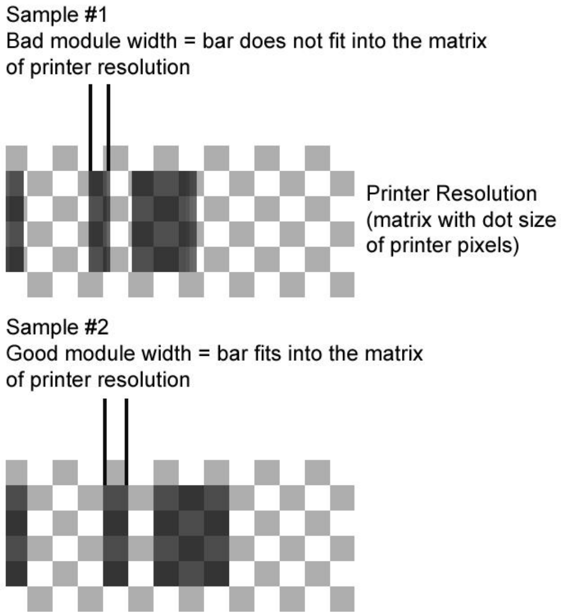


Figure 6: Raster Optimization

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 (1 mil = 1/1000 mm)	**Depth of Field (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 100µm with flexographic printing, 50µm with intaglio printing and 30µm 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 (µm), 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. It most cases the default ratio is the best choice for printing the barcode.

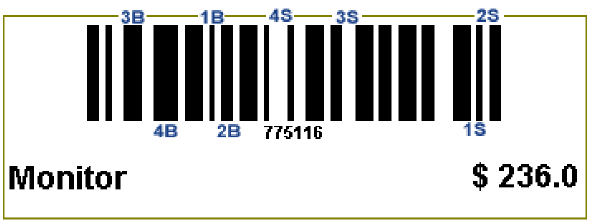


Figure 8: Print Ratio

<u>Example:</u>

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 Bars, the second four values (1S:2S:3S:4S) refer to the 4 different widths of the Spaces. 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 *Text*)
&	Stands for all remaining data characters in the input data (property *Text*)
^	Stands for the next check digit (use only if check digits will be computed!) ▪ TBarCode 6 (or earlier) computes the check digit for all characters in the input data. ▪ TBarCode 7 (or later) only uses input data left of the check digit placeholder for check digit computation (see examples below!).
A	Switch to Subset A (used in: Code 128, GS1-128) Start- or stop character A (only in: CODABAR)
B	Switch to Subset B (used in: Code 128, GS1-128) Start- or stop character B (only in: CODABAR)
C	Switch to Subset C (used in: Code 128, GS1-128) 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), Only for *Pharmacode*: encode the Pharmacode directly (bar by bar) Only for *Data Matrix*: 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: ▪ EAN 8 and add-on variants (both sides) ▪ EAN 13 and add-on variants (only right side) ▪ UPC-A with 2 and 5 digit add-on (only right side) ▪ UPC-E with 2 and 5 digit add-on (only right side) ▪ ISBN (only right side)
>	

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 calcu-lation, c will be ▪ Mod-10 (12345) = 5 for TBarCode 6 (or earlier). ▪ Mod-10 (1234) = 0 for TBarCode 7 (or later).
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	#####^#####	12345**7**67890	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
\a	Bell (alert)	All
\b	Backspace	
\f	Form feed	
\n	New Line	
\r	Carriage Return	
\t	Horizontal Tab	
\v	Vertical Tab	
\\	The backslash \ itself	
\0	Zero Byte (if subsequent char is non-numeric) Available in TBarCode V10+	
\0*ooo*	ASCII-character in octal notation: *ooo* … up to 3 octal digits (0..7) First digit is always zero.	
ddd	ASCII-character in decimal notation: *ddd* … up to decimal digits (0..9) First digit must not be zero.	
\x*hh*	For encoding bytes or ASCII-characters in hexadecimal notation *hh* … hexadecimal digits (0..F)	
\C*rrggbb*	Color selection	See Pharmacode
\Ce	Reset the color to default	
\F	FNC1 (Function Number Character 1) used as field separator	GS-128, Codablock-F MicroPDF417: a special FNC1 code word is inserted when using emulation mode for GS1-128 or Code-128 Data Matrix: a special FNC1 code word is inserted
\F	Inserts a Gs (Group Separator) or ASCII 1DHex. Do not encode the \x1d directly!	PDF417, MaxiCode and in QR Code QR Code: When using format UCC/EAN/GS1 Gs is inserted in Byte Mode, a % is inserted in alphanumeric mode.
\E*nnnnnn*	**E**xtended **C**hannel **I**nterpretation (ECI). *nnnnnn* … 6 digit ECI number with leading zeros 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
\EB, \EE	Special ECI identifiers for nesting ECIs. \EB (**E**CI **B**egin) opens a nesting level, \EE (**E**CI **E**nd) closes it.	QR Code
\G	**G**lobal **L**anguage **I**dentifier (GLI), similar to ECI (see \E).	PDF417
\S	Symbol separator character for C128 emulation	
\<FNCx>	Function sequence. Currently *FNC1*, *FNC2*, *FNC3*, and *FNC4* are implemented. \<FNC1> is equal to \F.	
\x11	DC1	Code93, Code93Ext
\x12	DC2	Code93, Code93Ext
\x13	DC3	Code93, Code93Ext
\x14	DC4	Code93, Code93Ext
\x1e	Rs (Record Separator), ASCII 1EHex	PDF417, QR Code, Data Matrix, MaxiCode (Mode 3,4 SCM)
\x1d	Gs (Group Separator), ASCII 1DHex	PDF417, QR Code, Data Matrix, MaxiCode (Mode 3,4 SCM)
\x04	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)
eCDCode128	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
eCDMod10ItlPst25	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
eCDMod10IMPackage	32	Modulo 10 for Intelligent Mail Package Barcode
eCDMod11W10	33	Modulo 11 (using maximum weight 10)
eCDUPU/ eCDSwedishPostal	34	Modulo 11 method for UPU (Universal Postal Union) 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 = 0112345678901231101234567 8
Human readable text	(01)12345678901231(10)12345678
Encoded data	0112345678901231101234567 8

► 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	10L12345678*FNC1*21S12345

► 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:	0112345678901231 11060606

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)	Must start with 9 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)	Must start with 9 for variable units	
+ AI (392x)	For the price	x = 0..3
or + 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

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[1]
  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

[1] 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 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	
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). Modulo 103 (eCDCode128)	
Possible check digits:	Modulo 10, EAN-14	
Symbol size:	--	
Print control:	C=128	

Alphanum

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	
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). Modulo 103 (eCDCode128)	
Possible check digits:	Modulo 10, EAN-14	
Symbol size:	--	
Print control:	C=128A	

ABab123+/-

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
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). Modulo 103 (eCDCode128)
Possible check digits:	Modulo 10, EAN-14
Symbol size:	--
Print control:	C=128B

ABab123+/-

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
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). Modulo 103 (eCDCode128)
Possible check digits:	Modulo 10, EAN-14
Symbol size:	--
Print control:	C=128C

ABab123+/-

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
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

12345

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:	--

0123456789

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>= 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

12345

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>= 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

0123456

6.1.12 Code 2 of 5 Interleaved

Symbology number:	3
Valid characters:	"0".."9"
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 10 (eCDMod10)
Symbol size:	--
Print control:	C=25L

012345

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
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!) H: Height of the barcode without human readable text L: width of the barcode
Print control:	C=39

TEC-IT

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
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:	--

A012345676

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
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!) H: Height of the barcode without human readable text L: width of the barcode
Print control:	C=39E

Tec

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
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). Modulo 47 (eCD2Mod47)
Symbol size:	--
Print control:	C=93

ABC123-/+

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

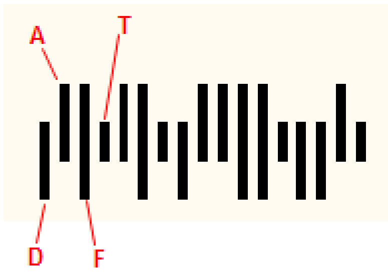
Symbology number:	62
Valid characters:	ASCII-characters between 0..127
Quiet zone:	left/right: 10X, min. ¼ inch
Module width:	X >= 0.19 mm
Standard print ratio:	1:2:3:4:1:2:3:4
Ratio format:	1B:2B:3B:4B:1S:2S:3S:4S
Default check digit:	Automatic (symbology specific). Modulo 47 (eCD2Mod47)
Symbol size:	--
Print control:	C=93E

ABab12-/+

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
Valid characters:	ASCII-characters between 0..127 (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). 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

EAN128

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[2] 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).

[2] Formerly European Article Number (EAN)

6.1.28 EAN-14

Symbology number:	72	
Valid characters:	ASCII-characters between 0..127, 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.

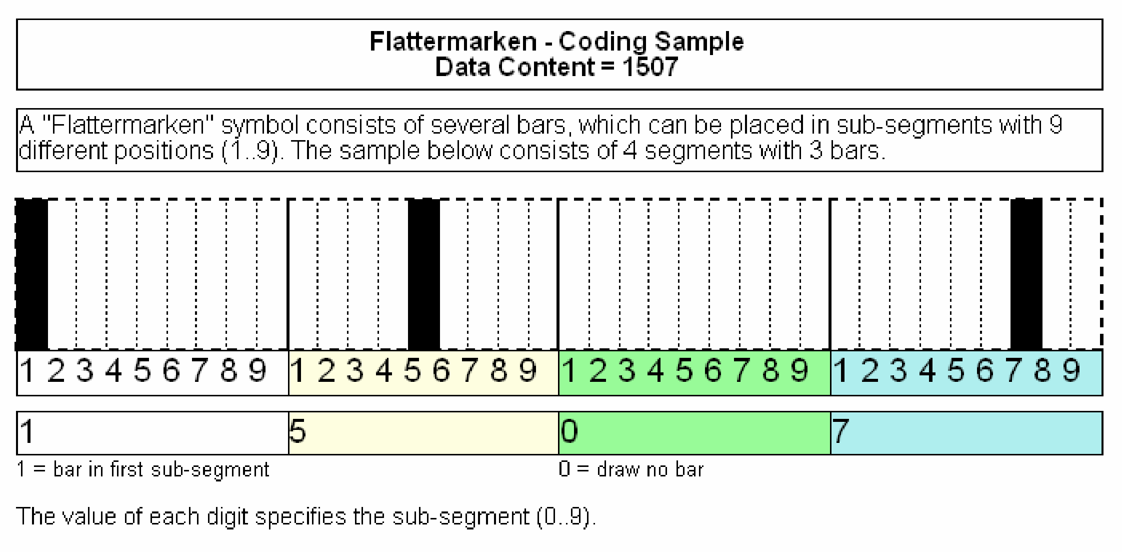


Figure 9: Flattermarken Coding Sample

6.1.35 GS1-128

The GS1-128 is simply another name for the existing EAN-128 (or UCC-128) barcode. The EAN and UCC standardization organizations founded GS1 in order to globalize (and harmonize) their different standards. See section 6.1.24.

6.1.36 GTIN

GTIN stands for Global Trade Item Number and is not a barcode symbology.

A GTIN is used for the unique identification of trade items worldwide within the GS1 (EAN.UCC) system. The GTIN may be encoded in UPC-A, EAN-8, EAN-13, EAN-14, ITF-14, and GS1-128 symbologies.

Depending on the number of digits available in the bar code, the GTIN is divided into GTIN-8, GTIN-12, GTIN-13 and GTIN-14.

6.1.37 HIBC

HIBC is an abbreviation for Health Industry Bar Code. The HIBC is a numbering system – and not a specific barcode symbology. It is used for product identification codes as well as for worldwide identification of shipping units.

The primary code contains the manufacturer id, the article number, the package number and a check digit. The secondary code contains the serial number, the expiration date and the units per package.

The following symbologies are commonly used for encoding: Code 39, Code 128, Codablock F. For more information, please refer to section 6.4 and to https://www.hibcc.org.

6.1.38 I-2/5

Short for Code 2 of 5 Interleaved (see section 6.1.12). It is also known as Code 25.

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

9 780201 379686

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

9 790123 456785

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
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!) H: Height of barcode symbol without human readable text L: Width of barcode

AB12$+

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
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 (eCDMSI1)
Possible check digits:	User supplied and MSI 2 digit (eCDMSI2)
Symbol size:	14 digits incl. check digits
Print control:	C=MSI

012345674

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	(00)123456789012345675
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). 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 **\C***rrggbb* (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	PZN -1234562
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	PZN -12345678
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	ABC123B3
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). Modulo 10 (eCDMod10) and Modulo 103 (eCDEAN128)
Symbol size:	see GS1-128
Print control:	C=SSCC18

(00)012345678901234560

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:	--

12Az

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:	--

0123456X

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 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. 72527272070712). 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.

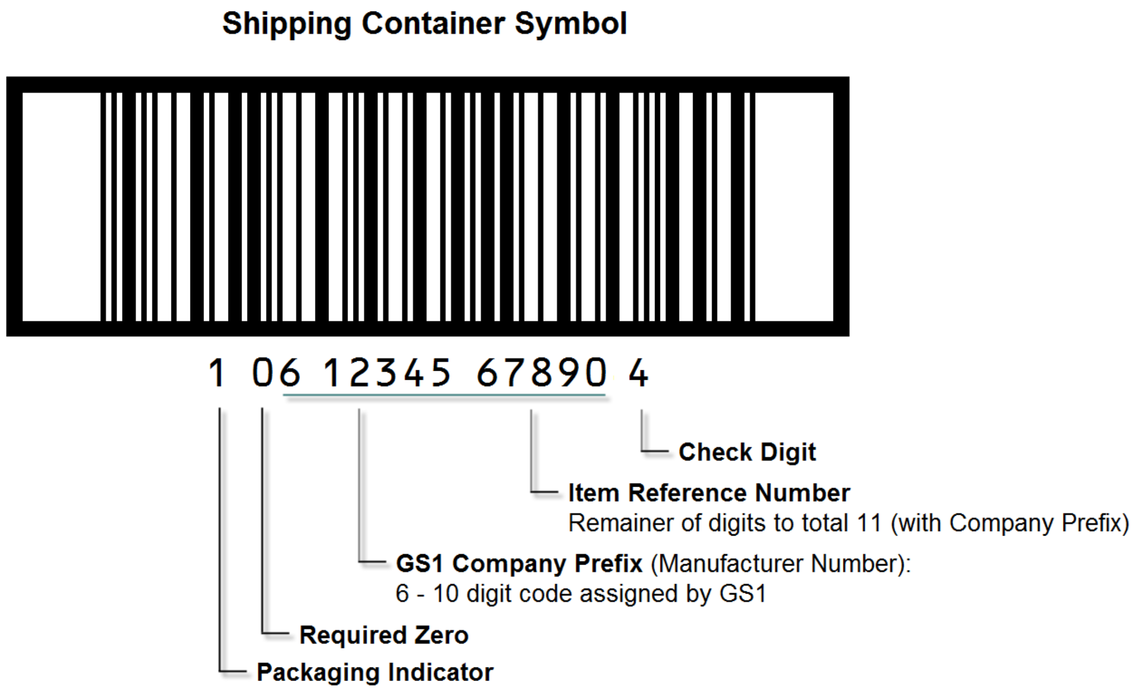


Figure 10: UPC Shipping Container Symbol (SCS)

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
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!) H: Height of the barcode without human readable text L: width of the barcode

VB1YYY1JX3M386752

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

12345678

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

12345678ABab

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

12345678ABCabc

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:	--

12345678

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

12345678

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

12345678

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 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

123456784

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). DP Identcode (eCDDPIdent)	
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). 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). Modulo 103 (eCDCode128)	
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

```
IPPPPPPPTTTTTTTTTTTTTTTTSSSCCC
```

Whereas the human readable text is defined as:

```
PPPPPPPTTTTTTTTTTTTTTTTSSSCCCD
```

With:

Character	Description	Data Type	Length
I	Identifier (in **barcode data only**)	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 **human readable text only**)	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 (eCDMod10ItlPst25)
Symbol size:	--

12345678901-2

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”, “-“, 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:	--

1234567

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コーポB604号
Barcode text	Postal code + Address B
Barcode text	273-0102　東３丁目－２０－５　郵便・A&bコーポ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)*[3].
  - 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
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:	--

2500GG30250

This code is used by the Dutch Postal system.

6.2.14 Korean Postal Authority

Symbology number:	77
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). Modulo10 (eCDMod10Kor)
Symbol size:	--

1234569

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 (7th digit marked red) is calculated automatically.

[3] 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	123456789014
Valid characters:	“0”..”9”, 11 digits + 1 check digit	
Quiet zone:	left/right: 1/25 inch 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	12345678901239
Valid characters:	“0”..”9”, 13 digits + 1 check digit	
Quiet zone:	left/right: 1/25 inch 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	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 0101000000700009001B707RH1A 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
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).

EM 10 002 799 5 SE

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.

EM 10 002 799 5 SE

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 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: 000000000-999999999)
- Delivery point ZIP code (0, 5, 9, or 11-digit ZIP code)

6.2.26 USPS Intelligent Mail® Package Barcode

Symbology number:	117
Valid characters:	"0".."9" + FNC1, Routing Information: 0, 8, or 12 digits + Tracking Information: 22 to 26 digits.
Quiet zone:	vertical: 1/25 inch horizontal: 1/8 inch
Module width:	--
Standard print ratio:	1:1
Ratio format:	1B:1S
Default check digit:	Modulo 10 (USPS IM Package) (eCDMod10IMPackage)
Possible check digits:	User supplied
Symbol size:	22 to 34 digits

9102 8052 1368 3062 5229 20

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 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

123455

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 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

123455

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 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

1234567895

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	1234567895
Valid characters:	“0”..”9”, 9 digits + 1 check digit	
Quiet zone:	vertical: 1/25 inch 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 10th digit).

6.2.27.5 USPS POSTNET 11

Symbology number:	44	123456789014
Valid characters:	“0”..”9”, 11 digits + 1 check digit	
Quiet zone:	vertical: 1/25 inch 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	123456789014
Valid characters:	“0”..”9”, 11 digits + 1 check digit	
Quiet zone:	vertical: 1/25 inch 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:	1 digits, 1 check digit	

Same as POSTNET 11, but the check digit can be specified (the 12th 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 15×15 through 27×27 pixels, may surround the compact Aztec code core. The full core version supports up to 32 layers (that are up to 151×151 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 "]z2" (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 1st position; this format is used for the "GS1 Data Matrix")
- 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)
- 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)[4]	
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	~~22 x 40~~ 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.

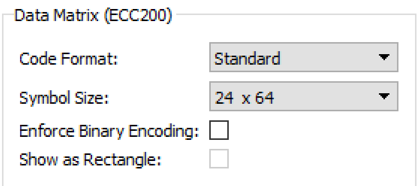


Figure 11: Data Matrix Symbol Size Property

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 1st position).

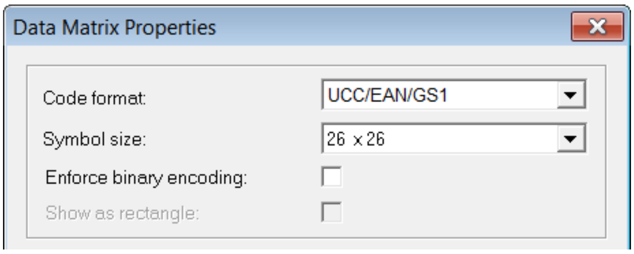


Figure 13: GS1 Data Matrix Code Format

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

[4] 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.

<u>Example:</u>

Original data:

```
444541080D02540BE3FF0052232D242D000065000000010100015A31
```

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 *Adjust* 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.

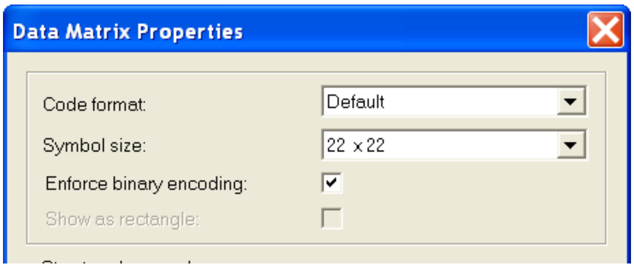


Figure 14: Data Matrix Properties

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:

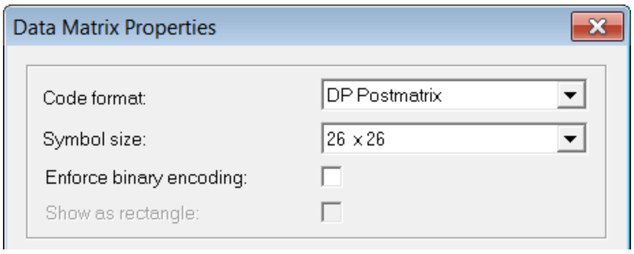


Figure 15: Data Matrix DP PostMatrix Code format

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 (\xnn):
  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:

[)>Rs01Gs96841706672Gs840Gs066Gs1Z12345677GsUPSNGs123556Gs089GsGs1/1Gs10GsYGsGsSALT LAKE CITYGsUTRsEot

Most of the information is easily identified and can be separated into its component data elements as shown below:

[)>Rs	Message Header
01Gs96	Transportation Data Format Header
841706672 Gs	Postal Code
840 Gs	Country Code
066 Gs	Class of Service
1Z12345677 Gs	Tracking Number
UPSNGs	SCAC
123556 Gs	UPS Account Number
089 Gs	Julian Day Of Collection
Gs	Place holder for Shipment ID Number
1/1 Gs	Package n/x
10Gs	Package Weight
YGs	Address Validation
Gs	Place holder for Ship To Street Address
SALT LAKE CITY Gs	Ship To City
UTRs	Ship To State
Eot	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:	*$_tbcs b84 dThis is a MicroPDF417$_tbce*
For V2.x:	*$_tbcs -b84 –d"This is a MicroPDF417"$_tbce*

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: 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: 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
- 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)

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

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

```
+IIIIP*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
Q*	Quantity Field (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

```
+IIIIP*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. • The Secondary Data Structure contains the lot number.	Alphanumeric	2 + 1-18
“**/16D**”	Date of Manufacture	YYYYMMDD (Year, Month, Day)	4 + 8
“**/14D**”	Expiry Date formatted as YYYYMMDD • The Secondary Data Structure may also contain the expiry date, but not in this format.	YYYYMMDD (Year, Month, Day)	4 + 8
“**/Q**”	Quantity • In legacy versions of the LIC standard, the quantity was located in the Secondary Data Structure.	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*DDDDDC1
```

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_1	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*G1*D1D1D1/G2*D2D2D2C
```

Character	Description	Data Type	Length
+/	HIBC Provider Applications Standard Flag	“**+/**”	2
F*	„Where“ Flag	Alpha	1 or 3
G_1*	„What“ Flag for D_1	Alpha	1 or 3
D_1	First Application Data	Alphanumeric	1-15
/	Separator Character between First and Second Data Structure	“**/**”	1
G_2*	„What“ Flag for D_2	Alpha	1 or 3
D_2	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_2) 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:

```
+/1F*G*DDDDC₁
```

It is much the same as the Single Data Structure but has “**1**” as prefix.

The **Second Data Structure** is defined as

```
+/2DDDDC₁C₂
```

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_1	Check Digit (mod 43) - conforms to the check digit in the First Data Structure.		1
C_2	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

Symbology number:	98
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:	--

+A99912345/$$52001510X33

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

Symbology number:	99
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!) H: Height of the barcode without human readable text L: width of the barcode

+A123BJC5D6E71G

+$$583278F8G9HØJ2G$

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: 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
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:	--

+/EU9C83416F/Z34H159$

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!) H: Height of the barcode without human readable text L: width of the barcode

+/EAH783/Z34H159$

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: 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
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: 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

(01)01234567890128

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 14th 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
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: 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

(01)01234567890128

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: 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

(01)01234567890128

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: 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: 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
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: 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 Alphanumeric: 41 characters
Print control:	C=RE

ABab+

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: 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	(01)12345678901231
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: 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	(01)12345678901231
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: 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
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: 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: 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: 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
Valid characters RSS Exp.:	ASCII characters between 0..127
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: 1S:2S:3S:4S:5S:6S:7S:8S:9S
Default check digit:	None (eCDNone).
Possible check digits:	Modulo 10 (eCDMod10). EAN-14 (eCDEAN14)
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
Valid characters RSS ES:	ASCII characters between 0..127
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: 1S:2S:3S:4S:5S:6S:7S:8S:9S
Default check digit:	None (eCDNone).
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
Valid characters EAN 128:	ASCII-characters between 0..127
Valid characters CC-A/B/C:	ISO 646 character set, up to 2361 characters
Standard print ratio:	1:2:3:4:1:2:3:4
Ratio format:	1B:2B:3B:4B1S:2S:3S:4S
Default check digit:	None (eCDNone).
Possible check digits:	Modulo 10 (eCDMod10). EAN-14 (eCDEAN14)
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
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
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
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
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[5].

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)	Enhancd 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 **TBarCode 7**
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) eIMPEpsVector (8)	EPS / PostScript vector based format
PCL	eIMPcl (9)	PCL 5 (vector based format)
SVG	eIMSvg (10)	SVG vector based format, supported since **TBarCode SDK 11.2**
AI	eIMAi (11)	Adobe Illustrator® V7 format, supported since **TBarCode SDK 11.2**

Table 29: Supported Image Types

7.1.2 Compression Modes

<table>
<tr><th>Image format</th><th colspan="2">Compression / Quality</th><th>Remark</th></tr>
<tr><td>BMP</td><td colspan="2">0..1, 0 = uncompressed, 1 = compressed</td><td></td></tr>
<tr><td>EMF</td><td colspan="2">No compression is used.</td><td></td></tr>
<tr><td>EPS</td><td colspan="2">Bitmap EPS: unused
Vector EPS: adjust font substitution.</td><td>With vector EPS files, you can choose between using Windows fonts (0) and only PostScript compatible fonts (1).</td></tr>
<tr><td>JPG</td><td colspan="2">0..100, 0=highest compression, worst quality, 100 =lowest compression, best quality</td><td>Value of 100 suggested, especially for high data density</td></tr>
<tr><td>PCX</td><td colspan="2">Not used</td><td>In ConvertToStream and ConvertTo-StreamEx not supported</td></tr>
<tr><td rowspan="6">PNG</td><td>PNGALLFILTERS (0)</td><td>Use best filter for each row (highest compression)</td><td rowspan="6">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).
Example: to save a file with maximum compression and interlaced, the quality parameter is calculated as follows:</td></tr>
<tr><td>PNGINTERLACE (1)</td><td>Interlace filter</td></tr>
<tr><td>PNGNOFILTER (2)</td><td>No filter will be used (fastest runtime)</td></tr>
<tr><td>PNGSUBFILTER (4)</td><td>Difference filter with adjacent pixel</td></tr>
<tr><td>PNGUPFILTER (6)</td><td>Difference filter with pixel from the previous row</td></tr>
<tr><td>PNGAVGFILTER (8)</td><td>Average filter</td></tr>
</table>

[5] Depending on the API not all image types are available for streaming – see API reference for more information.

<table>
<tr><td></td><td>PNGPAETHFILTER (10)</td><td>Path filter</td><td><code>PNGALLFILTERS | PNGINTERLACE</code></td></tr>
<tr><td>TIF</td><td colspan="2">0.. No compression
1.. LZW *
2.. Pack Bits compression
3.. Group 3 1D compression (CCITT Modified Huffman RLE)
4.. Group 4 2D compression (CCITT Group 4 FAX) *
5.. CCITT Group 3 compression (= CCITT Group 4 FAX) *
7.. JPEG *</td><td>* is supported with TBarCode 7 and higher</td></tr>
<tr><td>EPS</td><td colspan="2">No compression is used.</td><td></td></tr>
<tr><td>PCL</td><td colspan="2">No compression is used.</td><td></td></tr>
<tr><td>SVG</td><td colspan="2">No compression is used.</td><td></td></tr>
<tr><td>AI</td><td colspan="2">No compression is used.</td><td></td></tr>
</table>

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 MicroPDF417	ASCII Extended (Code Page 437)
QR Code (AIM '97) Micro QR-Code Japanese Postal	Shift-JIS (Code Page 932)
Aztec Code Codablock-F Data Matrix DotCode Han Xin Code MaxiCode QR Code 2005 QR Code (ISO/IEC 18004:2015)	Latin-1 / ISO 8859-1 / Windows 28591 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.

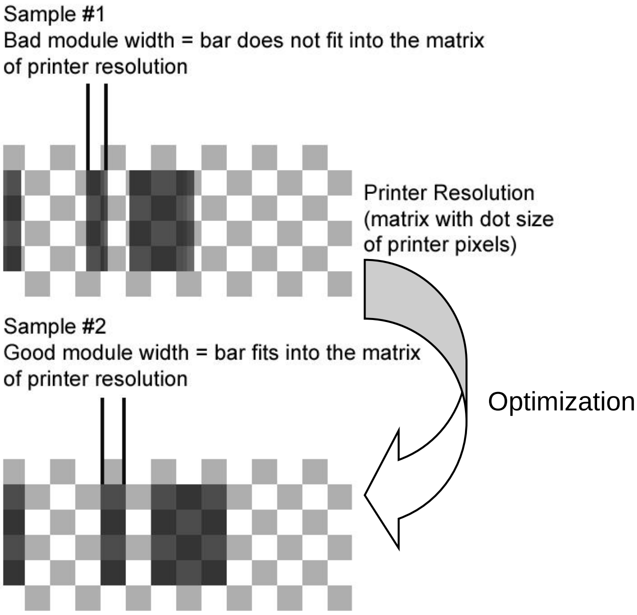

Figure 18: Optimize Barcode for Output Device Resolution

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:

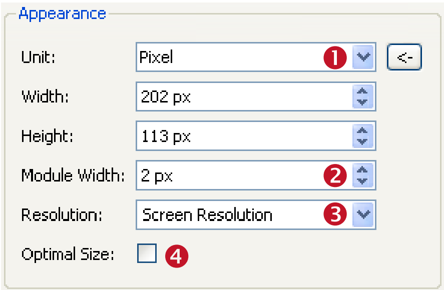

Figure 19: Barcode Optimization in Barcode Studio

The easiest method is to set the check mark in ❹. This will automatically optimize the barcode for the given output resolution (see ❸).
As an alternative you can also set the scaling unit to “Pixel” (see ❶) and then adjust the module width in ❷. 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 ❺). This will optimize the barcode for the printer on which the document is actually printed.

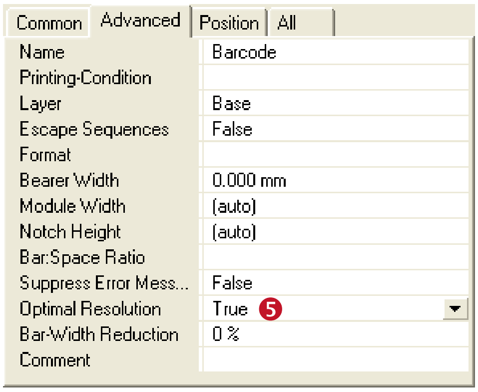

Figure 20: Barcode Optimization in TFORMer Designer

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).

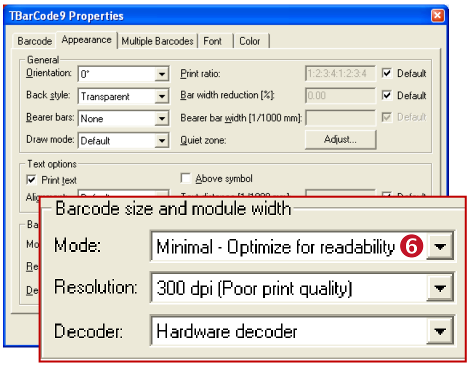

Figure 21: Barcode Optimization in TBarCode OCX (Version 1)

The settings shown in the figure above are available in the properties dialog of the barcode control. The "Minimal" mode ❻ 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 (≅ 20 mils).

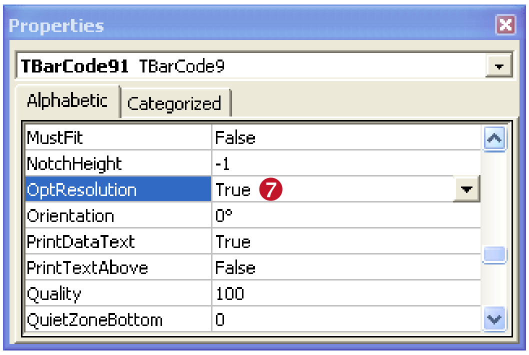

Figure 22: Barcode Optimization in TBarCode OCX (Version 2)

In the application specific property window (and not in the properties page as shown in Figure 21) you will find the property *OptResolution* ❼. 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 ❹, ❺ and ❼) 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 ≅ 0.00167 inches ≅ 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 *BCGet-OptimalBitmapSize().* 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 conse-quence, 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 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:

```
<img src="/images/barcode.png" width="250" height="60">
```

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 ≅ 2.083 inches ≅ 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

```
<img src="/images/barcode.png" width="144" height="60">
```

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 ≅ 1.97 inches
   → Calculated image width = 1.97 * 600 ≅ 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[6].
   → Module width (in pixel) = 1181 / 101 ≅ 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 ≅ 1.85 inches ≅ 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!

[6] 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 ≅ 472.44 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 width 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.

[7] In TBarCode SDK V10+ you can use DLL function BCGetOptimalBitmapSize()
[8] In TBarCode SDK V10+ you can use COM method GetOptimalBitmapSize()

```
DispWidth  = BitmapWidth  * 96 / 200
DispHeight = BitmapHeight * 96 / 200

<img src="<%="Barcode.asp?" & URLPARAM%>" 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				
25	Code 93	–		10X, min. ¼ inch	
62	Code 93 Extended				
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[9]	–		7X	
11	EAN-8 with 2 digits add-on[9]			add-on: 7-10X	add-on: 5X
12	EAN-8 with 5 digits add-on[9]				
13	EAN-13[9]	–		11X	7X
14	EAN-13 with 2 digits add-on[9]			add-on: 7-10X	add-on: 5X
15	EAN-13 with 5 digits add-on[9]				
72	EAN-14	see EAN-128			
16	GS1-128 (EAN-128)	–		10X, min. ¼ inch	

[9] 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 (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[10]	–		9X	
35	UPC version A, 2 digits add-on[10]			add-on: 9-12X	add-on: 5X
36	UPC version A, 5 digits add-on[10]				
37	UPC version E[10]	–		9X	7X
38	UPC version E, 2 digits add-on[10]			add-on: 9-12X	add-on: 5X
39	UPC version E, 5 digits add-on[10]				
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 Symbologies)

B.2 2D Symbologies

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)	

[10] In TEC-IT software, the quiet zones for this symbology are included in the barcode generation algorithm. You need no extra adjustments.

<table>
<tr><td>116</td><td>Han Xin Code</td><td>3 cells (3X)</td><td>3 cells (3X)</td></tr>
<tr><td>57</td><td>MaxiCode</td><td>1 cell (1X)</td><td>1 cell (1X)</td></tr>
<tr><td>84</td><td>MicroPDF417</td><td>–</td><td>1X</td></tr>
<tr><td>97</td><td>Micro QR Code</td><td>4 cells (4X)</td><td>4 cells (4X)</td></tr>
<tr><td>55</td><td>PDF417</td><td rowspan="2">2X</td><td rowspan="2">2X</td></tr>
<tr><td>56</td><td>PDF417 Truncated</td></tr>
<tr><td>58</td><td>QR Code®</td><td>4 cells (4X)</td><td>4 cells (4X)</td></tr>
<tr><td>79</td><td>GS1 DataBar Stacked
(RSS-14 Stacked)</td><td rowspan="3">–</td><td rowspan="3">–</td></tr>
<tr><td>80</td><td>GS1 DataBar Stacked Omni directional
(RSS-14 Stacked Omni directional)</td></tr>
<tr><td>81</td><td>GS1 DataBar Expanded Stacked
(RSS Expanded Stacked)</td></tr>
</table>

Table 33: Quiet Zones (2D Symbologies)

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. 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. 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