

RepliMark

User manual for 2D and 3D Industrial Laser Marking Software

Version 2.1

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3 Safety

This application is designed to control laser equipment which may effect a person's health or may otherwise cause damage. Prior to installation and operation compliance with all relevant safety regulations including additional hardware-controlled safety measures has to be secured.

Beside of that some laser equipment can be damaged in case it is controlled with wrong signals. Thus it is highly recommended to check the output generated by this plug in using e.g. an oscilloscope to avoid problems caused by wrong configurations. This should be done prior to putting a system into operation for the first time and whenever a software update was installed or whenever some of the relevant parameters have been modified.

Here "software update" not only means updates of the RepliMark software but also modifications with dependent software, like components or drivers for scanner controller cards.

4 Overview

This document describes the RepliMark software including all existing functionalities, options and additional software components. Depending on the software variant you really use some of the described features and functionalities may be not available or may be available only in a limited state.

RepliMark is a CAD application specialised for creation and processing of laser marking data. These data can be used together with a laser scanner system to perform the material processing. This application is not only able to generate these data but also to test it and to start laser marking and related motion processes directly out of the application. It provides direct support of different kinds of hardware and output devices such as scanner controller cards, motion controllers, CNC controllers and others more.

RepliMark can be used for various kind of 2D and 3D laser marking applications such as welding, cutting, engraving, cleaning, deep-engraving and others. RepliMark is highly specialised in and optimised for these kinds of applications and therefore provides a lot of enhanced and easy to use features.

For 3D printing / SLS / SLM applications, please check out RepliSLS3D instead. This software is specialised on this kind of additive manufacturing processes and is described in related manual.

5 RepliMark

5.1 Quick Start into RepliMark

This section describes how to use RepliMark in direct operation mode where laser marking is done out of the application. It gives a short overview about basic set-up and usage of RepliMark and describes with some short steps how to get first results easily. So this section is a shortcut to start into this software very fast but it ignores most of the useful features. These features are described in detail in following sections of the users manual, so it is recommended to use this quick start only to understand the very basic working principles of the software while going deeper into it afterwards.

1. **SECURITY CHECK:** The following steps describe how to set up RepliMark and how to control laser equipment out of it. Thus all laser safety rules and regulations need to be respected, all required technical security mechanisms need to be available and active prior to starting with this software.
2. **Main configuration:** First the scanner controller card that has to be used needs to be selected and configured. To do that, select Menu "Project" menu item "Project settings..." and go to panel "Hardware" of the now opening settings dialogue. Within the selection-list named with "Scanner Card" choose the scanner controller card you want to use. After selecting it, press the button "Configure" and set up the scanner controller card according to its specific needs (choose things like firmware file, correction table, working area size, number of controlled axes or what ever your card requires for proper operation) and according to your local hardware configuration.
3. **Save Configuration:** Leave all these settings dialogues by pressing "OK" once all parameters have been entered correctly and select menu "Project" menu item "Save as default configuration". Now whenever you start RepliMark and as long as you do not load a project file with a different hardware set-up, these settings are used by the application.
4. **Create basic geometry:** Select the triangle-symbol within the tool bar and draw that triangle within the drawing area right below the tool bar. There you have to left-click your mouse three times at different positions to create the triangle, every of these mouse-clicks specifies an other corner of the triangle.
5. **Modify existing geometry interactively:** Once you have finished creation of the triangle this new element is selected and highlighted by a double-lined blue box surrounding it. This box can be used to modify the geometry. While picking and dragging one of the coloured squares that are contained in this surrounding, the triangles size can be changed (the grey squares) as well as its rotation (via the red square). The cyan-coloured squares can be used to slant the geometry. When the triangle is dragged by clicking the selection frame between these coloured squares, its position can be changed.
PLEASE NOTE: When modification of the geometry has finished it still has to be located completely within the working area that is symbolised by the grey rectangle. This working area is the maximum range your scanner can work within, so all geometry that is located outside of that range will be cropped.
6. **Modifying existing geometry manually:** The method described previously is a very quick way to change the geometry but it is also a very inaccurate one. Thus there exists an other possibility: As long as an element is selected, there is a configuration panel usable at the windows left hand side. The first configuration panel is always an element-specific one, in this example it contains several parameters and values that influence the creation of the triangles base geometry. On the same side of the main window there also exists an other tab-pane "Geometry" where the generic geometric data of an element can be changed by entering the desired numeric values. Using this way things like size, position and rotation can be modified in a very exact way. The related values are taken over and applied to the geometry as soon as the data input is confirmed by pressing "Return" or by leaving the input field.
Several of these data depend on each other and will change automatically whenever one of them is modified. So in case you change the scale factor of your geometry, the position and size values of it will be changed too as soon as you hit your "Return"-key within the scale value input field.

7. **Apply laser parameters:** Required laser parameters can be applied to existing geometry via a number of predefined and freely definable pens. Such an (existing) pen can be set via the tab-pane "Element" and the selection list named "Pen". Whenever a new pen is selected for an existing geometry it is applied to it automatically, which means the visual representation of that geometry within the drawing area changes its colour and the next laser marking cycle would use the parameters of this pen when this specific geometry is processed.
The different laser and scanner parameters that are assigned to such a pen can be modified by selecting menu "Project" menu item "Pen settings...". There a dialogue opens where you can select the pen that has to be modified (by using the selection list on the upper side of the dialogue). The tab-panes below this list give access to all relevant parameters that influence mark and jump speed, laser power and frequency, scanner delays and others more. When you change some of these parameters and leave the dialogue by pressing "OK" all the geometries that are assigned to this (now changed) pen will use the modified parameters during next laser marking process.
8. **Adding a hatch pattern:** Currently only the outline of the triangle is shown and only this outline would be processed during laser marking. To process the inner side of the triangle too, a fill pattern has to be added by using the Additional Geometry element "Hatch". It is symbolised by a purple-coloured tool bar icon that consists of several horizontal lines. When this icon is clicked as long as a Primary Geometry element (like the triangle) is selected, it is added to this element automatically. Now the appearance of the geometry and the appearance of the application changes:
 - the first panel on the main windows left hand side switches to show all the "Hatch" parameters
 - the Element Tree on the main windows right hand side now shows the new hierarchical structure of the element with the "Hatch" as sub-element of the primary "Triangle" geometry
 - the triangle within the drawing area is filled with some hatch lines
 This hatch pattern now can be changed by modifying the values within the property-panel "Hatch" on the main windows left hand side.
PLEASE NOTE: after clicking the Hatch-button within the tool bar, the new geometry of the now added hatch/fill pattern is selected instead of the triangle! That means all modifications to the selected geometry (as described previously) now would apply to the hatch geometry only but NOT to its parents triangle! So in order to manipulate the whole element the parent of the hatch has to be selected – which is the base element generated in previous step.
9. **Save data:** To avoid the currently generated geometry gets lost, the project has to be saved now. To do that, select menu "Project" menu item "Save as..." and save these data at a suitable position using the .BEAMP format.
PLEASE NOTE: this project contains all the hardware definitions that have been done during configuration of the software in first steps. Whenever you change this configuration and then load this project again, the hardware set-up of the project is used instead of the changed one of the application. To avoid that after loading such a project, the menu "Project" menu item "Load default configuration" can be chosen to replace the projects hardware set-up by the local, desired one.
10. **SECURITY CHECK:** Next the scanner controller card together with a possibly connected laser will be accessed for the first time. That means it is opened and initialised and all connected equipment may start working now. Thus it is very important to ensure all security regulations are met and nobody can be injured and no damage can be caused also in case laser output or other motion starts spontaneously and unexpectedly!
11. **Prepare for laser marking:** Now the created geometry has to be sent to the connected laser and scanner system for processing it on some material. To do that the menu "Process" menu item "Mark" has to be selected. It opens the marking dialogue and tries to access the connected hardware. In case it is not possible to access the scanner controller card, an error message is shown and none of the buttons of the mark dialogue are usable (except the "Cancel" button to leave the dialogue). In this case you have to go back to the project settings as described in step 2 and to correct the set-up of your scanner controller card.
12. **SECURITY CHECK:** Next the laser and scanner will be accessed. Since there are some (laser) controllers available that are VERY sensitive to wrong laser signals, it is recommended first to check the output your scanner controller card produces. This can be done e.g. by using an oscilloscope instead of the real hardware. The target equipment should be connected only in case all signals are checked, correct and acceptable by the hardware. More than this it is recommended to repeat this step whenever the something within the complete set-up changed; changes may be caused e.g. by modified parameters, by software or driver updates.

13. **Start marking:** Now marking can be started by pressing the big yellow button (the one with the laser warning sign) in the middle of the marking dialogue. This starts sending of all laser and scanner data to the scanner controller card so that it is able to output motion and laser control data synchronously. Such a marking operation can be stopped by pressing the big red button (with the STOP-symbol) at the dialogues right hand side.

PLEASE NOTE: this stop-button is not a replacement for a real emergency stop, it will try to stop the currently running laser process only via software which – in worst case – may fail for an example due to an abnormal problem or in case of a hardware failure. Thus there must be independent and working emergency stop equipment available in every case!

5.2 User interface

5.2.1 The Project menu

The menu “Project” gives access to different global, project- or application-specific operations:

- New project – create a new project, this deletes all possibly existing data and sets RepliMark to default configuration values
- Open project – open an existing .BEAMP RepliMark project which contains all required data like hardware settings, geometries, control elements, pen settings,...; when using this function, all data of a previously used project will get lost
- Insert project – load a .BEAMP project without deleting the current one: the hardware settings of the current project are left unchanged and the elements and pen settings of the new project are appended to the new one
- Import – load vector data out of a file that is not a RepliMark project file (.BEAMP or .BEAMV), the newly loaded geometries are added to the current project. Depending on the capabilities of the chosen import format, a dialogue is opened here which gives the possibility to define several import parameters. When a raster image (such as BMP, JPG, GIF, PNG,...) is imported, the user can choose between different options how to deal with the raster data:

Use as scanner bitmap The picture is kept as raster image and marked as greyscale or b/w bitmap. Such an element always should make use of an own pen which uses bitmap-specific pen-settings (as described in section “5.6.3 Bitmap Pen Settings”)

Use as coloured scanner bitmap Same as the standard bitmap as described above but supports marking of coloured images as described in section “5.6.5 Using Pens for Coloured Bitmap Marking”

Use as light-table image When this option is chosen, the imported bitmap becomes part of the project but it is not marked. It is visible as some background image only and e.g. can be used as some template to draw vector geometries on top of it which itself then are marked

Point cloud Instead of keeping a raster image, when using this option, the image is converted into a point cloud which is similar to a dithered black/white image. Here instead of having single pixels within the bitmap, each dot is a real vector point. Following parameters can be chosen here:

- Assign to pen – the pen which has to be set for the points. The laser spot-size in this pen defines the size and therefore the number of points to be created and corresponds to the following parameter:
- Overlap dots – the ratio the (round) dots have to overlap each other independent from their original positions where they would not overlap each other
- Resulting size – size the point cloud has to cover after importing; here an option “Keep aspect ratio” can be chosen to allow a more convenient selection of a proper size
- Orientation – the orientation of the resulting point cloud can be selected here
- Brightness layers: normally a raster image is converted to one point cloud where the dots in this cloud define pixels in the input image which are below of a specific brightness level. With the brightness-layer-options, it is possible to have a defined number of different point clouds which each re-

present a different brightness level of the pixels of the original image. Via the “Brightness layer distance” it is possible to place each of these layers to a different Z-level. The “Layer levels” define the threshold for each of the layers to be created, so they are responsible for sorting the points into the different cloud-layers depending on the brightness of their source pixel.

Beside of these import-specific options, in upper part of the import dialogue there are different parameters to correct the input image. A preview right beside these sliders shows what the result will look like when the image is imported with these correction values.

When a 2D import format is used which results in a marking geometry (but not in a 3D mesh), and when these data are imported into one single, non-grouped and non sub-structured element, an option “Reload on file change” is offered in the property tab-pane of this imported element. When this option is checked, now whenever the source-file on disk changes, the file is imported again. This function can be used to easily implement a simple reload-function which allows it to replace the currently loaded geometry quick and easy.

- Save project – save the currently loaded project using the same name, this operation overwrites an existing project without further notice
- Save project as – save the currently loaded project while giving it a (new) name by using a file dialogue
- Save with options – save the currently loaded project with the possibility to specify what this project may contain exactly
- Export as – here data or parts of data of the currently loaded project can be exported using one of the following file formats:
 - CSV – saves the 2D vector data using comma separated values
 - HPGL – saves the 2D vector data using HPGL/PLT file format
 - CLI – saves the different slices of an already processed 3D mesh in CLI layer format
 - RWX – saves the model data of all 3D meshes of the current project in RWX 3D file format
- Project settings – open the global settings dialogue where all application and hardware related configurations can be done; for details please refer to section “5.3 Project Configuration”
- Pen settings – open the dialogue where all material and output related parameters can be configured; for details please refer to section “5.6 Pen Settings”
- Save as default configuration – save the current hardware and pen settings as default so that these parameters are loaded as default on next start-up of RepliMark or when a new project is created by selecting menu “New project”
- Load default configuration – when a process file was loaded, it possibly can contain an own hardware configuration which does not fit to the current device. Using this menu item the local default configuration can be loaded overriding the parameters of the loaded project

5.2.2 The Help menu

This menu gives access to different informational and service functions:

- About – displays information about software version, copyright and vendors homepage
- License – displays information about the current license, when your application pops up with an error message “Insufficient license” at some functions, please check here if you really have the license which is required
- Reset license – this function can be used to get rid of a software license which was retrieved online. After this function has been called, RepliMark is no longer licensed and runs in demo mode
- Generate bugreport – this function can be used in case of problems with the software to gather different data which are helpful to analyse these problems.
Please note: this function collects different information which may include sensitive, personal or

other confidential data. When you do not agree to share these data, do not use this function. Otherwise you agree that we get, store, analyse and read these data for an undefined time (but typically only as long as it is necessary to check your specific problem).

In case of a problem with the software, please use this function to generate a bug report. When you experienced a crash, where the software has died completely and therefore this function is no longer accessible, please restart RepliMark, load the last project you used and where you experienced this crash and then call this function.

This function creates a ZIP-file where you can specify where to store it. This ZIP-file contains the bugreport-data and has to be sent to the support HALaser Systems in order to check what causes the problems. HALaser Systems always provides a public key for encryption of e-mails and data, so you also can send us such a bugreport fully encrypted.

- Save project protocol – saves several data of the current project and configuration into a CSV file. These data can be used e.g. during development to track changes or for documentation purposes while experimenting with different parameters and settings
- Credits – displays credits regarding to people and companies which contributed things to this software

5.3 Project Configuration

When starting with a new project it has to be configured first so that the editing environment of RepliMark reflects the real processing conditions within production.

This can be done in global settings, the related dialogue can be found in menu “Project” sub-menu “Project settings...”. There a dialogue opens which offers several configuration options within different tab panes. The following parameters can be set and modified within these panes:

In tab-pane “User interface”:

- Visual grid size – this is a helper grid that is used and visible within the working area as an array of points with a distance in X and Y direction as specified here
- Snap to Grid – when this check box is selected, all geometry that is drawn or re-positioned within the working area automatically snaps to a position that is defined by the visual grid; this option gives the possibility to position elements very exact
- Background Colour – this option changes the visual representation of the editor and does not have any influence on the generated data, it specifies the colour of the background within RepliMark’s drawing area
- Working area Border – the working areas (as defined in scanner controller settings for every scanhead) are shown as rectangle within the drawing area of the application, here the colour of the bounds of related rectangles can be changed; similar to the previous option this one also does not influence the generated data
- Editing area border – beside the working area, which specifies the range a single scanhead can cover, an editing area exists which is a visual help showing the user where drawing is allowed for the current configuration. This area exists only once for a configuration, it can be equal or smaller than the working area of a single scanhead (in single head environments), it can include several scanheads working areas (in multihead environments) or it can be larger than the available scanheads working area (e.g. when it has to be used together with the functionality of Active Split Group). Here the colour of the bounds of this area can be changed; similar to the previous option this one also does not influence the generated data
- Editing area shape – here the shape of the editing area can be selected. By default it is cuboid, alternatively it can be switched to a cylindrical shape
- Editing area upper left – specifies the upper left corner of the global editing area within the coordinate system of the application
- Editing area size – specifies the size of the global editing area within the coordinate system of the application; this is for the cuboid shape width, height and depth and for the cylindrical shape diameter and depth (aka height of the cylinder)

In tab-pane “Scanner” it is possible to configure the scanner controller(s). In case these components are set up properly according to the used hardware environment, it is possible to start marking and motion operations directly from within RepliMark:

- Scanner Controller Selection – this combo box has to be used in multihead mode where RepliMark controls more than one scanner card at the same time. The selection with this combo box influences the settings of all following parameters. Please note: in multihead and singlehead mode the first scanner controller always has to be set, it is not possible to start e.g. with settings for the second scanner controller and leave the first one empty.
- Scanner Controller – here a scanner card can be chosen out of a list of available scanner controllers; this list makes use of the related plug-ins that belong to the ControlRoom environment. As soon as a scanner card is selected for usage within RepliMark, it can be configured by pressing the button “Configure”. Although this configuration is done for the scanner controller card all the parameters like the working area size and position are used to set up RepliMark too. For a description of the available scanner controller plug-ins, their usage and parameters, please refer to section “Error: Reference source not foundError: Reference source not found” above
- Initialise on startup – when this option is set, the scanner controller card and – when available and configured – image capture devices, motion-, laser- and process-controllers are initialised on startup

of the software. Normally this is done when the Mark-dialogue is opened for the first time, but when this option is enabled, it happens when RepliMark is executed. In general it is not recommended to use this option since it causes possibly unnecessary accesses to the hardware. Only in very rare cases where some external equipment has to be initialised as early as possible (e.g. when some hardware needs to be heated up), this function should be used

- Home position – when this option is set, the scanner is moved back to the XY-coordinates given right beside this checkbox whenever a marking cycle was finished; using this function the head always ends up in a defined position on regular marking cycles, no matter what the last marked vector really was.
- Override manual stop – when a marking operation is stopped manually (e.g. by pressing the stop-button in marking dialogue or by sending a stop via one of the programming interface) all operations are cancelled as fast as possible and a probably used home position is ignored. When this option is enabled, the software tries to reach the home position also in case of a stop so that markign always ends at this defined position.
- Pilot Laser – this section is related to the configuration of a pilot laser that does not perform marking operations but points to the position where the main laser would influence the working piece (as some kind of preview-laser). This pilot laser can be used out of RepliMark's marking dialogue directly (please refer below for more details); the related parameters are enabled only in case a scanner controller card was chosen and configured properly
- Output Port – here a port can be chosen that has to be used to turn the pilot laser on and off
- Output Number – here the bit number at the previously chosen output port has to be selected which shall be used to toggle the pilot laser;
PLEASE NOTE: some scanner controller cards use some of their output bits for specific, reserved purposes, these bits should not be used for the pilot laser to avoid any unwanted and undefined behaviour. As a second precondition it is necessary to connect the pilot lasers on/off input with the output that was selected here.
- Timeout – here a timeout (in unit minutes) can be specified which turns off a pilot laser after this time. Using this function it can be ensured a user does not (accidentally) let a pilot laser run over hours or independently
- Invert Output Logic – inverts the output value for the signal that should turn the pilot laser on, this option needs to be set for some specific pilot lasers to invert their behaviour
- Always on – when this option is set, the pilot laser is kept on all the time, means it is not modulated and not turned off during jumps. Only before next real marking operation it is ensured the pilot laser is turned off since some laser types can't turn on the main laser as long as the pilot is still on.
- Drop home positions – this option can be checked when a project configuration makes use of the home position but the pilot laser should not include this position during preview. When it is set, only the plain geometries are shown during pilot laser preview, when it is set and when a home position is used, both, the geometries and the home position are shown in preview.
- Correction Factor / Correction Offset – pilot lasers normally have a different colour and therefore a different wavelength than the main laser. In case some optics are used within the scan head, this may result in variances in the marked positions due to a different light refraction factor. Using these parameters such variances can be compensated. The correction factor is a factor that modifies the size of the pilot lasers output in X and Y direction while the correction offset modifies its absolute position
- Ready For Marking Signal – here a signal can be defined that is emitted on a digital output of the scanner card as soon as the software is ready for marking
- Output Port – here a port can be chosen that has to be used for the “Ready For Marking” signal
- Output Number – here the bit number at the previously chosen output port has to be selected which shall be used to toggle the “Ready For Marking” signal;
PLEASE NOTE: some scanner controller cards use some of their output bits for specific, reserved purposes, these bits should not be used for this signal in order to avoid any unwanted and undefined behaviour.

- Invert Output Logic – inverts the output value for the ready-signal
- Mark dialogue opened signal – here a signal can be defined that is emitted on a digital output of the scanner card as long as the marking dialogue is open
- Output Port – here a port can be chosen that has to be used for the “mark dialogue open” signal
- Output Number – here the bit number at the previously chosen output port has to be selected which shall be used to toggle the “marking dialogue open” signal;
PLEASE NOTE: some scanner controller cards use some of their output bits for specific, reserved purposes, these bits should not be used for this signal in order to avoid any unwanted and undefined behaviour.
- Follow-up time – here a time range (in unit seconds) can be specified the “mark dialogue open” signals stays turned on after this dialogue window was closed. When it is reopened again before this time elapses, the output stays active without interruption
- Invert Output Logic – inverts the output value for the active-signal
- Marking Active Signal – here a signal can be defined that is emitted on a digital output of the scanner card as long as marking is in process; this signal is NOT identical to the laser gate which turns laser on and off during such a marking process
- Output Port – here a port can be chosen that has to be used for the “Marking Active” signal
- Output Number – here the bit number at the previously chosen output port has to be selected which shall be used to toggle the “Marking Active” signal;
PLEASE NOTE: some scanner controller cards use some of their output bits for specific, reserved purposes, these bits should not be used for this signal in order to avoid any unwanted and undefined behaviour.
- Invert Output Logic – inverts the output value for the active-signal
- Interlock Input – this section provides functionality to watch the state of an interlock / emergency stop circuit.
PLEASE NOTE: this function is NOT intended to perform any security-related functions, it neither is able to implement emergency stop functionality nor is it able to turn of any hardware in case of an emergency! All these emergency-stop-functions have to be done in hardware only and apart from any software or connected control boards! This function is only able to watch the state of external emergency/interlock circuitry and to ensure reinitialisation of the connected controllers when an external event has occurred, was handled by the external hardware and is no longer active!
When this function is used, the input selected with the options below, is expected to be HIGH. In case it is not, no marking operations are possible. When it goes to LOW during a marking operation is running, it is stopped. Once the input was LOW, a possibly opened marking dialogue has to be closed and all connections to used devices are shut-down automatically. Due to the shut-down of the connected devices, as soon as the input is back at HIGH, a complete initialisation of all hardware is performed including referencing operations (if necessary). So this function can ensure all these devices are in a proper and defined state also after an emergency stop.
- Input Port – here an input port can be chosen where the interlock/emergency stop signal can be read at
- Input Number – here the bit number at the previously chosen input port has to be selected which shall be used to watch the emergency stop/interlock signa

When more than one scanner/head was configured, it is possible to do some multihead-related configurations in tab-pane “Multihead”. When only one scanner controller/scanhead exists, these settings do not have any influence on marking operations:

- Preferred head usage – within this matrix it is possible to define which head should be used for what kind of operations. So as long this is really possible for a head and related geometries, the head then

will be used for this operation. Here following options can be chosen for a head, search order for suitable heads during marking is from left to right:

- Automatic (default) – the geometries are assigned to this head, which is suited best to process them. So in case of partial overlapping working fields the automatic operation tries to spread the geometries over the heads in a way so that as long as possible marking operations are done while switching as seldom as possible from one head to an other
- Contour – the head should try to mark only contours. Only when a contour is located in an area of an other scanhead and outside of the working field of the selected scanhead, or when an other head in “Automatic” mode fits better, this option is ignored and an other scanhead will mark contours
- Hatch – the head should try to mark only hatches. Only when a hatch is located in an area of an other scanhead and outside of the working field of the selected one, or when an other head in “Automatic” mode fits better, this option is ignored and this other scanhead will mark the related hatch
- Require trigger – when marking data are available for and have to be sent to this head, a trigger is inserted into the stream of data. So when this option is set, the change from one head to an other is neither done automatic nor do they run in parallel permanently, but an external trigger signal is needed (ExtStart) in order to start output of marking data at the head where this option is set
- Wait for tool – this option is related to milling output devices which have the ability to send some kind of “Tool change”-command. When this option is set and the software detects a change of the pen during a marking cycle, a) a tool-change command is sent to the related controller and b) a message box pops up for the head where this option is set. This message box asks the user to change the tool and the marking process will not continue until this message box is confirmed

In tab panel Motion Axes it is possible to configure up to two different motion controllers with up to four independent axes each. Both possible motion controllers are identified via names OUT2 and OUT3, which are identically to the outputs of the related RepliMark2Control plug-in. So when a RepliMark project is executed out of a ControlRoom environment using this plug-in, the hardware settings given here are ignored and the motion data are emitted at these plug-ins outputs. When the motion controllers have to be driven by RepliMark directly here a valid configuration is required for at least one of them:

- Motion Controller OUT2 or OUT3 – this combo box can be used to select a motion controller that would be accessed whenever a motion control information is assigned to output OUT2 or OUT3 (please refer to the description of the Primary Element “Motion” and other motion-related functionalities below). The parameters that are set for such a motion controller are NOT handed over to RepliMark fully, so when some of the axes of a motion controller are not enabled here within its settings, they are still be usable and configurable within the related RepliMark elements. This is necessary to keep all options and possibilities for a user that wants to export a RepliMark project and use it within a ControlRoom project where more/other axes may be available.
- Bind axis to slices Z-position – this function is related to marking of sliced 3D data. This option should be set for all these axes, which perform a Z-movement which has to have the same height as the slice thickness of a 3D slice group which is processed. Then the height of the slice is set as motion distance automatically – no matter, what value the related element is configured really. So when a 3D model is sliced with different parameters, the motion settings of a globally configured process project (an external project which is executed between slices automatically) do not need to be changed manually. Only the sign of the motion distance of the motion element is kept, means when a negative movement is specified, the negative movement direction will be performed – but using the slice height.
This option can be set for all axes which in any way are related to a motion operation which depends on the height of a slice.
Following preconditions have to be met in order to let the motion distance of an axis automatically be set to the current height of a slice:
 - the option “Bind axis to slices Z-position” needs to be set
 - within the related motion element the axis motion needs to be set to relative
 - a positive or negative relative motion distance needs to be set
 - the motion element is part of a sliced 3D group (as child of the related slice) or it is part of a project which is processed between slices (please refer to parameter “Process between slices” below)

- Auto-move back to start position: when this option is set for an axis, its position at the beginning of a marking cycle is stored. As soon as the marking operation has ended, the axis will be moved back to this starting position automatically.
- Key controlled – configure single axes for control via keyboard operation. When this option is enabled, these axes can be moved out of mark-dialogue or “Motion”-panel by pressing ALT-key plus one of the cursor keys up/down/left/right. Then these axes are moved by the step distance and the speed as entered in related input fields.
Here it is possible to configure up to two axes for this operation mode. When the related checkbox is set for a longitudinal or vertical axis, it can be controlled by the key-combination ALT plus cursor up/down. When the checkbox is set for a horizontal axis, it can be moved step-wise by the key-combination ALT plus cursor up/down in motion panel or mark dialogue.
- Reference axis on start-up – here these axes can be specified that have to be referenced on application start-up or on first opening of devices automatically
- Referencing order – this option is related to the referencing-function which can be enabled with the reference-checkbox as described above. Using these drop-down-lists, an order can be specified in which the axes shall be referenced. The smaller a number is, that is selected for an axis here, the earlier the related axis will be referenced. When different axes make use of the same order number, they are either referenced at the same time or the underlying motion-controller decides which order is suitable.
- Axis alias and orientation – here for the default axes A, B, C and D an own name can be set that is shown e.g. within mark dialogue to identify the axis; additionally for planar axes it can be specified in which direction movement is done, the setting made here influences what kind of arrows are shown for axis movements in mark dialogue
- Don't show warning when referencing axes – when some axes are configured to perform referencing/homing operation on start-up, this may result in an unexpected, surprising and therefore possibly dangerous movement. Because of this prior to referencing operations an information is shown the user has to confirm in order to start the referencing operation. When this option is set, this information is NOT shown, referencing of axes starts immediately and WITHOUT ANY WARNING! Thus this option has to be used carefully and only in case the whole machine is secure and covered completely.

The tab-pane “Other hardware” contains the possibility to configure other external devices which may be required for operating a machine which is controlled by RepliMark:

- Image capture – this gives the possibility to choose a source for a live background video which is displayed in drawing area behind all vector and bitmap data. This live image can be used to adjust the current marking project to the working piece that is shown by a connected camera.
To have a background image just as pattern for a laser project, it is recommended not to use such a live image but to import a still image and use it as light-table background (via menu item “Project” → “Import”, please refer to description of import functionality below).
For a description of the available image and video capture plug-ins, their usage and parameters, please refer to section “Error: Reference source not foundError: Reference source not found” above.
- Position / Size – using these input fields the position and displayed size of the captured video can be specified, it expects the same coordinate system and orientation like it is used for definition of working area.
Beside of entering values for position and size of the live background image manually, it is also possible to right-click into the drawing area, select option “Modify live background” and then drag and scale the background image like any normal geometric element in order to place and stretch/shrink it as desired
- Display image on manual activation only – when this option is set, the image is not shown all the time, it has to be enabled manually and can be disabled afterwards to continue without a live background image; this can be done via vision menu or via the image button in mark dialogue
- Stop image capture on motion operations – this option may be useful on systems with limited computing power, when it is set, capturing of image data is stopped as long as an external axis is driven
- Stop image capture during marking operations – this option may be useful on systems with limited computing power, when it is set, capturing of image data is stopped as long as marking is in

progress

- Scanhead Selection – this combo box is dedicated to multihead configuration too, different to the other combo box which can be found in “Scanner” tab-pane, it is assigned to a scan head. This differentiation is made because one scanner controller / one plug-in defined above may access several scan heads independently, therefore head-specific parameters have to be set separately. The selection made with this box belongs to the following two parameters:
- Additional laser control – here a laser controller plug-in can be selected that communicates with a laser independent from the scanner card. As soon as a laser controller is selected for usage within RepliMark, it can be configured by pressing the button “Configure”. This function is useful in case a laser is used that requires control via a different communication channel that does not exist on a scanner controller card. This can be e.g. an Ethernet connection or a serial interface which is used to send control commands to the laser.
For a description of the available scanner controller plug-ins, their usage and parameters, please refer to section “5.4 Hardware Control Plug-Ins” above.
- Z-Shifter – here a plug-in can be selected that communicates with a special motion axis to be used for shifting the Z-position, expanding the beam or shifting the lasers focus independent from the scanner card. As soon as such as Z-Shifter is selected for usage within RepliMark, it can be configured by pressing the button “Configure”.
For a description of the available scanner controller plug-ins, their usage and parameters, please refer to section “5.4 Hardware Control Plug-Ins” above.
- Process Controller – here plug-ins can be selected that are able to control additional process parameters (beside the laser marking related ones). Possible parameters are pressure, temperature, gas flow and others where the current value is read from an external device. Depending on the possibilities and settings of the used plug-ins, other devices can be controlled or switched and/or the currently running marking process can be halted or continued. Also depending on the used plug-ins, the pen settings dialogue may be extended by an additional tab-pane as soon as such a process control plug-in is enabled. This additional tab-pane then contains parameters which are handed over to this plug-in during runtime and dependent on which pen is currently selected.
As soon as such as Process Control plug-in is selected for usage within BeamConstruct, it can be configured by pressing the button “Configure”. There all parameters can be set according to the capabilities of this plug-in.
Here several process-control plug-ins can be selected. The combination of these plug-ins allows to access different sensors which are connected via different interfaces. Typically a plug-in supports exactly one type of sensor and in most cases is able to measure one value via this sensor. Now by combining several plug-ins, several types of sensors can be combined and used. So these plug-ins provide some kind of tree-structure:
 - process-control plug ins (several can be chosen and combined freely in this panel)
 - one or more values measured and displayed by this plug in (such as temperature, gas pressure, gas concentration,...); typically one plug-in is responsible for one sensor and one measured value
 - up to four parameters that belong to each measured and displayed value (such as lower threshold, upper threshold, setpoint, ...), which can be configured in settings of the plug in (here their default values can be set) and which can have different values for each pen (the pen-dependent values can be set in pen settings dialogue as soon as such a process-control plug-in was set up)
For a description of the available process-control plug-ins, their usage and parameters, please refer to section “5.4 Hardware Control Plug-Ins” above.

Tab-pane "Misc" contains options and configuration possibilities that do not belong to any of the previous ones logically:

- Enable IOSelect-Mode – this checkbox can be used to activate the IOSelect functionality (please refer below) and to enable the settings that belong to it:
- Numbered Projects directory – here path to a directory has to be specified that contains the project data to be loaded depending on the current input state

- Card 1 Input Port – the digital input port that has to be used for external selection of next project; this selection is important in case a card provides more than one digital input port; as specified by the name of this parameter, only the first scanner card can be used to read the IOSelect input data from
- Auto-Start Marking – when this option is set, marking of IO-selected project starts automatically after mark-dialogue was opened. Attention: this function may be dangerous and should be handled with care! The start of a marking operation directly after opening the mark-dialogue and without further actions may be unexpected and surprising for the user!
- Auto-optimise vectors on marking – RepliMark is able to handle a very high accuracy internally – which is in very most cases much higher than what the controller hardware and scanhead are able to produce on output. When this option is set, the vector data are analysed before they are sent to the scanner controller(s) and all data that are beyond the resolution of the used hardware are removed. Depending on the data to be marked this can save nameable amount of marking time and data.
- Show Tab-Panes in Mark-Dialogue – this area consists of a set of checkboxes that correspond to the different tab-panes shown in Mark-Dialogue. Here it is possible to uncheck some of them in order to hide the related tab-panes. This function can be used to not to show unused functions to the end user
- The sub-section “Limits” gives the possibility to configure allowed ranges and behaviour of some pen parameters.
Here for each scanhead the minimum and maximum value that can be specified within pen settings dialogue can be predefined. The head these limits have to be applied for can be selected via the combobox right above the input fields. The allowed range of following values can be configured for each head separately:
 - Pen Frequency
 - Jump Speed
 - Mark Speed
 Beside of that the behaviour of the related slider can be changed, when check box “Logarithmic” is set, the sliders no longer act linear.
Option “Allow unrestricted laser on/off delays” disables some logic checks in pen settings: Normally the delays applied to a pen have to follow some logic rules which are automatically checked when the user modifies their values. When this option is set, these logic checks are disabled and illegal laser delay values can be set for a pen. Since this may result in some very strange and undefined behaviour during marking, this function should be used only in some very rare cases where it is clear what happens when such illegal laser parameters are used!
- Parts Counter / Enable – with these two parameters some processing-related limits can be set: this option enables the parts counter; a function which counts how many parts already have been processed and informs the user when a limit was reached; in this case the user has to confirm this limit and needs to reset the counter to continue marking; confirmation and resetting can be done in mark dialogue
- Default part number – here a number of default parts can be specified that is used for the parts counter, it can be overwritten by the user in mark dialogue and requires the parts counter option to be enabled
- Power down laser / Enable – enables a function which gives the possibility to power down a laser when it is unused for a given time
- Power down idle timeout – here a value in seconds can be set which specifies after what idle time a connected laser has to be turned off; this requires the power-down option to be enabled

Tab-pane “Custom dot” contains configuration possibilities to set up one or more custom dots which then can be used in elements for creating geometries:

- Custom dot – gives the possibility to choose from a list of dot configurations which then can be edited using the parameters below

- Custom dot name – here the selected custom dot can be renamed to give it a unique, easy to identify name
- Custom Dot Style – the following parameters are responsible for defining a style for a customised dot layout that is used by several geometric elements; this drop-down box selects the type of geometry, here polygon (includes a circle) or spiral can be chosen to be used as replacement for simple dots
- Edges/Segments – specifies the number of the edges or segments the custom geometry has to consist of
- Outer Radius – sets the size of the custom geometry
- Inner Radius – this parameter is used only in case of a spiral, it specifies the inner size of it
- Slope – here the same is true, this parameter applies to a spiral only and can be used to set the steepness the spiral grows with
- Draw CCW – here the drawing direction of the custom geometry can be inverted
- Inside To Outside – when this option is set for a spiral, it is drawn starting from its inner point

All parameters from this dialogue are stored within local default settings and within every .BEAMP project file. Thus it may happen a project file is loaded that contains different hardware settings and therefore is not compatible to the local system. To avoid such troubles two functions can be found in menu “Project” that handle the local default data:

- Save as default configuration – saves the current set up as default, whenever the application is started or a new project is generated, this configuration is used automatically; this not only includes the settings done within the project settings but also the number of pens and pen settings
- Load default configuration – loads a saved default configuration, overwrites the current project settings and appends the loaded pen definitions to the currently used ones

5.4 Hardware Control Plug-Ins

RepliMark is able to access different external devices directly in order to control the whole laser marking process. This includes plug-ins for scanner-controllers and other output devices (such as CNC-controllers), motion controllers (to access additional motion axes), laser-controllers (which give additional communication paths and possibilities to access used lasers), Z-shifter/focus-shifters (to control the Z-distance apart from a Z-channel managed by the scanner controller), process-control plug-ins (to watch and react on additional process parameters such as temperature, pressure, gas concentration and others) as well as image capture plug-ins to gain pictures and videos from external cameras.

All these plug-ins and their parameters are fully described in RepliSLS3D-manual. So for a full description of them, please refer there.

5.5 Machine Configuration

There is a set of machine-dependent parameters which are not stored within each project file or in default project configuration, but locally on each machine where RepliMark is installed at. These parameters can be configured via related dialogue in menu “Project” sub-menu “Machine settings...” which offers several configuration options within different tab panes. The following parameters can be set and modified within these panes:

In tab-pane “User interface”:

- Expand / Move entity tree to tab panel – this option saves some space in X-direction; the entity tree that is shown on main windows right hand side normally will be moved to the left side and becomes a normal tabbed panel there; changes to this parameter do require restarting of the software in order to take effect
- Security / No warning message at start-up – in general it is not recommended to use this option, it makes sense in some very rare cases only: when this checkbox is set, the warning message about the possible dangers of this application is no longer shown. This means, prior to turning of this warning, other ways of informing the user have to be established in order to avoid unwanted and possible dangerous usage of this option.
Changes to this parameter do not require saving of the current configuration as default one, the related information is stored automatically and always only locally, it does not belong to a project file which can be given away.
- No license progress bar on start-up – on application start RepliMark checks for a valid license. Depending on the speed of the used computer this can take some seconds. During this time a progress bar is shown. When this option is set, this progress bar is no longer used but license checking is still done – so with this option the delay at application start up is still there but without a visual feedback.
- Switch back to old OpenGL 1.1 – the 3D view within the application makes use of modern OpenGL for fast drawing also of complex geometries and 3D models. On some graphics hardware and in case of poor quality of drivers of such graphics card this can cause issues – starting from wrong or corrupt displaying of models and ending up in a crash of the software as soon as the 3D view is opened. In such cases it is recommended to turn on this option to switch back to the slower OpenGL version 1.1
- Use preview-projector – normally the pilot laser is used to generate a preview of the current project to be marked. As this method is limited in terms of accuracy and visibility of details, RepliMark offers the possibility to use a digital or video projector to show the current projects data directly within the working area. For details about set-up and usage of such a projector for immersive production processes please refer to related section “5.5.1 Preview Projector” below.
- Disable centre point – every element that contains some geometry comes with a centre point that is used for rotations of this geometry. This centre point can be edited, means it can be moved to any suitable position relative to the geometry itself. When this option is enabled, this centre point is no longer visible when an element is selected and it no longer can be repositioned.
- Disable 3D view – beside the flat, 2D views, there is also the possibility to switch to a 3D view mode. For applications where this 3D view does not make any sense, this option can be used. It disables the 3D view completely, it will be no longer available, also in case the scanner controller card is configured to support the third axis
- Language – by default this parameter is set to “Automatic”, means the application chooses the language the underlying operating system is configured for. When other translations are available, they are listed in the related combobox and can be chosen to be used instead. Then on next start of the application, this language is used for the user interface.
- Menu item shortcuts – the area below of these parameters contains an editor that gives the possibility to edit the shortcuts of RepliMarks menu items. On lower left hand side the menu item to be edited can be selected in a tree view. Next right beside that tree the new shortcut has to be typed in field “New Shortcut” and then can be added using button “Add”. The new shortcut is shown in the list right beside the menu tree view and can be removed from there using button “Remove”. After the

settings dialogue is left with “OK” these new menu shortcuts are applied to the menus.
These settings are locally only and do not become part of a project.

The tab-pane “Toolbars” gives the possibility to configure which tools are shown in the toolbars and which are hidden in order to not to be accessible by the user. With the selection list at the top, the toolbar to be configured can be chosen. Next the list at the right shows the tools that are accessible. Selecting such an entry gives the possibility to move it to the left (the list of hidden and therefore not accessible tools) by pressing the button with the arrow to the left. In same way it is possible to chose a hidden tool and move it to the right list by pressing the button with the arrow to the right.

After changing the tools within the toolbars, the software needs to be restarted.

Please note: tools, which already have been disabled by the related customisation functions (as described in “5.17.3 Custom menus and functions”), are not visible here, neither in the “shown” nor in the “hidden” section. Furthermore, in case of custom installations, where specific tools have to be disabled on set-up of the software, it is recommended to not to use the toolbars-function out of the machine settings, but to use the customisation functions out of the section 5.17.3 too.

The “Smart Factory” tab-pane offers functionalities which are related to machine integration into automated production lines:

- Machine name – here a name can be set which identifies a software installation/a machine uniquely. By default an auto-generated name is set here which can be replaced by a human-readable value. This name is used for all Smart Factory related functions, e.g. within all Smart Interface state messages to identify the machine it comes from and within the relevant Hermes messages that require a unique identification too.
- Enable Smart Interface – when this checkbox is set, the Smart Interface is enabled and the software can be integrated into a Smart Factory / Industry 4.0 environment. For details regarding this interface please refer below
- Enable MQTT connection – when this checkbox is set, state messages are sent to a suitable broker using the MQTT protocol
- Broker – here IP and port number of the broker to publish the MQTT state messages to has to be set
- Topic base-name – using this field a topic for the MQTT messages can be configured. It will consist of a base-part of the topic which always is expanded by the machine name configured above
- Enable Hermes automatic control – when this checkbox is set, support for machine integration according to the Hermes-standard is enabled (for details please refer to <https://www.the-hermes-standard.info>). This enables several configuration parameters which can be used to specify connection to other machines within the same line. Here it depends on the availability of previous and/or next machine if RepliMark acts as end of line machine, begin of line machine or something in between. If the next or previous machine does not connect according to the Hermes specification, RepliMark automatically switches to end/begin of line mode.
- Previous machine – here IP and port number of the machine which transfers working pieces to RepliMark can be configured
- Next machine – here the port number of the machine RepliMark transfers working pieces to can be configured. Since the next machine connects with RepliMark actively, here no IP has to be specified. Instead of this the local IP must be known at the next machine.
- Conveyor axis – using the following comboboxes it can be specified which motion controller and which of its axes has to be used as conveyor to feed the working pieces. Here also the movement direction of the conveyor can be set.
- TransportFinished distance – when the conveyor axis moves to transport a working piece to the next machine, a TransportFinished command has be sent to the next one, as soon as this transport is complete. Using this field the motion distance can be specified which has to be used to move a working piece out of the current machine. This parameter is used only when RepliMark does not act as end-of-line machine.
- Enable Hermes remote configuration – according to the Hermes standard there is a possibility to send configuration data from a remote host and to overwrite local information as they may have

been specified here. When this checkbox is set, overwriting of the local configuration is allowed and possible. When it is not set, the Hermes-configuration of this machine can be changed only by direct manual interaction.

In tab-pane “Users” access to functions can be limited depending on logged-in users, their roles and privileges. By checking the box “Enable user management”, this functionality is activated and some predefined settings are provided. For all existing, preconfigured users the password is similar to the username and should be changed prior to operating it on the target system.

The users-tab-pane lists the available users on the left hand side. By selecting one of them, the related privileges and settings are shown on the right hand side of the pane. Once a user is selected, its privileges can be changed, the login and full name as well as the state and the comment can be modified. To activate such changes after setting them, the button “Apply” has to be pressed, elsewhere the changes of a users parameters are not activated.

The check-boxes on upper right side of this tab-pane define what a user can do after logging into the software successfully:

- Supervision – this is a special privilege that applies only to user “Supervisor”, as long as this user is logged in, all functionalities are enabled, no restrictions exist
- Manager Users – a user with this privilege is allowed to modify the users and its privileges within this tab-pane; this should be combined with the “Modify Settings” privilege in order to give the related user access to the configuration dialogue
- Exit Application – this privilege gives a user the possibility to leave the application
- Modify Settings – a user with this privilege is able to enter the project configuration dialogue and to change the global parameters and settings of an installed software
- Edit Geometry – when this privilege is set for a user, this user will be able to modify loaded geometry and to edit the data of the currently loaded project
- Load Project – this gives a user the possibility to load an other project, this privilege is similar to “load recipe” like it may be named in other software
- Save Project – a user with this privilege is allowed to save the current project to disk; this privilege should be combined with an other privilege that gives the possibility to change the project settings, to edit the loaded project or to load/insert an other project, elsewhere it would not make sense for this user to save an unchanged project only
- Control Marking – when this privilege is set, a user is allowed to start and stop the marking process

These user data are stored in the default application data directory of the used operating system within a sub-folder “beamhome”. The exact position depends on the used operating system. The data are neither encrypted nor protected, so deletion of the directory and its contents would disable the user management completely. Thus it has to be ensured by using the operating systems functionalities that no user is able to access this folder without permission (e.g. by disallowing users to exit the application and by locking the whole system as long as RepliMark is running). This is done by intention to offer the possibility to restore a system just by deleting the “beamhome” directory when some relevant passwords got lost.

In case the user management was activated, on next software start-up all functions are disabled until a valid user logs in by using the correct password. Logging into the software can be done by pressing the user-symbol in toolbar:



5.5.1 Preview Projector

To get a more detailed and more complete preview of the current project to be marked, as an alternative to the slow and limited pilot laser a projector can be used that is adjusted to display its contents directly into the marking area. RepliMark then offers extensive possibilities to use and control such an additional projector.

Following preconditions have to be met in order to make use of such a comfortable, additional view to the project to be marked:

- a PC with a second video-output is needed that can be configured to display separate contents on a screen

- a projector (video or digital projector) is needed which can be connected to this PC in order to display the contents visible on this second screen

To install and adjust such a projection system, following steps are necessary:

- mount the video projector in your machine at a position where it can cover the working area completely
- configure the PC in a way so that each of the available video outputs (aka “screens”) shows separate contents and an own desktop (“Extend displays”)
- reposition RepliMark’s main window so that it is shown on the first screen (the screen with the system-toolbar)
- connect the projector (aka “Beamer”) to the video output that is assigned to the second screen
- go to menu “Project” → “Machine settings” and enable the function for the preview projector
- leave the machine settings dialogue with “OK”; now a new window appears which contains the preview which has to be shown by the projector
- move the new window to the second screen and maximize it so that it fills this second screen completely – to simplify this at this stage the frame around this window is still visible
- create a project in RepliMark that contains some geometries which can be used to adjust the projected view in next steps; this typically is a rectangle which is as large as the whole working area as well as some additional graphics which mark specific positions within the machine (e.g. a cross-hair to mark the centre position); this projects vector data now are also shown via the beamer and projected into the machine, but still not at the correct position and spatially distorted
- go to menu “Help” → “Adjust projector”; now a dialogue opens which offers different functions to correct the view of the projector in order to be perfectly aligned to the working area also in case the beamer is mounted angular and at the side of the machine which causes some spatial distortions
- first uncheck the box “Enable window dragging border” to turn off the frame around the projection window within your projectors view; now it is impossible to move the projection window any more
- scale and adjust the projected view in the machines so that it fits to the real world working area using the available adjustment parameters:
 - Offset X / Offset Y – to move the view in X and Y direction
 - Zoom – scale the whole view
 - Spatial correction X / Spatial correction Y – adjust the spatial distortions caused by the non-parallel mounting position of the projector
 - Rotation – rotate the whole view
 these values can be changed either in larger steps by pressing the related “+” or “-” buttons or by entering exact values into the related input fields. When the view got lost accidentally and can’t be brought back to the projection any more, enter a value of 1 to the zoom-input field and a value of 0 to all other input fields
- leave the dialogue with “OK” in order to let the current settings be saved

Now whenever a project is loaded, the contents of this project are shown within the working area too. Here a different colouring scheme is used for a better contrast and brightness within the machine, so the colours for pens background which have been configured in pen and project settings are not used here.

5.6 Pen Settings

Every element that is created within a RepliMark project has a pen assigned to its geometry (or for scanner bitmaps to its bitmap data). This pen contains all information the related element will be marked with: scanner speeds, delays, laser power and frequency and others more. These parameters can be set within the pen settings dialogue that opens when the menu “Project” menu item “Pen settings...” is selected.

On top of that dialogue the head can be selected this pen applies to. This is important for multihead environments where more than one scanner controller/more than one independent working area is used.

There will always exist the same number of pens for all heads but the same pen number can have different parameters for different heads.

Below of this a pen can be chosen for editing, the same combo box can be used to create a new pen, in this case the option "Append new pen..." has to be selected there. After selecting an existing or a new pen all its parameters can be changed within the lower part of the dialogue. It is separated into some sections that contain different categories of pen parameters.

All tab-panes that hold these categories have one common functionality for selected parameters: by pressing the button "To all pens" a parameters value can be applied to all pens that currently exists. So in case a specific pen parameter has to be changed globally, with this function it is not necessary to edit it manually within every single pen.

PLEASE NOTE: there is no feedback from a possibly connected laser or scanner equipment to this dialogue, so the application can't know if a value is suitable for the connected equipment or not. Although there are some logical and range checks that try to avoid heavy mistakes it is up to the user to keep all parameters within valid and useful ranges.

5.6.1 General Pen Settings

This panel contains some basic pen parameters. On top of it an input field can be found that can be used to rename the current pen, there its name can be changed and the new name can be applied by pressing the return key.

Beside of that the following parameters can be edited here:

- Power – the output power in range 0..100% the laser has to be driven with
- Frequency – the frequency in unit Hz the laser has to be driven with; the allowed frequency range can be configured within project configuration dialogue
- Mark Speed – the speed of the scanner that is used during marking (motion while laser is turned on); the allowed speed range can be configured within project configuration dialogue
- Jump Speed – the scanners speed that is used during jumps (motion while laser is turned off); the allowed speed range can be configured within project configuration dialogue
- Spot Size – the diameter of the lasers spot on the surface, this value should be as exact as possible because it is used for different calculations
- Draw Off-Movements – this option is related to the visual representation of a project within RepliMark only; when this option is set not only these parts of the geometry are shown within the drawing area where the laser is turned on but also the jumps where the laser is turned off; this option can be helpful to optimise a project and to re-arrange elements to perform as less jumps as possible
- Use as default Pen – the pen where this option is set for is used as default pen for all newly created geometries. More than this, whenever a new pen is created the parameters of this pen will be set to the values specified for the default pen. Within a project only one pen can be default, so whenever this option is selected for a pen, it is disabled, resetting this option can be done only by choosing an other pen as default one.
- Use for Pilot-Laser – the parameters of this pen are used to control the pilot-laser. This means the speed and delay settings are used whenever the pilot laser is started. Since this laser can be turned on and off only, all values like power, frequency and some delays are disabled, they are not relevant for the pilot laser. Within a project only one pen can be used for the pilot laser, so whenever this option is selected for a pen, it is disabled. Resetting this option can be done only by choosing an other pen for the pilot laser.
- Pen On-Colour – this colour is used within the drawing area for all geometries
- Pen Off-Colour – this colour is used when "Draw Off-Movements" are enabled to show the laser jumps within the drawing area
- Use for coloured scanner-bitmaps – when this checkbox is set the current pen is used for coloured scanner bitmaps; this option should be enabled only
 - 1) when the current pen parameters cause a coloured result on current material

2) when the colour of this result is specified using button “Colour after marking”; PLEASE NOTE: setting the resulting colour requires a calibrated monitor in order to have exact results

5.6.1.1 Pen Parameter Wizard

It is sometimes difficult to find parameter-combinations that fit to a special material or application. Thus the pen dialogue offers a special wizard that creates a matrix out of different values where the user can choose a suitable result from. To open this wizard, the button “Parameter Wizard” on upper left corner of the pen settings windows has to be pressed.

There a window opens where a 4x4 to 10x10 sized matrix of small marking areas is symbolised by a matrix of buttons. On upper part of the window the parameters to be used have to be selected and their range to be checked can be entered. These values are spread over the matrix in order to find best parameters. Next the yellow “Mark Start” button right beside the button matrix has to be pressed in order to start output to the material. Alternatively it is possible to use the button “As project” in order to not to mark out of the pen parameter wizard directly but to use the generated pen parameter matrix as current project which then is editable like every normal RepliMark marking project.

ATTENTION: by pressing the mark-button a laser operation is started! This may operate with up to 100% power and therefore is potentially dangerous! Prior to opening the pen parameter wizard and prior to starting output out of this wizard all security measures have to be ensured!

As soon as marking has finished, the area with the best marking result has to be chosen from marked material and the related button in pen parameter wizard has to be pressed.

To make it easier to find the correct position there is one circle and one triangle used for marking, these symbols identify orientation and direction of the matrix uniquely. So to find the position of the best result it is possible to first count from triangle to circle until the correct column is found and then count the row number. When the same is done in pen parameters button matrix of the wizard dialogue, the exact position is found and this button can be pressed. Such a button-press opens a popup-menu where one of the following options can be chosen for further processing:

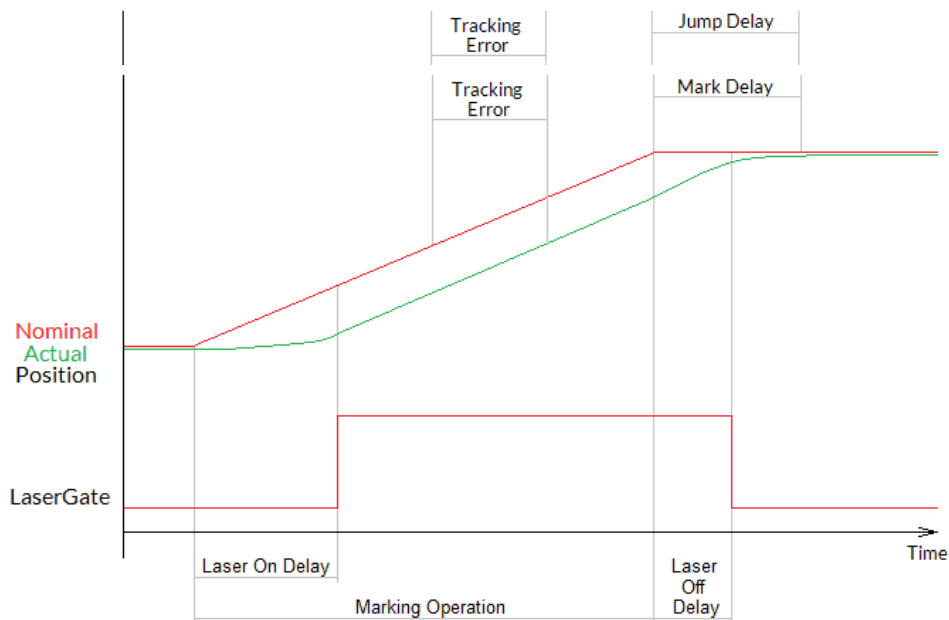
- Refine this result – some values close to the chosen position are used to create a new matrix for a next, more accurate calibration step
- Go back from this result – this option performs the opposite operation of the previous one, it creates a new parameter matrix with a larger range of values and should be used when a parameter range out of a refined result or when the initial parameter range does not give expected marking results
- Use parameters for pen – when this item is chosen the parameter wizard will be closed and the found parameters that belong to the selected field are set to the current pen.

For the other marking parameters apart the selected ones the pen parameter wizard always used values of the currently selected pen, only the selected ones are varied and modified by this function.

5.6.2 Scanner Pen Settings

This tab-pane contains all scanner-related pen parameters:

- Dot-length – this is a convenience function which shows and calculates the number of pulses a dot consists of with the current settings. The value given here depends on the frequency and the current laser on and laser off delays.
So when the value in this field is changed, the corresponding laser off delay is changed automatically. On the other hand, when frequency, laser on delay or laser off delay are changed, the number of pulses shown in this field are changed according to the modified values.
- Jump Delay – time the scanner waits when a jump was executed; this delay applies at the end of a jump to let the scanner finish its movement

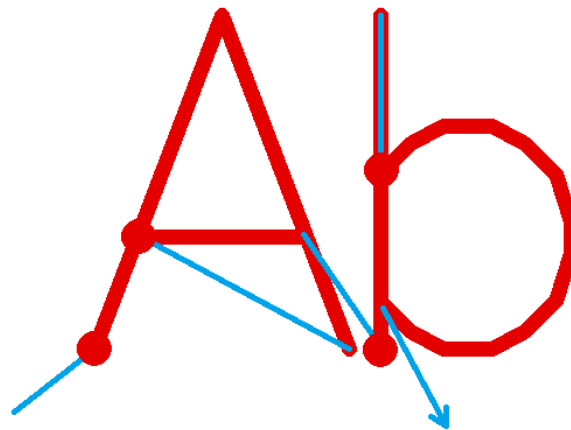


- Mark Delay – time the scanner waits when a marking operation was executed; this delay applies at the end of a marked line to let the scanner finish its movement
- Polygon Delay – the time the scanner has to wait for every corner within a polygon when the laser is turned on and stays turned on
- Use variable polygon delay – this option belongs to parameter Polygon Delay. When it is set, there is no static delay used in every corner of a polygon, but a variable one which depends on the current angle between two lines of the polygon. The sharper the angle is, the longer the used polygon delay becomes. This option is available only when a scanner controller card is configured which supports this feature.
- Auto-generate delays – the delay values described above are essential to get high quality marking results also in case of an as high as possible marking speed. Since the evaluation of the correct values is a difficult and time-consuming process, RepliMark offers a possibility to set some default values which can be used as starting point for optimising these delays. After pressing this button, a dialogue opens, where the used scan head can be selected out of a list of predefined types. Then some base delay values are generated for this scan head. In case a used scanhead is not listed there, option “Other” has to be chosen, which requires to enter one single value for delay calculation: Every scan head vendor should provide a value named “time lag”, “tracking error” (or something similar) within its technical documentation. This value describes the specific inertia of this scan head and needs to be entered here. When this dialogue is left by pressing “OK”, RepliMark calculates some basic delay parameters (including not only the jump- and mark delay but also laser-on and -off delay as per section “5.6.4 Laser Pen Parameters” below) that fit to the scan heads mechanical properties and often can be used directly. Alternatively these delays can be used for further optimisations for these applications, where a more strong and exact set-up of the scan head is required. For more details about the purpose of all these delays and their influence please refer to your scan heads or scanner controller manufacturers manual.
- Set Defaults for Bitmap-Marking – when marking scanner bitmaps instead of vector data, some very specific pen parameters have to be used that follow other rules. In such cases it is recommended to use this button, it changes the current pen parameters including the scanner delays to values that are suitable for marking scanner bitmap elements.
- Wobble Frequency / Wobble Amplitude – when wobble is enabled the linear movement of the scanner during marking is distorted by an additional frequency that lets the scanner oscillate around the predefined position. This functionality can be used e.g. to warm up larger areas of a material, for welding or similar things. To enable wobble both parameters amplitude and frequency have to be greater than 0. The wobble frequency specifies how fast to oscillate and the wobble amplitude how

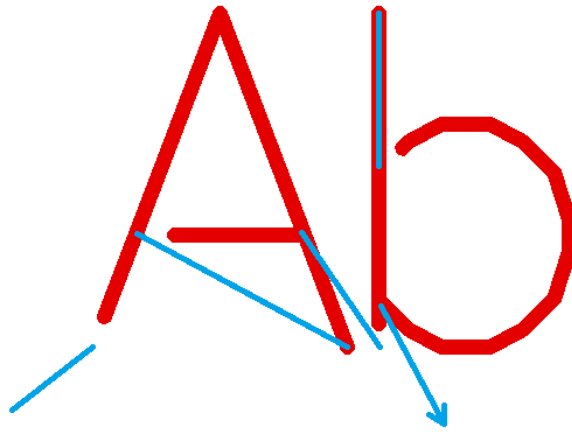
much to vary over the original position. Wobble has to be supported by the used scanner controller card in order to have any effect during marking.

The given delay values have a direct influence on the marking result and need to be adjusted carefully. Wrong delay values can result in inaccurate geometries, burn-in points at some specific positions and/or unnecessary long marking times. Out of the visible result it can be evaluated which delays are too small or too big by checking following rules:

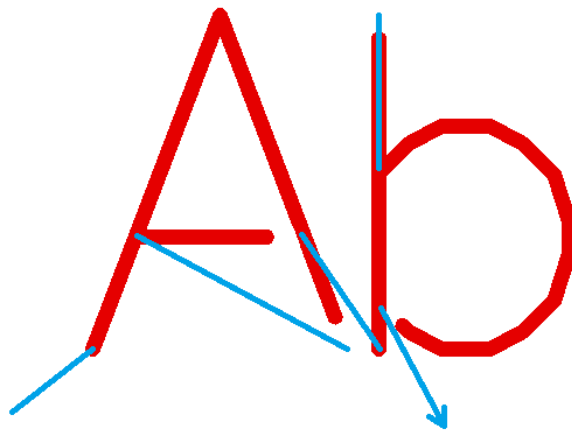
Parameter	Value too big	Value too small	Remark
Laser On Delay	First part of a mark vector (following a jump vector) is not marked	Burn-in point at the beginning of a mark vector that follows a jump vector	See pictures below
Laser Off Delay	Burn-in point at the end of a mark vector and before the next jump vector	Last part of a mark vector (before a jump vector) is not marked	See pictures below
Jump Delay	Mark time is longer than necessary	Geometry is damaged at the end of jump (transient oscillation)	
Mark Delay	Mark time is longer than necessary	The end of a vector is turned towards the direction of the following jump vector	See picture below
In-Polygon Delay	Burn-in points at the corners	The corners of the polygon are not sharp but rounded and at wrong position	



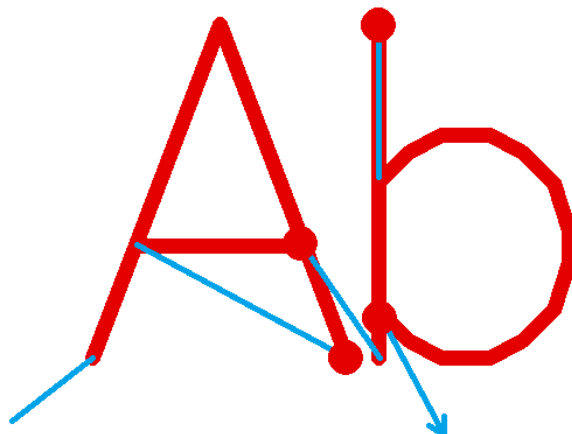
Laser-on delay is too short, laser is switched on too early while mirrors are still slow or accelerating, thus it fires on the same position for a too long time which results in burn-in points; please refer to section “5.6.4 Laser Pen Parameters” below for this parameter



Laser-on delay is too long, laser is turned on too late while scanhead already started marking of the next vector, thus parts of the mark geometry are missing at the beginning; please refer to section “5.6.4 Laser Pen Parameters” below for this parameter

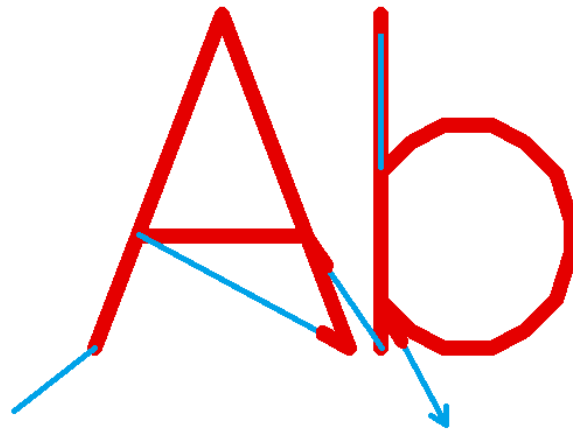


Laser-off delay is too short, laser is turned off before the end of the current mark vector is reached, thus parts of the mark geometry are missing at the end

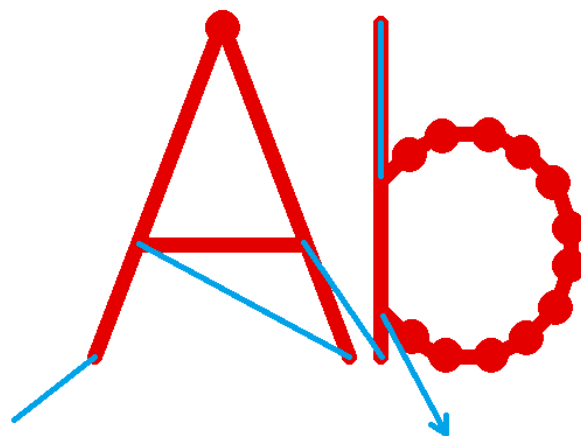


Laser-off delay is too long, laser is turned off too late while end point of the vector is already reached and

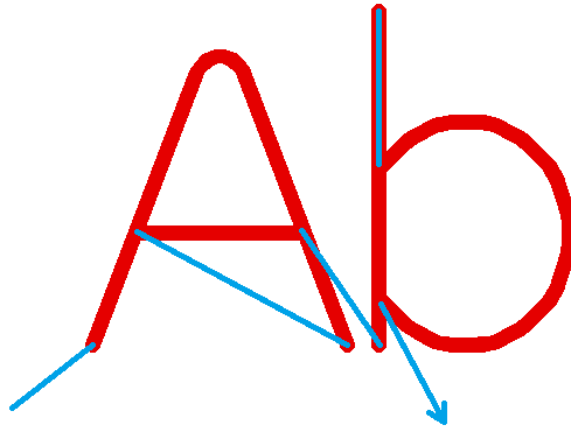
mirrors of the scanhead slow down, this results in burn-in points at the end of the mark vectors; please refer to section "5.6.4 Laser Pen Parameters" below for this parameter



Mark delay too short, motion of next jump vector is started too early and before end position of previous mark vector was reached, thus the laser is still on when motion for the following jump vector is performed



In-polygon delay too long, scanner stops for a too long time at the position of a corner point within a polygon, thus burn-in points appear at these positions.

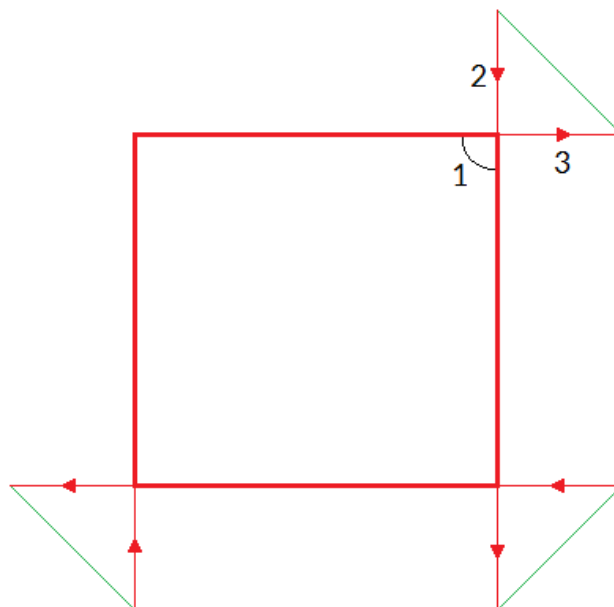


In-polygon delay too short, mirrors are not able to arrive at the positions of the corner points within a polygon before the next mark vector starts, thus the whole geometry is rounded, the vectors are pulled into direction of the next one

5.6.2.1 Sky-Writing

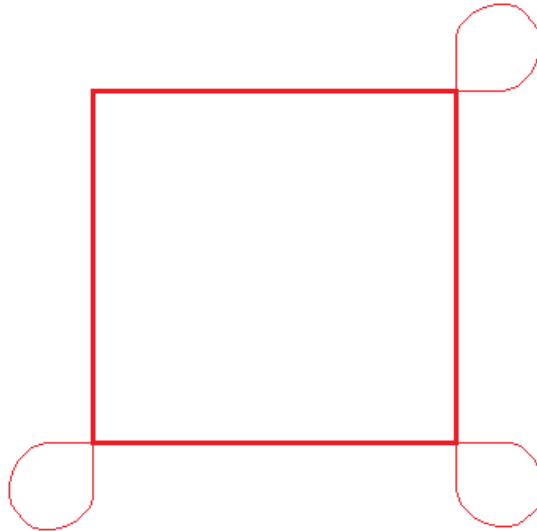
As described in previous section, it is necessary to apply delays in order to have clear and sharp corners within polygons. Depending on the used hardware and its capabilities these delays can become quite long, slowing down the total marking speed. To avoid this, the “sky-writing” mode is available (on selected scanner controller hardware which supports this feature or has required capabilities). When this mode is active, the configured polygon delays are no longer used which waste some marking time. On the other hand the vectors to be marked become longer which itself again needs some time. So it depends on the used hardware and its specific capabilities if sky-writing really saves time during marking.

Sky-writing avoids delays and rounded, blurred corners by starting vectors earlier, ending them later and turn on/off the laser at exactly the position where the polygons line begins/ends:



In this picture the thick red lines symbolise the marks where laser is turned on. The thin red lines show the movements where vector lines are extended by a given length but where laser is already turned off. For a better understanding small arrows in the jump lines show the marking direction. The thin green lines show the jumps, only at these positions the chosen jump speed is used, all other movements are done with mark speed.

Here each line of the rectangle starts earlier, turns on the laser at the point where the polygon line has to begin, turns it off at the point where it has to end and then continues a bit in the same direction. Next a jump is done to the position where the next extended vector line has to start. Now when the scanhead would distort vectors because there is no more in-polygon delay active, this distortion would happen outside the rectangle and at a position where the laser is turned off. Thus the distortion would no longer be visible in the marking result when the lengths given for the polygon are long enough:



In this image the real scanner movements are shown. Here the movements at the corners are rounded and distorted due to the high speed, but these distortions do not influence the marking result since they happen when the laser is already turned off. In this specific example the lengths the lines are extended by could be shortened because there is still a longer straight line before and after every line.

Sky-writing requires following parameters to be configured:

- activation threshold – marked with a “1” in picture above: this is a value that specifies at which angle between two lines within a polygon the sky-writing mode needs to be activated, if an angle is equal or smaller (means sharper) than this value, sky-writing is used to keep the marking result clear, for bigger (means flatter) angles the normal in-polygon delay (as described above) is used
- fade-in distance – marked with a “2” in picture above: this value specifies the length a line has to be extended with at the beginning, means this is the size which is added before laser is turned on. This value should be as small as possible in order to not to waste marking time. At the borders of the current working area it may be possible this value can't be applied fully because the starting point would be located outside of the valid range of the scanhead.
- fade-out distance – marked with a “3” in picture above: this value specifies the length a line has to be extended with at the end, means this is the size which is added after the laser was turned off. This value should be as small as possible in order to not to waste marking time. At the borders of the current working area it may be possible this value can't be applied fully because the end point would be located outside of the valid range of the scanhead.

5.6.3 Bitmap Pen Settings

Within the panel “Bitmap” some scanner-bitmap-specific parameters can be set. They are used only, when this pen is assigned to a bitmap but has no effect when it is used with vector data.

Please also note the button “Set Defaults for Bitmap-Marking“ which is described in section “5.6.2 Scanner Pen Settings” above.

This panel provides the following parameters:

- Bitmap greyscale mapping – in some cases a linear 0..100% power range does not result in similar, linear grey tones. This happens when the laser does not react linear on provided power values and/or when the material does show a non-linear behaviour on marking. In such cases this option can be enabled to define an own greyscale mapping which allows to adjust such deviations.

On upper part of the window a nominal (linear) greyscale range is shown. Below of these the mapping values can be entered which have to be assigned to the nominal, input grey values of the bitmap to be marked. Below of these sliders and input fields the resulting greyscale map is shown as it would be sent to the laser in terms of power values. When the given values are correct, this non-linear, lower greymap then would result in linear marking results.

The given values are in range 0..255 which corresponds to the 8 bit greyscale values of a scanner bitmap.

This greyscale map is used only with greyscale bitmaps where a pen is assigned to in which this option is enabled.

To adjust a bitmaps greyscales with this map, the test image from

https://halaser.eu/scannerbitmap_test.png can be used – beside different patters which can be used to evaluate the quality of a greyscale marking it contains seven grey values in lower right corner which directly correspond to the seven grey parameters which can be set with this option. So as soon as these seven fields have the correct brightness after marking, the given greyscale map is correct.

5.6.3.1 Overspeed

An other method of getting a higher speed out of a scanhead is the overspeed-functionality. With this feature the galvos of a scanhead are driven with a speed that is far beyond of its limits and normally results in a totally distorted marking result. Here the scanner controller card takes care about the movement of the galvo and drives it with a specific speed curve that avoids these distortions. When this feature is used, the exact improvement highly depends on the used marking data. The more long vectors it contains and the less inertly a scanhead is, the higher is the possibility to find vectors that can be driven with overspeed and the better is the possible improvement in speed.

To make use of the overspeed-function, some specific requirements needs to be met:

- the used scanner controller card supports these speed curves for overspeed movements
- scanhead bases on galvo-technology
- scanhead does not artificially limit the maximum speed

The overspeed-function can be enabled and configured in pen settings, tab-pane “Scanner”. Here following parameters can be set:

- Enable overspeed – enables the overspeed-function for the related pen; when this checkbox is set, the following parameters need to be configured:
- Tracking error – this is a scanner-specific value (also named “time lag” sometimes) which describes the inertia of the mechanical parts of the used scanhead. This value is fixed for each type of scanhead and is typically provided by the vendor of the scanhead.
- Jump speed factor – this value is the overspeed factor which is used for jumps. Normally jumps are done using the speed defined in tab-pane “General”. When the overspeed-feature is enabled and when a jump vector is suitable to be driven faster, it no longer is moved with the nominal jump speed but with the nominal jump speed multiplied by the factor given here.
The maximum value this factor can have depends on the used scanhead but typically is in range 3..9

To adjust a scanhead for usage with the overspeed-function and to find suitable parameters, please perform the following steps:

1. Create a test-project that represents a typical application but also contains some large jumps (at least half of the working area is recommended). These large jumps later are used to find the maximum overspeed factor
2. Start with the overspeed-function disabled.
3. Use the test project from step 1 to find the proper scanner and laser-delays as well as the nominal maximum jump and mark speed the scanner can be driven with while it still provides acceptable marking results with no distortions (this is the normal procedure of setting scanner parameters, so please refer to previous sections about adjustment of these delays).

4. Enable the overspeed-function for the pen(s) used in the test project and set the tracking error value according to the technical data of the used scanhead.
5. Increase the jump speed factor until you find a value where the marking results start to become distorted, here especially the marking results which are located close to the long jump vector(s) are important and have to be checked

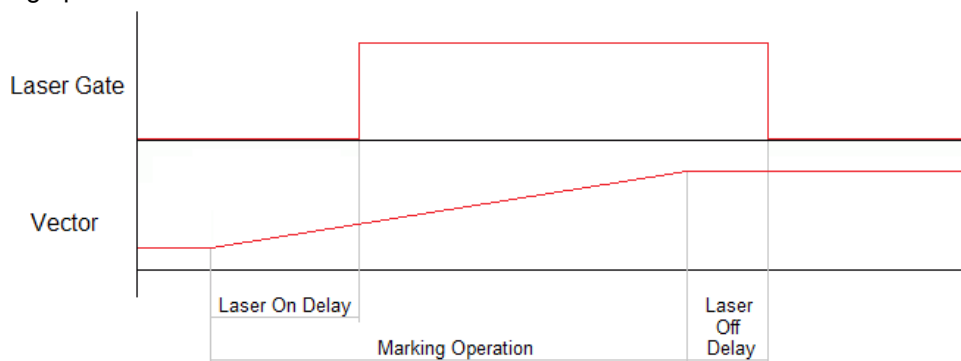
5.6.4 Laser Pen Parameters

This panel contains several parameters that belong to the used laser and the parameters/signals that are required to operate it. So depending on the laser type that was configured for the current project these options are enabled that contain useful parameters for proper laser operation. For a detailed description of these parameters and their meaning please refer to your laser vendors manual.

PLEASE NOTE: some laser types need to be operated using relatively tight parameter ranges. When they are controlled with wrong parameters the results may be an undefined behaviour or the laser hardware may be damaged in worst case. So when setting up new parameters or when changing them or after a software update was done, it is highly recommended to (re-)check these laser parameters and the output signals of the scanner controller in order to avoid problems with the laser. Here “software update” not only includes updates of the RepliSLS3D software package or RepliMark. Also in case the software or drivers that for an example belong to the scanner controller card are modified, it is recommended to perform these checks.

This tab-pane contains all scanner-related pen parameters:

- Laser On Delay – the time that is set between start of a mark movement and the moment the laser is switched on; so this parameter specifies if and if yes how much the laser should be turned on delayed in case a marking operation is started
- Laser Off Delay – the time that is set between the end of a mark operation and the moment the laser is turned off; so this parameter specifies how much turning the laser off has to be delayed in case a marking operation ends



- Dot-length – this is a convenience function which shows and calculates the number of pulses a dot consists of with the current settings. The value given here depends on the frequency and the current laser on and laser off delays. So when the value in this field is changed, the corresponding laser off delay is changed automatically. On the other hand, when frequency, laser on delay or laser off delay are changed, the number of pulses shown in this field are changed according to the modified values.

5.6.5 Using Pens for Coloured Bitmap Marking

On some materials variations of power, speed and frequency cause marking results in different colours. This behaviour can be used within RepliMark to easily mark coloured bitmaps. Following the steps are described to get such images. First of all it is important to know that the process of marking colours is not easy to handle. Environmental conditions may have a strong influence the result so that pen parameters that cause a specific colour one day may result in a different colour the next day. So the whole process should be done in a well-defined environment. Next the material condition can have an influence too, its state of oxidation,

grease or dirt on the surface may affect the resulting colour. So in case of troubles a defined cleaning process may be necessary, possibly by using a laser- or plasma cleaning process.

To get coloured bitmaps following steps are necessary:

- check image and the colours it contains
- find as much as possible pen parameters that result in different colours when they are used for marking on your target material; they should include as much of the colours that are contained in image to be marked
- calibrate your monitor so that the colours displayed there are as close as possible to the real colours
- walk through all pens where you found parameters for coloured marking results, enable option “Use for coloured scanner-bitmaps” and click the colour chooser “Colour after marking”, there select a colour that is as close as possible to the marking result of this pen (that’s the step where the calibrated monitor is required)
- close pen dialogue
- import your coloured image using menu Project → Import
- select option “Use as coloured scanner bitmap” in image import dialogue; when this option is not enabled, you don't have enough pens defined for usage in coloured bitmaps
- on top left corner of import dialogue a preview of the image can be seen that makes use of the colours defined by the pens; now the image can be manipulated using the sliders for Brightness, Gamma, Contrast, Correction Red, Correction Green and Correction Blue to improve the result

Now after clicking OK the image is imported. It is processed in a way that maps the existing coloured pens to closest colours in image. During marking, such an image is processed in several cycles, one for every colour/pen that is contained.

5.7 Construction Of Geometry

Comparing to other CAD applications that offer basic primitives with huge amount of options and parameters the concept of RepliMark is different: It offers several basic primitives like lines, circles and others that contain only as less parameters as necessary. To get a wide range of effects and complex geometries, these basic data can be combined with other elements that add new data to them or that modify and manipulate them. Thus several simple and easy to understand elements can be put together to complex geometries.

RepliMark offers following element types that can be used for these combinations:

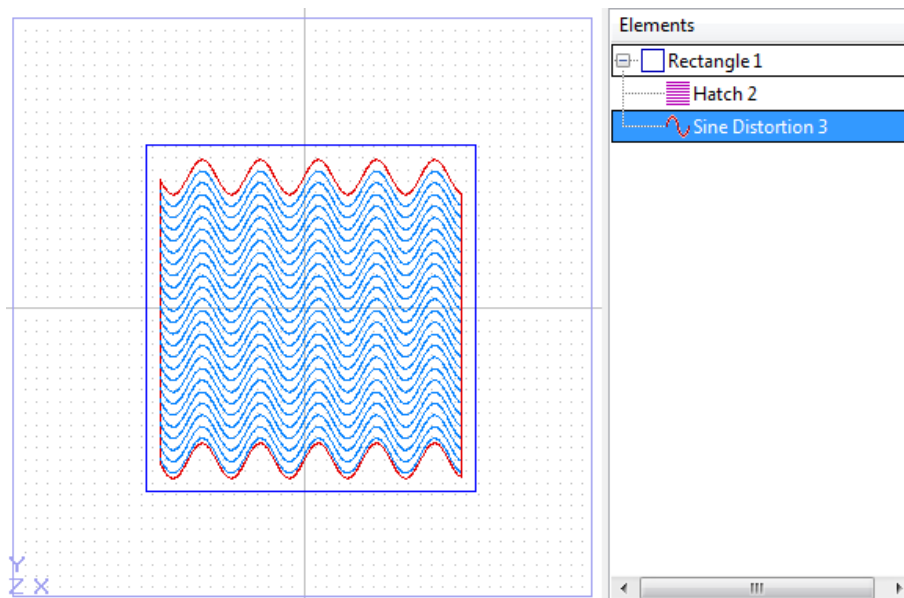
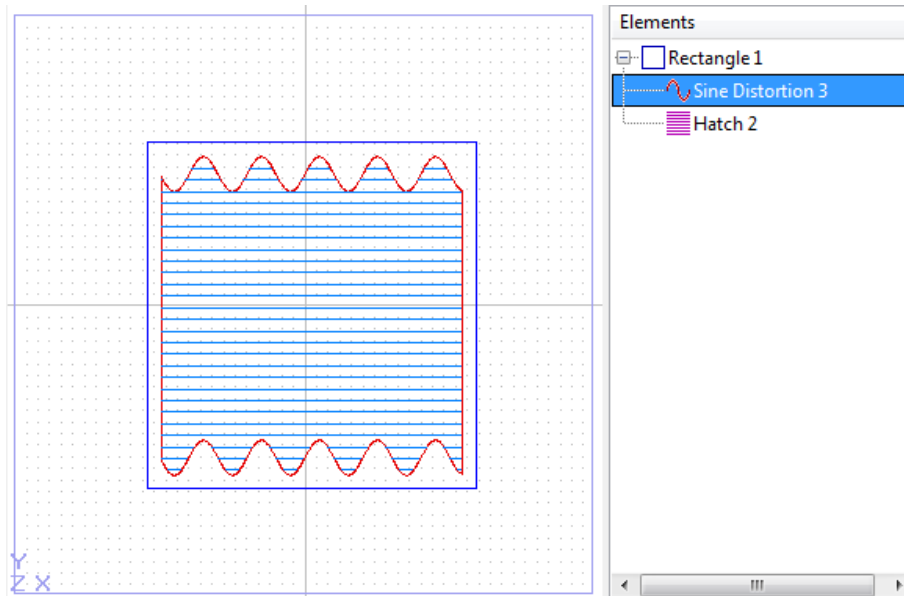
- Primary Geometry – such an element is always the starting point and offers a basic, primitive geometric element (like a rectangle, triangle, text or others like this); this element can be combined with several other elements like:
- Additional Geometry – this elements uses a previously defined geometry and adds some more geometry to it
- Post-processing Tool – this element modifies existing geometry
- Input Element – here an indirect influence to existing geometries is possible, this kind of element gets data from an external source and puts it into Primary Geometry elements that can use these data for their own geometry (like the text or barcode element)

Following rules apply to these elements:

- a Primary Geometry element can have several child elements but none of type “Primary Geometry”
- Additional Geometry and Post-Processing Tools can exist several times as child of a Primary Geometry element, but they influence only the state of the geometry like it exists before their own position
- an Input Element can exist exactly once for a Primary Geometry element and only for such elements that really are able to handle input data)

The second rule can be made explained better with an example: as Primary Geometry a rectangle is drawn. It is modified with a “Sine Distortion” Post-processing Tool which changes the borders of the rectangle to have a sine waveform. Next an additional element “Hatch” is used which adds lines to the geometry that fill the rectangle

In this case the sine distortion is applied to the rectangle only (because it is located before the sine-element) but not to the hatching lines (because they are added after the sine distortion takes place. So the hatching lines stay straight:



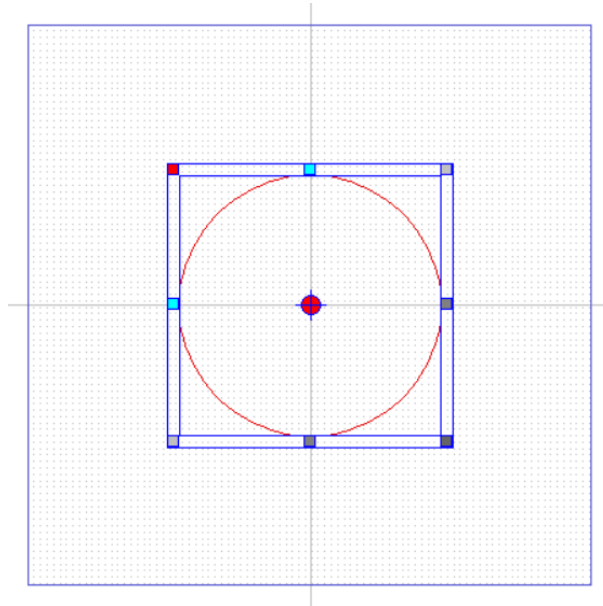
The situation becomes different when the two sub-elements change their position. When the first child element below of the primary element is the hatcher the resulting hatch lines will be distorted by the following Post-processing Element too. They are no longer straight lines but have the same sine shape like the rectangles border because the sine distortion now applies to the hatcher too: that's caused by the fact that the sine distortion Post-Processing Tool stays after the hatcher:

PLEASE NOTE: for the example explained above the line styles for rectangle and hatch have to be switched to “Connected Lines”.

5.7.1 The Drawing Area

Within RepliMark's main window the drawing area for geometry is located in the middle. There new primary elements can be created or existing geometry can be modified. Whenever an element is selected, it is highlighted by a double-lined, blue border. This border can be used to manipulate the element. When pressing the left mouse button within this border and outside the coloured squares it contains, it can be moved and repositioned. Left-clicking it within one of the squares gives access to other manipulation functions:

- the dark-grey rectangle at the lower right corner provides a resizing-function where the aspect ratio



between both visible directions is kept intact

- the medium grey rectangles at the lower or right border of the rectangle provide resizing functionality in one direction only
- the light-grey rectangles in upper right and lower left corner allow to rescale the element in every direction and without keeping the current aspect ration between the two visible directions
- the cyan rectangles at the left and upper border can be used to slant the geometry in one of the visible directions
- the red rectangle in upper left corner can be used to rotate it
- the red circle with the blue cross-hairs specifies the centre position which is used for rotation operations; it can be dragged to any other position resulting in a different rotation centre. To set this centre point to a specific position manually by entering coordinate values, please check out the related function in “Geometry” tab-pane (for details please refer to section “5.7.2.2 The Geometry Tab-Pane” below)

How and by which value the elements are changed can be seen within the panels on the main windows left hand side as described in following section.

Beside the possibility to drag and move the element by holding it in its outer, double-lined border it also can be moved via the cursor keys when Control is held down:

- holding Control- and Shift-key and hitting cursor up/down/left/right moves the selected element by 5 mm into the given direction
- holding the Control-key and hitting cursor up/down/left/right moves the selected element by 1 mm into the given direction
- holding Control- and Alt-key and hitting cursor up/down/left/right moves the selected element by 0,1 mm into the given direction

PLEASE NOTE: The manipulation possibilities described above apply to the geometry that is currently selected. When a primary element is selected the changes apply to its geometry, possibly existing additional

or Post-processing Tools are re-calculated according to these changes. Whenever additional geometry within a Primary Element is selected and manipulated, this has no feedback to its parent Primary Element, in this case the Additional Geometry might be changed without any relation to the parents geometry and therefore in a way that is not desired.

The part of the current project that is visible within the drawing area can be changed too: when no element is selected the whole area can be moved by holding down the left mouse button and dragging it into the direction where the complete view has to be moved to. Beside of that there are zoom-buttons available within the tool-bar:

- Zoom In – zooms into the drawing area so that more details become visible
- Zoom Out – show a bigger area but less geometry details
- Zoom To Working Area – changes zoom and position of the current view so that the full working area is visible in the maximum size that is available in the drawing area
- Zoom To Selected – changes zoom and position of the current view so that the currently selected element is visible in the maximum size that is available in the drawing area

When one single element is selected that contains some geometry, a special point editing mode can be enabled to modify the single points this element consists of. This mode can be enabled by turning on the tool-bar button right beside the zoom-buttons. Once this button is enabled the appearance of the current element changes, now all editable points are surrounded by a rectangle. These points now can be dragged to other positions. This can be done for every point separately. To drag a group of points together please refer the description of the Geometry Tab Panes table “Coordinates” below.

5.7.1.1 Select Elements

To select existing elements for further editing there exist different possibilities:

- left-click the geometry of a single element in drawing view → the element is selected, when it is part of a group, the whole group is selected
- left-click the name of a single element in element tree → the element is selected
- left-click the geometry of several elements in drawing view while Shift- or Ctrl-key is held down → the elements are selected, when one of them it is part of a group, the whole group is selected
- left-click the name of several elements in element tree while the Ctrl-key is held down → the clicked elements are selected, clicking an element again un-selects it
- left-click the name of two elements in element tree while the Shift-key is held down → all elements which are in range from first to the second clicked element are selected
- draw a frame around several elements in drawing view while the Alt-key is held down → all elements which are touched by the drawn frame are selected, when one of them is part of a group, the single element is selected but not the whole group

5.7.1.2 2D and 3D Editing

Within most scanner controller parameters (please refer to the description of the project settings above) it is possible to choose between a 2D operation mode (two-axis mode) and a 3D operation mode (three axes controlled by the scanner controller). This option depends on the capabilities of the used scanner controller and influences the behaviour of RepliMark's drawing area. When a two-axis mode is selected, only the two axes X and Y can be modified within RepliMark and the drawing area offers manipulation possibilities for X (horizontal direction) and Y (vertical direction) only.

As soon as 3D mode is enabled, the drawing area is extended by some semi-transparent buttons that are shown directly within the drawing areas upper left corner. These buttons can be used to switch the current view and the axes that are visible within this view:

- top view – the default view for a laser marking system from top where the laser source is located above the working piece, here X/Y are shown in horizontal/vertical direction of the drawing area

- front view – view from front where X/Z are shown in horizontal/vertical direction of the drawing area
- right view – view from right side where Y/Z are shown in horizontal/vertical direction of the drawing area
- 3D view – here all three dimensions of the current project are visible at the same time within a three-dimensional, foreshortened view; comparing to the other views here no elements can be created and edited but it is possible to rotate the view by moving the mouse while holding down the right mouse button
- split view – when this view is enabled, all four views described above are shown at the same time within a split view. This mode requires more hardware resources but makes editing easier because all three views (top, front, right) can be edited simultaneously.

5.7.1.3 Drawing Area with 3D surface

Normally the drawing area – which is related to the marking area – is assumed to be flat. For special applications and when a 3D scanhead is used, here also a three-dimensional surface can be defined where the 2D vector data can be projected onto. This allows to mark on irregular surfaces while keeping the focus of the laser.

To make use of a marking area with a 3D surface, following steps are necessary:

- import a 3D model (via menu item “Import”) which contains the 3D surface
- in import dialogue, select the option “Use as ground shape”
- now a 3D Mesh object is part of the whole project, which is a bit special: it can not be marked and it can not be selected by left-clicking it in the Drawing Area, this can be done only via element tree
- select the ground mesh in element tree and place it within the Drawing Area as required
- recommended: assign this 3D mesh to a specific layer which then can be hidden via the “Layer” tab pane – this makes it easier to edit marking geometries as the ground object is not always shown
- create/edit marking data as usual (for details about the different primary geometric elements and their purpose, please refer to section 5.7.4 Primary Geometry Elements below)
- as soon as the geometry is complete, select all elements to be marked on top of the ground surface, right-click the selection and choose function “Project onto ground”
- now a dialogue opens which asks for the minimum vector length the geometries have to be split into prior to projecting them to the ground object: the smaller this value is, the more accuracy the projection results become but the more marking data are generated and the more computer resources are consumed

After that the marking vector data follow the shape of the ground object in Z.

5.7.2 The Property Tab-Panes

The main window of RepliMark contains some special tab-panes on its left hand side. These panes give access to different parameters and values, they can be used to influence geometries in a very exact way.

5.7.2.1 The tab-pane Of The Currently Selected Element

The very left tab-pane is a dynamic one, it changes its contents depending on the element that is currently selected. As long as no element is selected this panel is empty, no parameters can be changed here. These element-specific values that become visible as soon as something is selected within the drawing area or within the element tree on the windows right hand side are described in detail below together with the different elements.

In case more than one element or in case a simple group element is selected this tab-pane is empty too.

5.7.2.2 The Geometry Tab-Pane

This panel can be used only when an element is selected that contains some geometry. Thus it does not offer any functionality as long as no element or as long as a geometry-less Post-Processing Tools is selected.

Within this panel geometry-related values are displayed and can be changed. When 3D mode is enabled, the number of available and usable options and parameters depends on the currently selected view, in 2D mode only these values and options can be changed and used that belong to a flat, two-dimensional project that only extend in X and Y direction:

- Mirror X, Mirror Y and Mirror Z buttons – when pressing one of these buttons the currently selected geometry is mirrored in X, Y or Z direction; pressing the same button twice results in no changes (element is mirrored and then mirrored back to original state in this case)
- Centre X, Centre Y and Centre Z buttons – these buttons reposition the selected geometry within the current working area, they centre it in X, Y or Z direction
- Scale – these input fields show the current scaling factor comparing to the original state of the geometry for X, Y and Z direction, a value of 1.0 means the geometry is not scaled, values smaller than 1.0 mean it is shrunk in this direction, values greater than 1.0 mean it is bigger comparing to the original size
- Top Left – the upper left coordinates of the selected element, whenever they are changed the element is repositioned without changing its size
- Centre – the centre coordinates of the selected element, whenever they are changed the element is repositioned without changing its size
- Bottom Right – the lower right coordinates of the selected element, whenever they are changed the element is repositioned without changing its size
- Size – the total width, height and depth of the element, when it is changed the geometry is scaled in X-, Y- or Z-direction, the related values for scaling
- Rotation – the angle in unit degrees the element is rotated with, here the rotation can be changed which may result in changes of other parameters depending on the shape of the used geometry
- Coordinates – this list contains the coordinates of all points of the currently selected geometry, here they can be changed to re-position a single point of it; selecting a point within this list also affects the highlighted element within the drawing area: there the selected point is surrounded by a separate, blue box which can be used to drag this point, thus the geometry can be edited using the mouse. Within this table of coordinates a single point or groups of points can be selected. This can be done by left-clicking into the row of the point that has to be selected. Additional points can be chosen by selecting additional rows of points while the shift or control key is held down. In case more elements are selected they can be modified within the drawing area by dragging them to other positions, here all highlighted points are moved together.
Comparing to this a point editing mode is available that gives the possibility to highlight and edit all points of an element separately. For more details about this mode please refer above.

For the parameters described here the same is true as described for the manipulation functionalities within the drawing panel: When the changes are applied to a primary element, they influence the subsequent elements too. When an additional element is selected there is no feedback to its parent primary element, the changes may override the parents geometry.

5.7.2.3 The Element Tab-Pane

Comparing to the Geometry-panel this one contains more global parameters of the selected element. Depending on the type of selected element only some of the parameters are accessible:

- Type – this is an informational field and therefore read-only, it displays the type of the element

- Name – here the name of the element is shown and can be changed; this name is auto-generated when the element is created and shown within this panel and within the element-tree on the main windows right hand side; for some operations out of e.g. RepliServer or own applications it may be necessary to have unique names here.
- Pen – a pen is a definition about how the related geometry has to be processed on the target system; here up to five different pens as well as the number of repeated marks this pen has to be used with can be assigned to the current geometry so that it is processed using these specific pen parameters (please refer above for a description of the pen parameters)
An element always needs to have at least one pen, so the first one is mandatory and can't be neither disabled nor turned off.
All following pens below of this first one are optional: they can be enabled by checking the related box. When an element makes use of more than one pen, it is processed repeatedly using each of the provided pens. Thus it is possible to mark the same element with several pens without the need to duplicate its geometry.
The number input field right behind every of these pen-definition-rows specifies an additional type of loop: this value specifies, how often a geometry has to be marked with the related pen. A value of 0 means, the geometry is marked exactly once with this pen.
- Head – in case of a multihead environment (as described in “5.14 Multihead Operations”) there is the possibility different controller cards are able to process the same geometries. Here the software typically decides for its own and based on the current global settings (as done in tab-pane “Multihead” as described at “5.3 Project Configuration”) which controller is responsible for which part of the geometry. For these cases, where a geometry has to be assigned to a controller card (aka “head”) directly, this selection box can be used. Here a head can be selected to process the geometries of the related element. When no head is selected but option “Automatic” is chosen, the default, automatic behaviour as defined in general project settings is used for this element. Here “Automatic” is the default behaviour and should be used unless an other selection is necessary.
- Alignment – in general pen-settings there is one option to align the laser/the milling tool at the inner or outer side of a polygon (please refer to “5.6.4 Laser Pen Parameters” for details). This gives the possibility to cut elements in exactly the size specified by these geometry by taking the cutting width of the laser/tool into account. Instead of defining such an alignment globally via the pen settings, using this selection list it is possible to align a single element in the same way. Means when a different value than “From pen settings” is chosen here, the “Align spot to vectors” parameter out of the used pen is ignored but the local definitions as per these settings are used.
- Layer – RepliMark supports several drawing and displaying layers that can be used to separate parts of the whole project from each other and to make it easier to manage complex projects. These layers can be hidden and shown depending on which has to be visible. Using the combo-box provided here the selected element can be assigned to one of the available layers. For more information please refer the section about the layer tab-pane below.
- Process element – this check-box decides if the related element has to be processed or not, when it is not checked, this element acts as some kind of placeholder only, it is not used by the target system for processing the working piece
- Mark contour first – on a standard marking process first the additional element (the “hatch”) is marked and at the end the contour is appended. When this option is set for a element which himself is the contour (e.g. a primary element), this order is incersed, then first the contour is marked followed by the hatch
- Set invisible – turns off the geometry in the Drawing View; when this option is set for an element, it is no longer visible but the related geometries are still marked. In this state it can be selected and modified via the Element Tree only
- Trace data – when this option is set, the name and when available unique data of this element are used for traceability purposes. This means, when a marking cycle was performed successfully, the related Smart Interface message contains information about this element too. These information consist of the name of the element. When this option is enabled for an input element, beside the name also the possibly unique input data are added to the trace data. For more information please refer to section “5.19 Smart Interface“

- Count X/Y/Z and Distance X/Y/Z – these four parameter fields belong to each other and can be used to create arrays of geometry without the need to duplicate them; here it can be defined how often they have to be repeated in X, Y and Z direction and which distance has to be set between them
- Number of vectors – this is an informational element and can't be changed directly, it displays the number of vector lines that are used to create the selected element
- Repeat marks – using this parameter it can be specified how often marking of a single element has to be repeated during a single marking cycle; here a value of 0 means, it has not to be repeated, thus it will be marked exactly once
- Skip marks – when this is set to a value greater than 0, the related element is no longer marked on every process cycle but skipped for the given number of times; after this number has elapsed, it is marked once and skipped afterwards again
- Skip offset – this parameter belongs to "Skip marks" and specifies an offset at what mark/skip counting has to start; so with both parameters elements can be created that are marked interleaved:
 - Element 1 with skip marks = 1 and skip offset = 0
 - Element 2 with skip marks = 1 and skip offset = 1
 - results in two elements that are marked alternating, each exclusively

 - Element 1 with skip marks = 2 and skip offset = 0
 - Element 2 with skip marks = 2 and skip offset = 1
 - Element 3 with skip marks = 2 and skip offset = 2
 - results in three elements that are marked alternating, each exclusively
- Total line length – this field contains an information too, here the total length of the geometry is shown; this value takes the "on"-lines into account only, "off"-lines (movements with the tool turned off to go to the beginning of the next "on"-line) are ignored here
- Process time – here the time is displayed that is needed to process the currently selected element; this value is calculated out of the length of "on"-lines, the length of "off"-lines between them and the speed and delay information of the pen that is assigned to this element

5.7.2.4 The Layer Tab-Pane

Every element can be assigned to exactly one layer. These layers are in no way related to the processing of the data within the target system, but they are a useful utility that makes it easier to handle complex projects.

Within this tab panel two things can be done: layers can be renamed according to their meaning and they can be turned on and off.

When the box in front of a layer is checked, all elements that are assigned to this layer are drawn within the drawing area. Layers that are not checked are not visible within the drawing area, they are hidden and therefore can't be selected or edited.

When a marking process is started out of RepliMark the layer visibility states do not have an influence on the marking result. Means also these layers that are currently hidden will be marked.

5.7.2.5 The Motion Tab-Pane

In tab panel Motion it is possible to drive configured motion axes manually and independent from any motion elements in current marking project. Please note: when there are some marking elements used directly within the project, it has to be taken into account that the user may have changed the position of the axes via these manual functions. Thus at least the first motion element of a project should perform a movement to a defined, absolute position or should reference its position.

Within the motion tab-pane following functions are available:

- OUT2 / OUT3 – specifies which of the two possible motion controllers has to be used
- Speed – specifies the speed a manual motion operation can be performed with;
PLEASE NOTE: when the speed value given here is bigger than the maximum speed of the related

axis, this value is clipped internally, means the axis moves with it's maximum speed which may be slower than the nominal speed entered here

- movement value – the value that can be entered in middle between the arrows specifies the relative movement distance or the absolute motion position to move to (depending on the arrow button that was pressed)
- Double arrows – these buttons cause a movement as long as the button is pressed
- Single arrows – these buttons cause a single movement via the distance or angle specified with the number input field in the middle, here the time the button is pressed does not influence the motion
- Arrow to dot – when this button is pressed an absolute movement is performed, the number input field in the middle between the buttons specifies the target position to move to, the time the button is pressed does not influence the motion
- Ref – start referencing of the related axis

For planar movement axes the images of the buttons can be changed within the motion axis configuration panel of the general project settings. Depending on the real movement direction (left/right, up/down, in/out) a different symbol can be shown here in order to make it easier for the operator to decide which direction a motion will use. The same is true for the axis names, they can be configured via the axis alias value in general project settings.

5.7.3 The Element-Tree

On the main windows right hand side a tree is shown that represents the current projects structure. It consists of a list of primary elements and their (optional) child elements. During processing on the target system the elements are processed in the same order as they are listed there from top to bottom (including their children).

Every primary element may contain several Additional Geometry elements and several Post-Processing Tools. They are listed as child nodes of their Primary Geometry parents within this tree.

All these primary and child nodes can be edited within this tree via a context menu. This menu can be opened by selecting a node within the tree and clicking the right mouse button. Then following functions can be chosen:

- Group Elements – while holding down the Shift- or Ctrl-key it is possible to select a range of elements within the entity tree; in case more than one Primary Geometry element is selected it is possible to put them into a group using this function
- UnGroup Elements – this item can be used when a group element is selected, it resolves the group, pulls all element out of it into the hierarchical level where the group existed before
- Resort Elements – this option is active only when a group with some sub-elements is selected. It gives the possibility to automatically re-order the elements within this group. For a detailed description of this function please refer below
- Project onto ground – this function is part of the possibility to have a 3D working area surface (as described in section “5.7.1.3 Drawing Area with 3D surface ”). It changes all selected geometries in Z-direction in a way, so that they are located on the ground surface
- Delete Element(s) – deletes an element completely; in case this is applied to a primary element all its sub-elements are removed too
- Duplicate – the currently selected Primary Geometry element is copied and inserted at a position that is slightly shifted according to the original element
- Move To Top – the selected element is moved to the top position within its same hierarchically level (means a child of a primary element will stay a child of it but it will become the first one)
- Move Up – the selected element is moved one position up but also within the same hierarchically level
- Move Down – the selected element is moved one position down within the same hierarchically level

- Move To Bottom – the selected element is moved to the bottom position within its same hierarchically level (means a child of a primary element will stay a child of it but it will become the last one)
- Import 3D Model – this option is active only when a single Sliced 3D Mesh Group element is selected, it gives the possibility to import an additional 3D Mesh into this Sliced 3D Mesh Group; after successful import this Sliced 3D Mesh Group keeps two more 3D Meshes and creates slices that consist of all of their 3D data, the 3D Meshes which can be positioned within the working area independent from each other
- Clean between slices – this option is active only when a single Sliced 3D Mesh Group element is selected; when this option is set, such a 3D Slice Cleaner element is generated on construction of the Sliced 3D Mesh Group. For more information about this type of element which can be used for cleaning purposes between slices, please refer to section “Error: Reference source not foundError: Reference source not found”
- Auto-Arrange – this option is active only when a single Sliced 3D Mesh Group element, when a group or when several primary elements are selected, it gives the possibility to arrange several 3D Meshes or child elements within a group; for a detailed description of the auto-arrange function please refer below
- Merge 3D Meshes – when several 3D slice groups are selected, this option can be chosen to merge their 3D meshes into one element. After this operation has been finished, all the selected 3D slice groups are combined into one containing all the 3D meshes as one single object
- Collapse all – closes all nodes in the current element tree; when all nodes are collapsed and the whole tree is selected (with shift-key held down) only the top level primary elements are selected but not their sub-elements
- Expand all – opens all nodes in the current element tree

5.7.3.1 Auto-Resorting of elements in groups

A group can hold several sub-elements as children. The order these elements are marked is specified by the order they are added to their parent group. This order can be changed by manually moving single elements up or down within this group using the related context menu functions within the element tree. Alternatively it is possible to let RepliMark resort these elements automatically. Different to the rearrange-function as described below, this one does not change the geometric position of the elements, but their order.

To resort the elements, the group has to be selected and right-clicked in element tree, then menu item "Resort Elements" has to be selected. Now a dialogue opens which provides options to change the order of the elements within their parent group. This is done via the configuration possibilities within the dialogue:

- Skip fixed size – the current order of elements is changed in a way where every nth element is used for the new order. This is done repeatedly until all elements are used. Here value “n” can be specified by the related input field. For an example: a value of 2 will first take every odd-numbered element and then all remaining (even-numbered) elements for the new order.

5.7.3.2 Auto-Arrangement of elements in groups

For a description of auto-arrange function of 3D Meshes in Sliced 3D Mesh Groups please refer to the related section below.

A group can hold several sub-elements as children. The location of these elements within the drawing view can be positioned with the standard functions in tab-pane "Geometry" in order to place them at suitable positions in working area. Alternatively it is possible to let RepliMark arrange these elements automatically. Different to the resort-function as described above, this one does not change the marking order of the elements, but their position.

To rearrange the elements, the group has to be selected and right-clicked in element tree, then menu item "Auto-Arrange" has to be selected. Now a dialogue opens which provides options to arrange the elements in

X- and Y-direction and to align them at a specific Z-height. This is done via the configuration possibilities within the dialogue:

- Arrange in X and Y – when enabled, the sub-elements are arranged on working area using the following parameters
- Distance to borders – specifies the minimum distance the child-elements of the group need to have to the border in both, X and Y direction of the working area
- Distance between elements – specifies the minimum distance the children of the group need to have between each other
- Arrange in Z – when enabled, the elements are aligned at a specific height using the following options and parameters
- Align geometries at top or bottom – here it can be selected if all the elements need to be aligned at their upper or lower position
- Arrange in Z – this is an option which can be enabled when elements have to be top or bottom aligned at a specific, absolute height; when it is set, the height has to be specified in unit mm; in case this option is not set but arrangement in Z is enabled, all sub-elements of the group are aligned at the highest/lowest top/bottom position of that element, that is located at the highest/lowest position (according to its outlines top/bottom border)

5.7.4 Primary Geometry Elements

To create a new primary element following steps have to be performed:

1. select the related button within the tool-bar, all primary elements use blue tool-bar symbols
2. click into the working area to position the element; depending on the geometry that is created by the related function it can be drawn now with some additional clicks into this area
3. now the new element is selected and its parameters are shown within the first, element-specific tab-pane on the main windows left hand side

When the parameters of such an element are changed within its tab-pane, all following elements of the same type use exactly these parameters as default values.

Following the available elements, the steps to create them within the working area and their parameters are described.

5.7.4.1 Dot

This is the most simple element that is possible. When it is selected for drawing within the tool-bar, the first click into the drawing area creates a single point at the left-clicked position.

This element does not offer any parameters, so there are no input fields available within the element-specific tab panel as soon as such a dot is selected.

Within the options the dot can be configured:

- Style – specifies the style of the created point, here Dot is a simple one that consists of a single coordinate and has no size or Custom for a dot as configured within the global parameters (please refer to section 5.6.1 above)

5.7.4.2 Line

When drawing a line two left-clicks are necessary within the drawing area: the first click specifies the starting position of the line, the second one the end position. It is not necessary to keep the mouse pressed between these two clicks.

Drawing functionality can be extended by pressing one of the keys "Shift" or "Ctrl" after specifying the starting point of the line (first click): when Shift is held down, a horizontal line is drawn, and vertical deviations of current mouse position are ignored. When Control is held down, a vertical line is drawn, and horizontal deviations of current mouse position are ignored.

After drawing or selecting such a line following parameters are available to manipulate them:

- Line Style – the style the line is created with, here following options exist:
 - Continuous: the geometry consists of exactly one starting and one end point where one single line is drawn between
 - Connected Lines: the geometry consists of several short lines including additional points between the start and end point, all these lines are connected
 - Dashed: the geometry consists of several short lines including additional points between the start and end point, every second line is drawn that results in a dashed line style
 - Dotted: no lines are drawn, the geometry consists of a set of not connected dots
 - Dotted (Custom): no lines are drawn, the geometry consists of a set of not connected points in custom dot style as configured within the project settings (please refer to section 5.3 Project Configuration above)
- Distance – whenever a non-continuous line style is selected, this distance value specifies the length of the additional points that form the selected line style
- Expand By Dot – expands the line according to the chosen distance-value by one dot (or one line segment)
- Remove Last Dot – removes the last dot or line segment

5.7.4.3 Triangle

To draw a triangle all three corners have to be specified separately by single left mouse clicks for each. First the starting point is defined, with the next click another corner of the triangle is specified and the last one completes the triangle by setting the third corner of it.

Drawing functionality can be extended by pressing one of the keys "Shift" or "Ctrl" after specifying the first corner point of the triangle (first click): when Shift is held down, a horizontal line is drawn next, and vertical deviations of current mouse position are ignored. When Control is held down, a vertical line is drawn, and horizontal deviations of current mouse position are ignored.

Within the triangles property tab-pane following options are available:

- Line Style – the style the triangles lines are created with, here following options exist:
 - Continuous: the geometry consists of exactly three points that are connected by three completed lines
 - Connected Lines: the geometry consists of several short lines connecting the three corners including additional points, all these lines are connected and therefore form a closed shape
 - Dashed: the geometry consists of several short lines including additional points between the three corners, every second line is drawn that results in a dashed line style
 - Dotted: no lines are drawn, the geometry consists of a set of not connected dots
 - Dotted (Custom): no lines are drawn, the geometry consists of a set of not connected points in custom dot style as configured within the project settings (please refer to section 5.3 Project Configuration above)
- Distance – whenever a non-continuous line style is selected this distance value specifies the length of the additional points that form the selected line style

5.7.4.4 Rectangle

When drawing a rectangle the upper left and the lower right corner of it are specified by two separate mouse clicks. The resulting rectangle will always be parallel to the coordinate axes.

Drawing functionality can be extended by pressing the "Shift"-key after specifying the first corner point of the rectangle (first click): when this key is held down, a square is created instead of a rectangle. Horizontal distance from first point specifies the side length of the square.

Within the rectangles property tab-pane following options are available:

- Line Style – the style the rectangles lines are created with, here following options exist:
 - Continuous: the geometry consists of exactly four points that are connected by four completed lines which form a rectangle
 - Connected Lines: the geometry consists of several short lines connecting the four corners including additional points, all these lines are connected and therefore form a closed, rectangular shape
 - Dashed: the geometry consists of several short lines including additional points between the four corners, every second line is drawn so that it results in a dashed line style
 - Dotted: no lines are drawn, the geometry consists of a set of not connected dots
 - Dotted (Custom): no lines are drawn, the geometry consists of a set of not connected points in custom dot style as configured within the project settings (please refer to section 5.3 Project Configuration above)
- Distance – whenever a non-continuous line style is selected this distance value specifies the length of the additional points that form the selected line style
- Nominal width – this is the width of the rectangle (in X-direction) as done by this primary element; so this value does NOT reflect possible scale factors done in “Geometry”-tab-pane, the real geometry width is shown only there
- Nominal height – this is the height of the rectangle (in Y-direction) as done by this primary element; this value does NOT reflect possible scale factors done in “Geometry”-tab-pane, the real geometry height (after all transformation operations have been applied) is shown only there
- Nominal depth – this is the depth of the rectangle (in Z-direction) as done by this primary element; this value does NOT reflect possible scale factors done in “Geometry”-tab-pane, the real geometry depth (after all transformation operations have been applied) is shown only there
- Corner radius – when this value is greater than 0 and when the rectangle is large enough, it is created with rounded corners
- Segments – when the rectangle is created with rounded corners, this value specifies of how much segments all these corners consist and therefore how smooth they are

5.7.4.5 Circle

This primary element can be used to create circles and arcs. Starting point is always a circle that is drawn in two steps: the first left mouse click into the drawing area specifies the centre point of it, the second one specifies the radius (via its distance from the first point).

Next the circle can be modified further:

- Line Style – the style the circle is created with, here following options exist:
 - Continuous: the geometry consists of several short, fully connected lines that form a closed circle; for this mode the parameter “Segments” specifies how much of these short lines are used to create this circle, the more lines are used the more smooth the circle becomes
 - Connected Lines: the geometry consists of several short lines that form the circle, comparing to the previous option here the parameter “Distance” influences the length of these lines and therefore the resolution; here the shorter the lines are the more segments this circle consists of and the more smooth it becomes
 - Dashed (Arcs): the circle consists of dashes where the dashes are not straight lines but follow the shape of the circle and therefore are round
 - Dashed (Straights): the circle consists of dashes where the dashes do not follow the shape of the circle but are straight lines
 - Dotted: no lines are drawn, the geometry consists of a set of not connected dots
 - Dotted (Custom): no lines are drawn, the geometry consists of a set of not connected points in custom dot style as configured within the project settings (please refer to section 5.3 Project Configuration above)
- Distance – this parameter decides how long the resulting lines of the chosen line style have to be, it is not valid for the continuous line style where the length would be always equal to the circumference
- Radius – the radius of the circle

- Second radius – this is an optional parameter. When enabled, a radius value can be entered here which is used to create a second circle. Both, the primary and the second radius can be used to form specific shapes like rings.
- Segments – here it can be chosen how much segments the circle has to consist of, this parameter influences the accuracy of the resulting circle; for the line style “Dashed (Arcs)” it influences the smoothness of the resulting arcs while the “Distance”-parameter influences their length
- Start Angle and End Angle – these two parameters can be used to change the circles starting and end angle, it can be used to draw arcs (in case the resulting total angle is smaller than 360 degrees) or to let a circle be drawn several times (in case the resulting total angle is a multiple of 360 degrees)
- Grow: this parameter is valid in 3D mode only; it defines how much the circle shall grow in the third direction per every rotation of it. Here “third direction” does not necessarily mean Z-direction, this depends on the view the circle is drawn in. So in case the right side view is enabled the circle extends in Y and Z direction, resulting from that the third direction where the grow parameter applies to is the X direction.
- Layered Sphere: in 3D mode this option can be used to create a sphere that consists of circles of different diameters that form a sphere; to use this option the Grow value has to be set which specifies the distance between the circles that form the sphere
- Draw CCW – normally the circle has a clockwise orientation, means it is drawn to right direction; when this check box is set, the drawing direction is reversed

5.7.4.6 Star

This element is a special variant of a circle, it consists of two radii where every second point the element consists of, belongs to an other radius. Resulting from that stars can be drawn and modified by its parameters. Such a star is drawn in two steps: the first left mouse click into the drawing area specifies the centre point of it, the second one specifies the first radius. While drawing the star the second radius is set automatically to value smaller than the first radius.

After the star is drawn it still can be modified interactively. Here every second point (the ones that belong to the second radius) is marked by a small, blue cross. This cross can be dragged with the mouse in order to change the second radius independent from the first one and in order to apply an offset to the angle of these points.

Next the star can be modified via its options:

- Line Style – the style the circle is created with, here following options exist:
Continuous: the geometry consists of single, continuous lines
Connected Lines: the geometry consists of several short lines including additional points, all these lines are connected
Dashed: the geometry consists of several short lines including additional points, every second line is drawn that results in a dashed line style
Dotted: no lines are drawn, the geometry consists of a set of not connected dots
Dotted (Custom): no lines are drawn, the geometry consists of a set of not connected points in custom dot style as configured within the project settings (please refer to section 5.3 Project Configuration above)
- Distance – this parameter decides how long the resulting lines of the chosen line style have to be, it is not valid for the continuous line style
- Radius 1 – the first radius that is valid for all odd-numbered points
- Radius 2 – the second radius that is valid for all even-numbered points
- Spikes – here it can be chosen how much spikes (or rays) the star shall have,
- Angle offset – here an offset can be specified for the points that are assigned to the second radius in order to create non-regular spikes
- Draw CCW – normally the star has a clockwise orientation, means it is drawn to right direction; when this check box is set, the drawing direction is reversed

5.7.4.7 Spiral

This primary element can be used to create spirals. Starting point is always a spiral that is drawn in two steps: the first left mouse click into the drawing area specifies the centre point of it, the second one specifies the outer radius.

Next the spiral can be modified via its options:

- Line Style – the style the spiral is created with, here following options exist:
 - Continuous: the geometry consists of several short, fully connected lines that form a continuous spiral; for this mode the parameter “Segments” specifies how much of these short lines are used to create this spiral, the more lines are used the more smooth the resulting spiral becomes
 - Connected Lines: the geometry consists of several short lines that form the spiral, comparing to the previous option here the parameter “Distance” influences the length of these lines and therefore the resolution; here the shorter the lines are the more segments this spiral consists of and the more smooth it becomes
 - Dashed (Arcs): the spiral consists of dashes where the dashes are not straight lines but follow the shape of the spiral and therefore are round
 - Dashed (Straights): the spiral consists of dashes where the dashes do not follow the shape of the spiral but are straight lines
 - Dotted: no lines are drawn, the geometry consists of a set of not connected dots
 - Dotted (Custom): no lines are drawn, the geometry consists of a set of not connected points in custom dot style as configured within the project settings (please refer to section 5.3 Project Configuration above)
- Distance – this parameter decides how long the resulting lines of the chosen line style have to be, it is not valid for the continuous line style where the length would be always equal to the circumference
- Inner Radius – the inner, minimum radius of the spiral
- Outer Radius – the outer, maximum radius of the spiral
- Slope – this value defines the steepness of the spiral, so this value influences how strong it rises per rotation
- Segments – here it can be chosen how much segments the outer part of the spiral has to consist of, this parameter influences the accuracy of the result; for the line style “Dashed (Arcs)” it influences the smoothness of the resulting arcs while the “Distance”-parameter influences their length
- Smoothing Factor – normally a spiral is generated out of short lines where the length is calculated out of the number of segments and the current radius. This leads to an adaptive line length with as less as much data and an as fast as possible, resulting process time. But in some cases this may lead to spirals that are not very smooth but angular at their inner radius. Here the number of segments could be increased (what would lead to a higher amount of data used because of smoother corners also at curves where it would not be possible) or the smoothing factor can be set to values greater 1.0: this changes the calculation of a spiral in a way where the inner line length becomes shorter and therefore more smooth while not using more data than necessary. So the more smoothing factor is taken for the calculation the smaller the radius becomes.
- Start Angle – this parameters can be used to change the spirals starting angle
- Grow: this parameter is valid in 3D mode only; it defines how much the spiral shall grow in the third direction per every segment. Here “third direction” does not necessarily mean Z-direction, this depends on the view the spiral is drawn in. So in case the front side view is enabled the spiral extends in X and Z direction, resulting from that the third direction where the grow parameter applies to is the Y direction.
- Draw CCW – normally a spiral has a clockwise orientation, means it is drawn from its starting point to right direction; when this check box is set, the drawing direction is reversed
- Inside To Outside – this option influences the growing direction, when the check box is set, drawing of the spiral starts at the inner side and ends outside; in case it is not set it starts at the outer side and ends at the inner

5.7.4.8 Polygon

A polygon consists of an undefined number of edges (but requires at least three). Drawing it can be done by left clicking at the position where a corner between the connecting lines has to be positioned. This can be done several times, the process of drawing this polygon can be finished by right-clicking the mouse. Then the last corner and the first position where the user left-clicked are connected by a line.

Drawing functionality can be extended by pressing one of the keys "Shift" or "Ctrl" after specifying the starting point of the polygon (first click): when Shift is held down for one of the following points, a horizontal line is drawn next, and vertical deviations of current mouse position are ignored. When Control is held down, a vertical line is drawn, and horizontal deviations of current mouse position are ignored.

Following options are available to modify the parameters of the polygon:

- Line Style – the style the polygons lines is created with, here following options exist:
 - Continuous: the geometry consists of lines that use exactly one starting and one end point where one single line is drawn between
 - Connected Lines: the geometry consists of several short lines including additional points, all these lines are connected
 - Dashed: the geometry consists of several short lines including additional points, every second line is drawn that results in a dashed line style
 - Dotted: no lines are drawn, the geometry consists of a set of not connected dots
 - Dotted (Custom): no lines are drawn, the geometry consists of a set of not connected points in custom dot style as configured within the project settings (please refer to section 5.3 Project Configuration above)
- Distance – whenever a non-continuous line style is selected, this distance value specifies the length of the additional points that form the selected line style
- Polygon Style – here it can be chosen if the last polygon point and the first one are connected by a line (style "Closed") or not (style "Open")

5.7.4.9 Bezier Curve

Creation and parameters of this element are very similar to the polygon described above but it does not generate direct connections between the specified base points. Using this element a smooth, round Bezier curve is generated. This curve uses the given base points as creation hint but does not necessarily cross them.

Such a Bezier curve consists of an undefined number of base points but requires at least three of them. Specifying the position of these base points can be done by left clicking within the drawing area. This can be done several times, the process of drawing the related curve has to be finished by right-clicking the mouse.

After that the positions of the base points still can be modified interactively. As long as this element is selected, the real position of the base points are marked by blue crosses. These crosses can be dragged with the mouse. Changing the position of the base points also changes the appearance of the resulting Bezier curve.

Following parameters are available to modify the parameters of the Bezier curve:

- Line Style – the style the polygons lines is created with, here following options exist:
 - Continuous: the geometry consists of continuous lines that consist of a number of sub-segments which are specified by the parameter "Resolution"
 - Connected Lines: the geometry consists of several short lines of a defined length including additional points, all these lines are connected
 - Dashed: the geometry consists of several short lines of a defined length including additional points, every second line is drawn that results in a dashed line style
 - Dotted: no lines are drawn, the geometry consists of a set of not connected dots
 - Dotted (Custom): no lines are drawn, the geometry consists of a set of not connected points in custom dot style as configured within the project settings (please refer to section 5.3 Project Configuration above)
- Distance – whenever a non-continuous line style is selected, this distance value specifies the length of the additional points that form the selected line style

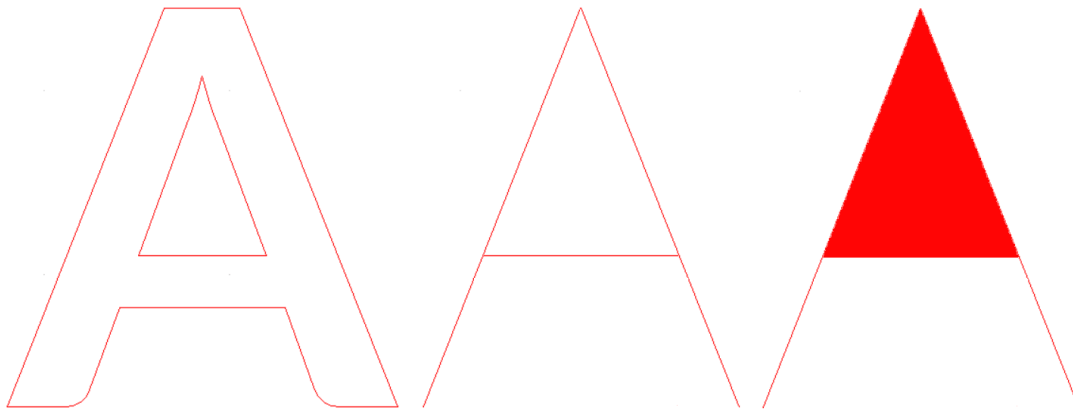
- Bezier Style – here it can be chosen if the last polygon point and the first one are connected by a line (style “Closed”) or not (style “Open”)
- Resolution: this parameter specifies the smoothness of the Bezier line, the bigger it is the more sub-lines are used to create such a curve, the more smooth it becomes and the more resources are used for it

5.7.4.10 Text

This primary geometry can be used to draw some text using an existing TrueType or special laser font. This element accepts static texts or dynamic values that can be set via an Input Element. When such a project is moved from one computer to another or from one operating system to another it has to be made sure a used font is available on the other system too (this applies to TrueType fonts only since the fast laser fonts are part of RepliMark). Otherwise the application tries to find a similar font which might be only somehow similar, but exact positions, sizes and outlines may be got lost in such a case.

Drawing such a text is quite easy: only one single click into the drawing area is necessary to specify the position of the text, there a new geometry is set using a default text. This text can be changed together with some other parameters:

- Line Style – the style the lines the text consists of is created with, here following options exist:
 - Continuous: the geometry consists of closed, connected lines with as less as possible points
 - Connected Lines: the geometry consists of several short lines including additional points, all these lines are connected
 - Dashed: the geometry consists of several short lines including additional points, every second line is drawn that results in a dashed line style
 - Dotted: no lines are drawn, the geometry consists of a set of not connected dots
 - Dotted (Custom): no lines are drawn, the geometry consists of a set of not connected points in custom dot style as configured within the project settings (please refer to section 5.3 Project Configuration above)
- Distance – whenever a non-continuous line style is selected, this distance value specifies the length of the additional points that form the selected line style
- Text – here a multi-line text can be specified that has to be drawn; a modified text is applied as soon as the text input area is left, either by clicking another element or by pressing the Tab-key
- Unicode – instead of characters here space-separated Unicode values can be entered either as decimal numbers or as hexadecimal numbers with a leading “0x”. On pressing “Return” the entered numbers are converted to text and shown as their character-representation in input area “Text”
- Font Type – here the type of font that has to be used for this text element can be chosen, following options are available to select from:
 - TrueType: the standard fonts that are installed on the system can be used. When this option is selected, the combo box directly below of this one is enabled to select a font out of it; all these fonts are in no way optimised for output via a laser scanner system, their intended target is publishing, therefore their lines and paths are optimised for quality which may result in a slow output
 - Laser Vector: this special type of fonts is optimised for laser marking operations. They consist of as less as possible lines and are designed for single-lined outputs like they are done with lasers. Using these fonts marking of texts is much faster than with the TrueType fonts. When this font type is selected the font list below of this combo box is modified to show the available laser fonts to choose from.
- Standard outline – this option is enabled only in case TrueType font type is selected and it is enabled by default. When a normal TrueType font is used, it always should be selected. This option becomes useful when a non-standard TrueType font is used that is designed as laser font. Typically the characters of a TrueType font consist of an outline that forms the shape of the character and can be filled with a hatch pattern. Due to the lots of lines such a font is slow for laser marking. A faster, speed-optimised font would consist of single lines only which itself define the shape and typically do not need to be filled. Now when this option “Standard outline” is unset, such special fonts can be used (as TrueType does not know anything about laser marking, the option has to be reset explicitly by the user). Such fonts can be drawn in every standard TTF-editor and will look like laser fonts as soon as they are used in RepliMark and as soon as this option is disabled:



From left to right: normal, outlined shape of a standard TrueType font, single line shape of a lasermarking-optimised font, view of a single line font when drawn into a TTF editor – the filled area is a wrong preview of most external editors and will be gone automatically as soon as this font is used in RepliMark and as soon as the option “Standard outline” is disabled there

- Font – this list of available fonts can be used to select a specific font and style for the text. Depending on the font type chosen above, here a specific font can be selected. In TrueType mode the number and types of available fonts depends on the operation system and which ones are installed there. In Laser Vector mode the internal laser fonts are listed here, these fonts are delivered with RepliMark and do not depend on the fonts installed on the system.
- Alignment – the text is always drawn from a fixed position that is specified by the left mouse click when setting the text initially; using this list it can be chosen how the text has to be aligned to this position (left, centred or right)
- Orientation – this list specifies the direction the single characters of the text have to be drawn
- Spacing – this value can be used to modify the distance between the characters; here a value of 100% is the distance that is specified by the used font, smaller values set the characters closer to each other, larger ones stretch it to a bigger distance
- Kerning – this value can be used to influence the kerning distance for fonts that support it, here 100% is equal to the kerning value that it specified by the font, bigger values set the characters with a kerning value closer to each other, values smaller than 100% set a bigger distance between them; this parameter is different to the “Spacing”-value, it only influences character-combinations where kerning is defined for
- Arc Length – when creating geometry out of the available font information depending on the style of the chosen font different round parts have to be created (like the two arcs that are needed for creating a letter “B”). This parameter specifies the segment length for these round parts, the smaller it is the more accurate the result is but the more data are used to hold it.
- Nominal height – here the nominal height of a line of text can be specified in unit mm; this does not only include all possible characters and their heights but also the distance between two lines of the chosen TrueType font. So the height specified here in most cases will be always bigger than the vector height of every possible characters of the chosen font. Beside of that this is the nominal value on creation of the text, means no additional scaling operations which are done with this element or with optional parent groups elements are included in this value.
- Set monospaced – when this option is checked, equal distance is set between all characters independent from their shape and independent from the distance information of the used font
- Lock size – this option can be used to force a text element to always keep a specific size. When this option is enabled, the current geometric size of the element is stored. Whenever the text changes – either by manual modification, by remote access via a command interface or because the related input element changes the data – the element is scaled in a way so that the size is left unchanged. Depending on how much the real length of the texts changes, this means the characters itself are shrunk or stretched

To create radial text this element can be combined with the Curve Post-Processing Tool (please refer below)

5.7.4.11 Barcode

Using this function several types of 1D and 2D barcodes can be created. This element accepts static data for creating a barcode or dynamic values that can be set via an Input Element. The size of the created barcode can be defined freely, when creating this element a rectangle is drawn exactly in the same way like it is done for the Rectangle Primary Element. This rectangle describes the outline of the barcode. For some barcode types that use a fixed aspect ratio between width and height the predefined outline is modified automatically.

The complete layout and structure of the barcode is defined via the parameters that can be set within the elements tab-pane:

- Data – the text or numeric data that are encoded within the barcode, here it depends on the chosen barcode type if and which characters, numbers or combinations of them are allowed and will result in a valid barcode. This means it is not possible to enter any kind of data for any type of barcode! For most barcode types special formatting rules need to be respected, elsewhere no barcode is created and the primary element stays empty.
For these barcode types that support carriage return and/or line feeds (“\r” and/or “\n”), the related characters can be added by setting some special placeholders. So a “[CR]” within the data will be replaced by a carriage return character before the barcode is encoded and a “[LF]” will be replaced by a line feed character.
- Type – here the type of barcode can be chosen, depending on this type several of the following options are available and can be used for further definitions that are necessary for this type
- Mode – this is a barcode-type-specific option, here an encoding mode can be chosen for some of the barcodes
- Error Correction – this is a barcode-type-specific option, here an error-correction level can be set
- Size – this is a barcode-type-specific option, here the resulting size can be specified (which not influences the dimension of the barcode but the encoded data size)
- Bar Width – this parameter influences 1D barcodes only, here the size of the resulting bar lines can be modified; this value might be changed depending on the method of material processing in order to get a readable barcode
- Segments – this parameter is used only for the Maxicode barcode, it specifies the number of segments and therefore the smoothness of its circles
- Fade In Size – this parameter is used for inverted barcodes, it defines the size of the additional frame that is drawn around the barcode to get an inverted representation
- Force to Square – this option applies to DataMatrix barcodes only, in case it is set, the resulting barcode is always a square and never a rectangle
- Merge Cells – several barcode types may consist of cells (rectangles or squares) that are located directly beside each other; this option merges such cells wherever that is possible without destroying the barcode information, it can be used to save vector data
- Draw Cells as Dots – when this option is enabled, the cells some barcode types consist of are replaced by plain dots
- Draw Cells as Custom Dots – when this option is enabled, the cells some barcode types consist of are replaced by the custom dot geometry as defined within the settings (please refer to section 5.3 Project Configuration above)
- Invert – barcodes created by this element consist only of the outlines, together with the Hatching Additional Geometry element these outlines can be filled. Depending on the used material processing method these filled areas may result in lighter or darker areas. In case the result is not readable by barcode scanners the light and dark areas can be exchanged by this option, here an additional border is drawn around the barcode so that the hatching function generates an inverted fill pattern
- Invert with embedded normal – this option combines the normal mode and mode “Invert” into one element. When this mode is enabled, the visual representation of the barcode is switched to

“inverted” with the possibility to define fade in size for the additional bounds created around it. This inverted barcode will make use of the pen assigned to the element as usual.

Additional (but not directly visible) a non-inverted, normal barcode is created too making use of exactly the same input data like the inverted one. This non-inverted barcode is located at exactly the same position overlapping its inverted pendant perfectly. When this mode is enabled, the pen to be used for the embedded, non-inverted (=normal) barcode can be selected using the pen combobox which is shown right below the checkbox of this mode.

This special mode can be used e.g. in cases where both, inverted and normal barcode needs to be marked with different pen parameters in order to have a good contrast on resulting material. With this mode it is not necessary to manually overlap two separate barcodes and it is guaranteed they both have the correct position and the same input data.

5.7.4.12 Delay

This element does not have a visual representation, it does not accept any additional data or post-processing but it can be used to influence the material processing. The elements of a project are processed in the order they appear within the Element Tree. At the position where this element is added, the full process is delayed for the given time. Thus this element can be used whenever a delay is necessary e.g. to let material become dry, let material become colder or whatever.

This element expects exactly one parameter:

- Delay – the delay (in unit seconds) the full process has to stop

PLEASE NOTE: the accuracy of the delay given here depends on the used hardware. When the scanner controller supports delays, it is handled by it directly and is normally very exact. When the scanner controller does not support this, the delay is done within RepliMark and much less accurate since timer resolution of the host operating system is quite low and transmission times to and from scanner controller card are unpredictable.

5.7.4.13 Motion

This element does not have a visual representation, it does not accept any additional data or post-processing elements but it can be used to influence the material processing in general. The elements of a project are processed in the order they appear within the entity tree. At the position where this element is placed additional motion axes (apart from the axes of the used scanner) can be driven.

The motion can be influenced by the parameters that have to be set for this element. First of all up to three axes can be controlled by the element using following parameters:

- Enable – specifies if an axis has to be changed by the following parameters or if it has to be left untouched, axes that are not enabled stay at their current position
- Position – the new position to move the axis to; this field is highlighted in yellow when the current settings of the axis may lead to a situation where the position value entered here is not used but overwritten during marking. This is possible e.g. in cases where an axis is bound to the height of a slice while marking 3D slice groups. For additional information please refer to axis settings as described in section “5.3 Project Configuration”.
- Speed – the speed for the movement to the given position
- Relative – defines a non-absolute movement, means the axis does not drive to the given position but changes its current position by the given distance
- Stop axis – the motion of an axis is stopped immediately, this option is available only for motion controllers that support this function and ignores the given position and speed values
- Move axes to home-position – the axis is moved to its home / reference position, this option is available only for motion controllers that support this function and ignores the given position and speed values

- Don't wait for end of motion – in normal operation mode full processing is halted as long as a motion operation is running. But when this option is set, this is no longer the case: then the motion operation is started and without waiting for its end, the following elements of the current project are executed. For such an asynchronous motion operation some things have to be noted:
 1. Prior to any other motion operation to be started, the current one needs to be stopped by adding another Motion element with the “Stop axis” option set.
 2. At the end of the current project it is recommended to add another Motion element with the “Stop axis” option set in order to end the project with a defined state
 3. This option is always valid for all axes of a motion controller, it is not possible to wait for the end of one axis and to let another axis work asynchronously

All other parameters influence the whole motion element:

- Pre-Motion Delay – this delay is done before the motion is triggered
- Use Control Output – the “RepliMark to Control”-plug-in provides two CTRL-outputs where motion control data can be emitted, this option gives the possibility to define which of both outputs OUT2 or OUT3 have to emit the motion information defined for this element

5.7.4.14 Custom Output


Most scanner controller cards provide several analogue and/or digital outputs. As soon as a scanner controller card is configured within the project settings this element can be used to send values to these outputs. This Primary Element does not contain any geometry so clicking the related tool-bar button immediately adds it to the current project.

The exact layout of the related property panel highly depends on the capabilities of the used scanner controller card. There options are shown depending on the outputs the used card provides.

So it is possible that following types of outputs can be enabled for modification and set within this element:

- Laserport – a numerical value according to the valid range of the (LP8) laserport (e.g. 0..255) can be entered, this value is sent to the card during processing in case the related check box is enabled
- Digital – several buttons are shown that influence the related output ports bits and can be toggled into different states: “X” means this bit is left unchanged, “1” sets a bit to HIGH and “0” clears it; here the first button is the highest bit while the last button is always bit 0
- Analogue – a numerical value according to the resolution of the analogue output (e.g. 0..1023) can be entered, this value is sent to the card during processing in case the related check box is enabled
- Pulse Output – when this option is not set the output(s) simply is/are set according to the settings that are done above. In case this option is enabled and a time in unit milliseconds is given, the output is switched to the defined state only for this time, after that it is set back to its previous state. So this option can be used to emit only pulsed signals instead of a permanent output value.

PLEASE NOTE: The scanner controller card has to be set up and configured BEFORE this element is used for the first time. This is necessary because the capabilities of the scanner controller card need to be known for this element so that it can show the correct output options that belong to the card. When a completely different scanner controller card is selected for a project, it is necessary to save this project, close and restart the application to force a re-initialisation, load the project again and then check if all Custom Output elements still use the correct ports and values.

This element is symbolised by this toolbar icon: 

5.7.4.15 Custom Input

Most scanner controller cards provide several digital inputs. As soon as a scanner controller card is configured within the project settings, this element can be used to read values from these inputs and to halt processing of current project until a predefined state is found there. This Primary Element does not contain any geometry so clicking the related tool-bar button immediately adds it to the current project.

The exact layout of the related property panel highly depends on the capabilities of the used scanner controller card. There options are shown depending on the outputs the used card provides.

So it is possible that following types of inputs can be enabled and used within this element:

- Digital – several buttons are shown that read the related input ports bits and can be toggled into different states: “X” means this bit is ignored, “1” expects a HIGH value at this input and “0” a LOW; here the first button is the highest bit while the last button is always bit 0
- Serial interface – when supported by the used scanner controller card, data can be read from the serial interface periodically by this element. A comparison is done with the data read from this serial interface, here it can be selected if this has to be done with a full string (complete match) or with a substring (partial match).
- Display message during wait – when this option is set, a text can be entered which then is shown during operation as long as the software is waiting for the input signal to arrive as specified by the options above. This text is shown in a top-level window which is closed only when mark operation is stopped or when the expected input signal is detected and processing of the current project continues

This element is symbolised by this toolbar icon:



5.7.4.16 External Trigger

This element does not contain geometry. After clicking the related tool-bar symbol it is added to the project immediately. Whenever the project reaches this elements position during execution, all output is stopped until an external trigger signal is detected. Here the external trigger according to the used scanner controller cards capability is used. Within the elements tab-pane the controller card has to be chosen, where the external trigger will appear.

For some controller cards, it is also possible to release such a trigger automatically when a given distance has been passed by (in marking on-the-fly applications), then the application does not wait for an external start signal. When this option is chosen by selecting the related checkbox “MOTF-Distance”, an encoder signal needs to be available and need to count into the correct direction, elsewhere the project will wait endless at this position.

This element also accepts an input element such as the CSV Data Input. When such an input element is configured, given input data are used to set a new MOTF-distance. The input data need to be whole-numbered values in unit micrometers. When a value equal or smaller than 0 is given or when invalid data (such as some texts) are given by the input element, the MOTF-distance is not modified and stays unchanged.

PLEASE NOTE: starting the geometry after a trigger is received is done by the scanner controller, the time between detection of the external trigger signal and output of the next geometry depends on the used scanner card and typically is less than some microseconds.

Waiting for a trigger after the last geometry has been sent (or after the last Primary Element was processed completely) is controlled by the application. Here the reaction time highly depends on the used operating system and the available computing power. So it is recommended to ensure a gap of of at least 20 milliseconds after the last element was processed until the external trigger may appear.

This element is symbolised by this toolbar icon:



5.7.4.17 Serial port output

This element does not contain any geometry but can be used to output some data to a serial port connected to the host PC where the application is running at. To submit data via the serial interface integrated into a connected scanner controller, please refer to section “5.7.4.14 Custom Output” above.

Within the element tab-pane the serial port has to be configured which has to be used for data transmission. This includes the port name, transmission rate and port parameters.

Below of the serial port configuration elements, a text field “Data” is available where the data have to be entered which need to be submitted. Here all types of ASCII-texts can be given as well as the two special place-holders [CR] and [LF] for adding a carriage return (“\r”) and a line feed (“\n”) to the data. A line break done in the text field is not converted to such characters but dropped, so it is mandatory to use these place-holders at all positions where this is required.

This element also accepts an input element such as the CSV Data Input. When such an input element is configured, given input data are used to set new data to be sent via the serial port. These input data need to follow the same rules as described above in order to add correct line feed/carriage return characters to the data stream.

Sending of the data is done synchronously, means when such an element is found, application waits until processing of data is finished for all scanner controller cards. Then the data are sent but without waiting for a response before processing the next element in current project.

This element is symbolised by this toolbar icon:



5.7.4.18 Z-Shifter

This element does not have a visual representation but is similar to the motion primary element. It does not accept any additional data or post-processing elements but it can be used to influence the material processing in general by changing the lasers focus. The elements of a project are processed in the order they appear within the entity tree. At the position where this element is placed, a focus shifter or beam expander is accessed. The related Z-Shifter plug-in has to be configured in projects hardware settings.

The focus/z-position can be influenced by the parameters that have to be set for this element:

- Position – the new position to move the z-position to
- Speed – the speed for the movement to the given position
- Relative – defines a non-absolute movement, means the axis does not drive to the given position but changes its current position by the given distance
- Move axes to home-position – the axis is moved to its home / reference position, this option is available only for motion controllers that support this function and ignores the given position and speed values

All other parameters influence the whole motion element:

- Pre-Motion Delay – this delay is done before the motion is triggered

5.7.5 Additional Geometry Elements

Additional Geometry elements add new geometry based on the already available geometry of the primary element it belongs to. Here the additional element only takes care of the primary one, it ignores possibly existing, other additional elements that might exist for the same primary element. Additional Geometry elements do not modify any of the existing geometries but only add their own ones to them.

To add an Additional Geometry element to an existing Primary Geometry, the drawing area doesn't have to be used. Here the desired primary element has to be selected within the element tree, then the additional element has to be clicked within the tool-bar. There the Additional Geometry elements are shown in purple colour and are added to the Primary Geometry element as soon as the tool-bar item is clicked.

5.7.5.1 Hatcher

Hatching is the process of filling a closed polygon with a pattern. This can be used to process a bigger area. It can be useful e.g. combined with texts to get characters that consist not only of its outline.

Hatching will work only with closed polygons and might fail on specific geometries that do not describe a closed area non-ambiguous. In such cases the resulting hatch pattern may be incomplete or may be located outside of the polygon.

In general only two-dimensional geometry can be hatched. Lines and dots – which do not describe a closed polygon – are not extended by this element. As an other condition a polygon can be hatched only at positions where the outline has a closed line style, geometry with dotted lines can't be hatched, geometry with a dashed outline is hatched only at positions where a line is drawn.

Also in case 3D mode or 3D geometry is used the hatcher offers a 2D-functionality only but it can be applied to 3D elements. In such cases the hatcher always uses the geometry in X and Y direction (similar to the top view) and ignores the Z-value to create the hatch pattern. After this pattern is generated the Z-information out of the lines they start from/end at are used to modify the hatch lines. This results in perfect 3D hatch patterns in most cases but may have unexpected results when complex geometries are combined with more advanced hatch options (like beam compensation or inner hatch lines).

The hatcher offers following parameters:

- Line Style – the style the lines the text consists of is created with, here following options exist:
 - Continuous: the geometry consists of closed, connected lines with as less as possible points
 - Connected Lines: the geometry consists of several short lines including additional points, all these lines are connected; from its visual representation this looks identically to “Continuous” but behaves different when a post-processing element is applied to this hatch afterwards
 - Dashed (simple): the geometry consists of several short lines including additional points, every second line is drawn that results in a dashed line style; this mode starts with a line at every beginning of a hatch line
 - Dashed (interleaved): the geometry consists of several short lines including additional points, every second line is drawn that results in a dashed line style; this mode starts with a line and a space alternative at every new beginning of a hatch line
 - Dashed (continuous): the geometry consists of several short lines including additional points, every second line is drawn that results in a dashed line style; this mode starts with a line or a space at the next beginning of a hatch line depending on the previous hatch line, the pattern is kept continuous
 - Dotted: no lines are drawn, the geometry consists of a set of not connected dots
 - Dotted (Custom): no lines are drawn, the geometry consists of a set of not connected points in custom dot style as configured within the project settings (please refer to section 5.3 Project Configuration above)
 - Dotted pairs: no lines are drawn, the geometry consists of a set of not connected pairs of dots with the given distance between each pair and half of the distance between the dots of a pair
 - Dotted pairs (custom): no lines are drawn, the geometry consists of a set of not connected pairs of dots with the given distance between each pair and half of the distance between the dots of a pair using the custom dot style as configured within the project settings (please refer to section 5.3 Project Configuration above)
- Distance – whenever a non-continuous line style is selected above, this distance value specifies the length of the additional points that form the selected line style
- Offset – whenever a non-continuous line style is selected, the related pattern is calculated in a way so that it starts at the beginning of the related hatch line. Dependent on the filled shape this may result in line patterns which are aligned in a way which is not intended. Using this parameter an additional offset can be added to each line incrementally, so that the beginning of the hatch pattern is shifted by this offset. As soon as the real, accumulated offset value becomes bigger than the line distance defined with previous parameter, the distance is subtracted from the current offset value
- Align dots to raster – whenever a non-continuous line style is selected, the related pattern is calculated in a way so that it starts relative to the beginning of the related hatch line taking an optionally set offset-value into account. When the current hatch angle (as described below) defines an exact horizontal or vertical line (0, 90, 180 or 270 degrees) and this option is set, the pattern for the line is no longer calculated relative to the beginning of the line but aligned to the coordinate 0,0 of the underlying coordinate system. This is useful e.g. for polygons with different edge angles where e.g. a dot-pattern would result in an irregular, uneven distribution of dots.
- Hatch Style – here the hatching mode is defined, depending on the selection made here a different pattern is used to fill a polygon
 - Lines, forward – filling is done with parallel lines that all go into the same direction

Lines, forward/backward – the polygon is filled with parallel lines that change their direction

Connected lines – this mode extends the previous one, here the parallel lines are connected and form some kind of wavy lines

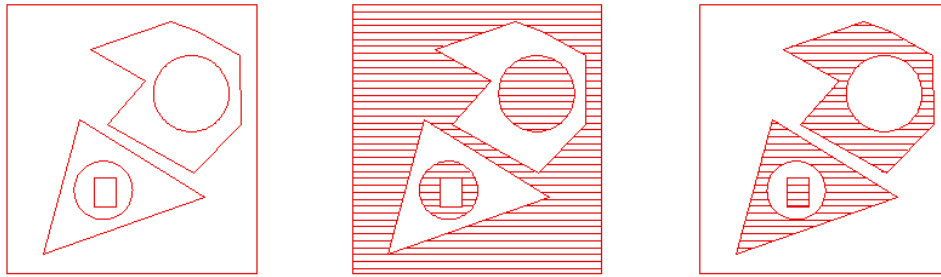
Zig-zag – these lines are no longer parallel, they exchange their direction alternative and are connected at their ends directly

Inner lines – this mode repeats the outline of the hatched polygon in its inner side as often as it fits with the chosen hatch distance

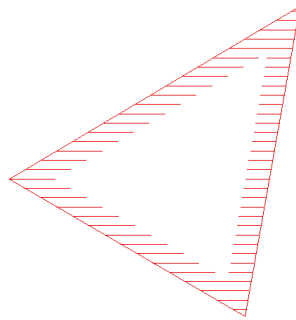
Outer lines straight – this mode is similar to "Inner lines" but not a plain hatch mode that can be used to really *fill* a geometry. It repeats the outline of the hatched polygon on its outer side as often as specified by the value given in field "Number of Lines". At corner points where additional lines are necessary to close the polygon, the shortest way is used by adding a straight line.

Outer lines rounded – this mode is similar to "Inner lines" but not a plain hatch mode that can be used to really *fill* a geometry. It repeats the outline of the hatched polygon on its outer side as often as specified by the value given in field "Number of Lines". At corner points where additional lines are necessary to close the polygon, a round shape is created. Please note: this adds a lot of polygon points and may – dependent on the geometry – increase memory and processing time consumption dramatically. So this mode should be handled with care and only in cases where it is really necessary to use this special shape!

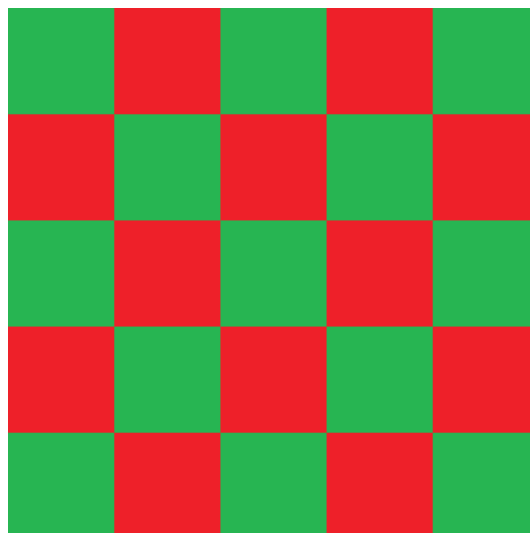
- Hatch Angle – this angle specifies the orientation of the hatch lines according to the coordinate system, it does not apply to the inner/outer lines hatch modes
- Angle Offset – this parameter applies only in case the hatcher is set as sub-element of a group that contains more than one geometric element to be hatched; in this case only the first primary element within that group is hatched with the original hatch angle, for all following elements the hatch angle is modified by this offset. So this parameter can be used to have some kind of rotating hatch angle for several elements that are concatenated together within a group. It does not apply to the inner/outer lines hatch modes.
- Repeat – this option becomes enabled when an angle offset is defined with previous parameter. When "Repeat" is set to values greater than 0, the hatch generation is repeated for the given number, each with a different angle according to the given offset. So this function can be used to create complex hatch patterns with rotating angles while using one hatch element only.
- Hatch Distance – this is the distance that is kept between the hatching lines, for the zig-zag hatching mode it applies to the ends of the lines
- Hatch Offset – normally hatching starts at the border of a polygon; this parameter allows to specify an offset (in positive and negative direction) to modify the position where hatching really starts
- Align hatch to raster – when the current hatch angle (as described above) defines an exact horizontal or vertical line (0, 90, 180 or 270 degrees) and this option is set, the hatch lines are no longer calculated relative to the beginning of the element to be hatched but aligned to the coordinate 0,0 of the underlying coordinate system. This is useful e.g. when different independent elements have to be hatched with the same hatch lines alignment.
- Number of Lines – this input field is activated only when "lines" hatch styles are used; it specifies the maximum number of inner or outer lines to be calculated; when this value is smaller than the number of inner lines required to fill a geometry completely, inner part of the element will contain a non-hatched hole
- Interleave Lines – when this parameter comes with a value greater than 1, hatch lines are not marked one after another but by dropping that number of lines after each, that is specified by this parameter. The remaining lines then are marked in additional cycles skipping the same number of lines in between. This mode slows down marking process caused by many additional jumps but gives the possibility to let the material not heat up too much. This can be useful in case of temperature-sensitive materials, there the currently marked areas get some time to cool down until the lines in their direct neighbourhood are processed. As an example: instead of marking lines 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 with an interleave-value of 4 it would mark lines 1, 5, 9, 2, 6, 10, 3, 7, 11, 4, 8, 12.
- Invert – this function applies to nested polygons only: when it is set, the order of hatched/not hatched polygons is inverted as shown in picture below:
From left to right: input geometry with nested polygons, hatched geometry (no-inverted), inverted hatched geometry



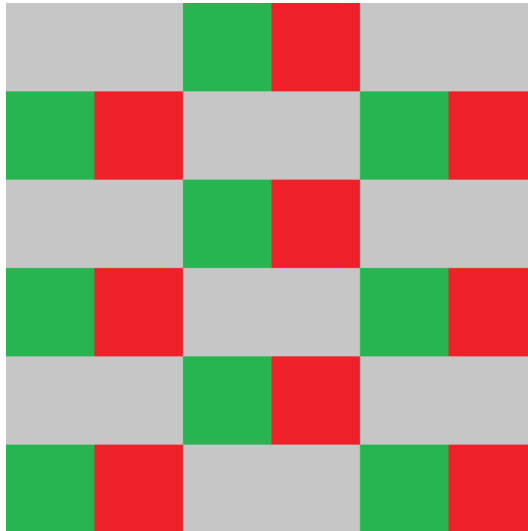
- From bounding box – hatching is started from the (not visible) bounding box, when this option is set, hatch lines start outside of the polygon; this function should not be used in cases where the bounding box is the same as the shape of the hatched geometries which is true for all rectangles which are aligned parallel to the working area border
- At border – when this option is set, polygons are no longer filled completely but only at the borders, the given distance in unit specifies the “thickness” of the resulting border hatch in unit mm:



- Beam Compensation – the laser beam that is used to process a working piece itself has an own size that results in the width of the lines that are processed by it; for the hatcher it might be necessary to compensate this lasers spot size to avoid parts of the working piece to be processed more than once by the overlapping beam, this compensation can be chosen here:
Use spotsize from pen – here the tool compensation sizes are calculated automatically out of the spot sizes of the used pens
Custom –when this option is used a custom value for compensation can be entered
- Split To Tiles – when this option is set, the hatch lines are split into tiles that are aligned to the working area and that subdivide the hatch pattern additionally. Using these tiles it can be avoided to heat up the material during hatching too much. When this option is set, the following parameters can be used to specify exact behaviour of this function. After enabling this option, the hatches are split and reorganised but there will be no obvious visible representation of the changes, it can be noticed during marking or via the voordinate values only.
Together with the following parameters this function can be used to e.g. mark every second tile:



Assumed the working area has a size of 100 mm x 100 mm, for this behaviour "Tile Size" needs to be set to 20 mm and "Tile Skip Size" has to be set to 2. With these settings first all these areas are marked that have vectors within red tiles, finally all the remaining areas that have a vector in green tiles are marked. Tiles itself are processed from upper left to lower right corner row by row. It is also possible to have even bigger distances between tiles so that they do not touch at their edges:



Parameters for a 90 mm x 90 mm working area are 15 mm for "Tile Size" and 4 for "Tile Skip Size". This results in a behaviour where marking starts with these areas of the hatch that own vectors in red tiles, next the areas in green tiles are marked. This is continued until the whole working area was processed (in this example by processing the remaining two tile sets in grey areas with two additional steps).

- Tile Size – the size of a tile in working area, this value should be such a fraction of the working area size that lets the tiles fit fully into whole working area
- Tile Overlap – when this parameter is set to a value greater than 0, it specifies how much neighbouring lies should overlap, when it is smaller than 0, the value sets a gap between such neighbouring tiles using the given size in unit mm
- Tile Skip Size – skip distance between tiles, this value decides how many tiles in horizontal direction should be skipped before marking continues in next tile; remaining tiles are processed on next cycle; this value should be much smaller than the total number of tiles that fit into the working area
- Tile drop offset – when this parameter is set to a value greater than 0, the hatcher no longer creates a complete set of tiles resulting in a closed hatch for the complete element. Instead of this, the parameter specifies at which tile the function should start dropping the tiles so that there exist non-hatched parts in the whole geometry. This function can be used to combine several hatches with different hatch angles in tiles. As an example: when one hatch is set with a hatching angle of 0 degrees and a tile drop offset of 1 and the next hatch on the same element is set with a hatch angle of 90 degrees and a tile drop offset of 2 (while both use a tile skip size of 2), the result is a closed, tiled hatch with alternating hatch angles of 0 and 90 degrees in the different tiles.
- Hide hatch from view – this option does not influence generation of data, so no matter if it is set or not, the marking result will stay the same. When this checkbox is set, the hatch is not shown in the drawing area in order to make displaying of the whole project faster. This can be useful in case of very complex hatch patterns with millions of single lines or dots
- Save as default – when this button is pressed, the current hatch parameters are saved as default values. On next application start and on first usage of the hatch element, these saved parameters then will be used instead of the predefined ones

5.7.6 Post-processing Tool Elements

The Post-Processing Tools influence all geometric elements that are located on an earlier position within the Element Tree and below of the same primary element. So the manipulation of geometry that is done by such a tool is always applied to the Primary Geometry element it belongs to and to all previously applied Additional Geometry elements of this primary one. Additional elements that follow a tool are not changed, they apply their additional geometry to the modified geometry.

Post-Processing Tools are symbolised by red tool-bar buttons and can be added to a primary element simply by clicking this tool-bar button. To do that, the related Primary Geometry element has to be selected within the Element Tree.

Post-Processing Tools do not add any new points or lines to existing geometry, thus it requires an outline that consists of lines that are short enough to let the tool apply its function, elsewhere the result would not look like expected. So within the parameters of the elements that have to be modified the line-style has to be set to a non-continuous mode (for an example connected lines, dashed lines or dots with a small distance should be used here).

5.7.6.1 Sine Distortion

This Post-processing Tool applies a sine waveform to existing geometry. This tool does not add any new points or lines to existing geometry, thus it requires an outline that consists of lines that are much shorter than the wavelength. Elsewhere the result would not look like a real sine waveform.

Following parameters can be set for this tool:

- Direction – the direction the waveform has to be applied to, beside the two values that are relevant for 2D data (“Horizontal” sets a sine parallel to X-axis, “Vertical” sets a waveform parallel to Y-axis) four additional options are available that are relevant for 3D data only. These options can be used to specify the direction of the amplitude and the direction the wave grows into
- Wavelength – the length of a single wave
- Amplitude – the amplitude of the sine wave
- Offset – an offset that defines at which position within the wave the sine calculation has to be started, this offset can be used to shift the waveform

5.7.6.2 Curve Distortion

Using this tool an existing geometry can be bend around a defined centre point to get a radial, round shape. It is useful e.g. in combination with the Text Primary Geometry element to define radial or ellipsoidal texts.

This tool does not add any new points or lines to existing geometry, thus it requires an outline that consists of lines that are short enough for a result that looks like a bent outline.

Following parameters can be used to influence the result:

- Axis – this field specifies around which coordinate axis the text has to be bent. Here “Z” is preselected and can be used for 2D applications. “X” and “Y” are for 3D applications and bend the post-processed geometries in Z-direction.
- Radius – the radius of the circle the geometry is bent to, this is the distance from the middle of the geometry to the radial centre point; here negative values are allowed too to invert the geometries position relative to the chosen axis
- Radius – the second radius value can optionally be enabled in order to create ellipsoidal shapes. In this case a different radius can be entered specifying the ellipses second radius. Please note: when the first radius is negative, the second one has to be negative too, elsewhere the results are undefined
- Angle Offset – an offset for the bending angle starting point, using this value the geometry can be shifted

- Force to centre coordinate – when bending some geometry, this is done using some (imaginary) coordinate which is used as centre for the geometry. When this option is set, the centre coordinate can be entered directly within the settings of this plug-in, forcing the geometry to a position with exactly this centre coordinate. This makes it easier to properly adjust and position a bent element. PLEASE NOTE: when this option is set, all other functions to translate or change the position of this element are disabled in order to avoid overlapping coordinate transformations! So as long as this function is used, the element can be repositioned only via the X and Y coordinate input fields of this post-processing element!
- Rotate CCW – rotate the parent-element counter-clockwise. This mainly is useful in case of text-elements used for rotation.

5.7.7 Data Input Elements

This type of element influences geometry only in a very indirect way, it provides data that can be used by Primary Geometry elements to create their geometry. So all types of Primary Geometry elements that accept such input data can be combined with all types of Data Input elements. Of course it is not possible to have more than one Data Input element per Primary Geometry element.

To add such a Data Input element, the Primary Geometry element has to be selected within the Entity Tree. Next the green tool-bar symbol of the Data Input has to be clicked to assign it to the Primary Geometry element.

5.7.7.1 CSV Data Input

This plug-in offers connectivity to data out of tables in CSV format (comma separated values, a platform- and application-independent table file format). It loads data out of such a CSV table and jumps to next line/row of this file automatically during marking. The data read from this table are applied to the related Primary Element. Within the settings panel of this plug-in first the path to the CSV file has to be chosen, then the related input elements become enabled which can be used to configure the behaviour of this element:

- Column separator – here the delimiter character has to be chosen which separates the data columns within the selected CSV file
- Data column – using this field the column has to be specified where the data have to be read from, this value is 1-based
- Data repeat column – using this checkbox and input field a function can be activated where an other column in the same CSV file specifies how often the data from the previous configuration field have to be repeated until the next row of data has to be read out of the file. The repeat-value given here is 0-based, means with a value of 1 data out of the current row would appear two times (once the original value and once repeated due to the repeat column value)
- Endless loop – when this checkbox is set, the application will jump to the beginning of the CSV file as soon as all data have been read. When this option is not set and when there are no more data available within the CSV file, a marking process will be cancelled with a related error message.

During marking in Element Tree the name of this element is prepended by two numbers showing the current row of the loaded CSV file and the maximum number of rows it contains. Using these displayed values it can be seen how much CSV data of the current file are already processed and how much are still left.

5.7.7.2 Serial/Date/Time

This is a very complex Data Input element that can be used to generate numbers, date or time information or combinations of them. The result can be used to create e.g. complex serial numbers, “best-before” information or others within a text or a bar code – depending on the Primary Geometry element where this input is assigned to.

The Data itself are updated before the next material processing cycle is started. Depending on the used configuration this update increments/decrements the serial number and/or updates the date or time information to represent the current time.

Following parameters can be used to influence the resulting data and their behaviour:

- Start Value – the starting value where the serial number has to count from when the project is loaded initially
- Reset At – here a number can be defined that is used as limit for the serial number, as soon as the current serial number is equal to the value given here the serial number is reset to the start value defined above
- Increment – the value the serial number has to be incremented by for every update; this value can be negative which results in a decrement for every cycle
- Beat Count – this number specifies the number of cycles a serial number has to be left unchanged until it is updated, here a value of three – as an example – would mean, a serial number is updated and incremented only at every third marking cycle
- Beat Offset – this parameter corresponds to the preceding one, it adds an offset to the beat count, means it defines at which number it has to be started to count for the number of Beat Counts
- Numeric Base – by default a serial number consists of numerical values in range 0..9 which means the numeric base is 10; this parameter can be used to define any other numeric base so that less numeral values are used (Numeric Base < 10) or in a way where letters in range A..Z are added for counting the serial number (Numeric Base >10)
- Minimum Digits – this parameter specifies the number of digits a serial number has to consist of at minimum – independent from their real value; in case a number would have less digits than specified here, it would be filled with one or more preceding zeros
- Time Offset – here an offset can be specified using freely selectable numbers of years, days, hours and minutes, this offset is added to the time information that can be incorporated into the resulting data and can be used e.g. to define a best-before date counted from the current date/time
- Format String – this format string defines the layout and contents of the resulting data which are handed over to the assigned Primary Geometry element. Here any desired text can be added and combined with some place-holders which are replaced by serial number or date or time information. Here following place-holders are possible:
 - %S – this string is replaced by the serial number as defined with the parameters above
 - %A – is replaced by national representation of the full weekday name
 - %a – is replaced by national representation of the abbreviated weekday name
 - %B – is replaced by national representation of the full month name
 - %b and %h – are replaced by national representation of the abbreviated month name (these placeholders are not supported when using Windows)
 - %C – is replaced by the year divided by 100 (this placeholder is not supported when using Windows)
 - %c – is replaced by national representation of time and date
 - %D – is equivalent to "%m/%d/%y" (this placeholder is not supported when using Windows)
 - %d – is replaced by the day of the month as a decimal number (01..31)
 - %e – is replaced by the day of month as a decimal number (1..31); single digits are preceded by a blank (this placeholder is not supported when using Windows)
 - %F – is equivalent to "%Y-%m-%d" (this placeholder is not supported when using Windows)
 - %G – is replaced by a year as a decimal number with century. This year is the one that contains the greater part of the week (Monday as the first day of the week)
 - %g – is replaced by the same year as in "%G", but as a decimal number without century (00..99)
 - %H – is replaced by the hour (24-hour clock) as a decimal number (00..23)
 - %I – is replaced by the hour (12-hour clock) as a decimal number (01..12)
 - %j – is replaced by the day of the year as a decimal number (001..366)
 - %k – is replaced by the hour (24-hour clock) as a decimal number (0..23); single digits are preceded by a blank (this placeholder is not supported when using Windows)
 - %l – is replaced by the hour (12-hour clock) as a decimal number (1..12); single digits are preceded by a blank
 - %M – is replaced by the minute as a decimal number (00..59)

- %m – is replaced by the month as a decimal number (01..12)
 - %p – is replaced by national representation of either "ante meridiem" ("AM") or "post meridiem" ("PM") as appropriate
 - %R – is equivalent to "%H:%M" (this placeholder is not supported when using Windows)
 - %r – is equivalent to "%I:%M:%S %p" (this placeholder is not supported when using Windows)
 - %S – is replaced by the second as a decimal number (00..60)
 - %s – is replaced by the number of seconds since January 1st, 1970, 00:00 o'clock, UTC (this placeholder is not supported when using Windows)
 - %T – is equivalent to "%H:%M:%S" (this placeholder is not supported when using Windows)
 - %U – is replaced by the week number of the year (Sunday as the first day of the week) as a decimal number (00..53)
 - %u – is replaced by the weekday (Monday as the first day of the week) as a decimal number (1..7) (this placeholder is not supported when using Windows)
 - %V – is replaced by the week number of the year (Monday as the first day of the week) as a decimal number (01..53). If the week containing January 1st has four or more days in the new year, then it is week 1; otherwise it is the last week of the previous year, and the next week is week 1.
 - %v – is equivalent to "%e-%b-%Y" (this placeholder is not supported when using Windows)
 - %W – is replaced by the week number of the year (Monday as the first day of the week) as a decimal number (00..53)
 - %w – is replaced by the weekday (Sunday as the first day of the week) as a decimal number (0..6)
 - %X – is replaced by national representation of the time
 - %x – is replaced by national representation of the date
 - %Y – is replaced by the year with century as a decimal number
 - %y – is replaced by the year without century as a decimal number (00..99)
 - %Z – is replaced by the time zone name
 - %z – is replaced by the time zone offset from UTC; a leading plus sign stands for east of UTC, a minus sign for west of UTC, hours and minutes follow with two digits each and no delimiter between them
 - %+ – is replaced by national representation of the date and time (this placeholder is not supported when using Windows)
 - %\$m – is replaced by the month representing it as a character in range a..j
 - %\$M – is replaced by the month representing it as a character in range A..J
 - %\$y – is replaced by the year representing it as a character in range a..z
 - %\$Y – is replaced by the year representing it as a character in range A..Z
- Locale – some of the date/time place holders are replaced by information that depend on a language and or on local specialities; using this parameter the locale can be chosen that has to be used for these time information

5.8 Edit Geometry

Geometries are mainly generated by Primary Geometry elements. Whenever the parameters of such an element are changed the geometry is re-created and all assigned Additional and Post-Processing Elements are executed again to apply their modifications to this new geometry. Thus modifications that are done for single vectors get lost as soon as such modifications are done. Nevertheless it is possible to perform such modifications in case one of the two conditions are met:

- the parameters of the elements that create a geometry are not touched
- a geometry is converted to a static one where no Primary Geometry element with variable parameters is available and where no Additional Geometry or no Post-Processing Element is assigned

Functions to edit geometries can be found at two places: in menu "Edit" and its sub-menus "Non-Destructive" and "Destructive" within the main window and within the context menu of the drawing area that opens when an element is selected and the right mouse button is clicked.

5.8.1 Edit Vectors

Editing of one or more separate vectors requires selection of these vectors. This can be done within the Coordinates-list of the Geometry-tab-pane when an element is selected. Here following functions are available:

- Delete selected Points – all selected points are deleted, resulting from that the lines between them are removed too
- Delete selected Lines – all lines between the selected points are removed, the points itself are left untouched
- Insert point before – a new point is added in the middle between the currently selected point and its preceding one
- Insert point after – a new point is added in the middle between the currently selected point and its subsequent one

5.8.2 Edit Non-Destructive

The non-destructive editing functions perform modifications that leave the geometries and the elements they are created from untouched. Some of them are available also from within the context menu of the Element Tree. Alternatively they can be found in Menu “Edit” sub-menu “Non-Destructive” and require at least one element to be selected:

- Group – several selected Primary Geometry elements are concatenated together within a group
- Group to Active Split – using this function geometries that are larger than the available working area can be cut into smaller pieces and processed step by step either by horizontal or rotational movements using an additional drive; for more information please refer the related section below
- Group to Active Rotational Split – this is a convenience function which is similar to Active Splits mentioned above but which encapsulates the rotational part only
- Group to Active Move – here full geometries can be processed repeatedly and combined with movements so that the same geometry is arranged in tiles or at the circumference of a ring several times; for more information please refer the related section below
- UnGroup – an existing group of elements is removed, the contents of the group are put out of it
- Duplicate – a copy of the currently selected element is created, the copy is 100% identically to its original (except its position, it is placed a bit above the original element)
- Align left – this function can be used to left-align several selected elements at each other. Here the left-most-position of all these elements is taken to place all elements at this position in horizontal direction
- Centre horizontal – this function can be used to centre several selected elements along each other. Here the centre-position of all these elements is taken to also centre-align all elements at this position in horizontal direction
- Align right – this function can be used to right-align several selected elements at each other. Here the right-most-position of all these elements is taken to place all elements at this position in horizontal direction
- Align top – this function can be used to top-align several selected elements at each other. Here the top-most-position of all these elements is taken to place all elements at this position in vertical direction
- Centre vertical – this function can be used to centre several selected elements along each other. Here the centre-position of all these elements is taken to also centre-align all elements at this position in vertical direction
- Align bottom – this function can be used to bottom-align several selected elements at each other. Here the lowest position of all these elements is taken to place all elements at this position in vertical direction

5.8.2.1 Active Split Group

This is a special kind of group that concatenates several elements into one group. Due to the kind of this group it is recommended to use only geometries and scanner bitmaps and not to put other ones like motion elements into it.

An Active Split Group is able to handle geometries and bitmaps that are larger than the available working space. It cuts them into smaller pieces and combines them with motion control information so that these large and cut geometries and bitmaps can be put together during processing. So this functionality can be used to handle big working pieces that e.g. are moved by a XY-table. The cutting operation only applies to X-Y-direction (equal to top view).

An other application is processing on the surface of rings, here a special radial mode is supported. This mode gives the possibility to cut geometries into segments and to process the whole ring (inner or outer side).

As soon as some geometric elements are grouped together within such an Active Split Group it's behaviour can be modified using the parameters that are available within the property panel of this group:

- Split horizontal – splits the grouped geometry along X axis, this option can be combined with “Split vertical” to define two-dimensional movements
- Split distance – the split size in horizontal direction
- Split vertical – splits the grouped geometry along Y axis, this option can be combined with “Split horizontal” to define two-dimensional movements
- Split distance – the split size in vertical direction
- Split radial – defines a splitting operation onto a ring, this option can not be combined with one of the previous splitting direction modes
- Direction – specifies the direction for the rotational splitting, here it can be chosen between “Horizontal” and “Vertical”, the axis that is assigned to this direction has to be aligned properly
- Diameter – the total diameter of the ring where the split pieces have to be marked at
- Split angle – the movement angle for every split, the size of the single split pieces result out of this angle and the diameter of the ring
- Keystone correction – when marking the inner side of a ring the laser beam has to be slanted in order to hit only the lower inner side of the ring and not the upper outer side too. Resulting from that the length of the beam varies dependent on the X/Y position of the geometry which results in a distortion when no special optic is used.
Using the keystone correction this distortion can be suppressed so that the marking result will look like expected. This correction is done by setting an as a percentage correction factor and by defining the side of the geometry this factor may apply to. The correction factor specifies how much the geometry shall grow or shrink according to its original size at the outer position where the full distortion has to be expected.
- Invert motion direction – this option has to be used in case the inner side of a ring needs to be processed, there an inverted motion direction is required to concatenate the pieces in correct order
- Process order – this order applies to the planar splitting modes and defines in which order the pieces have to be processed:
 - Left to right – horizontal direction always starts from left
 - Right to left – horizontal direction always starts from right
 - Zig-zag from left – horizontal direction starts from left and performs zig-zag movements
 - Zig-zag from right - horizontal direction starts from right and performs zig-zag movements
 - Top to bottom – vertical movement starts from top
 - Bottom to top – vertical movement starts from bottomIn case two-dimensional motion is defined both process order selections are combined with each other to describe the 2D motion.
- Motion speed: the movement speed in unit mm/sec or degrees/sec that is applied to the motion between the splits.

- Overlap splits: here an as a percentage value can be set that specifies how much the pieces should overlap, means how much of the geometry should exist twice so that it is processed two times at the areas of intersection
- Try split between pieces – here the splitting algorithm tries to find empty spaces between geometries to avoid cutting of lines; in case this option is set the specified split distance or split angle is used as maximum value: a cut is set wherever space between geometries is found or latest after the given split distance/split angle. In last case cutting of lines is still done. So in this mode split distance/split angle define the absolute maximum size of a resulting piece while the distances where the geometry are cut really can be smaller than this.
- Axis mapping: at the lower end of the property panel a matrix of radio buttons exists where the axes can be mapped to the related movements, there it can be specified which of the axes A, B or C of the two possible outputs OUT2 and OUT3 have to provide the related planar movements in horizontal or vertical direction or the angular movement.
- Save as default – after application start-up new split-groups are created with some default parameters. When these parameters are changed, other Active Split Groups then are created with these changed parameters, but after restarting RepliMark, the default parameters are used again. When this button is pressed, the current split-group parameters are saved as new default so that they are used whenever a new Active Split Group is created after RepliMark was started newly. The related data are stored within the users working directory in a file named “.beamuiSPLT”

After such a splitting group has been created and after the correct parameters have been set, the appearance of the related geometry changes: now it is overlapped by horizontal and/or vertical lines. These lines specify the cutting positions and can be modified manually. They can be dragged with the mouse in horizontal or vertical direction exclusively to change the position where the geometry has to be cut. The related modifications are done as soon as such a cutting line is released.

Please note: the positions of the cutting lines do not influence the parameters given within the property panel but as soon as the parameters within the property panel are modified, the position of the cutting lines are reset to their default. Thus their positions should be changed only in case all other parameters do fit perfectly.

5.8.2.2 Active Move Group

This is a special kind of group that concatenates several elements into one group. Due to the kind of this group it is recommended to use only geometries and not to put other ones like motion elements into it.

An Active Move Group is able to repeat a grouped geometry several times and to combine it with movements so that e.g. a ring can be processed with a repeated pattern on its surface or to repeat the current geometry on a large working piece that itself is re-positioned by using an XY-table. The active movement functionality only applies in 2D mode or in X-Y-direction (equal to top view). Comparing to the Active Split Group here the contents of such a group are not cut or somehow else modified, they are marked all in once repeatedly.

As soon as some geometric elements are grouped together within such an Active Move Group the groups behaviour can be modified using the parameters that are available within the property panel of this group:

- Move horizontal – moves the grouped geometry along X axis, this option can be combined with “Move vertical” to define two-dimensional movements
- Move distance – the distance a movement has to be done in horizontal direction between two processing cycles
- Move steps – specifies how often processing of the geometry has to be repeated in horizontal direction
- Move vertical – moves the grouped geometry along Y axis, this option can be combined with “Move horizontal” to define two-dimensional movements
- Move distance – the distance a movement has to be done in vertical direction between two processing cycles
- Move steps – specifies how often processing of the geometry has to be repeated in vertical direction

- Move radial – defines a movement operation onto a ring, this option can not be combined with one of the previous splitting direction modes
- Diameter – the total diameter of the ring where the geometry has to be marked at
- Move angle – the movement angle for every split, the size of the single split pieces result out of this angle and the diameter of the ring
- Move steps – specifies how often processing of the geometry has to be repeated on the ring
- Keystone correction – when marking the inner side of a ring the laser beam has to be slanted in order to hit only the lower inner side of the ring and not the upper outer side too. Resulting from that the length of the beam varies dependent on the X/Y position of the geometry which results in a distortion when no special optic is used.
Using the keystone correction this distortion can be suppressed so that the marking result will look like expected. This correction is done by setting an as a percentage correction factor and by defining the side of the geometry this factor may apply to. The correction factor specifies how much the geometry shall grow or shrink according to its original size at the outer position where the full distortion has to be expected.
- Process order – this order applies to the planar movement modes and defines in which order the grouped geometry have to be repeated:
 - Left to right – horizontal direction always starts from left
 - Right to left – horizontal direction always starts from right
 - Zig-zag from left - horizontal direction starts from left and performs zig-zag movements
 - Zig-zag from right - horizontal direction starts from right and performs zig-zag movements
 - Top to bottom – vertical movement starts from top
 - Bottom to top – vertical movement starts from bottom
 In case two-dimensional motion is defined both process order selections are combined with each other to describe the 2D motion.
- Motion speed: the movement speed in unit mm/sec or degrees/sec that is applied to the motion
- Axis mapping: at the lower end of the property panel a matrix of radio buttons exists where the axes can be mapped to the related movements, there it can be specified which of the axes A, B or C of the two possible outputs OUT2 and OUT3 have to provide the related planar movements in horizontal or vertical direction or the angular movement.
- Save as default – after application start-up new move-groups are created with some default parameters. When these parameters are changed, other move-groups then are created with these changed parameters, but after restarting RepliMark, the default parameters are used again. When this button is pressed, the current move-group parameters are saved as new default so that they are used whenever a new Active Move Group is created after RepliMark was started newly. The related data are stored within the users working directory in a file named “.beamuiMOVE”

After such a splitting group has been created and after the correct parameters have been set, the appearance of the related geometry does not change but within the entity list a different symbol for the group is shown in order to point to the fact a special kind of group is used here.

5.8.3 Edit Destructive

The functions of this category perform irreversible modifications to the input geometry. That means only the resulting geometry is used for further processing and all source elements that have been used to create this geometry get lost.

Resulting from that there is much less computing time and memory used to hold such geometry and editing on a per-vector-level is much less difficult because the data no longer can't be overwritten by a re-creation caused by some parameter changes. On the other hand the conversion to static geometry means that no more dynamic changes are possible like they can be performed when Data Input elements are used – as soon as these elements have been modified by such a destructive modification, all the (sub)elements it consisted of are lost. But afterwards it is possible to assign Additional Geometry and Post-processing elements to this static geometry again.

Following functions exist that perform such destructive modifications:

- Merge – the geometries of the selected elements are merged together, the result is one static element with all geometries included into it; this function can also be applied to one single Primary Geometry element and its sub-elements to reduce its memory usage to the absolute minimum so that only the resulting static data of it are stored
- Split – tries to split the geometry of an element into several pieces, here splitting is done at positions where a geometry ends (e.g. at the end of a logic element or the end of a polygon). There are several levels of splitting so that it is possible to perform a splitting operation up to two times at the same data. As an example: when the splitting-function is applied to a geometry that represents the string “Text” for the first time, the result are four elements containing the geometries for the letters “T”, “e”, “x” and “t”. In a second step the splitting function can be applied to the geometry of the letter “e” again. Now it is split based on the contained poly-lines, the result are two elements that contain the two polygons the letter “e” consisted of (one with the outline and one with the small part within the head of the “e”).
- Optimize – this function checks geometry for inefficient structures and optimizes them. Here the visual representation of a geometry is not changed but the number of vectors and vertices is reduced if possible.
- Reduce Geometry – here the data a geometry consists of can be reduced. After selecting this menu item a dialogue is opened which provides different reduction methods and modes:
 - Smooth lines – this is not a real data reduction method but combined with the other options it can have stronger effects and better results; this expects a line-length in unit mm, when chosen all lines within a polygon that are smaller than this value are smoothed, means their values are combined in a way which tries to result in softer shapes with less edges (low pass filter); this function should be used with round shapes and can improve the effect of option “remove lines” when used in combination
 - “Remove lines” - here a parameter in unit mm is expected which specifies the minimum length a single line within a polygon shall have, lines that are smaller than this are concatenated with their predecessor
 - “Remove points in angles” - this option expects a parameter in unit degrees and removes all points within a polygon which form an angle that is smaller than the specified value (means three points are inspected which form an angle and the middle point is removed when the angle is below the given threshold); the effect of this option becomes weaker when it is combined with function “smooth lines”
 - “Close polygon with endpoint” - this is not a real data reduction method but combined with the other options it can have stronger effects and better results; this function tries to create closed polygons out of a shape; when the end of a polygon line is found, it is checked if it is a closed polygon (means the end is located at the same position like its beginning) or not; in case it is not closed, the beginning of an other polygon line is tried to be found which is closer than the parameter entered for this function (in unit mm) – and when one could be found, the whole geometry is rearranged in order to get one continuous polygon; this function can improve the effect of option “remove lines” when used in combination
- Extrude – this function extrudes a flat, two-dimensional element into the third dimension. After clicking this menu item, a dialogue opens, where several options can be chosen which influence the extrusion result:
 - Extrusion axis – specifies along which axis the extrusion has to take place, this is done always parallel to one of the three axes X, Y or Z so that it is recommended to align and position the element properly before this function is called
 - Extrusion direction – specifies the extrusion direction (up or down, left or right, in our out)
 - Distance – in normal extrusion mode (3D mesh option not selected) this operation is performed by duplicating the element and by placing the duplicates close to the original. This value can be used to choose the distance between all these copies, the smaller is it, the more closed the resulting geometry is
 - Extrusion length – specifies the total extrusion depth, means how much the element shall grow into the selected direction
 - Create 3D mesh – then this option is set, the “Distance” parameter is no longer used. Here instead of a normal primary element a 3D Mesh is created which is part of a slice group (please refer to related sections below) and which can be used to modify existing 3D meshes
- Boolean add / Boolean subtract / Boolean intersect – these functions perform boolean operations with selected primary elements. For such an operation at least two elements need to be selected. But in general several primary elements can be selected to perform one of these operations with.

The “add” function concatenates the elements to form one single, closed polygon out of them. Overlapping parts will result in one closed shape afterwards.

With the “subtract” function that element which is selected as second is used to cut from the shape of the first one. For this operation it is recommended to always use exactly two elements as the results may be confusing elsewhere.

The “intersect” function finds and returns these parts, where the selected polygons overlap each other.

- Project onto ground – this function is part of the possibility to have a 3D working area surface (as described in section “5.7.1.3 Drawing Area with 3D surface ”). It changes all selected geometries in Z-direction in a way, so that they are located on the ground surface
- Delete Element(s) – deletes the selected element(s)

5.9 Vision

RepliMark provides an integrated Vision system for automatic adjustment and correction of marking data. Using this vision system special markers – so called fiducials – can be taught. Later the Vision system is able to recognise such a fiducial on a working piece and adjust position and rotation of the current marking data according to the fiducials measured position. Vision functions can be found in menu “Edit” submenu “Vision” and in mark dialogue.

To use the vision system it is mandatory to connect a camera and to configure a Video Controller in hardware settings. This enables the Vision menu entries and functionalities.

5.9.1 Vision Functions

Menu Vision → Start Video

When image capture is configured to be started manually this menu item can be used to start (menu item checked) and stop capturing (menu item unchecked)

Menu Vision → Freeze Video:

As soon as a Video Controller is configured, a live image is shown in background of the working area. This image changes permanently and can be freezed using this menu. This is a toggle menu, selecting it turns freeze mode on, selecting it a second time turns this mode off and enables the live-image again.

Menu Vision → False Colours:

In some cases captured images have a very low contrast in desired parts of the image. In such cases the shown image and the required details can be improved and made more visible by false colours. The submenu below of this menu item offers several false colour modes that can be used for this

Menu Vision → Calibrate Camera:

This functionality can be used to calibrate a camera and to adjust and correct distortions caused by the lens of the camera. When selecting this menu item, a calibration dialogue opens. For camera calibration following steps have to be performed:

1. A black/white checkerboard has to be placed in cameras view. Such a board can be found e.g. at <http://halaser.systems/checkerboard.png>. Here the board must be visible in cameras live image fully, none off the squares have to be cut.
2. The camera calibration dialogue has to be opened and the boards parameters have to be entered: here the number of crossing points between squares (the chessboards inner corners, not the number of squares itself!) have to be entered for horizontal and vertical direction.
3. The button “Try calibration” has to be pressed. It starts a calibration run where the checkerboards inner corners are searched. If this is successful, all these crossing points are marked by blue circles and the “OK”-button of the dialogue is enabled.
4. The dialogue has to be left with “OK” in order to take over the calibration data. Now they can be saved by selecting menu “Project” → “Save as default configuration”.

Menu Vision → Crop Camera:

Here it is possible to clip the camera image, means to cut the borders of the captured image to limit the view to these parts, that are really needed. After selecting this menu item a dialogue opens where the horizontal and vertical crop values can be set – the result is shown via a preview, that contains blue lines marking the new borders of the image. Cropping of an image takes place after a (possible existing) calibration was applied.

Menu Vision → Drop Calibration:

The current calibration data are dropped, afterwards the shown camera image is uncalibrated

Menu Vision → Teach Fiducial

Here one or more fiducials can be taught that have to be recognised later. This can be done in fiducial teaching dialogue which opens after selecting this menu item.

This dialogue shows the current – probably calibrated – image. There an area can be marked by drawing a rectangle directly into that image. After releasing the left mouse button a fiducial detection is performed within that area. The result of this operation is a list of keypoints which are marked by circles within the image and listed on the dialogues left hand side. Now within that list all these keypoints have to be removed (by pressing the “Delete” key or by using the related button) that do not belong to a fiducial (e.g. because marking of the area within the image was inaccurate or because they are located between desired positions when more than one fiducial is marked). During all that time a fiducial detection is performed with the same image to get a rough recognition quality value. This value is shown on lower left side of the dialogue. It should be as close as possible to 100%. When too much keypoints are removed, this values decreases – and the expected detection accuracy decreases as well.

This process of selecting image-areas that are of interest for the detection can be repeated several times, each time an area is selected, the resulting data are added to the list of keypoints. This way it is possible to mark several, non-rectangular areas within an image.

As soon as this dialogue is left by pressing the “OK”-button, the fiducials are taught and can be used. These fiducials can be saved in a separate file and can be loaded as needed with the following menu items.

Menu Vision → Load Fiducial

This menu can be used to load an already existing, saved fiducial definition. Currently used fiducial(s) is/are replaced by this function.

Menu Vision → Save Fiducial

This menu can be used to save the current fiducial definitions for later usage.

Menu Vision → Drop Fiducial

The current fiducial definitions are dropped, no more fiducial recognition is possible until new fiducial(s) is/are taught or loaded.

As soon as there is a fiducial definition active and valid, it is used for marking operations. When the marking dialogue is opened, a fiducial recognition is performed automatically. When the fiducial(s) can be detected in current live image, the orientation and position of the actual marking project is changed according to the fiducial(s) orientation and position. This procedure is repeated after every marking process automatically. Additionally it can be triggered again in mark dialogue by pressing button “Auto”, it starts a new cycle of recognition and correction.

5.9.2 Camera Calibration Cookbook

Sometimes the image shown by a camera may be distorted for different reasons. This may be caused e.g. by the optics of the camera or when it is not mounted 100% parallel to the working area. This may result in a somehow stretched and distorted image. Using camera calibration function this can be adjusted. To get an accurate and exact camera calibration is not an easy thing and may require a lot of trial and also some experience with such systems.

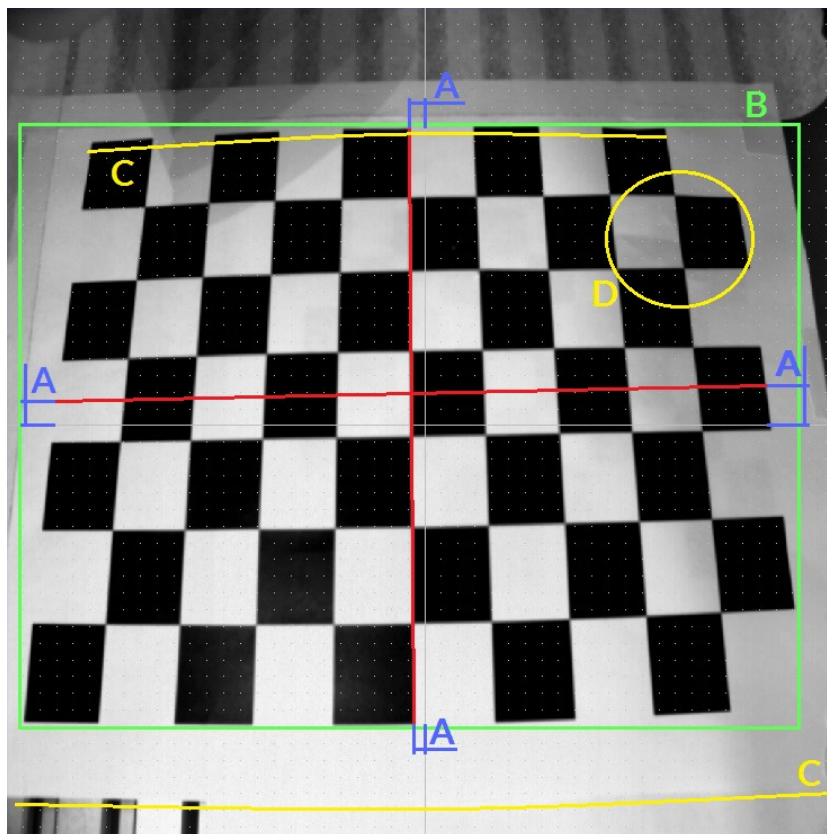
To make this easier, here some steps are described which should help to get an accurate calibration:

1. Print out the calibration template from <http://halaser.eu/checkerboard.png> or – when it does not fit to your visible working area size and aspect ratio – create an own one consisting of black and white squares. For printing an as thick as possible paper should be used so that it can be placed on the

working area without being bent, warped or folded. If necessary stick the checker board on a flat sheet of metal or an other stable material.

2. Use a camera with a high resolution. The checker board from the calibration template should be visible very clear.
3. Adjust the camera parameters in RepliMarks hardware settings. First of all a monochrome image should be used. The vision system does not make use of colours and would convert the image to monochrome representation in every case. So enable greyscale mode in camera plug-in and check the points 1) and 2) again. Next it is recommended to use the native hardware resolution of the camera and to avoid to scale the image to a different size. Also keep the native aspect ratio of the camera.
4. Place the checker board template in cameras view, it should be located exactly centred, parallel to the borders of the camera, it should fit to the whole visible area completely. Beside of that it should not be bent.
5. Go into camera calibration dialogue, enter the number of visible checker board cross points and try a calibration.
6. Now crossing points all should be marked with a circle. When some crossing points of the checker board do not contain such a circle or when at least one of them does not fit to the real position of the crossing point exactly, the calibration recognition has failed. In this case you should adjust lighting of the calibration template as well as brightness and contrast settings until all crossing points can be detected exactly.
7. Now you can leave the camera calibration dialogue by pressing "OK" and you should be able to see a corrected camera image.

Following image shows some typical mistakes that would lead to a camera correction that damages the resulting image instead of correcting it:



A (blue) – the checker board is not aligned properly, it is rotated and shifted. Here the red lines mark where the crosshair from RepliMarks working area should be located at really. The calibration template in this image is shifted to the left, to top and rotated to left. Since camera calibration system does not know this is the template only, it will assume this is caused by the camera and will try to compensate it.

B (green) – marks where the visible area of the camera really should end and how the calibration template should cover the cameras visible field. If necessary, an own checker board has to be created that has the required aspect ratio and that contains the required amount of squares. The more squares that are visible, the more exact the calibration becomes.

C (yellow) – here the calibration template is bent, it is not placed flat on and parallel to the working area. Here the camera calibration function will also try to compensate this bent part of the image – which will result in an overcompensated image since the real working area is not bent in the same way.

D (yellow) – the calibration template is folded. The calibration function will try to compensate this damage too (which is in template only but not a camera-caused distortion).

5.9.3 Fiducial Calibration Cookbook

To get a vision system with a fiducial recognition that is working well and that produces exact results is not an easy thing and requires a lot of adjustment and experience. As a starting point and to get some basic information to make own experiences with, following some hints are given to get better results. The steps listed below should be performed as accurate as possible:

1. Use a camera with a high resolution. The fiducial(s) should be visible very clear and quite large so that all relevant details of it/them can be seen in cameras image.
2. Adjust the lighting. As first step a working piece should be placed in cameras view. Now adjust the light so that the fiducial(s) on that working piece can be seen clear and has/have a good contrast comparing to its underground and comparing to other markers on this working piece. Think about using coloured light which could result in better contrast between fiducial and background.
3. Adjust the camera parameters in RepliMarks hardware settings. First of all a monochrome image should be used. The vision system does not make use of colours and would convert the image to monochrome representation in every case. So enable grayscale mode in camera plug-in and check the points 1) and 2) again. Next it is recommended to use the native hardware resolution of the camera and to avoid to scale the image to a different size.
4. Calibrate the camera as described above. Please note: in case your camera has a really good lens, does not distort the image and is mounted parallel and on top above the working area, this step should be dropped. The camera calibration always results in a loss of information and quality and therefore should be avoided when possible. Nevertheless: a lens distortion is much more worse than this loss of information, so this should be dropped only in case of a really good camera!
5. Teach the fiducials as described above. It is not possible to make any forecast which of the fiducial recognition keypoints has which influence on the recognition result. Thus several iterations are necessary here: select the fiducial(s) in teach dialogue, remove the unused keypoints, accept the result and try recognition with a changed position of the working piece. And depending on the results: start from the beginning with fiducial selection and keypoint removal.

5.10 Processing Operation

To manipulate a loaded project related to the processing operation several functions can be found in menu “Process” of the main window:

- Simulate – a full process cycle is simulated, means the complete project is updated, all serial numbers, date and time objects are triggered, the process time of geometries is calculated, delays are measured and movements are (partially) simulated. The resulting total process time is displayed to the user. This time is nearly the same time such a process would need within the target environment. It differs only in case motion elements are used that perform absolute movements, here the real processing time can't be calculated because the starting position of an driven axis is not known.
- Mark: this option requires at least a scanner card to be configured within the global project settings and gives the possibility to start a real marking process instead of simulating it. In case the current project uses motion elements the related motion controllers should be configured too within the

project settings.

After selecting this menu item a marking dialogue opens, for more information about its functionalities please refer below.

- Write Stand Alone Data – this function applies only to these scanner controllers that support the related feature; it gives the possibility to write scanner data to a disk for later usage in stand-alone mode. When this function is used in a multihead-setup (please refer to “5.14 Multihead Operations” for additional information) where all controllers support this function, multiple files are generated. For all additional files, the number of the related head is appended to the file name.
- Send Stand Alone Data – this function applies only to these scanner controllers that support the related feature; it gives the possibility to send unidentifiable scanner data to the controller without starting a mark operation immediately but for later usage in stand-alone mode
- Send Named Stand Alone Data – this function applies only to these scanner controllers that support the related feature; it gives the possibility to send named scanner data to the controller without starting a mark operation immediately but for later usage in stand-alone mode. Comparing to the preceding option this one opens a dialogue where following data can be entered:
 - the name the data are stored with at the scanner controller card and which can be used later to select this specific project in stand-alone mode; the rules this name has to be created with depend on the scanner card
 - an option “Send full data to all cards” which is enabled in multihead mode; when it is set, it can be used to copy the full vector data to all configured controller cards, elsewhere only these data are to every card, which really belong to it according to the multihead marking rules
 - an option “Reset controller after download” which reboots the controller after downloading has been finished; this option can be useful when data have been updated on the controller which are somehow prebuffered and need to be reloaded on boot. This option requires a hardware and plug-in which supports rebooting of the connected device. If no reset-functionality is available for a scanner controller, this function is ignored.
- Show State – this option shows different scanner controller state information; which information are shown depends on the used scanner card and its capabilities but it may consist of
 - digital output data (reflects the data that have been sent to the output but not necessarily the data that really are set as long as the card does not support readback of these outputs)
 - digital input data
 - analogue input data
 - plug-in information
 - scanhead information
- Increment – all serial number elements of the current project are incremented, the date and time elements are updated
- Decrement – all serial number elements of the current project are decremented, the date and time elements are updated
- Reset – all serial number elements of the current project are reset to its starting value, the date and time elements are updated

5.11 Marking

The mark dialogue can be opened via menu “Process” menu item “Mark”. When this dialogue is opened for the first time or in case the hardware settings have been changed after it was used the last time, as first operation the scanner controller cards and the – optionally configured – motion devices are opened. Motion axes that are configured to reference on start-up are moved to its reference/home position. All these operations may take some time dependent on the connected hardware.

In case this could be completed successfully, the dialogues mark-buttons can be used afterwards. It provides a button for starting the pilot laser (requires fully configured pilot laser outputs in project settings) on the left side of the dialogue, a mark-button in the middle that starts the main laser and a stop-button on the right side that stops the main or pilot laser. Below of them some options can be found that influence the marking operation:

- Mark repeatedly – starts an infinite loop, as soon as the mark-button is pressed the current geometry is marked again and again until the stop-button is pressed
- Fast repeat – this check box becomes active only if a) “Mark repeatedly” is set and b) all used scanner controller cards within the current configuration support this function. When it is set, it gives the possibility to have a very fast loop without any delay between end of previous and begin of current mark cycle. This function buffers several mark-cycles on the scanner controller card in advance and is intended to be used with short projects which have to be marked very fast after each other (e.g. when marking of these projects is started by external triggers following in short time distances after each other).
- Mark selected elements – when this option is set only these parts of a project are marked that are selected within the Entity-Tree and highlighted within the drawing area
- Wait for external trigger – using this option marking is started only under two conditions: first the start-button is pressed, next an external trigger signal is applied. Together with the “mark repeatedly” function this can be used to start marking via an external hardware signal and no longer by pressing the start-button repeatedly.
- Suppress MOTF – in case of marking on-the-fly applications a project may be designed in a way where the external trigger signal is mandatory, elsewhere the project will not work. But exactly this behaviour which is wanted during normal operation, can be a problem when a project is adjusted as it will not work and not show what is marked. So checking this option, marking on-the-fly functionalities are inhibited so that a project is marked also without external encoder pulses being available. This mode is for testing a project only, and of course it will damage the layout when it is designed in a way where it does not fit to the working area completely. Nevertheless with this option temporarily unwanted MOTF-functions can be turned on and of fast and easy

Additional marking-related functionalities are arranged in separate tab-panes that are grouped according to the functionality they contain. tab-pane “Pilot Laser” contains functions for accessing the preview/pilot-laser that can be started by the upper left mark button:

- Mode – this combo box gives the possibility to choose the pilot laser marking mode, “Off” disables usage of the pilot laser “Manual” expects that the user starts the pilot laser manually by pressing the big pilot-laser-button on the windows upper left hand side and “Auto” re-starts the pilot laser after every marking process automatically. Also in mode “Auto” the pilot laser has to be started manually for the first time because of security reasons.
- The radio buttons below this combo box can be chosen to select what the pilot laser shall show in its preview, “Use total projects outline” draws a simple rectangle that includes the whole project, “Use individual elements outline” draws a simple rectangle for every element within the current project (except dots, lines and triangles which are shown fully) and “Use real element shapes” draws the full shape of all elements except hatches.
The pen – and therefore the related speed and delay values – that is used for the pilot laser can be defined within the pen settings dialogue (please refer above).

Tab panel “Manual” offers direct access to the position of scanhead. Here mirrors can be moved to a specific position:

- In upper combobox the scanhead can be chosen this operation has to be performed on (valid only for multihead configurations, elsewhere “Scanhead 1” has to be used
- four arrows give the possibility to move the scanner position in positive and negative X- and Y-direction; the input field between these arrows specifies the jump length every button press has to cause; pressing these buttons lets the scanner jump immediately
- In fields “X” and “Y” coordinates can be selected the scanner has to be moved to, by pressing button “Jump” motion to these positions is started
- The button with the camera symbol in upper right corner of this tab-pane gives the possibility to toggle a live-background image (in case an image capture device is available and it is configured to be shown within the drawing area). On weak computer systems this function can be useful to turn this live view on only as long as it is needed to not to slow down or disturb the main marking process.
- Below of the camera-button there is a small pilot-laser-button which gives the possibility to turn on and off the pilot laser (only available in case a pilot output is configured in hardware settings).

Together with the coordinate buttons it can be used e.g. for referencing purposes – when the pilot laser permanently points to a fixed, defined position which also can be changed as needed.

In tab panel Geometry the current projects vector data can be manipulated:

- Arrows left/right/up/down – using these arrows the whole geometry of the project can be shifted into the given direction (in top view for 3D mode); the shift step size in unit mm is taken out of the input field below of these arrows
- Arrows rotation left/right – using these arrows the whole geometry of the project can be rotated into the given direction (in top view for 3D mode); the rotation step size in unit degrees is taken out of the input field below of these arrows
- Button Auto – this button can be used only when a live image is captured and when fiducials are taught using the integrated vision system, it tries to detect the taught fiducials in current image and aligns and rotates the current geometry automatically according to the position and orientation of these fiducials
- Button Reset – when this button is pressed all changes in position and rotation of the current projects geometry are taken back, it is reset to its default values

In tab panel Motion it is possible to drive configured motion axes manually and independent from any motion elements in marking project. Please note: when there are some marking elements used directly within the project, it has to be taken into account that the user may have changed the position of the axes via these manual functions. Thus at least the first motion element should perform a movement to an absolute position or should reference its position. Within the mark dialogue following motion functions are available:

- OUT2 / OUT3 – specifies which of the two possible motion controllers has to be used
- Speed – specifies the speed a manual motion operation can be performed with;
PLEASE NOTE: when the speed value given here is bigger than the maximum speed of the related axis, this value is clipped internally, means the axis moves with it's maximum speed which may be slower than the nominal speed entered here
- Camera – this button can be used to toggle the background image on and of in case manual image capture enabling is configured within project settings; this button has the same functionality like the related vision menu item
- movement value – the value that can be entered in middle between the arrows specifies the relative movement distance or the absolute motion position to move to (depending on the arrow button that was pressed)
- Double arrows – these buttons cause a movement as long as the button is pressed
- Single arrows – these buttons cause a single movement via the distance or angle specified with the number input field in the middle, here the time the button is pressed does not influence the motion
- Arrow to dot – when this button is pressed an absolute movement is performed, the number input field in the middle between the buttons specifies the target position to move to, the time the button is pressed does not influence the motion
- Ref – start referencing of the related axis

For planar movement axes the images of the buttons can be changed within the motion axis configuration panel of the general project settings. Depending on the real movement direction (left/right, up/down, in/out) a different symbol can be shown here in order to make it easier for the operator to decide which direction a motion will use. The same is true for the axis names, they can be configured via the axis alias value in general project settings.

The third tab panel Parts is related to parts and part counting, some of its buttons and functionalities will be enabled only when part counting is enabled for the current project (can be done in general project settings dialogue). It offers the following functions:

- When part counting mode is enabled the large counter shows the current number of parts already marked. When the limit specified in project settings or in input field “To produce” is reached, no more marking operations are possible until the user presses button “Reset Counter”
- The “Serial numbers” buttons can be used to change the state of all input elements of the current project for the next part to be marked, here “Increment” increments all of them by one, “Decrement”

decrements them by one step and "Reset" sets them back to their start value. This is the same functionality like it is accessible from within menu "Process".

The tab panel "Progress" shows some information regarding the current marking progress, its functionality is limited to some specific applications. First of all it is feed with timing and operational data only when sliced 3D marking data are processed. Next it will not show the real marking state of the connected controller but only the state of data sent to the scanner card. So when a scanner controller card with a large buffer is used, it may hold some none-processed data while for this progress bar they are already finished. So this progress information is mainly suitable for long-running processes (where relative deviation between mark-dialogue-estimated and real marking time is quite small) but not for getting a process forecast for fast marking operations. For last case it is still recommended to use the function "Simulate" in menu "Process".

5.12 Switching the Laser

Beside the possibility to mark the geometries of the current project, there is also an option to turn on and off the laser for a longer time without moving the scanner. This function is useful e.g. for measuring the laser output or for calibration tasks and can be found in menu "Process" menu item "Toggle laser".

This opens a mark-dialogue-like window which contains a big yellow "Laser"-button to turn on the laser and a red "Stop"-button to turn it off.

PLEASE NOTE: when pressing the Start-button, the laser is turned on immediately, so it will fire independent fro many geometry or delays or input signals which may be defined in the current project! So this button switches the laser on directly and without respecting any precondition which may be defined in current project! Thus all security measures have to be active as soon as this dialogue is opened and prior to pressing the Start-button!

Beside start and stop this dialogue offers the following functions:

- - Head – here the head (aka controller card) can be selected for which the laser has to be turned on
- Pen – with this combo box a pen can be chosen. The parameters of this pen (e.g. frequency, power, pulse-width) are used to drive the laser with as soon as the Start-button is pressed
- Edit – by pressing this button the pen settings dialogue is opened which allows it to modify the currently selected pen and resulting from this the parameters the laser is driven with when turned on via this dialogue

5.13 Exporting Data

To use the created data on the target system for processing work pieces they have to be stored in a usable format. Here following possibilities exist:

RepliMark ".BEAMP" project files:

This is the project file format of RepliMark, here all information about used elements and sub-elements, modified geometry, scanner and laser parameters are contained, no information are lost when this format is used.

CSV format:

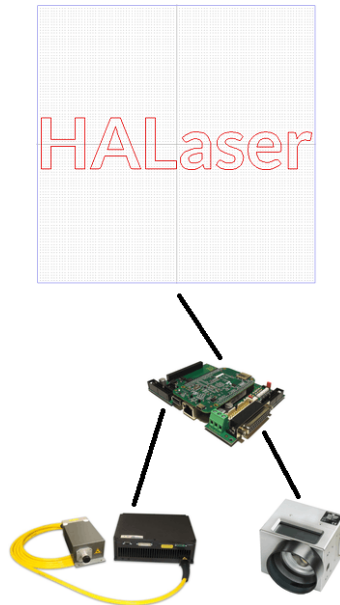
The "comma separated values" format is more a simple list of parameters that are comma-separated. This format includes all geometry and some pen information. Here no dynamic information are contained, only static geometry can be marked when this format is used.

HPGL format:

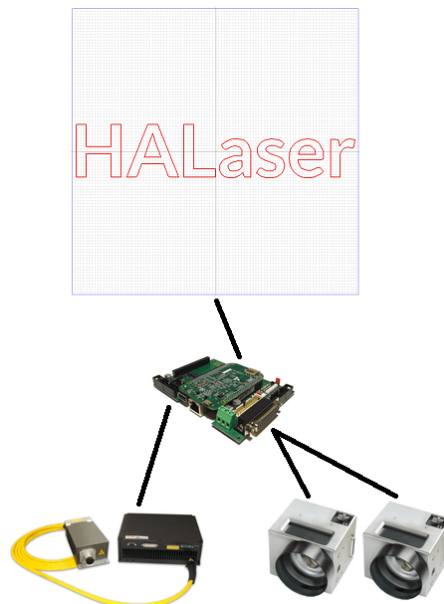
This is a vector graphics format that contains only geometry information, the pen (and thus the processing data) are not part of this format. So it should be used for data exchange with other applications only. This format can be used with the HPGL to Control plug-in. Because of the missing pen information they have to be entered within the plug-ins settings manually. Here no dynamic information are contained, only static geometry can be marked when this format is used.

5.14 Multihead Operations

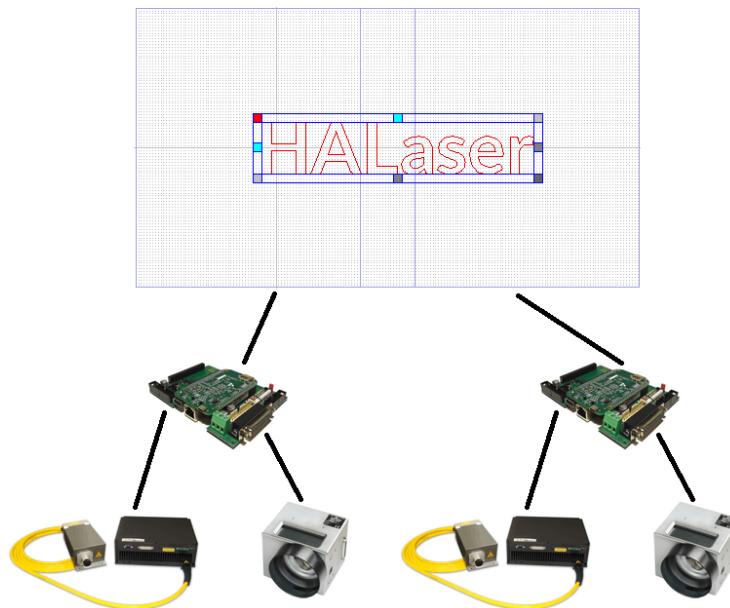
In many cases RepliMark will use one scanner card that uses exactly one rectangular working area. In this configuration there will be one scan head performing movements for this working area:



In some special cases this so called singlehead operation mode can make use of a second (and optionally third, fourth,...) working area and a second scan head where both heads perform the same movement. This mode is often called "secondary head", it simply doubles the output but does not allow to mark different, independent geometries with these two heads:



Full independence of all used heads is possible only with a real multihead mode. In this mode RepliMark knows about more working areas that can overlap each other or that can exist beside each other. But all these working areas are completely independent, every area is assigned to an own scan head that performs separate movements:



This multihead mode can be used to:

- mark geometries that are larger than a single working area (in this case it is recommended to let the working areas overlap a bit to profit from vector data optimisations RepliMark performs automatically)
- mark large, complex geometries faster (in this case big overlapping areas have to be configured to let both heads work on same area in parallel)
- mark independent geometries faster (in this case working areas do not need to overlap each other)

In last case it is recommended to use scan heads with the same performance and lasers with same power, elsewhere it may happen one marking area slows down the full marking process.

In first two cases different lasers and scan heads can be used but it is recommended to have the more powerful lasers and the faster scan heads configured at the first position.

Setting up of a multihead configuration is quite easy and can be done in general project settings (please refer to detailed description of settings above). There in tab-pane “Hardware” two combo boxes can be found. One is for selecting a scanner controller and one for selecting a scan head. Both can be separate things but don't have to, this depends on the used scanner controller / the used scanner controller plug-in. The difference between both:

- the scanner controller is a piece of hardware / a plug-in that accesses this scanner controller device, where more than one scan head can be connected to.
- the scan head is assigned to a single working area and a single laser that is used for this working area, it is possible to have more than one scan head connected to a scanner controller.

In many cases there will be a 1:1 relation where scanner controller selection is equal to scan head selection, but in case one scanner controller plug-in is able to control more scan heads independently, this separation between “controller” and “head” is necessary.

The same can be found in pen settings (please refer to description above). There the scan head can be selected, means different pen parameters can be set for every working area – independent from the fact which scanner controller plug-in really controls this head.

To configure a multihead-environment, following steps have to be done in global settings of RepliMark:

- go to scanner-settings
- in upper combobox select the first scanhead (which is default)
- below of it choose a scanner controller card and configure it, optionally change the field left and top position within the scanner controller card's settings
- select the second scanhead in the combobox on top of the scanner settings tab-pane in global settings
- choose a scanner controller card and configure it → this step now creates a new working area which is assigned to this second scanner controller card and the laser and scanhead it is connected with, so in configuration of this scanner controller the field left and upper size have to be set to appropriate values in order to overlap or to not to be connected with the working field from the first scanner controller card; as soon as a second scanhead/scanner card is configured, RepliMark is in multihead-mode automatically
- optionally continue this procedure with a third, fourth, fifth,... scanner controller card and related lasers/scanheads/working fields
- optionally go to tab-pane "Multihead" within project configuration dialogue to configure a specific, preferred behaviour for each of the scanheads created in previous step

5.15 IOSelect Mode

Normally a project can be loaded by using the related menu item and by selecting the path and name of the project file manually. This can be automated, using IOSelect mode it is possible to read the state of digital input port of a connected scanner controller and to use the value received from there to automatically load a project file. When this mode is enabled, marking dialogue is opened and the state of the used digital input port changes, a new project is loaded and can be processed during next marking operation. In case the input state changes when a marking process is still running, loading of the new project is performed as soon as the current marking cycle was finished. To set-up IOSelect mode following steps are necessary:

1. create a subdirectory that will hold all the project files
2. create the project files that have to be loaded, here the filename has to consist of a number followed by the file extension ".beamp". The number has to correspond to the bitpattern detected on digital input. So when bit 0 of an input is set, a file "1.beamp" would be loaded. When all bits of an 8-bit digital input are set, a file "255.beamp" would be loaded. When no bits of a digital input are set, a file "0.beamp" would be loaded - nevertheless it is not recommended to use this file name in order to have a neutral state with no active marking data. All these files have to be placed into directory created in previous step.
3. go to project settings, enable IOSelect-mode in "Misc" panel, specify the directory created above and select the digital input that has to be used for reading the input state. This step requires a scanner controller card configured properly.
4. Select menu "Process" -> "Mark" to activate automatic IOSelect and to start marking operations

Following things have to be noticed:

- when the digital input provides an input pattern for a file name where no corresponding project file exists, current project is flushed so that there are no marking data available
- loading a project automatically does not overwrite the current hardware settings, so all project parameters found in loaded file are ignored and current settings are kept
- in IOSelect mode marking is not controlled by external trigger automatically, to do that all the numbered projects stored in IOSelect-directory have to start with an External Trigger Primary Element and mark-loop option has to be set in Mark-dialogue
- in multihead-environments currently only card 1 can be used to select a project via digital inputs

- IOSelect-mode is started only after mark-dialogue was opened; during switch to an other project mark-dialogue is closed and re-opens automatically afterwards

5.16 Command line options

RepliMark either can be started as is, then it opens the default view. Beside of that it is possible to hand over some parameters which all are optional. For Windows such a call with additional command line parameters looks like this:

```
RepliMark.exe f:/path/to/project.beamp -o mode
```

For Linux such a call would look like this:

```
RepliMark.exe /path/to/project.beamp -o mode
```

When a path to a valid BEAMP-project file is handed over, this project is loaded on start-up and shown as default project file.

When the optional parameter `-o` is handed over, a specific working mode can be defined which influences what operation(s) RepliMark performs directly after start-up. Here mode can have the following values:

- 1 – this mode requires a project file to be loaded, it immediately starts a single marking operation with this file and then exits the complete application
- 2 – when this mode is selected, the “Mark repeatedly”-checkbox in Mark-dialogue is set and disabled so that a user can perform only looped operations and no single marking cycles. Such a looped operation the needs to be interrupted by pressing the Stop-button
- 3 – in this mode the Mark-dialogue is opened after start-up automatically and the “Mark repeatedly” as well as the “Wait for external trigger” checkboxes are set. For this mode it also is recommended to define a project file to be loaded automatically, elsewhere the user would not have anything to mark

5.17 Customise RepliMark

5.17.1 Rebranding

RepliMark can be modified in a way so that it can be delivered together with machinery or additional equipment using an own brand. Here following attributes can be changed:

- the applications name, this value replaces the name RepliMark completely
- the homepage which is shown in “About”-dialogue
- the splash image shown during application start-up and in “About”-dialogue
- the application icon shown in taskbar and main window (not supported on all operating systems)
- the copyright as shown in “About”-dialogue; this custom copyright does not replace the default one but is added to it
- the images shown in toolbar and entity-tree
- the menu items which are visible to the end user

To customise the application, different things can be done, which are optional each:

A plain text file with the name `replisls.oem` has to be created in UTF-8 format. To become active, it has to be placed in installation directory of the application for Windows operating systems (typically `C:\Program Files\RepliSLS3D`) or in `/usr/local/openapc` for Linux systems. Within this file every single line contains one customisation definition:

1. the name of the application

2. the homepage URL to be shown in “About”-dialogue
3. path to the splash image in PNG format
4. path to the icon image in PNG format
5. copyright text to be shown in “About”-dialogue

As an example:

```
Beamy Raymanipulator
https://replimark.replisls3d.com
beamoem.png
beamoem_icon.png
Copyright (c) 2021 by LaserFreak
```

This file (in UTF-8 encoding) placed within the directory described above renames RepliMark to “Beamy Raymanipulator”, shows <https://replimark.replisls3d.com> within the “About”-dialogue (instead of <https://halaser.eu>) as well as the additional copyright information. As splash image for the startup-screen the image out of file `beamoem.png` is used. When this file name is given without an absolute path, the application tries to find it in installation directory (Windows) or in directory `/usr/local/openapc` (Linux). The same is true for `beamoem_icon.png` which is used as image for the applications icon.

5.17.2 In-application images

The images that are shown within toolbar and entity tree can be replaced by own ones too. Here two different methods have to be used to replace all of them.

To replace the toolbar- and entity-tree images, alternative images in PNG-format have to be put into the plug-ins location but with different names. The base name is always the name of the plug-in without extension. For the toolbar image a “1.png” has to be added to this base name, for the entity-tree image a “2.png” has to be added. As an example: The images of the barcode plug-in have to be replaced. It can be found in folder “priplugins” with the file name “libio_pri_barcode.dll” or “libio_pri_barcode.so”. Here two images “libio_pri_barcode1.png” with a size of 23x23 pixels and “libio_pri_barcode2.png” with a size of 15x15 pixels have to be put into the same folder. After next software start the barcode appears with the new images.

To replace all other images PNG files with special names have to be placed in folder “icons”:

- “newprj.png” for the “New”-symbol (23x23 pixels)
- “openprj.png” for the “Load project”-symbol (23x23 pixels)
- “saveprj.png” for the “Save project”-symbol (23x23 pixels)
- “saveprjas.png” for the “Save project as”-symbol (23x23 pixels)
- “quit.png” for the “Quit application”-symbol (23x23 pixels)
- “zoomin.png” for the “Zoom in”-symbol (23x23 pixels)
- “zoomout.png” for the “Zoom out”-symbol (23x23 pixels)
- “zoomworkarea.png” for the “Zoom full editing area”-symbol (23x23 pixels, for compatibility reasons the name of the image contains “work” but not “editing”)
- “zoomselected.png” for the “Zoom selected entity”-symbol (23x23 pixels)
- “pointdrag.png” for the “Point drag mode”-symbol (23x23 pixels)
- “drawdir.png” for the “Show marking direction”-symbol (23x23 pixels)
- “openmarkdlg.png” for the symbol to open the mark dialogue (23x23 pixels)
- “undo.png” for the “Undo”-symbol in right hand side, vertical toolbar (25x25 pixels)
- “redo.png” for the “Redo”-symbol in right hand side, vertical toolbar (25x25 pixels)

- “group.png” for the “Group”-symbol in right hand side, vertical toolbar (25x25 pixels)
- “ungroup.png” for the “UnGroup”-symbol in right hand side, vertical toolbar (25x25 pixels)
- “alignleft.png” for the “Align left”-symbol in right hand side, vertical toolbar (25x25 pixels)
- “centrehoriz.png” for the “Centre horizontal”-symbol in right hand side, vertical toolbar (25x25 pixels)
- “mirrorx.png” for the “Mirror horizontal”-symbol in right hand side, vertical toolbar (25x25 pixels)
- “mirrory.png” for the “Mirror vertical”-symbol in right hand side, vertical toolbar (25x25 pixels)
- “alignright.png” for the “Align right”-symbol in right hand side, vertical toolbar (25x25 pixels)
- “aligntop.png” for the “Align top”-symbol in right hand side, vertical toolbar (25x25 pixels)
- “centrevert.png” for the “Centre vertical”-symbol in right hand side, vertical toolbar (25x25 pixels)
- “alignbot.png” for the “Align bottom”-symbol in right hand side, vertical toolbar (25x25 pixels)
- “booladd.png” for the “Boolean add”-symbol in right hand side, vertical toolbar (25x25 pixels)
- “boolsub.png” for the “Boolean subtract”-symbol in right hand side, vertical toolbar (25x25 pixels)
- “boolinter.png” for the “Boolean intersect”-symbol in right hand side, vertical toolbar (25x25 pixels)

- “dlgmark_pilot.png” for the pilot laser symbol in mark dialogue (113x113 pixels)
- “dlgmark_mark.png” for the mark-start symbol in mark dialogue (113x113 pixels)
- “dlgmark_stop.png” for the stop button symbol in mark dialogue (113x113 pixels)
- “penwizard.png” for the pen parameter wizard button in pen settings dialogue (55x55 pixels)
- “rotate_move_left_xpm.png”, “rotate_step_left_xpm.png”, “rotate_step_right_xpm.png”, “rotate_move_right_xpm.png” and “rotate_to.png” for rotational movement buttons in “Motion” tab-pane and mark dialogue (17x17 pixels)
- “arrow_move_down_xpm.png”, “arrow_step_down_xpm.png”, “arrow_step_up_xpm.png”, “arrow_move_up_xpm.png” and “vertical_to.png” for planar, vertically oriented movement buttons in “Motion” tab-pane and mark dialogue (17x17 pixels)
- “arrow_move_out_xpm.png”, “arrow_step_out_xpm.png”, “arrow_step_in_xpm.png”, “arrow_move_in_xpm.png” and “longit_to.png” for planar, longitudinally oriented movement buttons in “Motion” tab-pane and mark dialogue (17x17 pixels)
- “arrow_move_left_xpm.png”, “arrow_step_left_xpm.png”, “arrow_step_right_xpm.png”, “arrow_move_right_xpm.png” and “horiz_to.png” for planar, horizontally oriented movement buttons in “Motion” tab-pane and mark dialogue (17x17 pixels)

5.17.3 Custom menus and functions

To hide specific menu items from RepliMark main window, a plain text file with the name `beammenu.oem` has to be created. To become active, it has to be placed in installation directory of the application for Windows operating systems (typically `C:\Program Files\HALsoftware`) or in `/usr/local/openapc` for Linux systems. This text file contains one number for each menu item which has to be disabled. Every number has to be placed in a new line. Following numbers exist and disable the menu items as described below (lists are ordered in appearance of menu items).

For menu “Project”:

- 1001 – New project
- 1002 – Open project
- 1013 – Insert Project...
- 1003 – Import...
- 1004 – Save project
- 1005 – Save project as...
- 1010 – Save with options...
- 1101 – Export CSV
- 1102 – Export HPGL

- 1103 – Export CLI
- 1104 – Export RWX
- 1006 – Project settings...
- 1007 – Pen settings...
- 1008 – Save as default configuration
- 1009 – Load default configuration
- 1018 – Machine settings...

For menu “Edit”:

- 2101 – Group
- 2102 – Group to Active Split
- 2103 – Group to Active Move
- 2104 – UnGroup
- 2105 – Duplicate
- 2106 – Align left
- 2107 – Centre horizontally
- 2108 – Align right
- 2109 – Align top
- 2110 – Centre vertically
- 2111 – Align bottom
- 2112 – Group to Active Rotational Split
- 2201 – Merge
- 2202 – Split
- 2203 – Optimise
- 2204 – Reduce Geometry
- 2206 – Delete Element(s)
- 2207 – Boolean add
- 2208 – Boolean subtract
- 2209 – Boolean intersect
- 2210 – Project to ground
- 2308 – Start Video
- 2301 – Freeze Video
- 2302 – Calibrate Camera
- 2309 – Crop Camera
- 2307 – Drop Calibration
- 2303 – Teach Fiducial
- 2304 – Load Fiducial
- 2305 – Save Fiducial
- 2306 – Drop Fiducial
- 2001 – Undo
- 2002 – Redo
- 2901 – the complete “Vision” submenu including “False colours”
- 2902 – the complete “False colours” submenu

For menu “Process”:

- 3001 – Simulate
- 3002 – Mark
- 3005 – Write Stand Alone Data
- 3009 – Send Stand Alone Data
- 3010 – Send Named Stand Alone Data
- 3013 – Show State
- 3006 – Increment
- 3007 – Decrement
- 3008 – Reset

For menu “Help”:

- 4002 – License
- 4003 – Reset License

- 4006 – Generate bugreport
- 4007 – Adjust projection
- 4004 – Credits

As an example: a file `beammenu.oem` with following contents:

```
1013
2102
2103
3001
```

would hide the following menu items from the main window so that they can't be used any longer:

- menu "Project", menu item "Insert project..."
- menu "Edit", menu items "Group to Active Split" and "Group to Active Move"
- menu "Process", menu item "Simulate"

5.17.4 Custom geometries

By default, RepliMark comes with a set of geometric elements which can be accessed via the toolbar. Here all base elements such as circle, rectangle, triangle, text, barcode and others are contained. These base elements can be extended by own, custom geometries which also are accessible via the toolbar. When set up properly, the elements appear as sub-tool within a new toolbar entry. Once the related element was selected, it can be placed as static geometry (which can be hatched, scaled rotated,... like any other geometry) within the drawing view.

To set up such a custom geometry tool, following steps have to be performed

1. draw the desired geometry within the drawing view; to let it be usable with the hatching additional element, please ensure the geometry form a closed polygon with no holes in the outline
2. place the whole geometry in a proper way around the coordinate position 0,0; this coordinate position will be the centre point of the geometry later
3. go to menu "Export as" → "HPGL" and save the geometry within the installation directory of the main application and within a subfolder "templates" (so for Windows the location to save the HPGL-file to, probably would be "C:\Program Files\HALsoftware\templates"). The file name of the saved HPGL file should be an English name describing the geometry, the extension has to be .plt
4. create a 25x25 pixel wide PNG file that symbolises the custom geometry and save it in same templates-directory using the sam base name and the extension .plt
5. Optionally: translate the name of the new toolbar element using the custom_xx.property translation file (as described in SDK-manual from https://sourceforge.net/p/oapc/code/ci/master/tree/sdk_manual.pdf section "Localisation")

Now when you restart the application, you find a new toolbar-element which shows a pen. When clicking this pen-symbol, a menu opens where the custom geometry is shown (using the PNG image form the last pen above). After clicking this symbol and after left-clicking within the drawing view, the related geometries are placed within the drawing view at the point where the left-click was done. Here for the new geometry the clicked position is similar to position coordinate 0,0 out of step 2) above.

5.18 RepliServer Remote Control Interface

5.18.1 Overview

RepliMark provides an operation mode where whole application can be remote-controlled. This can be used to do some script-or program-controlled automation or to hide RepliMark while (visually) performing some other tasks in foreground. To do this, a special program is provided: RepliServer. When it is started (RepliServer.exe under Windows, RepliServer when using Linux) instead of RepliMark, a TCP server socket is created using port 11350. Now an external application can connect to this socket and send some specific ASCII-commands. These commands then invoke usage of RepliMark itself. To make that clear: RepliMark does not need to be started in this case, this will be done by RepliServer automatically when related commands are sent.

5.18.2 Usage

A standard sequence of commands sent to RepliServer always looks like this:

1. Start RepliServer with a number as command line parameter specifying which parts of the UI have to be shown
2. Create a TCP-connection to the IP of the computer where RepliSLS3D software package is installed and where RepliServer is running at, connection has to be established to port 11350
3. and following: send several ASCII-commands as described below to control RepliMark

finally: Send

ExitUI

to shut down and close RepliMark and RepliServer

When TCP connection to RepliServer is interrupted somewhere within this sequence, RepliMark is NOT shut down. After re-connecting to RepliServer a controlling application can continue at the point where it has been before interruption. Beside of that only one connection to RepliServer is allowed at the same time.

For testing purposes it is also possible to connect with a normal Telnet-client to RepliServer and to give commands manually. In this case Telnet client has to be used in RAW operational mode (auto-negotiation deactivated).

5.18.3 Starting RepliServer

RepliServer expects a command line parameter specifying which parts of RepliMark UI have to be shown. This parameter is a number. When this number is set to 0, RepliMark acts completely invisible. When it is set to 255, full GUI is shown. Between these numbers it is possible to define some subsets of the GUI to be shown just by adding the following values and giving the result as parameter:

- 1 – show drawing area (the big area in the middle where vector data are drawn)
- 2 – show toolbars (on top of main window where some basic functions and elements are accessible)
- 4 – show left hand side element panels
- 8 – show right hand side element tree
- 16 – show the menu bar with all menu items
- 32 – show the close button in frame of main window
- 64 – show the status bar at bottom of main window

131072 – disables the possibility for the user to exit the application; when this value is enabled, the application can be left via command "ExitUI" only

262144 – disable all possibilities for a user to edit projects or geometries, when this value is set, even dragging, rotating or scaling of elements is no longer possible

524288 – the warning-dialogue on start-up is disabled; this value should be used only very rarely and only when user is already informed what the software does so that there can't be any surprising and therefore dangerous operations

1048576 – applies only to mark-dialogue, when this value is used, the manual scanner control tab-pane in mark-dialogue is not shown

2097152 - applies only to mark-dialogue, this hides the part counter tab-pane

4194304 – applies only to mark-dialogue, it hides the "Motion" tab-pane

8388608 – applies only to mark-dialogue, when this value is set, the "Geometry" tab-pane in mark-dialogue is hidden

16777216 – applies only to mark-dialogue, this hides the pilot laser tab-pane

33554432 – applies only when value 2 (see above) is used and when value 1073741824 (see below) is not set, this option hides the "edit pen" button in "Element" tab pane

67108864 – this centers and locks drawing area (in case it is visible by setting the value 1) so that its positions can't be changed by dragging the mouse; the view can be changed only by sending commands that modify the current zoom

134217728 – applies only when value 2 (see above) is used, it inhibits the possibility to edit single points; when this value is used, the coordinates grid in "Geometry" tab-pane is disabled; it is not necessary to set this value when 262144 (see above) is already set

1073741824 – applies only when value 2 (see above) is used, if it is set, the "Element" panel is not shown

536870912 – applies only when value 2 (see above) is used, this hides the dynamically changing panel with the parameters of the currently selected element

1073741824 – applies only when value 2 (see above) is used, this disables and hides the layers-panel

2147483648 – do not load and use locally stored default settings, the software starts with an (empty) default configuration when this initialisation value is used

As an example: "RepliServer.exe 17" would show RepliMark consisting of drawing area (=1) and menu bar (=16) only

For Windows please note: RepliServer.exe has to be started using HALsoftware installation directory as working directory. To ensure this directory is used, it is recommended to create a shortcut to RepliServer.exe out of the HALsoftware installation directory, this configures the correct directory automatically. Additionally it is possible to set the parameter within the shortcut definitions too. When RepliServer.exe is started using any other directory, it will not work properly and will not be able to use any of the elements and plug-ins.

5.18.4 Remote Control Commands

Every command that is sent to RepliServer via TCP/IP is responded either by a text "OK" when operation was successful or by a text "ERROR" signalling the last command could not be executed successfully. "ERROR" is always followed by two error codes where the first one describes the kind of the error that happened and the second one is an internal error number that may be helpful in case of problems of the RepliServer itself. For first error code following values are possible:

3 – `OAPC_ERROR_DEVICE` – tried to access an external device (scanner controller card, motor controller,...) which was configured for usage but which was not accessible

- 7 – `OAPC_ERROR_RESOURCE` – tried to access a resource that does not exist (e.g. when using UID or name of an element that could not be found)
- 11 – `OAPC_ERROR_NO_MEMORY` – not enough memory available
- 16 – `OAPC_ERROR_INVALID_INPUT` – the data/parameters given within last command are incomplete or wrong
- 18 – `OAPC_ERROR_CREATE_FILE_FAILED` – creation of a new file/appending data to an existing file failed, file could not be opened
- 19 – `OAPC_ERROR_OPEN_FILE_FAILED` – opening a file for reading failed (happens e.g. when the file does not exist or is not accessible for some reason)
- 20 – `OAPC_ERROR_WRITE_FILE_FAILED` – writing data into an already opened file failed (e.g. because there is no more space left on a device)
- 21 – `OAPC_ERROR_READ_FILE_FAILED` – reading data from an already opened file failed either because the file is damaged or truncated or because the file format is not as expected

Following commands are supported by RepliServer:

ExitUI

After sending this command RepliMark is stopped and - if visible - the GUI of it is closed. The RepliServer and it's TCP/IP socket is shut down as well. Afterwards it is not possible to send any other command.

CreateLog <path>

Creates a (new) logfile at the given path. This logfile will contain all commands sent to the RepliServer, all responses on these commands sent back to the client which is connected to the RepliServer and all notes generated with command `WriteLogNote`. When this command is called and a logfile is already open and used, the old one is closed and log data are written to the new file. When the file specified by parameter `path` already exists, the contents of this logfile are deleted and a new file is created.

Every line within the logfile starts with a fixed character to identify the type of log entry:

C: - command sent from client to RepliServer

R: - response to a command, sent from RepliServer back to client

N: - log note as set by command `WriteLogNote`

WriteLogNote <text>

Writes the given text into a logfile. To use this command, a log has to be created by calling `CreateLog` before. The `text` specified as parameter to this command is written to the log file without any further modifications.

CmdStopMark

Tries to stop a running marking operation in the same way like it would be done by a user pressing the "STOP"-button in mark dialogue.

This command is intended to be used with mark-operations which work non-blocking, means where the command returns immediately and not only after operation has finished. For all blocking commands it would not make sense to send `CmdStopMark` since the RepliServer would not be able to receive and to process this command.

CmdIsMarking

Checks if an asynchronous marking operation is still pending/a mark dialogue is still open. This function returns 0 when no mark operation is pending and 1 when marking is active.

TriggerUI <number>

This command can be used to invoke any action that would be possible by user interaction within RepliMark too. The given <number> specifies which operation has to be triggered, here every user action like selecting a menu item or pressing a toolbar is possible. Most of the commands return immediately, independent if the operation was successful or not. Synchronous commands that return only when related operation was finished are mentioned explicitly below. Currently following <number>-values are possible:

All four-digit numbers correspond to menu items and/or tool bar buttons and their functionality within the main application, when such a number is used the related operation is invoked (for a more detailed description please refer to RepliMark documentation above):

- 1001 – new project
 - 1002 – load existing project file
 - 1003 – import custom file format (as supported by RepliMark: vector and raster image formats)
 - 1004 – save the current project using a known name
 - 1005 – save the current project using a new name
 - 1101 – export vector data in CSV format
 - 1102 – export vector data in HPGL/PLT format
 - 1103 – export layer vector data in CLI format
 - 1104 – export 3D mesh data in RWX format
 - 1006 – open general project settings dialogue
 - 1007 – open pen settings dialogue
 - 1008 – save the current configuration as default settings
 - 1009 – load default settings
 - 1010 – save project with options
 - 1011 – import 3D custom file format (as supported by RepliMark: vector formats to be used as 3D mesh)
 - 1012 – open general settings dialogue right as code 1006 but brings the “Scanner” tab pane to front
 - 1018 – open general machine settings dialogue
 - 1019 – import custom file format (as supported by RepliMark: vector, 3D and raster image formats) in case of a 3D mesh add the data to an already existing Active Slice Group instead of creating a new, separate one
 - 1020 – import custom 3D file format (as supported by RepliMark: 3D meshes) and add it to an already existing Active Slice Group instead of creating a new, separate one
 - 1021 – import custom bitmap image file format and open the related import dialogue to let the user set import parameters
-
- 2001 – undo last operation
 - 2002 – redo last un-done operation
 - 2101 – concatenate all selected elements into one group
 - 2102 – concatenate all selected elements into a splitgroup which can perform rotational and 1D/2D planar splits
 - 2103 – concatenate all selected elements into a movegroup
 - 2104 – ungroup the elements out of the selected group
 - 2105 – duplicate the selected element
 - 2106 – right-align the selected element
 - 2107 – centre the selected element horizontally
 - 2108 – left-align the selected element
 - 2109 – top-align the selected element
 - 2110 – centre the selected element vertically
 - 2111 – bottom-align the selected element
 - 2112 – concatenate all selected elements into a splitgroup which can perform only rotational splits
 - 2201 – merge the geometries of the selected element into a static one
 - 2202 – split the geometries of the selected element logically
 - 2203 – optimise the geometries of the selected element

2204 – reduce the geometries of the selected element using a lossy algorithm
 2205 – extrude the selected element into third dimension
 2206 – delete the currently selected element(s)
 2207 – Boolean add
 2208 – Boolean subtract
 2209 – Boolean intersect
 2210 – Project to ground
 2301 – freeze the currently shown background video
 2302 – calibrate the currently connected camera
 2303 – teach fiducials
 2304 – load fiducials
 2305 – save teached fiducial(s)
 2306 – drop teached fiducial(s)
 2307 – drop camera calibration data
 2308 – toggle image capturing on or of (when configured to be started manually in global project settings)
 2309 – configure cropping of camera image

 3001 – start process simulation
 3002 – opens the marking dialogue to let the user control the marking process
 3003 – marks the current project once, here the mark dialogue is opened to let the user stop the marking process if necessary; the dialogue is closed automatically as soon as marking was finished; the return information "OK" for this command is sent only after marking process has finished, thus it is not necessary to check the marking state, as soon as a response is received, marking is complete (or was stopped)
 3004 – marks the current project silently and without opening the mark dialogue; the return information "OK" for this command is sent only after marking process has finished, thus it is not necessary to check the marking state, as soon as a response is received, marking is complete (or was stopped)
 3006 – increment the elements in current project
 3007 – decrement the elements in current project
 3008 – reset the elements in current project to their default/start values
 3013 – open devices when not already done and show scanner card state dialogue
 3015 – marks the selected elements out of the current project once, here the mark dialogue is opened to let the user stop the marking process if necessary; the dialogue is closed automatically as soon as marking was finished
 3020 – this command starts marking of the current project in a loop while opening the fully equipped mark dialogue. This mark dialogue and mark-loop can be left by pressing the stop-button, by clicking the close-symbol of the mark-dialogue itself or by sending command `CmdStopMark`.
 3021 – start the pilot laser with the mark dialogue visible, pilot laser mode and number of loops can be set with commands `CmdSetPilotMode` and `CmdSetPilotLoop`
 3022 – start the pilot laser without a visible mark dialogue, pilot laser mode and number of loops can be set with commands `CmdSetPilotMode` and `CmdSetPilotLoop`
 3023 – this command is similar to command 3020, it starts marking of the current project in a loop but it does not show any mark dialogue where the operation could be stopped by the user. This mark dialogue and mark-loop can be left only by sending command `CmdStopMark`. As long as this looped mark operation is running, the user interface is locked and no manual operations are possible with RepliMark.
 3024 – this command starts marking of the current project in a loop such as command 3020 but while opening a mark dialogue which consists of a stop-button only. This mark dialogue and mark-loop can be left by pressing the stop-button, by clicking the close-symbol of the mark-dialogue itself or by sending command `CmdStopMark`.

 4001 – show the "about"-dialogue
 4002 – show license information
 4003 – reset the current license
 4004 – show the "credits"-dialogue
 4006 – generate a bugreport
 4007 – open the dialogue to adjust a preview projection
 4008 – save a protocol of the current loaded project/used configuration

 5001 – switch the current drawing area view to (default) top view
 5002 – switch the current drawing area view to front view
 5003 – switch the current drawing area view to right side view

- 5004 – switch the current drawing area view to 3D view
- 5005 – switch the current drawing area view to split mode with all views combined

All five-digit numbers correspond to remaining tool bar buttons and their functionality within the main application, please refer to section „RepliMark“ above to get detailed information about them:

- 10001 – zoom into view
- 10002 – zoom out of view
- 10003 – zoom to view full working area
- 10004 – zoom to fully view selected element
- 10005 – enable pointdrag mode for selected element
- 10006 – log in a user
- 10007 – toggle the mode which shows/hides mark start point and marking direction in geometry
- 10008 – zoom to view full editing area

CmdNewPrj

Clears all current data and flushes all existing elements, settings and pens. After calling this command default settings are restored and project does not contain any geometries. When `CmdAppendPrj` is used afterwards to load a new project, current (default) settings are kept.

CmdClrElems

Removes all elements of the current project. Comparing to `CmdNewPrj` after a call to this command the current configuration is still available and the connections to used controllers are unchanged. So this function does not switch back to the default configuration but behaves like all available geometries and elements have been deleted separately.

CmdLoadPrj <path>

Loads a new .BEAMP project from given <path>. The elements contained in the given project are appended to the current ones (if there are any). The current settings and pens are overwritten by the ones found in the loaded project file.

CmdSavePrj <path>

Saves the current project into a .BEAMP project file as specified by <path>.

CmdLoadPenPrj <path>

Loads the pens out of a .BEAMP project from given <path>. This project has to contain only pen definitions, no vector data and no hardware settings. When this command is used, all current pens are removed, the pen definitions out of this file are loaded and when it contains less pens than the original project, the missing pens are filled up using the default pen settings out of the loaded file. So this function can be used to replace pen definitions without loading a completely new project.

CmdSavePenPrj <path>

Saves the pens out of the current project into a .BEAMP project at the given <path>. This project then will contain only pen definitions, but no vector data and no hardware settings.

CmdAppendPrj <path>

Loads a new .BEAMP project from given <path>. The elements contained in the given project are appended to the current ones (if there are any). The current settings and pens are kept, the ones in loaded project file are ignored.

CmdGetPrjName

Returns the (file) name of the currently loaded project. When no project is loaded, an empty line is returned.

CmdGetPrjPath

Returns the full path name of the currently loaded project. When no project is loaded, an empty line is returned.

CmdGetEstMarkTime

Returns the estimated marking time of the current project in unit milliseconds. When no project is loaded, the returned marking time will be 0.

CmdImport <path>

Imports some vector data that do not have standard .BEAMP project file format. The imported element then gets a name which consists of path separator and file name. As an example: when a file is imported from `C:\tmp\test.svg` the imported element will get the name `\test.svg`

CmdImportSilent <path>

Imports some vector data that do not have standard .BEAMP project file format. Comparing to `CmdImport` here importing is done silently and without any configuration dialogues opening during this operation. Instead of this data are imported using default parameter. The imported element then gets a name which consists of path separator and file name. As an example: when a file is imported from `C:\tmp\test.svg` the imported element will get the name `\test.svg`

CmdSetCharIO2 <new text>
CmdSetCharIO3 <new text>
CmdSetCharIO4 <new text>
CmdSetCharIO5 <new text>

Set a new ASCII text to be used for all input elements that make use of the logical "Char" inputs. When such an input element is assigned to a text or barcode primary element, the text or barcode is replaced by the given `<new text>` for the next marking operation. The four commands for char IO 2..5 correspond to the inputs 2..5 that can be selected in used input elements. The `<new text>` has to be given in plain 8 bit ASCII (local default encoding). For changing texts in Unicode-encoding, please refer to functions `CmdSetUniIOx` below.

CmdSetUniIO2 <new text>
CmdSetUniIO3 <new text>
CmdSetUniIO4 <new text>
CmdSetUniIO5 <new text>

Set a new Unicode text to be used for all input elements that make use of the logical "Char" inputs. When such an input element is assigned to a text or barcode primary element, the text or barcode is replaced by the given `<new text>` for the next marking operation. The four commands for char IO 2..5 correspond to the inputs 2..5 that can be selected in used input elements. The `<new text>` has to be given in UTF-8 encoding. For changing texts using plain ASCII-encoding, please refer to functions `CmdSetCharIOx` above.

CmdLaserOn <pen>

This command turns on the laser for the currently selected head immediately and without dependence of any vector data. The parameter handed over together with this command specifies a pen which has to be used

for controlling the laser. To use this command, the scanner controller device needs to be opened. This can be done with command `CmdOpenDevs`. To select a head, command `CmdSelHead` can be used.

CmdLaserOff

This command turns off the laser for the currently selected head immediately and without dependence of any vector data. When the laser has been turned on before by calling `CmdLaserOn`, it is mandatory to use this command before the device is closed with `CmdCloseDevs`. Elsewhere the state of the laser after closing the device is undefined. To select a head, command `CmdSelHead` can be used.

CmdGetCardInpVal <inputflag>

Read and return the status of a selected input of the card that belongs to the currently selected head. When this card does not have such an input or when an illegal value is given for parameter `inputflag`, an error is returned. The parameter itself can have exactly one of these values which specifies the input to be read:

- `IOCTRL_ANALOGUE_8_1` – 4
- `IOCTRL_ANALOGUE_8_2` – 8
- `IOCTRL_ANALOGUE_10_1` – 16
- `IOCTRL_ANALOGUE_10_2` – 32
- `IOCTRL_ANALOGUE_10_3` – 64
- `IOCTRL_ANALOGUE_10_4` – 128
- `IOCTRL_ANALOGUE_10_5` – 256
- `IOCTRL_ANALOGUE_10_6` – 512
- `IOCTRL_ANALOGUE_12_1` – 1024
- `IOCTRL_ANALOGUE_12_2` – 2048
- `IOCTRL_ANALOGUE_12_3` – 4096
- `IOCTRL_DIGITAL_8_1` – 8192
- `IOCTRL_DIGITAL_8_2` – 16384
- `IOCTRL_DIGITAL_16_1` – 32768
- `IOCTRL_DIGITAL_16_2` – 65536
- `IOCTRL_DIGITAL_32` – 131072
- `IOCTRL_ANALOGUE_16` – 262144
- `IOCTRL_ANALOGUE_12_4` – 524288
- `IOCTRL_ANALOGUE_16_1` – 1048576
- `IOCTRL_ANALOGUE_16_2` – 2097152

To select the head and therefore the card this command has to be used with, prior to calling this command `CmdSelHead` can be used.

CmdSetCardOutpVal

This command has to be used before `CmdSetCardOutput`, it is used to set a value which has to be sent to one of the outputs of a connected controller.

CmdSetCardOutpMask

This command can be used before `CmdSetCardOutput`, it is used to set a mask-value which has to be sent to one of the outputs of a connected controller.

CmdSetCardOutput

Using this command a value is sent to an output of the currently connected scanner controller card. This value has to be handed over by a preceding call to `CmdSetCardOutpVal` and mask is which an optional value set by a call to `CmdSetCardOutpMask`. It makes use of the card of the currently selected head (refer to `CmdSelHead`) and a single `IOCTL_`-flag which is handed over as parameter. When no mask is set or the mask is set to `0xFFFFFFFF`, then the full value is handed over to the controller. When a mask is set, only these bits of the value are changed at the output, which are specified by a "1" (=bit set) in the mask value.

The flag which has to be handed over specifies the output where the value has to be set to, here it depends on the currently used card which one is available and usable. The flags are the ones defined in header file `oapc_libio.h`. Following are supported (exclusively, it is not allowed to OR-concatenate them):

- `IOCTRL_LASERPORT_8_1` – 1
- `IOCTRL_LASERPORT_8_2` – 2
- `IOCTRL_ANALOGUE_8_1` – 4
- `IOCTRL_ANALOGUE_8_2` – 8
- `IOCTRL_ANALOGUE_10_1` – 16
- `IOCTRL_ANALOGUE_10_2` – 32
- `IOCTRL_ANALOGUE_10_3` – 64
- `IOCTRL_ANALOGUE_10_4` – 128
- `IOCTRL_ANALOGUE_10_5` – 256
- `IOCTRL_ANALOGUE_10_6` – 512
- `IOCTRL_ANALOGUE_12_1` – 1024
- `IOCTRL_ANALOGUE_12_2` – 2048
- `IOCTRL_ANALOGUE_12_3` – 4096
- `IOCTRL_DIGITAL_8_1` – 8192
- `IOCTRL_DIGITAL_8_2` – 16384
- `IOCTRL_DIGITAL_16_1` – 32768
- `IOCTRL_DIGITAL_16_2` – 65536
- `IOCTRL_DIGITAL_32` – 131072
- `IOCTRL_ANALOGUE_16` – 262144
- `IOCTRL_ANALOGUE_12_4` – 524288
- `IOCTRL_ANALOGUE_16_1` – 1048576
- `IOCTRL_ANALOGUE_16_2` – 2097152

When an invalid flag is handed over, the function call fails with error `OAPC_ERROR_INVALID_INPUT` immediately.

CmdSendMark

Using this command it is possible to send the current project data as stand-alone marking data to a connected scanner card. This requires a configuration where a scanner controller is set up properly, that supports this feature (like Scanlab RTC4 ScanAlone). Here no additional parameters are required since this function sends one exclusive set of marking data to the card.

CmdWriteMark <path>

Using this command it is possible to write the current project data as stand-alone marking data into a local file. This requires a configuration where a scanner controller is set up properly, that supports this feature (like HALaser E1701 or HALaser E1803 controller series). The given path specifies the full path of the file that has to be used for the stand-alone data. When the file already exists, it will be overwritten without further notice. Such a file can be transferred to the scanner controller manually in next step (e.g. by storing it onto the microSD card of E1701 and then putting this card back into the controller).

CmdSendNamedMark <name>

Using this command it is possible to send the current project data as stand-alone marking data to a connected scanner card using a given name. This requires a configuration where a scanner controller is set up properly, that supports this feature (like HALaser E1701 or HALaser E1803 controller series). The given <name> is an identifier the marking data are stored on the card with. Here the naming structure has to be according to the regulations of the used scanner card. For E1701 controller this means the name needs to be something like "0:/filename.epr" where "0:/" specifies microSD-card as storage place and ".epr" is the recommended file name extension for such stand-alone data. When a file with this name already exists on the controller, it will be overwritten without further notice.

CmdSelEntName <name of element>

Logically selects an element (but not highlights it in view). After an element with the given name was selected, it can be processed using other commands (as described below). In case the whole project was selected using `CmdSelPrj`, this selection is no longer valid.

CmdSelEnt <id>

Logically selects an element (but not highlights it in view). After an element with the given identifier was selected, it can be processed using other commands (as described below). In case the whole project was selected using `CmdSelPrj`, this selection is no longer valid.

CmdSelPrj

Logically selects the whole project including all elements (but does not highlight them in view). Afterwards this project and all of the contained elements can be processed using other commands (as described below). In case a single element was selected using `CmdSelEnt` or `CmdSelEntName`, this selection is no longer valid.

CmdSetSelEnt <0/1>

Select or deselect a selected element visibly in view. This operation is similar to a left-click on an element by the user while shift-key is held down. An additional parameter 0 or 1 decides if the element has to be selected or deselected. The element itself which is modified by this operation can be chosen by a call to function `CmdSelEntName` or `CmdSelEnt` which internally selects the element for further operations. After setting an element visibly selected by this command, all UI-operations can be performed that belong to selected elements. To fully zoom into a single element following sequence of commands can be used:

```
CmdSelEntName elementname  
CmdSetSelEnt 1  
CmdZoomElem
```

To zoom to two elements, this sequence of commands can be used:

```
CmdSelEntName elementname1  
CmdSetSelEnt 1  
CmdSelEntName elementname2
```

```
CmdSetSelEnt 1
CmdZoomElem
```

To unselect a previously selected element, parameter "0" has to be used

```
CmdSelEntName elementname1
CmdSetSelEnt 0
```

CmdZoomElem

Zooms view to fully show all selected elements. The element(s) to be shown after this command has/have to be selected by calling `CmdSelEntName/CmdSelEnt` and `CmdSetSelEnt` before.

CmdDeleteEnt <id>

Deletes an element completely. When the parameter `id` is set, the element with this identifier is deleted. When no parameter `id` is given, the currently selected element is deleted: This element has to be selected by calling `CmdSelEntName` or `CmdSelEnt` before. To make the element disappear from current view, a call to `CmdRedraw` may be necessary.

An example about how an element with the name "Rectangle 5" can be deleted:

```
CmdSelEntName Rectangle 5
CmdDeleteEnt
```

An example about how an element with the unique identifier 18 can be deleted:

```
CmdDeleteEnt 18
```

CmdDeleteAllEnts

Deletes all elements within the current project. Different to `CmdNewPrj` this command only removes the geometries but leaves hardware settings, pens and all possibly opened devices unchanged.

CmdSetLoopRepeat <repeats>

Changes the amount of repeats which have to be done for this element. A value of 0 means, the element is marked once and without repeating this operation. The element to be modified has to be selected by calling `CmdSelEntName` or `CmdSelEnt` before.

CmdSetPosX <position>

In case an element was selected by calling `CmdSelEntName` or `CmdSelEnt` before:

This command changes the X-position of the current element (left corner) to the value given as parameter in unit 1/1000 mm.

In case the whole project was selected by calling `CmdSelPrj` before:

This command translates the X-position of all elements of the current project by the given value in unit 1/1000 mm. Here "translation" means, the position value given with the command is added to the current position of all elements of the project, their positions are not overwritten by it.

To make the changes visible which have been applied by this command, a call to `CmdRedraw` may be necessary.

CmdSetPosY <position>

In case an element was selected by calling `CmdSelEntName` or `CmdSelEnt` before:

This command changes the Y-position of the current element (top corner) to the value given as parameter in unit 1/1000 mm.

In case the whole project was selected by calling `CmdSelPrj` before:

This command translates the Y-position of all elements of the current project by the given value in unit 1/1000 mm. Here “translation” means, the position value given with the command is added to the current position of all elements of the project, their positions are not overwritten by it.

To make the changes visible which have been applied by this command, a call to `CmdRedraw` may be necessary.

CmdSetPosZ <position>

In case an element was selected by calling `CmdSelEntName` or `CmdSelEnt` before:

This command changes the Z-position of the current element to the value given as parameter in unit 1/1000 mm.

In case the whole project was selected by calling `CmdSelPrj` before:

This command translates the Z-position of all elements of the current project by the given value in unit 1/1000 mm. Here “translation” means, the position value given with the command is added to the current position of all elements of the project, their positions are not overwritten by it.

To make the changes visible which have been applied by this command, a call to `CmdRedraw` may be necessary.

CmdGetPosX

Gets the X-position (horizontal) of the current element and returns it using unit 1/10000 mm. The related element has to be selected by calling `CmdSelEntName` or `CmdSelEnt` before.

CmdGetPosY

Gets the Y-position (vertical) of the current element and returns it using unit 1/10000 mm. The related element has to be selected by calling `CmdSelEntName` or `CmdSelEnt` before.

CmdGetPosZ

Gets the Z-position (depth) of the current element and returns it using unit 1/10000 mm. The related element has to be selected by calling `CmdSelEntName` or `CmdSelEnt` before.

CmdSetScaleX <factor*1000>

Changes the width of the current element by the factor given as parameter. The element to be modified has to be selected by calling `CmdSelEntName` or `CmdSelEnt` before. To make the changes visible which have been applied by this command, a call to `CmdRedraw` may be necessary.

CmdSetScaleY <factor*1000>

Changes the height of the current element by the factor given as parameter. The element to be modified has to be selected by calling `CmdSelEntName` or `CmdSelEnt` before. To make the changes visible which have been applied by this command, a call to `CmdRedraw` may be necessary.

CmdSetScaleZ <factor*1000>

Changes the depth of the current element by the factor given as parameter. The element to be modified has to be selected by calling `CmdSelEntName` or `CmdSelEnt` before.

CmdGetScaleX

Returns the scale factor which is applied to the width of the current element in unit *1000. The element the scale factor has to be retrieved for needs to be selected by calling `CmdSelEntName` or `CmdSelEnt`.

CmdGetScaleY

Returns the scale factor which is applied to the height of the current element in unit *1000. The element the scale factor has to be retrieved for needs to be selected by calling `CmdSelEntName` or `CmdSelEnt`.

CmdGetScaleZ

Returns the scale factor which is applied to the depth of the current element in unit *1000. The element the scale factor has to be retrieved for needs to be selected by calling `CmdSelEntName` or `CmdSelEnt`.

CmdGetSizeX

Gets the X-size (width) of the current element and returns it using unit 1/10000 mm. The related element has to be selected by calling `CmdSelEntName` or `CmdSelEnt` before.

CmdGetSizeY

Gets the Y-size (height) of the current element and returns it using unit 1/10000 mm. The related element has to be selected by calling `CmdSelEntName` or `CmdSelEnt` before.

CmdGetSizeZ

Gets the Z-size (depth) of the current element and returns it using unit 1/10000 mm. The related element has to be selected by calling `CmdSelEntName` or `CmdSelEnt` before.

CmdGetOutline

Gets the complete outline (bounding box) of the current element and returns it using six values in unit 1/10000 mm. The returned values are separated by spaces and provide position X, position Y, position Z, size X, size Y and size Z consecutively in one single line. The element the outline has to be retrieved for needs to be selected by calling `CmdSelEntName` or `CmdSelEnt` before.

This is a convenience function which incorporates the functionality of commands `CmdGetPosX`, `CmdGetPosY`, `CmdGetPosZ`, `CmdGetSizeX`, `CmdGetSizeY` and `CmdGetSizeZ`.

CmdSetRotX <angle>

Changes the rotation around X-axis of the current element to the value given as parameter in unit 1/1000 degrees. The element to be modified has to be selected by calling `CmdSelEntName` or `CmdSelEnt` before. To make the changes visible which have been applied by this command, a call to `CmdRedraw` may be necessary.

CmdSetRotY <angle>

Changes the rotation around Y-axis of the current element to the value given as parameter in unit 1/1000 degrees. The element to be modified has to be selected by calling `CmdSelEntName` or `CmdSelEnt` before. To make the changes visible which have been applied by this command, a call to `CmdRedraw` may be necessary.

CmdSetRotZ <angle>

Changes the rotation around Z-axis of the current element to the value given as parameter in unit 1/1000 degrees. The element to be modified has to be selected by calling `CmdSelEntName` or `CmdSelEnt` before. To make the changes visible which have been applied by this command, a call to `CmdRedraw` may be necessary.

CmdSetHatchAngle <angle>

This function sets a hatch angle parameter in unit 1/1000 degrees. The value is set internally but not yet applied to any element. To do this, an additional call to `CmdSetHatch` is necessary.

CmdSetHatchDist <distance>

This function sets a hatch distance parameter in unit 1/1000 mm. The value is set internally but not yet applied to any element. To do this, an additional call to `CmdSetHatch` is necessary.

CmdSetHatchOffs <offset>

This function sets a hatch lines offset parameter in unit 1/1000 mm. The value is set internally but not yet applied to any element. To do this, an additional call to `CmdSetHatch` is necessary.

CmdSetHatchPen <pen-number>

This function sets a hatch pen. The value is set internally but not yet applied to any element. To do this, an additional call to `CmdSetHatch` is necessary.

CmdSetHatchStyle <style-id>

This function specifies the hatch style to be used. It can be one of the following text values:

- “fwd” – separate lines, forwarded
- “fwdbwd” – separate lines forward and backward
- “connected” – connected lines forward and backward
- “zigzag” – connected zigzag lines
- “inner” – inner lines repeating the shape of the element-specific

The value is set internally but not yet applied to any element. To do this, an additional call to `CmdSetHatch` is necessary.

CmdSetHatchLinemode <mode-id>

This function specifies the mode of the hatch lines to be used. It corresponds with the “linelength” parameter to be set with function `CmdSetHatchLinelen` and can be one of the following text values:

- “continuous” – hatch lines consist of single lines with one start and endpoint each, parameter “linelength” is ignored in this case
- “lines” – hatch lines consist of short lines combined to one longer, continuous line, parameter “linelength” specifies the length of the short line segments
- “dashed” – hatch lines are dashed lines, parameter “linelength” specifies the length of the lines and the distances between them
- “dotted” – hatch lines consist of single dots, parameter “linelength” specifies the distance between them

- “cust” – hatch lines consist of custom dots as specified in current projects settings, parameter “linelength” specifies the distance between the centre point of each of these custom dots

The value is set internally but not yet applied to any element. To do this, an additional call to `CmdSetHatch` is necessary.

CmdSetHatchLinelen <length>

This function sets the length of a hatch line which is used when a custom line mode is used (please refer to function `CmdSetHatchLinemode` above for details). The value is set internally but not yet applied to any element. To do this, an additional call to `CmdSetHatch` is necessary.

CmdSetHatch <id>

When this command is executed, the previously set hatch parameter are applied to an element. This element has to be selected by calling `CmdSelEntName` or `CmdSelEnt` before. To make the changes visible which have been applied by this command, a call to `CmdRedraw` may be necessary.

When no parameter `id` is given, a new hatch element is added to the selected element. The ID of the new element is returned. When the identifier of an existing hatch element is handed over as parameter `id`, this hatch element is modified and the new parameters are applied to it.

The returned value is the unique identifier for the hatch element and can be used with commands like `CmdDeleteEnt`, `CmdSelEnt` or `CmdSetHatch`.

An example about how to set a new hatch with 0,5 mm hatch distance, 45 degrees hatch angle and pen number 2 to an existing element “Circle 1”:

```
CmdSetHatchDist 500
CmdSetHatchAngle 45000
CmdSetHatchPen 2
CmdSelEntName Circle 1
CmdSetHatch
```

An example about how to modify an existing hatch element with the identifier 8 to use 0,1 mm hatch distance, 180 degrees hatch angle and pen number 3:

```
CmdSetHatchDist 100
CmdSetHatchAngle 180000
CmdSetHatchPen 3
CmdSetHatch 8
```

Two examples about how to remove an existing hatch element with the identifier 8 from a parent element:

```
CmdSelEnt 8
CmdDeleteEnt
```

or

```
CmdDeleteEnt 8
```

CmdRefresh

Refresh the current view. This updates the shown geometries without recalculating and redrawing everything new

CmdRedraw

Redraw the current view. This performs a full re-calculation and re-drawing of all geometries and therefore is slower than `CmdRefresh`. This command should be called only when vector data of elements of the current project have been changed and the changes are not yet visible.

CmdListName <num>

This command expects a positive number `num` as parameter and can be used to list all available elements with their name. To get all elements, it has to be called repeatedly with increasing numbers (starting from 0). For every call with a different number the related element name will be given. When there are no more elements, an error is returned.

CmdListUID <num>

This command expects a positive number `num` as parameter and can be used to list the UIDs of all available elements. To get all elements UIDs, this command has to be called repeatedly with increasing numbers (starting from 0). For every call with a different number the related element UID will be returned. When there are no more elements, an error is returned.

CmdSetElemFile <path>

Changes the file that is assigned to an element and replaces the related data. This command can be used e.g. with Scanner Bitmap Elements to replace the current image.

The `path` to the new file has to be given as parameter and needs to point to an existing file in appropriate file format.

The element where the data are replaced by this command has to be selected by calling `CmdSelEntName` or `CmdSelEnt` before.

CmdSetElemFlag <name>

Sets a flag to an element that was selected by calling `CmdSelEntName` or `CmdSelEnt` before. The flag itself is specified by the given `name` and is activated by this function. The name of the flag and its functionality depends on the type of element that is selected. For an overview of available flags please refer to section below.

CmdResetElemFlag <name>

Resets a flag of an element that was selected by calling `CmdSelEntName` or `CmdSelEnt` before. The flag itself is specified by the given `name` and is deactivated by this function.

The name of the flag and its functionality depends on the type of element that is selected. For an overview of available flags please refer to section below.

CmdSetElemText <text>

Changes the text of a barcode or text primary element to the value given as parameter. The barcode or text element this new value is set for, has to be selected by calling `CmdSelEntName` or `CmdSelEnt` before. In case the GUI is visible, the element typically does not change its appearance immediately after this command is set. Although the internal data already have changed after this call, an additional call `CmdRefresh` is necessary to update the visual representation.

CmdGetPen

Returns the pen-number that is assigned to a selected element. The element where this command retrieves the pen-number from, has to be selected by calling `CmdSelEntName` or `CmdSelEnt` before.

CmdGetPenFreq <pen-number>

Returns the frequency in unit Hz that is assigned to the pen with the given number and to the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdGetPenPower <pen-number>

Returns the power in unit 1/1000% that is assigned to the pen with the given number and to the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdGetPenColour <pen-number>

Returns the RGB-colour that is assigned to the pen with the given number, to the head selected with command `CmdSelHead` (or head 0 by default) and which is used for drawing mark lines. Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdGetPenOffColour <pen-number>

Returns the RGB-colour that is assigned to the pen with the given number, to the head selected with command `CmdSelHead` (or head 0 by default) and which is used for drawing jump lines when the related option is enabled. Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdGetPenJSpeed <pen-number>

Returns the jump speed in unit $\mu\text{m}/\text{sec}$ that is assigned to the pen with the given number and to the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdGetPenMSpeed <pen-number>

Returns the mark speed in unit $\mu\text{m}/\text{sec}$ that is assigned to the pen with the given number and to the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdGetPenLOffDelay <pen-number>

Returns the laser-off-delay in unit μsec that is assigned to the pen with the given number and to the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdGetPenLOnDelay <pen-number>

Returns the laser-on-delay in unit μsec that is assigned to the pen with the given number and to the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdGetPenJDelay <pen-number>

Returns the jump-delay in unit μsec that is assigned to the pen with the given number and to the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdGetPenMDelay <pen-number>

Returns the mark-delay in unit μsec that is assigned to the pen with the given number and to the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdGetPenPDelay <pen-number>

Returns the in-polygon-delay in unit μsec that is assigned to the pen with the given number and to the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdGetPenSpotsize <pen-number>

Returns the lasers spotsize in unit $1/10 \mu\text{m}$ that is assigned to the pen with the given number and to the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdGetPenWobbleAmp <pen-number>

Returns the wobble amplitude in unit μm that is assigned to the pen with the given number and to the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdGetPenWobbleFreq <pen-number>

Returns the wobble frequency in unit $1/1000 \text{ Hz}$ that is assigned to the pen with the given number and to the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdGetPenPLength <pen-number>

Returns the pulse length in unit μsec that is assigned to the pen with the given number and to the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdGetPenFPK <pen-number>

Returns the first pulse killer pulse length in unit nsec that is assigned to the pen with the given number and to the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdGetPenStdByPLength <pen-number>

Returns the stand-by pulse length in unit usec that is assigned to the pen with the given number and to the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdGetPenValues <pen-number>

Returns a list of all pen-parameters in the order of the single `CmdGetPenXXX`-commands listed above using the given pen number and the head which can be selected with command `CmdSelHead`. Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdSetPenFreq <pen-number> <frequency>

Sets the *frequency* (in unit Hz) to the pen with the given number and the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdSetPenPower <pen-number> <power>

Sets the `power` (in unit 1/1000%) to the pen with the given number and the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdSetPenColour <pen-number> <colour>

Sets the `RGB-colour` which is used for drawing mark lines to the pen with the given number and the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdSetPenOffColour <pen-number> <colour>

Sets the `RGB-colour` which is used for drawing jump lines to the pen with the given number and the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdSetPenJSpeed <pen-number> <speed>

Sets the jump `speed` (in unit $\mu\text{m}/\text{sec}$) to the pen with the given number and the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdSetPenMSpeed <pen-number> <speed>

Sets the mark `speed` (in unit $\mu\text{m}/\text{sec}$) to the pen with the given number and the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdSetPenLOffDelay <pen-number> <delay>

Sets the laser-off-`delay` (in unit μsec) to the pen with the given number and the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdSetPenLONDelay <pen-number> <delay>

Sets the laser-on-`delay` (in unit μsec) to the pen with the given number and the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdSetPenJDelay <pen-number> <delay>

Sets the jump-`delay` (in unit μsec) to the pen with the given number and the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdSetPenMDelay <pen-number> <delay>

Sets the mark-`delay` (in unit μsec) to the pen with the given number and the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdSetPenPDelay <pen-number> <delay>

Sets the in-polygon-delay (in unit μsec) to the pen with the given number and the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdSetPenSpotsize <pen-number> <spotsize>

Sets the lasers `spotsize` (in unit $1/10 \mu\text{m}$) to the pen with the given number and the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdSetPenWobbleAmp <pen-number> <amp>

Sets the wobble amplitude (in unit μm) to the pen with the given number and the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdSetPenWobbleFreq <pen-number> <frequency>

Sets the wobble frequency (in unit $1/1000 \text{ Hz}$) to the pen with the given number and the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdSetPenPLength <pen-number> <length>

Sets the pulse `length` (in unit μsec) to the pen with the given number and the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdSetPenFPK <pen-number> <length>

Sets the first pulse killer pulse (FPK) `length` (in unit nsec) to the pen with the given number and the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdSetPenStdByPLength <pen-number> <length>

Sets the stand-by pulse `length` (in unit usec) to the pen with the given number and the head selected with command `CmdSelHead` (or head 0 by default). Which pen is assigned to a specific element can be evaluated by calling function `CmdGetPen`.

CmdSelHead <head-number>

Sets the number of a head which has to be used for a subsequent command. Here `head-number` is a 0-based value that specifies a special head in multihead-environments. When this function is never called, all commands that are head-dependent, use head number 0 by default.

CmdSetWAX <position>

Set the X-position of the current working area using unit μm . The head this new value has to be applied for needs to be specified by a preceding call of `CmdSelHead`.

CmdSetWAY <position>

Set the Y-position of the current working area using unit μm . The head this new value has to be applied for needs to be specified by a preceding call of `CmdSelHead`.

CmdSetWAZ <position>

Set the Z-position of the current working area using unit μm . The head this new value has to be applied for needs to be specified by a preceding call of `CmdSelHead`.

CmdSetWAWidth <size>

Set the width (=horizontal size) of the current working area using unit μm . The head this new value has to be applied for needs to be specified by a preceding call of `CmdSelHead`.

CmdSetWAHeight <size>

Set the height (=vertical size) of the current working area using unit μm . The head this new value has to be applied for needs to be specified by a preceding call of `CmdSelHead`.

CmdSetWADepth <size>

Set the depth (=Z direction) of the current working area using unit μm . The head this new value has to be applied for needs to be specified by a preceding call of `CmdSelHead`.

CmdSetEAX <position>

Set the X-position of the global editing area using unit μm .

CmdSetEAY <position>

Set the Y-position of the global editing area using unit μm .

CmdSetEAZ <position>

Set the Z-position of the global editing area using unit μm .

CmdSetEAWidth <size>

Set the width (=horizontal size) of the global editing area using unit μm .

CmdSetEAHeight <size>

Set the height (=vertical size) of the global editing area using unit μm .

CmdSetEADepth <size>

This function returns the number of elements which exist in current project. Here not only primary elements are counted but every group, every groups sub-element(s), every hatch and every input element is counted as an own, separate one

CmdGetElemNum

Set the depth (=Z direction) of the global editing area using unit μm .

CmdSetPilotMode <mode>

This command corresponds to `TriggerUI 3021` and `TriggerUI 3022` and can be used to set the mode the pilot laser is working with. Following values are allowed to be set for `mode`:

- `PrjOutline` – let the pilot laser show the whole projects outline
- `ElemOutline` – let the pilot laser show every elements outline
- `ElemShape` – let the pilot laser show every elements real shape (without hatching)

CmdSetPilotLoop <cnt>

This command corresponds to `TriggerUI 3021` and `TriggerUI 3021` and can be used to set the number of loops the pilot laser has to perform at once. Here for `cnt` every value greater than 0 can be set.

CmdCaptureView <width> <height> <path>

Captures the drawing area and saves it as image into a file. Here `width` and `height` specify the size of the image to be saved. When positive values for both, `width` and `height` are specified, the image is scaled to that size. When one of both values is -1, the image is scaled using the value given for the other one by keeping the aspect ratio for that side that is set to -1. When both values are -1, the view is saved in it's original resolution.

`path` is the full path where the image has to be saved at. The file extension used for the name of the file in this path decides what format has to be used for saving. Supported file formats are `.png`, `.bmp`, `.gif` and `.jpeg` (while JPEG is not recommended to be used for unscaled images).

Example:

```
CmdCaptureView -1 -1 F:/viewcapture.png
```

will save the view in PNG format using it's original size on drive F: using file name `viewcapture.png`.

5.18.4.1 Element Flags

This section describes the flags that are available for the different element types that can be set or reset with commands like `CmdSetElemFlag` and `CmdResetElemFlag`.

5.18.4.1.1 Scanner Bitmap Element Flags

`ditherFS`, `bw`, `greyscale` – these flags are special, they can only be set and not reset and only one of them can be set. Means when a flag `bw` is set, the two other flags `ditherFS` and `greyscale` are automatically reset. These flags decide the format of the image which can be either a Floyd-Steinberg-dithered black-and-white image, a plain black-and-white image or a greyscale image

`mark_bidir` – this flag has an influence on behaviour during marking and enables a mode where lines are marked from beginning to end and from end to beginning alternating. This saves some marking time since the jump back to the beginning of the next line is saved.

`mark_fromlastline` – this flag has an influence on behaviour during marking and lets the image be processed from bottom to top when it is set

`mark_wo_lineincr` – this flag has an influence on behaviour during marking and marks all lines of an image at the same y-position

`mark_inverted` – this flag has an influence on behaviour during marking and inverts the power values resulting in an image that is negative to the visual representation; depending on the used material this finally may result in a positive image

`aspect_fixed_x`, `aspect_fixed_y` – these flags have no counterpart in RepliMark's UI and can be set or reset via RepliServer only; they are used when an image of an existing Scanner Bitmap Element is replaced by command `CmdSetElemFile`. When none of these flags is set, the new image is scaled to the same size like the previous image which may result in a loss of the current aspect ratio. When one of both flags is set, the aspect ratio of the new image is kept while one of the two sides X or Y uses the same width or height like the original image. When both flags are set, behaviour is undefined

5.18.5 Compatibility commands

To give the possibility to migrate existing software fast and easy, some non-standard compatibility commands are available. These commands behave like the ones in their original API, for details about their usage please refer to the related vendors manual. When developing new RepliServer applications these functions should not be used but the native remote control commands described above.

Following compatibility commands are supported at the moment:

- `ScCciChangeTextByName()`
- `ScCciIsMarking()`
- `ScCciLoadJob()`
- `ScCciMarkEntityByName()`

5.19 Smart Interface

The interface described here is read-only. It can be used to implement Smart Factory (Industry 4.0) applications and provides different status informations which give the possibility to react on events during marking/production.

When only this interface is used, it is possible to watch processing of one or more RepliMark-controlled machines without the need to have an eye on them all the time. As soon as something important happens which requires user interaction, a notification is sent via the Smart Interface. This notification can be received by a suitable device (e.g. a Smartphone-application) which then informs the user that something has to be done at a specific machine. Now the operator can check that machine.

In combination with the RepliServer remote control interface or when programming interface of `libRepliMark` is used out of an own application, this interface gives extended possibilities to automate production with RepliMark according to the concept of smart factories. Now not only detailed state information are available but it is possible to react on them automatically. So e.g. when marking came to an end the application can decide if it starts the next marking operation or if it is necessary to have some operator interaction in order to continue production.

For more details about the RepliMark programming interface, please refer to the information about BeamSDK at <https://halaser.eu/feature.php#BeamSDK>.

5.19.1 Accessing the Smart Interface

The smart interface data are provided via an unencrypted, unauthenticated TCP/IP socket using port number 11355. RepliMark sends several UTF-8-encoded XML documents via this interface. These documents

provide state information but the interface does not accept any data sent by the connected client. So independent from what (unauthorized) client connects here, it is not possible to cause any dangerous operation via this connection.

This interface accepts an unlimited number of incoming connections. But to avoid an unnecessary high load on a running instance of RepliMark, it is recommended to not to connect with too much clients to this interface. For security reasons it is highly recommended to not to make this interface available via the Internet but only within a protected, walled-off production network.

The data provided at the Smart Interface all come in XML format and all have one common basic structure:

```
<?xml version="1.0" encoding="UTF-8"?>
  <BCMsg Time="2017-08-17T15:17:31" ID="901B0E5A06A2">
    . . .
  </BCMsg>
```

The first line is mandatory and specifies the beginning of a new XML document according to the XML specification. The second line starts the root-node `BCMsg` of every Smart Interface message. This root-node can contain two optional attributes `Time` specifying the time the message was sent (ISO 8601 time format, local time) and `ID` uniquely identifying the Machine/software installation this message was sent from.

Dependent on the kind of message which is sent, it may be extended by some more sub-nodes and attributes (symbolised by "... in the example above).

Following the messages are described which are supported by the Smart Interface. PLEASE NOTE: although these messages are described as separate XML structures, they all can be combined within one `BCMsg`-node:

Alive Message

This message is sent latest 40 seconds after last transmission in order to signal connected clients the software is still alive. When no messages have been received by a client for a longer time (e.g. for more than 150 seconds), the client should close the connection and try to reconnect. This alive-message does not provide any further information and therefore comes with an empty `BCMsg`-node:

```
<?xml version="1.0" encoding="UTF-8"?>
  <BCMsg/>
```

Status Message

This message is sent whenever the operational state of the application changes. It comes with a sub-node `Data` which contains an attribute `State`:

```
<?xml version="1.0" encoding="UTF-8"?>
  <BCMsg>
    <Data State="<state>"/>
  </BCMsg>
```

Here `<state>` can have following values:

`idle` – software is started but marking dialogue is not open and no mark operation is running

`ready` – mark dialogue is open but no marking operation is active yet

`marking` – a marking process is active

`paused` – a sliced 3D project was halted by pressing the “Pause”-button in mark dialogue; when this project is continued later and no error happens, it switches back to state “`marking`”

`error` – an error occurred, no marking is possible at the moment; in case this state is used, an additional Attribute `Text` provides the error text related to the current error (using the language the software is running with)

Project Message

This message specifies which project is loaded at the moment. It comes with a sub-node `Data` which contains an attribute `Project`:

```
<?xml version="1.0" encoding="UTF-8"?>
  <BCMsg>
    <Data Project="<pathname>"/>
  </BCMsg>
```

Here `<pathname>` is the full path to the project file which just was loaded. When it is empty, the "New" function was used and the last project was flushed completely.

Immediate Trace Messages

This message is submitted as soon as an element is about to be marked where the “Trace data” option is set:

```
<BCMsg Time="2020-02-07T09:11:19" ID="B0C0904A5F15">
  <Trace Name="<name>" ID="<identifier>"/>
</BCMsg>
```

The body encapsulates exactly one nodes of type `<Trace>` that contains an attribute `Name` which keeps the name of the element in project which is about to be marked. For input elements an additional attribute `ID` is contained which holds the input data which have been processed.

Please note: the information provided here only inform about the fact the current element is about to be marked. Since this software can't check if e.g. the working piece really was in place and was properly aligned, it does not necessarily mean the marking result was as expected, so additional inspection may be necessary with the working piece in order to ensure the correct result. Beside of that at this point it is also not known if the marking cycle was interrupted, possibly before the element announced with this message was processed. So to get a summary about the successful completion of a marking operation, refer to the “Number-Of-Parts Message” below.

Number-Of-Parts Message

This message returns information about the current part number which has been produced and corresponds to the `parts`-parameter in global settings. When a `<parts>`-value of 0 is sent, the parts-counter was reset by the operator. Additionally there can be some optional attributes `ID` which uniquely identifies the current working piece and `ProdID` which uniquely identifies the product which is currently process. These identifiers typically are set externally, e.g. when RepliMark is integrated into an automated production line where previous machines provide these data via a suitable communication interface (like a Hermes connection):

```
<?xml version="1.0" encoding="UTF-8"?>
  <BCMsg>
    <Data Parts="<parts>" ID="<id>" ProdID="<prodid>">
      <Trace Name="<name>" />
      <Trace Name="<name>" ID="<identifier>" />
    </Data>
  </BCMsg>
```

The `<Data>`-section may encapsulate one or more nodes of type `<Trace>` when the “Trace data” option is enabled for elements in the current project. Every `<Trace>` section contains an attribute `Name` which keeps the name of the element in project which has been processed successfully by the last marking operation. For input elements an additional attribute `ID` is contained which holds the input data which have been processed. So this functionality can be used e.g. for traceability purposes. Since the Number-of-Parts message is emitted only in case a marking cycle was performed successfully, did not fail due to an error and was not interrupted by a stop-operation, the data contained in this message can be used for further automated processing of the produced working piece. Together with an input element that provides unique data, it can be identified uniquely.

These trace information are also submitted immediately with an own message as soon as the related element is about to be marked. For more information please refer to the “Immediate Trace Message” above. Please note: the information provided here only inform about the fact a marking cycle has been performed successfully. Since this software can't check if e.g. the working piece really was in place and was properly aligned, it does not necessarily mean the marking result was as expected, so additional inspection may be necessary with the working piece in order to ensure the correct result.

Process data Message

This message is sent when a process control plug-in is used and when this plug-in sends measured process data. These process data are provided via this interface:

```
<?xml version="1.0" encoding="UTF-8"?>
  <BCMsg>
    <Process Name="<name>" Unit="<unit>" Idx="<index>" Value="<value>" />
  </BCMsg>
```

The data are encapsulated in a `Process`-tag which can exist several times within a XML package and which contains the following attributes:

`Name` – the name of the measured `<value>`

`Unit` – the measurement unit the `<value>` is given with

`Idx` – an index value in range 0..3; a plug in can measure up to four different values, this index specifies which of these values is provided

`Value` – the measured `<value>` which is further specified by the other attributes

Notification message

Using this message, generic information can be submitted to a client. Such a notification message contains some text which is useful to the user and which can have different priorities:

```
<?xml version="1.0" encoding="UTF-8"?>
  <BCMsg>
    <Msg Src="<sender>" Text="<shorttext>" Prio="<prio_number>"
    PrioText="<prio_text>" Desc="<detailtext>"/>
  </BCMsg>
```

Different to the preceding ones this message provides different attributes within a `Msg`-tag:

- `Src` specifies the sender of this notification message, here either a unique machine identifier is provided (in case it is available) or a generic description
- `Text` is a short variant of the notification text, it acts as some kind of headline to give an overview what the notification is about
- `Desc` is the complete, detailed notification message
- `Prio` is a number and `PrioText` is a text corresponding to the number, both specify the priority this notification has:
 - 1 = "Fatal error"
 - 2 = "Error"
 - 3 = "Warning"
 - 4 = "Info"
 - all values >4 = "Other"

5.20 MQTT Data Interface

The interface described here is one-way only. The application connects to a MQTT broker (as configured in "5.5 Machine Configuration") and sends state information to this broker which then can be used by other clients which are connected to the same MQTT data broker.

When only this interface is used, it is possible to watch processing of one or more RepliMark-controlled machines without the need to have an eye on them all the time. As soon as something important happens which requires user interaction, a notification is sent via the MQTT Data Interface. This notification can be analysed by a suitable client application which then informs the user that something has to be done at a specific machine. Now the operator can check that machine.

In combination with the RepliServer remote control interface or when programming interface of libRepliMark is used out of an own application, this interface gives extended possibilities to automate production with RepliMark according to the concept of smart factories. Now not only detailed state information are available but it is possible to react on them automatically. So e.g. when marking came to an end the application can decide if it starts the next marking operation or if it is necessary to have some operator interaction in order to continue production.

For more details about the RepliMark programming interface, please refer to the information about BeamSDK at <https://halaser.eu/feature.php#BeamSDK>.

For more details about the MQTT protocol, please refer to <https://mqtt.org>

5.20.1 MQTT Messages

RepliMark sends several MQTT-messages to a connected broker automatically when a related event occurs. These messages provide state information but the interface does not accept any data sent by the broker RepliMark has connected to. So independent to what (unauthorized) client the software may connect to, it is not possible to cause any dangerous operation via this connection.

The data provided via the MQTT data interface are structured according to the MQTT specification and contain information as described below. Here the field "Topic" always contains a part `<basetopic>`, this is the topic as configured in "5.5 Machine Configuration". Unless otherwise noted all data come as plain ASCII-texts.

Status Message

This message is sent whenever the operational state of the application changes:

Topic: <basetopic>/state/

Data: `IDLE` – software is started but marking dialogue is not open and no mark operation is running

`READY` – mark dialogue is open but no marking operation is active yet

`MARKING` – a marking process is active

`PAUSED` – a sliced 3D project was halted by pressing the “Pause”-button in mark dialogue; when this project is continued later and no error happens, it switches back to state “`MARKING`”

`ERROR` – an error occurred, no marking is possible at the moment; in case this state is used, an additional error-message is submitted

Error Message

This message is sent whenever the operational state of the application changes to or from “`ERROR`”:

Topic: <basetopic>/error/

Data: an error text in case a previous status message signalled an error state or an empty string in case no error happened or in case a previous error was reset

Project Message

This message specifies which project is loaded at the moment:

Topic: <basetopic>/project/

Data: the full path to the project file which just was loaded. When it is empty, the “New” function was used and the last project was flushed completely.

Number-Of-Parts Message

This message returns information about the current part number which has been produced and corresponds to the parts-parameter in global settings. When a value of 0 is sent, the parts-counter was reset by the operator:

Topic: <basetopic>/parts/

Data: the number of parts (as human readable ASCII-text)

6 ScannerAdjust

6.1 Overview

When a scanhead – a system with two mirrors that deflect a laser in X and Y direction – is used, the resulting movement on the working area can be distorted. Here a few major reasons for distortions can be found:

1. a pincushion distortion that is caused by the mirrors and the used optics
2. a 3D focal distortion that happens because the distance between last mirror and working area differs dependent on the position where the laser hits it – the distance is shorter in the middle directly below of the mirror and longer on the borders of the working area, resulting in a loss of focus for some of the positions
3. a spatial correction because the scanhead is not mounted in parallel to working area because it has to work inside of a concave working piece

To correct such distortions special correction tables are used. In most cases these correction tables are specific to and delivered together with a scanhead. They use a vendor-specific file format that has to be converted depending on the used software/the used scanner controller plug-in. In other cases no such correction file exist and has to be generated from scratch. As a third case for some very high accuracy applications existing correction files have to be modified so that they fit to the used hardware exactly.

All these three tasks can be done with ScannerAdjust correction file tool that is described here. The resulting correction table afterwards can be saved in RepliMark HD (.bco) correction file format – a special format that provides much better accuracy than most other formats. Such a correction file can be used for some of the scanner controller plug-ins of RepliSLS3D software package directly.

The usage of the ScannerAdjust software is described in RepliSLS3D manual, so for a detailed description with usage examples please refer there.

7 BeamControl

As described above, RepliMark is a fully featured editor with loads of functions to create projects, manipulate geometries, modify parameters and even to control the whole process of marking. Although it contains a user management which gives the possibility to hide functions from users which are not privileged to do specific things, often it does not make sense to place this fully equipped software on a machine which does nothing more than marking already existing projects.

Here BeamControl comes into account (not to be confused with AndroidBeamControl which is an app for an Android-device and intended to watch running instances of RepliMark or even BeamControl). This software is stripped down to the minimum functionality that is needed for loading a project and marking it. It has a plain and clear user interface offering only these functions which are really needed, comes with big buttons and input fields that allow usage with a touch-screen and even provides a user management to not to let users start potential dangerous operations which are not privileged to do that.

BeamControl comes as separate executable which is located in HALsoftware installation directory (Windows) or in standard search path \$PATH (Linux). It is up to the machine integrator to start this application automatically and in foreground.

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