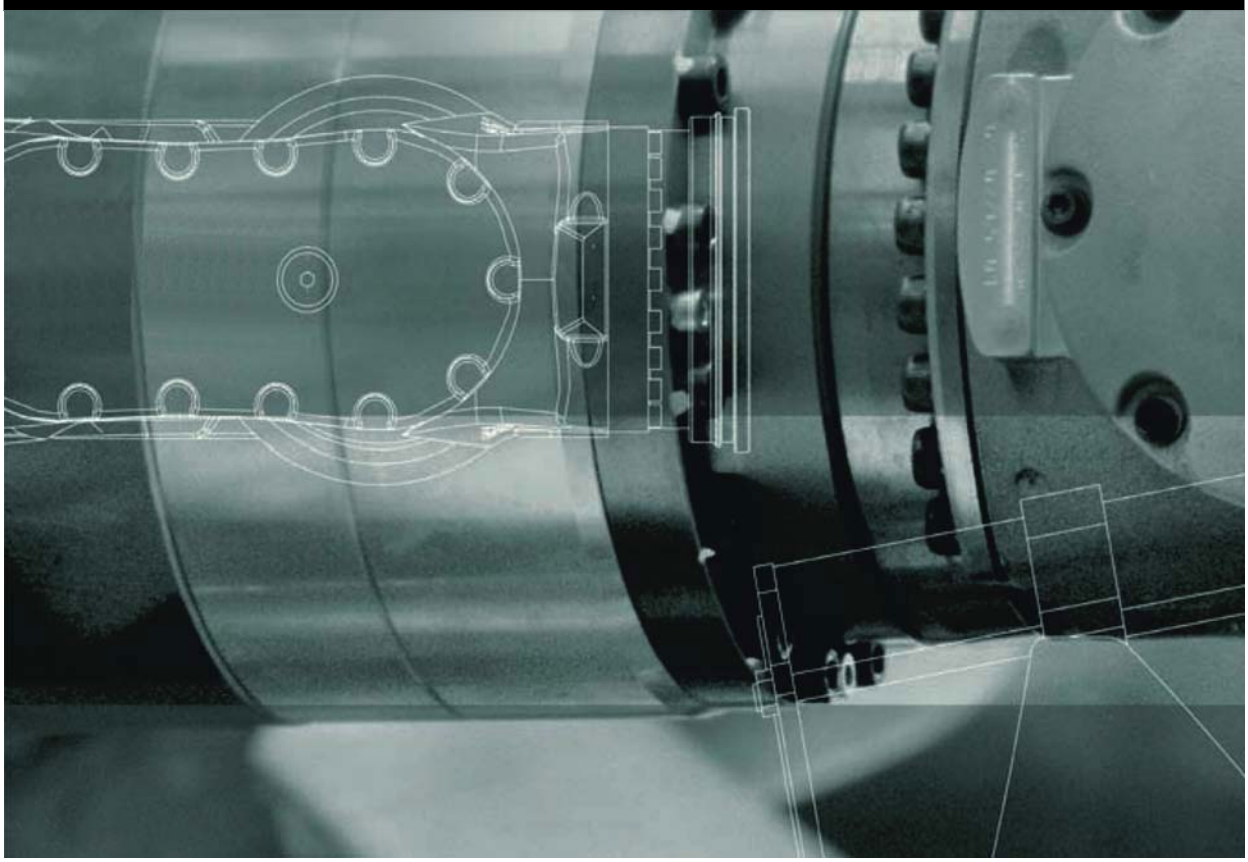
KUKA

KUKA System Technology

KUKA Roboter GmbH

KUKA.LaserTech 3.0

For KUKA System Software 8.2



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Other functions not described in this documentation may be operable in the controller. The user has no claims to these functions, however, in the case of a replacement or service work.

We have checked the content of this documentation for conformity with the hardware and software described. Nevertheless, discrepancies cannot be precluded, for which reason we are not able to guarantee total conformity. The information in this documentation is checked on a regular basis, however, and necessary corrections will be incorporated in the subsequent edition.

Subject to technical alterations without an effect on the function.

Translation of the original documentation

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Contents

1 Introduction

1.1 Target group

This documentation is aimed at users with the following knowledge and skills:

- Advanced KRL programming skills
- Advanced knowledge of the robot controller system
- Advanced knowledge of the laser controller systems
- Knowledge of the other peripheral controller systems (e.g. distance controller)
- Knowledge of field bus interfaces

For optimal use of our products, we recommend that our customers take part in a course of training at KUKA College. Information about the training program can be found at www.kuka.com or can be obtained directly from our subsidiaries.

1.2 Industrial robot documentation

The industrial robot documentation consists of the following parts:

- Documentation for the manipulator
- Documentation for the robot controller
- Operating and programming instructions for the KUKA System Software
- Documentation relating to options and accessories
- Parts catalog on storage medium

Each of these sets of instructions is a separate document.

1.3 Representation of warnings and notes

Safety

These warnings are relevant to safety and **must** be observed.

DANGER These warnings mean that it is certain or highly probable that death or severe injuries **will** occur, if no precautions are taken.

WARNING These warnings mean that death or severe injuries **may** occur, if no precautions are taken.

CAUTION These warnings mean that minor injuries **may** occur, if no precautions are taken.

NOTICE These warnings mean that damage to property **may** occur, if no precautions are taken.

These warnings contain references to safety-relevant information or general safety measures. These warnings do not refer to individual hazards or individual precautionary measures.

Notes

These hints serve to make your work easier or contain references to further information.

Tip to make your work easier or reference to further information.

1.4 Terms used

Term	Description
Cross Jet	Gas that keeps the lens of the laser free of dirt.
Laser program	Program executed in the laser controller.
Process gas	The process gas keeps the welding site free from oxygen, thereby protecting the seam against oxidation.
Root gas	Process gas that protects the seam against oxidation from beneath. Only relevant in the case of through-welding of the plate and if gas can be fed in from underneath.

1.5 Trademarks

TruControl is a trademark of Trumpf.

2 Product description

2.1 Overview of KUKA.LaserTech

Functions

KUKA.LaserTech is an add-on technology package with the following functions:

- Configuration and programming of laser applications
- Configuration and programming of laser cutting applications
- Configuration and programming of laser welding applications with/without filler wire

The backwards movement option is deactivated when working with this technology package.

Areas of application

- Laser cutting
- Laser welding

KUKA.LaserTech supports the following systems:

- TRUMPF laser controllers
- PRECITEC distance controllers (for laser cutting)

For information about adaptation for systems from other manufacturers, please contact KUKA Roboter GmbH. (>>> 11 "KUKA Service" Page 81)

Communication

The robot controller communicates with the laser controller via a field bus.

2.2 Laser power and path velocity

KUKA.LaserTech regulates the laser power proportionally to the velocity of the robot. If the programmed robot velocity is not reached, the laser power is reduced accordingly.

The proportionality is restricted by the upper and lower power limits of the laser. The lower power limit of the laser is always > 0, as the laser power cannot be regulated down to 0.

Precondition for velocity-dependent laser power:

The parameter LSR_UsePwrVelCtrld must be set to TRUE in the configuration.

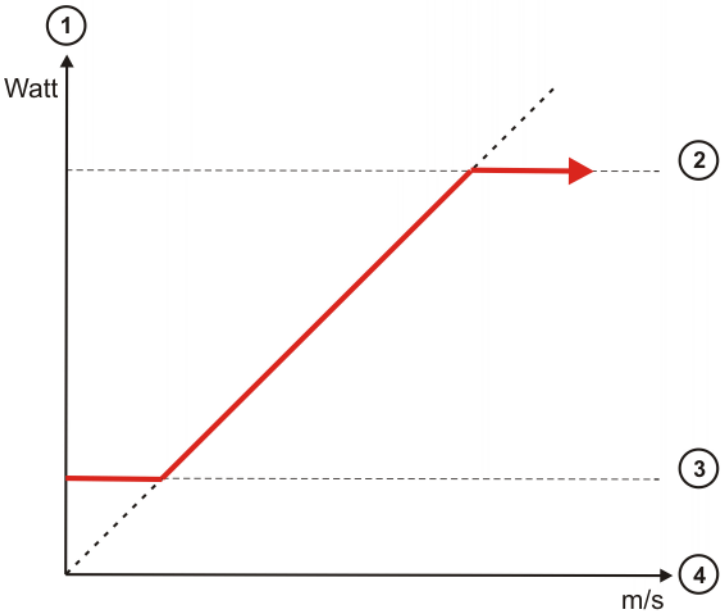

Fig. 2-1: Relationship between velocity and laser power

1 Laser power in watts
2 Upper laser power limit
3 Lower laser power limit
4 Velocity in m/s

3 Safety

This documentation contains safety instructions which refer specifically to the software described here.

The fundamental safety information for the industrial robot can be found in the “Safety” chapter of the Operating and Programming Instructions for System Integrators or the Operating and Programming Instructions for End Users.

The “Safety” chapter in the operating and programming instructions must be observed. Death to persons, severe injuries or considerable damage to property may otherwise result.

The safety standards must be observed when working with the laser. Injuries or damage to property may otherwise result. For further information and specification of the laser class, please refer to the documentation of the laser manufacturer.

The safety measures of the laser system must be observed when wiring the system. In particular the EMERGENCY STOP circuit and operator safety must be wired correctly before this software is used. Injuries or damage to property may otherwise result. The safety measures of the laser system can be found in the documentation of the laser manufacturer.

4 Installation

4.1 System requirements

Hardware

- KR C4
- KUKA field bus cards (Interbus or PROFIBUS)
- Specific components for the application

Software

- KUKA System Software 8.2

4.2 Installing or updating KUKA.LaserTech

It is advisable to archive all relevant data before updating a software package.

Preparation

- Copy software from CD to KUKA USB stick.
  The software must be copied onto the stick with the file Setup.exe at the highest level (i.e. not in a folder).

NOTICE Recommendation: Use a KUKA stick. Data may be lost if any other stick is used.

Precondition

- "Expert" user group

Procedure

1. Connect the USB stick to the robot controller or smartPAD.
2. In the main menu, select **Start-up** > **Install additional software**.
3. Press **New software**. The entry **LaserTech** must be displayed in the **Name** column and drive **E:** or **K:** in the **Path** column.
   If not, press **Refresh**.
4. If the specified entries are now displayed, continue with step 5.
   If not, the drive from which the software is being installed must be configured first:
   - Press the **Configuration** button. A new window opens.
   - Select a line in the **Installation paths for options** area.
     Note: If the line already contains a path, this path will be overwritten.
   - Press **Path selection**. The available drives are displayed.
   - Select **E:**. (If stick connected to the robot controller.)
     Or select **K:**. (If stick connected to the smartPAD.)
   - Press **Save**. The window closes again.

   The drive only needs to be configured once and then remains saved for further installations.
5. Mark the entry **LaserTech** and click on **Install**. Answer the request for confirmation with **Yes**.
6. Confirm the reboot prompts with **OK**.
7. Remove the stick.
8. Reboot the robot controller.
   On rebooting, a reminder is displayed about installing the LaserWeld and LaserCut options. If the reminder should not be displayed again, select **No longer ask**.

During installation of LaserTech, the LaserWeld and LaserCut options are copied to the directory D:\KUKA_OPT. If required, the options must be installed separately from this directory.

LOG file A LOG file is created under C:\KRC\ROBOTER\LOG.

4.3 Uninstalling LaserTech

It is advisable to archive all relevant data before uninstalling a software package.

Precondition

- "Expert" user group

Procedure

1. Select **Start-up** > **Install additional software** in the main menu. All additional programs installed are displayed.
2. Depending on which part of the technology package is to be uninstalled, select the corresponding entry:
   - LaserTech: select the entry **LaserTech**.
   - LaserWeld: select the entry **LaserWeld**.
   - LaserCut: select the entry **LaserCut**.
3. Press **Uninstall**. Reply to the request for confirmation with **Yes**. Uninstallation is prepared.
4. Reboot the robot controller. Uninstallation is resumed and completed.

LOG file A LOG file is created under C:\KRC\ROBOTER\LOG.

5 Operation

5.1 Menus

The following menus and commands are specific to this technology package:

Main menu:

- **Configuration** > **Status keys**
  - **LaserTech**
  - **Laser Cut**

Menu sequence **Commands** > **LaserTech**

- **Switching**
  - **Activate process**
  - **Switch process**
  - **Deactivate process**
  - **Step seam**
  - **Laser test pulse**
- **Control commands**
  - **Initialize laser**
  - **Enable laser**
  - **Laser off**
  - **Laser request**
- **Media control**
  - **Switch gas**
  - **Initialize gas**
  - **Cut wire**
- **Sensor control**
  - **Switch sensor**
  - **Sensor settings**
- **Cutting**
  - **Rectangle**
  - **Slot**
  - **Hexagon**
  - **Circle**

5.2 Basic laser function status keys

Select **Configuration** > **Status keys** > **LaserTech** in the main menu to display the status keys.

For safety reasons, the status keys are deactivated. To activate them, the enabling switch on the smartPAD must be pressed.

The status keys are not available in Automatic External mode.

	Off	On	Inactive	Description
Laser				The status key “Laser off” is displayed: the program is executed without laser power. The status key “Laser on” is displayed: the program is executed with laser power.
Pilot laser				Pressing “Pilot laser off” switches the pilot laser on. Pressing “Pilot laser on” switches the pilot laser off.
Gas				Pressing “Gas off” activates the process gas, root gas and CrossJet. Releasing the status key stops the flow of gas. **Note**: When process gas, root gas and CrossJet is activated, the high pressure of the emerging gas may result in injuries and in material damage to sensitive system components. Do not aim the gas at the body.
Wire				Pressing “Wire off” activates the wire feed. Releasing the status key stops the wire feed. **Note**: Welding wire emerging from the wire feeder can cause injuries to hands, face and eyes. Be sure to maintain a safe distance.

5.3 LaserCut status keys

Select **Configuration** > **Status keys** > **Laser Cut** in the main menu to display the status keys.

For safety reasons, the status keys are deactivated. To activate them, the enabling switch on the KCP must be pressed.

The status keys are not available in Automatic External mode.

	Off	On	Inactive	Description
Sensor				Status key “Sensor off” is displayed: the sensor functions are inactive. Status key “Sensor on” is displayed: the sensor functions are active.
Distance control				Pressing “Distance control Off” switches distance control on. Pressing “Distance control On” switches distance control off.

	Off	On	Inactive	Description
Reference run	—			Pressing “Reference run on” starts a reference run.
Sensor in position	—			Pressing “Sensor in position” moves the sensor to the “programmed position”.

6 Start-up and configuration

Overview

Step	Description
1	Install and prepare the laser controller; in particular: prepare the laser program. (>>> 6.1 "Laser program" Page 19)
2	Configure the field bus between the robot controller and the laser controller in WorkVisual.
3	Calibrate the tool and base.
4	Configure gas types for inline forms. (>>> 6.2 "Configuring gas types for inline forms" Page 19)
5	Configure the inputs/outputs for gases and other properties. (>>> 6.3 "Configuring the inputs/outputs for gases and other properties" Page 20)
6	Configure the program number for the pilot laser. (>>> 6.4 "Configuring the pilot laser" Page 21)
7	Modify maximum values for ramp times (optional). (>>> 6.5 "Modifying maximum values for ramp times" Page 22)

6.1 Laser program

On the laser controller there must be a laser program which can read in the parameters from an external controller (robot).

Fig. 6-1: Required laser program (example)

6.2 Configuring gas types for inline forms

Here the user defines how many types of which gas are to be available in the inline forms. The names displayed in the inline forms for the gases can also be changed.

A maximum of 12 types of gas can be configured.

Precondition

- Windows interface (**Minimize HMI**)

Procedure

1. Open the file LsrTechILf.xml in the directory C:\KRC\TP\LaserTech\LIB.
2. Find the section for gases in the file.
   - Process gases: section `ProcessGas`
   - Root gases: section `RootGas`
   - Cutting gases: section `CutGas`
3. To change the name of a gas, modify the value of `EnumValue Key`.
   To add a gas, copy a line that starts with `EnumValue Key` and paste it after the other lines. Renumber the values of `KrlValue="…"` and `OrderID="…"`.

No modifications may be made other than those specified here!

4. Close the file by means of the **Close** icon and answer the request for confirmation with **Yes**. The file is saved.

Description

Excerpt from the `ProcessGas` section. The structure of the sections for the other gases is analogous.

```
...
<TechParam xsi:type="TechParamEnum" Name="ProcessGas" …
  <EnumValues Max="12">
  <EnumValue Key="Gas1" KrlValue="1" OrderID="0"
VisibleStyle="Allways"/>
  <EnumValue Key="Gas2" KrlValue="2" OrderID="1"
VisibleStyle="Allways"/>
  <EnumValue Key="Gas3" KrlValue="3" OrderID="2"
VisibleStyle="Allways"/>
  <EnumValue Key="Gas4" KrlValue="4" OrderID="3"
VisibleStyle="Allways"/>
  </EnumValues>
</TechParam>
...
```

6.3 Configuring the inputs/outputs for gases and other properties

Precondition

- “Expert” user group

Procedure

1. Open file.
   - Process gases: R1\TP\LaserTech\laser.dat
     Open the `Process Gas Settings` fold.
   - Cutting gases: R1\TP\LASERCUT\lsc_main.dat
     Open the `Cut Gas Settings` fold.
   - Root gases: R1\TP\LaserTech\laser.dat
     Open the `Root Gas Settings` fold.
2. Edit file.
3. Close the file by means of the **Close** icon and answer the request for confirmation with **Yes**. The file is saved.

Description

Excerpt from the `Process Gas Settings` fold in the file laser.dat:

```
LSR_ProcGAS[1]={OUT_NR 430,IN_NR 1025,ANA_GAS_OUT TRUE,
ANA_GAS_IN TRUE,ExtIlf FALSE,ANA_MAX_VALUE 30.0,GAS_NAME[] "NONE"}
```

The structure of the folds in the other files is analogous. The excerpt shows the default values for the properties.

“Proportional Gas Valve” = FALSE

Element	Description
OUT_NR	Number of the digital output that is used to activate the gas
IN_NR	Number of the digital input that is used to indicate that the gas has been activated
ANA_GAS_OUT	Only **FALSE** meaningful.
ANA_GAS_IN	The currently measured gas pressure is returned to this analog channel.
ExtIIf	**TRUE**: advanced monitoring. Not only IN_NR is polled, but also the actual analog value of the gas pressure.
ANA_MAX_VALUE	Value irrelevant.
GAS_NAME[]	Default value: **“NONE”** Modification of the default value does not have any effect.

“Proportional Gas Valve” = TRUE

Element	Description
OUT_NR	Number of the digital output that is used to activate the gas (The number of the analog channel is defined using the configuration parameter LSRO_GasPressure.)
IN_NR	Number of the digital input that is used to indicate that the gas pressure is OK (The number of the analog channel is defined using the configuration parameter LSRI_GasPressure.)
ANA_GAS_OUT	**TRUE**: this gas uses a proportional gas valve. **FALSE**: this gas does not use a proportional gas valve.
ANA_GAS_IN	The currently measured gas pressure is returned to this analog channel.
ExtIIf	**TRUE**: advanced monitoring. Not only IN_NR is polled, but also the actual analog value of the gas pressure.
ANA_MAX_VALUE	Maximum gas pressure transferred by the laser controller. If a higher value is set in the inline form, the lower value set here nonetheless applies. Unit: bar. Value must be greater than 0.0.
GAS_NAME[]	Default value: **“NONE”** Modification of the default value does not have any effect.

6.4 Configuring the pilot laser

Here the program number is defined that is to be selected internally when the pilot laser is switched on using the status key. The program number must be present in the laser controller.

Precondition

- “Expert” user group

- No program is selected.

Procedure

1. Open the file laser.dat in the directory R1\TP\LaserTech.
2. Open the `Temporary Process Setting` fold. In the following declaration, specify the desired program number for the element `LSR_PRG`.

```
DECL GLOBAL LSR_PWR_T LSR_LsrPilotSet={LSR_MAX_PWR 2000,
LSR_MIN_PWR 1,LSR_PRG 20,LSR_RAISE_TIME 1,LSR_DROP_TIME 1}
```

   In this example, laser program 20 is selected (LSR_PRG 20). In order to be able to use the pilot laser, there must be a program with the number 20 on the laser controller.

> The correct fiber number must be entered in the laser program that is selected here. Otherwise it is possible that the pilot laser will not be visible.
> Further settings in the laser controller software must be observed.

3. Close the file by means of the **Close** icon and answer the request for confirmation with **Yes**. The file is saved.

6.5 Modifying maximum values for ramp times

Description

The ramp time when switching on (Laser power rise time) is programmed in the option window **Laser data** – **Activate process**.

(>>> 7.3.10 "Option window “Laser data” – “Activate process”" Page 35)

The ramp time when switching over (Laser power switching time) is programmed in the option window **Laser data** – **Switch process**.

(>>> 7.3.11 "Option window “Laser data” – “Switch process”" Page 36)

The ramp time when switching off (Laser power drop time) is programmed in the option window **Laser data** – **Deactivate process**.

(>>> 7.3.12 "Option window “Laser data” – “Deactivate process”" Page 36)

The maximum values can be modified in the registry.

Procedure

1. Press the Windows **Start** button and select **Run...**.
2. In the **Open** box, enter “regedit” and press **OK**. The **Registry editor** window opens.
3. Select the following folder under “HKEY_CURRENT_USER\Software\VB and VBA Program Settings\KUKATPLASER\” in the tree structure:
   - LSR_DROP_TIME (for ramp time when switching off)
   - LSR_RAISE_TIME (for ramp time when switching on)
4. Click on the parameter **Max** and select **Change**.
5. Enter the desired value and confirm it by pressing **OK**.

7 Programming

NOTICE Following creation of a laser program or modification of laser and motion commands, the program sequence, the actual switching points of the laser and the periphery must be checked. Damage to the system may otherwise result.

7.1 Programming with spline

Overview

The overview shows which LaserTech commands can be used in spline blocks.

Command	Usable in spline block?
Activate process	Yes
Switch process	Yes
Deactivate process	Yes
Step seam	Yes
Laser test pulse	No
Initialize laser	No
Enable laser	Yes
Laser off	No
Laser request	No
Switch gas	Yes
Initialize gas	No
Cut wire	No
Switch sensor	Yes
Sensor settings	Yes
Rectangle, **Slot**, **Hexagon**, **Circle**	No

7.2 Programming tips for KUKA.LaserTech

Ramp times

- To be able to execute ramps, the parameter LSR_RampOption must be set to TRUE.
  (>>> 10.2.6 "LaserTech: Process options" Page 72)
- The ramp time when switching on (Laser power rise time) is programmed in the option window **Laser data** – **Activate process**.
  (>>> 7.3.10 "Option window “Laser data” – “Activate process”" Page 35)
- The ramp time when switching over (Laser power switching time) is programmed in the option window **Laser data** – **Switch process**.
  (>>> 7.3.11 "Option window “Laser data” – “Switch process”" Page 36)
- The ramp time when switching off (Laser power drop time) is programmed in the option window **Laser data** – **Deactivate process**.
  (>>> 7.3.12 "Option window “Laser data” – “Deactivate process”" Page 36)
- The maximum values in the option windows can be modified in the registry.
  (>>> 6.5 "Modifying maximum values for ramp times" Page 22)

Delay times

Procedure:

1. Program weld seams.
2. Determine the delay times empirically.

Set the following parameters according to these times:

- LSR_ShutterDelayConst
- LSR_ShutterOn
- LSR_ShutterOff

(>>> 10.2.6 "LaserTech: Process options" Page 72)

3. For the other weld velocities, adapt the switching points by means of the Path specification in the inline forms.

Parameter values:

The delay times are defined using the following parameters:

- Delay time when switching on = LSR_ShutterDelayConst + LSR_ShutterOn
- Delay time when switching off = LSR_ShutterDelayConst + LSR_ShutterOff
- Delay time when switching over = LSR_ShutterDelayConst - LSR_ShutterOn

These parameters are only used to compensate for delay times. They must not be used to offset switching points.

NOTICE If laser programs are already present and the delay times are changed, this can cause the activation and deactivation points of the laser to be shifted so far that damage to the device or other system components can result. Check existing programs following a modification.

Example 1

Required delay:

- When switching on: 80 ms
- When switching off: 50 ms
- When switching over: 20 ms

Set parameters:

- LSR_ShutterDelayConst = 50
- LSR_ShutterOn = 30
- LSR_ShutterOff = 0

Example 2

Required delay:

- When switching on: 80 ms
- When switching off: 50 ms
- When switching over: 0 ms

If the delay when switching over is to be 0 ms, LSR_ShutterDelayConst and LSR_ShutterOn must always have the same value.

Set parameters:

- LSR_ShutterDelayConst = 40
- LSR_ShutterOn = 40
- LSR_ShutterOff = 10

Standstill monitoring

If the robot is stationary and the laser power is active, the shutter automatically closes after a defined time. The time is defined via the parameter LSR_Stop_InspectionTime. The purpose is to prevent the laser from burning through the material.

If welding is to be carried out for longer at a specific position, i.e. without robot motion, the value of LSR_Stop_InspectionTime must be increased.

(>>> 10.2.6 "LaserTech: Process options" Page 72)

NOTICE If the value of LSR_Stop_InspectionTime is changed or if the option is deactivated, this can result in damage to the system.

If a test pulse is generated using the instruction **Laser test pulse**, the parameter LSR_Stop_InspectionTime is not active.

Switching points

- Program switching points in phases in which the velocity is as constant as possible.
- If a switching action is to be carried out before the taught point, the approximate positioning radius must be selected in such a way that the action is executed in the approximate positioning range of the point.

Circles

- To generate full circles, it is advisable not to teach the coordinates, but to calculate them.
- If the KUKA.ExpertTech technology package is available, use the specification **CA** for the circular angle.

7.3 Programming laser functions

7.3.1 Inline form “Activate process”

Call

- Select the menu sequence **Commands** > **LaserTech** > **Switching** > **Activate process**.

Description

This instruction switches the laser on.

This instruction refers to the next motion instruction in the program. This motion instruction must be a CP motion. There must be no instructions triggering an advance run stop between the laser instruction and the motion instruction.

The CP motion to the laser activation position is generally approximated. In the case of exact positioning to the point, the laser is aimed at the point for longer than in the case of approximate positioning. This means that more energy is directed onto the point than is generally desirable.

If the CUT application is selected, the piercing and cutting data for laser cutting can optionally be defined.

If the piercing and cutting data are defined, the instruction calls a piercing function that implicitly activates the distance sensor. In this case, the instruction replaces the instruction **Switch sensor**.

(>>> 7.6.1 "Inline form “Switch sensor”" Page 45)

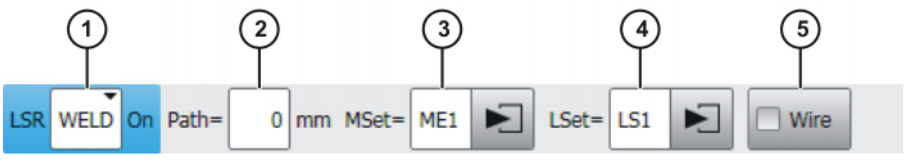

Fig. 7-1: Inline form “Activate process” (with Weld)

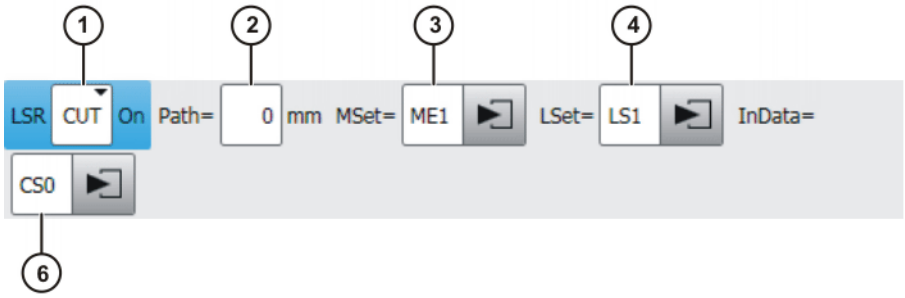

Fig. 7-2: Inline form “Activate process” (with Cut)

Item	Description
1	Selects an application. ■ **[Empty box]**: Only displayed if LaserWeld is not installed. ■ **WELD**: Laser welding (with wire feed) ■ **CUT**: Laser cutting
2	Shifts the activation point of the laser. ■ **-100 … 100 mm** **Note**: If the activation point is shifted to the wrong point, this can result in damage to the device or other system components.
3	Name for the media data (name freely definable) Touch the arrow to edit the data. The corresponding option window is opened. ■ For the applications **[Empty box]** and **WELD**: (>>> 7.3.6 "Option window “Media setting” – activating laser welding" Page 31) ■ For the application **CUT**: (>>> 7.7.4 "Option window “Media data” – activating laser cutting" Page 52)
4	Name for the laser data (name freely definable) Touch the arrow to edit the data. The corresponding option window is opened. (>>> 7.3.10 "Option window “Laser data” – “Activate process”" Page 35)
5	Only relevant for **WELD** application: Use of filler wire ■ **Check box active**: use filler wire. ■ **Check box not active:** do not use filler wire.
6	Only relevant for **CUT** application: Name for the piercing and cutting data (name freely definable) Touch the arrow to edit the data. The corresponding option window is opened. (>>> 7.7.8 "Option window “Sensor parameters” and “Process parameters”" Page 54) This box can be displayed or hidden using the **Add Cut** and **Rem Cut** buttons.

If the gas is activated with the **Switch gas** instruction before the **Activate process** instruction and the setting “Continuous” is activated, the robot controller ignores the media data of the **Activate process** instruction (“Gas pressure” and “Gas preflow time”).
(>>> 7.5.1 "Inline form “Switch gas”" Page 43)
If there is no preceding **Switch gas** instruction with the setting “Continuous”, the gas is activated by the **Activate process** instruction.

7.3.2 Inline form “Switch process”

Call

- Select the menu sequence **Commands** > **LaserTech** > **Switching** > **Switch process**.

Description

This instruction is used to modify the weld parameters within a weld path. The monitoring functions of the laser and weld media remain active following this instruction. If the application WELD is selected, the wire is fed further.

This instruction refers to the next motion instruction in the program. This motion instruction must be a CP motion.
There must be no instructions triggering an advance run stop between the laser instruction and the motion instruction.

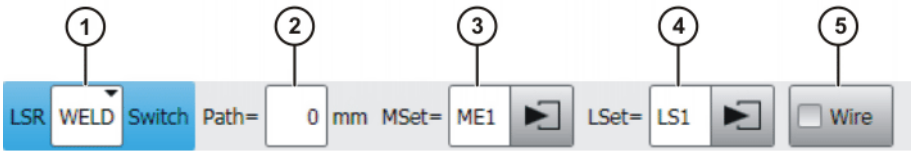

Fig. 7-3: Inline form “Switch process”

Item	Description
1	Selects an application. - **[Empty box]**: Only displayed if LaserWeld is not installed. - **WELD**: Laser welding (with wire feed) - **CUT**: Laser cutting
2	Shifts the switching point of the laser. - **-100 … 100 mm**
3	Name for the media data (name freely definable) Touch the arrow to edit the data. The corresponding option window is opened. - For the applications **[Empty box]** and **WELD**: (>>> 7.3.7 "Option window “Media setting” – switching laser welding" Page 32) - For the application **CUT**: (>>> 7.7.5 "Option window “Media data” – switching laser cutting" Page 52)

Item	Description
4	Name for the laser data (name freely definable) Touch the arrow to edit the data. The corresponding option window is opened. (>>> 7.3.11 "Option window “Laser data” – “Switch process”" Page 36)
5	Only relevant for **WELD** application: Use of filler wire ■ **Check box active**: use filler wire. ■ **Check box not active:** do not use filler wire.

If the **Switch process** instruction is preceded by a **Switch gas** instruction with the setting “Continuous”, the robot controller ignores the parameters in the media set of the **Switch process** instruction (“Gas pressure” and “Gas preflow time”).
(>>> 7.5.1 "Inline form “Switch gas”" Page 43)

7.3.3 Inline form “Deactivate process”

Call

- Select the menu sequence **Commands** > **LaserTech** > **Switching** > **Deactivate process**.

Description

This instruction switches off the laser power and terminates the laser program. The laser is not switched off.

If the gas has been activated earlier in the program with the **Switch gas** instruction and the setting “Continuous”, the robot controller ignores the media data of the **Deactivate process** instruction (“Gas pressure” and “Gas postflow time”).

The gas must be deactivated with the **Switch gas** instruction in such a case.

If there is no preceding **Switch gas** instruction with the setting “Continuous”, the gas is deactivated by the **Deactivate process** instruction.

This instruction refers to the next motion instruction in the program. This motion instruction must be a CP motion.
There must be no instructions triggering an advance run stop between the laser instruction and the motion instruction.

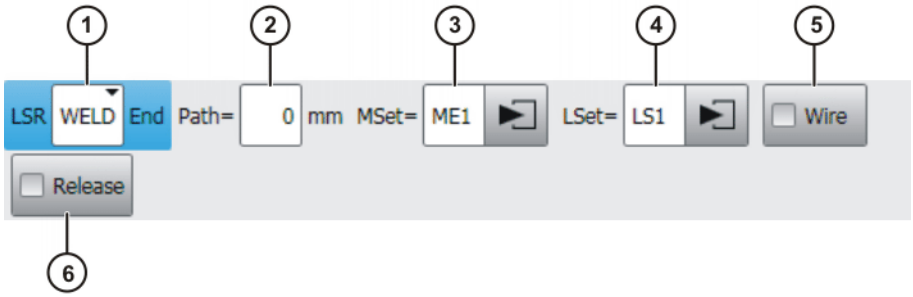

Fig. 7-4: Inline form “Deactivate process” (with Weld)

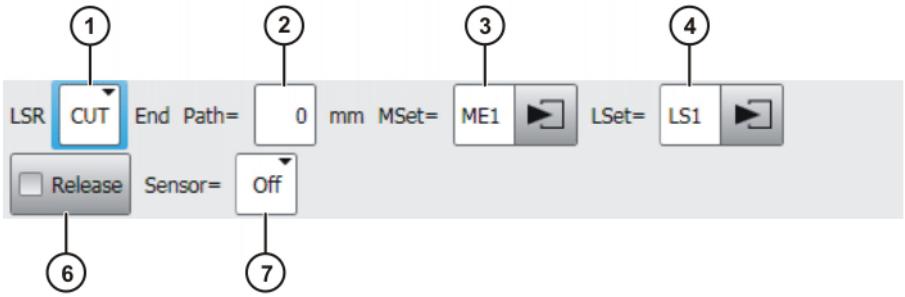

Fig. 7-5: Inline form “Deactivate process” (with Cut)

Item	Description
1	Selects an application. ■ **[Empty box]**: Only displayed if LaserWeld is not installed. ■ **WELD**: Laser welding (with wire feed) ■ **CUT**: Laser cutting
2	Shifts the end point. ■ **-100 … 100 mm**
3	Name for the media data (name freely definable) Touch the arrow to edit the data. The corresponding option window is opened. ■ For the applications **[Empty box]** and **WELD**: (>>> 7.3.8 "Option window “Media setting” – deactivating laser welding" Page 33) ■ For the application **CUT**: (>>> 7.7.6 "Option window “Media data” – deactivating laser cutting" Page 53)
4	Name for the laser data (name freely definable) Touch the arrow to edit the data. The corresponding option window is opened. (>>> 7.3.12 "Option window “Laser data” – “Deactivate process”" Page 36)
5	Only relevant for **WELD** application: Use of filler wire ■ **Check box active**: use filler wire. ■ **Check box not active:** do not use filler wire.
6	■ **Check box active**: The laser is enabled. ■ **Check box not active:** Not enabled.
7	Only relevant for **CUT** application: Distance sensor ■ **Off**: Distance sensor OFF ■ **Hold**: The distance sensor remains in the current position. ■ **PrPos**: The distance sensor goes to the programmed position.

7.3.4 Inline form “Step seam”

Call

- Select the menu sequence **Commands** > **LaserTech** > **Switching** > **Step seam**.

Description

This instruction performs a step seam. The instruction cannot be used with laser welding or laser cutting.

This instruction refers to the next motion instruction in the program. This motion instruction must be a CP motion.
There must be no instructions triggering an advance run stop between the laser instruction and the motion instruction.

The step seam is canceled in the following cases:

- **Activate process** instruction
- **Deactivate process** instruction
- Exact positioning
- A smooth transition is made from a CP motion to a PTP motion.

Step seams are only possible without filler wire.

Step seams are velocity-dependent. If the velocity is modified, the seam must then be checked and optimized.

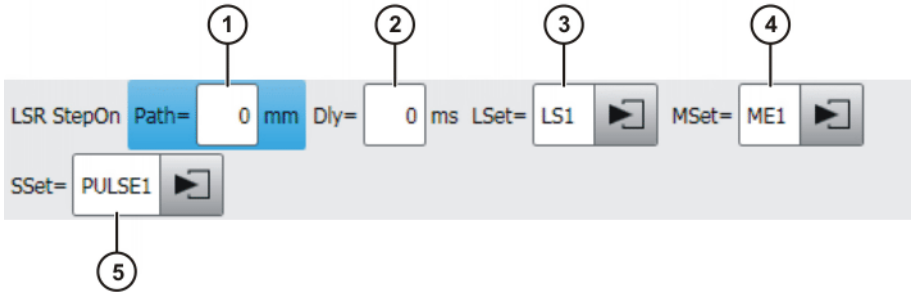

Fig. 7-6: Inline form “Step seam”

Item	Description
1	Shifts the activation point of the laser. ■ **-100 … 100 mm**
2	Execution of the instruction is brought forward in time or delayed. ■ **-100 … 100 ms**
3	Name for the laser data (name freely definable) Touch the arrow to edit the data. The corresponding option window is opened. (>>> 7.3.13 "Option window “Laser data” – “Step seam”" Page 37)
4	Name for the media data (name freely definable) Touch the arrow to edit the data. The corresponding option window is opened. (>>> 7.3.9 "Option window “Media data” – Step seam" Page 34)
5	Name for the step parameters (name freely definable) Touch the arrow to edit the data. The corresponding option window is opened. (>>> 7.3.14 "Option window “Step parameters”" Page 38)

7.3.5 Inline form “Laser test pulse”

Call

- Select the menu sequence **Commands** > **LaserTech** > **Switching** > **Laser test pulse**.

Description

This instruction generates a test pulse.

- The test pulse can be measured to test the laser power. (Precondition: T1 mode.)
- The test pulse can be executed several times to determine the focus of the optics. (Precondition: operating mode T1 or T2.)

NOTICE Not all monitoring functions are active with this instruction. Incorrect use can cause material damage. The instruction may only be used by trained personnel.

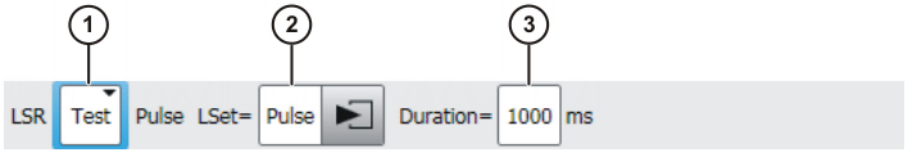

Fig. 7-7: Inline form “Laser test pulse”

Item	Description
1	Select function. ■ **Test**: Test the laser power. ■ **Focus**: Determine the focus of the optics.
2	Name for the laser data (name freely definable) Touch the arrow to edit the data. The corresponding option window is opened. (>>> 7.3.15 "Option window “Laser data” – “Laser test pulse”" Page 38)
3	Duration of the test pulse ■ **12 … 20 000 ms**

7.3.6 Option window “Media setting” – activating laser welding

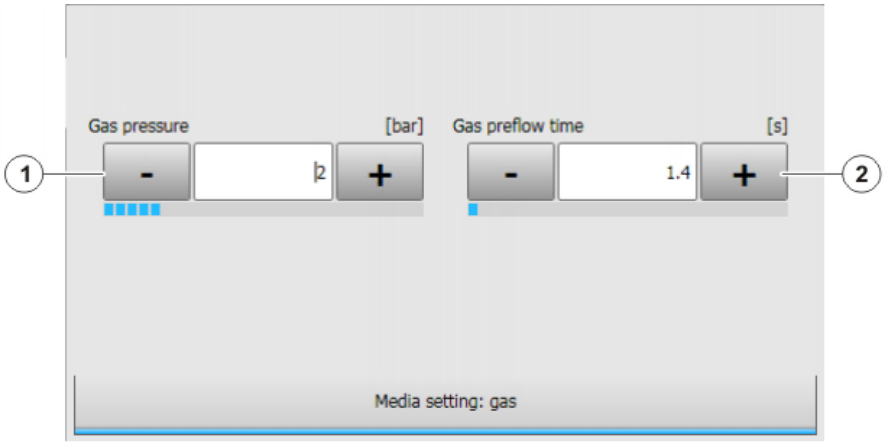

Fig. 7-8: Option window “Media setting: gas” – activating laser welding, without wire

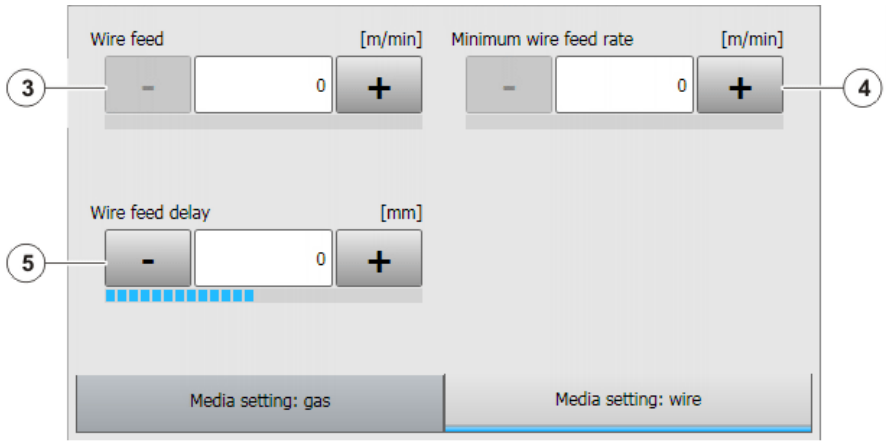

Fig. 7-9: Option window “Media setting: wire” – activating laser welding, with wire

Item	Description
1	Gas pressure ■ **0 … 10 bar**
2	Gas preflow time ■ **0 … 25 s**
3	Wirefeed ■ **0 … 25 m/min**
4	Minimum wire feed rate ■ **0 … 15 m/min**
5	Wirefeed delay ■ **-30 … 30 mm**

7.3.7 Option window “Media setting” – switching laser welding

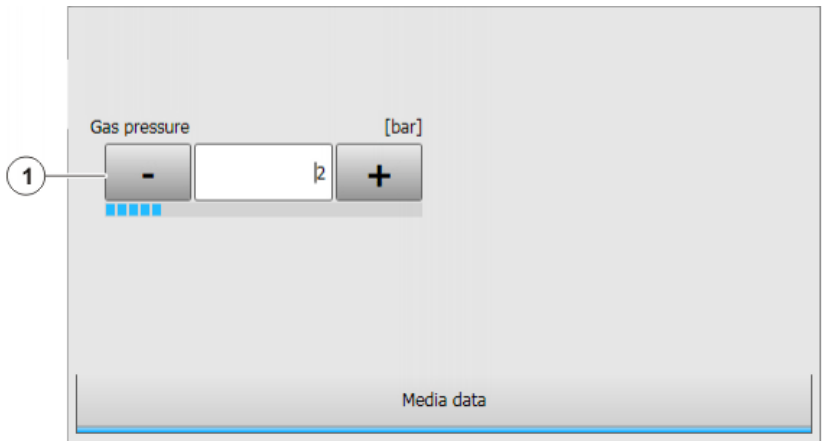

Fig. 7-10: Option window “Media setting: gas” – switching laser welding, without wire

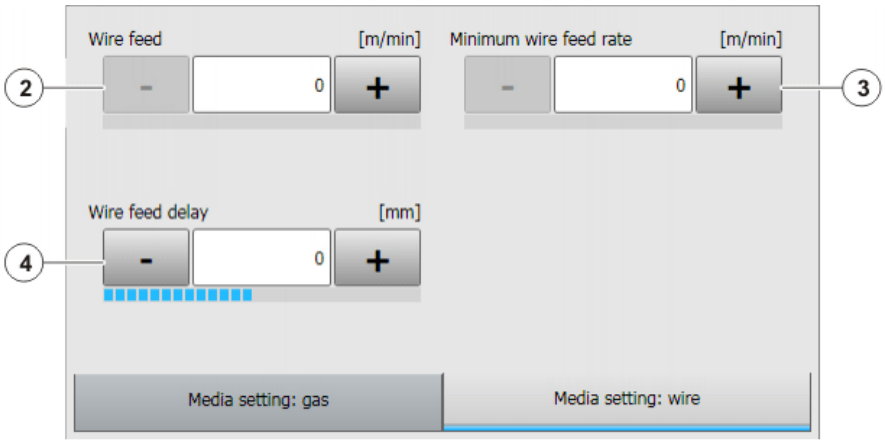

Fig. 7-11: Option window “Media setting: wire” – switching laser welding, with wire

Item	Description
1	Gas pressure ■ **0 … 10 bar**
2	Wirefeed ■ **0 … 25 m/min**
3	Minimum wire feed rate ■ **0 … 15 m/min**
4	Wirefeed delay ■ **-30 … 30 mm**

7.3.8 Option window “Media setting” – deactivating laser welding

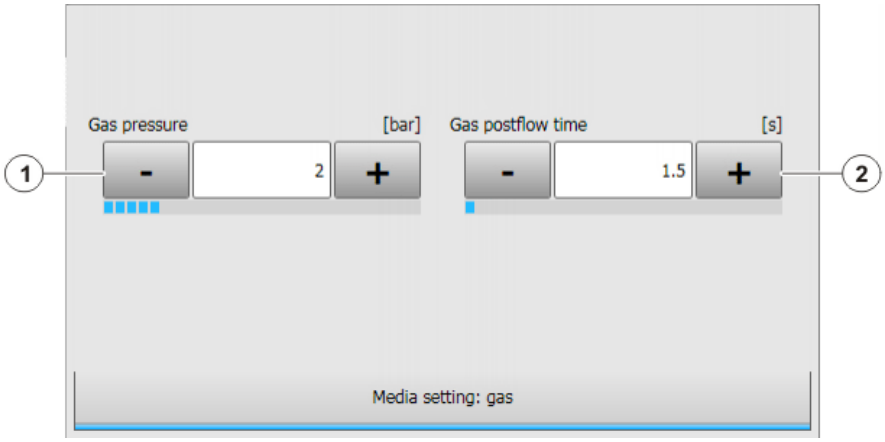

Fig. 7-12: Option window “Media setting: gas” – deactivating laser welding, without wire

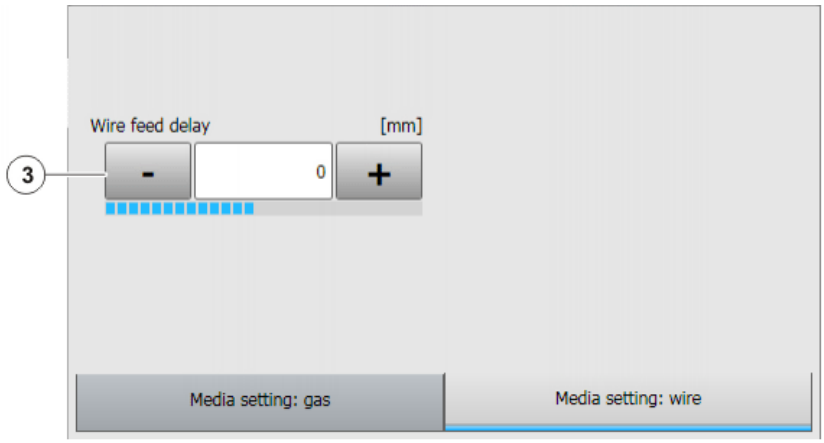

Fig. 7-13: Option window “Media setting: wire” – deactivating laser welding, with wire

Item	Description
1	Gas pressure ■ **0 … 10 bar**
2	Gas postflow time ■ **0 … 25 s**
3	Wirefeed delay ■ **-30 … 30 mm**

7.3.9 Option window “Media data” – Step seam

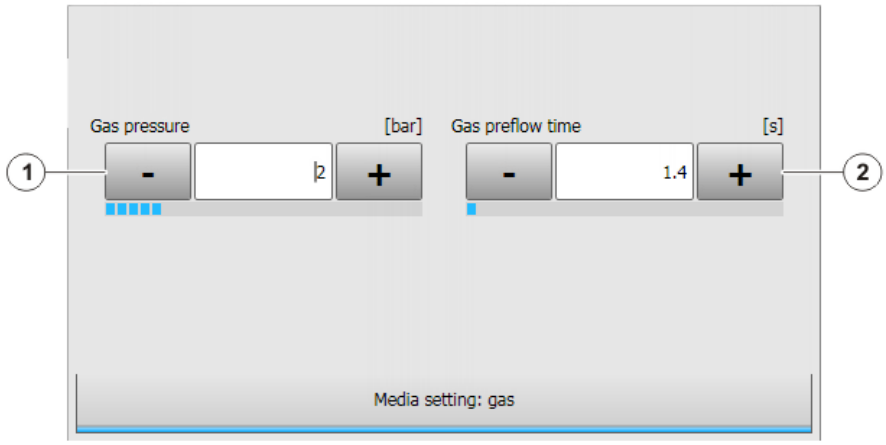

Fig. 7-14: Option window “Media data” – Step seam

Item	Description
1	Gas pressure ■ **0 … 10 bar**
2	Gas preflow time ■ **0 … 25 s**

If the gas preflow time overlaps with the gas postflow time of the previous motion, the gas continues to flow without interruption.

7.3.10 Option window “Laser data” – “Activate process”

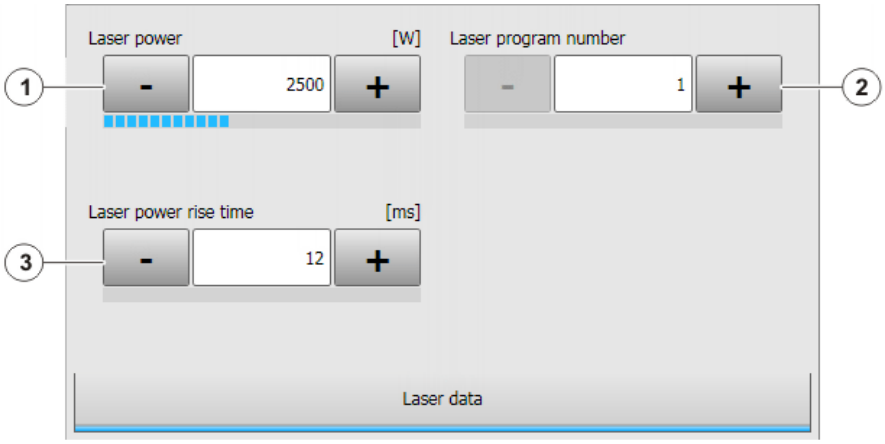

Fig. 7-15: Option window “Laser data” – “Activate process”

Item	Description
1	Laser power at 100% velocity ■ **60 … 6 000 W**
2	Laser program number ■ **1 … 200**
3	Laser power rise time Time that elapses after activation before the laser reaches full power ■ **1 … 2 000 ms** The maximum laser power rise time can be modified in the registry. (>>> 6.5 "Modifying maximum values for ramp times" Page 22) **Note**: The setting is only displayed if the parameter LSR_RampOption has the value TRUE.

Precondition for velocity-dependent laser power:

The parameter LSR_UsePwrVelCtrld must be set to TRUE in the configuration.

7.3.11 Option window “Laser data” – “Switch process”

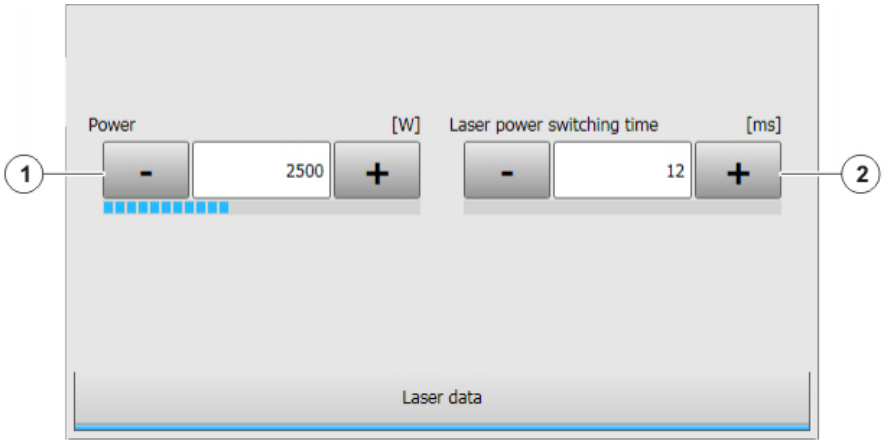

Fig. 7-16: Option window “Laser data” – “Switch process”

Item	Description
1	Laser power at 100% velocity ■ **60 … 6 000 W**
2	Laser power switching time Time that elapses after switching before the laser reaches full power ■ **1 … 2 000 ms** The maximum laser power switching time can be modified in the registry. (>>> 6.5 "Modifying maximum values for ramp times" Page 22) **Note**: The setting is only displayed if the parameter LSR_RampOption has the value TRUE.

7.3.12 Option window “Laser data” – “Deactivate process”

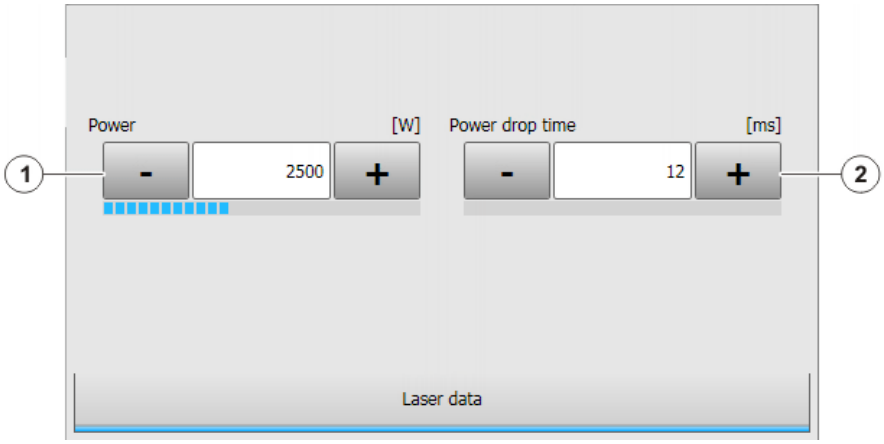

Fig. 7-17: Option window “Laser data” – “Deactivate process”

Item	Description
1	Power limit during deactivation ■ **60 … 6 000 W**
2	Laser power drop time Time taken after deactivation for the laser to decrease its power ■ **1 … 2 000 ms** The maximum laser power drop time can be modified in the registry. (>>> 6.5 "Modifying maximum values for ramp times" Page 22) **Note**: The setting is only displayed if the parameter LSR_RampOption has the value TRUE.

7.3.13 Option window “Laser data” – “Step seam”

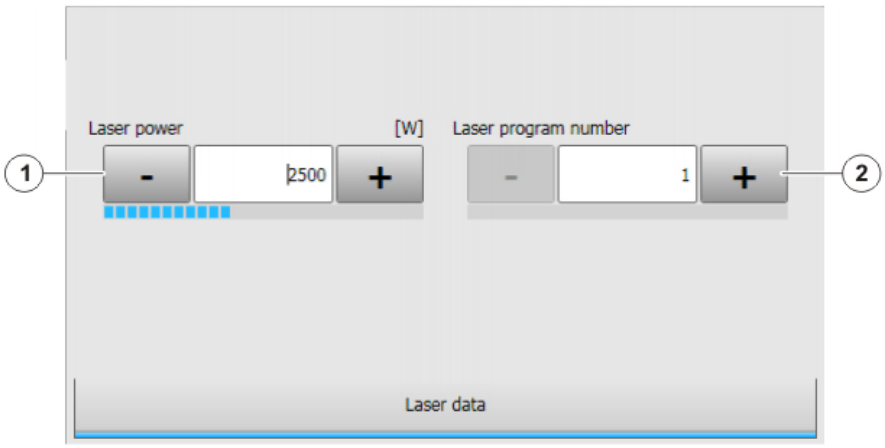

Fig. 7-18: Option window “Laser data” – “Step seam”

Item	Description
1	Laser power at 100% velocity ■ **60 … 6 000 W**
2	Laser program number ■ **1 … 200**

7.3.14 Option window “Step parameters”

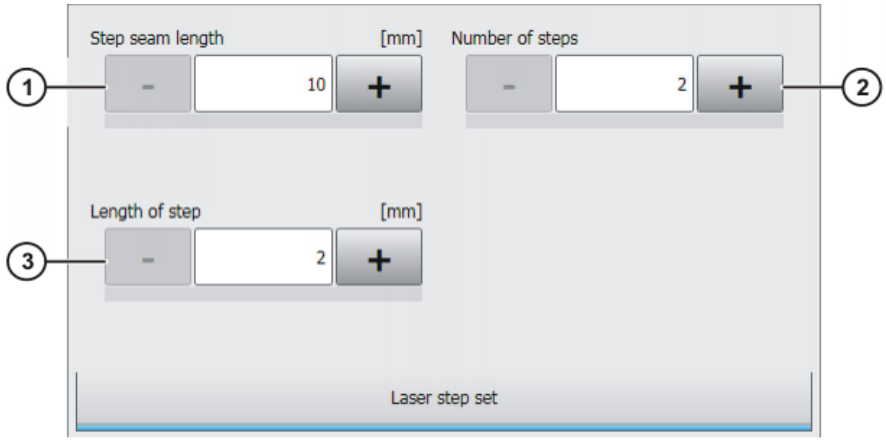

Fig. 7-19: Option window: Step parameters

Item	Description
1	Length of the step seam ■ **10 … 10,000 mm**
2	Number of steps ■ **2 … 500**
3	Length of a step ■ **2 … 50 mm**

7.3.15 Option window “Laser data” – “Laser test pulse”

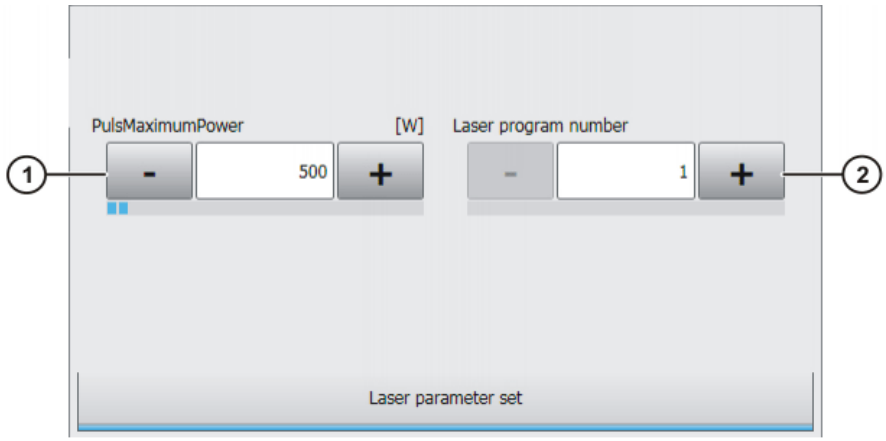

Fig. 7-20: Option window “Laser data” – “Laser test pulse”

Item	Description
1	Laser power for the test pulse ■ **60 … 6,000 W**
2	Laser program number ■ **1 … 200**

7.4 Programming laser control

7.4.1 Inline form “Initialize laser”

Call

- Select the menu sequence **Commands** > **LaserTech** > **Control commands** > **Initialize laser**.

Description

This instruction initializes the laser. The first laser instruction in the KRL program must always be **Initialize laser**.

This instruction triggers an advance run stop.

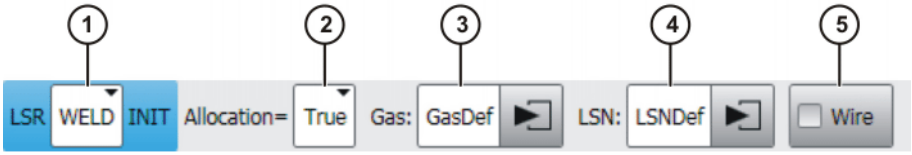

Fig. 7-21: Inline form “Initialize laser”

Item	Description
1	Selects an application. ■ **[Empty box]**: Only displayed if LaserWeld is not installed. ■ **WELD**: Laser welding (with wire feed) ■ **CUT**: Laser cutting
2	Defines whether the laser is to be allocated to the robot during initialization. Only relevant if the robot belongs to a laser network. ■ **True**: Laser is allocated to the robot during initialization. ■ **False**: Laser is not allocated to a robot during initialization.
3	Name for the defined gas types (name freely definable) Touch the arrow to select the gas type. The corresponding option window is opened. ■ For the application **WELD**: (>>> 7.4.5 "Option window “Gas selection” – laser welding" Page 41) ■ For the application **CUT**: (>>> 7.4.6 "Option window “Gas selection” – laser cutting" Page 42)
4	Name for the defined lasers (name freely definable) Touch the arrow to select the laser. The corresponding option window is opened. (>>> 7.4.7 "Option window “Laser network” – Initialize laser" Page 42)
5	Only relevant for **WELD** application: Use of filler wire ■ **Check box active**: use filler wire. ■ **Check box not active:** do not use filler wire.

7.4.2 Inline form “Enable laser”

Call

- Select the menu sequence **Commands** > **LaserTech** > **Control commands** > **Enable laser**.

Description

This instruction can be used to enable the laser for use by other robots at the end of a path. It is only relevant if the robot belongs to a laser network.

The instruction has the following effects:

- The gas supply is shut off.
- The laser is enabled.

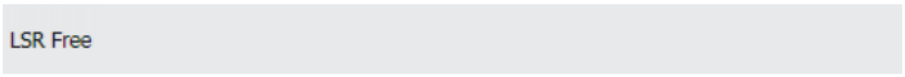

Fig. 7-22: Inline form “Enable laser”

7.4.3 Inline form “Laser off”

Call

- Select the menu sequence **Commands** > **LaserTech** > **Control commands** > **Laser off**.

Description

This instruction has the following effects:

- The laser is deactivated.
- The gas supply is shut off.
- The laser is enabled.
- The laser lamp is switched off.

NOTICE This instruction should only be used if the laser is to be deactivated for a prolonged period.

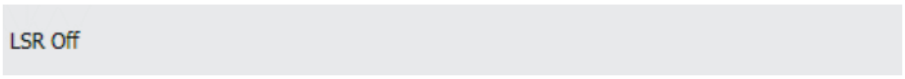

Fig. 7-23: Inline form “Laser off”

7.4.4 Inline form “Laser request”

Call

- Select the menu sequence **Commands** > **LaserTech** > **Control commands** > **Laser request**.

Description

This instruction requests the laser via the signal LSRO_LsrRequest.

It is possible to program the robot controller to wait for the laser if the laser is allocated. To do so, use the instruction with **Allocate** (check box is activated).

The switching point for the instruction should be far enough before the next activation point to enable the robot to brake before the start of the seam to wait for allocation of the laser. Following allocation, the robot must be able to accelerate in order to reach the programmed velocity at the start of the seam. This is possible with the parameters **Path** and **Delay**.

This instruction refers to the next motion instruction in the program. This motion instruction must be a CP motion.
There must be no instructions triggering an advance run stop between the laser instruction and the motion instruction.

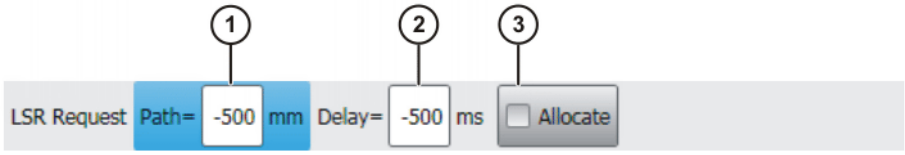

Fig. 7-24: Inline form “Laser request”

Item	Description
1	The point at which the instruction is executed is shifted forwards or backwards. ■ **-2,000 … 1,000 mm**
2	Execution of the instruction is brought forward in time or delayed. ■ **-2,000 … 1,000 ms**
3	Laser Allocate ■ **Check box active**: The robot controller accesses the laser if it is not allocated. If the laser is allocated, the robot stops. The robot controller waits for the laser to be assigned to it. ■ **Check box not active:** If the laser is allocated, the robot controller does not wait until the laser is assigned to it.

7.4.5 Option window “Gas selection” – laser welding

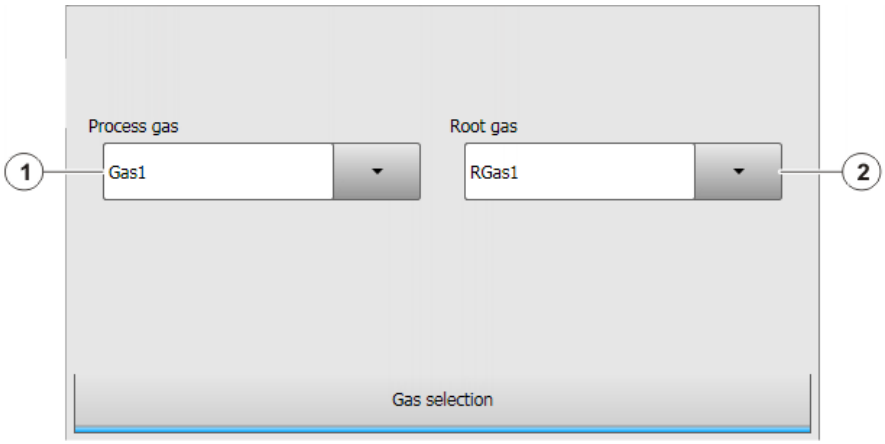

Fig. 7-25: Option window “Gas selection” – laser welding

Item	Description
1	Select process gas. The range of values depends on how many gas types have been configured. (>>> 6.2 "Configuring gas types for inline forms" Page 19)
2	Select root gas. The range of values depends on how many gas types have been configured. (>>> 6.2 "Configuring gas types for inline forms" Page 19) **Note**: This selection box is only displayed if the configuration parameter Lsr_useRootGas is set to TRUE.

7.4.6 Option window “Gas selection” – laser cutting

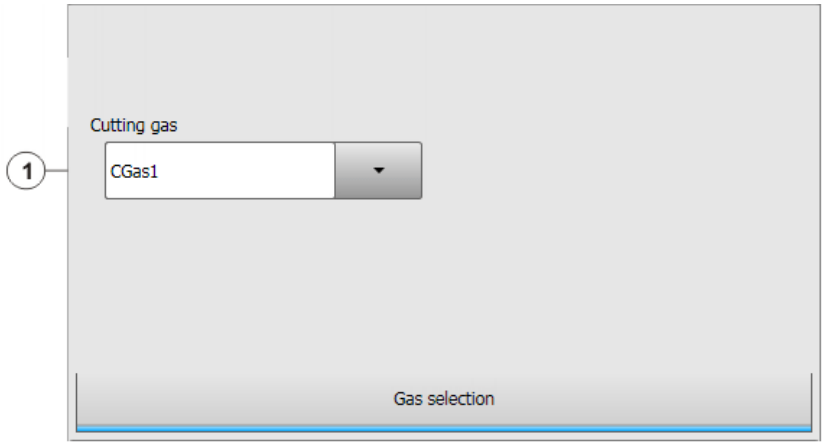

Fig. 7-26: Option window “Gas selection” – laser cutting

Item	Description
1	Select cutting gas. The range of values depends on how many gas types have been configured. (>>> 6.2 "Configuring gas types for inline forms" Page 19)

7.4.7 Option window “Laser network” – Initialize laser

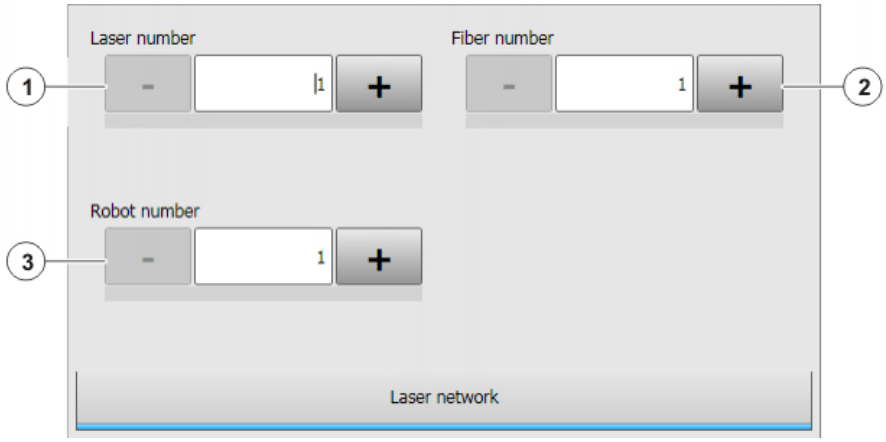

Fig. 7-27: Option window “Laser network” – Initialize laser

Item	Description
1	Select laser number. ■ **1 … 15**
2	Select light path number. ■ **1 … 8**
3	Select robot number. ■ **1 … 6**

7.5 Programming media control

7.5.1 Inline form “Switch gas”

Call

- Select the menu sequence **Commands** > **LaserTech** > **Media control** > **Switch gas**.

Description

This instruction switches the gas on or off.

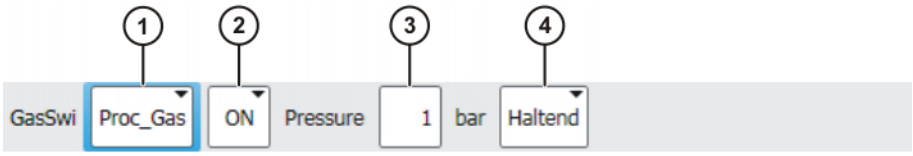

Fig. 7-28: Inline form “Switch gas”

Item	Description
1	Selects a gas. ■ **Proc_Gas**: process gas ■ **Root_Gas**: root gas ■ **Cut_Gas**: cutting gas ■ **CrossJet** ■ **All**: all gases **Note**: It is not possible to activate all gases simultaneously. **All** can only be used to deactivate the gases simultaneously.
2	Switches the selected gas on or off. ■ **ON**: Switches the gas on. ■ **OFF**: Switches the gas off. **Note**: The gas is only switched off if the laser is not active.
3	Gas pressure ■ **0 … 20 bar** This box is only displayed if the configuration parameter “Proportional Gas Valve” is set to TRUE.
4	Only relevant for **ON**: ■ **Continuous**: The instruction applies until the next **Switch gas** instruction is programmed. Until then, the gas parameters (gas pressure, gas preflow time, gas postflow time) for the **Activate process**, **Switch process** and **Deactivate process** instructions are ignored. ■ **Once**: The gas parameters for the subsequent **Activate process**, **Switch process** and **Deactivate process** instructions in the program apply until a new gas is activated with the instruction **Switch gas**.

7.5.2 Inline form “Initialize gas”

Call

- Select the menu sequence **Commands** > **LaserTech** > **Media control** > **Initialize gas**.

Description

This instruction is used to select the gases required for the process. The instruction must be used at least once in an application program. It must be placed before the **Initialize laser** instruction and before the first **Activate process** instruction.

Within a program, the instruction is used to change the type of gas. If there is a process gas active when the instruction is executed, the process gas is deactivated. The **Switch gas** instruction is then required to activate the gas.

If the **Initialize gas** instruction is not used in a KRL program, the gas is automatically initialized with the **Initialize laser** instruction.

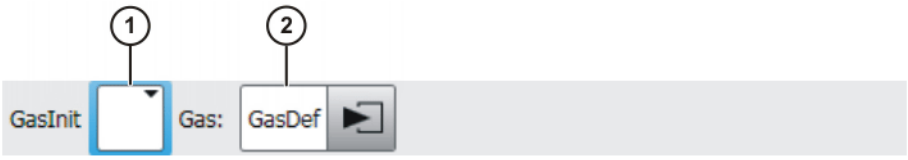

Fig. 7-29: Inline form “Initialize gas”

Item	Description
1	Selects an application. ■ **[Empty box]**: Only displayed if LaserWeld is not installed. ■ **WELD**: Laser welding (with wire feed) ■ **CUT**: Laser cutting
2	Name for the defined gas types (name freely definable) Touch the arrow to select the gas type. The corresponding option window is opened. ■ For the application **WELD**: (>>> 7.4.5 "Option window “Gas selection” – laser welding" Page 41) ■ For the application **CUT**: (>>> 7.4.6 "Option window “Gas selection” – laser cutting" Page 42)

7.5.3 Inline form “Cut wire”

Call

- Select the menu sequence **Commands** > **LaserTech** > **Media control** > **Cut wire**.

Description

To cut the welding wire to length reliably using a cutting device, the wire can be advanced a certain distance using this instruction. (Check box **Cut** is not active.)

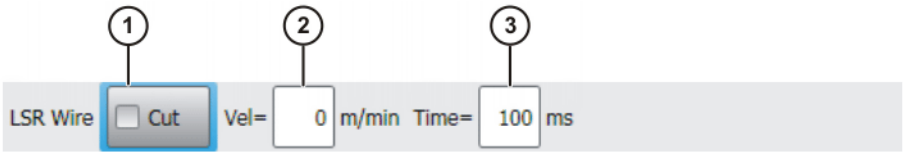

Fig. 7-30: Inline form “Cut wire” (without Cut)

This instruction is used to cut the wire with the laser. (Check box **Cut** is active.)

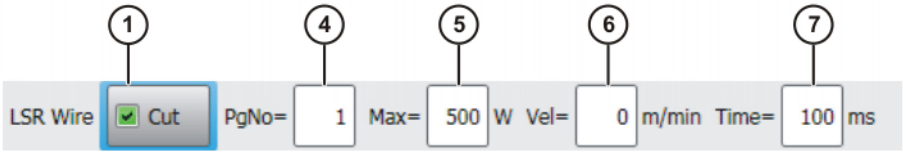

Fig. 7-31: Inline form “Cut wire” (with Cut)

Item	Description
1	Wire cutting with laser pulse ■ **Check box active**: Wire is cut with laser pulse. ■ **Check box not active:** Wire is not cut with laser pulse.
2	Velocity of the wire feed ■ **0 … 25 m/min**
3	Duration of the wire feed ■ **100 … 3,000 ms**
4	Laser program number ■ **1 … 200** This box is only displayed if the check box **Cut** is activated.
5	Laser power for cutting the wire ■ **60 … 60,000 W** This box is only displayed if the check box **Cut** is activated.
6	Wire feed rate ■ **0 … 25 m/min**
7	Pulse duration for cutting the wire ■ **100 … 3,000 ms**

7.6 Programming sensor control

7.6.1 Inline form “Switch sensor”

Call

- Select the menu sequence **Commands** > **LaserTech** > **Sensor control** > **Switch sensor**.

Description

This command is used to define the settings for the distance sensor.

Depending on the configuration parameter LSC_AnaCutDistance, the cutting distance is specified as an analog value or under program control.

- TRUE: Analog
- FALSE: program control

Procedure for InDLY > 0:

1. Tip compensation time 2 is taken into consideration.
2. Motion stop
3. The robot moves to the point specified by the value defined in LSC_SecDistance.
4. The wait time defined in InDLY expires.
5. The cutting gas is switched. The distance defined in the inline form is set.
6. The wait time defined in LSC_SecInDly expires.
7. The motion is resumed.

The instruction is also used to modify an existing cutting distance. In this case, LsrCutSensor = On, InDLY = 0 and the new distance are programmed.

Detailed information about the distance sensor and distance controller is contained in the PRECITEC documentation.

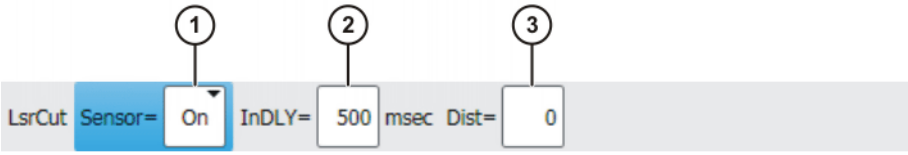

Fig. 7-32: Inline form “Switch sensor” (analog distance)

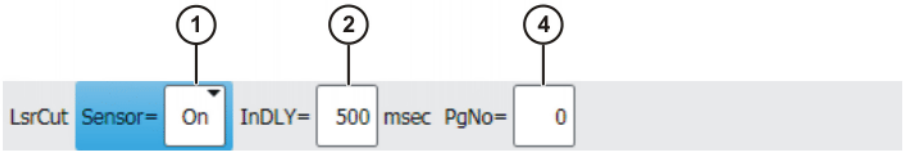

Fig. 7-33: Inline form “Switch sensor” (program-controlled distance)

Item	Description
1	Distance sensor ■ **On**: Distance sensor ON ■ **Off**: Distance sensor OFF ■ **Hold**: The distance sensor remains in the current position. ■ **PrPos**: The distance sensor goes to the programmed position.
2	Piercing position after the end point of the motion. ■ **0 ... 4,000 ms**
3	Cutting distance; unit: 1/10 mm ■ **1 … 300** This box is only displayed if the configuration parameter LSC_AnaCutDistance is set to TRUE.
4	Number of the program in the sensor controller that regulates the cutting distance ■ **1 … 3**

7.6.2 Inline form “Sensor settings”

Call

- Select the menu sequence **Commands** > **LaserTech** > **Sensor control** > **Sensor settings**.

Description

This instruction can be used to set the cutting and piercing data for laser cutting and call a piercing function. This piercing function implicitly switches the distance sensor on.

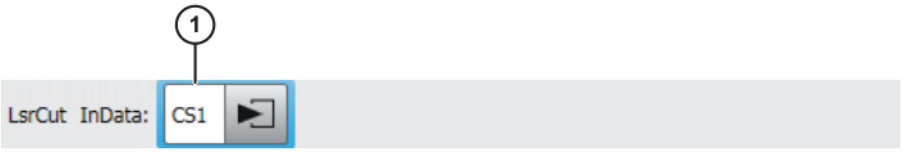

Fig. 7-34: Inline form “Sensor settings”

Item	Description
1	Name for the piercing and cutting data (name freely definable) Touch the arrow to edit the data. The corresponding option window is opened. (>>> 7.7.8 "Option window “Sensor parameters” and “Process parameters”" Page 54)

7.7 Programming laser cutting

7.7.1 Inline form “Rectangle”, “Slot”, “Hexagon”, “Circle”

Call

- Select the menu sequence **Commands** > **LaserTech** > **Cutting**.

  The following menu items are available:

  - **Rectangle**
  - **Slot**
  - **Hexagon**
  - **Circle**

Description

This command defines which pattern will be cut. Optionally, the cutting and piercing data for laser cutting can be defined.

If the piercing and cutting data are defined, the instruction calls a piercing function that implicitly activates the distance sensor. In this case, the instruction replaces the instruction **Switch sensor**.

(>>> 7.6.1 "Inline form “Switch sensor”" Page 45)

Every cutting pattern is executed as a spline motion.

NOTICE These instructions execute a calculated motion based on the parameters set in the option window. Incorrectly set parameters can result in damage to the system. Always carry out a test tun after creating or modifying these instructions.

To cut lines, a LIN motion command is used.

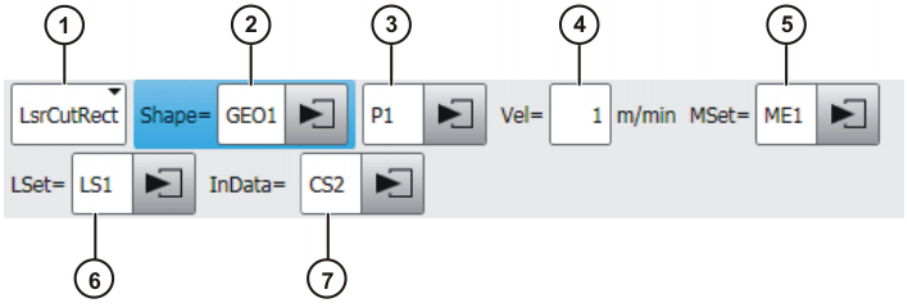

Fig. 7-35: Inline form “Rectangle”

Item	Description
1	Selects a pattern. ■ **LsrCutRect**: Rectangle ■ **LsrCutSlot**: Slot ■ **LsrCutHex**: Hexagon ■ **LsrCutCircle**: Circle
2	Name for the geometry data (name freely definable) Touch the arrow to edit the data. The corresponding option window is opened. (>>> 7.7.2 "Option windows “Geometry data” and “Geo motion data”" Page 48)
3	Name of the end point (name freely definable) Touch the arrow to edit the point data. The corresponding option window is opened. (>>> 7.7.3 "Option window: Frames" Page 51)
4	Velocity ■ **0.01 … 10 m/min**
5	Name for the media data (name freely definable) Touch the arrow to edit the data. The corresponding option window is opened. (>>> 7.7.4 "Option window “Media data” – activating laser cutting" Page 52)
6	Name for the laser data (name freely definable) Touch the arrow to edit the data. The corresponding option window is opened. (>>> 7.7.7 "Option window “Laser data” – Rectangle, Slot, Hexagon, Circle" Page 53)
7	Name for the piercing and cutting data (name freely definable) Touch the arrow to edit the data. The corresponding option window is opened. (>>> 7.7.8 "Option window “Sensor parameters” and “Process parameters”" Page 54) This box can be displayed or hidden using the **Add Cut** and **Rem Cut** buttons.

7.7.2 Option windows “Geometry data” and “Geo motion data”

Description

This option window is called from the following inline forms:

- **Rectangle**
- **Slot**
- **Hexagon**
- **Circle**

The meaning of the boxes depends on the pattern selected in the inline form.

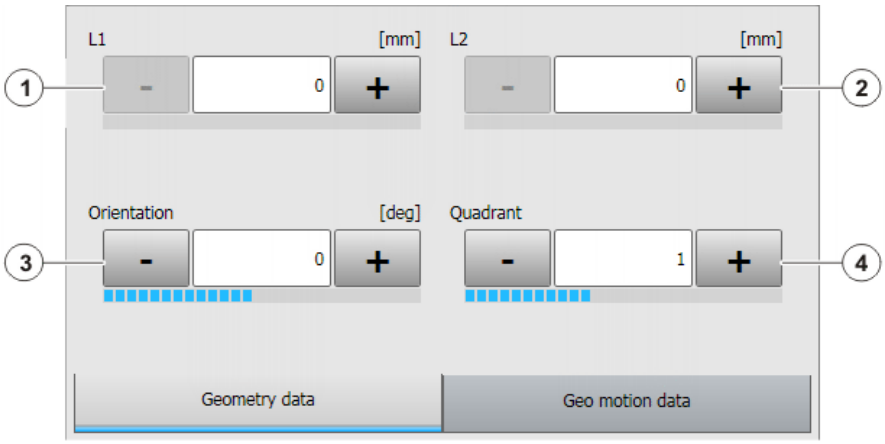

Fig. 7-36: Option window “Geometry data”

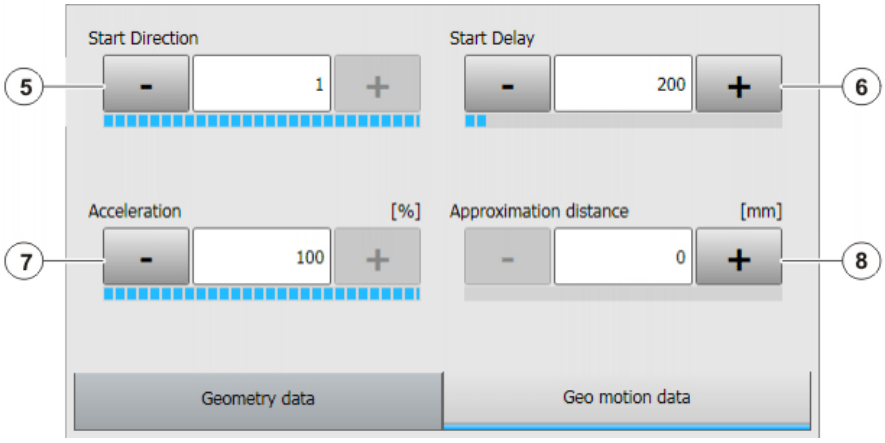

Fig. 7-37: Option window “Geo motion data”

Rectangle

Item	Description
1	Side length of 1st cut ■ Positive values
2	Side length of 2nd cut ■ Positive values
3	Orientation angle of the rectangle in the XY plane relative to the current base system ■ **0° … 360°**
4	Area within the rectangle where initial piercing takes place ■ **1 … 4**
5	Initial cutting direction ■ **-1**: to the left ■ **1**: to the right
6	Interval between laser switch-on and start of robot motion ■ **0 … 3000 ms**
7	Acceleration Refers to the maximum value specified in the machine data. The maximum value depends on the robot type and the selected operating mode.
8	Approximation distance

Slot

Item	Description
1	Length of the long side The value must be greater than the length of the short side.
2	Length of the short side The value must be less than the length of the long side.
3	Orientation angle of the slot in the XY plane relative to the current base system ■ **0° … 360°**
4	Area within the slot where initial piercing takes place ■ **1 … 4**
5	— — —
6	Interval between laser switch-on and start of robot motion ■ **0 … 3000 ms**
7	Acceleration Refers to the maximum value specified in the machine data. The maximum value depends on the robot type and the selected operating mode.
8	Approximation distance

Hexagon

Item	Description
1	Side length of hexagon ■ Positive values
2	— — —
3	Orientation angle of the hexagon in the XY plane relative to the current base system ■ **0° … 360°**
4	Area within the hexagon where initial piercing takes place ■ **1 … 4**
5	Initial cutting direction ■ **-1**: to the left ■ **1**: to the right
6	Interval between laser switch-on and start of robot motion ■ **0 … 3000 ms**
7	Acceleration Refers to the maximum value specified in the machine data. The maximum value depends on the robot type and the selected operating mode.
8	Approximation distance

Circle

Item	Description
1	Diameter of the circle ■ Positive values
2	Angle, if only an arc is being cut ■ Positive values
3	— — —
4	Area within the circle where initial piercing takes place ■ **1 … 4**

Item	Description
5	Initial cutting direction ■ **-1**: to the left If an arc is cut , "-1" must be entered. ■ **1**: to the right
6	Interval between laser switch-on and start of robot motion ■ **0 … 3000 ms**
7	Acceleration Refers to the maximum value specified in the machine data. The maximum value depends on the robot type and the selected operating mode.
8	Approximation distance

7.7.3 Option window: Frames

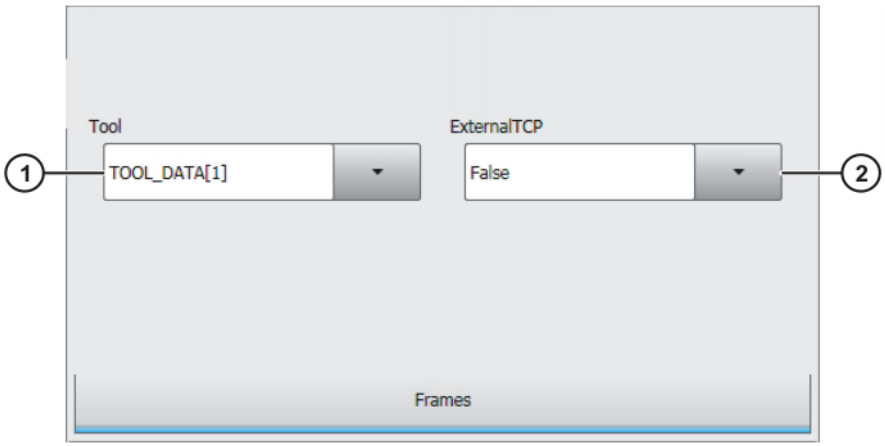

Fig. 7-38: Option window: Frames

Item	Description
1	Tool selection. ■ **[1] … [16]** If **True** in the box **ExternalTCP**: workpiece selection.
2	Interpolation mode ■ **False**: The tool is mounted on the mounting flange. ■ **True**: The tool is a fixed tool.

7.7.4 Option window “Media data” – activating laser cutting

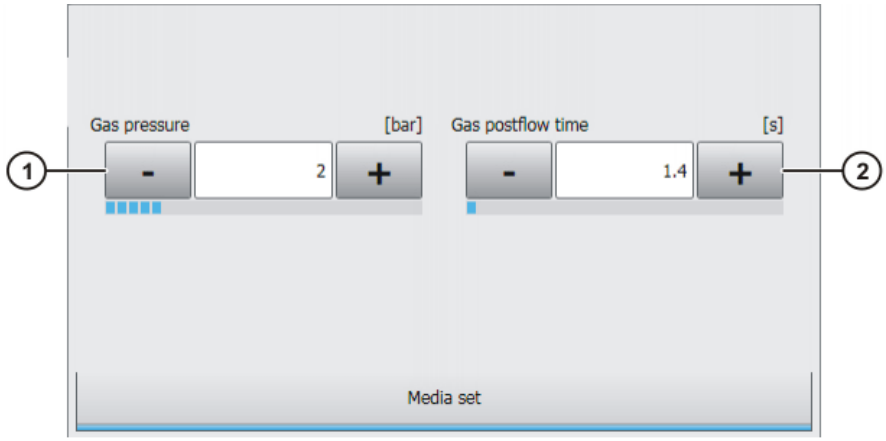

Fig. 7-39: Option window “Media data” – activating laser cutting

Item	Description
1	Gas pressure ■ **0 … 10 bar**
2	Gas preflow time ■ **0 … 25 s**

If the gas preflow time overlaps with the gas postflow time of the previous motion, the gas continues to flow without interruption.

7.7.5 Option window “Media data” – switching laser cutting

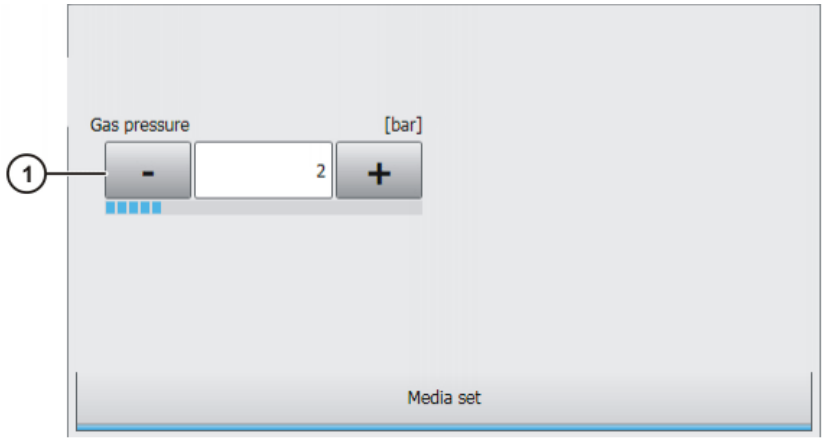

Fig. 7-40: Option window “Media data” – switching laser cutting

Item	Description
1	Gas pressure ■ **0 … 10 bar**

7.7.6 Option window “Media data” – deactivating laser cutting

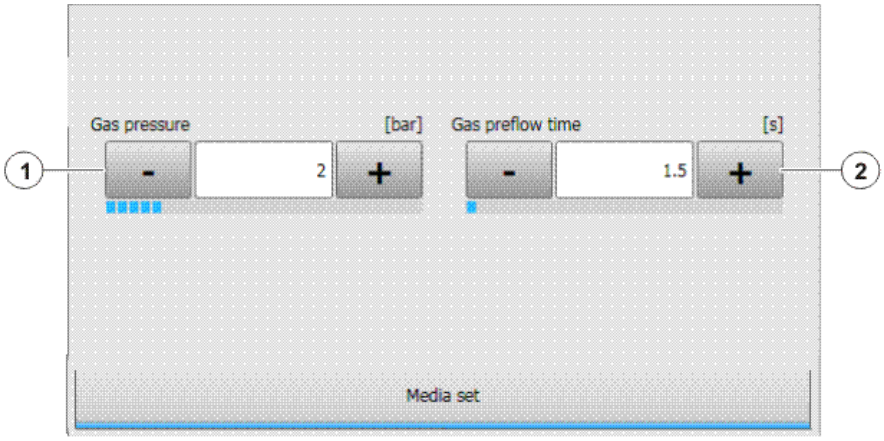

Fig. 7-41: Option window “Media data” – deactivating laser cutting

Item	Description
1	Gas pressure ■ **0 … 10 bar**
2	Gas postflow time ■ **0 … 25 s**

If the gas preflow time overlaps with the gas postflow time of the previous motion, the gas continues to flow without interruption.

7.7.7 Option window “Laser data” – Rectangle, Slot, Hexagon, Circle

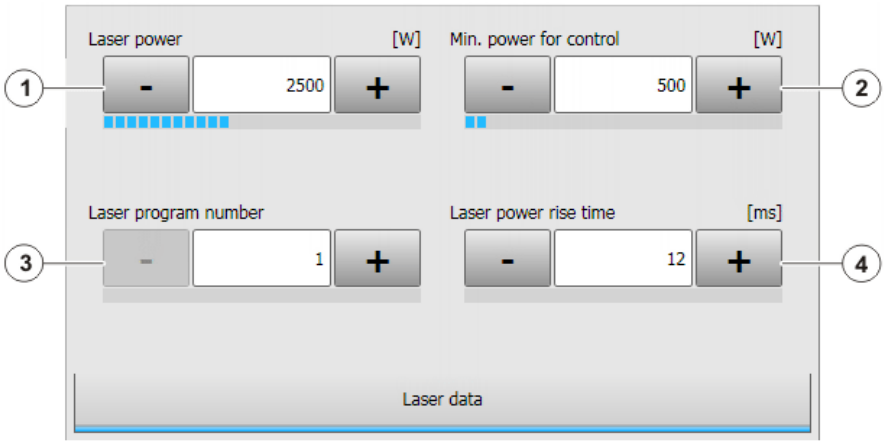

Fig. 7-42: Option window “Laser data” – Rectangle, Slot, Hexagon, Circle

Item	Description
1	Laser power at 100% velocity ■ **60 … 6 000 W**
2	Minimum power for control When power control is active, the set power corresponds to the power of a stationary robot. ■ **60 … 6 000 W** **Note**: The setting is only displayed if the parameter LSR_UsePwrVelCtrld has the value TRUE.

Item	Description
3	Laser program number ■ **1 … 200**
4	Laser power rise time Time that elapses after activation before the laser reaches full power ■ **1 … 2 000 ms** The maximum laser power rise time can be modified in the registry. (>>> 6.5 "Modifying maximum values for ramp times" Page 22) **Note**: The setting is only displayed if the parameter LSR_RampOption has the value TRUE.

7.7.8 Option window “Sensor parameters” and “Process parameters”

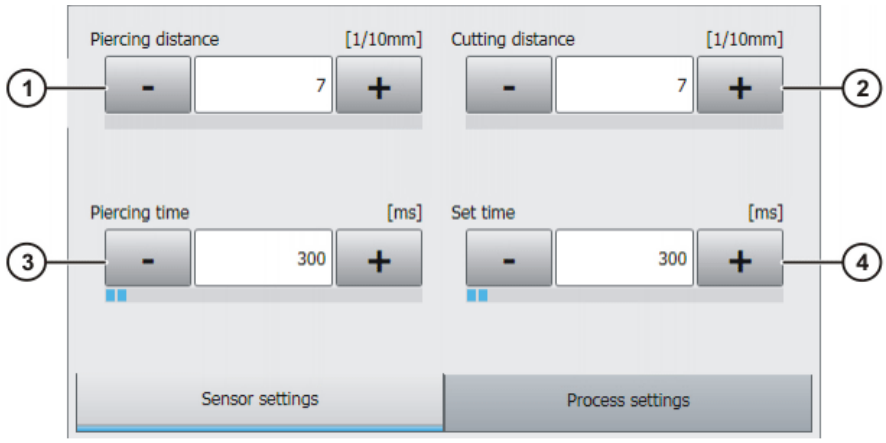

Fig. 7-43: Option window: Sensor parameters

Item	Description
1	Piercing distance (TCP of the sensor – component); unit: 1/10 mm ■ **0 … 300**
2	Cutting distance; unit: 1/10 mm ■ **0 … 300**
3	Piercing time ■ **0 … 3,000 ms**
4	Wait time after changing the cutting gas ■ **0 … 3,000 ms**

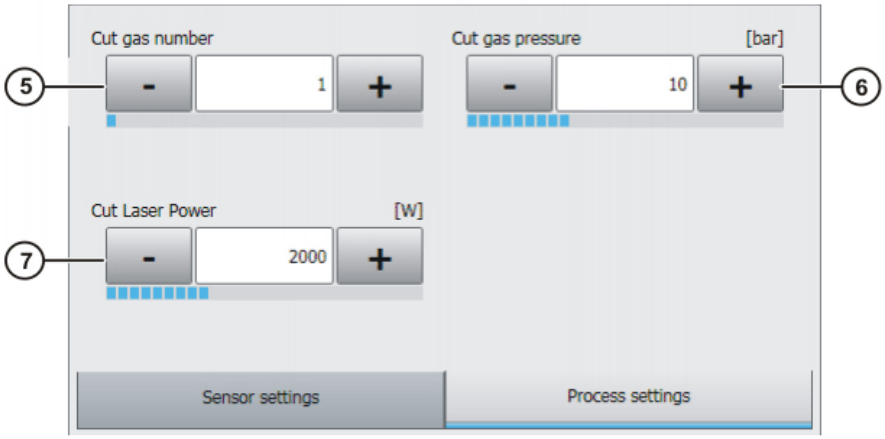

Fig. 7-44: Option window “Process parameters”

Item	Description
5	Cutting gas number ■ **0 … 30**
6	Cutting gas pressure during cutting ■ **0 … 30 bar**
7	Laser power during cutting ■ **60 … 6,000 W**

8 Example programs

8.1 Example program: step seam

The velocity of the laser must be kept constant until the switching point is reached. Otherwise it is possible that the laser may switch before or after the planned switching point.

Program

```
 1  DEF step( )
 2  INI
 3  PTP HOME  Vel= 100 % DEFAULT
 4  PTP Start CONT Vel=100 % PDAT0 Tool[1] Base[0]
 5  LSR WELD Allocation=True Gas: GasDef LSN: LSNDef
 6  LIN P1 CONT Vel=0.2 m/s CPDAT1 Tool[1] Base[0]
 7  GasSwi Proc_Gas ON
 8  GasSwi CrossJet ON Haltend
 9  LIN P2 CONT Vel=0.2 m/s CPDAT2 Tool[1] Base[0]
10  LSR StepOn Path=0 mm Dly=0 ms LSet=LS22 SSet=SP3
11  LIN P3 CONT Vel=0.1 m/s CPDAT3 Tool[1] Base[0]
12  LIN P4 CONT Vel=0.1 m/s CPDAT4 Tool[1] Base[0]
13  LSR WELD End Path=0 mm Min=100 W MSet=ME10 LSet=LS11 Release
14  LIN P5 CONT Vel=0.1 m/s CPDAT5 Tool[1] Base[0]
15  GasSwi All OFF
16  PTP HOME  Vel= 100 % DEFAULT
17  END
```

Description

Line	Description
5	Initializes the laser. The instruction carries out an implicit request. Light path and laser are selected. This instruction does not perform a reset. The robot motion is generally stopped due to handshake operations with the laser.
7	The process gas is switched on.
8	CrossJet is activated. **Continuous**: until `GasSwi All OFF`, the gas parameters (pressure, gas preflow time, gas postflow time) for all LaserOn, LaserSwi and LaserEnd instructions are ignored.
10	The next motion instruction executes a step seam. The overall length of the step seam and the number and length of the steps are defined in the option window **Step parameters**.
13	The laser power is switched off and the laser program terminated at the end point of the motion block LIN P5. The laser itself is not switched off.
15	All gases are deactivated.

8.2 Example program: gas and laser welding functions

Program

```
 1  DEF Gas( )
 2  INI
 3  PTP HOME Vel=100 % DEFAULT
 4  PTP Start CONT Vel=100 % PDAT0 Tool[1] Base[0]
 5  LSR WELD Allocation=True Gas: GasDef LSN: LSNDef
 6  LIN P1 CONT Vel=0.2 m/s CPDAT1 Tool[1] Base[0]
 7  GasSwi Proc_Gas ON Nicht Haltend
 8  GasSwi CrossJet ON Nicht Haltend
 9  GasSwi Root_Gas ON Nicht Haltend
10  LIN P2 CONT Vel=0.2 m/s CPDAT2 Tool[1] Base[0]
11  LSR WELD On Path=0 mm Min=500 W MSet=ME19 LSet=LS21 Wire
12  LIN P3 CONT Vel=0.1 m/s CPDAT3 Tool[1] Base[0]
13  LIN P4 CONT Vel=0.1 m/s CPDAT4 Tool[1] Base[0]
14  LIN P5 CONT Vel=0.1 m/s CPDAT5 Tool[1] Base[0]
15  LSR WELD Switch Path=0 mm MSet=ME8 LSet=LS9
16  LIN P6 CONT Vel=0.1 m/s CPDAT6 Tool[1] Base[0]
17  LSR WELD End Path=0 mm Min=100 W MSet=ME10 LSet=LS11 Release
18  LIN P7 CONT Vel=0.1 m/s CPDAT7 Tool[1] Base[0]
19  PTP HOME Vel= 100 % DEFAULT
20  END
```

Description

Line	Description
5	Initializes the laser. The instruction carries out an implicit request. Light path and laser are selected. This instruction does not perform a reset. The robot motion is generally stopped due to handshake operations with the laser.
7	The process gas is switched on.
8	CrossJet is activated.
9	The root gas is switched on.
11	The instruction refers to the next motion instruction. The laser program starts at the end point of the motion block LIN P3. If the laser has not yet been requested, it is now requested implicitly by means of this instruction. This causes the motion to stop.
15	Modification of the weld parameters. The instruction refers to the next motion instruction.
17	The laser power is switched off and the laser program terminated at the end point of the motion block LIN P7. The laser itself is not switched off. The instruction switches the gas off, as a GasSWI ON instruction has been programmed with the setting “Once”. It is not necessary to deactivate the gas with GasSWI OFF. The laser power is ramped down if a ramp time has been programmed.

8.3 Example program: set piercing and cutting data

Program

```
 1  DEF SetCut( )
 2  INI
 3  PTP HOME Vel=100 % DEFAULT
 4  PTP Start CONT Vel=100 % PDAT0 Tool[1] Base[0]
 5  LSR CUT Allocation=True Gas: GasDef LSN: LSNDef
 6  PTP P1 CONT Vel=10 % PDAT1 Tool[2] Base[0]
 7  LIN P2 CONT Vel=0.2 m/s CPDAT1 Tool[1] Base[0]
 8  LsrCut InData: CS1
 9  LsrCut Sensor=On InDLY=500 msec PgNo=1
10  LIN P3 CONT Vel=0.1 m/s CPDAT4 Tool[1] Base[0]
11  LIN P4 CONT Vel=0.1 m/s CPDAT5 Tool[1] Base[0]
12  LIN P5 CONT Vel=0.1 m/s CPDAT6 Tool[1] Base[0]
13  LsrCut Sensor=Hold InDLY=500 msec PgNo=1
14  LIN P6 CONT Vel=0.1 m/s CPDAT7 Tool[1] Base[0]
15  PTP HOME  Vel= 100 % DEFAULT
16  END
```

Description

Line	Description
5	Initializes the laser. The instruction carries out an implicit request. Light path and laser are selected. This instruction does not perform a reset. The robot motion is generally stopped due to handshake operations with the laser.
8	The piercing and cutting data are set.
9	The distance sensor is switched on. If InDLY > 0, piercing is carried out from a standstill.
13	The distance sensor remains in the current position.

8.4 Example program: piercing function

When the piercing function is called, the following piercing operation is executed:

1. The piercing data are set before the laser is switched on.
2. The robot waits at the start point of the cut (exact positioning).
3. The sensor is moved to the piercing distance.
4. Once the sensor has reached the piercing distance (LSCI_SnsrPosReached = TRUE), it remains in this position.
5. After a wait time (=piercing time), the sensor is set to the cutting distance.
6. The laser power is reduced to approx. 1% of the maximum power.
7. The cutting gas is changed.
8. The robot starts the laser cutting.

Program

```
 1  DEF Shape_einstechen( )
 2  INI
 3  PTP HOME Vel=100 % DEFAULT
 4  PTP Start CONT Vel=100 % PDAT0 Tool[1] Base[0]
 5  LSR CUT Allocation=True Gas: GasDef LSN: LSNDef
 6  LIN P6 CONT Vel=0.2 m/s CPDAT1 Tool[1] Base[0]
 7  GasSwi Cut_Gas ON Nicht Haltend
 8  GasSwi CrossJet ON Nicht Haltend
 9  LIN P7 CONT Vel=0.2 m/s CPDAT2 Tool[1] Base[0]
10  LsrCutHex Shape=GP1 P12 Vel=1 m/min MSet=ME20 LSet=LS22
    InData=CS1
11  LIN P8 CONT Vel=0.1 m/s CPDAT3 Tool[1] Base[0]
12  LSR Free
13  PTP HOME  Vel= 100 % DEFAULT
14  END
```

Description

Line	Description
5	Initializes the laser. The instruction carries out an implicit request. Light path and laser are selected. This instruction does not perform a reset. The robot motion is generally stopped due to handshake operations with the laser.
7	The cutting gas is switched on.
8	CrossJet is activated.
10	The piercing and cutting data are set. The piercing function is called and the distance sensor is switched on.
12	The laser is enabled.

9 Messages

9.1 Basic laser function messages

Message	Description/remedy	Key
Collision protection device triggered! Please move the robot clear in Test1 or Test2 mode	A collision has occurred. ■ Move away from the collision in T1 or T2 mode. ■ Resume program execution or reset program and laser.	CollissionDetected
The laser shutter will be closed during block selection	For safety reasons, use of the laser power is prevented during block selection.	LaserShutDownAtBlockSelect
Laser is still not activated: No LASER ON state	Possible causes: ■ The laser is not switched on. ■ The laser is currently being reset. ■ The laser is in manual mode.	NoLaserOnStatus
No laser application possible without crossjet!	■ Activate CrossJet. ■ Acknowledge the message. ■ Resume or restart program	MissingCrossJet
Block command failed.	An error has occurred during execution of a technology-specific instruction. Please contact the Service Department if this error recurs.	BlockCommandFailed
No valid inline form	An error has occurred during execution of a technology-specific instruction. Please contact the Service Department if this error recurs.	NoInlineForm
Wrong value of $PRO_I_O[] ($CUSTOM.DAT) or no submit routine selected	■ Deselect program. ■ Deselect Submit. ■ Change value, start Submit.	WrongSubmitInterpreter
Error message at laser system	■ Eliminate laser error. ■ Acknowledge the message. ■ Resume or restart program	ErrorAtLaser
Continuing the process only sensible with correct operating mode and previous overide value!	A collision has occurred. ■ Move away from the collision in T1 or T2 mode. ■ Reset program and laser.	CollissionCorrectModeOperation
Internal error!	An error has occurred during execution of a technology-specific instruction. Please contact the Service Department if this error recurs.	InternalError
No gas available! Please check gas equipment	This error message is triggered by the process gas monitoring.	NoGasFlow

Message	Description/remedy	Key
Laser is not available and shutter is closed	Possible causes: ■ A required signal has not been generated or was not detected by the laser. ■ Error in the laser controller	NoLaserActive-AndShutter-Closed
No feedback of the laser by external control	The signal LSRI_LsrExternEnabled is not generated. Possible causes: ■ The laser is not switched on. ■ The laser is currently being reset. ■ The laser is in manual mode.	NoExternMode-Possible
Laser is still not in standby mode	Possible causes: ■ A required signal has not been generated or was not detected by the laser. ■ Error in the laser controller	LaserStillNotIn-Standby
Laser still not ready or not assigned	The laser program cannot be started. Possible causes: ■ The laser is not switched on. ■ The laser is currently being reset. ■ The laser is in manual mode.	LaserStill-NotReady
Laser flags critical error to cell control	An error has occurred in the laser periphery. Depending on the configuration, this may also be a robot error.	LsrExternError
Laser still waiting for allocation	The instruction LSR Allocate has been called. The laser is not free, however. This message is displayed during the wait time.	LaserWaiting-ForAllocation
Laser error -> Details on console of laser system	Refer to message on the laser console.	DetailsToLsrErrorsOnConsole
Laser error -> Details on laser console ---> Resumption of program after laser reset	Refer to message on the laser console.	LsrErrorLookOn-Console
Laser error has occurred	■ Eliminate laser error. ■ Acknowledge the message. ■ Resume or restart program Depending on the nature of the error, the message “ErrorAtLaser” may also be generated.	LaserErrorAvail-able
Invalid laser command -> LASER INIT command necessary	An invalid laser command has been initiated. A program reset is generally required.	LaserCommand-IncompatibleTo-Package

Message	Description/remedy	Key
Laser program was canceled	The laser signals the cancelation of an active program. Possible causes: ■ The signal LSRO_LsrReset is set during an active program. ■ The signal LSRO_LsrStartStatic is reset before the signal LSRO_LsrStopProgram has been set.	LsrProgramCancel
Laser program could not be activated: Please check errors on laser console	Possible causes: ■ A required signal has not been generated or was not detected by the laser. ■ Error in the laser controller	NotProgramActive
Laser was switched to manual mode ---> Resumption of process after laser reset	Cause: Manual mode has been forced on the laser console.	LsrInManualMode
Check media control!	■ Eliminate media error. ■ Acknowledge the message. ■ Resume or restart program	CheckMediaControl
Periphery not in a safe state	■ Check the safety equipment. ■ Eliminate problem. ■ Reset program and laser.	LsrPeripheryNotSafe
Complete program will be continued without active process. Resumption with active process by executing LASER_INIT command	Cause: Following an error, this option (= continue complete program without active process) has been selected as a response in a dialog window.	CompleteColdRun
Cold run selected	The value of LSR_UseLaserPower is FALSE. To use the laser, set the value to TRUE.	NoLsrControlColdRun
Program was aborted or external error signal active	■ Eliminate problem. ■ Acknowledge the message. ■ Resume or restart program	ProgAbortOrExtFailure
No process gas!	■ Activate process gas. ■ Acknowledge the message. ■ Resume or restart program	MissingProcessGas
Please acknowledge errors on laser console first	Laser errors cannot be reset from the robot.	LsrReceiptMessage
Robot was stopped by an interpreter stop	The robot interpreter has been stopped by: ■ STOP key ■ EMERGENCY STOP ■ Operator safety ■ Operating mode change ■ Releasing the enabling switch	LsrInTechStop
Laser safety circuit is still open: Ensure laser safety before the robot program is resumed	Possible causes: ■ The safety circuit is open. ■ Light path settings in the laser do not match the requested light path.	SikContactOpen

Message	Description/remedy	Key
Safety circuit open, shutter closed	Possible causes: ■ The safety circuit is open. ■ Light path settings in the laser do not match the requested light path.	ShutterOpen
Standstill monitoring: Laser was switched off because robot welded for too long at the same position	If welding is to be carried out for longer at a specific position, i.e. without robot motion, the value of LSR_Stop_InspectionTime must be increased.	RobotStandStill
Standstill monitoring: Laser has not been used for a long time and has just been shut down	The interval after which the laser is deactivated can be increased in the configuration. (LSR_LaserStandbyDelay)	LaserStandStill
Robot stopped ---> Resumption of the process	■ Eliminate cause of the stop reaction. ■ Answer the dialog and resume or restart the program.	LsrRobotError
Error of laser system ---> Resumption of process possible after dialog and forced reset of laser	Refer to message on the laser console.	CollectionErrorOfLaser
Test commands only possible in operating mode Test1 or Test2!	■ Change operating mode. ■ Restart the program.	NoFocusPulsInAutomatic
Invalid parameter list	An error has occurred during execution of a technology-specific instruction. Please contact the Service Department if this error recurs.	ParamListHandleUnknown
Insufficient gas pressure! Please check gas equipment.	■ Eliminate problem. ■ Reset program.	NotEnoughGasPressure
No root gas!	■ Activate root gas. ■ Acknowledge the message. ■ Resume or restart program	MissingRootGas
Cell or laser safety error. Check safety equipment!	■ Eliminate problem. ■ Acknowledge the message. ■ Resume or restart program	LsrCellOrSafetyError
Gas pressure too low. The current program will be aborted. Please check gas !!!	■ Correct the gas pressure. ■ Acknowledge the message. ■ Resume or restart program	LastPartToLessGas
Laser allocation denied	Possible causes: ■ The laser is allocated to a different station. ■ The laser is in manual mode. ■ An error has occurred.	LaserAllocationAvoided

9.2 LaserCut messages

Message	Description/remedy	Key
Error in user-defined sensor code!	An error has occurred within the user-defined function so that the return value <> 0. Remedy: Eliminate the error and ensure that the return value = 0.	ErrorInUserDef-SnsrProc
Function not implemented!	A non-implemented function has been called. Please inform the Service Department.	NOT_IMPLEMENTED
Initialization of user-defined sensor code failed!	An error has occurred within the user-defined function so that the return value <> 0. Remedy: Eliminate the error and ensure that the return value = 0.	InitOfUserDef-SensorFailed
Programmed position not reached	■ Reset the sensor using the sensor controller. ■ Reset program.	NoProgPos
Sensor error	Eliminate the sensor controller error and acknowledge the message.	SnsrError
Sensor cable interrupted!	■ Eliminate problem. ■ Reset program.	SnsrCableError
Collision monitoring	The distance sensor signals a collision. Eliminate the sensor controller error and acknowledge the message.	SnsrCollision
Use of a reserved sensor type!	An attempt has been made to initialize a reserved sensor type within a user-defined function.	UseOfReseverd-SnsrType

9.3 LaserWeld messages

Message	Description/remedy	Key
Wire or wirefeeder not available	■ Check wire feed system. ■ Check configuration for the wire feed system in the robot controller.	WireFeeder-NotReady
Please acknowledge errors of the wirefeed unit	■ Acknowledge message on wire feed system. ■ Acknowledge this message on the robot controller.	WfdReceiptMessage
Please acknowledge errors on the wire heater unit	■ Acknowledge message on the welding wire heater. ■ Acknowledge this message on the robot controller.	AcknWfdHeat-Message
Wire heater error	■ Eliminate error in the wire heater. ■ Acknowledge the message.	WireFeedHeat-Problem

10 Appendix

10.1 Configuration parameters: overview of inputs/outputs, interrupts, timers and cyclical flags

The numbers for inputs/outputs, interrupts, timers and cyclical flags may only be assigned once in the entire robot controller.

NOTICE Incorrect configuration of the internal analog channels can result in the laser working with incorrect parameters. Damage to the system may result.

Analog outputs Outputs 1 to 32 are available.

Parameter	Variable name	Values
Analog channel for laser power (>>> 10.2.1 "LaserTech: Outputs to the laser" Page 69)	LSRO_LsrPwr	Default value: 2
Analog channel for wirefeeder (>>> 10.3.1 "LaserWeld: Outputs to the wire feed system" Page 75)	LSWO_WireFeedChannel	Default value: 9
Analog channel for wire heater (>>> 10.3.1 "LaserWeld: Outputs to the wire feed system" Page 75)	LSWO_WireFeedHeatChan	Default value: 8
Analog channel for gas pressure (>>> 10.2.3 "LaserTech: Outputs to the periphery" Page 71)	LSRO_GasPressure	Default value: 4
Analog channel for the working distance (>>> 10.4.1 "LaserCut: Outputs to the sensor" Page 77)	LSCO_LscDistance	Default value: 5
Analog channel for tip compensation (>>> 10.4.1 "LaserCut: Outputs to the sensor" Page 77)	LSCO_LscTipComp	Default value: 6
Analog channel for the programmed position (>>> 10.4.1 "LaserCut: Outputs to the sensor" Page 77)	LSCO_LscProgPos	Default value: 7

Analog inputs Inputs 1 to 32 are available.

Parameter	Variable name	Values
Analog channel for gas pressure (>>> 10.2.4 "LaserTech: Inputs from the periphery" Page 72)	LSRI_GasPressure	Default value: 4

Interrupts

NOTICE If the priority of the interrupts is changed, this may result in a double assignment. Furthermore, the interrupts for the LaserTech monitoring functions may receive a priority that is so low that they are processed too late. This can cause damage to the system.

Parameter	Variable name	Values
Interrupt media	LSR_InterruptMedias	■ **4 … 39** Default value: 10
Interrupt step function	LSR_TC_STEP	■ **1 … 39** Default value: 17
Interrupt step seam monitoring	LSR_InterruptStepMon	■ **1 … 39** Default value: 11
Interrupt anticollision device	LSR_InterrAntiCollission	■ **4 … 39** Default value: 7
Interrupt laser safety	LSR_InterruptLaserSafety	■ **4 … 39** Default value: 8
Interrupt distance sensor	LSR_InterruptDistSensor	■ **4 … 39** Default value: 9

Timer

Parameter	Variable name	Values
Timer number gas postflow control	LSR_TC_PostGas	■ **1 … 32** Default value: 15
Timer number gas preflow time	LSR_TC_PreFlowGas	■ **1 … 32** Default value: 16
Timer number sensor status keys (>>> 10.4.3 "LaserCut: Process parameters" Page 78)	LSC_TC_PrecPLC	■ **1 … 32** Default value: 19

Cycflags

NOTICE If the number of cyclical flags is changed, this may result in a double assignment. Furthermore, the numbers of the cyclical flags for the LaserTech monitoring functions may be overwritten. This can cause damage to the system.

Parameter	Variable name	Values
Cycflag step control	LSR_CF_STEP	■ **1 … 32** Default value: 29
Cycflag step seam monitoring	LSR_InterruptStepMon	■ **1 … 32** Default value: 13
Cycflag gas control	LSR_CF_GasCtrl	■ **1 … 32** Default value: 11
Cycflag media monitoring	LSR_CF_MediaCtrl	■ **1 … 32** Default value: 32
Cycflag laser monitoring	LSR_CF_LaserCtrl	■ **1 … 32** Default value: 30
Cycflag sensor control (>>> 10.4.3 "LaserCut: Process parameters" Page 78)	LSR_CF_SensorCtrl	■ **1 … 32** Default value: 31

10.2 LaserTech configuration parameters

NOTICE Incorrect configuration of inputs and outputs can result in the laser switching on or off at the wrong time and/or with incorrect parameters. This can cause damage to the system.

10.2.1 LaserTech: Outputs to the laser

Detailed information about the laser controller is contained in the TRUMPF documentation.

The signals described in this section can be found in the file $config.dat in the directory R1\System. To adapt the values, the file must be edited.

Parameter	Description/variable name	Data type
Laser request	LSRO_LsrRequest	BOOL
Pilot laser on	LSRO_LsrPilotOn	BOOL
Sync with laser 1	Query whether laser ready. LSRO_LsrSync1	BOOL
Sync with laser 2	Query whether laser ready. By default, the robot controller uses LSRO_LsrSync1 for the query. LSRO_LsrSync2	BOOL
Error in the peripherie of laser	Robot fault (fault that is external to the laser controller) LSRO_LsrFaultExtern	BOOL
Laser reset	LSRO_LsrReset	BOOL

Parameter	Description/variable name	Data type
Stop laser program	LSRO_LsrStopProgram	BOOL
Laser program start dynamic	LSRO_LsrStartDynamic	BOOL
Laser program start static	LSRO_LsrStartStatic	BOOL
Set laser to standby	LSRO_LsrStandby	BOOL
Laser on	LSRO_LsrOn	BOOL
Disable laser console	LSRO_LsrOperationOff	BOOL
Enable external control	LSRO_LsrExternControl	BOOL
BCD code program number upper bits*	LSRO_LsrPrgNrBCD10	4 bits
BCD code program number lower bits*	LSRO_LsrPrgNrBCD1	4 bits
Laser program number binary coded*	LSRO_LsrPrgSetDual	Byte
Laser Fiber	LSRO_LsrFiber	Byte
Laser number	LSRO_LsrLaserNr	Byte
Robot number	LSRO_LsrRobotNr	Byte
Laser control word 0	LSRO_LsrDataWord0	Word
Analog channel for laser power	LSRO_LsrPwr	INT
Laser control word 3	LSRO_LsrDataWord3	Word
Laser control word 4	LSRO_LsrDataWord4	Word
Ramp length	LSRO_LsrRampTime	Word
Ramp start value; ramp up	LSRO_LsrRmpUpStartVal	Word
Ramp end value; ramp up	LSRO_LsrRmpUpEndVal	Word
Ramp start value; ramp down	LSRO_LsrRmpDownStartVal	Word
Ramp end value; ramp down	LSRO_LsrRmpDownEndVal	Word

* Whether program numbers are transferred as BCD coded or binary coded values depends on the parameter LSR_MPI_Interface .

10.2.2 LaserTech: Inputs from the laser

The signals described in this section can be found in the file $config.dat in the directory R1\System. To adapt the values, the file must be edited.

Parameter	Description/variable name	Data type
Warnlamps are on	LSRI_LsrWarnLampOn	BOOL
Pilot laser is on	LSRI_LsrPilotOn	BOOL
Laser is assigned	LSRI_LsrAssigned	BOOL
Monitoring message of laser	LSRI_LsrInternFault	BOOL
Internal laser error	LSRI_LsrFailure	BOOL
Shutter is closed	LSRI_LsrShutterClosed	BOOL
Sync input 1	LSRI_LsrSet1	BOOL
Sync input 2	LSRI_LsrSet2	BOOL
Sync input 3	By default, the robot controller polls sync input 3. LSRI_LsrSet3	BOOL
Laser program canceled	LSRI_LsrProgAbort	BOOL
End of laser program	LSRI_LsrProgEnd	BOOL
Laser program is active	LSRI_LsrProgActive	BOOL
Laser is in standby	LSRI_LsrStandby	BOOL

Parameter	Description/variable name	Data type
Laser is active	LSRI_LsrActive	BOOL
External control is enabled	LSRI_LsrExternEnabled	BOOL
Laser fiber number	LSRI_LsrFiberNo	Word
Laserfiber number from safetybox	LSRI_LsrFiberSafetyCode	Word
Safetycircuit monitoring	LSRI_LsrUserSafety	BOOL
Keyswitch monitoring (laser)	LSRI_LsrKeyEnable	BOOL

Detailed information about the laser controller is contained in the TRUMPF documentation.

10.2.3 LaserTech: Outputs to the periphery

The signals described in this section can be found in the file $config.dat in the directory R1\System. To adapt the values, the file must be edited.

Parameter	Description/variable name	Data type
Cell error, flag to PLC	LSRO_Error_Cell	BOOL
Media error, flag to PLC	LSRO_Error_Media	BOOL
Collision monitoring, flag to PLC	LSRO_AntiCollissionDev	BOOL
Sensor error, flag to PLC	LSRO_Error_Sensor	BOOL
Without power for one section, flag to PLC	The next section is carried out as a dry run. The section is what comes between the following commands: ■ LaserOn - LaserSwi ■ LaserSwi - LaserSwi ■ Laser Swi - Laser End LSRO_ColdFor1Section	BOOL
Next seam without power, flag to PLC	The next seam is carried out as a dry run. The seam is what comes between the following commands: ■ LaserOn - LaserEnd LSRO_ColdFor1Seam	BOOL
Without power to next init command, flag to PLC	LSRO_ColdForEver	BOOL
Activate/deactivate CrossJet	LSRO_CrossJet	BOOL
Analog channel for gas valve	Number of the analog channel for the gas pressure Only relevant if “Proportional Gas Valve” = TRUE LSRO_GasPressure	INT
Output enable the selected gas	Only relevant if “Proportional Gas Valve” = TRUE LSRO_GasEnable **Note**: Normally used with an additional main valve.	BOOL

10.2.4 LaserTech: Inputs from the periphery

The signals described in this section can be found in the file $config.dat in the directory R1\System. To adapt the values, the file must be edited.

Parameter	Description/variable name	Data type
CrossJet is On/Off	CrossJet gas is OK. LSRI_CrossJet	BOOL
Anloge in channel actual gas pressure	Number of the analog channel for the gas pressure Only relevant if “Proportional Gas Valve” = TRUE LSRI_GasPressure	INT
State of collision Sensor	LSRI_AntiCollisionDev	BOOL
User defined Input 1	This input can be used to integrate customer signals into the process monitoring in order to stop the process in the event of a fault. LSRI_UsrInput1	BOOL
User defined Input 2	This input can be used to integrate customer signals into the process monitoring in order to stop the process in the event of a fault. LSRI_UsrInput2	BOOL

10.2.5 LaserTech: Other outputs

The variables described in this section can be found in the file Laser.dat in the directory R1\TP\LaserTech. To display or change the values, select **Display** > **Variable** > **Single** from the main menu.

Parameter	Description/variable name	Values
Output number submit watchdog	This output can be used together with the parameter S_Int_Cycl to monitor whether the submit interpreter is running cyclically. The monitoring only works usefully if this output is continuously TRUE. To achieve this, the value of S_Int_Cycl must be a little higher than the cycle time of the SPS.SUB program. S_Int_Flag	■ **1 … 4 096**
Suspend error messages	This output is used internally during monitoring of the process. The output may only be used once. LSRO_Error_Bypass	■ **1 … 4 096**

10.2.6 LaserTech: Process options

The variables described in this section can be found in the file Laser.dat in the directory R1\TP\LaserTech. To display or change the values, select **Display** > **Variable** > **Single** from the main menu.

Parameter	Description/variable name
Activate/deactivate CrossJet	**TRUE**: CrossJet is activated on initialization of the laser and deactivated at the end of the program. **FALSE**: CrossJet is activated and deactivated via the inline forms “Activate process”, “Deactivate process” and “Switch gas”. LSR_CrossJetOption
Activate/deactivate ramp function on LaserSwi	**TRUE**: Ramps are possible on switching over the laser power. **Note**: For this, a suitable laser program is required. **FALSE**: No ramps are possible on switching over the laser power. LSR_RampOption
Enable/Disable velocity controlled laser power	**TRUE**: Laser power is proportional to the robot velocity. **FALSE**: The laser power remains constant at the value entered in the inline form. LSR_UsePwrVelCtrld
Enable/Disable mirror laser fiber	**TRUE**: The laser fiber number mirrored by the laser controller is evaluated. **FALSE**: The laser fiber number mirrored by the laser controller is not evaluated. LSR_LsrFiberMirrorOption
Run programs without laser	**TRUE**: The programs are executed without laser power. This is suitable, for example, for test purposes where no laser power is desired. LSR_UseLaserPower
Proportional Gas Valve	**Note**: If this parameter has been changed, the user interface must be reinitialized. **TRUE**: The gas pressure can be defined. **FALSE**: The gas pressure cannot be defined. The value of this parameter also influences which properties can be defined for the gases. (>>> 6.3 "Configuring the inputs/outputs for gases and other properties" Page 20) LSR_PropGasValve
Analog power control	The parameter must only be used if the laser has an analog input module. Additionally, the scaling values must be set. (>>> 10.2.7 "LaserTech: Process constants" Page 74) **TRUE**: The value is output as a real analog value. **FALSE**: The value is output in binary coded form via the field bus. Lsr_UseAnaModPwr
Use root for tech commands	**Note**: If this parameter has been changed, the user interface must be reinitialized. **TRUE**: An additional process gas (root gas) can be used. **FALSE**: No additional process gas (root gas) can be used. LSR_UseRootFlag

10.2.7 LaserTech: Process constants

The specified ranges of values contain the values that will be accepted by the system. They do not, however, constitute a recommendation of which values are useful in practice.

The variables described in this section can be found in the file Laser.dat in the directory R1\TP\LaserTech. To display or change the values, select **Display** > **Variable** > **Single** from the main menu.

Parameter	Description/variable name
Time for reset pulse	Time for which the reset signal is set to acknowledge a laser fault. ■ **0 … 9 999 s** LSR_PulsTime
Timeout for error signal	Maximum wait time for a response from the laser during initialization. ■ **0 … 9 999 s** LSR_Timeout
Shutter delay constant	Minimum value for starting the laser switching actions before the taught point. ■ **-10 000 ms … +9 999 ms** The value must be determined empirically. LSR_ShutterDelayConst
Additional to Shutterdelay at laser Off	Delay at end of welding, additional to LSR_ShutterDelayConst. This value is added to the shutter delay of the laser (LSR_ShutterDelayConst) when switching off the laser (LaserEnd). ■ **-10 000 ms … +9 999 ms** LSR_ShutterOff
Additional to Shutterdelay at laser On	Delay at start of welding, additional to LSR_ShutterDelayConst. This value is added to the shutter delay of the laser (LSR_ShutterDelayConst) when switching on the laser (LaserOn). ■ **-10 000 ms … +9 999 ms** LSR_ShutterOn
Delay for test commands	Interval between activating the shielding gas and switching on the laser. This time applies only to the commands “Test the laser power” and “Determine the focus of the optics”. ■ **0 … 9 999 ms** LSR_TestDelay
Scaling Gas pressure	Scaling factor for the gas pressure ■ **1 … 65 535** LSR_GasScale
Submit Watchdog Time	This parameter can be used together with the output S_Int_Flag to monitor whether the submit interpreter is running cyclically. The monitoring only works usefully if the output S_Int_Flag is continuously TRUE. To achieve this, the value of this parameter must be a little higher than the cycle time of the SPS.SUB program. ■ **1 … 9 999 ms** S_Int_Cycl

Parameter	Description/variable name
Scaling laser power	Only relevant if the parameter “Analog power control” is TRUE. ■ **1 … 9 999** PwrScale
Maximum laser power	Maximum laser power of the laser used (in watts). Only relevant if the parameter “Analog power control” is TRUE. LSR_MAX_POWER
Gas init delay	Delay on triggering the GasInit command. ■ **-2 000 ms … +2 000 ms** Lsr_InitGasDly
Gas check pressure	Gas pressure used when checking the process gases during initialization. Only relevant if the parameter “Proportional Gas Valve” is TRUE. ■ **1 … 30 bar** LSR_GasCheckPressure
Gas switch delay	Delay on triggering the GasSwi command. ■ **-2 000 ms … +2 000 ms** Lsr_GasDlySwi
Enable/Disable increase impact pressure	Wait time for the robot controller in order to eliminate the back-pressure in the gas line. Corresponds to the gas preflow time on switching on the laser when the laser is restarted after a fault. ■ **0 … 9 999 s** **Note**: This wait time is ignored with the commands “Test the laser power” and “Determine the focus of the optics”. LSR_TimeToAvoidGasPress
Standstill monitoring at active laser	If the robot is stationary and the laser power is active, the laser is deactivated after the time defined. ■ **0 … 9 999 ms** LSR_Stop_InspectionTime
Switching delay	Time difference between setting the laser parameters and starting the laser program ■ **0 … 9 999 ms** PreDelay

10.3 LaserWeld configuration parameters

10.3.1 LaserWeld: Outputs to the wire feed system

The signals described in this section can be found in the file $config.dat in the directory R1\System. To adapt the values, the file must be edited.

Parameter	Description/variable name	Data type
Wirefeed manual On/Off	Wire feed on/off via status key LSWO_WireFeedForward	BOOL
Wirefeed On/Off	LSWO_WireFeedStart	BOOL

Parameter	Description/variable name	Data type
Analog channel for wirefeeder	LSWO_WireFeedChannel	INT
Analog channel for wire heater	LSWO_WireFeedHeatChan	INT
Wireheater On/Off	LSWO_WireFeedHeater	BOOL
Wirefeeder error, flag to PLC	LSWO_ErrorWireFeeder	BOOL
Wireheater error, flag to PLC	LSWO_ErrorWireHeat	BOOL

10.3.2 LaserWeld: Inputs from the wire feed system

The signals described in this section can be found in the file $config.dat in the directory R1\System. To adapt the values, the file must be edited.

Parameter	Description/variable name	Data type
Wireheater Ok	LSWI_WireFeedHeatControl	BOOL
Wirefeed Ok	LSWI_WireFeedReady	BOOL

10.3.3 LaserWeld: Process parameters

The specified ranges of values contain the values that will be accepted by the system. They do not, however, constitute a recommendation of which values are useful in practice.

The variables described in this section can be found in the file Lsw_Main.dat in the directory R1\TP\LaserWeld. To display or change the values, select **Display** > **Variable** > **Single** from the main menu.

Parameter	Description/variable name
Use wire controller	■ **TRUE, FALSE** LSW_UseWireFeed
Use hot wire controller	■ **TRUE, FALSE** LSW_HotWireOption
Enable/Disable velocity depending wirefeed	**Note**: If this parameter has been changed, the user interface must be reinitialized. **TRUE**: The wire feed rate is regulated relative to the robot velocity. LSW_UseWFDVelCtrld
Reduced wirefeed value	**TRUE**: The wire feed rate is reduced in the case of a start following a weld fault. LSW_StaticRedWfdOption
Reduced wirefeed distance	Distance for which the reduced wire feed rate in LSW_StaticRedWfdOption applies. Precondition: LSW_StaticRedWfdOption is ON. ■ **0 … 9 999 mm** LSW_WfdDistanceMax

Parameter	Description/variable name
Wirefeed reduce value	Value by which the wire feed rate is decreased. The wire feed rate is increased until the distance specified in LSW_WfdDistanceMax has been covered. Precondition: LSW_StaticRedWfdOption is TRUE. ■ **0 … 100 %** LSW_ReducedLimitWfdValue
Wireheat delay	■ **-9 999 … 0 … 9 999 mm** Positive value: Wire heater start delayed. Negative value: Wire heater start brought forward. LSW_WireHeatDelayConst
Trigger delay for wire controller	■ **0.001 … 9 999 s** LSW_WFD_DELAY
Maximum wirefeed	■ **0 … 9 999 m/min** LSW_WireFeedMaximum
Wirefeed minimum	■ **0 … 9 999 m/min** LSW_WireFeedMinimum
Maximum wirefeed voltage	Maximum voltage for analog channel for wirefeed ■ **0 … 9 999** LSW_WFD_AnalogMaxValue
Minimum wirefeed voltage	Minimum voltage for analog channel for wirefeed ■ **0 … 9 999** LSW_WFD_AnalogMinValue
Maximum wireheat scaling	■ **0 … 100 %** LSW_WireHeatMaximum
Minimum wireheat scaling	■ **0 … 100 %** LSW_WireHeatMinimum
Maximum wireheat voltage	Maximum voltage for analog channel for wire heater ■ **0 … 9 999** LSW_Heat_AnalogMaxValue
Wire heat voltage	Minimum voltage for analog channel for wire heater ■ **0 … 9 999** LSW_Heat_AnalogMiniValue

10.4 LaserCut configuration parameters

10.4.1 LaserCut: Outputs to the sensor

Detailed information about the distance sensor and distance controller is contained in the PRECITEC documentation.

The signals described in this section can be found in the file $config.dat in the directory R1\System. To adapt the values, the file must be edited.

Parameter	Description/variable name	Data type
Workdistance 2*	LSCO_SnsrWorkdistance2	BOOL
Workdistance 3*	LSCO_SnsrWorkdistance3	BOOL
Enable extended range	Use increased workspace. LSCO_SnsrLargeRange	BOOL
Enable manual mode	LSCO_SnsrEnableManual	BOOL
Distance control On/Off	LSCO_SnsrAuto	BOOL
Move sensor into home position	LSCO_SnsrHome	BOOL
Run reference motion	LSCO_SnsrReference	BOOL
Move sensor up	LSCO_SnsrManualUp	BOOL
Move sensor down	LSCO_SnsrManualDown	BOOL
Enable slow motion mode	LSCO_SnsrSlowMotion	BOOL
Internal control data	Comprises the entire output range. LSCO_SnsrDataWord	Word
Analog channel working distance	LSCO_LscDistance	INT
Analog channel tip compensation	LSCO_LscTipComp	INT
Analog channel programmed position	LSCO_LscProgPos	INT

10.4.2 LaserCut: Inputs from the sensor

Detailed information about the distance sensor and distance controller is contained in the PRECITEC documentation.

The signals described in this section can be found in the file $config.dat in the directory R1\System. To adapt the values, the file must be edited.

Parameter	Description/variable name	Data type
Sensor is out of range	LSCI_SnsrOutOfRange	BOOL
Collision	LSCI_SnsrCollision	BOOL
Position reached	LSCI_SnsrPosReached	BOOL
Sensor error	LSCI_SnsrError	BOOL
Sensor reference error	LSCI_SnsrRefErr	BOOL
Sensor ready	LSCI_SnsrReady	BOOL
Monitor sensor cable	LSCI_SnsrCableCut	BOOL

10.4.3 LaserCut: Process parameters

The specified ranges of values contain the values that will be accepted by the system. They do not, however, constitute a recommendation of which values are useful in practice.

The variables described in this section can be found in the file Lsc_Main.dat in the directory R1\TP\LaserCut. To display or change the values, select **Display** > **Variable** > **Single** from the main menu.

Parameter	Description/variable name
Cycflag sensor control	■ **1 … 32** LSR_CF_SensorCtrl
Timer number sensor status keys	■ **1 … 32** LSC_TC_PrecPLC
Analog distance	**Note**: If this parameter has been changed, the user interface must be reinitialized. **TRUE**: The cutting distance in the inline form LsrCut Sensor is transferred as an analog value. **FALSE**: The cutting distance in the inline form LsrCut Sensor is transferred via a program number. LSC_AnaCutDistance
Start velocity for pattern cutting	■ **0.2 … 9 999 %** LSC_STRT_VEL
Distance scaling	■ **1 … 9 999** LSC_AnaCutScale
Programmed position	“Home position” of the sensor. Refers to the zero position of the sensor. ■ **3 … 9 999** Unit: 1/10 mm Precondition: The parameter LSC_AnaCutDistance is TRUE. LSC_ProgPos
Maximum programmed position	Limit value for the programmed position. ■ **0 … 300** Unit: 1/10 mm Precondition: The parameter LSC_AnaCutDistance is TRUE. LSC_MaxProgPos
Defined programmed Position	■ **0 … 300** Unit: 1/10 mm Precondition: The parameter LSC_AnaCutDistance is TRUE. LSC_DefProgPos
Tip compensation time 1	Limit value for the permissible contact duration during cutting ■ **1 … 9 999 ms** LSC_TipComp1
Tip compensation time 2	Limit value for the permissible contact duration during piercing ■ **1 … 9 999 ms** LSC_TipComp2
Gas change duration	Time for the purging of the gas line on changing the gas after piercing. ■ **1 … 9 999 ms** LSC_GasRinseTime

11 KUKA Service

11.1 Requesting support

Introduction

The KUKA Roboter GmbH documentation offers information on operation and provides assistance with troubleshooting. For further assistance, please contact your local KUKA subsidiary.

Information

The following information is required for processing a support request:

- Model and serial number of the robot
- Model and serial number of the controller
- Model and serial number of the linear unit (if applicable)
- Model and serial number of the linear unit (if applicable)
- Version of the KUKA System Software
- Optional software or modifications
- Archive of the software

  For KUKA System Software V8: instead of a conventional archive, generate the special data package for fault analysis (via **KrcDiag**).
- Application used
- Any external axes used
- Description of the problem, duration and frequency of the fault

11.2 KUKA Customer Support

Availability

KUKA Customer Support is available in many countries. Please do not hesitate to contact us if you have any questions.

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