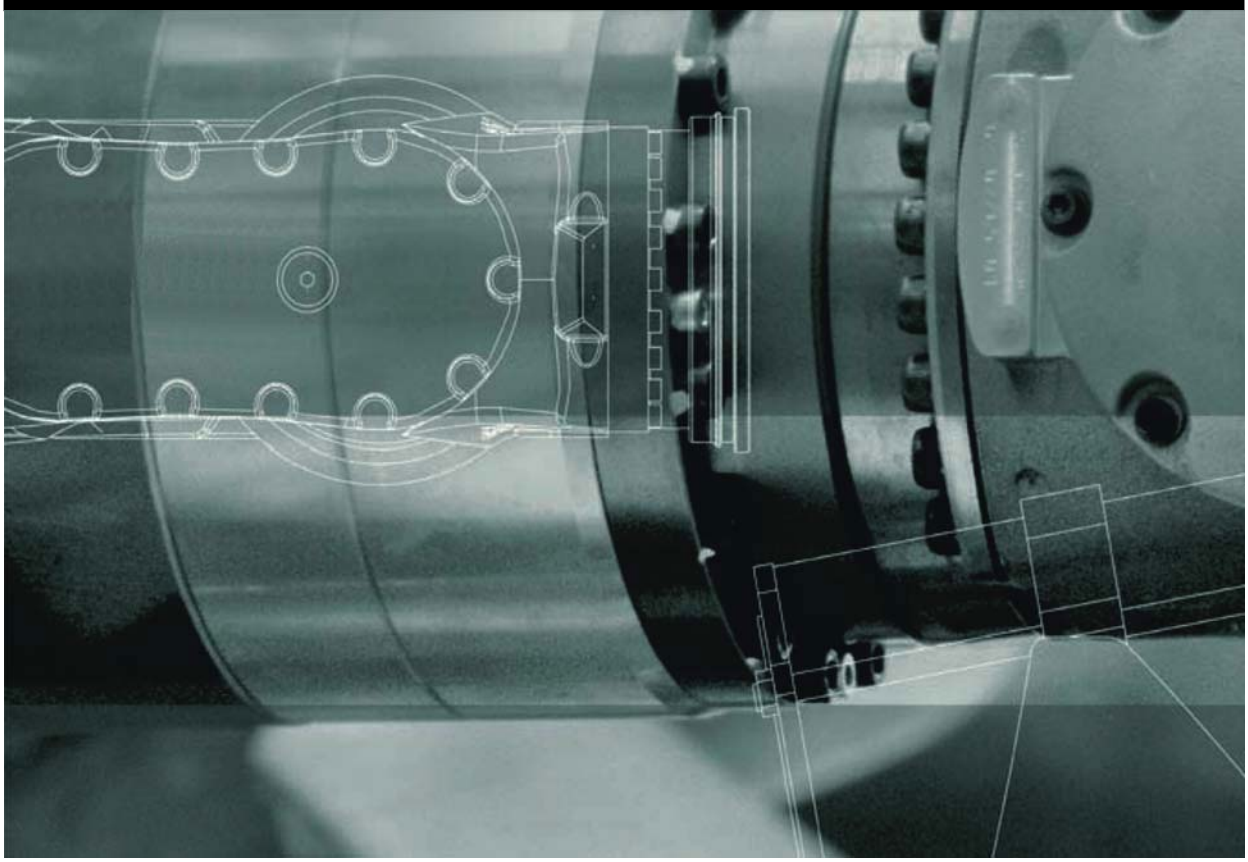
KUKA

KUKA System Technology

KUKA Roboter GmbH

KUKA.ServoGun FC 2.0

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
- Knowledge of field bus interfaces
- Knowledge of spot welding

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 physical injury **will** occur, if no precautions are taken.

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

CAUTION These warnings mean that minor physical 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 Trademarks

Windows is a trademark of Microsoft Corporation.

WordPad is a trademark of Microsoft Corporation.

1.5 Terms used

Term	Description
Burn-off (tip wear)	Deformation of the electrode tips caused by the welding process or by tip dressing
Compensation (equalization)	Pneumatic compensation cylinder for compensating the position of the gun: ■ Compensation activated: “soft” gun position ■ Compensation deactivated: “exact” gun position
First initialization	Pressing in the new electrode tips and remeasuring the tip burn-off (EG_WEAR[])
Mastering	Definition of the zero point (closed position) of the weld gun
Calibration	Comparison of the force sensor with an external force gauge and calculation of the following characteristics: ■ Force characteristic ■ Gun flexion characteristic
Tip dressing (TippDress)	Restoring the profile of the electrode tips by cutting
Force build-up	Generation of the closing force during gun closure
Force gauge	Instrument for measuring the closing force of the weld gun
Force control	During force control, the position of the axis/gun is corrected until the force acting on the gun is equal to the setpoint force (welding force).
Force sensor	Sensor in the motor of the spot weld gun, for determining the welding force
Position control	During position control, the position of the axis/gun is corrected until the setpoint position is reached.
Pole pair	Signal pick-up in the resolver of the gun motor A pole pair consists of two poles.
Reset	Resetting the force sensor (zeroing)
Residual travel	The residual travel is the distance between the software limit switch and the hardware limit stop; serves to protect the spindle and motor.
Weld timer	(= weld controller) Device for controlling the welding time and welding current
SDC	Servo Digital Converter The SDC is a hardware expansion required for ServoGun FC. It is located on the RDC box.
Servo gun	Weld gun with servomotor drive
Trace	The trace is the recorded measurement curve for a parameter, which is determined using the controller tool.

Term	Description
Water monitor	Monitoring unit in the cooling water circuit of the weld gun. The water monitor monitors the cooling water volume at the input and output of the cooling water circuit.
Exchangeable gun	Exchangeable weld gun which can be decoupled from the gun mount on the robot by the program
Gun flexion	Deformation of the weld gun caused by the action of the closing force
Gear ratio	Ratio between the motor stroke and gun opening
Cyclical initialization	Determination of the current electrode burn-off and adjustment to the current closing position

2 Product description

2.1 ServoGun FC – overview

Functions

ServoGun FC is an add-on technology package with the following functions:

- Force control of the gun via force sensor
- Control of up to 6 force-controlled, electric motor-driven spot weld guns:
  - Up to 6 exchangeable guns
  - 1 stationary spot weld gun and up to 5 exchangeable guns
  - 2 stationary spot weld guns

  If a linear unit is used:
  - Up to 5 exchangeable guns
  - Or 1 stationary spot weld gun
- Force calibration of guns
- Automatic TCP correction after tip dressing (electrode burn-off)
- Monitoring of various parameters

The servo gun is implemented as an external axis. Every taught point contains the positions of the 6 robot axes and the opening width of the gun.

WorkVisual

The following software is required for configuring the servo guns:

- WorkVisual 2.2

EqualizingTech

The software KUKA.EqualizingTech is available as a supplement to ServoGun. With EqualizingTech, conventional gun compensation systems are no longer required. This makes it possible to dispense with e.g. the complicated start-up procedures for pneumatic compensation systems. EqualizingTech results in only minor changes in the operation of ServoGun for the user.

Information about installing EqualizingTech is contained in the **KUKA.EqualizingTech** documentation.

Cell overview

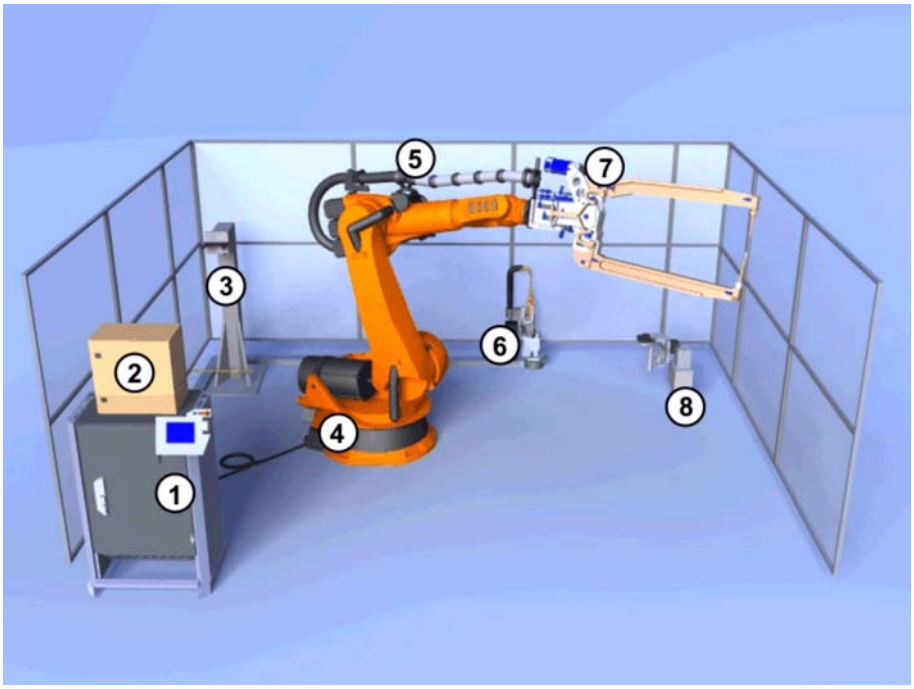

Fig. 2-1: Overview of a welding cell

1	KR C4 robot controller
2	Weld timer
3	Tool rack
4	Robot
5	Energy supply system
6	Stationary servo gun
7	Servo gun
8	Tip dresser

2.2 Functional principle

The robot approaches the taught weld spot using position control. Before the gun makes contact with the workpiece, the robot is braked to a defined velocity. The gun closes and presses the workpiece together. When the switch-on threshold (normally 0.8 kN) is reached, the robot controller switches from position control to force control (during the motion). The gun continues to press the workpiece together under force control until the welding force is reached. The signal for the start of welding is set, and the force on the gun is controlled during the welding process. The spot is welded. During the welding process, the force sensor measures the force acting on the gun and transfers the measurement result to the robot controller. When the weld timer gives the signal for the end of welding, the robot controller switches back to position control, and the gun opens.

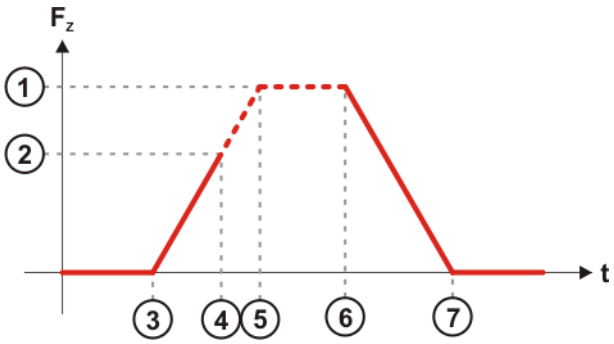

Fig. 2-2: Position and force control during the welding cycle

F_Z	Measured force acting on the gun
t	Time
1	Welding force reached
2	Force reaches switch-on threshold
3	Electrodes in contact with the workpiece
4	Switchover to force control on reaching the switch-on threshold
5	Weld timer starts and the spot is welded
6	Weld timer signals the end of welding; switchover to position control
7	Electrodes lift off the workpiece and the gun opens

2.3 Overview of connecting cables

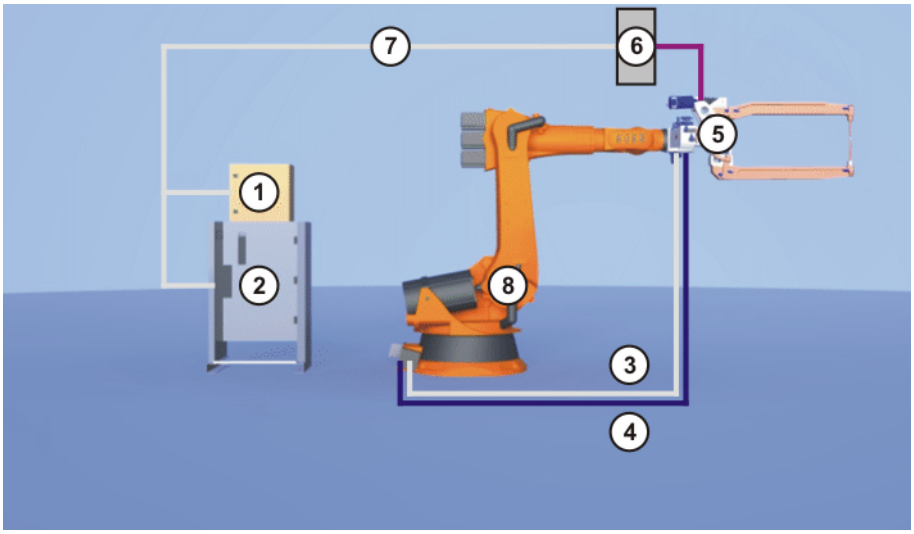

Fig. 2-3: Overview of connecting cables

1 Weld timer
2 Robot controller
3 Resolver-sensor cable
4 Motor cable to the gun
5 Weld gun
6 Field bus module on the weld gun (Not necessary if EqualizingTech is used. Otherwise, depending on the weld gun used.)
7 Field bus connection between the following components:
   - Weld timer
   - Robot controller
   - If used: Field bus module on the weld gun
8 Robot

The following connections depend on the type of weld gun being used:

- Connection for water cooling of the weld gun and the motor
- Air connection for the gun compensation
- Connection for the weld current

Further information about the connections on the weld gun can be obtained from the gun manufacturer.

2.4 Electrical connections on the weld gun motor

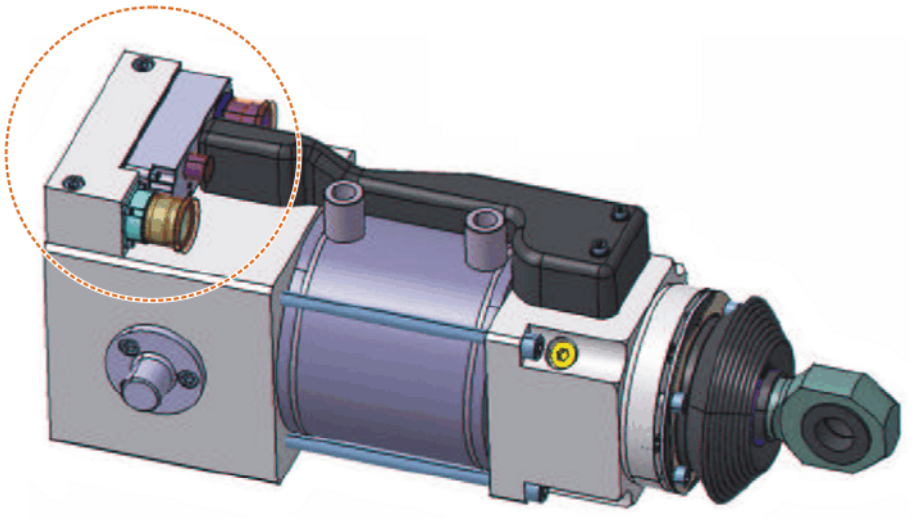

Fig. 2-4: Position of the electrical connections on the weld gun motor

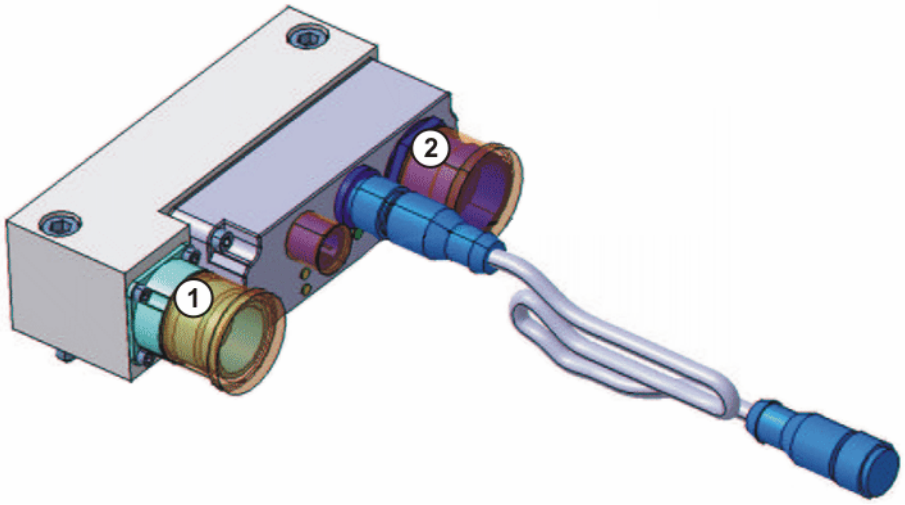

Fig. 2-5: Electrical connections of the weld gun motor

1	Connection for motor cable
2	Connection for resolver-sensor cable

2.5 Connector pin allocation X52

Description

The connector is a 19-contact (16+3) Intercontec connector with female crimp contacts on the P side.

Further information can be found in the parts list of the energy supply system.

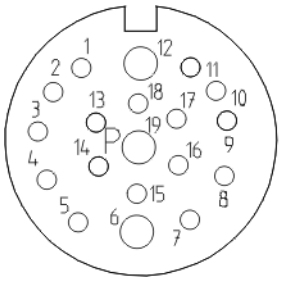

Fig. 2-6: Connector pin allocation X52

Pin	Designation
1	24 V sensor (IO-2)
2	GND sensor (IO-2)
3	Analog IN (IO-2)
4	n. c.
5	n. c.
6	n. c.
7	n. c.
8	Digital OUT (IO-2)
9	n. c.
10	SIN OUT 4+ (R1)
11	SIN OUT 4- (R2+)
12	n. c.
13	S2
14	S4
15	S1
16	S3
17	GND TMP (temp.)
18	TMP 7 (temp.)
19	n. c.

The shields of the wire pairs for "24 V sensor" (pin 1) / "GND sensor" (pin 2) and "Analog IN" (pin 3) / "Digital OUT" (pin 8) are connected to the connector housing.

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 physical injuries or considerable damage to property may otherwise result.

⚠ WARNING The force signal is measured in analog form at the sensor box without electrically isolated voltage supply. This measurement can be disrupted by discharged currents from the welding process. Interference is particularly liable to occur if the following constellation is used in the cell:

- The secondary neutral of the welding transformer is grounded.
- And: the workpiece fixture (e.g. a clamping fixture) is grounded.

It must be ensured that the force signal is transmitted to the sensor box without any interference. In particular, the constellation described above must not be used in the cell. If this precaution is not observed, the robot controller might receive corrupted force signals. Physical injuries or damage to property may result.

⚠ DANGER If the secondary neutral of the welding transformer is not grounded, this will endanger persons working at the cell. In particular, a voltage of 500 V is liable to be generated on the gun and not discharged. To avoid this hazard, one of the following elements must be installed in the primary weld power supply:

- Isolating contactor
- Residual-current circuit-breaker matching the welding technology (medium frequency or mains frequency)

Failure to observe this may result in severe physical injuries or death to persons.

NOTICE Weld spots and tip dressing points that were taught without EqualizingTech having been installed, must not be used with EqualizingTech.
Weld spots and tip dressing points that were taught with EqualizingTech must not be used without EqualizingTech.
The points must be retaught. Damage to the gun or the workpiece may otherwise result.

4 Installation

4.1 System requirements

Hardware

- KR C4 robot controller
- Robot with SDC
- Energy supply system with sensor cable for force-controlled electric motor-driven spot weld gun

  If a stationary gun is used: Suitable connecting cable
- Servo gun with force sensor

Software

- KUKA System Software 8.2

4.2 Installing ServoGun FC

During installation of ServoGun, one gun is automatically installed as external axis E1. Any existing E1 is overwritten.
If the gun is to be assigned to a different external axis number, this must be configured in WorkVisual.
All other configuration settings affecting the external axis must also be performed in WorkVisual.

Preparation

- Copy the folder with the software from the CD to the USB stick.

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. Click on **New software**. The entry **ServoGun FC** 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:
   - Click on 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 **ServoGun FC** and click on **Install**. Answer the request for confirmation with **Yes**.
6. Confirm the reboot prompt with **OK**.
7. Remove the stick.
8. Reboot the robot controller.

LOG file

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

4.3 Uninstalling ServoGun FC

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

Precondition

- "Expert" user group

Procedure

1. In the main menu, select **Start-up** > **Install additional software**.
2. Mark the entry **ServoGun_FC** and click on **Uninstall**. Reply to the request for confirmation with **Yes**. Uninstallation is prepared.
3. 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** > **ServoTech**
- **Configuration** > **ServoGun Force Control**
  - **Inputs**
  - **Outputs**
  - **Configuration**
  - **Gun parameters**
  - **Force control**
  - **Load all**
  - **Save all**
- **Configuration** > **ServoGun Diagnosis**
- **Configuration** > **Servo Gun Parameter Tool**

Menu sequence **Commands** > **ServoTech**:

- **SPOT**
  - **PTP**, **LIN**, **CIRC**
- **INIT**
- **TippDress**
  - **PTP**, **LIN**
- **ServoGun Decouple**
- **ServoGun Couple**

5.2 Status keys

Procedure

Displaying the status keys:

- In the main menu, select **Configuration** > **Status keys** > **ServoTech**.

Description

Status key	Name / description
	**Toggle status keys** Displays additional status keys.
	**First initialization**
	**Cyclical initialization**
	**Gun** Gun to which the status keys refer
	**Compensator 1** Close gun with compensator 1 (>>> 5.5 "Manually activating gun compensation" Page 23)

Status key	Name / description
	**Compensator 2** Close gun with compensator 2 (>>> 5.5 "Manually activating gun compensation" Page 23)
	**Decouple** (>>> 5.4 "Manually coupling / decoupling the gun" Page 22)
	**Couple** (>>> 5.4 "Manually coupling / decoupling the gun" Page 22)

5.3 Manually opening / closing the gun

Precondition

- Operating mode T1
- Settings on the **Keys** tab in the **Jog options** window:
  - The check box **Activate keys** is activated.
  - Under **Kinematic groups**, a group is selected that contains the external axis, e.g. **External axes**.

    The type and number of kinematics groups available depend on the system configuration.
  - Under **Coordinate system**, the option **Axes** is selected.

Procedure

1. Set jog override.
2. Hold down the enabling switch.
3. The axes of the selected kinematics group are displayed next to the jog keys.
   - Press the “plus” key of the external axis to close the gun.
   - Press the “minus” key of the external axis to open the gun.

If the functions of the status keys are interchanged (i.e. if the gun opens when “plus” is pressed), the sign of the configuration parameter **Gear ratio** must be changed.

Further information about axis combinations and external axes in general can be found in the documentation **External Axes**.

5.4 Manually coupling / decoupling the gun

Description

The gun is coupled or decoupled by the software.

The opening width of the gun must be identical in both the coupling and decoupling position. **Recommendation:** The gun should be open at least 10 mm.
Do not decouple the gun if it is in the mastering position, since the mastering would otherwise be lost when the gun is recoupled.

Procedure

1. Select the gun using the **Gun** status key.
2. Couple the gun with the **Couple** status key, or decouple it using **Decouple**.

5.5 Manually activating gun compensation

> This function is not required if EqualizingTech is installed.

Description

This functionality can be used to check the pneumatic compensation.

Precondition

- T1 or T2 operating mode
- The gun is coupled.

Procedure

1. Move the gun to the panel/position where the check is to be carried out.
2. Select the gun using the **Gun** status key.
3. Press the status key **Compensator 1** or **Compensator 2**. The gun closes and opens again after 0.5 s.
4. If the panel deforms in an undesired manner, change the setting of the pneumatic compension on the gun.
5. Repeat steps 3 and 4 until compensation is carried out as desired.

5.6 Calling the variable overview

Description

The variable overview displays the different ServoGun parameters and the corresponding values.

> Information about the meaning of the parameters can be found in the chapter “System variables”.
> (>>> 9 "System variables" Page 77)

Procedure

- In the main menu, select **Display** > **Variable** > **Overview** > **Display**. The variable overview is opened.

6 Start-up and configuration

6.1 Start-up and configuration – overview

⚠ WARNING The force signal is measured in analog form at the sensor box without electrically isolated voltage supply. This measurement can be disrupted by discharged currents from the welding process. Interference is particularly liable to occur if the following constellation is used in the cell:

- The secondary neutral of the welding transformer is grounded.
- And: the workpiece fixture (e.g. a clamping fixture) is grounded.

It must be ensured that the force signal is transmitted to the sensor box without any interference. In particular, the constellation described above must not be used in the cell. If this precaution is not observed, the robot controller might receive corrupted force signals. Physical injuries or damage to property may result.

⚠ DANGER If the secondary neutral of the welding transformer is not grounded, this will endanger persons working at the cell. In particular, a voltage of 500 V is liable to be generated on the gun and not discharged. To avoid this hazard, one of the following elements must be installed in the primary weld power supply:

- Isolating contactor
- Residual-current circuit-breaker matching the welding technology (medium frequency or mains frequency)

Failure to observe this may result in severe physical injuries or death to persons.

Step	Description
1	Mount the gun.
2	Connect the connecting cables.
3	Enter the weld parameters in the weld timer, e.g. welding time, welding current, dressing time. **Note:** Information can be found in the documentation for the weld timer.
4	Install ServoGun TC.
5	If required: Install EqualizingTech.
6	Transfer the project to WorkVisual and carry out configuration via WorkVisual. Then transfer the project from WorkVisual back to the robot controller. (>>> 6.2 "Configuration in WorkVisual – overview" Page 26)
7	Calibrate the gun as the tool. **Note:** Observe the information about servo gun calibration in this documentation. (>>> 6.3 "TCP calibration and tool direction" Page 29)
8	Enter and save the gun names. (>>> 6.4 "Setting configuration parameters" Page 29)

Step	Description
9	Configure the inputs/outputs. (>>> 6.4.3.1 ""Inputs" screen" Page 31) (>>> 6.4.3.2 ""Outputs" screen" Page 33)
10	Configure the parameters for **Configuration**. With the exception of the following parameters: **Force gauge**, **First calibration position**, **Calibration steps** (>>> 6.4.3.3 ""Configuration" screen" Page 34)
11	Configure the parameters for **Maximum gun force in kN**. (configuration screen **Force control**) (>>> 6.4.3.5 ""Force control" screen" Page 35)
12	Master the gun. (>>> 6.5 "Manual gun mastering" Page 37)
13	Determining the gear ratio. (>>> 6.6 "Determining the gear ratio" Page 37)
14	Determine the thickness of the force gauge. (>>> 6.7 "Determining the thickness of the force gauge" Page 38)
15	Test the sensor reset. (>>> 6.8 "Testing the sensor reset" Page 38)
16	Determine the calibration step size. (>>> 6.9 "Determining the calibration step size" Page 39)
17	Calibrate the force sensor. (>>> 6.10 "Calibrating the force sensor" Page 40)
18	Set the software limit switches for the gun. (>>> 6.11 "Setting the software limit switches" Page 44)
19	Check the residual travel and software limit switches. (>>> 6.12 "Checking the residual travel and software limit switches" Page 45)
20	Carry out first initialization of the electrode tips. (>>> 6.13 "Tip initialization – overview" Page 50)
21	If required: Optimize the controller parameters. (>>> 6.14 "Controller parameters – overview" Page 51)

6.2 Configuration in WorkVisual – overview

Step	Description
1	Transfer the project from the robot controller to WorkVisual.
2	Configure the field bus.
3	Configure the controller bus. (>>> 6.2.1 "Controller bus configuration for KUKA.ServoGun FC" Page 27)
4	Configure the gun. (>>> 6.2.2 "Configuring the gun" Page 27)
5	If required: perform further settings in WorkVisual.
6	Transfer the project from WorkVisual to the robot controller.

Information about bus configuration and project deployment can be found in the **WorkVisual** documentation.

6.2.1 Controller bus configuration for KUKA.ServoGun FC

SDC topology

The SDC is connected to connection B of the RDC. The connection is a permanent connection (= not disconnectable).

6.2.2 Configuring the gun

Description

During installation of ServoGun, one gun is automatically installed as external axis E1. Any existing E1 is overwritten.
If the gun is to be assigned to a different external axis number, this must be configured in WorkVisual.
All other configuration settings affecting the external axis must also be performed in WorkVisual.

The following guns/combinations can be configured:

- Up to 6 exchangeable guns
- 1 stationary spot weld gun and up to 5 exchangeable guns
- 2 stationary spot weld guns

If a linear unit is used:

- Up to 5 exchangeable guns
- Or 1 stationary spot weld gun

Preparation

1. Copy the file **ServoGunFC.afc** from the **Catalogs** folder on the ServoGun CD.
2. Copy the file to the following folder on the PC on which WorkVisual is installed:
   C:\Progam Files\KUKA\WorkVisual…\Catalogs
3. Import the catalog in WorkVisual via **File** > **Catalog management...**.
   The catalog is now displayed in the **Catalogs** window.

KUKA Roboter GmbH must be consulted if guns are to be used that are not contained in the catalog.

Precondition

- The robot controller has been set as the active controller.

Procedure

1. Select the gun in the **ServoGun [...]** catalog in the **Catalogs** window.

The guns are named after their motors. If the name does not contain any specification of the gun type, then it does not matter which gun type the motor is combined with in reality.

2. Drag the gun into the **Project structure** window: into the **Hardware** tab, onto the robot controller there. (Not onto the node **Unassigned active devices**.)
3. If the gun is used as a stationary gun, continue directly with step 4.
   If it is used on the robot flange, select the **Geometry** tab. There, drag the gun onto the **Flange Base** node of the robot.
   (This specifies that the gun may be coupled to this robot. It does not specify whether the gun is actually coupled, but merely that coupling is possible.)

4. Select the gun and select the menu sequence **Editors** > **Machine data configuration**. The **Machine data configuration** window is opened.
5. Only if this ServoGun project has already been transferred 2 or more times to WorkVisual:

   Click on the following button: **Import axis-specific machine data of the kinematic system from external files**

NOTICE If the data are not imported in the specified case, configuration data may be lost, resulting in a faulty project being transferred to the robot controller. This may result in damage to property or necessitate extensive corrective measures.

6. If the tab [*Axis_name*] (e.g. **Joint 1**) is closed, click on it. The tab is opened.
7. In the **Axis ID** box in the area **General axis-specific machine data**, specify which drive the gun is assigned to in the real cell.
8. Fill out the **Supply channel** box.
9. Set the check mark in the box **Axis decouplable**.
10. If required: edit the other parameters.
11. Repeat steps 1 to 9 for all the guns used.
12. Only with stationary guns: The gun must be linked to the robot with which it is to be kinematically coupled in the real cell.
    a. Select the cell on the **Hardware** tab and select the menu sequence **Editors** > **Configure kinematic relations…**. An editor opens.

       (If couplable guns are used, these are linked to their robot in the editor by means of arrows. This is only a display and cannot be changed here.)

    b. Right-click in the empty space in the editor and select  from the context menu.
    c. Click on the stationary gun. Hold down the mouse button, drag the mouse pointer to the robot and release the mouse button.

       In the editor, the link is now displayed by an arrow line. The designation of the gun is now displayed in the node of the robot on the **Hardware** tab.
    d. Repeat these steps for all stationary guns used.
13. Switch back to the **Machine data configuration** window.
14. Only perform in the following case:
    - If this project has been configured in WorkVisual for the first time.
    - And if one or more guns had already been configured manually on the robot controller before the project was transferred to WorkVisual.

    Click on the following button: **Import axis-specific machine data of the kinematic system from external files**

NOTICE If the data are not imported in the specified case, configuration data may be lost, resulting in a faulty project being transferred to the robot controller. This may result in damage to property or necessitate extensive corrective measures.

System variables

The following ServoGun system variables are adapted by the configuration in WorkVisual:

EG_EXTAX_ACTIVE

EG_SERVOGUN_EXAXIS[1] … [6]

EG_COUPLE_AXIS

6.3 TCP calibration and tool direction

- When calibrating the servo gun, always position the TCP on the fixed electrode.
- The tool direction must be defined as shown in the illustration (plus and minus directions). (>>> Fig. 6-1)
- In the KUKA System Software, the X, Y or Z direction can be selected as the tool direction.

  The direction that was selected there must be entered during the configuration of ServoGun on the configuration screen **Configuration**. (Default: -X direction)

  (>>> 6.4.3.3 ""Configuration" screen" Page 34)

Information about calibration and definition of the tool direction is contained in the operating and programming instructions for the KUKA System Software (KSS).

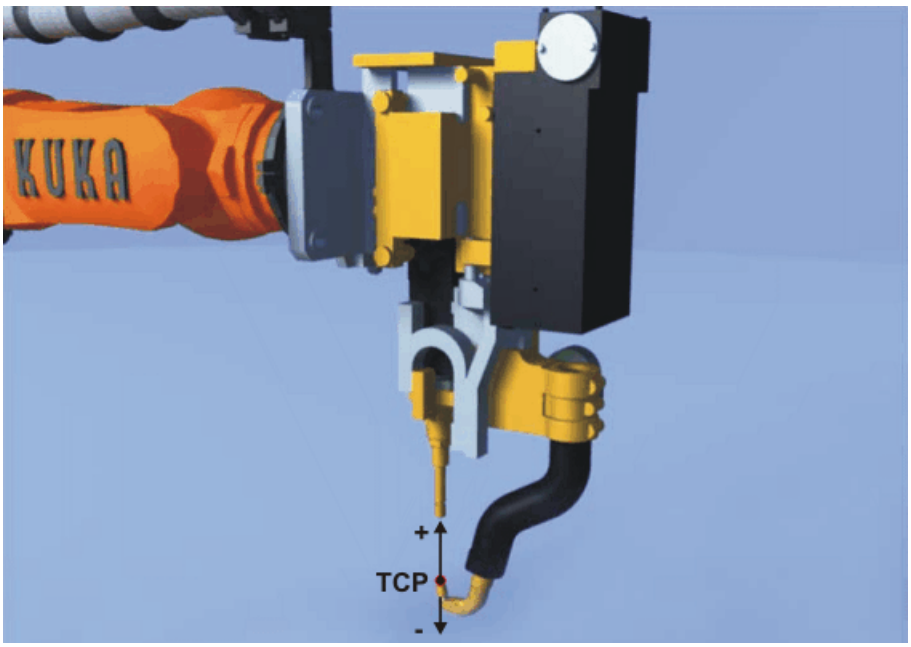

Fig. 6-1: TCP and tool direction

6.4 Setting configuration parameters

Precondition

- "Expert" user group

Procedure

1. In the main menu, select **Configuration** > **ServoGun Force Control** and then one of the following menu items:
   - **Inputs**
   - **Outputs**
   - **Configuration**
   - **Gun parameters**
   - **Force control**

   The corresponding configuration screen is opened.
2. If there is more than one gun configured: In the **Selected gun** box, select the gun (no.) to which the settings are to apply.
3. Enter a distinctive name for the gun in the **Gun description** box.

This needs to be done only once per gun, on one of the screens.

4. Configure the parameters as required on the selected screen.
   (>>> 6.4.3 "Configuration parameters" Page 31)
5. Press **Save**. The changes are saved.
6. Close the screen via the **Close** icon.
7. Configure the parameters as required on the other screens.

Alternative procedure

The parameters can also be loaded from a data medium.

- The parameters can be loaded for each screen.
  (>>> "Buttons" Page 30)
- The parameters can be loaded for a number of screens at once.
  (>>> 6.4.1 "Loading gun data from a TXT file" Page 30)

Buttons

The following buttons are available on the configuration screens:

Button	Description
Import	If the data for this screen are available in a TXT file, they can be loaded using this button. Precondition: The TXT file is located on a drive to which the robot controller has access. Or a USB stick with the TXT file is connected.
Export	Saves the data in this screen to a TXT file. A name can be assigned to the file. As the memory location, it is possible to select a drive to which the robot controller has access, or a USB stick.
Load	Updates the data in this screen in accordance with the current state of the robot controller. If changes have been entered but not yet saved on this screen, the initial state can be restored in this way.
Save	Saves the changes on this screen.
Calculate	Only available in the **Force control** screen. Calculates the current calibration of the gun on the basis of the values **Force 1 in kN**, etc. The calibration is not saved.

6.4.1 Loading gun data from a TXT file

Description

If the data for the following configuration screens are available in a TXT file, they can be loaded at once:

- **Configuration**
- **Gun parameters**
- **Force control**

Precondition

- The TXT file is located on a drive to which the robot controller has access.
  Or: A USB stick with the TXT file is connected.
- “Expert” user group

Procedure

1. In the main menu, select **Configuration** > **ServoGun Force Control** > **Load all**.
2. All available drives are displayed. Navigate to the TXT file and select it.
3. Click on **Load**.

4. A request for confirmation is displayed, asking if the existing data should be overwritten. Confirm with **Yes**.
   The data are loaded.

6.4.2 Saving gun data in a TXT file

Description

This procedure saves the data in the following configuration screen to a TXT file:

- **Configuration**
- **Gun parameters**
- **Force control**

Precondition

- "Expert" user group

Procedure

1. If data are to be saved to a USB stick, this should be connected.
2. In the main menu, select **Configuration** > **ServoGun Force Control** > **Save all**.
3. The available drives are displayed. Navigate to the desired memory location and select it.
4. Enter a name for the file in the **Select file** box.
5. Click on **OK**. The data are saved and the following message is displayed: *Saving successful!*

6.4.3 Configuration parameters

6.4.3.1 "Inputs" screen

Digital inputs/ outputs

Digital inputs/outputs 1 to 4096 are available by default. This number can be reduced via the variable $SET_IO_SIZE.

Inputs/outputs

If an input or output is set, the LED icon next to the box is green (otherwise gray).

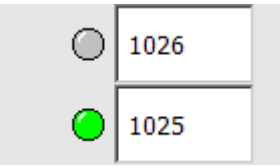

Fig. 6-2: Lamps for inputs/outputs

Input	Description
Motion with/without closing	HIGH = Gun remains open at the weld spot LOW = Gun closes at the weld spot
Weld end	HIGH = End of weld reached LOW = End of weld not reached
Error messages	For customization Address range for transfer of error messages from the weld timer
Error from timer	HIGH = Error from weld timer present LOW = No error from weld timer present

Input	Description
With/without weld current	Weld instruction executed with/without current. In AUT and EXT modes, an error message is displayed if the weld current is deactivated. HIGH = With weld current LOW = Without weld current
Option tip dressing	Not supported For customization
Acknowledge without repeat **Acknowledge with repeat**	Certain dialog messages can also be answered by the PLC instead of the user. These two inputs receive the answer from the PLC. (>>> "Acknowledgement by PLC" Page 32) HIGH for **Acknowledge without repeat** = NO (The program is continued without repeating the point.) HIGH for **Acknowledge with repeat** = YES (The last point is repeated.) Both inputs must not be HIGH at the same time. If both inputs are LOW, this means “no answer”, and the message remains in the message window. **Note:** After the dialog message has been answered, the input must be reset by the PLC for the program to be resumed.
New electrodes	For customization
Stop after end of point	Robot stops after weld instruction. HIGH = Robot stops LOW = Robot continues to move
Dressing start request	For customization
Dressing follow request	For customization
Timer valid bit	Weld timer confirms program number. HIGH = Weld timer confirms program number LOW = No confirmation from the weld timer
Timer ready	Status of weld timer HIGH = Weld timer ready LOW = Weld timer not ready
Process monitoring	For customization
Water monitor 1	Monitoring of the cooling water volume at the gun intake HIGH = No alarm LOW = Alarm triggered
Water monitor 2	Monitoring of the cooling water volume at the gun outflow HIGH = No alarm LOW = Alarm triggered
Thermo contact transformer	Monitoring of the temperature of the transformer on the gun HIGH = Transformer has normal operating temperature LOW = Transformer is overheating

Acknowledgement by PLC

The following dialog messages can be acknowledged by the PLC:

- *No cycle end signal, input ..., repeat point?*

- *Welding controller error, input ..., repeat point?*
- *No TIMER READY signal, input ..., repeat point?*

6.4.3.2 “Outputs” screen

Digital inputs/ outputs Digital inputs/outputs 1 to 4096 are available by default. This number can be reduced via the variable $SET_IO_SIZE.

Inputs/outputs If an input or output is set, the LED icon next to the box is green (otherwise gray).

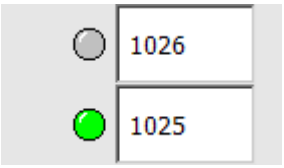

Fig. 6-3: Lamps for inputs/outputs

Output	Description
Weld start	Start the welding process (also start of cycle) HIGH = Start of welding LOW = No start of welding
Compensator 1	Only effective for gun with pneumatic compensation: activate compensator 1 HIGH = Compensation activated LOW = Compensation deactivated
Compensator 2	Only effective for gun with pneumatic compensation: activate compensator 2 HIGH = Compensation activated LOW = Compensation deactivated
Program number	Address range for transfer of the program number. The bit width must not exceed 32 bits. HIGH = Bit set LOW = Bit not set
With/without weld current	This input is LOW if the timer type “TEST” or T1 mode is selected. Otherwise, this input is HIGH.
Acknowledge weld error	Reset error in the weld timer HIGH = Error will be reset LOW = Error will not be reset
New electrodes	This output is used by the robot controller to signal to the weld timer that first initialization with new electrodes has taken place.
Stop after end of point	Confirmation, stop after end of welding HIGH = End of weld reached LOW = End of weld not yet reached
Acknowledge tip dressing	For customization

6.4.3.3 “Configuration” screen

Input	Description
Timer type	Manufacturer of the weld timer used If **TEST** is selected, the gun is closed for 0.5 seconds with the define force and then opened again. No welding is carried out. ■ **TEST** (default), **ARO**, **BOSCH**, **FASE**, **SERRA**
Gun type	■ **X**: X gun (default) ■ **C, G, J**: C gun
TCP orientation	Working direction of the tool (TCP) ■ **-X** (default), **-Y**, **-Z**, **+X** (default), **+Y**, **+Z** (>>> 6.3 "TCP calibration and tool direction" Page 29)
TCP correction	Automatic correction of the point coordinates, corresponding to the tip wear ■ **On** (default): The point coordinates are corrected, i.e. they are adapted in accordance with the tip wear determined during tip initialization. ■ **Off**: The point coordinates are not corrected. If the burn-off has been determined, this is ignored.
Tip detection	The system checks for the presence of tips on the gun. ■ **On** (default): Tip detection activated. If an electrode tip falls off, this is detected and an error message is generated. After force build-up, the closing width of the gun is measured. This value is compared with the value entered under **Part** in the inline form **TippDress**, taking into account the flexion. ■ **Off**: Tip detection deactivated
X-Compensation	**Maximum comp.**: The distance traveled by the tips at maximum force. ■ **0 ... 10 mm** Default: 0.00
	Direction: The direction in which the tips travel. ■ **-X** (default), **-Y**, **-Z**, **+X** (default), **+Y**, **+Z**
	Compensation active: X-compensation on/off ■ **Off** (default), **On**
Force gauge	**Thickness**: Thickness of the force gauge ■ **0 … 100 mm** Default: 50.00 (>>> 6.7 "Determining the thickness of the force gauge" Page 38)
Calibration positions	**First calibration position**: First measurement position during calibration. ■ **0 … 100 mm** Default: 0.10
	Calibration steps: Size of the calibration step for the 4 subsequent measurements of the calibration in [mm/kN]. ■ **0 … 100 mm** Default: 0.10

Input	Description
First Init force	The force with which the gun is closed during the first motion during first initialization **Note:** Suitable values are values from 2.5 kN. ■ **2** … max. gun force Default: 3.00
Tip wear (burn-off)	Maximum permissible value of the tip burn-off (both tips together) ■ **0 … 20 mm** Default: 8.00

6.4.3.4 “Gun parameters” screen

Input	Description
Motor file **Servo file** **Position control file** **Force control file**	The files currently used are displayed here. (display only) If other files are to be loaded, this must be done in WorkVisual.
Gear ratio	Distance moved by electrodes in [mm] per revolution of the motor ■ **-100 … 100 mm** Default: 5.00 **Note:** Enter the value without sign, or with a positive sign. (>>> 6.6 "Determining the gear ratio" Page 37)
Max. opening (mm)	Enter the negative software limit switch. ■ **0 … 1,000 mm** Default: 100.00 (>>> 6.11.1 "Setting the negative software limit switch" Page 44)
Software limit (mm)	Enter the positive software limit switch. ■ **0 … 1,000 mm** Default: 35.00 (>>> 6.11.2 "Setting the positive software limit switch" Page 45)
Max. flexion (mm)	Maximum flexion of the gun (calculated from the calibration) + 5 mm reserve (display only)
Max. speed (rpm)	Revolutions per minute of the gun motor (display only)

6.4.3.5 “Force control” screen

Input	Description
Force 1 in kN … **Force 5 in kN**	Enter here the values determined during calibration. Default: 0.001
Force 1 in Inc … **Force 5 in Inc**	These values are determined during coarse and fine calibration and displayed here automatically. (display only)

Input	Description
Calibration position 1 in degrees … **Calibration position 5 in degrees**	Gun positions during the 5 calibration measurements. The values are displayed here automatically. (display only)
Position / Force	Ratio of position (degrees) to force (kN) (display only)
Force-control switch-on in kN	Switching threshold between position control and force control (kN) ■ **0.1 … 10.00** Default: 0.80 **Recommendation:** Do not change the default value.
Maximum gun force in kN	Enter the maximum closing force of the gun. This can be taken from the gun manufacturer's data sheet. (kN) ■ **1 … 10.00** Default: 5.00 **Note:** If this maximum force cannot be achieved on the force gauge during determination of the calibration step size, then enter here the highest force measured on the force gauge. (>>> 6.9 "Determining the calibration step size" Page 39)
Proportional factor	Gain factor of the force controller ■ **0.00001 … 1.00** Default: 0.01 **Recommendation:** Do not change the default value.
Lower limit in kN	Tolerance relative to the switch-on threshold, below which the force must not drop during force control (kN) ■ **0 … 2.00** Default: 2.00 **Recommendation:** Do not change the default value.
Upper limit in kN	Tolerance relative to the maximum force of the weld gun, which must not be exceeded during force control (kN) ■ **0 … 2.00** Default: 0.50 **Recommendation:** Do not change the default value.
Max. speed of constant motion phase (rpm)	Maximum speed of the constant motion phase (rpm). Default: 1000.00 **Recommendation:** Do not change the default value.
Workpiece detection monitoring tolerance	Factor which is multiplied by the value of **Maximum gun force in kN** and then converted into a distance, taking account of the gun flexion (**Max. flexion (mm)**). If this distance is exceeded after contact with the workpiece has been detected, without the force sensor signal exceeding the force controller switch-on threshold, then it is assumed that there has been a fault in the measuring chain (force sensor, splitter box, sensor cable, A/D converter module) and the robot stops. ■ **0.5 … 1** Default: 0.50 **Recommendation:** Do not change the default value.

6.5 Manual gun mastering

Description

A gun must be mastered in the following cases:

- Commissioning a gun (first mastering)
- After exchanging gun components
- After a loss of mastering

Precondition

- Operating mode T1
- New electrode tips are fitted on the gun.

NOTICE Used electrodes must not be used in this case, as this would result in an incorrect mastering value. This could damage the gun.

Procedure

1. Close the gun manually with the jog keys until the electrodes are just touching.

   NOTICE The gun must not exert any force, otherwise it may become damaged.

   Whether or not the electrodes are just touching can be ascertained by a visual check, or using a strip of paper held between the electrodes. (Close the gun until the strip of paper is lightly clamped.)
2. In the main menu, select **Start-up** > **Master** > **Dial**. A window opens.
3. In this window, select the external axis to be mastered and press the **Master** softkey. The axis is removed from the window.
4. Close the window.

6.6 Determining the gear ratio

Precondition

- The gun is mastered.
- Operating mode T1

Procedure

For C guns:

The gear ratio corresponds to the screw pitch of spindle.

1. Consult the gun manufacturer's data sheet to find out the value for the screw pitch of spindle.
2. Enter the value in the **Gear ratio** box in the **Gun parameters** configuration screen and save.

If no value for the spindle screw pitch is available from the manufacturer, the gear ratio can be determined using the same method as for X guns.

For X guns:

The gear ratio is the change in the opening width over 1 motor revolution.

1. Close the gun without exerting any force.
2. In the main menu, select **Display** > **Actual position**. The Cartesian actual position is displayed.
3. Press **Axis-specific** to display the axis-specific actual position. The gun position is displayed as *0* in the **Motor [deg]** column.
4. Open the gun manually until the value *360* is displayed in the **Motor [deg]** column.
5. Measure the distance between the electrodes.
6. Enter the distance in the **Gear ratio** box in the **Gun parameters** configuration screen and save.

The value for the gear ratio is more precise if the gun is opened by more than one motor revolution and the measured distance is divided by the number of revolutions.
Recommendation: If there is sufficient space available, open the gun by 10 revolutions and then divide the measured distance by 10.

6.7 Determining the thickness of the force gauge

Description

The thickness of the sensor plate of the force gauge is determined and entered in the configuration. This is the basis for measuring the closing forces of the gun with the force gauge during subsequent gun calibration.

Fig. 6-4: Measuring with the force gauge

Precondition

- The gun is mastered.
- Operating mode T1

Accessories

- Force gauge

Procedure

1. Set jog override to 3%.
2. Open the gun manually.
3. In the main menu, select **Display** > **Variable** > **Overview** > **Display**.
4. Place the force gauge on the fixed electrode.
5. Close the gun until the moving electrode just touches the sensor plate.
6. In the **Variable overview – Display** window, read and note down the value for the **Position** variable.
7. Open the gun and remove the force gauge.
8. Enter the value in the **Thickness** box in the configuration screen **Configuration**.

6.8 Testing the sensor reset

Precondition

- The gun motor is connected.
- The outputs are configured.
- The gun is mastered.

Procedure

If there is an LED on the distributor box of the weld gun motor:

1. Set the system variable $SG_SENSOR_RESET[*axis_number*] to TRUE.
   The LED must light up.
2. Set the system variable $SG_SENSOR_RESET[*axis_number*] to FALSE.
   The LED must go out.

If there is no LED on the distributor box of the weld gun motor:

1. Set the system variable $SG_SENSOR_RESET[*axis_number*] to TRUE.
   Carefully close the gun manually. At the same time, observe $FORCE_ACT: $FORCE_ACT must maintain the same value.
2. Set the system variable $SG_SENSOR_RESET[*axis_number*] to FALSE.
   Carefully close the gun manually. At the same time, observe $FORCE_ACT: $FORCE_ACT must increase continuously as the actual force increases.

NOTICE If the LED or $FORCE_ACT responds in a different way from that described, the force sensor is supplying incorrect values. There is a risk of damage to the gun and/or the workpiece. Check the cabling and correct if necessary.

6.9 Determining the calibration step size

Description

The calibration step defines the ratio between the travel and the force [mm/kN] of the gun and must be determined for the coarse calibration.

Precondition

- The gun is mastered.
- The electrode tips are firmly pressed on.
- The gear ratio has been entered.
- The thickness of the force gauge has been entered.
- The maximum gun force has been entered.
- Operating mode T1

Accessories

- Force gauge

Procedure

1. Set jog override to 3%.
2. Open the gun manually.
3. In the main menu, select **Display** > **Actual position** > **Cartesian**.
4. Place the force gauge on the fixed electrode.
5. Close the gun until the force gauge shows a value of approx. 0.8 kN.
6. Note the actual position of the external axis.
7. Continue to close the gun until the maximum gun force is displayed on the force gauge.
   If the maximum force is not reached, note the highest force achieved.
8. Note the actual position of the external axis at maximum force.
   If the maximum force was not reached in the previous step, note the actual position at the highest force achieved.
9. Open the gun and remove the force gauge.
10. Calculate the first calibration position and the size of the calibration step.
    (>>> 6.9.1 "Calculating the first calibration position and the calibration step size" Page 40)
11. Enter the value in the boxes **First calibration position** and **Calibration steps** in the configuration screen **Configuration**.

12. If the maximum force specified by the manufacturer is not reached on the force gauge, enter the highest force achieved on the configuration screen **Force control** under **Maximum gun force in kN**.

6.9.1 Calculating the first calibration position and the calibration step size

Example values

Thickness of the force gauge	23 mm
Lower gun force	Always use the following value: 0.8 kN
Maximum gun force	If the maximum force specified by the manufacturer is not reached on the force gauge, enter the highest force achieved. 3.4 kN
Actual position for lower force	3 mm
Actual position for maximum force	21 mm

First calibration position

First calibration position = Force gauge thickness – Actual position for maximum force

First calibration position = 23 mm – 21 mm

Result: 2 mm

Calibration steps

Calibration steps = (Actual position for maximum force – Actual position for lower force) / 4

The divisor “4” is determined by the number of calibration steps for coarse calibration.

Calibration steps = (21 mm – 3 mm) / 4

Result = 4.5 mm

6.10 Calibrating the force sensor

During calibration, the force sensor is compared with an external force gauge and the gun flexion is determined.

Overview

Step	Description
1	Coarse calibration with EG_CAL_F program (>>> 6.10.1 "Coarse calibration with EG_CAL_F program" Page 41) (>>> 6.10.2 "Description of coarse calibration" Page 41)
2	Force test with EG_FORCE_F program (>>> 6.10.3 "Force test with EG_FORCE_F program" Page 43)
3	Only necessary if the force test with EG_FORCE_F results in too high a deviation between the setpoint and actual force values: Fine calibration with the EG_RECAL_F program (>>> 6.10.4 "Fine calibration with the EG_RECAL_F program" Page 43)

The programs can only be executed in T1 mode.

6.10.1 Coarse calibration with EG_CAL_F program

(>>> 6.10.2 "Description of coarse calibration" Page 41)

WARNING During calibration, the gun closes at process velocity, not at test velocity.

Precondition

- The gun is mastered.
- The gear ratio has been entered.
- The thickness of the force gauge has been entered.
- The maximum gun force has been entered.
- The calibration step size and first calibration position have been entered.
- New electrode tips
- Operating mode T1

Accessories

- Force gauge

NOTICE If it becomes apparent during the measuring process that the maximum gun force will be exceeded at the next measuring step, the EG_CAL_F program must be aborted. If this is not done, the force gauge and/or gun may be damaged.
On the configuration screen **Configuration**, a lower value must be entered under **Calibration steps**. Then restart EG_CAL_F.

Procedure

1. Select and start the program EG_CAL_F.
2. Follow the dialog messages and note the values of the 5 measurements.
3. After the 5th measurement, take the force gauge out of the gun.

NOTICE If the force gauge is not removed from the gun, this may result in damage to property.

4. The gun moves to the mastering position and stops there. Carry out a visual check that the mastering position is correct.
   - If it is: continue with the next step.
   - If not: remaster the gripper. Then repeat the entire calibration.
5. Execute the program through to the end.
6. The values noted must be entered on the **Force control** configuration screen in **Force 1 in kN** to **Force 5 in kN**.
7. Click on **Calculate**, then save.

The measured values should cover the force range of the gun. If the measured values are too low, a higher value must be entered at the following place: On the configuration screen **Configuration** under **Calibration steps**.
Then restart EG_CAL_F.
The force range is dependent on the gun. Guide values:

- **Force 1 in kN**: 0.8 kN … 1.2 kN
- **Force 5 in kN**: Maximum force

6.10.2 Description of coarse calibration

The program EG_CAL_F is used to determine the relationship between the force sensor increments and the external force, and between the gun position and the external force. This results in the following characteristics:

- Force characteristic of the force sensor

- Gun flexion characteristic

The program EG_CAL_F closes the gun under position control. The resulting force value is determined using a force gauge.

In 5 measurements, 5 increment/force pairs are determined. The increment/force pairs are saved and added to the force characteristic of the force sensor, with interpolation of the intermediate values.

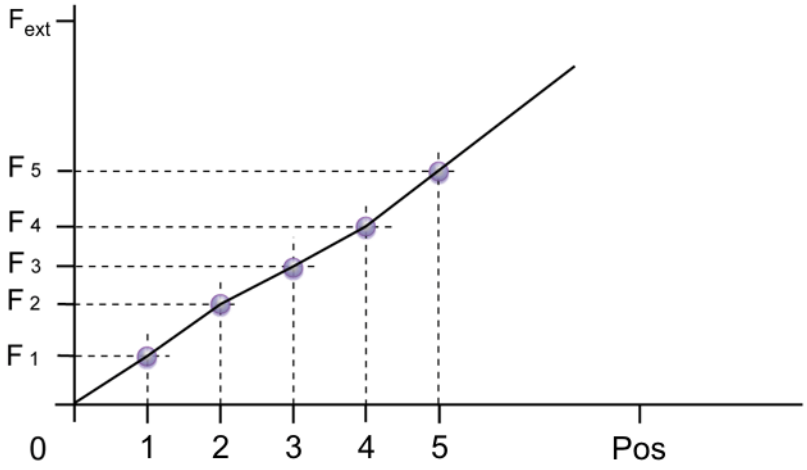

Fig. 6-5: Force characteristic

F_{ext}	Force on the external force gauge
Pos	Measurement position (in force sensor increments)
$F_1...F_2$	Measured forces at the measurement positions
1...5	Measurement positions

The gun flexion characteristic is calculated from the force values, the motor position and the gear ratio.

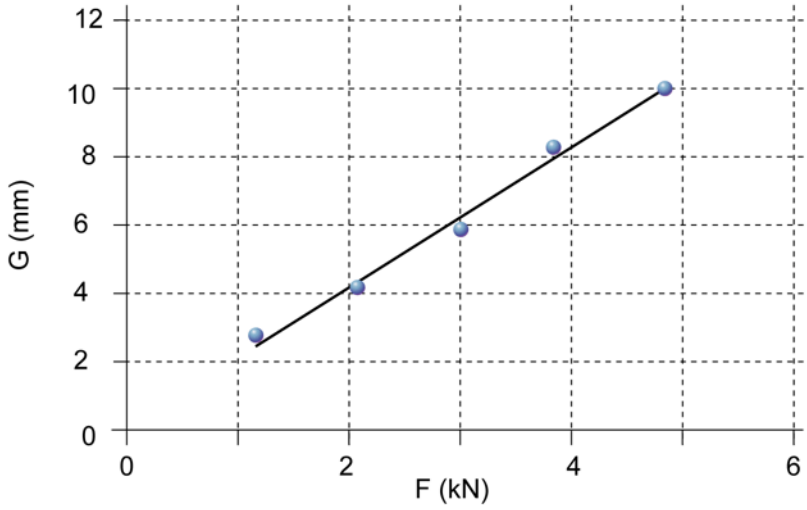

Fig. 6-6: Force / gun flexion characteristic

G	Gun flexion in mm
F	Force in kN

6.10.3 Force test with EG_FORCE_F program

Description

The EG_FORCE_F program is used to check the force characteristic. A force sensor is placed in the gun. The user selects the force with which the gun is to be closed.

The robot controller closes the gun with the selected setpoint force. The actual force on the gun can then be read off on the force gauge.

Precondition

- The gun is mastered.
- The gear ratio has been entered.
- The thickness of the force gauge has been entered.
- The maximum gun force has been entered.
- The calibration step size and first calibration position have been entered.
- Coarse calibration with EG_CAL_F has been carried out.
- Operating mode T1

Procedure

1. Select and start the program EG_FORCE_F.
2. Follow the dialog messages.
3. Select the lowest setpoint force using the corresponding button.
4. Measure the actual force with the force gauge and note it down.

NOTICE If the measured force is significantly higher than the selected force, cancel the program without performing any further measurements, and carry out calibration with EG_CAL. This also applies to the following steps. Further measurements may cause damage to property.

5. Repeat steps 3 and 4 for all forces.
   The **->** button is used to display further buttons with higher forces.
6. If the actual force values deviate from the setpoint values by more than ±3%, carry out fine calibration with the program EG_RECAL_F.
   (>>> 6.10.4 "Fine calibration with the EG_RECAL_F program" Page 43)

6.10.4 Fine calibration with the EG_RECAL_F program

Description

If the force test with EG_FORCE_F results in too high a deviation between the setpoint and actual force values, fine calibration must be carried out. EG_RECAL_F performs the same measurements as EG_CAL_F, but closes the gun under force control.

⚠ WARNING During calibration, the gun closes at process velocity, not at test velocity.

Precondition

- The gun is mastered.
- The gear ratio has been entered.
- The thickness of the force gauge has been entered.
- The maximum gun force has been entered.
- The calibration step size and first calibration position have been entered.
- Coarse calibration with EG_CAL_F has been carried out.
- Operating mode T1

Accessories

- Force gauge

Procedure

1. Select and start the program EG_RECAL_F.
2. Follow the dialog messages and note the values of the 5 measurements.

3. After the 5th measurement, take the force gauge out of the gun.

NOTICE If the force gauge is not removed from the gun, this may result in damage to property.

4. The gun moves to the mastering position and stops there. Carry out a visual check that the mastering position is correct.
   - If it is: continue with the next step.
   - If not: remaster the gripper. Then repeat the entire calibration.
5. Execute the program through to the end.
6. The values noted must be entered on the **Force control** configuration screen in **Force 1 in kN** to **Force 5 in kN**.
7. Click on **Calculate**, then save.
8. Test the obtained force values with the program EG_FORCE_F.

If the deviation between the setpoint and actual force is still too great after fine calibration with EG_RECAL_F, execute the program EG_RECAL_F again.

6.11 Setting the software limit switches

The positive and negative software limit switches for the gun (external axis) must be set. This limits the stroke of the gun.

6.11.1 Setting the negative software limit switch

Precondition

- "Expert" user group
- The gun is mastered.
- The gear ratio has been entered.
- The gun is calibrated.
- New electrode tips

NOTICE Do not open the gun all the way. If in doubt, stop a little earlier. Damage to property may otherwise result.

Procedure

1. Determine the value for the negative software limit switch:
   a. Open the gun until it is almost completely open.
   b. In the main menu, select **Display** > **Variable** > **Overview** > **Display**. Note the value of the **Position** variable.
   c. Value sought = value of **Position** variable + reserve (recommended: height of 2 motor revolutions)
2. Enter this value in the **Gun parameters** configuration screen under **Software limit (mm)** and save.

Alternative procedure

1. Take the value from the gun data sheet, and enter and save it in the **Gun parameters** configuration screen under **Software limit (mm)**.
2. Check that the value is correct.
   - To do this, open the gun manually and observe whether it stops automatically at the point corresponding to the entered value, before reaching the stop.
   - If the gun does not stop automatically, stop manual motion before the stop is reached. The value from the data sheet is not correct. The positive limit switch must be determined as described in the first procedure.

6.11.2 Setting the positive software limit switch

Precondition

- "Expert" user group
- The gun is mastered.
- The gear ratio has been entered.
- The gun is calibrated.
- New electrode tips

Procedure

1. Calculate the value for the positive software limit switch:
   Max. flexion (mm) + **Tip wear (burn-off)** + reserve (approx. 3 mm)
   The values can be taken from the following sources:
   - **Max. flexion (mm)**: configuration screen **Gun parameters**
   - **Tip wear (burn-off)**: configuration screen **Configuration**
   - Reserve: This value can be chosen freely as required. Guide value: 3 mm
2. Enter the calculated value in the **Gun parameters** configuration screen under **Software limit (mm)** and save.

6.12 Checking the residual travel and software limit switches

To prevent mechanical damage to the spindle, the residual travel and software limit switches must be checked.

6.12.1 Dimensions and distances on a C gun

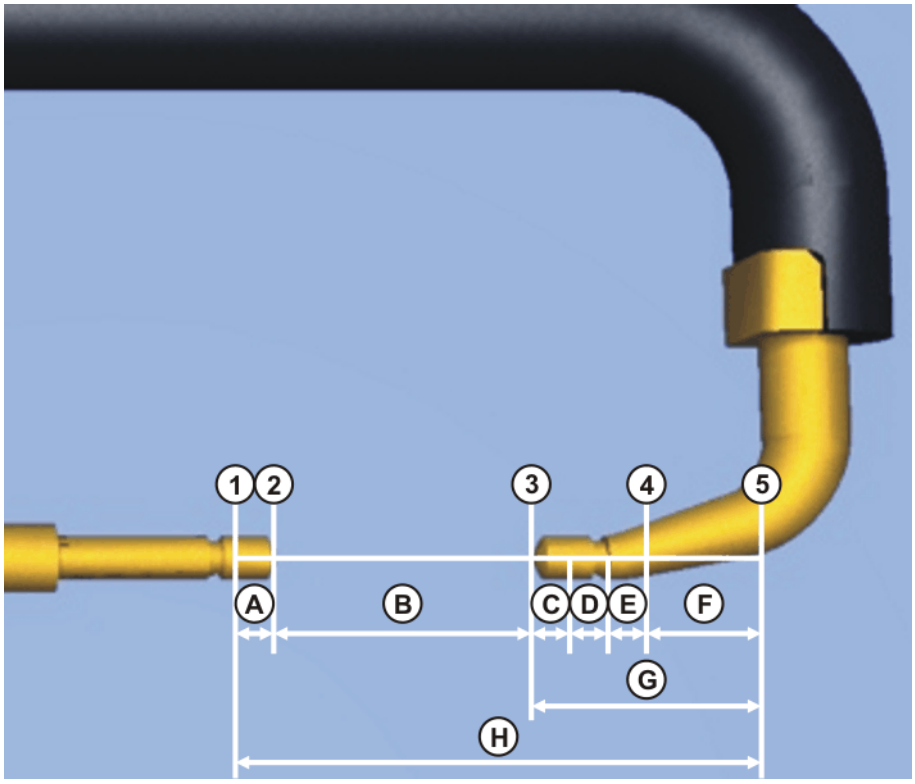

Fig. 6-7: Dimensions and distances on a C gun

1	Hardware stop
2	Negative software limit switch
3	Mastering position
4	Positive software limit switch

5	Hardware stop
A	Residual travel before negative software limit switch (min. 1 revolution of the motor)
B	Maximum opening width of the gun
C	Maximum tip burn-off (sum of the tip burn-off for both electrodes)
D	Maximum gun flexion
E	3 mm reserve
F	Residual travel before positive software limit switch (min. 2 revolutions of the motor)
G	Reserve distance
H	Complete spindle travel

6.12.2 Checking the residual travel and software limit switches for C guns

Precondition

- The gun is mastered.
- The gun is calibrated.
- The pos. and neg. software limit switches have been configured.
- New electrode tips

Procedure

1. Calculate the residual travel between the positive software limit switch and the hardware stop using the following formula:

   Residual travel = Total spindle travel – (positive software limit switch + maximum opening width specified by gun manufacturer + negative software limit switch)

Result	Activity
Residual travel ≥ 2 revolutions of the motor	----------
Residual travel < 2 revolutions of the motor	Reduce the maximum tip burn-off in the configuration plug-in so that the residual travel = 2 motor revolutions.

2. Calculate the reserve distance using the following formula:

   Reserve distance = positive software limit switch + residual travel after positive software limit switch
3. Calculate the spindle opening using the following formula:

   Spindle opening = Total spindle travel – reserve distance
4. Move the weld gun to the mastering position.
5. Measure the spindle opening on the weld gun motor.

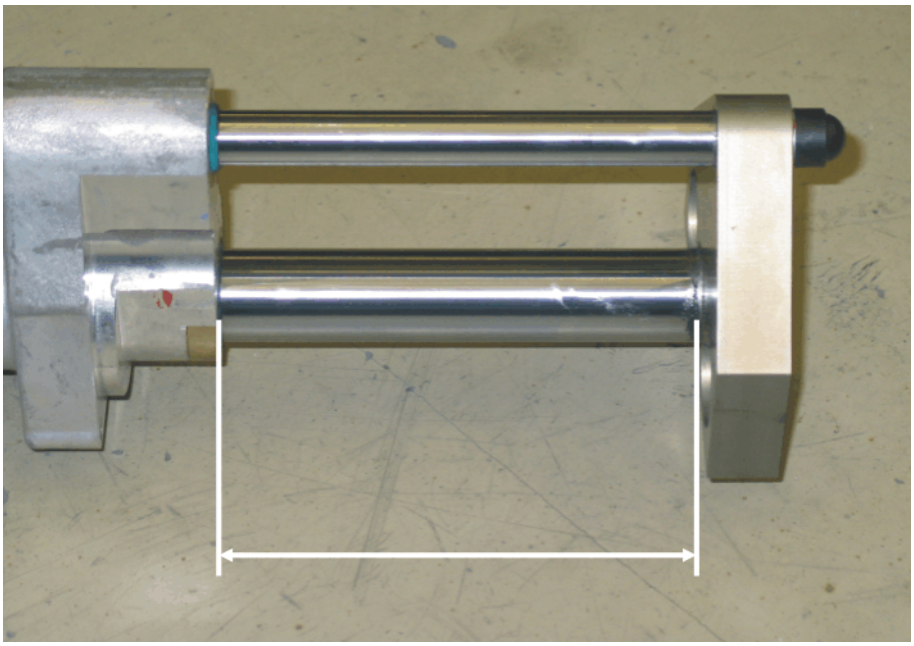

Fig. 6-8: Spindle opening of an extended C gun motor

Result	Activity
Measured spindle opening > calculated spindle opening	Reduce the maximum tip burn-off in the configuration plug-in so that the measured spindle opening is no greater than the calculated spindle opening.
Measured spindle opening ≤ calculated spindle opening	----------

6. Move the weld gun to the negative software limit switch.
7. Measure the spindle opening on the weld gun motor.

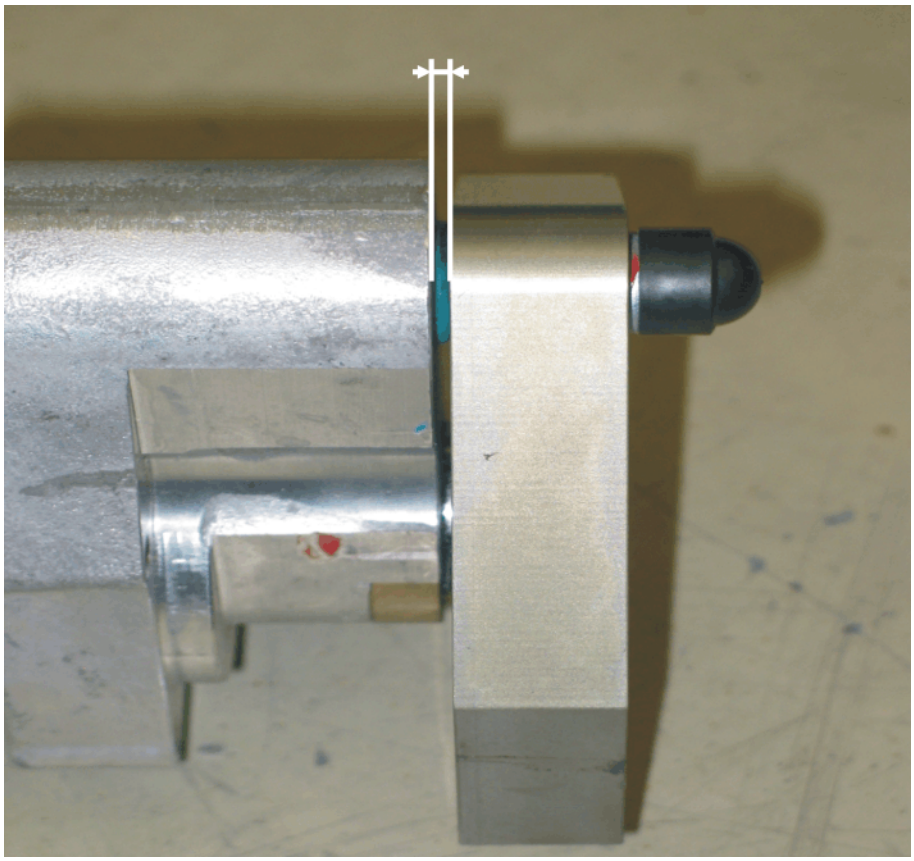

Fig. 6-9: Spindle opening of a retracted C gun motor

Result	Activity
Spindle opening ≥ 1 revolution of the motor	----------
Spindle opening < 1 revolution of the motor	Reduce the maximum opening in the configuration plug-in so that the spindle opening = 1 motor revolution.

6.12.3 Checking the residual travel and software limit switches for X guns

Precondition

- The gun is mastered.
- The gun is calibrated.
- The pos. and neg. software limit switches have been configured.
- The minimum and maximum spindle dimension of the X gun motor are known.
- New electrode tips

The minimum or maximum spindle dimension is the distance between the motor flange and the outer surface of the eye when the motor is at the hardware stop.

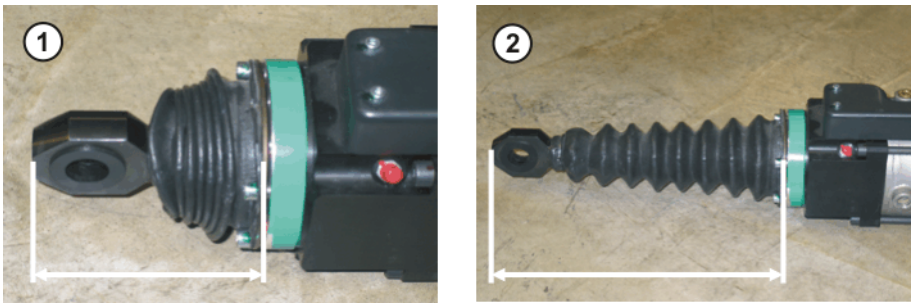

Fig. 6-10: Spindle dimensions on the X gun motor

1	Minimum spindle dimension of the X gun motor
2	Maximum spindle dimension of the X gun motor

Procedure

1. Check the gear ratio:
   - Open the gun until the distance between the electrodes is exactly 10 mm. (Measure the distance.)
   - In the main menu, select **Display** > **Actual position** > **Axis-specific**. The gun opening width is displayed in the column **Pos. [deg, mm]**.
   - Compare the measured value with the value displayed.
   - If the displayed value deviates by more than ±0.2 mm from the measured value, the gear ratio must be determined again.
2. Calculate the gear ratio using the following formula:

   Gear ratio = change in the opening width over 1 motor revolution / spindle screw pitch
3. Convert the positive software limit switch to the spindle using the following formula:

   Positive software limit switch on the spindle = value for positive software limit switch / gear ratio
4. Calculate the reserve distance using the following formula:

   Reserve distance = positive software limit switch on the spindle + residual travel (2 revolutions of the motor)
5. Calculate the spindle dimension in the mastering position using the following formula:

   Spindle dimension in the mastering position = maximum spindle dimension – reserve distance
6. Move the gun to the mastering position and measure the spindle dimension on the motor.
7. If the measured spindle dimension is larger than the calculated spindle dimenstion in the mastering position, then the maximum tip burn-off must be reduced.

The measured spindle dimension must not be larger than the calculated spindle dimension in the mastering position.

8. Move the gun to the negative software limit switch and measure the spindle dimension on the motor.

Result	Activity
Measured spindle dimension ≥ minimum spindle dimension + 1 motor revolution	----------
Measured spindle dimension < minimum spindle dimension + 1 motor revolution	Reduce the maximum opening in the configuration plug-in so that the measured spindle dimension = minimum spindle dimension + 1 motor revolution.

6.13 Tip initialization – overview

Description

During tip initialization, the current electrode burn-off is measured and saved. This enables the TCP and the gun opening to be automatically adapted to the burn-off.

> The gun opening is adapted to the current burn-off if the parameter **TCP correction** is set to **On** in the configuration screen **Configuration**.

There are 2 types of tip initialization:

- **First initialization**
  Must be carried out in the following cases:
  - During commissioning
  - Every time the electrode tips are exchanged
- **Cyclical initialization**
  Cyclical initialization must be carried out after tip dressing.

Overview

Initialization can be performed using a status key or via a KRL program.

- **First initialization**
  Via status key: (>>> 6.13.1 "First initialization via status key" Page 50)
  Via KRL: (>>> 7.5.1 "Programming first initialization" Page 61)
- **Cyclical initialization**
  Via status key: (>>> 6.13.2 "Cyclical initialization via status key" Page 51)
  Via KRL: (>>> 7.5.2 "Programming cyclical initialization" Page 62)

6.13.1 First initialization via status key

Precondition

- T1 or T2 operating mode
- The gun is mastered.
- The gun is calibrated.
- New electrode tips are fitted on the gun.
- The value **First Init force** has been entered and saved in the configuration screen **Configuration**.

Procedure

1. Set program override to 100%.
2. Open the gun manually at least 10 mm.
3. Hold down the enabling switch.
4. Press the status key **First initialization**. First initialization is performed:

Sequence

With this first initialization, the following occurs:

- The gun closes at a constant velocity until the first initialization force is reached. The electrode tips are pressed firmly onto the electrodes.

- The gun opens.
- The gun closes twice with initialization force.
- The robot controller saves the current tip wear in EG_WEAR[]. The variable EG_WORN is set to FALSE. The output **New electrodes** is set and reset.

6.13.2 Cyclical initialization via status key

Precondition

- T1 or T2 operating mode
- The gun is mastered.
- The gun is calibrated.
- First initialization has been performed.

Procedure

1. Set program override to 100%.
2. Open the gun manually at least 10 mm.
3. Hold down the enabling switch.
4. Press the **Cyclical initialization** status key. Cyclical initialization is carried out.

Sequence

With this cyclical initialization, the following occurs:

- The gun closes twice with initialization force.
- The robot controller saves the current tip wear in EG_WEAR[]. It generates a message if the current wear is greater than the maximum permissible wear (EG_WEAR_MAX). The electrode tips must then be exchanged.

6.14 Controller parameters – overview

Description

The controller tool can be used to determine and optimize the motor-specific and gun-specific controller parameters for PTP and CP motions. In addition, the proportional factor for the force controller can be determined.

The parameters must be determined in the following order:

Step	Parameter / description
1	Proportional factor of the speed controller for PTP and CP motions **VEL GAIN (Speed controller gain)**
2	Integration time constant of the speed controller for PTP and CP motions **VEL INT TIME (Reset time of speed controller)**
3	Position control gain for PTP and CP motions **POS GAIN (Position controller gain)**
4	Proportional factor for force controller **FORCE GAIN (Force controller gain)**

Sequence

The controller tool calls up programs which execute a defined motion profile cyclically with the active weld gun. At each program cycle, the parameter is increased by the defined increment (‘step size’), starting from the lower limit and continuing until the upper limit is reached. The entire sequence for a parameter is recorded as a measurement curve (trace).

While the parameters for the position and speed controllers are being determined, the axis of the active gun moves between a position before the negative software limit switch and the mastering position.

While the parameter for the force controller is being determined, the measurement curve is recorded at 3 different forces for each value of FORCE GAIN. The precise value of FORCE GAIN is determined in 2 program cycles.

Servo Gun parameter finding

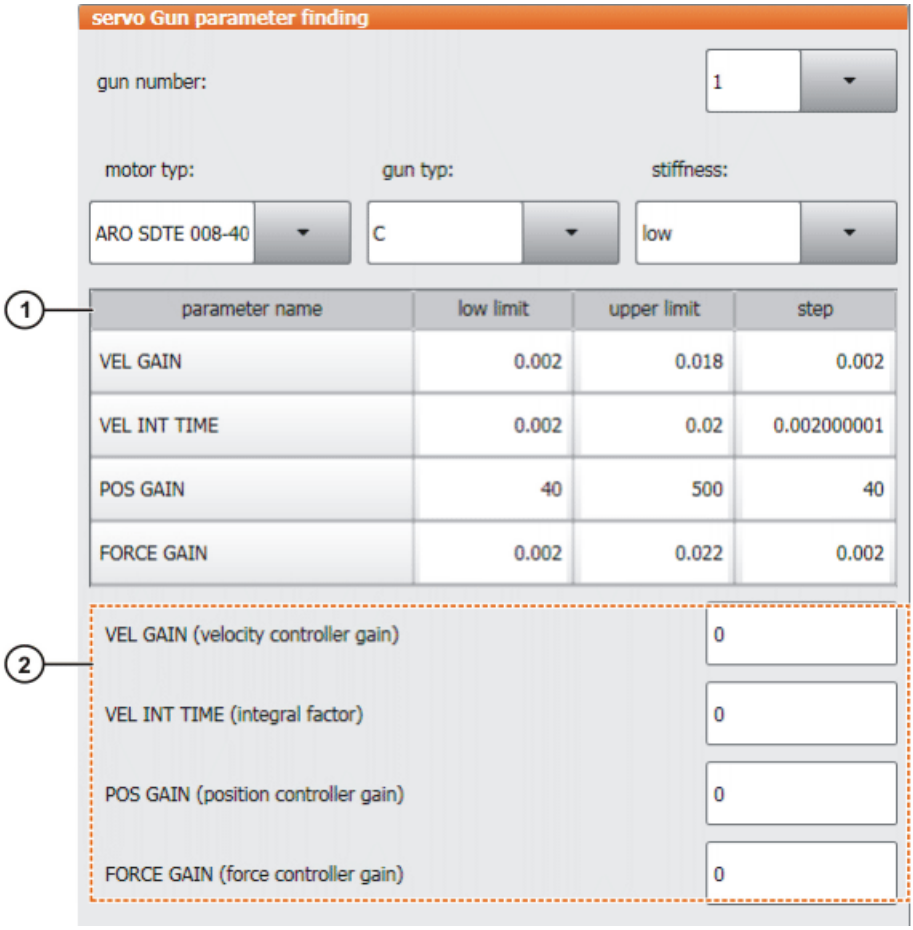

Fig. 6-11: Window: Servo Gun parameter finding

1 Table
2 Enter the determined parameters here.

The following buttons are available:

Button	Description
Motor param.	Selects the program EG_SET_MOTOR_PARAM. This program is used to determine the parameters for the speed and position controllers.
Force parameter	Selects the program EG_SET_FORCE_PARAM. This program is used to determine the parameters for the force controller.
Trace > [*controller_parameter*]	Only available to the user group “Expert” or higher. Opens the measurement curve for the selected parameter.

Button	Description
Table > **Load table**	Only available to the user group “Expert” or higher. Loads the default values for the following parameters: **Lower limit**, **Upper limit**, **Steps** The default values depend on what is selected in the following boxes: **Motor type**, **Gun type**, **Stiffness**
Table > **Discard table**	Only available to the user group “Expert” or higher. Discards the current entries in the following boxes: **Lower limit**, **Upper limit**, **Steps**. Instead, the most recently saved values are displayed.
Save table	Saves the following values: **Lower limit**, **Upper limit**, **Steps**
Save values	Saves the entered values.

6.14.1 Optimizing the parameters for the speed and position controllers

Precondition

- The weld gun is fully configured.
- The software limit switches have been set.
- The weld gun is mastered.
- The gun has been calibrated.
- The gear ratio has been entered.
- Operating mode T2

Procedure

1. In the main menu, select **Configuration** > **ServoGun controller param.**. The **Servo Gun parameter finding** window is opened.
2. Fill out the following boxes: **Gun number:**, **Motor type**, **Gun type** and **Stiffness**.
3. Fill out the following boxes: **Lower limit**, **Upper limit** and **Steps**. (Not necessary for the parameter **FORCE GAIN**.)
4. Press the **Motor param.** button. The program EG_SET_MOTOR_PARAM is selected.
5. Set program override to 100% and execute the program up to the first HALT.

If the program override is not set to 100%, the measurements will be incorrect.

6. In the main menu, select **Configuration** > **ServoGun controller param.**.
7. Select the menu sequence **Trace** > **VEL GAIN**. The measurement curve for VEL GAIN opens.
8. Read and note the value of VEL GAIN from the measurement curve. (VEL GAIN = half the value at which the motor current begins to oscillate.)
9. Close the measurement curve and enter the determined value in the **Servo Gun parameter finding** in the following box: **VEL GAIN (Speed controller gain)**. Then click on **Save values**.
10. Close the **Servo Gun parameter finding** window and execute the selected program until the next HALT.
11. In the main menu, select **Configuration** > **ServoGun controller param.**.
12. Select the menu sequence **Trace** > **VEL INT TIME**. The measurement curve for VEL INT TIME opens.

13. Read and note the value of VEL INT TIME from the measurement curve. (VEL INT TIME = value with the smallest following error at standstill.)
14. Close the measurement curve and enter the determined value in the **Servo Gun parameter finding** in the following box: **VEL INT TIME (Reset time of speed controller)**. Then click on **Save values**.
15. Close the **Servo Gun parameter finding** window and execute the selected program until the next HALT.
16. In the main menu, select **Configuration** > **ServoGun controller param.**.
17. Select the menu sequence **Trace** > **POS GAIN**. The measurement curve for POS GAIN opens.
18. Read and note the value of POS GAIN from the measurement curve. (POS GAIN = half the value at which the motor current begins to oscillate.)
19. Close the measurement curve and enter the determined value in the **Servo Gun parameter finding** in the following box: **POS GAIN (Position controller gain)**. Then click on **Save values**.
20. Close the **Servo Gun parameter finding** window and execute the selected program through to the end.

    The PTP parameters are automatically saved in addition as CP parameters.

6.14.2 Optimizing the parameters for the force controller

Description

The proportional factor for the force controller FORCE_GAIN is determined in 2 program cycles, in order to obtain a value that is as precise as possible. In the first cycle, FORCE_GAIN is determined approximately, and in the second cycle the precise value is determined using a smaller increment.

Precondition

- The weld gun is fully configured.
- The software limit switches have been set.
- The weld gun is mastered.
- The gun has been calibrated.
- The gear ratio has been entered.
- Operating mode T2
- The parameters for the speed and position controllers have been determined.

Procedure

1. In the main menu, select **Configuration** > **ServoGun controller param.**. The **Servo Gun parameter finding** window is opened.
2. Fill out the following boxes: **Gun number:**, **Motor type**, **Gun type** and **Stiffness**.
3. In the **FORCE GAIN** line, fill out the following boxes: **Lower limit**, **Upper limit** and **Steps**.
4. Press the **Force parameter** button. The program EG_SET_FORCE_PARAM is selected.
5. Set program override to 100% and execute the program up to the first HALT.

If the program override is not set to 100%, the measurements will be incorrect.

6. In the main menu, select **Configuration** > **ServoGun controller param.**.
7. Select the menu sequence **Trace** > **FORCE GAIN**. The measurement curve for FORCE GAIN opens.
8. Read and note the value of FORCE GAIN from the measurement curve. (FORCE GAIN = value with the best velocity and the smallest overshoot.)

9. Close the measurement curve and enter the determined value in the **Servo Gun parameter finding** in the following box: **FORCE GAIN (Force controller gain)**. Then click on **Save values**.
10. In the **Servo Gun parameter finding** window, reduce the lower limit, upper limit and step size, in order to limit the search range.
11. Click on **Save table**.
12. Close the **Servo Gun parameter finding** window and execute the selected program until the next HALT.
13. In the main menu, select **Configuration** > **ServoGun controller param.**.
14. Select the menu sequence **Trace** > **FORCE GAIN FINE**. The measurement curve for FORCE GAIN FINE opens.
15. Read and note the value of FORCE GAIN FINE from the measurement curve. (FORCE GAIN FINE = value with the best velocity and the smallest overshoot.)
16. Close the measurement curve and enter the determined value in the **Servo Gun parameter finding** in the following box: **FORCE GAIN (Force controller gain)**. Then click on **Save values**.
17. Close the **Servo Gun parameter finding** window and execute the selected program through to the end.

    The PTP parameters are automatically saved in addition as CP parameters.

7 Programming

7.1 Inline forms – overview

Inline form	Description
SPOT	Programming a weld spot with/without EqualizingTech (>>> 7.3 "Programming a weld spot" Page 58) (>>> 7.4 "Programming a weld spot with EqualizingTech" Page 59)
INIT	Measuring and saving the current wear (>>> 7.5.1 "Programming first initialization" Page 61) (>>> 7.5.2 "Programming cyclical initialization" Page 62)
TippDress	Tip dressing with/without EqualizingTech (>>> 7.6 "Programming tip dressing" Page 63) (>>> 7.7 "Programming tip dressing with EqualizingTech" Page 66)
ServoGun Decouple	Decoupling the gun (>>> 7.8 "Inline form ServoGun Decouple" Page 68)
ServoGun Couple	Coupling the gun (>>> 7.9 "Inline form ServoGun Couple" Page 68)

7.2 Instructions

Recommendation: Do not weld in T1 mode. In T1, the velocity is limited: force build-up takes a long time and can therefore trigger monitoring functions.

NOTICE Weld spots and tip dressing points that were taught without EqualizingTech having been installed, must not be used with EqualizingTech.
Weld spots and tip dressing points that were taught with EqualizingTech must not be used without EqualizingTech.
The points must be retaught. Damage to the gun or the workpiece may otherwise result.

7.2.1 Instructions for use of stationary guns

The descriptions regarding programming refer to guns mounted on the robot flange. For stationary guns, the programming must be adapted accordingly.

Aspects requiring special consideration:

- In the option window **Frames** the interpolation mode must be set to **True**, indicating that a stationary gun is being used. This concerns the following inline forms:
  - **SPOT**
  - **TippDress**
- While tip dressing or initialization is being carried out with a stationary gun, the robot is not available for other work (e.g. fetching a new workpiece).
  Reason: Robot axes and an external axis (= gun) are moved synchronously. This means they perform common motions that start and finish simulta-

neously. Even though the robot axes are usually stationary during dressing and initialization, this is nevertheless part of the overall motion. The robot axes are therefore not able to execute other movements independently of the external axis.

7.3 Programming a weld spot

> This description refers to ServoGun without EqualizingTech. If EqualizingTech is installed, the relevant description must be used: (>>> 7.4 "Programming a weld spot with EqualizingTech" Page 59)

Distances

The following distances are required for the position of the gun during teaching:

Distance …	Value
Moving electrode	Min. 15 mm distance from the workpiece
Fixed electrode	Max. 5 mm distance from the workpiece
Gun opening	Must be at least 4 mm less than the negative software limit switch.

Procedure

1. Position the gun on the desired weld spot. Observe the required distances.
2. Select the menu sequence **Commands** > **ServoTech** > **SPOT** and then select the desired motion type.
3. Set the parameters in the inline form.
   (>>> 7.3.1 "Inline form “SPOT”" Page 58)
4. Press **Cmd OK** to save the instruction.

7.3.1 Inline form “SPOT”

The instruction performs a motion and executes a weld spot at the end point.

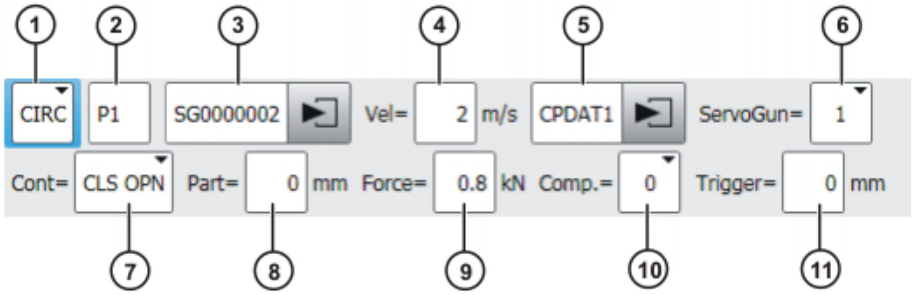

Fig. 7-1: Inline form: SPOT with CIRC, point selection

Item	Description
1	Type of motion ■ **PTP**, **LIN** or **CIRC**
2	Only for CIRC motions: Auxiliary point
3	The point index (7 figures) is communicated to the weld timer as the program number. Observe all 7 places including leading zeros! ■ **1 … 9 999 999** Touch the arrow to edit the point data. The corresponding option window is opened. (>>> 7.10 "Option window “Frames”" Page 69)

Item	Description
4	Velocity ■ For **PTP**: 0 … 100 % ■ For **LIN** or **CIRC**: 0.001 … 2 m/s
5	Name for the motion data set The system automatically generates a name. The name can be overwritten. Touch the arrow to edit the point data. The corresponding option window is opened. (>>> 7.11 "Option window: Motion parameters (PTP)" Page 70) (>>> 7.12 "Option window: Motion parameters (LIN, CIRC)" Page 70)
6	Active gun ■ **1 … 6**
7	■ **CLS OPN**: Approximate positioning during closing and opening motions ■ **OPN**: Approximate positioning during opening motion ■ **CLS**: Approximate positioning during closing motion ■ (blank): Without approximate positioning
8	Total thickness of the workpieces to be welded ■ **0 … 100 mm**
9	Welding force ■ Switch-on threshold … **10 kN**
10	■ **0**: Without compensation ■ **1**: Compensator 1 ■ **2**: Compensator 2
11	Distance after which compensation is deactivated on opening the gun.

■ The point index is incremented automatically.
■ Changing the gun number also changes the point name. A new point is created.

7.4 Programming a weld spot with EqualizingTech

Distances

The following distances are required for the position of the gun during teaching:

Distance …	Value
Fixed electrode	No distance from the workpiece; must be in contact with the workpiece.
Gun opening	Must be at least 4 mm away from the negative software limit switch.

Procedure

1. Position the gun on the desired weld spot. Observe the required distances.
2. Select the menu sequence **Commands** > **ServoTech** > **SPOT** and then select the desired motion type.
3. Set the parameters in the inline form. (>>> 7.4.1 "Inline form “SPOT” (EqualizingTech)" Page 60)
4. Press **Cmd OK** to save the instruction.

Sequence

Program sequence for welding:

When approaching points, the robot maintains a certain distance from the workpiece so that the fixed electrode does not scrape against the workpiece. The user can configure this distance (for all weld spots for the gun) via the REAL variable EG_TOUCH_DIFF[] in the file EG_EXTERN.DAT. Default setting: 3 mm.

The actual opening width of the gun at the point is the sum of the taught opening width and this distance.

7.4.1 Inline form “SPOT” (EqualizingTech)

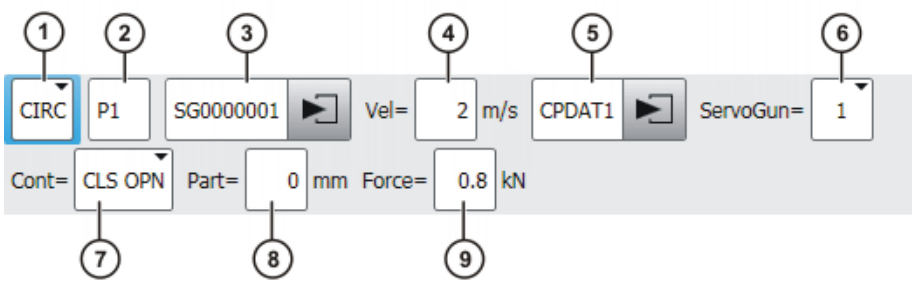

Fig. 7-2: SPOT (EqualizingTech), Point name

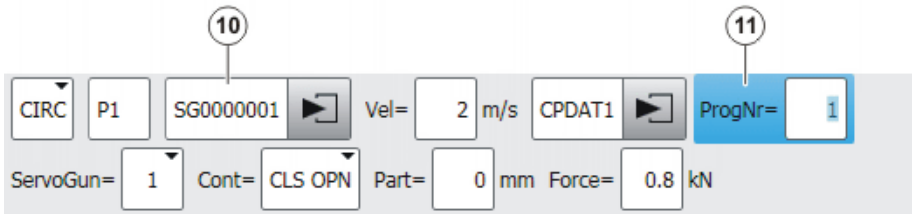

Fig. 7-3: SPOT (EqualizingTech), Program number

Item	Description
1	Motion type ■ **PTP**, **LIN** or **CIRC**
2	Only for CIRC motions: Auxiliary point
3	For the **Point name** option: Name of the end point. The last 7 characters (= default number) must be digits. The robot controller communicates these digits to the weld timer as the program number. ■ **[…]0 000 001… […]9 999 999** The number of relevant final characters can be configured in WorkVisual. Touch the arrow to edit the point data. The corresponding option window is opened. (>>> 7.10 "Option window “Frames”" Page 69)
4	Velocity ■ For **PTP**: 0 … 100 % ■ For **LIN** or **CIRC**: 0.001 … 2 m/s

Item	Description
5	Name for the motion data set The system automatically generates a name. The name can be overwritten. Touch the arrow to edit the point data. The corresponding option window is opened. (>>> 7.11 "Option window: Motion parameters (PTP)" Page 70) (>>> 7.12 "Option window: Motion parameters (LIN, CIRC)" Page 70)
6	Active gun ■ **1 … 6**
7	■ **CLS OPN**: Approximate positioning during closing and opening motions ■ **OPN**: Approximate positioning during opening motion ■ **CLS**: Approximate positioning during closing motion ■ [*blank*]: Without approximate positioning
8	Total thickness of the workpieces to be welded ■ **0 … 100 mm**
9	Closing force of the gun ■ Maximum value: Value of the configuration parameter **Maximum gun force in kN** **Note:** If the option **Force from Timer** was selected, this box is not shown.
10	With the **Program number** option: Name of the end point Touch the arrow to edit the point data. The corresponding option window is opened. (>>> 7.10 "Option window “Frames”" Page 69)
11	With the **Program number** option: Program number for the weld timer ■ **1 … 100 000**

7.5 Programming tip initialization

Overview

Initialization can be performed using a status key or via a KRL program.

- **First initialization**
  Via status key: (>>> 6.13.1 "First initialization via status key" Page 50)
  Via KRL: (>>> 7.5.1 "Programming first initialization" Page 61)
- **Cyclical initialization**
  Via status key: (>>> 6.13.2 "Cyclical initialization via status key" Page 51)
  Via KRL: (>>> 7.5.2 "Programming cyclical initialization" Page 62)

7.5.1 Programming first initialization

Description

1 position must be taught for initialization. This is taught as a normal motion point.

Precondition

- T1 or T2 operating mode
- The gun has been calibrated as a tool. This tool is currently selected.
- The gun is mastered.
- The gun is calibrated.

- New electrode tips are fitted on the gun.
- The following values have been entered and saved in the configuration screen **Configuration**: **First Init force**, **TCP orientation**
- The software limit switches have been set.

Procedure

1. Move the gun to the position at which initialization is to be performed.
   The position must be at least 4 mm away from the negative software limit switch.
2. Teach a conventional PTP, LIN or CIRC point at this position.
3. Select the menu sequence **Commands** > **ServoTech** > **INIT**.
4. Select the gun in the inline form.
5. Select **New** in the inline form.
   (>>> 7.5.3 "Inline form “INIT”" Page 63)
6. Press **Cmd OK** to save the instruction.

Sequence

With this first initialization, the following occurs:

- The gun closes at a constant velocity until the first initialization force is reached. The electrode tips are pressed firmly onto the electrodes.
- The gun opens.
- The gun closes twice with initialization force.
- The robot controller saves the current tip wear in EG_WEAR[].
- The gun moves to the initialization position.
- The moving gun arm performs a motion with initialization force.
- The variable EG_WORN is set to FALSE. The output **New electrodes** is set and reset.

7.5.2 Programming cyclical initialization

Description

1 position must be taught for initialization. This is taught as a normal motion point.

Precondition

- T1 or T2 operating mode
- The gun has been calibrated as a tool. This tool is currently selected.
- The gun is mastered.
- The gun is calibrated.
- The software limit switches have been set.
- First initialization has been performed.

Procedure

1. Move the gun to the position at which initialization is to be performed.
   The position must be at least 4 mm away from the negative software limit switch.
2. Teach a conventional PTP, LIN or CIRC point at this position.
3. Select the menu sequence **Commands** > **ServoTech** > **INIT**.
4. Select the gun in the inline form.
5. Select **Same** in the inline form.
   (>>> 7.5.3 "Inline form “INIT”" Page 63)
6. Press **Cmd OK** to save the instruction.

Sequence

With this cyclical initialization, the following occurs:

- The gun closes twice with initialization force.
- The robot controller saves the current tip wear in EG_WEAR[]. It generates a message if the current wear is greater than the maximum permissible wear (EG_WEAR_MAX). The electrode tips must then be exchanged.

7.5.3 Inline form “INIT”

This instruction is used for initializing the tips.

> The inline form does not contain any position data; the preceding point is used. The point must be at least 4 mm away from the negative software limit switch.

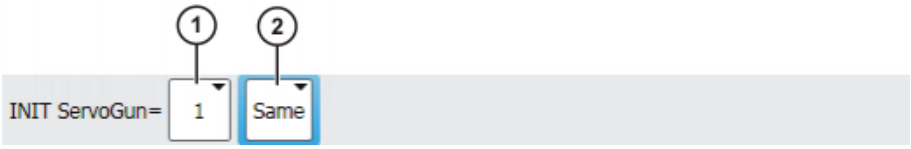

Fig. 7-4: Inline form: INIT

Item	Description
1	Select the active gun. ■ **1 … 6**
2	■ **New**: First initialization ■ **Same**: Cyclical initialization

7.6 Programming tip dressing

> This description refers to ServoGun without EqualizingTech. If EqualizingTech is installed, the relevant description must be used: (>>> 7.4 "Programming a weld spot with EqualizingTech" Page 59)

Description

TipDress executes a weld spot without approximate positioning.

> **NOTICE** Dressing must be performed without weld current. This must be set in the weld timer. If dressing is carried out with weld current, damage to property is liable to occur.

The default sequence for tip dressing corresponds to the sequence for welding: the robot controller sends the point index to the weld timer and the gun closes until the force programmed in the inline form is reached. Once the force is reached, the robot controller sets the output **Weld start** and waits for the input **Weld end**.

If a different sequence is required for tip dressing, this can be programmed in the subprogram EG_USERDRESS. In order for the robot controller to perform this different sequence, the variable EG_NON_KUKA_DRESS must be set to TRUE.

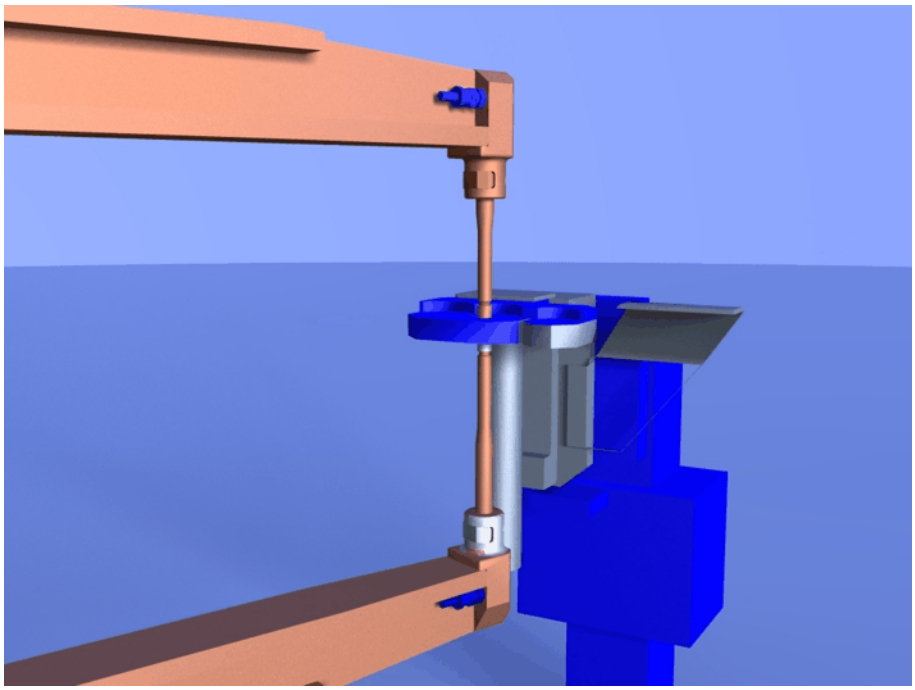

Fig. 7-5: Tip dressing

Distances

The following distances are required for the position of the gun during teaching:

Distance …	Value
Moving electrode	Min. 15 mm distance from the workpiece
Fixed electrode	Max. 5 mm distance from the workpiece
Gun opening	Must be at least 4 mm less than the negative software limit switch.

Precondition

- The thickness of the tip dresser has been determined.
  (>>> 7.6.1 "Determining the thickness of the tip dresser" Page 64)

Procedure

1. Position the gun on the desired tip dressing point. Observe the required distances.
2. Select the menu sequence **Commands** > **ServoTech** > **TippDress** and then select the desired motion type.
3. Set the parameters in the inline form. Also enter the thickness of the tip dresser.
   (>>> 7.6.2 "Inline form “TippDress”" Page 65)
4. Press **Cmd OK** to save the instruction.

After tip dressing, cyclical initialization must be performed.

7.6.1 Determining the thickness of the tip dresser

Description

The thickness of the tip dresser is required for the inline form **TippDress**.

Precondition

- The gun is mastered.
- New electrode tips are fitted on the gun.
- T1 or T2 operating mode

Procedure

1. Position the gun with both electrodes on the the tip dresser.

2. Close the gun until build-up of tip dressing force.
3. In the main menu, select **Display** > **Variable** > **Overview** > **Display**.
4. Read and note the value of the **Position** variable.

7.6.2 Inline form “TippDress”

This instruction dresses the electrode tips.

The following parameters must be set in the weld timer:

- Dressing time (complete cycle time)
- Cycle without current

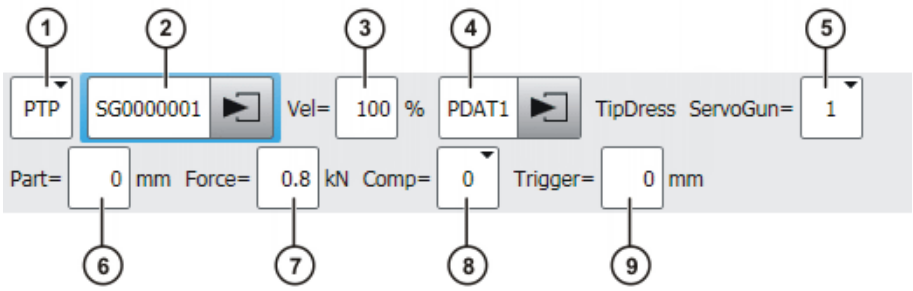

Fig. 7-6: Inline form: TippDress with PTP, point selection

Item	Description
1	Type of motion ■ **PTP** or **LIN**
2	The point index (7 figures) is communicated to the weld timer as the program number. Observe all 7 places including leading zeros! ■ **1 … 9 999 999** Touch the arrow to edit the point data. The corresponding option window is opened. (>>> 7.10 "Option window “Frames”" Page 69)
3	Velocity ■ **1 … 100 %**
4	Name for the motion data set The system automatically generates a name. The name can be overwritten. Touch the arrow to edit the point data. The corresponding option window is opened. (>>> 7.11 "Option window: Motion parameters (PTP)" Page 70) (>>> 7.12 "Option window: Motion parameters (LIN, CIRC)" Page 70)
5	Active gun ■ **1 … 6**
6	Thickness of the tip dresser ■ **1 … 100 mm**
7	Closing force of the gun ■ **0.75 … 10 kN**

Item	Description
8	■ **0**: Without compensation ■ **1**: Compensator 1 ■ **2**: Compensator 2
9	Distance after which compensation is deactivated on opening the gun.

■The point index is incremented automatically.
■Changing the gun number also changes the point name. A new point is created.

7.7 Programming tip dressing with EqualizingTech

Description

TippDress executes a weld spot without approximate positioning.

The following parameters must be set in the weld timer:

- Dressing time (complete cycle time)
- Cycle without current

NOTICE Dressing must be performed without weld current. If dressing is carried out with weld current, damage to property is liable to occur.

Distances

The following distances are required for the position of the gun during teaching:

Distance …	Value
Fixed electrode	No distance from the workpiece; must be in contact with the workpiece.
Gun opening	Must be at least 4 mm away from the negative software limit switch.

Precondition

- The thickness of the tip dresser has been determined.
  (>>> 7.6.1 "Determining the thickness of the tip dresser" Page 64)

Procedure

1. Position the gun on the desired tip dressing point. Observe the required distances.
2. Select the menu sequence **Commands** > **ServoTech** > **TippDress** > **ServoTech** or **LIN**.
3. Set the parameters in the inline form. Also enter the thickness of the tip dresser. (>>> 7.7.1 "Inline form “TippDress” (EqualizingTech)" Page 67)
4. Press **Cmd OK** to save the instruction.

After tip dressing, cyclical initialization must be performed.

Sequence

Program sequence for tip dressing:

The default sequence corresponds to the sequence for welding.

If a different sequence is required for tip dressing, this can be programmed in the subprogram EG_USERDRESS. In order for the robot controller to perform this different sequence, the variable EG_NON_KUKA_DRESS must be set to TRUE.

7.7.1 Inline form “TippDress” (EqualizingTech)

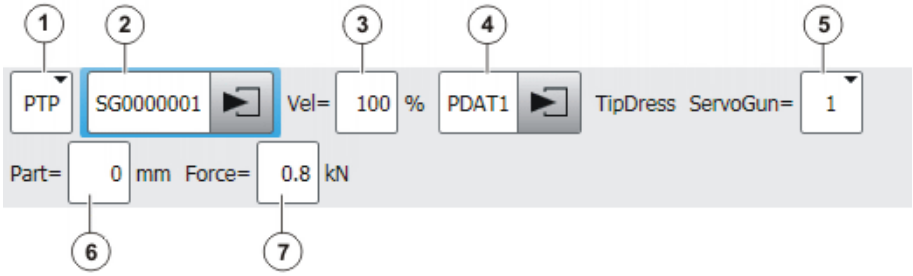

Fig. 7-7: TippDress (EqualizingTech), Point name

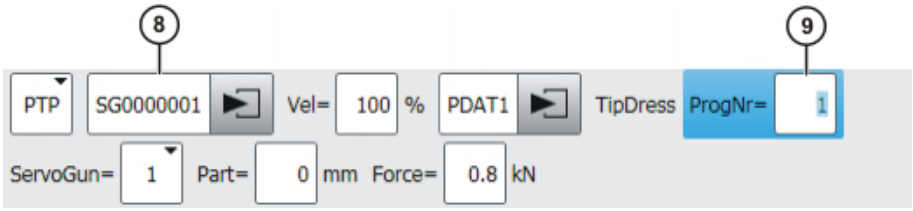

Fig. 7-8: TippDress (EqualizingTech), Program number

Item	Description
1	Motion type ■ **PTP** or **LIN**
2	With the **Point name** option: Name of the end point. The last 7 characters (= default number) must be digits. The robot controller communicates these digits to the weld timer as the program number. ■ **[…]0 000 001… […]9 999 999** The number of relevant final characters can be configured in WorkVisual. Touch the arrow to edit the point data. The corresponding option window is opened. (>>> 7.10 "Option window “Frames”" Page 69)
3	Velocity ■ For **PTP**: 0 … 100 % ■ For **LIN** or **CIRC**: 0.001 … 2 m/s
4	Name for the motion data set The system automatically generates a name. The name can be overwritten. Touch the arrow to edit the point data. The corresponding option window is opened. (>>> 7.11 "Option window: Motion parameters (PTP)" Page 70) (>>> 7.12 "Option window: Motion parameters (LIN, CIRC)" Page 70)
5	Active gun ■ **1 … 6**
6	Thickness of the tip dresser ■ **0 … 100 mm**

Item	Description
7	Closing force of the gun ■ Maximum value: Value of the configuration parameter **Maximum gun force in kN** **Note:** If the option **Force from timer** was selected, this box is not shown.
8	With the **Program number** option: Name of the end point Touch the arrow to edit the point data. The corresponding option window is opened. (>>> 7.10 "Option window “Frames”" Page 69)
9	With the **Program number** option: Program number for the weld timer ■ **1 … 100 000**

7.8 Inline form ServoGun Decouple

Description

This command decouples – within the software – the gun currently in use. The inline form does not control any hardware, inputs or outputs.

The opening width of the gun must be identical in both the coupling and decoupling position. **Recommendation:** The gun should be open at least 10 mm.
Do not decouple the gun if it is in the mastering position, since the mastering would otherwise be lost when the gun is recoupled.

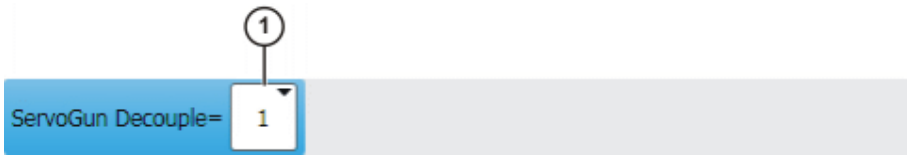

Fig. 7-9

Item	Description
1	Select the active gun. ■ **1 ... 6**

7.9 Inline form ServoGun Couple

Description

This command couples – within the software – the gun currently in use. The inline form does not control any hardware, inputs or outputs.

The opening width of the gun must be identical in both the coupling and decoupling position. **Recommendation:** The gun should be open at least 10 mm.

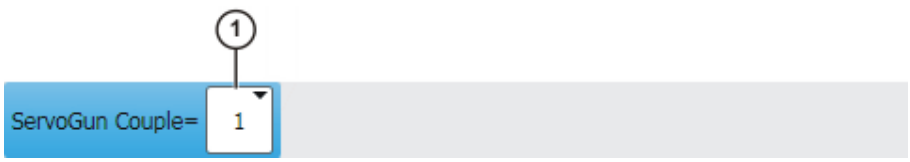

Fig. 7-10

Item	Description
1	Select the active gun. ■ **1 ... 6**

7.10 Option window “Frames”

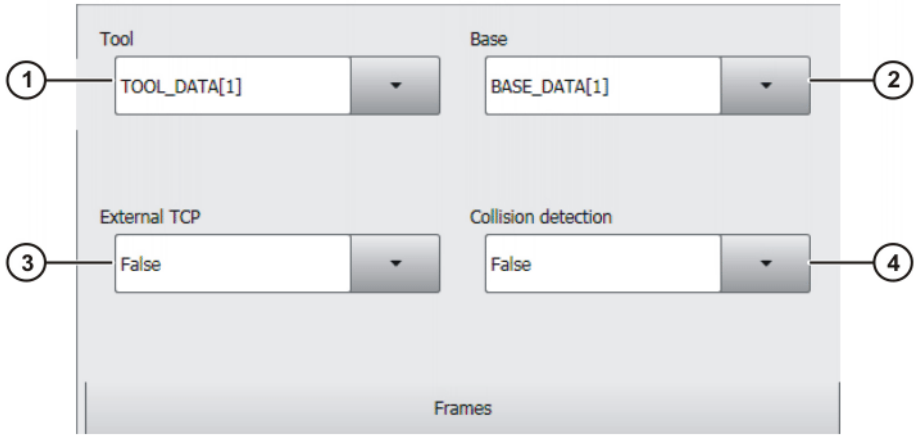

Fig. 7-11: Option window: Frames

Item	Description
1	Tool selection. If **True** in the box **External TCP**: workpiece selection. Range of values: [1] … [16]
2	Base selection. If **True** in the box **External TCP**: fixed tool selection. Range of values: [1] … [32]
3	Interpolation mode ■ **False**: The tool is mounted on the mounting flange. ■ **True**: The tool is a fixed tool.
4	■ **True**: For this motion, the robot controller calculates the axis torques. These are required for collision detection. ■ **False**: For this motion, the robot controller does not calculate the axis torques. Collision detection is thus not possible for this motion.

7.11 Option window: Motion parameters (PTP)

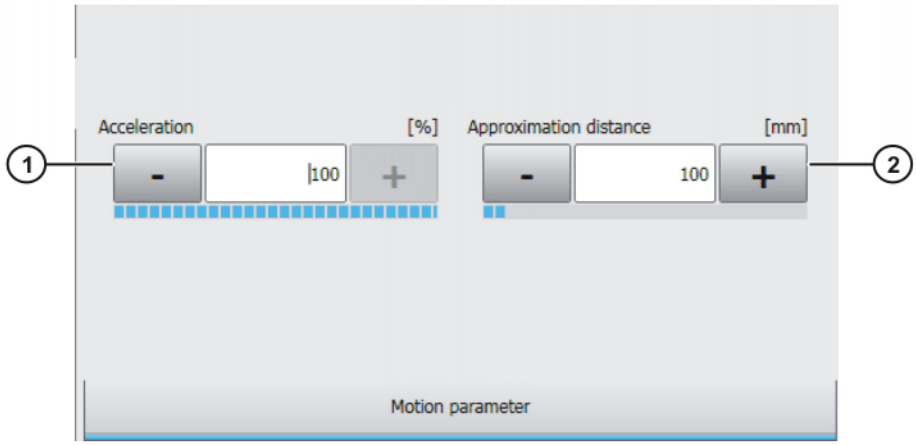

Fig. 7-12: Option window: Motion parameters (PTP)

Item	Description
1	Acceleration Refers to the maximum value specified in the machine data. The maximum value depends on the robot type and the selected operating mode. ■ **1 … 100 %**
2	This box is only displayed if it is specified in the inline form that the point is to be approximated. Furthest distance before the end point at which approximate positioning can begin. Maximum distance 100%: half the distance between the start point and the end point relative to the contour of the PTP motion without approximate positioning ■ **1 … 100 %**

7.12 Option window: Motion parameters (LIN, CIRC)

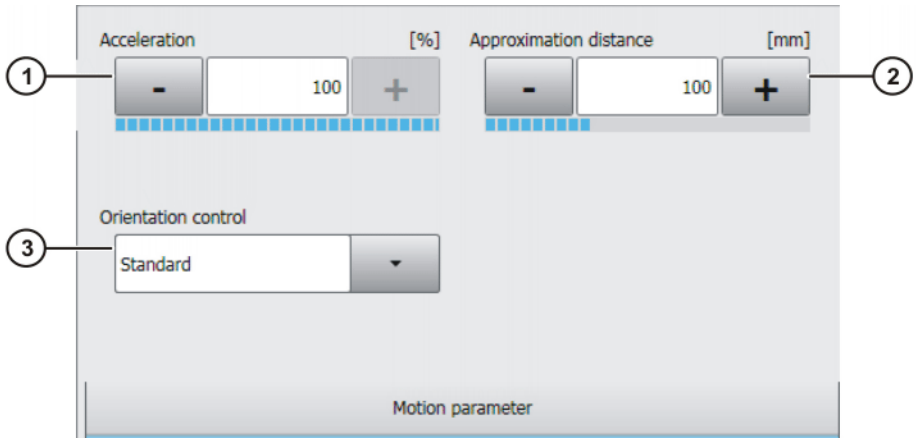

Fig. 7-13: Option window: Motion parameters (LIN, CIRC)

Item	Description
1	Acceleration Refers to the maximum value specified in the machine data. The maximum value depends on the robot type and the selected operating mode.
2	This box is only displayed if it is specified in the inline form that the point is to be approximated. Furthest distance before the end point at which approximate positioning can begin The maximum permissible value is half the distance between the start point and the end point. If a higher value is entered, this is ignored and the maximum value is used.
3	Orientation control selection. ■ **Standard** ■ **Wrist PTP** ■ **Constant orientation control**

7.13 Adaptable subprograms

The following subprograms can be adapted to the specific requirements by the user.

The subprograms can be found here:

- In the directory R1\TP\ServoGun_FC in the file EG_User.SRC

Precondition

- “Expert” user group

Subprograms

Subprogram	Description
EG_PRE	Called by the robot controller before each weld spot.
EG_POST	Called by the robot controller after each weld spot.
EG_PRED	Called by the robot controller before each tip dressing point.
EG_POSTD	Called by the robot controller after each tip dressing point.
EG_USERDRESS	If the default sequence is not desired for tip dressing, the user can program a different sequence here. In order for the robot controller to perform this different sequence, the variable EG_NON_KUKA_DRESS must be set to TRUE.

Inputs/outputs can be set in the subprograms. This triggers exact positioning.

8 Diagnosis

8.1 Carrying out tests

Precondition

- Operating mode T2
- Program override 100%
- For **Calibration test**: The gun flexion has been determined.
  (>>> 8.3 "Determining the gun flexion (independently of the force sensor)" Page 75)

NOTICE There must be no object positioned between the electrode tips, otherwise damage to property may result.

Procedure

1. Hold down the enabling switch.
2. Start the program EG_DIAGNOSE.

The robot controller performs all the tests and displays the relevant messages. A trace is generated for each test in the directory KRC:\Roboter\Trace.

If an error occurs during a test, the robot controller generates an error message. The remaining tests are then no longer carried out.

(>>> 8.2 "Description of the tests" Page 74)

Alternative procedure

This procedure can be used to perform the tests individually. It is suitable for users with experience in fault diagnosis.

Additional precondition: User group “Expert”

1. In the main menu, select **Configuration** > **ServoGun Diagnosis**.
   The **ServoGun Diagnosis Tool** window is opened.
2. Select the number of the active gun in the **Active gun number** box.
3. Hold down the enabling switch.
4. Start the required test.

Description

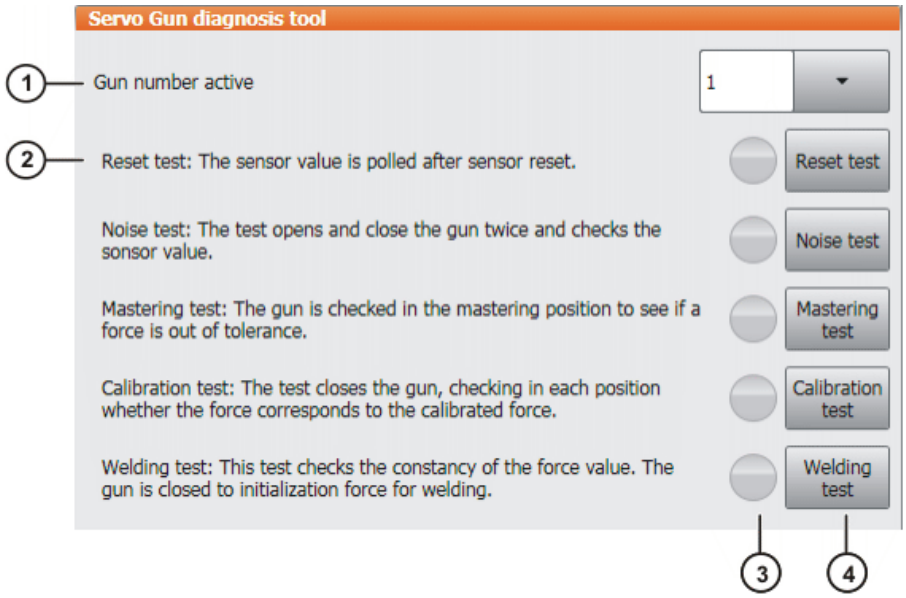

Fig. 8-1: ServoGun Diagnosis Tool window

Item	Description
1	Select the active gun.
2	Descriptions of the tests

Item	Description
3	LED icon showing the test status. If a test is running, the icon is green.
4	Click on a button to start the corresponding test. A trace recording is generated for each test.

8.2 Description of the tests

Reset test

The sensor value is polled after sensor reset.

- Sensor value < 450: message *The sensor reset works well*
- Sensor value ≥ 450: message *The sensor reset does not work. See "Reset" trace, channel 11/24*

The name of the trace recording is RESET.

Noise test

The test opens and closes the gun twice (5 mm from the negative software limit switch to 5 mm from the gun mastering) and checks the sensor value. The tolerances are configured in the file EG_EXTERN.DAT using the variables EG_NOISE_TOL_P (positive direction) and EG_NOISE_TOL_N (negative direction).

Default value for both directions: 50 incr.

- Value within tolerance: message *The noise test was OK*
- Value out of tolerance: message *The noise test failed. See "Noise" trace, channel 11/24*

The name of the trace recording is NOISE.

Mastering test

The gun is checked in the mastering position to see if a force is out of tolerance. In addition, the user must check the mastering position visually.

The name of the trace recording is MASTER.

Procedure:

1. Start **Mastering test**.
   The gun is closed to the mastering position. The message *Check the gun mastering. Is it OK?* is displayed.
2. Check the mastering position visually.
3. Answer the prompt with **Yes** or **No**. The gun opens.

The tolerance is configured in the file EG_EXTERN.DAT using the variable EG_MASTER_TOL_P.

Default value: 100 N

- Value within tolerance: message *The gun mastering is OK*
- Value out of tolerance: message *The gun mastering is not OK. See "Master" trace, channel 10/23*

Calibration test

Description:

The test closes the gun once to ¼ and once to ¾ of the maximum force, checking in each position whether the force corresponds to the calibrated force. The tolerances are configured in the file EG_EXTERN.DAT using the variables EG_CALIB_TOL_P (positive direction) and EG_CALIB_TOL_N (negative direction).

Default value for both directions: 100 N

- Value within tolerance: message *The gun calibration is OK*
- Value out of tolerance: message *The gun calibration is not OK. See "Calib" trace, channel 10/23*

The name of the trace recording is CALIB.

Welding test

This test checks the constancy of the force value. The gun is closed to initialization force for welding. The tolerances are configured in the file EG_EXTERN.DAT using the variables EG_WELDTEST_TOL_P (positive direction) and EG_WELDTEST_TOL_N (negative direction).

Default value for both directions: 50 N

The test is only carried out if the configuration parameter **Timer type** is not set to **TEST**.

- Value within tolerance: message *The welding test was OK*
- Value out of tolerance: message *The welding test failed. See "WeldTest" trace, channel 10/23*
- No timer configured: message *The welding test is not possible because the timer type is "test"*

The name of the trace recording is WELD.

8.3 Determining the gun flexion (independently of the force sensor)

Description

The program EG_FLEXXX determines the gun flexion. Unlike with calibration, the gun flexion is determined independently of the flexion of the force sensor. This value is not needed for welding, but is required for the calibration test as part of diagnosis.

Precondition

- Operating mode T2
- Program override 100%
- The gun is calibrated.

Precondition

- Operating mode T2
- Program override 100%

NOTICE There must be no object positioned between the electrode tips, otherwise damage to property may result.

Procedure

1. If a force sensor is still attached to the gun, this must be removed.
2. In the Navigator, start the program KRC:\R1\Program\EG_FLEXXX.
3. Follow the messages.

   The flexion is determined. The determined value is not displayed, but saved internally.

9 System variables

9.1 Important variables in EG_EXTERN.DAT

Variable	Description
EG_COMPENSATE_DELAY	INT Distance after resetting compensation until settling of the gun position Default value: 0 mm
EG_FORCE_INIT[1] ... [6]	REAL Initialization force Default value: 2.0 kN
EG_FORCE_INIT_NEW[1] ... [6]	REAL First initialization force Default value: 3 kN
EG_INIT_TOL_N[1] ... [6]	REAL Negative position tolerance for initialization Default value: -5 mm
EG_INIT_TOL_P[1] ... [6]	REAL Positive position tolerance for initialization Default value: 5 mm
EG_NON_KUKA_DRESS	BOOL ■ FALSE (default): Default sequence for tip dressing ■ TRUE: Use a user-defined program EG_USERDRESS for tip dressing
EG_OFFICE	BOOL Office mode Default value: FALSE
EG_PART_CONTROL	BOOL Workpiece check Default value: TRUE
EG_RESET_CHECK_VALUE	REAL Force check after sensor reset. If the value is < 1, the reset is accepted. Default value: 1
EG_SERVOGUN_EXAXIS[1] ... [6]	INT Assignment of a gun to an external axis Default value: 0
EG_TIMEOUT[4]	REAL Timeout for different types of error messages Default value: (various)

Variable	Description
EG_TOUCH_DIFF[1] ... [6]	REAL Only relevant if Equalizing is installed. When approaching weld spots and tip dressing points, the robot maintains a certain distance from the workpiece so that the fixed electrode does not scrape against the workpiece. The variable defines the distance. The opening width of the gun at the point is the sum of the taught opening width and the distance. Default value: 3 mm
EG_WEAR[1] ... [6]	REAL Current electrode wear (both electrodes) Default value: 0 mm
EG_WEAR_MAX[1] ... [6]	REAL Maximum permissible electrode wear (both electrodes) Default value: 8 mm
EG_WELD_DISTANCE [1] ... [6]	REAL Gun flexion calculated by EG_CAL Default value: 20 mm
EG_WELD_TOL_N	REAL Negative position tolerance for the weld spot Default value: -5 mm
EG_WELD_TOL_P	REAL Positive position tolerance for the weld spot Default value: 5 mm
EG_WORN[1] ... [6]	BOOL Current electrode wear greater than max. permissible electrode wear Default value: FALSE

9.2 Important kernel system variables

Variable	Description
$FORCE_ACT[7]...[12]	REAL Actual force on the force sensor Default value: 0 N

10 Messages

10.1 Overview of error messages

The error messages of ServoGun FC are generated either by the kernel system or by the technology package.

Source of error message	Error number	Effect
Kernel system	With error number	In the case of an error message from the kernel system, the weld gun remains in the actual position.
Technology package	Without error number	In the case of an error message from the technology package under force control, the weld gun opens automatically. The spot can be repeated or the next spot can be moved to. Default value of the maximum weld time: 3 s

10.2 Error messages caused by the weld gun

Message text	Cause	Remedy
The selected gun is not calibrated.	The selected weld gun has not yet been calibrated.	Calibrate the weld gun.
Gun cannot close.	The gun could not be closed due to mechanical locking.	Eliminate mechanical locking.
Error during first initialization. Tip wear is out of tolerance.	Electrode tip missing.	Fit new electrode tip.
	Tips are not properly seated.	Ensure that tips are fitted correctly.
	Incorrect mastering, initialization or calibration.	Check start-up procedure.
Incorrect gun position. Initialization, mastering, part thickness?	Programmed sum of the workpiece thicknesses is not correct.	Correct the value for the workpiece thickness.
	1 or more electrode tips are missing.	Fit missing electrode tip(s).
	Gun does not close to the programmed thickness due to mechanical locking.	Check mechanical system of gun.
	Incorrect mastering, initialization or gun flexion calibration.	Check start-up procedure.
The electrode burn-off is out of tolerance. Please check mastering and tip wear. Repeat initialization, Yes/No?	Electrode burn-off is outside the set maximum burn-off. Incorrect mastering, initialization or gun flexion calibration.	■ Fit new electrode tips. ■ Ensure that tips are fitted correctly. ■ Carry out first initialization.
Tip wear is out of tolerance. Please check the tip wear and the gun mastering. Do you want to proceed, Yes/No?	■ Electrode burn-off is outside the set maximum burn-off. ■ Incorrect mastering, initialization or gun flexion calibration.	■ Fit new electrode tips (correct length). ■ Ensure that tips are fitted correctly. ■ Carry out first initialization.

10.3 Error messages caused by force control

Message text	Cause	Remedy
Programmed force not reached!	The workpiece thickness is lower than the programmed value.	Correct the value for the workpiece thickness.
	The maximum flexion value is too low.	Correct the maximum flexion value.
	Error due to mechanical locking during force build-up.	Eliminate mechanical locking.
Command force is higher than maximum gun force	The welding force is higher than the maximum gun force.	■ Reduce the welding force. ■ Correct the maximum gun force.
Incorrect force or calibration	■ Open circuit at welding transformer ■ Force = 0 ■ Force calibration values = 0 ■ Desired force greater than maximum force	■ Calibrate force. ■ Check welding transformer and connecting cables. ■ Set the force calibration values in ascending order greater than 0 and carry out force calibration again. ■ Select a desired force that is less than or equal to the maximum force of the gun.
The target force is lower than the switch-on threshold for force control!	The welding force is lower than the switch-on threshold.	■ Increase the welding force. ■ Check the switch-on threshold.
Permitted maximum force exceeded	The upper monitoring limit was exceeded while the weld gun was under force control. Possible causes: ■ Value for FORCE_GAIN too high. ■ There is interference on the sensor signal.	■ Check the value for FORCE_GAIN. ■ Check the connection between the SDC and the RDC box. ■ Check the resolver-sensor cable.
No force rise in force control	Force sensor defective.	Exchange the weld gun motor.
	SDC defective.	Check the connection between the SDC and the RDC box.
	■ Sensor reset is set continuously. ■ No connection between force sensor and SDC.	■ Check the connection between the SDC and the RDC box. ■ Check the force sensor. ■ Check the resolver-sensor cable.
Gun moves force-controlled less than FORCE_LIM	The force dropped below the lower monitoring limit while the weld gun was under force control. ■ Value for FORCE_GAIN too high. ■ There is interference on the sensor signal.	■ Check the value for FORCE_GAIN. ■ Check the connection between the SDC and the RDC box. ■ Check the resolver-sensor cable.

10.4 Error messages caused by the weld timer / configuration

Message text	Cause	Remedy
No cycle end signal, input {No.}	No end of weld signal present.	Check: ■ I/O configuration ■ Incorrect signal declaration ■ Bus configuration ■ Hardware
	Incorrect signal declaration	
	Incorrect I/O configuration	Check I/O configuration.
Welding controller error, input {No.}	Weld timer error	Refer to the weld timer handbook
	Incorrect I/O configuration	Check I/O configuration.
Welding start signal is already true, output {No.}	The weld start signal is already set before the start of welding.	Check weld timer, manually reset weld start signal and repeat welding.
Cycle end has not been reset, input {No.}	The weld start signal is already set before the start of welding.	Check weld timer.
	Incorrect I/O configuration	Check I/O configuration.
Incorrect program number!	The selected program index is out of range.	■ Check program index. ■ Check signal definition of the program index.
No TIMER READY signal, input {No.}	Weld timer is switched off, disconnected or defective.	Check weld timer, connecting cables and power supply.
	Incorrect I/O configuration	Check I/O configuration.
No CURRENT ON signal, input {No.}	Weld timer defective	Check weld timer.
	Incorrect I/O configuration	Check I/O configuration.
No water monitor 1 signal, input {No.}, repeat point? *No water monitor 2 signal, input {No.}, repeat point?*	Defective flow monitor	Check flow monitor.
	Electrode tip pulled off.	Check electrode tips.
	Incorrect I/O configuration	Check I/O configuration.
No THERMO CONTACT signal, input {No.}	Welding transformer defective.	Check welding transformer and connecting cables.
	Open circuit at welding transformer	
	Incorrect I/O configuration	Check I/O configuration.
Attention! Timer type is TEST!	The timer type TEST is not permissible in EXT mode.	■ Set the correct timer type. ■ Change operating mode.
Process monitoring is disabled, input {No.}	Weld timer defective	Check weld timer.
	Process monitoring signal is not set.	Set process monitoring signal.
	Incorrect I/O configuration	Check I/O configuration.

10.5 Error messages caused by the force sensor

Message text	Cause	Remedy
Caution!!! Sensor could not be reset!	Force sensor defective.	Exchange the weld gun motor.
	SDC defective or not present.	Check the connection between the SDC and the RDC box.
	Resolver-sensor cable is interrupted.	Check the resolver-sensor cable.
	Field bus module defective or wrongly configured.	Check the field bus module.
No sensor values available!	Resolver-sensor cable is incorrectly connected or defective.	Check the resolver-sensor cable.
	Force sensor defective.	Exchange the weld gun motor.
Measuring range of the force sensor exceeded	Resolver-sensor cable interrupted.	Check the resolver-sensor cable and/or exchange.
	SDC defective or not correctly connected.	Check the SDC. Check the connection between the SDC and the RDC box.
	Force sensor defective.	Exchange the weld gun motor.

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)
- Version of the KUKA System Software
- Optional software or modifications
- Archive of the software
- 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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