DAIMLER

Powertrain Requirement Specifications 2020
Part III Robotics
Process: Welding - KUKA
Version 2020.0.2

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Table of Contents

1. General Information

1.1 Document Control

This document is part of the collection of documents for the design of robot welding systems. Please refer to the documents listed below to ensure that you have all the information you need for project processing. Questions about the documents should be addressed at the launch event.

Title	Location	Remark
1 Project Book **Robotics General**	Not yet defined	General requirements for robotics (safe, etc.) – manufacturer-independent
1.1 Project Book **Robotics ABB**	Not yet defined	Supplementary or additional detail on 1 for the manufacturer ABB
1.2 Project Book **Robotics KUKA**	Not yet defined	Supplementary or additional detail on 1 for the manufacturer KUKA
2.0 Project Book Robotics **Welding Cells – General**	Not yet defined	General requirements for robot welding cells – manufacturer independent, based on 1
2.1 Project Book Robotics **Welding Cells – ABB**	Not yet defined	Supplementary or additional detail on 2.0 for the manufacturer ABB
2.2 Project Book Robotics **Welding Cells – KUKA**	Not yet defined	Supplementary or additional detail on 2.0 for the manufacturer KUKA, also including the NANO standard
2.3 Project Book Robotics Welding Cells – **Welding Technology**	Not yet defined	All the technology that must be used for welding cells (beyond that listed at 1.0) must be used in conjunction with 2.0 and 2.1 or 2.2.
Robotics Model Programs	Download portal	Template for base robot program Welding sample programs including error handling

Table 1: Overview of related documents for welding technology

References to these documents are given as follows: ↑*Title of the document*

The version identifier contained in each document is structured as follows:

[H].[U].[Revision]

H=main version = specifications version
U=subversion = update (0= original release of the main version)
Revision = sequentially incremented number which is not reset when a new main version is released
(Every change (even if not published) causes the revision number to be incremented)

This project book defines the specifications for the use of welding robots for all production locations and production centers within the Passenger Car/Powertrain (GFP/P) divisions of Daimler AG.

All information in this project book has been compiled based on the current state of knowledge and the current state of technology. Technical modifications in the software and hardware areas, as part of ongoing developments and/or project-specific requirements, remain reserved.

The information makes no claim to completeness and the technical boundary conditions shall be coordinated with the pertinent specialist unit in the corresponding project phase in individual cases, if necessary.

1.2 Record of Revisions

Version	Last revised:	Chapter / topic	Changed by:
2020.0.1	23.03.2020	All / new document with supplier	MR, RD (KUKA)
2020.0.2	03.04.2020	3.1/11.1, 13 / Training recommendations, minor adjustments to system status	MR, RD (KUKA)

Changes to the last version are marked as shown in this example.

Previous version:
This text is before. This is the original text. This text is after.

New version:
This text is before. This is the modified text. This text is after.

1.2.1 Contacts

The contacts responsible must be identified at project launch.

1.3 Information Coding

NOTE	Information to be observed in the design.

IMPORTANT	Disregard of this information will cause problems in the process

SPECIFICATION	Organizationally mandatory specifications.

2. Other Applicable Provisions

The specifications on programming and commissioning industrial robots for welding can be seen in the robotic specifications from the individual manufacturers. Model programs for arc-welding applications: See Appendix: Robotic Programming Specifications (↑*KUKA Robotic Specifications / ABB Robotic Specifications*).
The specifications for welding technology itself (↑*Project Book on Welding*) must also be observed.

The general specifications of ↑*SPPA Requirement Specifications* (especially Part 3 – Electrical Components) shall be complied with.

3. IR Selection Criteria

The robots are selected as per ↑*Robotics: General Powertrain*.
KUKA offers Robo Team systems combining multiple robots and optional external axes in a controller network.
For welding applications, the interlinked welding robots must be implemented in a Robo Team system.
Figure 1 shows the configuration.

Figure 1: *Examples of Robo Team installations (left: flexible positioner, right: Robo Team system with rotator)*

Motions and logical instructions are organized in robot programs. Motions can be coordinated chronologically or geometrically. Geometrical linking occurs via a reference coordinate system (typically workpiece coordinates) that is either static or coupled to a robot or positioner. All units participating in the motion move relative to this reference coordinate system. For each robot, a measurement occurs in a separate workpiece coordinate system. A KUKA Robo Team is limited to a maximum of six robots. The Robo Team members with the external axis are measured with reference to each other. The robots are measured with reference to each other and with reference to the external axis. A detailed description of the measurement process for the individual components is included in a separate chapter.

KUKA offers the possibility to define background tasks (formerly SPS.SUB).

Specification
For the simulation and analysis of process data, at least one free background task must be available.

Detailed information about Robo Team can be found in the manufacturer's documentation. Please note that, at the start of the project, Daimler AG will provide the latest valid sample programs for template installation and welding programming on the *download portal* provided for this purpose.
The programming specifications ↑*Robotics: General Powertrain* must be complied with. You can also find these on the *exchange medium*.
The use of Robo Team in handling areas must be approved by the client prior to ordering (Planning + Maintenance).

Note:
Deviations from this arrangement are possible if approved by the client.

3.1. Load Selection and Commissioning

For the standard GMAW arc-welding process, a load capacity of up to 8 kg is required. For laser hybrid processes a load capacity of 30-60 kg shall be provided.

Process	KR8 R2100-2 arc HW	KR30_3 KR60_3
GMAW arc-welding	X	-
Laser Hybrid	-	X (1" or 2" head)

Specification
The system builder shall follow the initial operation of the robot with the load determination.

3.2. Training Choices

KUKA offers the following training courses, and the robot programmer must provide evidence of successful participation in them.

Commissioner or manufacturer of the installation:

- **Basic KRC4 courses** or **conversion courses** for the KUKA KRC4 controllers

Robot programmer (commissioning and welding process):

- **Configuration and programming RoboTeam KSS 8.x (KR C4)**
  The aim of the seminar is to acquire all the skills required for commissioning and programming the KUKA.RoboTeam technology.
- **Robot Operation KUKA.ArcTech**
  The aim of the seminar is to modify and adapt existing robot welding programs or to create simple, new ones using the KUKA.ArcTech technology package. Robot welding with one or two robots is taught as well as the handling of a two-axis turn-and-tilt positioner.

4. Hose Packages (GMAW + Laser Hybrid)

The process-specific hose packages (e.g. MIG/MAG welding) appear in the corresponding ↑*Welding Technology Programming* and shall be included. Assembly is carried out **by the provider of the power source** on-site as part of robot commissioning (construction site). A function test for the process shall be performed by the power source manufacturer. **Commissioning shall be ordered by the manufacturer of the installation!**

The laser hybrid package is installed externally and therefore has no interface to the robot.

Note:
The prerequisites for commissioning are the complete routing of the cable to the power source, the Profinet programming and the energy supply to the power source and robot control system.

4.1. Welding Ground for Handling Robot

If a KR60-HA3 handling robot is used for stationary torches (free finish welding) or within a KIR cell, that robot must be fitted with a welding-specific package.
The following substances shall be provided:

- Welding ground 2x35 mm² current feedback
- Control line 23x1 + (2x1)
- Profinet 2x2xAWG 22 bare CU strand 22/19
- Profinet power supply 5x1.5 mm² voltage
- Functional ground 1x10 mm² potential equalization
- Air blue 3/8"
- Air black 3/8"

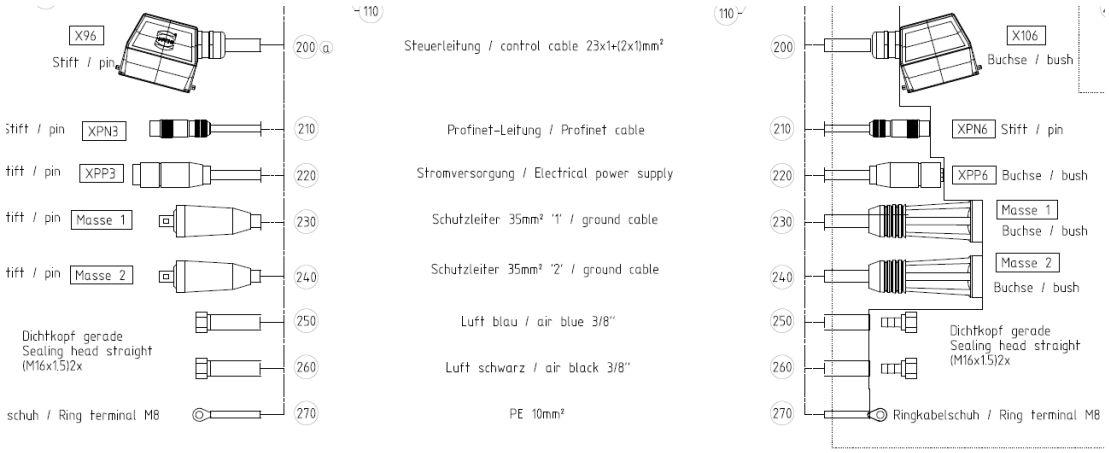


Figure 2: **Here is an example of a standard package from KUKA (Art 217-887).**
FOLLOW THE INSTRUCTIONS IN THE ROBOTICS SECTION.

For a pending project, the current status of the energy supply system must be requested and this must be specific to the robot type.

Important
In tandem processes or with the use of multiple welding robots on a component part, for each power source at least one ground line shall be provided in the hose package. If the **2x35 mm²** does not suffice for the planned process, a separate welding earth must be provided. This special package shall be coordinated with the robot manufacturer.

KUKA supplies standard hose packages for handling robots from axis 1 to axis 3, or axis 3 to axis 6.
The specifications (connection types, etc.) of the hose package appears in the appendices of
the ↑*KUKA Robot Specifications*.

4.2. Welding Torch Hose Package

The length of the hose package must be matched to the KR8 R2100-2 Arc HW. Details: see ↑*Welding Technology Programming*. The welding package manufacturer Fronius supplies the complete welding package for the KR8 R2100-2 Arc HW robot. The order number and filling can be obtained from the welding package manufacturer. The package-specific limits for the energy supply system are determined by the supplier of the energy supply system.

Specification
The monitoring of the packet-specific limits must be implemented by the manufacturer of the installation (e.g. setting up background task).

Important
The package-specific limits for the rotational ranges of axis 6 or the combined rotation of axes 4 and 6 shall be observed in the simulation **and** programming.

Example of a permitted combined rotation (torsion of the torch hose package) through +/-240° (Cloos):

Axis 4	Axis 6	Torsion	Permitted
0°	0°	0°	Yes
250°	0°	+250°	No
-250°	0°	-250°	No
250°	-100°	+150°	Yes
-250°	100°	-150°	Yes

Table 2: Examples of combined torsion of hose assemblies and their classification for permissibility

Example of a typical procedure during a welding seam:

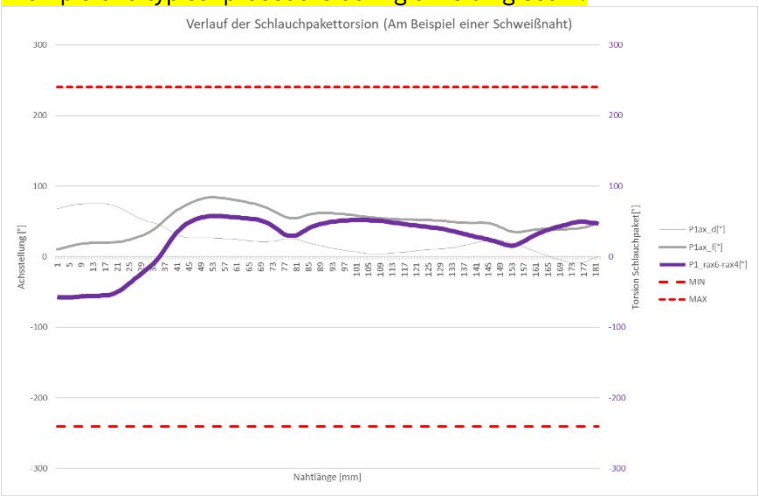
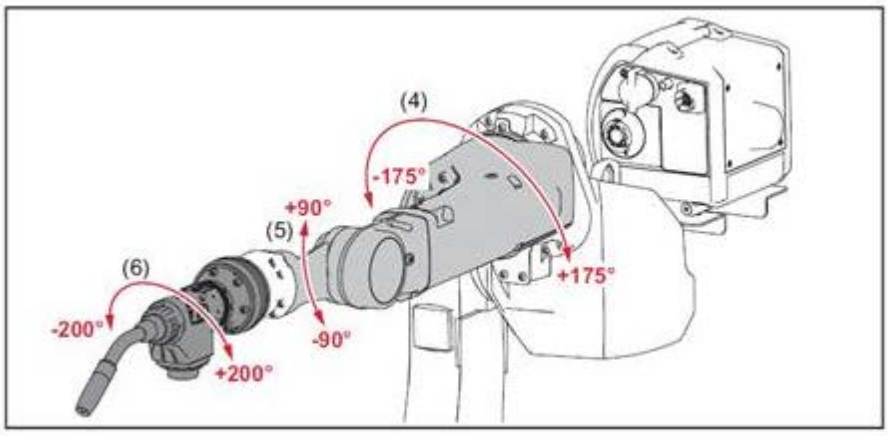


Figure 3: Example of a torsion course (purple) along a seam. You can see that the axis rotations A4 and A6 (grey) partially compensate each other. The actual torsion of the package must be within the manufacturer's limits.

Important
If the wire feed unit (DVS) is mounted on the robot arm, make sure that the attachment of the DVS does not restrict the motion of the robot. Should this not be possible, the robot must be appropriately adjusted regarding the axis boundaries A3, to prevent damage to DVS and the robot kinematics.

Range of motion of the KR8 R2100 ARC HW ARC with Fronius hose package



Fronius specifies in its documentation for the KR8 R2100 ARC HW which hand motions are permitted.

Axis 4 has a permitted working range of +/- 175°.
Axis 5 has a permitted working range of +/- 90°.
Axis 6 has a permitted working range of +/- 200°.
The two axes 4 and 6 together may sweep a range of motion of +/- 360°.

5. General Specifications on the Use of Positioning

- The following versions are available:
  - Endlessly rotating version without the power supply
  - The version with energy supply system is planned to use a flexible power duct. This flexible power duct is designed for a turning range of 720°. Consultation with robot manufacturer on the current status is necessary. (Planning status see Appendix 5)
- Regardless of the available positioners, the following implementations must be adhered to by the manufacturer of the installation:
  - Operating range of the table axes: **-at least -180° / +360° in version with torsion cable**
  - Endlessly rotating version with slip ring (Profinet, voltage, air, welding earth) **only if approved by client**
  - Version with flexible power duct **only after consultation with robot manufacturer**.
- A positioning accuracy (transmission play + control) of **0.08 mm** at a **distance of 500 mm** from the axis of rotation must be assumed
- All positioners have a standard feed line length of **7 m**. Other lengths shall be requested when ordering.
- Mount lists for jigs/fixtures as per Daimler version. (See Appendix or consult the robot manufacturer)
  - KUKA will carry out a corresponding adaptation according to Daimler specifications at the start of the project. Consultation with robot manufacturer on the current status is necessary.
- It shall be ensured that the table does not vibrate during loading and unloading. If necessary, a mechanical support must be provided (not available as a KUKA product).
  This is especially important when H-tables are used.
  Overshooting tables require an additional waiting time before the process can start. This will affect the takt time. **For this reason, overshoot prevention must be designed in.** (Optimized centers of mass and corresponding design of the positioners)
- During commissioning, KUKA checks and optimizes the load on the positioners with regard to acceleration/speed curves dependent on load moments (center of mass outside the axis of rotation).
  The manufacturer of the installation must order this in conjunction with the KUKA commissioning.
  If no optimization is necessary, this must be clarified with Daimler by the manufacturer of the installation at the start of the project.
- **Load arrangements of the jigs/fixtures must have a safety margin of approx. 20%,**, to allow any necessary adaptations of the jigs/fixtures on the construction site.

Important
All **standard positioners** must be parameterized during commissioning regarding the load and inertia moments. Optimization via KUKA can be ordered as a service. **This optimization shall be requested by the system builder.**

Programming without load measurement is not permissible!

Note
There are currently no dynamic models for the **positioners**. On request, checks can be carried out as to whether a dynamic model can be created for the requested positioner. This can then be ordered from KUKA as a service. If it is not possible to create a dynamic model, at least the handling characteristics can be optimized according to the machine data. This can also be offered as a KUKA service.
The services must be requested by the manufacturer of the installation.

5.1. KRC4 Equipment for Operating Additional External Axes

Drive modules or controller variants are available for the operation of external axes. The control system is supplemented with the corresponding driver stages for the additional axes. The standard robot types can be fitted with up to six additional axes. The necessary components must be ordered according to the KUKA order list (see KUKA project book).
The additional axes may have to be activated via the Work Visual configuration tool.

For examples of control, please refer to the robot manufacturer's documentation or request details. Observe the specifications for robot programming (↑*Robotics: General Powertrain*). The latter shall be requested from Daimler at the start of the project.

IMPORTANT
Connector plugs for the external axes must be HAN modular. Deviations from this requirement must be approved by the client.

Circuit diagrams and further information can be seen in the appear in the manufacturer's documentation.

5.2. Safe Deactivation of the External Axes

IMPORTANT NOTE
With the KRC4, no additional hardware is required for safe shutdown of the external axes, as the drive modules are inherently safe components.
Standstill monitoring of the axes is possible through safe configuration.

6. Robot Base

Welding robots can be placed on bases. The bases shall be procured from the IR manufacturer.
KUKA offers different heights of attachment frames for the various robot types. Bases are available for the KR 8 R2100-2 arc HW welding robot from a height of 200 mm up to a maximum height of 2000 mm. These bases are available in grid sizes of 200 mm. For other robot types, different heights of robot bases are also available.
Special shapes of bases must be coordinated with the IR manufacturer (KUKA Deutschland).
For details, see the product handbook of the particular robot or Appendix in the Project Book ↑*Robotics: General Powertrain*.

7. Software Options

For a welding robot (including free finish welding), in addition to the default options the following software options shall be ordered. Optional packages are marked with an asterisk *.

Process	Single robots	Multi-robot systems, robot & ext. axis, robot & robot
MIG / TIG	• KUKA.ArcTech Basic 3.0 • KUKA.SeamTech Finding 3.0* • KUKA.SeamTech Tracking 3.0* • KUKA.TouchSense 3.0* • PointCorrection online 1.0	• KUKA.ArcTech Basic 3.0 • KUKA.ArcTech Advanced 3.0 • KUKA.SeamTech Finding 3.0* • KUKA.SeamTech Tracking 3.0* • KUKA.TouchSense 3.0* • KUKA.RoboTeam 3.0 • PointCorrection online 1.0
Laser Hybrid	• KUKA.LaserTech 4.0 • KUKA.ArcTech Basic 3.0 • KUKA.ArcTech Advanced 3.0 • KUKA.SeamTech Finding 3.0* • KUKA.SeamTech Tracking 3.0* • KUKA.TouchSense 3.0* • KUKA.TouchSense 3.0* • PointCorrection online 1.0	• KUKA.LaserTech 4.0 • KUKA.ArcTech Basic 3.0 • KUKA.ArcTech Advanced 3.0 • KUKA.SeamTech Finding 3.0* • KUKA.SeamTech Tracking 3.0* • KUKA.TouchSense 3.0* • KUKA.RoboTeam 3.0 • PointCorrection online 1.0

Table 3: Overview of the software options by use case

Multirobot systems are systems with multiple robots or positioners. When commissioning the robot control system: **the 1st welding robot is always robot 1**.

The versions listed above are authoritative for the basic release KSS 8.5. If version KSS 8.6 is used, please request assistance.
Point Correction Online (see Appendix 7) must be used for the correction of weld spots after consultation with the client.
In addition, further software options are available and can be installed independently of the welding application. Details from KUKA on request.

7.1. User

NOTE
For security reasons, users should have different passwords **for each** robot. The allocation and setup of users is carried out by the maintenance department.

8. Parameterization Specifications

Specification
All welding robots **must** be parameterized according to the settings described below. The correct settings are checked randomly during the shipping acceptance procedure. The parameterization can optionally be ordered from the IR manufacturer.

8.1. Start-up Routines

To ensure the conditions when the controller is started, the signals required for welding **must** be automatically set to a defined state (to avoid undefined states and unpredictable reactions). This must be ensured by the IR programmer accordingly.

This matter is explained specifically as part of the start-up event.

8.2. PCO

To use PCO, it is necessary to implement the programming for the weld tracks accordingly. This must be ensured by the IR programmer accordingly. KUKA Deutschland offers documentation and technical support on this issue.

8.3. Laser Hybrid

This matter is explained specifically as part of the start-up event.

8.4. Limited Modifications (Limited ModPos)

The KUKA controller restricts the correction of programmed points. However, the parameters must be set **before** handover and are checked during shipping acceptance. This is activated after initial programming and as part of handover for production.
The KRC4 controller restricts the correction of programmed points. However, the parameters must be set **before** handover and are checked during shipping acceptance. This is activated after initial programming and as part of handover for production. The correction limit must be activated so that the values entered are taken into account during re-teaching. Adjustable user rights with passwords prevent unauthorized changes.

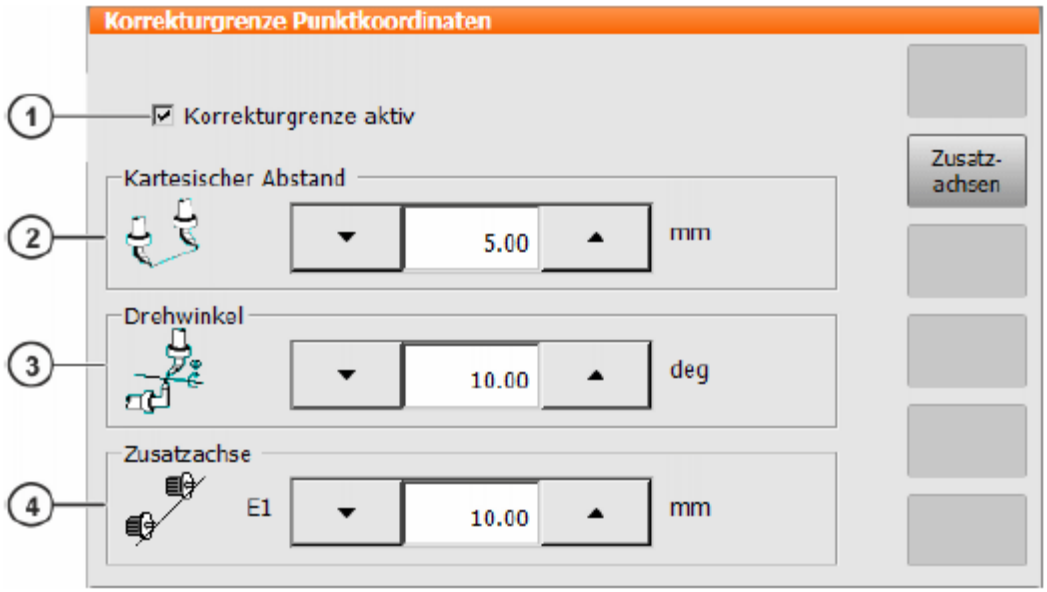


Figure 4: Specifications for setting the correction restriction

To make adjustments, proceed according to the manual:
Correction limits for point coordinates
1: Check mark means that set limits are active
2: Maximum changes of X, Y, Z are 1.00 …… 100.00 mm. The value represents the radius of an imaginary sphere around the original point.
3: Maximum changes for A, B, C are 0.00 … 20.00 deg
4: This field applies to additional axes. Permitted changes 0.00 … 100.00 mm

8.5. Definition and Storage of System Configurations (Profinet, Excel Spreadsheet for Creating Signal Names)

The communication participants in the welding application are known before the project starts. Based on this information, a catalog element can be created in advance that contains the bus type used and its modules. The signal assignment can also be defined in more detail using long texts. The catalog element thus created can then easily be integrated into any robot project that contains these system components. This means that the complete configuration only needs to be created once. A kind of catalog element is created that already contains all the information and can be included in a project.

If other software packages are used, they must be handed over to the client and the maintenance department, including any necessary licenses, so that they can expand the project programming.

Specification
The project data belonging to the Profinet controller must be stored in full as a ZIP file in a folder of the controller. The current Excel spreadsheets for the interface must also be stored in that folder.

Specification
The ZIP file must include all the GSDML files required to enable all I/O units (power source, Leoni, Murr MVK modules, HKS, etc.) to be addressed by a fresh installation of the Profinet parameterization software. (Operating instructions, CAD data, etc., which are included in the GSDML downloads of some manufacturers, are not permitted to be included in the ZIP).

8.6. Setting the Arc Package for KUKA Welding Robots

8.6.1. Configuring the Power Source

Before the start of a project, the power source to be used is determined by Daimler. At this point, the functions of the power source to be applied are also defined. The interface assignment (I/O part) and the error strategies to be used are already known before the project is delivered. This information can be used to define the configuration of the power source completely in a catalog item for that power source.

The creation of this catalog element is to be commissioned by the manufacturer of the installation himself or commissioned by the manufacturer of the installation from the IR manufacturer. If a catalog element is already available, it will be provided to the manufacturer of the installation by Daimler.

This complete configuration is thus stored in one catalog element. That catalog element, which then contains all the necessary information, must be used by the manufacturer of the installation. This also ensures that each robot and power source is configured in the same way.

8.6.2. Typical Configuration of a Power Source via the Work Visual Configuration Tool

The settings apply to a Fronius TPS job mode or a related power source. The settings are suitable for single and Robo Team robots. The lower view is not complete. It is intended to represent the simple procedure of how to configure a power source in case of need.

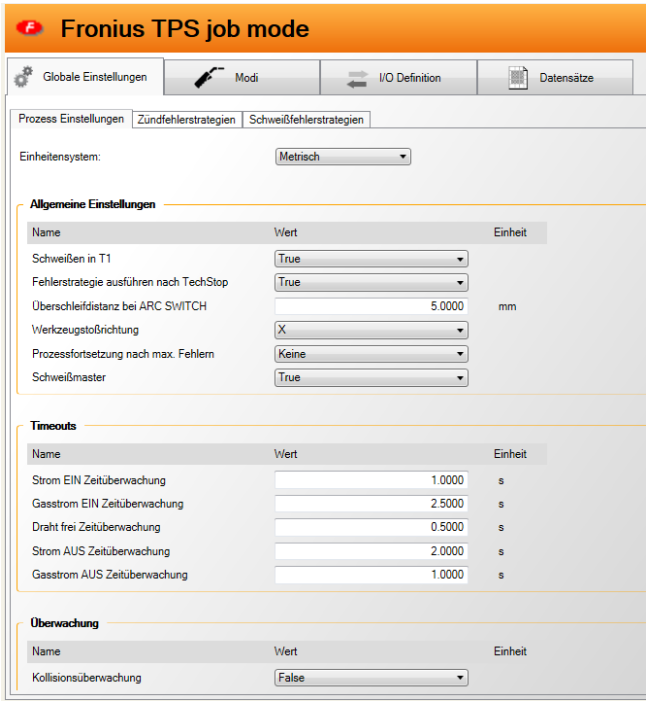


Figure 5: Global process settings (Part 1)

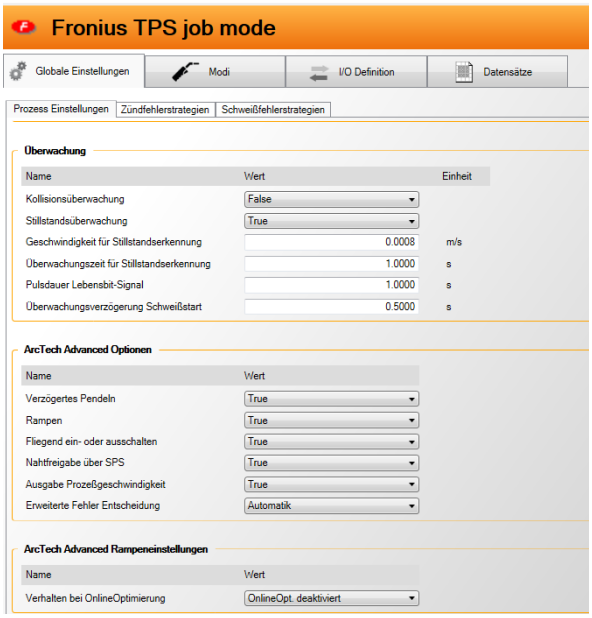


Figure 6: Global process settings (Part 2)

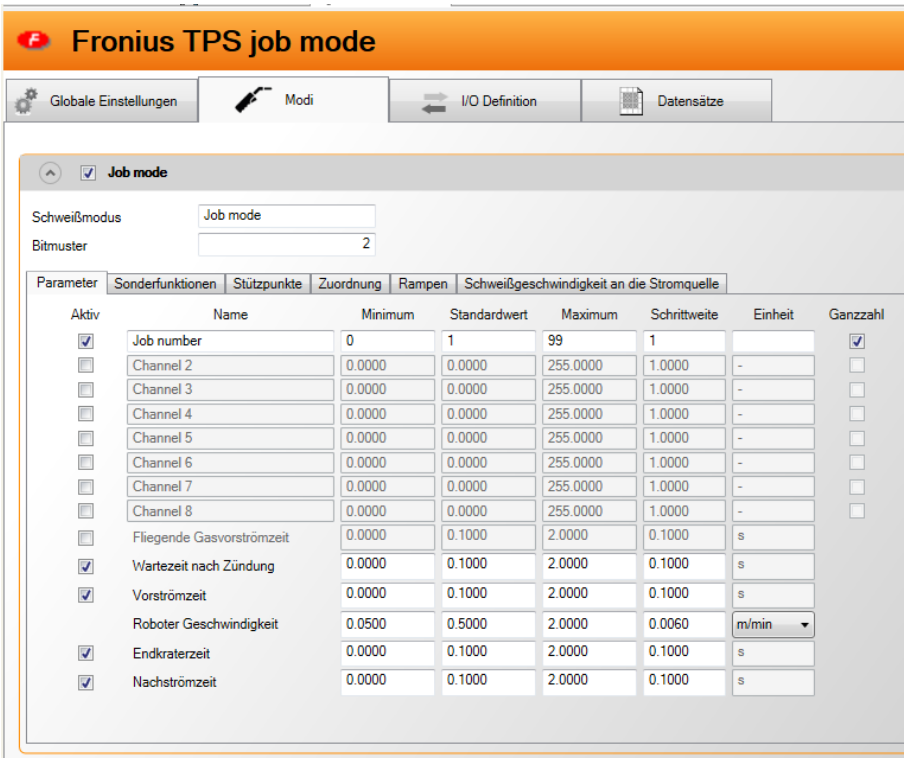


Figure 7: Setting the power source for JOB mode

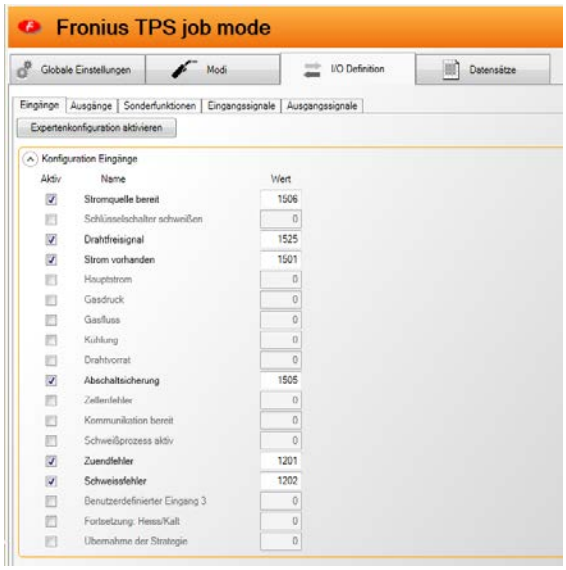


Figure 8: Configuring the input signals

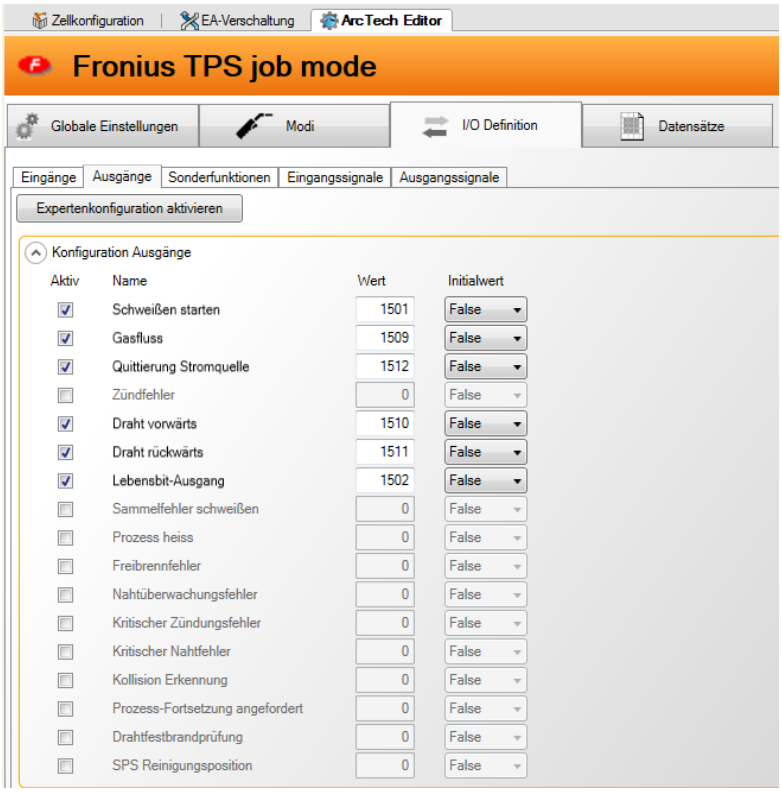


Figure 9: Configuring the output signals

The controllers must be set according to the I/O specifications so that the error handling strategy defined in the welding project book is implemented correctly. The functionality and parameterization of the arc-ware is to be demonstrated to the client by the manufacturer of the installation using a control system, **before** further controls can be parameterized.

Observe the instructions in conjunction with start-up event.
Please note any available specifications on the download portal.

9. System Concepts

The following describes the standard systems. The necessary measurement sequence and the technical specifications to be observed are discussed.

Further information on specifications and the procedure in measuring KUKA welding cells is contained in the manufacturer's documentation and the Project Book ↑*Robotics: General Powertrain*.

9.1. Handling IR with Stationary Welding Torch

Important
In tandem processes or with the use of multiple welding torches on a handling robot, for each power source a ground line shall be provided.

The following describes the procedure in commissioning regarding measurements.

1 robot (stationary jig/fixture)

Step	Measurement to be performed
1	Determine robot TCP
2	Determine external TCP for welding torch
3	Define the workpiece coordinates ("workpiece at flange")

Important
For welding at the tops and bottoms of jigs/fixtures, separate work objects shall be used in each case, to improve the accuracy of the system.

9.2. Robots (1-2) and Two-axis Turntable

The following variants of a two-axis positioner are available from KUKA:
The following two-axis turntable (L-positioner) is available

Load capacity / Type	DKP 400
Order number	See order list
Load capacity	400 kg
Type	Standard positioner

Working range: A1: -90° to +90°
A2: -185° to +180°

Load capacity / Type	KP2-SV1100 HW
Order number	See order list
Load capacity	1100 kg
Type	Standard positioner

Other two-axis positioners with load capacities of 2600 kg and 5000 kg are possible on request and pending approval by Daimler.

To ensure an optimum operating position, the robot must be mounted on a base.

The following media must be provided at the plate (for available connection points, see manufacturer's documentation):

- Profinet + voltage
- Air
- Welding ground

The axes are reversible.

The design of the energy supply system for the 2-axle positioners still needs to be clarified in detail as to what extent it complies with the Daimler standard or needs to be adapted.

Important
In tandem processes or with the use of multiple welding robots on a DCP, for each power source a ground line shall be provided in the DCP. Additional ground lines shall be routed externally.

The following describes the procedure in commissioning regarding measurements.

Measurement of the jig/fixture load is possible before and after the calibration of the robots.

1 x robot on two-axis positioner / turntable

Step	Measurement to be performed
1	Determine robot TCP
2	Calibrate robot with DKP (calibrate root point of the DKP with TCP (reference tool))
3	Define workpiece coordinates (work object) (Offset measurement of the external axis)

2 x robot on two-axis positioner / turntable

Step	Measurement to be performed
1	Determine robot 1 TCP
2	Determine robot 2 TCP
3	Calibrate robot 1 with DKP (calibrate root point of the DKP with TCP (reference tool))
4	Measure robot 2 on robot 1
5	Calculate the root point of the DKP with robot 2 via menu, alternatively measure as described in point (3)
5	Define workpiece coordinates of robot 1 (base) (Offset measurement of the external axis)
6	Define workpiece coordinates of robot 2 (base) (Offset measurement of the external axis)

Important
For welding at the tops and bottoms of jigs/fixtures, separate work objects shall be used in each case, to improve the accuracy of the system.

The commissioning shall conclude with a check of the synchronized trip from robot 1 and robot 2 onto the plate of the DCP. No programming may occur beforehand.

9.3. Robots (1-2) and Closing Unit

No closing unit is available from KUKA.

Checks are to be carried out as to whether the functionality can be reproduced by a two-axis positioner with a special device to be constructed by the manufacturer of the installation.

9.4. Robots (1-2) and Rotator (1 Station)

Load capacity / Type	KP1-HC2000
Order number	See order list
Load capacity	2000 kg
Type	Standard positioner

The rotator comprises the drive and the support bushing. Positioners are available in two versions.

- Endlessly rotating version without the power supply.
- A design with an energy supply system is available from KUKA, and this is then implemented when the order is placed. The rotation angle range of the positioner is 720°.

The following substances are available at the plate:

- Profinet + voltage
- Air
- Welding ground

Important
In tandem processes or with the use of multiple welding robots on a rotator, for each power source a ground line shall be provided.

To ensure an optimal operating position, the robot shall be placed on a base.

Clarify the current version with media version with KUKA before ordering.

The following describes the procedure in commissioning regarding measurements.

1 x robot on rotator

Step	Measurement to be performed
1	Determine robot TCP
2	Determine the root point of the rotator to the robot.
3	Set offset measurement (base coordinates)

2 x robot on rotator

Step	Measurement to be performed
1	Determine robot 1 TCP
2	Determine robot 2 TCP
3	Determine the root point of the rotator to robot 1.
4	Measure robot 1 with robot 2
5	Calculate the root point of the rotator with robot 2 via the measurement menu, alternatively proceed as described in point 3.
6	Determine robot 1 offset measurement (base) for top and bottom
6	Determine robot 2 workpiece coordinates for top and bottom

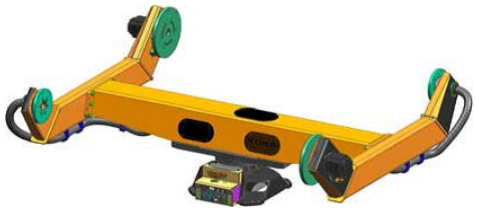
Important
For welding on the tops and undersides of jigs/fixtures, separate bases must be used in each case to improve the accuracy of the system.

The commissioning shall conclude with a check of the synchronized trip from robot 1 and robot 2 onto the plate of the rotator. No programming may occur beforehand.

9.5. Robots (1-2) and Rotator (2 Stations)

The following two-axis turntable is available

Load capacity / Type	KP3-V2H1000
Order number	See order list
Load capacity	1000 kg
Type	Standard positioner



Other three-axis positioners with load capacities of 250 kg, 500 kg and 750 kg are possible on request and pending approval by Daimler.

To achieve an optimal position of the robot to the three-axis positioner, the robot must be mounted on a base.

The following substances shall be provided at the plate (for available connection points, see ***APPENDIX 5 Positioner, Rotator and Rotator*** Interface):

- Profinet + voltage
- Air
- Welding ground

The axes are reversible. The plate is endlessly rotating depending on the wiring.
The design of the energy supply system for the 3-axle positioners still needs to be clarified in detail as to what extent it complies with the Daimler standard or needs to be adapted.

Important
In tandem processes or where several welding robots are in use on a three-axis positioner, an earth line must be provided for each power source in the three-axis positioner. Additional ground lines shall be routed externally.

The following describes the procedure in commissioning regarding measurements.

Measurement of the jig/fixture load is possible before and after the calibration of the robots.

1 x robot on three-axis positioner

Step	Measurement to be performed
1	Determine robot TCP
2	Calibrate robot root point with three-axis positioner for each side
3	Set offset root point (work object) for each side

2 x robot on three-axis positioner

Step	Measurement to be performed
1	Determine robot 1 TCP
2	Determine robot 2 TCP
3	Calibrate robot 1 root point with three-axis positioner
4	Measure robot 2 on robot 1
4	Determine the external axis on robot 2 using the calculation menu
5	Calculate offset for robot 1 on external axis (work object)
6	Calculate offset for robot 1 on external axis (work object)
7	Carry out measurement for each side.

Important
For welding **at** the tops and bottoms of jigs/fixtures, separate work objects shall be used in each case, to improve the accuracy of the system.

Commissioning shall conclude with a check of synchronized motion of robot 1 and robot 2 to the plate of the three-axis positioner. No programming may occur beforehand.

9.6. Flexible Positioner (KIR)

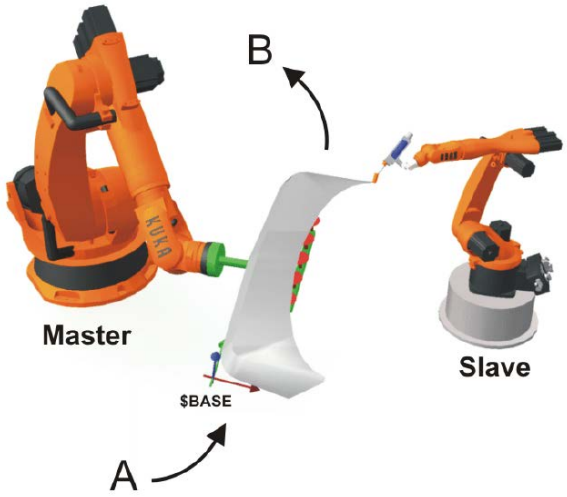
To ensure an optimal operating position, the welding robot shall be placed on a base.

The following substances are available at the handling robot:

- Profinet + voltage
- Air
- Welding ground

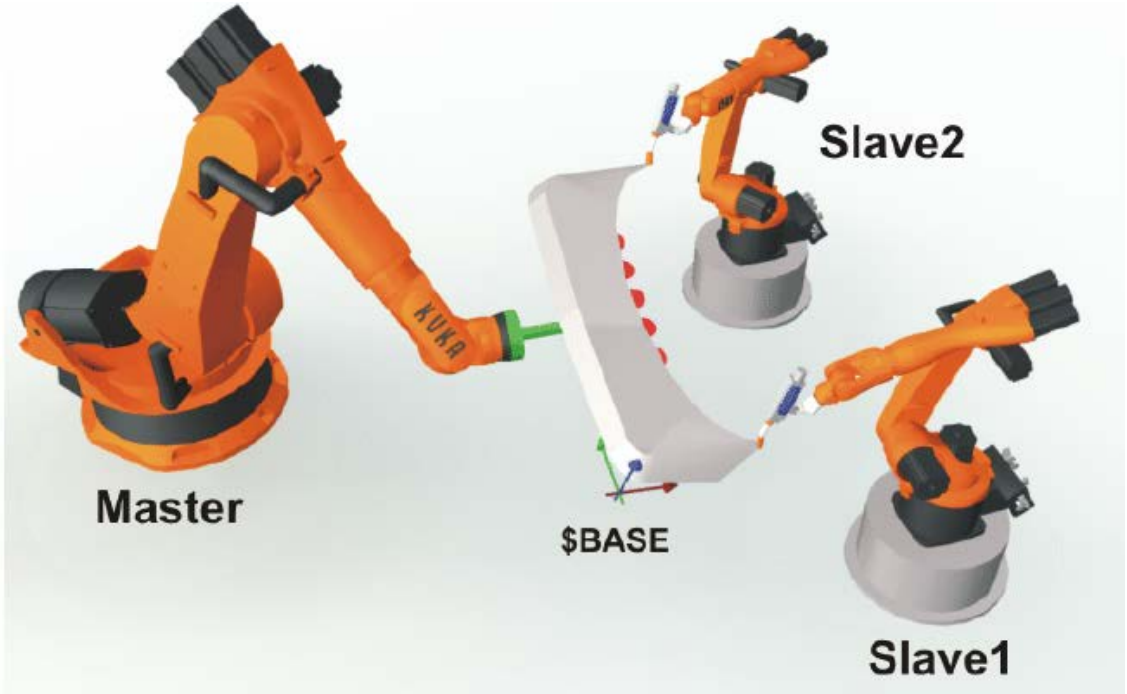
Important
In tandem processes or with the use of multiple welding robots, for each power source a ground line shall be provided.

The following describes the procedure in commissioning regarding measurements.



1 x welding robot on handling robot

Step	Measurement to be performed
1	Determine robot 1 TCP (welding robot)
2	Determine robot 2 TCP (for handling and measuring)
3	Measure robot 1 and robot 2 relative to each other (robot 1 = master)
4	Determine workpiece coordinates robot 1 (linked base to R2 hand flange) on robot 2, and if necessary measure another linked base for the bottom of the fixture.
5	If necessary, define trays for component parts by workpiece coordinates for robot 2 (base)



2 x welding robot on handling robot

Step	Measurement to be performed
1	Determine robot 1 TCP (welding robot)
2	Determine robot 2 TCP (welding robot)

3	Determine robot 3 TCP (handling robot)
4	Measure robot 1 on robot 3
5	Measure robot 2 on robot 3
6	Determine workpiece coordinates of robot 1 (linked base on hand flange R3) on robot 3, if necessary also for underside
7	Determine workpiece coordinates of robot 2 (linked base on hand flange R3) on robot 3, if necessary also for underside

Commissioning shall conclude with a check of the synchronized trips of all robots on the handling robot. No programming may occur beforehand.

9.7. Other System Concepts

The manufacturer shall be asked about any special shapes, which shall be discussed with Daimler **prior to use**.

If IRs are placed on positioners, holding a 150 kg wire drum **per** robot shall be possible.

10. Specifications on Weld Programming

The manufacturer's documentation (amongst other things *Application Handbook KUKA.ArcTech Basic 3.1 and KUKA.ArcTech Advanced 3.1*) for programming welding jobs must be observed. At the project start the system builder will receive sample programs for designing the welding programs, including error handling. ↑*Robotics: General Powertrain* and on the download portal.

Specifications
For welding with KUKA robots the error handler must be set as given in 8.6.
(For additional information and to clarify other issues, please contact the IR manufacturer KUKA Deutschland)

At the start of the project, a sample program for welding with the error handler must be obtained from the download portal (Planning is the contact) by the supplier. Questions can be clarified during the initial launch meeting.

Specifications
The supplier must demonstrate the functionality of error handling, KIR welding and re-programming with one (1) multi-robot cell while the robot program is running as part of the design release. The installation must be booted with all the necessary software options, I/O interface and template. This cell then serves as a blueprint for further cells. At that point, the cell does not have to contain a correct frame and a real component part – but two robots and one rotator must be demonstrated and each robot must run through at least three weld seams when the external axis is rotated. PLC signals may be simulated or bypassed. Power sources / cleaning units may be simulated
Power source-specific data recording is described in ↑*Welding Technology Programming* and **implemented by the system manufacturer (including the necessary robot programming)**. Sample programs for this purpose are available on the download portal.

Specification
The DMC relating to the component part to be welded now (or the partial information clearly required for identification within a plant life cycle - to be clarified in the start discussion) must be communicated to the robot by the PLC, but **before the 1st seam is welded**. If this is not possible for some reason, the robot may use an internal component part counter for this purpose after **explicit approval**.

Important
As a general rule, the following limitations must be observed when programming with Arc Tech Basic and Arc Tech Advance:
Only one weld track may be included in one subroutine in order to be able to use the "Advanced Error Recovery Strategy" error handling system. Otherwise, malfunctions due to weld seam and ignition defects cannot be ruled out.

11. Specifications on Measuring

11.1. TCP / Welding Torch Measurement / Measurement of External Axes

The welding torch service system (TSC, Torch Service Center) consists of a TCP measurement unit and welding torch cleaning system).

The following systems are available for KUKA robots:

- **ABB TSC Edition 2018 with** welding torch service unit and *Leoni Advintec TCP 3D* TCP measuring system (see ↑*Robotics: General Powertrain* Appendix 5) constructed as per ↑*Welding Technology Programming*

- **Cloos Sparematic** with torch service unit, Leoni TCP measuring system and automatic change of contact tube and gas nozzle ↑*Welding Project Planning*

Specification
All welding robots **must** be fitted with automatic TCP correction. Sharing the TCP correction (2 robots use 1 TSC) is **not** permitted. The measurement and cleaning sequences in the TSC shall also be possible while a positioner is being rotated (observe robot interference contours).

For the measurement of IR and external axes, automated measurement is recommended, if possible.
The Leoni Advintec TCP3D system is available for KUKA robots. To attain maximum accuracy, the system is used, instead of manual measurement with measuring tips, also for measuring the work objects in welding jigs/fixtures and for calibrating the welding robots on external axes or a handling robot. The system is in this case 100% compatible with the measuring tips described in ↑*Robotics: General Powertrain* Appendix 5.

There is no available variant at the time of going to press. At the start of the project, the availability must be clarified with Leoni by the manufacturer of the installation.

Specification
In order to ensure that the **Leoni can be used to measure IR-IR, IR-ext. axis** and the **work objects**, it **must be possible to fit the adapters for the Leoni system to the mounting points of the measuring tips on the clamping frame and it must be possible to carry out measurements without dismantling fixture elements**. (Observe the robot interference contours).

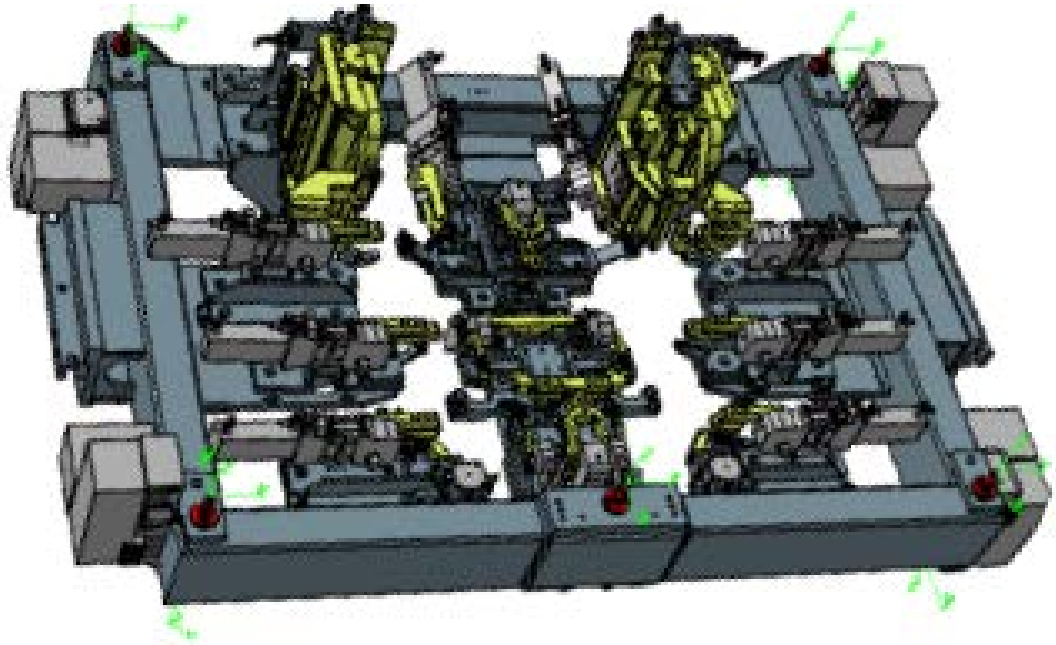


Figure 10: Measurement of tensioning frame – here we see the mounting of the tips on the tensioning frame

Figure 11: Example for the measurement of a tip with Leoni on the tensioning frame

11.2. Specifications on Programming the Measuring Process

In the course of the start-up meeting, one of the robot programmers from the manufacturer of the installation will be instructed in the specifications (service routines). The test routines must be stored for each measurement. Examples are available on the download portal.

12. Directories

12.1. Source Code Directory

Es konnten keine Einträge für ein Abbildungsverzeichnis gefunden werden.

12.2. List of Figures

12.3. List of Tables

12.4. List of Appendices

APPENDIX 1 TSC for KUKA NANO

Images of layout of TSC for KUKA Nano brief documentation, Instruction Manual for components

Version	File	Description
	TSC for KUKA-NANO.pdf	List of components
	Images of Leoni configuration	
	BRG-2000DE_with DA-2000E ..	Circuit diagram excerpt
	Advintec_TCP_3D	Light barrier

APPENDIX 2 Powertrain Guideline for Welding Applications, Handling

Version	File	Description

APPENDIX 3 Specifications for IR Measurement and Checking

Version	File	Description

APPENDIX 4 Robo Team

Version	File	Description
KST RoboTeam 3.0 V2	KST_RoboTeam_3.0.	User documentation

APPENDIX 5 Positioner, Rotator and Rotator Interface

At project start, all available updated versions must be requested from KUKA.

Version	File	Description
1.0	180802_Info_KUKA Rotator_KP1-HC2000	Notes on versions of the positioners
1.0		
1.0		

APPENDIX 6 PRL NANO

At project start, all available updated versions must be requested from KUKA.

Version	File	Description
	PRL_Nano 14.1	NANO Cell Project Engineering Guidelines
	GL_DE_Roboter NANO V00.02	Description of NANO error strategy

APPENDIX 7 **Point Correction Online 1.0**

Version	File	Description
	KST_PointCorrection_Online_10_de.pdf	KUKA system Technology Point Correction Online
	Testmodul.src, Testmodul.dat	Sample of weld seam program with data list
	Testmodul.xml	Sample configuration file
	Point_of_correction.docx	Description of file structure for Point Correction Online

13. Checklist & Summary

Below is a list of the main topics dealt with in the previous document:

	Description ➔ Text criterion	Responsible	Inspection by				
			Supplier	Planning	TFT	Maintenance	IR manufacturer
1	1 free background task →Monitoring	Plant manufacturer	X/P			A	
2	Robots have been installed with template and sample program →Check options and program	Plant manufacturer	X/P			A	
3	Names of the robots (R1, R2, etc.) match the specifications →Check	Plant manufacturer	X/P			A	
4	Robo Team only for welding (Exceptions have been agreed with Project)	Plant manufacturer	X/P	A			
5	Welding load specification complied with (GMAW 8 kg, LH 60 kg) Load data have been determined (not copy+paste data.) →Monitoring	Plant manufacturer	X	P		A	
6	Commissioning of hose package by SQ manufacturer completed →Commissioning log	Plant manufacturer	P		A		X
7	Welding earth correctly dimensioned + laid →Check compartments and fixtures	Plant manufacturer	X/P		A		
8	Torsion limits for torch hose package adhered to during all movements (reserve 0°) →Analyze the course of movement	Plant manufacturer	X		P/A		
9	Robot soft limits adapted to DVS assembly position →IR moves all axes + test collision	Plant manufacturer	X/P		A		
10	Degree of freedom of rotator -180/+360° or DKP complied with, cable installation according to specifications	Plant manufacturer	P			A	X
11	Fixture does not oscillate during feed and loading/unloading →opt. monitoring	Plant manufacturer	X/P	A			
12	Mounting strips for fixture according to specifications →opt. monitoring	Plant manufacturer	X	P/A			
13	Robot base according to specifications – special shapes agreed with the manufacturer and approved.	Plant manufacturer	X			P/A	
14	Load on the positioners (20% reserve), commissioning by IR manufacturer → Commissioning log, load planning	Plant manufacturer	P			A	X
15	KRC4 with safe interface and positioner control in line with specifications	Plant manufacturer	P			A	X

16	SafeMove with Cartesian monitoring only for absolutely essential areas →Safe project programming	Plant manufacturer	X	P		A	
17	Software options (→7.) correctly booted (ArcTech, error handling) →Check backup	IR manufacturer	P			A	X
18	Parameterization ModPos (programming ball) →Test	Plant manufacturer					
19	PCO programming implemented, tech package installed →Check backup	Plant manufacturer	X		P/A		
20	For LH: Technology package installed and correctly applied →Check backup	Plant manufacturer	X		P/A		
21	Is the Profinet project included in the backup? →Check backup	Plant manufacturer	X			P/A	
22	Parameterization ARC Tech (incl. error handler)	Plant manufacturer	X		P/A		
23	All installation concepts are in accordance with specifications	Plant manufacturer	X	P/A			
24	Measurement sequence according to specifications → Commissioning log	Plant manufacturer	X			P/A	
25	Work objects available on top and bottom →Welding program	Plant manufacturer	X		P/A		
26	Earth lines have not been joined together	Plant manufacturer	X/P		A		
27	Use of more than two robots in SafeMove version must be agreed with the client and IR manufacturer (safety engineering)	Plant manufacturer	X			A	P
28	**At the start of the project, KUKA will provide a virtual cell for Robo Team and external axis.** In this virtual cell, the manufacturer of the installation will demonstrate the fully functional robot program and error handler. → Handover of data + presentation	Plant manufacturer	X		P/A		
29	DMC (or part info) transmitted from PLC to robot before welding →Test	Plant manufacturer	X	P/A			
30	Each weld track in a separate procedure →Backup	Plant manufacturer	X/P		A		
31	Necessary users created → Check log-in	Maintenance	P		A	X	
32	TCP measurement using Leoni or Sparematic →Presentation	Plant manufacturer	X/P		A		
33	A Leoni sensor can be attached to the fixture for ext. axis and robot measurement	Plant manufacturer	X/P		A		
34	Measurement with Leoni ext. axis and robot is possible without dismantling the jig (Option: Automatic execution is programmed)						
35	Measurement programs for work objects, tensioning frame/rotator and robot are used →Presentation	Plant manufacturer	X/P		A		
36							

14. Abbreviations

Abbreviation	Explanation
IRB	Industrial Robot
KIR	Cooperating Industrial Robot (Kooperierende Industrie Roboter)
TCP	Tool Center Point
TSC	Torch Service Center (welding torch cleaning device, wire cutter, TCP measurement)
PLC	Programmable Logic Controller
I/O	Inputs & outputs of a control program (the interface)
SQ	Power source
LS	Laser
LH	Laser hybrid – combined GMAW and laser process
GMAW	Gas metal arc welding
Robo Team	Cooperating Industrial Robot (Kooperierende Industrie Roboter)
KR	KUKA Robots
Work object	Base / User coordinate system / Work piece coordinate system