Documentation

RotoLAB Setup

ABB

Version 2.9 As at: 16.02.2022

Wiest Aktiengesellschaft
Siemensstr. 4, 86356 Neusäß
www.wiest-ag.de

Content:

Figures:

Tables:

1. Supported robot controllers and available interfaces

- **IRC5**

  Available Interfaces:
  - RS232
  - Ethernet (Software option “PC interface“ is required)
  - Fieldbus via protocol converter

2. Scope of delivery

The following are included in RotoLAB delivery:

- RotoLAB measuring system
- Flange for mounting RotoLAB
- Robot programs for operation of RotoLAB (see USB-Stick)
- Documentation of RotoLAB setup and application (see USB-Stick and hard-copy)

3. Mechanical installation

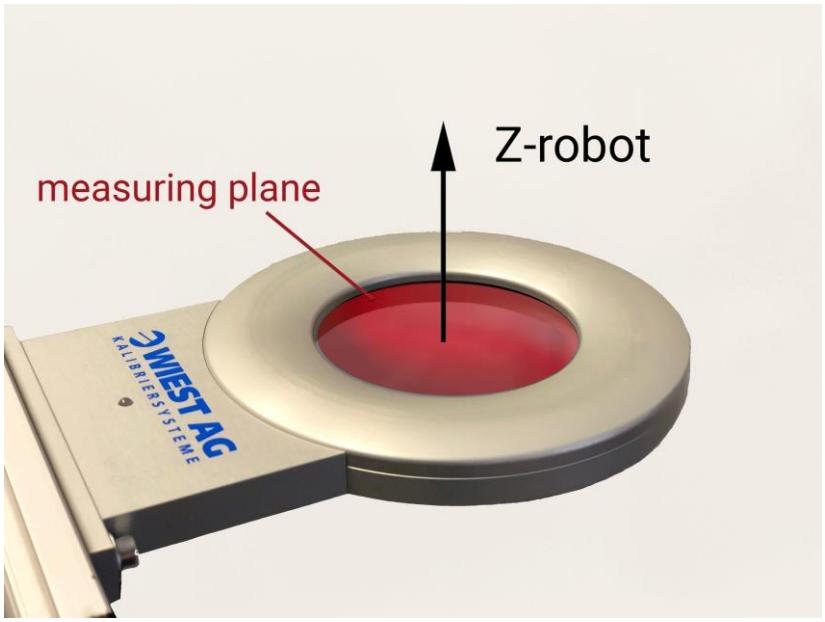


Figure 1: Measuring plane of RotoLAB

Important:

RotoLAB must be positioned in a way that the **measuring plane (Figure 1) of RotoLAB is in a 90° angle to Z+ of the robot coordinate system.** Otherwise RotoLAB will not work.

If the robot is installed on the floor, RotoLAB is fitted horizontally (in parallel to the floor).

RotoLAB is an optical measuring system. It is designed to be insensitive to the irradiation of extraneous light (e.g.: light from above does not have any effect). Make sure, that RotoLAB is installed in a way that strong lateral light (angle of incidence < 22° in relation to the measuring plane) is avoided, as this could result in a malfunction. The arc of light during welding does not constitute a source of interference as lateral light, however only interferences during the measuring cycle.

This means that with multi-robot environments care must be taken to ensure that none of the other robots is welding during a measurement.

Hint!

If lateral light irradiation cannot be avoided, for example because welding is still going on while a measurement is in progress, we offer an additional cover (item no.: 5 32 001 00) which can be used to shield the system from lateral light.

On the mount to which you wish to secure the RotoLAB, drill through-holes 140 mm apart, with a diameter of 6mm (Figure 2). Now secure RotoLAB to the mount by means of the flange.

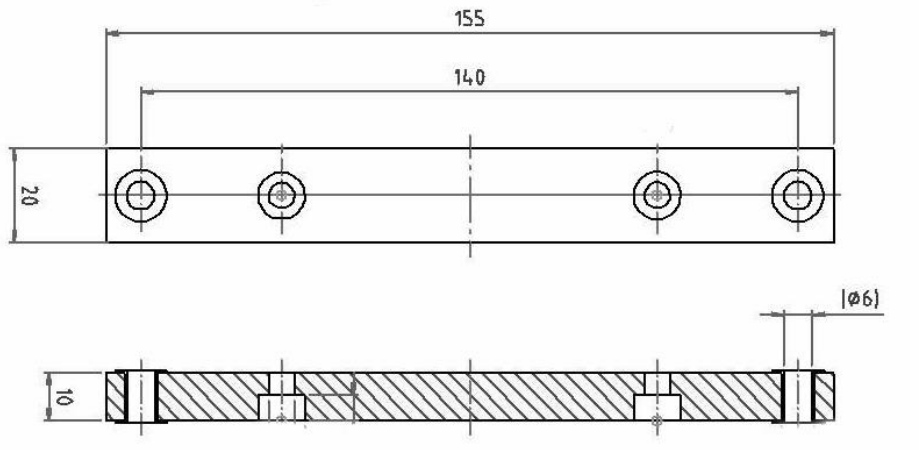


Figure 2: Flange

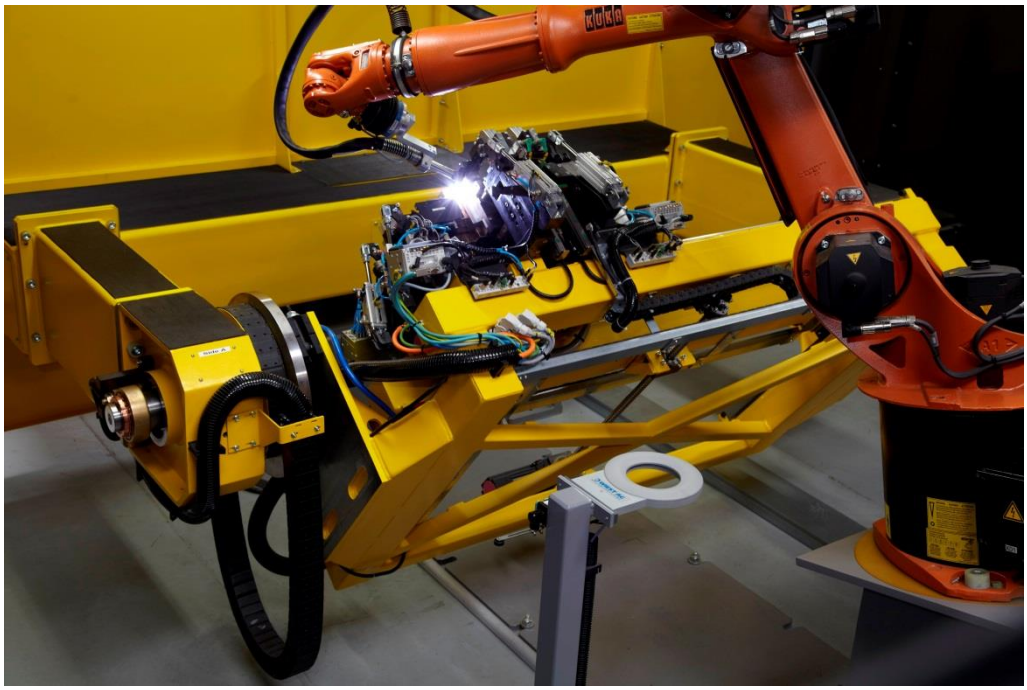


Figure 3: Example for a mounted RotoLAB

4. Electrical installation

4.1. Power supply

RotoLAB features a M12 A-coded flange connector for the power supply (see Figure 4). +24V are required.

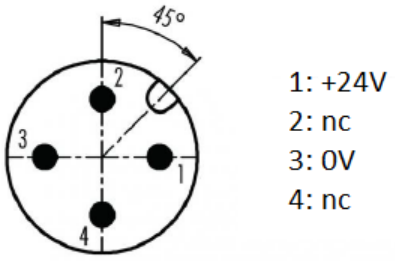


Figure 4: Pin assignment M12 flange connector

4.2. RS232

A RS232 data cable with Sub-D 9pin female to Sub-D 9pin male with 1:1 assignment is needed. Connect the data cable with COM1 port on the robot controller and the other end with the RS232 connector on the RotoLAB.

4.3. Ethernet

RotoLAB features a M12 D-coded flange socket (see Figure 5) for Ethernet connection. Either connect RotoLAB directly to the robot controller or via the local network.

Important:

The WAN Port of the robot controller must be used to connect the RotoLAB.

Signal	Name	PROFINET colors	Colors claimed EIA T568B	Pin RJ45	Pin M12
TD+	Transmission Data +	yellow	white/orange	1	1
TD-	Transmission Data -	orange	orange	2	3
RD+	Receive Data +	white	white/green	3	2
RD-	Receive Data -	blue	green	6	4

Table 1: Pin assignment for M12 d-coding and RJ45

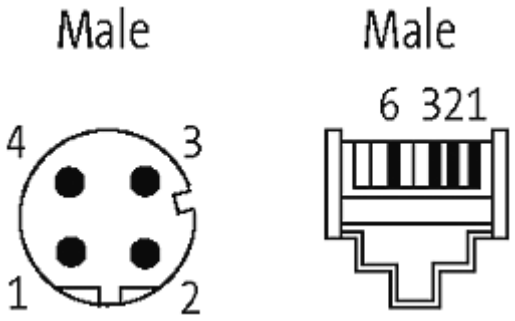


Figure 5: Flange socket M12 / RJ45

4.4. Fieldbus interface

4.4.1. Power supply

Power the protocol converter with +24V via the labelled input terminal.

4.4.2. Data cable

A RS232 data cable with Sub-D 9pin female to Sub-D 9pin male with 1:1 assignment is needed. Connect the data cable via gender changer with the protocol converter and the other end with the RS232 connector on the RotoLAB.

5. Software installation

5.1. Overview of the supplied files

Module	Description
RL_MainModule.sys	This module contains all routines and parameters for the RotoLAB.
RL_Text.sys	The message texts are included in this module.
RL_Com_Ser.sys	Module for the serial communication with RotoLAB.
RL_Com_Eth.sys	Module for the Ethernet communication with RotoLAB.
RL_Com_Bus.sys	Module for the Fieldbus communication with RotoLAB.
RL_User.sys	Example for the call of RL_MAIN with a tool and a subsequent evaluation of RL_ERROR_STATE. Individual event procedures at the beginning and ending of the measurement.

Table 2: Modules for RotoLAB

5.2. Robot program loading

Load the robot modules via “Module load” into the task. The modules are system modules permanently loaded in the controller.

Important:

Load only one module “RL_Com_...” depending on your used interface into the controller.

6. Language selection

For the RotoLAB application German and English language are available. In the RotoLAB main menu (see section 17.1) the language can be changed (variable „nRL_Language“).

7. Communication interface setup

Hint!

If RotoLAB is connected to the robot controller (see section 4) and the communication is set up, the connection to the RotoLAB can be checked by means of the function test (see section 20.1).

7.1. RS232 interface

Important:

In the delivery state no change of the settings must be done.

If there are any changes of the RS232 interface settings were done, the settings must be reset on the robot controller to the following values:

Baud rate = 9600

Data bits = 8

Parity = none

Stop bits = 1

Flow control = none

7.2. Ethernet interface

Important:

For this communication interface the software option “PC Interface“ is required.

7.2.1. RotoLAB network settings

RotoLABs default IP-address is 192.168.1.200 with subnet mask 255.255.255.0. Network settings can be changed via RotoLABs web-interface. In delivery state, the web-interface can be accessed at the address 192.168.1.200:8080 via any web browser. Make sure that the used computer is within the same IP-address range and subnet as the RotoLAB.

Important:

In delivery state the password to apply changes is “rotolab”. After making changes RotoLAB must be restarted by disconnecting the power supply.

7.2.2. Robot controller

The IP-Address of the RotoLAB and the port for the communication must be stored on the robot controller. In the Interface Settings Menu (see section 17.4) the parameter for the Ethernet communication can be adjusted under “RotoLAB interface” (variables “stRotoLAB_IP” and “nRotoLAB_Port”).

7.3. Fieldbus interface

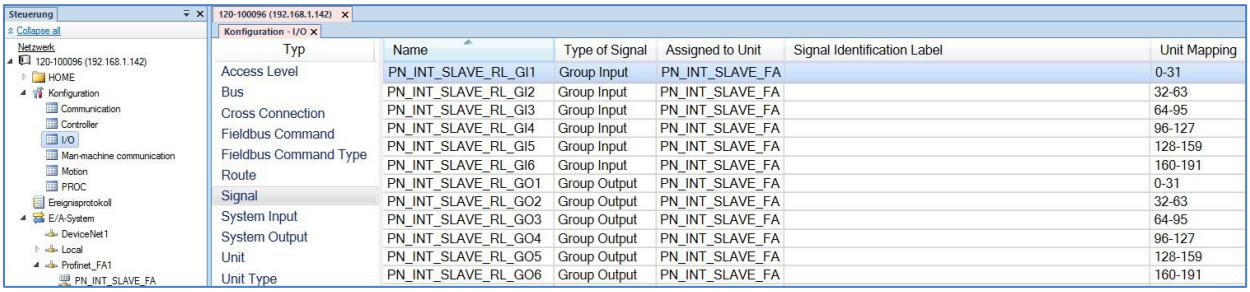
7.3.1. Protocol converter

The protocol converter must be integrated into the respective fieldbus. The device files can be found on the USB stick in the folder “Anybus”. For the communication between robot controller and protocol converter 24 input bytes and output bytes are necessary (robot controller ↔ fieldbus ↔ protocol converter).
The protocol converter will be delivered pre-configured. However, if changes must made (e.g.: change of IP-address), proceed as follows:

- Install the Configuration Manager (in folder “Anybus“)
- Connect the protocol converter with the PC via the delivered serial connecting cable.
- Establish a connection to the protocol converter and carry out a “Upload from communicator”. Alternatively, the .cfg files can be found in the folder “Anybus”.
- Modify the settings in the tab “fieldbus” and afterwards carry out a “Download to communicator”.

7.3.2. Robot controller

6 group inputs and 6 group outputs must be created in the I/O configuration on the robot controller. With a size of 32 bits or 4 bytes, in total this results in 24 input and output bytes.



Name	Type of Signal	Assigned to Unit	Signal Identification Label	Unit Mapping
PN_INT_SLAVE_RL_GI1	Group Input	PN_INT_SLAVE_FA		0-31
PN_INT_SLAVE_RL_GI2	Group Input	PN_INT_SLAVE_FA		32-63
PN_INT_SLAVE_RL_GI3	Group Input	PN_INT_SLAVE_FA		64-95
PN_INT_SLAVE_RL_GI4	Group Input	PN_INT_SLAVE_FA		96-127
PN_INT_SLAVE_RL_GI5	Group Input	PN_INT_SLAVE_FA		128-159
PN_INT_SLAVE_RL_GI6	Group Input	PN_INT_SLAVE_FA		160-191
PN_INT_SLAVE_RL_GO1	Group Output	PN_INT_SLAVE_FA		0-31
PN_INT_SLAVE_RL_GO2	Group Output	PN_INT_SLAVE_FA		32-63
PN_INT_SLAVE_RL_GO3	Group Output	PN_INT_SLAVE_FA		64-95
PN_INT_SLAVE_RL_GO4	Group Output	PN_INT_SLAVE_FA		96-127
PN_INT_SLAVE_RL_GO5	Group Output	PN_INT_SLAVE_FA		128-159
PN_INT_SLAVE_RL_GO6	Group Output	PN_INT_SLAVE_FA		160-191

Figure 6: Example I/O configuration

In the module RL_Com_Bus.sys, the names of the created group inputs and group outputs must be assigned to the corresponding string variables. The string variables are needed for the AliasIO connection. Replace <ID> with the names of the in- and outputs:

```
15  !################################
16  !*** Assign the signal names from I/O configuration to the strings ***!
17  !*** 6x 32Bit Group Inputs and Outputs are needed
18  !*** signalgo ***
19  LOCAL CONST string st_goRL_BYTE0_3   := "<ID>";
20  LOCAL CONST string st_goRL_BYTE4_7   := "<ID>";
21  LOCAL CONST string st_goRL_BYTE8_11  := "<ID>";
22  LOCAL CONST string st_goRL_BYTE12_15 := "<ID>";
23  LOCAL CONST string st_goRL_BYTE16_19 := "<ID>";
24  LOCAL CONST string st_goRL_BYTE20_23 := "<ID>";
25  !*** signalgi ***
26  LOCAL CONST string st_giRL_BYTE0_3   := "<ID>";
27  LOCAL CONST string st_giRL_BYTE4_7   := "<ID>";
28  LOCAL CONST string st_giRL_BYTE8_11  := "<ID>";
29  LOCAL CONST string st_giRL_BYTE12_15 := "<ID>";
30  LOCAL CONST string st_giRL_BYTE16_19 := "<ID>";
31  LOCAL CONST string st_giRL_BYTE20_23 := "<ID>";
32  !*****************************************************************!
```

Figure 7: Allocation RL_Com_Bus.sys

```
15  !################################
16  !*** Assign the signal names from I/O configuration to the strings ***!
17  !*** 6x 32Bit Group Inputs and Outputs are needed
18  !*** signalgo ***
19  LOCAL CONST string st_goRL_BYTE0_3   := "PN_INT_SLAVE_RL_GO1";
20  LOCAL CONST string st_goRL_BYTE4_7   := "PN_INT_SLAVE_RL_GO2";
21  LOCAL CONST string st_goRL_BYTE8_11  := "PN_INT_SLAVE_RL_GO3";
22  LOCAL CONST string st_goRL_BYTE12_15 := "PN_INT_SLAVE_RL_GO4";
23  LOCAL CONST string st_goRL_BYTE16_19 := "PN_INT_SLAVE_RL_GO5";
24  LOCAL CONST string st_goRL_BYTE20_23 := "PN_INT_SLAVE_RL_GO6";
25  !*** signalgi ***
26  LOCAL CONST string st_giRL_BYTE0_3   := "PN_INT_SLAVE_RL_GI1";
27  LOCAL CONST string st_giRL_BYTE4_7   := "PN_INT_SLAVE_RL_GI2";
28  LOCAL CONST string st_giRL_BYTE8_11  := "PN_INT_SLAVE_RL_GI3";
29  LOCAL CONST string st_giRL_BYTE12_15 := "PN_INT_SLAVE_RL_GI4";
30  LOCAL CONST string st_giRL_BYTE16_19 := "PN_INT_SLAVE_RL_GI5";
31  LOCAL CONST string st_giRL_BYTE20_23 := "PN_INT_SLAVE_RL_GI6";
32  !*****************************************************************!
```

Figure 8: Example RL_Com_Bus.sys

8. Naming convention

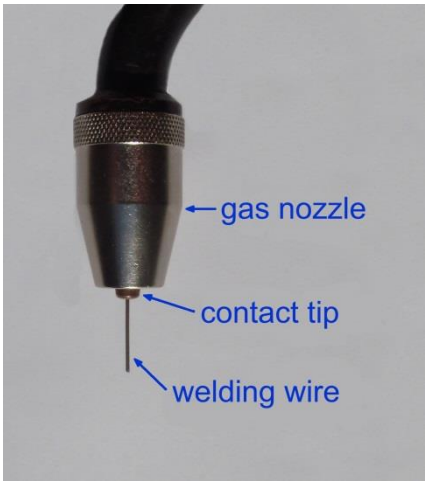


Figure 9: Naming conventions

Figure 9 gives the designations of the components of a welding torch as used in this documentation.

9. RotoLAB mode of operation

RotoLAB checks and calibrates robot tools to ensure a constant production quality. RotoLAB allows the compensation of TCP changes, however it does not initially determine TCP data.

During TCP alignment the geometric changes of the tool are recorded and the tool data is corrected accordingly.

All rotation-symmetric tools (and approximates) with a diameter of 0.8 mm to 50 mm can be measured.

RotoLAB is based on a two-step procedure for 3D measuring. A 2D coordinate measurement (X, Y) is performed and a 1D bisection procedure (Z). The measurement area of RotoLAB is 75 mm in diameter.

Due to the short duration of the test (minimum 4 sec), it is possible to continuously check the dimensional accuracy of the tool during production cycles.

If the defined threshold is exceeded, an automatic calibration is started (which takes approx. 30 sec).

Hint!

If a 2D correction (X, Y) for the tool is sufficient, the Z-correction can be disabled in the RotoLAB Settings (see section 17.3) under “Tool parameter“ (variable “bRL_DoZIter“). In addition, the duration of the test will be reduced.

9.1. Status LED

Status LED	Description
Green	RotoLAB is ready for operation.
Red	RotoLAB is busy, a measurement is being carried out.
Flashing red	Initialization of measuring sensors failed.

Table 3: Status LED states

9.2. Power-up – Initialization of the measuring sensor

Once RotoLAB is connected to the power supply it will start automatically and initializes the measuring sensors. This procedure takes about one minute and is indicated by the red operating LED. During initialization, the illumination brightness will be adjusted.

Important:

To allow proper initialization of the measuring sensors, the measuring area of RotoLAB must be clear at power-up.

Hint!

For optimal initialization of the measuring sensors, it makes sense to ensure that when RotoLAB is powered-up, the approx. same ambient brightness prevails as during regular operation.

Hint!

The measuring sensors only must be initialized once. Changes in the ambient conditions or aging of the lighting equipment are checked by RotoLAB continuously at each measurement and the illumination brightness is adjusted if necessary.

Once initialization has been successfully completed, the RotoLAB operating LED switches to green, indicating that RotoLAB is ready for operation.

If the initialization was unsuccessful, the operating LED flashes red. Check whether there is strong lateral light irradiation (see section 3), or whether the measuring area was not clear at initialization. Disconnect RotoLAB from the power supply and reconnect it. For troubleshooting see also section 19.

10. Initial setup

In delivery state, RotoLAB is configured for a standard welding torch (see section 13). If a standard welding torch is used, no configuration of geometric parameters is required, and the default parameters can be used. Where unsure, see sections on geometric configuration (section 14) to check whether the default parameters are suitable. The parameter can be adjusted in the RotoLAB Settings in the RotoLAB Menu (see section 17.3) under “Tool parameter“.

10.1. Start of measuring program

You find the example program “RL_Example” (see Figure 10) in the module RL_User.sys. The main program “RL_Main” is called with the used tool which will calibrated: “RL_Main Toolname;”. Replace *<ID>* with the used tool. After the call of RL_Main the RotoLAB Main Menu (see Figure 11) is displayed. The full RotoLAB Menu is described in section 17.

Hint!

Rename the example program RL_Example() to the respective tool name (e.g.: RL_tWelding) or copy the example program.

Important:

Occurs the error message “No available ToolID found!” after calling RL_Main, all 16 tools are occupied. If not all 16 Tools are needed, you can release the unused tools. For this, delete the unused tools in the string array “stRL_Toolnames{16}”. The double quotes must be thereby not deleted: stRL_Toolnames{16} := ["tExample", … → stRL_Toolnames{16} := ["", …

```
PROC RL_Example()

    !*****************************************
    !* Fuegen Sie hier ggf Zwischenpunkte ein *
    !* Where necessary, insert waypoints here *
    !*****************************************

  !ROTOLAB FUNCTION CALL:
  !RL_Main(Toolname);

    RL_Main <ID>;
```

Figure 10: Call of RL_Main in RL_Example()

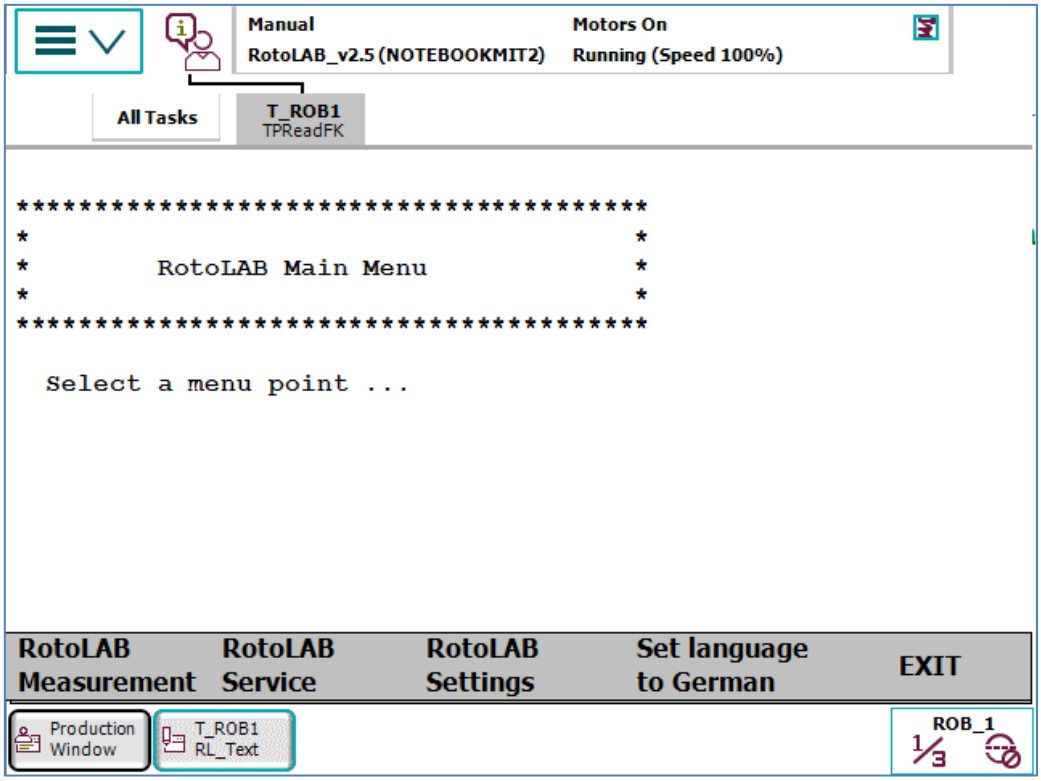


Figure 11: RotoLAB Main Menu

10.2. Teach-in of start positions

Important:

Teach-in the start positions only after a call of RL_Main how described under 10.1! The Points must be teached-in with the Tool tRL_ActTool!

You have to select in the RotoLAB Main Menu “RotoLAB Measurement” to get to the start positions. If the tool is not yet measured, the program stops respectively on the automatic allocated positions pPrepos and pNominal (see Figure 12). You can set the stop again in the Service Menu (see section 17.2).

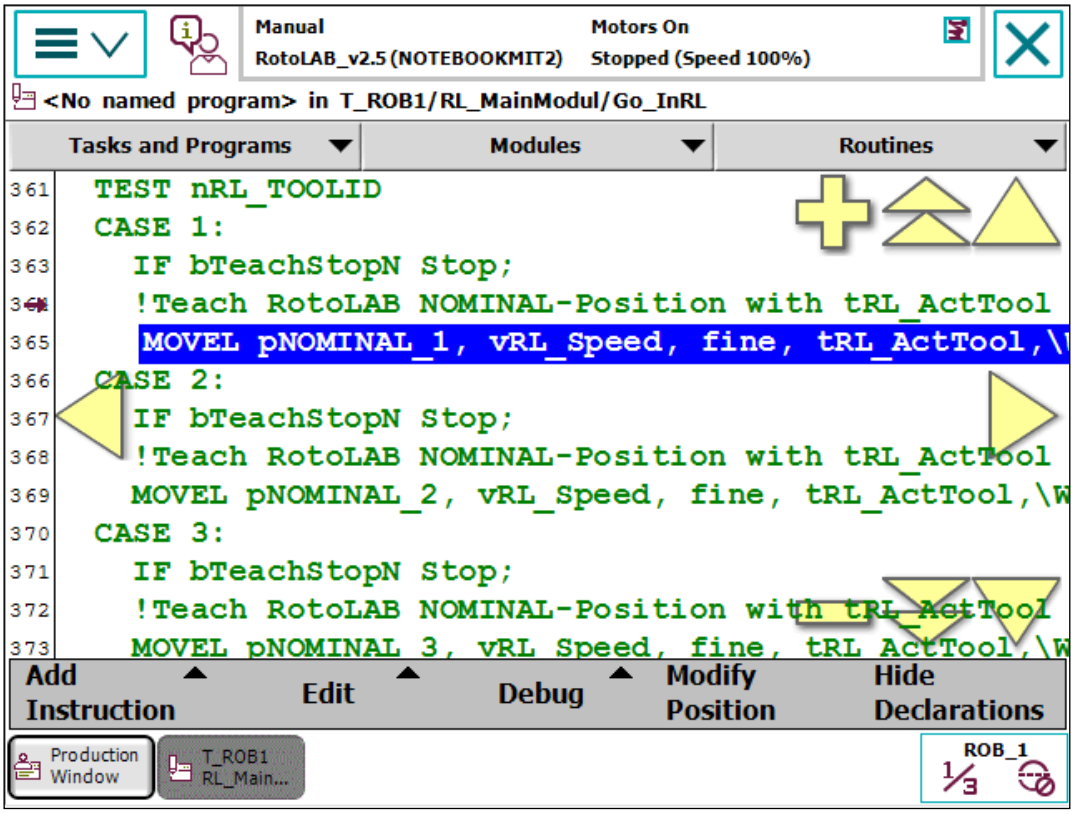


Figure 12: RotoLAB start positions

10.2.1. Position pNominal

At point pNOMINAL teach-in a start position for measuring with RotoLAB. For the used robot tool, choose a point where the tool is vertical and close to the center of the measuring plane of RotoLAB (see Figure 13).

Hint!

The central position of the tool is determined precisely when the tool is calibrated, so the taught position only needs to be approximately correct.

Important:

Absolutely use the position pNOMINAL where the program stops (e.g.: pNOMINAL_1)!

Figure 13: Position pNOMINAL

In Figure 13 the welding torch is shown without the gas nozzle, as it must be removed for the measurement of the RotoLAB location. The robot tool should be lowered a few centimeters into the measuring plane for the measurement of the RotoLAB location.

10.2.2. Position pPREPOS

The position pPREPOS is a preposition above the RotoLAB. This is the start and end position of each measurement.
Teach-in the point pPREPOS for the used tool, so that the robot tool is above the measuring plane of RotoLAB (see Figure 14).

Important:

Absolutely use the position pPREPOS where the program stops (e.g.: pPREPOS_1)!

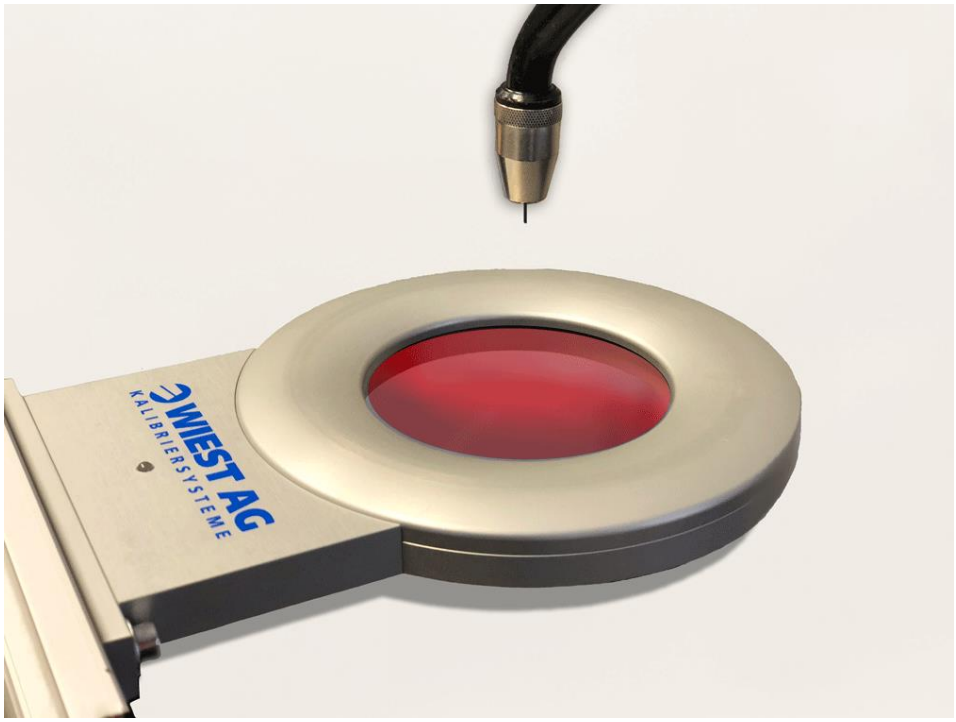


Figure 14: Position pPREPOS

Hint!

If multiple tools are used, the sections 10.2.1 and 10.2.2 must be repeated for each tool.

10.3. Measuring the RotoLAB location

Important:

Changes to the location of the RotoLAB in relation to the robot or if the RotoLAB was replaced, the location must be new measured. The location can be reset in the RotoLAB Settings (see section 17.3) under “New measurement of RL or Tool”.
Subsequently run “RotoLAB Measurement“.
If the location is reset, all tools must be re-measured (see section 10.4).

Select the menu item “RotoLAB Measurement” in the RotoLAB Main Menu (see Figure 11) to start the location measurement. If the location is already measured, this step will be skipped automatically. The location for each robot must be measured once.
A message will prompt to remove the gas nozzle. Remove it, if not already done and confirm with OK.

Hint!

For the location measuring also a rotationally symmetrical aid (e.g.: a pen) with a diameter > 4 mm can be fixed on the tool.

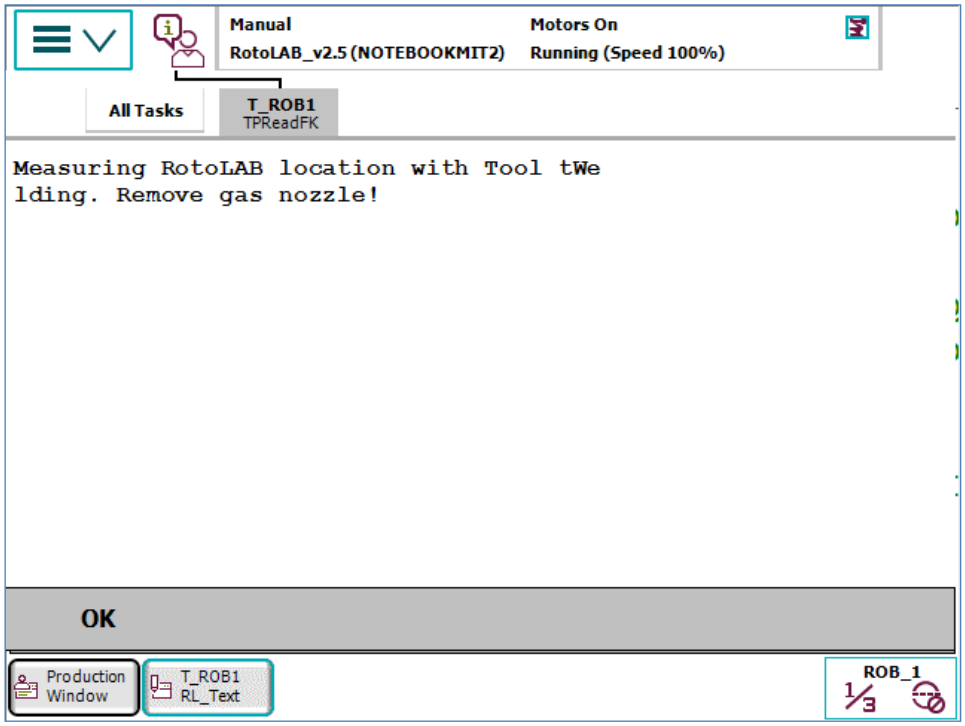


Figure 15: Start of location measuring

RotoLAB now fully automatically begins to measure the location. It moves in a star-shaped pattern.

Once the measuring procedure is completed, a message is displayed to remount the gas nozzle.

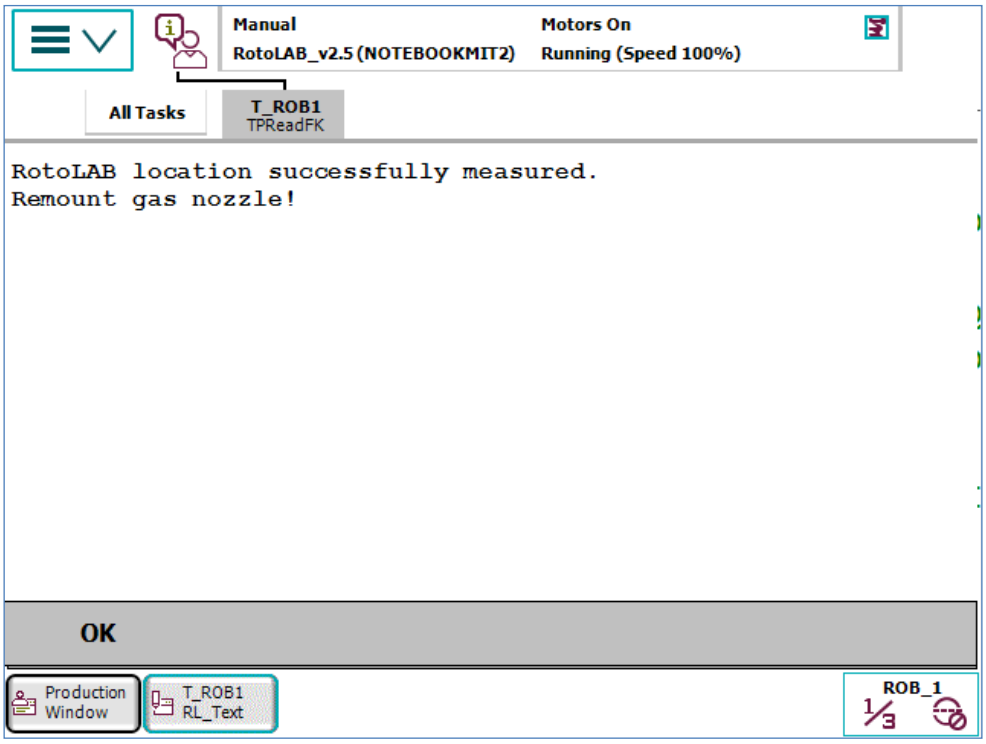


Figure 16: Location measuring successfully completed

After acknowledgment of the message, tool measurement is immediately (see section 10.4).

Hint!

For troubleshooting see section 20.

10.4. Initial measurement of a tool

The initial measurement of a tool starts immediately after the location measurement. In case the location is already measured, or a new tool should be initial measured (see section 10.5) the measurement starts after the selection of “RotoLAB Measurement” in the RotoLAB Main Menu.

Hint!

If a new initial measurement of a tool should be carried out, the tool must be reset in the RotoLAB Settings (see section 17.3) under “New measurement of RL or Tool”. Subsequently run “RotoLAB Measurement” in the RotoLAB Main Menu.

The measurement of the robot tool is carried out fully automatic. Messages will inform about the individual process steps.

When the initial measurement is completed, a message is displayed (see Figure 17).

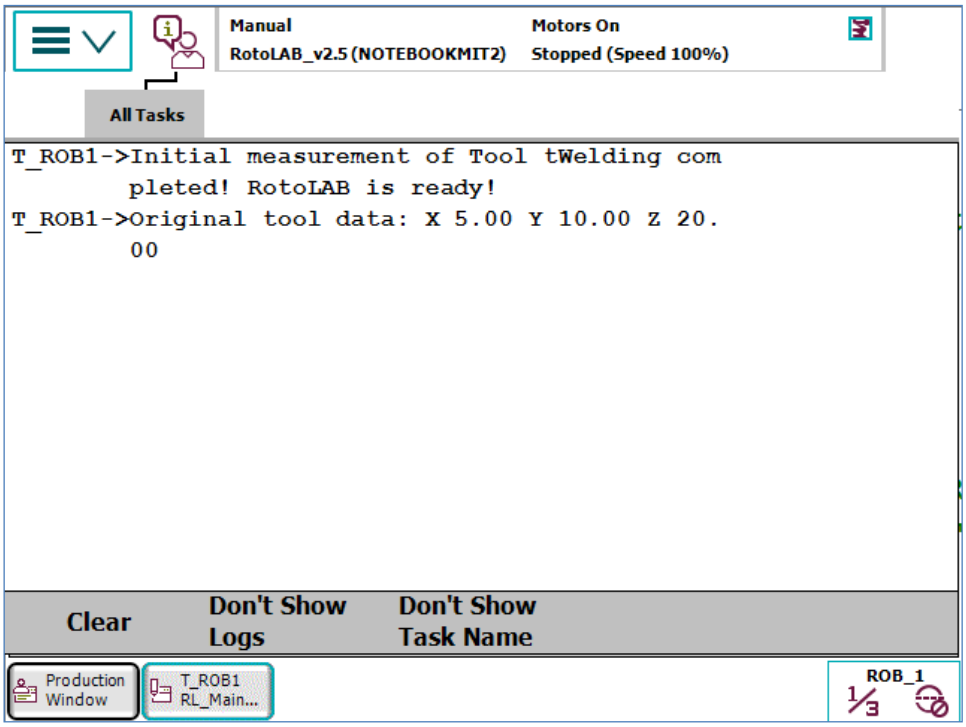


Figure 17: Message on completion of initial measurement

To ensure that the tool was correctly initially measured, a tool test is carried out subsequently. On success the RotoLAB is ready for operation.

Important:

If the geometric parameters are changed (see section 13), a new initial measurement of the tool is required! Otherwise, a correct calibration of the tool cannot be ensured.

Hint!

For troubleshooting see section 20.

10.5. Measuring additional tools

RotoLAB can measure up to 16 tools. For a new tool start again with the initial setup (see section 10). If the RotoLAB location is already measured, the step 10.3 will be skipped automatically.

Hint!

Duplicate the example program RL_Example for the new tool and adjust the transfer parameter (see section 10.1) accordingly. By this the error evaluation (see section 12.3) is already implemented in the new program.

10.6. Using additional robots

RotoLAB can be used with up to four robots (with up to 16 tools each). For a new robot start with initial setup (see section 10) again.

Important:

Every robot needs an individual “RL_RobID“ for registration with RotoLAB. This variable can be adjusted in the Interface Settings (see section 17.4) under “RotoLAB Interface“ (variable “nRL_RobID“).

Hint!

Between the location measurements of several robots, the RotoLAB must be restarted.

10.6.1. RS232 interface

A maximum of two robot controllers can be connected with one RotoLAB via RS232. A RotoLAB with two serial interfaces is required (item no.: 531 002 02).

10.6.2. Ethernet interface

Up to four robot controllers can be connected with the RotoLAB via network. The robot controllers must be in the same network as the RotoLAB.

11. RotoLAB integration into the production process

If the initial setup for the desired tool has been successfully completed, the RotoLAB measure routine can be integrated into the production process.

11.1. Call of the RotoLAB program

The RotoLAB program (e.g.: RL_Example) can be called at any point in the production process. Approach and drive off points can be taught in RL_Example.
As an alternative RL_MAIN can be called directly with one transfer parameters (see section 10.1). For this option, the error evaluation (see section 12.3) must be complemented.

11.2. Test in automatic operation

In automatic operation the standard test is performed immediately including a possible correction of the tool. The RotoLAB menu is disabled.

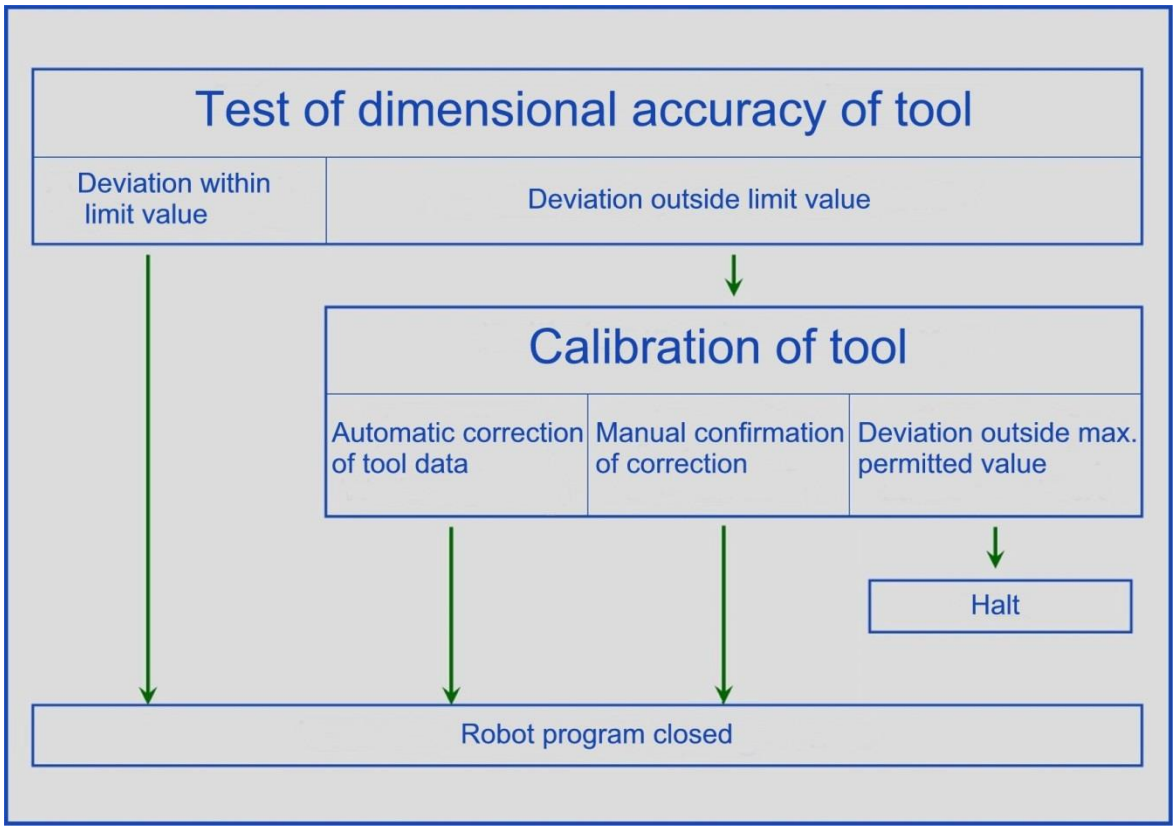


Figure 18: Schematic diagram of standard test

11.3. Test in manual operation

If RL_MAIN is called in manual operation, the RotoLAB menu is (see section 17). Select “RotoLAB Measurement“. Choose between a control measurement and a standard test:

- Control measurement: The deviation of the tool is determined and displayed on the end of the measurement. No adjustment of the tool data is performed.
- Standard test: Test with possible correction of the tool data (see Figure 18).

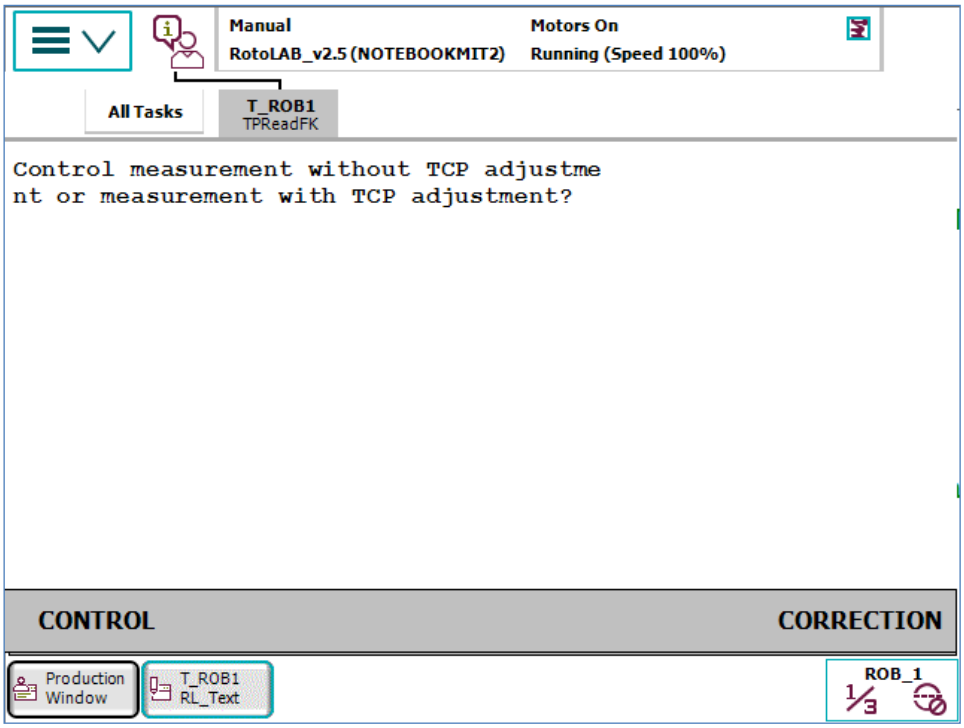


Figure 19: Selection options in manual operation

12. Individual event procedures

RotoLAB gives you the option of performing individual actions at the start and at the end of the test. Furthermore the variable “nRL_ERROR_STATE“ can be evaluated after the end of the measurement program.

12.1. Routine RL_ON_START

The routine RL_ON_START is in the module RL_User.sys. This routine is run at the start of the measuring procedure. At this particular time the robot is on the pre-position.

For measurement of welding torches with the default geometric parameters (see section 13), the welding wire must be of a sufficient length.

To ensure this, a wire feed can be executed in this routine.

Proceed as follows:

- Select the module RL_User.sys and insert in the routine RL_ON_START the desired action.

Important:

Afterward remove the “stop” command. Otherwise, the robot stops there on every call.

12.2. Routine RL_ON_END

The routine RL_ON_END is also in the module RL_User.sys. This routine is run at the end of the measuring procedure. The robot is standing in the RotoLAB measuring system and then moves to the pre-position.

A possible wire feed issued during RL_ON_START can be reversed here.

Proceed as follows:

- Select the module RL_User.sys and insert in the routine RL_ON_END the desired action.

Important:

Afterward remove the “stop” command. Otherwise, the robot stops there on every call.

12.3. Variable RL_ERROR_STATE

Different values depending on the measure result or measure error (see Table 4) are assigned to the variable “nRL_ERROR_STATE”. The variable is evaluated in the example program “RL_Example” after the call of “RL_Main”.

Value	Description	Predefined instruction in the program RL_R1T1.TP
0	Measurement successfully completed (including possible correction).	RL_Example will be closed
1	Deviation is in manual correction range. Tool has not been corrected (only possible in manual operation).	RL_Example will be closed
2	Deviation is outside the absolute tolerance. No correction of the tool data allowed.	1. Comments: „Repair the Tool now“ „Insert Service Position“ 2. Stop 3. RL_Main will be called again
3	No object detected. There is no object in the measuring plane.	1. Comments: „Check Welding Wire“ „Insert Service Position“ 2. Stop 3. RL_Main will be called again
4	X-Y-measurement does not converge.	1. Comments: „Insert Error Handling“ 2. RL_Example will be closed → Troubleshooting see section 20
5	Maximum of the Z-value-changing achieved. The tool moves too deep into the RotoLAB.	1. Comments: „Repair the Tool now“ „Insert Service Position“ 2. Stop 3. RL_Main will be called again
6	Communication error with the RotoLAB.	RL_Example will be closed → Troubleshooting see section 20
7	RotoLAB error. Measurement cannot be performed.	RL_Example will be closed → Troubleshooting see section 20

Table 4: Variable nRL_ERROR_STATE

13. Geometric configuration – TCP alignment

RotoLAB is a measuring system that can be flexibly used for testing and correcting changes of robot tools.

In delivery state the geometric parameters are configured for a standard welding torch, as shown Figure 20.

Important:

If you change the geometric configuration, an initial measurement of the tool (see section 10.4) is required.

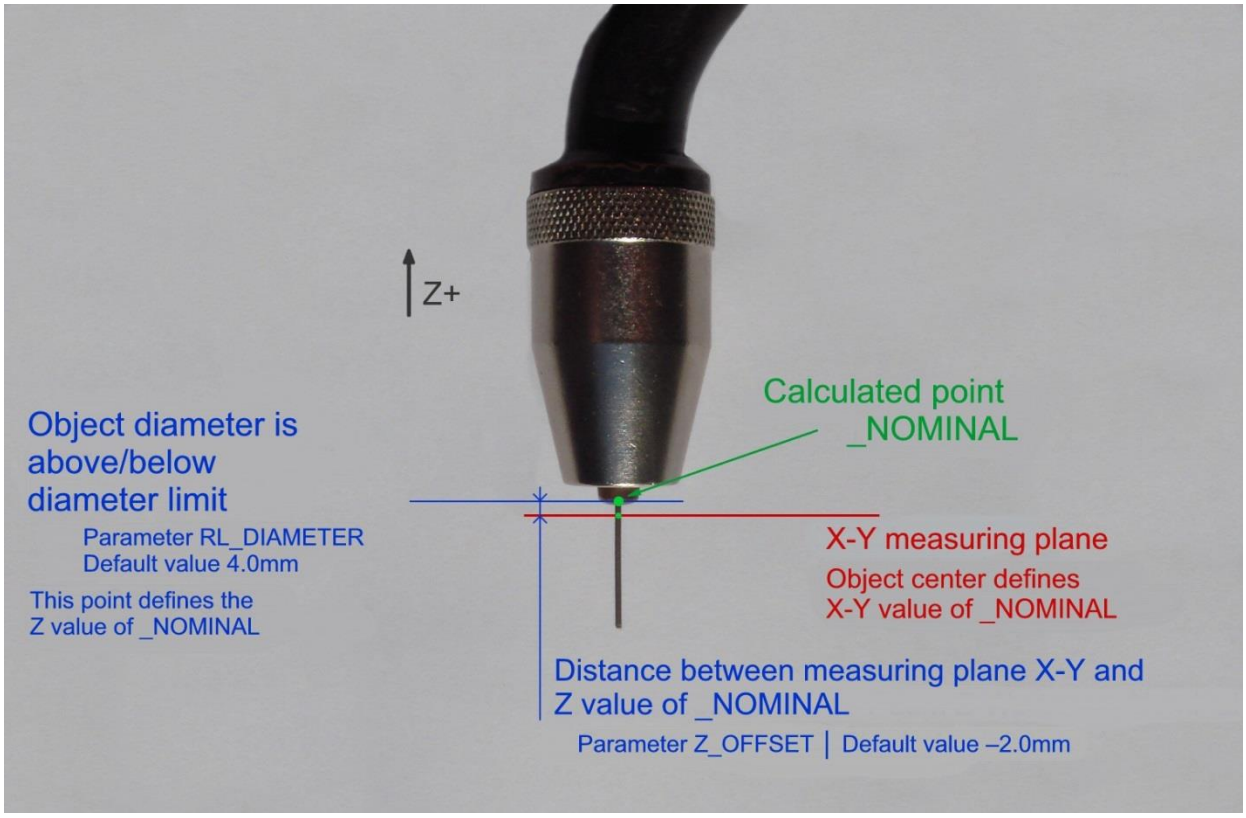


Figure 20: Measuring parameters for TCP alignment

Figure 20 shows the parameters relevant to TCP alignment with their delivery state configuration.

Hint!

The coordinate directions always refer to the RotoLAB coordinate system, so Z+ is not necessarily identical to the Z component of the tool coordinate system. The reference to the tool is established via the orientation of RotoLAB in relation to the Z component of the robot coordinate system (see section 3).

The point _NOMINAL is the reference point by which the geometry of the welding torch is memorized.

13.1. Parameter RL_DIAMETER

Hint!

The parameter RL_DIAMETER can be adjusted in the RotoLAB Settings (see section 17.3) under “Tool parameter“ (variable “nRL_Diameter“).

Important:

If the variable “nRL_Diameter“ will be changed directly (not via RotoLAB Settings), the parameter RL_DIAMETER must be transferred to the RotoLAB. To do this, select the item “Send RL_DIAMETER to RotoLAB” in the RotoLAB Service Menu (see section 17.2). Only the RL_DIAMETER of the current used tool is transferred.

RotoLAB allows a calibration to be performed on any point of a tool that shows a profile change. This is done by detecting the change of the diameter. The Z component (RotoLAB coordinate system) of the point on which the calibration is to be based on, is defined by means of its diameter.
The maximum diameter is 35 mm.
The parameter RL_DIAMETER is set to 4 mm in delivery state, so that calibration can be performed on the lower end of the contact tip. If this value does not match the given welding torch geometric, this parameter is to be adjusted accordingly.
If the parameter is set to 0 mm, the calibration is based on the end of the tool. E.g.: the end of the wire on a welding torch or the welding cap tip on a spot-welding gun.

13.2. Parameter RL_Z_OFFSET

Hint!

The parameter RL_Z_OFFSET can be adjusted in the RotoLAB Settings (see section 17.3) under “Tool parameter“ (variable “nRL_Z_Offset“).

With RotoLAB the recording of the Z component can be separated from the calculation of the X-Y component and offset by a specific value (along the Z component of the RotoLAB coordinate system, which corresponds to the Z component of the robot coordinate system).

You can modify this parameter as required and thus shift the X-Y measuring plane in relation to the reference point _NOMINAL in the Z-direction.

Important:

In the default configuration the X-Y measuring is executed at the welding wire (see Figure 20). Therefore, the welding wire must have a sufficient length before the program starts. Otherwise, no object can be detected.

A wire feed can be executed in RL_ON_START, which is called before the start of measuring (see section 12.1 Routine RL_ON_START). The wire can be retracted again in RL_ON_END, which is called when the program terminates (see section 12.2 Routine RL_ON_END).

Advantages of RL_Z_OFFSET -2.0mm (delivery state):

- The feed-in of the contact tip is detected and compensated, as the X, Y position of the wire is measured and not the contact tip.
- Any soiling of the contact tip will not result in a distortion of the measurement result.
- If a contact tip does not allow a wire feed (e.g.: if the contact tip is clogged with waste matter), it will output an error message (see section 20)

When must RL_Z_OFFSET be modified?

The value RL_Z_OFFSET can be modified according to the specific requirements of the tool. E.g.: if the value is set to 0 mm, the measurement of the X-Y value of _NOMINAL takes place in the same plane as the Z component of _NOMINAL.
If the end (e.g.: cap tip) of a tool is to be detected (parameter RL_DIAMETER=0) as it is the case with the measurement of spot-welding guns, the parameter RL_Z_OFFSET must be modified. In this case set the parameter to a positive value (e.g.: to 1.0 mm). This means the measurement of the X-Y value takes place 1 mm above the measured point _NOMINAL.

.

14. Geometric Configuration – Typical Settings

14.1. Stand application welding torch

By default, the position of the welding wire is checked 2 mm below the contact tip. For the measurement of the z-component a position is required where a strong diameter change occurs. A common choice is the transition between contact tip and welding wire. The actual measuring point on the wire is located 2 mm below the level where the diameter falls below RL_Diameter. On this level the x/y-measurement is carried out. The default settings are shown in Figure 21.

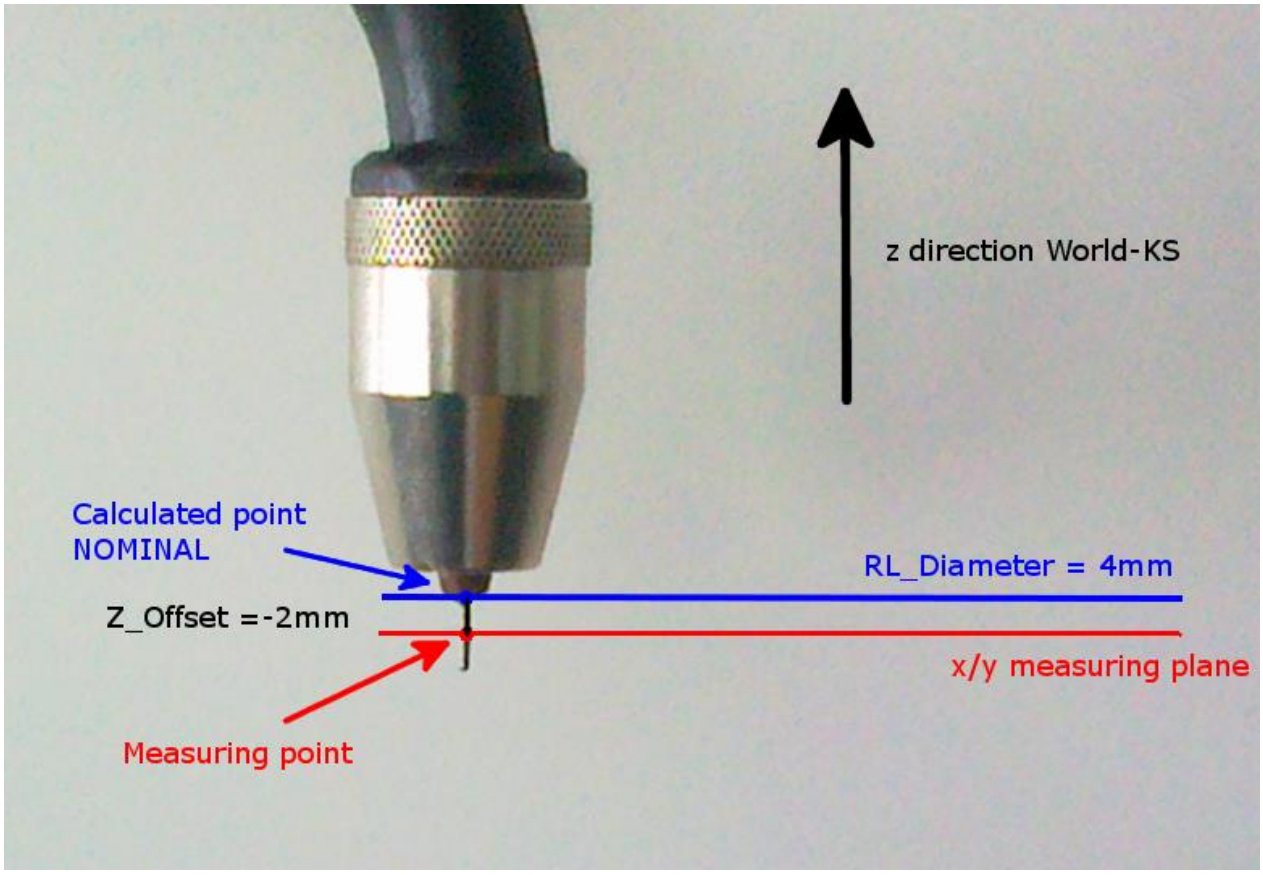


Figure 21: Standard settings

14.2. Alternative measuring position welding torch

If the contact tip is frequently polluted, e.g.: by soot or liquid drops still the same measuring point can be used. In this case the measurement is carried out at a position where the diameter of the gas nozzle tapers down. RL_Z_OFFSET must be adjusted accordingly. The exact values depend on the geometry of the gas nozzle and the location of the contact tip. An example of possible settings is shown in Figure 22.

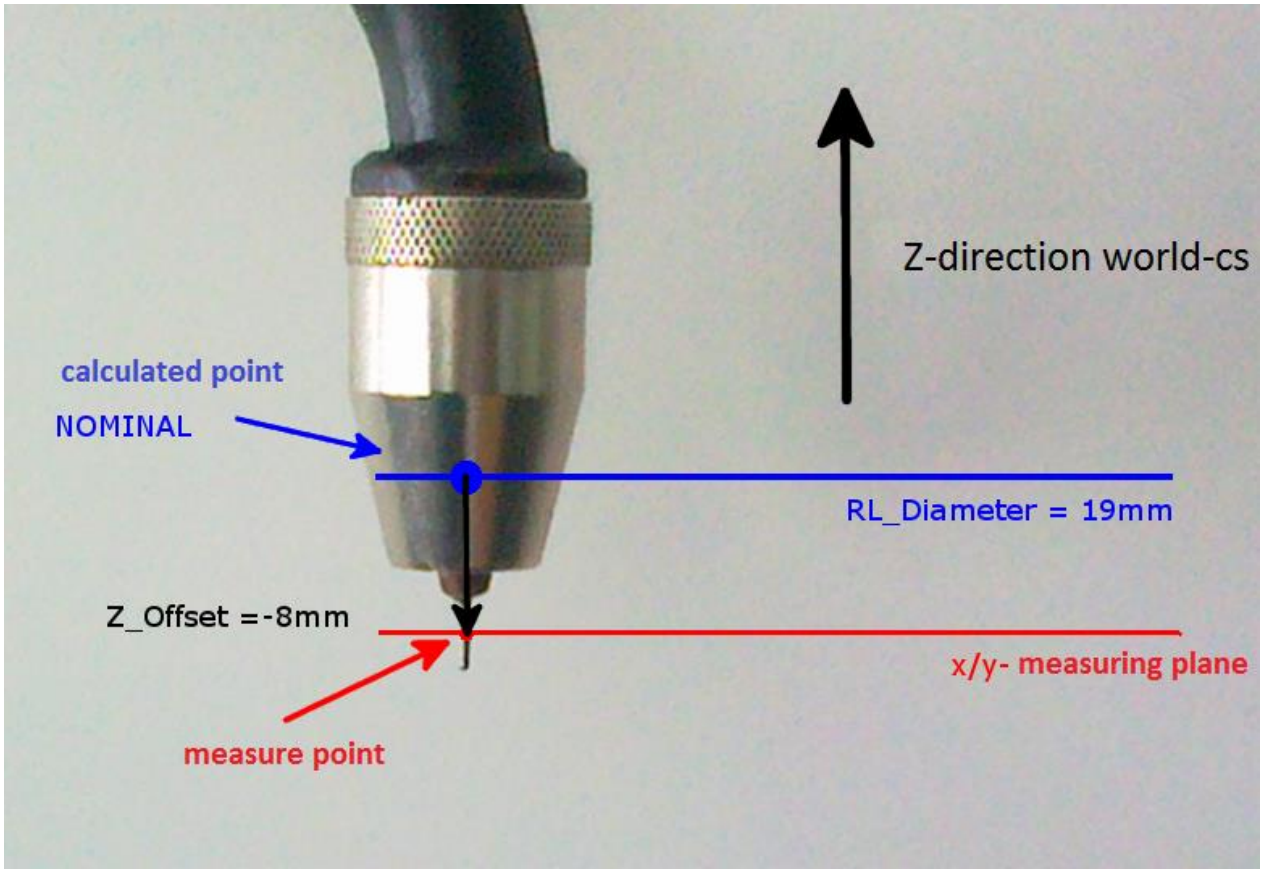


Figure 22: Alternative settings for welding torches

14.3. Spot welding guns, gluing nozzles

Other tools like nozzles for gluing and sealing are checked directly at the tip of the tool. Therefore RL_DIAMETER is set to 0 mm. The X/Y-measurement is carried out 1 mm above this level. In Figure 23 the tip of the spire is being controlled.

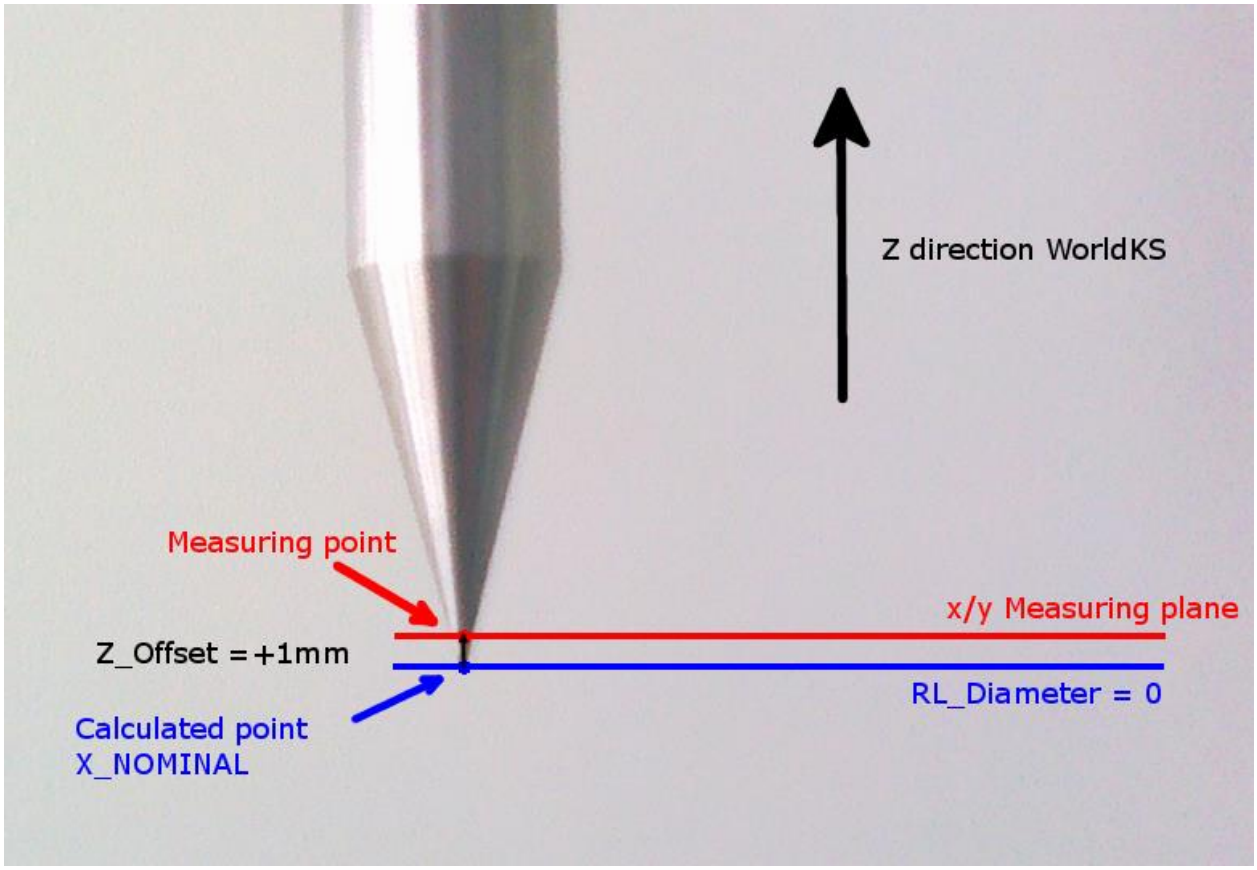


Figure 23: Settings for gluing nozzles

A list of typical parameter combinations is shown in Table 5.

	Welding gun (standard)	Spot welding gun, Gluing nozzle	Welding gun (alternative setting) (see above)
RL_DIAMETER in mm	4	0	approx. 19
RL_Z_OFFSET in mm	-2	1	approx. -8

Table 5: Typical settings

15. Configuration of thresholds

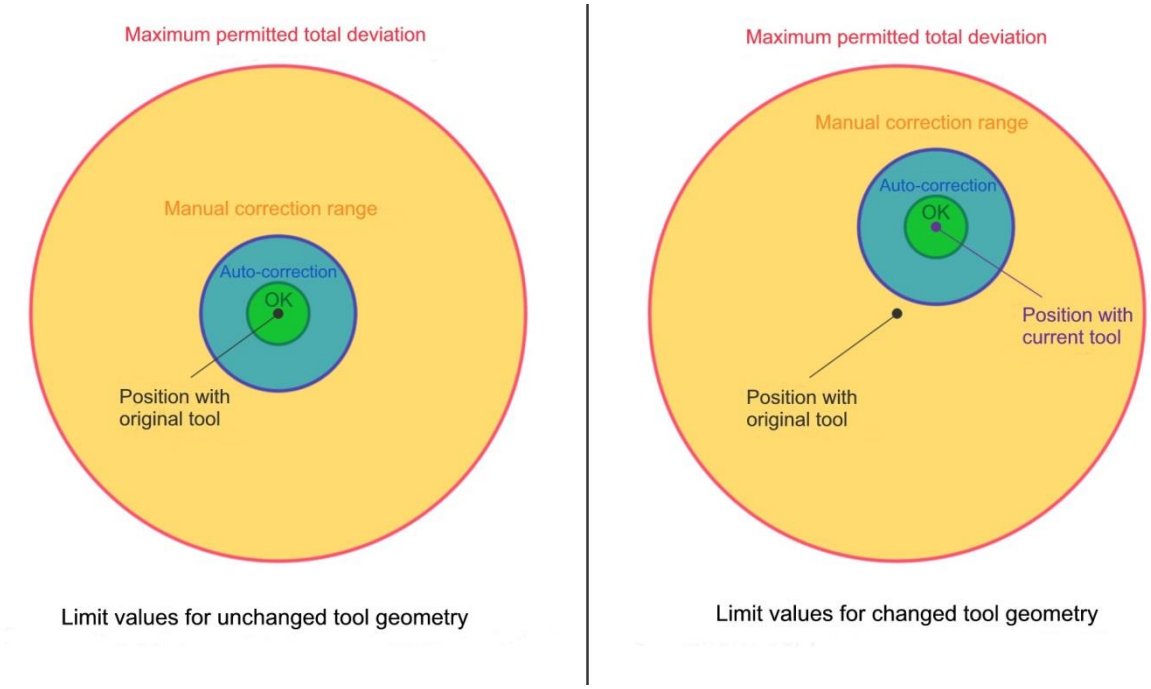


Figure 24: Threshold values for tool measurement

Hint!

The thresholds can be watched and adjusted in the RotoLAB Settings (see section 17.3) under "Thresholds for correction" (variables "nRL_REL_OK", "nRL_REL_AUTO" and "nRL_ABS_MAX").

The figure shows only two dimensions. The thresholds apply to all three dimensions, however (the circles therefore should be regarded as spheres). The third dimension was not included in order to make the illustration clearer.

Designation	Description
RL_REL_OK	Upper threshold of the OK range (reference: current tool)
RL_REL_AUTO	Upper threshold of the automatic correction range (reference: current tool)
RL_ABS_MAX	Maximum total deviation of the current tool data regarding the original tool data (reference: original tool)

Table 6: Threshold values (all threshold values are absolute values)

15.1. OK range

Mathematical definition: [0, RL_REL_OK [

This range is defined by the threshold “RL_REL_OK”. It constitutes the upper limit of the range within the tool deviation is considered OK and no correction is performed.

15.2. Automatic correction range

Mathematical definition: [RL_REL_OK, RL_REL_AUTO [

This range is defined by the threshold “RL_REL_OK” and “RL_REL_AUTO”. If the tool deviation is in this range, an automatic correction of the tool data is performed without any user interaction.

Hint!

If an automatic correction is not required, it is possible to simply disable this range. In this case, set the value of RL_REL_AUTO equal to that of RL_REL_OK.

.

15.3. Manual correction range

Mathematical definition: [RL_REL_ AUTO, ∞ [without [RL_ABS_MAX, ∞ [

This range is defined on the one hand by the threshold RL_REL_AUTO, which refers to the currently measured deviation.
On the other hand, the threshold RL_ABS_MAX (this refers to the absolute deviation in relation to the original tool) constitutes the upper limit to the permitted correctable deviation.

If the deviation is within this range the user is prompted to confirm the correction of the tool data (see Figure 25). If the user confirms with “Yes”, the tool data will be updated. If the user rejects the correction, the tool data will not be changed.

Hint!

In practice a manual correction range is rarely needed. RotoLAB can be configured so that a manual correction is deactivated. In this case, set the value of RL_REL_AUTO to twice the value of RL_ABS_MAX. This results in the tool data being corrected automatically as long as the absolute tool change (deviation in relation to original tool) is not exceeded.

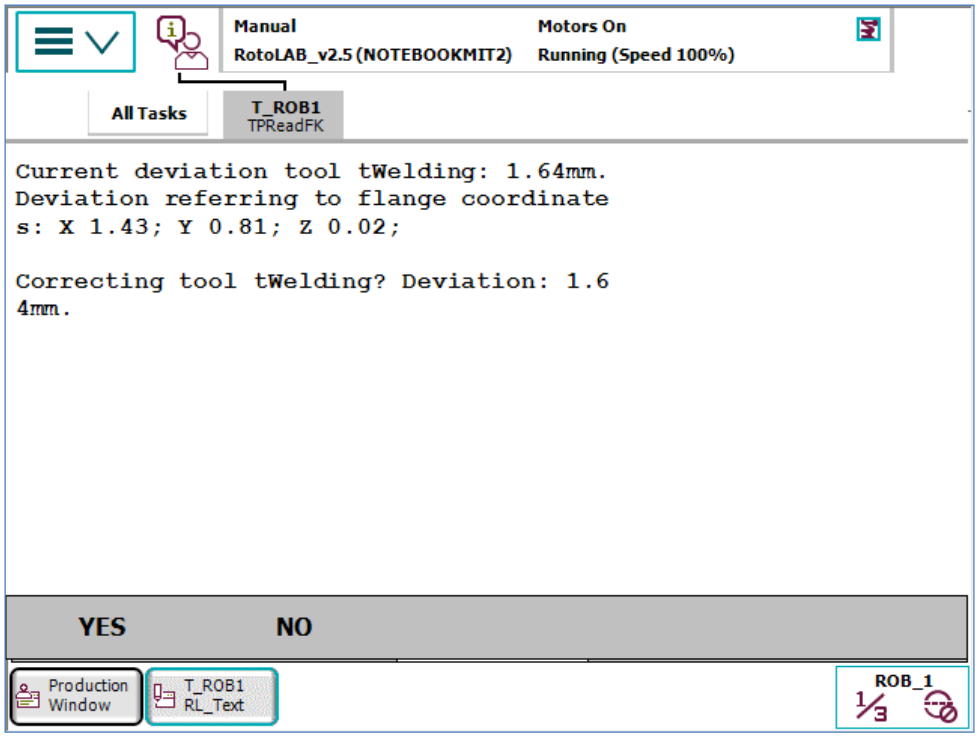


Figure 25: Deviation within the manual correction range

If the PLC interface is configured (see section 16), this dialog can also be answered via the PLC. Subsequent the RotoLAB program is continued.

15.4. No correction allowed

Mathematical definition: [RL_ABS_MAX, ∞ [

In this range no correction is carried out. Production is not allowed to continue, the robot is stopped. The tool must be replaced or repaired.

Hint!

The event procedure after this error message can be customized individually (see section 12.3).

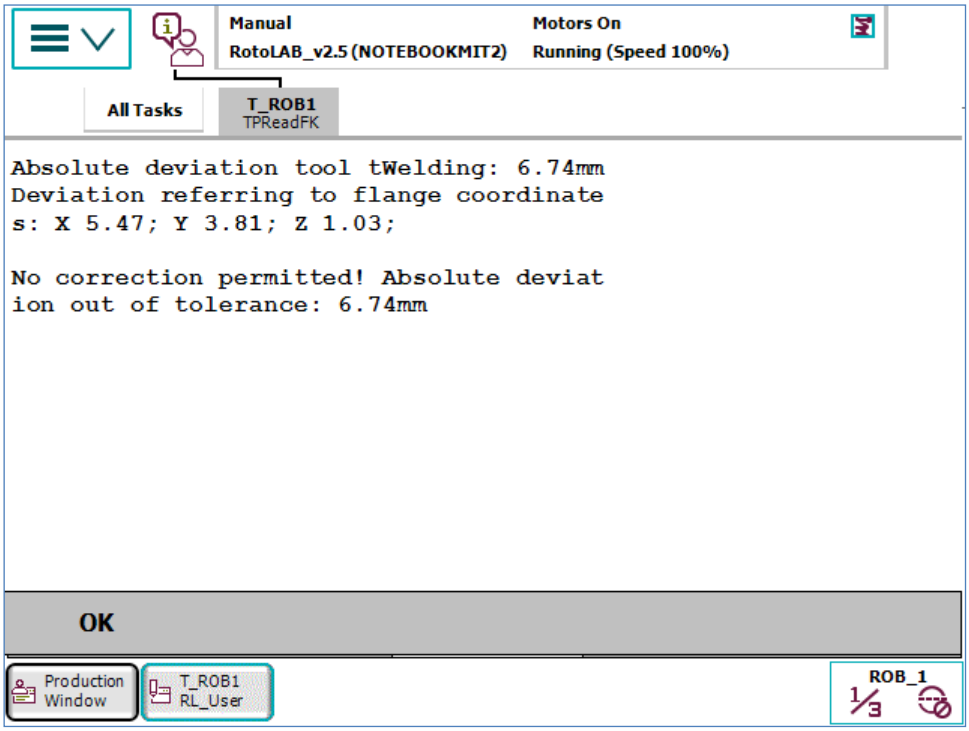


Figure 26: Error message absolute deviation too great

If the PLC interface is configured (see section 16), this dialog can also be answered via the PLC. Following this error message, a new measuring will be started in delivery state.

16. RotoLAB PLC interface configuration

All messages requiring acknowledgment can be forwarded to the PLC by means of three digital outputs. The messages will be acknowledged with two digital inputs and, if necessary, answered with yes or no.
To use the PLC interface, this has to be enabled in the Interface Settings (see section 17.4) under “PLC Interface“ (variable “bRL_USE_PLC“). In delivery state the plc interface is disabled.

16.1. Signal RL_PLC_RETURNVAL

The output signal “RL_PLC_RETURNVAL“ [bit2, bit1, bit0] consists of three binary coded output signals. Messages requiring acknowledgement which result in a stop of the robot, are hereby forwarded to the PLC.

Value	Description	Dialog at the PLC
0	Measurement OK	-
1	Deviation in the manual correction range	Deviation in the manual correction range. Should a correction of the tool data be carried out? (yes/no)
2	Deviation outside absolute tolerance	Deviation outside absolute tolerance. No correction allowed! Check the tool. (quit)
3	No object detected	No object in the measuring plane detected. Check tool and welding wire. (quit)
4	X-Y measurement does not converge	Resolve error, restart measurement (Troubleshooting see section 20)
5	Maximum change of Z-value achieved.	Change of Z-value too great. Check tool. (quit)
6	Communication error with the RotoLAB	Resolve error, restart measurement (Troubleshooting see section 20)
7	RotoLAB error, measuring cannot be performed	Resolve error, restart measurement (Troubleshooting see section 20)

Table 7: Signal RL_PLC_RETURNVAL

16.2. Signals RL_MSG_QUITT and RL_MSG_ANSWER

Acknowledgement of messages is done by the input signal “RL_MSG_QUITT“. As soon as this signal is set, the dialog is closed on the FlexPendant. The YES/NO selection for a dialog will be set by the input signal “RL_MSG_ANSWER“.

Important:

The signal “RL_MSG_ANSWER“ must be set before the acknowledgement. High means YES. Low means NO.

Signal	Description
RL_MSG_QUITT	As soon as the signal is set, the dialog is acknowledged on the FlexPendant.
RL_MSG_ANSW	If the signal is set, the dialog is answered with yes. Otherwise with no. Has to be set before the signal “RL_MSG_QUITT“!

Table 8: Signals RL_MSG_QUITT & RL_MSG_ANSWER

16.3. Determine input and output signals

The input and output signals are allocated in the module RL_MainModule.sys. Insert here the names of the signals from the I/O-configuration (see Figure 27).

```
!#################################
!*** Assign the signal names from I/O configuration to the strings ***!
LOCAL PERS string stRL_MSG_QUITT     := "";
LOCAL PERS string stRL_MSG_ANSWER    := "";
LOCAL PERS string stRL_PLC_RETURNVAL := "";
```

Figure 27: PLC signal names

17. The RotoLAB Menu

If the RotoLAB main program (RL_MAIN) is called in manual operation, the RotoLAB Main Menu is displayed (see Figure 28). The RotoLAB Software is controlled with this menu. A measuring can be started directly or settings in the parameters can be done.

Hint!

The questions to be answered in the menu navigation are highlighted in ***italic and green*** in this section.
The description refers to a call of the main program with “RL_MAIN tWelding” (tWelding is an example tool) and with the default values as in delivery state.

17.1. RotoLAB Main Menu

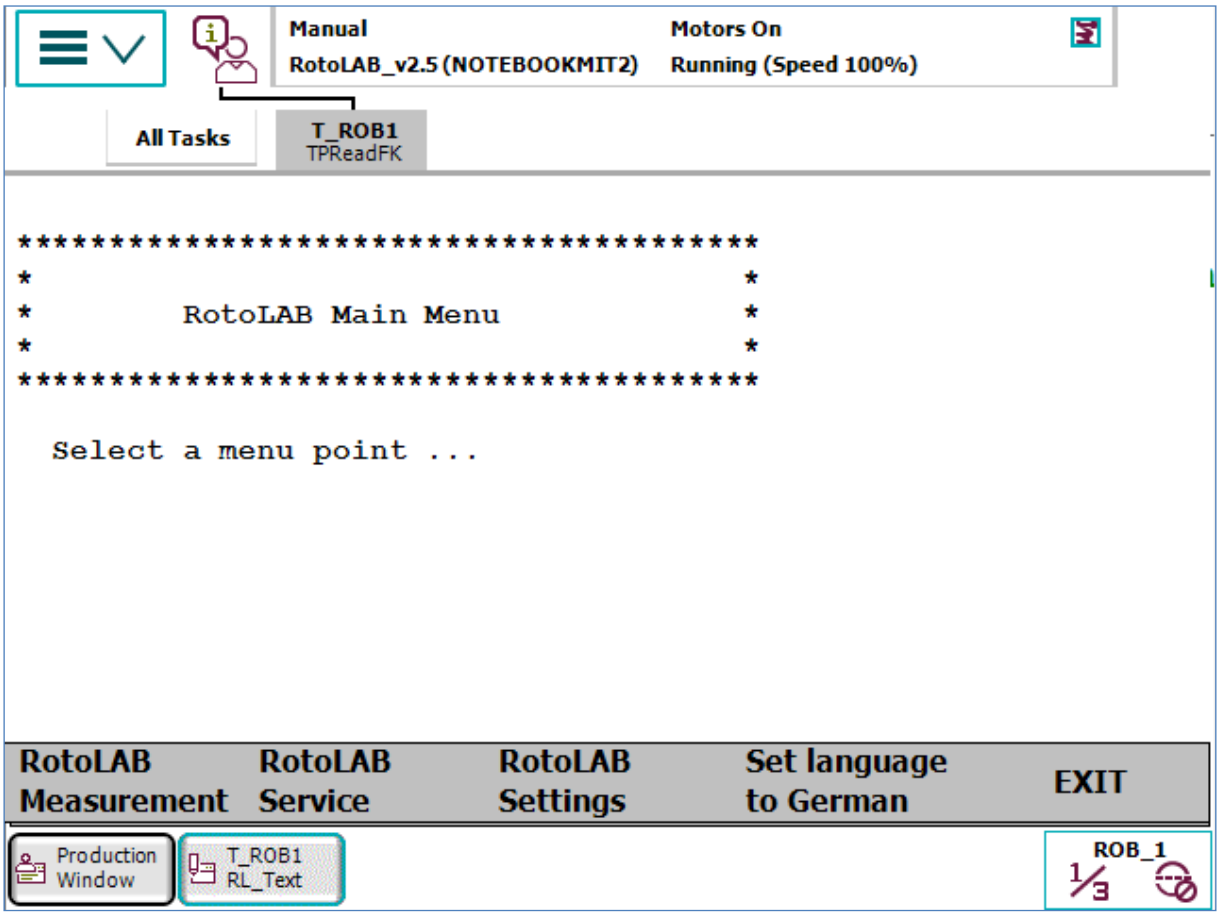


Figure 28: RotoLAB Main Menu

In the RotoLAB Main Menu you have following options:

- **RotoLAB Measurement:**
  The RotoLAB measuring process will be started (initial setup see section 10, tool calibration see section 11.3)
- **RotoLAB Service:**
  Menu “RotoLAB Service“ will be displayed (see section 17.2).
- **RotoLAB Settings:**
  Menu “RotoLAB Settings“ will be displayed (see section 17.3).
- **Set language to German:**
  Set the language of the RotoLAB application to German (see section 6).
- **EXIT:**
  Exit the RotoLAB program.

17.2. RotoLAB Service

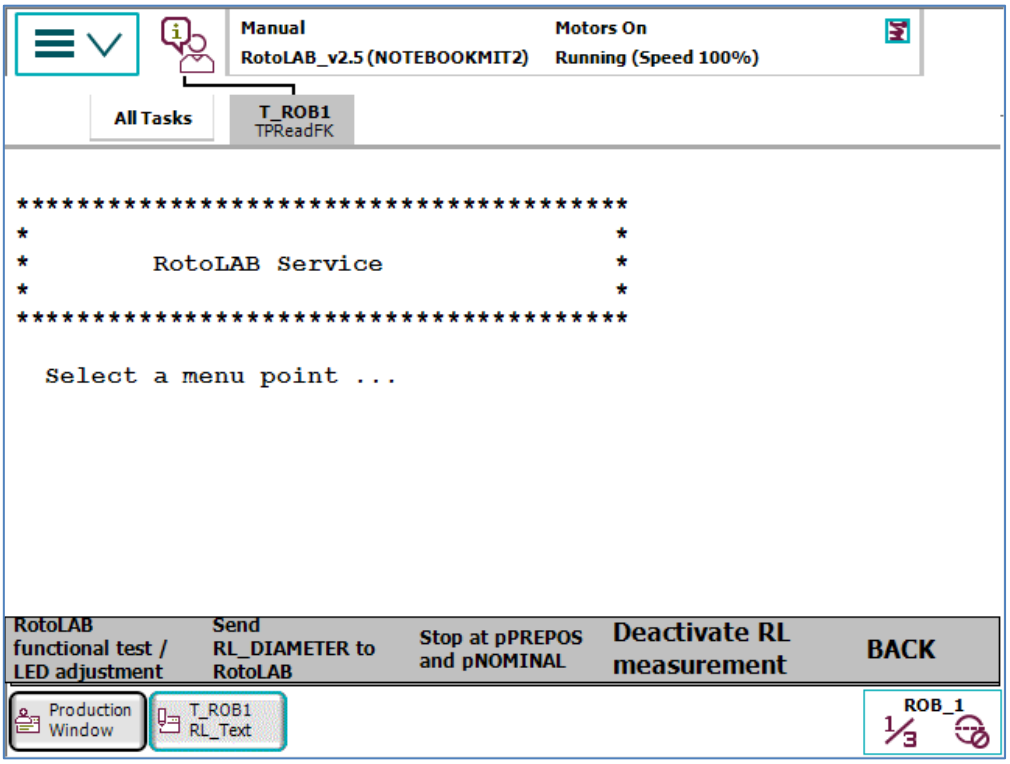


Figure 29: RotoLAB Service

In the RotoLAB Service Menu you have following options:

- **RotoLAB functional test / LED adjustment:**

  Carry out RotoLAB functional test?

  → *YES*: ***Running RotoLAB functional test.***
  Is measurement area clear?

  → *YES*: Functional test is carried out (see section 20.1).

  → *NO:* Back to the Service Menu.

  → *NO*: ***Carry out LED adjustment?***

  → *YES*: ***Running LED adjustment.***
  Is measurement area clear?

  → *YES*: Reinitializing the measurement sensors.

  → *NO:* Back to the Service Menu.

  → *NO*: Back to the Service Menu.

- **Send RL_DIAMETER to RotoLAB:**

  RL_DIAMETER = 4.00 mm for Tool 1 OK?

→ *YES*: Send „RL_DIAMETER“ to RotoLAB. After this setting you have to carry out a new initial tool measurement (see section 10.4).

→ *NO* : Back to the Service Menu.

- **Stop at pPREPOS and pNOMINAL:**

  Program stops one-time at positons pPREPOS and pNOMINAL on the next start with “RotoLAB Measurement”.

- **Deactivate RL measurement (F4):**

  Deactivate RotoLAB measurement in automatic operation?

  → *YES*: Deactivates RotoLAB measurement in automatic operation!

  → *NO*: Activates RotoLAB measurement in automatic operation!

- **BACK (F5):**

  Back to RotoLAB Main Menu.

17.3. RotoLAB Settings

Important:

To avoid unauthorized access of the RotoLAB parameters, the RotoLAB Settings can be disabled. Therefore, set the variable “bRL_EXPERT_FLAG” to FALSE. The variable is declared in the module RL_MainModule.sys

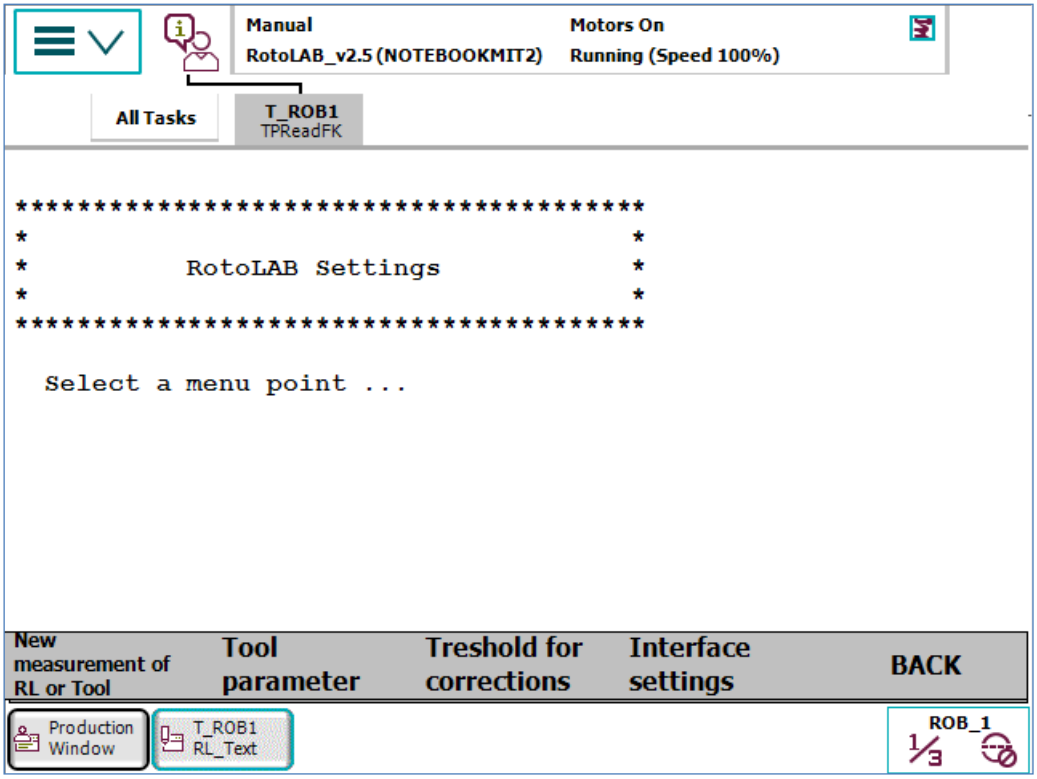


Figure 30: RotoLAB Settings

You must confirm that you are familiar with the documentation to get to the RotoLAB Settings.

In the RotoLAB Settings Menu you have following options:

- **New measurement of RL or Tool:**

  Re-calibrate tool tWelding? (No->Location dialog)

  → *YES*: Tool tWelding will be reset. Subsequent the tool required a new initial measurement with "RotoLAB Measurement" (see section 10.4).

  → *NO*: ***Re-calibrate location of RotoLAB in reference to robot with RL_RobID 1?***

  → *YES*: Location will be reset. Subsequent the location and the tool require a new initial measurement (see section 10.3).

  → *NO*: Back to RotoLAB Settings.

- **Tool parameter:**

  Carry out settings for tool tWelding?

  → *YES*: ***Is robot mounted on the floor?***

  → *YES*: Robot is mounted on the floor.

  → *NO*: Robot is mounted on the ceiling headfirst.

  Is tool moving into RL from above?

  → *YES*: Tool moves from above (e.g.: welding gun).

  → *NO*: Tool moves from below (e.g.: welding tongs).

  RL_Z_OFFSET = -2.00mm OK?

  → *YES*: RL_Z-OFFSET = -2.00mm will be used.

  → *NO*: Enter a value for RL_Z-OFFSET (see section 13.2)

  Calibration with Z-correction?

  → *YES*: Correction of X, Y and Z coordinates of the tool (3D).

  → *NO*: Correction of X, Y of the tool (2D).

  RL_DIAMETER = 4.00mm for tool tWelding OK?

  → *YES*: RL_DIAMETER = 4.00mm will be used.

  → *NO*: Enter a value for RL_DIAMETER (see section 13.1)

  Important:

  Afterwards the variable "RL_DIAMETER" is transmitted to the RotoLAB. To that the connection to the RotoLAB must be set up (see section 7).

  → *NO*: Call RL_MAIN with desired tool (e.g.: RL_MAIN tTool;).

- **Threshold for corrections:**

  Threshold OK-Range OK? RL_REL_OK = 0.30mm

  → *YES*: Threshold = 0.3 mm for OK-Range will be used.

  → *NO*: Enter a value for OK-range (see section 15.1).

  Threshold for automatic-correction OK? RL_REL_AUTO = 0.50mm

  → *YES*: Threshold = 0.5 mm for automatic-correction will be used.

  → *NO*: Enter a value for automatic-correction (see section 15.2).

  Threshold for manual-correction OK? RL_ABS_MAX = 5.00mm

  → *YES*: Threshold = 5.0 mm for manual-correction will be used.

  → *NO*: Enter a value for manual-correction (see section 15.3).

- **Interface Settings:**

  Opens „Interface Settings“ menu (see section 17.4).

- **BACK:**

  Back to RotoLAB Main Menu.

17.4. Interface Settings

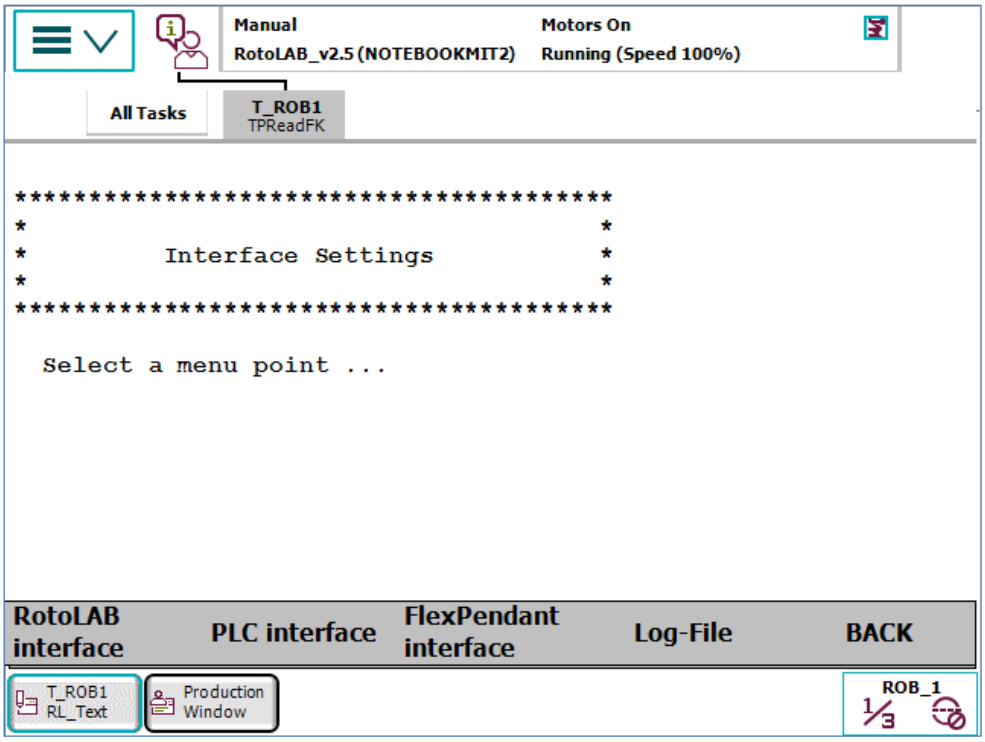


Figure 31: Interface Settings

In the Interface Settings Menu you have following options:

- **RotoLAB interface:**

  RL_RobID = 1 OK? Each robot on the same RotoLAB requires its own RL_RobID (1-4)

  → *YES*: RL_RobID = 1 will be used.

  → *NO*: Enter the preferred RL_RobID.

  Carry out settings for Ethernet communication with RotoLAB?

  → *YES*: ***IP-address = 192.168.1.200 OK?***

  → *YES*: IP-Address 192.168.1.200 will be used.

  → *NO*: Enter the new IP address into the string variable “stRotoLAB_IP” (see section 7.2).

  IP-PORT = 59152 OK?

  → *YES*: IP-Port 59152 will be used.

  → *NO*: Enter new port number (see section 7.2).

  → *NO*: Back to Interface Settings Menu.

- **PLC interface:**

  No PLC connectivity required?

  → *YES*: PLC interface will be deactivated.

  → *NO*: PLC interface will be activated. Absolutely configure the PLC interface first as described in section 16.

- **FlexPendant interface:**

  Acknowledgement of message texts via FlexPendant possible?

  → *YES*: Message texts can be acknowledged by the FlexPendant and via the PLC as well.

  → *NO*: Message texts can be acknowledged only via PLC.

  Output tool deviation in flange coordinate system? (alter. in tool c s)

  → *YES*: The deviations will be related on the flange coordinate system (standard).

  → *NO*: The deviations will be related on the tool coordinate system (perhaps better idea about the geometrical changes of the tool mechanics).

- **Log-File:**

  Waive Log-File?

  → *YES*: No Log-File will be created.

  → *NO*: ***Waive logging OK-range? (only a deviation will be logged)***

  → *YES*: Log entry only if a deviation occurs (see section 18).

  → *NO*: Log entry for each measurement (see section 18).

18. Log-File

In delivery state a log file for every tool is created. Every measuring process is logged and a maximum of 100 entries are written in a log file. The maximum of entries can be increased by changing of the variable “nRL_LogEntriesMax”. The files are saved in the path “\Home”. The log file can be disabled in the Interface Settings in the RotoLAB Menu (see section 17.4) under “Log-File“ (variable “bRL_LOGFILE”). Furthermore, you have the opportunity in this menu to disable the logging of the OK-Range (see section 15.1) (variable “bRL_LogOkRange”).

19. Approach RotoLAB exchange / maintenance

If the RotoLAB is exchanged or remounted after maintenance, the following steps have to be executed:

- **Send RL_DIAMETER to the RotoLAB:**

  If not the default value of 4 mm for RL_DIAMETER (see section 13.1) is used, this value must be sent to the RotoLAB. For this select the item “Send RL_DIAMETER to RL” in the RotoLAB Service Menu (see section 17.2). Only RL_DIAMETER of the current used tool is transmitted.

- **New measuring of location and tools:**

  First the location of the RotoLAB must be reset. For this select the item “New measurement of RL or tool” in the RotoLAB Settings (see section 17.3) and reset the location. The tools are automatically reset. Subsequent the location of the RotoLAB and all tools require a new initial measurement. See sections 10.3 and 10.4.

Important:

If these steps are not respected after an exchange or a remount, a correct function of the RotoLAB is not ensured.

20. Functional test / troubleshooting

20.1. Functional test

The function test checks the communication with the RotoLAB and the function of the RotoLAB. Choose “RotoLAB functional test” in the RotoLAB Service Menu (see section 17.2) and run the function test.

Possible results and troubleshooting:

- “RotoLAB is working and ready for operation”:
  Test of communication and function was successful. RotoLAB is functioning.
- “Timeout“ and “Error reading from channel“:
  Communication error with the RotoLAB. Check settings (see section 7) and check cable connection.
- Error numbers 144, 145, 163 und 164:
  The sensors are not optimal adjusted. Restart the RotoLAB or carry out “RotoLAB LED adjustment” in the RotoLAB Service Menu (see section 17.2). If the problem persists, please contact us.

20.2. Troubleshooting

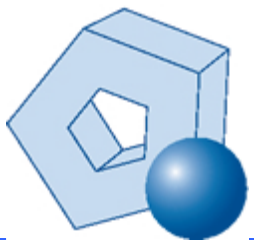
Error	Meaning	Cause	Solutions
144, 145, 163, 164	Sensors not optimal adjusted	Significant change of environment brightness since the initialization; Sensors soiled	Restart RotoLAB; Run the functional test (see section 20.1)
218	Measurement of orientation failed	Nominal position taught in to high; Diameter of the tool not optimal in the measuring plane.	Restart RotoLAB; Optimize nominal position (see section 10.2.1); New measuring of the location (see section 10.3)
219	No object detected	No welding wire present; Tool strongly damaged; Nominal position was changed	Check welding wire, tool and nominal position; Restart measuring
220, 254	Movement change too great	Wrong geometric parameter; Tool strongly damaged;	Check tool; Check geometric parameter (see section 14)
245	No object in measuring plane		
251	Maximal movement path exceeded	Location was not measured	New measuring of the location (see section 10.3)
252	xy measurement does not converge	Minor adjustment attempts of the robot (<1mm): Control accuracy of the robot not sufficient	Check the calibration of the robot; In rare cases it is necessary to increase the error threshold of the regulation (variable “nXYEps”).
		Major adjustment attempts of the robot: RotoLAB detects an incorrect shoulder and is possibly soiled	Run functional test (see section 20.1)
260	Timeout! RotoLAB is not responding	RotoLAB not responding in the given time	Check cable connection (see section 4); Check communication settings (see section 7)
261-283	Diverse communication errors	See error message	

Table 9: RotoLAB Errors

21. Technical data

Measuring procedure	2D coordinate measurement (x,y), 1D bisection procedure (z)
Relative repeat accuracy	< +/- 0,03 mm
Measurement area	75 mm in diameter
Measurable tools	All rotation-symmetric tools and approximates diameter: 0.8 mm – 50 mm
Tool test procedure	TCP test
Tool test duration	3 sec. (minimum, depending on robot speed)
Tool calibration procedure	TCP alignment
Tool calibration duration	< 30 sec. (depending on robot speed)
Tool calibration accuracy	< +/- 0.2 mm
Input voltage	24 V
Max. power consumption	150 mA
Data transfer	RS232 / Ethernet
Housing	Splash-proof aluminum housing
Dimensions	190 x 245 x 23 mm (WxDxH)
Affixing	horizontal

Table 10: Technical data



Wiest Aktiengesellschaft
Siemensstr. 4, 86356 Neusäß
www.wiest-ag.de
info@wiest-ag.de | Fon: +49 (0)821 / 480 44 99 -0 | Fax: +49 (0)821 / 480 44 99 -5