

Documentation

GripLAB Setup

ABB

Version 2.4

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1. Supported robot controllers and available interfaces

- **IRC5**

Available Interfaces:

- RS232
- Ethernet (Software option "PC Interface" is required)
- Fieldbus via protocol converter (on request)

2. Scope of delivery

The following parts are included in GripLAB delivery:

- GripLAB measuring system
- Base plate for mounting GripLAB
- Robot programs for operation of GripLAB (on USB-Stick)
- Documentation of GripLAB setup and application (on USB-Stick and hard-copy)
- GripLABs with RS232 interface:
 - Combined power/data cable
 - DC power connector
- Optional: measuring device for base measurement

3. Mechanical installation

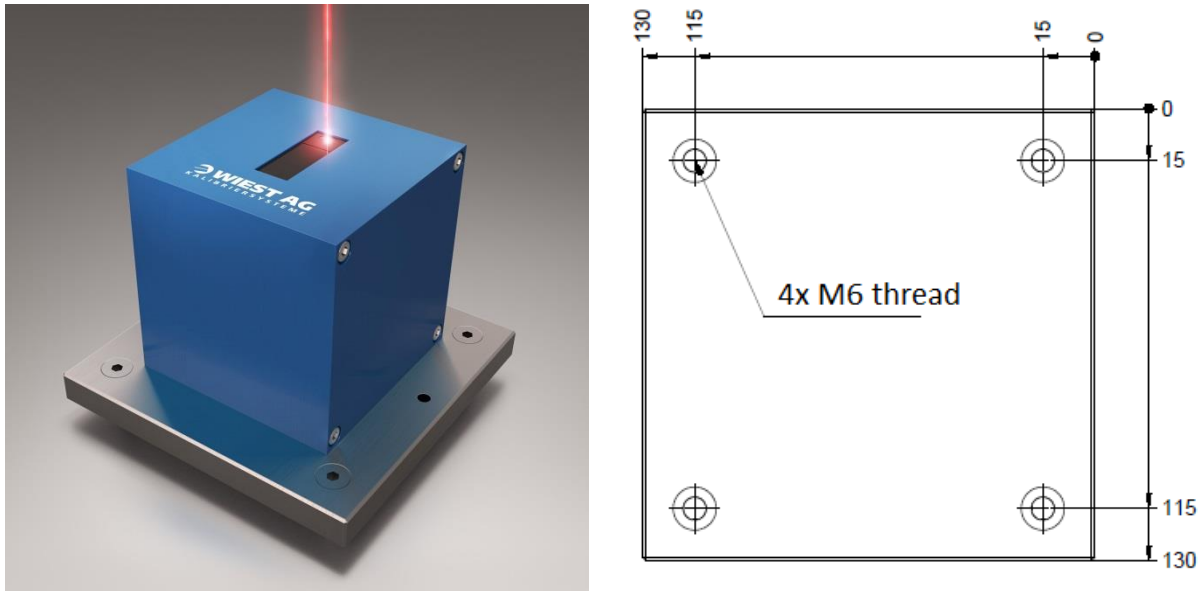


Figure 1: GripLAB and base plate drilling pattern

The GripLAB location has to be chosen so that optimal accessibility by the gripper is guaranteed. The measurement points are taught in a distance of about 120 mm above the GripLAB sensor.

Hint!

Mount GripLAB laterally to avoid dust deposits on the sensor.

For mounting GripLAB four M6 tapped holes at a distance of 100 mm are required (see Figure 1).

4. Electrical installation

4.1. RS232 interface

4.1.1. Robot

Connect the data cable (Sub-D 9-pin/male) of the supplied power/data cable with the COM1 port on the ABB robot controller.

Connect the DC connector of the power/data cable (see Figure 2) with a 24V DC power supply. Ideally the 24V DC for peripherals provided by the robot controller should be used.

The supplied DC power adapter can be used for power/data cable adaptation. Connect the power supply as follows:

- Red = 24V
- Black = 0V

4.1.2. GripLAB

Connect both the power supply and the RS232 connector of the power/data cable (see Figure 2) with GripLAB.



Figure 2: Combined power/data cable

4.2. Ethernet interface

4.2.1. Power supply

GripLAB features a M12 a-coded flange connector for the power supply (see Figure 3). +24V DC are required.

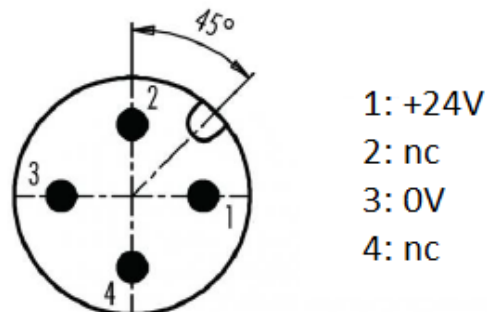


Figure 3: Pin assignment flange connector

4.2.2. Ethernet

GripLAB features a M12 d-coded flange socket for Ethernet connections. Either connect GripLAB directly to the robot controller or via the local network with the robot controller.

5. Software installation

5.1. Overview of supplied files

Module	Description
gl_main.sys	Module in which the measurement is performed. The measuring points are taught there. Also the parameters for the measuring process are declared there.
gl_check_points.sys	Module to check up to 30 measuring points on the gripper (see section 14).
gl_text.sys	The message texts are included in this module. As well there are set the language and the in- and outputs for the PLC connection.
gl_com_ser.sys	Module for the RS232 interface
gl_com_eth.sys	Module for the Ethernet interface

Table 1: Modules for GripLAB

5.2. Robot program loading

Load the modules with "Module load" into the Task. The modules are system modules and permanently loaded in the controller.

Important:

Depending on your used interface either load the module `gl_com_ser.sys` or the module `gl_com_eth.sys` into the controller.

5.3. Language selection

The variable "nGL_Language" in module `gl_text.sys` defines the language for the message texts. To switch the language change the value of the variable "nGL_Language". Default is 1 (German) selected. For English message texts change the value to 2.

6. Communication interface setup

6.1. RS232 interface

Important:

In delivery state, no changes have to be made.

If settings of the RS232 interface have already been changed, the robot controller has to be reset to the following values:

Baud rate = 9600

Data bits = 8

Parity = no

Stop bits = 1

Flow control = no

6.2. Ethernet interface

Important:

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

6.2.1. GripLAB network settings

GripLABs default IP-address is 192.168.1.200 with subnet mask 255.255.255.0. Network settings can be changed via GripLABs web-interface. Use any web browser to access it in delivery state at the address 192.168.1.200:8080. Make sure that your computer is in the same IP-address range with the same subnet mask as GripLAB.

Important:

In delivery state the password to apply changes is ”gripper“. After any changes GripLAB has to be restarted by disconnecting the power supply.

6.2.2. Robot controller

IP-address and communication port of GripLAB need to be specified in the module `gl_com_eth.sys` (see section 5.1). Change variables “stGripLAB_IP” and ”nGripLAB_Port“ to match your settings. In delivery state the variable “stGripLAB_IP” is set to value “192.168.1.200” and the variable “nGripLAB_Port” to value “59152“.

7. GripLAB operation principles

GripLAB checks and calibrates robot grippers in 6 dimensions. The measuring points can either be set directly on the gripper or on the managed object. GripLAB ensures that TCP changes are detected and corrected. However it cannot determine the initial TCP data. During correction of the TCP, the geometric changes of the gripper are detected. The tool data on the robot controller are adapted accordingly.

Important:

GripLAB exclusively compensates TCP changes of the gripper. Incorrect adjustment of the robot axes cannot be compensated and will result in a wrong measurement result. Therefore ensure that the robot adjustment has not changed prior to each measuring process.

Nine measuring points are required for the measurement in total. Three points for each spatial plane (see section 8.3 and Figure 4).

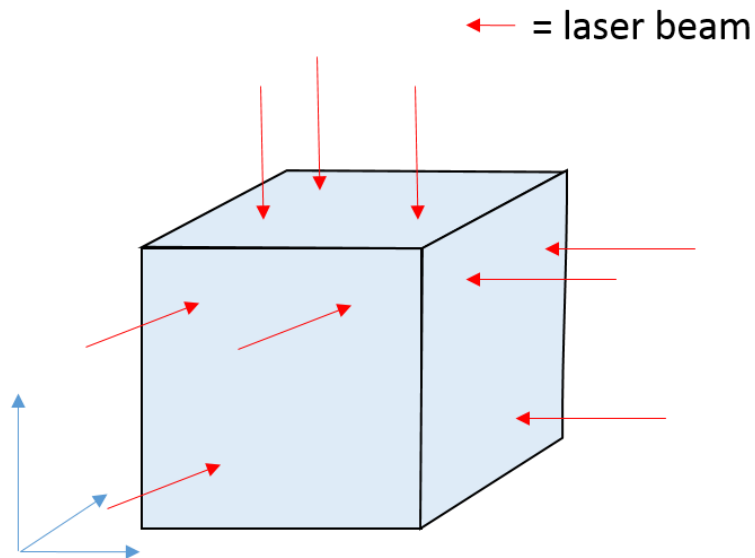


Figure 4: GripLAB measuring points

7.1. Test duration

The test duration is primarily determined by the measurement run and therefore by the speed of the robot.

If the defined threshold is exceeded, the tool will be corrected. For a correction several measurement runs are necessary. Usually an optimal measurement result is reached within 3 iterations.

7.2. Power up

The laser will switch on about 15 seconds after GripLAB is connected with the power supply. The laser will automatically switch off after 60 minutes or once a standard measurement run has ended.

Important:

To achieve optimal measurement results GripLAB has to be powered up at least 30 minutes prior to the measurement. During this time the laser can be switched off.

8. Initial setup

As soon as GripLAB is mounted and connected to the power supply, setup can commence.

8.1. Work object measurement

First step in the setup is the measurement of the GripLAB work object.

8.1.1. Preparation

For measuring the GripLAB work object, the measuring device for base measurement will be mounted on the base plate (see Figure 5). An already measured measuring tip is required on the robot (The tip can be measured with the 3-point method).

Hint!

By reorienting of the robot around the measuring tip you can verify that the measuring tip is correctly measured.

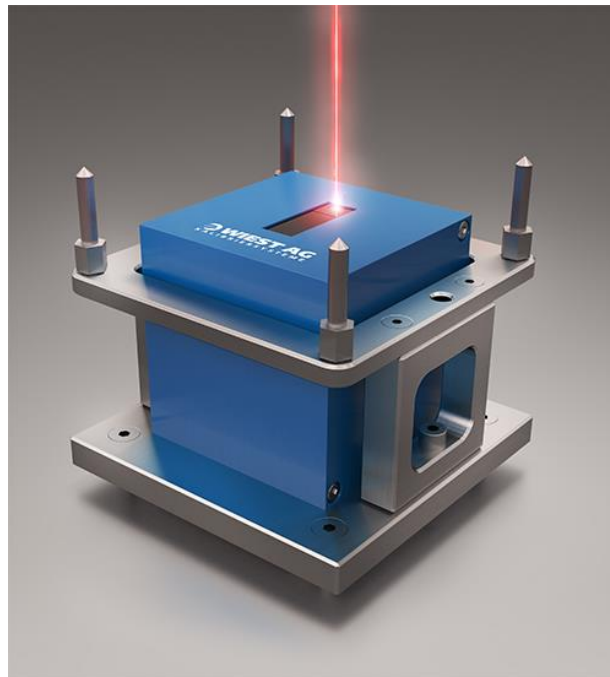


Figure 5: Measuring device for base measurement

8.1.2. Execution

Select the work objects under program data on the FlexPendant. Choose “wGL_WObj” → “Edit” → “Define”. Select at User method “3 Point”. The Object method will remain unchanged. In addition the same tool has to be used which was selected in section 8.1.1.

Move the measuring tip to the first tip of the measuring device for base measurement and define point X1. For point X2 move to the second tip and define it. Finally move to the fourth tip and define point Y1. Afterwards the work object measurement is completed.

Hint!

To verify the GripLAB work object, move the robot with the used measuring tip in a distance of 120 mm to GripLAB onto the laser beam. Ensure that the tool from section 8.1.1 and the GripLAB work object “wGL_Wobj” is selected. The robot position should now be in close proximity to the origin of the GripLAB work object.

8.2. Preparation of robot program

The actual measuring program is called by the routine “do_griplab”. In this routine define the Name of the tool which is to be measured with the string variable “stGL_ToolName” (see Figure 6). That followed the program “GL_Proc” is called with two passing parameters. Replace *<ID>* with the name of the tool to be measured. Afterwards, remove the **Stop** command.

```
Stop;
!*** Set tool to be calibrated, then remove the Stop above ***!
stGL_ToolName := "<ID>";
GL_Proc <ID>, wGL_WObj ;
```

Figure 6: Determine tool name

8.2.1. Define nGL_ToolID

“nGL_ToolID” tells GripLAB which tool should be corrected. For every tool to be measured a new measuring program with a different “nGL_ToolID” has to be created (see section 8.6). The variable “nGL_ToolID” is declared in module gl_main.sys.

8.2.2. Define nGL_ObjectID

For each “nGL_ToolID” a “nGL_ObjectID” is required. The “nGL_ObjectID” defines the object on which the measuring points are set. If there is only one measuring program, the “nGL_ObjectID” always remains 1. If multiple measuring programs are created for a single Tool (see section 8.6.1), the “nGL_ObjectID” has to be different in each measuring program. The variable “nGL_ObjectID” is defined in module gl_main.sys.

8.3. Defining of measuring points

The measuring points are either set directly on the gripper or on the managed object. For each spatial plane three measuring points are necessary (see Figure 4). The position of the coordinate system of the spatial planes should account the structural condition of the gripper. The spatial planes can be captured from both sides.

8.3.1. Required characteristics of measuring points

- The measuring point is located in a distance of about 120 mm to GripLAB (measuring range of the sensor: 120 mm +/- 60mm).
- The laser beam has to be perpendicular on the surface to be measured in the measuring point (see Figure 7).
- The laser beam must not be obstructed by any edge (see Figure 7).
- The surface to be measured may be inclined up to 15° to the respective spatial plane.
- The measuring point has to be repeatable. Do not place the measuring points on movable elements or move these elements to a defined position.
- The measuring point must be reachable by the robot.

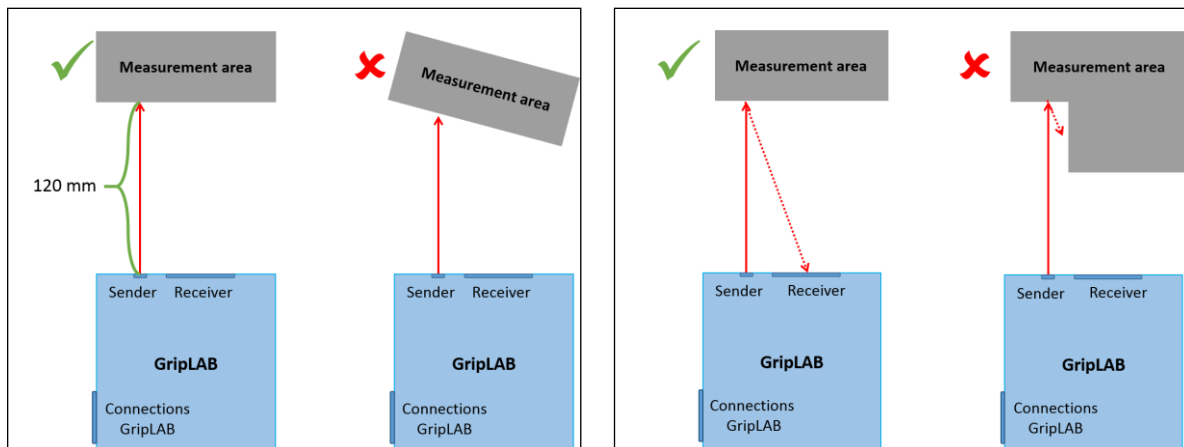


Figure 7: Regulations for measuring points

8.3.2. Recommended characteristics for measuring points

- Distribute the measuring points evenly over the object to be measured.
- Place the measuring points near the critical points of the handling application. The measurement result will improve in relation to these critical points.
- Select a surface as large as possible for the measuring point. The measuring point should still point on this surface in case of a fault. (Where does the measuring point drift in the event of a fault?)
- Don't teach the measuring points near the axes limits of the robot. After a tool correction the measuring point may no longer be reachable.

Important:

You can mark the measuring points with a permanent marker to facilitate the teaching (see section 8.4). Make sure that the laser beam does not hit the mark, as this would corrupt the measurement result. For example mark the points with a circle around the laser beam.

8.4. Teaching of measurement program

To teach the measurement program, the correct robot module (e.g. gl_main.sys) must be selected and the correct routine must be executed (e.g. do_griplab). Select "TEACHING" in the option menu (see Figure 8). The laser beam switches on for 60 minutes. Now continue the program in step mode and teach the measuring points defined in section 8.3 including the auxiliary points.

Important:

All nine measuring points have to be taught with the tool to be measured and in the GripLAB work object "wGL_Wobj"! Also pay attention to the distance to GripLAB of approximately 120 mm.

Hint!

The robot moves to the point "pStart" before the first and after the ninth auxiliary point. This ensures that several iterations can be performed consecutively without a collision. To verify smooth operation execute the program once in teach-mode.

Hint!

Move to all points of a spatial plane one after another. So the reorientation of the gripper will be minimized.

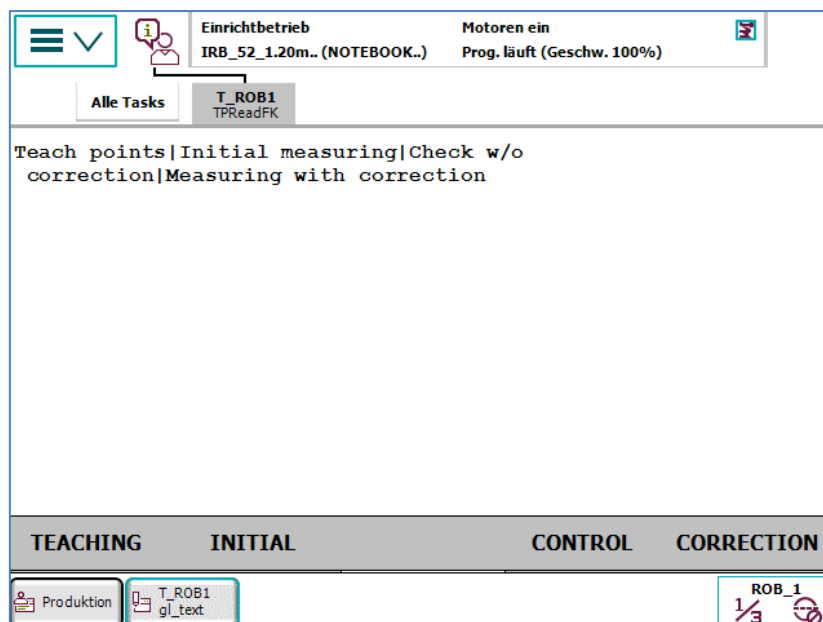


Figure 8: The option menu

8.5. Initial measuring process

The measuring points have to be initially stored before a gripper can be corrected with GripLAB. Start the measuring program and select “INITIAL” in the option menu (see Figure 8). The measuring points will now be saved in GripLAB. The distance of the measuring points will be displayed and should have a value of about 60 mm. (Calculated from the beginning of the laser measuring range).

Important:

Prerequisite for the initial measurement process is an intact gripper and a functioning application. The tool correction will always refer to the initial measurement.

Important:

In case the gripper oscillates after reaching a measuring point, the dwell time at the measuring points has to be increased. This is set with the variable “nGL_WAIT” in module gl_main.sys and is 1.5 seconds in delivery state. This is especially important at higher speeds (e.g. automatic operation).

Hint!

To verify the function of GripLAB, carry out a control measurement after the initial measurement (see section 9.1). The measured failure should be very small (<0.1 mm).

8.6. Creation of additional measuring programs

With GripLAB several grippers and tools can be measured.

Important:

If the module gl_main.sys is duplicated in the same task, the name of the calling routine “do_griplab” has to be changed in the duplicate as this routine is declared globally.

8.6.1. Multiple measuring programs for one tool

Duplicate the measuring module gl_main.sys and change the variable “nGL_ObjectID” (see section 8.2.2) in the new program to a not yet used number. Then carry out the steps 8.3 to 8.5.

Hint!

This is useful if the measuring points are set on the managed object and different objects are managed. In this scenario no specific object has to be gripped for the measuring program. Instead, the matching measuring program is executed for the respective object.

8.6.2. Measuring of additional Tools

Duplicate the measuring module `gl_main.sys` and change the variable “nGL_ToolID” (see section 8.2.1) in the new program to a not yet used number. Then enter the current tool name in the calling routine (e.g. `do_griplab`) (see Figure 6). Carry out the steps 8.3 to 8.5, for the new tool.

Hint!

This is useful if a gripper has several TCPs or several grippers with different TCPs are used.

8.6.3. Using additional robots

Important:

Only GripLABs with Ethernet interface can be used with multiple robots. All robots have to reside on the same network.

To use additional robots with one GripLAB, the full initial setup has to be carried out as described in this documentation. Choose an unused “nGL_ObjectID” for the measuring program. E.g. start with the “nGL_ObjectID” 20 on the new robot.

9. Standard measurement procedure

To perform a standard test, the calling routine (e.g. `do_griplab`) will be selected.

Important:

It has to be ensured that the same conditions as for the initial measurement are met. This may concern:

- current docked gripper
- gripper condition (open, closed)
- gripped object

Important:

In case the gripper oscillates after reaching a measuring point, the dwell time at the measuring points has to be increased. This is set with the variable “nGL_WAIT” in module `gl_main.sys` and is 1.5 seconds in delivery condition. This is especially important at higher speeds (e.g. automatic operation).

9.1. Manual operation

9.1.1. Measurement without correction

If CONTROL is selected in the option menu (see Figure 8), a measurement without correction is carried out. The determined deviation will be displayed on the FlexPendant at the end of the measurement.

9.1.2. Measurement with correction

If CORRECT is selected in the option menu (see Figure 8), a measurement with correction of the tool data is carried out.

9.2. Automatic operation

A measurement with correction is carried out at once. No dialog messages need to be answered.

9.3. Measurement data

Several data are displayed during the measuring process.

9.3.1. Measuring distances difference

The difference in distance of the current measuring point compared to the initial measurement will be displayed during the standard measurement.

Important:

These values are an indication for a misalignment or a damage of the gripper. Pay attention on how the individual surfaces have changed.

Positive values indicate that the measuring point is closer to GripLAB versus the initial measurement.

9.3.2. Correction values

The correction values for translation (X, Y, Z) and rotation (A, B, C) in reference to the used tool will be displayed at the end of a standard measurement. Based on these values the total deviation is determined and displayed. These deviations are used to evaluate the measuring result (see section 9.4).

9.3.3. Error value

The error value of the result calculation is displayed in addition to the correction values. This value indicates how well the two measured point clouds (initial measurement and current measurement) could be layered over each other.

Important:

If after several iterations the error value is greater than 0.3, this might be an indication that the gripper has changed in itself. The point clouds can no longer exactly layered over each other, because the measuring points have changed the relation to each other. This may be due to a damage of the gripper.

9.4. Evaluation of the measurement results

9.4.1. Tool OK

If the deviation is in the OK range (see section 11.1), the tool is correct. No correction will be done and the program will be terminated.

9.4.2. Automatic correction

If the deviation is within the automatic correction range (see section 11.2), the tool is automatically corrected. Subsequently a new measurement process will be started.

If the deviation is still not in the OK range after the set maximum number of iterations (defined by the variable "nGL_ITE_MAX" in module gl_main.sys), an error message is displayed. After confirmation of this message, the program is terminated. Error cause is possibly a damage of the gripper. Check the distance differences and the error value of the measuring result (see section 9.3).

9.4.3. Manual correction

If the deviation is in the manual correction range (see section 11.3), the user is asked if a correction should be carried out (see Figure 9).

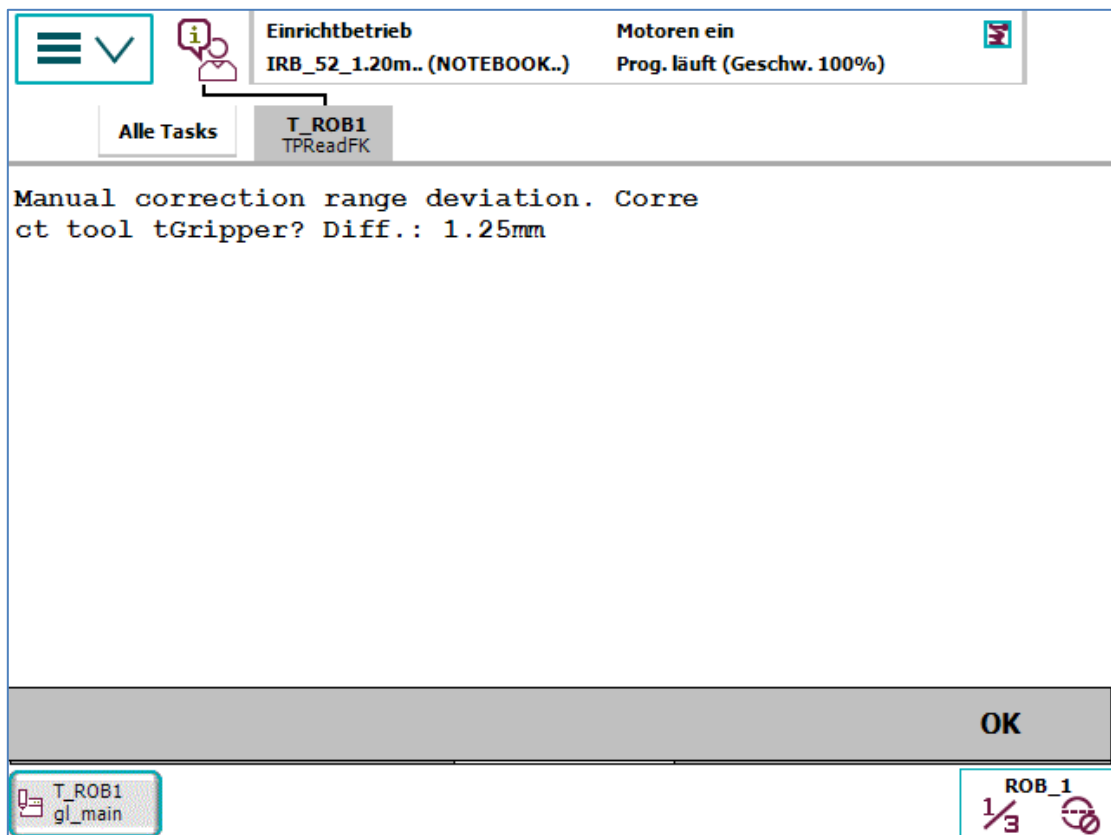


Figure 9: Deviation in the manual correction range

- Answer yes: The tool will be corrected. Afterwards a new measuring process will be started. If the maximum number of iterations has already been exceeded an error message appears. Error cause is possibly a damage of the gripper. Check the distance differences and the error value of the measuring result (see section 9.3).
- Answer no: The tool will not be correct. Afterwards the program is terminated.

9.4.4. No correction allowed

If the absolute deviation in regards to the initial measurement is above the absolute threshold (see section 11.4), no correction is allowed. This prevents a step-wise drifting of the gripper. An error message appears (see Figure 10). After confirmation of this message, the program is terminated. The gripper has to be inspected.

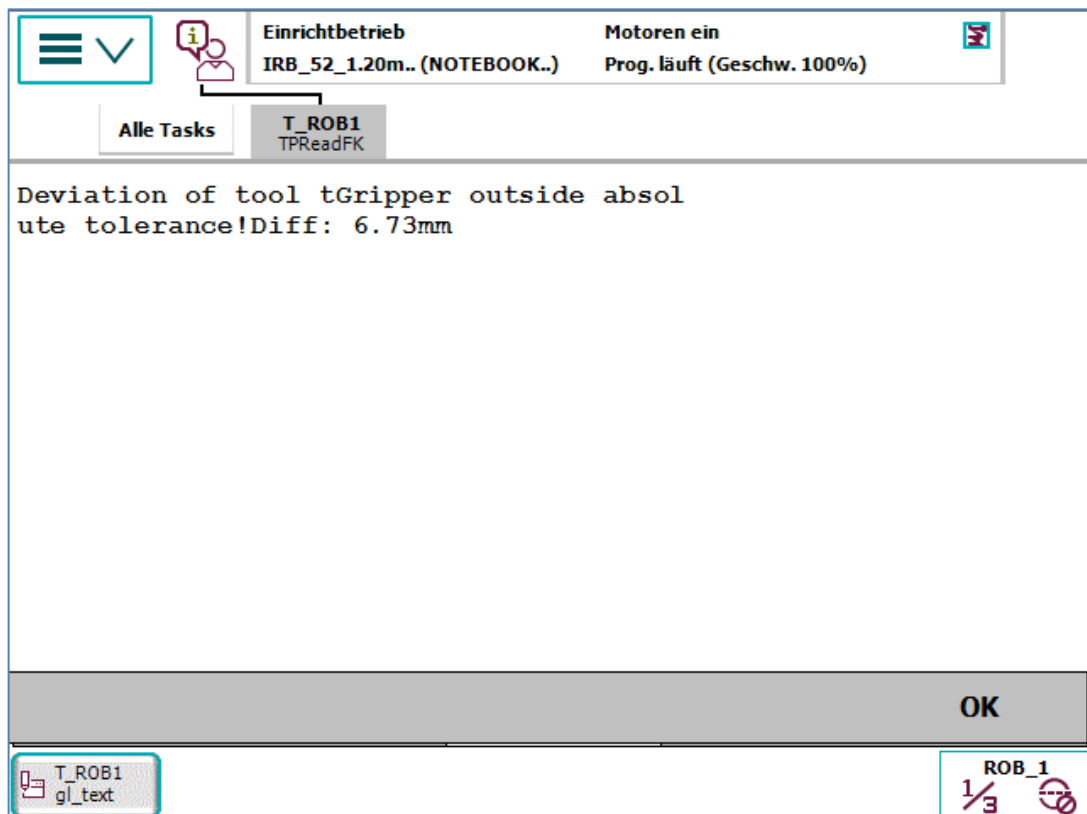


Figure 10: Error message: absolute deviation too high

9.5. Measuring point out of range

If the measuring point is no longer in the detection range of the GripLAB, the error message “measuring point not in the range of the sensor!” is displayed. This failure occurs when the laser beam no longer points on the surface of the gripper. Possible cause is a misalignment of the gripper. Acknowledge this message with OK. Subsequently the robot halts in a stop command. Move the robot manually so that the measuring point is back on the correct position on the gripper. Afterwards a line selection below the stop command on “SET_POINT(INDEX)” is mandatory.

The line selection prevents that the robot moves back to his original position.

Important:

Don't teach the measuring point! Subsequently continue the program.

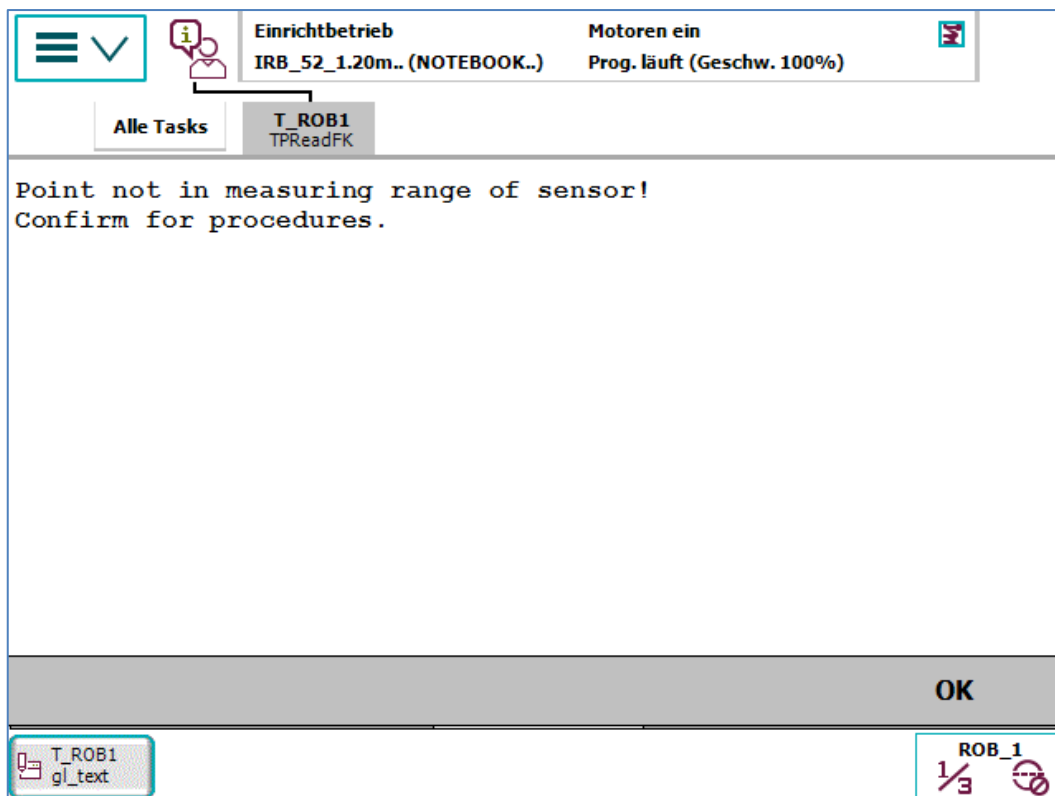


Figure 11: Measuring point out of range

10. GripLAB integration into the production process

To integrate GripLAB into the production process, the measurement program (e.g. do_griplab) has to be called within the production program. In automatic operation a measurement with correction is started immediately. No dialog messages need to be answered. The acknowledgement of the message texts can be done by the PLC (see section 12).

10.1. Routine do_griplab

The routine “gl_proc” is called by the routine “do_griplab”. Before and after the call, auxiliary points can be taught.

The variable “nGL_ERROR_STATE” is evaluated with the switch case instruction after the call from “gl_proc” (see section 10.2).

10.2. nGL_ERROR_STATE

The variable “nGL_ERROR_STATE” provides information on whether the measurement process with GripLAB was successful.

The variable can be evaluated after the call from “gl_proc”. Depending on the state, e.g. a service position can be approached to check the gripper.

Value	Description
0	The measurement process has successfully been completed (possibly with correction).
1	The manual correction was not carried out.
2	Deviation is outside the absolute tolerance.
3	Maximum number of iterations exceeded.
4	Result calculation was not possible (exception error).

Table 2: Variable nGL_ERROR_STATE

11. Configuration of thresholds

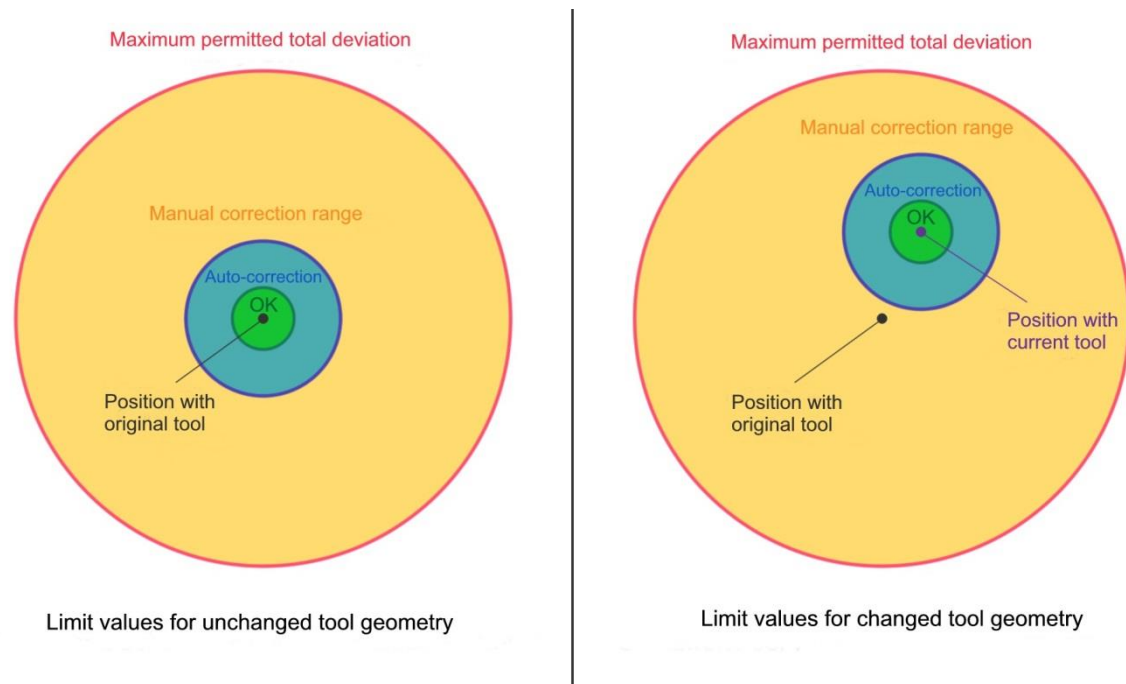


Figure 12: Limit values for tool measurement

The thresholds are declared in module `gl_main.sys`. Here they can be viewed and edited. Figure 12 shows a schematic representation in two dimensions.

Designation	Description
<code>nGL_REL_OK</code>	Upper threshold of the OK range (reference: current tool)
<code>nGL_REL_AUTO</code>	Upper threshold of the automatic correction range (reference: current tool)
<code>nGL_ABS_MAX</code>	Maximum total deviation of the current tool data regarding the original tool data (reference: original tool)

Table 3: Limit values

11.1. OK range

Mathematical definition: $[0, nGL_REL_OK [$

This range is defined by the threshold “`nGL_REL_OK`”. It constitutes the upper limit to the range within which the tool deviation is considered OK and is not corrected.

11.2. Automatic correction range

Mathematical definition: [nGL_REL_OK, nGL_REL_AUTO [

This range is defined by the threshold “nGL_REL_OK” and “nGL_REL_AUTO”. If the tool deviation is in this range, an automatic correction of the tool data takes place without any user input being required.

Hint!

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

11.3. Manual correction range

Mathematical definition: [nGL_REL_ AUTO, ∞ [without [nGL_ABS_MAX, ∞ [

This range is defined on the one hand by the threshold “nGL_REL_AUTO”, which refers to the currently measured deviation.

On the other hand the threshold “nGL_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 9). If the user confirms with “Yes”, the tool data are updated. If the user rejects the correction, the tool data are not changed.

The corresponding PLC signal is set in this range (see section 12).

11.4. No correction allowed

Mathematical definition: [nGL_ABS_MAX, ∞ [

In this range no correction is carried out. An error message is displayed (see Figure 11). The gripper has to be replaced or repaired.

If the deviation is in this range, the corresponding PLC signal is set (see section 12).

12. PLC Interface

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, the variable “bGL_USE_PLC” in module gl_text.sys has to be set to TRUE.

12.1. Signal description

The output signal “stGL_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 gripper and restart the measurement. (quit)
3	Maximum number of iterations exceeded	Maximum number of iterations exceeded. Check gripper! For error analysis check the measuring differences of the measuring points on the FlexPendant. (quit)
4	Current measuring point not in the range of the sensor!	Current measuring point not in range of the sensor! Troubleshooting will be displayed on the FlexPendant after acknowledge. (quit)
5	Error communicating with GripLAB	Timeout during communication with GripLAB! Move the robot away to avoid collision, resolve the error and restart the measurement. (quit)

Table 4: Signal GL_PLC_RETURNVAL

Acknowledgement of messages takes place by the input signal “stGL_MSG_QUITT”. As soon as this signal is set, the dialog is closed at the FlexPendant. The YES/NO selection for a dialog will be set by the input signal “stGL_MSG_ANSWER”.

Important:

The signal “stGL_MSG_ANSWER” has to be set before the acknowledgement. High means YES. Low means NO.

Signal	Description
stGL_MSG_QUITT	As soon as the signal is set, the dialog is acknowledged at the FlexPendant.
stGL_MSG_ANSWER	If the signal is set, the dialog is answered with yes. Otherwise with no. Has to be set before the signal "stGL_MSG_QUITT"!

Table 5: Signals stGL_MSG_QUITT & stGL_MSG_ANSWER

Important:

The signal "stGL_PLC_RETURNVAL" is always reset to 0 at the beginning of a standard measurement with correction.

Hint!

It is possible to disable the dialog messages on the robot controller during automatic operation. Thus the dialog messages can only be acknowledged with the PLC. For this, the variable "bGL_SHOWDIALOG" defined in the module gl_text.sys has to be set to FALSE.

12.2. Set inputs and outputs

The inputs and outputs are assigned in module gl_text.sys. Enter the names from the I/O configuration here (see Figure 13).

```
!*** Assign the signal names from I/O configuration to the strings ***!
LOCAL PERS string stGL_MSG_QUITT      := "";
LOCAL PERS string stGL_MSG_ANSWER    := "";
LOCAL PERS string stGL_PLC_RETURNVAL := "";
```

Figure 13: PLC signal names

13. Create log file

In delivery-state a log file for every tool is created. If this is not required, the variable "bGL_LOGFILE" has to be set to FALSE. The variable is declared in module gl_main.sys. A maximum of 100 entries are written to a log file. The files are stored in the \Home directory.

14. Module „gl_check_points“

The routine “do_check_points” in module gl_check_points.sys is used for a simplified checking of measuring points on the gripper. Through this misalignment of the gripper can be detected but will not be corrected. Up to 30 measuring points can be taught (Requirements of measuring points see section 8.3.1). In the routine “do_check_points”, use the string variable “stGL_ToolName” to specify the name of the tool to use (see Figure 14). Afterwards the routine “GL_Proc” is called with two parameters. Replace **<ID>** with the name of the tool to be used. Then remove the **Stop** Command.

```
Stop;  
!*** Set tool to be calibrated, then remove the Stop above ***!  
stGL_ToolName := "<ID>";  
GL_Proc <ID>, wGL_WObj ;
```

Figure 14: Determine tool name

The “nGL_ToolID” should be set to 0 and the “nGL_ObjectID” should be set to 100 to avoid conflicts with the other measuring routines. The number of used measuring points has to be specified with the variable “nGL_NUMBER_MP”. The variable “nGL_DISTANCE_TH” determines at what point a warning is issued. The variables are declared in module gl_check_points. At the end of the routine execution all critical measuring points will be displayed once again. A log file is created as well (see section 13).

15. Cleaning of the sensor and the measuring points

To ensure failure-free operation, the transmitter and receiver of the sensor have to be kept clean. Transmitter and receiver have to be free from soiling which can break or block the light. Watch out, for e.g., water stains, oil, fingerprints or dust deposits.

Small dust particles or fingerprints can be carefully wiped off with a microfiber cloth or lens cleaning paper.

For persistent dirt, carefully wipe the surface with an alcohol-soaked cloth.

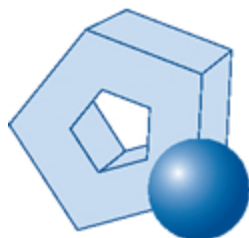
Important:

GripLAB is an optical measurement system. For optimal measurement results the surfaces of the measuring points have to be free of coarse soiling.

16. Technical data

Measuring procedure	6D measurement procedure
Relative repeat accuracy	< +/- 0,1 mm
Mean measuring distance	120 mm
Measuring range	+/- 60 mm
Measurable grippers	All gripper or objects with sufficient surfaces for the nine measuring points
Tool test procedure	TCP test in 6D
Tool test duration	Is determined by the duration of a measurement run
Tool calibration procedure	TCP alignment
Tool calibration duration	Is determined by the duration of about three measurement runs
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	85 x 85 x 85 mm (WxDxH)
Mounting	Freely selectable
Laser data	Class 2 Laser Product (IEC60825-1 2007) Maximum: Output 1mW Pulse Duration: 2ms Max. Medium: Semiconductor Laser Wavelength: 655nm

Table 6: Technical data



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