12. Communication Networks

12.1. Fieldbus

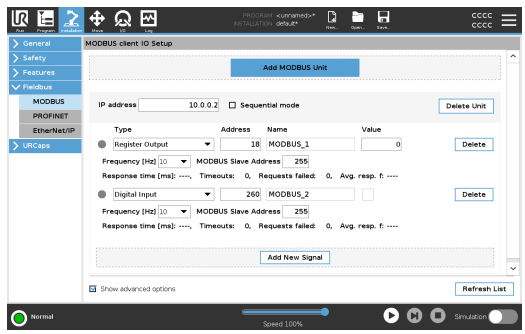
Description

You can use the Fieldbus options to define and configure the family of industrial computer network protocols used for real-time distributed control accepted by PolyScope:

- MODBUS
- Ethernet/IP
- PROFINET
- PROFIsafe

12.2. MODBUS

Description Here, the MODBUS client (master) signals can be set up. Connections to MODBUS servers (or slaves) on specified IP addresses can be created with input/output signals (registers or digital). Each signal has a unique name so it can be used in programs.



Refresh Push this button to refresh all MODBUS connections. Refreshing disconnects all modbus units, and connects them back again. All statistics are cleared.

Add unit Push this button to add a new MODBUS unit.

Delete unit Push this button to delete the MODBUS unit and all signals on that unit.

Set unit IP Here the IP address of the MODBUS unit is shown. Press the button to change it.

Sequential mode *Available only when Show Advanced Options selected.* Selecting this checkbox forces the modbus client to wait for a response before sending the next request. This mode is required by some fieldbus units. Turning this option on may help when there are multiple signals, and increasing request frequency results in signal disconnects.
The actual signal frequency may be lower than requested when multiple signals are defined in sequential mode. Actual signal frequency can be observed in signal statistics. The signal indicator turns yellow if the actual signal frequency is less than half of the value selected from the **Frequency** drop-down list.

Add signal Push this button to add a signal to the corresponding MODBUS unit.

Delete signal Push this button to delete a MODBUS signal from the corresponding MODBUS unit.

Set signal type

Use this drop down menu to choose the signal type. Available types are:

Digital input	A digital input (coil) is a one-bit quantity which is read from the MODBUS unit on the coil specified in the address field of the signal. Function code 0x02 (Read Discrete Inputs) is used.
Digital output	A digital output (coil) is a one-bit quantity which can be set to either high or low. Before the value of this output has been set by the user, the value is read from the remote MODBUS unit. This means that function code 0x01 (Read Coils) is used. When the output has been set by a robot program or by pressing the **set signal value** button, the function code 0x05 (Write Single Coil) is used onwards.
Register input	A register input is a 16-bit quantity read from the address specified in the address field. The function code 0x04 (Read Input Registers) is used.
Register output	A register output is a 16-bit quantity which can be set by the user. Before the value of the register has been set, the value of it is read from the remote MODBUS unit. This means that function code 0x03 (Read Holding Registers) is used. When the output has been set by a robot program or by specifying a signal value in the **set signal value** field, function code 0x06 (Write Single Register) is used to set the value on the remote MODBUS unit.

Set signal address

This field shows the address on the remote MODBUS server. Use the on-screen keypad to choose a different address. Valid addresses depends on the manufacturer and configuration of the remote MODBUS unit.

Set signal name

Using the on-screen keyboard, the user can give the signal a name. This name is used when the signal is used in programs.

Signal value

Here, the current value of the signal is shown. For register signals, the value is expressed as an unsigned integer. For output signals, the desired signal value can be set using the button. Again, for a register output, the value to write to the unit must be supplied as an unsigned integer.

Signal connectivity status

This icon shows whether the signal can be properly read/written (green), or if the unit responds unexpected or is not reachable (gray). If a MODBUS exception response is received, the response code is displayed. The MODBUS-TCP Exception responses are:

E1	ILLEGAL FUNCTION (0x01) The function code received in the query is not an allowable action for the server (or slave).
E2	ILLEGAL DATA ADDRESS (0x02) The function code received in the query is not an allowable action for the server (or slave), check that the entered signal address corresponds to the setup of the remote MODBUS server.
E3	ILLEGAL DATA VALUE (0x03) A value contained in the query data field is not an allowable value for server (or slave), check that the entered signal value is valid for the specified address on the remote MODBUS server.
E4	SLAVE DEVICE FAILURE (0x04) An unrecoverable error occurred while the server (or slave) was attempting to perform the requested action.
E5	ACKNOWLEDGE (0x05) Specialized use in conjunction with programming commands sent to the remote MODBUS unit.
E6	SLAVE DEVICE BUSY (0x06) Specialized use in conjunction with programming commands sent to the remote MODBUS unit, the slave (server) is not able to respond now.

Show Advanced Options

This check box shows/hides the advanced options for each signal.

Advanced Options

Update Frequency	This menu can be used to change the update frequency of the signal. This means the frequency with which requests are sent to the remote MODBUS unit for either reading or writing the signal value. When the frequency is set to 0, then modbus requests are initiated on demand using a *modbus_get_signal_status*, *modbus_set_output_register*, and *modbus_set_output_signal* script functions.
Slave Address	This text field can be used to set a specific slave address for the requests corresponding to a specific signal. The value must be in the range 0-255 both included, and the default is 255. If you change this value, it is recommended to consult the manual of the remote MODBUS device to verify its functionality when changing slave address.
Reconnect count	Number of times TCP connection was closed, and connected again.
Connection status	TCP connection status.
Response time [ms]	Time between modbus request sent, and response received - this is updated only when communication is active.
Modbus packet errors	Number of received packets that contained errors (i.e. invalid length, missing data, TCP socket error).
Timeouts	Number of modbus requests that didn't get response.
Requests failed	Number of packets that could not be sent due to invalid socket status.
Actual freq.	The average frequency of client (master) signal status updates. This value is recalculated each time the signal receives a response from the server (or slave).

All counters count up to 65535, and then wrap back to 0.

12.3. EtherNet/IP

Description

EtherNet/IP is a network protocol that enables the connection of the robot to an industrial EtherNet/IP Scanner Device.
If the connection is enabled, you can select the action that occurs when a program loses EtherNet/IP Scanner Device connection.
Those actions are:

None	PolyScope ignores the loss of EtherNet/IP connection and the program continues to run.
Pause	PolyScope pauses the current program. The program resumes from where it stopped.
Stop	PolyScope stops the current program.

12.4. PROFINET

Description

The PROFINET network protocol enables or disables the connection of the robot to an industrial PROFINET IO-Controller.
If the connection is enabled, you can select the action that occurs when a program loses PROFINET IO-Controller connection.
Those actions are:

None	PolyScope ignores the loss of PROFINET connection and the program continues to run.
Pause	PolyScope pauses the current program. The program resumes from where it stopped.
Stop	PolyScope stops the current program.

If the PROFINET engineering tool (e.g. TIA portal) emits a DCP Flash signal to the robot's PROFINET or PROFIsafe device, a popup in PolyScope is displayed.

12.5. PROFIsafe

Description

The PROFIsafe network protocol (implemented as version 2.6.1) allows the robot to communicate with a safety PLC according to ISO 13849, Cat 3 PLd requirements. The robot transmits safety state information to a safety PLC, then receives information to trigger safety related functions, such as: emergency stop or enter reduced mode.
The PROFIsafe interface provides a safe, network-based alternative to connecting wires to the safety IO pins of the robot control box.
PROFIsafe is only available on robots that have an enabling license, which you can obtain by contacting your local sales representative, once obtained, the license can be downloaded on myUR.
Please refer to Robot Registration and URCap License files for information regarding robot registration and license activation.

Advanced Options

A control message received from the safety PLC contains the information in the table below.

Signal	Description
E-Stop by system	Asserts the system e-stop.
Safeguard stop	Asserts the safeguard stop.
Reset safeguard stop	Resets safeguard stop state (on low-to-high transition in automatic mode) if the safeguard stop input is cleared beforehand.
Safeguard stop auto	Asserts safeguard stop if the robot is operating in Automatic mode. Safeguard stop auto shall only be used when a 3-Position Enabling (3PE) Device is configured. If no 3PE Device is configured, the safeguard stop auto acts as a normal safeguard stop input.
Reset safeguard stop auto	Resets safeguard stop auto state (on low-to-high transition when in automatic mode) if safeguard stop auto inputs are cleared beforehand.
Reduced mode	Activates the Reduced mode safety limits.
Operational mode	Activates either manual or automatic operational mode. If the safety configuration "Operational mode selection via PROFIsafe" is disabled, this field shall be omitted from the PROFIsafe control message.

Advanced Options

A status message sent to the safety PLC contains the information in the table below.

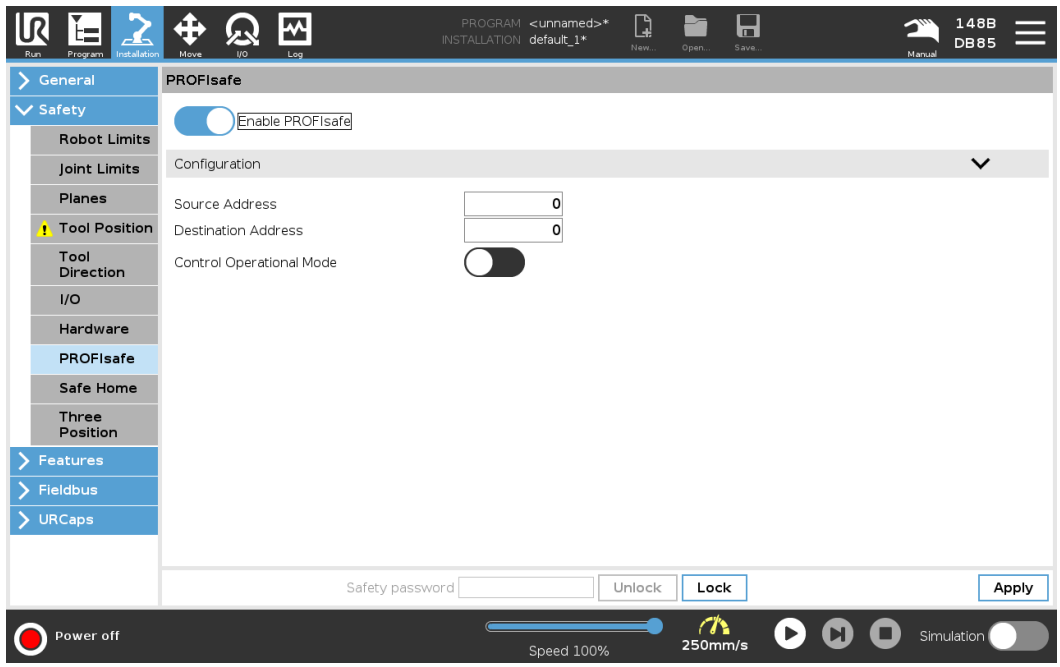
Signal	Description
Stop, cat. 0	Robot is performing, or it has completed, a safety stop of category 0; A hard stop by immediate removal of power to the arm and the motors.
Stop, cat. 1	Robot is performing, or it has completed, a safety stop of category 1; A controlled stop after which the motors are left in a power off state with brakes engaged.
Stop, cat. 2	Robot is performing, or it has completed, a safety stop of category 2; A controlled stop after which the motors are left in a power on state.
Violation	Robot is stopped because the safety system failed to comply with the safety limits currently defined.
Fault	Robot is stopped because of an unexpected exceptional error in the safety system.
E-stop by system	Robot is stopped because of one of the following conditions: • a safety PLC connected via PROFIsafe has asserted system level e-stop. • an IMMI module connected to the control box has asserted a system level e-stop. • a unit connected to the system e-stop configurable safety input of the control box has asserted system level e-stop.
E-stop by robot	The robot is stopped because of one of the following conditions: • The e-stop button of the teach pendant is pressed. • An e-stop button connected to the robot e-stop non-configurable safety input of the control box is pressed.
Safeguard stop	The robot is stopped due to one of the following conditions: • A safety PLC connected via PROFIsafe has asserted the safeguard stop. • A unit connected to the safeguard stop non-configurable input of the control box has asserted the safeguard stop. • A unit connected to the safeguard stop configurable safety input of the control box has asserted the safeguard stop. The signal follows the safeguard reset semantics. A configured safeguard stop reset functionality shall be used to reset this signal. PROFIsafe implies use of the safeguard reset functionality.

Signal	Description
Safeguard stop auto	The robot is stopped because it is operating in Automatic mode and because of one of the following conditions: • A safety PLC connected via PROFIsafe has asserted safeguard stop auto. • A unit connected to a safeguard stop auto configurable safety input of the control box has asserted safeguard stop auto. The signal follows the safeguard reset semantics. A configured safeguard stop reset functionality shall be used to reset this signal PROFIsafe implies use of the safeguard reset functionality
3PE stop	Robot is stopped because it is operating in Manual mode and because of one of the following conditions: • You are using a 3PE TP and none of the buttons are in the middle position. • A 3-position enabling device connected to a configurable safety input of the control box has asserted the 3PE stop.
Operational mode	Indication of the current operational mode of the robot. This mode can be: Disabled (0), Automatic (1), or Manual (2).
Reduced mode	Reduced mode safety limits are currently active.
Active limit set	The active set of safety limits. This can be: Normal (0), Reduced (1), or Recovery (2).
Robot moving	Robot is moving. If any joint moves at a velocity of 0.02 rad/s or higher the robot is considered in motion.
Safe home position	Robot is at rest (robot not moving), and in the position defined as the Safe Home Position.

Configuring PROFIsafe

Configuring PROFIsafe relates to programming the safety PLC, but requires minimal robot setup.

1. Connect the robot to a trusted network that accesses a safety compliant PLC.
2. On PolyScope, in the Header, tap **Installation**.
3. Tap Safety, select **PROFIsafe** and configure as needed.



Enabling PROFIsafe

1. Enter the robot safety password and tap **Unlock**.
2. Use the switch button to enable PROFIsafe.
3. Enter a source address and destination address into the corresponding boxes.

   These addresses are arbitrary numbers used by the robot and the safety PLC to identify each other.
4. You can switch the Control Operational Mode to the ON position if you want PROFIsafe to control the robot operational mode.

   Only one source can control the operational mode of the robot. Therefore other sources of mode selection are disabled when operational mode selection via PROFIsafe is enabled.

The robot is now setup to communicate with a safety PLC.
You cannot release the robot's brakes if the PLC is not responding or if it is misconfigured.