SIEMENS

Climatix™

Modbus communication

Basic Documentation

Building Technologies

Legal note

Legal note concept

This guide includes notes that must be followed for your own personal safety as well as to prevent damage to property.

Notes on your personal safety are identified by a warning triangle and use the signal word CAUTION.

CAUTION identifies a situation that can result in slight injuries.

Notes dealing only with damage to property do not have the warning triangle and use the signal word NOTICE and an exclamation point.

The notes are depicted as follows:

⚠	⚠ CAUTION
	Type and source of hazard
	Consequences in the event the hazard occurs
	• Measures/prohibitions to prevent the hazard

❗	*NOTICE*
	Type and source of hazard
	Consequences in the event the hazard occurs
	• Measures/prohibitions to prevent the hazard

Qualified personnel

Only qualified personnel may commission the device/system. In this regard, qualified personnel have the training and experience necessary to recognize and avoid risks when working with this device/system.

Proper use

The device/system described here may only be used in building technical plants and for the described applications only.

The trouble-free and safe operation of the device/system described here requires proper transportation, correct warehousing, mounting, installation, commissioning, operation, and maintenance.

You must comply with permissible ambient conditions. You must comply with the information provided in the Section "Technical data" and any notes in the associated documentation.

Fuses, switches, wiring and grounding must comply with local safety regulations for electrical installations. Observe all local and currently valid laws and regulations.

Exemption from liability

The content of this document was reviewed to ensure it matches the hardware and firmware described herein. Deviations cannot be precluded, however, so that we cannot guarantee that the document matches in full the actual device/system. The information provided in this document is reviewed on a regular basis and any required corrections are added to the next edition.

Cyber security disclaimer

Siemens provides a portfolio of products, solutions, systems and services that includes security functions that support the secure operation of plants, systems, machines and networks. In the field of Building Technologies, this includes building automation and control, fire safety, security management as well as physical security systems.

In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art security concept. Siemens' portfolio only forms one element of such a concept.

You are responsible for preventing unauthorized access to your plants, systems, machines and networks which should only be connected to an enterprise network or the internet if and to the extent such a connection is necessary and only when appropriate security measures (e.g. firewalls and/or network segmentation) are in place. Additionally, Siemens' guidance on appropriate security measures should be taken into account. For additional information, please contact your Siemens sales representative or visit https://www.siemens.com/global/en/home/company/topic-areas/future-of-manufacturing/industrial-security.html.

Siemens' portfolio undergoes continuous development to make it more secure. Siemens strongly recommends that updates are applied as soon as they are available and that the latest versions are used. Use of versions that are no longer supported, and failure to apply the latest updates may increase your exposure to cyber threats. Siemens strongly recommends to comply with security advisories on the latest security threats, patches and other related measures, published, among others, under https://www.siemens.com/cert/en/cert-security-advisories.htm.

Table of contents

1 About this document

1.1 Revision history

Date	Changes	Section
Current edition	• Various improvements and corrections • New section "Practical guide: RS485 / Modbus communication"	all sections 3
2015-10-15	POL42x.x0/STD information added and some corrections	1.1, 1.2, 1.3, 2.2, 2.3, 2.6, 3.1, 3.2
12.01.2015	• Main chapter 2 reworked and amended • Parameter lists replaced • Table of file names updated	2.2 to 2.6 3.5, 4.3 5.3
02.12.2013 (internal)	• Product version VVS 9.0 • Minor text enhancements and corrections	1.2 2.5, 3.1, 3.5, 4, 5.4
30.09.2011	Additional information on wiring topics	2.2, 2.3, 2.4, 2.5
27.09.2010	• BUS LED explanation, enhanced • New parameters • Troubleshooting tips, supplemented	3.4 3.5 5.1
01.03.2010	First edition	

1.2 Before you start

Validity

The documentation applies to the products with one or more Modbus interfaces (A+, B-, REF) respectively with an internal Modbus TCP interface.

Product versions

Description and functional scope of the products are based on the Climatix Valid Version Set 10.0 or higher and application per Siemens standard.

Target audience

This document is intended for the following audience:
- Modbus system integrators
- Measuring and control technicians
- Sales and commissioning personnel

Requirements

The above target audience:
- Has general professional knowledge on planning and commissioning measuring and control solutions for HVAC.
- Has basic knowledge of Modbus
- Has the document with the references for the specific product.

1.3 Further documentation

Further information

The following documents contain additional information on the products described in this manual

Document	Document ID
Data sheet "Modbus communication module POL902"	Q3934
Basic documentation "Modbus communication module POL902"	P3934en
Overview, "Reference addresses, Modbus communication, slave mode" Note! Specific documentation for each application.	Z2911en
Basic documentation "Climatix AHU application" Note! Specific documentation for each application.	P3997
Basic documentation, "Climatix DH1 application" Note! Specific documentation for each application.	P2910

1.4 Abbreviations

The following abbreviations are used in text and illustrations:

Abbreviation	Meaning
BSP	Board Support Package (operating system)
Climatix	Siemens controller range with common tools
HVAC	Heating Ventilation AC
HMI	Human Machine Interface, z.B. Bediengerät
HMI-DM	Climatix Dot Matrix HMI, POL895.51 or POL871.xx
RTU	Remote Terminal Unit
SELV	Safety Extra Low Voltage
TCP/IP	Transmission Control Protocol, e.g. Ethernet/Internet

1.5 Important information on electrical installation

⚠ CAUTION
Electrical shock
• Fuses, switches, wiring and grounding must comply with local safety regulations for electrical installations.
• When wiring, strictly separate AC 230 V mains voltage from AC 24 V safety extra-low voltage (SELV) to protect against electrical shock.

1.6 Trademarks and copyrights

Trademarks, legal owners

The table below lists the third-party trademarks used in this document and their legal owners. The use of trademarks is subject to international and domestic provisions of the law.

Trademarks	Legal owner
Modbus®	The Modbus Organization, Hopkinton, MA, USA

All product names listed in the table are registered (®) or not registered (™) trademarks of the owner listed in the table. We forgo the labeling (e.g. using the symbols ® and ™) of trademarks for the purposes of legibility based on the reference in this section.

Copyright

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1.7 Quality assurance

Document contents

These documents were prepared with great care.
- The contents of all documents are checked at regular intervals.
- All necessary corrections are included in subsequent versions.
- Documents are automatically amended as a consequence of modifications and corrections to the products described.

Please make sure that you are aware of the latest document revision date.

1.8 Document use/request to the reader

Request to the reader

Before using our products, it is important that you read the documents supplied with or ordered at the same time as the products (equipment, applications, tools etc.) carefully and in full.

We assume that persons using our products and documents are authorized and properly trained and have the requisite technical knowledge to use our products as intended.

Exemption from liability

Siemens assumes no liability to the extent allowed under the law for any losses resulting from a failure to comply with the aforementioned points or for the improper compliance of the same.

2 Modbus networks

2.1 Modbus protocol

Purpose of this section

This section provides a brief overview of the Modbus protocol.

For the full specification, see "Modicon Modbus Protocol Reference Guide PI MBUS 300 Rev. J".

Master/slave protocol

The Modbus is a master/slave protocol. This, by definition, means that a Modbus network contains only one master and at least one slave.

Telegrams on Modbus

The Modbus master uses a slave query to start transmitting data on the network. The slave either responds positively with the requested service (response) or transmits an "exception message".

Function codes

The type of transaction is defined by the function code transmitted in the Modbus telegrams.

A function code defines the following:

- Structure of the telegram, query and response.
- Direction of data transmission (master → slave or slave → master).
- Data format of data point.

Transmission modes

The Modbus protocol defines two alternative serial transmission modes: These modes have the following characteristics:

RTU (Remote Terminal Unit) mode

- Binary-coded data.
- The individual telegrams are marked by send pauses ("silent intervals").
- CRC (cyclical redundancy check) identify data faults.

ASCII mode

- Hexadecimal data as ASCII code.
- Beginning and end of telegrams marked by start and end characters.
- LRC (longitudinal redundancy check) identifies data faults.

Telegrams with multiple data points

Certain types of Modbus transactions allow for transmission of a variable number of Modbus data points in a single telegram.

Modbus TCP Ethernet

A Modbus TCP/RTU gateway helps connect a Modbus/TCP master to one or several Climatix controllers (slaves) if no Climatix controller with internal TCP/IP onboard is available:
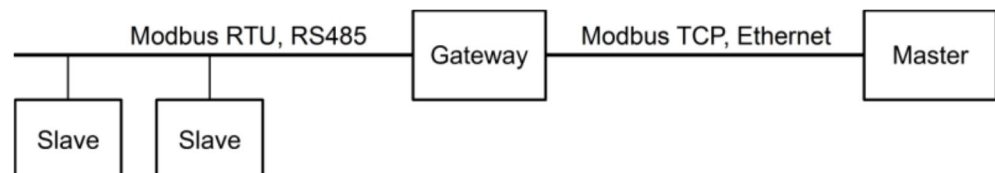
The Modbus TCP/RTU gateway acts as a Modbus/TCP slave on an Ethernet network and transforms the queries to the serial Modbus network and back.

For more information on Modbus:

See www.modbus.org

2.2 RS485 networks

RS485 definition

RS485 is a balanced line, half-duplex transmission system that meets the requirements for a truly multi-point communications network. The standard specifies up to 32 drivers and 32 receivers on a single (3-wire) bus.

Half-duplex data transmission means that data can be transmitted in both directions on a signal carrier, but not at the same time.

More than 32 devices on one RS485 trunk

This is possible using a repeater. A repeater is not always necessary, however:

- Although based on just 32 full load devices, most RS485 chips now require less than the specified unit load since initial development.
- Today, some devices on the market require only half or a quarter of the load units.

Refer to the associated data sheets and count the required load to determine how many devices you can install. This data is located in "UL" ("Unit Load").

Unit loads of Climatix devices

The following table outlines the Climatix devices that are using 3-wire RS-485 network interfaces:

Product name	Modbus protocol	Unit load	Isolated RS485 common
Controllers			
POL42x	Master/slave	1	no
POL46x	Master/slave	1. interface: 1	yes
	Master/slave	2. interface: 1	no
POL63x	Master/slave	0.25 (1/4)	no
POL687	Master/slave	0.25 (1/4)	yes
POL6x8	Master/slave	1. interface: 1	yes
	Master/slave	2. interface: 1	no
POS3x	Master/slave	1. interface: 0.125 (1/8)	no
	Master/slave	2. interface: 0.125 (1/8)	no
Communication module			
POL902	Slave	1. interface: 1	yes
	Slave	2. interface: 1	yes

Topology

An RS485-MODBUS configuration without repeater has one trunk cable, along which devices are connected, either directly (daisy chaining) or by short derivation cables.

2.3 Topologies

Introduction

The RS485 standard is simple and well-proven, but choosing the right topology is important. This starts with the selection of the topology.

Best: Individual line

The best topology is a single line (line topology), with the bus cable connected directly to the individual devices. This type of connection has the least problems.
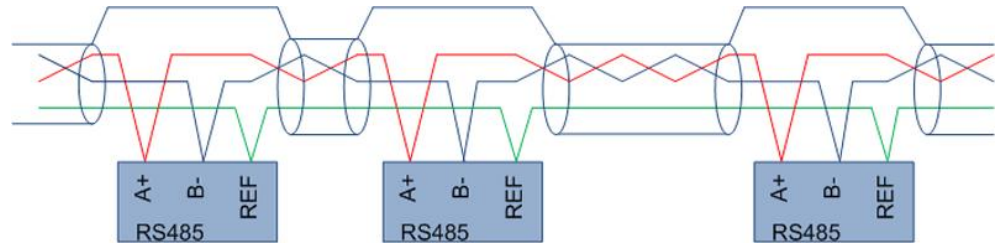
Disadvantages of intermediate terminals

Connecting network devices via intermediate terminals can result in reflections and harmonics of electrical signals. Long, untwisted intermediate lines increase the risk of interference.
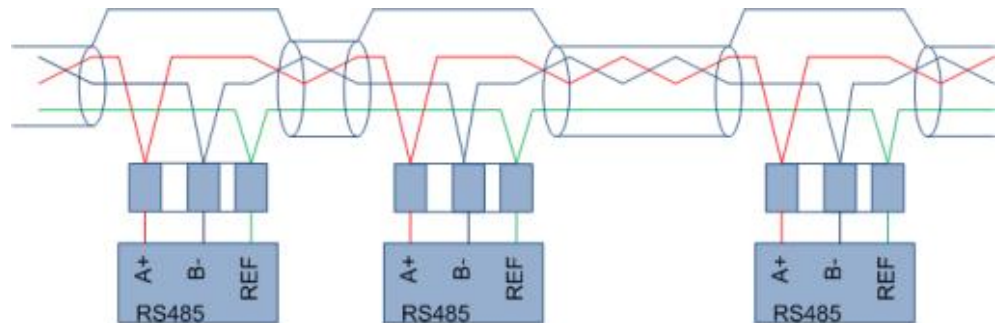
Error-prone: Star

Do not use star topologies!

They are prone to errors and troubleshooting is difficult to localize and correct.

Note on figure: Only one line + (A+) is shown in this example.

2.4 RS485, cable installation

Background

Task of the third wire

The Climatix Modbus network interface is a 3-wire RS-485 interface with a common reference (REF) signal to improve noise immunity and ensure high data security.

Naming

The name of the third wire on a 3-wire network interface varies by manufacturer (for example: Common, Ground, Com. SC (Signal Common), R (for Reference), GND, SG (Signal Ground) or REF (e.g. in Climatix)).

Function

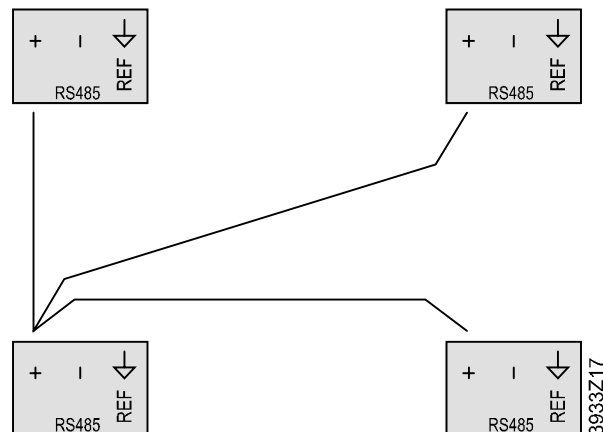This connection is for a common reference signal. Voltage on lines Tx/Rx (or +/-) is measured relative to the voltage level on the reference signal.

Grounding the REF terminal

- Connect the "REF" (common signal) to the protective ground, at only **one** point on the bus. Generally this point is on the master device or its connection.
- Test the wire with a DMM before connecting the "REF" (common signal) to the protective ground (this ensures that it is not already connected to the ground). Correct the fault condition if the wire is connected to protective ground before terminating the wire to the protective ground.
- You do not need to connect the "REF" (common signal) to the protective ground if it is already connected internally to a protective ground for a Modbus node.

Further tips

Risks due to missing third wire

Not using a third wire may:
- Destroy RS485 inputs.
- Result in unstable operation.
- Require a new installation.

The risks are greater:
- The higher the number of feeds to supply devices.
- The greater the physical separation.
- If fewer well grounded devices and feeds are used.

Screening not required	Screening is not required. The twisted cable for Tx and Rx suppresses interference more effectively than a screen.

!	*NOTICE*
	Wrong installation
	Do not use the shield as the "third wire"!

i	Shielding foil and drain wire provide additional noise protection.

Observe cabling	Observe the following when running the bus cable:

- Do not wind the bus cable around other cables or electric/magnetic sources (e.g. around a motor cable).
- Do not run the bus cable next to DC load switches (e.g. relay); the represent the main sources of induced interference.
- Caution around frequency-controlled actuators!
- Protect bus cable against unwanted movement (e.g. due to vibrations).

Cable type

Use a single twisted pair cable with third wire (1.5-pair) as the network cable on a 3-wire (isolated RS-485 common) connection; it keeps the RS-485 reference (communication common) together for all nodes on the network.
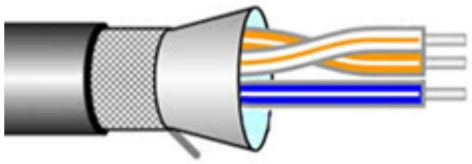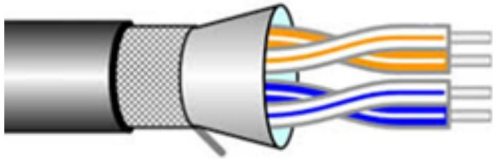
Impedance

Each cable has its own impedance. We recommend using cables with impedance that is relatively independent of length. Refer to the nominal impedance as a starting point:

- A cable is well suited if a number, e.g. 100 Ohm, is indicated.
- Do not use cables if impedance is indicated by meter/foot: The cables must be measured and calculated to determine the terminating resistance.
- • Select a cable with the lowest possible capacity.

Cat5 cables?

Cat5 cables are well suited: Use a twisted pair for Tx/Rx and a wire (1.5-pair) or the other pair (2-pair) for the reference signal (REF).

We recommend the following cables:

Manufacture/Type	Specification
Belden 3106A	Multi-Conductor - EIA Industrial RS-485 PLTC/CM • 22 AWG stranded (7×30) tinned copper conductors, • Datalene® insulation, • twisted pairs, • overall Beldfoil® shield (100% coverage) plus a tinned copper braid (90% coverage), • drain wire, • UV resistant PVC jacket.
Belden 3107A	Multi-Conductor - EIA Industrial RS-485 PLTC/CM • 22 AWG stranded (7×30) tinned copper conductors, • Datalene® insulation, • twisted pairs, • overall Beldfoil® shield (100% coverage) plus a tinned copper braid (90% coverage), • drain wire, • UV resistant PVC jacket.

Cable length and baud rates

The end-to-end length of the trunk cable (Bus) is limited. The maximum length is based on the baud rate, cable (Gauge, Capacitance or Characteristic Impedance), number of loads on the daisy chain, and network configuration.

Note the following:

- For a 9600 baud rate and AWG26 (or wider) gauge, the maximum length is 1000m.
- Stub lines must be short, never longer than 20m.
  For a multi-port tap with n stub lines, limit each stub length to 40 m divided by n to determine the maximum length.
- The higher the baud rate, the more sensitive the cable reacts to installation quality. Quality here refers, for example, to the number of twisted pairs that are wrapped around each connection.

2.5 Wiring examples

Climatix devices with Modbus master

Climatix POL63x Modbus master

The following illustrations show the correct wiring for Climatix POL63x controllers and POL902 communication modules with the Modbus master:
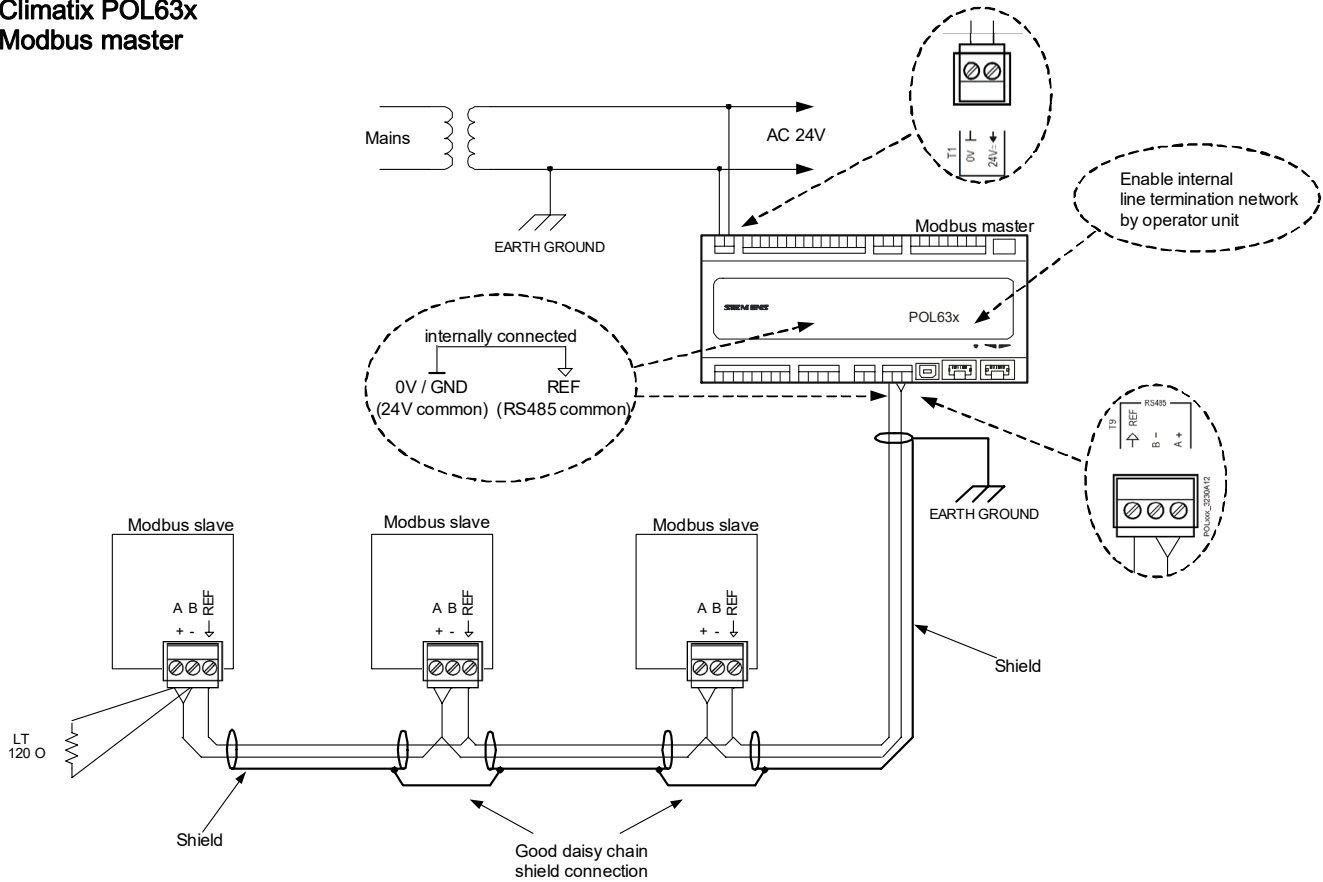
Climatix POL63x with POL902 Modbus slave
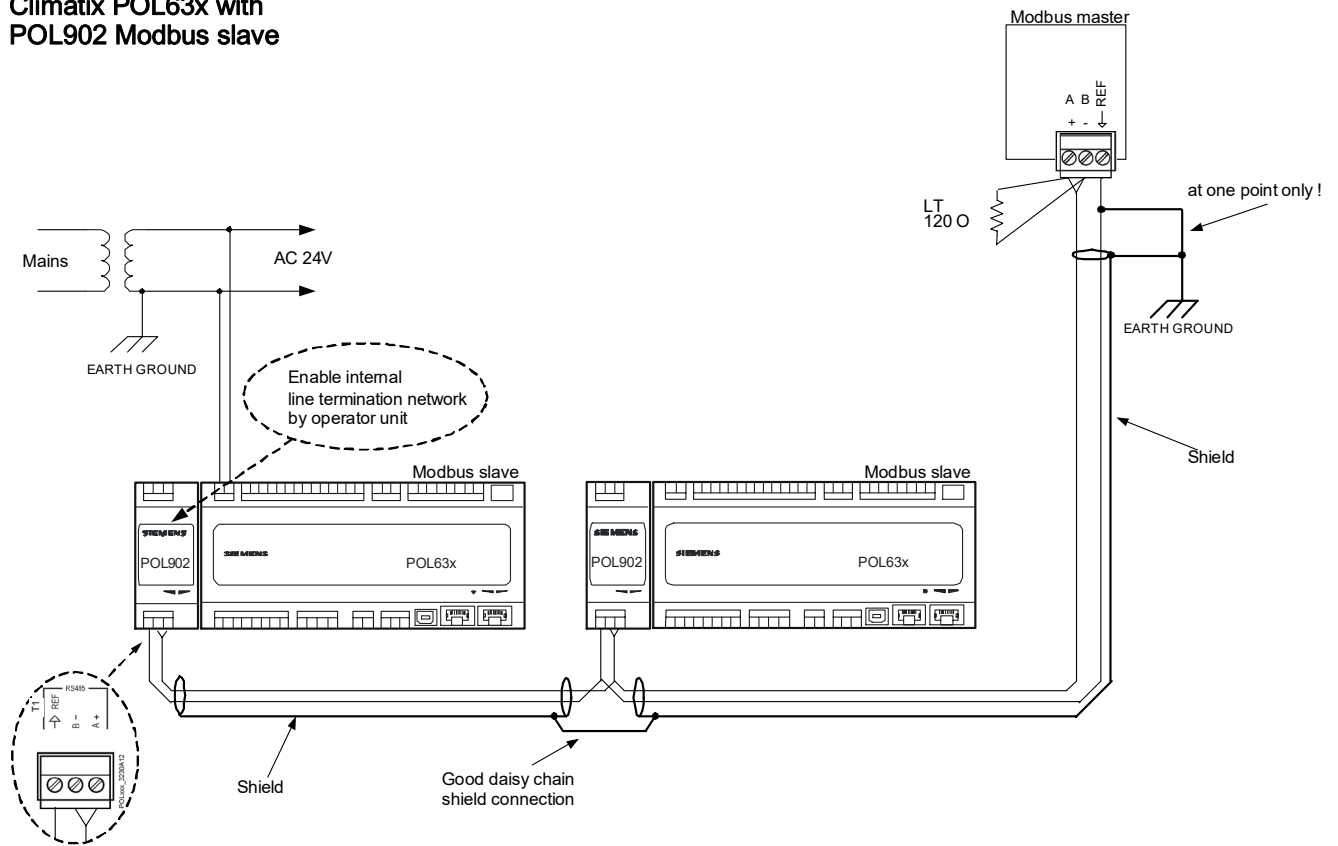
!	NOTICE
	Note the installation instructions in section "RS485, cable installation [➔ 13]".

2.6 Line termination/polarization

Line termination

Terminate each end of the line to minimize reflections from the end of the RS485-cable.

Polarization

Wires are not controlled if there is no data activity on an RS-485 bus and are therefore susceptible to external noise or interference.

Some devices require line polarization resistors (pull up/pull down) to bias the network to ensure the receiver stays in a constant state. The Modbus master normally does this.

Climatix POL6.. and POL902

The line termination and polarization can be switched on at only one end of the RS-485 line. The termination must be set externally or using a device at the other end that only switches on the internal termination (without polarization).

Example for Climatix POL6.. and POL902:
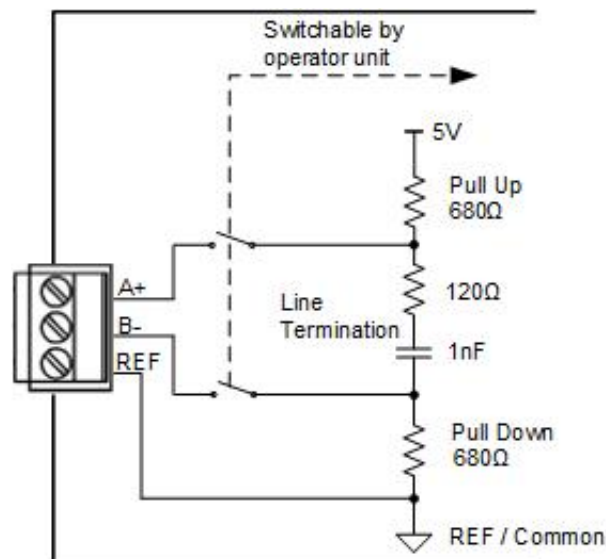
Climatix POL42x

Polarization can be switched on (only used on Modbus master devices). External line termination with a 150 Ω resistor is required at each end of the RS-485 line.

Example for Climatix POL42x:
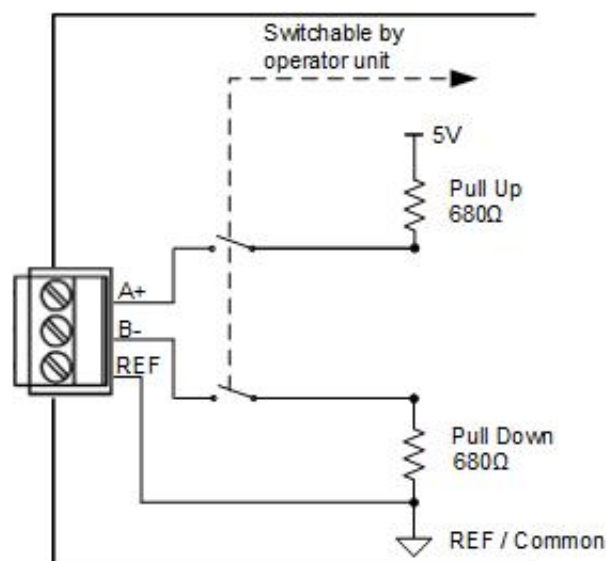
2.7 TCP/IP networks

Modbus TCP port Modbus TCP in Climatix (POL638 and POL687) uses TCP port 502 and is fixed.

IP address The IP address is assigned either dynamically via the DHCP server or set manually via HMI. A fixed IP address is normally used.

Modbus IP port A controller used as a server (slave) can operate 3 Modbus IP clients. For example, 3 touch panels can be connected to the same controller.

The onboard IP port can be used as the Modbus IP port. Furthermore, the WEB@HMI (web browser) can be used for simultaneous remote service.

2.8 Tools

Modbus master simulation tools Modbus slave devices, e.g. Climatix controllers, can be tested with several Modbus master simulation tools, such as "Modbus Poll" or "Modicon". "Modbus Poll" can be downloaded at www.modbustools.com.

A RS485/RS232 converter or a Modbus RTU/TCP gateway may be required to connect to a computer.

3 Practical guide: RS485 / Modbus communication

3.1 RS485 bus standard
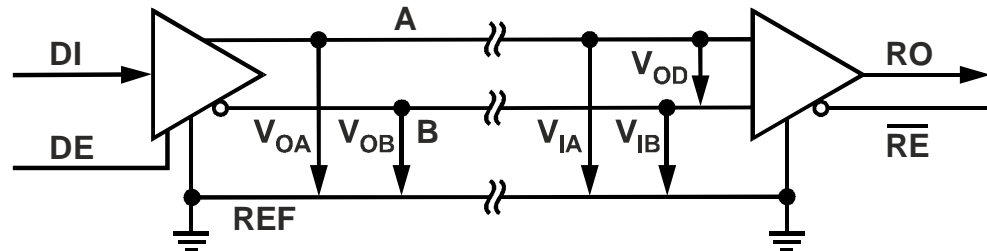
DI	data input	RO	receiver output
DE	data enable	RE	receiver enable

- The RS485 uses differential data transmission.
- And therefore has two differential lines (A+ and B-).
- Both lines (A+ and B-) are referred to REF.
- Normal voltage level of lines (A+ and B-) to REF is 5V.
- Maximum receiver input voltage (VIA, VIB) is limited to -7V....+12V.

ℹ️ For communication between all devices a reliable reference is required on the RS485 bus.

3.2 Introduction: Isolated/non-isolated nodes

3.2.1 Isolated RS485 interface

Some RS485 interfaces are isolated from system ground.

For example the controller POL687 and the communication modules POL902, POL904 have an isolated RS485 interface.

This isolation is more expensive but has the following advantages:

- Greater EMC immunity
- Increased robustness against potential differences between the device nodes
- No risk of equalizing current on the REF line

Recommendation

Use non-isolated RS485 interfaces only on local devices in close proximity to the machine. Always use isolated interface on longer distances outside the machine.

3.2.2 Non-isolated RS485 interface

Some RS485 interfaces are not isolated from system ground.

For example controllers POL63x and POL42x have non-isolated RS485 interfaces.

This is less expensive but the following restrictions to panel design must be considered:

- Maintain the REF potential differences between all bus devices within ±5V
- Avoid higher equalizing current on REF line (risk of burning cable
- Avoid current loops

Recommendation

Use non-isolated RS485 interfaces only on local devices in close proximity to the machine.

3.2.3 Wiring example: Three isolated nodes
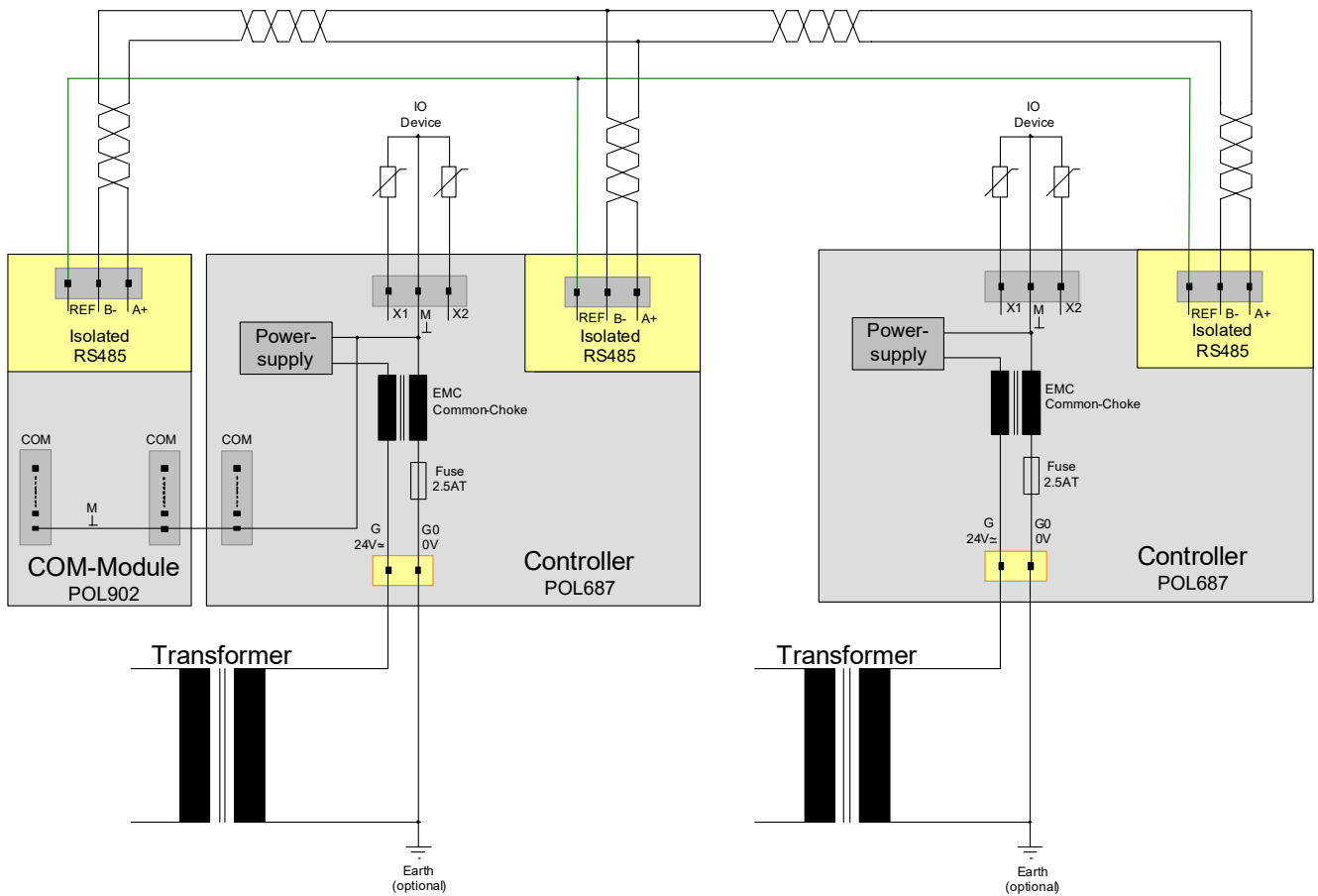
3.2.4 Wiring example: Two isolated nodes and one non-isolated node
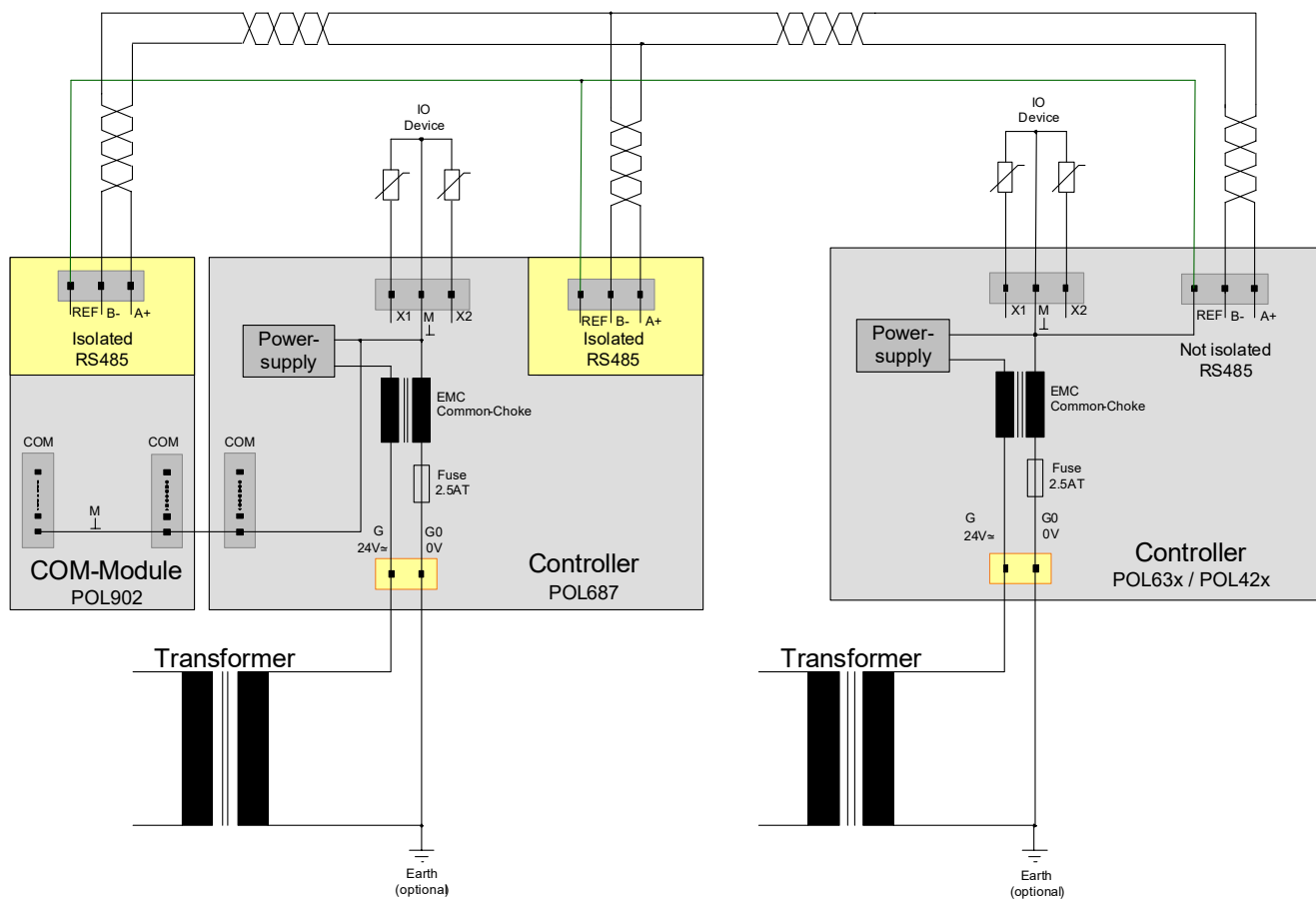
Note	Some restrictions must be considered (see next pages) if more than one non-isolated node is connected to the RS485 bus.

3.3 More than one non-isolated node

3.3.1 Two controllers with own isolated supply sources
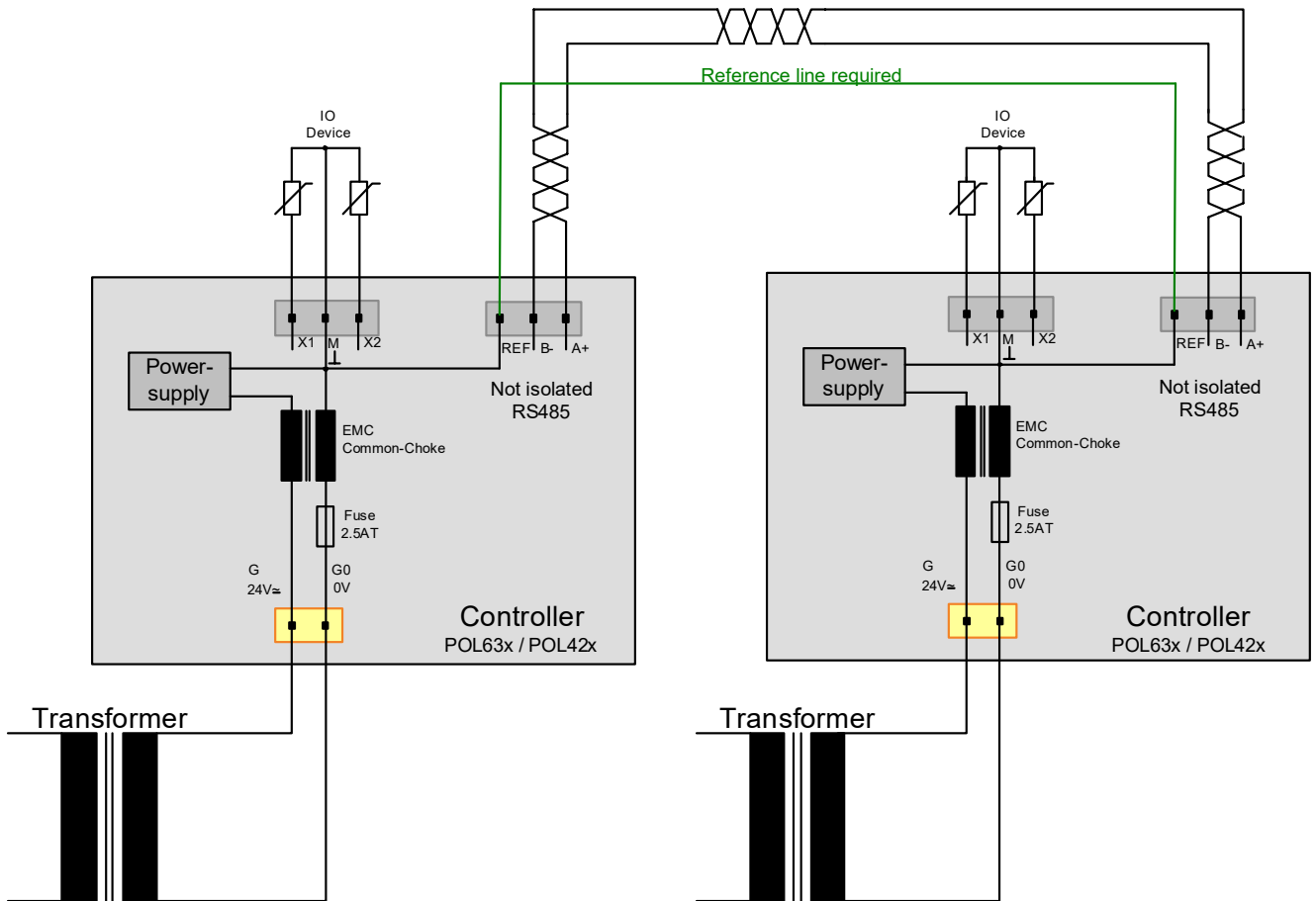
Use the REF line for proper operation of the RS485 bus if each RS485 node has a separate, isolated power supply.

3.3.2   Two controllers with same supply source
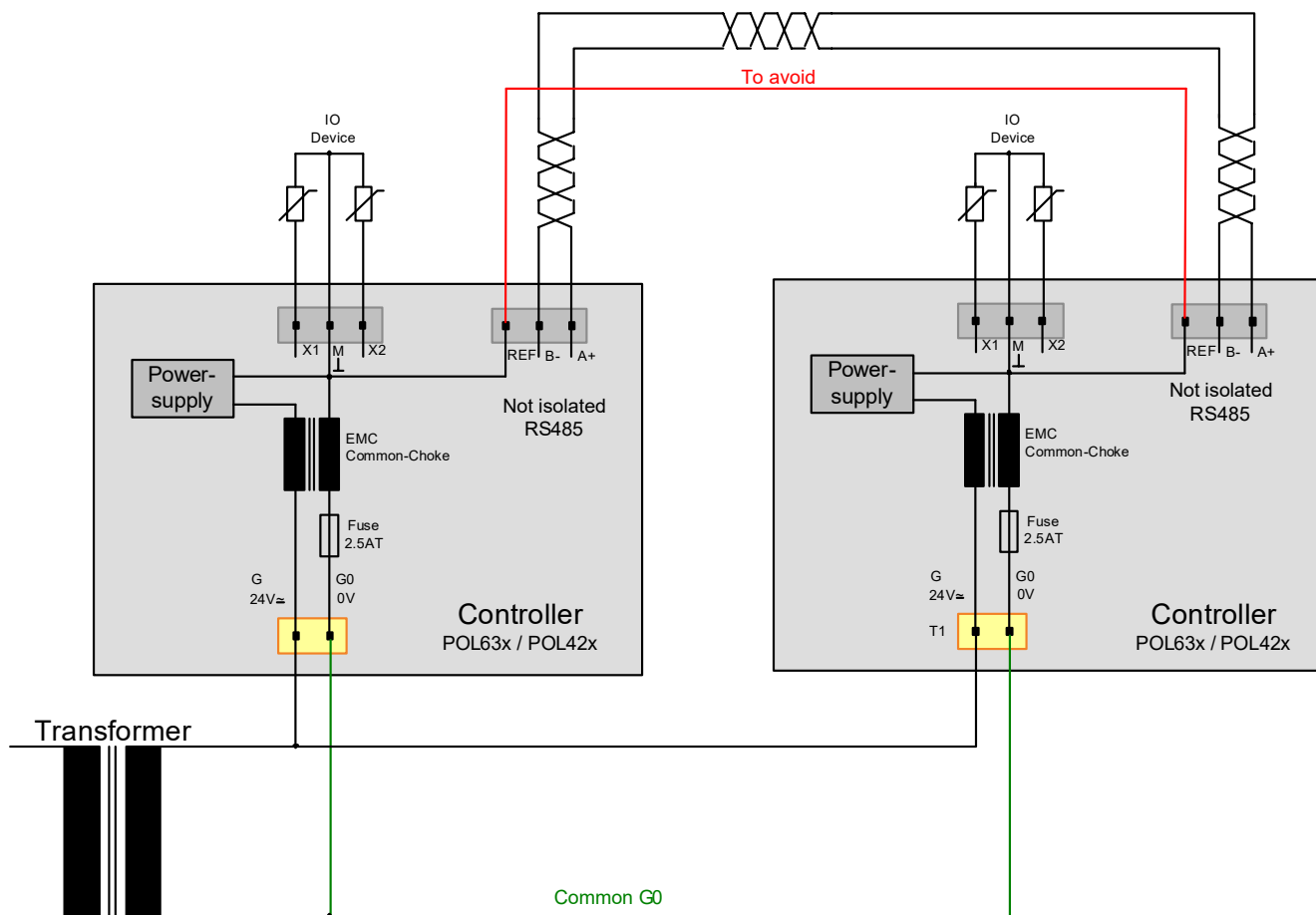
Both RS485-Interfaces can be referred using the common G0 connection.

In this case, you must disconnect the REF:

- to avoid bypassing the fuse
- to avoid high current on the REF line if G0 becomes disconnected

3.3.3 Two controllers with own supply source, and G0 is connected to ground
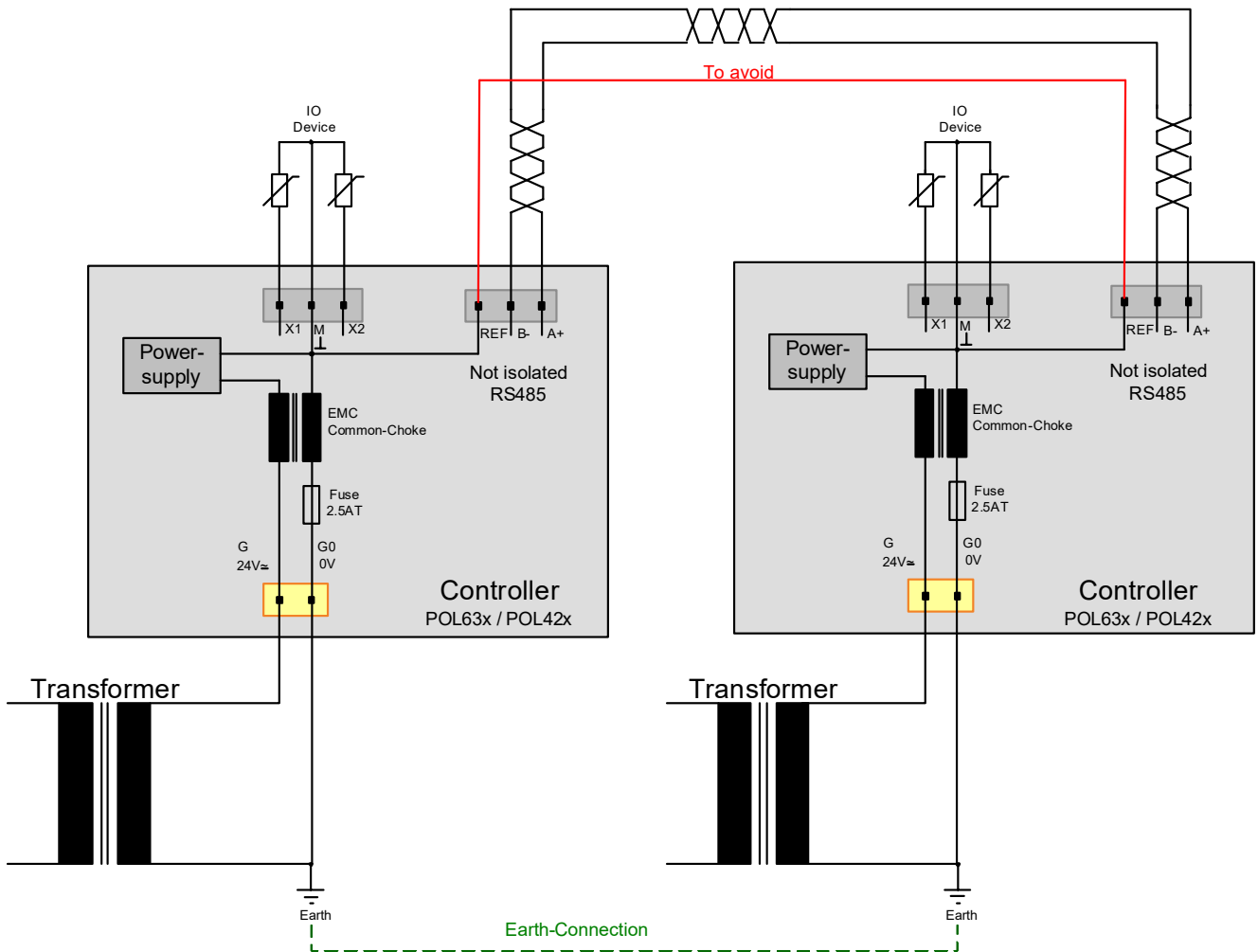
Both RS485-Interfaces can be referred using a low impedance ground connection. Disconnect the REF in this case:

- to avoid bypassing the fuse
- to avoid high current on REF line if G0 becomes disconnected

4 Commissioning

4.1 General

Connections

There are up to 3 ways to communicate with a Climatix controller over Modbus:

- Internal RTU (e.g. POL42x, POL63x)
- Internal TCP (e.g. POL638)
- External communication module POL902

Internal RTU

- A Modbus RTU interface, via RS485, is available by default on basic controllers.
- The interface can be defined as the master or slave or switched off.
- The internal Modbus interface is automatically set to master if any master function is enabled in the controller.

Internal TCP

- A Modbus TCP interface, via RS485, is available for example on POL638.
- The internal Modbus TCP interface is primarily used for slave mode.
- It can be used for slave mode even if the RS485 port is used as master.

Communication module POL902

The communication module POL902 is the slave interface. It has two separate channels.

Prerequisite

Prerequisite for commissioning the aforementioned communications:

A **working application** is loaded and started on the Climatix controller.

4.2 Commission internal Modbus RTU, slave mode

Active devices

The picture shows the devices and connections involved in commissioning:
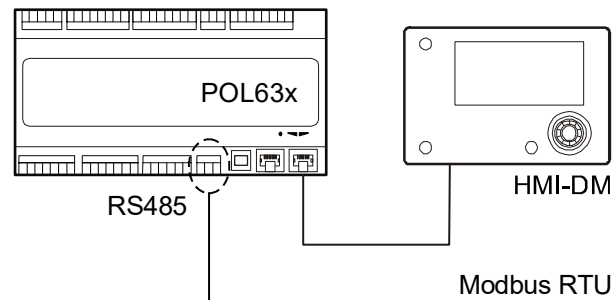
Connection

Proceed as follows to connect the Climatix controller to the Modbus line:

Step	Action
1	Controller **OFF**.
2	Connect Modbus bus cable to the RS485 interface (pins A+ and B-, REF for GND).
3	Controller **ON**.

Configuration via operator unit

Proceed as follows to configure the controller for internal Modbus RTU:

Step	Action (AHU3.xx)
1	Log in to HMI with the level 4 password (Service), Default **2000**.
2	Select **Main menu > Communication > Modbus >**
3	Select **+Internal settings > RS485 ModBus > Modbus internal:** Slave. **NOTICE! The integrated RS485 cannot be used as slave if already used as master. This slave function is disabled in this case.**
4	Select **Modbus slave addr**. Enter the corresponding Modbus slave address (1…247).
5	Select **Baud rate**. Enter the transmission rate as per the Modbus (2400, 4800, 9600, 19200, or 38400). **NOTICE! All participants must have the same setting.**
6	Select **Parity**. None, Even, or Odd. **NOTICE! All participants must have the same setting.**
7	Select **Stop bit**. One or Two stop bits. **NOTICE! All participants must have the same setting.**
8	Select **Modbus delay time**. Delays the response by n milliseconds.

-	**Response timeout** . Access time if used as master.
	The master must undertake read access within this period, otherwise an alarm is triggered. This has no influence on the Modbus slave mode.
9	Select **Termination**.
	Always terminate the RS485 topology with wave resistors (described in section 2.6).
10	Select **Reset required !**
	When done, restart controller using this command.
Extra	**Modbus Comm** is the alarm object and settings like alarm class, etc., for Modbus faults can be changed here.

- After restart, the internal Modbus RTU is configured and ready to use.
- As a matter of principle, the controller must be restarted with **"Reset required !"** or power off/on the controller after changing any settings to assume the data.
- Settings other than those described above have nothing to do with Modbus RTU slave mode and should not be changed.

4.3 Internal Modbus TCP interface

Active devices

The picture shows the devices and connections involved in commissioning:
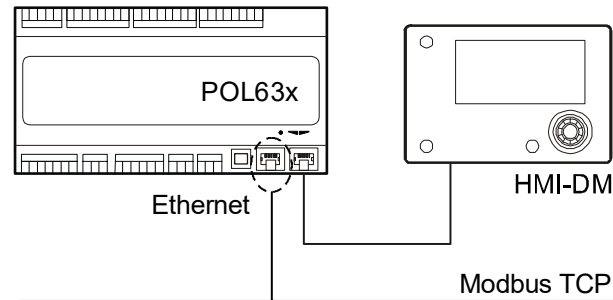
Connection

Connect the Climatix controller to the Ethernet (Modbus TCP) with a standard network cable.

Configuration via operator unit

Proceed as follows to configure the controller for internal Modbus TCP:

Step	Action (AHU3.xx)
1	Log in to HMI with the level 4 password (Service), Default **2000**.
2	Select **Main menu > Communication > Modbus >**
-	Note: The internal RS485 Modbus settings have no influence for Modbus TCP.
3	Select **+Internal settings > IP-Config >** *Note:* Settings for TCP/IP can also be displayed and changed in: **Main Menu > System > Communications > IP-Config >**
-	**NOTICE! Take care to change TCP/IP setting if the controller is already connected to Ethernet for other purpose.**
4	Select **DHCP**. • Active: DHCP server issues addresses. • Passive: IP address is fixed (normally)
5	Select **Given IP**. Enter controller IP address if DHCP is set to passive.
6	Select **Given Mask**. Enter subnet mask if DHCP is set to passive.
7	Select **Given Gateway**. Enter gateway address if DHCP is set to passive.
8	Select **Reset required !** When done, restart controller using this command.

- After restart, the internal Modbus TCP is configured and ready to use.
- As a matter of principle, the controller must be restarted with **"Reset required !"** or power off/on the controller after changing any settings to assume the data.
- Settings other than those described above have nothing to do with Modbus TCP slave mode and should not be changed.

4.4 Modbus module

Design

The figure shows the Modbus module. Properties:

- Two galvanically separated RS485 interfaces.
- Connection to the Climatix controller via internal communications extension bus using the plug on the controller's left.
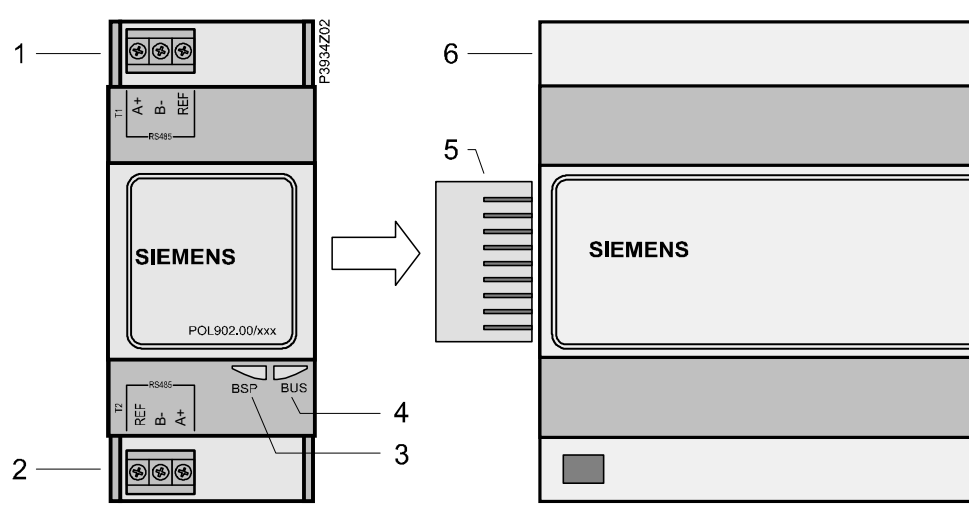
Elements and connections

The elements and connections in the figure are:

Pos.	Element/Pin
1	Modbus RS485 interface T1 (slave, channel 1).
2	Modbus RS485 interface T2 (slave, channel 2).
3	Status display "BSP" (Board Support Package).
4	Status display "BUS" (bus connections o.k./bus traffic).
5	Plug connection (Communication extension bus).
6	Climatix controller POL6..

Status LEDs | The status LEDs "BSP" and "BUS" can light red, green and orange during operation.

| LED	Color	Flashing frequency	Meaning/operating mode
BSP	Red/green	1 s red/1 s green	BSP upgrade mode in progress
	Green	Steady on	BSP operating and communication with controller working
	Orange	Steady on	BSP operating, but no communication with controller or BSP upgrade mode active
	Red	Flashing at 2 Hz	BSP error (software error)
	Red	Steady on	Hardware fault
BUS	Green	Steady on	• All communication is running, or • Timeout is set to zero (communication monitoring is disabled)
	Orange	Steady on	• Startup, or • One configured channel is not communicating to the master (2 interfaces activated, but communication of one (T1 or T2) is interrupted)
	Red	Steady on	• All configured communications are down (no communication to the master within set timeout), or • Mapping file not loaded

🛈 | If both LEDs stay dark: Power supply is outside the allowed range.

4.5   Commission Modbus modules

Active devices   The picture shows the devices involved in commissioning:

Modbus RTU

J3960Z04

POL902 / POL6XX

HMI-DM
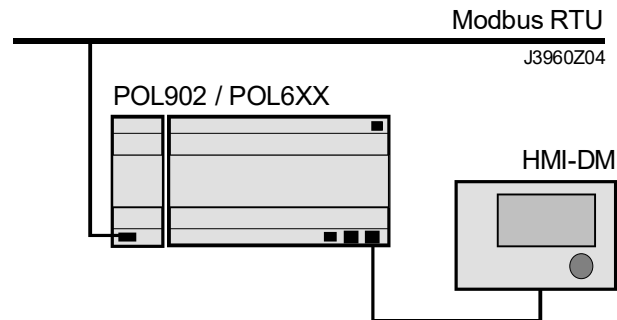
Connect Modbus module   Proceed as follows to connect the Modbus module to the Modbus bus via RS485:

Step	Action
1	Controller **OFF**.
2	Connect Modbus module to controller using plug connection.
3	Connect Modbus bus cable to Modbus module (pins + and -, REF for GND). • Use the T1 interface if only one master/bus is connected. • Use the T2 interface to connect an additional master/bus.
4	Controller **ON**. • The module starts/initialization begins. • Communication with the controller and Modbus bus is active as soon as the two LEDs "BSP" and "BUS" are steady green. **NOTICE! The controller must be reset a second time to update HMI; prior to parameterization.**.

Configuration via operator   Proceed as follows to configure the Modbus module for Modbus RTU step-by-step:
unit

Step	Action (AHU3.xx)
1	Log in to HMI with the level 4 password (Service), Default **2000**.
2	Select **Main menu > Communication > Communic.modules > Module[x] Modbus >** or **Main Menu > System > Communication > Communic.modules > Module[x] Modbus >** Note! [x] is the position of the connected communication module. This is only information used when more than one module is connected.
3	Select **+Channel [y] >** Channel 1/Channel 2. Displays as of this point the data for the first (channel 1, terminal T1) and the second Modbus channel (channel 2, terminal T2) of the module. These are the corresponding parameters, with the exception of Enable.
-	Select **Enable**. Only for channel 2. Set to **Active** to enable channel 2 (T2).
4	Select **Slave address**. Enter the corresponding Modbus slave address (1…247). Must be unique on the RS485 network.
5	Select **Baud rate**. Enter the transmission rate as per the Modbus (2400, 4800, 9600, 19200, and 38400). All participants must have the same setting.
6	Select **Stop bit**. One or two stop bits All participants must have the same setting.

7	Select **Parity.** None, Even, or Odd. All participants must have the same setting.
8	Select **Response delay**. Delays the response by n milliseconds.
9	Select **Termination**. Always terminate the RS485 topology with wave resistors (described in section 2.6).
10	Select **Timeout comm**. Timeout for the communication watchdog. The BUS LED goes to red or yellow if one or both of the interfaces/channels has no communication to the master within the set time. The watchdog is disabled if the timeout is set to zero.
11	Select **Reset required !** When done, restart the controller using this command.

- After restart, the Modbus module is configured and ready to use.
- As a matter of principle, the controller must be restarted with **"Reset required !"** or power off/on the controller after changing any settings to assume the new values.
- Other settings than described above are only options and are normally not being changed.

Some applications use the name channel 0 for terminal 1 and channel 1 for terminal 2 and other applications may use the same channel number as for the terminal.

Parameter list

The following table lists all other Modbus module parameters which are displayed by the HMI in the "Module[x] Modbus" page:

Parameter	Explanation
State	Current status of the communication module.
Comm failure	Active = Communications error
Slave	Displays whether the channel is used
Timeout	Active = Indicates communication timeout
Software version	Module BSP version
Advanced	Go to Advanced settings -> see below
Eng. unit support	Displays units in the imperial system
Device ID	Module hardware ID
Modules	Com module type (e.g. POL902MOD).
Use default	Reset communication module parameterization to default setting.

5   Integration

5.1   Map registers

Modbus data formats   Modbus registers are organized into reference types identified by the leading numeric character of the reference address:

The "x" following the leading character represents a four-digit reference address.

Modbus type	Reference	Description (refers to a master device)
Coil status	0xxxx	Read/write discrete outputs or coils. A 0x reference address drives output data to a digital 1-bit output channel.
Input status	1xxxx	Read discrete inputs. The 1-bit status of a 1x reference address is controlled by the corresponding digital input channel.
Input register	3xxxx	Read input registers A 3x reference register contains a 16-bit number.
Holding register	4xxxx	Read/write output or holding registers. A 4x register stores 16-bits of numerical data (binary or decimal), or sends the data from the CPU to an output channel.

Leading character   The leading character is generally determined by the function code followed by the address specified for a given function. The leading character also identifies the I/O data type.

5.2   Function codes

Meaning   The functions below are used to access the registers outlined in the register map of the module for sending and receiving data.

Function codes	Modbus function	Modbus master application
01	Read CoilStatus-Register (ID-COIL)	Read coil registers (bit register) from slave: (0xAdr)
02	Read InputStatus-Register (ID-STATE)	Read state registers (bit register) from slave: (1xAdr)
03	Read Holding-Register (ID-HOLD)	Read holding registers (16 bit register) from slave: (4xAdr)
04	Read Input-Register (ID-INP)	Read input registers (16 bit register) from slave: (3xAdr)
05	Write Single Coil-Register	Write one single coil register (bit register) to slave: (0xAdr)
06	Write Single Holding-Register	Write one single holding register (16 bit register) to slave: (4xAdr)
15	Write multiple Coil-Register	Write multiple coil registers (bit registers) to slave: (0xAdr)
16	Write multiple Holding-Register	Write multiple holding registers (16 bit registers) to slave: (4xAdr)

5.3 Reference Modbus addresses

Register restrictions

The internal Modbus onboard the controller has a limited number of registers. Input and holding registers are limited to max 999 addresses.

Addresses used

All reference addresses from 0001-999 are generated and can be accessed even if not listed.

As a result, multiple coils/registers can be forced/reset even if there is a gap between two reference addresses.

!	*NOTICE*
	Error accessing addresses
	Accessing addresses above 999 cause exceptions and communication fails.
	• Do not read/write any addresses above 999.

i	All address types start with 1. However, some master devices start with 0. In this case, subtract all addresses in the reference list by 1.

Using the right document!

All available reference addresses are in a separate document and are specific to the actual application. Different applications, and in some cases application versions as well, have different reference addresses. Always use the specific document for the actual application with the correct, available reference addresses!

i	The actual application name and version can be viewed in the HMI. We recommend checking the controller's BSP version.

Check actual versions

Proceed as follows to see the actual application name and BSP versions:

Select **Main Menu > System > Versions >**

Parameter	Explanation/examples
+Plant info	
-Application manufacturer/name	e.g. Siemens
-Application name/date	e.g. STD_AHU_vX.XX
BSP version	Controller operating system
-Comm module 1	BSP communication module 1
-Comm module 2	BSP communication module 2
-Comm module 3	BSP communication module 2

Check actual versions (alternative)

Older application versions could have another HMI structure, with the same information located in a different place (in the English language version).

1. Select **Main Menu > System objects > Application info >**
2. Select **Main Menu > System objects > Version >**

6 Appendix

6.1 Troubleshooting, tips

General measures

There are a few important items to remember:

Item	Action
Versions	Check the actual application version, controller BSP and communication module BSP version before calling support.
Change settings	The controller must be restarted as a rule with "Reset required !!" or power off/on the controller after changing any settings for them to take effect.
Default settings	Use the "Use default" parameter to go back to communication module's default settings, reset the controller, and reconfigure it.

Modbus communication error

Failure to comply with the following rules may result in a communication error:

- The slave address must be unique on the network, valid addresses are from 1-247.
- Only reference addresses that are generated can be read/write, see Section 4.3, Reference Modbus addresses.
- All address types start with 1. However, some master devices start with 0. In this case, subtract all addresses in the reference list by 1.

RS485 network

Observe the following for RS485 network design and structure:

- Baud rate, parity and stop bits must match network and master. All devices, including third-party devices, on the Modbus network must have the same settings.
- The 3-wire bus is NOT interchangeable and must be connected correctly.
- Consider using end-of-line resistors (e.g. 120 Ohms) on both sides (according to RS485 rules) for long distances and/or high baud rates. This can be done via HMI on Climatix.
- The REF must be used and connected properly.

Some devices have an integrated terminating resistance that may be enabled by default. Disable it unless the device is the last one on the network. Consult the data sheet.

Some providers install a number of pull-up/pull-down resistances in their devices, allowing for selection via software or jumper.

TCP/IP network

Observe the following for TCP/IP network design and structure:

- Check that the DHCP parameter is set to "Passive" if using a fixed IP address.
- Try to ping the controller if the communication is not working. If the ping fails something is wrong on the network or IP settings.
- Check that the defined TCP port is open in the firewall. For Modbus the TCP port 502 is used.

6.2 FAQs on TCP/IP

TCPI/UDP ports

Port number	Type	Used for …
21		FTP
23	UDP	Telnet/Ping
80		Web
502	TCP	Modbus
4242	TCP	Scope, Climatix OPC (TCP/IP)

Disconnected network?

Ping the communication module using the IP address to test communications:

Step	Action
1	Select **Start > Run** on the Windows start bar: → The "Run" dialog box opens.
2	Enter **CMD** and click **OK**: The "CMD.exe" DOS window opens.
3	Enter **C:\>ping XXX.XXX.XXX.XXX** and press **Enter**: → The ping result is displayed. *Note! (XXX.XXX.XXX.XXX is the set IP address)*

You are dealing with a network or IP settings error if pinging does not work.

6.3 Override I/Os via communication

Introduction
Some inputs can be overridden via Modbus, see Section 4.3, Reference Modbus addresses. However these inputs must first be setup in advance. Input must first be enabled and hardware place selected in configuration.

Requirements
Input must first be enabled and the hardware space selected in the configuration.

Configuration via operator unit
Proceed as follows to select input handling:

Step	Action
1	Log in to HMI with the level 4 password (Service), Default **2000**.
2	Select Main **Menu > Unit > Inputs > [Element group] > [Element] >** *Example Main Menu > Unit > Inputs > Temperatures > Outside temp >*

Parameter	Area	Function
Value selector (Digital inputs)		Select valid input value for the application:
	Hardware	• Value on hardware input.
	Comm	• Value from communications.
	AND	• Input is 1, if value on hardware input **and** communications = 1. Alarm triggers (if enabled), if one of the two values is invalid.
	OR	• Input is 1, if value on hardware input **or** communications = 1. Alarm triggers (if enabled), if one of the two values is invalid.
	Pref HW	• Value on hardware input has priority. The value from communications is taken, if the value is invalid. An alarm triggers (if enabled), if both values are invalid.
	Pref Comm	• Value from communications has priority. The value from the hardware input is taken if the value from communications is invalid. An alarm triggers (if enabled), if both values are invalid.
Value selector (Analog inputs)		Select valid input value for the application:
	Hardware	• Value on hardware input.
	Comm	• Value from communications.
	Average	• Average from the values on hardware input and from communications. Alarm triggers (if enabled), if one of the two values is invalid.
	Minimum	• The lowest value from the values on hardware input and from communications. Alarm triggers (if enabled), if one of the two values is invalid.
	Maximum	• The highest value from the values on hardware input and from communications. Alarm triggers (if enabled), if one of the two values is invalid.
	Pref HW	• Value on hardware input has priority. The value from communications is taken, if the value is invalid. An alarm triggers (if enabled), if both values are invalid.
	Pref Comm	• Value from communications has priority. The value from the hardware input is taken if the value from communications is invalid. An alarm triggers (if enabled), if both values are invalid.