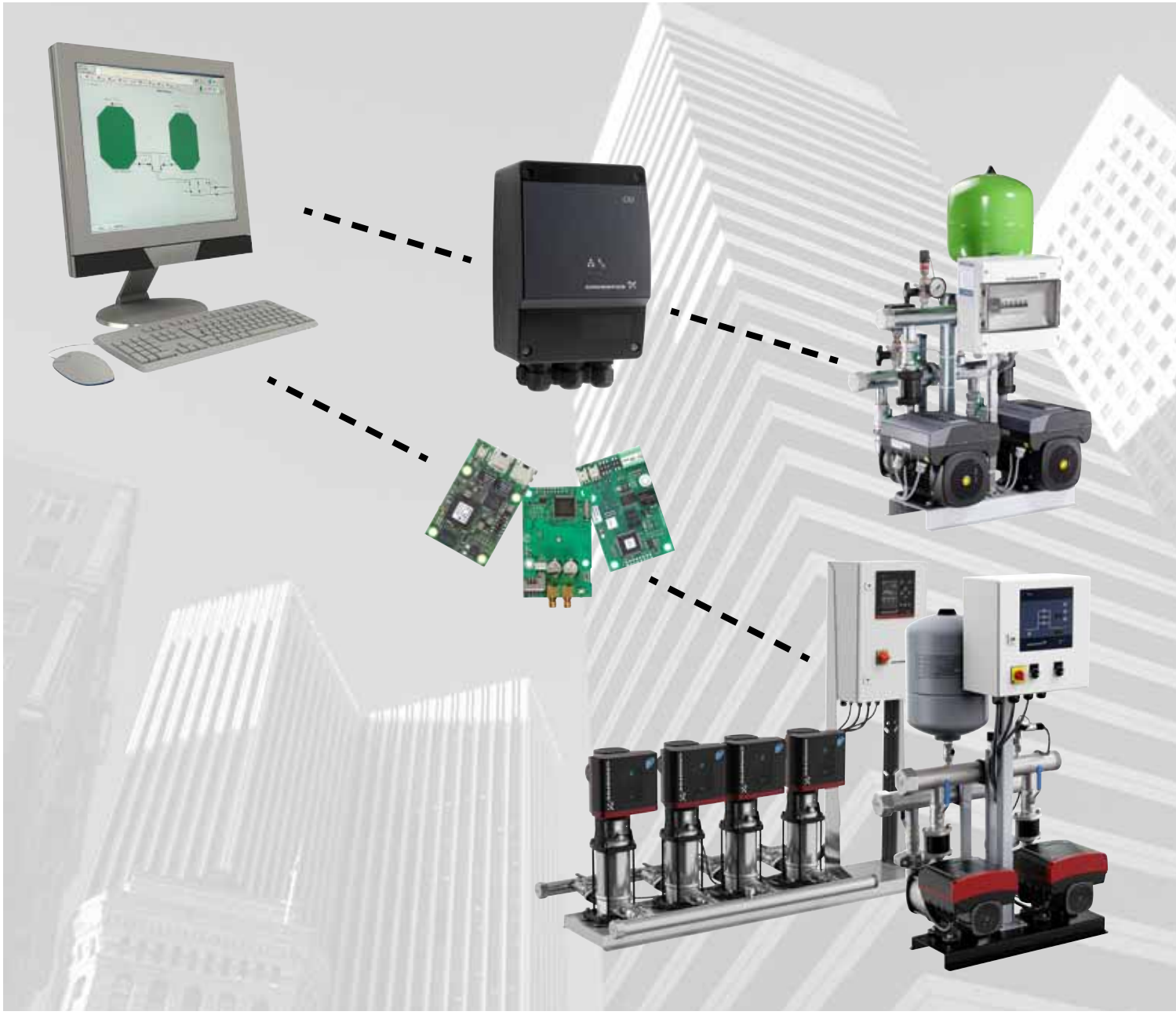
Modbus for Grundfos boosters

CIM/CIU 200 Modbus RTU
CIM/CIU 260 3G/4G cellular
CIM/CIU 500 Ethernet for Modbus TCP

Functional profile and user manual



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GRUNDFOS

Original functional profile and user manual.

This functional profile describes Grundfos Modbus for boosters.

CONTENTS

Read this document before installing the product. Installation and operation must comply with local regulations and accepted codes of good practice.

1. General information

1.1 Hazard statements

The symbols and hazard statements below may appear in Grundfos installation and operating instructions, safety instructions and service instructions.

DANGER

Indicates a hazardous situation which, if not avoided, will result in death or serious personal injury.

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious personal injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate personal injury.

The hazard statements are structured in the following way:

SIGNAL WORD

Description of hazard

Consequence of ignoring the warning.

- Action to avoid the hazard.

1.2 Notes

The symbols and notes below may appear in Grundfos installation and operating instructions, safety instructions and service instructions.

Observe these instructions for explosion-proof products.

A blue or grey circle with a white graphical symbol indicates that an action must be taken.

A red or grey circle with a diagonal bar, possibly with a black graphical symbol, indicates that an action must not be taken or must be stopped.

If these instructions are not observed, it may result in malfunction or damage to the equipment.

Tips and advice that make the work easier.

2. Introduction

2.1 About this functional profile

This functional profile describes the following modules and units:

- CIM/CIU 200 Modbus RTU
- CIM/CIU 260 Modbus 3G/4G cellular
- CIM/CIU 500 Modbus Ethernet for Modbus TCP

This functional profile applies to the following Grundfos booster systems:

- Grundfos Hydro Multi-B (CU 323)
- Grundfos Hydro MPC (CU 35X)
- Grundfos Control MPC (CU 35X)
- Grundfos DDD (CU 354)
- Grundfos Hydro Multi-E model G
- Grundfos Hydro Multi-E model H, I and J
- Grundfos TPED model H, I and J, twin-head pump
- Grundfos MAGNA3-D, twin-head pump

All Multi-E systems that are based on MGE model G and earlier models are referred to as Multi-E model G.

All Multi-E systems that are based on MGE model H and later models are referred to as Multi-E model H.

The register blocks for Hydro MPC and Control MPC are identical, so in the following, only Hydro MPC is mentioned. If not specifically mentioned, Hydro Multi-B, Hydro MPC, DDD, Hydro Multi-E model G and Hydro Multi-E model H are referred to as "booster system".

Grundfos cannot be held responsible for any problems caused directly or indirectly by using information in this functional profile.

2.2 Assumptions

This functional profile assumes that the reader is familiar with the commissioning and programming of Modbus devices. The reader should also have some basic knowledge of the Modbus protocol and technical specifications.

It is also assumed that an existing Modbus network with a Modbus master is present.

2.3 Definitions and abbreviations

0b	Prefix for a binary number.
0x	Prefix for a hexadecimal number.
3G	Third-generation mobile telephony network.
4G	Fourth-generation mobile telephony network.
ARP	Address Resolution Protocol. Translates IP addresses into MAC addresses.
Auto-MDIX	Ensures that both crossover cable types and non-crossover cable types can be used.
CAT5	Ethernet cable type with four twisted pairs of wires.
CAT5e	Enhanced CAT5 cable with better performance.
CAT6	Ethernet cable compatible with CAT5 and CAT5e and with very high performance.
CIM	Communication Interface Module.
CIU	Communication Interface Unit.
CRC	Cyclic Redundancy Check. A data error detection method.
CSD	Circuit Switched Data. Connection is established via a fixed connection that is a physical circuit or a reserved data channel.
CU 323	Grundfos Control Unit used in Hydro Multi-B booster systems.
CU 352	Grundfos Control Unit used in Hydro MPC booster systems.
CU 354	Grundfos Control Unit used in Demand Driven Distribution.
DDD	Demand Driven Distribution. A Grundfos system for municipal water supply.
DHCP	Dynamic Host Configuration Protocol. Used to configure network devices to enable them to communicate on an IP network.
DNS	Domain Name System. Used to resolve host names to IP addresses.
GENIbus	Proprietary Grundfos fieldbus standard.
GENIpro	Proprietary Grundfos fieldbus protocol.
Grundfos GO Remote	A Grundfos application designed to control Grundfos products via infrared or radio communication. Available for iOS and Android devices.
H	Head (pressure).
HTTP	HyperText Transfer Protocol. The protocol commonly used to navigate the World Wide Web.
IANA	Internet Assigned Numbers Authority.
IP	Internet protocol.
LED	Light-emitting diode.
MAC	Media Access Control. Unique network address for a piece of hardware.
Modbus	A serial communications protocol commonly used in industry and building automation systems.
Modbus RTU	Modbus is a fieldbus used worldwide. The RTU version is used for wired networks, CIM 200, and for call-up connections over telephone networks, CIM 260.
Modbus TCP	Modbus is a fieldbus used worldwide. The TCP version is adapted for use as an application protocol on TCP/IP using either CIM 260 3G/4G cellular or CIM 500 Ethernet as the basis.
MPC	Multi-Pump Controller.
PIN	Personal Identification Number. For SIM cards.
Ping	Packet InterNet Groper. A software utility that tests connectivity between two TCP/IP hosts.
PUK	Personal Unblocking Key. For SIM cards.

Q	Flow rate.
SELV	Separated or Safety Extra-Low Voltage.
SELV-E	Separated or Safety Extra-Low Voltage with earth connection.
SIM	Subscriber Identity Module. SIM card.
SMA	SubMiniature version A. Coaxial radio signal cable connection standard.
SMTP	Simple Mail Transfer Protocol.
SNTP	Simple Network Time Protocol. Used for clock synchronisation between computer systems.
TCP	Transmission Control Protocol. Protocol for Internet communication and Industrial Ethernet communication.
TCP/IP	Transmission Control Protocol/Internet Protocol. Protocol for Internet communication.
Transmission speed	Bits transferred per second, bits/s.
URL	Uniform Resource Locator. The IP address used to connect to a server.
UTC	Coordinated Universal Time. The primary time standard by which the world regulates clocks and time.
UTF-8	Unicode Transformation Format. Character encoding.
VPN	Virtual Private Network. A network using the Internet to connect nodes. These systems use encryption and other security mechanisms to ensure that only authorised users can access the network and that the data cannot be intercepted.

3. System description

3.1 Modbus

The system diagrams give an overview of the different technologies and how to connect the module or unit to the Grundfos Booster that you connect to a Modbus network.

Note that the Hydro MPC and Control MPC are available in two variants: with a CU 351 or a CU 352 control unit. They have different CIM/CIU connections, as described below.

CIM solution

The Communication Interface Module (CIM) is an add-on communication module that you install into the back of these control units:

- CU 352 Hydro MPC
- CU 323 Hydro Multi-B
- CU 354 DDD.

You can fit it inside the terminal box of the master pump in a Hydro Multi-E model H and later booster system.

You can also fit it in the master pump of the twin pump types TPED and MAGNA3-D.

In this setup, the booster system will supply power to CIM 200. See fig. 1.

CIU solution

The Communication Interface Unit (CIU) is a unit incorporating a power supply module and a CIM Modbus module. You can mount it either on a DIN rail or on a wall. See fig. 2.

You use CIU 200 with the older products:

- CU 351 MPC
- Multi-E model G.

Further, you must fit CU 351 MPC with an add-on module for the external GENIbus connection to connect to the CIU unit.

3.2 CIM 200 Modbus RTU

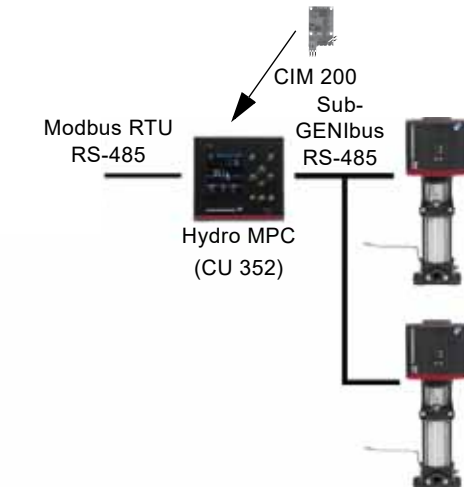

Fig. 1 Example of a CIM 200 solution. The module is installed inside the CU 352 controller

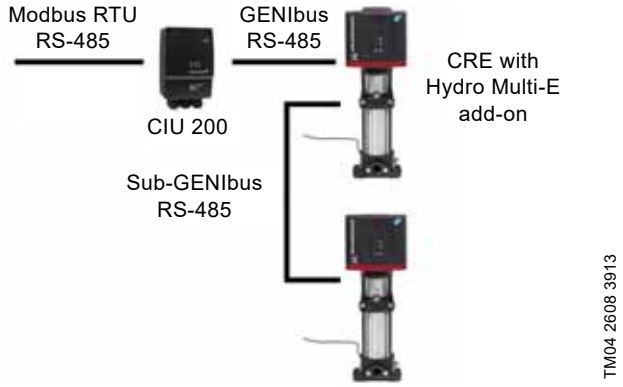

Fig. 2 Example of a CIU 200 solution for Hydro Multi-E model G

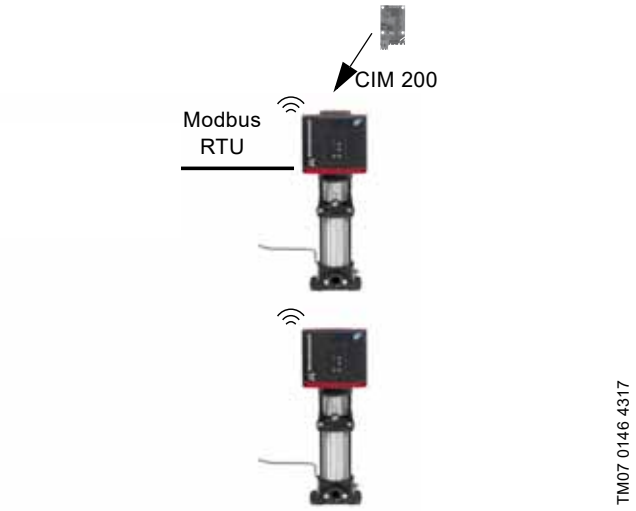

Fig. 3 Example of a CIM 200 solution for Hydro Multi-E model H and later. Pumps connected via built-in radio communication (Grundfos Glowpan)

The example for Multi-E model H and later is identical for TPED model H and later and MAGNA3-D. In all cases, mount the CIM module in the master pump placed to the left.

For the purpose of redundancy, you can mount a second CIM module in pump 2 for TPED and Multi-E (not MAGNA3-D). In that case, all writings from the Modbus master must be send to both CIM modules.

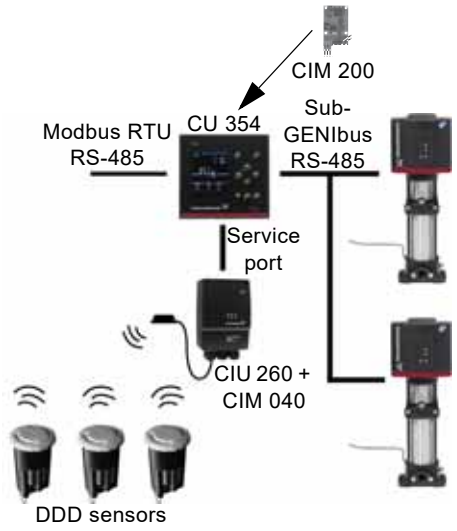

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Fig. 4 Example of a CIM 200 solution for Demand Driven Distribution

3.3 CIM 260 3G/4G cellular Modbus

You can establish remote communication via CIM/CIU 260 by using one of the following options:

- Modbus RTU protocol via a cellular call-up connection
- Modbus TCP protocol via a cellular data connection
- SMS commands from a mobile phone.

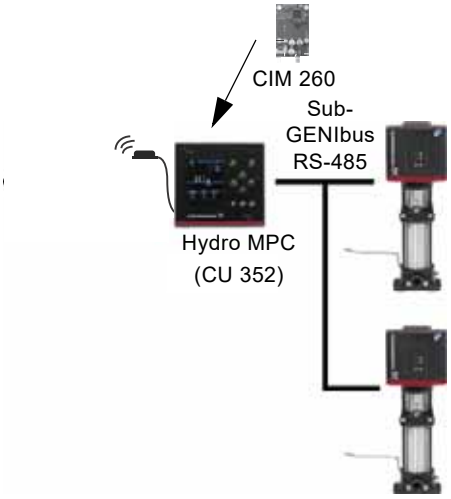

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Fig. 5 Example of a CIM 260 solution. The module is installed inside the CU 352 controller

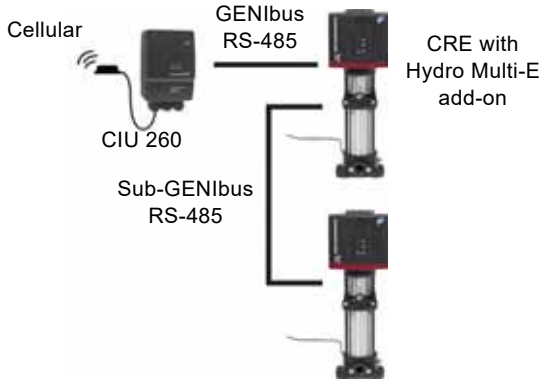

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Fig. 6 CIU 260 solution for Hydro Multi-E model G

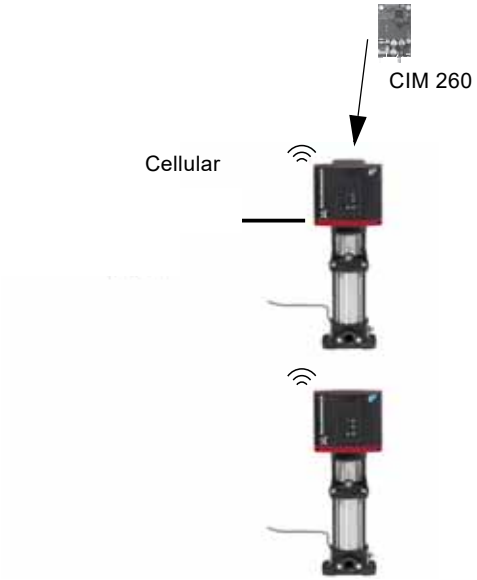

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Fig. 7 Example of a CIM 260 solution for Hydro Multi-E model H and later. Pumps connected via built-in radio communication (Grundfos Glowpan)

The example for Multi-E model H and later is identical for TPED model H and later and MAGNA3-D. In all cases, mount the CIM module in the master pump placed to the left.

For the purpose of redundancy, you can mount a second CIM module in pump 2 for TPED and Multi-E (not MAGNA3-D). In that case, all writings from the Modbus master must be sent to both CIM modules.

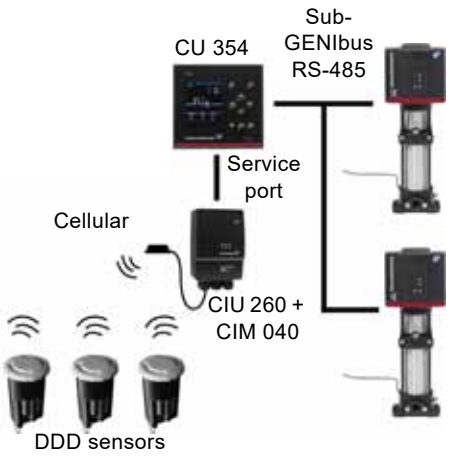

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Fig. 8 Example of a CIU 260 solution for Demand Driven Distribution

3.4 CIM 500 Modbus TCP

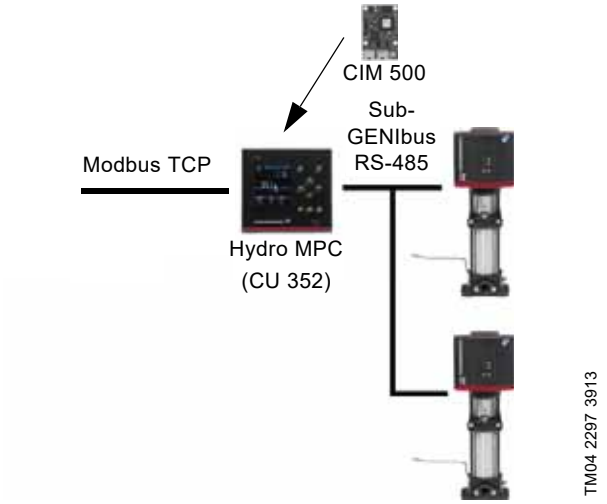

Fig. 9 Example of a CIM 500 solution. The module is installed inside the CU 352 controller

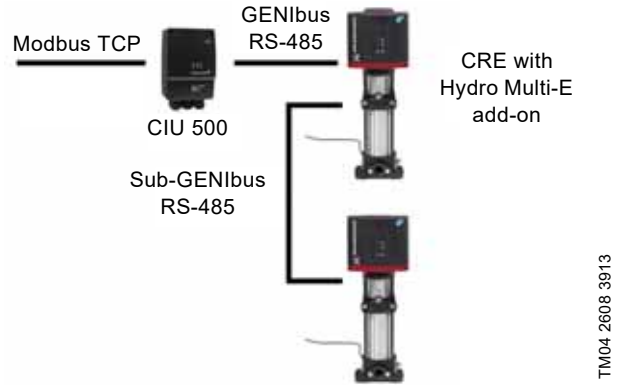

Fig. 10 Example of a CIU 500 solution for Hydro Multi-E model G

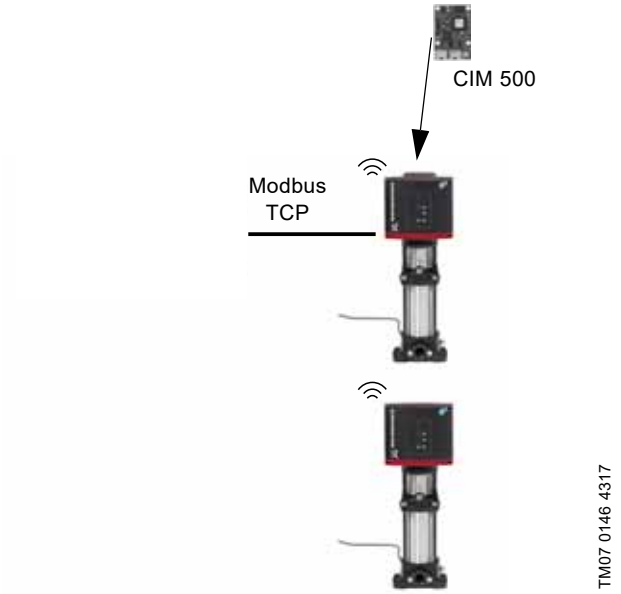

Fig. 11 Example of a CIM 500 solution for Hydro Multi-E model H and later. Pumps connected via built-in radio communication (Grundfos Glowpan)

The example for Multi-E model H and later is identical for TPED model H and later and MAGNA3-D. In all cases, mount the CIM module in the master pump placed to the left.

For the purpose of redundancy, you can mount a second CIM module in pump 2 for TPED and Multi-E (not MAGNA3-D). In that case, all writings from the Modbus master must be sent to both CIM modules.

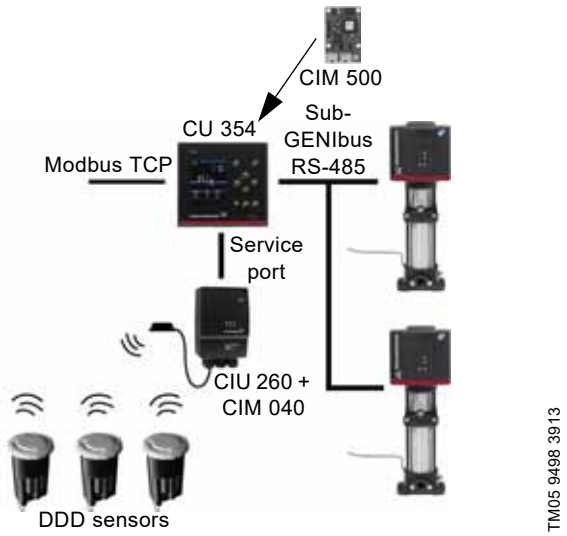

Fig. 12 Example of a CIM 500 solution for Demand Driven Distribution

4. Specifications

4.1 CIM module

General data	Description	Comments
Ambient humidity	30-95 %	Relative, non-condensing.
Operating temperature	-20 to +45 °C	
Storage temperature	-25 to +70 °C	
Battery, lithium-ion	You can only charge the battery if the battery temperature is within 0-45 °C.	CIM 260 only.
GENIbus visual diagnostics	LED2	The LED will be in one of these states: Off, permanently green, flashing red, permanently red. See section *5.5 Status LEDs*.
Power supply (CIU)	24-240 V	Located in the unit.
GENIbus connection type (CIU)	RS-485, 3-wire + screen	Conductors: A, B and Y.
CIU box enclosure class	IP54	
CIU box dimensions (H x W x D)	182 x 108 x 82 mm	

4.2 CIM 200 Modbus RTU

The table below provides an overview of the specifications for Grundfos CIM 200 and CIU 200. For further details, refer to the specific sections of this functional profile.

Modbus RTU specifications	Description	Comments
Modbus connector	Screw-type terminal	3 pins. See section *5. CIM 200 Modbus RTU setup*.
Modbus connection type	RS-485, 2-wire + common	Conductors: D0, D1 and Common. See section *5. CIM 200 Modbus RTU setup*.
Maximum cable length	1200 m	Equals 4000 ft.
Slave address	1-247	Set via rotary switches SW6 and SW7. See section *5.3 Modbus address selection*.
Line termination	On or Off	Set via DIP switches SW1 and SW2. See section *5.4 Termination resistor*.
Recommended cable cross-section	0.20 - 0.25 mm^2	AWG24 or AWG23
Supported transmission speeds	1200*, 2400*, 4800*, 9600, 19200, 38400 bits/s	Set via DIP switches SW4 and SW5. See section *5.1 Setting the Modbus transmission speed*.
Start bit	1	Fixed value.
Data bits	8	Fixed value.
Stop bits	1 or 2	Set via DIP switch SW3. See section *5.2 Setting the stop bits and the parity bit*.
Parity bit	Even parity, odd parity* or no parity	Set via DIP switch SW3. See section *5.2 Setting the stop bits and the parity bit*.
Modbus visual diagnostics	LED1	Off, flashing green, flashing red, permanently red. See section *5.5 Status LEDs*.
Maximum number of Modbus devices	32	Using repeaters, you can increase this number. Legal address range is 1-247.
Maximum Modbus telegram size	256 bytes	Total length. Node address and CRC included. See section *13. Modbus RTU telegram examples*.

* Can only be set via software.

4.3 CIM 260 3G/4G cellular

The table below provides an overview of the specifications for Grundfos CIM/CIU 260. For further details, refer to the specific sections of this functional profile.

Modbus cellular specifications	Description	Comments
Data protocol	Modbus RTU/Modbus TCP	Call-up connection uses RTU. Data connection uses TCP.
Slave address	Factory 231 (0xE7)	You can change the address via Modbus register 00003, SoftwareDefinedModbusAddress.
Cellular connection visual diagnostics	LED1	See section *6.2 LEDs*.
Maximum Modbus telegram size	260 bytes	Total Modbus TCP/IP application data unit. See fig. 32.

4.4 CIM 500 Modbus TCP

The table below provides an overview of the specifications for Grundfos CIM/CIU 500 for Modbus TCP. For further details, refer to the specific sections of this functional profile.

Modbus TCP specifications	Description	Comments
Application layer	DHCP, HTTP, Ping, FTP, SMTP, SNTP, Modbus TCP	Rotary switch in position 1 to select Modbus TCP.
Transport layer	TCP	
Internet layer	Internet protocol V4 (IPv4)	
Link layer	ARP, media access control (Ethernet)	
Ethernet cable	CAT5, CAT5e or CAT6	Supports auto cable-crossover detecting (Auto-MDIX).
Maximum cable length	100 metres	Corresponds to 328 feet.
Transmission speed	10 Mbits/s, 100 Mbits/s	Auto-detected.

5. CIM 200 Modbus RTU setup

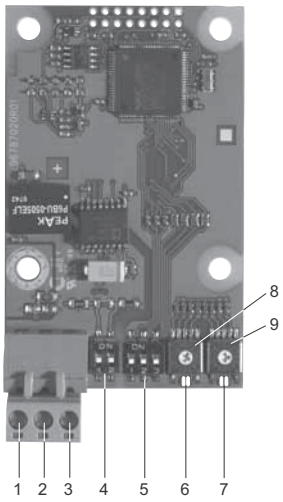

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Fig. 13 CIM 200 Modbus module

Pos.	Designation	Description
1	D1	Modbus terminal D1 (positive data signal)
2	D0	Modbus terminal D0 (negative data signal)
3	Common/GND	Modbus terminal Common and GND
4	SW1/SW2	On and off switches for termination resistor
5	SW3/SW4/SW5	Switches for selection of Modbus parity and transmission speed
6	LED1	Red and green status LED for Modbus communication
7	LED2	Red and green status LED for internal communication between CIM/CIU 200 and the booster system
8	SW6	Hexadecimal rotary switch for setting the Modbus address, four most significant bits
9	SW7	Hexadecimal rotary switch for setting the Modbus address, four least significant bits

Use a screened, twisted-pair cable. Connect the cable screen to protective earth at both ends.

Recommended connection

Modbus terminal	Colour code	Data signal
D1-TXD1	Yellow	Positive
D0-TXD0	Brown	Negative
Common/GND	Grey	Common/GND

5.1 Setting the Modbus transmission speed

Set the transmission speed correctly before the CIM 200 Modbus module is ready to communicate with the Modbus network. Use DIP switches SW4 and SW5 for setting the transmission speed. See fig. 14.

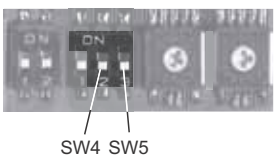

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Fig. 14 Modbus transmission speed

DIP switch settings

Available transmission speeds in bits/s: 1200, 2400, 4800, 9600, 19200 and 38400.

The first three transmission speeds are only available via software settings, whereas the last three are available via DIP switches.

Transmission speed [bits/s]	SW4	SW5
9600	OFF	ON
19200	OFF	OFF
38400	ON	OFF
Software-defined	ON	ON

Default transmission speed is 19200 bits per second, as per the Modbus RTU standard.

Software-defined

When SW4 and SW5 are set to "software-defined", writing a value to the holding register at address 00004 will set a new transmission speed.

Use the following values for software-defined transmission speeds:

Software-defined transmission speed	Value to set in register 00004
1200 bits/s	0
2400 bits/s	1
4800 bits/s	2
9600 bits/s	3
19200 bits/s	4
38400 bits/s	5

This value is set to 1200 bits/s as default.

The communication interface does not support transmission speeds above 38400 bits/s.

The software-defined transmission speed value is stored in the communication interface and remains after a power-off.

When software defined has been selected, then communication speed, parity bit, stop bits and address are all set via specific registers. See section *5.2 Setting the stop bits and the parity bit* and section *5.3 Modbus address selection*.

5.2 Setting the stop bits and the parity bit

When software-defined transmission speed is enabled (SW4 and SW5 are ON), software-defined parity and stop bits are also enabled.

You can set the parity either manually by using SW3 or via software-defined settings.

Manual setting of parity

Default byte format (11 bits):

- 1 start bit
- 8 data bits (least significant bit sent first)
- 1 parity bit (even parity)
- 1 stop bit.

The default setting of the CIM 200 Modbus module is even parity (1 stop bit). It is possible to change the parity using DIP switch SW3. You can change the parity to no parity (2 stop bits). See fig. 15.

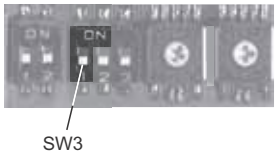

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Fig. 15 Parity

DIP switch settings

Parity	SW3
Even parity, 1 stop bit	OFF
No parity, 2 stop bits	ON

Software-defined parity and stop bits

When SW4 and SW5 are set to "software-defined", the value in the holding registers at addresses 00009 and 00010 will override the setting of SW3. See figs 14 and 15.

Software-defined parity	Value to set in register 00009
No parity [default]	0
Even parity	1
Odd parity	2

Software-defined stop bit	Value to set in register 00010
1 stop bit [default]	1
2 stop bits	2

The software-defined parity and stop bit values are stored in the communication interface and remain after a power-off.

For software-defined parity and stop bits to become active, you must set SW4 and SW5 to ON.

5.3 Modbus address selection

A Modbus slave on a Modbus network must have a unique address from 1-247. Address 0 is reserved for broadcasting and is not a valid slave address.

To set the Modbus address, use two hexadecimal rotary switches, SW6 and SW7. See fig. 16.

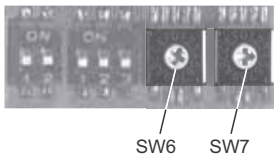

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Fig. 16 Setting the Modbus address

For a complete overview of Modbus addresses, see section *14. Fault finding the product*.

When software-defined transmission speed is enabled, software-defined address is also enabled and you set the address via register 00003.

You must set the Modbus address decimally from 1 to 247.

5.4 Termination resistor

The termination resistor is fitted on CIM 200 Modbus and has a value of 150 Ω.

CIM 200 has two DIP switches, SW1 and SW2, for cutting the termination resistor in and out. Fig. 17 shows the DIP switches in cut-out state.

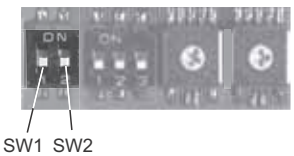

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Fig. 17 Cutting the termination resistor in and out

DIP switch settings

Status	SW1	SW2
Cut in	ON	ON
Cut out	OFF	OFF
	ON	OFF
	OFF	ON

Default setting: Termination resistor cut out.

Cable length

We recommend the following maximum lengths:

Bits/s	Maximum cable length	
	Terminated cable	Unterminated cable
	[m/ft]	[m/ft]
1200-9600	1200/4000	1200/4000
19200	1200/4000	500/1700
38400	1200/4000	250/800

To ensure stable and reliable communication, it is important that only the termination resistor of the first and last units in the Modbus network are cut in.

All switch settings will be effective immediately after setting the values. No power-off is needed.

5.5 Status LEDs

CIM 200 Modbus has two status LEDs: LED1 and LED2. See fig. 13.

- Red and green status LED1 for Modbus communication
- Red and green status LED2 for internal communication between CIM 200 and the Grundfos product.

LED1

Status	Description
Off	No Modbus communication.
Flashing green	Modbus communication active.
Flashing red	Fault in the Modbus communication.
Permanently red	Fault in the CIM 200 Modbus configuration.

LED2

Status	Description
Off	CIM 200 has been switched off.
Flashing red	No internal communication between CIM 200 and the Grundfos product.
Permanently red	CIM 200 does not support the Grundfos product connected.
Permanently green	Internal communication between CIM 200 and the Grundfos product is OK.

During startup, there is a delay of up to 5 seconds before LED2 status is updated.

6. CIM 260 3G/4G cellular Modbus setup

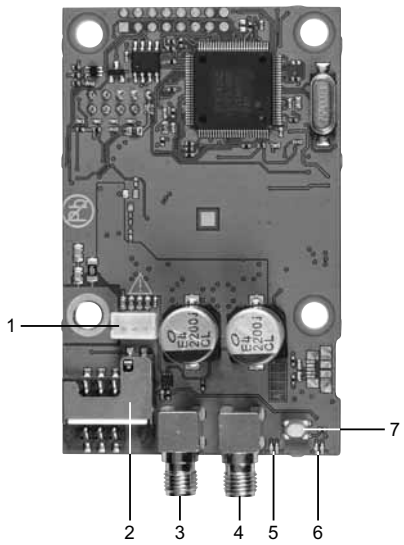

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Fig. 18 CIM 260 cellular module (top view)

Pos.	Designation	Description
1		Battery socket
2		SIM card holder
3		Secondary SMA connection for cellular antenna*
4		Primary SMA connection for cellular antenna. This antenna must always be connected.
5	LED1	Yellow and green status LED for cellular communication
6	LED2	Red and green status LED for internal communication between CIU 260 and the Grundfos product
7	SW1	To reset to factory settings, press and hold for at least 5 seconds.

* Only use this antenna connection if required by the telecom company.

6.1 Installation

DANGER

Electric shock

Death or serious personal injury

- Before starting any work on the product, make sure that the power supply has been switched off and that it cannot be accidentally switched on.

6.1.1 Fitting a cellular antenna

Connect an antenna to CIM 260 to establish connection to the cellular network.

If CIU 260 is installed in a metal control cabinet, we recommend fitting an external antenna.

Grundfos offers different kinds of antennas. No antenna is supplied with CIU 260. You can order it separately.

External antenna

See fig. 19.

Connect the antenna cable to the SMA connection (pos. 1) of CIM 260. The antenna must be installed outside the control cabinet in a position with good reception conditions. If required by the telecom company, connect an additional antenna.

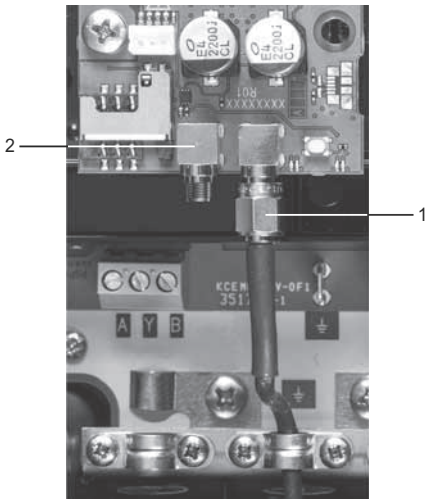

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Fig. 19 Fitting an external cellular antenna

Pos.	Description
1	Primary SMA connection for the cellular antenna
2	Secondary SMA connection for the cellular antenna*

* Only use this antenna connection if required by the telecom company

6.1.2 Inserting the SIM card

Before inserting the SIM card into CIM 260, remove the PIN code, or set the PIN code to "4321".

Procedure

1. Insert the SIM card into a mobile phone.
2. Remove the PIN code from the SIM card, or set the PIN code to "4321". See the manual for the mobile phone.
3. Insert the SIM card into the CIM 260. See fig. 20.

The slanted edge of the SIM card must point downwards, away from the connector.

The connectors on the SIM card must face inwards towards CIM 260. See fig. 20.

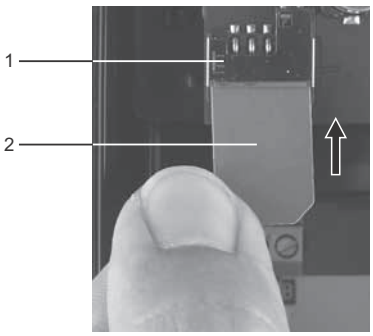

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Fig. 20 Inserting the SIM card

Pos.	Description
1	SIM card holder
2	SIM card

6.1.3 Connecting the battery and power supply

WARNING

Electric shock

Death or serious personal injury

- Connect CIM 260 only to SELV or SELV-E circuits.

WARNING

Flammable material

Death or serious personal injury

- The safety precautions listed below must be observed carefully as improper handling of the lithium-ion battery may result in injury or damage from electrolyte leakage, heating ignition or explosion.

These safety precautions must be observed:

- Only insert the approved Grundfos battery pack (97631960).
- Never use this battery pack in other battery chargers.
- Do not dismantle or modify the battery.
- Do not heat or incinerate the battery.
- Do not pierce, crush or cause mechanical damage to the battery.
- Do not short-circuit the battery.
- Do not allow the battery to get wet or be immersed in water.
- Do not strike or throw the battery.
- For long periods of storage, the temperature must be below 35 °C.

You can fit CIM 260 with a lithium-ion battery (order no. 97631960), which ensures sustained cellular connection with the product in which it is mounted, even if the power is switched off. The battery is secured by a velcro strap which absorbs vibrations and simplifies replacement. Connect the battery to CIM260 as shown in fig. 21.

If a battery is not connected, the user will not receive any information in case of a power cut.

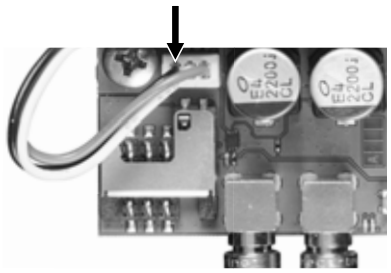

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Fig. 21 Connecting the battery

You can only charge the battery if the battery temperature is within 0 to 45 °C.

Switch on the power supply. CIM 260 is powered either by CIU 260 or by the battery.

LED1 flashes yellow, searching for cellular network. When the connection to the cellular network has been established, LED1 pulsates yellow: the cellular network is active. See fig. 22.

LED2 is permanently green, indicating that you have fitted CIM 260 correctly in CIU 260.

6.1.4 Configuration

For software configuration of CIU 260, which includes setting of SMS functions and SCADA communication parameters, see "CIM 260 SMS commands", which you can download from Grundfos Product Center.

6.2 LEDs

The CIM 260 module has two LEDs. See fig. 18.

- Yellow and green status LED1 for cellular communication
- Red and green status LED2 for internal communication between CIM 260 and the booster system.

LED1, yellow and green

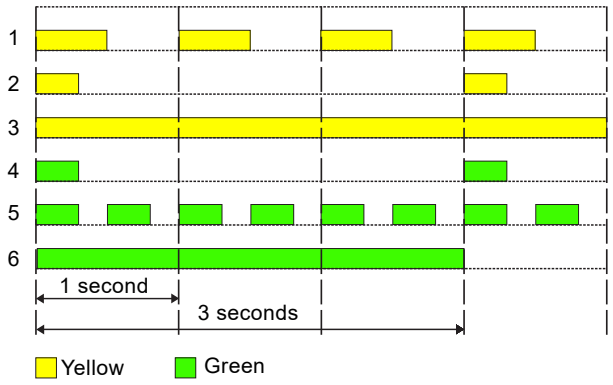

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Fig. 22 LED1 status

Pos.	Status	Description
1	Flashing yellow	Searching for cellular network.
2	Pulsating yellow, single pulse	Connection to the cellular network has been established.
3	Permanently yellow	Call-up connection has been established.
4	Pulsating green, single pulse	Communication via data connection.
5	Pulsating green, double pulse	Communication via the call-up connection.
6	Green (3 sec.)	Sending or receiving an SMS message.

LED2 (red and green)

Status	Description
Off	CIM has been switched off.
Flashing red	No communication between CIM 260 and the booster system.
Permanently red	The CIM 260 does not support the connected version of the booster system.
Permanently green	The connection between CIM 260 and the booster system is OK.

7. CIM 500 Modbus TCP setup

WARNING

Electric shock

Death or serious personal injury

- Connect CIM 500 only to SELV or SELV-E circuits.

7.1 Connecting the Ethernet cable

Use RJ45 plugs and Ethernet cable. Connect the cable shield to protective earth at both ends.

It is important to connect the cable shield to earth through an earth clamp or to connect the cable shield to earth in the connector.

Maximum cable length

Speed [Mbits/s]	Cable type	Maximum cable length [m/ft]
10	CAT5	100/328
100	CAT5e, CAT6	100/328

CIM 500 is designed for flexible network installation. The built-in two-port switch makes it possible to daisy chain from product to product without the need of additional Ethernet switches. The last product in the chain is only connected to one of the Ethernet ports. Each Ethernet port has its own MAC address.

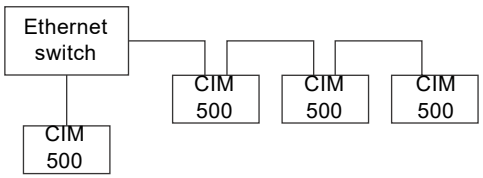

Fig. 23 Example of Industrial Ethernet network

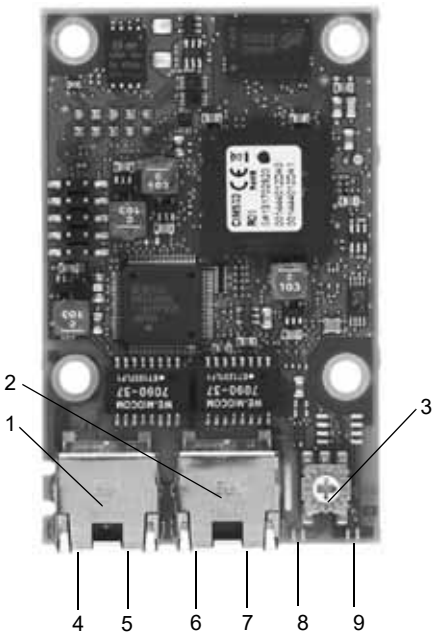

Fig. 24 Example of Ethernet connection

Pos.	Description	Designation
1	Industrial Ethernet RJ45 connector 1	ETH1
2	Industrial Ethernet RJ45 connector 2	ETH2
3	Rotary switch for protocol selection	SW1
4	Data activity LED for connector 1	DATA1
5	Link LED for connector 1	LINK1
6	Data activity LED for connector 2	DATA2
7	Link LED for connector 2	LINK2
8	Green and red status LED for Ethernet communication	LED1
9	Green and red status LED for internal communication between the module and the booster system.	LED2

7.2 Setting the Industrial Ethernet protocol

The CIM 500 Ethernet module has a rotary switch for selection of the Industrial Ethernet protocol. See fig. 25.

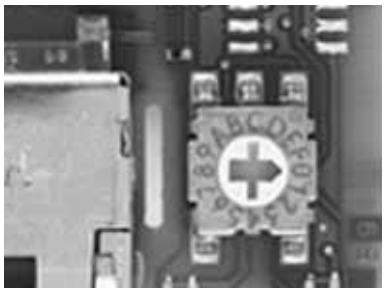

Fig. 25 Selecting the Industrial Ethernet protocol

Pos.	Description
0	PROFINET IO (default)
1	Modbus TCP
2	BACnet IP
3	EtherNet/IP
4	GRM IP (requires a contract with Grundfos)
5..E	Reserved, LED1 will be permanently red to indicate an invalid configuration.
F	Reset to factory default. Note that the rotary switch must be set in this position for 20 seconds to reset to factory default. During this period, LED1 flashes red and green at the same time to indicate that a reset will occur.

Every change of the rotary switch while the module is powered on will cause the module to restart.

7.3 Setting the IP addresses

The CIM 500 Ethernet module is by default set to a fixed IP address. It is possible to change the IP address settings from the built-in webserver.

Default IP settings used by the webserver	IP address: Subnet mask: Gateway:	192.168.1.100 255.255.255.0 192.168.1.1
IP settings for Modbus TCP	Make the settings via the webserver	

7.4 Establishing connection to the webserver

You can configure CIM 500 using the built-in webserver. To establish a connection from a PC to CIM 500, the following steps are required:

- Connect the PC and CIM 500 using an Ethernet cable.
- Configure the PC Ethernet port to the same subnetwork as CIM 500, for example 192.168.1.101, and the subnet mask to 255.255.255.0. See section *A.1 How to configure an IP address on your PC* on page 61.
- Open a standard internet browser and type 192.168.1.100 in the URL field.
- Log in to the webserver:

Username	Default: admin
Password	Default: Grundfos

Username and password may have been changed from their default values.

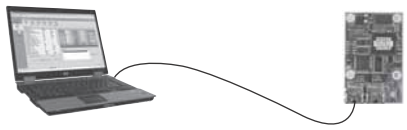

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Fig. 26 CIM 500 connected to PC via Ethernet cable

For further information on how to use the webserver, see section *A.3 Login* on page 62.

You can use both ETH1 and ETH2 to establish a connection to the webserver.

You can access the webserver while the selected Industrial Ethernet protocol is active.

7.5 Status LEDs

The CIM 500 Ethernet module has two status LEDs: LED1 and LED2. See fig. 24.

- Red and green status LED1 for Ethernet communication
- Red and green status LED2 for internal communication between CIM 500 and the Grundfos product.

LED1

Status	Description
Off	No Modbus TCP communication or switched off.
Flashing green	Modbus TCP communication active.
Permanently red	CIM 500 module configuration fault. See section *14.3.1 LED status*.
Permanently red and green	Error in the firmware download. See section *14.3.1 LED status*.
Flashing red and green	Resetting to factory default. After 20 seconds, CIM 500 restarts.

LED2

Status	Description
Off	CIM 500 is switched off.
Flashing red	No internal communication between CIM 500 and the Grundfos product.
Permanently red	CIM 500 does not support the Grundfos product connected.
Permanently green	Internal communication between CIM 500 and the Grundfos product is OK.
Permanently red and green	Memory fault.

During startup, there is a delay of up to 5 seconds before LED1 and LED2 status is updated.

7.6 DATA and LINK LEDs

The CIM 500 Ethernet module has two connectivity LEDs related to each RJ45 connector. See fig. 24.

DATA1 and DATA2

These yellow LEDs indicate data traffic activity.

Status	Description
Yellow off	No data communication on the RJ45 connector.
Yellow flashing	Data communication ongoing on the RJ45 connector.
Permanently yellow	Heavy network traffic.

LINK1 and LINK2

These green LEDs show whether the Ethernet cable is properly connected.

Status	Description
Green off	No Ethernet link on the RJ45 connector.
Green on	Ethernet link on the RJ45 connector is OK.

8. Modbus function code overview

The supported function codes are shown in the table below:

Type	Code	Hex	Name
16-bit data (registers)	03	0x03	Read holding registers
	04	0x04	Read input registers
	06	0x06	Write single register
	16	0x10	Write multiple registers
Diagnostics	08	08	Diagnostics See section *13.6 Diagnostics, 0x08* for subcodes.

Reading or writing coils is not supported.

The same data are available in both holding registers and input registers, meaning that either function (0x03 or 0x04) can be used for reading data.

Unless otherwise stated, the data type used for counters and scaled values is always an unsigned integer.

9. Modbus register addresses

9.1 Register block overview

The Modbus registers are grouped in the following register blocks:

Start address	Register block	Permissions	Description
00001	CIM configuration	R/W	Configuration of the CIM module.
00021	CIM status	R	Status registers for the CIM module.
00101	Control	R/W	Registers for control of the booster system.
00201	Status	R	Registers for reading mode status from the booster system.
00301	Data	R	Registers for reading measured data values from the booster system.
00401	Pump 1	R	Registers for pump 1 data and status.
00411	Pump 2	R	Registers for pump 2 data and status.
00421	Pump 3	R	Registers for pump 3 data and status.
00431	Pump 4	R	Registers for pump 4 data and status.
00441	Pump 5	R	Registers for pump 5 data and status.
00451	Pump 6	R	Registers for pump 6 data and status.
00461	Pilot pump	R	Registers for the pilot pump data and status.
00471	Backup pump	R	Registers for the backup pump data and status.
00701	Alarm simulation	R/W	Registers for simulating alarms and warnings.
00751-00800	User registers	R/W	This area is for device labelling by the user.

All addresses contain registers. Some are bit-interpreted, while others are 16-bit values or high-/low-order parts of 32-bit values.

9.2 CIM configuration register block

Registers in this block can be read by means of function codes 0x03 and/or 0x04. They can be written as holding registers with function codes 0x06 and 0x10.

Address	Register name	Description	CIM 200	CIM 260	CIM 500
00001	SlaveMinimumReplyDelay	The minimum reply delay from the slave in ms. Value range: 0-10000, i.e. up to 10 seconds reply delay. This delay is typically used in conjunction with a modem. The delay value is stored in the device and remains after a power-off. The delay set here is added to the internal delay in the device. Default setting: 0.	•	-	-
00002		RESERVED			
00003	SoftwareDefinedModbusAddress	If the Modbus address switch has not been set correctly, meaning outside the 1 to 247 range, the value in this register is used as Modbus address. See section *5.3 Modbus address selection*. The value is stored in the device and remains after a power-off. Note that for CIM 200, this value is used only when you have set the transmission speed to "software-defined" on DIP switches SW4 and SW5. Otherwise, CIM 200 ignores it.	•	•	•
00004	SoftwareDefinedBitRate	Modbus software-defined value for transmission speed. The software-defined value for transmission speed is stored in the device and remains after a power-off. 0: 1200 bits/s 1: 2400 bits/s 2: 4800 bits/s 3: 9600 bits/s 4: 19200 bits/s 5: 38400 bits/s. Note that for CIM 200, this value is used only when you have set the transmission speed to "software-defined" on DIP switches SW4 and SW5. Otherwise, CIM 200 ignores it.	•	-	-
00005	AutoAckControlBits	Used to select the behaviour of control bit acknowledgements from the CIM/CIU. 0: Disabled. Control bits are not automatically lowered when accepted by the device. The user must lower the triggered control bit manually before the control bit can be triggered again. 1: Enabled. Control bits are automatically lowered when accepted by the device. The user does not have to lower it manually (default).	•	•	•
00006		RESERVED			
00007		RESERVED			

Address	Register name	Description	CIM 200	CIM 260	CIM 500
00008	NoDataActivityTimeout	The elapsed time with no data activity before the module issues a restart of the APN connection.	-	●	-
00009	SoftwareDefinedParity	Parity setting when using software-defined settings. 0: No parity (default) 1: Even parity 2: Odd parity. Note that for CIM 200, this value is used only when you set the transmission speed to "software-defined" on DIP switches SW4 and SW5. Otherwise, CIM 200 ignores it.	●	-	-
00010	SoftwareDefinedStopBit	Stop bit setting when using software-defined settings. 0: No stop bit 1: 1 stop bit (default) 2: 2 stop bits. Note that for CIM 200, this value is used only when you set the transmission speed to "software-defined" on DIP switches SW4 and SW5. Otherwise, CIM 200 ignores it.	●	-	-
00011	ScadaPinCode	PIN code for SCADA systems, etc. If GeneralStatus.ScadaPinCodeEnabled (register 00029, bit 0) is enabled, enter the correct PIN code in this register in order to gain access to remote control and configuration. Verify acceptance in GeneralStatus.WriteAccess (register 00029, bit 1). You programme the SCADA PIN code via the SMS command "SETSCADACODE". See "CIM 260 SMS commands", which you can download from Grundfos Product Center.	-	●	-
00012	Watchdog	Configuration of fieldbus communication watchdog. 0: Watchdog is disabled (default) 1: Watchdog is enabled, timeout 5 s. Any other value disables the watchdog. Watchdog action: The pump will be set to Local mode. CIM 200: Watchdog is fed whenever serial line data appears on the network. It is not a requirement that valid Modbus telegrams are preset nor that CIM 200 is specifically addressed. An interruption of serial data for more than 5 seconds activates the watchdog. CIM 500: Watchdog is only fed if CIM 500 is specifically addressed with Modbus TCP telegrams, matching IP address. If CIM 500 is connected to a Modbus TCP network but never gets addressed, it will activate watchdog after 5 seconds.	●	-	●
00013	GENIbusDiodeOff	For disabling the GENIbus LED2. 0: GENIbus diode LED2 has normal function. 1: GENIbus diode LED2 is permanently switched off.	●	●	●

9.3 CIM status register block

Registers in this block can be read by means of function codes 0x03 and/or 0x04. They are read-only. Use this block for various kinds of fault finding.

Address	Register name	Description	CIM 200	CIM 260	CIM 500
00021	GENIbusCRCErrorCnt	Holds a CRC error counter for the GENIbus connection to the booster system.	●	●	●
00022	GENIbusDataErrorCnt	Holds a data error counter for the GENIbus connection to the booster system.	●	●	●
00023	VersionNumber	A Grundfos-specific version number. This is an unsigned integer value.	●	●	●
00024	ActualModbusAddress	Holds the current Modbus slave address of the device. Valid value range: 1…247.	●	●	●
00025 00026	GENIbusTXcountHI GENIbusTXcountLO	Holds a transmit counter for the total number of telegrams sent to the booster system on the GENIbus connection.	●	●	●
00027 00028	GENIbusRXcountHI GENIbusRXcountLO	Holds a receive counter for the total number of telegrams received from the booster system on the GENIbus connection.	●	●	●

Address	Register name	Description	CIM 200	CIM 260	CIM 500
00029	GeneralStatus Bit 0: ScadaPinCodeEnabled	PIN code functionality. 0: No PIN code required 1: PIN code required to perform remote control and configuration. Activation of SCADA PIn-code protection takes place via the SMS command "SCADACODE". See "CIM 260 SMS commands", which you can download from Grundfos Product Center.	-	●	-
	GeneralStatus Bit 1: WriteAccess	Remote write access. 0: No write access, the PIN code is incorrect. 1: Full write access, the PIN code is either correct or not enabled.			
00030	UnitFamily	Grundfos product family.	●	●	●
00031	UnitType	Grundfos product type.	●	●	●
00032	UnitVersion	Grundfos product version.	●	●	●
00033	BatteryState	State of CIM 260 module battery 0: Battery not present 1: Battery must be replaced 2: Battery charging 3: Battery needs charging, but temperature too high 4: Battery needs charging, but temperature too low 5: Battery low 6: Battery OK 255: Battery state not available	-	●	-
00034	ProductSoftwareVersionHI	Product software version - BCD digit 1-4 aa.bb	●	●	●
00035	ProductSoftwareVersionLO	Product software version - BCD digit 5-8 cc.dd	●	●	●
00036	ProductSoftwareDayMonth	Product software date - BCD ddmm	●	●	●
00037	ProductSoftwareYear	Product software date - BCD yyyy	●	●	●

9.4 Cellular network Real Time Clock

Address	Register name	Description	CIM 200	CIM 260	CIM 500
00080	SetUNIXRealTimeClockHI	Set real time clock (32 bit UNIX format) Triggered on value change	-	●	-
00081	SetUNIXRealTimeClockLO		-	●	-
00082	SetRtcSecond	Set real time clock - seconds	-	●	-
00083	SetRtcMinute	Set real time clock - minutes	-	●	-
00084	SetRtcHour	Set real time clock - hours	-	●	-
00085	SetRtcDay	Set real time clock - day	-	●	-
00086	SetRtcMonth	Set real time clock - month	-	●	-
00087	SetRtcYear	Set real time clock - year	-	●	-
00088	Bit 0: SetRtc	Triggers setting of real time clock - s/m/h/d/m/y format	-	●	-
00089	StatusUNIXRealTimeClockHI	Real time clock (32 bit UNIX format)	-	●	-
00090	StatusUNIXRealTimeClockLO		-	●	-
00091	StatusRtcSecond	Real time clock - seconds	-	●	-
00092	StatusRtcMinute	Real time clock - minutes	-	●	-
00093	StatusRtcHour	Real time clock - hours	-	●	-
00094	StatusRtcDay	Real time clock - day of month	-	●	-
00095	StatusRtcMonth	Real time clock - month	-	●	-
00096	StatusRtcYear	Real time clock - year (after 2000)	-	●	-
00097	Bit 0: StatusSetRTCAck	Acknowledge of set RTC command	-	●	-

9.5 Control register block

Registers in this block can be read by means of function codes 0x03 and/or 0x04. They can be written as holding registers with function codes 0x06 and 0x10.

1 For Multi-E with a module in the master pump, only set the master pump CopyToLocal bit to value "1".
For Multi-E with a module in two pumps, always set CopyToLocal reg. 00101 bit 4 to value "1" in both pumps. Any writings to the control registers 00101, 00102, 00103 and 00104 must be written to each pump.
A TPED model H is essentially a Multi-E model H with two pumps. If a CIM module is mounted in each pump head, always set CopyToLocal bit to value "1" in both pump heads. Any writings to control bits and registers must be written to each pump head.

2 If pump 2 also has a CIM mounted (for redundancy), any writings to control bits and registers must be written for each pump head.

Modbus address	Register name	Description	Multi-B	MPC	DDD	Multi-E model G	Multi-E/TPED model H and later[2]	MAGNA3-D
00101	Bit 0: RemoteAccessReq	Control bit that sets local or remote control. 0: Local 1: Remote (controlled by Modbus master). Set this bit to 1 if a Modbus master should control the booster system. For Hydro MPC and DDD, it is also necessary to enable bus control via the CU 35X control panel ("Settings" > "Secondary functions" > "Control source", select "From bus"). If the RemoteAccessReq bit is set to logical 0, the Hydro MPC or DDD will operate with local mode settings as selected on the CU 35X control panel. If you want local control, select this from the CU 35X control panel ("Settings" > "Secondary functions" > "Control source", select "From the CU 35X"), and set the RemoteAccessReq bit to 0.	●	●	●	-	●	●
	Bit 1: OnOffReq	Control bit that switches the booster system to on or off. 0: Off (stop) 1: On (start).	●	●	●	●	●	●
	Bit 2: ResetAlarm	Control bit that resets alarms and warnings from the booster system. 0: No resetting 1: Resetting alarm. This control bit is triggered on rising edge only, i.e. setting logical 0 to 1. See section *9.2 CIM configuration register block*, address 00005, for acknowledgement behaviour.	●	●	●	●	●	●
	Bit 3: RESERVED	-						
	Bit 4: CopyToLocal[1]	Copies ControlMode, OperationMode and Setpoint to Local, when changing from Remote to Local,	-	-	-	-	●	●
	Bit 5: ResetAccCounters	Resets the accumulation counters (volume and energy). 0: No resetting 1: Resetting.	-	●	●	-	●	●
	Bits 6-15: RESERVED	-						
00102	ControlMode	Sets the control mode. 0: Constant speed 1: Constant frequency 3: Constant head 4: Constant pressure 5: Constant differential pressure 6: Proportional pressure 7: Constant flow 8: Constant temperature 10: Constant level 128: AutoAdapt (Automatic adaption for DDD) 129: FlowAdapt 130: Closed-loop sensor See section *10.1 Control modes*. Note that the control mode depends on the primary sensor, and not all booster systems can run with all the control modes. Note that DDD can run with constant pressure, proportional pressure or automatic adaption.	-	●	●	-	●	●

Modbus address	Register name	Description	Multi-B	MPC	DDD	Multi-E model G	Multi-E/TPED model H and later[2]	MAGNA3-D
00103	OperationMode	A state to control the operating mode of the booster system. 0: Auto-control (setpoint control according to selected control mode) 4: OpenLoopMin (running at minimum speed) 6: OpenLoopMax (running at maximum speed). Note that "OnOffReq" has higher priority than the OperationMode, meaning that you must set "OnOffReq" to "On" for the OperationMode to have any effect. The Hydro Multi-B can only run in auto-control mode. The Hydro Multi-E model G can only run in auto-control mode and OpenLoopMax.	●	●	-	●	●	●
00104	Setpoint	Sets the setpoint of the booster. The scale is 0.01 %, so the value must be from 0 to 10000 to represent the entire 0-100 % range. Closed loop: MPC, Multi-E: Percentage of closed-loop feedback sensor maximum value. TPED, MAGNA3-D: Percentage of the setpoint range. Open loop: MPC, Multi-E: Percentage of the maximum performance. TPED, MAGNA3-D: Percentage of the nominal pump frequency. 4700: 47 % 8000: 80 %. See section *10.3 Setpoint in closed-loop control*.	●	●	●	●	●	●
00105	ControlPump1	Forces the control of pump 1. Default is auto-control. 0: Auto-control (controlled by the booster system) 2: Forced stop.	●	●	●	-	-	-
00106	ControlPump2	Forces the control of pump 2. Default is auto-control. 0: Auto-control (controlled by the booster system) 2: Forced stop.	●	●	●	-	-	-
00107	ControlPump3	Forces the control of pump 3. Default is auto-control. 0: Auto-control (controlled by the booster system) 2: Forced stop.	●	●	●	-	-	-
00108	ControlPump4	Forces the control of pump 4. Default is auto-control. 0: Auto-control (controlled by the booster system) 2: Forced stop.	●	●	●	-	-	-
00109	ControlPump5	Forces the control of pump 5. Default is auto-control. 0: Auto-control (controlled by the booster system) 2: Forced stop.	-	●	●	-	-	-
00110	ControlPump6	Forces the control of pump 6. Default is auto-control. 0: Auto-control (controlled by the booster system) 2: Forced stop.	-	●	●	-	-	-
00111	SetTankFillStartLimit	Sets the start limit in tank-filling mode. The scale is 0.01 % of tank height. See register 00215 for actual tank height. For tank-filling mode, see section *10.2 Tank-filling applications*.	●	-	-	-	-	-
00112	SetTankFillStopLimit	Sets the stop limit in tank-filling mode. The scale is 0.01 % of tank height.	●	-	-	-	-	-
00113	SetTankFillAlarmHighLimit	Sets the alarm high-limit in tank-filling mode. The scale is 0.01 % of tank height.	●	-	-	-	-	-
00114	SetTankFillWarningLowLimit	Sets the warning low-limit in tank-filling mode. The scale is 0.01 % of tank height.	●	-	-	-	-	-

Modbus address	Register name	Description	Multi-B	MPC	DDD	Multi-E model G	Multi-E/TPED model H and later[2]	MAGNA3-D
00115	SetPropControlReduction	Sets reduction in % in proportional-pressure mode. The scale is 0.01 %.	-	●	●	-	●	-
00116	SetPropControlFlowMax	Sets manual flow max. in proportional-pressure mode. The scale is 0.1 l/s.	-	●	●	-	●	-
00117	ControlPilotpump	Forces the control of the pilot pump. Default is auto-control. 0: Auto-control (controlled by the booster system) 2: Forced stop.	-	●	-	-	-	-
00118	ControlBackuppump	Forces the control of the backup pump. Default is auto-control. 0: Auto-control (controlled by the booster system) 2: Forced stop.	-	●	-	-	-	-
00119	SetpointDDDSensor1	Sets DDD remote sensor 1 setpoint. The scale is 0.001 bar.	-	-	●	-	-	-
00120	SetpointDDDSensor2	Sets DDD remote sensor 2 setpoint. The scale is 0.001 bar.	-	-	●	-	-	-
00121	SetpointDDDSensor3	Sets DDD remote sensor 3 setpoint. The scale is 0.001 bar.	-	-	●	-	-	-
00122	SetpointDDDSensor4	Sets DDD remote sensor 4 setpoint. The scale is 0.001 bar.	-	-	●	-	-	-
00123	SetpointDDDSensor5	Sets DDD remote sensor 5 setpoint. The scale is 0.001 bar.	-	-	●	-	-	-
00124	SetpointDDDSensor6	Sets DDD remote sensor 6 setpoint. The scale is 0.001 bar.	-	-	●	-	-	-
00125	SetpointDDDSensor7	Sets DDD remote sensor 7 setpoint. The scale is 0.001 bar.	-	-	●	-	-	-
00126	SetpointDDDSensor8	Sets DDD remote sensor 8 setpoint. The scale is 0.001 bar.	-	-	●	-	-	-
00127	SetpointDDDSensor9	Sets DDD remote sensor 9 setpoint. The scale is 0.001 bar.	-	-	●	-	-	-
00128	SetpointDDDSensor10	Sets DDD remote sensor 10 setpoint. The scale is 0.001 bar.	-	-	●	-	-	-
00129	ControlSystemFeedbackSensor	3: Flow sensor 6: Pressure sensor	-	●	-	-	-	-

9.6 Status register block

Registers in this register block can be read by means of function codes 0x03 and/or 0x04. They are read-only.

Address	Register name	Description	Multi-B	MPC	DDD	Multi-E model G	Multi-E/TPED model H and later	MAGNA3-D
00201	Bit 0: RESERVED	-						
	Bit 1: CopyToLocal	Copies remote settings to local settings. 1: Enable, 0: Disable.	-	-	-	-	●	●
	Bit 2: ResetAccCountersAck	Acknowledgement of ResetAccCounters (volume and energy). 0: No acknowledgement 1: Command acknowledged. This functionality is only used when AutoAcknowledgeEvents is disabled. See section *9.2 CIM configuration register block*.	-	●	●	-	●	●
	Bit 3: ResetAlarmAck	Indicates if a ResetAlarm command was acknowledged by the device. This bit is set when the module or unit have accepted a ResetAlarm command, and the programmer can clear the ResetAlarm bit. The CIM/CIU will automatically clear the ResetAlarmAck bit to 0 when the master device clears the ResetAlarm bit, and you can attempt a new ResetAlarm command by raising the ResetAlarm bit again. 0: No acknowledgement 1: Command acknowledged. This functionality is only used when AutoAcknowledgeEvents is disabled. See section *9.2 CIM configuration register block*.	●	●	●	●	●	●
	Bit 4: SetpointInfluence	Setpoint influence status 0: No setpoint influence 1: Setpoint influence active	-	●	●	-	●	●
	Bit 5: AtMaxPower	Running at power limit 0: Not at power limit 1: At power limit	-	-	-	-	●	●
	Bit 6: Rotation	Indicates if any pumps are rotating (running) or not. 0: No rotation 1: Rotation.	●	●	●	●	●	●
	Bit 7: RESERVED	-						
	Bit 8: AccessMode	Indicates if the booster system is locally or remotely controlled. 0: Local (a local control source with higher priority controls the system) 1: Remote (controlled by Modbus master).	●	●	●	●	●	●
	Bit 9: OnOff	Indicates if the booster system is on or off. 0: Off (stopped, the green LED on the booster system flashes) 1: On (started, the green LED on the booster system is on). "Started" does not necessarily indicate rotation, for instance in case of low-flow stop.	●	●	●	●	●	●
	Bit 10: Alarm	Indicates if there is an alarm or not. 0: No alarm 1: Alarm (red LED on the booster system is on).	●	●	●	●	●	●
	Bit 11: Warning	Indicates if there is a warning or not. 0: No warning 1: Warning (red LED on the booster system is on). The system will continue running even if there is a warning.	●	●	●	-	●	●
	Bit 12: RESERVED	-						
	Bit 13: AtMaxSpeed	Indicates if the system is running at maximum speed. 0: No 1: Yes.	-	●	-	●	●	●
	Bit 14: RESERVED	-						
	Bit 15: AtMinSpeed	Indicates if the system is running at minimum speed. 0: No 1: Yes.	-	●	-	●	●	●

Address	Register name	Description	Multi-B	MPC	DDD	Multi-E model G	Multi-E/TPED model H and later	MAGNA3-D
00202	ProcessFeedback	Indicates the actual process feedback from the booster system. The scale is 0.01 %, so the valid value range is from 0 to 10000. This value can be compared with the setpoint value. Closed loop: MPC, Multi-E: Percentage of closed-loop feedback sensor maximum value. TPED, MAGNA3-D: Percentage of the setpoint range. Open loop: MPC, Multi-E: Percentage of the maximum performance. TPED, MAGNA3-D: Percentage of the nominal pump frequency. Common examples 4700: 47 % 8000: 80 %.	•	•	•	•	•	•
00203	ControlMode	Indicates the actual control mode. 0: Constant speed 1: Constant frequency 3: Constant head 4: Constant pressure 5: Constant differential pressure 6: Proportional pressure 7: Constant flow 8: Constant temperature 10: Constant level 128: $AUTO_{ADAPT}$ (Automatic adaption for DDD) 129: $FLOW_{ADAPT}$ 130: Closed-loop sensor See section *10.1 Control modes*. Note that the control mode depends on the primary sensor, and not all booster systems can run with all the control modes. Note that DDD can run with constant pressure, proportional pressure or automatic adaption.	•	•	•	•	•	•
00204	OperationMode	Indicates the actual operating mode. 0: Auto-control (setpoint control according to selected control mode) 4: OpenLoopMin (running at minimum speed) 6: OpenLoopMax (running at maximum speed).	•	•	•	•	•	•
00205	AlarmCode	The Grundfos-specific alarm code. See section *16. Grundfos alarm and warning codes*.	•	•	•	•	•	•
00206	WarningCode	The Grundfos-specific warning code. See section *16. Grundfos alarm and warning codes*.	•	•	•	-	•	•
00207	RESERVED	-						
00208	PumpsPresent	Indicates presence of pumps. This value is bit-interpreted: Bit 0: Pump 1 Bit 1: Pump 2 Bit 2: Pump 3 Bit 3: Pump 4 Bit 4: Pump 5 Bit 5: Pump 6 Bit 6: Pilot pump Bit 7: Backup pump A bit value of "1" indicates that the pump is present.	•	•	•	•	•	•

Address	Register name	Description	Multi-B	MPC	DDD	Multi-E model G	Multi-E/TPED model H and later	MAGNA3-D
00209	PumpsRunning	Indicates the running status of pumps. This value is bit-interpreted: Bit 0: Pump 1 Bit 1: Pump 2 Bit 2: Pump 3 Bit 3: Pump 4 Bit 4: Pump 5 Bit 5: Pump 6 Bit 6: Pilot pump Bit 7: Backup pump A bit value of "1" indicates that the pump is running.	•	•	•	•	•	•
00210	PumpsFault	Indicates alarm status of pumps. This value is bit-interpreted: Bit 0: Pump 1 Bit 1: Pump 2 Bit 2: Pump 3 Bit 3: Pump 4 Bit 4: Pump 5 Bit 5: Pump 6 Bit 6: Pilot pump Bit 7: Backup pump A bit value of "1" indicates that the pump has an alarm.	•	•	•	•	•	•
00211	PumpsCommFault	Indicates communication status of pumps. This value is bit-interpreted: Bit 0: Pump 1 Bit 1: Pump 2 Bit 2: Pump 3 Bit 3: Pump 4 Bit 4: Pump 5 Bit 5: Pump 6 Bit 6: Pilot pump Bit 7: Backup pump A bit value of "1" indicates that there is no communication with the pump.	•	•	•	•	•	•
00212	SystemActiveFunctions	Indicates active system functions. Hydro MPC supports all bits. Hydro Multi-B only supports bits 7 and 12. Bit 0: - Bit 1: Emergency Run function active Bit 2: Standby pumps active Bit 3: Pump test run active Bit 4: Alternative setpoint active Bit 5: Clock program active Bit 6: Remote VNC, Virtual Network Connection, active Bit 7: Remote bus active Bit 8: Remote service port active Bit 9: Pressure relief function active Bit 10: Soft pressure function active Bit 11: Low-flow boost active Bit 12: Low-flow stop active Bit 13: Proportional pressure active.	•	•	•	-	-	-
00213	PumpsAutoMode	Indicates auto-control mode status of pumps. This value is bit-interpreted: Bit 0: Pump 1 Bit 1: Pump 2 Bit 2: Pump 3 Bit 3: Pump 4 Bit 4: Pump 5 Bit 5: Pump 6 Bit 6: Pilot pump Bit 7: Backup pump A bit value of "1" indicates that the pump is in auto-control mode.	•	•	•	-	-	-

Address	Register name	Description	Multi-B	MPC	DDD	Multi-E model G	Multi-E/TPED model H and later	MAGNA3-D
00214	ApplicationType	Indicates system application type status. You cannot change application type from Modbus. 0: Unknown 1: Pressure boosting 2: Heating pumps on hot side 3: Heating pumps on cold side 4: AirCon pumps on hot side 5: AirCon pumps on cold side 6: MPC S2000 heating pumps on hot side 7: MPC S2000 heating pumps on cold side 8: MPC S2000 AirCon pumps on hot side 9: MPC S2000 AirCon pumps on cold side 10: Tank filling (level sensor) 11: Tank filling (float switches).	•	•	-	-	-	-
00215	TankFillTankHeight	Indicates actual tank height in tank-filling mode. The scale is 0.01 % of tank height.	•	-	-	-	-	-
00216	TankFillStartLimit	Indicates actual start limit in tank-filling mode. The scale is 0.01 % of tank height.	•	-	-	-	-	-
00217	TankFillStopLimit	Indicates actual stop limit in tank-filling mode. The scale is 0.01 % of tank height.	•	-	-	-	-	-
00218	TankFillAlarmHighLimit	Indicates actual alarm high-limit in tank-filling mode. The scale is 0.01 % of tank height.	•	-	-	-	-	-
00219	TankFillWarningLowLimit	Indicates actual warning low-limit in tank-filling mode. The scale is 0.01 % of tank height.	•	-	-	-	-	-
00220	FeedBackSensorUnit	Unit of feedback sensor. 0: bar 1: mbar 2: m 3: kPa 4: psi 5: ft 6: m^3/h 7: m^3/s 8: l/s 9: gpm 10: °C 11: °F 12: % 13: K 14: l/h 255: -	•	•	•	-	•	•
00221	FeedBackSensorMin	Minimum of feedback sensor.	•	•	•	-	•	•
00222	FeedBackSensorMax	Maximum of feedback sensor.	•	•	•	-	•	•
00223	SystemFeedbackSensor	3: Flow sensor 6: Pressure sensor	-	•	-	-	-	-

9.7 System data register block

Registers in this block can be read by means of function codes 0x03 and/or 0x04. They are read-only. The table below shows which registers are supported by each booster system type.

Unless otherwise stated, the data type used for counters and scaled values is always an unsigned integer.

A data value of 0xFFFF indicates "not available". See section *6.2 LEDs* for descriptions.

Many of the measurement modules for the booster system require a particular sensor to be present. As a limited number of sensors are available, only a few of the measurement modules can be available simultaneously.

See section *10.9 Sensor-based Modbus registers* for the relation between the sensor-related modbus registers and for sensor setup of your booster system.

S: Sensor required. See section *10.9 Sensor-based Modbus registers*.

•: Always available.

Address	Register name	Description	Scale	Multi-B	MPC	DDD	Multi-E model G	Multi-E/TPED model H and later	MAGNA3-D
00301	Head	Actual system head/pressure.	0.001 bar	-	S	S	S	S	●
00302	VolumeFlow	Actual system flow.	0.1 m^3/h	-	S	S	S	S	●
00303	RelativePerformance	Performance relative to maximum performance.	0.01 %	●	●	●	●	●	●
00304 00305	RESERVED	-							
00306	DigitalInput	Logical value of external digital input signals.	Bits	●	●	●	●	●	●
00307	DigitalOutput	Logical value of external digital output signals.	Bits	●	●	●	●	●	●
00308	ActualSetpoint	Actual setpoint, according to control mode. See register 00104 for scaling description.	0.01 %	●	●	●	●	●	●
00309	MotorCurrent	Actual motor current.	0.1 A	-	-	-	●	-	-
00310 00311	RESERVED	-							
00312 00313	PowerHI PowerLO	Total power consumption of the system.	1 Watt	●	●	●	●	●	●
00314	RESERVED	-							
00315	InletPressure	System inlet pressure, relative to atmospheric pressure. Has an offset of -1.000 bar.	0.001 bar	S	S	S	-	S	-
00316	RemotePressure1	Measured pressure 1 at external sensor, relative to atmospheric pressure.	0.001 bar	-	S	-	-	S	S
00317	Level	Tank level. Has an offset of -100.00 metres.	0.01 m	-	S	S	S	S	-
00318 00319	RESERVED	-							
00320	RemoteTemp1	Temperature 1 at external sensor.	0.01 K	-	S	-	S	S	-
00321 … 00324	RESERVED	-							
00325	AuxSensorInput	Auxiliary sensor input.	0.01 %	-	-	-	S	S	-
00326	RESERVED	-							
00327 00328	OperationTimeHI OperationTimeLO	Total operating time of the system.	1 hour	●	●	●	●	●	●
00329 00330	TotalPoweredTimeHI TotalPoweredTimeLO	Total power-on time of the system.	1 hour	-	-	-	●	-	-
00331	RESERVED	-							
00332 00333	EnergyHI EnergyLO	Total energy consumption of the system.	1 kWh	●	●	●	●	●	●
00334 00335 00336	RESERVED	-							
00337	AmbientTemp	Ambient temperature	0.01 K	-	S	-	-	S	-
00338	InletTemp	Inlet water temperature.	0.01 K	-	S	-	-	-	-
00339	OutletTemp	Outlet water temperature.	0.01 K	-	S	-	-	-	-
00340	TempDifference	Differential temperature.	0.01 K	-	S	-	-	-	-
00341	OutletPressure	System outlet pressure.	0.001 bar	S	S	S	-	S	-
00342	FeedTankLevel	Tank feed level. It has an offset of -100.00 metres.	0.01 m	-	S	S	-	S	-
00343	UserSetpoint	Setpoint before modifications. See register 00104 for scaling description.	0.01 %	●	●	●	-	●	●
00344	AnalogueInfluence	Setpoint attenuator.	0.01 %	●	●	●	-	●	●
00345	NumberOfPowerOns	Number of times the booster system has been powered on.	Unscaled	●	●	●	-	-	-
00346	SpecificEnergy	Specific energy.	0.1 Wh/m^3	-	S	●	-	S	●
00347	SpecificEnergyAverage	Average specific energy.	0.1 Wh/m^3	-	S	●	-	-	-

Address	Register name	Description	Scale	Multi-B	MPC	DDD	Multi-E model G	Multi-E/TPED model H and later	MAGNA3-D
00348	FlowMeasurement 1	Flow measurement 1.	0.1 m^3/h	-	S	S	-	-	-
00349	FlowMeasurement 2	Flow measurement 2.	0.1 m^3/h	-	S	S	-	-	-
00350	FlowMeasurement 3	Flow measurement 3.	0.1 m^3/h	-	S	S	-	-	-
00351	PropControlReduction	Proportional control reduction.	0.01 %	-	●	●	-	●	-
00352	PropControlFlowMax	Proportional control maximum flowpoint.	0.1 m^3/h	-	●	●	-	●	-
00353	RemotePressure2	Measured pressure 2 at external sensor (relative to atmospheric pressure).	0.001 bar	-	-	-	-	S	-
00354	RemoteTemp2	Temperature 2 at external sensor.	0.01 K	-	-	-	-	S	S
00355	MediumTemp	Medium temperature.	0.01 K	-	-	-	-	S	●
00356	DifferentialPressure	Differential pressure.	0.001 bar	-	-	-	-	S	●
00357	DifferentialInletPressure	Differential inlet pressure.	0.001 bar	-	-	-	-	S	-
00358	DifferentialOutletPressure	Differential outlet pressure.	0.001 bar	-	-	-	-	S	-
00359	DifferentialRemotePressure	Differential remote pressure.	0.001 bar	-	-	-	-	S	-
00360	RemoteFlow	Flow measurement from remote sensor.	0.1 m^3/h	-	-	-	-	S	-
00361	LatestNightFlowAverage	Average night flow for the latest night.	0.1 m^3/h	-	-	●	-	S	-
00362	LatestNightPressAverage	Average night pressure for the latest night.	0.001 bar	-	-	●	-	S	-
00363 00364	VolumeHI VolumeLO	The pumped volume.	0.1 m^3	-	S	S	-	S	S
00365	HeatingEnergyCounter_HI	Life time accumulated heat energy Ext. temp. sensor required	1 kWh	-	-	-	-	S	S
00366	HeatEnergyCounter_LO								
00367	HeatPower_HI	Current heat power Ext. temp. sensor required	1 W	-	-	-	-	S	S
00368	HeatPower_LO								
00369	HeatDiffTemp	Forward/Return differential temperature Ext. temp. sensor required	0.01 °C	-	-	-	-	S	S
00481	Pump1.Energy	Energy consumption of pump 1	1 kWh	-	●	●	-	●	S
00482	Pump2.Energy	Energy consumption of pump 2	1 kWh	-	●	●	-	●	S
00483	Pump3.Energy	Energy consumption of pump 3	1 kWh	-	●	●	-	●	-
00484	Pump4.Energy	Energy consumption of pump 4	1 kWh	-	●	●	-	●	-
00485	Pump5.Energy	Energy consumption of pump 5	1 kWh	-	●	●	-	●	-
00486	Pump6.Energy	Energy consumption of pump 6	1 kWh	-	●	●	-	●	-
00487	PilotPump.Energy	Energy consumption of pilot pump	1 kWh	-	●	-	-	-	-
00488	BackupPump.Energy	Energy consumption of backup pump	1 kWh	-	●	-	-	-	-

9.8 Pump 1 register block

Unless otherwise stated, the data type used for counters and scaled values is always an unsigned integer.

Address	Register name	Scale	Notes
00401	Bit 0: AccessMode	Bool	Indicates if the pump is locally or remotely controlled. 0: Local, controlled by buttons on pump 1: Remote, controlled by the booster system. Note that this bit is not available for Hydro Multi-E model G.
	Bit 1: OnOff	Bool	Indicates if the pump is on or off. 0: Off 1: On.
	Bit 2: Fault	Bool	Indicates if a pump has a fault or not. 0: No fault 1: Fault.
00402	AlarmCode	Unscaled	The Grundfos-specific alarm code. See section *16. Grundfos alarm and warning codes.*
00403 00404	OperationTimeHI OperationTimeLO	1 hour	Operating time of the pump.
00405	Speed	0.01 %	Speed of the pump motor. Note that this data point is not available for Hydro Multi-E model G.
00406	LineCurrent	0.1 A	Average value of line currents on the pump. Note that this data point is not available for Hydro Multi-E model G.
00407	Power	10 W	Power consumption of the pump. Note that this data point is not available for Hydro Multi-E model G.
00408	MotorTemperature	0.01 K	Motor temperature of the pump. Note that this data point is not available for Hydro Multi-E model G.
00409	ControlSource	Enum	Control source of the pump. 0: Unknown 1: Buttons on the pump 2: GENIbus (booster controller) 3: GENIlink/GENIair (from handheld controller) 4: External control. Note that this data point is not available for Hydro Multi-E model G.
00410	RESERVED	-	-

A register value of 0xFFFF indicates "not available".

9.9 Pump 2 register block

Unless otherwise stated, the data type used for counters and scaled values is always an unsigned integer.

Address	Register name	Scale	Notes
00411	Bit 0: AccessMode	Bool	Indicates if the pump is locally or remotely controlled. 0: Local, controlled by buttons on pump 1: Remote, controlled by the booster system. Note that this bit is not available for Hydro Multi-E model G.
	Bit 1: OnOff	Bool	Indicates if the pump is on or off. 0: Off 1: On.
	Bit 2: Fault	Bool	Indicates if a pump has an alarm or not. 0: No fault 1: Fault.
00412	AlarmCode	Unscaled	The Grundfos-specific alarm code. See section *16. Grundfos alarm and warning codes.*
00413 00414	OperationTimeHI OperationTimeLO	1 hour	Operating time of the pump.
00415	Speed	0.01 %	Speed of the pump motor. Note that this data point is not available for Hydro Multi-E model G.
00416	LineCurrent	0.1 A	Average value of line currents on the pump. Note that this data point is not available for Hydro Multi-E model G.
00417	Power	10 W	Power consumption of the pump. Note that this data point is not available for Hydro Multi-E model G.
00418	MotorTemperature	0.01 K	Motor temperature of the pump. Note that this data point is not available for Hydro Multi-E model G.

Address	Register name	Scale	Notes
00419	ControlSource	Enum	Control source of the pump. 0: Unknown 1: Buttons on the pump 2: GENIbus (booster controller) 3: GENIlink/GENIair (from handheld controller) 4: External control. Note that this data point is not available for Hydro Multi-E model G.
00420	RESERVED	-	-

A register value of 0xFFFF indicates "not available".

9.10 Pump 3 register block

Unless otherwise stated, the data type used for counters and scaled values is always an unsigned integer.

Address	Register name	Scale	Notes
00421	Bit 0: AccessMode	Bool	Indicates if the pump is locally or remotely controlled. 0: Local, controlled by buttons on pump 1: Remote, controlled by the booster system. Note that this bit is not available for Hydro Multi-E model G.
	Bit 1: OnOff	Bool	Indicates if the pump is on or off. 0: Off 1: On.
	Bit 2: Fault	Bool	Indicates if a pump has a fault or not. 0: No fault 1: Fault.
00422	AlarmCode	Unscaled	The Grundfos-specific alarm code. See section *16. Grundfos alarm and warning codes*.
00423 00424	OperationTimeHI OperationTimeLO	1 hour	Operating time of the pump.
00425	Speed	0.01 %	Speed of the pump motor. Note that this data point is not available for Hydro Multi-E model G.
00426	LineCurrent	0.1 A	Average value of line currents on the pump. Note that this bit is not available for Hydro Multi-E model G.
00427	Power	10 W	Power consumption of the pump. Note that this bit is not available for Hydro Multi-E model G.
00428	MotorTemperature	0.01 K	Motor temperature of the pump. Note that this bit is not available for Hydro Multi-E model G.
00429	ControlSource	Enum	Control source of the pump. 0: Unknown 1: Buttons on the pump 2: GENIbus (booster controller) 3: GENIlink/GENIair (from handheld controller) 4: External control. Note that this bit is not available for Hydro Multi-E model G.
00430	RESERVED	-	-

A register value of 0xFFFF indicates "not available".

9.11 Pump 4 register block

Unless otherwise stated, the data type used for counters and scaled values is always an unsigned integer.

Address	Register name	Scale	Notes
00431	Bit 0: AccessMode	Bool	Indicates if the pump is locally or remotely controlled. 0: Local, controlled by buttons on pump 1: Remote, controlled by the booster system. Note that this bit is not available for Hydro Multi-E model G.
	Bit 1: OnOff	Bool	Indicates if the pump is on or off. 0: Off 1: On.
	Bit 2: Fault	Bool	Indicates if a pump has a fault or not. 0: No fault 1: Fault.
00432	AlarmCode	Unscaled	The Grundfos-specific alarm code. See section *16. Grundfos alarm and warning codes*.
00433 00434	OperationTimeHI OperationTimeLO	1 hour	Operating time of the pump.
00435	Speed	0.01 %	Speed of the pump motor. Note that this data point is not available for Hydro Multi-E model G.

Address	Register name	Scale	Notes
00436	LineCurrent	0.1 A	Average value of line currents on the pump. Note that this bit is not available for Hydro Multi-E model G.
00437	Power	10 W	Power consumption of the pump. Note that this bit is not available for Hydro Multi-E model G.
00438	MotorTemperature	0.01 K	Motor temperature of the pump. Note that this bit is not available for Hydro Multi-E model G.
00439	ControlSource	Enum	Control source of the pump. 0: Unknown 1: Buttons on the pump 2: GENIbus (booster controller) 3: GENIlink/GENIair (from handheld controller) 4: External control. Note that this bit is not available for Hydro Multi-E model G.
00440	RESERVED	-	-

A register value of 0xFFFF indicates "not available".

9.12 Pump 5 register block

Unless otherwise stated, the data type used for counters and scaled values is always an unsigned integer.

Address	Register name	Scale	Notes
00441	Bit 0: AccessMode	Bool	Indicates if the pump is locally or remotely controlled. 0: Local, controlled by buttons on pump 1: Remote, controlled by the booster system. Note that this bit is not available for Hydro Multi-E model G.
	Bit 1: OnOff	Bool	Indicates if the pump is on or off. 0: Off 1: On.
	Bit 2: Fault	Bool	Indicates if a pump has a fault or not. 0: No fault 1: Fault.
00442	AlarmCode	Unscaled	The Grundfos-specific alarm code. See section *16. Grundfos alarm and warning codes.*
00443 00444	OperationTimeHI OperationTimeLO	1 hour	Operating time of the pump.
00445	Speed	0.01 %	Speed of the pump motor. Note that this data point is not available for Hydro Multi-E model G.
00446	LineCurrent	0.1 A	Average value of line currents on the pump. Note that this bit is not available for Hydro Multi-E model G.
00447	Power	10 W	Power consumption of the pump. Note this bit is not available for Hydro Multi-E model G.
00448	MotorTemperature	0.01 K	Motor temperature of the pump. Note this bit is not available for Hydro Multi-E model G.
00449	ControlSource	Enum	Control source of the pump. 0: Unknown 1: Buttons on the pump 2: GENIbus (booster controller) 3: GENIlink/GENIair (from handheld controller) 4: External control. Note that this bit is not available for Hydro Multi-E model G.
00450	RESERVED	-	-

A register value of 0xFFFF indicates "not available".

9.13 Pump 6 register block

Unless otherwise stated, the data type used for counters and scaled values is always an unsigned integer.

Address	Register name	Scale	Notes
00451	Bit 0: AccessMode	Bool	Indicates if the pump is locally or remotely controlled. 0: Local, controlled by buttons on pump 1: Remote, controlled by the booster system. Note that this bit is not available for Hydro Multi-E model G.
	Bit 1: OnOff	Bool	Indicates if the pump is on or off. 0: Off 1: On.
	Bit 2: Fault	Bool	Indicates if a pump has a fault or not. 0: No fault 1: Fault.

Address	Register name	Scale	Notes
00452	AlarmCode	Unscaled	The Grundfos-specific alarm code. See section *16. Grundfos alarm and warning codes.*
00453 00454	OperationTimeHI OperationTimeLO	1 hour	Operating time of the pump.
00455	Speed	0.01 %	Speed of the pump motor. Note that this data point is not available for Hydro Multi-E model G.
00456	LineCurrent	0.1 A	Average value of line currents on the pump. Note that this bit is not available for Hydro Multi-E model G.
00457	Power	10 W	Power consumption of the pump. Note that this bit is not available for Hydro Multi-E model G.
00458	MotorTemperature	0.01 K	Motor temperature of the pump. Note that this bit is not available for Hydro Multi-E model G.
00459	ControlSource	Enum	Control source of the pump. 0: Unknown 1: Buttons on the pump 2: GENIbus (booster controller) 3: GENIlink/GENIair (from handheld controller) 4: External control. Note that this bit is not available for Hydro Multi-E model G.
00460	RESERVED	-	-

A register value of 0xFFFF indicates "not available".

9.14 Pilot pump register block, Hydro MPC only

Unless otherwise stated, the data type used for counters and scaled values is always an unsigned integer.

Address	Register name	Scale	Notes
00461	Bit 0: AccessMode	Bool	Indicates if the pump is locally or remotely controlled. 0: Local, controlled via buttons on pump 1: Remote, controlled by the booster system.
	Bit 1: OnOff	Bool	Indicates if the pump is on or off. 0: Off 1: On.
	Bit 2: Fault	Bool	Indicates if a pump has a fault or not. 0: No fault 1: Fault.
00462	AlarmCode	Unscaled	The Grundfos-specific alarm code. See section *16. Grundfos alarm and warning codes.*
00463 00464	OperationTimeHI OperationTimeLO	1 hour	Operating time of the pump.
00465	Speed	0.01 %	Speed of the pump motor.
00466	LineCurrent	0.1 A	Average value of line currents on the pump.
00467	Power	10 W	Power consumption of the pump.
00468	MotorTemperature	0.01 K	Motor temperature of the pump.
00469	ControlSource	Enum	Control source of the pump. 0: Unknown 1: Buttons on the pump 2: GENIbus (booster controller) 3: GENIlink/GENIair (from handheld controller) 4: External control.
00470	RESERVED	-	-

A register value of 0xFFFF indicates "not available".

9.15 Backup pump register block, Hydro MPC only

Unless otherwise stated, the data type used for counters and scaled values is always an unsigned integer.

Address	Register name	Scale	Notes
00471	Bit 0: AccessMode	Bool	Indicates if the pump is locally or remotely controlled. 0: Local, controlled via buttons on pump 1: Remote, controlled by the booster system.
	Bit 1: OnOff	Bool	Indicates if the pump is on or off. 0: Off 1: On.
	Bit 2: Fault	Bool	Indicates if a pump has a fault or not. 0: No fault 1: Fault.

Address	Register name	Scale	Notes
00472	AlarmCode	Unscaled	The Grundfos-specific alarm code. See section *16. Grundfos alarm and warning codes.*
00473 00474	OperationTimeHI OperationTimeLO	1 hour	Operating time of the pump.
00475	Speed	0.01 %	Speed of the pump motor.
00476	LineCurrent	0.1 A	Average value of line currents on the pump.
00477	Power	10 W	Power consumption of the pump.
00478	MotorTemperature	0.01 K	Motor temperature of the pump.
00479	ControlSource	Enum	Control source of the pump. 0: Unknown 1: Buttons on the pump 2: GENIbus (booster controller) 3: GENIlink/GENIair (from handheld controller) 4: External control.
00480	RESERVED	-	-

A register value of 0xFFFF indicates "not available".

9.16 DDD Remote Sensor Data

For a DDD system to run with Automatic adaption, you must have a number of remote sensors. (1 to 10). The following data are only available for DDD systems.

Unless otherwise stated, the data type used for counters and scaled values is always an unsigned integer.

Address	Register name	Scale	Notes
00601	Bit 0: BatteryWarningDDDSensor1	Bool	0: Sensor battery is OK 1: Sensor battery must be replaced
	Bit 1: BatteryWarningDDDSensor2	Bool	
	Bit 2: BatteryWarningDDDSensor3	Bool	
	Bit 3: BatteryWarningDDDSensor4	Bool	
	Bit 4: BatteryWarningDDDSensor5	Bool	
	Bit 5: BatteryWarningDDDSensor6	Bool	
	Bit 6: BatteryWarningDDDSensor7	Bool	
	Bit 7: BatteryWarningDDDSensor8	Bool	
	Bit 8: BatteryWarningDDDSensor9	Bool	
	Bit 9: BatteryWarningDDDSensor10	Bool	
00602	Bit 0: PressureLowDDDSensor1	Bool	0: Pressure is OK 1: Pressure is below warning limit
	Bit 1: PressureLowDDDSensor2	Bool	
	Bit 2: PressureLowDDDSensor3	Bool	
	Bit 3: PressureLowDDDSensor4	Bool	
	Bit 4: PressureLowDDDSensor5	Bool	
	Bit 5: PressureLowDDDSensor6	Bool	
	Bit 6: PressureLowDDDSensor7	Bool	
	Bit 7: PressureLowDDDSensor8	Bool	
	Bit 8: PressureLowDDDSensor9	Bool	
	Bit 9: PressureLowDDDSensor10	Bool	
00603	Bit 0: MissingDataDDDSensor1	Bool	0: Pressure data received 1: Pressure data missing
	Bit 1: MissingDataDDDSensor2	Bool	
	Bit 2: MissingDataDDDSensor3	Bool	
	Bit 3: MissingDataDDDSensor4	Bool	
	Bit 4: MissingDataDDDSensor5	Bool	
	Bit 5: MissingDataDDDSensor6	Bool	
	Bit 6: MissingDataDDDSensor7	Bool	
	Bit 7: MissingDataDDDSensor8	Bool	
	Bit 8: MissingDataDDDSensor9	Bool	
	Bit 9: MissingDataDDDSensor10	Bool	

Address	Register name	Scale	Notes
00604	Bit 0: DataWarningDDDSensor1	Bool	0: Data model is OK 1: Data model inconsistency warning
	Bit 1: DataWarningDDDSensor2	Bool	
	Bit 2: DataWarningDDDSensor3	Bool	
	Bit 3: DataWarningDDDSensor4	Bool	
	Bit 4: DataWarningDDDSensor5	Bool	
	Bit 5: DataWarningDDDSensor6	Bool	
	Bit 6: DataWarningDDDSensor7	Bool	
	Bit 7: DataWarningDDDSensor8	Bool	
	Bit 8: DataWarningDDDSensor9	Bool	
	Bit 9: DataWarningDDDSensor10	Bool	
00605	PressureYesterdayDDDSensor1	0.001 bar	The pressure from 24 hours ago at DDD remote sensor 1
00606	PressureYesterdayDDDSensor2	0.001 bar	The pressure from 24 hours ago at DDD remote sensor 2
00607	PressureYesterdayDDDSensor3	0.001 bar	The pressure from 24 hours ago at DDD remote sensor 3
00608	PressureYesterdayDDDSensor4	0.001 bar	The pressure from 24 hours ago at DDD remote sensor 4
00609	PressureYesterdayDDDSensor5	0.001 bar	The pressure from 24 hours ago at DDD remote sensor 5
00610	PressureYesterdayDDDSensor6	0.001 bar	The pressure from 24 hours ago at DDD remote sensor 6
00611	PressureYesterdayDDDSensor7	0.001 bar	The pressure from 24 hours ago at DDD remote sensor 7
00612	PressureYesterdayDDDSensor8	0.001 bar	The pressure from 24 hours ago at DDD remote sensor 8
00613	PressureYesterdayDDDSensor9	0.001 bar	The pressure from 24 hours ago at DDD remote sensor 9
00614	PressureYesterdayDDDSensor10	0.001 bar	The pressure from 24 hours ago at DDD remote sensor 10
00615	ActualSetpointDDDSensor1	0.001 bar	The pressure setpoint at DDD remote sensor 1
00616	ActualSetpointDDDSensor2	0.001 bar	The pressure setpoint at DDD remote sensor 2
00617	ActualSetpointDDDSensor3	0.001 bar	The pressure setpoint at DDD remote sensor 3
00618	ActualSetpointDDDSensor4	0.001 bar	The pressure setpoint at DDD remote sensor 4
00619	ActualSetpointDDDSensor5	0.001 bar	The pressure setpoint at DDD remote sensor 5
00620	ActualSetpointDDDSensor6	0.001 bar	The pressure setpoint at DDD remote sensor 6
00621	ActualSetpointDDDSensor7	0.001 bar	The pressure setpoint at DDD remote sensor 7
00622	ActualSetpointDDDSensor8	0.001 bar	The pressure setpoint at DDD remote sensor 8
00623	ActualSetpointDDDSensor9	0.001 bar	The pressure setpoint at DDD remote sensor 9
00624	ActualSetpointDDDSensor10	0.001 bar	The pressure setpoint at DDD remote sensor 10
00625 00626	UNIXlatestDataTimeDDDSensor1HI UNIXlatestDataTimeDDDSensor1LO	1 s	Latest data timestamp received from sensor 1
00627 00628	UNIXlatestDataTimeDDDSensor2HI UNIXlatestDataTimeDDDSensor2LO	1 s	Latest data timestamp received from sensor 2
00629 00630	UNIXlatestDataTimeDDDSensor3HI UNIXlatestDataTimeDDDSensor3LO	1 s	Latest data timestamp received from sensor 3
00631 00632	UNIXlatestDataTimeDDDSensor4HI UNIXlatestDataTimeDDDSensor4LO	1 s	Latest data timestamp received from sensor 4
00633 00634	UNIXlatestDataTimeDDDSensor5HI UNIXlatestDataTimeDDDSensor5LO	1 s	Latest data timestamp received from sensor 5
00635 00636	UNIXlatestDataTimeDDDSensor6HI UNIXlatestDataTimeDDDSensor6LO	1 s	Latest data timestamp received from sensor 6
00637 00638	UNIXlatestDataTimeDDDSensor7HI UNIXlatestDataTimeDDDSensor7LO	1 s	Latest data timestamp received from sensor 7
00639 00640	UNIXlatestDataTimeDDDSensor8HI UNIXlatestDataTimeDDDSensor8LO	1 s	Latest data timestamp received from sensor 8
00641 00642	UNIXlatestDataTimeDDDSensor9HI UNIXlatestDataTimeDDDSensor9LO	1 s	Latest data timestamp received from sensor 9
00643 00644	UNIXlatestDataTimeDDDSensor10HI UNIXlatestDataTimeDDDSensor10LO	1 s	Latest data timestamp received from sensor 10

9.17 Alarm simulation register block

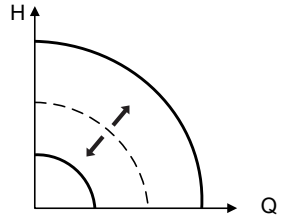
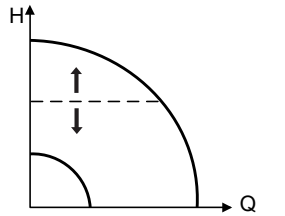
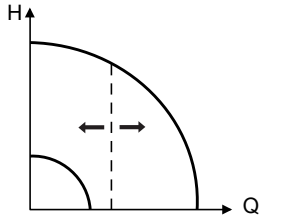
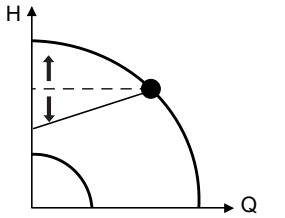
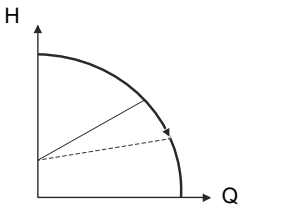
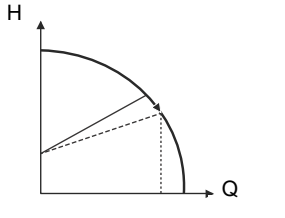
Registers in this register block can be read by means of function codes 0x03 and/or 0x04.

Address	Register name	Description	Multi-B	MPC	DDD	Multi-E model G	Multi-E/TPED model H and later	MAGNA3-D
00701 00702	RESERVED		-	-	-	-	-	-
00703	Simulation.EventCode	Code for the event (Alarm) to simulate. See section *9.17 Alarm simulation register block*.	●	●	●	-	●	●
00704	Simulation.DeviceType	Code for the device. 0: CU 351/352 controller 1: - 2: Pump 3: IO 351 pump module 4: Primary sensor 5: Redundant sensor 6: Secondary sensor 7: IO 351 I/O module 8: System 9: Analog input 10: Pilot pump 11: Limit exceeded function 12: Backup pump.	●	●	●	-	-	-
00705	Simulation.DeviceNumber	Code for the device number, according to device type. For example if Simulation.DeviceType: 2, then this register determines the pump number [1-8].	●	●	●	-	-	-
00706	Simulation.ActionType	Type of action for simulated event 0: Stop 1: Stop with delay 2: Minimum 3: User-defined 4: Maximum 5: Set pumps to local 6: No action, warning only 7: Emergency run.	-	●	●	-	-	-
00707	Simulation.ResetType	0: Manual 1: Automatic.	-	●	●	-	-	-
00708	Simulation.Activate	Used to activate alarm simulation with alarms and warnings. 0: Deactivate simulation 1: Activate simulation.	●	●	●	-	●	●
00709	Simulation.Active	Status of alarm simulation. 0: Alarm simulation not active 1: Alarm simulation active.	●	●	●	-	●	●

10. Detailed descriptions of functionality

10.1 Control modes

The supported control modes are described further in this section.

Control modes	Description	Illustration
> Constant speed (0) > Constant frequency (1)	Open loop: The setpoint of the booster is interpreted as the setpoint for the performance. The setpoint value is a percentage of the maximum performance of the booster. No sensor is required in these modes.	 TM04 2289 2208
> Constant head (3) > Constant pressure (4) > Constant differential pressure (5)	Closed loop: The setpoint of the booster is interpreted as the setpoint for the pressure. The booster adapts the speed so that the pressure is constant, regardless of the flow. A pressure sensor is required.	 TM04 2290 2208
> Constant flow (7) > Constant temperature (8) > Constant level (10)	Closed loop: The setpoint of the booster is interpreted as the setpoint for the flow, temperature or level. Constant flow is indicated in the diagram. A relevant sensor is required: • A flow sensor for flow control • a temperature sensor for temperature control • a level sensor for level control.	 TM04 2288 2208
> Proportional pressure (6)	Closed loop: The setpoint of the booster system is interpreted as a proportional-pressure setpoint as shown in the fig. A pressure sensor is required.	 TM04 2291 2208
> DDD AUTO$_{ADAPT}$ (128)	The setpoint of the DDD system is interpreted as a proportional-pressure setpoint as shown in the figure. The proportional curve is adjusted automatically once a day according to remote DDD sensor data.	 TM05 3241 1012
> FLOW$_{ADAPT}$ (129)	This control mode works similar to AUTO$_{ADAPT}$, except that the flow-limiting function, FLOW$_{LIMIT}$, is always active and limits the flow to the value ActualMaxFlowLimit.	 TM05 3242 1012
> Closed-loop sensor (130)	This is a general purpose closed-loop control mode that you can use in cases where the pump is used for a type of control not covered by one of the other control modes.	

H: Pressure (Head)

Q: Flow

10.2 Tank-filling applications

Normally, the Hydro Multi-B runs in pressure-boosting mode, but you can also set it to run in tank-filling mode.

Proceed as follows:

1. Set the application to tank-filling mode on CU 323 via Grundfos PC Tool E-Products. This cannot be set via Modbus.
2. To enable bus control via Modbus, set RemoteAccessReq, register 000101, bit 0, to the value of "1".
3. Set the tank height with Setpoint, register 00104, to 0.01 m.
4. Set start and stop levels as well as alarm and warning limits with registers 00111, 00112, 00113 and 00114. Note that these values are set in percentage of the total tank height.

Tank-filling mode is not possible with Hydro MPC and Multi-E.

10.3 Setpoint in closed-loop control

Hydro MPC and Multi-E

The setpoint is written to register 00104 Setpoint as a percentage value scaled in 0.01 % of the sensor maximum value, register 00222 FeedbackSensorMax. The sensor minimum value is always 0. The selected setpoint is reflected in register 00343 UserSetpoint with the same scaling.

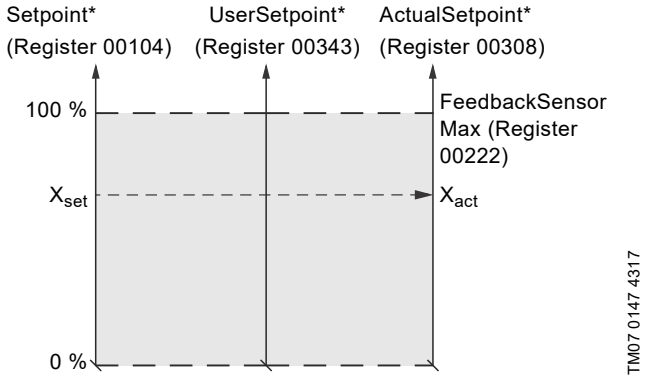
The actual setpoint, whether it has been set via Grundfos GO Remote, the pump display, the pump buttons or the fieldbus, can be read from register 00308 ActualSetpoint. It is a percentage value scaled in 0.01 % of register 00222 FeedbackSensorMax.

Generally, the actual setpoint value represents head, pressure, flow, temperature and so on depending on how the feedback sensor has been set to measure. The unit of measure can be read from register 00220 FeedbackSensorUnit.

Unless a setpoint influencing function, like proportional influence, is active, ActualSetpoint equals UserSetpoint.

It is possible to calculate back and forth between the setpoint in percent and its scaled value:

X_{act}[unit] =
X_{set}[%] × FeedbackSensorMax × FeedbackSensorUnit



* Percentage of sensor maximum.

Fig. 27 Setpoint in closed-loop control for Hydro MPC and Multi-E

TPED and MAGNA3-D

The setpoint is written to register 00104 Setpoint as a percentage value scaled in 0.01 % of the setpoint range [$r_{min;}$ r_{max}]. The selected setpoint is reflected in register 00343 UserSetpoint with the same scaling.

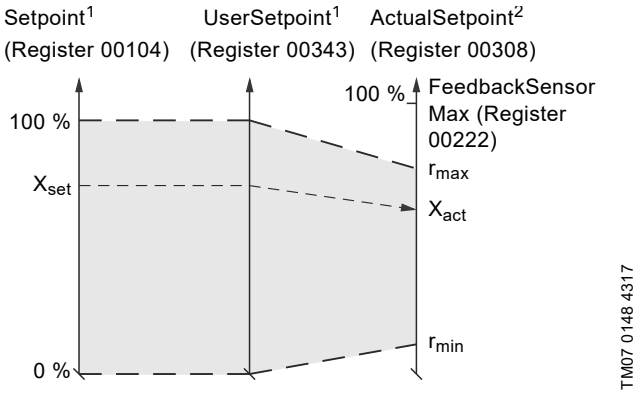
The actual setpoint, whether it has been set via Grundfos GO Remote, the pump display, the pump buttons or the fieldbus, can be read from register 00308 ActualSetpoint. It is a percentage value scaled in 0.01 % of register 00222 FeedbackSensorMax.

Generally, the actual setpoint value represents head, pressure, flow, temperature and so on depending on how the feedback sensor has been set to measure. The unit of measure can be read from register 00220 FeedbackSensorUnit.

It is possible to calculate back and forth between ActualSetpoint in percent and its scaled value:

X_{act}[unit] =
X_{act}[%] × FeedbackSensorMax × FeedbackSensorUnit

The setpoint range limits r_{min} and r_{max} cannot be read from the fieldbus but are found in the pump data sheet or in the Grundfos GO Remote "Setpoint" menu.



1 Percentage of setpoint range.

2 Percentage of sensor maximum.

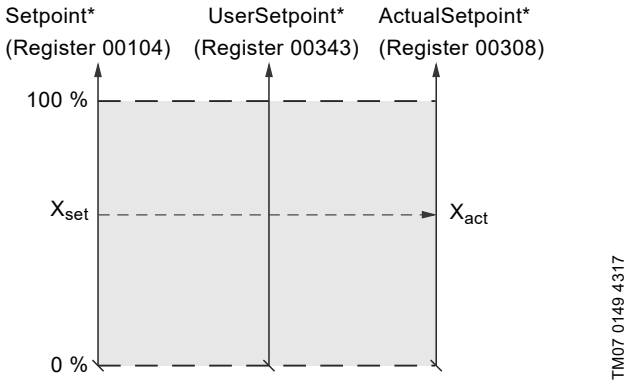
Fig. 28 Setpoint in closed-loop control for TPED and MAGNA3-D

10.4 Setpoint in open-loop control

Hydro MPC and Multi-E

The setpoint is written to register 00104 Setpoint as a percentage value scaled in 0.01 % of the maximum performance. The selected setpoint is reflected in register 00338 UserSetpoint with the same scaling.

The actual setpoint, whether it has been set via Grundfos GO Remote, the pump or controller display or buttons, or the fieldbus, can be read from register 00308 ActualSetpoint, and it reflects whatever limitations, for example power or frequency limits, that might be active in the system. It equals the value that the booster system actually uses.



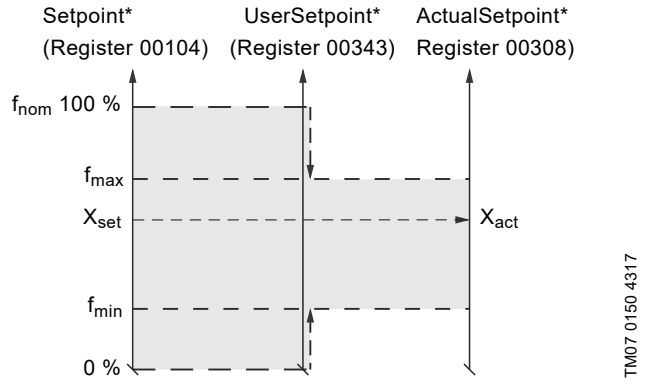
* Percentage of system performance.

Fig. 29 Setpoint in open-loop control for Hydro MPC and Multi-E

TPED and MAGNA3-D

The setpoint is written to regiser 00104 Setpoint as a percentage value scaled in 0.01 % of the nominal pump frequency f_{nom}. The selected setpoint is reflected in register 00338 UserSetpoint with the same scaling. From the fieldbus, it will get whatever value written to Setpoint but from the pump display and Grundfos GO Remote, it is truncated to the internal pump frequency limits [f_{min}; f_{max}].

The actual setpoint, whether it has been set via Grundfos GO Remote, the pump display, the pump buttons or the fieldbus, can be read from register 00308 ActualSetpoint, and it always reflects the frequency limitations. It equals the value that the pump actually uses. Values of f_{min}, f_{max} and f_{nom} can be read in Grundfos GO Remote.



* Percentage of f_{nom}.

Fig. 30 Setpoint in open-loop control for TPED and MAGNA3-D

10.5 Temperature calculation

All temperatures are available in Kelvin.

Conversion formulas for Celsius and Fahrenheit:

$T_C = T_K - 273.15$

$T_F = T_K \times 9/5 - 459.67$

10.6 Reading DDD remote sensor data

The DDD system is used for smart pressure management in municipal water supply systems. In automatic adaptation mode, it will maintain a stable pressure in critical points, where remote pressure sensors, data loggers, are installed.

Pressure data is logged every 15 minutes in remote sensors and sent to the DDD controller via text messages once a day. This means that the measured pressure data is not "live" in the Modbus profile. The registers from 00605 to 00614 show the data delayed by 24 hours and are updated every 15 minutes, for creating graph on a supervisory system for the remote sensors. Sensor warnings, for example low battery voltage, are displayed as soon as they are detected.

DDD systems always require a flow meter and an outlet pressure sensor at the pumping station.

10.7 Alarms and warnings from the booster system

Address	Name	Description
00206	WarningCode	Code for booster system warning.
00205	FaultCode	Code for booster system alarm.

In the WarningCode register, the cause of a booster system warning can be read. A warning has no influence on the booster system operation.

In the FaultCode register, the cause of a booster system alarm can be read. A booster system alarm always leads to a reaction in the booster system operation. Usually the booster system is stopped, but some alarms in some booster system types have programmable alarm action types.

The complete list of possible alarm and warning codes is shown below. Not all codes apply to all booster system types.

Code	Alarm/warning description	Reset type[1]	Action type[2]
3	External fault signal	A/M	Prog.
10	Communication fault, pump	A	None
80	Hardware fault, IO 351 pump module	A	None
80	Hardware fault, IO 351 I/O module	A	None
83	Verification error, EEPROM parameter area	A	None
88	Sensor fault, general measuring sensor	A	None
89	Signal fault, closed-loop feedback sensor	A/M	Prog.
91	Temperature sensor 1 signal fault	A/M	Prog.
157	Real-time clock error	A	None
161	Sensor supply fault, 5 V	A	None
162	Sensor supply fault, 24 V	A	None
165	Signal fault, analog input 1	A/M	Prog.
166	Signal fault, analog input 2	A/M	Prog.
167	Signal fault, analog input 3	A/M	Prog.
175	Temperature sensor 2 signal fault	A/M	Prog.
190	Limit exceeded, supervised item 1	A/M	Prog.
191	Limit exceeded, supervised item 2	A/M	Prog.
203	Alarm on all pumps	A/M	Prog.
204	Inconsistency between sensors	A	None
208	Operation outside performance range	A/M	Prog.
210	Overpressure	A/M	Prog.
211	Underpressure	A/M	Prog.
213	VFD not ready	A	None
214	Water shortage	A/M	Prog.
215	Soft pressure buildup time-out	A/M	Prog.
216	Pilot pump alarm	A	None
219	Pressure relief not adequate	A	None
231	Ethernet: No IP address from DHCP server	A	None
232	Ethernet: Auto-disabled due to misuse	A	None
248	Fault, battery/UPS	A	None
253	SMS data not received within time	A	None
254	Water pipe system model data inconsistency	A	None

Code	Alarm/warning description	Reset type[1]	Action type[2]
From device	Pump alarms, see section *10.8 Alarms from the individual pumps*	-	None

1 For Hydro/Control MPC, this can be automatic (A) or selectable Automatic/Manual (A/M)

2 For Hydro/Control MPC, this can be none or programmable (Prog.).
Event action programmable: Stop, Stop with delay, Min., UserDef, Max., Pumps in local, Emergency run.
The Hydro Multi-E is always stopped in case of an alarm.

10.8 Alarms from the individual pumps

Address	Name	Description
00402	AlarmCode	Alarm code from pump 1
00412	AlarmCode	Alarm code from pump 2
00422	AlarmCode	Alarm code from pump 3
00432	AlarmCode	Alarm code from pump 4
00442	AlarmCode	Alarm code from pump 5
00452	AlarmCode	Alarm code from pump 6
00462	AlarmCode	Alarm code from the pilot pump
00472	AlarmCode	Alarm code from the backup pump

The alarm code of an actual pump alarm can be read from each of the pump register blocks. Above, the registers are summarised for all the possible pumps while the codes that can possibly occur are described below.

Code	Alarm/warning description
1	Leakage current
2	Missing phase
3	External fault signal
4	Too many restarts
7	Too many hardware shutdowns
14	Electronic DC link protection activated (ERP)
16	Other
29	Turbine operation, impellers forced backwards
30	Change bearings (specific service information)
31	Change varistor(s) (specific service information)
32	Overvoltage
40	Undervoltage
41	Undervoltage transient
42	Cut-in fault (dV/dt)
45	Voltage asymmetry
48	Overload
49	Overcurrent (i_line, i_dc, i_mo)
50	Motor protection function (MPF), general shutdown
51	Blocked motor or pump
54	Motor protection function, 3 sec. limit
55	Motor current protection (MCP) activated
56	Underload
57	Dry-running
60	Low input power
64	Overtemperature
65	Motor temperature 1 (t_m or t_mo or t_mo1)
66	Temperature, control electronics
67	Temperature too high, internal frequency converter module (t_m)
70	Thermal relay 2 in motor (for example thermistor)
72	Hardware fault, type 1
73	Hardware shutdown (HSD)
76	Internal communication fault
77	Communication fault, twin-head pump
80	Hardware fault, type 2
83	Verification error, FE parameter area (EEPROM)
84	Memory access error
85	Verification error, BE parameter area (EEPROM)
88	Sensor fault
89	Signal fault, (feedback) sensor 1
91	Signal fault, temperature 1 sensor
93	Signal fault, sensor 2
96	Setpoint signal outside range
105	Electronic rectifier protection activated (ERP)
106	Electronic inverter protection activated (EIP)
148	Motor bearing temperature high (Pt100) in drive end (DE)
149	Motor bearing temperature high (Pt100) in non-drive end (NDE)
155	Inrush fault
156	Communication fault, internal frequency converter module
157	Real-time clock error
161	Sensor supply fault, 5 V
162	Sensor supply fault, 24 V
163	Measurement fault, motor protection
164	Signal fault, Liqtec sensor
165	Signal fault, analog input 1
166	Signal fault, analog input 2
167	Signal fault, analog input 3
175	Signal fault, temperature 2 sensor
176	Signal fault, temperature 3 sensor
190	Limit exceeded, sensor 1
191	Limit exceeded, sensor 2
240	Lubricate bearings (specific service information)
241	Motor phase failure
242	Automatic motor model recognition failed

10.9 Sensor-based Modbus registers

The tables below show the relation between the sensor-related Modbus registers and the sensor setup for the individual booster systems.

Hydro/Control MPC				
Address	**Register name**	**FeedBack SensorUnit**	**Measuring sensor, options**	**Primary sensor, options**
00301	Head	16: 0.01 m	Differential pressure, pump (zero equals -100 m)	Differential pressure, pump Differential pressure, Series 2000
00302	VolumeFlow	3: 0.1 m^3/h	Flow rate	Flow rate Flow rate, Series 2000
00315	InletPressure	7: 0.001 bar	Differential pressure, inlet	Differential pressure, inlet
00316	RemotePressure	5: 0.001 bar	Differential pressure, external External pressure	Differential pressure, external External pressure
00320	RemoteTemp	18: 0.01 K	Return-pipe temperature, external	Return-pipe temperature, external
00337	AmbientTemp	22: 0.01 K	Ambient temperature	Ambient temperature
00338	InletTemp	20: 0.01 K	Return-pipe temperature	Return-pipe temperature
00339	OutletTemp	19: 0.01 K	Flow-pipe temperature	Flow-pipe temperature
00340	TemperatureDifference	21: 0.01 K	Differential temperature	Differential temperature
00341	OutletPressure	6: 0.001 bar	Outlet pressure Differential pressure, outlet	Outlet pressure Differential pressure, outlet
	-	-	0-100 % signal	0-100 % signal

The table below shows the relationship between the measurement modules for the Hydro Multi-E model G Modbus and the measurement unit selected with Grundfos GO Remote for the feedback sensor. Only one of the measurement module groups in the table below will be available at a time.

Hydro Multi-E model G	
Sensor unit configuration with the Grundfos GO Remote	**Modbus data register generated from feedback sensor measurement**
bar	Head (00301) OutletPressure (00341)
mbar	
m	
kPa	
psi	
ft	
m^3/h	VolumeFlow (00302)
m^3/s	
l/s	
gpm	
°C	RemoteTemperature (00316)
°F	
%	-

The process feedback scaled according to ProcessFeedBackUnit can be calculated from this formula:

Feedback (scaled) = ProcessFeedBack × (FeedBackSensorMax - FeedBackSensorMin) / 100 % + FeedBackSensorMin

See also section *10.1 Control modes*.

Hydro Multi-E/TPED model H

Measured parameters (Selected from display or Grundfos GO Remote)			Mapped to Modbus register
Parameter	**Analog input AI1, AI2, AI3**	**Temperature PT100 input T1, T2**	
Pump inlet pressure	●		InletPressure (00315)
Pump inlet differential pressure	●		InletDiffPressure (00356)
Pump outlet pressure	●		OutletPressure (00341)
Pump outlet differential pressure	●		OutletDiffPressure (00358)
Remote pressure 1	●		RemotePressure1 (00316)
Remote pressure 2	●		RemotePressure2 (00353)
Remote differential pressure	●		RemoteDiffpressure (00359)
Feed tank level	●		FeedTankLevel (00342)
Storage tank level	●		StorageTankLevel (00350)
Pump flow	●		VolumeFlow (00302)
Remote flow	●		RemoteFlow (00360)
Temperature 1	●	●	RemoteTemp1 (00320)
Temperature 2	●	●	RemoteTemp2 (00354)
Ambient temperature	●	●	AmbientTemp (00337)
Other parameter	●		AuxSensorInput (00325)

MAGNA3-D

Measured parameters (Selected from display or Grundfos GO Remote)			Mapped to Modbus register
Parameter	**Analog input AI1, AI2, AI3**	**Temperature PT100 input T1, T2**	
Remote pressure 1	●		RemotePressure1 (00316)
Temperature 2	●		RemoteTemp2 (00354)

11. Modbus RTU commissioning, step-by-step guides

If the sensor configuration is changed, restart the CIM module or CIU unit to ensure a correct scaling of the sensor value.

11.1 Hardware setup, CIM 200

Step	Action
1	Install CIM 200 in the Grundfos booster system according to the booster system documentation.
2	Complete the booster system configuration, for example sensor configuration and local mode. This can be done either on the booster system control panel, via Grundfos GO Remote or Grundfos PC Tool E-Products.
3	Select the Modbus slave address (1-247).
4	Select the bit rate of the Modbus slave.
5	Select parity and stop bits of the Modbus slave, even parity with 1 stop bit or no parity with 2 stop bits.
6	If necessary, set line termination.
7	Connect the necessary cables from CIM 200 to the Modbus network.
8	Confirm that the GENIbus LED is permanently green and that the Modbus LED is either off, if no master is actively polling the slave, or flashing green, indicating error-free communication.
CIM 200 is now ready to be accessed via the Modbus network.	

11.2 Hardware setup, CIU 200

Step	Action
1	Complete the booster system configuration, for example sensor configuration and local mode. This can be done either via Grundfos GO Remote or Grundfos PC Tool E-Products.
2	Select the Modbus slave address (1-247).
3	Select the transmission speed of the Modbus slave.
4	Select parity and stop bits of the Modbus slave, even parity with 1 stop bit or no parity with 2 stop bits.
5	If necessary, set line termination.
6	Connect the GENIbus cable from CIU 200 to the booster system.
7	Connect the necessary cables from CIU 200 to the Modbus network.
8	Connect the power cable to CIU 200, and switch the unit on.
9	Confirm that the GENIbus LED is permanently green and that the Modbus LED is either off, if no master is actively polling the slave, or flashing green, indicating error-free communication.
CIU 200 is now ready to be accessed via the Modbus network.	

11.3 Hardware setup, CIM 260 call-up connection

Step	Action
1	Install CIM 260 in the Grundfos pump according to the booster system documentation.
2	Fit an antenna to the CIM module SMA connector. See section *6.1.1 Fitting a cellular antenna*.
3	Insert the SIM card in CIM 260. See section *6.1.2 Inserting the SIM card*.
4	Power on the booster system.
5	Observe that LED2 turns permanently green, indicating that CIM 260 is fitted correctly. See section *6.2 LEDs*
6	Observe that LED1 blinks yellow and changes to yellow pulsing after approximately 30 seconds, indicating that the cellular network connection is working. See section *6.2 LEDs* By making a call-up from a phone, the connection can be verified. LED1 turns permanently yellow.
7	To configure CIM 260 for a call-up connection, follow the instructions in the "CIM 260 SMS commands", which you can download from Grundfos Product Center.
8	To verify the settings after completion, you can use the SMS command "SMSSETTINGS".
CIM 260 is now ready to be accessed from a Modbus RTU master via call-up, or via SMS commands.	

11.4 Hardware setup, CIU 260 call-up connection

Step	Action
1	Connect the GENIbus cable from CIU 260 to the Grundfos product. See fig. 5 in the "CIU, Communication Interface Unit installation and operating instructions".
2	Fit an antenna to the CIM module SMA connector. See section *6.1.1 Fitting a cellular antenna*.
3	Insert the SIM card in CIM 260. See section *6.1.2 Inserting the SIM card*.
4	Connect the mains cable to CIU 260. See the CIU quick guide instruction, and power on CIU 260.
5	Power on the Grundfos product.
6	Observe that LED2 turns permanently green, indicating that the GENIbus connection is working. See section *6.2 LEDs*.
7	Observe that LED1 blinks yellow and changes to yellow pulsing after approximately 30 seconds, indicating that the cellular network connection is working. See section *6.2 LEDs*. By making a call-up from a phone, the connection can be verified (LED1 turns permanently yellow).
8	To configure CIU 260 for a call-up connection, follow the instructions in the "CIM 260 SMS commands" which you can download from Grundfos Product Center.
9	To verify the settings after completion, use the SMS command "APNSETTINGS".
CIU 260 is now ready to be accessed from a Modbus RTU master via call-up, or via SMS commands.	

11.5 Hardware setup, CIM 260 data connection

Step	Action
1	Install CIM 260 in the Grundfos product according to the product documentation.
2	Fit an antenna to the CIM module SMA connector. See section *6.1.1 Fitting a cellular antenna*.
3	Insert the SIM card in CIM 260. See section *6.1.2 Inserting the SIM card*.
4	Power on the Grundfos product.
5	Observe that LED2 turns permanently green. See section *6.2 LEDs*.
6	Observe that LED1 blinks yellow and changes to yellow pulsing after approximately 30 seconds, indicating that the cellular network connection is working. See section *6.2 LEDs*.
7	To configure CIM 260 for a data connection, follow the instructions in the "CIM 260 SMS commands" which you can download from Grundfos Product Center.
8	To verify the APN settings after completion, use the SMS command "APNSETTINGS". To verify that the data connection is working, use the SMS command "APNSTATUS". The connection state must be "Context active" if ready and "Connected" if a Modbus TCP master is already communicating.
CIM 260 is now ready to be accessed from a Modbus TCP master via a data connection, or via SMS commands.	

11.6 Hardware setup, CIU 260 data connection

Step	Action
1	Connect the GENIbus cable from CIU 260 to the Grundfos product, see the CIU quick guide instruction.
2	Fit an antenna to the CIM module SMA connector. See section *6.1.1 Fitting a cellular antenna*.
3	Insert the SIM card in CIM 260. See section *6.1.2 Inserting the SIM card*.
4	Connect the mains cable to CIU 260. See the CIU quick-guide instruction, and power on CIU 260.
5	Power on the Grundfos product.
6	Observe that LED2 turns permanently green, indicating that the GENIbus connection is working. See section *6.2 LEDs*.
7	Observe that LED1 blinks yellow and changes to yellow pulsing after approximately 30 seconds, indicating that the cellular network connection is working. See section *6.2 LEDs*.
8	To configure CIM 260 for a data connection, follow the instructions in the "CIM 260 SMS commands", which you can download from Grundfos Product Center.

Step	Action
9	To verify the APN settings after completion, use the SMS command "APNSETTINGS". To verify that the data connection is working, use the SMS command "APNSTATUS". The connection state must be "Context active" if ready and "Connected" if a Modbus TCP master is already communicating.

CIU 260 is now ready to be accessed from a Modbus TCP master via a data connection, or via SMS commands.

11.7 CIM 500 Modbus TCP communication setup

Step	Action
1	Install CIM 500 in the Grundfos booster system according to the booster system documentation.
2	Select position 1 at the protocol rotary switch. See section *7.2 Setting the Industrial Ethernet protocol*.
3	Power on the booster system, and observe LED2 turning permanently green and LED1 remaining off.
4	Complete the booster system configuration, for example sensor configuration and selection of local Operating mode, local Control mode and local Setpoint, for example via Grundfos GO Remote.
5	Connect one of the CIM 500 Ethernet ports (RJ45) to a PC using an Ethernet cable.
6	Configure the PC Ethernet port to the same subnetwork as CIM 500, for example 192.168.1.1, and the subnet mask to 255.255.255.0. See section *A.1 How to configure an IP address on your PC* on page 61.
7	Open your internet browser and make contact to the CIM 500 webserver. Factory default address: 192.168.1.100
8	Log in to the webserver. Default: User: admin Password: Grundfos
9	In the menu column to the left, select "Configuration" > "Real time Ethernet protocol".
10	Type in an IP address belonging to the same subnet as your PC, for example 192.168.1.2.
11	Type in the subnet mask 255.255.255.0, and leave the rest of the settings at their factory default values.
12	Click [Submit] to transfer the new settings, and close the internet browser.

CIM 500 is now ready to be accessed from a Modbus TCP master via one of its Ethernet ports. Use the IP address selected under step 9. The Modbus address (Unit ID) in the Modbus TCP telegram is not used.

- CIM 500 LED1 flashes green when Modbus TCP communication takes place.
- You can use the two Ethernet ports to daisy chain CIM 500 modules.
- It is possible to have connection to the webserver simultaneously with a connection to a Modbus TCP master.
- It is possible to have connection to more Modbus TCP masters simultaneously, for example to have connection to PC Tool CIM/CIU while connected to another Modbus TCP master.

11.8 CIU 500 Modbus TCP communication setup

Step	Action
1	Check that both the CIU 500 unit and the booster system are powered off.
2	Remove the front cover of CIU 500.
3	Select position 1 at the CIM 500 module protocol rotary switch. See section *7.2 Setting the Industrial Ethernet protocol*.
4	Connect the GENIbus cable from CIU 500 to the booster system. See fig. 5 in "CIU, Communication Interface Unit installation and operating instructions" or see the CIU quick guide
5	Power on CIU 500 and the booster system, and observe LED2 turning permanently green and LED1 remaining off.
6	Connect one of the CIU 500 Ethernet ports (RJ45) to a PC using an Ethernet cable.
7	Configure the PC Ethernet port to the same subnetwork as CIM 500, for example 192.168.1.1 and the subnet mask to 255.255.255.0. See section *A.1 How to configure an IP address on your PC* on page 61.
8	Open your internet browser, and make contact to the CIM 500 webserver. Factory default address: 192.168.1.100
9	Log in to the webserver. Default: Username: admin Password: Grundfos
10	In the menu column to the left, select "Configuration" > "Real time Ethernet protocol".
11	Type in an IP address belonging to the same subnet as your PC, for example 192.168.1.2.
12	Type in the subnet mask 255.255.255.0, and leave the rest of the settings at their factory default values.
13	Click [Submit] to transfer the new settings and close the internet browser.

CIM 500 is now ready to be accessed from a Modbus TCP master via one of its Ethernet ports. Use the IP address selected under step 10. The Modbus address (Unit ID) in the Modbus TCP telegram is not used.

- CIU 500 LED1 flashes green when Modbus TCP communication takes place.
- You can use the two Ethernet ports to daisy chain CIM 500 modules.
- It is possible to have connection to the webserver simultaneously with a connection to a Modbus TCP master.
- It is possible to have connection to more Modbus TCP masters simultaneously, for example to have connection to PC Tool CIM/CIU while connected to another Modbus TCP master.

12. Detailed descriptions of call-up and APN

12.1 Call-up

12.1.1 Call-up functional description

The call-up function is used for SCADA system communication via the cellular network. Connection is established when the SCADA system dials CIU 260. CIU 260 will automatically 'pick up the phone' and wait for data traffic in the form of Modbus RTU telegrams.

If legal data traffic has not been initiated within one minute, CIU 260 will hang up the line. This silence time-out is active during the whole communication session. Whenever the SCADA system has completed the Modbus communication, it hangs up the line. This is detected by CIU 260, which also hangs up the line, and the call-up communication session is thereby completed. See fig. 31.

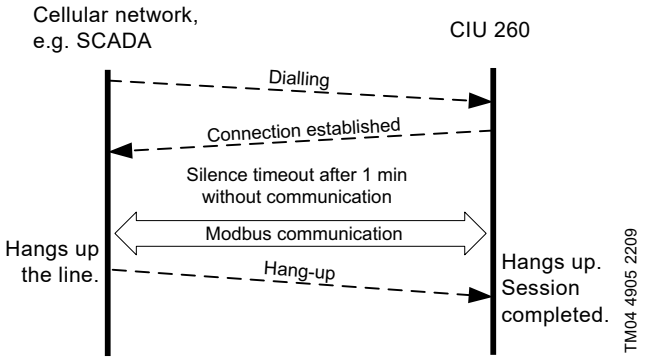


Fig. 31 Illustration of a call-up session

12.1.2 SCADA PIN code protection

It is always possible to get read access via Modbus, but if CIU 260 is SCADA PIN-code-protected (GeneralStatus register 00029, bit 0: 1), write access requires that the correct PIN code (ScadaPinCode, register 00011) has been entered. Entering the correct PIN code will trigger the write access control, and write access will be open, which you can verify with GeneralStatus, register 00029, bit 1: 1.

For call-up connections with PIN code protection, the ScadaPinCode register has to be written each time a new call-up is made.

12.1.3 Call-up options setup

To prepare CIU 260 for Modbus communication with a SCADA system via a call-up connection, some settings have to be made via SMS commands:

- Setting a SCADA PIN code:
  SETSCADACODE <access code> will enable write access protection.

Default is an empty SCADA PIN code, meaning no protection.

- Activating the SCADA PIN code:
  SCADACODE <ON | OFF>.

Default is "Off".

- Selecting the Modbus address:
  MODBUSADDR <1-247>.

Default setting: 231.

To verify the SCADA settings after completion, use the SMS command "SCADA".

For details about the use of SMS commands, see "CIM 260 SMS commands", which you can download from Grundfos Product Center.

12.2 APN

12.2.1 What is APN and Modbus TCP?

An APN connection (Access Point Name) is a wireless, 'always on' connection that remains active as long as CIU 260 is within range of the service. With a data connection, it is possible to establish a wireless connection to the Internet and thus enable a remote connection to a SCADA system computer or another PC application.

The APN connection takes care of the wireless data transfer via the cellular network. It plays the same role as Ethernet in a wired network. We will refer to an APN connection as a data connection, and it also makes use of the TCP/IP protocol, which enables easy integration with the Internet. The Modbus TCP protocol is used on the application layer communicating with a TCP port number (default 502). The difference when compared to the fieldbus protocol Modbus RTU is the exclusion of the 16-bit CRC checksum and the adding of a Modbus application program header as illustrated in fig. 32.

12.2.2 Subscription

You have to select the service provider and the technical solution that best suits your system, and it must be based on static IP addressing. You will get the following from the service provider:

- A Subscriber Identity Module (SIM card).
- An Access Point Name (APN), for example "Internet".
- A fixed user name that cannot be changed by the user.
- A fixed password that cannot be changed by the user.
- A static IP address.

Solutions based on a VPN, Virtual Private Network, involve the use of special routers, for example GRE, Generic Routing Encapsulation, routers, which you also get from the service provider.

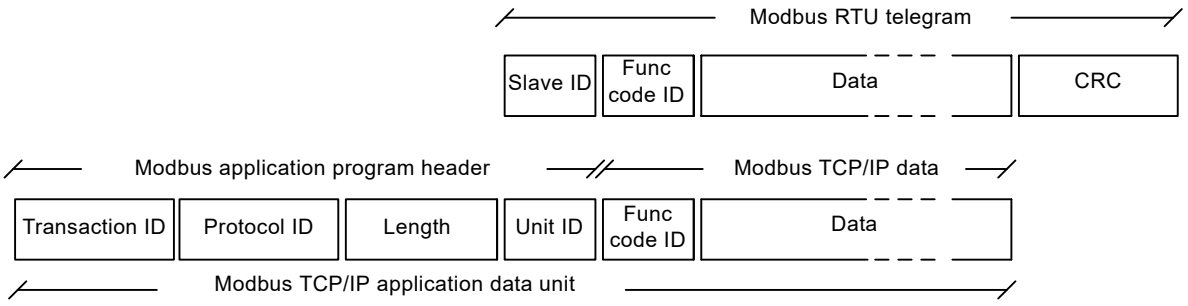


Fig. 32 Modbus TCP telegram

12.2.3 Installation

To prepare CIU 260 for data communication, some settings have to be made via SMS commands:

- Select Access Point Name:
  APN <ASCII string>
  This is always mandatory.
- Select Username:
  USERNAME <ASCII string>
  The need for a user name depends on your operator and the type of subscription.
- Select Password:
  PASSWORD <ASCII string>
  The need for a password depends on your operator and the type of subscription.

Some advanced APN-related settings have default values that usually work, but in special cases it might be necessary to change some of them. This is also done via SMS commands.

- Select Authentication:
  AUTHENTICATION <NORMAL | SECURE>
  Only used by some service providers.
  Default setting: NORMAL.
- Select Connection type:
  CONNECTION <SERVER | CLIENT | DISABLE>
  Default setting: SERVER.
- Set data roaming:
  DATAROAMING: <ON | OFF>
  Default setting: OFF.
- Select Modbus TCP port number:
  MODBUSPORT <port number>
  Default setting: 502.
- Select GENIpro port number:
  GENIPROPORT <port number>
  Default setting: 49152. This is only relevant when using Grundfos PC Tools.

It is possible to configure the APN connection with a single multi-parameter command:

- SETAPN <parameter 1, parameter 2, parameter 3, …>
  - <parameters>:<APN>,<Modbus port>,<GENIpro port>, <username>,<password>,<authentication>,<connection>, <data roaming>, <data silence time out>.

Example

SETAPN
Grundfos.dk2.tdc,502,49888,Grundfos,4321,normal,server,off, 60

To verify the APN settings after completion, use the SMS command "APNSETTINGS". The command "APNSTATUS" can verify if the APN connection is working.

The connection states have the following meaning:

- "Detached": Trying to locate APN connection service.
- "Attached": APN connection service located.
- "Context active": IP address has been assigned, ready for a client to establish a socket connection.
- "Connected": A client has established a socket connection. The system is ready for TCP/IP data exchange, or already exchanging data.

For details about the use of SMS commands, see "CIM 260 SMS commands", which you can download from Grundfos Product Center.

12.2.4 Operation

When powering on CIU 260 with the correct APN setting, the following APN connection sequence will take place:

1. CIU 260 locates the APN service. The connection state changes from "Detached" to "Attached".
2. CIU 260 attempts to connect to the APN it has been given and requests an IP address. The base station looks through its record of legal SIM cards and finds the IP address, the address associated with this SIM card, to assign to CIU 260. After CIU 260 has got the IP address, the connection state changes to "Context active".
3. CIU 260 is now ready for a client, for example SCADA system, to establish a socket connection and begin TCP/IP data exchange. When a client connects CIU 260, the connection state will change to "Connected", and cellular connection status LED1 will indicate when data transfer takes place. See section *5.5 Status LEDs*.

When no data is being transferred, the connection states "Attached", "Context active" and "Connected". All show the same LED1 status (short pulse).

A client, for example SCADA, establishes connection to CIU 260 by specifying the IP address and the TCP port 502. Data transfer is always initiated from the client in the form of a Modbus TCP telegram embedded in a TCP/IP frame and directed to TCP port 502. To the client software, the connection to CIU 260 is completely transparent.

The protection against unauthorised data access is high. The access to the APN network from the Internet can only take place via the VPN tunnel. See fig. 34. Moreover, data transfer requires a Modbus master client, knowledge of the Modbus functional profile and the use of a SCADA PIN code, if enabled.

CIU 260 supervises the APN connection system to ensure that it is still working. An automatic procedure ensures restarting of CIU 260 and repetition of the APN connection sequence in case a deadlock situation has occurred. It also closes down socket connections that are left open by the client and unused for more than 24 hours.

It is possible to use SMS communication while data communication is active. However in the "Connected" state, the delay time between reception and reply increases.

If the connection state is different from "Connected", it is possible to establish a call-up connection. When the call-up connection is established, APN data exchange will be blocked until the call-up is terminated by the caller.

A total of three Modbus clients can be connected to the Modbus TCP port of the CIU 260 and communicate simultaneously. Each connection, called a socket connection, is handled independently. If all three sockets are used simultaneously, a "Silence time-out" of only one minute is used to prevent complete occupation for a long time.

Fig. 33 Data connection directly from a PC to CIU 260

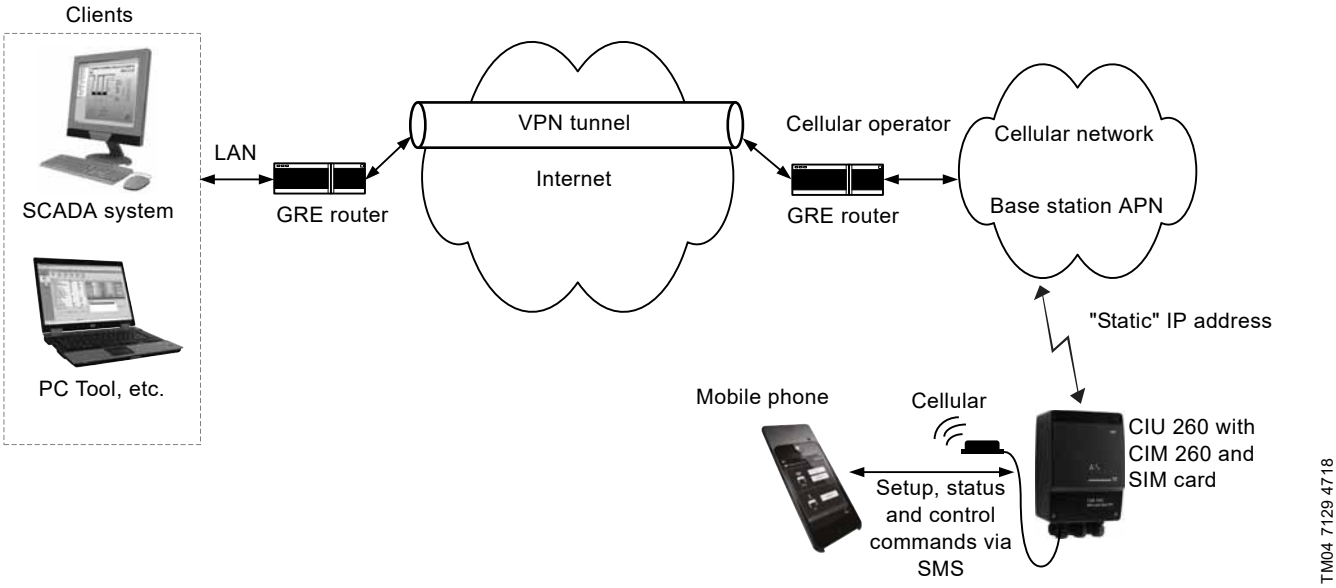


Fig. 34 Cellular connection via VPN tunnel

13. Modbus RTU telegram examples

The Modbus data model states that registers numbered X are addressed in telegrams as X - 1, for example register 00104 (setpoint) is addressed as 00103 in a Modbus telegram.

Note that CRC fields are not shown in the following examples.

13.1 Modbus telegram overview

The maximum size of a Modbus RTU telegram is 256 bytes. Telegrams must be separated by a silent interval of at least 3.5 character times.

The standard Modbus RTU telegram format is shown in the table below.

Slave address	Function code	Data	CRC
1 byte	1 byte	0 to 252 bytes	2 bytes

A telegram starts with the slave address occupying one byte. Then comes a variable-size data field. For each telegram, a CRC is calculated and appended to the telegram, two bytes total. All bytes in the telegram, except for the CRC itself, are included in the check.

Note that the CRC bytes are not shown in the examples in the following sections.

13.2 Read holding registers, 0x03

This function is used for reading holding registers from the slave.

The request telegram specifies the starting address, that is the address of the first register to be read, and the number of holding registers to read. In the telegram, register addresses start from zero, meaning that registers numbered 0-16 are addressed as 0-15.

Example of request from master to slave

Field	Value
Address	0x01
Function code	0x03
Start address HI	0x00
Start address LO	0x6B
Quantity HI	0x00
Quantity LO	0x03

In the request, the slave with address 1 is asked to deliver three contiguous registers starting from address 0x006b: 107, meaning register 108.

Example of response from slave to master

Field	Value
Address	0x01
Function code	0x03
Byte count	0x06
Register 108 HI	0x00
Register 108 LO	0x01
Register 109 HI	0x00
Register 109 LO	0x01
Register 110 HI	0x00
Register 110 LO	0x01

In the response, the byte count is six since there are three registers of two bytes. All three registers hold the value of 0x0001.

13.3 Read input registers, 0x04

This function is used for reading input registers from the slave. Input registers are read-only registers by definition. The request telegram specifies the starting address, that is the address of the first register to be read, and the number of holding registers to read. In the telegram, register addresses start from zero, meaning that registers numbered 1-16 are addressed as 0-15.

Example of request from master to slave

Field	Value
Address	0x01
Function code	0x04
Start address HI	0x10
Start address LO	0x10
Quantity HI	0x00
Quantity LO	0x03

In the request, the slave with address 1 is asked to deliver three contiguous registers starting from address 0x1010: 4112, meaning register 4113.

Example of response from slave to master

Field	Value
Address	0x01
Function code	0x04
Byte count	0x06
Register 4113 HI	0x22
Register 4113 LO	0x22
Register 4114 HI	0x22
Register 4114 LO	0x22
Register 4115 HI	0x22
Register 4115 LO	0x22

In the response, the byte count is six since there are three registers of two bytes. All three registers hold the value of 0x2222.

13.4 Write single register, 0x06

This function is used for writing a single holding register in the slave. The request telegram specifies the address of the register that is to be written. Register addresses start from zero, meaning that a register numbered 10 is addressed as 9.

The normal response is an echo of the request, indicating that the value was written.

Example of request from master to slave

Field	Value
Address	0x01
Function code	0x06
Address HI	0x10
Address LO	0x00
Value HI	0xAF
Value LO	0xFE

In the request, the slave with address 1 is asked to write the value of 0xAFFE to the register at address 0x1000.

Example of response from slave to master

Field	Value
Address	0x01
Function code	0x06
Address HI	0x10
Address LO	0x00
Value HI	0xAF
Value LO	0xFE

The response is an echo of the request.

13.5 Write multiple registers, 0x10

This function is used for writing a block of contiguous holding registers in the slave. Register addresses start from zero, meaning that a register numbered 100 is addressed as 99.

Example of request from master to slave

Field	Value
Address	0x01
Function code	0x10
Start address HI	0x00
Start address LO	0x20
Quantity HI	0x00
Quantity LO	0x02
Byte count	0x04
Register 33 HI	0x00
Register 33 LO	0x01
Register 34 HI	0xB0
Register 34 LO	0xB0

In the request, the slave with address 1 is asked to write the value of 0x0001 to the register at address 0x0020 and the value of 0xB0B0 to the register at address 0x0021.

Example of response from slave to master

Field	Value
Address	0x01
Function code	0x10
Start address HI	0x00
Start address LO	0x20
Quantity written HI	0x00
Quantity written LO	0x02

The response returns the function code, starting address and quantity of registers written.

13.6 Diagnostics, 0x08

This function provides a test for checking the communication system between the master and the Grundfos slave. It contains a single-byte subcode to identify the test to be performed.

The following subcodes are supported:

Subcode	Name
0x00	Return query data Data in this request are to be echoed in the response. The response must be identical to the request, so this function is often used to verify Modbus communication.
0x01	Restart communications All communication counters are cleared, and the device is restarted.
0x02	Return diagnostics register Returns the 16-bit diagnostics register. See section *13.7 Diagnostics register interpretation*.
0x04	Force listen only Forces the device into listen-only mode. This effectively mutes the device, making it unable to communicate on the network. To bring the device back to normal mode, a "Restart communications" command, code 0x08, subcode 0x01, must be issued.
0x0A	Clear counters and diagnostics register Clears all counters and the diagnostics register. These are also cleared on power-up and restart
0x0B	Return bus message count Returns the number of messages detected by the slave.
0x0C	Return bus CRC error count Returns the number of CRC errors in the slave.
0x0D	Return bus exception count Returns the number of Modbus exception responses that the slave has transmitted.
0x0E	Return slave message count Returns the number of messages that the slave has processed.
0x0F	Return slave no response count Returns the number of messages for which the slave has sent no response.
0x12	Return bus character overrun count Returns the number of overruns in the slave.
0x14	Clear overrun counter Clears the overrun counter. This is also cleared on power-up and restart.

Example of request from master to slave

Field	Value
Address	0x01
Function code	0x08
Subcode	0x00
Data	0xAB
Data	0xCD

The response is identical to the request.

Example of response from slave to master

Field	Value
Address	0x01
Function code	0x08
Subcode	0x00
Data	0xAB
Data	0xCD

13.7 Diagnostics register interpretation

The diagnostics register is interpreted as follows:

Bit	Description
0	Communication failure, with the Grundfos booster system.
1	EEPROM self-test has failed. The test is carried out when the system is booted.
2	Grundfos booster system is not supported.
3	Modbus address offset is different from default value, i.e. it differs from 0.
4	Using software-defined Modbus transmission speed.
5	RESERVED
6	RESERVED
7	RESERVED
8	RESERVED
9	RESERVED
10	RESERVED
11	RESERVED
12	RESERVED
13	RESERVED
14	RESERVED
15	RESERVED

A bit value of 1 means true, unless otherwise specified. The diagnostics register is read using function code 0x08 and subcode 0x02.

13.8 Diagnostics: Return query data

This function is useful to ensure that the communication path and slave configuration are correct. It will echo the request in the response.

In the example, slave address 0x01 is used.

Request from master to slave

Field	Value	Description
Slave address	0x01	-
Function code	0x08	Diagnostics
Subcode	0x00	Echo request
Data	0xAB	Test data
Data	0xCD	Test data

Example of response from slave to master

Field	Value	Description
Slave address	0x01	-
Function code	0x08	Diagnostics
Subcode	0x00	Echo request
Data	0xAB	Test data
Data	0xCD	Test data

If there is no response from the slave, see Fault finding, section *14.1.2 CIM/CIU 200 Modbus communication faults* or *14.2.2 CIM/CIU 260 Modbus connection communication faults*.

13.9 Reading the CIM configuration register block

This section shows how to read the first four registers of the CIM configuration register block.

In the example, slave address 0x01 is used.

Request from master to slave

Field	Value	Description
Slave address	0x01	-
Function code	0x04	Read input registers
Start address HI	0x00	Start address = 0x0001
Start address LO	0x00	
Quantity HI	0x00	Number of registers = 0x0004
Quantity LO	0x04	

Example of response from slave to master

Field	Value	Description
Slave address	0x01	-
Function code	0x04	Read input registers
Byte count	0x08	8 bytes follow
00001 HI	0x00	SlaveMinimumReplyDelay: 0x000A
00001 LO	0x0A	
00002 HI	0x00	RegisterOffset: 0x0000
00002 LO	0x00	
00003 HI	0x00	Reserved value: 0x0000
00003 LO	0x00	
00004 HI	0x00	SoftwareDefinedBitRate: 0x0004
00004 LO	0x04	

If there is no response from the slave, see Fault finding, section *14.1.2 CIM/CIU 200 Modbus communication faults* or *14.2.2 CIM/CIU 260 Modbus connection communication faults*.

13.10 Setting the setpoint

This section shows how to set a new setpoint (reference).

In the example, slave address 0x01 is used, and a value of 55 % (5500 = 0x157C) is set as new setpoint.

Request from master to slave

Field	Value	Description
Slave address	0x01	-
Function code	0x06	Write single register
Start address HI	0x00	Setpoint address: 00104 (0x0068)
Start address LO	0x67	
Value HI	0x15	New setpoint value: 5500 (0x157C)
Value LO	0x7C	

Example of response from slave to master

Field	Value	Description
Slave address	0x01	-
Function code	0x06	Write single register
Start address HI	0x00	Setpoint address: 00104 (0x0068)
Start address LO	0x67	
Value HI	0x15	New setpoint value: 5500 (0x157C)
Value LO	0x7C	

If there is no response from the slave, see Fault finding, section *14.1.2 CIM/CIU 200 Modbus communication faults* or *14.2.2 CIM/CIU 260 Modbus connection communication faults*.

13.11 Setting the control mode

This section shows how to set a control mode.

In the example, slave address 0x01 is used, and the control mode is set to 1 (Constant frequency).

Request from master to slave

Field	Value	Description
Slave address	0x01	-
Function code	0x06	Write single register
Start address HI	0x00	ControlMode address = 00102 (0x0066)
Start address LO	0x65	
Value HI	0x00	New ControlMode value = 1 (0x0001)
Value LO	0x01	

Example of response from slave to master

Field	Value	Description
Slave address	0x01	-
Function code	0x06	Write single register
Start address HI	0x00	ControlMode address = 00102 (0x0066)
Start address LO	0x65	
Value HI	0x00	New ControlMode value = 1 (0x0001)
Value LO	0x01	

If there is no response from the slave, see Fault finding, section *14.1.2 CIM/CIU 200 Modbus communication faults* or *14.2.2 CIM/CIU 260 Modbus connection communication faults*.

13.12 Starting the booster system

This section shows how to start the booster system.
In the example, slave address 0x01 is used.
Set the ControlRegister to the following values:

Bit 0:	1 (set the booster system to remote mode)
Bit 1:	1 (start the booster system)
Bit 2:	0 (do not send a reset fault command)
Bit 3:	0 (direction: clockwise rotation)
Bit 4:	0 (do not copy remote settings to local)
Bits 5-15:	0 (do not reset accumulated counters)

Hence the value to set is 0b0000000000000011 = 0x0003.

Request from master to slave

Field	Value	Description
Slave address	0x01	-
Function code	0x06	Write single register
Start address HI	0x00	ControlRegister address: 00101 (0x0065)
Start address LO	0x64	
Value HI	0x00	ControlRegister value: 3 (0x0003)
Value LO	0x03	

Example of response from slave to master

Field	Value	Description
Slave address	0x01	-
Function code	0x06	Write single register
Start address HI	0x00	ControlRegister address: 00101 (0x0065)
Start address LO	0x64	
Value HI	0x00	ControlRegister value: 3 (0x0003)
Value LO	0x03	

If there is no response from the slave, see Fault finding, section *14.1.2 CIM/CIU 200 Modbus communication faults* or *14.2.2 CIM/CIU 260 Modbus connection communication faults*.

13.13 Stopping the booster system

This section shows how to stop the booster system.
In the example, slave address 0x01 is used.
Set the ControlRegister to the following values:

Bit 0:	1 (set the booster system to remote mode)
Bit 1:	0 (stop the booster system)
Bit 2:	0 (do not send a reset fault command)
Bit 3:	0 (direction = clockwise rotation)
Bit 4:	0 (do not copy remote settings to local)
Bits 5-15:	0 (do not reset accumulated counters)

Hence the value to set is 0b0000000000000001 = 0x0001.

Request from master to slave

Field	Value	Description
Slave address	0x01	-
Function code	0x06	Write single register
Start address HI	0x00	ControlRegister address: 00101 (0x0065)
Start address LO	0x64	
Value HI	0x00	ControlRegister value: 1 (0x0001)
Value LO	0x01	

Example of response from slave to master

Field	Value	Description
Slave address	0x01	-
Function code	0x06	Write single register
Start address HI	0x00	ControlRegister address: 00101 (0x0065)
Start address LO	0x64	
Value HI	0x00	ControlRegister value: 1 (0x0001)
Value LO	0x01	

If there is no response from the slave, see Fault finding, section *14.1.2 CIM/CIU 200 Modbus communication faults* or *14.2.2 CIM/CIU 260 Modbus connection communication faults*.

14. Fault finding the product

14.1 CIM/CIU 200

You can detect faults in CIM/CIU 200 by observing the status of the two communication LEDs. See the table below and section *3.2 CIM 200 Modbus RTU*.

14.1.1 LED status

CIM 200 fitted in a Grundfos booster system

Fault (LED status)	Possible cause	Remedy
1. LED1 and LED2 remain off when the power supply is connected.	a) CIM 200 is fitted incorrectly in the Grundfos product.	Ensure that CIM 200 is fitted and connected correctly.
	b) CIM 200 is defective.	Replace CIM 200.
2. LED2 for internal communication is flashing red.	a) No internal communication between CIM 200 and the Grundfos product.	Ensure that CIM 200 is fitted correctly in the Grundfos product.
3. LED2 for internal communication is permanently red.	a) CIM 200 does not support the Grundfos product connected.	Contact the nearest Grundfos company.
4. Modbus LED1 is permanently red.	a) Fault in the CIM 200 Modbus configuration.	• Check the transmission speed, switches SW4 and SW5. If the switches are set to "software-defined", an invalid value may have been set via Modbus. Try one of the preselected transmission speeds, for example 19200 bits/s. • Check that the Modbus address, switches SW6 and SW7, has a valid value [1-247].
5. Modbus LED1 is flashing red.	a) Fault in the Modbus communication (fault in parity or cyclic redundancy check).	• Check the transmission speed, switches SW4 and SW5. See section *5.1 Setting the Modbus transmission speed*. • Check the parity setting, switch SW3. See section *5.2 Setting the stop bits and the parity bit*. • Check the cable connection between CIM 200 and the Modbus network. • Check the termination resistor settings, switches SW1 and SW2. See section *5.4 Termination resistor*.

CIM 200 fitted in CIU 200

Fault (LED status)	Possible cause	Remedy
1. LED1 and LED2 remain off when the power supply is connected.	a) CIU 200 is defective.	Replace CIU 200.
2. LED2 for internal communication is flashing red.	a) No internal communication between CIU 200 and the Grundfos product.	• Check the cable connection between the Grundfos product and CIU 200. • Check that the individual conductors have been fitted correctly. • Check the power supply to the Grundfos product.
3. LED2 for internal communication is permanently red.	a) CIU 200 does not support the Grundfos product connected.	Contact the nearest Grundfos company.
4. Modbus LED1 is permanently red.	a) Fault in the CIM 200 Modbus configuration.	• Check the transmission speed, switches SW4 and SW5. If the switches are set to "software-defined", an invalid value may have been set via Modbus. Try one of the preselected transmission speeds, for example 19200 bits/s. • Check that the Modbus address, switches SW6 and SW7, has a valid value [1-247].

Fault (LED status)	Possible cause	Remedy
5. Modbus LED1 is flashing red.	a) Fault in the Modbus communication (fault in parity or cyclic redundancy check).	• Check the transmission speed, switches SW4 and SW5. See section *5.1 Setting the Modbus transmission speed*. • Check the parity setting, switch SW3. See section *5.2 Setting the stop bits and the parity bit*. • Check the cable connection between CIM 200 and the Modbus network. • Check the termination resistor settings, switches SW1 and SW2. See section *5.4 Termination resistor*.

14.1.2 CIM/CIU 200 Modbus communication faults

Fault	Possible cause	Remedy
1. The slave does not respond to telegrams.	a) Configuration or wiring error.	• Check the visual diagnostics on the Modbus slave. Is the Grundfos GENIbus LED flashing green and the Modbus LED off or flashing green? • Ensure that the cable between the Modbus master and the Modbus slave is connected correctly. See section *5. CIM 200 Modbus RTU setup* for wiring recommendations. • Ensure that the slave address is configured correctly, and that the correct slave address is used in the Modbus master poll. See section *5.3 Modbus address selection* for slave address selection. • Ensure that the transmission speed and stop bit/parity settings are configured correctly in both master and slave. • Ensure that each end of the Modbus trunk cable is terminated, if necessary. See section *5.4 Termination resistor* for line termination of the Grundfos slave. • Ensure that the bus topology for a Modbus network is correct.
	b) The slave may be in listen-only mode.	Either send a restart communications diagnostics command, or restart the booster system manually.
	c) If the holding register of address 00001 "SlaveMinimumReplyDelay" is set too high, the master may time out before receiving the response from the slave.	Increase the time-out span in the master in order to communicate.
2. The slave responds with exception response 0x01: "Invalid function".	a) The master is trying to use an unsupported function in the module or unit.	See section *8. Modbus function code overview* for supported function codes. Note that reading and writing coils are not supported, so only register functions and diagnostics will be valid.
3. The slave responds with exception response 0x02: "Invalid data address".	a) The master is trying to read or write an invalid data address. If a master tries to read register addresses that are not listed in the tables, the slave responds with this exception response. Some masters may automatically try to read large blocks in one telegram, which will cause problems if some of the registers in the block are not supported. An example would be reading the CIM configuration and CIM status blocks in one telegram. This is not possible since there are unused addresses between the blocks.	• Avoid reading or writing invalid data addresses. • Ensure that register X is addressed as X-1 in Modbus telegrams, according to the Modbus standard.
	b) The register address offset may have been changed from default.	Read the holding register at address 00002 "Register Offset" to see if this value is different from 0. If so, write the value 0 to this address to make the slave return to the default used in this functional profile.
4. The slave returns data value 0xFFFF (65535).	a) The value is unavailable. A data value of 0xFFFF does not necessarily indicate an error condition. It means that the value is unavailable from the booster system.	See section *9. Modbus register addresses* for available data.
	b) The booster system is not configured to show the value or lacks a sensor to read the value.	See section *9.7 System data register block* for data values that require a sensor.

Fault	Possible cause	Remedy
5. The slave does not change Modbus transmission speed with register 00004.	a) Configuration error.	Set the transmission speed switches to software-defined. Otherwise, the value in register 00004 is ignored by the slave.
	b) An invalid value may be set in register 00004.	See section *5.1 Setting the Modbus transmission speed* for invalid values, and set correct value in register 00004.

14.2 CIM/CIU 260

You can detect faults in CIU 260 by observing the status of the two communication LEDs. See the table below and section *3.3 CIM 260 3G/4G cellular Modbus*.

14.2.1 LED status

CIU 260 fitted in a Grundfos booster system

Fault (LED status)	Possible cause	Remedy
1. LED1 and LED2 remain off when the power supply is connected.	a) CIU 260 is defective.	Replace CIU 260.
2. LED2 for internal communication is flashing red.	a) No internal communication between CIU 260 and the Grundfos product.	• Check the cable connection between the booster system and CIU 260. • Check that the individual conductors have been fitted correctly. • Check the power supply to the booster system.
3. LED2 for internal communication is permanently red.	a) CIU 260 does not support the Grundfos product connected.	Contact the nearest Grundfos company.
4. LED1 for cellular communication is flashing yellow. See signal 1 in fig. 22 on page 12.	a) The SIM card has not been inserted.	Insert the SIM card. See section *6.1.2 Inserting the SIM card*.
	b) The SIM card has not been inserted correctly.	Insert the SIM card. See section *6.1.2 Inserting the SIM card*.
	c) The SIM card PIN code is not correct.	Enter the correct PIN code. See section *6.1.2 Inserting the SIM card*.
	d) No connection to the cellular network.	• Check the connection to the antenna. • Check the cellular coverage of the area using for example a mobile phone. • Use an external antenna and experiment with the position.
5. The LED1 for cellular communication is pulsating yellow with single pulse, but CIM 260 cannot send or receive SMS messages.	a) CIM 260 has not been initialised.	Follow the configuration procedure in "CIM 260 SMS commands", which you can download from Grundfos Product Center.

CIM 260 fitted in CIU 260

Fault (LED status)	Possible cause	Remedy
1. LED1 and LED2 remain off when the power supply is connected.	a) CIM 260 is fitted incorrectly in the Grundfos product.	Ensure that CIM 260 is fitted and connected correctly.
	b) CIM 260 is defective.	Replace CIM 260.
2. LED2 for internal communication is flashing red.	a) No internal communication between CIM 260 and the Grundfos product.	Ensure that CIM 260 is fitted correctly in the Grundfos product.
3. The LED2 for internal communication is permanently red.	a) The 250 does not support the Grundfos product.	Contact the nearest Grundfos company.
4. LED1 for cellular communication is flashing yellow. See signal 1 in fig. 22 on page 12.	a) The SIM card has not been inserted.	Insert the SIM card. See section *6.1.2 Inserting the SIM card*.
	b) The SIM card has not been inserted correctly.	Insert the SIM card. See section *6.1.2 Inserting the SIM card*.
	c) The SIM card PIN code is not correct.	Enter the correct PIN code. See section *6.1.2 Inserting the SIM card*.
	d) No connection to the cellular network.	• Check the connection to the antenna. • Check the cellular coverage of the area using for example a mobile phone. • Use an external antenna and experiment with the position.
5. LED1 for cellular communication is pulsating yellow with single pulse, but CIM 260 cannot send or receive SMS messages.	a) CIM 260 has not been initialised.	Follow the configuration procedure in "CIM 260 SMS commands", which you can download from Grundfos Product Center.

14.2.2 CIM/CIU 260 Modbus connection communication faults

Fault	Possible cause	Remedy
1. The slave does not respond to telegrams.	a) Configuration or installation error.	• Ensure that CIU 260 has connection to the cellular network. LED1 must be pulsing yellow. If the LED1 signal is incorrect, see section *6. CIM 260 3G/4G cellular Modbus setup* for correct installation of CIM 260. • Ensure that the correct slave address is used in the Modbus master poll. See register 00003 SoftwareDefinedModbusAddress (factory value is 00231).
	b) The slave may be in listen-only mode.	Either send a restart communications diagnostics command, or restart the booster system manually.
	c) If the holding register of address 00001 "SlaveMinimumReplyDelay" is set too high, the master may time out before receiving the response from the slave.	Increase the reply delay in the master, or reduce the "SlaveMinimumReplyDelay" in order to communicate.
2. The slave responds with exception response 0x01: "Invalid function".	a) The master is trying to use an unsupported function in CIM/CIU 260.	See section *13. Modbus RTU telegram examples* for supported function codes. Note that reading and writing coils are not supported, so only register functions and diagnostics will be valid.
3. The slave responds with exception response 0x02: "Invalid data address".	a) The master is trying to read or write an invalid data address. If a master tries to read register addresses that are not listed in the tables, the slave responds with this exception response. Some masters may automatically try to read large blocks in one telegram, which will cause problems if some of the registers in the block are not supported. An example would be reading the CIM configuration and CIM status register blocks in one telegram. This is not possible since there are unused addresses between the blocks.	Avoid reading or writing invalid data addresses. Ensure that register X is addressed as X-1 in Modbus telegrams, according to the Modbus standard.
4. The slave returns data value 0xFFFF (65535).	a) The availability of data will in some cases depend on a configuration or the actual conditions of the system. For example, trying to request data from a booster system which is not present will return "data not available" (0xFFFF)).	See section *9. Modbus register addresses* for available data.
	b) With its present configuration or operating mode, the booster system is unable to supply the requested data.	See sections *9.8 Pump 1 register block* to *9.13 Pump 6 register block* for data values that require a sensor.
5. The slave does not react to control actions or to writing of settings.	a) CIU 260 is SCADA PIN-code-protected (GeneralStatus register 00029, bit 0: 1), and an incorrect PIN code has been written.	Write access requires a correct PIN code (ScadaPinCode, register 00011). Writing the correct PIN code value triggers the write access control, and write access is open, which can be verified with GeneralStatus, register 00029, bit 1: 1.

14.3 CIM/CIU 500

You can detect faults in CIU 500 by observing the status of the two communication LEDs. See the table below and section *4.4 CIM 500 Modbus TCP*.

14.3.1 LED status

CIU 500 fitted in a Grundfos booster system

Fault (LED status)	Possible cause	Remedy
1. LED1 and LED2 remain off when the power supply is connected.	a) CIM 500 is fitted incorrectly in the Grundfos product.	Check that CIM 500 is fitted and connected correctly.
	b) CIM 500 is defective.	Replace CIM 500.
2. The LED2 for internal communication is flashing red.	a) No internal communication between CIM 500 and the Grundfos product.	Check that CIM 500 is fitted correctly in the Grundfos product.
3. The LED2 for internal communication is permanently red.	a) CIM 500 does not support the Grundfos product connected.	Contact the nearest Grundfos company.
4. The Modbus LED1 is permanently red.	a) Fault in the CIM 500 Modbus TCP configuration.	Check that the rotary switch SW1 is set to 1. Check that the Modbus TCP/IP address configuration is correct. See section *A.4 Modbus TCP configuration* on page 62.
5. LED1 is permanently red and green at the same time.	a) Error in firmware download.	Use the webserver to download the firmware again.
6. LED2 is permanently red and green at the same time.	a) Memory fault.	Replace CIM 500.

CIM 500 fitted in CIU 500

Fault (LED status)	Possible cause	Remedy
1. LED1 and LED2 remain off when the power supply is connected.	a) CIU 500 is defective.	Replace CIU 500.
2. The LED2 for internal communication is flashing red.	a) No internal communication between CIU 500 and the Grundfos product.	• Check the cable connection between the Grundfos product and CIU 500. • Check that the individual conductors have been fitted correctly, for example not reversed. • Check the power supply to the Grundfos product.
3. The LED2 for internal communication is permanently red.	a) CIM 500 does not support the Grundfos product connected.	Contact the nearest Grundfos company.
4. The Ethernet LED1 is permanently red.	a) Fault in the CIM 500 Modbus TCP configuration.	Check that the rotary switch SW1 is set to 1. Check that the Modbus TCP/IP address configuration is correct. See section *A.4 Modbus TCP configuration* on page 62.
5. LED1 is permanently red and green at the same time.	a) Error in firmware download.	Use the webserver to download the firmware again.
6. LED2 is permanently red and green at the same time.	a) Memory fault.	Replace CIM 500.

14.3.2 CIM/CIU 500 Modbus TCP communication faults

Fault	Possible cause	Remedy
1. The slave does not respond to telegrams.	a) Configuration or wiring error.	• Check the visual diagnostics on the Modbus slave. Normal conditions are that the Grundfos GENIbus LED2 is permanently green and that the Modbus TCP LED1 is off or flashing green. If this is not fulfilled, see section *14.3.1 LED status*. • Ensure that the cable between the Modbus TCP master and the Modbus slave is connected correctly. See section *7.1 Connecting the Ethernet cable*. • Ensure that the slave IP address is configured correctly, and that the correct slave IP address is used in the Modbus master poll. See section *7.3 Setting the IP addresses*.

Fault	Possible cause	Remedy
2. The slave responds with exception response 0x01: "Invalid function".	a) The master is trying to use an unsupported function in CIM/CIU 500.	See section *8. Modbus function code overview* for supported function codes. Note that reading and writing coils are not supported, so only register functions and diagnostics are valid.
3. The slave responds with exception response 0x02: "Invalid data address".	a) The master is trying to read or write an invalid data address. If a master tries to read register addresses that are not listed in the tables, the slave responds with this exception response. Some masters may automatically try to read large blocks in one telegram, which will cause problems if some of the registers in the block are not supported. An example would be reading the CIM configuration and CIM status blocks in one telegram: this is not possible since there are unused addresses between the blocks.	Avoid reading or writing invalid data addresses. Ensure that a block of registers starting at address X is addressed as X-1 in Modbus telegrams, according to the Modbus standard.
	b) The register address offset may have been changed from default.	Read the holding register at address 00002 "Register Offset" to see if this value is different from 0. If so, write the value 0 to this address to make the slave return to the default used in this functional profile.
4. The slave returns data value 0xFFFF (65535).	a) The value is unavailable. A data value of 0xFFFF does not necessarily indicate an error condition. It means that the value is unavailable from the booster system.	See section *9. Modbus register addresses* for available data.
	b) The booster system is not configured to show the value or lacks a sensor to read the value.	See section *9.8 Pump 1 register block* to *9.13 Pump 6 register block* for data values that require a sensor.
5. The slave does not react to control actions or to writing of settings.	The booster system might be in "Local" mode, in which case Operating mode, Control mode and Setpoint cannot be changed from the bus. Register 00201 bit 8 AccessMode must be "1" (=Remote) for bus control to be active.	Set the booster system in "Remote mode" by setting register 00101 bit 0 RemoteAccessReq to "1" (=Remote).

15. Modbus RTU rotary switch addresses

Modbus address	SW6	SW7
1	0	1
2	0	2
3	0	3
4	0	4
5	0	5
6	0	6
7	0	7
8	0	8
9	0	9
10	0	A
11	0	B
12	0	C
13	0	D
14	0	E
15	0	F
16	1	0
17	1	1
18	1	2
19	1	3
20	1	4
21	1	5
22	1	6
23	1	7
24	1	8
25	1	9
26	1	A
27	1	B
28	1	C
29	1	D
30	1	E
31	1	F
32	2	0
33	2	1
34	2	2
35	2	3
36	2	4
37	2	5
38	2	6
39	2	7
40	2	8
41	2	9
42	2	A
43	2	B
44	2	C
45	2	D
46	2	E
47	2	F
48	3	0
49	3	1
50	3	2

Modbus address	SW6	SW7
51	3	3
52	3	4
53	3	5
54	3	6
55	3	7
56	3	8
57	3	9
58	3	A
59	3	B
60	3	C
61	3	D
62	3	E
63	3	F
64	4	0
65	4	1
66	4	2
67	4	3
68	4	4
69	4	5
70	4	6
71	4	7
72	4	8
73	4	9
74	4	A
75	4	B
76	4	C
77	4	D
78	4	E
79	4	F
80	5	0
81	5	1
82	5	2
83	5	3
84	5	4
85	5	5
86	5	6
87	5	7
88	5	8
89	5	9
90	5	A
91	5	B
92	5	C
93	5	D
94	5	E
95	5	F
96	6	0
97	6	1
98	6	2
99	6	3
100	6	4

Modbus address	SW6	SW7
101	6	5
102	6	6
103	6	7
104	6	8
105	6	9
106	6	A
107	6	B
108	6	C
109	6	D
110	6	E
111	6	F
112	7	0
113	7	1
114	7	2
115	7	3
116	7	4
117	7	5
118	7	6
119	7	7
120	7	8
121	7	9
122	7	A
123	7	B
124	7	C
125	7	D
126	7	E
127	7	F
128	8	0
129	8	1
130	8	2
131	8	3
132	8	4
133	8	5
134	8	6
135	8	7
136	8	8
137	8	9
138	8	A
139	8	B
140	8	C
141	8	D
142	8	E
143	8	F
144	9	0
145	9	1
146	9	2
147	9	3
148	9	4
149	9	5
150	9	6

Modbus address	SW6	SW7
151	9	7
152	9	8
153	9	9
154	9	A
155	9	B
156	9	C
157	9	D
158	9	E
159	9	F
160	A	0
161	A	1
162	A	2
163	A	3
164	A	4
165	A	5
166	A	6
167	A	7
168	A	8
169	A	9
170	A	A
171	A	B
172	A	C
173	A	D
174	A	E
175	B	F
176	B	0
177	B	1
178	B	2
179	B	3
180	B	4
181	B	5
182	B	6
183	B	7
184	B	8
185	B	9
186	B	A
187	B	B
188	B	C
189	B	D
190	B	E
191	B	F
192	C	0
193	C	1
194	C	2
195	C	3
196	C	4
197	C	5
198	C	6
199	C	7
200	C	8

Modbus address	SW6	SW7
201	C	9
202	C	A
203	C	B
204	C	C
205	C	D
206	C	E
207	C	F
208	D	0
209	D	1
210	D	2
211	D	3
212	D	4
213	D	5
214	D	6
215	D	7
216	D	8
217	D	9
218	D	A
219	D	B
220	D	C
221	D	D
222	D	E
223	D	F
224	E	0
225	E	1
226	E	2
227	E	3
228	E	4
229	E	5
230	E	6
231	E	7
232	E	8
233	E	9
234	E	A
235	E	B
236	E	C
237	E	D
238	E	E
239	E	F
240	F	0
241	F	1
242	F	2
243	F	3
244	F	4
245	F	5
246	F	6
247	F	7

Example**:** To set the slave address to the value 142, set the rotary switches SW6 and SW7 to "8" and "E", respectively. Note that 0 is not a valid slave address as this is used for broadcasting.

It is very important to ensure that two devices do not have the same address on the network. If two devices have the same address, the result will be an abnormal behaviour of the whole serial bus.

16. Grundfos alarm and warning codes

This is a complete list of alarm and warning codes for Grundfos products. For the codes supported by this product, see the alarms and warnings section.

Code	Description	Code	Description	Code	Description
1	Leakage current	36	Outlet valve leakage	71	Motor temperature 2 (Pt100, t_mo2)
2	Missing phase	37	Inlet valve leakage	72	Hardware fault, type 1
3	External fault signal	38	Vent valve defective	73	Hardware shutdown (HSD)
4	Too many restarts	39	Valve stuck or defective	74	Internal supply voltage too high
5	Regenerative braking	40	Undervoltage	75	Internal supply voltage too low
6	Mains fault	41	Undervoltage transient	76	Internal communication fault
7	Too many hardware shutdowns	42	Cut-in fault (dV/dt)	77	Communication fault, twin-head pump
8	PWM switching frequency reduced	43	-	78	Fault, speed plug
9	Phase sequence reversal	44	-	79	Functional fault, add-on module
10	Communication fault, pump	45	Voltage asymmetry	80	Hardware fault, type 2
11	Water-in-oil fault (motor oil)	46	-	81	Verification error, data area (RAM)
12	Time for service (general service information)	47	-	82	Verification error, code area (ROM, FLASH)
13	Moisture alarm, analog	48	Overload	83	Verification error, FE parameter area (EEPROM)
14	Electronic DC-link protection activated (ERP)	49	Overcurrent (i_line, i_dc, i_mo)	84	Memory access error
15	Communication fault, main system (SCADA)	50	Motor-protection function, general shutdown (MPF)	85	Verification error, BE parameter area (EEPROM)
16	Other	51	Blocked motor or pump	86	Fault (add-on) I/O module
17	Performance requirement cannot be met	52	Motor slip high	87	-
18	Commanded alarm standby (trip)	53	Stalled motor	88	Sensor fault
19	Diaphragm break (dosing pump)	54	Motor-protection function, 3 sec. limit	89	Signal fault, (feedback) sensor 1
20	Insulation resistance low	55	Motor current protection activated (MCP)	90	Signal fault, speed sensor
21	Too many starts per hour	56	Underload	91	Signal fault, temperature sensor 1
22	Moisture switch alarm, digital	57	Dry running	92	Calibration fault, (feedback) sensor
23	Smart trim gap alarm	58	Low flow	93	Signal fault, sensor 2
24	Vibration	59	No flow	94	Limit exceeded, sensor 1
25	Setup conflict	60	Low input power	95	Limit exceeded, sensor 2
26	Load continues even if the motor has been switched off	61	-	96	Setpoint signal outside range
27	External motor protector activated (for example MP 204)	62	-	97	Signal fault, setpoint input
28	Battery low	63	-	98	Signal fault, input for setpoint influence
29	Turbine operation (impellers forced backwards)	64	-	99	Signal fault, input for analog setpoint
30	Change bearings (specific service information)	65	Motor temperature 1 (t_m or t_mo or t_mo1)	100	RTC time synchronisation with cellular network occurred
31	Change varistor(s) (specific service information)	66	Temperature, control electronics (t_e)	101	-
32	Overvoltage	67	Temperature too high, internal frequency converter module (t_m)	102	Dosing pump not ready
33	Soon time for service (general service information)	68	External temperature or water temperature (t_w)	103	Emergency stop
34	No priming water	69	Thermal relay 1 in motor, for example Klixon	104	Software shutdown
35	Gas in pump head, de-aerating problem	70	Thermal relay 2 in motor, for example thermistor	105	Electronic rectifier protection activated (ERP)

Code	Description	Code	Description	Code	Description
106	Electronic inverter protection activated (EIP)	141	-	176	Signal fault, temperature sensor 3 (t_mo3)
107	-	142	-	177	Signal fault, Smart trim gap sensor
108	-	143	-	178	Signal fault, vibration sensor
109	-	144	Motor temperature 3 (Pt100, t_mo3)	179	Signal fault, bearing temperature sensor (Pt100), general or top bearing
110	Skew load, electrical asymmetry	145	Bearing temperature high (Pt100), in general or top bearing	180	Signal fault, bearing temperature sensor (Pt100), middle bearing
111	Current asymmetry	146	Bearing temperature high (Pt100), middle bearing	181	Signal fault, PTC sensor (short-circuited)
112	Cosφ too high	147	Bearing temperature high (Pt100), bottom bearing	182	Signal fault, bearing temperature sensor (Pt100), bottom bearing
113	Cosφ too low	148	Motor bearing temperature high (Pt100) in drive end (DE)	183	Signal fault, extra temperature sensor
114	Motor heater function activated (frost protection)	149	Motor bearing temperature high (Pt100) in non-drive end (NDE)	184	Signal fault, general-purpose sensor
115	Too many grinder reversals or grinder reversal attempt failed	150	Fault (add-on) pump module	185	Unknown sensor type
116	Grinder motor overtemperature	151	Fault, display (HMI)	186	Signal fault, power meter sensor
117	Intrusion (door opened)	152	Communication fault, add-on module	187	Signal fault, energy meter
118	Signal fault, hydrogen sulfide H2S sensor	153	Fault, analog output	188	Signal fault, user-defined sensor
119	Signal fault, analog input AI4	154	Communication fault, display	189	Signal fault, level sensor
120	Auxiliary winding fault (single phase motors)	155	Inrush fault	190	Limit exceeded, sensor 1 (for example alarm level in WW application)
121	Auxiliary winding current too high (single-phase motors)	156	Communication fault, internal frequency converter module	191	Limit exceeded, sensor 2 (for example high level in WW application)
122	Auxiliary winding current too low (single-phase motors)	157	Real-time clock out of order	192	Limit exceeded, sensor 3 (for example overflow level in WW application)
123	Start capacitor, low (single-phase motors)	158	Hardware circuit measurement fault	193	Limit exceeded, sensor 4 (for example low level in WW/tank filling application)
124	Run capacitor, low (single-phase motors)	159	CIM fault (Communication Interface Module)	194	Limit exceeded, sensor 5
125	Signal fault, outdoor temperature sensor	160	Cellular modem, SIM card fault	195	Limit exceeded, sensor 6
126	Signal fault, air temperature sensor	161	Sensor supply fault, 5 V	196	Operation with reduced efficiency
127	Signal fault, shunt relative pressure sensor	162	Sensor supply fault, 24 V	197	Operation with reduced pressure
128	Strainer clogged	163	Measurement fault, motor protection	198	Operation with increased power consumption
129	-	164	Signal fault, LiqTec sensor	199	Process out of range (monitoring, estimation, calculation, control)
130	-	165	Signal fault, analog input 1	200	Application alarm
131	-	166	Signal fault, analog input 2	201	External sensor input high
132	-	167	Signal fault, analog input 3	202	External sensor input low
133	-	168	Signal fault, pressure sensor	203	Alarm on all pumps
134	-	169	Signal fault, flow sensor	204	Inconsistency between sensors
135	-	170	Signal fault, water-in-oil (WIO) sensor	205	Level float switch sequence inconsistency
136	-	171	Signal fault, moisture sensor	206	Water shortage, level 1
137	-	172	Signal fault, atmospheric pressure sensor	207	Water leakage
138	-	173	Signal fault, rotor position sensor (Hall sensor)	208	Cavitation
139	-	174	Signal fault, rotor origo sensor	209	Non-return valve fault
140	-	175	Signal fault, temperature sensor 2 (t_mo2)	210	High pressure

Code	Description	Code	Description	Code	Description
211	Low pressure	226	Communication fault, I/O module	241	Motor phase failure
212	Diaphragm tank precharge pressure out of range	227	Combi event	242	Automatic motor model recognition failed
213	VFD not ready	228	Night flow max. limit exceeded	243	Motor relay has been forced (manually operated or commanded)
214	Water shortage, level 2	229	Water on floor	244	Fault, On/Off/Auto switch
215	Soft pressure buildup time-out	230	Network alarm	245	Pump continuous runtime too long
216	Pilot pump alarm	231	Ethernet: No IP address from DHCP server	246	User-defined relay has been forced (manually operated or commanded)
217	Alarm, general-purpose sensor high	232	Ethernet: Auto-disabled due to misuse	247	Power-on notice, (device or system has been switched off)
218	Alarm, general-purpose sensor low	233	Ethernet: IP address conflict	248	Fault, battery/UPS
219	Pressure relief not adequate	234	Backup pump alarm	249	User-defined event 1
220	Fault, motor contactor feedback	235	Gas detected	250	User-defined event 2
221	Fault, mixer contactor feedback	236	Pump 1 fault	251	User-defined event 3
222	Time for service, mixer	237	Pump 2 fault	252	User-defined event 4
223	Time for service, mixer	238	Pump 3 fault	253	SMS data from DDD sensor not received within time limit
224	Pump fault, due to auxiliary component or general fault	239	Pump 4 fault	254	Inconsistent data model
225	Communication fault, pump module	240	Lubricate bearings (specific service information)		

The appendix describes the parts of the CIM 500 webserver needed for the configuration of a Modbus TCP ethernet connection. For other CIM 500 webserver features not specifically related to Modbus TCP, see the installation and operating instructions for CIM 500.

A.1 How to configure an IP address on your PC

To connect a PC to CIM 500 via ethernet, the PC must be set up to use a fixed, static, IP address belonging to the same subnetwork as CIM 500.

Note that before you can acces the webserver, your PC must first be given an alternate IP address. If you have not already done this, follow the steps below:

Windows 10:

1. Click "Start".
2. Enter "Ethernet".
3. Select "Change adapter options".
4. Right-click "Ethernet".
5. Select "Properties".
6. Right-click "Internet protocol V4".
7. Select "Properties".
8. Select "Alternate configuration".

Windows 7:

1. Open "Control Panel".
2. Enter "Network and Sharing Center".
3. Select "Change adapter settings".
4. Right-click "Ethernet adapter".
5. Select "Local area connections".
6. Right-click "Internet protocol V4".
7. Select "Properties".
8. Select "Alternate configuration".

Key in IP address 192.168.1.10 and Subnet mask 255.255.255.0.

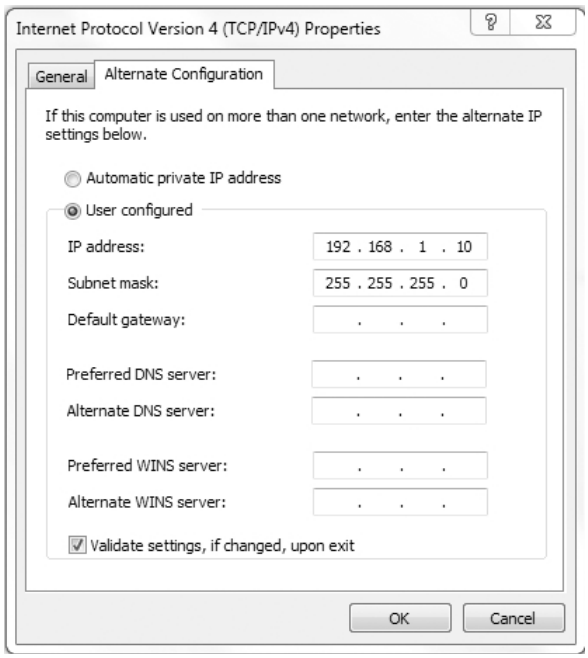


Fig. 1 Example from Windows 7

A.2 Webserver configuration

The built-in webserver is an easy and effective way to monitor the status of the CIM 500 module and configure the available functions and Industrial Ethernet protocols. The webserver also makes it possible to update the firmware of the CIM module and store or restore settings.

To establish a connection from a PC to CIM 500, proceed as follows:

Before configuration

- Check that the PC and CIM module are connected via an ethernet cable.
- Check that the PC ethernet port is set to the same network as the CIM module. For network configuration, see section *A.1 How to configure an IP address on your PC*.

To establish a connection from a PC to CIM 500 for the first time, the following steps are required:

1. Open a standard internet browser and type 192.168.1.100 in the URL address field.
2. Log in to the webserver.

A.3 Login

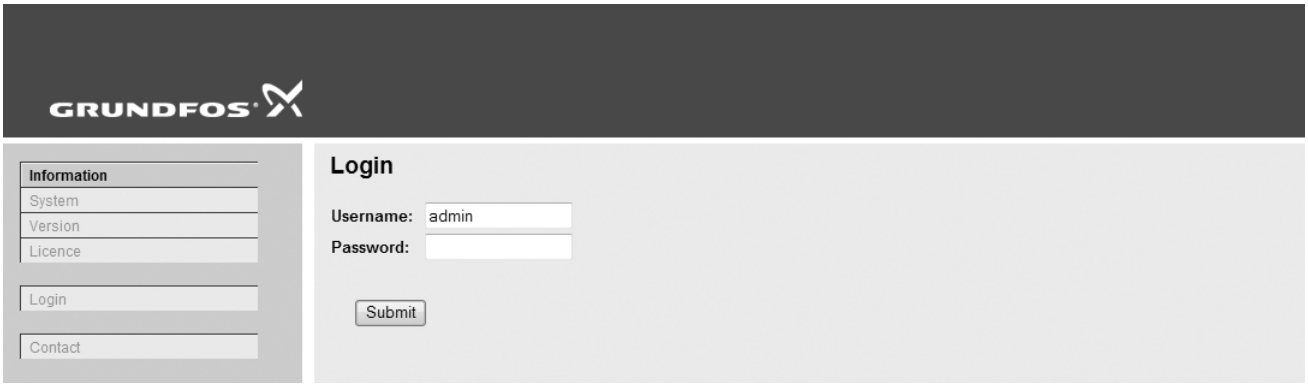


Fig. 2 Login

User name	Enter user name. Default: admin.
Password	Enter password. Default: Grundfos.

User name and password can be changed on the webserver under "User Management".

A.4 Modbus TCP configuration

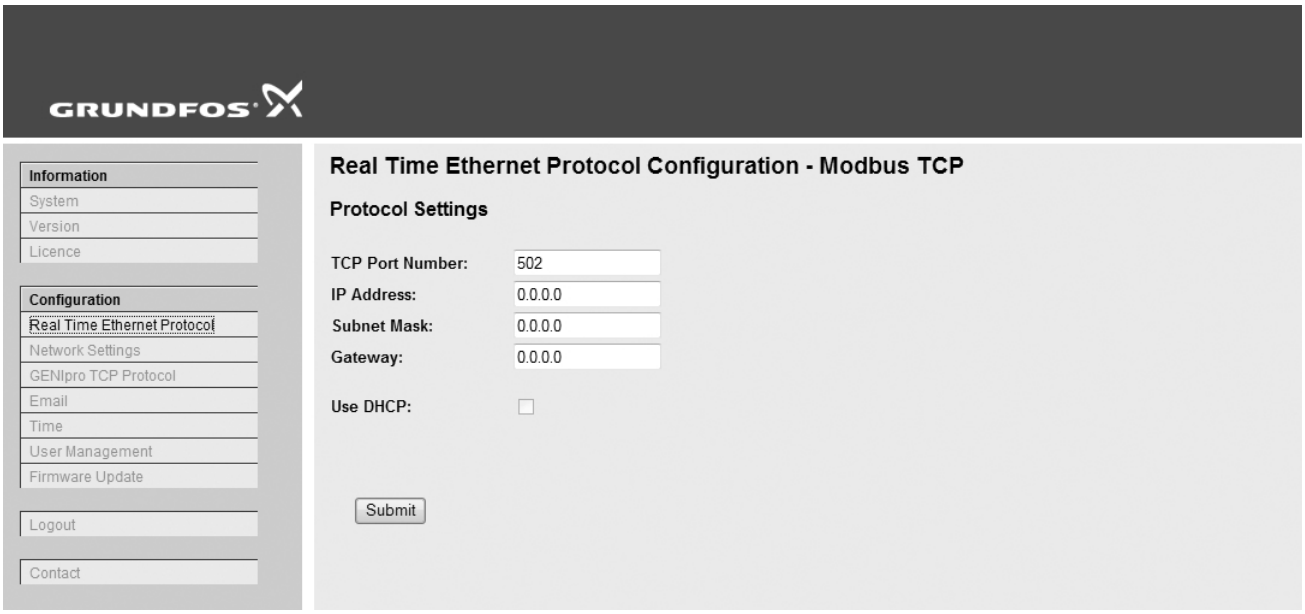


Fig. 3 Real Time Ethernet Protocol Configuration - Modbus TCP

Object	Description
TCP Port Number	The default value is 502, the official IANA-assigned Modbus TCP port number. Number 502 will always be active implicitly. If you select another value in the webserver configuration field, both the new value and value 502 will be active.
IP Address	The static IP address for CIM 500 on the Modbus TCP network.
Subnet Mask	The subnet mask for the CIM 500 module on the Modbus TCP network.
Gateway	The default gateway for the Modbus TCP network.
Use DHCP	The CIM 500 module can be configured to automatically obtain the IP address from a DHCP server on the network.

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