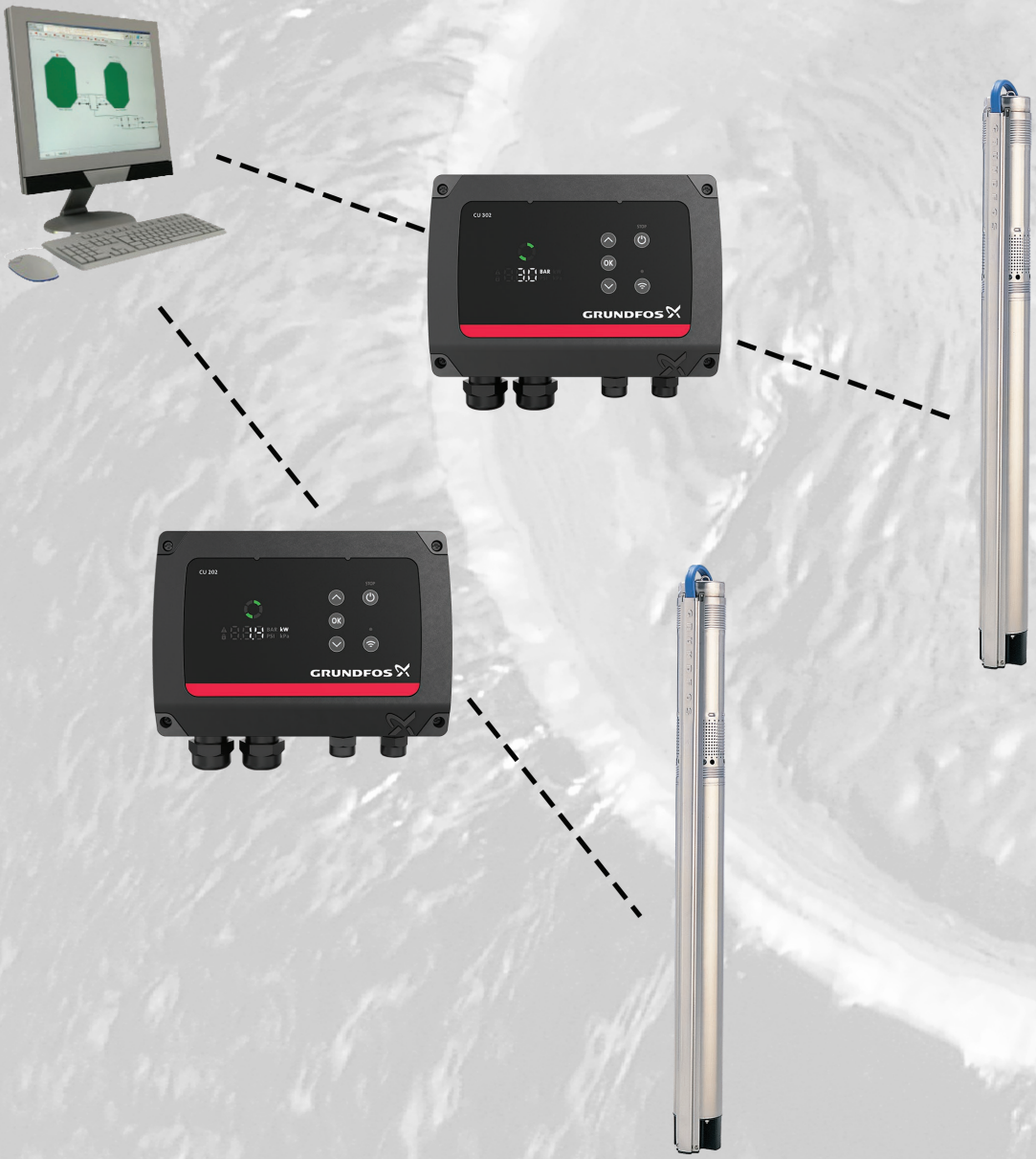
Modbus RTU for SQ Controller CU 302/202

Functional profile and user manual



GRUNDFOS

Modbus RTU for SQ Controller CU 302/202

Original functional profile and user manual

Table of contents

1. General information

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

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 the 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 Modbus RTU functional profile describes all the read and write parameters supported by the Modbus RTU communication with the Grundfos SQ Controllers CU 302/202.

2.2 Assumptions

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

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

2.3 Definitions and abbreviations

0b	Prefix for binary number
0x	Prefix for hexadecimal number
BCD	Binary Coded Decimal
CIM	Communication Interface Module
CRC	Cyclic Redundancy Check: adata error detection method
GENIbus	Proprietary Grundfos fieldbus standard
GENIpro	Proprietary Grundfos fieldbus protocol
Grundfos GO	Grundfos application for controlling Grundfos products via Bluetooth (available for iOS and Android)
H	Head (pressure)
HMI	Human Machine Interface
LED	Light-Emitting Diode
Modbus	Serial communications protocol commonly used in industry and building automation systems
Modbus RTU	Modbus is a fieldbus used worldwide. The CU 302/202 Modbus RTU is based on RS485 wired networking.
PELV	Protective Extra-Low Voltage
RTU	Remote Terminal Unit
SELV	Separated or Safety Extra-Low Voltage
Transmission speed	Bits transferred per second, bits/s
SoftCIM	Software Communication Interface Module: integrated communication protocol, that can be enabled and configured by the Grundfos GO app. The SQ Controller has a Modbus RTU SoftCIM.
CU 202	Grundfos clean water controller for SQ pumps in solar applications
CU 302	Grundfos clean water controller for standard SQ pumps

3. System description

The Grundfos SQ pump controller CU 302/202 is connected to a Grundfos SQ submersible pump for water supply. The controller offers status information, as well as control and monitoring of the pump via a user interface on the controller, and the Grundfos GO app communicating via Bluetooth. A Modbus RTU communications interface named SoftCIM Modbus RTU is integrated in the controller. The interface enables communication with a PLC or a SCADA system.

TM087066

Use Grundfos GO app to configure a CU 302/202 and to read measurements and status values

TM087162

Connection of a CU 302/202 controller to a SCADA system via the SoftCIM Modbus RTU interface

4. Specifications

4.1 SoftCIM Modbus RTU

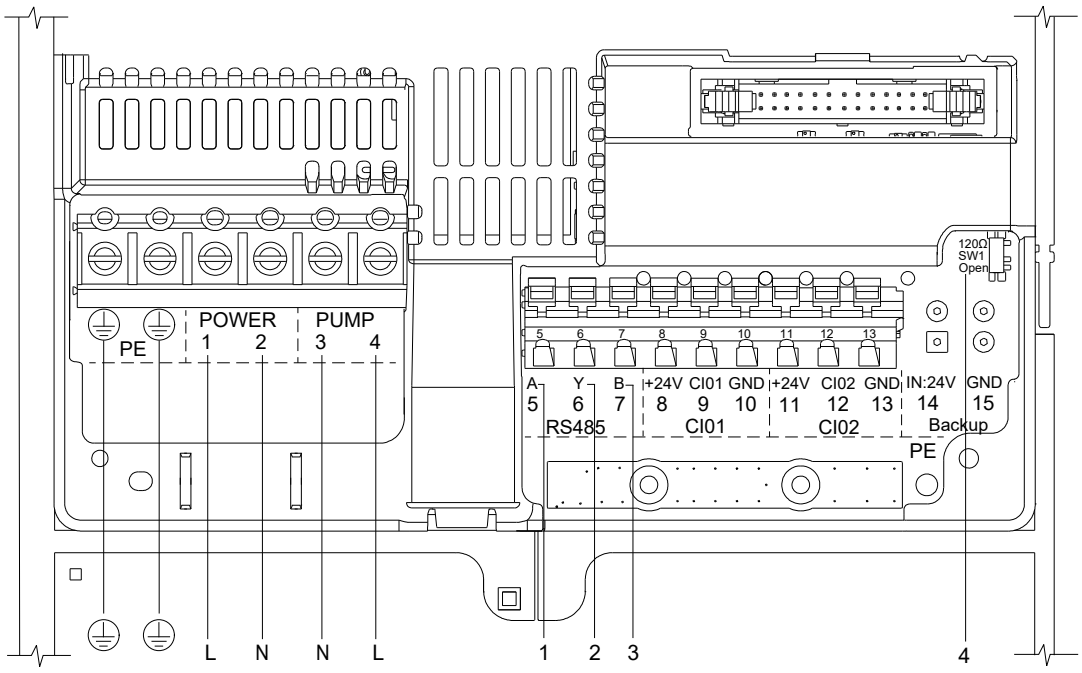
The table below provides an overview of the specifications for the Grundfos SoftCIM Modbus RTU. For further details, refer to the specific sections of this functional profile.

Modbus RTU specifications	Description	Comments
Modbus RTU connector	Screw-type terminal	3 pins
Modbus RTU connection type	RS-485, 2-wire + common	Conductors: A, Y, B
Maximum cable length	1200 m	4000 ft
Slave address	1-247	Set via the Grundfos GO app
Line termination	On or off	See section Modbus RTU setup.
Recommended cable cross-section	0.20 - 0.25 mm^2	AWG24 or AWG23
Supported transmission speeds	9600, 19200, 38400 bits/s	Set via the Grundfos GO app
Start bit	1	Fixed value
Data bits	8	Fixed value
Stop bits	1 or 2	Set via the Grundfos GO app
Parity bit	Even parity, odd parity or no parity	Set via the Grundfos GO app
Modbus RTU visual status	No communication Communication active Fault in communication	Status via the HMI or the Grundfos GO app
Maximum number of Modbus RTU devices	32	Using repeaters, this number can be increased. The legal address range is 1-247.
Maximum Modbus RTU telegram size	256 byte	Total length, node address and CRC included
Watchdog timeout	[5; 3600 s], disabled='0', min. 5 s	Set via the Grundfos GO app or the HMI, default: '0' (disabled)

Related information

5. *Modbus RTU setup*
6. *Modbus RTU function code overview*

5. Modbus RTU setup



TM086970

Terminals of the CU 302/202

Pos.	Designation	Description
1	A	Modbus RTU terminal D1, positive data signal
2	Y	Modbus RTU terminal, common and GND
3	B	Modbus RTU terminal D0, negative data signal
4	SW1	On and off switch for termination resistor

6. Modbus RTU 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

Reading or writing coils are not supported.

The same data are available in both holding registers and input registers, that is, 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.

Related information

10.6 Diagnostics, 0x08

7. Modbus RTU register overview

7.1 Register block overview

The Modbus RTU functional profile registers are grouped in the following register blocks:

Start address	Register block	Permissions	Description
00001	CIM configuration	R/W	Configuration of the CIM module itself
00021	CIM status	R	Status registers for the CIM module itself
00101	System control and configuration	W	Registers for control and configuration of the system
00201	System status	R	Registers for status from the system
00301	System data	R	Registers for measured values from the system
00401	Pump	R	Registers containing pump data and status
00701	Alarm simulation	R/W	Registers for simulation of alarms and warnings
00751	User	R/W	Registers for storing data freely
05001	Clock scheduler	R/W	Registers for configuring the clock scheduler
06001	Event log	R	Registers containing the latest 40 event log entries
07001	Data log index	R	Index for the configurable data log series
07301	Data log series	R	Configurable data log series

All addresses contain 16 bit registers. Some registers are bit-interpreted, consisting of one or more parameters of type bool, while others are 16-bit values or high/low order parts of 32-bit values. When a 32-bit value is split in two 16-bit registers, the names will be labeled HI and LO at the end of the register name. Re-combining into a 32-bit value is done as follows:

Parameter32bit = Parameter16bitHI × 65536 + Parmeter16bitLO

7.2 SoftCIM configuration register block

Registers in this block can be read by function codes 0x03 and/or 0x04. They can be written as holding registers with function codes 0x06 and 0x10. The below registers are applicable to the SoftCIM Modbus RTU in the CU 302/202.

Address	Register name	Description
00001	RESERVED	RESERVED
00002	RESERVED	RESERVED
00003	SoftwareDefinedModbusAddress	This register is used for setting the Modbus RTU address. A setting outside the legal range [1; 247] is ignored. The configured value is saved in EEPROM.
00004	SoftwareDefinedBitRate	This register is used for setting the Modbus RTU communication speed (bit rate). 0: 1200 bits/s 1: 2400 bits/s 2: 4800 bits/s 3: 9600 bits/s 4: 19200 bits/s (default) 5: 38400 bits/s. If a value outside the legal range is configured, the setting changes automatically to 4: 19200 bits/s. The configured value is saved in EEPROM.
00005	AutoAckControlBits	The register is used for selecting the behaviour of control bit acknowledgements from the SoftCIM. 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). The configured value is saved in EEPROM.
00006	ReadWriteSeparation	The register is used for selecting the read-back behaviour of value-setting registers 00110-00128. 0: Read and write are not separated. The real value of the status register is reflected in its setting register. 1: Read and write are separated. The setting register reflects the value that was written to it the last time. It may differ from the real value of the status register that it represents. Example: If the high-level value is set with Grundfos GO, it is shown in status register 00241 HighLevel. However, it is only shown in 00122 SetHighLevel if the ReadWriteSeparation register is set to 0. The configured value is saved in EEPROM.
00007	RESERVED	RESERVED
00008	RESERVED	RESERVED

Address	Register name	Description
00009	SoftwareDefinedParity	This register is used for setting the Modbus RTU parity bit handling. 0: No parity 1: Even parity (default) 2: Odd parity If a value outside the legal range is configured, the setting changes automatically to 1: Even parity. The configured value is saved in EEPROM.
00010	SoftwareDefinedStopBit	This register is used for setting the Modbus RTU option for Stop bit handling. 1: 1 stop bit (default) 2: 2 stop bits If a value outside the legal range is configured, the setting changes automatically to 1: 1 stop bit. The configured value is saved in EEPROM.
00012	Watchdog	This register is used for configuring the watchdog timeout [5; 3600]s. 0: Disable from bus (default) Values 1-4: set value = 5s Values > 3600: set value = 3600s The configured value is saved in EEPROM.

7.3 SoftCIM status register block

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

Address	Register name	Description
00021	RESERVED	RESERVED
00022	RESERVED	RESERVED
00023	VersionNumber	SoftCIM Modbus RTU software version. This is a BCD value, digit aa.bb.
00024	ActualModbusAddress	The register holds the current Modbus RTU slave address of the product. Valid value range: [1; 247]
00025 00026 00027 00028 00029	RESERVED	RESERVED
00030	UnitFamily	This indicates the Grundfos product family. The CU 202/302 holds the value 65.
00031	UnitType	Grundfos product type: 1: CU 302 2: CU 202.
00032	UnitVersion	Grundfos product version.
00033	RESERVED	RESERVED
00034	ProductSoftwareVersionHI	This is a product software version, BCD digit 1-4 aa.bb.
00035	ProductSoftwareVersionLO	This is a product software version, BCD digit 5-8 cc.dd.
00036	ProductSoftwareDayMonth	This is a product software date, BCD ddmm.
00037	ProductSoftwareYear	This is a product software date, BCD yyyy.

7.4 System control and configuration register block

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

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

Address	Register name	Scale	Description
00101	Control Bit 0: ResetAlarm	Bool	This control bit resets alarms and warnings from the CU 302/202. 0: No resetting 1: Resetting alarm This control bit is triggered on rising edge only, so if the register is changed from 0 to 1, the CU 302/202 resets the alarm. See section SoftCIM configuration register block, address 00005, for acknowledgement behaviour.
	Control Bit 2: ResetEventLog	Bool	This control bit resets the SCADA event log in the CU 302/202. 0: No resetting 1: Resetting event log This control bit is triggered on rising edge only, so if the register is changed from 0 to 1, the CU 302/202 resets the alarm. See section SoftCIM configuration register block, address 00005, for acknowledgement behaviour.
	Control Bit 10: PumpOut	Bool	This control bit triggers a pump out of all water in the well. 0: No action 1: PumpOut function triggered This control bit is triggered on rising edge only, so if the bit is changed from 0 to 1, the well pump out begins. See section SoftCIM configuration register block, address 00005, for acknowledgment behavior.
00103	PumpControl	enum	This register is for remote manual control of the pump. 0: "Auto" mode (the pump is controlled by CU the 302/202) 1: Forced start 2: Forced stop
00110	SetEventLogClearID	Unscaled	This register selects which records to clear in the event log.
00112	SetRealTimeClockHI	1 second	This register is for setting the real-time clock in seconds since midnight 1 January 1970 (UNIX time). First, set SetRealTimeClockHI, then SetRealTimeClockLO in order to set a new time in UNIX format.
00113	SetRealTimeClockLO		
00114	SetRtcSecond	1 second	Real-time clock: second of the minute [0; 59]
00115	SetRtcMinute	1 minute	Real-time clock: minute of the hour [0; 59]
00116	SetRtcHour	1 hour	Real-time clock: hour of the day [0; 23]
00117	SetRtcDay	1 day	Real-time clock: day of the month [1; 31]
00118	SetRtcMonth	1 month	Real-time clock: month of the year [1; 12]
00119	SetRtcYear	1 year	Real-time clock: year [0; 254] (corresponding to year year 2000 and year 2254 respectively)
00120	SetRtc Bit 0: SetRtc	Bool	This control bit sets the new real-time clock. 1: Set new real-time clock from registers 00114 to 00119 This control bit is triggered on rising edge only, that is, setting logical 0 to 1. See section SoftCIM configuration register block, address 00005, for acknowledgement behaviour.
00122	SetHighLevel	0.01 m	Setting a new level for activation of high-level alarm [1)]
00124	SetDryRunningLevel	0.01 m	This register is for setting a new level for activation of dry-running alarm. [1)]
00126	SetStartLevelPump	0.01 m	This register is for setting a new start level for the pump. [1)]

Address	Register name	Scale	Description
00127	SetStopLevelPump	0.01 m	This register is for setting a new stop level for the pump. [1)]
00185	SetControlMode	enum	This register is for setting the SQ Controller control mode: 0: Monitoring, CU 202/203 1: Filling, CU 202/203 On/Off level control 2: Emptying, CU 202/203 On/Off level control 3: Pressure Control, CU 202/203 On/Off pressure control 4: Constant Frequency, CU 302 speed controlled 5: Constant Pressure, CU 302 speed controlled pressure 6: Pump Out, CU 302/202 speed control / On/off control 7: Constant Temperature, CU 302 speed controlled temp 8: Constant Flow, CU 302 speed controlled flow 9: Constant Level, CU 302 speed controlled level
00186	SetSetpoint	See description.	This register is for setting the SQ Controller setpoint. Scaling according to Control mode: 0: Monitoring, no setpoint used, SQ pump not controlled 1: Filling, no setpoint used, using float switches 2: Emptying, no setpoint used, using float switches 3: Pressure Control, no setpoint used, using float switches 4: Constant Frequency, setpoint scaling [0.01 %] 5: Constant Pressure, setpoint scaling bar [0.001 bar] 6: Pump Out, setpoint scaling [0.01 %] 7: Constant Temperature Setpoint scaling [1 °C] 8: Constant Flow, setpoint scaling [0.01 m^3/h] 9: Constant Level, setpoint scaling [0.01 m]

1) If ReadWriteSeparation (register 00006, bit 0) is set to "0", the SoftCIM Modbus RTU overwrites this register value with the resulting level.

7.5 System status register block

Registers in this block can be read by function codes 0x03 and/or 0x04. It is not possible to write to these registers.
Unless otherwise stated, the data type used for counters and scaled values is always an unsigned integer.

Address	Register name	Scale	Description
00201	AcknowledgeRegister Bit 0: AckResetAlarm	Bool	This register indicates if a ResetAlarm control bit was acknowledged by the device. This bit is only active if AutoAckControlBits (register 00005, bit 0) is set to "0". 0: Not acknowledged 1: Acknowledged
	AcknowledgeRegister Bit 1: AckSetRtc		This register indicates if a SetRtc (real-time clock) control bit was acknowledged by the device. This bit is only active if AutoAckControlBits (register 00005, bit 0) is set to "0". 0: Not acknowledged 1: Acknowledged
	AcknowledgeRegister Bit 2: AckResetEventLog		This register indicates if a ResetEventLog control bit was acknowledged by the device. This bit is only active if AutoAckControlBits (register 00005, bit 0) is set to "0". 0: Not acknowledged 1: Acknowledged
00202	Bit 0: RESERVED	-	-
	SystemStatus Bit 1: AlarmActive	Bool	Alarm condition: 0: No active alarms 1: One or more active alarms
	SystemStatus Bit 2: WarningActive		Warning condition: 0: No active warnings 1: One or more active warnings
	SystemStatus Bit 3: ManualControl		Manual control condition: 0: No manual control 1: Manual control
00210	SystemAlarms1	Bits	System alarm events, item 1: Bit-interpreted See section Alarms and warnings.
00211	SystemAlarms2	Bits	System alarm events, item 2: Bit-interpreted See section Alarms and warnings.
00212	SystemAlarms3	Bits	System alarm events, item 3: Bit-interpreted See section Alarms and warnings.
00213	SystemWarnings1	Bits	System warning events, item 1: Bit-interpreted See section Alarms and warnings.
00214	SystemWarnings2	Bits	System warning events, item 2: Bit-interpreted See section Alarms and warnings.
00215	SystemWarnings3	Bits	System warning events, item 3: Bit-interpreted See section Alarms and warnings.
00216	EventLogLatestID	Unscaled	This register is the ID code of the latest event log.
00217	NumberOfFloatSwitches	enum	This register shows the number of installed float switches in the system, 0-5.
00218	FloatSwitchesStatus Bit 0: FloatSwitch1Status	Bool	On and off state of float switch 1, if installed: 0: Off 1: On
	FloatSwitchesStatus Bit 1: FloatSwitch2Status		On and off state of float switch 2, if installed: 0: Off 1: On
	FloatSwitchesStatus Bit 2: FloatSwitch3Status		On and off state of float switch 3, if installed: 0: Off 1: On
	FloatSwitchesStatus Bit 3: FloatSwitch4Status		On and off state of float switch 4, if installed: 0: Off 1: On
	FloatSwitchesStatus Bit 4: FloatSwitch5Status		On and off state of float switch 5, if installed: 0: Off 1: On

Address	Register name	Scale	Description
00219	FloatSwitch1Function	enum	Function of the float switch: 0: RESERVED 1: Dry running 3: Stop of all pumps 11: Start or stop 14: Start of first pump 23: High level
00220	FloatSwitch2Function	enum	Function of the float switch: 0: RESERVED 1: Dry running 3: Stop of all pumps 11: Start or stop 14: Start of first pump 23: High level
00221	FloatSwitch3Function	enum	Function of the float switch: 0: RESERVED 1: Dry running 3: Stop of all pumps 11: Start or stop 14: Start of first pump 23: High level
00222	FloatSwitch4Function	enum	Function of the float switch: 0: RESERVED 1: Dry running 3: Stop of all pumps 11: Start or stop 14: Start of first pump 23: High level
00223	FloatSwitch5Function	enum	Function of the float switch: 0: RESERVED 1: Dry running 3: Stop of all pumps 11: Start or stop 14: Start of first pump 23: High level

Address	Register name	Scale	Description
00224	Sensors Bits 0: LevelControlSensor	Bool	Presence of level control sensor via analog input: 0: Not present 1: Present
	Sensors Bits 1: PressureSensor		RESERVED
	Sensors Bits 2: FloatSwitches		Presence of float switches: 0: Not present 1: Present
	Sensors Bits 3: FlowSensor		Presence of flow sensor via analog input: 0: Not present 1: Present
	Sensors Bits 4: Power/EnergySensor		Presence of power/energy sensor via analog input: 0: Not present 1: Present
	Sensors Bits 5: UserDefinedAIsensor1present		Presence of user-defined sensor 1 via analog input: 0: Not present 1: Present
	Sensors Bits 6: UserDefinedAIsensor2present		Presence of user-defined sensor 2 via analog input: 0: Not present 1: Present
	Sensors Bits 7: UserDefinedAIsensor3present		Presence of user-defined sensor 3 via analog input: 0: Not present 1: Present
	Sensors Bits 8: UserDefinedAIsensor4present		Presence of user-defined sensor 4 via analog input: 0: Not present 1: Present
	Sensors Bits 9: UserDefinedAIsensor5present		Presence of user-defined sensor 5 via analog input: 0: Not present 1: Present
	Sensors Bits 10: TurbiditySensor		Presence of turbidity sensor via analog input: 0: Not present 1: Present
	Sensors Bits 11: PHSensor		Presence of PH sensor via analog input: 0: Not present 1: Present
	Sensors Bits 12: ConductivitySensor		Presence of conductivity sensor via analog input: 0: Not present 1: Present
	Sensors Bits 13: PulseFlowSensor		Presence of pulse flow sensor via digital input: 0: Not present 1: Present
	Sensors Bits 14: PressureSensor		Presence of pressure sensor via analog input: 0: Not present 1: Present
	Sensors Bits 15: LevelSensor		Presence of level sensor via analog input: 0: Not present 1: Present
00228	RealTimeClockHI	1 second	The real-time clock counts in seconds since midnight 1 January 1970 (UNIX time).
00229	RealTimeClockLO		
00230	RtcSecond	1 second	Second of the minute [0; 59]
00231	RtcMinute	1 minute	Minute of the hour [0; 59]
00232	RtcHour	1 hour	Hour of the day [0; 23]
00233	RtcDay	1 day	Day of the month [1; 31]
00234	RtcMonth	1 month	Month of the year [1; 12]
00235	RtcYear	1 year	Year [0; 254]: [year 2000; year 2254]
00241	HighLevel	0.01 m	Level for activation of high-level alarm
00243	DryRunningLevel	0.01 m	Level for activation of dry-running level alarm
00245	StartLevelPump	0.01 m	Start level for the pump
00246	StopLevelPump	0.01 m	Stop level for the pump
00272	SystemAlarms5	Bits	System alarm events, item 5 Bit-interpreted See section Alarms and warnings.
00273	SystemWarnings5	Bits	System warning events, item 5 Bit-interpreted See section Alarms and warnings.

Address	Register name	Scale	Description
00289	ActualControlMode	enum	Actual Control Mode: 0: Monitoring, CU 302/202 1: Filling, CU 202 On/Off level control 2: Emptying, CU 202 On/Off level control 3: Pressure Control, CU 202 On/Off pressure control 4: Constant Frequency, CU 302 speed controlled 5: Const. Pressure, CU 302 speed controlled pressure 6: Pump Out, CU 302/202 speed control / On/off control 7: Const. Temp., CU 302 speed controlled temperature 8: Constant Flow, CU 302 speed controlled flow 9: Constant Level, CU 302 speed controlled level
00290	SystemAlarms6	Bits	System alarm events, item 6 Bit-interpreted See section Alarms and warnings.
00291	SystemWarnings6	bitBitss	System warning events, item 6 Bit-interpreted See section Alarms and warnings.

Related information

9.3 Real-time clock

9.5 Alarms and warnings

7.6 Generic scaling of analogue measurements

The following equation presents information that enables a SCADA system to automatically scale the analogue measurements:

$X_{scaled} = Unit \times (X_{register} \times (S_{max} - S_{min}) / 1000 + S_{min})$

The full range is 1000, because the analogue inputs count in 0.1 %.

Address	Register name	Scale	Description
00274	AnalogIn1Min	unit	Minimum sensor range, S_{min}. Counts in associated sensor unit.
00275	AnalogIn1Max		Maximum sensor range, S_{max}. Counts in associated sensor unit.
00276	AnalogIn1Unit	enum	Associated sensor unit. See the table below.
00277	AnalogIn2Min	unit	Minimum sensor range, S_{min}. Counts in associated sensor unit.
00278	AnalogIn2Max		Maximum sensor range, S_{max}. Counts in associated sensor unit.
00279	AnalogIn2Unit	enum	Associated sensor unit. See the table below.
00280	AnalogIn3Min	unit	Minimum sensor range, S_{min}. Counts in associated sensor unit.
00281	AnalogIn3Max		Maximum sensor range, S_{max}. Counts in associated sensor unit.
00282	AnalogIn3Unit	enum	Associated sensor unit. See the table below.
00283	AnalogIn4Min	unit	Minimum sensor range, S_{min}. Counts in associated sensor unit.
00284	AnalogIn4Max		Maximum sensor range, S_{max}. Counts in associated sensor unit.
00285	AnalogIn4Unit	enum	Associated sensor unit. See the table below.
00286	AnalogIn5Min	unit	Minimum sensor range, S_{min}. Counts in associated sensor unit.
00287	AnalogIn5Max		Maximum sensor range, S_{max}. Counts in associated sensor unit.
00288	AnalogIn5Unit	enum	Associated sensor unit. See the table below.

7.7 Modbus RTU scaling

The following table lists the associated units for analog sensor measurement scaling.

Unit index	Description	Unit	Unit index	Description	Unit
1	Current	0.1 A	83	Water level or head	0.01 m
3	Electrical potential difference	0.1 V	84	Kelvin temperature	0.01 K
8	Power	10 W	97	Torque	0.1 Nm
12	Relative value / percentage	0.1 %	98	Revolutions per minutes	rpm
37	Time	s	103	Energy	0.1 kWh
43	Electrical resistance insulation	10 kΩ	105	Frequency	0.01 Hz
51	Pressure	mbar	108	Unix time, seconds since 1/1-1970	s
63	Volume flow	0.1 l/s	110	Temperature difference	0.01 K
64	Volume	0.1 m^3	120	Electrolytic conductivity	µS/cm
74	Specific energy	Wh/m^3	121	Nephelometric turbidity units	0.1 NTU
77	Dimensionless, PH, Cos	0.01			

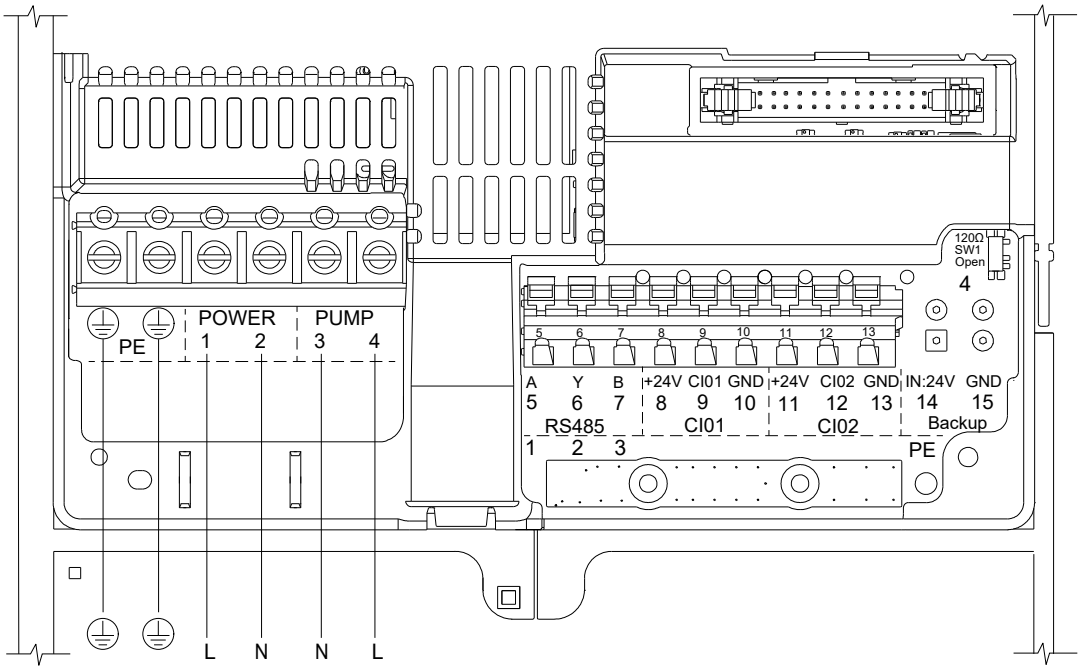
7.8 System data register block

Registers in this block can be read by function codes 0x03 and/or 0x04. It is not possible to write to these registers.
Unless otherwise stated, the data type used for counters and scaled values is always an unsigned integer.
0xFFFF indicates that the data value is not available.

Address	Register name	Scale	Description
00301	SystemWaterLevel	0.01 m	Sensor-measured water level in the system, level sensor needed.
00308	SystemPowerHI	1 W	Power consumption of the system
00309	SystemPowerLO		
00310	SystemEnergyHI	0.1 kWh	Energy consumption of the system
00311	SystemEnergyLO		
00312	SystemEnergyYesterday	0.1 kWh	System energy consumption yesterday
00313	SystemEnergyToday	0.1 kWh	System energy consumption today
00329	SystemOperatingTimeHI	1 minute	Total system operating time (power-on time)
00330	SystemOperatingTimeLO		
00351	UserAnalogInput 1	0.1 %	User-defined measurement, analog input 1 [2)]
00352	UserAnalogInput 2	0.1 %	User-defined measurement, analog input 2 [2)]
00353	UserAnalogInput 3	0.1 %	User-defined measurement, analog input 3 [2)]
00378	ActualSetpoint	See description.	Actual setpoint for SQ pump The scaling is according to Control mode, see 00186 SetSetpoint.
00379	SensorFeedback	See description.	Feedback from control loop sensor for SQ pump The scaling is according to Control mode, see 00186 SetSetpoint.
00380	Pressure	0.001 bar	Pressure, pressure sensor needed
00381	Temperature	0.01 °C	Temperature, temperature sensor needed
00382	UserAnalogOutput1	0.1 %	User-defined analog output 1 [2)]
00383	UserAnalogOutput2	0.1 %	User-defined analog output 2 [2)]
00391	UserDigitalInBlock1	Bits	User digital-inputs bits 15-0 (= DI16-DI1) [2)]
00392	UserDigitalInBlock2	Bits	User digital-inputs bits 31-16 (= DI32-DI17) [2)]
00393	UserDigitalOutputs	Bits	User digital-outputs bits 15-0 (= DO16-DO1) [2)]
00394	UserAnalogInput4	0.1 %	User-defined measurement, analog input 4 [2)]
00395	UserAnalogInput5	0.1 %	User-defined measurement, analog input 5 [2)]

2) See section CU 302/202 terminal mapping.

7.9 CU 302/202 terminal mapping



Terminals of the CU 302/202

Terminal		Address	Register name	Scale	Description
CIO 1	As DI	00391 bit 4	UserDigitalInBlock1 bit 4	Bool	User-configurable digital input 5
	As DO	00393 bit 4	UserDigitalOutputs bit 4	Bool	User-configurable digital output 5
	As AI/PT	00351	UserAnalogInput1	0.1 %	User-configurable analog input 1
	As AO	Future	-	-	-
CIO 2	As DI	00391 bit 4	UserDigitalInBlock1 bit 5	Bool	User-configurable digital input 6
	As DO	00393 bit 5	UserDigitalOutputs bit 5	Bool	User-configurable digital output 6
	As AI/PT	00352	UserAnalogInput2	0.1 %	User-configurable analog input 2
	As AO	Future	-	-	-

7.10 Pump register block

All register values are read-only and 0xFFFF indicates that the data value is not available.
Unless otherwise stated, the data type used for counters and scaled values is always an unsigned integer.

Address	Register name	Scale	Description
00401	PumpStatus Bit 0: Presence	Bool	Presence of the pump: 0: Not present 1: Present
	PumpStatus Bit 1: Running	Bool	Running state of the pump: 0: Not running 1: Running
	PumpStatus Bit 3: Warning	Bool	Warning state of the pump: 0: No warning 1: Warning
	PumpStatus Bit 4: Alarm	Bool	Alarm state of the pump: 0: No alarm 1: Alarm
00402	PumpControlSource	enum	Control source of the pump: 0: Auto 1: Manually by switch 2: Manually via display 3: Remote-controlled by bus
00403	PumpConnectionType	enum	Pump-connection type: 0: Pump connected to a wall-mounted controller or not present 0: Pump connected to a controller or not present 1: Pump connected via pump module
00404	PumpOperatingTimeHI	1 minute	Total operating time
00405	PumpOperatingTimeLO		
00406	PumpTimeToServiceHI	1 minute	Time to next service
00407	PumpTimeToServiceLO		
00408	PumpOperatingTimeYesterday	1 minute	Operating time yesterday
00409	PumpOpratingTimeToday	1 minute	Operating time today
00410	PumpLatestOperatingTime	1 second	Operating time last time it was operated
00411	PumpStartCounterHI	Unscaled	Total number of pump starts
00412	PumpStartCounterLO		
00413	PumpStartCounterYesterday	Unscaled	Total number of pump starts yesterday
00414	PumpStartCounterToday	Unscaled	Total number of pump starts today
00415	PumpStartsPerHour	Unscaled	Number of pump starts within the last hour
00418	PumpCurrent	0.1 A	Motor current
00419	PumpLatestCurrent	0.1 A	Latest Motor current
00420	PumpVoltage	0.1 V	Motor voltage
00423	PumpAlarms1	Bits	See section Alarms and warnings.
00424	PumpAlarms2	Bits	See section Alarms and warnings.
00425	PumpAlarms3	Bits	See section Alarms and warnings.
00426	PumpWarnings1	Bits	See section Alarms and warnings.
00427	PumpWarnings2	Bits	See section Alarms and warnings.
00428	PumpWarnings3	Bits	See section Alarms and warnings.
00431	PumpPowerHI	1 W	Power consumption
00432	PumpPowerLO		
00433	PumpEnergyHI	0.1 kWh	Energy consumption
00434	PumpEnergyLO		
00435	PumpCosPhi	0.01	Motor cosine phi
00436	PumpSpeed	1 rpm	Speed, pump
00437	PumpMotorTemp	0.01 °C	Motor temperature, pump
00441	PumpAlarms4	Bits	See section Alarms and warnings.
00442	PumpWarnings4	Bits	See section Alarms and warnings.
00451	PumpAlarms5	Bits	See section Alarms and warnings.
00452	PumpWarnings5	Bits	See section Alarms and warnings.
00453	PumpAlarms6	Bits	See section Alarms and warnings.
00454	PumpWarnings6	Bits	See section Alarms and warnings.

7.11 Alarm simulation register block

Address	Register name	R/W	Scale	Description
00703	SimulationEventCode	W	enum	Event code to simulate Only supported codes can be used.
00704	SimulationDeviceType	W	enum	Device type to simulate: 0: system 6: pump
00705	SimulationDeviceNo	W	enum	Device number to simulate: 1: pump 1 2: pump 2
00708	SimulationActivate	W	Bool	Activation of simulation features: 0: Deactivate simulation 1: Activate simulation
00709	SimulationActiveCode	R	enum	The active simulation event code

7.12 User register block

Address	Register name	R/W	Scale	Description
00751-00800	UserRegisters	R/W	Unscaled	This area is for device labelling by the user. The user area values are stored in the device and remain after a power-off.

7.13 Clock scheduler

Address	Register name	Scale	Description
05001	SetMonBegin1Hour	1 hour	Monday, begin 1 time per day, hours
05002	SetMonBegin1Min	1 minute	Monday, begin 1 time per day, minute (trigger)
05003	SetMonEnd1Hour	1 hour	Monday, end 1 time per day, hours
05004	SetMonEnd1Min	1 minute	Monday, end 1 time per day, minute (trigger)
05005	SetMonBegin2Hour	1 hour	Monday, begin 2 times per day, hours
05006	SetMonBegin2Min	1 minute	Monday, begin 2 times per day, minute (trigger)
05007	SetMonEnd2Hour	1 hour	Monday, end 2 times per day, hours
05008	SetMonEnd2Min	1 minute	Monday, end 2 times per day, minute (trigger)
05009	SetMonBegin3Hour	1 hour	Monday, begin 3 times per day, hours
05010	SetMonBegin3Min	1 minute	Monday, begin 3 times per day, minute (trigger)
05011	SetMonEnd3Hour	1 hour	Monday, end 3 times per day, hours
05012	SetMonEnd3Min	1 minute	Monday, end 3 times per day, minute (trigger)
05013	SetMonBegin4Hour	1 hour	Monday, begin 4 times per day, hours
05014	SetMonBegin4Min	1 minute	Monday, begin 4 times per day, minute (trigger)
05015	SetMonEnd4Hour	1 hour	Monday, end 4 times per day, hours
05016	SetMonEnd4Min	1 minute	Monday, end 4 times per day, minute (trigger)
05017	SetMonBegin5Hour	1 hour	Monday, begin 5 times per day, hours
05018	SetMonBegin5Min	1 minute	Monday, begin 5 times per day, min (trigger)
05019	SetMonEnd5Hour	1 hour	Monday, end 5 times per day, hours
05020	SetMonEnd5Min	1 minute	Monday, end 5 times per day, min (trigger)
05021-05040	SetTue...	-	Same registers as above but for Tuesday
05041-05060	SetWed...	-	Same registers as above but for Wednesday
05061-05080	SetThu...	-	Same registers as above but for Thursday
05081-05100	SetFri...	-	Same registers as above but for Friday
05101-05120	SetSat...	-	Same registers as above but for Saturday
05121-05140	SetSun...	-	Same registers as above but for Sunday

7.14 Event log register block

The event log contains the latest 40 event entries. Each entry consists of seven registers, containing information about the event.

Address	Register name	Scale	Description
06001	NoOfEventsInLog	Unscaled	Number of events in the event log
06002	EventIDLog1	Unscaled	Event ID for logged event No 1
06003	EventCodeLog1	enum	Event code for logged event No 1
06004	EventSourceLog1	enum	Event source for logged event No 1: 0: System 6: Pump
06005	EventDeviceNo	Unscaled	Device number related to the event or its recognition: 0: No related number 1: Value of related number, pump 1 2: Value of related number, pump 2
06006	EventTypeAndConditionLog1	enum	Event type and condition of logged event No 1: 0: - 1: Alarm condition appearing 2: Alarm condition disappearing 3: Warning condition appearing 4: Warning condition disappearing
06007	EventTimeStampLog1HI	1 second	Seconds since midnight 1 January 1970 (UNIX time)
06008	EventTimeStampLog1LO		
06009-06274	Event log 2…39	-	-
06275	EventIDLog40	Unscaled	Event ID for logged event No 40
06276	EventCodeLog40	enum	Event code for logged event No 40
06277	EventSourceLog40	enum	Event source for logged event No 40
06278	EventDeviceNo	Unscaled	Device number related to the event or its recognition
06279	EventTypeAndConditionLog40	enum	Event type and condition of logged event No 40
06280	EventTimeStampLog40HI	1 second	Seconds since midnight 1 January 1970 (UNIX time)
06281	EventTimeStampLog40LO		

7.15 Reading the event log

The event log has a size of 282 registers containing the latest 40 alarm and warning events. The number of contained event logs can be read from NoOfEventsInLog (register 06001).

Each event is represented as an event record of seven registers:

- EventID
- EventCode
- EventSource
- EventDeviceNo
- EventTypeAndCondition
- EventTimeStampHI
- EventTimeStampLO.

The EventID is a unique tag for the event record. These IDs are incremented successively, corresponding to the succession of the events they represent. The event log can be handled in three ways:

- The complete log, that is, all 40 event records, can be read regularly, and afterwards sorted "new" ones from "old" ones.
- The event ID of the latest record (EventLogLatestID, register 00216) can be read and compared to the event ID of the previously read record to see how many "new" records are generated. Afterwards, only the "new" ones can be read.
- the event log can be cleared with Control.ResetEventLog (register 00101, bit 2) after it is read. Afterwards, the event log contains "new" events only.

The SoftCIM Modbus RTU ensures that logged data are protected against internal updates during the time they are accessed from the Modbus RTU, so that the event log constitutes a time-consistent block (data coherency).

7.16 Data log index register block

This is an index area for the configurable data log. The data log index registers are read-only.
By default, the configurable logs are not set. This can only be done via Grundfos GO.

Address	Register name	Scale	Description
07001	NoOfLogSeries	Unscaled	Number of available log series [0; 64]
07002	LogSeries1ItemNo	Unscaled	Log series 1 item number.
07003	LogSeries1RegAddr	Unscaled	Register start address of log series 1
07004	LogSeries1SamplingTime	1 second	Time period between samples in log series 1
07005	LogSeries1NoOfSamples	Unscaled	Number of samples in log series 1, N_1
07006	LogSeries2ItemNo	Unscaled	Log series 2 item number
07007	LogSeries2RegAddr	Unscaled	Register start address of log series 2
07008	LogSeries2SamplingTime	1 second	Time period between samples in log series 2
07009	LogSeries2NoOfSamples	Unscaled	Number of samples in log series 2, N_2
… [3]	LogSeries#ItemNo	Unscal	Log series # item number
… [3]	LogSeries#RegAddr	Unscaled	Register start address of log series #
… [3]	LogSeries#SamplingTime	1 second	Time period between samples in log series #
… [3]	LogSeries#NoOfSamples	Unscaled	Number of samples in log series #, $N_{\#}$
07254	LogSeriesLItemNo	Unscaled	Log series "L" item number (last series)
07255	LogSeriesLRegAddr	Unscaled	Register start address of log series "L"
07256	LogSeriesLSamplingTime	1 second	Time period between samples in log series "L"
07257	LogSeriesLNoOfSamples	Unscaled	Number of samples in log series "L", N_L
07258	LogSeriesEndMark	Unscaled	End mark to end the index (always 0)

[3] It indicates variable register address.

Related information

9.1 Separation of reads and writes

7.17 Data log series register block

This data area is for the configurable data log series (maximum 64 series). The log data are read-only and have a fixed starting address, so log series 1 always starts at register 07301.

Address	Register name	Scale	Description
07301	LogSeries1ItemNo	Unscaled	Log series 1 item number
07302	LogSeries1SamplingTime	1 second	Time period between samples in log series 1, configurable for CU 302/202 via Grundfos GO
07303	LogSeries1NoOfSamples	Unscaled	Number of samples in log series 1, N_1, configurable for CU 302/202 via Grundfos GO
07304	LogSeries1TimeStampHI	1 second	Log series 1 Unix time stamp Subtracting "Sampling time" gives the time stamp of sample No 2 in this series, etc.
07305	LogSeries1TimeStampLO		
07306	LogSeries1Sample1	-	Value of log series 1 sample No 1.
… [4]	LogSeries1SampleN1	-	Value of log series 1 sample No N_1 (last sample in series)
… [4]	LogSeries2ItemNo	-	Log series 2 item number
… [4]	LogSeries2SamplingTime	-	Time period between samples in log series 2, configurable for CU 302/202 via Grundfos GO
… [4]	LogSeries2TimeStampHI	-	Log series 2 Unix time stamp Subtracting "Sampling time" gives the time stamp of sample No 2 in this series, etc.
… [4]	LogSeries2TimeStampLO		
… [4]	LogSeries2Sample1	-	Value of log series 2 sample No 1
… [4]	…	-	-
… [4]	LogSeries2SampleN2	-	Value of log series 2 sample No N_2 (last sample in series)
… [4]	LogSeries#ItemNo	-	Log series # item number
… [4]	LogSeries#SamplingTime	-	Time period between samples in log series #
… [4]	LogSeries#NoOfSamples	-	Number of samples in log series #, $N_{\#}$
… [4]	LogSeries#TimeStampHI	-	Log series # Unix time stamp Subtracting "Sampling time" gives the time stamp of sample No 2 in this series, etc.
… [4]	LogSeries#TimeStampLO		
… [4]	LogSeries#Sample1	-	Value of log series # sample No 1
… [4]	…	-	-
… [4]	LogSeries#SampleN#	-	Value of log series # sample No $N_{\#}$ (last sample in series)
… [4]	LogSeriesLItemNo	-	Log series "L" item number

Address	Register name	Scale	Description
…[4]	LogSeriesLSamplingTime	-	Time period between samples in log series "L"
…[4]	LogSeriesLNoOfSamples	-	Number of samples in log series "L", N_L
…[4]	LogSeriesLTimeStampHI	-	Log series "L" Unix time stamp Subtracting "Sampling time" gives the time stamp of sample No 2 in this series, etc.
…[4]	LogSeriesLTimeStampLO		
…[4]	LogSeriesLSample1	-	Value of log series "L" sample No 1
…[4]	…	-	-
…[4]	LogSeriesLSampleNL	-	Value of log series "L" sample No N_L (last sample in series)

4) It indicates variable register address.

Related information

6. Modbus RTU function code overview

7.18 Reading the configurable data log series

LogSeriesItemNo

The log series item numbers are shown in the table below. Note that the scaling of the registers with the present values is identical to the scaling of the logged data values, except for power values where the scaling has been changed from [1 W] to [10 W] to fit into 16 bit.

System

Log series item No	Log item register	Scale
0100	Pulse flow rate	0.1 l/s
0101	Pulse flow rate reverse	
0102	System pulse flow rate	
0200	LevelAI1	0.01 m
0201	FlowAI1	0.1 l/s
0202	PressureAI1	0.001 bar
0203	CurrentAI1	0.1 A
0204	PercentageAI1	0.1 %
0205	TemperatureAI1	0.01 K
0206	ConductivityAI1	µS/cm
0207	TurbidityAI1	0.1 NTU
0208	PHmeasureAI1	0.01
0250-0258	Same registers as above but for AI2	
0300-0308	Same registers as above but for AI3	
0350-0358	Same registers as above but for AI4	
0400-0408	Same registers as above but for AI5	
0550	Digital input 1, DI1	Bool
0599	Digital input 1, DI49	
0600	Digital output 1, DO1	
0649	Digital output 1, DO49	

Pump

Log series item No	Log item register	Scale
1002	Pump current	0.1 A
1008	Pump power	10 W
1016	Pump speed	1 rpm

8. Modbus RTU commissioning, step-by-step guide

1. Use the Grundfos GO app menu Settings > Bus > RS485 to configure the SoftCIM Modbus RTU port.

Protocol:	Select the Modbus RTU.
Address:	Select the address as a number in the interval [1; 247]. The address must be unique on the Modbus RTU network.
Baud rate:	Choose from 1200 bit/s, 2400 bit/s, 4800 bit/s, 9600 bit/s, 19200 bit/s or 38400 bit/s. This must match the baud rate of the Modbus RTU master.
Parity:	Choose from Even, Odd or None. This must match the baud rate of the Modbus RTU master.
Stop bits:	Choose from 1 or 2 stop bits. This must match the baud rate of the Modbus RTU master.
Watchdog:	Select between disable or a timeout time in the interval [5; 3600] s. If the watchdog is enabled, it monitors the communication with the CU 302/202 and if the communication breaks for a time longer than the selected watchdog timeout time, the SoftCIM forces the pump to stop (PumpControl 00103 set to 2=Force stop). When communication is reestablished, the SoftCIM automatically cancels the forced stop condition (PumpControl 00103 set to 0=Auto).

2. Connect the RS485 cable from the Modbus RTU network to the A, Y, B terminals of the CU 302/202. See section Modbus RTU setup.
3. If the controller is an “end device” on the Modbus RTU network, activate the line termination. See section Modbus RTU setup.
4. The CU 302/202 is now ready to be accessed via the Modbus RTU network. Select Settings > Bus > RS485 in the Grundfos GO app menu where the communication state of the SoftCIM can be seen:

No communication	The CU 302/202 has not received any Modbus telegrams for 10 s.
Communication successful	The CU 302/202 has received at least one telegram within the last 10 s, and the error rate is below 10 %.
Fault in communication	The CU 302/202 has received telegrams with a CRC error rate above 10 %. The error rate must in this situation go below 1 % before “Communication successful” is indicated.

When setting communication parameters via the Grundfos GO app, only legal are allowed by the app, that is, selecting values outside the legal range is not possible. However, if the communication parameters are configured from Modbus itself via registers 00003 SoftwareDefinedModbusAddr, 00004 SoftwareDefinedBitRate, 00009 SoftwareDefinedParity and 00010 SoftwareDefinedStopBit, illegal settings are possible and SoftCIM behavior will be as listed below:

Illegal baud rate:	The SoftCIM sets the baud rate to default value **19200 bit/s**.
Illegal parity:	The SoftCIM sets the parity to default value **Even**.
Illegal stop bit setting:	The SoftCIM sets the number of stop bits to default value **1**.
Illegal watchdog setting:	If value the value is higher than 3600 s, the SoftCIM sets timeout value to 3600s. If the value is 1-4 s, the SoftCIM sets it to 5 s.
Illegal address setting:	The SoftCIM does not change the address value but keeps the current value.

9. Detailed descriptions of functionality

9.1 Separation of reads and writes

The functional profile supports Modbus the RTU holding registers, which means that registers can be both read and written. By default, most of the register values meant for writing by the Modbus RTU master are also updated by the CU 302/202 itself to reflect the actual value used by the CU 302/202.

Differences arise due to internal value limitations and some settings and control values that can have other sources, for example, service port and display, that can change the actual values. To avoid such conflicts, the profile has the option of read and write separation with the option Config.ReadWriteSeparation (register 00006, bit 1: 1). Using this option means that all writing registers [W] use an associated reading location [R] where the resulting status of the writing can always be verified. In this case, reading and writing never take place via the same registers, Event Simulation registers being the only exceptions. Reading a writing register only means reading what has previously been written to the Modbus RTU interface, and in the normally this will not reflect what value the CU 302/202 control unit is actually using.

Example 1

This example presents setting and reading overflow level with ReadWriteSeparation disabled (default).

The user writes a new value to SetHighLevel (register 00122).

The resulting high level is then read from SetHighLevel (register 00122).

ReadWriteSeparation is disabled by default.

Example 2

This example presents setting and reading high level with ReadWriteSeparation enabled.

The user writes a new value to SetHIghLevel (register 00122).

The resulting high level is then read from HighLevel (register 00241), hence separating reads from writes.

9.2 Control bit acknowledgement

All control bits in the functional profile are triggered on the rising edge of a bit. The system supports two different approaches to control-bit acknowledgement: auto and manual.

The AutoAckControlBits setting (register 00005) sets the desired approach:

0: Disabled

Control bits are not automatically lowered when accepted by the device. The user must lower the control bit manually before the control bit can be triggered again. When a control bit is accepted by the device, the corresponding control-bit acknowledgement is be raised, and the user can lower the control bit.

1: Enabled

Control bits are automatically lowered when accepted by the device, so the user does not have to lower it manually (default).

Example 1

This example presents the ResetAlarm with auto-acknowledgement enabled (default).

The user sets the Control.ResetAlarm control-bit (register 00101, bit 0) to 1 to reset an alarm. When accepted by the slave, the Control.ResetAlarm control-bit is automatically reset to 0. The user can then set the Control.ResetAlarm control-bit to 1 again to reset an alarm again.

AutoAckEnabled is the default setting.

Example 2

his example presents the ResetAlarm with auto-acknowledgement disabled.

The user sets the Control.ResetAlarm control-bit (register 00101, bit 0) to 1 to reset an alarm. When accepted by the slave, the AcknowledgeRegister.AckResetAlarm (register 00201, bit 0) is set to 1, and the Control.ResetAlarm is still 1. The user must then manually set Control.ResetAlarm to 0 before another alarm can be reset. When doing so, the AcknowledgeRegister.AckResetAlarm will revert to 0 as well.

9.3 Real-time clock

The real-time clock can be set and read from the controller in two ways: Unix format or standard format.

All time stamps in the event log and in the data log are also in Unix time format. Read the time with UNIXRealTimeClockHI (register 00228) and UNIXRealTimeClockLO (register 00229), or set a new time with SetRealTimeClockHI (register 00112) and SetRealTimeClockLO (register 00113). The new time is activated in the CU 302/202 when writing the LO-order register. We recommend writing the HI/LO registers in the same telegram.

9.3.1 Standard format

In the standard format, there are registers for specifying second, minute, hour, day, month and year (year, offset by 2000) in a human-readable way. With registers from 00230 to 00235, the actual values can be read, and with registers 00114 to 00119, new values can be set. The new values are activated when writing the value "1" to SetRtc (register 00120, bit 0).

9.4 Event simulation

It is possible to simulate alarm/warning events by writing appropriate values to the following registers:

- SimulationEventCode (register 00703)
- SimulationDeviceType (register 00704)
- SimulationDeviceNo (register 00705).

Afterwards, it is possible to trigger the simulated event via SimulationActivate (register 00708, bit 0). The event recording takes place as if the event was real, but the system operation is not influenced.

The SimulationActiveCode (register 00709) can be used for checking if event simulation is active. If the value is 0, there is no active event simulation.

By clearing the SimulationActivate (register 00708, bit 0) control bit, the simulated event is cancelled.

Event simulation procedure

- Write a valid event code, see section Alarm simulation register block to SimulationEventCode (register 00703).
- Write a device type to SimulationDeviceType (register 00704), 0: system, 6: pump.
- Write a device number to SimulationDeviceNo (register 00705). 1: pump 1.
- Activate the alarm simulation with the above settings by writing 1 to SimulationActivate (register 00708, bit 0).

Related information

7.11 Alarm simulation register block

9.5 Alarms and warnings

These registers reflect the actual alarm and warning conditions of the system or the pump. Alarms and warnings that have acknowledgement type "Auto-ack" are cleared automatically when normal conditions are restored. Alarms and warnings that have acknowledgement type "Manual-ack" require a Control.ResetAlarm command to be cleared.

Warning and alarm registers use the same bit interpretation.

System alarms 1 (register 00210) and System warnings 1 (register 00213)

Description	Data item	Code.Subcode	Event source
High level	SystemAlarms/Warnings1.1	191	System
Dry running alarm	SystemAlarms/Warnings1.3	57	System
Float switch sequence inconsistency	SystemAlarms/Warnings1.5	205	CU 302/202
Communication fault, I/O module	SystemAlarms/Warnings1.11	226	Pump module

SystemAlarms2 (register 00211) and SystemWarnings2 (register 00214)

Description	Data item	Code.Subcode	Event source
Battery fault	SystemAlarms/Warnings2.0	248	Battery
AI sensor 1 signal fault	SystemAlarms/Warnings2.13	165	AI1 sensor

SystemAlarms3 (register 00212) and SystemWarnings3 (register 00215)

Description	Data item	Code.Subcode	Event source
Water on floor warning	SystemAlarms/Warnings3.1	229	System
External fault signal	SystemAlarms/Warnings3.10	3	System
Intrusion (door opened)	SystemAlarms/Warnings3.12	117	System

SystemAlarms5 (register 00272) and SystemWarnings5 (register 00273)

Description	Data item	Code.Subcode	Event source
External warning signal	SystemAlarms/Warnings5.1	46	System
Real time clock out of order	SystemAlarms/Warnings5.3	157	CU 302/202
Start or stop level setting invalid or missing	SystemAlarms/Warnings5.5	25.1009	CU 302/202
Analog level sensor not configured	SystemAlarms/Warnings5.6	25.1010	CU 302/202
Duplicate switch setting	SystemAlarms/Warnings5.7	25.1011	CU 302/202
Operating on battery backup	SystemAlarms/Warnings5.8	142	Mains
PT motor temperature measurement configured, but disabled	SystemAlarms/Warnings5.9	25.1020	CU 302/202

SystemAlarms6 (register 00290) and SystemWarnings6 (register 00291)

Description	Data item	Code.Subcode	Event source
Setup Conflict. Illegal sensor/switch conf	SystemAlarms/Warnings6.0	25.1001	CU 302/202
Setup Conflict. Level control settings conflict	SystemAlarms/Warnings6.1	25.1005	CU 302/202
Setup Conflict. Control/ApplicationMode	SystemAlarms/Warnings6.2	25.1014	CU 302/202
No flow. Flow switch shows no flow	SystemAlarms/Warnings6.3	59	System
Battery low	SystemAlarms/Warnings6.4	28	System
Limit 1 exceeded	SystemAlarms/Warnings6.5	133.1001	System
Limit 2 exceeded	SystemAlarms/Warnings6.6	133.1002	System
Pump Out within the set Pumping Time failed	SystemAlarms/Warnings6.7	200.1001	System
Pressure build up within set time failed	SystemAlarms/Warnings6.8	200.1002	System
Water leakage detected	SystemAlarms/Warnings6.9	207	System
Low input power, solar	SystemAlarms/Warnings6.10	60	System
Overpressure	SystemAlarms/Warnings6.11	210	System
Underpressure. Could not pressurize system within time.	SystemAlarms/Warnings6.12	211	System
Pressure setting is below low-pressure alarm/stop level	SystemAlarms/Warnings6.13	25.1022	CU 302/202
Setup conflict. Configured sensor conflicts with attached sensor	SystemAlarms/Warnings6.14	25.1004	CU 302/202

PumpAlarms1 (register 00423) and PumpWarnings1 (register 00426)

Description	Data item	Code.Subcode	Event source
Motor voltage low	PumpAlarms/Warnings1.7	40	Mains
Motor voltage high	PumpAlarms/Warnings1.8	32	Mains
Motor overload	PumpAlarms/Warnings1.10	48	Pump/motor

PumpAlarms2 (register 00424) and PumpWarnings2 (register 00427)

Description	Data item	Code.Subcode	Event source
Motor service time exceeded	PumpAlarms/Warnings2.8	12	Pump/motor

PumpAlarms3 (register 00425) and PumpWarnings3 (register 00428)

Description	Data item	Code.Subcode	Event source
Pump communication fault	PumpAlarms/Warnings3.8	10	Pump/motor

PumpAlarms4 (register 00441) and PumpWarnings3 (register 00442)

Description	Data item	Code.Subcode	Event source
Dry-running	PumpAlarms/Warnings4.10	57	Pump/motor
PumpBlocked	PumpAlarms/Warnings4.13	51	Pump/motor

PumpAlarms5 (register 00451) and PumpWarnings5 (register 00452)

Description	Data item	Code.Subcode	Event source
Overvoltage detected by inrush circuit	PumpAlarms/Warnings5.0	32.1001	Pump/motor
Overvoltage, hardware shutdown, DPFC	PumpAlarms/Warnings5.1	32.1002	Pump/motor
Overvoltage, DC link voltage too high	PumpAlarms/Warnings5.2	32.1003	Pump/motor
Blocked motor, rotor/stator out of sync. in closed loop opr.	PumpAlarms/Warnings5.3	51.1001	Pump/motor
Blocked motor, rotor/stator out of sync. during start	PumpAlarms/Warnings5.4	51.1002	Pump/motor
Blocked motor, running min speed due to derating function	PumpAlarms/Warnings5.5	51.1003	Pump/motor
Dry running detection based on pump power measurement	PumpAlarms/Warnings5.6	57.1002	Pump/motor
Dry running detection based on level measurement	PumpAlarms/Warnings5.7	57.1003	Pump/motor
Dry running detection based on inlet press. measurement	PumpAlarms/Warnings5.8	57.1004	Pump/motor
Dry running detection based on dedicated dry run signal	PumpAlarms/Warnings5.9	57.1005	Pump/motor
Dry running detection with dry run sensor integrated in pump	PumpAlarms/Warnings5.10	57.1006	Pump/motor
Overtemperature, internal frequency c13onverter module	PumpAlarms/Warnings5.11	67	Pump/motor

PumpAlarms6 (register 00453) and PumpWarnings5 (register 00454)

Description	Data item	Code.Subcode	Event source
Hardware shutdown	PumpAlarms/Warnings6.0	73	Pump/motor
Hardware shutdown, DC link current too high during stopping	PumpAlarms/Warnings6.1	73.1001	Pump/motor
Hardware shutdown, A/D converter MUX test failed	PumpAlarms/Warnings6.2	73.1002	Pump/motor
Hardware shutdown, DC link current too high in cl. Operation	PumpAlarms/Warnings6.3	73.1003	Pump/motor
Hardware shutdown, fault in motor current measurement	PumpAlarms/Warnings6.4	73.1004	Pump/motor
Hardware shutdown, impossible to brake motor before start	PumpAlarms/Warnings6.5	73.1005	Pump/motor

10. Modbus RTU telegram examples

The Modbus RTU 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 RTU telegram.

10.1 Modbus RTU 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 followed by a one-byte function code. 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 sum.

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

10.2 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 1-16 are addressed as 0-15.

The following is an example of a request from the master to a slave. Note that CRC fields are not shown.

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.

The following is an example of a response from a slave to the master. Note that CRC fields are not shown.

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.

10.3 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.

The following is an example of a request from the master to a slave. Note that CRC fields are not shown.

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.

The following is an example of response from a slave to the master. Note that CRC fields are not shown.

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.

10.4 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 has been written.

The following is an example of a request from the master to a slave. Note that CRC fields are not shown.

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.

The following is an example of a response from a slave to the master. Note that CRC fields are not shown.

Field	Value
Address	0x01
Function code	0x06
Address HI	0x10

Field	Value
Address LO	0x00
Value HI	0xAF
Value LO	0xFE

The response is an echo of the request.

10.5 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.

The following is an example of a request from the master to a slave. Note that CRC fields are not shown.

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.

The following is an example of a response from a slave to the master. Note that CRC fields are not shown.

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.

10.6 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 RTU communication.
0x01	Restart communications All communication counters are cleared and the device is restarted.
0x02	Return diagnostics register It returns the 16-bit diagnostics register. See section Diagnostics register interpretation.
0x04	Force listen only It 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 It clears all counters and the diagnostics register. These are also cleared on power-up and restart.
0x0B	Return bus message count It returns the number of messages detected by the slave.
0x0C	Return bus CRC error count It returns the number of CRC errors in the slave.
0x0D	Return bus exception count It returns the number of Modbus RTU exception responses that the slave has transmitted.
0x0E	Return slave message count It returns the number of messages that the slave has processed.
0x0F	Return slave no response count It returns the number of messages for which the slave has sent no response.

Related information

10.7 Diagnostics register interpretation

10.7 Diagnostics register interpretation

The diagnostics register is interpreted as follows:

Bit	Description
0	RESERVED
1	RESERVED
2	RESERVED
3	RESERVED
4	Using software-defined Modbus RTU 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 that the statement in the description is true, unless otherwise specified. The diagnostics register is read using function code 0x08 and subcode 0x02.

11. Modbus RTU telegram application examples

The Modbus RTU 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 RTU telegram.

11.1 Diagnostics: return query data

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

In the example, slave address 0x01 is used.

The example shows a request from the master to a slave. Note that CRC fields are not shown.

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

The following is an example of a response from a slave to the master. Note that CRC fields are not shown.

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 section Fault finding.

11.2 Reading the system water level

This section shows how to read and interpret the water level of the system.

In the example, slave address 0x01 is used.

The example shows a request from the master to a slave. Note that CRC fields are not shown.

Field	Value	Description
Slave address	0x01	-
Function code	0x04	Read input registers
Start address HI	0x01	Start register (00301) = 0x012D
Start address LO	0x2C	
Quantity HI	0x00	Number of registers = 0x0001
Quantity LO	0x01	

The following is an example of a response from a slave to the master. Note that CRC fields are not shown.

Field	Value	Description
Slave address	0x01	-
Function code	0x04	Read input registers
Byte count	0x02	2 bytes follow
00301 HI	0x00	System water level = 0x00DC (220)
00301 LO	0xDC	

A system water-level value of 220 [0.01 m] equals a water level of 2.20 m.

If there is no response from the CU 302/202, see section Fault finding the product.

11.3 Reading the system alarms

This section shows how to read and interpret three of the alarm registers of the system. The system alarms start at Modbus RTU register address 00210.

In the example, slave address 0x01 is used.

The example shows a request from the master to a slave. Note that CRC fields are not shown.

Field	Value	Description
Slave address	0x01	-
Function code	0x04	Read input registers
Start address HI	0x00	Start register (00210): 0x00D2
Start address LO	0xD1	
Quantity HI	0x00	Number of registers: 0x0003
Quantity LO	0x03	

The following is an example of a response from a slave to the master. Note that CRC fields are not shown.

Field	Value	Description
Slave address	0x01	-
Function code	0x04	Read input registers
Byte count	0x06	6 bytes follow
00210 HI	0x00	System alarms 1
00210 LO	0x08	
00211 HI	0x00	System alarms 2
00211 LO	0x00	
00212 HI	0x00	System alarms 3
00212 LO	0x00	

If there is no response from the slave, see section Fault finding.

When reading the three system alarm registers, the following data becomes available:

System alarms 1: 0b 0000 0000 0000 1000

System alarms 2: 0b 0000 0000 0000 0000

System alarms 3: 0b 0000 0000 0000 0000.

As seen from the alarms table, the bit for dry-running alarm is set in System alarms 1.

12. Fault finding

12.1 The CU 302/202 does not respond to telegrams.

Cause	Remedy
There are faults in the network wiring or faults in the Modbus RTU parameter settings.	• Check if the wire connections AYB are correct, and if A and B are not reversed. • Check if the cable screen is connected to the screen clamps and the CU 302/202 is properly connected to earth. • Check if the Modbus RTU network is terminated correctly. • Check if there is no address conflict between connected devices. • Confirm with Grundfos GO that the Modbus RTU protocol, and not GENIbus, has been selected. • Confirm with Grundfos GO that the Modbus RTU parameter settings are correct: - communication speed setting - parity setting - stop bit setting. • Check the Address setting with Grundfos GO, and make sure all devices on the network have unique addresses. • Voltage potential problems with long cabled systems, particularly if different earthing systems are involved, can in rare cases necessitate a GND wire. Use, for example, a double twisted pair cable.

12.2 The CU 302/202 responds with the exception response 0x01: "Invalid function".

Cause	Remedy
Request telegrams from master use an illegal function code.	• Check if master telegrams only use the supported function codes, see section Modbus RTU function code overview.

12.3 The CU 302/202 responds with the exception response 0x02: "Invalid data address".

Cause	Remedy
The master is trying to read or write an invalid register 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 causes problems if some of the registers in the block are not supported.	• Find out what registers cause the exception and avoid reading them.

12.4 The CU 302/202 returns register value 0xFFFF (65535).

Cause	Remedy
A data value of 0xFFFF does not necessarily indicate an error condition. It only means that the value is unavailable from the connected Grundfos product.	• If the value is based on a sensor reading, this is an indication that the sensor measurement does not work. Check the sensor setup and compare with the Grundfos GO reading of the value. • Some parameters are closely related to specific Control Modes and might not be available in other Control Modes. • Fault conditions in the pumping system might result in some parameters being unavailable. Normally, there will be an associated alarm/warning indication.

12.5 The CU 302/202 returns strange register values.

Cause	Remedy
It is likely that the master is not requesting data from the correct registers or not interpreting the values correctly.	• Check if telegrams comply with the Modbus RTU “Minus one rule” stating that a register or a register block at address X is addressed in telegrams as X-1. • Check if the correct functional profile manual is used and not the manual for a similar Grundfos product. • 32-bit values are implemented in consecutive registers named ‘HI’ for high order part and ‘LO’ for low order part. Both registers must be read and the resulting 32-bit value can be calculated as follows: Value32 = Value16HI × 65536 + Value16LO

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