TPEM

Fieldbus Interface Modbus

EN
Valid from Release 1.7.2
2022-09
Competence level CL 1

This document is a part of the operating manual in accordance with Machinery Directive 2006/42/EC.
This is a translation of the German original. All translations are based on the German original.

Technical modifications required to improve our products are reserved with regard to specification data and other technical information contained in the document. No parts of this document may be reproduced in any form or by any means without the written approval of the manufacturer.

The document contains information that is necessary for maintenance and repair work on the product. When carrying out the work listed in the maintenance schedule, only original parts or parts and operating media approved by the manufacturer may be used.

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1 Information about this manual

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1.1 Introduction

1.1.1 Target audience

The document is aimed at authorized specialist personnel with the competence level 1 (CL1). Only authorized specialist personnel may perform the described activities.

For further information on the requirements and qualifications of the authorized specialist personnel, see

- Operating Manual ⇒ General ⇒ Safety regulations
  - Personnel - Qualifications and Duties

1.1.2 Validity

The document is valid for the TPEM system from the release 1.7.2.

This document is part of a commission-specific documentation, which consists of two parts:

- Interface Description: general part. Specification of the Interface and Explanation of the Modbus Functionality in the TPEM system
- Commission-specific Part: Illustration of Commission-specific Telegram Data of the Genset and the Periphery

Note

This interface description is only complete in conjunction with the respective commission-specific part.

The document is drafted in German. In other languages, the document is a translation of the original manual.

1.1.3 Storage

This document is a component of the product. Keep the document in the immediate vicinity of the product. The document must be accessible at any time.

1.1.4 Other applicable documents

The end customer documentation supplied includes a large number of documents. This document is a component of the end customer documentation and describes the product.

The end customer documentation includes the following documents:

- Power plants layout - Planning notes and assembly notes
- Safety regulations
- Operating media specifications
- Protocols, specifications, certificates
- Technical drawings
- Wiring diagrams and circuit diagrams
- P&I diagram
- Component documentation

  - Assembly notes
  - Operating Manual
  - Maintenance information
  - Work instructions
- Spare parts catalog

1.1.5 Handling

The notes and descriptions given in the document enable safe and efficient handling of the product. Observe and comply with all warnings, safety notes and instructions for handling in order to work safely on the product.

In the document, illustrations assist in basic understanding and may deviate from the actual design.

1.1.6 Operator obligations

The operator must observe and ensure the following points so that the product functions without impairment:

- Have all activities on the product performed in accordance with the applicable standards and specifications
- Determine the responsibilities for operation, servicing and troubleshooting
- Inform the authorized specialist personnel of possible dangers that may arise from handling the product
- Ensure that the authorized specialist personnel have read and understood the operating manual

1.1.7 Symbols used

Symbols are used in this document so that the authorized specialist personnel can quickly recognize issues and clearly categorize them. Warnings are marked with symbols.

For necessary information on the symbols used, see

- Operating Manual ⇒ General ⇒ Safety regulations
  - Signs and symbols

1.2 Legal information, limitations of liability, exclusions of liability

1.2.1 Limitations of liability

In this document, all information and notes have been compiled taking the relevant standards and specifications for the product and the state of the art technology into account.

The manufacturer assumes no liability for damage resulting from the following causes:

- Non-observance of the operating manual
- Non-intended use
- Deployment of unauthorized specialist personnel
- Unauthorized conversions
- Technical alterations
- Use of unapproved spare parts or attachments
- Use of unapproved operating media

The actual scope of delivery may differ under the following conditions:

- Special versions
- Utilization of additional order options
- Due to the latest technical modifications

The regulations apply in the following order:

1. Obligations agreed in the delivery agreement
2. Terms and conditions of the manufacturer for the sales and delivery of new engines, new plants and original parts in the current version
3. Legal provisions valid when the contract was concluded

The right for the manufacturer to undertake technical alterations to improve the performance characteristics and further development is reserved.

1.2.2 Modbus exclusions of liability

Aggregate data can be read out via the Modbus interface and control functions can also be carried out via superior control. These functions are identical for Modbus RTU and Modbus TCP.

The Modbus communication protocol is a protocol widely used in the energy sector.

The Modbus communication protocol is not protected (in the sense of IT/OT* security) and therefore represents an exploitable vulnerability for a potential attacker when used or in connection with the Modbus interface. An information and/or data security incident may result.

The customer must secure their IT/OT infrastructure in accordance with the recognized codes of practice.

* IT (Information technology), OT (Operational technology)

Note

The security of the IT/OT infrastructure beyond the (physical) Modbus interface is outside the responsibility or influence of the manufacturer.

The security and protection of this IT/OT infrastructure beyond the Modbus interface is therefore the sole responsibility of the customer.

By activating and/or using this Modbus interface and connecting to the genset via this Modbus interface, the customer expressly agrees to assume full responsibility and liability for the Modbus information and data security.

The manufacturer is not liable for damages or costs of any kind arising from an information and/or data security incident using or in connection with the Modbus interface.

1.2.3 Copyright

2 Safety

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2.1 Safety regulations

Observe the applicable safety regulations for operation, maintenance and servicing. Observe and comply with all instructions for handling and safety notes given in this document. Otherwise, substantial hazards may arise.

The product is used in the commercial sector. The operator is subject to the legal obligations for health and safety at work.

The operator must comply with the following for the product's and overall plant's area of application:

- Safety notes in this document
- Safety regulations
- Accident prevention regulations
- Environmental protection specifications
- General rules on health and safety at work
- Risk assessment of the operator
- Directives and ordinances on operational safety

Directives, ordinances and regulations are available from trade associations or specialist dealers.

For necessary information on the safety regulations, see

- Operating Manual ⇒ General ⇒ Safety regulations
  - Safety and Product Information Specification

2.2 Intended use

The Modbus interface is a serial interface for client/server communication.

It is used for the communication of the TPEM system with a superior plant control system via the Modbus protocol. The superior plant control uses commands in the form of function codes to request e.g. data and measured values that are recorded by the TPEM system.

Risk of destruction of components

The operation of a TPEM system requires comprehensive knowledge of the structure, function and operating method of the entire plant. Improper interventions can put safe operation of the plant at risk or can cause damage to the plant.
Thus, as a matter of principle, only competent and appropriately trained personnel may be tasked with the installation and operation of TPEM systems.

3 Specification

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3.1 Modbus RTU physical interface

- Transmission medium: RS-485 in Bus Topology, half duplex
- Cable: 2-wire, twisted, GND, shielding, terminating resistor
- Connection: Terminal Block in TPEM Control Cabinet,
- Terminal allocation: See commission-specific circuit diagram
- Baud rate: ⇒ parameter `20530011 Baud rate`
- Serial transmission mode: RTU
- Default parity mode: ⇒ parameter `20530033 Parity`
- Address: ⇒ parameter `20530022 Slave address`

Parameters

- `20530079 Protocol type write mode`
- `20530040 Protocol type`
- `20530011 Baud rate`
- `20530033 Parity`
- `20530022 Slave address`

For further information on the parameters, see

- Separate Operating Manual ⇒ TPEM Parameter description ⇒ General ⇒ Superior control

For detailed information, see

- https://modbus.org/docs/Modbus_over_serial_line_V1_02.pdf

3.2 Modbus TCP physical interface

- Transmission medium: 10/100BASE TX
- Cable: min CAT5 twisted pair
- Plug-in connectors: the installation cable can be connected by field-terminable plug-in connectors (manufacturers e.g. Harting, Metz Connect, Phoenix Contact, Tyco Electronics)
- Connection: RJ45 for direct connection to Ethernet transfer module via 1:1 connection to switch or router

For the connection of the TPEM system to a superordinate control center via Ethernet, proper equipotential bonding and correct installation of the network cabling are mandatory. In heavily disturbed environments, additional interference suppression measures (e.g. sheath current chokes, folding ferrites) or an optical data transfer may be required.

Parameters

- `20530079 Protocol type write mode`
- `20530040 Protocol type`
- `20530054 IP address`
- `20530065 Subnet mask`
- `20530087 Maximum number of connections`
- `20530098 Device address`

For further information on the parameters, see

- Separate Operating Manual ⇒ TPEM Parameter description ⇒ General ⇒ Superior control

For detailed information, see

- https://modbus.org/docs/Modbus_Messaging_Implementation_Guide_V1_0b.pdf

4 Modbus functionality

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4.1 Modbus information

For detailed information about the Modbus functions, see

- https://www.modbus.org/

4.2 Modbus protocol, client/server communication

The Modbus protocol is a communication protocol that is based on client/server architecture. The bus consists of one client and one or several servers. The communication is controlled exclusively via the client, while the server executes instructions.

Modbus RTU (Remote Terminal Unit) represents a specific data transfer operation mode. The data is transferred serially via a two-wire line.

With Modbus TCP, TCP/IP packets are used to transfer data.

Incoming TCP/IP packets are waited on for a maximum of 60 seconds, after which the connection is terminated by the TPEM system (timeout).

A data exchange with TPEM via Modbus requires the Unicast communication mechanism (question/answer (polling)). The client sends a request telegram to a desired server and waits for the server to send a reply telegram.

In a Modbus architecture, the TPEM system always acts as a server, while the superior plant control is the client.

4.3 Failure of Communication - Exception codes

The server transmits an exception code to the client if it cannot execute a command or cannot answer a request. In the exception code, the client receives the encoded cause for the communication failure.

Supported exception codes:

Code*	Name	Description
01H	Unauthorized function	The function code in the request is an unauthorized action for the server.
02H	Unauthorized Data address	In the requested address area, one or more addresses are unauthorized or unknown to the server.
03H	Unauthorized data value	A value in the request data field is an unauthorized value for the server.
04H	Device error	An error occurred when processing the message. The request telegram may not fulfil the Modbus specification.
0BH	Gateway Target Device does not reply	Internal data server has not delivered a value to at least one valid address.

* H: Code in hexadecimal representation

4.4 Data model Separate Register

TPEM uses the following separate register types for access to different data types:

Register type	Object type	Function in TPEM System
Coils	Bit	Acknowledging events by writing a 1
Discrete inputs	Bit	Digital signals and events
Input registers	UINT	2-byte signal values from module
Holding registers	UINT	2-byte default values on the module

The address area used per register of potential 65536 data word addresses or bit addresses per register can be taken from the commission-specific data word list.

4.5 Supported Modbus functions

The Modbus RTU interface of the TPEM system supports the following functions:

Function code*	Function	Use
01 (01H)	Read Coils	Reading out the acknowledgement status of events.
02 (02H)	Read DiscreteInputs	Reading digital signal values or event status.
03 (03H)	Read HoldingRegisters	Reading out the UINT preset values sent to TPEM
04 (04H)	Read InputRegisters	Reading out UINT signal values from TPEM
05 (05H)	Write SingleCoil	Acknowledging an event (value: 1)
06 (06H)	Write SingleRegister	Send UINT preset value to TPEM.
15 (0FH)	Write MultipleCoils	Setting the acknowledgement status of a sequence of events.
16 (10H)	Write MultipleRegisters	Sending a sequence of preset values to TPEM.

* Function code in decimal and (H) hexadecimal representation

Reading a sequence of register addresses

For undefined addresses, Exceptions Code 02H appears.

Writing a sequence of register addresses

For values at undefined addresses, Exceptions Code 03H appears.

4.6 Encoding

UINT data are transferred in big-endian byte order.

5 Modbus functionality TPEM system

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5.1 Power demand

The TPEM System distinguishes four demand types for the genset. In the Serial demand type, the power demand is made via the Modbus interface.

In order for a change of the power demand to become effective, the following conditions must be met:

- Parameter `20530006 Start and power demand type` is set to `Serial`.
- The genset is running in automatic mode
- The plant control sends a value larger than 30 % of the rated power as a power requirement for the genset.
- The plant control closes the potential-free contact demand.

For more information on `power demand` see

- TPEM Operating Manual ⇒ `Operation modes` ⇒ `Mains parallel mode`

5.2 Reactive power demand for PF

Specifications from the network operator can be used to generate a PF setpoint value for the generator controller.

The PF specifications can be demanded via Modbus. Either Register 1202 or Register 1242 can be used for this. A different encoding is assigned to the PF value.

For Register 1202, the encoding value range is 0 to 600.

For Register 1242, the encoding is defined as a fixed point number with three decimal places and an offset of 1.

PF	Value transmitted per Modbus (Register 1202)	Value transmitted per Modbus (Register 1242)
-0.700	0	300
-0.999	299	1
1.000	300	2000
0.999	301	1999
0.700	600	1700

Example: PF -0.876 corresponds to a value transmitted from Modbus of 176 (Register 1202) or of 124 (Register 1242).

For more information, see

- Operating Manual ⇒ TPEM Parameter description ⇒ Displacement factor PF (Grid code mode: BDEW) ⇒ `20251826 Displacement factor demand source`
- Operating Manual ⇒ TPEM Parameter description ⇒ Displacement factor PF (Grid code mode: AR-N 4110 and General Grid Code) ⇒ `20250998 PF demand source`

5.3 Read out reactive power setpoint

Similarly to the reactive power demand for PF, the setpoint can be read out in two different ways.

PF	Value transmitted per Modbus (Register 412)	Value transmitted per Modbus (Register 679)
- 0.700	0	300
- 0.999	299	1
1.000	300	2000
0.999	301	1999
0.700	600	1700

5.4 Conditional writing of parameters

In the TPEM system, conditional writing of parameters is possible via Modbus. This changes the parameter value shown on the HMI to the value written via Modbus. Conditional writing must be activated on the HMI via parameters. The activation cannot be done via Modbus. Conditional writing is available for defined parameters of the grid code.

Reading the parameter values via Modbus is always possible, independent of conditional writing.

The following parameters activate or deactivate conditional writing:

- `20025230 Change of FSM settings via Modbus`
- `20025225 Change of active power ramps via Modbus`
- `20025249 Change of LFSM settings via Modbus`
- `20105685 Option Mains operator power limitation`
- `20106714 Mains operator power demand source`

For more information, see

- Operating manual ⇒ TPEM Parameter description
- Commission-specific TPEM Modbus list

5.5 Encoding and byte order

5.5.1 Byte order for 32-bit values or larger

The byte order (endianess) of 32-bit or larger values is carried out as a mid-little endian.

5.5.2 Encoding for parameterizable counters

To cover the entire value range of parameterizable counters, these are transmitted as 64-bit floating point numbers (IEEE 754). This is done via four consecutive Modbus registers.

As an example below the number 0.001

	Value	Value as hexadecimal number
Modbus register 652	43516	A9FC
Modbus register 653	54001	D2F1
Modbus register 654	25165	624D
Modbus register 655	16208	3F50
Value as 64-bit floating point number	1.0000000000000000e-3	3F50624DD2F1A9FC

5.6 Collective acknowledgement

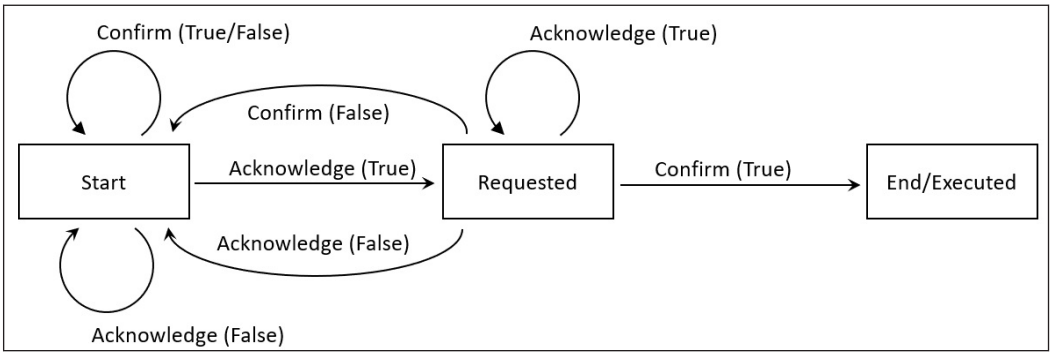
A collective acknowledgement of all pending warnings and alarms via Modbus is possible if parameter `20106687 Collective acknowledgement` is activated.

For further information on the parameters, see

- Separate Operating Manual ⇒ TPEM Parameter description ⇒ General ⇒ Plant

Register type	Register number	Value
Holding register	1257	1 = Acknowledge
Holding register	1258	1= Confirm Acknowledge
Holding register	1259	0 = Automatic 1 = Manual

State-machine collective acknowledgement



74715-001

Register 1257 must be set to 1 before 1 is sent to register 1258 (Status Requested: 1257 = 1 /1258 = 0). If 1 is sent to register 1258 first, register 1258 is reset to 0 in the start state (Status Start 1257 = 0 /1258 = 0). In order to carry out the collective acknowledgement, the collective acknowledgement must be confirmed after register 1257 has been set to 1 (1258 =1).

send 1 to register 1257: Status "Requested" (1257 = 1 /1258 = 0)

then send 1 to register 1258: Status "End/Execute" (1257 =1 / 1258 =1)

State	Acknowledge	Confirm
Start	0	0
Requested	1	0
End / Executed	1	1

6 Data structure in the tables

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6.1 Commands

Table columns for access to holding registers:

Column	Meaning
Address	Modbus address of the command word
Designation	distinguishing name of command
UID	TPEM-internally standardized ID for command
Scale factor	according to offset, divisor for conversion of the preset value to the UINT value to be transferred
Offset	offset value to be subtracted before scaling
Unit	Measuring unit of the preset value to be transferred

6.2 Data

6.2.1 Data 1 Word information

Table columns for access to input register:

Value = (register value X scale factor) + offset

Example:

T207 Coolant temperature engine inlet

Address 242

Scale factor 0.1

Offset -273

Register value 3422

T207 = (3422 X 0.1) - 273 = 69.2 °C

Column	Meaning
Address	Modbus address of the data word
Designation	Distinguishing name of the data word
UID	TPEM-internal ID which also appears on the TPEM user interface
SensorID	Labeling of the sensor from the plant diagrams
Scale factor	Scale value for converting the transferred 2-byte unsigned integer value
Offset	Offset value to be added after scaling
Unit	Measuring unit of the value to be transferred

Assignment of status information from transferred number to term, see

- Section 6.1 Status of the genset

6.2.2 Data 2 Digital data

Table columns for access to binary data in the lower address area of the discrete input register:

Column	Meaning
Address	Modbus address of the data word, one address per bit word
Designation	Distinguishing name for the bit content
UID	TPEM-internal ID which also appears on the TPEM user interface

Column	Meaning
Meaning logical 1	Meaning of the bit value 1 in relation to the use of the address (see designation)
Meaning logical 0	Meaning of the bit value 0 in relation to the use of the address (see designation)

6.3 Events including acknowledgement

Table columns for access to discrete input register and coil register.

Events can be queried via the discrete input registers. The acknowledgement status of the warnings and alarms can be queried via the respective coil register.

Address area > 1000.

The events are acknowledged via the coil registers at the specified acknowledgement address. Every event must be acknowledged. A collective acknowledgement is possible
⇒ Section 5.5 `Collective acknowledgement`.

Column	Meaning
Address	Modbus address of the event
Designation	Distinguishing name for the event
UID	TPEM-internally standardized ID for the event
Severity	Classification of severity of the event
Meaning logical 1	Event is active
Meaning logical 0	Event is not active
Acknowledgement address If permitted	Modbus address of the associated coil register

6.4 Status information

Status data with more than two digital statuses are displayed via the input register.

The meaning of the transmitted numerical values is explained in the rear section of the commission-specific Modbus list.

7 Appendix

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7.1 Changes with TPEM Release 1.7.2

- Chapter 4 Modbus functionality
  - Chapter 4.1 Modbus information updated.
  - Chapter 4.4 Data model "Separate Register" updated.
- Chapter 5 Modbus functionality TPEM system
  - Chapter 5.4 Conditional writing of parameters expanded.