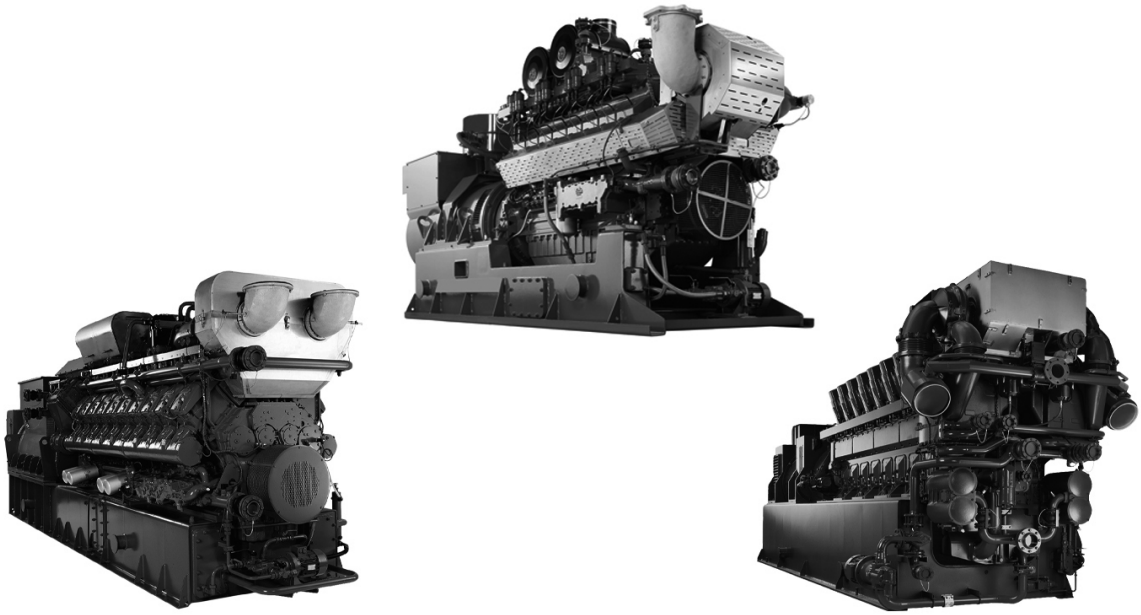
System Manual

TEM *Evolution* System

Data Exchange via Ethernet TCP/IP

Interface Description Fieldbus Interface Modbus TCP

Release 2.03.00



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Imprint:
Caterpillar Energy Solutions GmbH
Servicedokumentation
Carl-Benz-Str. 1
68167 Mannheim
Germany
Phone: +49 621 384-0
Fax: +49 621 384-8841

Contents

1 Introduction

1.1 Validity

This manual is part of a commission-specific documentation that consist of two parts.

- Interface description: General part
  Specification of the interface and description of Modbus functionality in the TEM-Evo system
- Appendix A: Commission-specific part
  Presentation of commission-specific telegram data of the engine and the periphery

Notice

This interface description is only complete and valid in connection with the respective commission-specific appendix A.

1.2 Designated use

The Modbus TCP interface is a fieldbus interface.

It is used for communication of the TEM-Evo system with a higher plant control via the Modbus protocol. The higher plant control requests, e.g., data and measured values via commands that are recorded by the TEM-Evo system.

see "Modbus Functionality" on page 8

Information

Detailed information about the Modbus functions can be found at www.modbus.org.

1.3 Safety instructions

Further documents

When operating TEM-Evo systems, the following further documents must be adhered to:

- Documentation concerning the genset
- Documentation concerning the plant
- TEM-Evo system operating instructions
- Supervisory authority and trade association guidelines

Personnel

They are to have extensive knowledge of the configuration, function and the mode of operation of the entire plant in order to be able to operate a TEM-Evo system. Improper interventions can threaten the safe operation of the plant or cause damage to the plant.

Only skilled and trained personnel are therefore authorised to install and operate TEM-Evo systems.

1.4 Symbol explanation

Symbol	Meaning	Explanation
	**Safety**	This symbol is used in all safety instructions. Observe these notes carefully. Give safety instructions to the operating personnel.
	**Notice**	Important note concerning function. Disregarding these may lead to malfunctions.
	**Information**	Further information: Read the indicated system manuals carefully.
✓	**Requirement**	The requirements are marked with a tick. These requirements must be met before any activities can be executed.
⇨	**Instruction**	Instructions are marked with an arrow. Follow the instructions carefully.
	Result	Usually, an instruction is followed by one or more descriptions of results.

2 Specification

2.1 Protocol and supported functions of Modbus TCP interface

- Fieldbus type: Modbus TCP
- Supported Modbus functions: 2, 3, 4, 6, 16

2.2 Physical interface

- Transmission medium: 10/100BASE TX
- Cable: Min. CAT5 twisted pair
- Plug connector Installation cable can be connected using field-assembly plug 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 a switch or router
- Communication via Modbus TCP is activated via the operating software.
  - Parameter "26001 Fieldbus type": Setting "4"
- The network configuration (IP address, etc.) is set via the PC package operating software.

Notice

To connect the TEM-Evo system to a higher control system via Ethernet, proper equipotential bonding and correct installation of the network cabling are absolutely necessary.

In heavily disturbed environments, additional disturbance suppression measures (e.g. sheath current throttle, folding ferrites) or optical data transmission may be necessary.

2.3 Server parameters

- Static IP address
- Access via port 502
- Max. one client connection at any given time
- Simultaneous transactions are not supported

3 Modbus Functionality

Information

Detailed information about the Modbus functions can be found at www.modbus.org.

3.1 Modbus protocol

The Modbus protocol is a communication protocol based on a client/ server architecture. The client submits requests that are then executed or answered by the server.

TEM-Evo system in Modbus architecture

In a Modbus architecture, the TEM-Evo system always behaves as a "Server", the higher plant control is the "Client".

Modbus TCP

A telegram in Modbus TCP format consists of:

- Transaction ID
- Protocol ID
- Length
- Unit ID (0xFF)
- Function code
- Data field

3.2 Communication fault

Normal communication

If the "Client" addresses a certain "Server", it expects an answer. The "Server" usually sends back a response telegram.

Faulty communication

The causes of faulty communication and the possible reactions of the "Server" are displayed in Table 1:

Fault	"Server" reaction
The "Server" cannot receive the request telegram.	No answer
The "Server" receives the request telegram but is unable to answer it (e.g. read non-defined data points).	The "Server" sends an exception code. see "Exception codes" on page 9

Table 1: Faulty communication between the "Client" and the "Server"

3.2.1 Exception codes

The "Server" sends an exception code to the "Client" when it is unable to execute a command or answer a request. In the exception code, the "Client" receives an encrypted message stating the cause of the communication fault.

The following exception codes are supported:

Code	Name	Description
01	"Illegal function"	The function code received with the request represents an illegal action for the "Slave".
02	"Illegal data address"	The data address in the request is considered an illegal or unknown address for the slave device.
03	"Illegal data value"	A value in the request data field is an illegal value for the slave device.
04	"Device error"	An error occurred when processing the message. The request telegram does not meet the Modbus specification.

Table 2: Exception codes

3.3 Modbus addresses

The Modbus server is addressed via its IP address. The IP address is configured via the PC package operating software.

3.4 Fieldbus register

Modbus devices ("Server") store measured values, set values and state information in fieldbus registers, thus enabling access to this information.

The "Client" accesses the fieldbus registers via Modbus functions in order to monitor, configure and control the individual "servers".

According to the Modbus convention, fieldbus registers are combined into groups (according to reference types). The reference type is indicted by the first digit of the reference address.

Reference	Function	Function in the TEM-Evo system
0xxxx	Coil status	Read digital data
1xxxx	Input status	Read digital data
3xxxx	Input register	Read analogue data
4xxxx	Holding register	Read/Write analogue data

Table 3: Reference types (according to Modbus addresses) and their function in the TEM-Evo system

Notice

The "X" behind the first character stands for a four-digit address in the user data memory.

3.5 Supported Modbus functions

The Modbus TCP interface of the TEM-Evo system supports the following functions:

Function code	Function	Reference
02 (02H)	Read discrete inputs	1xxxx
03 (03H)	Read holding register	4xxxx
04 (04H)	Read input registers	3xxxx
06 (06H)	Write single register	4xxxx
16 (10H)	Write multiple registers	4xxxx

Table 4: Supported Modbus functions

4 Modbus Functionality TEM-Evo system

4.1 Address list of process data

The following table shows the preferred address ranges of the Modbus addresses and the corresponding function codes for the TEM-Evo system.

Modbus TCP clients which do not support the defined address ranges can also access the process data of the TEM-Evo system via alternative addresses.

The preferred address ranges are shown bold.

Complete address lists for the preferred address ranges are shown, sorted by topic, in the commission-specific appendix A.

	Function code	**Preferred Modbus address**		Alternative Modbus address[1]	
		Start	**Finish**	Start	Finish
Logic information (messages, alarms, faults, fault SC)	2 (read discrete inputs)	**10001**	**11024**	40001	40064
Word information	4 (read input registers)	**30201**	**30712**	40201	40712
Data and commands	3 (read holding register) 6 (write single register) 16 (write multiple registers)	**41025**	**41036**		

1) Only with function code 3 (read holding register)

Table 5: Address ranges of Modbus addresses

Notice

Requests for undefined information
(e.g. reading a non-existent coil or register) are answered with an error telegram.

see "Communication fault" on page 9

Requests for information defined but not documented in this document are reserved for internal purposes and can assume values that are not equal to zero. These points of information must be ignored.

16-bit values

When accessing bit values as 16-bit values, the bits are stored in the words in ascending order.
The writing of set values and commands is only possible via addresses 4xxxx.

	MSB															**LSB**
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Address 1xxxx	10008							10001	10016							10009
Address 4xxxx	Register 40001															

4.2 Data and commands

4.2.1 Command data words

Only the following are used as command data words:

- 10E1h(4321d)
- 0FA0h(4000d)

All other values are ignored by the TEM-Evo system.

4.2.2 Power preset

The TEM-Evo system differentiates between three power preset types for the genset (types of demand). In "Control system" type of demand, power preset occurs via the Modbus interface.

The following conditions must be met:

- The parameter "13010 Type of demand" is set to value "3".
- The plant control sends a value greater than 30% of the nominal power as the set power of the genset.
- The plant control closes the potential-free "Demand" contact.

Notice

If the genset is to be started exclusively via the Modbus interface, the "Demand" contact can be bypassed.

4.2.3 Remote acknowledgement

All the alarms and some faults can be acknowledged remotely from the plant control.

Notice

Pending faults or alarms cannot be acknowledged remotely.

Command data word

The following is defined as the command data word of remote acknowledgement for the TEM-Evo system:

- 10E1h: set

Notice

Continuous transmission of the value 10E1h does not lead to further acknowledgements. New acknowledgement can only be triggered (edge triggering) after transmitting a value that differs from 10E1h.

Register remote acknowledgement

Modbus	Instruction / Set values
41030	Remote acknowledgement fault, fault SC, alarm

Faults

Faults that can be acknowledged remotely are shown in the list of faults in the "FQ" column

- "X": The fault can be acknowledged remotely without any limitations.
- "10h": The fault can be acknowledged remotely once within 10 hours.

5 Requesting State Information

5.1 Genset state

The genset state can be requested via the following Modbus addresses:

Modbus addresses "30279" and "30280"

- Modbus address "30279": Genset state
- Modbus address "30280": Genset state in dual gas operation (optional)

5.2 Power reduction

Modbus address "30230"

In some situations, the TEM-Evo system limits the maximum admissible power of the genset to a defined value. This value can be requested via the following Modbus address:

- Modbus address "30230":
  Maximum admissible power of the genset, with power reduction through the TEM-Evo system.

5.3 Alarm, fault, fault SC

Information about the presence of an alarm, fault and fault SC can be requested via the following Modbus addresses.

Notice

The meaning of the feedback is inverted.
- **FALSE**: Alarm, fault, fault SC **present**.
- **TRUE**: Alarm, fault, fault SC **not present**.

Modbus	Meaning
10027	Collective fault SC (controlled shutdown is active)
10028	Collective alarm (at least one alarm is active)
10029	Collective fault (genset shuts down)

Table 6: State request alarm, fault, fault SC

5.3.1 Faults

Modbus address "10029"

The presence of a fault is reported back to the control system via the Modbus address "10029".

In case of an active "Fault" event, the genset is shut down immediately.

The genset state changes to the "Fault" state.

5.3.2 Faults with controlled shutdown

Modbus address "10027"

The presence of a fault SC is reported back to the control system via the Modbus address "10027".

In case of an active "Fault SC" event, the genset is run down with a delay via the load ramp.

The genset state changes to the "Shutdown due to fault SC" state.

Modbus address "30347"

The remaining time until the power is reduced can be requested via the Modbus address "30347".

Modbus address "30347"	Meaning
-1	No "Fault SC" event
>0	Remaining time until the power is reduced
0	Genset is run down or shut down

Table 7: Feedback of time until controlled shutdown via the Modbus address "30347"

After running down the load, the genset shuts down with the "Fault" state.

6 Data Structure in the Tables

6.1 Word information

Word information, such as measured values and similar variables, is transmitted as signed integer 16-bit words. Each value is stored right-aligned in the word. The higher order byte is transmitted before the lower order byte.

The list of word information in the commission-specific appendix A consists of 4 columns with the following meaning:

Column	Designation	Meaning
1	"Modbus"	Modbus address
2	"Factor"	Scaling of variable
3	"Unit"	Unit of variable
4	"Designation"	Designation of word information

Table 8: Description of word information table

Calculating data word

The value of a data word is calculated as follows:

- Value = factor x data word

Notice

Word information that is defined but not used or needed is reserved for internal purposes and can assume values that are not equal to zero. These points of information must, therefore, be ignored.

6.2 Logic information

The lists of messages and alarms in the commission-specific appendix A consist of 5 columns.

Column 6 is additionally displayed in the list of faults.

Column	Designation	Meaning
1	"Modbus"	Modbus address
2	"Type"	Message, alarm, fault or fault SC
3	"Logic 0"	Meaning of logic 0
4	"Logic 1"	Meaning of logic 1
5	"Designation"	Designation of logic information
6	"FQ"	Remote acknowledgeable faults; See chap. "Remote acknowledgement" on page 15

Table 9: Description of logic information table

Notice

Parameterisable messages and limit value monitoring of the parameterisable measured values and control circuits can be set in the TEM-Evo system as a message, alarm or fault.

Notice

Logic information that is defined but not used or needed is reserved for internal purposes and can assume values that are not equal to zero. These points of information must, therefore, be ignored.

6.3 Data and commands

The list of data and commands in the commission-specific appendix A consists of 5 columns.

Column	Designation	Meaning
1	"Modbus"	Modbus address
2	"Designation"	Designation of value or command
3	"Factor"	Scaling of variable
4	"Unit"	Unit of variable
5	"Meaning"	Assignment of command data word

Table 10: Description of data and commands table