TPEM

Operating manual
EN
Valid from release 1.9
2024-02
Competence level CL 2

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.

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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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1.1 Introduction

1.1.1 Target audience

The document is aimed at authorized specialist personnel with the competence level 2 (CL2). 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 as of release 1.9.

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:

- Planning notes and installation notes
- Safety regulations
- Operating media regulations
- Reports, specifications, certificates
- Technical drawings
- Wiring diagrams and circuit diagrams
- Component documentation
  - Installation 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 notes

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

Genset data can be read out via the Modbus customer 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. However, the Modbus communication protocol is not protected and therefore represents an exploitable vulnerability for a potential attacker.

The security of the networks beyond the (physical) customer interface is outside the responsibility or influence of the manufacturer. The security and protection of these networks beyond the customer interface is therefore the sole responsibility of the customer.

By activating and/or using this interface and connecting the genset to a network via this customer 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 customer interface.

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1.2.3 Copyright

1.3 Feedback on documentation

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So that we can allocate your feedback, please also provide the following information:

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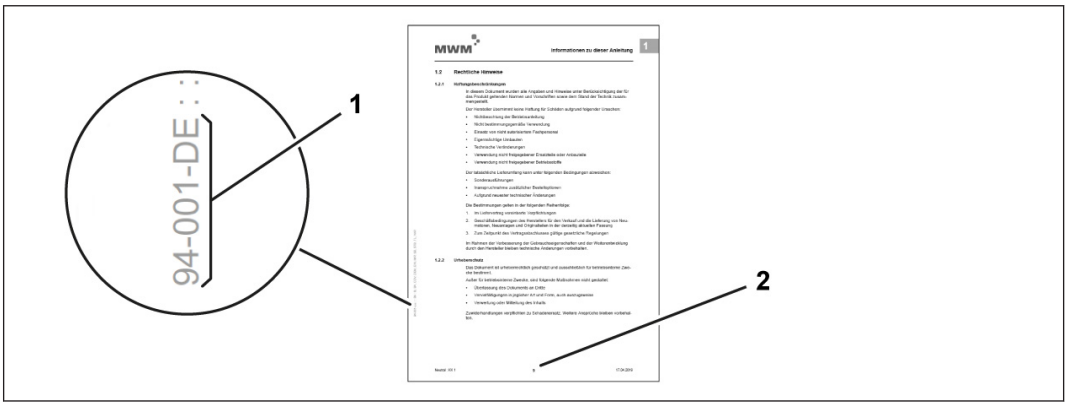
- Page number (2)
- Contact data (name, email) for potential further enquiries



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Thank you for your support. We read all feedback carefully.

We look forward to hearing from you!

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 Use and misuse of the TPEM system

Proper use of the TPEM system

The TPEM system (Total Plant and Energy Management System) assumes the complete plant management for modules with gas engines.

The TPEM system controls, regulates and monitors the essential functions of the individual plant components (e.g. genset, cooling/heating circuits).

Proper use also includes compliance with all the information in this document.

Any use other than that defined as proper use of the genset or which goes beyond that use is considered misuse and may lead to hazardous situations.

All types of claims due to damage resulting from improper use are excluded.

Risk of destruction of components

Misuse of the genset

- Use only approved operating media
- Only operate the genset within the limit values
- Never retrofit the genset independently without authorization from the manufacturer

Risk of destruction of components

Incorrectly set parameters may lead to the genset or auxiliaries becoming damaged. Take utmost care when setting the parameters. Standard values are reference values and must be checked in terms of their applicability.
Parameters may only be modified when the emergency stop button has been pressed and the genset is stationary.

Exceptions include:

- Controller parameters
- Setpoint values
- Limits

For further information on the proper use and improper use of the genset, see

- Operating Manual ⇒ General ⇒ Safety regulations
  - Safety regulations

3 Technical data and rating plates

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3.1 Rating plates

Rating plates identify components of the plant. Important components have a serial number.

For important serial numbers, see

- TPEM Touch Panel ⇒ Chapter "Operation" ⇒ Functional group "System" ⇒ Overview
  - Serial number

4 Structure and function

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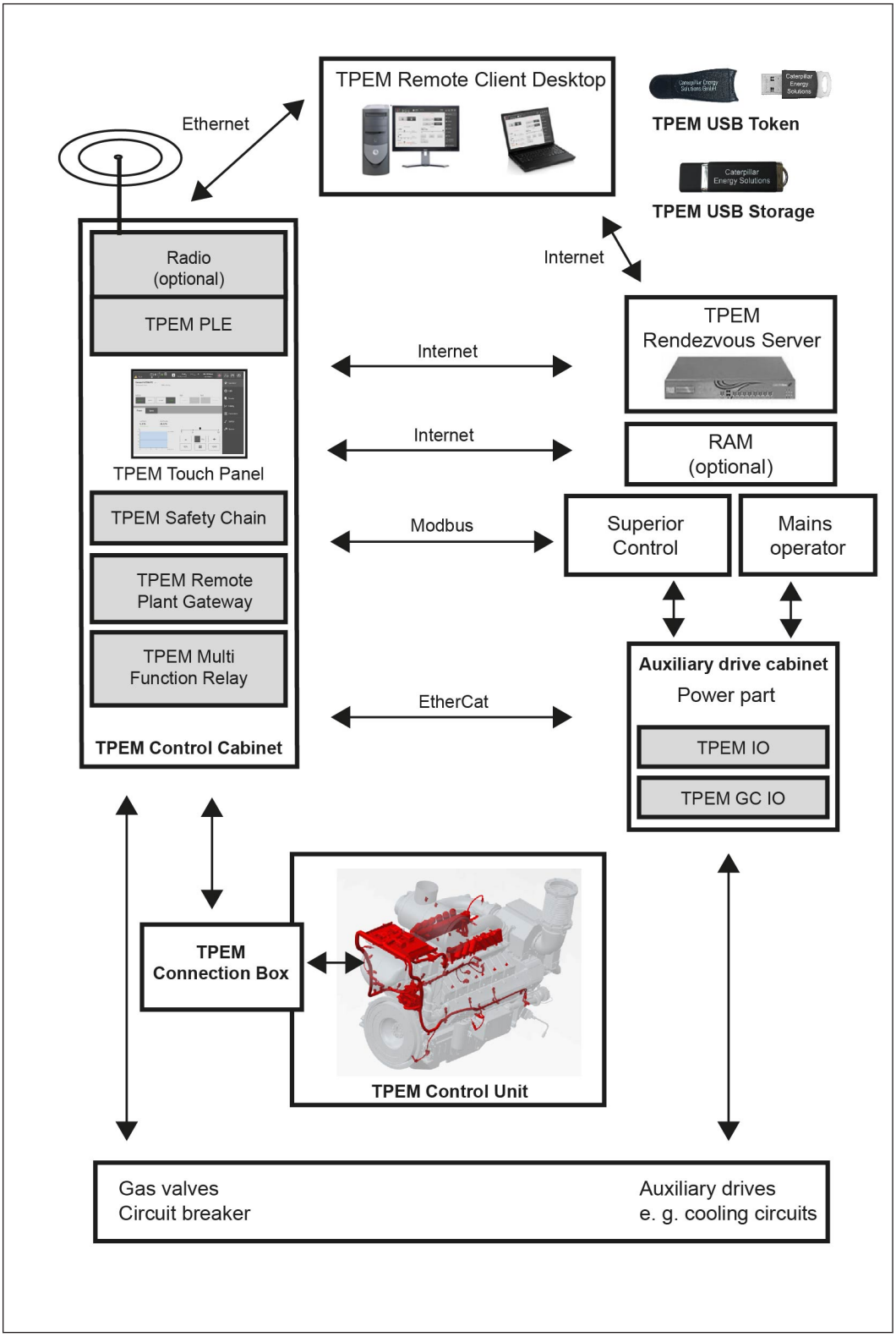
4.1 TPEM system structure

4.1.1 Components

The TPEM system (Total Plant and Energy Management System) consists of the following components:

- TPEM Control Cabinet (TPEM CC): central control cabinet for the exchange of signals between the engine control devices and the control of the generator and auxiliary drives
- TPEM Rendezvous Server (TPEM RVS): enables access to the TPEM system with a TPEM Remote Client
- TPEM Remote Client Desktop (TPEM RC DT): Software for visualization on a computer ⇒ Section - Operation ⇒ Introduction to operation of the TPEM system ⇒ Operation via TPEM Remote Client Desktop.
- TPEM Control Unit (TPEM CU): assumes all tasks required for controlling and regulating the genset
- TPEM Connection Box (TPEM CB): interface between the TPEM Control Unit, the TPEM Control Cabinet and the gas valves of the gas train
- TPEM Product Link Elite (TPEM PLE): Telematics hardware that reads telematics data from the genset and plant controls and transmits it via a network to an evaluation system (RAM) in real time.
- TPEM IO Controller (TPEM IO): interface between the TPEM system and the auxiliary drives. The TPEM system controls the auxiliary drives via the TPEM IO Controller. It is installed in the auxiliary drive cabinet. The TPEM system does not provide the power supply for the auxiliary drives. Data is exchanged between the TPEM IO Controller and TPEM system via EtherCat.



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4.1.2 TPEM Control Cabinet (TPEM CC)

The TPEM Control Cabinet is the central control cabinet for the exchange of signals between the engine control devices and the control of the generator and auxiliary drives.

For further information on the TPEM Control Cabinet, see

- Operating Manual ⇒ TPEM Control Cabinet ⇒ Installation
- Operating Manual ⇒ TPEM Control Cabinet ⇒ Operation
- Operating Manual ⇒ TPEM Control Cabinet ⇒ Maintenance

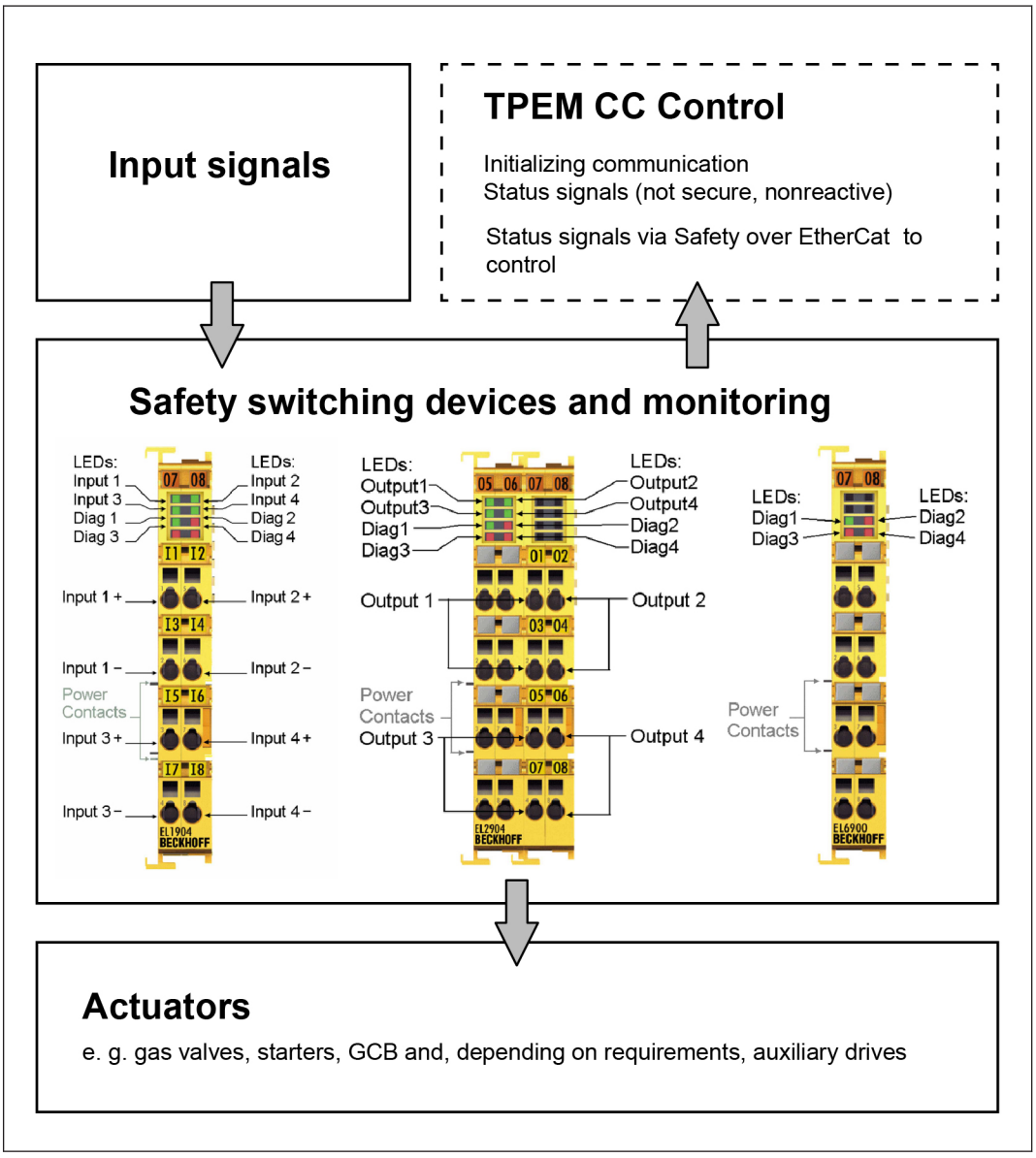
4.1.3 TPEM Safety Chain (TPEM SaC)

The safety chain (TPEM SaC) interprets signals from sensors. The safety chain monitors limits such as pressures and temperatures from safety-related measuring points. If safety-related limits are exceeded, the safety chain switches off subsystems or the plant.

The protective system consists of three secure subsystems:

- Input signals
- Safety switching devices for monitoring and shutting down
- Actuators

The status signals are not a component of the protective system. All inputs monitored by the TPEM SaC lead to corresponding alarms in TPEM CC. The alarms are displayed on the TPEM Touch Panel and can be acknowledged.



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TwinSAFE logic bus input terminals and output terminals

The protective system consists of the following safe subsystems:

- **6 TwinSAFE digital input terminals EL1904** with four fail-safe inputs each for sensors with potential-free contacts
- **1 TwinSAFE logic bus terminal EL6900** linking unit between TwinSAFE input terminals and output terminals
- **1 TwinSAFE digital output terminal EL2904** with four fail-safe channels for actuators

Each terminal has an individual DIP switch address. The address must be set on each terminal. See TPEM CC circuit diagram.

Sensors that are connected to the safety input terminals may only be supplied by means of safety terminals and may not be connected to an external supply. The terminals are monitored for sensor errors, external supply and cross-circuit.

Input signals

The following input signals are used for the variants: exhaust heat exchanger in HC, exhaust heat exchanger in the MCC and exhaust heat exchanger in the coupling circuit.

The inputs represent a maximum configuration for a heating circuit with heating water temperatures of 110 °C < T_{Flow} < 120 °C.

No.	ID	Designation	Feedback ormonitor-ing at
116	---	External emergency stop with run-on	Emergency stop switch category 1, e.g. emergency stop switch in the control room
117 114	---	External emergency stop without run-on channel 1 External emergency stop without run-on channel 2	Emergency stop switch category 0, e.g. all emergency stop switches inside and outside of the contain-er
141	---	Internal emergency stop without run-on	Emergency stop switch category 0 on the TPEM Control Cabinet and TPEM Connection Box
121	---	Generator protection collective fault	
231	PDZA –	EHE 2 differential pressure flow monitor	Δp too low
281 126 457	PDZA –	Heating circuit differential pressure flow monitor, or engine cooling circuit differential pressure flow monitor, or coupling circuit differential pressure flow monitor	Δp too low
276 135 452	TZA ++	Heating circuit safety temperature limiter (1), or engine cooling circuit safety temperature limiter, or coupling circuit safety temperature limiter	Temperature too high

No.	ID	Designation	Feedback ormonitor-ing at
277 137 453	TSA +	Heating circuit safety temperature monitor (1), or engine cooling circuit temperature monitor, or coupling circuit temperature monitor	Temperature too high
435 136	TZA ++	Heating circuit safety temperature limiter 2, or coupling circuit safety temperature limiter 2	Temperature too high
436	TSA +	Heating circuit safety temperature monitor 2	Temperature too high
278 138 455	PZA	Heating circuit safety pressure monitor minimum (1), or engine cooling circuit pressure minimum monitor, or coupling circuit pressure minimum monitor	Pressure too low
279 139 454	PZA +	Heating circuit safety pressure limiter maximum (1), or engine cooling circuit safety pressure limiter, or coupling circuit pressure limiter	Pressure too high
437 237 140	PZA +	Heating circuit safety pressure limiter maximum 2, or engine cooling circuit safety pressure limiter 2, or coupling circuit safety pressure limiter 2	Δp too low
438 322	PSA-	Heating circuit safety pressure monitor minimum 2, or coupling circuit pressure minimum monitor 2	Pressure too low
280 261 456	LSA –	Heating circuit low coolant level exhaust heat exchang-er, or Engine cooling circuit low coolant circuit 2, or Coupling circuit low coolant level	Low liquid level
308	LSA –	Mixture cooling circuit low coolant circuit	Low liquid level
123	LSA –	Engine cooling circuit low coolant level	Low liquid level
458	LSA –	Dump cooling circuit low liquid level	Low liquid level
638 283	QSA+ QSA+	Gas alarm level 2 collective input, channel 1 Gas alarm level 2 collective input, channel 2	40 % LFL
284	---	Parametrizable safety input 1	Reserve
285	---	Parametrizable safety input 2	Reserve

Safety switching devices for monitoring and shutting down

If a measured value exceeds or falls below defined limits, the contact of this sensor opens at the TwinSAFE digital terminal EL1904. As a result, the safety module closes the gas valves and interrupts the fuel supply. The starter is blocked and the generator circuit breaker opens.

If the safety module is activated via the inputs 141 SaC internal emergency stop without pump run-on or 117 and 114 SaC emergency stop without pump run-on or SaC gas alarm step 2, the potential-free contact 45Q1 switches off the outputs of the TPEM CC as well as additionally connected assemblies (pumps, ventilators, etc.).

When the contact of a sensor opens, a status signal is transmitted to the control system.

Communication between TPEM CC and TPEM SaC, EL6900

The TPEM SaC integrated in TPEM CC must be controlled by various digital signals in order to enable a plant for operation. Relevant alarms or causes for an emergency stop must be acknowledged or eliminated accordingly.

The TPEM SaC is initially in a safe state. It is not possible to start the genset.

- Gas safety shut-off valves closed
- Ignition is not possible
- Starter disabled
- Generator circuit breaker open
- TPEM IO Controller outputs switched off
- Auxiliary drives switched off

From TPEM CC to TPEM SaC:

Signaling the operational readiness of TPEM CC and the EtherCAT communication: After starting the plant control, the TPEM SaC requires an initialization signal which checks the communication is functioning correctly between TPEM CC and TPEM SaC. Initialization does not yet involve leaving the safe state. It is still not possible to start the genset.

Resetting the TPEM SaC (leaving the safe state): If the TPEM SaC is in a safe state, a reset must be performed so that it is possible to start the genset.

If the following conditions are met, the TPEM CC performs the reset automatically:

- A start of the genset or the periphery/auxiliary drive is demanded.
- All sensors that lead to the triggering of TPEM SaC no longer report an error.
- All TPEM SaC alarms have been acknowledged by the user.
- All monitored safety inputs show no fault.
- The bridges are active for all bridgeable inputs.

Start of the bridging time for differential pressure monitoring: The TPEM SaC has bridgeable hardware inputs. Monitoring these hardware inputs is only required if the coolant pump is demanded. In order to start the genset, the bridging of the differential pressure monitoring can be demanded by the TPEM CC. Bridging is carried out in a safety-oriented manner by the TPEM SaC. After the specified bridging time has expired, the input is monitored again by the TPEM SaC.

Depending on the start situation or operating situation, different bridging times for the differential pressure monitoring are provided:

- 30 s for a normal start
- 3 s for a brief interruption in the 400 V supply during operation
- 120 s for black start

From TPEM SaC to TPEM CC:

Status signals: All inputs monitored by TPEM SaC lead to corresponding alarms in TPEM CC. The alarms are displayed on the TPEM Touch Panel and can be acknowledged.

Actuators

The actuators in the protective system with pump run-on are:

- Gas valves
- Starter, ignition
- Generator circuit breaker

Additional actuators in the protective system without pump run-on are:

- TPEM IO Controller outputs
- Auxiliary drives

Emergency stop for quick stop in the TPEM Control Cabinet and TPEM Connection Box

The emergency stop for quick stop is a safety device in the door of the TPEM Control Cabinet.

When pressing the emergency stop for quick stop:

- An alarm is triggered which stops the genset immediately
- The supply of the auxiliary drives can be switched off
- The gas safety shut-off valves are closed
- Ignition is no longer possible
- The starter is disabled
- The command to open the generator circuit breaker is given
- The outputs of the TPEM IO Controller are switched off

Emergency stop for quick stop without pump run-on

When pressing the emergency stop for quick stop:

- An alarm is triggered which stops the genset immediately
- The supply of the auxiliary drives can be switched off
- The gas safety shut-off valves are closed
- Ignition is no longer possible
- The starter is disabled
- The command to open the generator circuit breaker is given
- The outputs of the TPEM IO Controller are switched off

Emergency stop for quick stop with pump run-on

When pressing the emergency stop for quick stop:

- An alarm is triggered which stops the genset immediately
- The gas safety shut-off valves are closed
- Ignition is no longer possible once a defined speed is undercut
- The starter is disabled
- The command to open the generator circuit breaker is given

Function of the protective system

Triggering factors

- A sensor detects values outside of the defined measuring range, e.g. safety temperature limiter pressure too high.
- An emergency stop switch is pressed.

Responses

1. The safety switching device interrupts the gas supply.

If a measured value exceeds or falls below defined limits, the contact of this sensor opens at the TwinSAFE digital terminal EL1904. As a result, the safety module closes the gas valves and interrupts the fuel supply. The starter is blocked and the generator circuit breaker opens.

2. Further assemblies are switched off.

If the safety module is activated via the inputs 141 SaC internal emergency stop without pump run-on or 117 and 114 SaC emergency stop without pump run-on or SaC gas alarm step 2, the potential-free contact 45Q1 switches off the outputs of the TPEM CC as well as additionally connected assemblies (pumps, ventilators, etc.).

3. Transmission of messages.

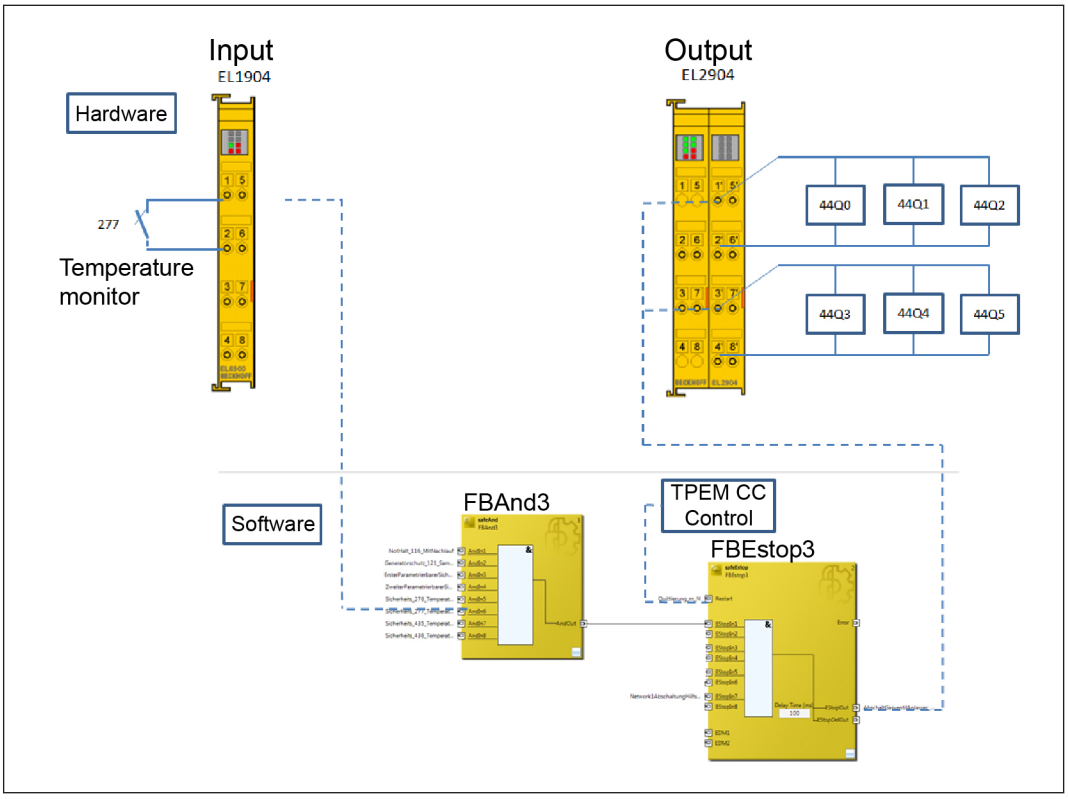
When the contact of a sensor opens, a status signal is transmitted to the control system.

Temperature example

In this section, the simplified behavior of the temperature sensor is shown as an example. The behavior of the pressure sensors, the generator collective fault, the temperature sensors, the parameterizable inputs, the emergency stop for quick stop with pump over-run and the low liquid level safeguards is identical.

The safety temperature sensor 277 is connected to a normally closed contact and a safe input terminal EL1904. When contact 277 opens, the sixth input of FBAnd3 falls from 1 to 0 and as a result the first input of FBEstop3 also falls from 1 to 0. All outputs of EL2904 fall from 1 to 0 and as a result the relays 44Q0 to 44Q5 all fall from 24 V to 0 V.

When the temperature is back within the valid range, contact 277 closes again. FBEstop3 must be acknowledged. Acknowledgment is performed on the TPEM Touch Panel.



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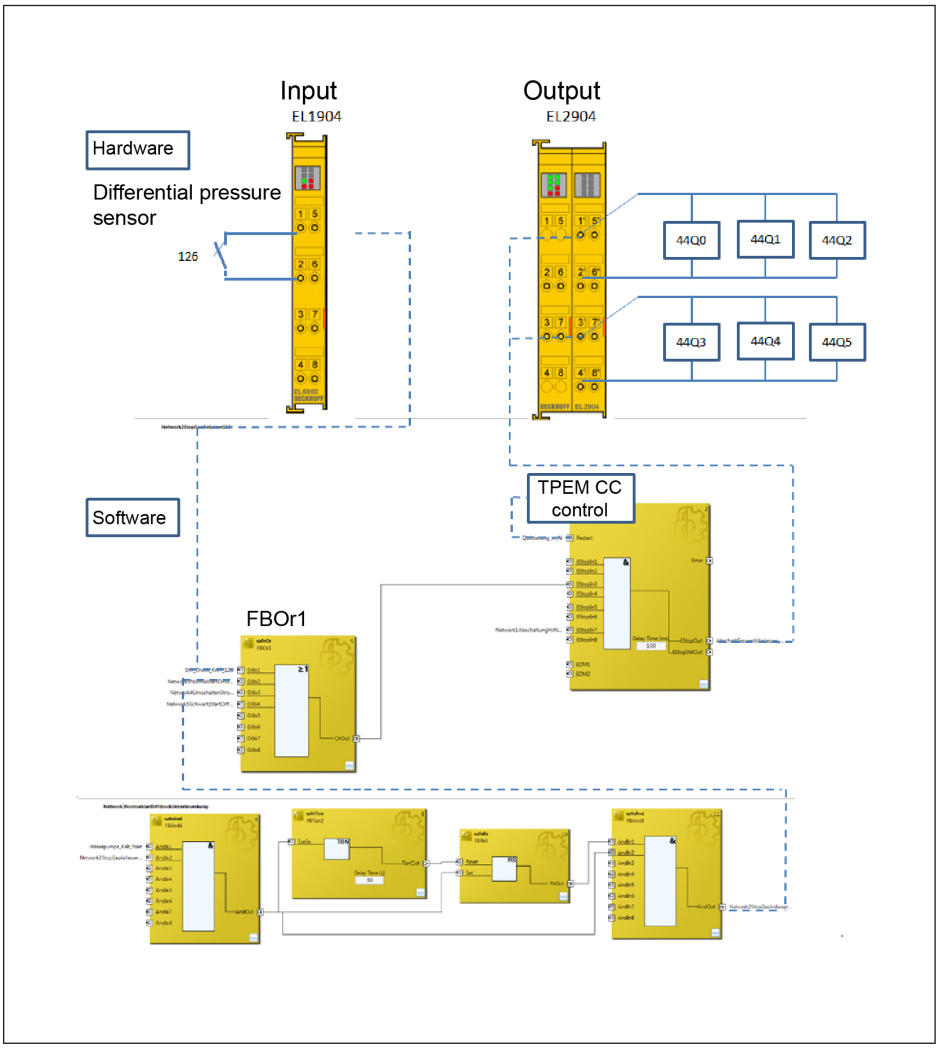
Differential pressure example

The simplified behavior of differential pressure sensor 126 in normal operation is shown as an example in this section. The monitoring starts after a delay time.

The behavior of the other differential pressure sensors is identical. The differential pressure sensor 126 is connected to a normally closed contact and a safe input terminal EL1904. In normal operation, when the liquid is no longer flowing in the pipe, no flow is measured. In order to start the genset, the bridging of the differential pressure monitoring can be demanded by the TPEM CC. Once 30 s have elapsed, the input with the differential pressure sensor is monitored.

For the first 30 s, the first input of FBOR 1 is low. The second input of FBOR 1 remains high for 30 s. This signal is triggered by the TPEM CC Controller. After 30 s, the second input FBOr1 falls to 0. If a differential pressure is built up during this 30 s, the output of EL2904 remains high. If no differential pressure is built up after 30 s, then the first input of FBOr1 falls to low and the output EL2409 also falls to 0. As a result, all relays 44Q0 to 44Q5 fall from 24 V to 0 V.

Acknowledgment is performed on the TPEM Touch Panel.



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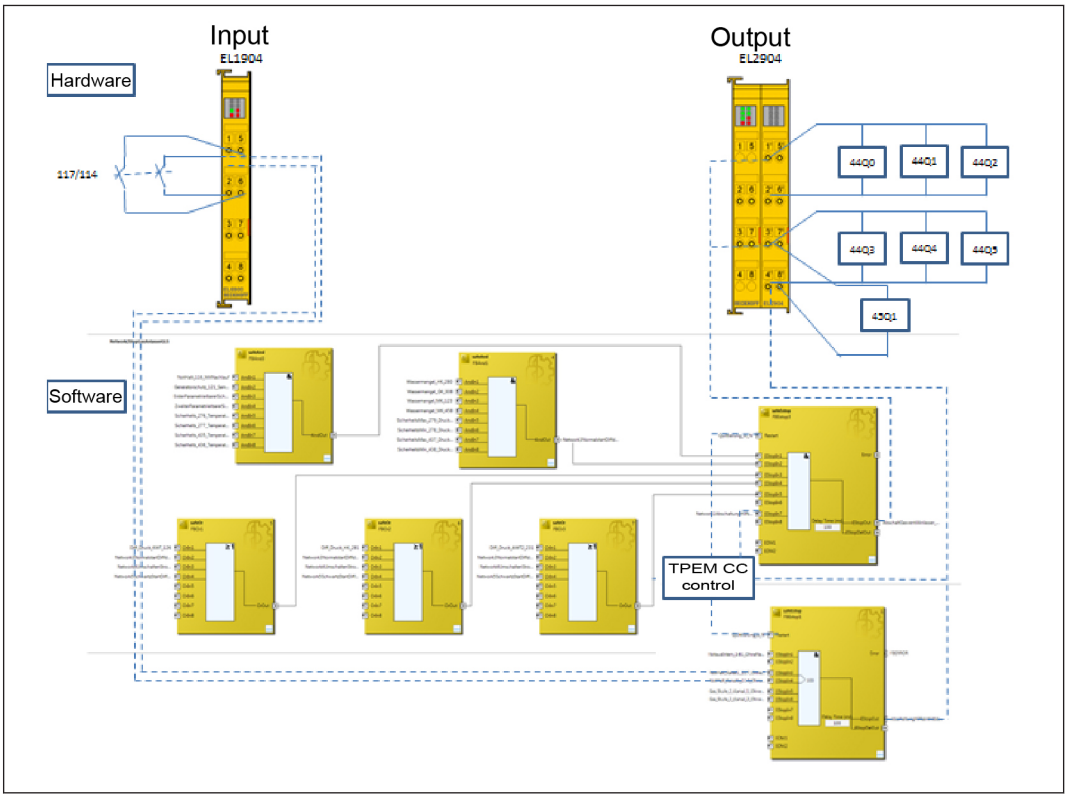
External emergency stop without pump run-on example

The simplified behavior of the external emergency stop without pump run-on (117/114) is shown as an example in this section. The external emergency stop without pump run-on has a dual-channel configuration. However, the internal emergency stop 141 has a single-channel configuration. Both emergency stop switches are an emergency stop without pump run-on.

The emergency stop switch is connected to two normally closed contacts and two safe input terminals EL1904. The output of the first function block ESTOP 1 is connected to the output terminals 1 and 2. If the output of the first function block ESTOP 1 falls to 0, then the outputs 1 and 2 of the EL29094 fall as a result and the relays 44Q0 to 44Q5 all fall from 24 V to 0 V. The output of the second function block ESTOP 2 is connected to output 4 of the output terminal. If the output of the second function block ESTOP 2 falls to 0, then the output 4 of EL29094 and the relay 45Q1 fall from 24 V to 0 V as a result.

Acknowledgment is performed on the TPEM Touch Panel.



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4.1.4 TPEM Multi Function Relay (TPEM MFR)

- Integrated in the TPEM Control Cabinet
- Always synchronizes the generator circuit breaker and, where necessary, the mains circuit breaker
- Offers generator monitoring and mains monitoring in accordance with the ANSI standard
- If needed, communicates with additional TPEM MFR modules in order to proportionally distribute the load in island parallel mode across the modules

Generator monitoring	
ANSI# 81O/U	Overfrequency and underfrequency
ANSI# 59/27	Overvoltage and undervoltage
ANSI# 55V	Power factor
ANSI# 51V	Time-dependent overcurrent
ANSI# 50	Present overcurrent
ANSI# 46/47	Unbalanced load
ANSI# 32/32 R	Overload and reverse power
ANSI# 25	Synchronization check

Mains monitoring	
ANSI# 81O/U	Overfrequency and underfrequency
ANSI# 59/27	Overvoltage and undervoltage
ANSI# 78	Phase shift (not permissible in Germany)
ANSI# 78PS	Pole slip
ANSI# 25	Synchronization check

For more information on the TPEM MFR, see

- Separate operating manual ⇒ TPEM Multi Function Relay

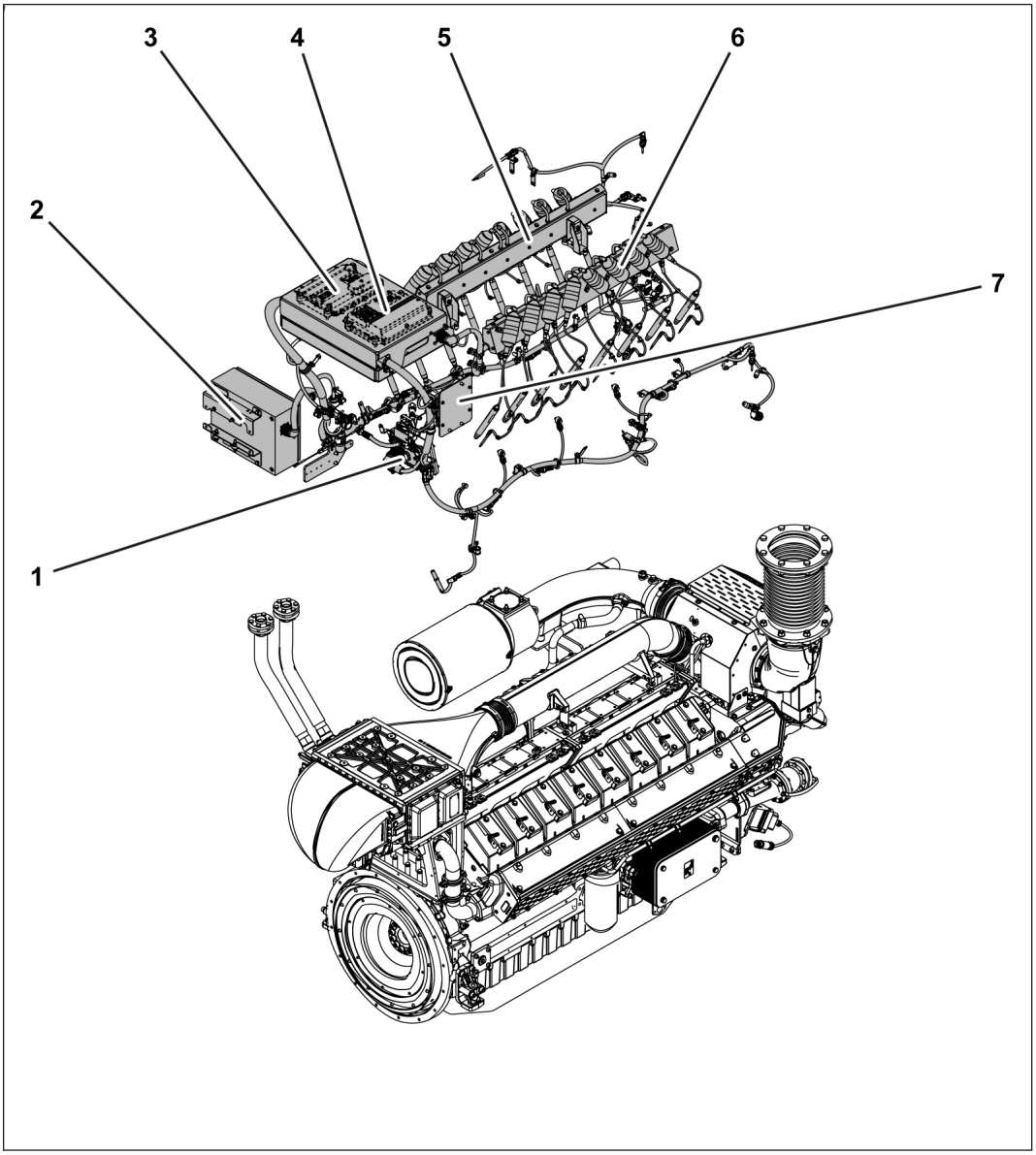
4.1.5 TPEM Control Unit (TPEM CU)

The TPEM Control Unit assumes all tasks required for controlling and regulating the engine.

Layout TCG 3016

The TPEM Control Unit is installed on the engine and consists of:

- A main control device with control logic and output stages for the ignition system and interface with TPEM CC.
- An auxiliary control device for detecting sensor signals with an emphasis on knock monitoring and measuring temperature. The auxiliary control device analyzes knocking sensor signals and forwards these to the main control device in interpreted form for anti-knock control.
- Two output stage control devices for activation of the actuators and the stepper motor
- The actuator system consists of the throttle valve and the wastegate (TCG 3016 V16 only) and a stepper motor on the gas-air mixer.
  - The throttle valve throttles the mixture mass flow so as to control the power of the genset.
  - The wastegate bypasses exhaust gases at the exhaust turbocharger. Using the wastegate increases the efficiency in the partial load range and the dynamics of the genset.
  - The stepper motor on the gas-air mixer sets the mixture quality (air ratio or lambda) of the combustible mixture in order to control the NOx emissions.
- A wiring harness system, consisting of:
  - A main wiring harness
  - Two cable bundles of the ignition rails
  - A cable bundle for the gas-air mixer
  - A cable bundle for the sensor system
- A TPEM Connection Box for simplifying the cabling on the plant side.



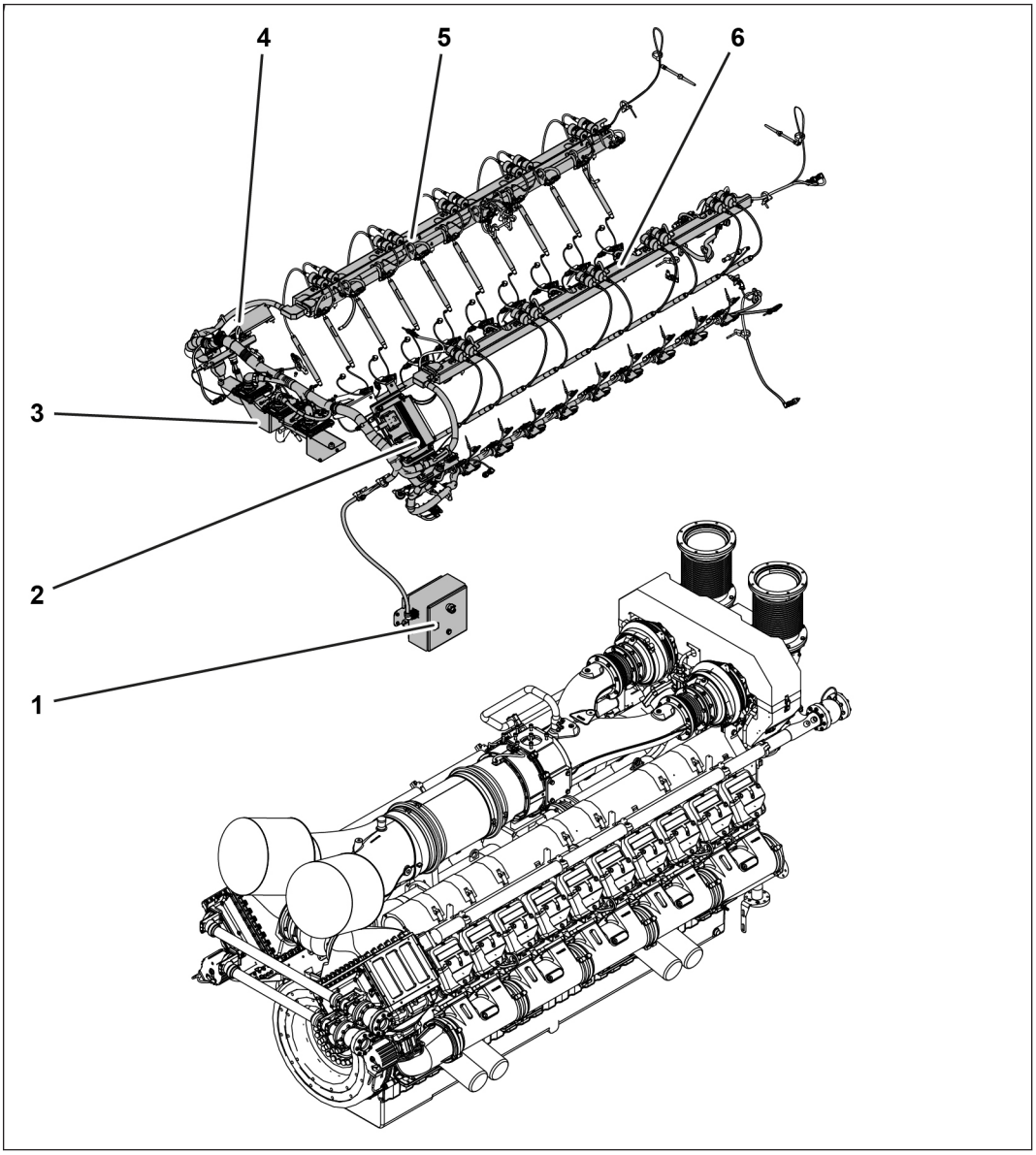
62644-002 TCG 3016

1 Output stage control device for gas-air mixer
2 TPEM Connection Box
3 Auxiliary control device
4 Main control device
5 Cylinder row A ignition rail
6 Cylinder row B ignition rail
7 Output stage control device for throttle valve and wastegate

Layout TCG 3020

The TPEM Control Unit is installed on the engine and consists of:

- A main control device with control logic and output stages for the ignition system and interface with TPEM CC.
- An auxiliary control device for detecting sensor signals with an emphasis on knock monitoring and measuring temperature. The auxiliary control device analyzes knocking sensor signals and forwards these to the main control device in interpreted form for anti-knock control.
- Three output stage control devices for activation of the actuators and the stepper motor
- The actuator system consists of the throttle valve and the wastegate and a stepper motor on the gas-air mixer.
  - The throttle valve throttles the mixture mass flow so as to control the power of the genset.
  - The wastegate bypasses exhaust gases at the exhaust turbocharger. Using the wastegate increases the efficiency in the partial load range and the dynamics of the genset.
  - The stepper motor on the gas-air mixer sets the mixture quality (air ratio or lambda) of the combustible mixture in order to control the NOx emissions.
- A wiring harness system, consisting of:
  - A main wiring harness for connecting the control devices to each other and the interface to the TPEM Connection Box and sensor system
  - Two ignition wiring harnesses with cable bundles to the ignition rails and the gas-air mixer and sensor system
  - Two engine wiring harnesses for connecting the knocking sensor system, thermocouples and actuators
- A TPEM Connection Box for simplifying the cabling on the plant side.



68138-001 TCG 3020

1 TPEM Connection Box

2 Main control device

3 Output stage control devices:
- A-side: Throttle valve B
- Middle: Gas-air mixer
- B-side: Throttle valve A and wastegate

4 Auxiliary control device

5 Cylinder row A ignition rail

6 Cylinder row B ignition rail

Control strategies depending on the operation mode

Speed control is performed in island operation. If the genset itself forms the mains in island operation, the frequency of the current generated and thus the speed quality is very important. The TPEM Control Unit maintains the speed of the genset at the prescribed setpoint.

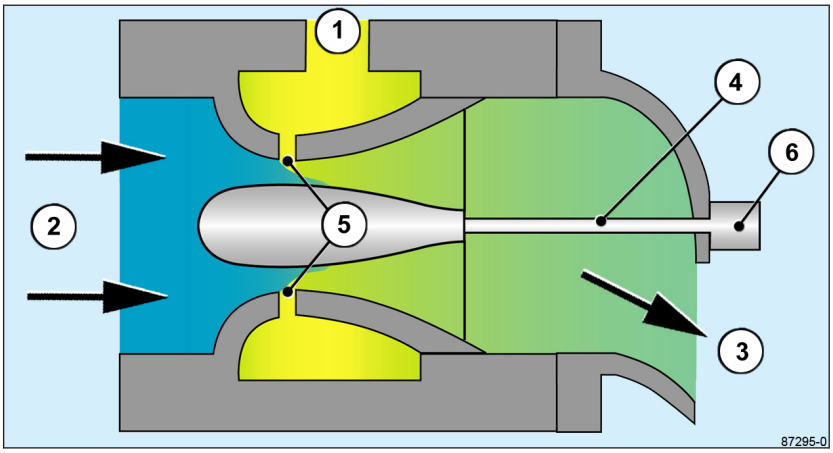
Power control is performed in grid-parallel operation. The generator is synchronized with the mains and in doing so defines the speed of the genset. The TPEM Control Unit maintains the power of the genset at the prescribed setpoint.

Combustion control including exhaust gas emissions control

The NOx emissions of the individual cylinders directly correlate to the measured combustion chamber temperature in the cylinder. The manipulation of the ignition angle brings the individual cylinders to the same level of emissions. This equalization of the cylinders has a positive effect on the engine's service life. This equalization aligns the load placed on the individual cylinders by the two related variables of pressure and temperature to one another.

The genset's NOx emissions are controlled by averaging the different cylinder temperatures and through manipulation of the amount of combustion gas mixed in. A spindle drive with stepper motor in the gas-air mixer adjusts the ring gap for this.

The fuel gas supplied to a greater or lesser degree to the combustion air introduced to the air stream determines the combustion air ratio (lambda).



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1 Gas inlet

2 Air inlet

3 Gas-air mixture outlet

4 Spindle drive for the stepper motor

5 Ring gap

6 Stepper motor

Knock monitoring and anti-knock control

Efficiency-optimized gas engines tend to develop knocking combustion under higher loads. In the event of knocking, there is a second combustion front from the volume of the mixture in the cylinder that has not combusted yet after the ignition triggered at the spark plug. Both of these combustion fronts spread in a roughly spherical shape and overlie and reinforce each other. This causes a high-frequency excitation of the engine

mechanics and the characteristic, audible knocking. Acceleration sensors on the crankcase measure the knocking. The anti-knock control converts the knocking into a cylinder-specific knocking intensity. The TPEM Control Unit delays the ignition timing of the affected cylinders in accordance with the level of knocking intensity until the knocking stops. The combustion then takes place at lower pressures and lower temperatures. When the knocking has stopped, the TPEM Control Unit brings the ignition timing back to the most efficient ignition timing in increments if possible.

Diagnosis and monitoring of engine parameters

The genset is monitored using a six-stage diagnostic strategy and alarm strategy. Along with engine parameters, values from the hardware and interface check are also considered. The respective limit values are individually adjustable for each parameter. The six event types range from a simple communication in the event of a tolerance deviation to the genset's immediate shutdown.

For more information on the event types, see

- Chapter 9 Operation ⇒ Functional group Messages ⇒ Submenu Logbook ⇒ Event types

Efficiency-increasing regulation of the charging process

In order to pre-compress a mixture for combustion, an exhaust turbocharger uses part of the exhaust energy. This means that high cylinder fillings, high specific outputs and high efficiencies can be achieved. The high charging rate and the power-oriented design of the charging process are primarily aimed at a small range of the characteristic diagram, namely full load at nominal speed. The gas engine is throttled with the throttle valve.

In engines with wastegate: A continuously variable wastegate on the exhaust turbocharger increases the efficiency in the partial load range and the response behavior in dynamic operation. One of the crucial variables in the control of the wastegate is the differential pressure across the throttle valve. Another name for this differential pressure is charge pressure reserve.

4.1.6 TPEM Connection Box (TPEM CB)

Interface between the TPEM Control Unit, the TPEM Control Cabinet and the gas valves of the gas control line.

For further information on the TPEM Connection Box, see

- Operating Manual ⇒ TPEM Control Cabinet ⇒ Assembly

4.1.7 TPEM Remote Client Desktop (TPEM RC DT)

The TPEM Remote Client Desktop (TPEM RC DT) is a piece of software for TPEM visualization on a computer. Required software version: 1.34.3.1 or later.

It is possible via a TPEM RC DT:

- For service: to perform remote diagnostics and remote maintenance of the plant
- For the operator: remote operation and monitoring of the plant

The remote access is realized via a router, the so-called TPEM Remote Plant Gateway, which displays the interface in the plant. The Remote Plant Gateway is installed in the TPEM Control Cabinet.

The remote access to the plant control is established using a secured connection (VPN tunnel).

To authenticate the users at the plant and when accessing remotely, a TPEM USB token is used. To transport data to and from the plant, TPEM USB storage is also necessary.

TPEM USB tokens and TPEM USB storages are encrypted and can only be read or written via TPEM Remote Client.

For more information on the TPEM RC DT, see

- Operating Manual ⇒ TPEM Remote Client Desktop

4.1.8 TPEM PLE

TPEM PLE (Product Link Elite) is a telematics hardware that reads telematics data from the genset and plant controls and transmits it via a network to an evaluation system (RAM) in real time.

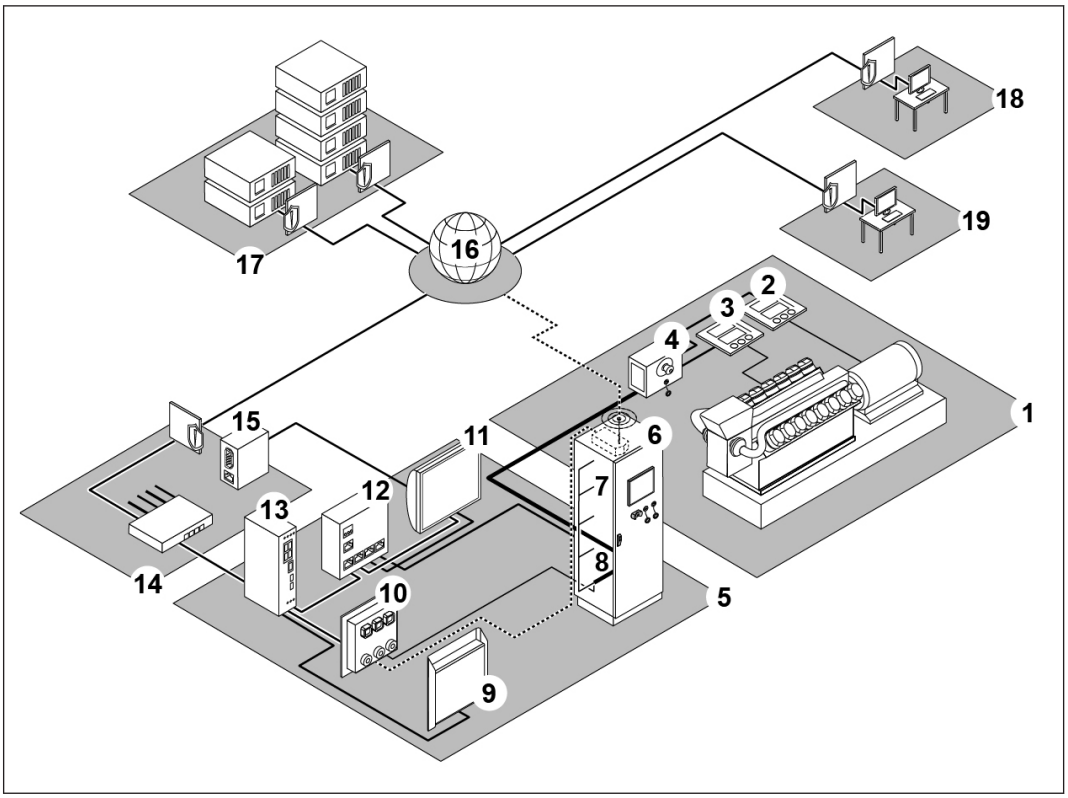
Components are:

- **Network Manager**: Router that records and stores plant data and sends it to the RAM server via an internet connection (WAN).
- **Mobile modem** (optional): Modem that sends data from the Network Manager to the RAM server via mobile radio.

Remote Asset Monitoring (RAM)

System that can remotely exchange, evaluate and visualize data with a genset or plant control.

The TPEM system is connected to RAM via the Network Manager (10) in the switch cabinet TPEM Control Cabinet (TPEM CC) (5) and its networking with the various electronic systems or components (9, 11-13). Depending on the situation, data exchange with RAM is done via connection to the local LAN (14) or via the optional TPEM PLE cellphone radio (6).



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1 Asset (genset)
2 Generator controller
3 TPEM Control Unit (TPEM CU)
4 TPEM Connection Box (TPEM CB)
5 TPEM Control Cabinet (TPEM CC), important installations are shown on the left
6 TPEM PLE cellphone radio (optional)

7 TPEM Modbus connection
8 TPEM CAN bus connection
9 TPEM Multifunction Relay (TPEM MFR)
10 TPEM PLE Network Manager
11 TPEM Touch Panel (TPEM TP) with operating computer
12 TPEM Switch
13 TPEM Remote Plant Gateway (TPEM RPG)
14 Operator-side network with firewall and internet connection
15 Operator-side Modbus connection
16 Wide Area Network (WAN)
17 RAM infrastructure with firewall and internet connection
18 RAM access for the service partner
19 RAM access for the operator

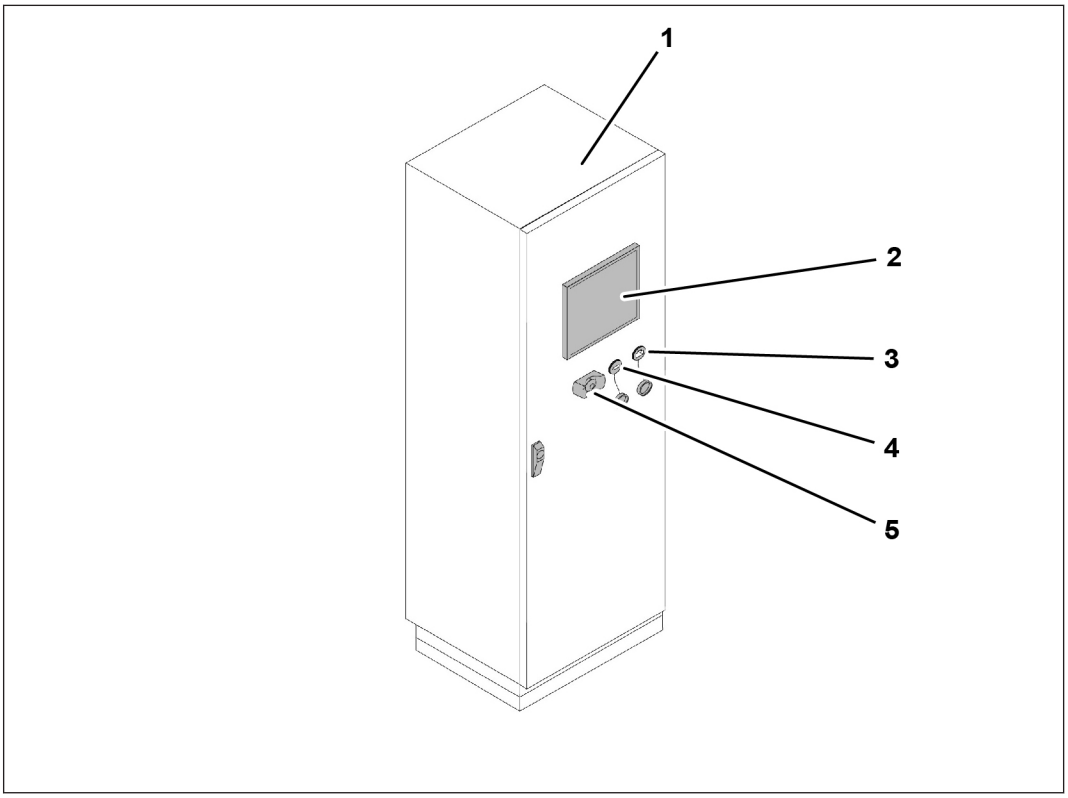
For further information on the TPEM PLE, see

- Operating manual ⇒ TPEM Product Link Elite Retrofit Kit

4.2 TPEM USB token

The software provides a range of operating and display options of the overall plant. The basic functions can be used safely by every suitably qualified and instructed user. Some areas of the parameterization remain reserved for specially trained personnel (e.g. commissioners) for safety reasons. The TPEM USB token and the authorization levels regulate who may use which functions.

4.2.1 TPEM USB token / TPEM USB storage



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1 TPEM Control Cabinet

2 TPEM Touch Panel

3 RJ45 interface

4 USB interface for TPEM USB token and TPEM USB storage

5 EMERGENCY stop button

A token activates functions which only specially trained users may access. When the TPEM USB token is inserted, the validity of the access authorization is checked (authentication). The user's actions are documented by the TPEM system. The serial number of the TPEM USB token is stored in the logbook for all actions.

The authorizations are stored on the TPEM USB token in compliance with the authorization levels. Users must attain and demonstrate the qualifications for working above authorization level 100 in training programs.

Depending on the order, several TPEM USB tokens with authorization level 50 may be part of the scope of supply. If included, the tokens are in a pocket in the cover of the first documentation folder.

TPEM USB tokens with and without integrated memory are in circulation. Both types of TPEM USB tokens make it possible to export data. Data export using TPEM USB tokens without integrated memory is only possible in conjunction with a separate TPEM USB storage. The TPEM USB storage is configured accordingly and can only be used for data export from TPEM.

Both TPEM USB tokens also offer data export via TPEM Remote Client DT.

TPEM USB token with integrated memory	
TPEM USB token without integrated memory	
TPEM USB storage	

Designation	Authentication possible?	Data export possible?	Software update possible?	Transferring Software Update Container to the IPC possible?
TPEM USB token with integrated memory	YES	YES	YES	YES
TPEM USB token without integrated memory	YES	only via TPEM RC (DT)	YES	No
TPEM USB token without integrated memory + TPEM USB storage	YES	YES	YES	YES

4.2.2 Authorization levels

Depending on their level of training and expertise, the users obtain a specific authorization level. Five authorization levels regulate the different access authorizations.

Operators

Level	Description
0	Access via local network or intranet with the TPEM Remote Client. No authentication by token required. Only reading rights, no operation possible.
50	Access via the Touch Panel without authentication or via local network with the TPEM Remote Client. Authentication via token with user name and password required. The following are possible: • Starting and stopping the genset • Power demand of the genset • Auxiliary drive tests • Lube oil change • Acknowledging events • Data export for token with integrated memory • Data export using tokens without integrated memory to TPEM USB storage
100	Access via TPEM Touch Panel with authentication by token. Access via local network or via remote access with the TPEM Remote Client and authentication by token with username and password. Operation of the TPEM interface is possible in compliance with the authorization level.

Service

Level	Description
200	Access via TPEM Touch Panel with authentication by token. Access via local network or via remote access with the TPEM Remote Client and authentication by token with username and password. Operation of the TPEM interface is possible in compliance with the authorization level.
230	Access authorization such as level 200. Operation of the TPEM interface for the generator, the TPEM Multi Function Relay and the TPEM Remote Plant Gateway is additionally possible in compliance with the authorization level. Additional required qualification: qualified electrician

4.2.3 Validity of the access authorization

Access authorizations are allocated for a limited time. Once validity has expired, the access authorization must be attained again with an appropriate training course.

The validity of the access authorization is checked when the TPEM USB token is inserted.

Details checked:

- Validity period of the access authorization
- Access authorization for the desired plant

If the checked TPEM USB token is valid:

- Authorization status is displayed
- Activated functions are adjusted to the new access authorization
- Homepage is reloaded

If the checked TPEM USB token is invalid (expired):

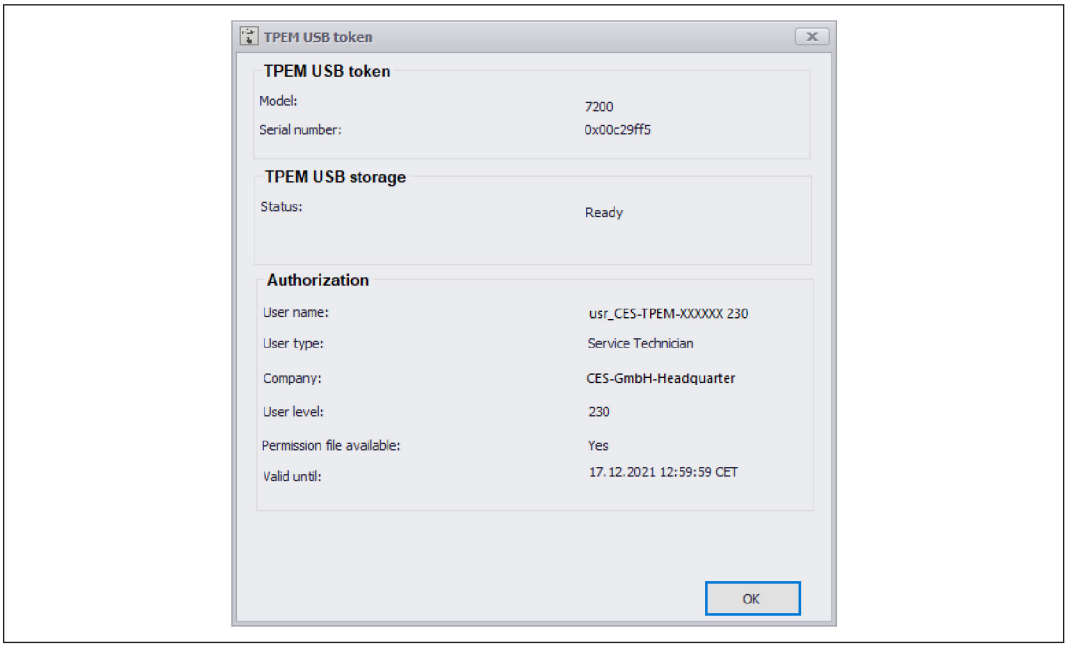
- Authorization status `no authorization` is displayed
- Activated functions are adjusted to the new access authorization

To retrieve access rights, see

- Section "Operation" ⇒ Function group "System" ⇒ Mask `Overview`

The `Overview` mask displays all essential authorization information.

4.2.4 Information about the TPEM USB token



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Different pieces of information about the TPEM USB token can be displayed. For example, the validity of a TPEM USB token can be checked and the TPEM USB token can be updated before the validity period expires.

The TPEM USB token window shows the following information:

Information	Value and description
User type	The following user types are possible: • Service Technician • Customer • Dealer
Authorization level	The authorization level shows the access authorization that exists until the validity of the TPEM USB token has expired.
Authorization file	Yes: An extended authorization file which regulates further authorizations was found on the TPEM USB token. This may be: temporary higher access authorization or temporary access to a certain plant.
	No: No extended authorization file was found on the TPEM USB token.
Status	Ready: The TPEM USB storage is ready for use.
	Not Initialized: The TPEM USB storage is not ready for use. The TPEM USB storage must be initialized. Initialization is performed automatically during the first connection to the TPEM RC DT or TPEM TP.
	Not Connected: No TPEM USB storage is connected to the USB interface.
	Unknown Error: The TPEM USB storage is not ready for use. An unknown error needs to be fixed with the help of the support.
Token valid until	Date and time after which the TPEM USB token loses the access authorizations entered into it.

For further information on initializing and updating TPEM USB token and TPEM USB storage, see

- Operating Manual ⇒ TPEM Remote Client Desktop

Accessing information about the TPEM USB token

1. Connect TPEM USB token to the USB interface.
2. In the “Help” menu, select “TPEM USB token”.
   → The TPEM USB token window appears.
3. Press the X button to close the interface.

4.3 TPEM Functions

The TPEM system comprises all functions that are required to ensure a reliable and comfortable control of the plant and genset.

- Connection of actuators and sensors to the TPEM IO Controller in the auxiliary drive cabinet and data transfer to the TPEM Control Cabinet via EtherCat
- Test mode for verification of connected actuators, sensors and auxiliary drives
- Recording of measured values (histories) for checking and diagnostic purposes
- Integrated data processing and monitoring of the sensors and actuators for electrical faults such as cable break and short-circuit
- Recording of alarms, warnings, operating messages and parameter changes with their dates and times of occurrence. The recordings are used for detailed monitoring of the operation
- Possibility of connection of a service laptop to a RJ45 interface directly on the TPEM Control Cabinet
- Operator access to the TPEM control via TPEM Rendezvous Server and TPEM Remote Plant Gateway e.g. for remote diagnostics and/or remote maintenance and connection to a local network
- TPEM Remote Client: Software for computer for remote diagnostics and remote maintenance by the service team and remote operation from remote control rooms by the operator

Depending on plant-specific features, the TPEM system can be supplemented by special functions.

4.3.1 Inputs and outputs in the TPEM system

Note

The following inputs and outputs are a component of the basic system. Further inputs and outputs are shown in the descriptions of the functions.

Digital inputs in the TPEM Control Cabinet

No.	ID	Designation	Feedback /Monitoring
101	---	Speed -	
102	---	Speed +	
		Circuit breaker safety chain	
		Circuit breaker, general	
375	---	Generator circuit breaker feedback open	GCB open
376	---	Mains circuit breaker feedback open	MCB open
431	---	Generator controller fault	
430	---	Generator controller warning	
		Slow ramp after mains decoupling	
		Enable GCB from ECU	

Digital outputs in the TPEM Control Cabinet

No.	Actuator	At +24 V	At 0 V
171	Generator controller, reactive power statics	On	Off
	Excitation Start		
	Mains parallel mode		
360	Generator circuit breaker, release TPEM CC	Release approved	No release
361	Open mains circuit breaker TPEM CC	Open circuit breaker	No command
900	Starter	On	Off

Digital inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	ID	Designation	Feedback
100	---	Contact demand genset	
124	PSA -	Gas control line A gas pressure	
125	PDSA -	Gas control line A leakage check	
132	PSA +	Gas control line A gas pressure monitor max. ⇒ Parameter `20130350 P132 gas GTR A monitoring`	
157	PSA +	Exhaust back pressure	Pressure too high
330	---	Oil reservoir pump monitoring ⇒ Parameter `20130189 Lube oil sump automatic refill`	
336	---	Engine cooling pump monitoring	
339	---	Prelubrication pump monitoring Requirement: Terminal 110K5-TIODI0501 is assigned a high signal	
341	---	Mains operator PF = 0.95 ind overexcited	
342	---	Mains operator PF = 0.97 ind overexcited	
343	---	Mains operator PF = 1.0	
344	---	Mains operator PF = 0.97 cap underexcited	
345	---	Mains operator PF = 0.95 cap underexcited	
346	---	Mains operator power limit 0 %	
347	---	Mains operator power limit 30 %	
348	---	Mains operator power limit 60 %	
349	---	Mains operator power limit 100 %	
379	GOSA+	Safety shut-off valve gas control line A ⇒ parameter `20130342 GCL A SSOV monitoring`	

No.	ID	Designation	Feedback
403	---	Circuit breaker, auxiliary drives	
597	---	Monitoring mains starting device ⇒ parameter `20130369 monitoring mains starting device`	
613	---	Starter battery charge monitoring ⇒ Parameter `20130375 613 starter batteries charge monitoring`	
	---	Circuit breaker 24 V	
621	LS+	Generator bearing A oil level full	
622	LS-	Generator bearing A oil level empty	
623	LS+	Generator bearing B oil level full	
624	LS-	Generator bearing B oil level empty	

Digital outputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	Actuator	At +24 V	At 0 V
	Genset operation mode	Automatic	Manual
267	Demand for preheating	On	Off
627	Feedback genset running	Genset running	Genset stopped
953	Gas leakage check A	Active	Inactive
998	Collective warning	No warning	Warning
999	Collective alarm	No alarm	Alarm

Analog inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	ID	Designation	Feedback
199	---	Demanded power	-
209	TISA +	Generator winding temperature U	Temperature too high
210	TISA +	Generator winding temperature V	Temperature too high
211	TISA +	Generator winding temperature W	Temperature too high
286	TISA +	Exhaust temperature downstream of engine (DENG)	Temperature too high
287	TISA +	Exhaust temperature downstream of catalytic converter A (DCAT)	Temperature too high
459	TISA +	Generator bearing temperature A-side (GB)	Temperature too high
460	TISA +	Generator bearing temperature B-side (GB)	Temperature too high
487	TISA +	Generator air temperature inlet	Temperature too high
488	TISA +	Generator air temperature outlet	Temperature too high

Analog outputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	ID	Designation	Feedback
238	---	Generator power factor actual value	

Inputs and outputs on the TPEM Control Unit

No.	ID	Designation	Feedback
145	PISA +	Crankcase chamber pressure	Pressure too high
159	GS -	Gas-air mixer position	Limit stop lean
177	GIS +	Throttle valve B position	Throttle valve open
196	PISA -	Lube oil pressure upstream of filter	Pressure too low
197	GIS +	Throttle valve A position	Throttle valve open
201	TICSA +	Receiver temperature A	Temperature too high
203	TISA +	Intake air temperature, cylinder row A	Temperature too high
208	TISA +	Lube oil temperature engine inlet	Temperature too high
232	PI	Receiver pressure, A-side	
234	LICSA +/-	Lube oil tray lube oil level	Minimum/maximum lube oil level
270	PI	Receiver pressure, B-side	
319	SC	Camshaft sensor	-
320	PDIC	Throttle valve A differential pressure	
321	PDIC	Throttle valve B differential pressure	
327	LICSA +/-	Oil reservoir lube oil level	Minimum/maximum lube oil level
371	PISA -	Compressed air monitor 16 - 20 bar	Pressure too low
378	TICSA +	Receiver temperature B	Temperature too high
377	TISA +	Intake air temperature, cylinder row B	Temperature too high
461 - 470	TISA +/-	Combustion chamber temperature, cylinder A1 - A10	Temperature too high / too low
471 - 480	TISA +/-	Combustion chamber temperature, cylinder B1 - B10	Temperature too high / too low
618	LSA +/+	Oil reservoir overfilled	Lube oil level overfilled
481	TIA +	Exhaust gas temperature upstream of ETC A	Temperature too high
482	TIA +	Exhaust gas temperature upstream of ETC B	Temperature too high
492	SICSA +	Speed ETC A	Speed too high
493	SICSA +	Speed ETC B	Speed too high
494	TIA +	Exhaust temperature downstream of ETC A	Temperature too high

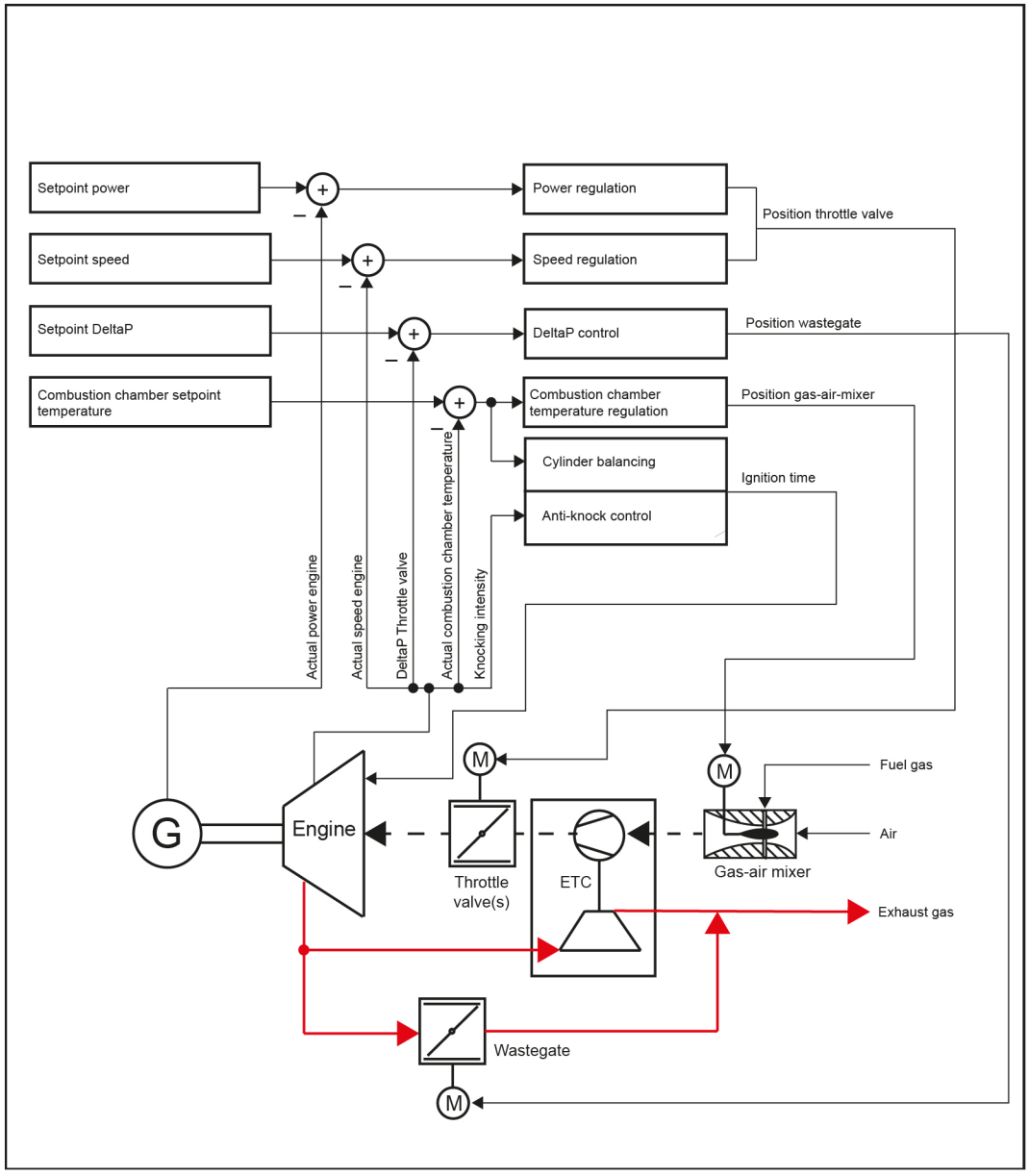
No.	ID	Designation	Feedback
495	TIA +	Exhaust temperature downstream of ETC B	Temperature too high
761 to 772	---	Ignition A1 to A12	
781 to 792	---	Ignition B1 to B12	

4.4 Engine control

The engine control is a conventional control system. The controlled variables speed or power, combustion chamber temperature and charge pressure reserve are each controlled by one control output.

The engine control regulates the engine by a set of simultaneous reactions of the throttle valve(s), gas-air mixer and, where necessary, wastegate, based on a control deviation (difference between setpoint value – actual value).

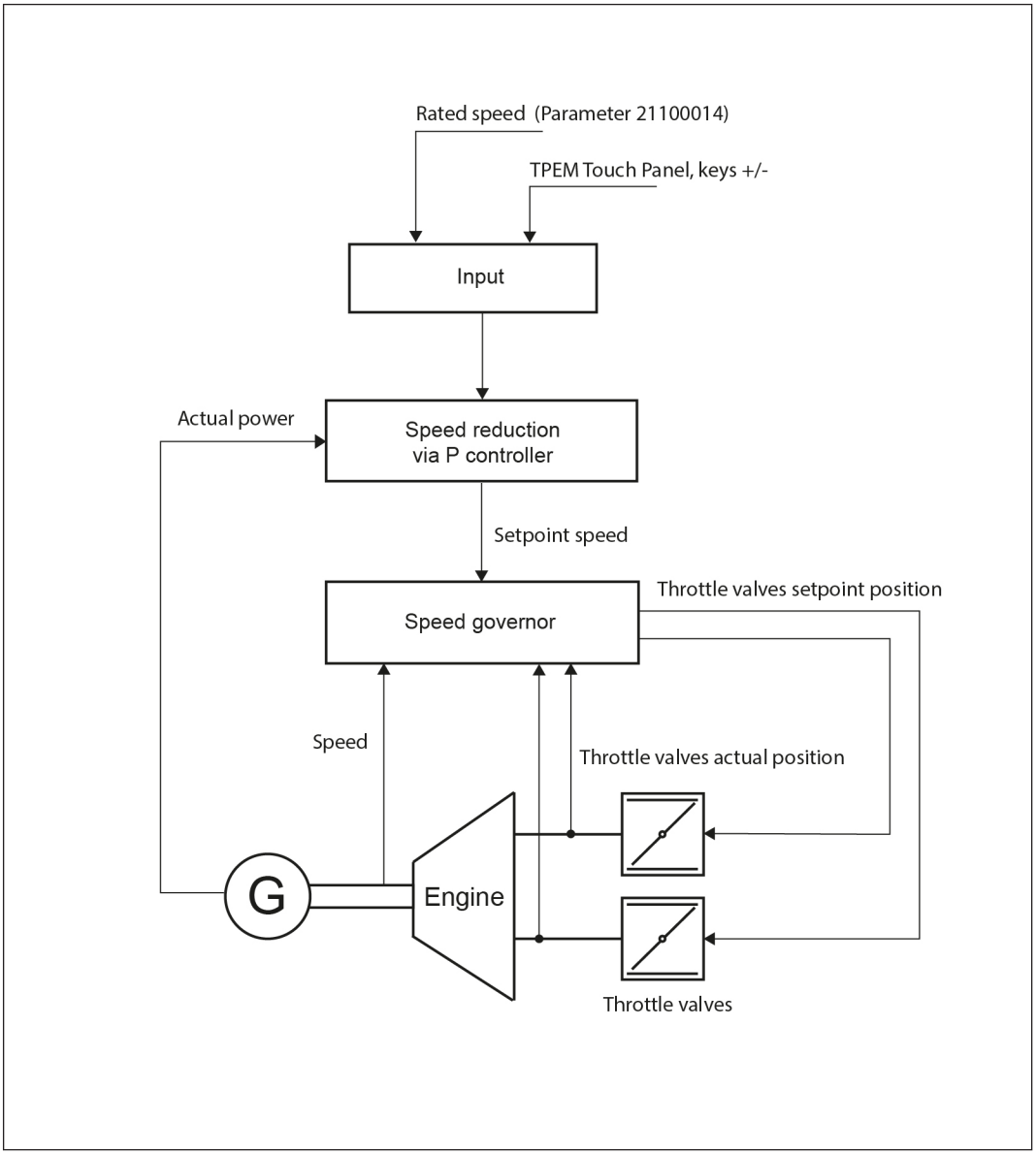
Equipment	TCG 3016			TCG 3020		
	V8	V12	V16	V12	V16	V20
Throttle valve, number	1	1	1	1	2	2
Wastegate in single-gas operation	no	no	yes	yes	yes	yes
Wastegate during dual gas operation	yes	yes	yes	yes	yes	yes
Exhaust turbocharger, number	1	1	1	1	2	2



61037-007

4.4.1 Speed control

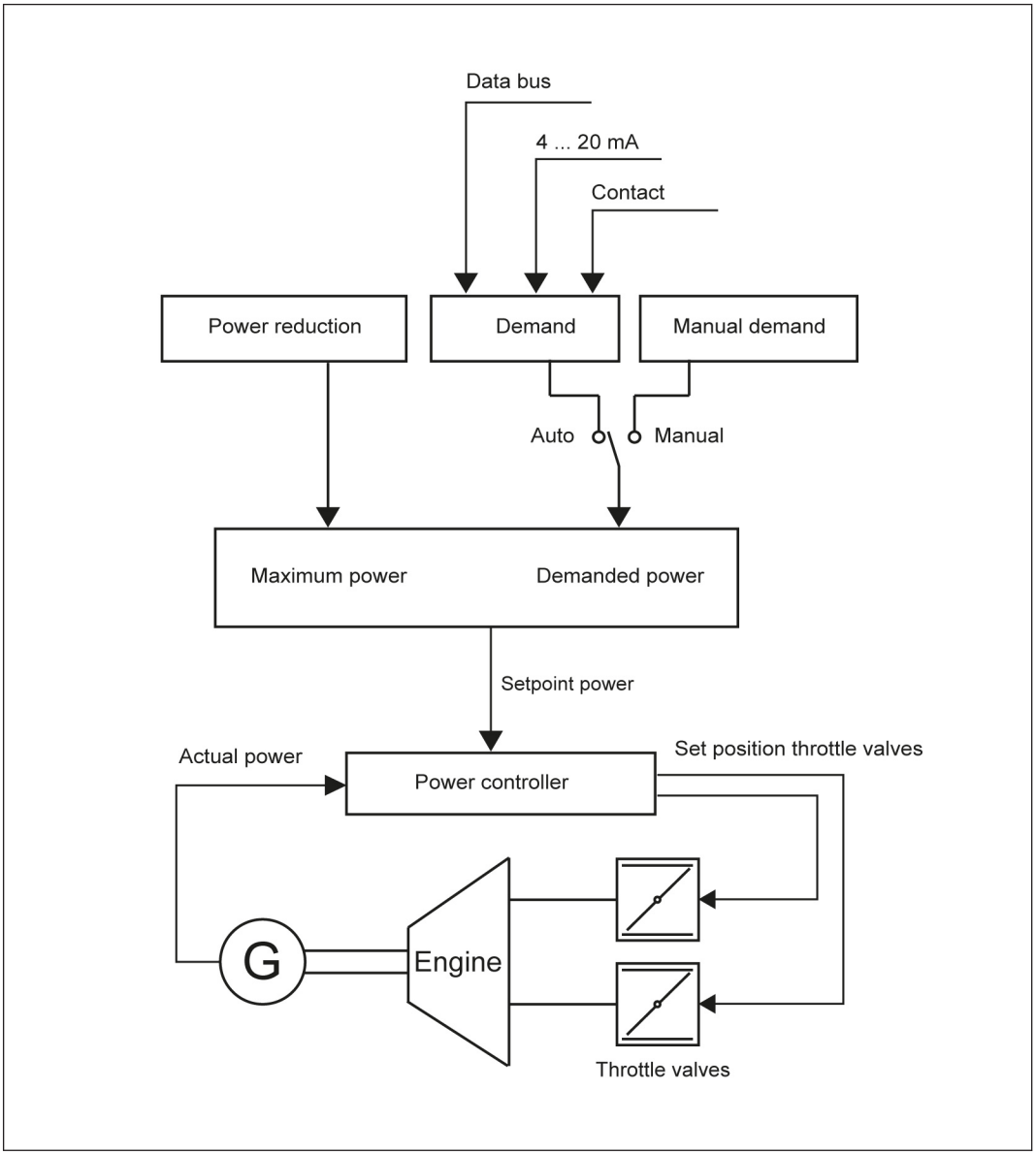
When running idle and in island mode, the speed governor sets the speed to a parameterized rated speed. The operator can manipulate the speed by +/- 2 % around this value. The load is controlled indirectly by specifying a speed deviation from the idle speed. When running in island mode, a load-dependent speed reduction ensures a uniform loading of multiple gensets operating in parallel.



61039-008

4.4.2 Power control

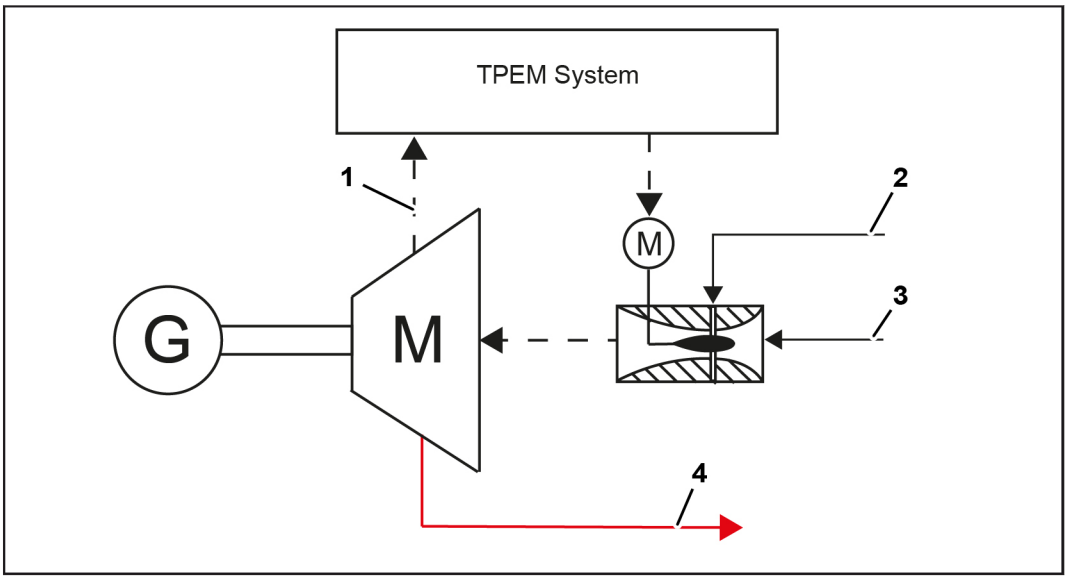
In mains parallel mode, the power controller controls the power of the genset to the demanded power in so far as it falls within the maximum permissible value.



61038-005

4.4.3 Exhaust emission control

Using the electronic mixture control integrated in the TPEM System, the genset attains stable low pollutant values at optimum efficiencies over the entire engine load range. The mixture control uses the average process temperatures or combustion chamber temperatures among others in all cylinders. The mixture control sets the gas supply of the genset at a gas-air mixer via a stepper motor.



61036-003

1 Combustion chamber temperatures

2 Fuel gas

3 Air

4 Exhaust gas

4.4.4 Reduced power

Overload

If there is a risk of the genset or individual components overloading, the TPEM system reduces the power limit. The reduced power prevents damage to the genset or prevents the genset from switching off. The genset is then run with less power than demanded. This behavior should be taken into consideration when a superior control is monitoring the actual power in relation to the demanded power.

Switching off

If there is also a risk of overload in normal operation or in power-reduced operation, the TPEM system will switch off the genset.

Island mode

In island mode, the TPEM system can only have a limited effect on the loading of the genset. In this operation mode, the operator must pay particular attention to the intake air temperature and the coolant temperature at the engine inlet. The TPEM Touch Panel displays a reduced power in a message.

The following states lead to reduced power:

- Coolant temperature in the engine cooling circuit at the engine inlet too high
- Gas-air mixture temperature in the receiver too high
- Knocking combustion, e.g. due to mixture being too rich
- Communication failure between main control device and knocking sensors
- In case of problems with the knocking sensors
- Fully opened throttle valve
- In case of failure of the throttle valve differential pressure sensors
- Speed of the exhaust turbocharger too high
- Combustion chamber temperature too high
- Combustion chamber sensors failed
- Persistent control errors in combustion chamber regulation
- CH_4 value in the fuel gas too low

4.4.5 Anti-knock control (AKC)

Functional description

The anti-knock control enables the best possible performance and efficiency for each cylinder under observance of the emission limits, even at low methane numbers.

The function of the anti-knock control can be governed very easily, particularly with the history function.

The operating cycle history shows the current knocking intensity and the ignition timing adjustments that result.

Inputs on the TPEM Control Unit

No.	ID	Designation	Monitoring
241-250	SSA+	Knocking sensor, cylinder rows A1 - A10	Knocking too loud Wire break
251-260	SSA+	Knocking sensor, cylinder rows B1 - B10	Knocking too loud Wire break
319	SC	Camshaft sensor	Angle of rotation Calibration
200	SICSA+	Engine speed	Speed too high

Control sequence

The anti-knock control has the effect of protecting the engine from knocking combustion. Knocking combustion causes an increase in the mechanical load of the engine.

The anti-knock control examines every engine cycle for knocking and determines a corresponding ignition timing for each individual cylinder. The anti-knock control adjusts the ignition timing for a knocking cylinder as early as during the next operating cycle.

The anti-knock control guarantees the most efficient operation free from knocking with a fluctuating gas quality with regards to the methane number and knock resistance. The fuel consumption is minimized at the same time.

The anti-knock control is based on the principle of measuring impact sounds. The impact sound signal is subjected to a spectral analysis. A digital signal processor (DSP) analyzes the digitized sensor signal. The result of the spectral analysis is the input variable for knocking detection and quantification of the knocking intensity. The extracted signal proportions relevant to knocking serve to form the input variable for the anti-knock control. Due to the spectral analysis, the anti-knock control is able to differentiate the sounds of knocking engine cycles. The anti-knock control only responds to engine cycles that are actually knocking.

Another function of the anti-knock control is the knocking history record. The knocking history record enables the knocking behavior for each cylinder to be tracked over a prolonged period.

Emission limits

Both the cylinder-specific ignition timing control and the mixture control contribute to compliance with the emission limits in all operating situations.

Reduced power

The anti-knock control adjusts the ignition timing and the composition of the gas-air mixture such that reduced power is only required in the event of a sharp reduction in the methane number. In the event that adjusting the ignition timing is not enough to drive the engine out of the knocking range, the power limit will be reduced.

Switching off

If there is also a risk of overloading the engine in power-reduced operation, it will be switched off by the TPEM System.

4.4.6 Wastegate

Equipment	TCG 3016			TCG 3020		
	V8	V12	V16	V12	V16	V20
Throttle valve, number	1	1	1	1	2	2
Wastegate in single-gas operation	no	no	yes	yes	yes	yes
Wastegate during dual gas operation	yes	yes	yes	yes	yes	yes
Exhaust turbocharger, number	1	1	1	1	2	2

Functional description

Gas engines are charged with exhaust turbochargers in order to increase the mixture pressure and thus to increase the engine power.

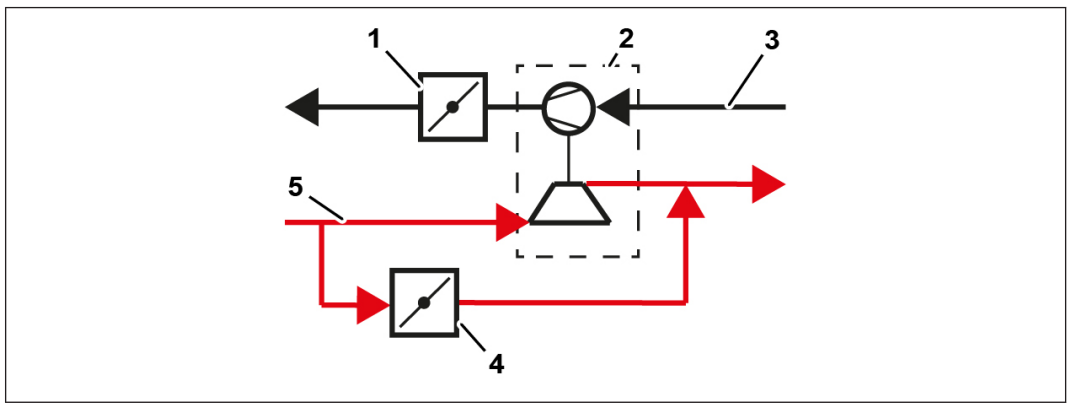
The exhaust turbocharger consists of these parts:

- Turbine: The turbine draws energy from the exhaust flow and drives the compressor via the common shaft
- Compressor: The compressor compresses the gas-air mixture

The TPEM system regulates the amount of the mixture available for combustion via the throttle valve installed downstream.

The wastegate regulates the exhaust energy for the turbine, if necessary. This increases the efficiency of the engine.

The TPEM system automatically regulates the wastegate. The TPEM system compensates environmental conditions such as fluctuations of the intake air temperature or the air pressure.



60788-004

1 Throttle valve
2 Exhaust turbocharger
3 Gas-air mixture
4 Wastegate
5 Exhaust gas

Inputs on the TPEM Control Unit

No.	ID	Designation	Monitoring
273	GIS +/-	Wastegate position	Position Wire break, short-circuit

Actuator control by the TPEM Control Unit

Actuator	Version
Actuator, wastegate	Position regulation

4.5 Demand for external starting preparations (DES)

4.5.1 Functional description

The function allows the genset startup to be subject to additional conditions. Examples of the conditions may include a started compressor blower or open exhaust dampers. The startup of the genset is disabled until corresponding feedback is available.

4.5.2 Inputs and outputs in the TPEM system

Digital inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	ID	Designation	Feedback
541	---	PM1 Feedback for external starting preparations	Message

Digital outputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	Version	At +24 V	At 0 V
625	Demand for external starting preparations	Demand	No demand

4.5.3 Control sequence

In the event of a start demand, the TPEM System sets the output. The output remains active until the genset stops.

Start release conditions

- The digital input for the enabling condition "Demand" is closed
- The input "Feedback for external starting preparations" is set

Parameters

- `60008009 DES (Demand for external starting preparations)`
- `20105449 DES feedback text 1`
- `20105458 DES feedback text 2`
- `20105463 DES feedback text 3`

4.6 CH_4 compensation (CH4)

4.6.1 Functional description

In plants with variable CH_4 content in the fuel gas such as in landfill gas plants, the genset performance can be optimally adjusted to the changing fuel gas values.

Parameters

- `20130014 CH4 compensation`
- `21380401 CH4 sensor`
- `20390009 CH4 value min (at 4 mA)`
- `20390014 CH4 value max (at 20 mA)`

4.6.2 Inputs and outputs in the TPEM system

Analog inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	ID	Designation	Sensor	Monitoring
311	QISA-	CH4 value	4 … 20 mA = 0 … 30-100 %	Dropping below the limit value

The assignment for the value 20 mA is parameterizable in the range of 30-100 % CH_4.

4.7 Dual gas operation

4.7.1 Functional description

Depending on the version of the plant, dual gas operation allows the genset to be operated with two different fuel gases. The gases are generally a quality gas, e.g. natural gas, hereinafter called gas type A, and a lean gas, e.g. biogas, hereinafter called gas type B.

There are three usage variants to be distinguished between:

- Full mix mode
- Admix mode
- Switch over operation

Full mix mode

It is possible to choose between two gas types or a mixture of the two when the genset is stopped or running. Both 100 % volume fraction of gas type A and 100 % volume fraction of gas type B can be selected, as well as any mixing ratio in between. A pre-pressure controller and a gas metering valve are available for each gas type. The pre-pressures must be set to identical values for both gas types. The pre-pressures must be chosen so that gas type B has sufficient reserves at 100 % volume fraction for 100 % of the genset load.

The request of the content of gas type B that is to be mixed with gas type A must be provided to the TPEM control. This is done via an analog input on the TPEM IO Controller or via the control system interface Modbus (parameter 20380169). A request via the TPEM Touch Panel is not possible.

If the request of the content of gas type B is < 5 %, operation takes place with 100 % gas type A. If the request of the content of gas type B is > 95 %, operation takes place with 100 % gas type B (parameters 21380115 and 21380128).

If the change in the mixing content of gas type B, e.g. from 70 % to 90 % or vice versa, is demanded when the genset is running, this is done with a ramp over a certain period of time (parameter 21380211 or 21380222). When the genset is stopped, the gas metering valves are adjusted without ramps.

See also the following parameters:

- `20380169 Dual gas control type`
- `20380057 Gas share B min (at 4 mA)`
- `20380061 Gas share B max (at 20 mA)`
- `21380115 Max demand gas type B for active GTR A`
- `21380128 Min demand gas type B for active GTR B`
- `21380211 Mix share gas B ramp positive`
- `21380222 Mix share gas B ramp negative`

Admix mode

Gas type A is mixed into gas type B using a fixed gap mixer. Gas type A can reach a maximum of 30 % volume fraction in this. The fixed gap mixer is a Venturi mixer. Gas type B is used instead of air like in a normal “gas-air” mixer. Gas type A is mixed in through the ring gap. Gas type A has an overpressure relative to gas type B. A gas metering valve for gas type A before the gas-air mixer makes it possible to influence the volume of gas type A that is mixed in.

The request of the content of gas type B that is to be mixed into gas type A must be provided to the TPEM control. This is done via an analog input on the TPEM IO Controller or via the control system interface Modbus (parameter 20380169). The request can be triggered when the genset is stopped or running. A request via the TPEM Touch Panel is not possible.

The request of the content of gas type B can be between 70 % and 100 %.

If the request of the content of gas type B is > 95 %, operation takes place with 100 % gas type B.

If the change in the mixing content of gas type B, e.g. from 70 % to 90 % or vice versa, is demanded when the genset is running, this is done with a ramp over a certain period of time (parameter 21380211 or 21380222). When the genset is stopped, the gas metering valve is adjusted without ramps.

See also the following parameters:

- 20380169 Dual gas control type
- 21380233 Minimum share gas type B in admix mode
- 20380057 Gas share B min (at 4 mA)
- 20380061 Gas share B max (at 20 mA)
- 21380115 Max demand gas type B for active GTR A
- 21380128 Min demand gas type B for active GTR B
- 21380211 Mix share gas B ramp positive
- 21380222 Mix share gas B ramp negative
- 20130401 GTR B leakage check

Switch over operation

Changing the gas type is only possible when the genset is stopped. The transition from one gas type to the other is done by restarting in the other gas type. The genset can start in either of the two gas types. Whether the next start is to be done with gas type A or gas type B is specified via a digital input, via the control system interface or directly via the HMI. If the digital input is active, gas type B is selected, otherwise gas type A. The switchover is made by opening the respective gas shut-off valves for gas type A or gas type B.

The monitoring at gas pressure loss is only done for the gas type used in each case. If the genset is started in a gas type that reports gas pressure loss, the start is aborted with a fault. If a gas pressure loss of the non-active gas type is detected, a warning occurs.

Switch over operation is possible with one or two gas trains. If the gas quality of the gas types is sufficient (propane and natural gas, for example), a gas train can be used for both gas types. The parameter 21351258 Number of gas trains defines the number of installed gas trains. In the case of operation with one gas train, only 2 gas shut-off valves instead of 4 are available via the TPEM and the optional monitoring for gas train B cannot be selected. The gas pressure loss of P127 can be used or bridged during commissioning. The setpoint for the combustion chamber temperature, the ignition timing, the start position for the gas-air mixer and the temperature of the mixture cooling circuit are switched according to the selected gas type.

See also the following parameters:

- 20380169 Dual gas control type
- 20130166 GTR A leakage check
- 20130401 GTR B leakage check
- 21351258 Number of gas trains

CH4 sensor

TPEM CU uses the measured CH4 value of gas type B and a value for gas type A that can be set via HMI to calculate the resulting gas quality.

The resulting gas quality = (CH4 value of gas type A × content of gas type A[%] + CH4 value of gas type B × content of gas type B[%])/100 %.

4.7.2 Effect of the dual gas operation on other functions

Ignition timing

The ignition timing is determined from a characteristic curve dependent on the gas quality.

See also the following parameters:

- 21330227 Global ignition angle (Y-axis)

Gas-air mixer start position

The gas-air mixer start position is determined from a characteristic curve dependent on the gas quality. This is done using a curve about the resulting gas quality.

See also the following parameters:

- 21260027 GAM A start position (X-axis)
- 21260016 GAM A start position (Y-axis)
- 21260091 GAM A start position: offset

Valve proving system

A gas leakage check is optional.

If the parameters for checking the gas trains for leaks are activated, the gas train of the active gas type is checked for leaks before every genset start (exception for black start). If the gas train is found to be leaking in this check, the start of the genset is aborted.

See also the following parameters:

- 20130166 GTR A leakage check
- 20130401 GTR B leakage check

Power decrease

The limit for the power decrease because of excessive receiver temperature (T201) is dependent on the gas type. There is one value each for gas type A and gas type B here. If only one gas type is used, the appropriate values in that case are used. If both gas types are active, the lower value in that case is used.

MCC T set mixture cooler inlet gas type B at 40 %

There are separate set values for gas type A and gas type B at each of 40 % load and 100 % load. An interpolation takes place for setpoint A and setpoint B each over the power. If gas type A is active, the setpoint value for gas type A is used. If gas type B is active, the setpoint value for gas type B is used. If any mixing ratio of the two gas types is being used, the minimum of the two set values is used.

See also the following parameters:

- 20750040 T202 set MCC inlet at 40 % power
- 20750054 T202 set MCC inlet at 100 % power
- 20750185 T202 set MCC inlet at 40 % power gas type B
- 20750199 T202 set MCC inlet at 100 % power gas type B

MCC T set recooler outlet gas type B at 40 %

There are separate set values for gas type A and B at each of 40 % load and 100 % load. An interpolation takes place for setpoint value A and setpoint value B each over the power. If gas type A is active, the setpoint value for gas type A is used. If gas type B is active, the setpoint value for gas type B is used. If any mixing ratio of the two gas types is being used, the minimum of the two set values is used.

See also the following parameters:

- 20750006 T405 set MCC RDTR outlet at 40 % power
- 20750011 T405 set MCC RDTR outlet at 100 % power
- 20750173 T405 set MCC RDTR outlet at 40 % power gas type B
- 20750161 T405 set MCC RDTR outlet at 100 % power gas type B

Maximum power

There are separate setpoints for gas type A and gas type B. If only one gas type is active, the corresponding setpoint is used. If gas mixing is operated with shares of gas types A and B, the lower value from the parameter pair 21100023 Set power maximum value (gas type A) and 21100038 Set power maximum value gas type B is always used.

Throttle valves set differential pressure

There are separate set values for gas types A and B.

If only one gas type is active, the corresponding setpoint is used. If both gas types are active, the two set values are determined and the curve between them is interpolated depending on the mixing ratio.

See also the following parameters:

- 21270517 TV P diff set mains parallel mode (Y-axis)
- 21270525 TV P diff set island mode (Y-axis)
- 21270530 TV P diff set mains parallel mode gas type B (Y-axis)
- 21270549 TV P diff set island mode gas type B (Y-axis)

Gas train B gas pressure monitor max.

A gas train gas pressure monitor max. is used for certain applications. This goes to an input on the TPEM IO Controller and in the event of an error triggers an alarm.

See also the following parameters:

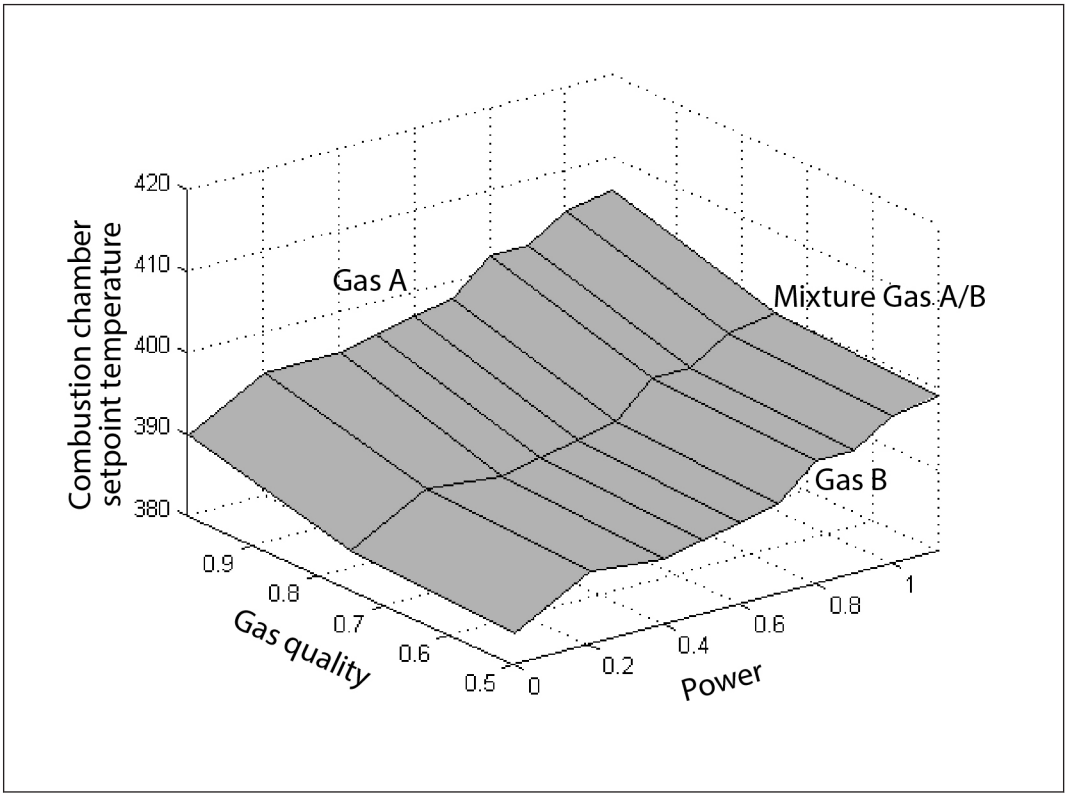
- 20130350 P132 gas GTR A monitoring
- 20380073 P152 gas GTR B monitoring

Combustion chamber temperature set curve in full mix mode and admix mode

In full mix mode and in admix mode the combustion chamber set temperature is calculated from three characteristic curves.

- T set combustion chamber at max expected gas quality (gas type A)
- T set combustion chamber at min expected gas quality (gas type B)
- T set combustion chamber at average expected gas quality (mixture of gas type A and gas type B)

The third characteristic curve includes the combustion chamber set temperature values for the most frequently used mixing ratio. With regards to the gas quality, this is between gas type A and gas type B.



68148-001 Combustion chamber set temperature in full mix mode and admix mode characteristic diagram

The gas qualities increase in the following order:

Gas type B < Mixture of gas type A and gas type B < Gas type A.

If the gas quality is lower than the gas quality assigned to the mixed gas set temperature characteristic curve, the curve between the “Gas type B” and “Mixture of gas type A and gas type B” set temperature characteristic curves is interpolated.

If the gas quality is higher than the gas quality assigned to the mixed gas set temperature characteristic curve, the curve between the “Mixture of gas type A and gas type B” and “Gas type A” set temperature characteristic curves is interpolated.

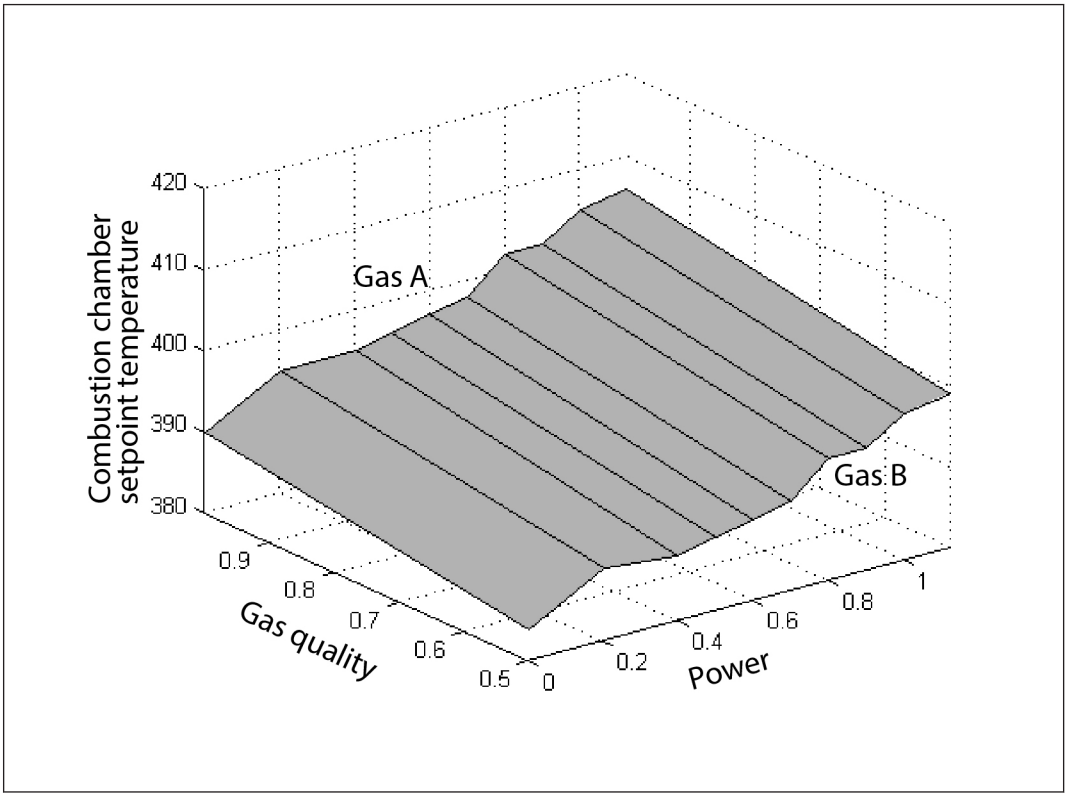
The gas quality values from 0 to 1 used in the two characteristic diagrams correspond to the following CH4 values:

Gas quality	CH4 value
1	89 %
0.9	80 %
0.8	71 %
0.7	62 %
0.6	53 %
0.56	50 %
0.5	45 %
0.4	36 %
0.3	27 %
0.2	18 %
0.1	9 %
0	0 %

Combustion chamber temperature set curve in switch over operation

In switch over operation the combustion chamber set temperature is calculated from two characteristic curves.

- `T set combustion chamber at max expected gas quality (gas type A)`
- `T set combustion chamber at min expected gas quality (gas type B)`



68155-001 Combustion chamber set temperature in switch over operation characteristic diagram

If the gas quality is lower than that of the gas type A set temperature characteristic curve, the curve between the "Gas type A" and "Gas type B" set temperature characteristic curves is interpolated.

4.7.3 Inputs and outputs in the TPEM system

Digital inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	ID	Designation	Feedback
107	---	Selection of gas type B	
124	PSA-	Gas control line A gas pressure	Pressure too low
125	PDSA+	Gas control line A leakage check	Pressure too low
147	TSA+	Gas control line A temperature monitor	Temperature too high
599	GOSA+	Gas control line A safety shut-off valve	Valve closed
127	PSA-	Gas control line B gas pressure	Pressure too low
128	PDSA+	Gas control line B leakage check	Pressure too low
131	TSA+	Gas control line B temperature monitor	Temperature too high
595	GOSA+	Gas control line B safety shut-off valve	Valve closed

No.	ID	Designation	Feedback
132	PSA+	Gas control line A gas pressure monitor max.	Pressure too high
152	PSA+	Gas control line B gas pressure monitor max. ⇒ parameter `20380073 P152 gas GTR B monitoring`	Pressure too high

Digital outputs on the TPEM IO Controller in the auxiliary drive cabinet

Actuator	at +24 V	at 0 V
Gas shut-off valve A1	Open	Closed
Gas shut-off valve A2	Open	Closed
Gas shut-off valve B1	Open	Closed
Gas shut-off valve B2	Open	Closed

Analog inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	ID	Designation	Sensor	Monitoring
108	H	Demand value gas type B	4 … 20 mA = 0 % … 100 %	
602	GIC	Gas metering valve gas type A Valve position	4 … 20 mA = 0 % … 100 %	none
603	GIC	Gas metering valve gas type B Valve position	4 … 20 mA = 0 % … 100 %	none

Analog outputs on the TPEM IO Controller in the auxiliary drive cabinet

Actuator	Version	
Gas metering valve gas type A	Setpoint position	4 ... 20 mA = Closed 0 %... Open 100 %
Gas metering valve gas type B	Setpoint position	4 ... 20 mA = Closed 0 %... Open 100 %

4.8 Mixture cooling circuit (MCC)

Activates with parameter `20130417 MCC RDTR type`

4.8.1 Functional description

To achieve greater rated power, turbocharged gas engines are fitted with a mixture cooler. The mixture cooler cools the compressed gas-air mixture after the exhaust turbocharger in two stages.

The gas-air mixture first flows through the high-temperature stage of the mixture cooler and then the low-temperature stage.

The return flow from the engine cooling circuit is fed through the high-temperature stage, which is not regulated in relation to the mixture cooling circuit.

Coolant from the mixture cooling circuit is fed through the low-temperature stage. The mixture cooling circuit controls the coolant temperature at the inlet into the mixture cooler (TIC 202) in accordance with the parameterized characteristic curve. It is recommended that the heat is discharged via an independent recooler ⇒ `Mixture cooling circuit recooler (MMC RDTR)` or together with the recooler of the engine cooling circuit in a dual core radiator ⇒ `Dual core radiator in the engine cooling circuit and mixture cooling circuit (DCR).`

4.8.2 Inputs and outputs in the TPEM system

Safety chain digital inputs in the TPEM Control Cabinet

No.	ID	Designation	Feedback
308	LSA –	Mixture cooling circuit low liquid level	Low liquid level

Digital inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	ID	Designation	Feedback
309	PDSA –	Mixture cooling circuit, pressure difference, flow monitor	Δp too low
335	---	Mixture cooling circuit pump monitoring	MCC pump failed
885	GIS +	Mixture cooling circuit 3-way valve limit stop cold (open, to recooler)	Limit stop cold (Open)
886	GIS –	Mixture cooling circuit 3-way valve limit stop warm (closed, bypass)	Limit stop warm (Closed)

Digital outputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	Actuator	At +24 V	At 0 V
329	Mixture cooling circuit pump	ON	OFF
629	Mixture cooling circuit 3-way valve direction of movement colder	colder	–
630	Mixture cooling circuit 3-way valve direction of movement warmer	warmer	–

Inputs on the TPEM Control Unit

No.	ID	Designation	Feedback
201	TICSA +	Receiver temperature	Wire break, short-circuit
202	TIC	Mixture coolant temperature inlet	Wire break, short-circuit

4.8.3 Control sequence

For further information on parameterization and setting of the desired values, see

- Separate operating manual ⇒ TPEM Parameter description ⇒
  - Initial setup
  - Heating circuit (HC), cooling circuits (ECC, DCC, MCC) ⇒ Mixture cooling circuit (MCC)

Control

The inlet temperature of the coolant into the mixture cooler (TIC 202) is controlled to a parameterizable characteristic curve with the parameters 20750040 and 20750054 or 20750185 and 20750199. To do so, the controller operates on the 3-way valve ahead of the coolant of the mixture cooler.

Power decrease

If the temperature of the gas-air mixture in the receiver at 100 % load (TICSA 201) exceeds the limit, the genset can no longer deliver the maximum power.

In order to prevent overloading the engine, the power is reduced (parameters 21202212 and 21202236).

The power is reduced on a ramp of 3 % per Kelvin of excess temperature.

Switching off

If the temperature exceeds the limit by five Kelvin in power-reduced operation, the genset will be switched off.

Parameters

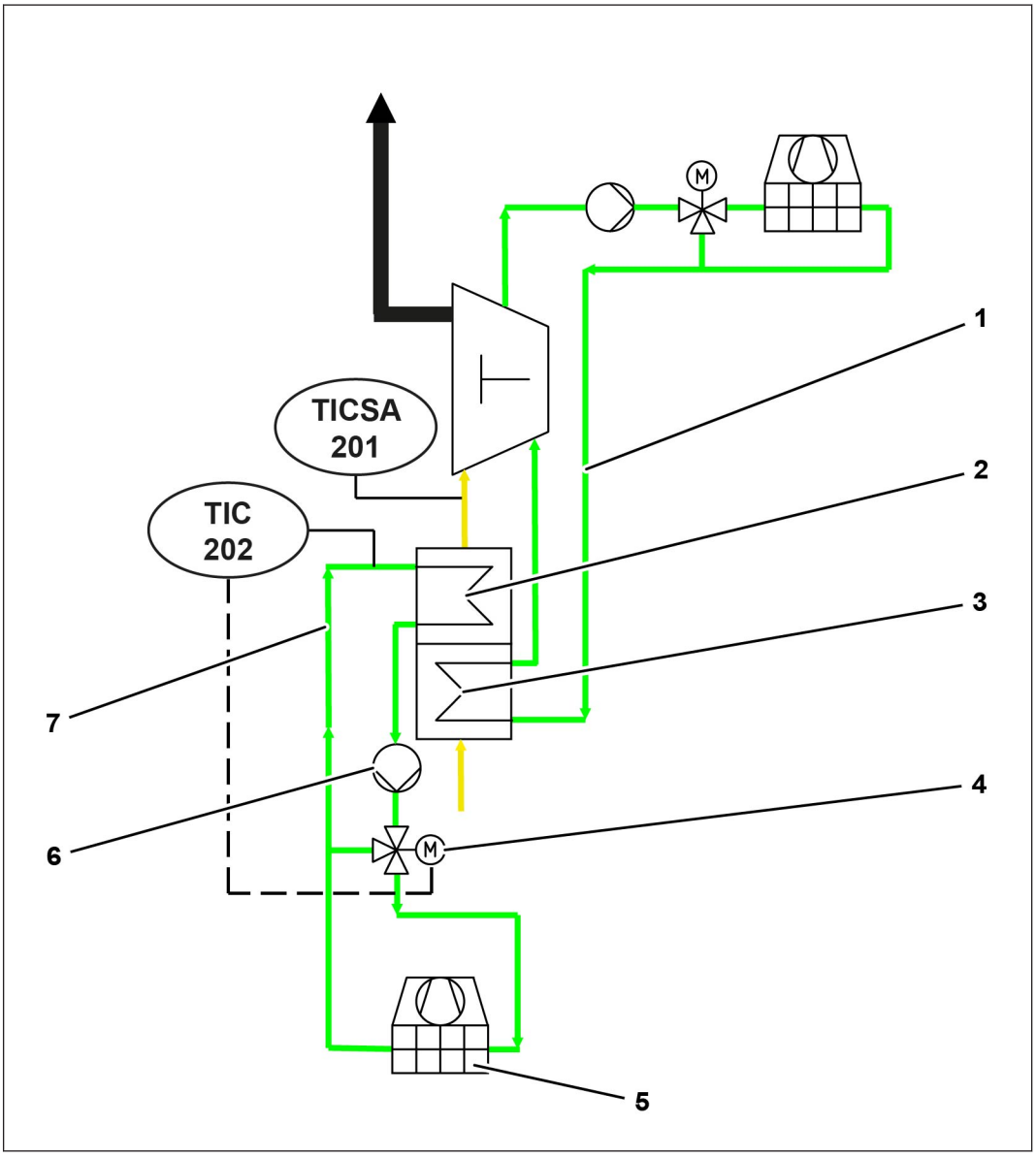
- `20130417 MCC RDTR type`
- `20750040 T202 set MCC inlet at 40 % power`
- `20750054 T202 set MCC inlet at 100 % power`
- `20750185 T202 set MCC inlet at 40 % power gas type B`

- 20750199 T202 set MCC inlet at 100 % power gas type B
- 20480047 MCC control P proportional gain
- 20480052 MCC control D proportional gain
- 20480071 MCC pump switch-off delay
- 20480083 MCC control dead band
- 20480094 MCC control low pass time
- 21202212 RP from T201 receiver gas type A
- 21202236 RP from T201 receiver gas type B

4.8.4 Flow diagram: mixture cooling circuit

Note

The flow diagram is an example. The order-specific documents contain the exact equipment and the technical implementation of the assembly.



60772-003

1	Engine cooling circuit	5	Recooler in mixture cooling circuit
2	Mixture cooler LT stage	6	Mixture cooling pump
3	Mixture cooler HT stage	7	Mixture cooling circuit
4	3-way valve mixture cooling circuit		

4.9 Mixture cooling circuit recooler (MCC RDTR)

Activates with parameter `20130417 MCC RDTR type`.

If the system is parameterized for a dual core radiator, parameter `20130417 MCC RDTR type` is not available ⇒ Section `Dual core radiator in the engine cooling circuit and mixture cooling circuit (DCR)`.

4.9.1 Functional description

In the low-temperature stage of the mixture cooling circuit, it is recommended to discharge the heat via an independent recooler.

The TPEM system can be parameterized for one of the following recooler variants:

- Recooler with frequency control (infinitely variable ventilator speed)
- Recooler with stage switching (max 8 stages)
- External control, heat is discharged by the customer

Only one of the above mentioned variants can be selected.

Aim of the regulation

- Safe maintenance of the coolant temperature at the recooler outlet (TIC 405)
- Minimal energy consumption for the ventilators of the recooler

An advantage of frequency-controlled recoolers is the reduced noise at nighttime. Due to the low outdoor temperatures, the required cooling output can still be achieved when the ventilator is at a lower speed.

4.9.2 Inputs and outputs in the TPEM system

Digital inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	Designation	Feedback
332	MCC RDTR FC monitoring	FC failed

Digital outputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	Actuator	At +24 V	At 0 V
340	MCC RDTR FC demanded	ON	OFF
---	MCC RDTR cooler group 1-8	Stage ON	Stage OFF

Analog inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	ID	Designation	Sensor	Monitoring
405	TIC	MCC RDTR outlet temperature	4 … 20 mA = 0 … 200 °C	Wire break

Analog outputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	Actuator	Version	
992	Set speed MCC RDTR FC	Recooler ventilator speed	4 … 20 mA = 0 …100 %

4.9.3 Control sequence recooler with frequency control

For further information on parameterization and setting of the desired values, see

- Separate operating manual ⇒ TPEM Parameter description ⇒
  - Initial setup
  - Heating circuit (HC), cooling circuits (ECC, DCC, MCC) ⇒ Mixture cooling circuit (MCC)

The control of the recooler in the mixture cooling circuit is active together with the control of the mixture cooling circuit.

In the case of recoolers with frequency control, all ventilators are activated with the mixture cooling circuit pump. When the cooling demand increases or decreases, the ventilator speeds are increased or decreased via a frequency converter.

Control to the outlet temperature at the recooler in mixture cooling circuit

The outlet temperature at the recooler in the mixture cooling circuit (TIC 405) is controlled to a parameterizable characteristic curve, see also the following parameters:

- `20750006 T405 set MCC RDTR outlet at 40 % power`
- `20750011 T405 set MCC RDTR outlet at 100 % power`
- `20750173 T405 set MCC RDTR outlet at 40 % power gas type B`
- `20750161 T405 set MCC RDTR outlet at 100 % power gas type B`

The ventilator speed is infinitely variable.

Setting recommendation

Set the desired value for the outlet temperature at the recooler in mixture cooling circuit (TIC 405) so that it is > 3 K below the desired value for the inlet temperature at the mixture cooler (TIC 202) ⇒ `Mixture cooling circuit (MCC)`. The 3-way valve in the mixture cooling circuit constantly mixes in a small amount of warm coolant. Both controllers are in use.

Parameters

- `20130417 MCC RDTR type`
- `20750006 T405 set MCC RDTR outlet at 40 % power`
- `20750011 T405 set MCC RDTR outlet at 100 % power`
- `20750173 T405 set MCC RDTR outlet at 40 % power gas type B`
- `20750161 T405 set MCC RDTR outlet at 100 % power gas type B`
- `20490049 MCC RDTR control P proportional gain`
- `20490074 MCC RDTR control I proportional gain`
- `20490058 MCC RDTR control D proportional gain`
- `20490082 MCC RDTR control low pass time`

4.9.4 Control sequence recooler with stage switching

For further information on parameterization and setting of the desired values, see

- Separate operating manual ⇒ TPEM Parameter description ⇒
  - Initial setup
  - Heating circuit (HC), cooling circuits (ECC, DCC, MCC) ⇒ Mixture cooling circuit (MCC)

The control of the recooler in the mixture cooling circuit is active together with the control of the mixture cooling circuit.

In the case of recoolers with stage switching, the cooling capacity is controlled by switching on or off cooling units (e.g. ventilators) in cooling steps. To do so, several cooling units can be combined to form a cooler group which are addressed by TPEM via a common digital output. When the cooling demand increases or decreases, the changeover between the cooling stages takes place by activating or deactivating another cooler group so that one cooler group is active in cooling stage 1, two cooler groups are active in cooling stage 2, and so on. The following applies to ventilator cooler stages: All ventilators are operated at an identical, constant speed.

Control to the outlet temperature at the recooler in mixture cooling circuit

The outlet temperature at the recooler in the mixture cooling circuit (TIC 405) is controlled to a parameterizable characteristic curve, see also the following parameters:

- `20750006 T405 set MCC RDTR outlet at 40 % power`
- `20750011 T405 set MCC RDTR outlet at 100 % power`
- `20750173 T405 set MCC RDTR outlet at 40 % power gas type B`
- `20750161 T405 set MCC RDTR outlet at 100 % power gas type B`

Individual cooler stages are activated or deactivated depending on the cooling demand. A downtime prevents the cooler stages from switching frequently. The downtime is parameterizable (parameter 20490105).

If the outlet temperature at the recooler in mixture cooling circuit (TIC 405) is longer than the reaction time and the temperature difference is greater than the desired value, cooler stages are activated at downtime intervals.

Setting recommendation

Set the desired value for the outlet temperature at the recooler in mixture cooling circuit (TIC 405) so that it is > 3 K below the desired value for the inlet temperature at the mixture cooler (TIC 202) ⇒ `Mixture cooling circuit (MCC)`. The 3-way valve in the mixture cooling circuit constantly mixes in a small amount of warm coolant. Both controllers are in use.

As a result of its design, brief fluctuations in the inlet temperature at the mixture cooler (TIC 202), which are corrected in the mixture cooling circuit by the control valve, occur when activating and deactivating the individual cooling stages.

Make the downtime for the switchover process long enough to avoid any unnecessary switching. Too large a downtime makes it difficult for the setpoint value to be adhered to.

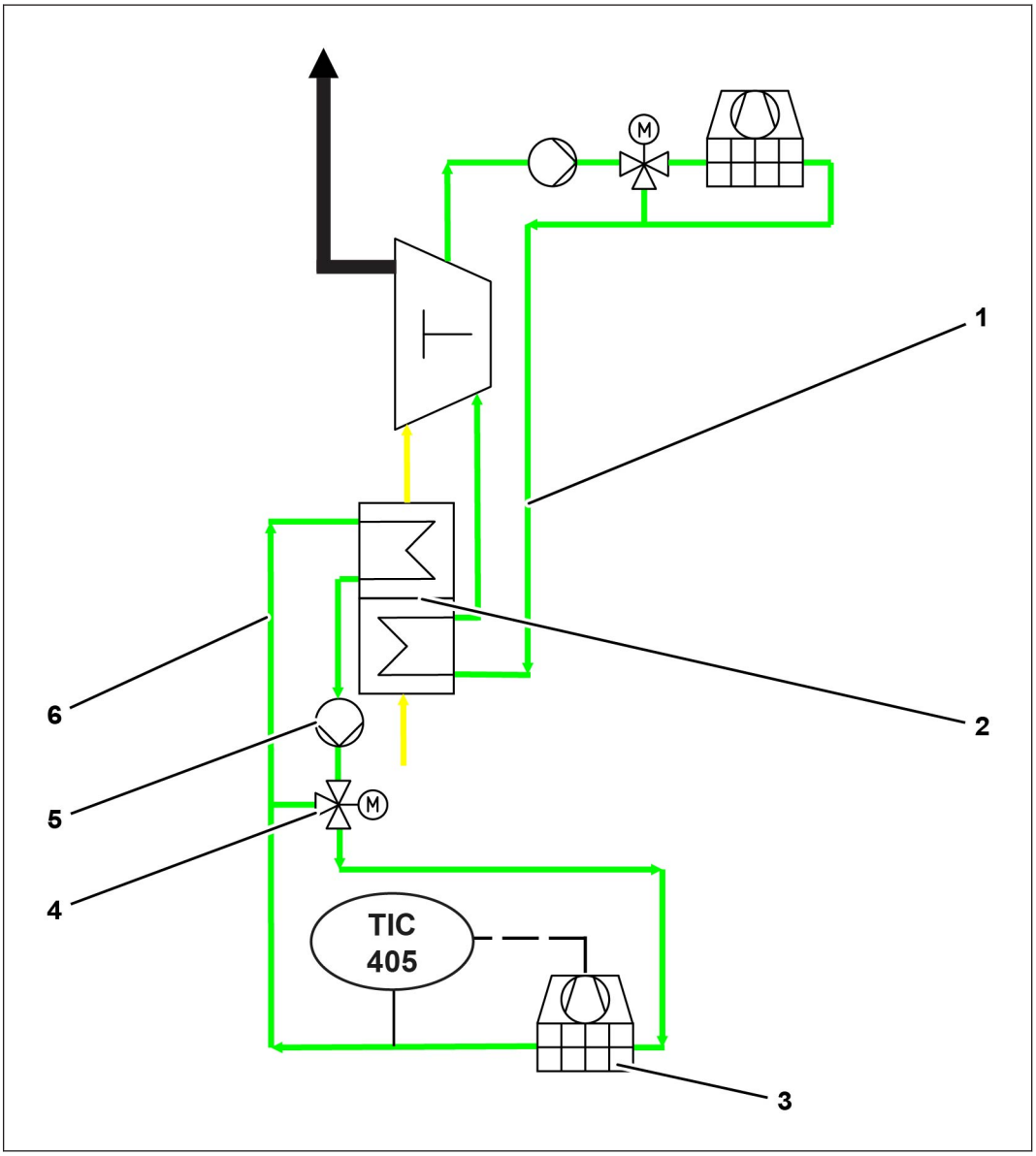
Parameters

- 20130417 MCC RDTR type
- 20750006 T405 set MCC RDTR outlet at 40 % power
- 20750011 T405 set MCC RDTR outlet at 100 % power
- 20750173 T405 set MCC RDTR outlet at 40 % power gas type B
- 20750161 T405 set MCC RDTR outlet at 100 % power gas type B
- 20490096 MCC RDTR max stage number
- 20490118 MCC RDTR temperature difference
- 20490105 MCC RDTR downtime
- 20490126 MCC RDTR reaction time

4.9.5 Flow diagram: recooler with frequency control or stage switching in the mixture cooling circuit

Note

The flow diagram is an example. The order-specific documents contain the exact equipment and the technical implementation of the assembly.



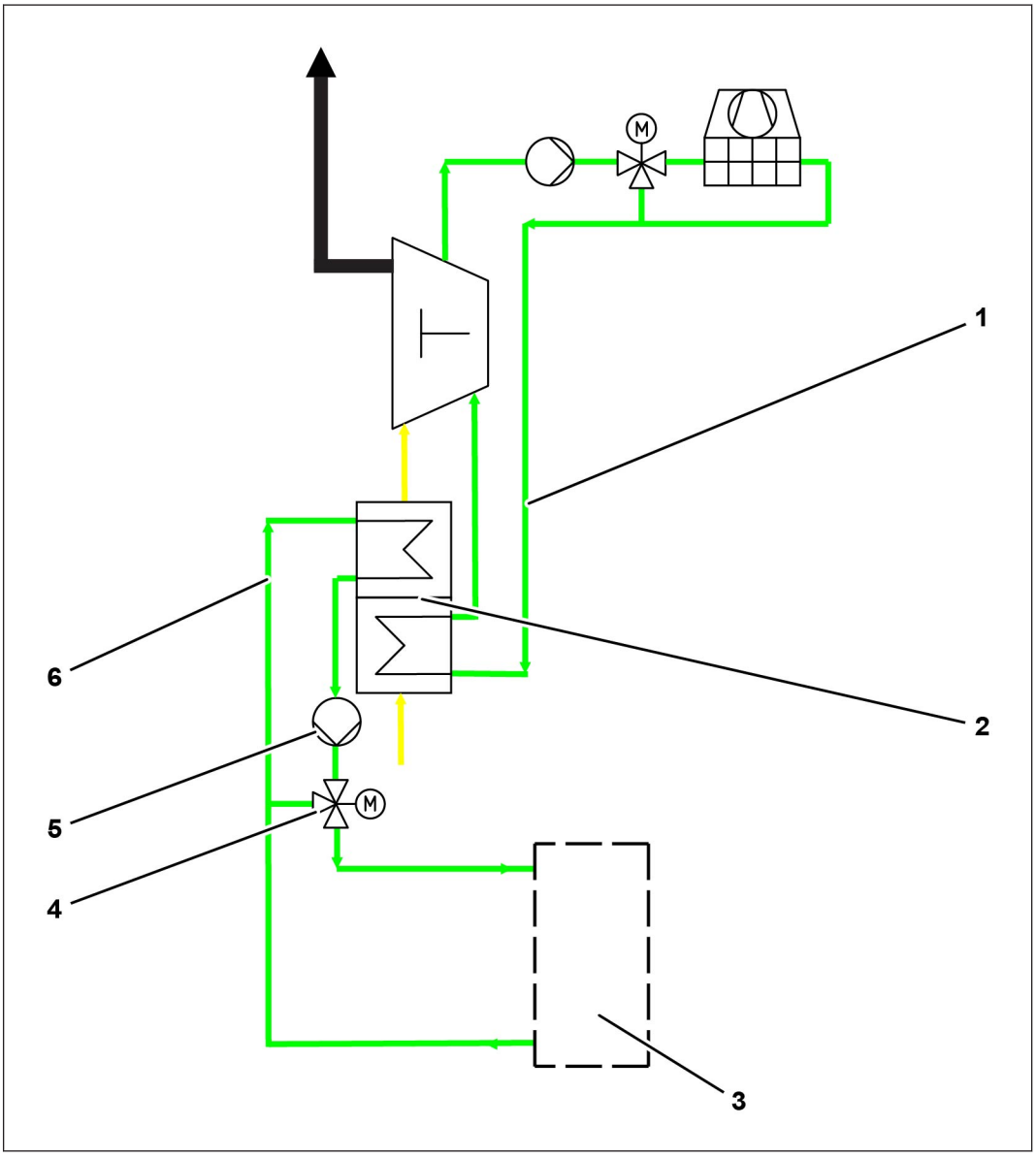
60773-003

1	Engine cooling circuit	4	3-way valve mixture cooling circuit
2	Mixture cooler	5	Mixture cooling circuit pump
3	Recooler in mixture cooling circuit	6	Mixture cooling circuit

4.9.6 Flow diagram: heat discharge through external control in the mixture cooling circuit

Note

The flow diagram is an example. The order-specific documents contain the exact equipment and the technical implementation of the assembly.



68382-002

1	Engine cooling circuit	4	3-way valve mixture cooling circuit
2	Mixture cooler	5	Mixture cooling circuit pump
3	External control for heat discharge (by customer)	6	Mixture cooling circuit

4.10 Heating circuit control (HC)

Activated with parameter 20130505 HC

4.10.1 Functional description

An aim of the heating circuit control is to guarantee a constant flow temperature of the heating water even when the engine is at partial load. Another aim is to satisfy the requirements of the engine with regards to the coolant temperature.

The inlet temperature of the engine coolant (TICSA + 207) and the heating circuit flow temperature (TIC 291) are regulated by controlling a 3-way valve in the heating circuit.

Additional monitoring devices such as flow monitors and safety temperature limiters are generally required for operating the heating circuit. These monitoring devices are positioned in the safety chain of the TPEM System and also monitored separately.

4.10.2 Inputs and outputs in the TPEM system

The heating circuit contains all the measuring points of the engine cooling circuit. However, the 3-way valve is in the heating circuit.

Safety chain digital inputs in the TPEM Control Cabinet

The inputs represent a maximum configuration for a heating circuit with heating water temperatures of 110 °C < T_{Flow} < 120 °C.

No.	ID	Designation	Monitoring
231	PDZA –	EHE 2 differential pressure flow monitor	Δp too low
276	TZA ++	Heating circuit safety temperature limiter 1	Temperature too high
277	TSA +	Heating circuit temperature monitor 1	Temperature too high
278	PZA –	Heating circuit pressure monitor minimum 1	Pressure too low
279	PZA +	Heating circuit safety pressure limiter maximum 1	Pressure too high
280	LZA –	Low liquid level of heating circuit	Low coolant level
281	PDZA – PDSA –	Heating circuit differential pressure flow monitor	Δp too low
435	TZA ++	Heating circuit safety temperature limiter 2	Temperature too high
436	TSA +	Heating circuit temperature monitor 2	Temperature too high
437	PZA +	Heating circuit safety pressure limiter maximum 2	Pressure too high
438	PZA –	Heating circuit pressure monitor minimum 2	Pressure too low

Digital inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	ID	Designation	Feedback
126	PDSA –	Engine cooling circuit differential pressure flow monitor	Δp too low
281	PDZA – PDSA –	Heating circuit differential pressure flow monitor (bridged input)	Δp too low
336	---	Engine cooling pump monitoring	No fault

No.	ID	Designation	Feedback
337	---	Heating circuit pump monitoring	No fault
867	GIS +	Engine cooling circuit 3-way valve end position direction of movement colder	Limit stop cold (Open)
870	GIS +	Exhaust bypass open position	Limit stop open
871	GS +	Exhaust bypass closed position	Limit stop closed
880	GIS +	Heating circuit 3-way valve limit stop cold (Open)	Limit stop cold (Open)
881	GIS –	Heating circuit 3-way valve limit stop warm (Closed)	Limit stop warm (Closed)
890	GIS +	Dump cooling circuit 3-way valve limit stop cold (open)	Limit stop cold (Open)
891	GIS –	Dump cooling circuit 3-way valve limit stop warm (closed)	Limit stop warm (Closed)

Digital outputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	Actuator	At +24 V	At 0 V
631	Engine cooling circuit pump	ON	OFF
634	Heating circuit pump	ON	OFF
635	Heating circuit valve direction of movement colder	colder	–
636	Heating circuit valve direction of movement warmer	warmer	–
640	Open EHE bypass motion direction Control signal open exhaust bypass valve and close valve upstream of EHE	activated	deactivated
641	Close EHE bypass motion direction Control signal close exhaust bypass valve and open valve upstream of EHE	activated	deactivated

Analog inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	ID	Designation	Sensor
289	TIS	Heating circuit temperature return	4...20 mA = 0...200 °C
290	TI	Heating circuit temperature before cooling water heat exchanger	4...20 mA = 0...200 °C
291	TIC	Heating circuit temperature flow	4...20 mA = 0...200 °C
385	TI	Heating circuit temperature before exhaust heat exchanger (option)	4...20 mA = 0...1000 °C
386	TI	Heating circuit temperature before lube oil heat exchanger (option)	4...20 mA = 0...1000 °C

Inputs on the TPEM Control Unit

No.	ID	Designation
206	TISA +	Coolant temperature engine outlet
207	TICSA +	Coolant temperature engine inlet
497	PISA -	Coolant pressure engine outlet

4.10.3 Control sequence

For further information on parameterization and setting of the desired values, see

- Separate operating manual ⇒ TPEM Parameter description

Control

The heating circuit flow temperature is set depending on the design of the heat exchangers, the pumps and the load. The setpoint temperature characteristic curve for TICSA + 207 is parameterizable with the parameters 20750065 and 20750079.

If the heating circuit flow temperature (TIC 291) exceeds the parameterizable setpoint value (parameter 20430092), then the setpoint value for the inlet temperature of the engine coolant is slowly reduced. The reduction can be maximum 10 K from the setpoint. The system stabilizes at the setpoint value for TIC 291 or a value below the setpoint temperature characteristic curve for TICSA + 207 after a certain amount of time.

Power decrease

If the temperature of the coolant at the engine inlet (TICSA + 207) exceeds the limit, the power is reduced so that no knocking combustion occurs.

The power is reduced on a ramp of 3 % per Kelvin of excess temperature.

Switching off

If there is also a risk of knocking combustion in power-reduced operation, the genset will be switched off.

Parameters

- `20750065 T207 set ECC engine inlet at 40 % power`
- `20750079 T207 set ECC engine inlet at 100 % power`
- `20430092 HC supply flow control T291 set`
- `20430076 HC supply flow control P proportional gain`
- `20430084 HC supply flow control I proportional gain`
- `20430207 HC supply flow control low pass time`
- `20430130 ECC pump switch-off delay`

Exhaust bypass

Activation

If the following conditions are met at the same time, exhaust bypass control is activated and the emergency cooling is enabled:

- Exhaust bypass system activated (parameter `20450004 EHE bypass`)
- The 3-way valve in HC is at full flow to the heating circuit (G880 end position cold) and the 3-way valve in the engine cooling circuit is at full flow to the CHE (G867 end position cold).

Deactivation

If the following conditions are met at the same time, the exhaust bypass control is deactivated and the emergency cooling is canceled:

- The above-mentioned conditions for activation are no longer fulfilled.
- The exhaust bypass is closed (G871 end position closed).
- The 3-way valve in the dump cooling circuit is closed (G891 end position warm).
- The heating water flow temperature (T291) no longer exceeds the setpoint value by the parameterized temperature difference.
- The parameterized downtime has expired.

Deactivation primarily prevents the intervention of the emergency cooling while the full exhaust heat is being introduced into the system via the EHE. The bypass can be controlled continuously.

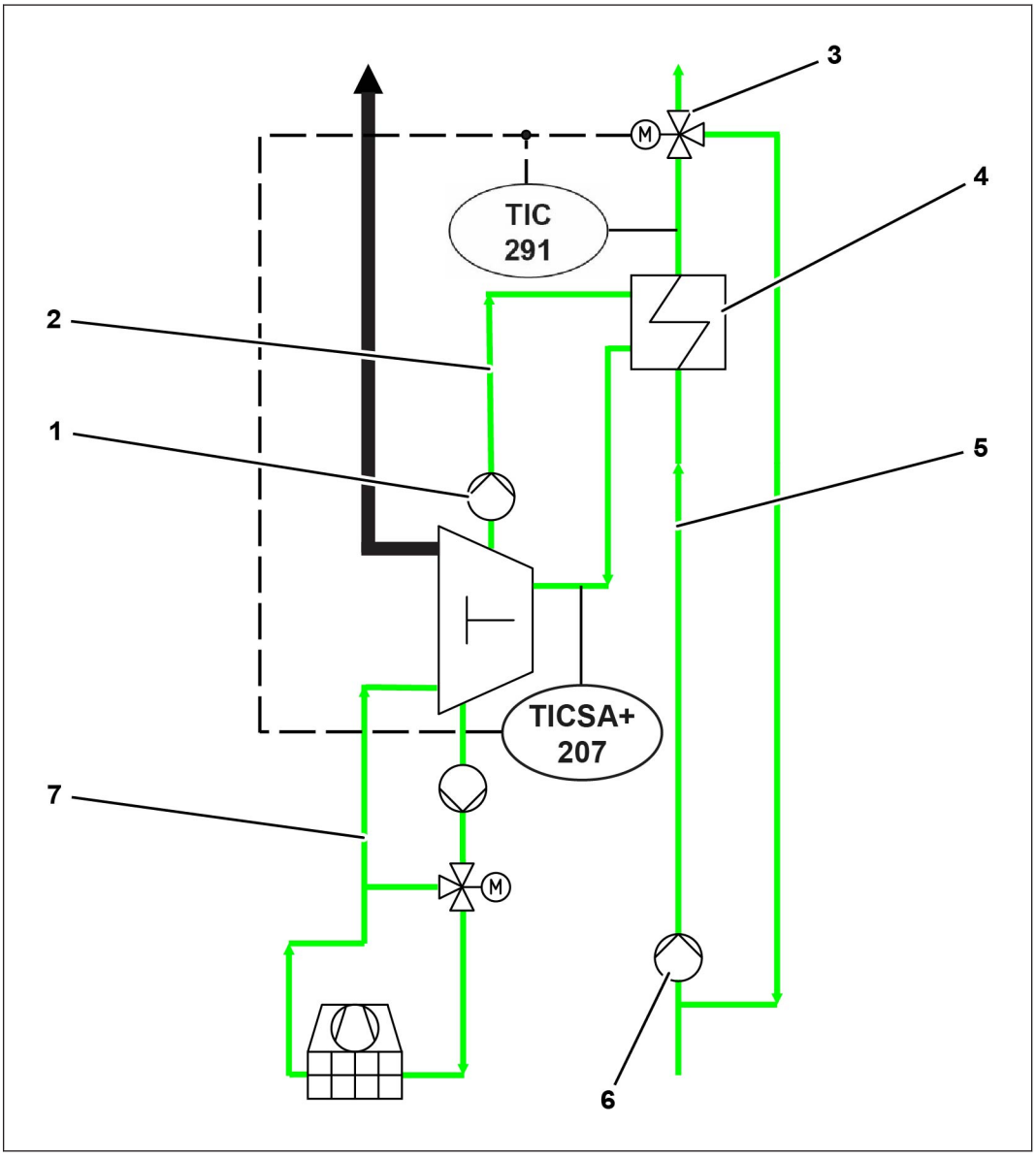
Parameters

- 20450004 EHE bypass
- 20450048 EHE bypass T diff to T291 set
- 20450061 EHE bypass control low pass time
- 20450020 EHE bypass control P proportional gain
- 20450012 EHE bypass control D proportional gain
- 20450036 EHE bypass control dead band

4.10.4 Flow diagram: heating circuit with coolant heat exchanger

Note

The flow diagram is an example. The order-specific documents contain the exact equipment and the technical implementation of the assembly.



60774-003

1	Engine cooling circuit	4	Heating circuit
2	3-way valve heating circuit	5	Heating circuit pump
3	Coolant heat exchanger	6	Mixture cooling circuit

4.11 Heating circuit with exhaust heat exchanger in the ECC or HC

4.11.1 Functional description

An exhaust heat exchanger is used to extract part of the heat energy from the engine's exhaust gas. The energy is then available for raising the heating circuit temperature.

The exhaust heat exchanger can be arranged both in the engine cooling circuit and directly in the heating circuit. If configured in the engine cooling circuit, the heat energy is firstly transmitted to the engine cooling circuit and then to the heating circuit in the cooling water heat exchanger. If configured in the heating circuit, the heat energy is directly transmitted to the heating circuit.

Exhaust bypass

The exhaust bypass control enables the plant to reduce the heat flow into the heating circuit and to maintain temperatures at the desired level. The engine output does not need to be reduced and the excess heat does not need to be discharged via the cooler.

The exhaust bypass system consists of two valves in the exhaust system of the plant which route the exhaust flow via the exhaust heat exchanger in normal operation. The bypass is blocked and the bypass valve is closed.

When the exhaust bypass system is activated, the exhaust heat exchanger is partially or completely bypassed through a controlled opening of the bypass valve.

Typically, two valves are installed, which are connected to one another in order to be operated by one actuator. Opening the bypass valve closes the heat exchanger valve and vice versa.

4.11.2 Inputs and outputs in the TPEM system

The heating circuit contains all the measuring points of the engine cooling circuit. However, the 3-way valve is in the heating circuit.

Safety chain digital inputs in the TPEM Control Cabinet

The inputs represent a maximum configuration for a heating circuit with heating water temperatures of 110 °C < T_{Flow} < 120 °C.

No.	ID	Designation	Monitoring
126	PDSA –	Engine cooling circuit differential pressure flow monitor	Δp too low
135	TZA ++	Engine cooling circuit safety temperature limiter 1	Temperature too high
137	TSA +	Engine cooling circuit temperature monitor	Temperature too high
138	PZA	Engine cooling circuit pressure monitor minimum 1	Pressure too low
139	PZA +	Engine cooling circuit safety pressure limiter maximum 1	Pressure too high
237	PZA ++	Engine cooling circuit safety pressure limiter maximum 2	Δp too low
261	LSA –	Low liquid level of engine cooling circuit 2	Low coolant level

Digital inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	ID	Designation	Feedback
126	PDSA -	Engine cooling circuit differential pressure flow monitor (input bridged)	Δp too low
126	PDSA -	Engine cooling circuit differential pressure flow monitor	Δp too low
281	PDSA -	Heating circuit differential pressure flow monitor	Δp too low
336	---	Engine cooling pump monitoring	No fault
337	---	Heating circuit pump monitoring	No fault
867	GIS +	Engine cooling circuit 3-way valve end position direction of movement colder	Limit stop cold (Open)
870	GIS +	Exhaust bypass open position	Limit stop open
871	GS +	Exhaust bypass closed position	Limit stop closed
880	GIS +	Heating circuit 3-way valve limit stop cold (Open)	Limit stop cold (Open)
881	GIS –	Heating circuit 3-way valve limit stop warm (Closed)	Limit stop warm (Closed)
890	GIS +	Dump cooling circuit 3-way valve limit stop cold (open)	Limit stop cold (Open)
891	GIS –	Dump cooling circuit 3-way valve limit stop warm (closed)	Limit stop warm (Closed)

Digital outputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	Actuator	At +24 V	At 0 V
631	Engine cooling circuit pump	ON	OFF
634	Heating circuit pump	ON	OFF
635	Heating circuit valve direction of movement colder	colder	–
636	Heating circuit valve direction of movement warmer	warmer	–
640	Open EHE bypass motion direction Control signal open exhaust bypass valve and close valve upstream of EHE	activated	deactivated
641	Close EHE bypass motion direction Control signal close exhaust bypass valve and open valve upstream of EHE	activated	deactivated

Analog inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	ID	Designation	Sensor
288	TI	Exhaust temperature after exhaust heat exchanger	4...20 mA = 0...200 °C
289	TI	Heating circuit temperature return	4...20 mA = 0...200 °C
290	TI	Heating circuit temperature before cooling water heat exchanger	4...20 mA = 0...200 °C
291	TIC	Heating circuit temperature flow	4...20 mA = 0...200 °C
385	TI	Heating circuit temperature before exhaust heat exchanger	4...20 mA = 0...200 °C
386	TI	Heating circuit temperature before lube oil heat exchanger (option)	4...20 mA = 0...200 °C
412	TI	Coolant temperature after exhaust heat exchanger	4...20 mA = 0...200 °C

Inputs on the TPEM Control Unit

No.	ID	Designation
206	TISA +	Coolant temperature engine outlet
207	TICSA +	Coolant temperature engine inlet
497	PISA –	Engine coolant, engine outlet pressure

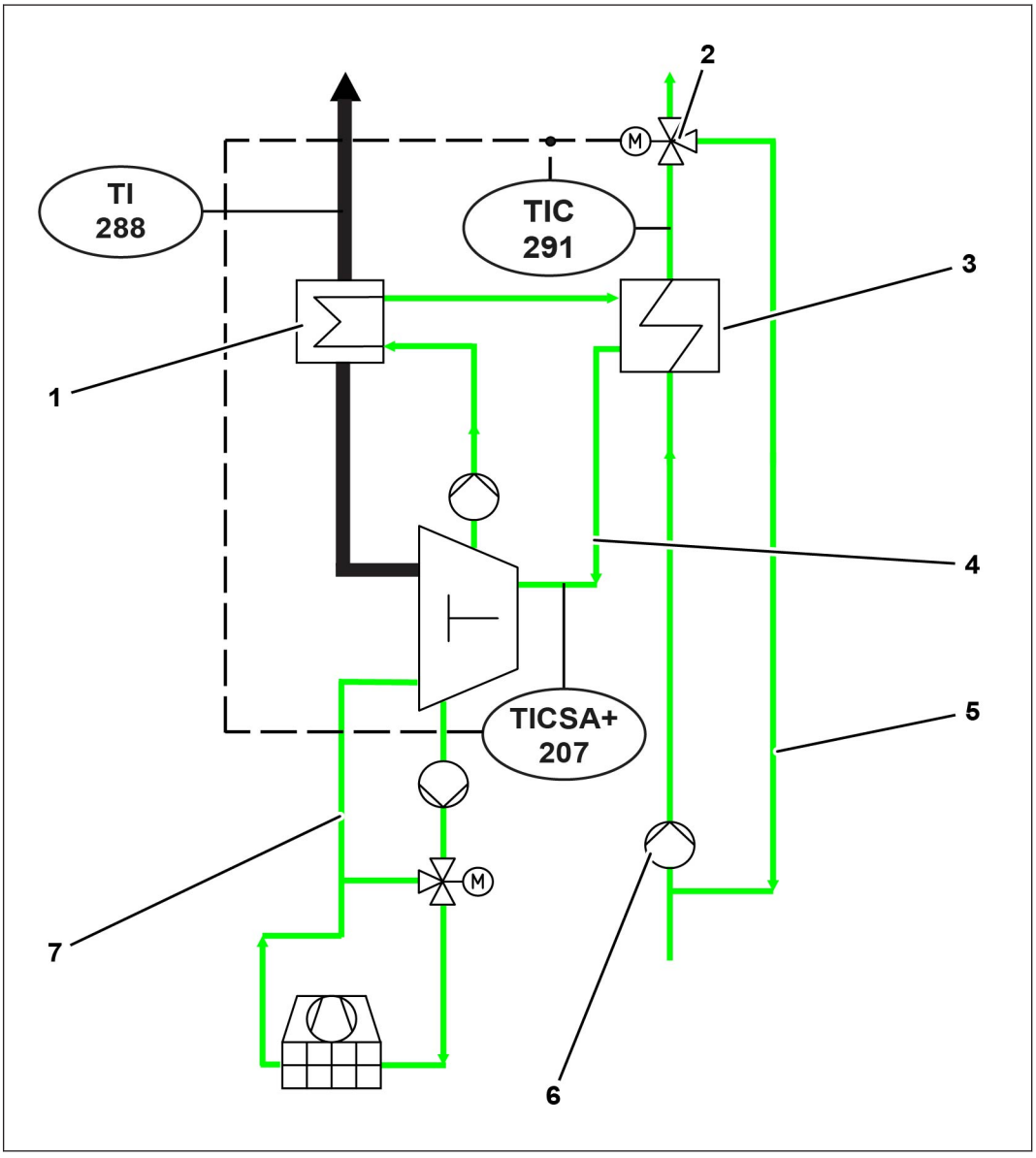
4.11.3 Control sequence

⇒ Section Heating circuit control (HC)

4.11.4 Flow diagram: heating circuit with EHE without bypass in engine cooling circuit

Note

The flow diagram is an example. The order-specific documents contain the exact equipment and the technical implementation of the assembly.



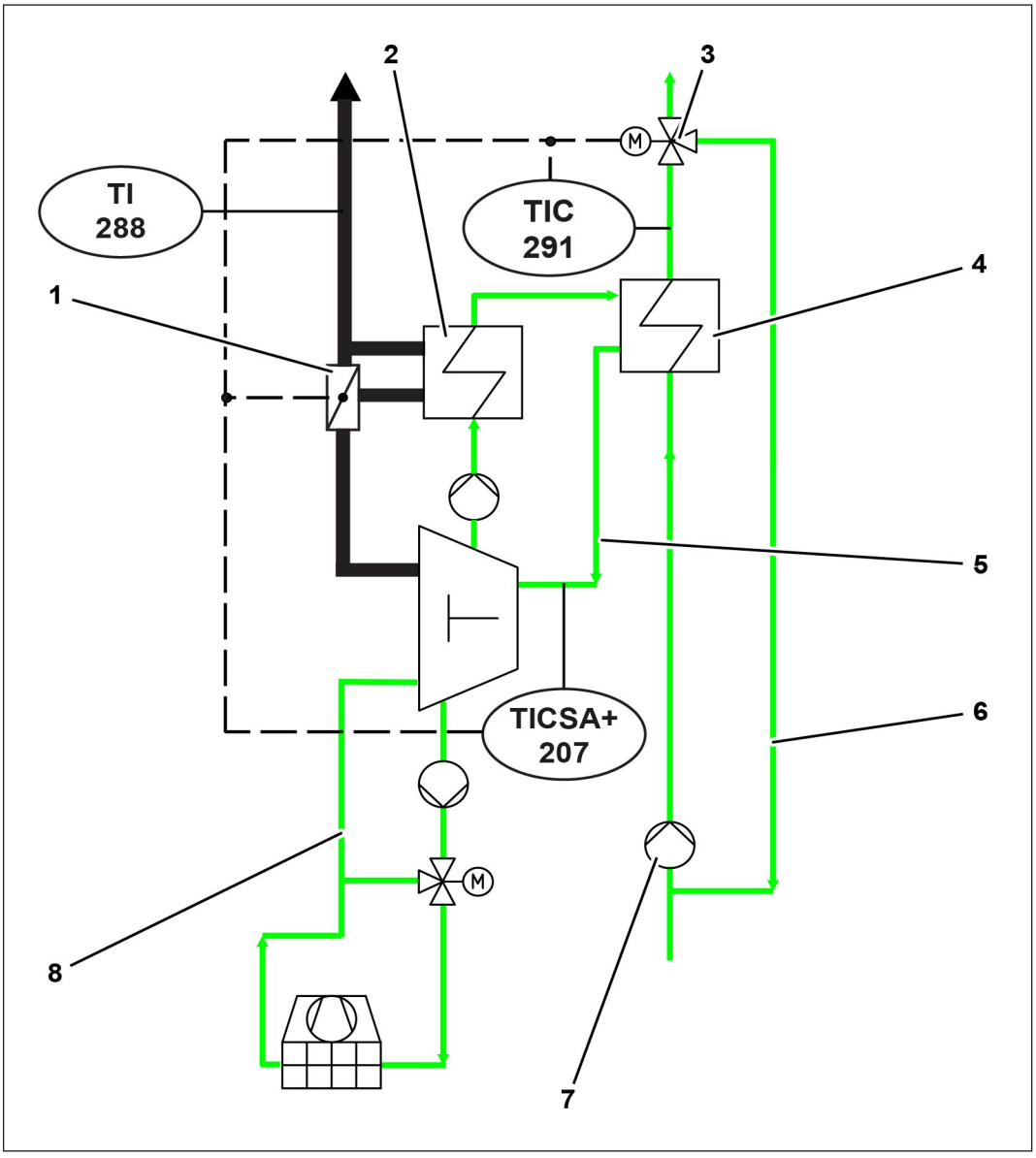
60775-003

1	Exhaust heat exchanger	5	Heating circuit
2	3-way valve heating circuit	6	Heating circuit pump
3	Coolant heat exchanger	7	Mixture cooling circuit
4	Engine cooling circuit		

4.11.5 Flow diagram: heating circuit with EHE with bypass in engine cooling circuit

Note

The flow diagram is an example. The order-specific documents contain the exact equipment and the technical implementation of the assembly.



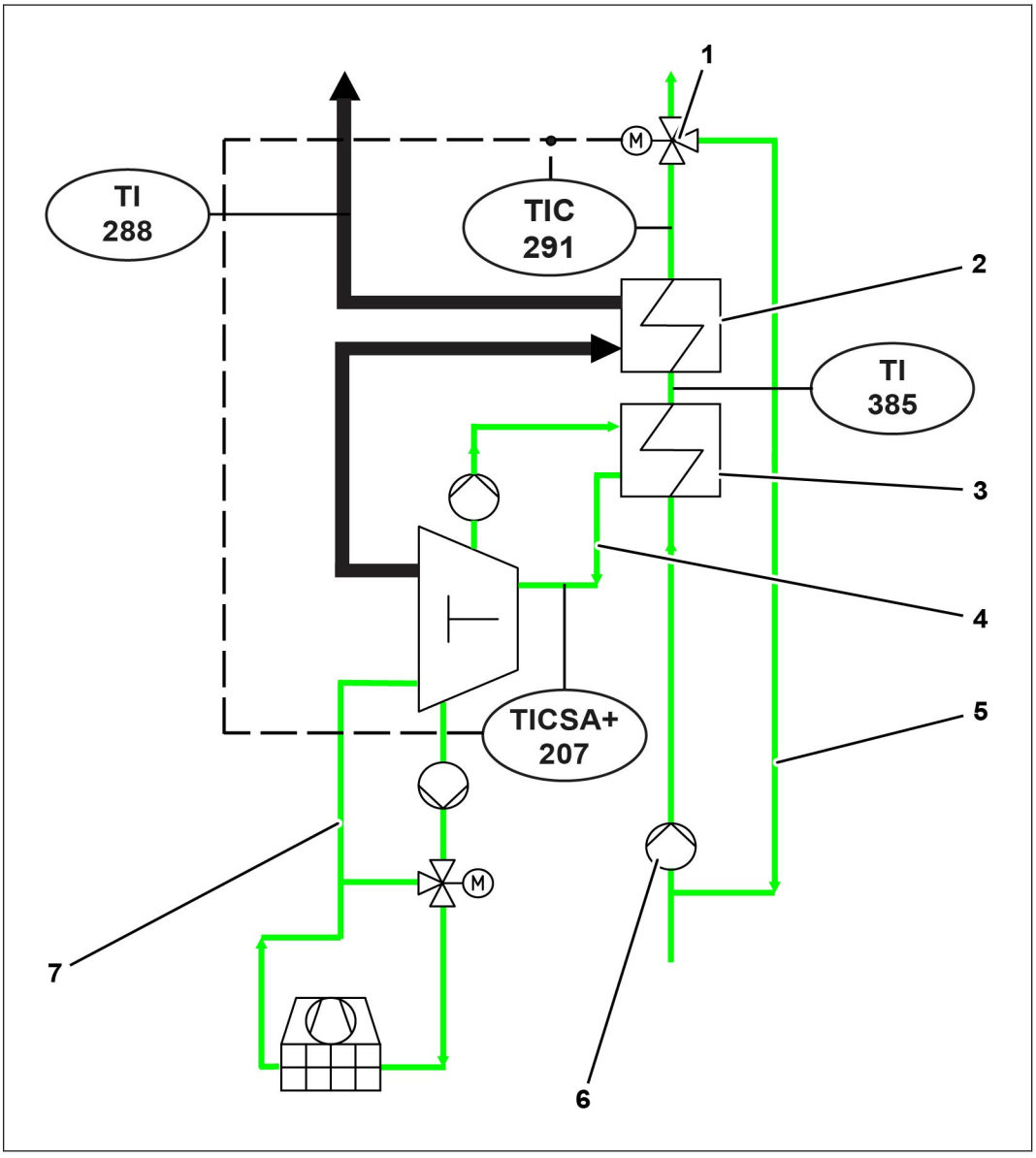
69143-002

1	Exhaust bypass valve	5	Engine cooling circuit
2	Exhaust heat exchanger	6	Heating circuit
3	3-way valve heating circuit	7	Heating circuit pump
4	Coolant heat exchanger	8	Mixture cooling circuit

4.11.6 Flow diagram: heating circuit with EHE without bypass in heating circuit

Note

The flow diagram is an example. The order-specific documents contain the exact equipment and the technical implementation of the assembly.



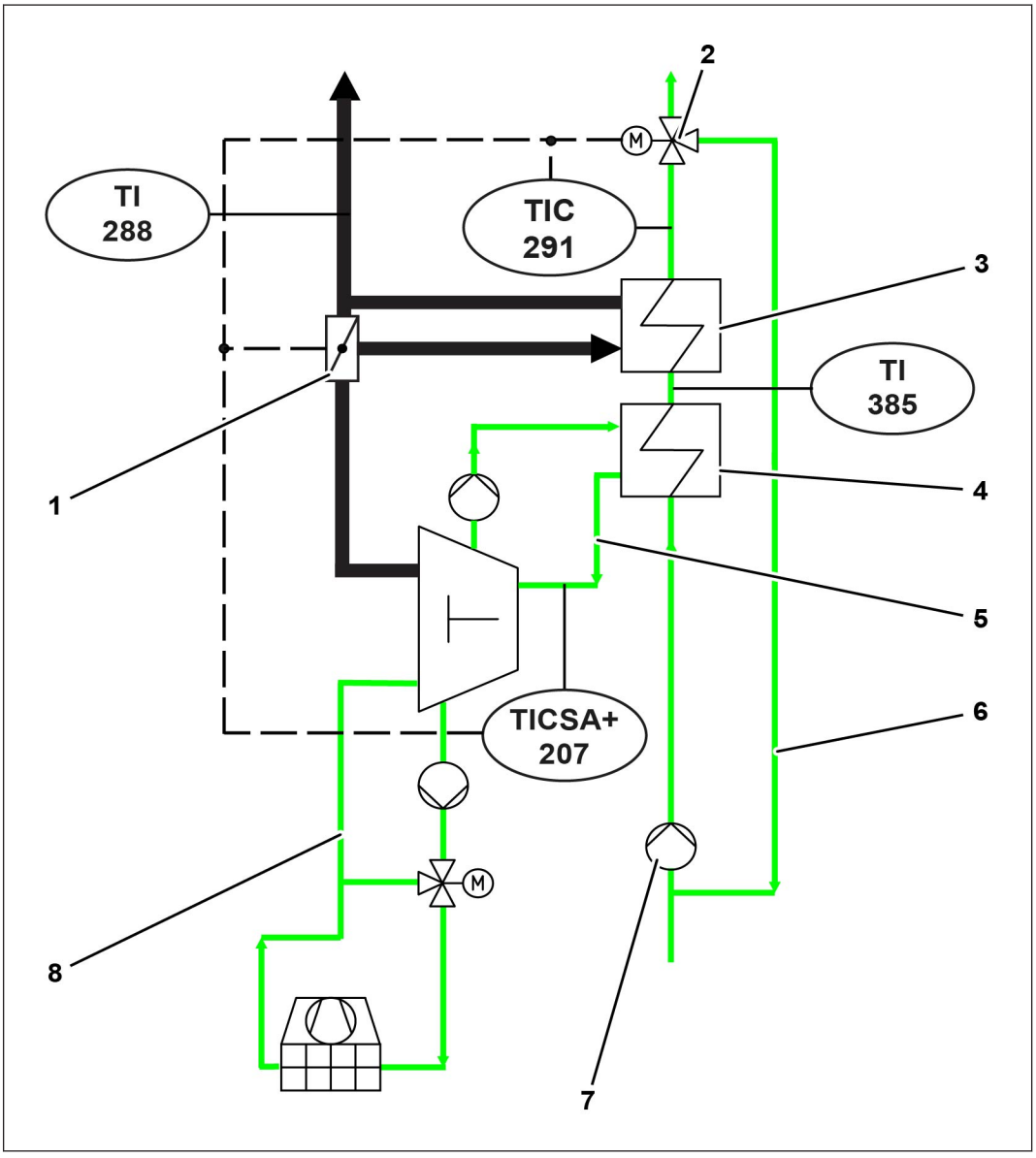
68211-002

1	3-way valve heating circuit	5	Heating circuit
2	Exhaust heat exchanger	6	Heating circuit pump
3	Coolant heat exchanger	7	Mixture cooling circuit
4	Engine cooling circuit		

4.11.7 Flow diagram: heating circuit with EHE with bypass in heating circuit

Note

The flow diagram is an example. The order-specific documents contain the exact equipment and the technical implementation of the assembly.



69142-002

1	Exhaust bypass valve	5	Engine cooling circuit
2	3-way valve heating circuit	6	Heating circuit
3	Exhaust heat exchanger	7	Heating circuit pump
4	Coolant heat exchanger	8	Mixture cooling circuit

4.12 Engine cooling circuit (ECC)

Activated with parameter 20130518 ECC control.

4.12.1 Functional description

The objective of the engine cooling circuit control is to control the temperature of the coolant at the engine inlet (TICSA+ 207) in accordance with a parameterized characteristic curve. The control is largely independent of the load of the genset.

In the case of gensets without heat recovery, it is recommended to discharge the excess heat energy from the engine cooling circuit via an independent recooler ⇒ `Recooler in engine cooling circuit or dump cooling circuit (DCC RDTR)` or together with the recooler of the mixture cooling circuit in a dual core radiator ⇒ `Dual core radiator in the engine cooling circuit and mixture cooling circuit (DCR).`

In the case of gensets with heat recovery, the excess heat energy is transferred to the heating circuit in a coolant heat exchanger.

4.12.2 Inputs and outputs in the TPEM system

Safety chain digital inputs in the TPEM Control Cabinet

No.	ID	Designation	Monitoring
123	LZA –	Low liquid level of engine cooling circuit 1	Low liquid level

Digital inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	ID	Designation	Feedback
126	PDSA –	Engine cooling circuit pressure difference flow monitor	Δp too low
281	PDSA –	Heating circuit pressure difference flow monitor (input bridged)	Δp too low
336	---	Engine cooling circuit pump monitoring	No fault
867	GIS +	Coolant 3-way valve open position (to recooler)	End position cold (Open)
868	GIS –	Coolant 3-way valve closed position (bypass)	End position warm (Closed)

Digital outputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	Actuator	At +24 V	At 0 V
631	Engine cooling circuit pump	ON	OFF
632	Engine cooling circuit 3-way valve direction of movement colder	colder	–
633	Engine cooling circuit 3-way valve direction of movement warmer	warmer	–

Inputs on the TPEM Control Unit

No.	ID	Designation	Monitoring
206	TISA +	Coolant temperature engine outlet	Wire break, short-circuit
207	TICSA +	Coolant temperature engine inlet	Wire break, short-circuit
386	TI	Heating circuit temperature before lube oil heat exchanger (option)	4...20 mA = 0...1000 °C
497	PISA –	Engine coolant, engine outlet pressure	Pressure too low Wire break, short-circuit

4.12.3 Control sequence

For further information on parameterization and setting of the desired values, see

- Separate operating manual ⇒ TPEM Parameter description ⇒
  - Initial setup
  - Heating circuit (HC), cooling circuits (ECC, DCC, MCC) ⇒ Heating circuit and engine cooling circuit (HC, ECC)

Control

The inlet temperature of the coolant into the engine (TICSA + 207) is controlled to a parameterizable characteristic curve (parameters 20750065 and 20750079). To do so, the controller operates on the 3-way valve of the engine cooling circuit.

Power decrease

If the temperature of the coolant at the engine inlet (TICSA + 207) exceeds the limit, the power is reduced so that no knocking combustion occurs.

The power is reduced on a ramp of 3 % per Kelvin of excess temperature.

Switching off

If there is also a risk of knocking combustion in power-reduced operation, the genset will be switched off.

Return temperature increase

After the genset has started, if the power is reduced or the return temperature of the heating circuit is too low, an increase in the coolant temperature at the engine inlet can be specified using the parameterizable characteristic curve. An increase can be performed in two ways:

- In an engine cooling circuit with heat recovery by actuating a 3-way valve in the heating circuit. Warm heating circuit fluid is admixed into the return of the heating circuit via the 3-way valve. This means that less heat is lost from the engine cooling circuit in the coolant heat exchanger. The return temperature of the engine cooling circuit is thereby increased to the required temperature (parameter `60008997 Return temperature increase` activated).
- Alternatively or in an engine cooling circuit without heat recovery by actuating a 3-way valve directly in the engine cooling circuit. Warm heating circuit fluid is admixed into the return of the heating circuit via the 3-way valve. This means that less heat is lost from the engine cooling circuit in the coolant heat exchanger. The return temperature of the engine cooling circuit is thereby increased to the required temperature (parameter `60008997 Return temperature increase` deactivated).

Parameters

- `20130518 ECC control`
- `60008997 Return temperature increase`
- `20750065 T207 set ECC engine inlet at 40 % power`
- `20750079 T207 set ECC engine inlet at 100 % power`
- `20430130 ECC pump switch-off delay`

at deactivated Return temperature increase

- 20430229 ECC control P proportional gain
- 20430210 ECC control D proportional gain
- 20430255 ECC control low pass time
- 20430232 ECC control dead band

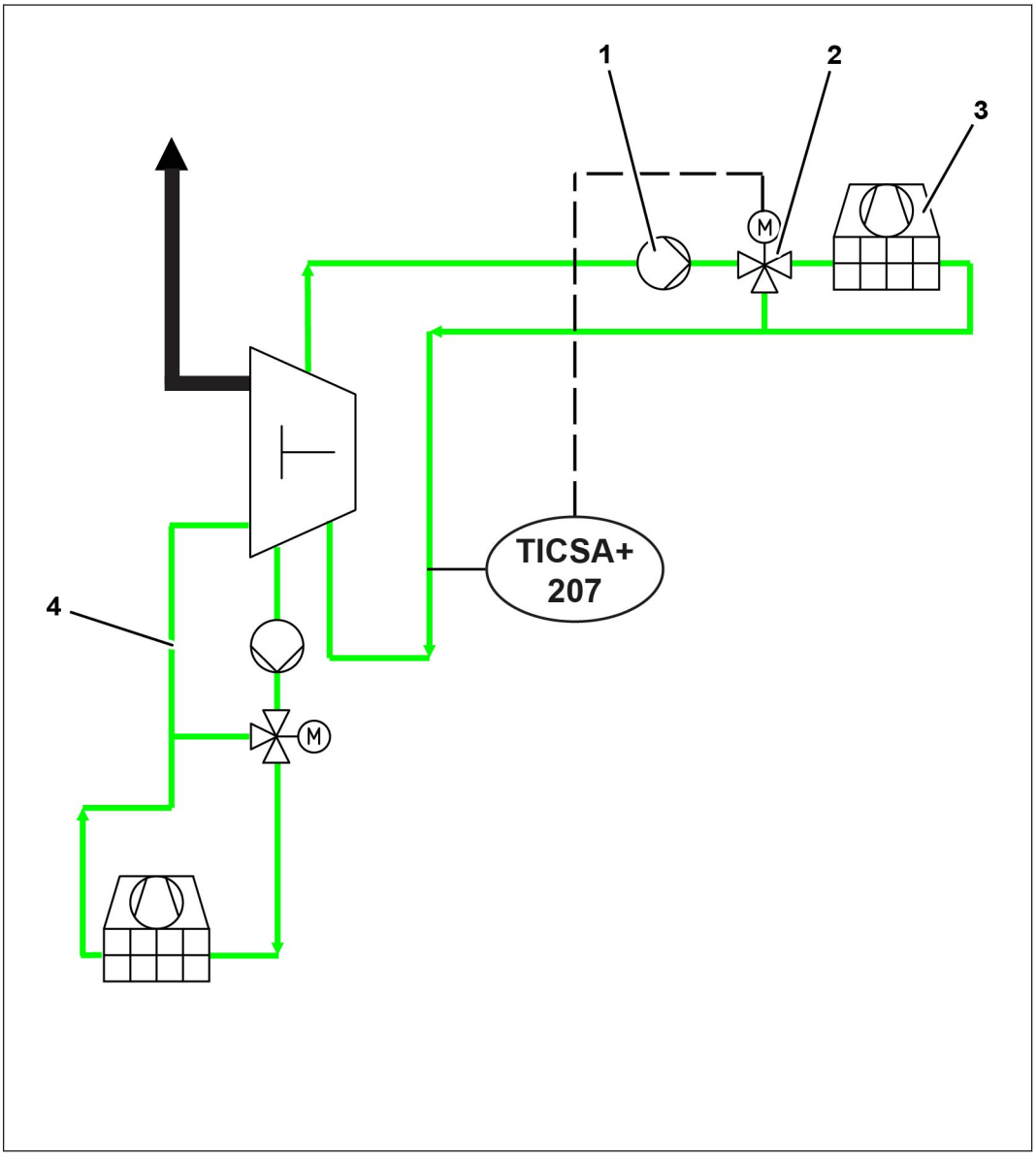
at activated Return temperature increase

- 20430101 ECC control P proportional gain
- 20430117 ECC control D proportional gain
- 20430196 ECC control low pass time
- 20430174 ECC control dead band

4.12.4 Flow diagram: engine cooling circuit without heat recovery

Note

The flow diagram is an example. The order-specific documents contain the exact equipment and the technical implementation of the assembly.



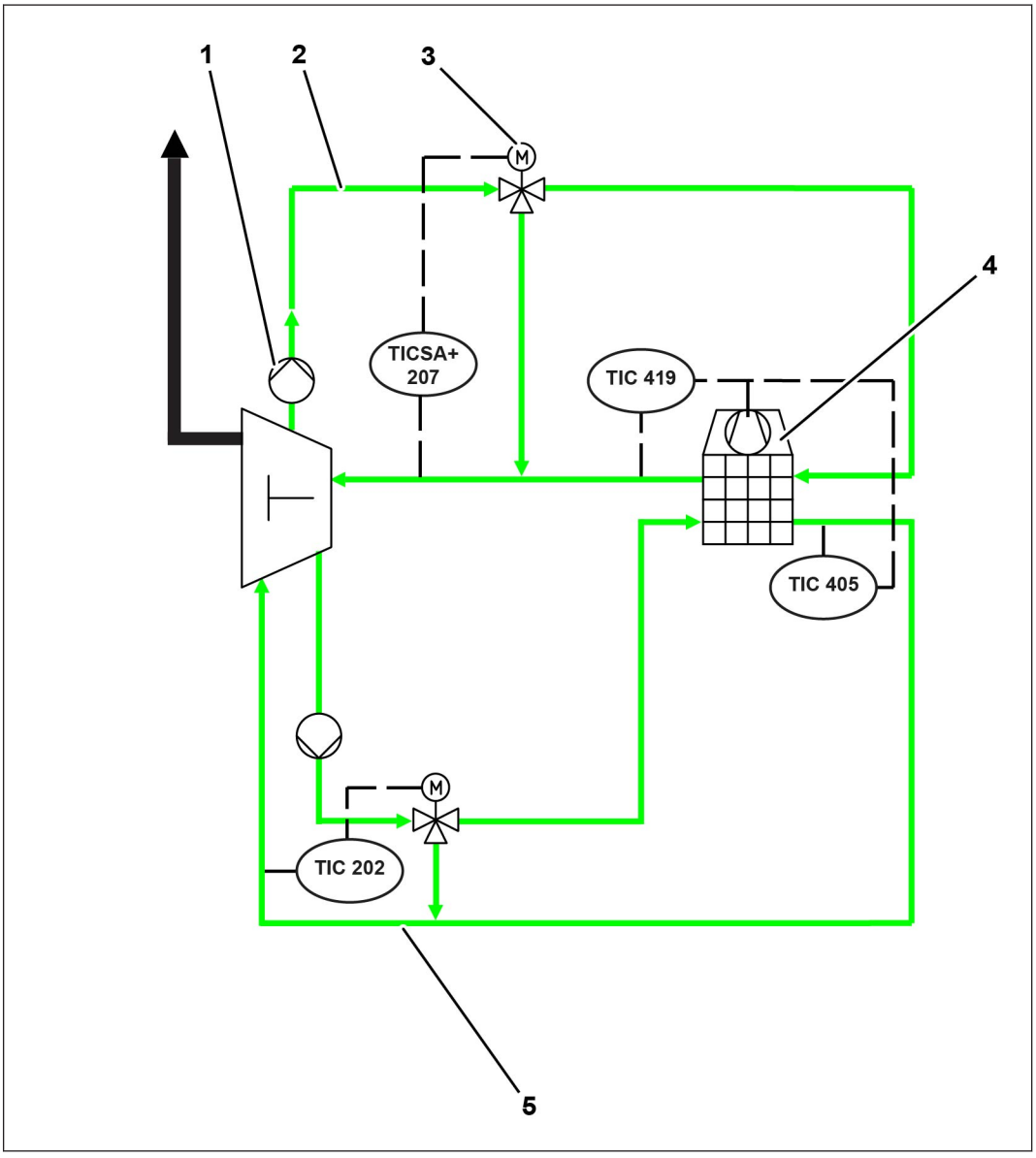
60768-003

1	Engine cooling circuit pump	3	Recooler
2	3-way valve engine cooling circuit	4	Mixture cooling circuit

4.12.5 Flow diagram: engine cooling circuit without heat recovery with DCR

Note

The flow diagram is an example. The order-specific documents contain the exact equipment and the technical implementation of the assembly.



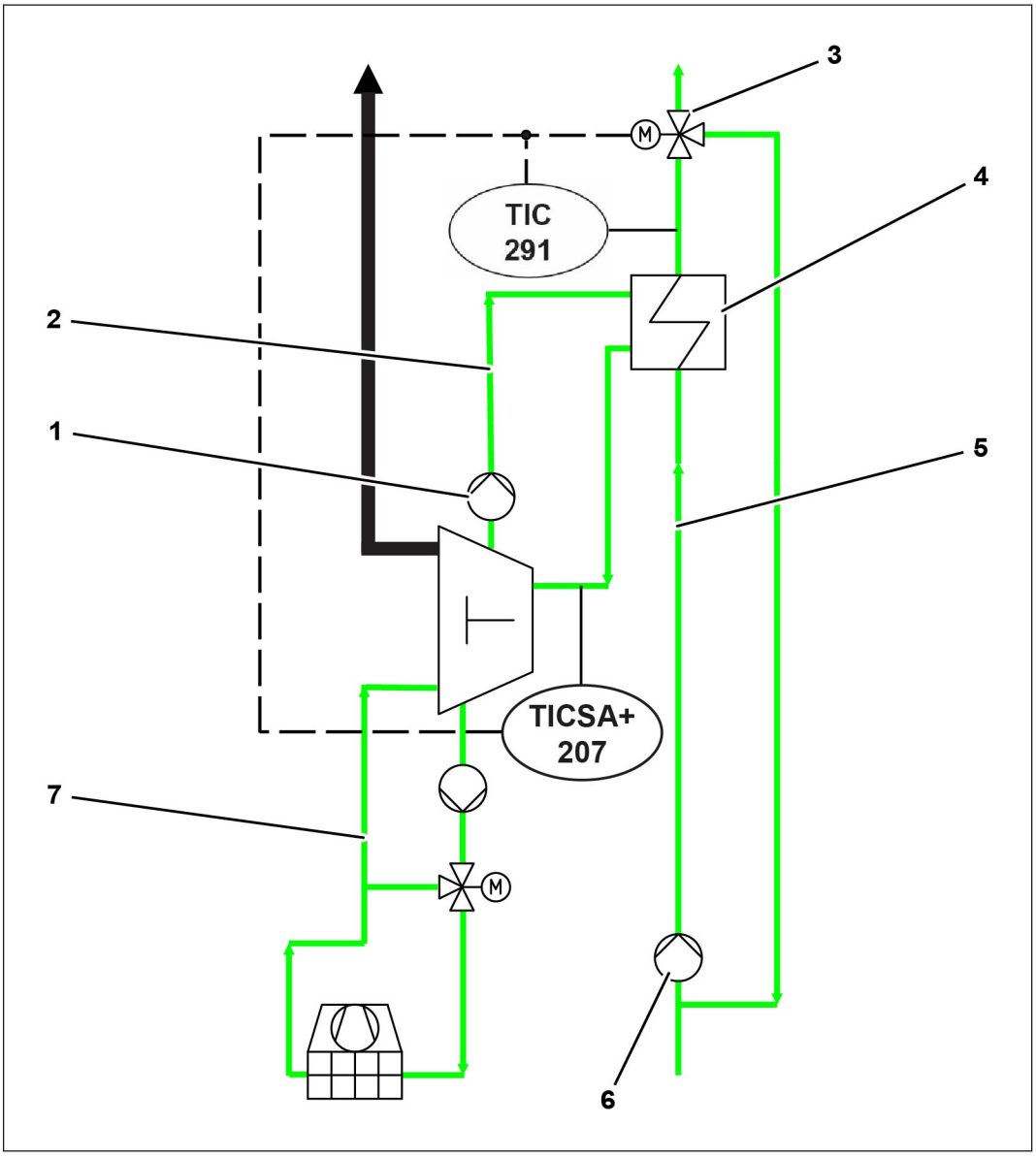
74290-001

1	Engine cooling circuit pump	4	Dual core radiator
2	Engine cooling circuit	5	Mixture cooling circuit LT
3	3-way valve engine cooling circuit		

4.12.6 Flow diagram: engine cooling circuit with heat recovery

Note

The flow diagram is an example. The order-specific documents contain the exact equipment and the technical implementation of the assembly.



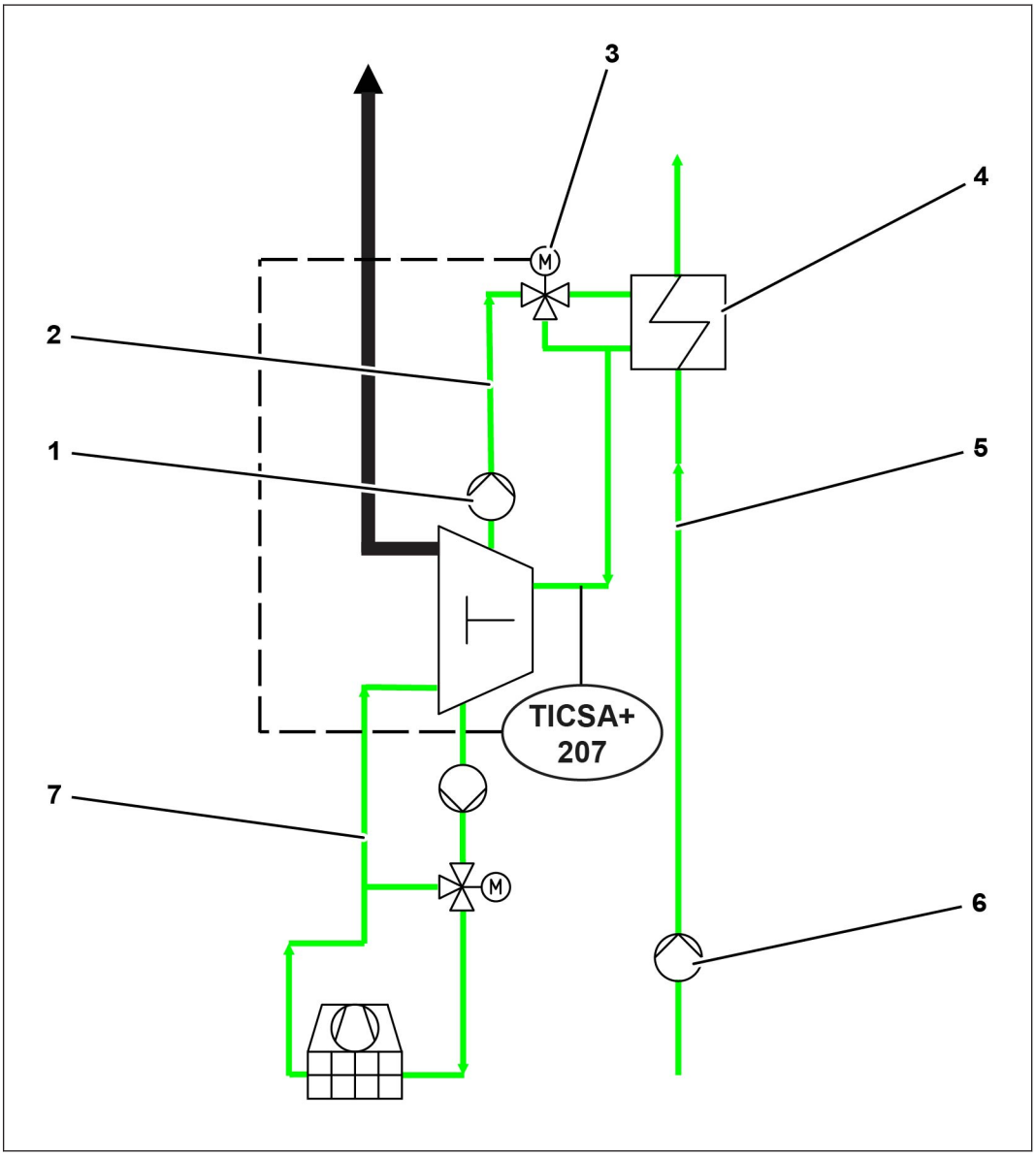
60774-003

1	Engine cooling circuit pump	5	Heating circuit
2	Engine cooling circuit	6	Heating circuit pump
3	3-way valve heating circuit	7	Mixture cooling circuit
4	Coolant heat exchanger		

4.12.7 Flow diagram: engine cooling circuit with heat recovery and 3-way valve

Note

The flow diagram is an example. The order-specific documents contain the exact equipment and the technical implementation of the assembly.



68441-002

1	Engine cooling circuit pump	5	Heating circuit
2	Engine cooling circuit	6	Heating circuit pump
3	3-way valve engine cooling circuit	7	Mixture cooling circuit
4	Coolant heat exchanger		

4.13 Coolant preheating (CPH)

4.13.1 Functional description

The aim of the engine coolant preheating is to keep the temperature of the coolant at a minimum value even when the engine is stopped.

After starting, the temperature of the engine coolant therefore quickly reaches the operating temperature. Engine coolant preheating occurs independently of the temperature level of the heating circuit.

The preheating takes place via an electric heating element.The circulation of the engine coolant takes place with the engine cooling circuit pump.

Flex module

In addition to the standard coolant preheating, an external preheating module (flex module) can be fitted. With an additionally activated flex module, the heating process of the coolant is distributed to both preheating modules, ⇒ Control with flex module.

4.13.2 Inputs and outputs in the TPEM system

Digital inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	ID	Designation	Feedback
156	TA +	Monitoring of engine cooling circuit preheating	failed

Digital outputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	Actuator	At +24 V	At 0 V
631	Engine cooling circuit pump	ON	OFF
---	Flex module demanded	ON	OFF

4.13.3 Control sequence

For further information on parameterization and setting of the desired values, see

- Separate operating manual ⇒ TPEM Parameter description

Control

The coolant preheating is activated by the parameter `20130009 Coolant preheating (CPH)`.

When the genset is switched off, the TPEM controls the inlet temperature of the coolant into the engine at a desired value + 5 K (parameter `20430125 T207 set CPH`). If the inlet temperature is below the parameterized value, the controller switches on the heating element and the coolant pump. If the inlet temperature reaches desired value +5 K, the controller switches off the heating element and the coolant pump.

If a pump switch-off delay is parameterized (parameter 20430130), the TPEM switches off the coolant pump once the delay time has expired.

If the genset is started, the TPEM switches off the coolant preheating. After switching off the genset, the TPEM switches on the activated coolant preheating.

Control with flex module

The coolant preheating is activated by the parameter `20130009 Coolant preheating (CPH)` and parameter `20133842 Coolant preheating (CPH) flex module`.

When the genset is switched off, the TPEM first controls the inlet temperature of the coolant into the engine at the desired value of parameter `20430125 T207 set CPH`. When the upper threshold is reached, the flex module takes over the temperature control of the coolant to the desired value of parameter `20430264 T set CPH flex module`.

The pump controls are identical with and without the flex module.

When the genset is started, all coolant preheating is switched off. After the genset is switched off the coolant preheating is switched on.

Low coolant level

If the control system detects a low coolant level, the safety chain is triggered. To prevent damage to components, the TPEM switches off the coolant preheating immediately.

If a switch-off delay is activated and there is no longer a low coolant level, the remaining switch-off delay is reactivated again.

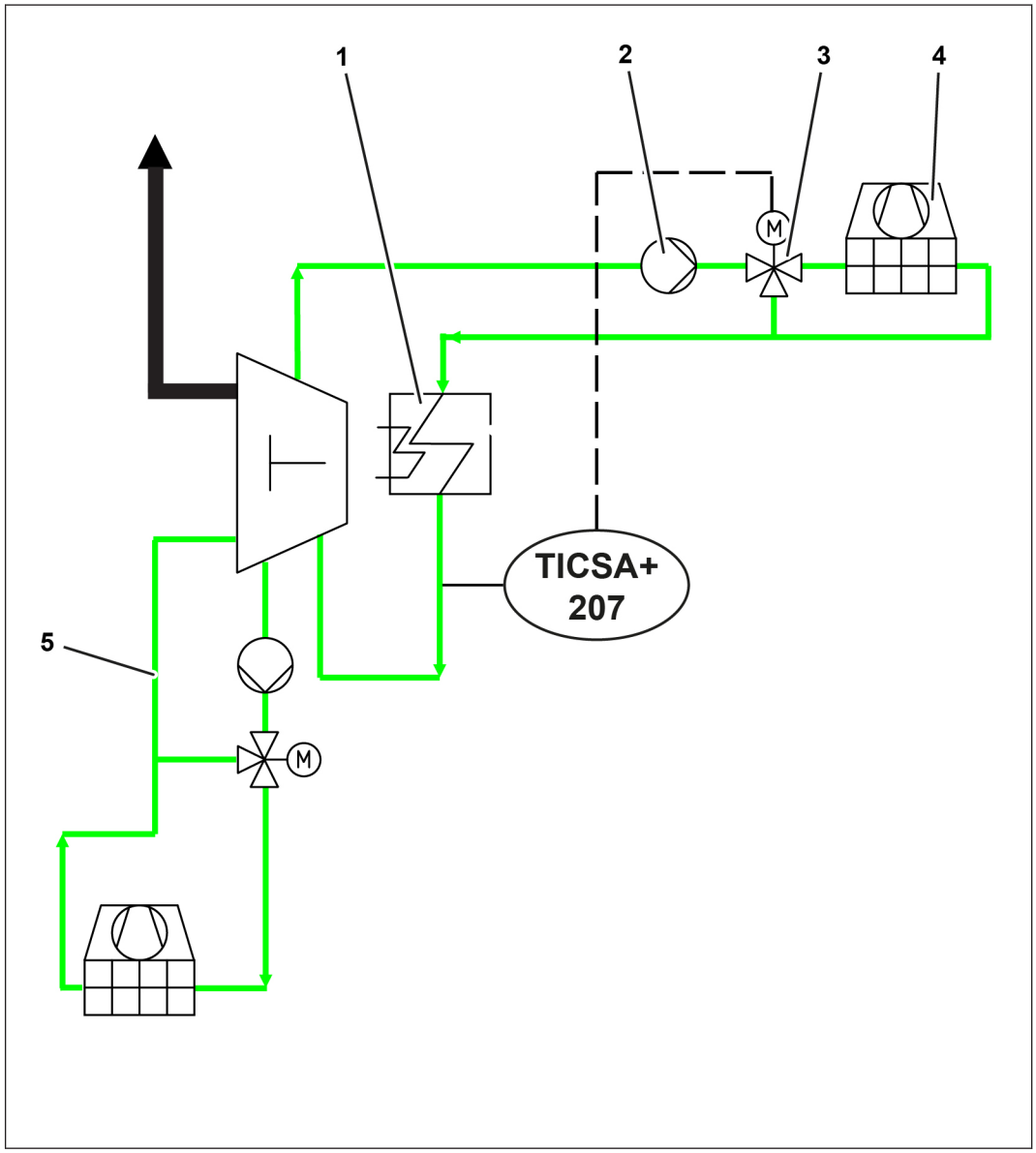
Parameters

- `20130009 Coolant preheating (CPH)`
- `20430125 T207 set CPH`
- `20133842 Coolant preheating (CPH) flex module`
- `20430264 T set CPH flex module`
- `20430130 ECC pump switch-off delay`

4.13.4 Flow diagram: coolant preheating

Note

The flow diagram is an example. The order-specific documents contain the exact equipment and the technical implementation of the assembly.



63301-002

1	Coolant preheating	4	Recooler
2	Engine cooling circuit pump	5	Mixture cooling circuit
3	3-way valve engine cooling circuit		

4.14 Dump cooling circuit (DCC)

Activates with parameter `201030425 DCC RDTR type`.

4.14.1 Functional description

If too little heat is extracted from the engine cooling circuit by the heating water circuit, the engine cooling is insufficient. In order to ensure adequate engine cooling, it is recommended that the dump cooling circuit discharges the required residual heat via an independent recooler ⇒ `Recooler in engine cooling circuit or dump cooling circuit (DCC RDTR)`.

To do so, the controller operates on the control valve ahead of the coolant of the dump cooling circuit.

The following dump cooling circuit variants are possible via parameter `60008496 DCC configuration`:

- Dump cooling circuit directly in engine cooling circuit
- Dump cooling circuit with plate heat exchanger in engine cooling circuit
- Dump cooling circuit directly in heating circuit
- Dump cooling circuit with plate heat exchanger in heating circuit
- No dump cooling circuit

4.14.2 Inputs and outputs in the TPEM system

Safety chain digital inputs in the TPEM Control Cabinet

No.	ID	Designation	Monitoring
458	LSA –	Low liquid level of dump cooling circuit	Low liquid level

Digital inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	ID	Designation	Feedback
338	---	Dump cooling circuit pump monitoring	DCC pump failed
890	GIS +	Dump cooling circuit (heating circuit, engine cooling circuit) 3-way valve open (passage)	End position cold (Open)
891	GIS –	Dump cooling circuit (heating circuit, engine cooling circuit) 3-way valve closed (bypass)	End position warm (Closed)

Digital outputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	Actuator	At +24 V	At 0 V
938	Dump cooling circuit pump	ON	OFF
939	Dump cooling circuit 3-way valve direction of movement colder	colder	–
940	Dump cooling circuit 3-way valve direction of movement warmer	warmer	–

Analog inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	ID	Designation	Feedback
384	TI	Heating circuit temperature before emergency cooler (option)	4...20 mA = 0...200 °C

4.14.3 Control sequence

For further information on parameterization and setting of the desired values, see

- Separate operating manual ⇒ TPEM Parameter description ⇒
  - Initial setup
  - Heating circuit (HC), cooling circuits (ECC, DCC, MCC) ⇒ Dump cooling circuit or dual core radiator (DCC/DCR)

Control

If the temperature of the coolant at the engine inlet (TICSA+ 207) increases beyond the value of the parameterizable characteristic curve (parameters 20750065 and 20750079) and the 3-way valve in the heating circuit is at full flow, the dump cooling circuit controller will take control.

In emergency cooling the coolant temperature at the engine inlet (TICSA+ 207) is also controlled to the value of the parameterizable characteristic curve. However, the controller operates on the 3-way valve in the dump cooling circuit.

If the temperature of the coolant at the engine inlet (TICSA+ 207) falls below the value of the parameterizable characteristic curve and the 3-way valve in the dump cooling circuit is fully closed, the heating circuit controller will take back control.

The dump cooling circuit control and control of the optional exhaust bypass valve are coordinated in the TPEM system. This means that a safe and efficient interaction of the two functions is ensured.

Power decrease

If the temperature of the coolant at the engine inlet (TICSA + 207) exceeds the limit, the power is reduced so that no knocking combustion occurs.

The power is reduced on a ramp of 3 % per Kelvin of excess temperature.

Switching off

If there is also a risk of knocking combustion in power-reduced operation, the genset will be switched off.

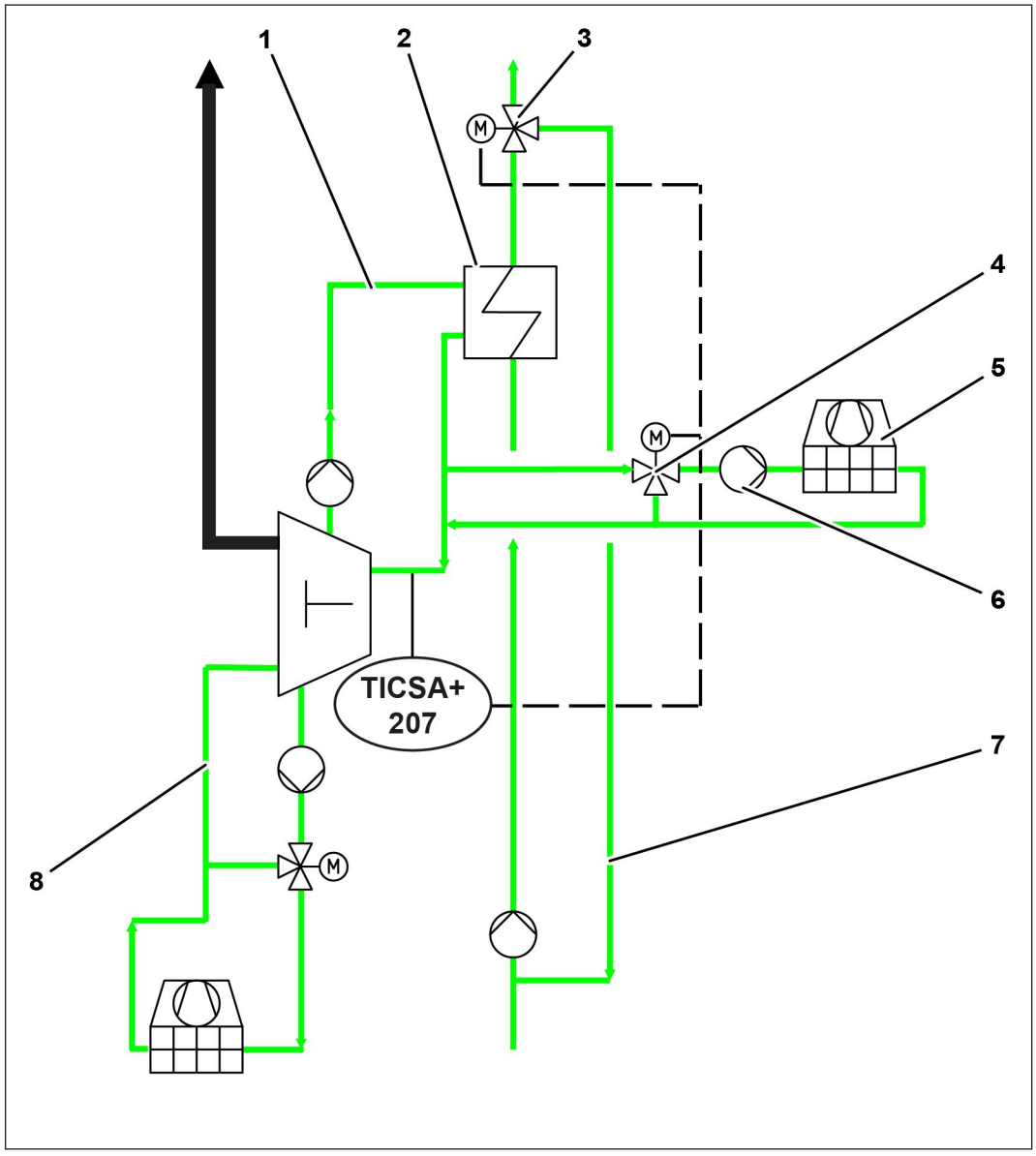
Parameters

- 20130425 DCC RDTR type
- 60008496 DCC configuration
- 20430045 DCC control P proportional gain
- 20430059 DCC control D proportional gain
- 20430182 DCC control low pass time
- 20430163 DCC control dead band
- 20430149 DCC pump switch-off delay

4.14.4 Flow diagram: dump cooling circuit directly in engine cooling circuit

Note

The flow diagram is an example. The order-specific documents contain the exact equipment and the technical implementation of the assembly.



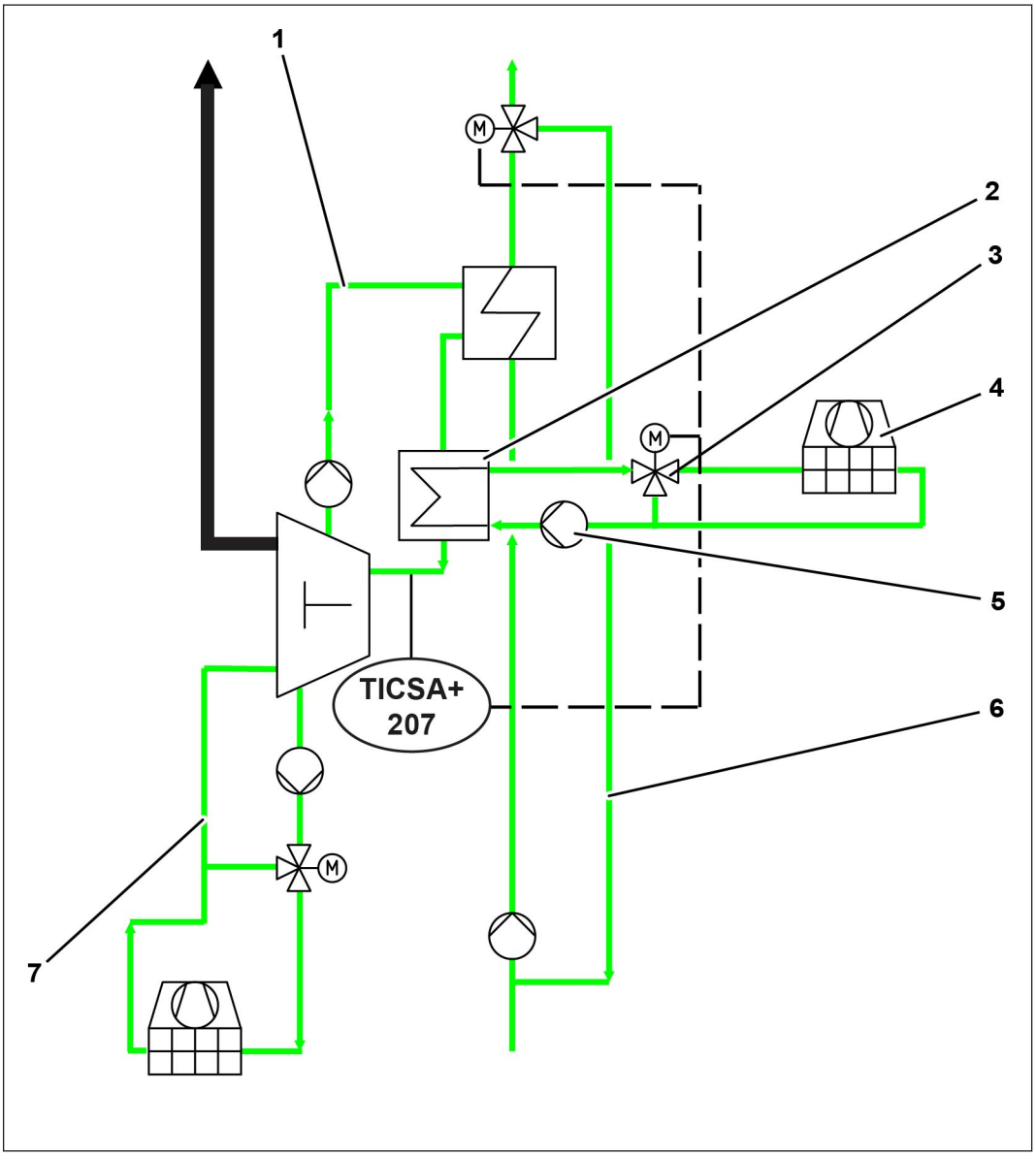
60770-003

1	Engine cooling circuit	5	Dump cooling circuit - recooler
2	Coolant heat exchanger	6	Dump cooling circuit pump
3	3-way valve heating circuit	7	Heating circuit
4	3-way valve dump cooling circuit	8	Mixture cooling circuit

4.14.5 Flow diagram: dump cooling circuit with plate heat exchanger (PHE) in engine cooling circuit

Note

The flow diagram is an example. The order-specific documents contain the exact equipment and the technical implementation of the assembly.



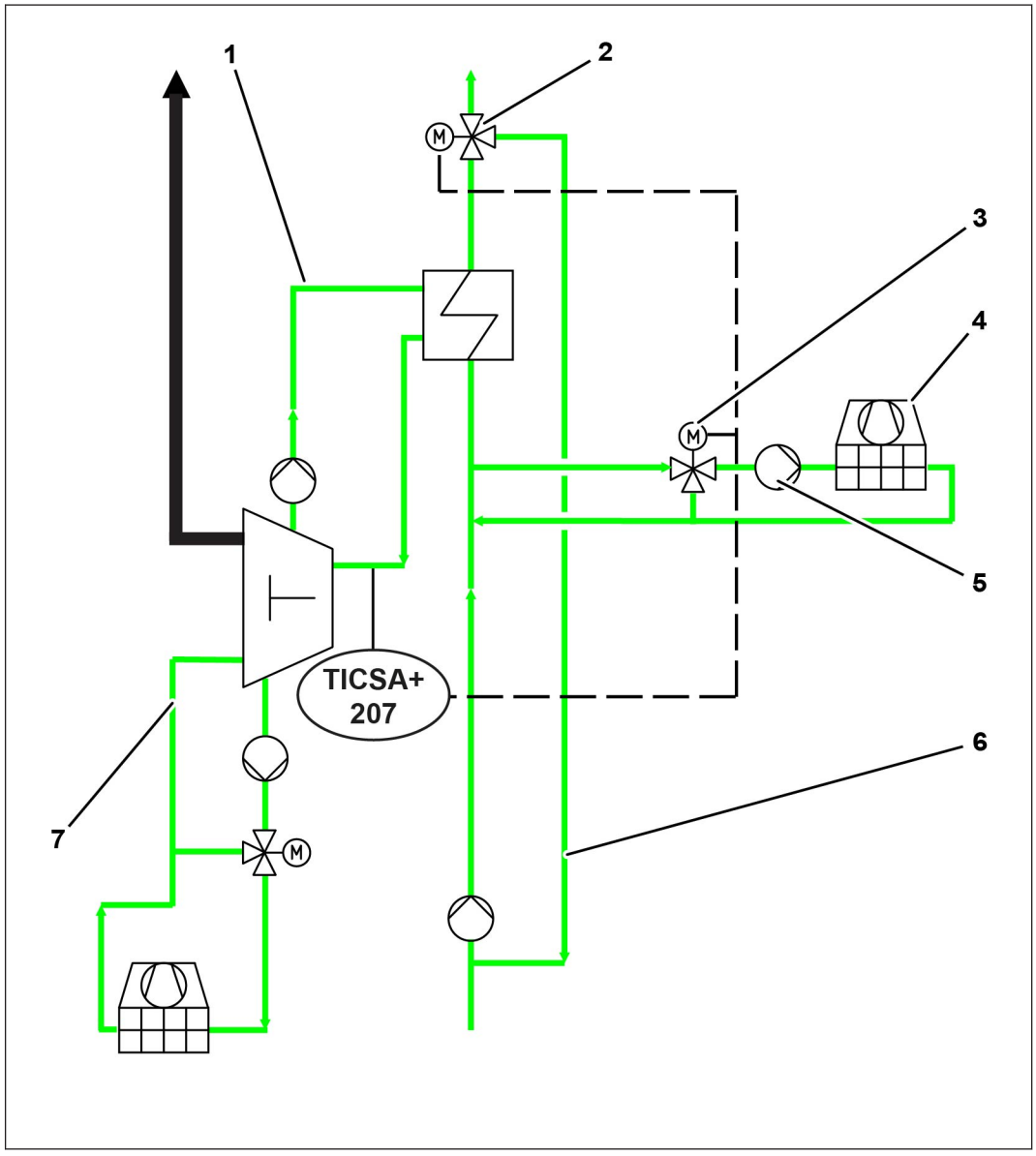
68260-002

1	Engine cooling circuit	5	Dump cooling circuit pump
2	Coolant heat exchanger	6	Heating circuit
3	3-way valve dump cooling circuit	7	Mixture cooling circuit
4	Dump cooling circuit recooler		

4.14.6 Flow diagram: dump cooling circuit directly in heating circuit

Note

The flow diagram is an example. The order-specific documents contain the exact equipment and the technical implementation of the assembly.



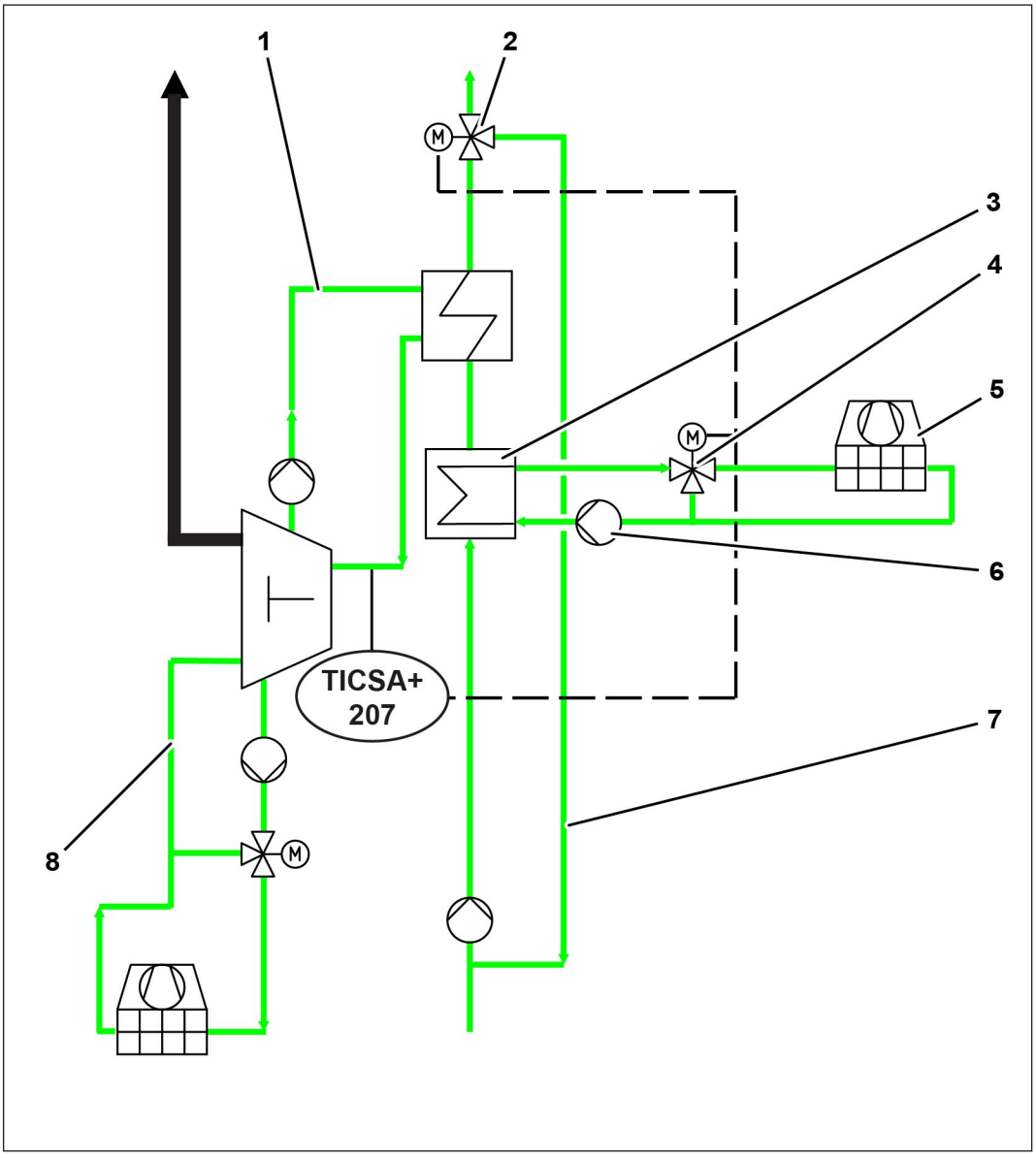
68261-002

1	Engine cooling circuit	5	Dump cooling circuit pump
2	3-way valve heating circuit	6	Heating circuit
3	3-way valve dump cooling circuit	7	Mixture cooling circuit
4	Dump cooling circuit recooler		

4.14.7 Flow diagram: dump cooling circuit with plate heat exchanger (PHE) in heating circuit

Note

The flow diagram is an example. The order-specific documents contain the exact equipment and the technical implementation of the assembly.



68262-002

1	Engine cooling circuit	5	Dump cooling circuit - recooler
2	3-way valve heating circuit	6	Dump cooling circuit pump
3	Plate heat exchanger	7	Heating circuit
4	3-way valve dump cooling circuit	8	Mixture cooling circuit

4.15 Recooler in engine cooling circuit or dump cooling circuit (DCC RDTR)

Activates with parameter `20130425 DCC RDTR type`.

If the system is parameterized for a dual core radiator, parameter `20130425 DCC RDTR type` is not available ⇒ Section `Dual core radiator in the engine cooling circuit and mixture cooling circuit (DCR)`.

4.15.1 Functional description

In the engine cooling circuit and dump cooling circuit, it is recommended to discharge the heat using an independent recooler.

The TPEM system can be parameterized for one of the following recooler variants:

- Recooler with frequency control (infinitely variable ventilator speed)
- Recooler with stage switching (max 8 stages)
- External control, heat is discharged by the customer

Only one of the above mentioned variants can be selected.

Aim of the regulation

- Safe maintenance of the coolant temperature at the recooler outlet (TIC 419)
- Minimal energy consumption for the ventilators of the recooler

An advantage of frequency-controlled recooler ventilators is the reduced noise at nighttime. Due to the low outdoor temperatures, the required cooling output can still be achieved when the ventilator is at a lower speed.

4.15.2 Inputs and outputs in the TPEM system

Digital inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	Designation	Feedback
333	DCC RDTR/DCR FC monitoring	FC failed

Digital outputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	Actuator	At +24 V	At 0 V
937	DCC RDTR/DCR FC demanded	ON	OFF
573 - 580	DCC RDTR/DCR cooler group 1-8	Stage ON	Stage OFF

Analog inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	ID	Designation	Sensor	Monitoring
419	TIC	DCC RDTR outlet temperature	4 ... 20 mA = 0 ... 200 °C	Wire break

Analog outputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	Actuator	Version	
993	Set speed DCC RDTR/DCR FC	Recooler ventilator speed	4 … 20 mA = 0 …100 %

4.15.3 Control sequence recooler with frequency control

For further information on parameterization and setting of the desired values, see

- Separate operating manual ⇒ TPEM Parameter description ⇒
  - Initial setup
  - Heating circuit (HC), cooling circuits (ECC, DCC, MCC) ⇒ Dump cooling circuit or dual core radiator (DCC/DCR)

In the case of recoolers in frequency control, all ventilators are activated together. When the cooling demand increases or decreases, the ventilator speeds are increased or decreased via a frequency converter.

The function of the recooler control is independent of whether the recooler is arranged directly in the engine cooling circuit or in its own dump cooling circuit.

a) Recooler in the engine cooling circuit

The recooler ventilators are activated together with the pump in the engine cooling circuit.

Control to the outlet temperature at the recooler

The outlet temperature at the recooler (TIC 419) is controlled to a parameterizable characteristic curve with the parameters 20750022 and 20750033. In this process, the ventilator speed is variable.

Setting recommendation

Set the desired value for the outlet temperature at the recooler (TIC 419) so that it is > 3 K below the desired value for the inlet temperature of the engine coolant (TICSA + 207) ⇒ `Engine cooling circuit (ECC)`. The 3-way valve in the engine cooling circuit adds the required amount of cooler coolant. Both controllers are in use.

b) Recooler in dump cooling circuit

The control of the recoolers is only active when the dump cooling operation (parameter 20130051) is activated. The recooler ventilators are activated together with the pump in the dump cooling circuit.

Control to the outlet temperature at the recooler in dump cooling circuit

The outlet temperature at the recooler in dump cooling circuit (TIC 419) is controlled to a parameterizable characteristic curve (parameters 20750022 and 20750033). In this process, the ventilator speed is variable.

Setting recommendation

Set the desired value for the outlet temperature at the recooler (TIC 419) so that it is > 3 K below the desired value for the inlet temperature of the engine coolant (TICSA + 207) ⇒ `Engine cooling circuit (ECC)`. The 3-way valve in the engine cooling circuit adds the required amount of cooler coolant. Both controllers are in use.

Parameters

- `20130425 DCC RDTR type`
- `60008496 DCC configuration`
- `20750022 T419 set DCC RDTR outlet at 40 % power`
- `20750033 T419 set DCC RDTR outlet at 100 % power`
- `20470042 DCC RDTR/DCR control P proportional gain`

- 20470075 DCC RDTR/DCR control I proportional gain
- 20470050 DCC RDTR/DCR control D proportional gain
- 20470088 DCC RDTR/DCR control low pass time

4.15.4 Control sequence recooler with stage switching

For further information on parameterization and setting of the desired values, see

- Separate operating manual ⇒ TPEM Parameter description ⇒ Heating circuit (HC), cooling circuits (ECC, DCC, MCC) ⇒ Dump cooling circuit or dual core radiator (DCC/DCR)

The function of the recooler control is independent of whether the recooler is arranged directly in the engine cooling circuit or in its own dump cooling circuit.

In the case of recoolers with stage switching, the cooling capacity is controlled by switching on or off cooling units (e.g. ventilators) in cooling steps. To do so, several cooling units can be combined to form a cooler group which are addressed by TPEM via a common digital output. When the cooling demand increases or decreases, the changeover between the cooling stages takes place by activating or deactivating another cooler group so that one cooler group is active in cooling stage 1, two cooler groups are active in cooling stage 2, and so on. The following applies to ventilator cooler stages: All ventilators are operated at an identical, constant speed.

Thanks to the parameterization options, energy-optimized operation is also possible for recoolers with stage switching. As a result of its design, brief fluctuations in the engine inlet temperature, which are corrected in the mixture cooling circuit by the control valve, occur when activating and deactivating the individual cooling stages.

a) Recooler in the engine cooling circuit

Cooler stage 1 is activated together with the pump in the engine cooling circuit.

Control to the outlet temperature at the recooler

The outlet temperature at the recooler (TIC 419) is controlled to a parameterizable characteristic curve with the parameters 20750022 and 20750033. The system switches to a higher or lower cooling stage depending on the cooling demand. A downtime prevents the cooler stages from switching frequently. The downtime is parameterizable (parameter 20470109).

If the outlet temperature at the recooler (TIC 419) is longer than the reaction time and the temperature difference is greater than the desired value, cooler stages are activated at downtime intervals.

Setting recommendation

Set the desired value for the outlet temperature at the recooler (TIC 419) so that it is > 3 K below the desired value for the inlet temperature of the engine coolant (TICSA + 207) ⇒ `Engine cooling circuit (ECC)`. The 3-way valve in the engine cooling circuit adds the required amount of cooler coolant. Both controllers are in use.

As a result of its design, brief fluctuations of the inlet temperature at the mixture cooler (TICSA + 207), which are corrected in the mixture cooling circuit by the control valve, occur when activating and deactivating the individual cooler stages.

Make the downtime for the switchover process long enough to avoid any unnecessary switching. Too large a downtime makes it difficult for the setpoint value to be adhered to.

b) Recooler in dump cooling circuit

The control of the recoolers is only active when the dump cooling operation (parameter 20130051) is activated. Cooler stage 1 is activated together with the pump in the dump cooling circuit.

Control to the outlet temperature at the recooler in dump cooling circuit

The outlet temperature at the recooler (TIC 419) is controlled to a parameterizable characteristic curve with the parameters 20750022 and 20750033. The system switches to a higher or lower cooling stage depending on the cooling demand. A downtime prevents the cooler stages from switching frequently. The width of the downtime displayed on the axis is parameterizable (parameter 20470109).

If the inlet temperature of the engine coolant (T207) is longer than the reaction time and the temperature difference is greater than the desired value, cooler stages are activated at downtime intervals.

Setting recommendation

Set the desired value for the outlet temperature at the recooler (TIC 419) so that it is > 3 K below the desired value for the inlet temperature of the engine coolant (TICSA + 207) ⇒ `Engine cooling circuit (ECC)`. The 3-way valve in the engine cooling circuit adds the required amount of cooler coolant. Both controllers are in use.

As a result of its design, brief fluctuations of the inlet temperature at the mixture cooler (TICSA + 207), which are corrected in the mixture cooling circuit by the control valve, occur when activating and deactivating the individual cooler stages.

Make the downtime for the switchover process long enough to avoid any unnecessary switching. Too large a downtime makes it difficult for the setpoint value to be adhered to.

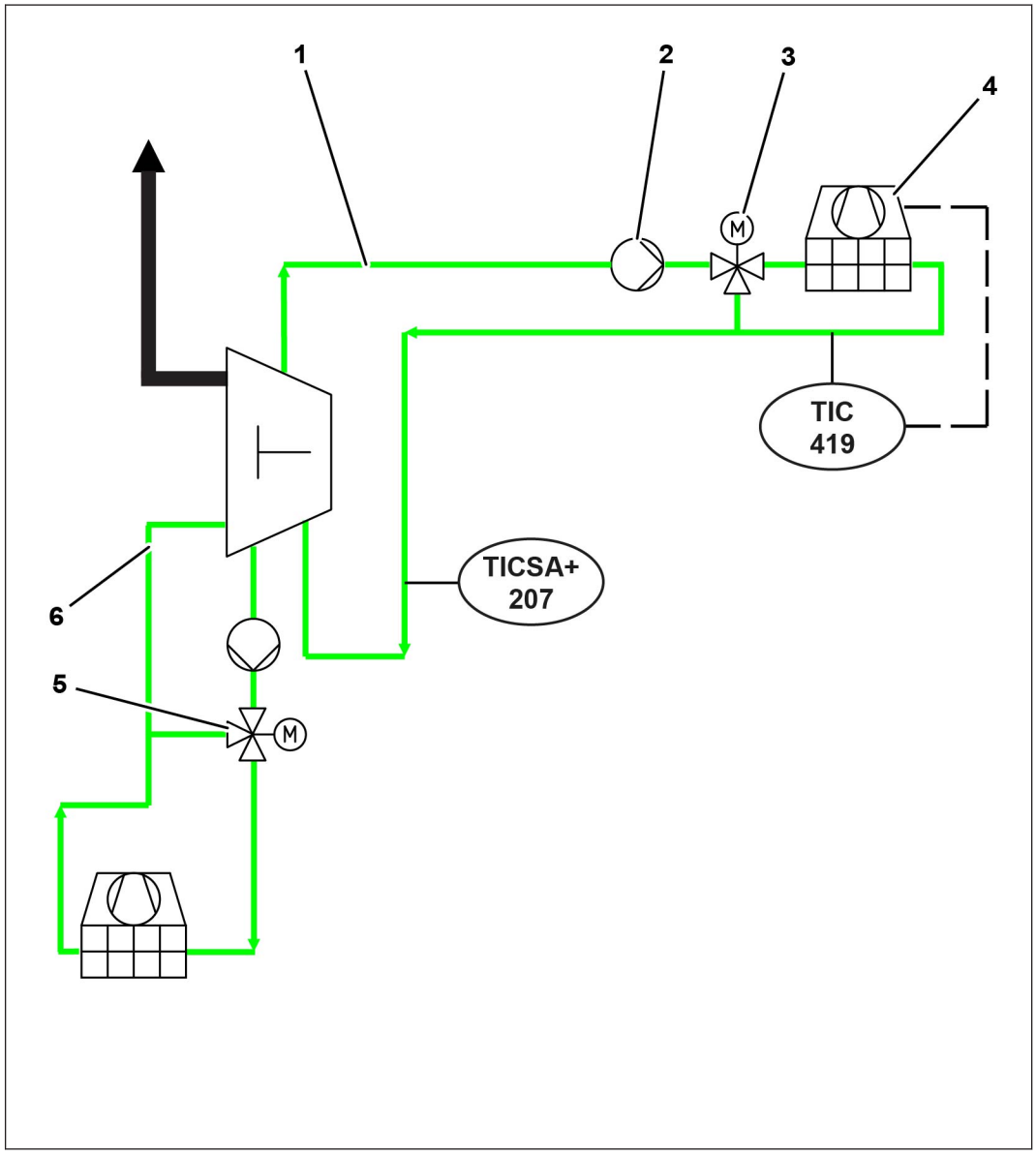
Parameters

- `20130334 DCC RDTR type`
- `60008496 DCC configuration`
- `20750022 T419 set DCC RDTR outlet at 40 % power`
- `20750033 T419 set DCC RDTR outlet at 100 % power`
- `20470091 DCC RDTR/DCR max stage number`
- `20470109 DCC RDTR/DCR downtime`
- `20470114 DCC RDTR/DCR temperature difference`
- `20470123 DCC RDTR/DCR reaction time`

4.15.5 Flow diagram: recooler in the engine cooling circuit

Note

The flow diagram is an example. The order-specific documents contain the exact equipment and the technical implementation of the assembly.



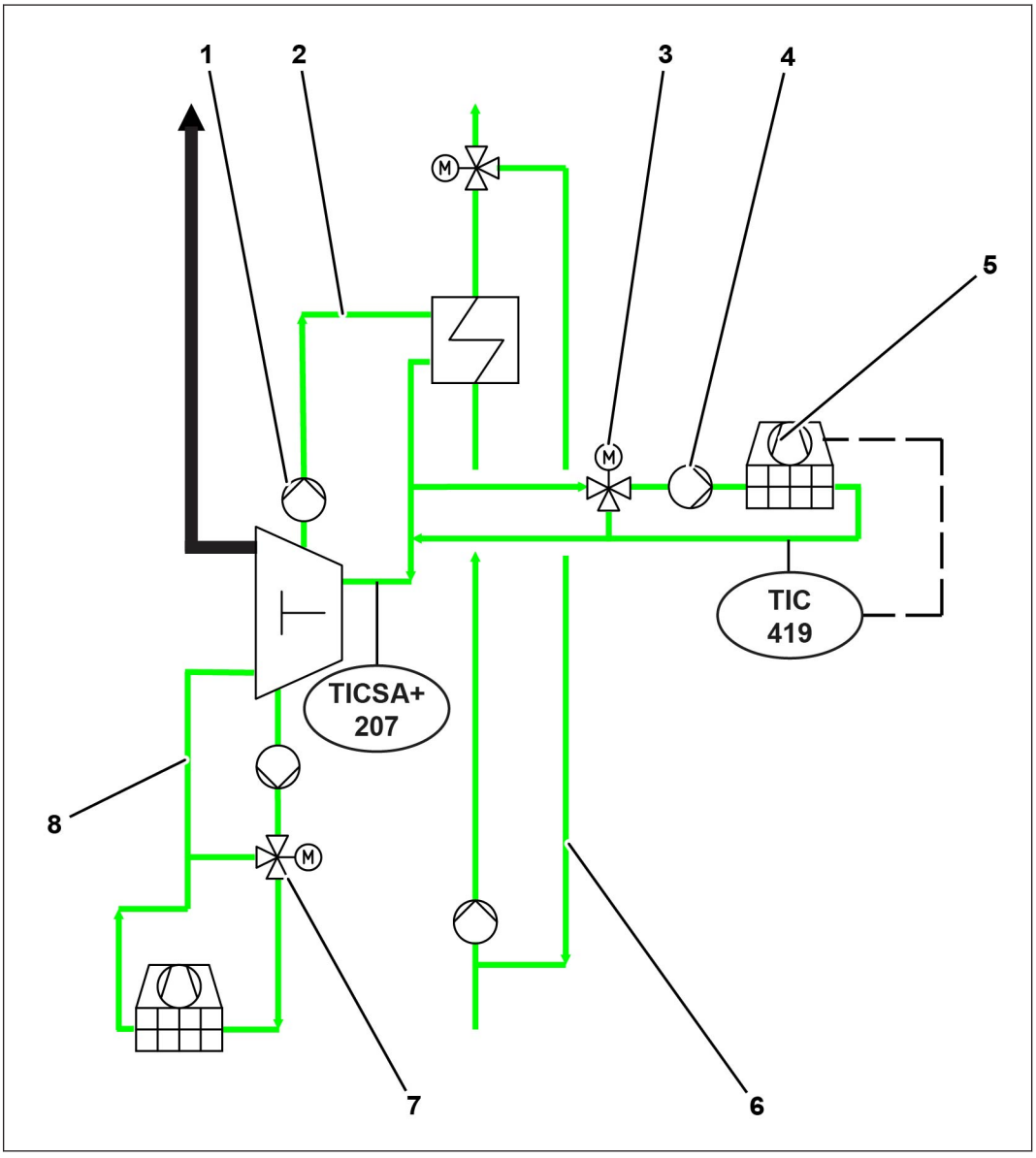
60769-002

1	Engine cooling circuit	4	Recooler
2	Engine cooling circuit pump	5	3-way valve mixture cooling circuit
3	3-way valve engine cooling circuit	6	Mixture cooling circuit

4.15.6 Flow diagram: recooler in dump cooling circuit

Note

The flow diagram is an example. The order-specific documents contain the exact equipment and the technical implementation of the assembly.



60771-002

1	Engine cooling circuit pump	5	Dump cooling circuit - recooler
2	Engine cooling circuit	6	Heating circuit
3	3-way valve dump cooling circuit	7	3-way valve mixture cooling circuit
4	Dump cooling circuit pump	8	Mixture cooling circuit

4.16 Dual core radiator in the engine cooling circuit and mixture cooling circuit (DCR)

Activated by parameter `20130474 DCR type`. The dual core radiator cannot be used if a heating circuit is used.

4.16.1 Functional description

To discharge the heat in the engine cooling circuit and in the low-temperature stage of the mixture cooling circuit, dual core radiators are used that combine the individual recoolers of both cooling circuits in a single recooler ⇒ `Recooler in engine cooling circuit or dump cooling circuit (DCC RDTR)` and `Mixture cooling circuit recooler (MCC RDTR)`.

Dual core radiators with two hydraulically independent cooling circuits are used in particular in compact plants. The space advantage is offset by the somewhat lower control quality. The cooling circuit with the greater cooling demand sets the cooling output of the dual core radiator.

The TPEM system can be parameterized for one of the following recooler variants:

- Recooler with frequency control (infinitely variable ventilator speed)
- Recooler with stage switching (max 8 stages)
- External control, the customer is responsible for heat discharge and the control of the dual core radiator

Aim of the regulation

- Maintaining the coolant temperatures at the recooler outlet (TIC 419 and TIC 405)
- Minimal energy consumption for the ventilators of the recooler

For table cooler recoolers, the use of frequency-controlled recoolers is recommended. A big advantage of frequency-controlled recoolers is the reduction of noise at nighttime. Due to the lower outdoor temperatures, the required cooling output can still be achieved even when the ventilator is operating at a lower speed.

4.16.2 Inputs and outputs in the TPEM system

Digital inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	Designation	Feedback
333	DCC RDTR/DCR FC monitoring	FC failed

Digital outputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	Actuator	At +24 V	At 0 V
937	DCC RDTR/DCR	ON	OFF
573 - 580	DCC RDTR/DCR cooler group 1-8	Stage ON	Stage OFF

Analog inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	ID	Designation	Sensor	Monitoring
405	TIC	Mixture cooling circuit recooler outlet temperature	4 … 20 mA =0 … 200° C	Wire break
419	TIC	Dump cooling circuit recooler outlet temperature	4 … 20 mA =0 … 200° C	Wire break

Analog outputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	Actuator	Version	
993	DCC RDTR/DCR FC	Recooler ventilator speed	4 … 20 mA = 0 …100 %

4.16.3 Control sequence recooler with frequency control

For further information on parameterization and setting of the desired values, see

- Separate operating manual parameter description ⇒ Initial setup
- Separate operating manual ⇒ Dump cooling circuit or dual core radiator (DCC/DCR)
- Separate operating manual parameter description ⇒ Mixture cooling circuit (MCC)

The control of the dual core radiator is active at the same time as the engine cooling circuit or mixture cooling circuit. The ventilators are activated and deactivated at the same time as the pumps in the engine cooling circuit and the mixture cooling circuit.

Control to the outlet temperature at the DCR

The outlet temperatures at the cooling circuits of the DCR are controlled to parameterizable characteristic curves.

- TIC 405 with parameters 20750006 and 20750011 or 20750173 and 20750161
- TIC 419 with parameters 20750022 and 20750033

When the cooling demand increases or decreases, the ventilator speeds are increased or decreased via a frequency converter.

The cooling circuit with the greater cooling demand sets the cooling output.

The active temperature desired value of the DCR which is determined by the control circuit with the greater cooling demand therefore corresponds to either the active desired value T405.3 set MCC RDTR outlet or the active desired value T419.3 set DCC RDTR outlet.

Setting recommendation

Set the desired value for the outlet temperature (TIC 405) so that it is > 3 K below the desired value for the inlet temperature at the mixture cooling circuit (TIC 202) ⇒ `Mixture cooling circuit (MCC)`. The 3-way valve in the mixture cooling circuit adds the required amount of cooler coolant.

Set the desired value for the outlet temperature (TIC 419) so that it is > 3 K below the desired value for the inlet temperature at the engine cooling circuit (TICSA + 207) ⇒ ECC. The 3-way valve in the engine cooling circuit adds the required amount of cooler coolant.

The controllers of the mixture cooling circuit, engine cooling circuit and dual core radiator are in use.

Control

The control is carried out via the following DCC parameters:

- 20470042 DCC RDTR/DCR control P proportional gain
- 20470075 DCC RDTR/DCR control I proportional gain
- 20470050 DCC RDTR/DCR control D proportional gain
- 20470088 DCC RDTR/DCR control low pass time

Desired value input

The desired values are entered via the following MCC and DCC parameters:

- 20750006 T405 set MCC RDTR outlet at 40 % power
- 20750011 T405 set MCC RDTR outlet at 100 % power
- 20750173 T405 set MCC RDTR outlet at 40 % power gas type B
- 20750161 T405 set MCC RDTR outlet at 100 % power gas type B
- 20750022 T419 set DCC RDTR outlet at 40 % power
- 20750033 T419 set DCC RDTR outlet at 100 % power

4.16.4 Control sequence recooler with stage switching

For further information on parameterization and setting of the desired values, see

- Separate operating manual parameter description ⇒ Initial setup
- Separate operating manual ⇒ Dump cooling circuit or dual core radiator (DCC/DCR)
- Separate operating manual parameter description ⇒ Mixture cooling circuit (MCC)

The control of the dual core radiator is active at the same time as the engine cooling circuit or mixture cooling circuit. The ventilators are activated and deactivated at the same time as the pumps in the engine cooling circuit and the mixture cooling circuit.

Control to the outlet temperature at the DCR

The outlet temperatures at the cooling circuits of the DCR are controlled to parameterizable characteristic curves.

- TIC 405 with parameters 20750006 and 20750011 or 20750173 and 20750161
- TIC 419 with parameters 20750022 and 20750033

In the case of recoolers with stage switching, the cooling capacity is controlled by switching on or off cooling units (e.g. ventilators) in cooling steps. To do so, several cooling units can be combined to form a cooler group which are addressed by TPEM via a common digital output. When the cooling demand increases or decreases, the changeover between the cooling stages takes place by activating or deactivating another cooler group so that one cooler group is active in cooling stage 1, two cooler groups are active in cooling stage 2, and so on. The following applies to ventilator cooler stages: All ventilators are operated at an identical, constant speed.

The number of activated cooler stages is determined by the cooling circuit with the greater cooling demand.

The active temperature desired value of the DCR which is determined by the control circuit with the greater cooling demand therefore corresponds to either the active desired value T405.3 set MCC RDTR outlet or the active desired value T419.3 set DCC RDTR outlet.

A downtime prevents the cooler stages from switching frequently. The downtime is parameterizable with parameter `20470109 DCC RDTR/DCR downtime`.

If the outlet temperature at the DCR is longer than the reaction time and the temperature difference is greater than the desired value, the system switches to a higher or lower cooling stage at downtime intervals. For TIC 419 with parameter `20470123 DCC RDTR/DCR reaction time`.

Control

The control is carried out via the following DCC/DCR parameters:

- `20470091 DCC RDTR/DCR max stage number`
- `20470114 DCC RDTR/DCR temperature difference`
- `20470109 DCC RDTR/DCR downtime`
- `20470123 DCC RDTR/DCR reaction time`

Desired value input

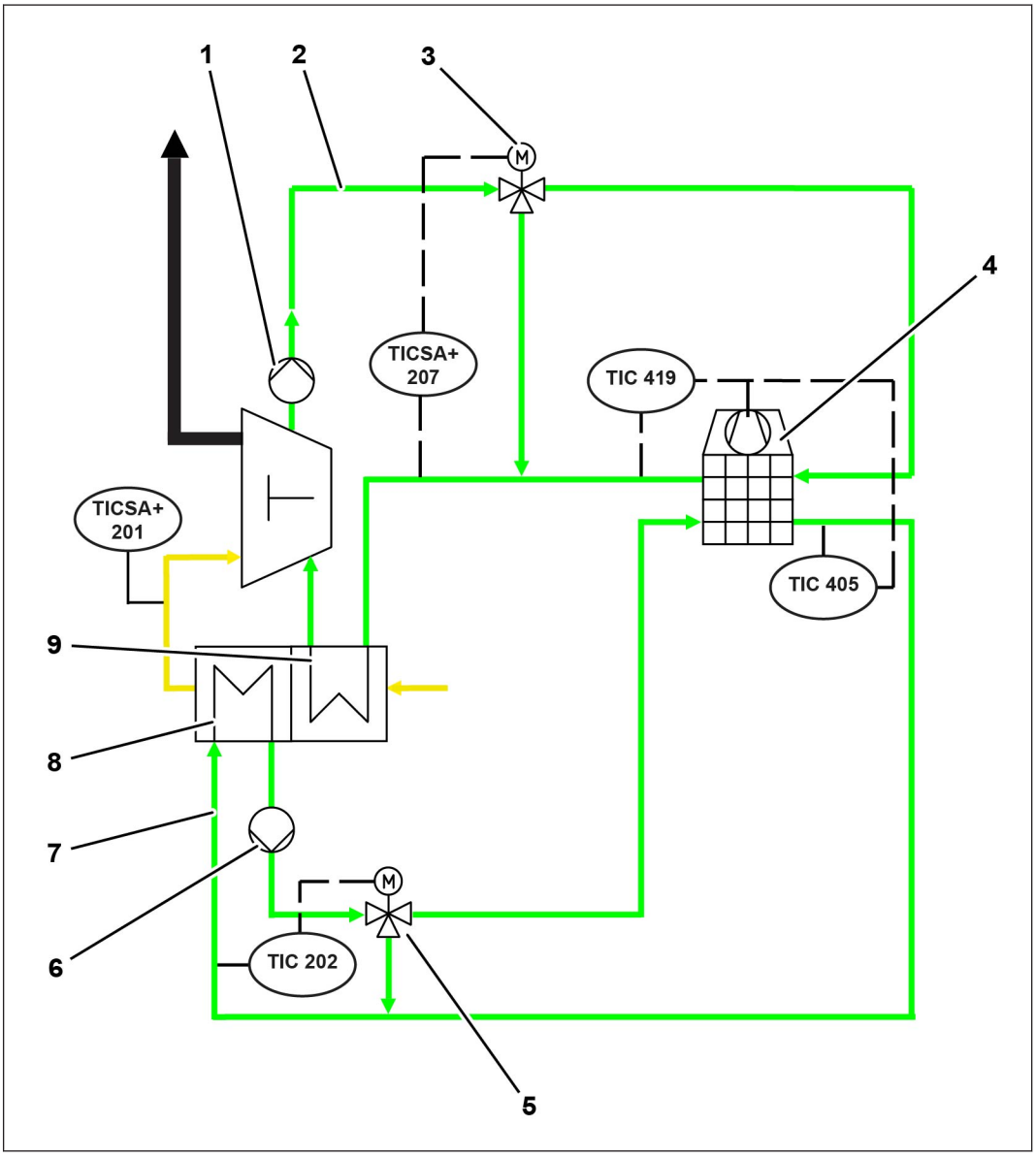
The desired values are entered via the following MCC and DCC/DCR parameters:

- `20750006 T405 set MCC RDTR outlet at 40 % power`
- `20750011 T405 set MCC RDTR outlet at 100 % power`
- `20750173 T405 set MCC RDTR outlet at 40 % power gas type B`
- `20750161 T405 set MCC RDTR outlet at 100 % power gas type B`
- `20750022 T419 set DCC RDTR outlet at 40 % power`
- `20750033 T419 set DCC RDTR outlet at 100 % power`

4.16.5 Flow diagram: dual core radiator in ECC and MCC

Note

The flow diagram is an example. The order-specific documents contain the exact equipment and the technical implementation of the assembly.



74122-001

1	Engine cooling circuit pump	6	Mixture cooling circuit pump
2	Engine cooling circuit	7	Mixture cooling circuit LT
3	3-way valve engine cooling circuit	8	Mixture cooler LT stage
4	Dual core radiator	9	Mixture cooler HT stage
5	3-way valve mixture cooling circuit		

4.17 Cabin ventilation control without circulating air

Activated in `Initial setup` with parameter `20130287 Cabin ventilation (with/without circulating air)`.

4.17.1 Functional description

The supply air flows into the genset room via a weather protection grille, inlet flap, filter and muffler. The ventilator pushes the air from the generator side into the genset room. The radiated heat given off by the generator, engine and the auxiliary drives heats the air that is blown in. The heated air then flows into the environment via the outlet flap, muffler and weather protection grille.

The parameterizable exhaust temperature upstream of the air outlet is regulated by the ventilator speed ⇒ parameter 20420055. (TIC 604) functions as a control variable. When the temperature increases, the ventilator speed increases.

With parameter `20420170 CV control at genset standstill`, the control of the cabin air temperature can be controlled even when the genset is at standstill. In this case, the exhaust air temperature can be set independently of the temperature during operation ⇒ parameter 20420197.

4.17.2 Inputs and outputs in the TPEM system

Digital inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	ID	Designation	Feedback
350	GS +	CV outlet flap limit stop opened	Limit stop cold
351	GS –	CV outlet flap limit stop closed	Limit stop warm
491	---	Fault CV	No fault
987	GS +	CV inlet flap limit stop opened	Limit stop cold
988	GS –	CV inlet flap limit stop closed	Limit stop warm

Digital outputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	Actuator	At +24 V	At 0 V
642	CV demanded		
955	Inlet flap direction of movement open	open	–
956	Inlet flap direction of movement close	close	–
957	Outlet flap direction of movement open	open	–
958	Outlet flap direction of movement close	close	–

Analog inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	ID	Designation	Sensor	Monitoring
404	TIC	CV supply air	4 … 20 mA = -30 °C … 60 °C	Temperature too high
604	TIC	CV exhaust air	4 … 20 mA = -30 °C … 60 °C	Temperature too high

Analog outputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	Actuator	Version	
994	Cabin ventilation Setpoint value FC/EC	Ventilator speed	4 … 20 mA = 0 … 100 %

Inputs on the TPEM Control Unit

No.	ID	Designation	Sensor	Monitoring
203	TISA +	Intake air temperature (cylinder row A)	Thermocouple	Temperature too low Temperature too high

4.17.3 Control sequence

For further information on parameterization and setting of the desired values, see

- Separate operating manual ⇒ TPEM Parameter description ⇒ Cabin ventilation (CV) ⇒ General

Genset not in operation, available

- Inlet flap: closed
- Ventilator: OFF
- Outlet flap: closed

Genset started

- Inlet flap: OPEN
- Ventilator: minimum speed dependent on genset output
- Outlet flap: opened
- Exhaust air temperature: control via ventilator speed (T604)

Genset switched off, CV control at genset standstill deactivated

- Ventilator: continues to run according to the parameterized run-on time ⇒ parameter 20420064.
- Controls: remain active, T exhaust air in operation
- After the run-on time has expired: ventilator shuts off, inlet and outlet flaps close

Genset switched off, CV control at genset standstill activated

- Ventilator: continues to run according to the parameterized run-on time ⇒ parameter 20420064.
- Controls: remain active
- After the shut-off delay expires:
  - T-control remains active, new setpoint value T exhaust air at standstill
  - If T604 falls below the setpoint value and the outlet flap is closed, the inlet flap is closed and the ventilator is deactivated.

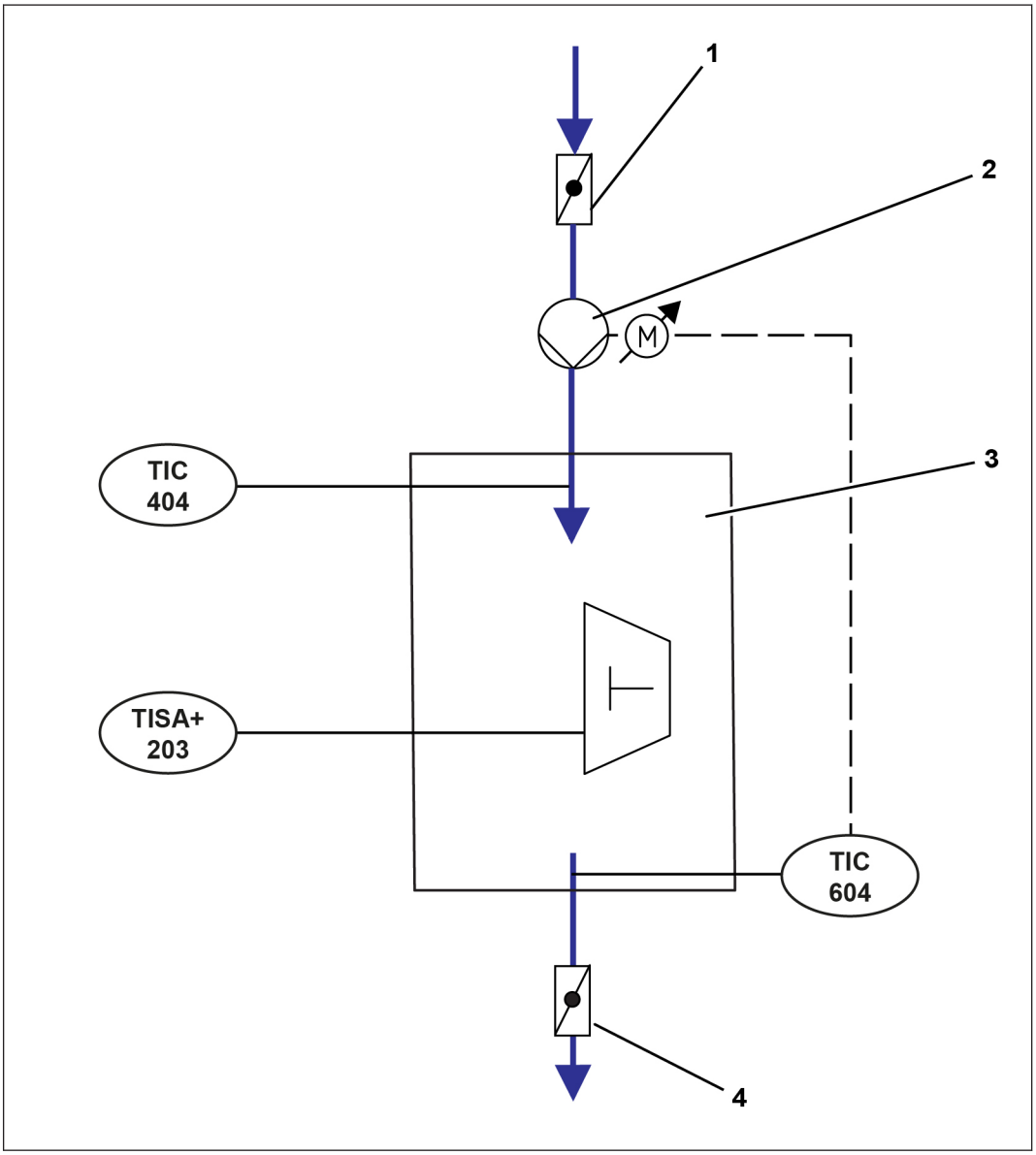
Parameters

- `20420055 T604 set CV exhaust air during operation`
- `20420170 CV control at genset standstill`
- `20420197 T604 set CV exhaust air at genset standstill`
- `20420064 CV cabin ventilation run-on time`

4.17.4 Flow diagram: cabin ventilation without circulating air

Note

The flow diagram is an example. The order-specific documents contain the exact equipment and the technical implementation of the assembly.



65513-001

1 Inlet flap
2 Ventilator
3 Genset room
4 Outlet flap

4.18 Cabin ventilation control with circulating air

Activated in `Initial setup` with parameter `20130287 Cabin ventilation (with/without circulating air)`.

4.18.1 Functional description

The supply air flows into the genset room via a weather protection grille, inlet flap, filter and muffler. The ventilator pushes the air from the generator side into the genset room. The radiated heat given off by the generator, engine and the auxiliary drives heats the air that is blown in. The heated air then flows into the environment via the outlet flap, muffler and weather protection grille. Warm exhaust air can be fed back through a circulating air duct with circulation flap upstream of the ventilator.

The flap positions of the circulation and outlet flaps regulate the parameterizable inlet air temperature to the genset room while the genset is in operation ⇒ parameter 20420041. When the temperature is too low, the circulation flap moves in the OPEN direction. If the outlet flap is opened up to the limit stop and the temperature is still too low, the outlet flap is moved in the CLOSED direction. This means that the cold outside air is mixed with warm exhaust air using the circulating air duct and the temperature at the air inlet is maintained. The cabin air temperature (TIC 404) or, when the circuit breaker is closed, the engine inlet air temperature (TISA + 203) functions as a control variable.

The parameterizable exhaust temperature upstream of the air outlet is regulated by the ventilator speed ⇒ parameter 20420055. (TIC 604) functions as a control variable. When the temperature increases, the ventilator speed increases.

With parameter `20420170 CV control at genset standstill`, the control of the cabin air temperature can be controlled even when the genset is at standstill. In this case, the supply air temperature and the exhaust air temperature can be set independently of the temperatures during operation ⇒ parameters 20420181 and 20420197.

4.18.2 Inputs and outputs in the TPEM system

Digital inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	ID	Designation	Feedback
350	GS +	CV outlet flap limit stop opened	Limit stop cold
351	GS –	CV outlet flap limit stop closed	Limit stop warm
353	GS +	CV circulation flap limit stop opened	Limit stop warm
354	GS –	CV circulation flap limit stop closed	Limit stop cold
491	---	Cabin ventilation fault	No fault
987	GS +	CV inlet flap limit stop opened	Limit stop cold
988	GS –	CV inlet flap limit stop closed	Limit stop warm

Digital outputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	Actuator	At +24 V	At 0 V
642	CV demanded		
955	Inlet flap direction of movement open	open	–
956	Inlet flap direction of movement close	close	–
957	Outlet flap direction of movement open	open	–
958	Outlet flap direction of movement close	close	–
959	Circulation flap direction of movement open	open	–
960	Circulation flap direction of movement close	close	–

Analog inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	ID	Designation	Sensor	Monitoring
404	TIC	CV supply air	4 … 20 mA = -30 °C … 60 °C	Temperature too high
604	TIC	CV exhaust air	4 … 20 mA = -30 °C … 60 °C	Temperature too high

Analog outputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	Actuator	Version	
994	Cabin ventilation Setpoint value FC/EC	Ventilator speed	4 … 20 mA = 0 … 100 %

Inputs on the TPEM Control Unit

No.	ID	Designation	Sensor	Monitoring
203	TISA +	Intake air temperature (cylinder row A)	Thermocouple	Temperature too low Temperature too high

4.18.3 Control sequence

For further information on parameterization and setting of the desired values, see

- Separate operating manual ⇒ TPEM Parameter description ⇒ Cabin ventilation (CV) ⇒ General

Genset not in operation, available

- Inlet flap: closed
- Ventilator: OFF
- Circulation flap: opened
- Outlet flap: closed

Genset started

- Inlet flap: OPEN
- Ventilator: minimum speed dependent on genset output
- Inlet air temperature: control via circulation flap and outlet flap (T404 / T203)
- Exhaust air temperature: control via ventilator speed (T604)

Genset switched off, CV control at genset standstill deactivated

- Ventilator: continues to run according to the parameterized run-on time ⇒ parameter 20420064.
- Controls: remain active, T supply air in operation, T exhaust air in operation
- After the run-on time has expired: ventilator shuts off, inlet flap and outlet flap close

Genset switched off, CV control at genset standstill activated

- Ventilator: continues to run according to the parameterized run-on time ⇒ parameter 20420064.
- Controls: remain active, T supply air in operation, T exhaust air in operation
- After the shut-off delay expires:
  - T-control remains active, new setpoint values from T supply air at standstill, T exhaust air at standstill
  - If T404 and T604 fall below their setpoint value and the outlet flap is closed, the inlet flap is closed and the ventilator is deactivated.

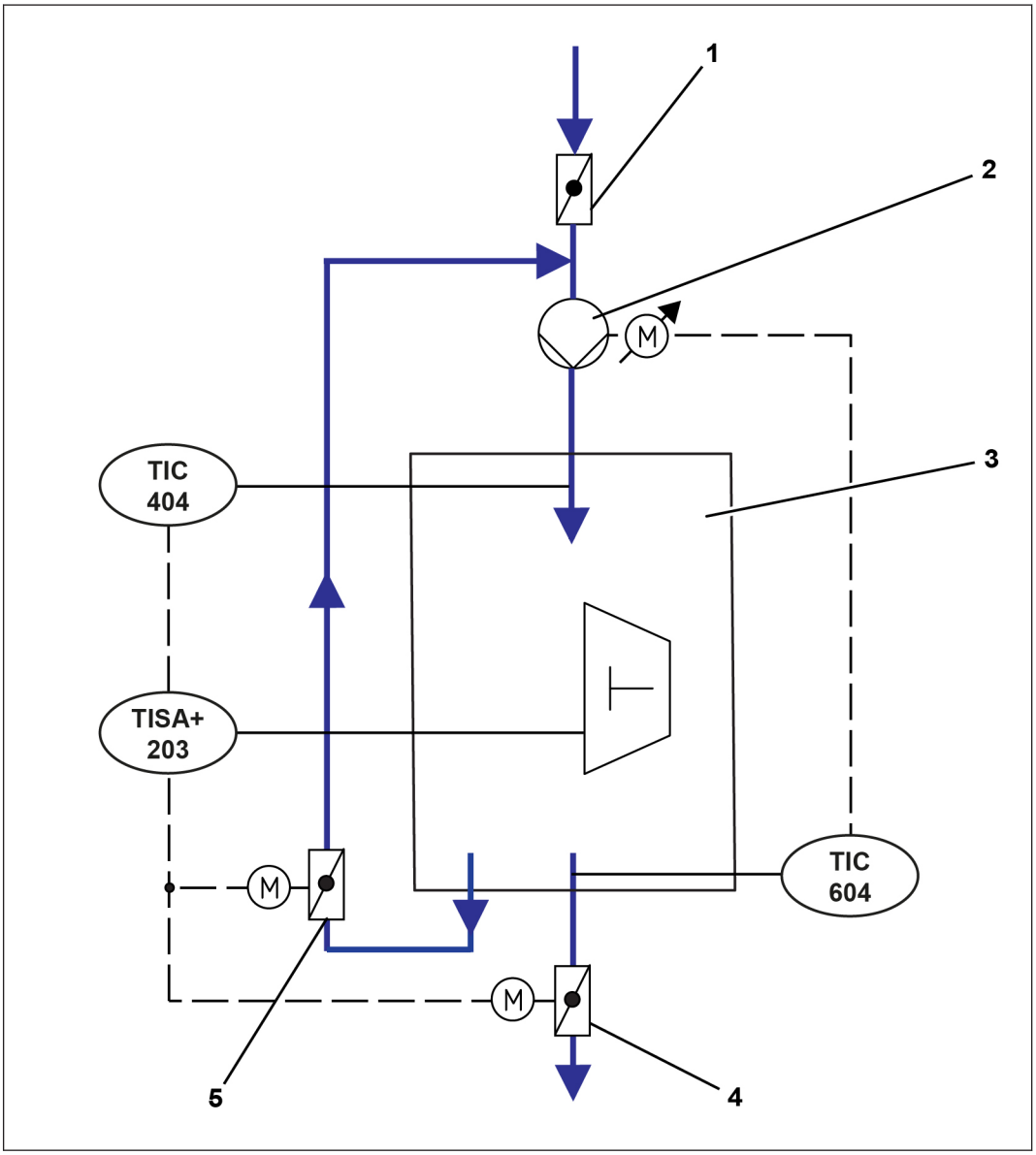
Parameters

- `20420041 T set CV supply air during operation`
- `20420055 T604 set CV exhaust air during operation`
- `20420170 CV control at genset standstill`
- `20420181 T404 set CV supply air at genset standstill`
- `20420197 T604 set CV exhaust air at genset standstill`
- `20420135 994 Ventilator minimum speed at 40 % power`
- `20420064 CV cabin ventilation run-on time`

4.18.4 Flow diagram: cabin ventilation with circulating air

Note

The flow diagram is an example. The order-specific documents contain the exact equipment and the technical implementation of the assembly.



60787-002

1 Inlet flap
2 Fan
3 Genset room
4 Outlet flap
5 Circulation flap

4.19 Intake air preheating

4.19.1 Functional description

At intake air temperatures below the permissible range for the engine, the intake air must be preheated so that the genset can work with maximum power for this site. If required, the preheating is achieved by a heat exchanger, which heats the intake air. The required heat energy is removed from the engine cooling circuit.

To control the minimum temperature of the intake air (T203), a 3-way valve and a circulation pump are actuated ⇒ Flow diagram: Intake air preheating.

4.19.2 Inputs and outputs in the TPEM system

Digital inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	ID	Designation	Feedback
---	---	Monitoring intake air preheating	failed
863	GIS –	Air preheater control valve stop position warm (open)	End position open
864	GIS +	Air preheater control valve stop position cold (closed)	End position closed

Digital outputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	Actuator	At +24 V	At 0 V
989	Intake air preheating pump ON	Pump ON	Pump OFF
990	Intake air preheating valve direction of movement colder	close	–
991	Intake air preheating valve direction of movement warmer	open	

Analog inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	ID	Designation	Sensor	Monitoring
203	TICSA+	Intake air temperature	4 … 20 mA = -15 °C … 56 °C	Temperature too low

4.19.3 Control sequence

For further information on parameterization and setting of the setpoint values, see

- Separate operating manual ⇒ TPEM Parameter description ⇒ Section Cabin ventilation (CV) ⇒ Intake air preheating

For the following control sequences it is necessary for parameter `20410002 Intake air preheating (IAP)` to be activated.

The genset is stopped

Upon a start demand, the control of the intake air preheating and circulation pump are started within the start sequence. If the engine starts to turn and combustion air is sucked in, the temperature T203 is controlled by the intake air preheating ⇒ parameter 20410015 or 20410028. If the intake air temperature T203 is already above the desired setpoint value, the 3-way valve is moved into a fully closed position after a delay ⇒ parameter 20410090. The circulation pump is switched off and the control is deactivated. If the intake air temperature is below the desired setpoint value, the control controls the 3-way valve in order to reach the setpoint temperature and then keep this constant.

The genset is running

The temperature of the intake air T203 drops below the parameterized setpoint value during operation of the plant:

After a delay ⇒ parameter 20410089, the control of the intake air preheating and circulation pump is started and the 3-way valve is opened slowly until the setpoint temperature of the intake air is reached. After this, the control of the 3-way valve keeps this temperature constant.

The temperature of the intake air T203 rises above the parameterized setpoint value T203 and the parameterized dead band during operation of the plant ⇒ parameter 20410031:

The 3-way valve closes slowly and ultimately reaches the end position. After a delay ⇒ parameter 20410090, the 3-way valve is moved into a fully closed position. The circulation pump is switched off and the control is deactivated.

Dual gas operation

In dual gas operation, an additional setpoint temperature is used for the intake air ⇒ parameter 20410028 for gas type B. In switch over operation or if only one gas type is used, the setpoint value of this gas type is used. In mixed gas operation, the higher setpoint value of the two gas types is used.

Low coolant level

If the control system detects a low coolant level, the safety chain is triggered. To prevent damage to components, the TPEM switches off the intake air preheating immediately.

Parameters

Parameter `20410002 Intake air preheating (IAP)` activates the following parameters:

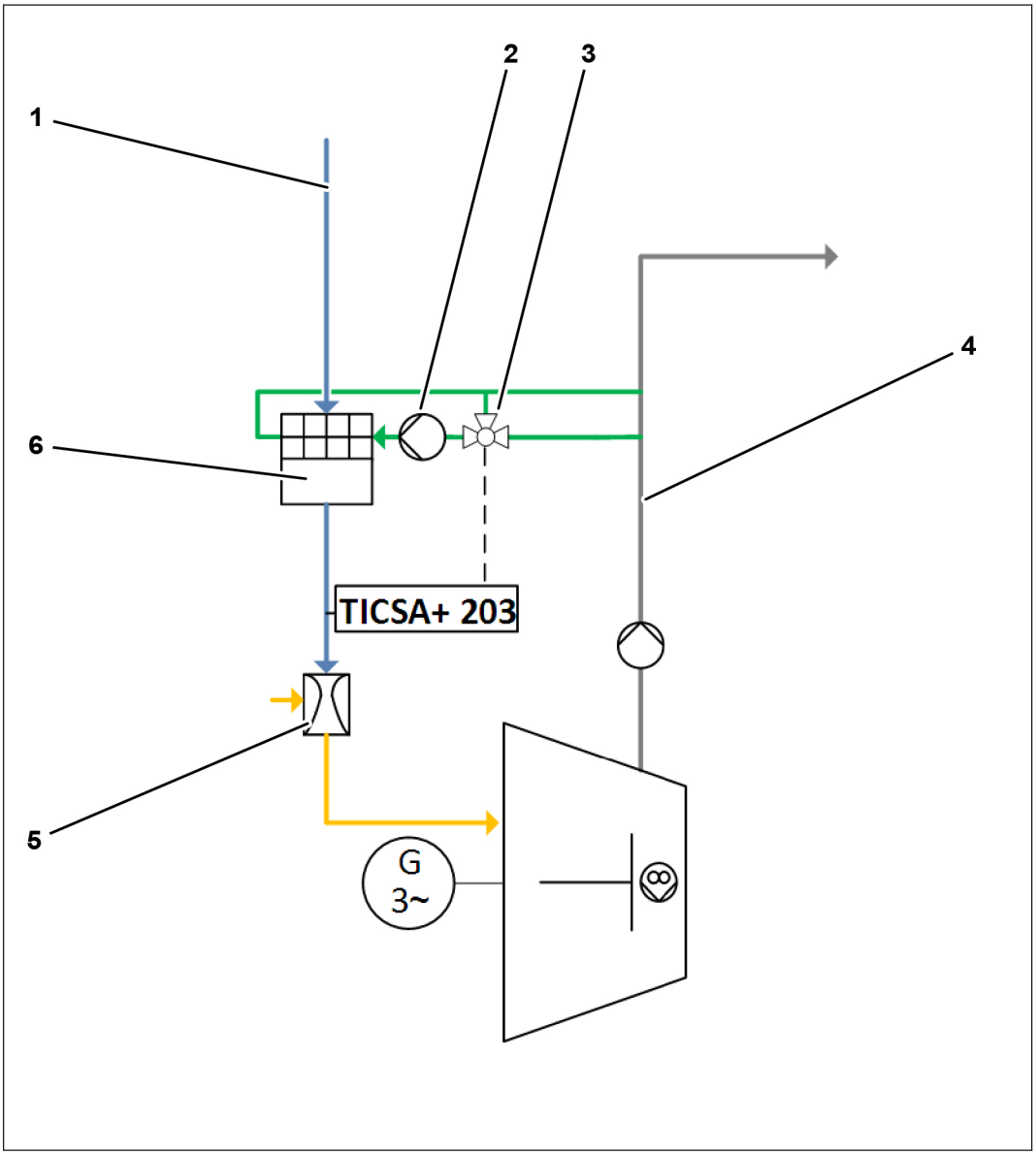
- `20410015 T203 set intake air`
- `20410028 T203 set intake air gas type B`
- `20410031 T203 set intake air dead band deactivation`
- `20410044 IAP control minimum signal length`

- 20410053 IAP control P proportional gain
- 20410066 IAP control D proportional gain
- 20410077 IAP control I proportional gain
- 20410089 IAP control delay time activation
- 20410090 IAP control delay time deactivation

4.19.4 Flow diagram: Intake air preheating

Note

The flow diagram is an example. The order-specific documents contain the exact equipment and the technical implementation of the assembly.



70843-001

1 Intake air
2 Circulation pump
3 3-way valve intake air preheating
4 Engine cooling circuit
5 Gas-air mixer
6 Tubular heat exchanger

4.20 Lube oil management TCG 3016

4.20.1 Functional description

The lube oil system of the TCG 3016 is designed as a wet sump lubricating system. The lube oil system uses three volumes of oil and three pumps on the genset.

The lube oil system consists of:

- Lube oil sump
- Extended oil circulation volume (in the base frame)
- Oil reservoir (in the base frame)
- Lube oil pump (powered via the engine crankshaft)
- Prelubrication pump (electrically powered)
- Oil reservoir pump (electrically powered)

The lube oil in the lube oil sump and in the extended oil circulation volume in the base frame forms the lube oil volume that is available to the engine for lubrication.

The mechanical lube oil pump supplies the engine with lube oil from the lube oil sump. A lube oil heat exchanger in the flow pipe cools the lube oil before feeding it to the lubricating points in the engine via a lube oil filter.

The lube oil pump pumps a small amount of the cooled lube oil back into the extended oil circulation volume in the base frame. The expanded circulating oil volume in the base frame is always completely filled with lube oil. Overflow causes the lube oil to flow depressurized back into the lube oil sump. As a result, the full lube oil volume is recycled several times per hour. After approx. three to four operating hours from a cold engine, the oil will have reached a consistent temperature throughout.

Before starting the genset each time, an automatic prelubrication takes place using the prelubrication pump. Prelubrication reduces engine wear. When the engine is shut down, relubrication takes place.

Sensors in the lube oil sump and in the oil reservoir monitor the lube oil levels.

If the lube oil level in the lube oil sump drops below the minimum level, the control shuts down the genset.

The `20130189 Lube oil sump automatic refill` parameter activates the automatic refilling of the lube oil sump during operation. If the parameter is activated and the fill level in the lube oil sump falls below a certain level, the oil reservoir pump pumps fresh oil out of the oil reservoir and into the extended oil circulation volume. From the expanded circulating oil volume, the lube oil enters the lube oil sump via the overflow. When the fill level in the lube oil sump has reached the specified level again, the oil reservoir pump switches off.

The parameter `20105776 Oil reservoir automatic refill` activates the automatic refilling of the oil reservoir during operation. If the parameter is activated and the fill level in the oil reservoir falls below a certain level, the control controls an output on the TPEM IO Controller. This makes it possible to activate a fresh oil pump that pumps fresh oil from an external fresh oil container into the oil reservoir. When the fill level in the oil reservoir reaches a certain fill level again, the control takes back control of the output and switches off the fresh oil pump.

The parameter 20130594 Alternative oil level limits for oil change activates the parameter for the automatic refilling of the lube oil sump and the oil reservoir during the guided lube oil change. The parameters can be used to define alternative fill levels that can be used instead of the fill levels for the automatic refilling during operation (parameters 20130189 and 20105776). If the parameter 20130594 is deactivated, the parameters 20130189 and 20105776 are used. The lube oil pump and the oil reservoir pump are turned on or off for refilling according to the fill levels. If the parameter 21130158 L327 oil reservoir sensor is deactivated, the oil reservoir pump is not demanded.

4.20.2 Lube oil management parameters TCG 3016

For necessary information on the parameter settings, see

- Separate Operating Manual ⇒ TPEM Parameter description ⇒ Lube oil section ⇒ General

If the parameter 21130158 L327 oil reservoir sensor is activated, the following parameters are available:

- 20105776 Oil reservoir automatic refill
  - 20190000 Oil reservoir oil level start value refill
  - 20190013 Oil reservoir oil level stop value refill
- 20130189 Lube oil sump automatic refill
  - 20130233 Oil sump oil level start value refill
  - 20130240 Oil sump oil level stop value refill
  - 20190021 Oil reservoir pump dry running protection
  - 20190037 Oil reservoir pump dry running protection deactivation
  - 20130190 Oil reservoir pump maximum runtime
  - 20130206 Oil reservoir pump pause time
  - 20130222 Oil sump wait time for rise in oil level
  - 20130211 Oil sump wait time after refill failure
- 20190045 Lube oil change prelubrication time
- 20130547 Waste oil tank monitoring
  - 20130552 Waste oil tank leakage monitoring
- 20130594 Alternative oil level limits for oil change
  - 20130571 Oil sump oil level start value refill (oil change)
  - 20190021 Oil reservoir pump dry running protection
  - 20190037 Oil reservoir pump dry running protection deactivation
  - 20190068 Oil reservoir oil level start value refill (oil change)
  - 20190084 Oil reservoir oil level stop value refill (oil change)

If the parameter 21130158 L327 oil reservoir sensor is deactivated, the following parameters are available:

- 20130279 Lube oil sump automatic refill
  - 20130233 Oil sump oil level start value refill
  - 20130240 Oil sump oil level stop value refill
  - 20130222 Oil sump wait time for rise in oil level
  - 20130211 Oil sump wait time after refill failure
- 20190045 Lube oil change prelubrication time
- 20130547 Waste oil tank monitoring
  - 20130552 Waste oil tank leakage monitoring
- 20130594 Alternative oil level limits for oil change
  - 20130571 Oil sump oil level start value refill (oil change)

4.20.3 Inputs and outputs in the TPEM system TCG 3016

Digital inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	ID	Designation	Feedback
330	---	Oil reservoir pump monitoring Requirement: Terminal 110K4: DI8 is assigned a high signal	Warning: Oil reservoir pump failed
339	---	Prelubrication pump monitoring Requirement: Terminal 110K5: DI1 is assigned a high signal	Warning: Prelubrication pump failed
835	---	Waste oil tank monitoring, fill level Requirement: Terminal 110K5: DI3 is assigned a high signal	Warning: L835 waste oil tank overfilled
617	---	Waste oil tank monitoring, leakage Requirement: Terminal 110K5: DI4 is assigned a low signal	Warning: L617 waste oil tank leakage

Digital outputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	Actuator	at +24 V	at 0 V
173	Demand for fresh oil refill	On	Off
331	Oil reservoir pump ON	On	Off
913	Prelubrication pump ON	On	Off

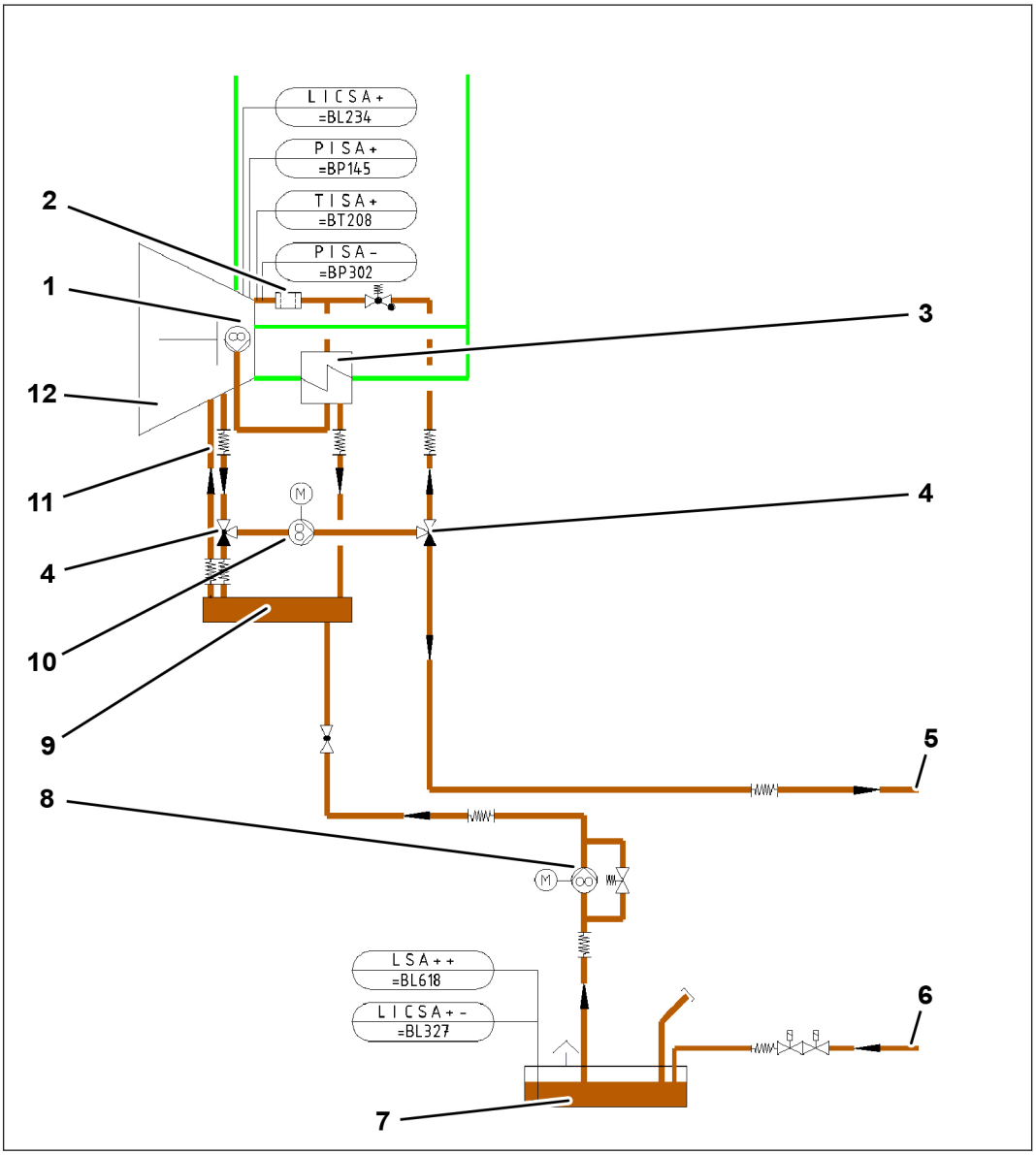
Inputs on the TPEM Control Unit

No.	ID	Designation	Feedback
302	PISA -	Lube oil pressure after filter	Pressure too low
208	TISA +	Lube oil temperature engine inlet	Temperature too high
234	LICSA +/-	Lube oil sump fill level	Minimum/maximum fill level
327	LICSA +/-	Oil reservoir fill level	Minimum/maximum fill level
618	LSA ++	Oil reservoir overfilled	Lube oil level overfilled
617	LSA +	Waste oil container leakage monitoring	Waste oil container leakage
835	LSA ++	Waste oil container fill level monitoring	Waste oil container fill level

4.20.4 Flow diagram: Lube oil management TCG 3016

Note

The flow diagram is an example. The order-specific documents contain the exact equipment and the technical implementation of the assembly.



62727-004

1 Lube oil pump (mechanical)
2 Oil filter
3 Lube oil heat exchanger
4 3-way valves on the prelubrication pump (hand-operated)
5 Waste oil connection
6 Fresh oil connection
7 Oil reservoir

8 Oil reservoir pump (electrical)
9 Expanded circulating oil volume in the base frame
10 Prelubrication pump
11 Overflow to the lube oil tray
12 Lube oil tray in the engine

4.21 Lube oil management TCG 3020

4.21.1 Functional description

The lube oil system of the TCG 3020 is designed as a wet sump lubricating system. The lube oil system uses two volumes of oil and two pumps on the genset.

The lube oil system consists of:

- Lube oil sump
- Extended oil circulation volume
- Lube oil pump (powered via the engine crankshaft)
- Prelubrication pump (electrically powered)

The lube oil in the lube oil sump and in the extended oil circulation volume in the base frame forms the lube oil volume that is available to the engine for lubrication.

The mechanical lube oil pump supplies the engine with lube oil from the lube oil sump. A lube oil heat exchanger in the flow pipe cools the lube oil before feeding it to the lubricating points in the engine via a lube oil filter.

The lube oil pump pumps a small amount of the cooled lube oil back into the extended oil circulation volume. The extended oil circulation volume is always completely filled with lube oil. Overflow causes the lube oil to flow depressurized back into the lube oil sump. As a result, the full lube oil volume is recycled several times per hour. After approx. three to four operating hours from a cold engine, the oil will have reached a consistent temperature throughout.

Before starting the genset each time, an automatic prelubrication takes place using the prelubrication pump. Prelubrication reduces engine wear. When the engine is shut down, relubrication takes place if parameter `21130021 ETC cooling` is parameterized to `Oil cooling`.

A sensor in the lube oil sump monitors the lube oil level.

If the lube oil level in the lube oil sump drops below the minimum level, the control shuts down the genset.

The `20130189 Lube oil sump automatic refill` parameter activates the automatic refilling of the lube oil sump during operation. If the parameter is activated and the fill level in the lube oil sump falls below a certain level, the control controls an output on the TPEM IO Controller. This makes it possible to activate a fresh oil pump that pumps fresh oil from an external fresh oil container into the expanded circulating oil volume. From the expanded circulating oil volume, the lube oil enters the lube oil sump via the overflow. When the fill level in the lube oil sump has reached the specified level again, the control takes back control of the output and switches off the fresh oil pump.

The parameter `20130594 Alternative oil level limits for oil change` activates parameters for the automatic refilling of the lube oil sump during the guided lube oil change. The parameters can be used to define alternative fill levels that can be used instead of the fill levels for the automatic refilling during operation (parameter `20130189`). If the parameter `20130594` is deactivated, the fill levels of parameter `20130189` are used. The lube oil pump is turned on or off according to the fill levels for refilling.

4.21.2 Lube oil management parameters TCG 3020

For necessary information on the parameter settings, see

- Separate Operating Manual ⇒ TPEM Parameter description ⇒ Lube oil section ⇒ General

- 20130279 Lube oil sump automatic refill
  - 20130233 Oil sump oil level start value refill
  - 20130240 Oil sump oil level stop value refill
  - 20130222 Oil sump wait time for rise in oil level
  - 20130211 Oil sump wait time after refill failure
- 20190045 Lube oil change prelubrication time
- 20130547 Waste oil tank monitoring
  - 20130552 Waste oil tank leakage monitoring
- 20130594 Alternative oil level limits for oil change
  - 20130571 Oil sump oil level start value refill (oil change)

4.21.3 Inputs and outputs in the TPEM system TCG 3020

Digital inputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	ID	Designation	Feedback
339	---	Prelubrication pump monitoring Requirement: Terminal 110K5: DI1 is assigned a high signal	Warning: Prelubrication pump failed
835	---	Waste oil tank monitoring, fill level Requirement: Terminal 110K5: DI3 is assigned a high signal	Warning: L835 waste oil tank overfilled
617	---	Waste oil tank monitoring, leakage Requirement: Terminal 110K5: DI4 is assigned a low signal	Warning: L617 waste oil tank leakage

Digital outputs on the TPEM IO Controller in the auxiliary drive cabinet

No.	Actuator	at +24 V	at 0 V
173	Demand for fresh oil refill	On	Off
913	Prelubrication pump ON	On	Off

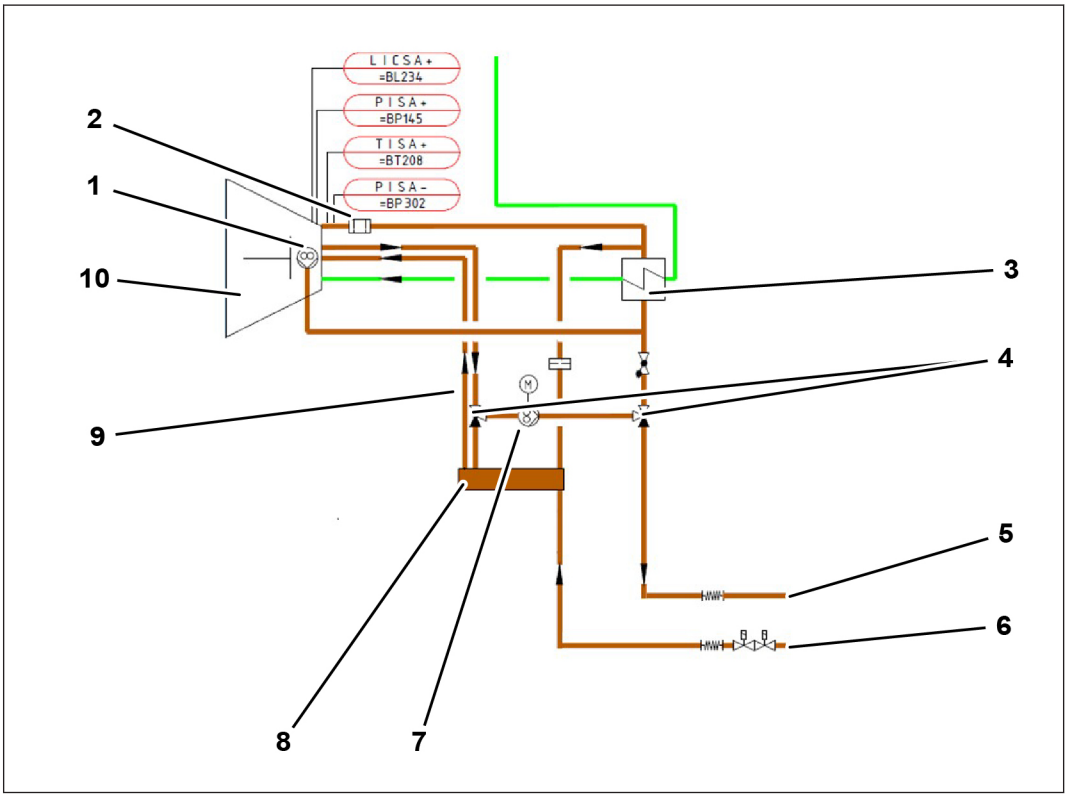
Inputs on the TPEM Control Unit

No.	ID	Designation	Feedback
302	PISA -	Lube oil pressure after filter	Pressure too low
208	TISA +	Lube oil temperature engine inlet	Temperature too high
234	LICSA +/-	Lube oil sump fill level	Minimum/maximum fill level
617	LSA ++	Waste oil container leakage monitoring	Waste oil container leakage
835	LSA ++	Waste oil container fill level monitoring	Waste oil container fill level

4.21.4 Flow diagram: Lube oil management TCG 3020

Note

The flow diagram is an example. The order-specific documents contain the exact equipment and the technical implementation of the assembly.



66590-002

1 Lube oil pump (mechanical)
2 Oil filter
3 Lube oil heat exchanger
4 3-way valves on the prelubrication pump (hand-operated)
5 Waste oil connection
6 Fresh oil connection
7 Prelubrication pump
8 Extended oil circulation volume
9 Overflow to the lube oil sump
10 Lube oil sump in the engine

4.22 Black start

If the available voltage supply is not sufficient for the operation of the auxiliary drives (e.g. prelubrication pump, cooling pumps), a black start is possible instead of the usual normal start. The auxiliary drives run as soon as the engine is running and the generator is generating power. The black start is performed without a leakage check of the gas supply and without prelubrication. The genset is shut down in the same way as a normal start.

A black start is possible both in island mode and in mains parallel mode.

Requirements:

- 24 V voltage supply available
- Parameter `20105303 Black start possible` activated
- Demand contact 179 Black start on the TPEM IO Controller closed

In order to perform a black start, a start command is required in addition to the aforementioned requirements.

The start command for the genset can be initiated both via the TPEM Touch Panel or the TPEM Remote Client as well as via a superior control.

For more information on the black start, see

- Operating manual ⇒ Operation ⇒ Operation modes ⇒ Starting the genset
  - Black starting the genset in the manual operation mode

4.23 Smoke alarm, gas alarm

The plant has a smoke warning system and a gas warning system. The smoke warning system and gas warning system may consist of several smoke detectors, gas sensors, optical signals and acoustic signals. If the smoke detector or gas sensor triggers, the TPEM control will initiate the corresponding protective measures.

Optical and acoustic signals trigger independently of the TPEM control.

When the plant is operational, the smoke warning system and the gas warning system are activated. It makes no difference here whether the genset is switched off, the genset is running or whether the auxiliary drives are in the follow-up time after shutting down the genset.

For more information on smoke alarm and gas alarm, see

- Separate document Layout of power plants

4.23.1 Smoke alarm

The triggered smoke alarm operates automatically.

Smoke alarm

- The alarm `Smoke alarm` appears on the TPEM TP
- If the genset is running: shuts down (Alarm)
- Safety shut-off valves of the gas train or gas trains: Close
- Depending on the plant design:
  - Quick closing valve of the gas supply: closes
  - Supply air louver dampers and exhaust air louver dampers: close completely

4.23.2 Gas alarm

The triggered gas alarm operates automatically. The gas alarm is divided into alarm level 1 and alarm level 2.

The alarm levels each refer to the lower explosion limit of the gas-air mixture.

- Alarm level 1 from 20 % of the lower explosion limit (low signal on 110K4, DI11)
- Alarm level 2 from 40 % of the lower explosion limit (low signal on 62K7, DI 1 or 62K7, DI2)

Gas alarm level 1

- The alarm `Gas alarm level 1` appears on the TPEM TP
- If the genset is running: shuts down with pump run-on (Alarm SC)
- Forced ventilation switches on
  - Supply air louver dampers and exhaust air louver dampers: open completely
  - Circulating air louver damper (if present): closes completely
  - Supply air ventilators: max. speed

Gas alarm level 2

- The alarm `SaC gas alarm level 2` appears on the TPEM TP
- If the genset is running: shuts down without pump run-on (Alarm WO)
- Safety shut-off valves of the gas train or gas trains: Close
- Quick closing valve of the gas supply (depending on the plant version): closes

4.24 Parameterizable inputs and outputs in the TPEM system

The TPEM IO Controller in the auxiliary drive cabinet has several digital and analog inputs, which can be parameterized individually.

4.24.1 DES (Demand for external starting preparations)

The TPEM IO Controller has 3 digital inputs (541 to 543) for which DES feedback can be compiled.

For further information on parameterizable inputs, see

- TPEM Parameter description ⇒ General ⇒ Parameterizable inputs

4.24.2 Parameterizable operating messages

The TPEM IO Controller has 13 digital inputs (544 to 556), which can be monitored individually after activating and setting the corresponding parameters. An operating message is issued upon corresponding signal.

For further information on parameterizable inputs, see

- TPEM Parameter description ⇒ General ⇒ Parameterizable inputs

4.24.3 Parameterizable Counters

The TPEM IO Controller has four digital inputs (581 to 584), which can be used as parameterizable counters. The counters can be used to determine the gas consumption or the amount of electrical energy produced, for example. The counter readings are displayed in TPEM TP ⇒ Data ⇒ Measured values, counted values.

The counted values can be transmitted to a superior plant control per Modbus.

Depending on the plant version, one or more counters can be preset.

No.	Designation
581	Parameterizable counter 1
582	Parameterizable counter 2
583	Parameterizable counter 3
584	Parameterizable counter 4

For further information on parameterizable counters, see

- TPEM Parameter description ⇒ General ⇒ Parameterizable counters

4.24.4 Parameterizable measured values

TPEM has four analog inputs in order to display plant-specific measured values and monitor limits. This allows additional devices to be monitored. Depending on the measured value, three limits can be parameterized, which trigger an event if exceeded or undercut.

For each parameterizable measured value, an input is available at the TPEM IO Controller for a 4 ... 20 mA signal.

It must be ensured that the analog ground of the signals is interconnected, also to the ground of the transmitters included in the standard scope. A supply voltage of 24 V is available for connecting two-conductor sensors.

The current measured values are displayed in the Data functional group.

For further information on parameterizable inputs, see

- TPEM Parameter description ⇒ General ⇒ Parameterizable measured values

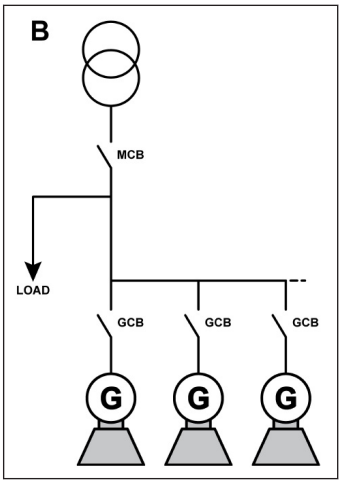
4.24.5 Digital outputs on the TPEM IO Controller in the HAS

The acknowledged warnings or alarms 547 to 556 can be sent as feedback to the externally triggering devices.

4.25 Run-up synchronization

The run-up synchronization is used for the excitation of transformers. If the inrush current of a transformer exceeds the available start-up current that the generator can supply, run-up synchronization should be used.

Using run-up synchronization, the generator and transformer can slowly build up voltage during startup without producing an excessive inrush current.



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4.26 Emission monitoring

The emission monitoring forms the basis for verifying that the plant complies with nitrogen oxide (NOx) emissions according to the regulations.

Activated with parameter `21130207 Emission monitoring`.

Note

If parameters of the emission monitoring are changed or parameters that have an effect on the emission of the nitrogen dioxides of the plant, this should be documented on a logbook.

4.26.1 Functional description

The plant is monitored for NOx and O2. An NOx sensor in the exhaust system allows the requisite measured values to be recorded and evaluated by the TPEM control.

The recording of all sensor signals is limited to normal operation of the plant. Startup and shutdown processes are excluded from the monitoring.

The following data are displayed ⇒ Data functional group ⇒ Engine 2/2 ⇒ Emission monitoring:

`NOx raw value` [g/m³]	The `NOx raw value`measured by the NOx sensor.
`NOx value` [g/m³]	Value, which is calculated by the control from the `NOx raw value` currently measured and parameter `20260029 NOx calibration slope` and, if applicable, parameter `20260032 NOx calibration offset`.
`O2 value` [%]	The `O2 value` currently measured by the NOx sensor.
`O2 current daily mean value` [g/m³]	The daily mean value formed from the measured O2 values until the current time.
`NOx current daily mean value` [g/m³]	The daily mean value formed from the NOx values until the current time.

`NOx raw value`, `NOx value` and `O2 value` are only displayed if the NOx sensor communicates data to the control. No data is transmitted during a shutdown, while the genset is starting or stopping and as long as the NOx sensor has not reached its operating temperature.

The current daily mean values of NOx and O2 are formed from 0 hours until the current time. These daily mean values are saved as final daily mean values at midnight.

The final daily mean values of NOx and O2 are saved for 455 days and can be exported ⇒ Operation ⇒ Introduction to operation of the TPEM system ⇒ Data export.

If the limit value for the final daily mean value of NOx or O2 is exceeded, a corresponding message is issued ⇒ Operation ⇒ Functional group "Messages".

The progression of the current values of `NOx raw value`, `NOx value` and `O2 value` can be recorded in the history ⇒ Operation ⇒ History ⇒ Selection ⇒ Display.

4.26.2 Emission monitoring parameters

For necessary information on the parameter settings, see

- Separate operating manual ⇒ TPEM Parameter description ⇒ Section Engine ⇒ Basic settings

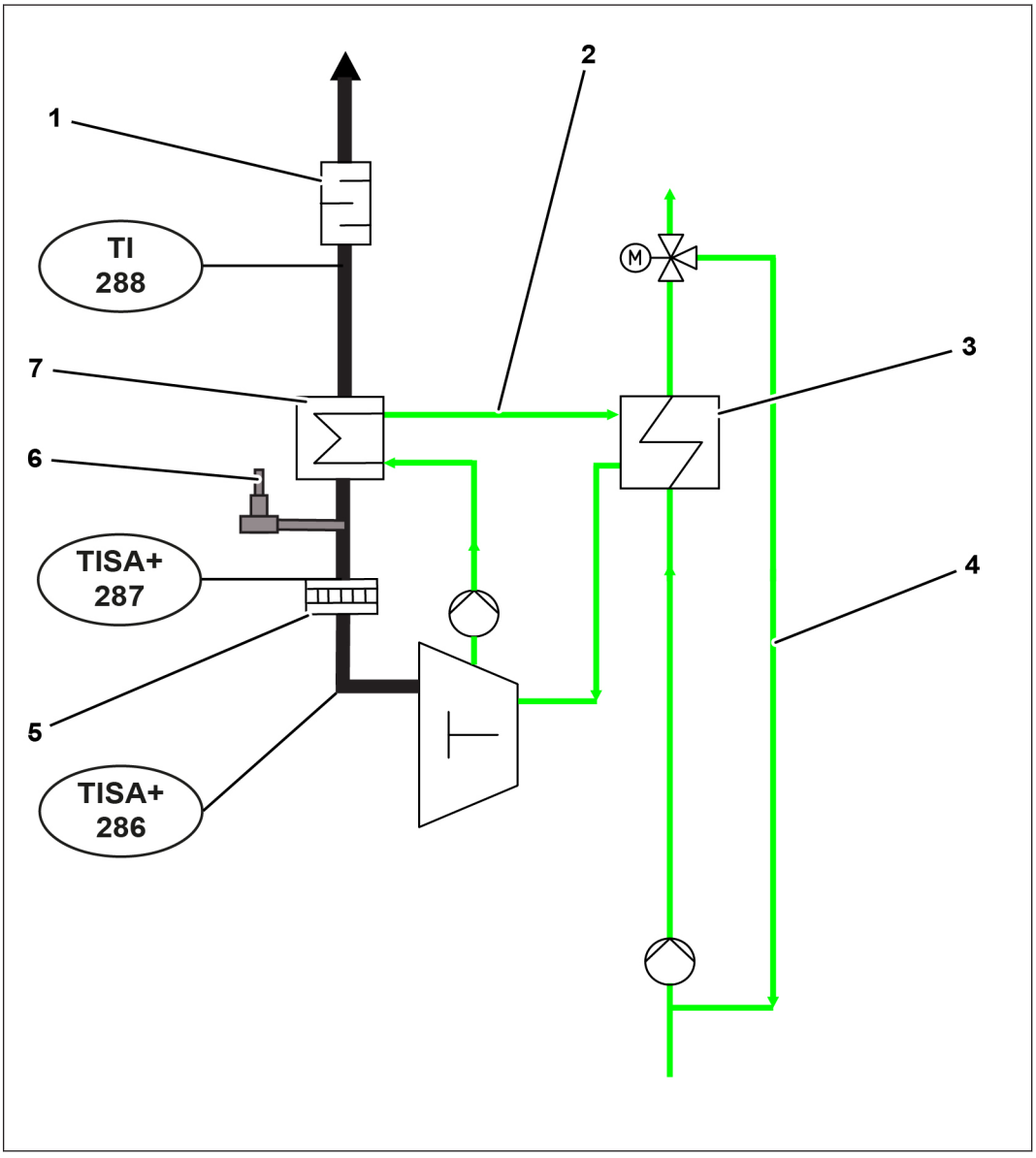
The following parameters are available for calibration and configuration of the emission monitoring:

- 21130207 Emission monitoring
- 20260029 NOx calibration slope
- 20260032 NOx calibration offset
- 21130210 Plant-specific ratio NO2 to NOx
- 20260010 NOx limit
- 20260041 O2 limit
- 20260181 Event type O2 daily mean value too high
- 20260197 Event type NOx daily mean value too high

4.26.3 Flow diagram: Emission monitoring

Note

The flow diagram is an example. The order-specific documents contain the exact equipment and the technical implementation of the assembly.



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1	Exhaust muffler	5	Catalytic converter
2	Engine cooling circuit	6	NOx sensor with measuring probe
3	Coolant heat exchanger	7	Exhaust heat exchanger
4	Heating circuit		

5 Preservation, packaging, transport and storage

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5.6 Notes on storage 167
5.7 Notes on preservation 168

5.1 Safety notes

WARNING!

Risk of injury from swinging, slipping or falling loads

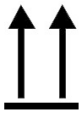
This can lead to severe injuries and even death.

- Do not stand underneath suspended loads.
- Secure the swivel range of the suspended load.
- Raise or lower load slowly and evenly.
- Only use tested load suspension devices and lifting equipment which are of a suitable size for the relevant weight.

For necessary information on preservation, packaging, transport, and storage, see

- Operating Manual ⇒ General ⇒ Operating media regulations
  - Technical Bulletin (TR) 2169 Specification for preservation, packaging, transport and storage

5.2 Symbols on the packaging

	**Attach here** Position fastening material for lifting the package - as shown.
	**Center of gravity** Shows the center of gravity of the respective package.
	**Top** Shows the correct upright position of the package. Only transport and store the packages in an upright position.
	**Protect from moisture** Protect packages from moisture and store in a dry place.
	**Fragile** Indicates packages with fragile or sensitive contents. Treat packages with care, do not throw and be careful not to knock or bump them.

5.3 Removing from transport

Immediately check the delivery for completeness and transport damage upon receipt.

In the event of visible transport damage on the outside, proceed as follows:

1. Do not accept the delivery or only accept under reserve
2. Note the extent of the damage on the transport documents or on the hauler's delivery note
3. Lodge complaint

Note

Make a claim for each fault as soon as it is detected. Claims for damage may only be made within the legal and contractually agreed claim deadlines.

5.4 Transporting packages and pallets

All notes in this section refer to transporting individual packages or pallets.

For further information on transport, see

- Operating Manual ⇒ General ⇒ Operating media regulations
  - Technical Bulletin (TR) 2169 Specification for preservation, packaging, transport and storage

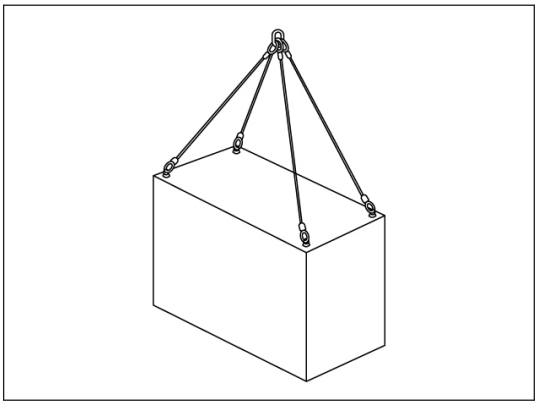
Transporting packages by crane

Prerequisites

- The packages are fitted with attachment points.
- Cranes and lifting equipments are designed for the weight of the package.
- The personnel are authorized to operate a crane.

Proceed as follows:

1. Attach lifting equipment at the application points



61134-002

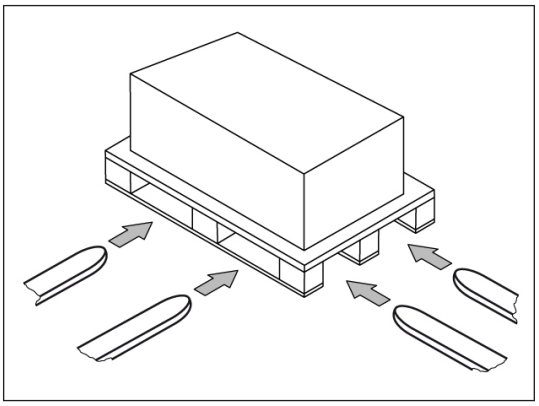
2. Ensure that the package hangs straight
   → Pay attention to the off-center center of gravity when attaching gear.
3. Lift package slowly and begin with the transport

Transporting pallets with the forklift

Prerequisites

- The packages are fixed to pallets, which can be transported with a forklift.
- The forklift is designed to take the weight of the transport unit.
- The personnel are authorized to operate a forklift.

Proceed as follows:



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1. Drive the forklift with the forks between the blocks of the pallet
   → Drive the forks into the pallet as far as possible.
2. Ensure that the pallet cannot tip over
   → Pay attention to the off-center center of gravity when attaching gear.
3. Lift pallet slowly and begin with the transport

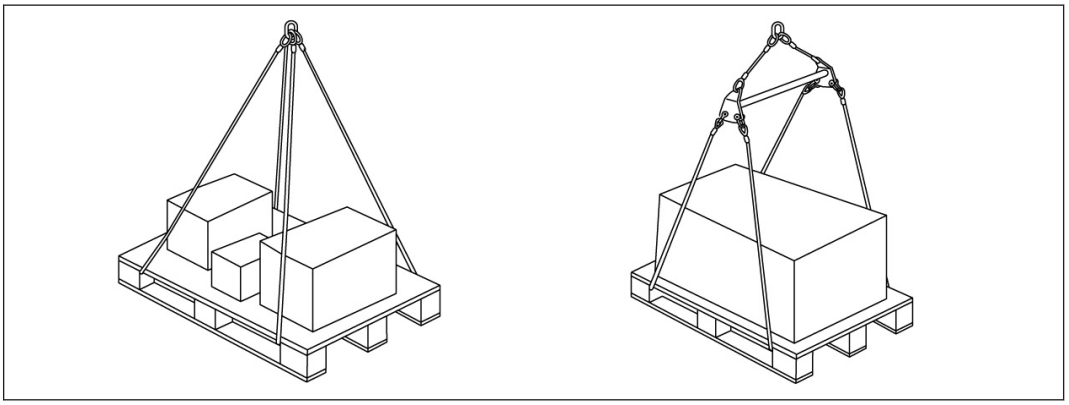
Transporting pallets by crane

Prerequisites

- The packages are fixed to pallets, which can be lifted and transported with a crane.
- Crane and lifting equipments are designed to take the weight of the transport unit.
- The personnel are authorized to operate a crane.

Proceed as follows:

1. Attach lifting equipment



61136-003

2. Ensure that the packages are not damaged by the fastening materials
   → If necessary, use other fastening materials.

3. Ensure that the pallet hangs straight
   → Pay attention to the off-center center of gravity when attaching gear.
4. Lift pallet slowly and begin with the transport

5.5 Information on packaging

The individual packages are packed according to the transport conditions to be expected.

Note

For required information on packaging, see

- Operating Manual ⇒ General ⇒ Operating media regulations
  - Technical Bulletin (TR) 2169 Specification for preservation, packaging, transport and storage

The packaging should protect the individual components up to assembly. Therefore, do not destroy the packaging and only remove it directly before assembly.

Handling packaging materials

Danger to the environment

Incorrect disposal of packaging materials may cause environmental damage.

- Dispose of packaging material according to the respectively applicable legal regulations and local specifications.
- Pass recyclable packaging material on to be recycled
- Commission a specialist company if necessary

5.6 Notes on storage

All notes in this section refer to the storage of individual packages or pallets.

For further information on the storage, see

- Operating Manual ⇒ General ⇒ Operating media regulations
  - Technical Bulletin (TR) 2169 Specification for preservation, packaging, transport and storage

Store packages under the following conditions:

- Do not store outside
- Store in a dry, dust-free place
- Protect from sunlight
- Avoid mechanical vibrations
- Storage temperature: free of frost to 45 °C
- Relative air humidity: max. 60 %
- If storing for more than three months:
  - Regularly check the condition of all packages and their packaging
  - Renew damaged packaging if necessary
  - Refresh or renew preservation if necessary

Note

Under certain conditions, there are notes about storage on the packages which go beyond the requirements stated.

Observe and comply with these notes.

5.7 Notes on preservation

All notes in this section refer to the preservation of individual packages, pallets or spare parts.

For further information on preservation of the genset, see

- Operating Manual ⇒ General ⇒ Operating media regulations
  - Technical Bulletin (TR) 2169 Specification for preservation, packaging, transport and storage

Packages, pallets and spare parts are protected from corrosion before being dispatched.

The period of preservation should extend to at least twelve months. The actual length of protection also depends on:

- Method of preservation
- Packaging
- Storage conditions

Note

In some circumstances, there are additional notes in relation to preservation on the packages, pallets and spare parts, as well as in the supply documents of the spare parts.

Observe and comply with these notes.

Check the preservation of all packages, pallets and spare parts regularly and renew or refresh where necessary.

6 Assembly

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6.1 Safety notes

WARNING!

Electric shock if live components are touched

This can lead to severe injuries and even death.

- Only authorized specialist personnel may work on the electrical system.
- Turn off electrical power supply and secure against restarting:
  - Disconnect electrical system.
  - Secure against reconnection.
  - Check that equipment is de-energized.
  - Ground and short-circuit the electrical system.
  - Cover or cordon off adjacent components which are electrically live.

WARNING!

Injury due to improper installation

This can lead to severe injuries and even death.

- Only authorized specialist personnel may install the product.
- Ensure sufficient installation space.
- Handle sharp-edged components carefully.
- Ensure tidiness and cleanliness in the workplace.
  - Do not leave tools lying around.
  - Components left lying around and on top of one another are accident hazards.
- Assemble components properly.
  - Observe specified tightening torques.
- Secure components from being knocked over or falling down.

WARNING!

Injury due to improper installation

This can lead to severe injuries and even death.

- Only qualified specialist personnel may work on the electrical system.
- Only qualified specialist personnel are permitted to work on the fuel gas system.

6.2 Requirements

Tightening specifications

For necessary information on the tightening specifications, see

- Chapter Maintenance, Tightening specifications section

Personnel

- Only qualified specialist personnel may carry out assembly work on the product
- Only qualified specialist personnel may work on the electrical system
- Only qualified specialist personnel are permitted to work on the fuel gas system.

Personal protective equipment

Wear the following personal protective equipment during all assembly work:

- Protective work wear
- Safety helmet
- Safety shoes
- Safety gloves
- Goggles

Required preliminary work

- The foundation is capable of bearing loads, is resistant to frost, dry, incombustible and horizontal
- The supply connections for the operating media are wired
- Sufficient ventilation to the outside is available
- The fresh air is free of chemical additives (e.g. fluorine, chlorine, sulfur)
- The installation location is equipped with a sealing, self-closing, fire-proof door
- There is a suitable chimney connection available at the installation location
- A free space of at least one meter around the genset exists at the installation location

For further information on the requirements of the installation location, see

- Operating Manual ⇒ General ⇒ Installation directive
- Operating Manual ⇒ Assembly note ⇒ Genset installation

7 Commissioning

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7.1 Safety notes

WARNING!

Injury due to improper commissioning

This can lead to severe injuries and even death.

- Only authorized specialist personnel may operate the product

7.2 Initial commissioning TPEM Control Cabinet

The initial commissioning is carried out in consultation between the owner and the commissioner.

Have the work for the initial commissioning carried out according to the commissioning specification. Only have the work carried out by employees of the manufacturer or people authorized by the manufacturer.

As part of the initial commissioning, an update to the current TPEM version is mandatory. This is the only way to ensure that the control contains the expected range of functions and important service functions. The current TPEM version can be downloaded from the Service Library.

7.3 Configuring the generator controller

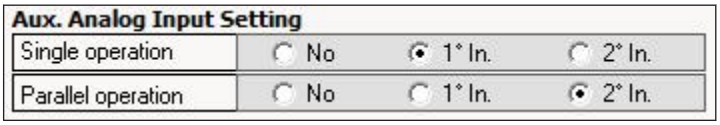
Gensets with TPEM control can be delivered with various different generator controllers. The functionality of the generator controllers Marelli MEC100 or D-Vo, ABB Unitrol 1005 and Basler DECS100 is largely comparable, but the commissioning is different.

Marelli MEC100 or D-Vo, ABB Unitrol 1005

This generator controller requires two analog signals from the TPEM system. One analog signal is the setpoint value for the voltage control (island mode/idle) and comes from the MFR output in the TPEM CC. The second signal is the setpoint value for the shift factor control (exclusively in explicit exceptional cases without grid code requirements) or for the reactive power control (Unitrol 1005 in the standard case) in mains parallel mode. This signal comes from the TPEM IO Controller in the HAS. The analog signals are to be applied to the analog inputs of the generator controller. The generator controllers are to be set so that the correct setpoint value is used in each operation mode.

MEC100 example: controller setting Aux. Analog input setting

- Single operation (island mode/idle): Analog input 1
- Parallel operation (mains parallel mode): Analog input 2



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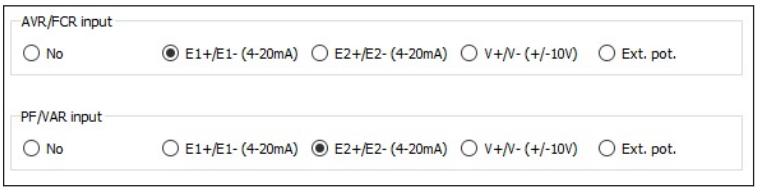
D-Vo example: Programmable Inputs --> Analog Inputs

- Voltage controller: Analog input E1+ / E1-
- PF controller: Analog input E2+ / E2-



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Configuring the TPEM

When using the MEC100, the D-Vo or the Unitrol 1005, the TPEM system must be configured so that it issues the shift factor or reactive power setpoint value from the corresponding analog output of the TPEM IO Controller and so that the PF controller of the TPEM MFR is deactivated. The generator controller input and the TPEM IO output must be set so that their scaling corresponds. An incorrect setting leads to an incorrect shift factor or an incorrect reactive power value. The TPEM IO Controller has two separate analog outputs for the shift factor and reactive power setpoint values. The latter is located on the TPEM Grid Code IO Controller used for grid code applications.

TPEM parameter settings

- `20250075 Min PF output set (at 4 mA)`: Set to minimum.
- `20250088 Max PF output set (at 20 mA)`: Set to maximum.
- `20251019 Output Qset min (at 4 mA)`: Set to minimum.

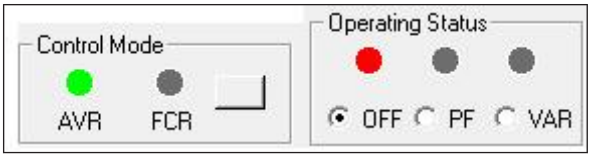
- `20251008 Output Qset max (at 20 mA)`: Set to maximum.
- Set `22056259 PF controller`: `Deactivated`. No shift factor control is carried out in the TPEM MFR.
- `22052186 Source value at min level`: Set to 0. Sets the analog output minimum to 0 % for the voltage offset.
- `22052204 Source value at max level`: Set to 100. Sets the analog output maximum to 100 % for the voltage offset.

Basler DECS100

The DECS100 has only one analog input for manipulating the internal setpoint value via the TPEM MFR. This performs an internal voltage control (island mode/idle) or a shift factor control (mains parallel mode), superior to the generator controller, and issues the result as an analog signal at analog output 2. This signal serves as an offset for the internal voltage setpoint value of the DECS100, which is operated only in voltage control mode.

Controller setting DECS100

- Control Mode: AVR
- Operating Status: OFF



66251-001

Configuring the TPEM

When using the DECS100, the TPEM system must be configured so that the PF controller of the TPEM MFR is active in mains parallel mode. An incorrect setting leads to an incorrect shift factor.

TPEM parameter settings

- `22056259 PF controller`: set `PID analog`. The power factor control is carried out in TPEM MFR.
- `22052186 Source value at min level`: Set to 0. Set the analog output minimum to 0 % for the voltage offset and the shift factor offset.
- `22052204 Source value at max level`: Set to 100. Set the analog output maximum to 100 % for the voltage offset and the shift factor offset.

7.4 Emission monitoring

7.4.1 Parameterization

Call up the following parameters for configuration of the emission monitoring:

For necessary information on the emission monitoring, see

- Parameter description ⇒ Engine ⇒ Basic settings

1.	Enable emission monitoring: 21130207 Emission monitoring
2.	21130210 K factor: To be determined during calibration
3.	20260029 NOx calibration slope: Have default value 1 set
4.	20260010 NOx limit: Specify
5.	20260197 Event type NOx daily mean value too high: Specify event type
6.	20260041 O2 limit: Specify
7.	20260181 Event type O2 daily mean value too high: Specify event type
8.	20260032 NOx calibration offset: If required enter the determined offset

7.4.2 Calibrate NOx sensor

During the course of commissioning the plant, the plant-specific K factor and a potentially required calibration offset must be determined and set. A template for the calibration protocol to be printed out can be found in the appendix.

Parameter 21130210 K factor

The plant-specific ratio NO2 to NOx (K factor) must be determined as follows:

K factor = NO2 [ppm] / NOx [ppm]

The reference measurement must be carried out in the same section of the exhaust tract in which the NOx sensor is located. The measuring instrument must be set to mean value formation and the measurement duration must be at least 2 minutes. If a mean value formation is not supported by the device, measurement can alternatively be carried out at three different time points and then the K factor averaged.

Example:

	Measurement 1	Measurement 2	Measurement 3
NO2 [ppm]	22	25	23
NOx [ppm]	100	101	101
K factor	0.22	0.25	0.23

The mean value of these K factors corresponds to 0.23 and is to be entered as a parameter value.

The value must be documented in the calibration protocol.

Parameter 20260032 NOx calibration offset

After entering the determined parameter value for the K factor, it is necessary to check whether the measured NOx value (in mg/m³) corresponds to the value of the reference measurement. The reference measurement must be set to a reference oxygen content of 5 %.

In the event that the NOx value of the reference measurement deviates from the NOx value of TPEM by +/- 0.02 g/m³, a corresponding offset must be entered in TPEM. The inspection and adjustment of the offset value must be repeated until the measured values are in the tolerance range. The measurement duration must be at least 5 minutes. An offset can assume positive or negative values and is defined as follows:

Offset = $NOx_{Measuring\ instrument}$ [g/m³] – NOx_{TPEM} [g/m³]

The value must be documented in the calibration protocol.

7.4.3 Catalytic converter

TPEM temperature monitoring

The temperature of the catalytic converter must be monitored and a warning must be output if the permissible temperatures are exceeded.

If there is no temperature monitoring of the catalytic converter (T287) at the plant, this must be installed.

Seal

For the monitoring of the oxidation catalytic converter, a seal against unauthorized removal of the catalytic converter must be provided. The seal must be given a uniquely identifiable number, which must remain recognizable over the complete life cycle of the seal.

When commissioning the catalytic converter, the catalytic converter must always be sealed by appropriately trained and authorized personnel immediately afterwards. CES is responsible for the installation of the catalytic converter into the exhaust system and the compliance of the exhaust emissions associated with it.

The seal may only be removed for the following purposes:

- Cleaning the catalytic converter
- Maintenance work on the catalytic converter
- Repair of the catalytic converter
- Replacement of the catalytic converter

The removal and reattachment of the seal may only be carried out by personnel (authorized service technicians) trained by MWM (or CES) with an authorization level of minimum 200 or a notified test institute. After the above work, the catalytic converter must be sealed immediately by an authorized person and checked by an inspection measurement.

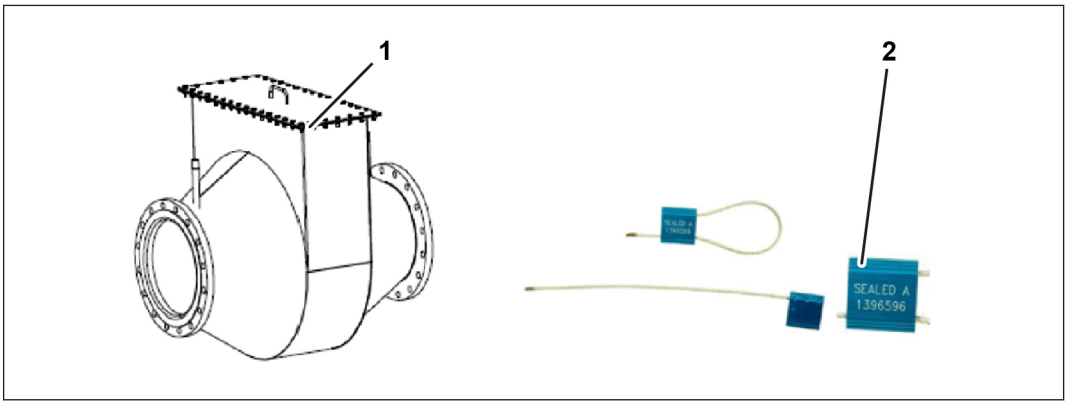
The reason for the removal or the reattachment of the seal must be documented in the logbook with date and indication of the identifying number of the seal and personal identification of the authorized service technician along with the values from the inspection measurement for NOx. This must uniquely reveal which person (with complete name and company affiliation) has carried out the conversion measures. This must be entered in the logbook.

As part of the annual discontinuous emission measurement, the relevant test institute inspects the intactness of the seal together with the owner. In addition, the authorized service technician must document the intactness of the seal and document this in the logbook during corresponding maintenance work.

Sealing the plug-in catalytic converters

For sealing the plug-in catalytic converters, we recommend drilling a hole in the connecting flange of the catalytic converter with a diameter of 5 mm, as shown in the following figure. The MWM seal shall then be guided through this hole and closed off. No special tool is needed to attach the seal. To remove the seal, we recommend a standard side cutter.

Seal for plug-in catalytic converter: MWM part number 12218486



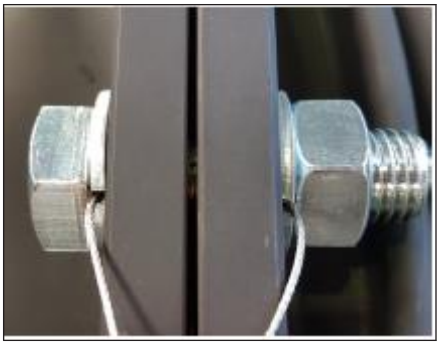
71120-002

1 Drill hole for seal 2 Seal

Seal of the conical catalytic converters

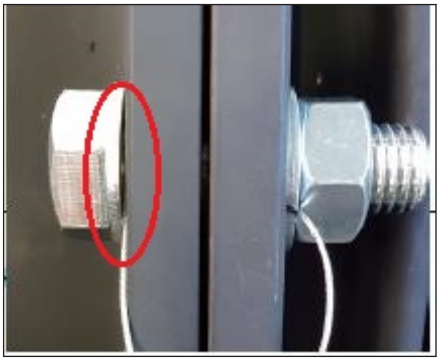
For sealing conical catalytic converters, we recommend guiding the MWM seal through a screw hole on the flange connection with a diameter of 26 mm and fastening it there. We recommend using an M24 screw with the matching, slotted washer.

Seal for conical catalytic converter: MWM part number 12218499



71121-002

If the washer is not slotted, an optimal surface pressure cannot be ensured.



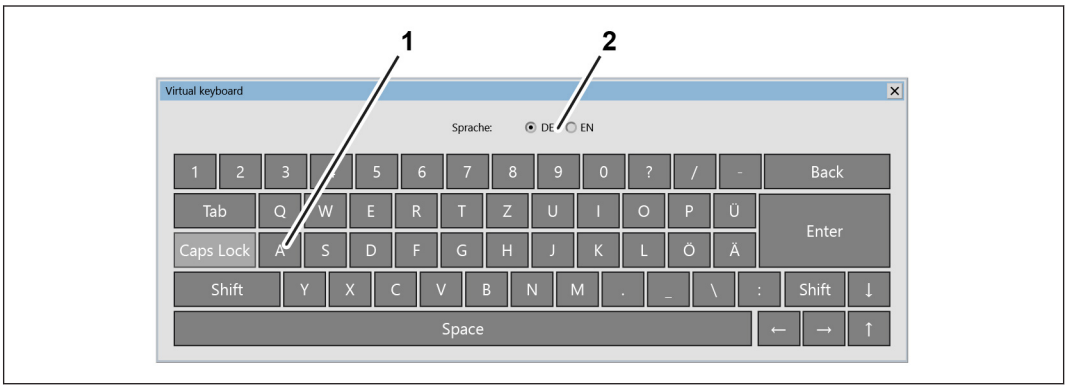
71122-002

No special tool is needed to attach the seal. To remove the seal, we recommend a standard side cutter.

7.5 Initial setup

The initial setup must be performed once during commissioning of the genset. A parameter set for the initial setup can be exported from a genset that has already had parameters assigned to it. This parameter set can be imported to another genset.

Keypad

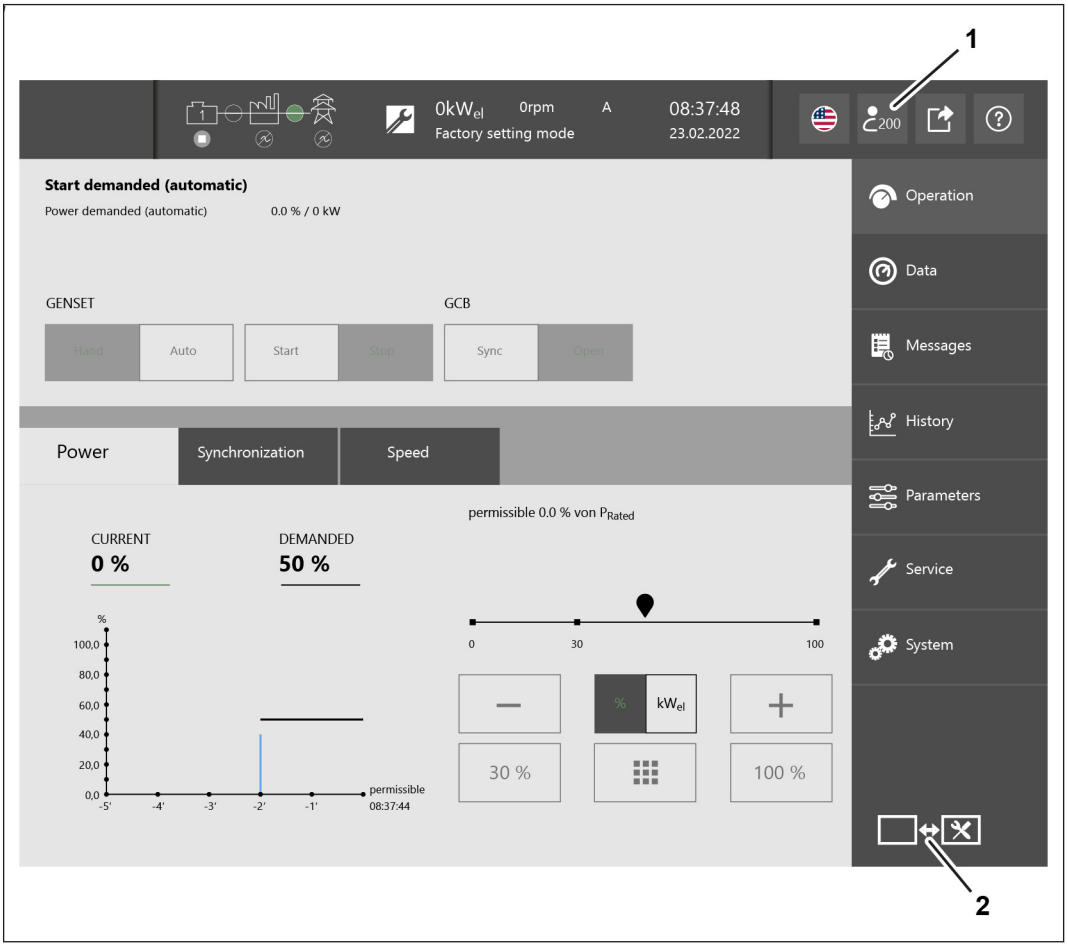


75189-001

If an input field is tapped during the initial setup, a keypad (1) will appear. The keypad layout can be set to German or English (2).

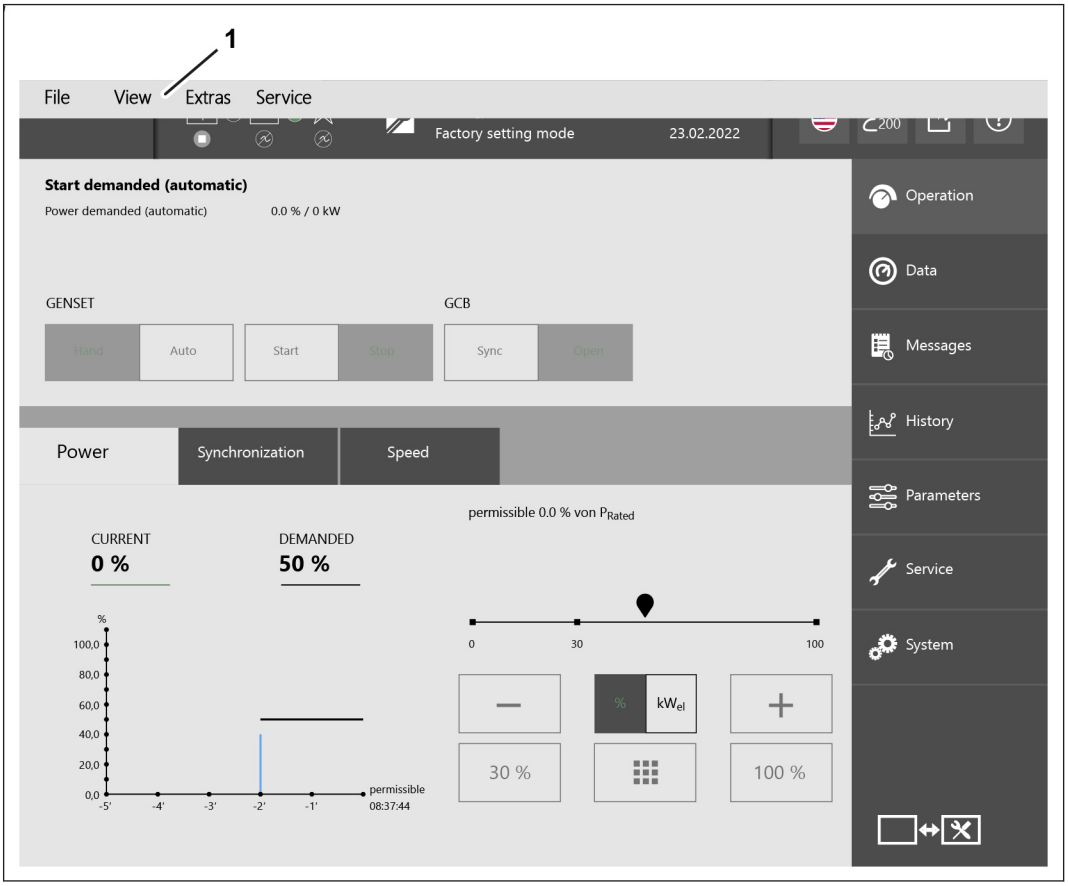
Opening the Service menu

1. Connect TPEM USB token with authorization level 200 or higher to the USB interface on the TPEM CC.
   → The authorization level (1) is displayed.
   → The button for the Service menu (2) appears.



75182-001

2. Tap the button for the Service menu (2).
   → The Service menu (1) appears.



75184-001

Performing the initial setup

Prerequisites

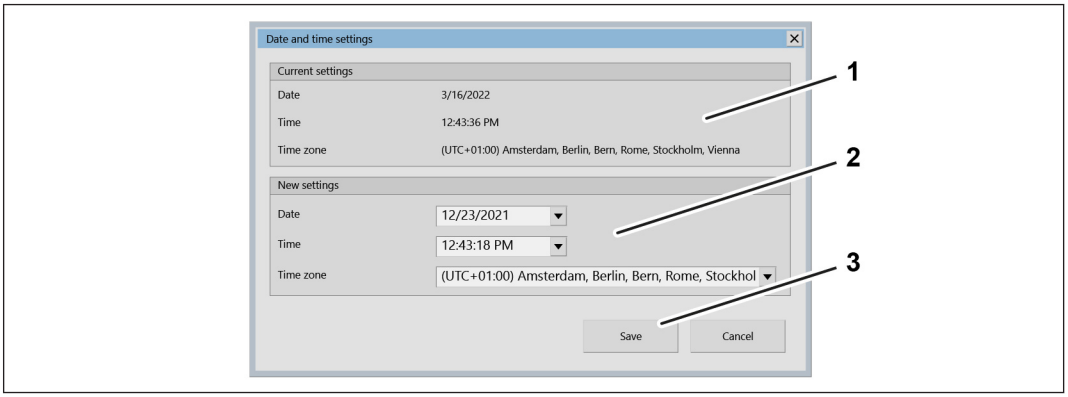
- The genset is in `Factory setting mode`. If the genset is in `Factory setting mode`, then the `Service` > `Initial setup` menu is available.

1. Open the Service menu.
2. In the Service menu, tap `Service` > `Initial setup`.

   → The initial setup launches.

Setting the date, time and time zone for the system time

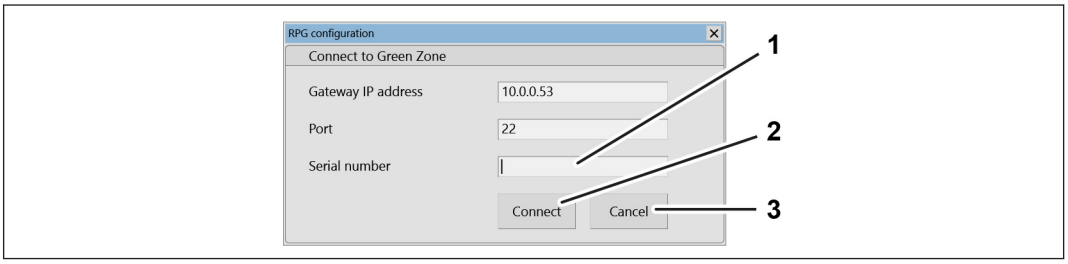
The system time must be set once during commissioning of the genset. The window for setting the system time can be opened via the Service menu `Extras > Date and time settings`. If the window is not opened via the Service menu, the window will appear in the initial setup.



75190-001

1. Check the data in the upper pane (1).
   → The upper pane (1) shows the current data.
2. Adjust the data in the lower pane (2) if necessary.
   → The data from the lower pane (2) will be applied.
   → The data must lie within the validity period of the certificate that is on the TPEM USB token.
3. Tap the `Save` button (3).
   → The date, time and time zone of the system time have been set.

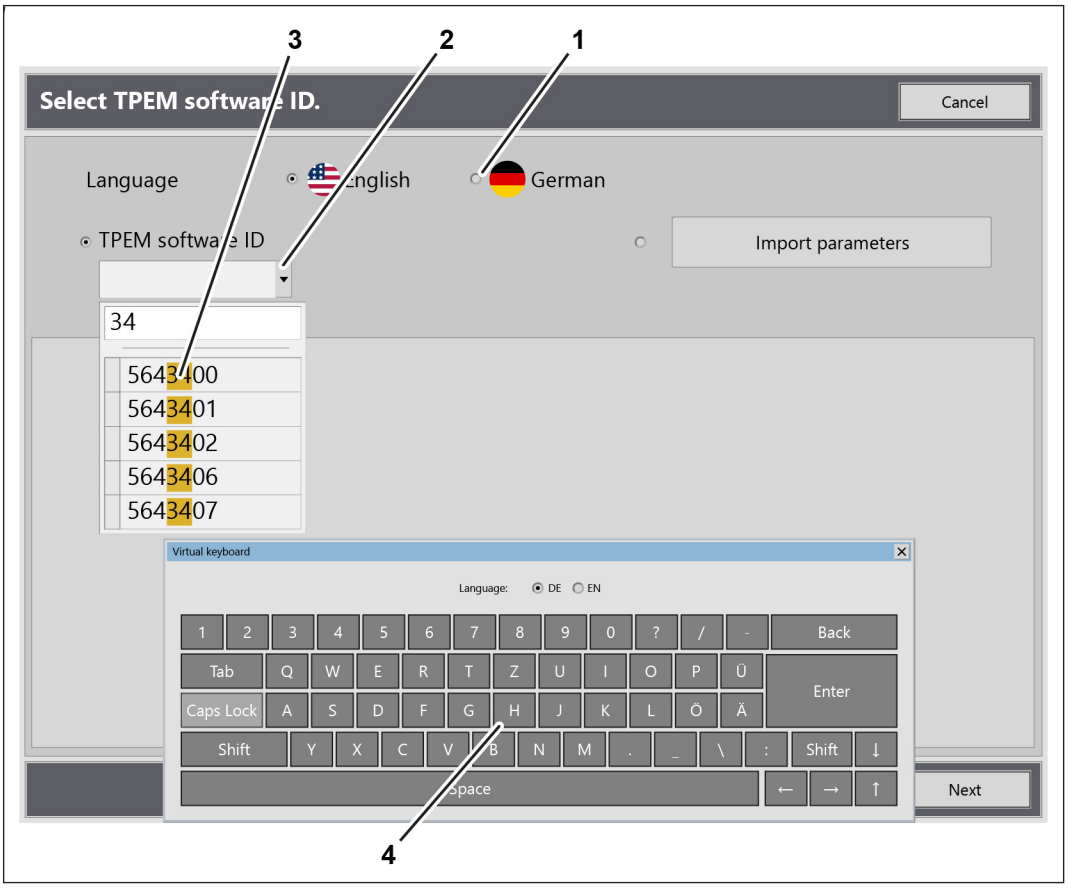
Configuring TPEM RPG



75191-001

1. Option: Exit TPEM RPG configuration with the `Abort` button (3) and perform it later.
2. Enter the serial number of the TPEM RPG in the field (1).
3. Tap the `Connect` button (2).
   → The TPEM RPG configurator appears and TPEM RPG can be configured.

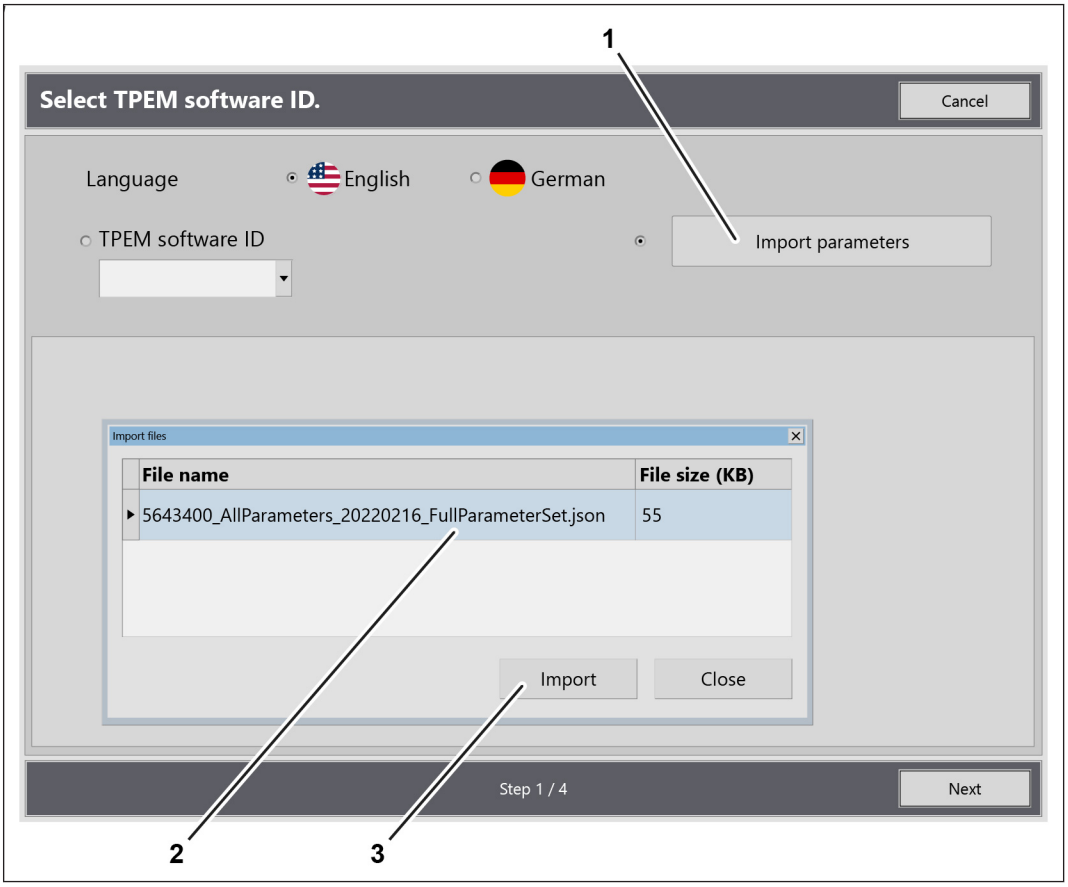
Selecting the language and TPEM software ID



75192-001

1. Select the language (1).
2. Option: Tap field (2). Select TPEM software ID from the list (3) or enter it with the keyboard (4).

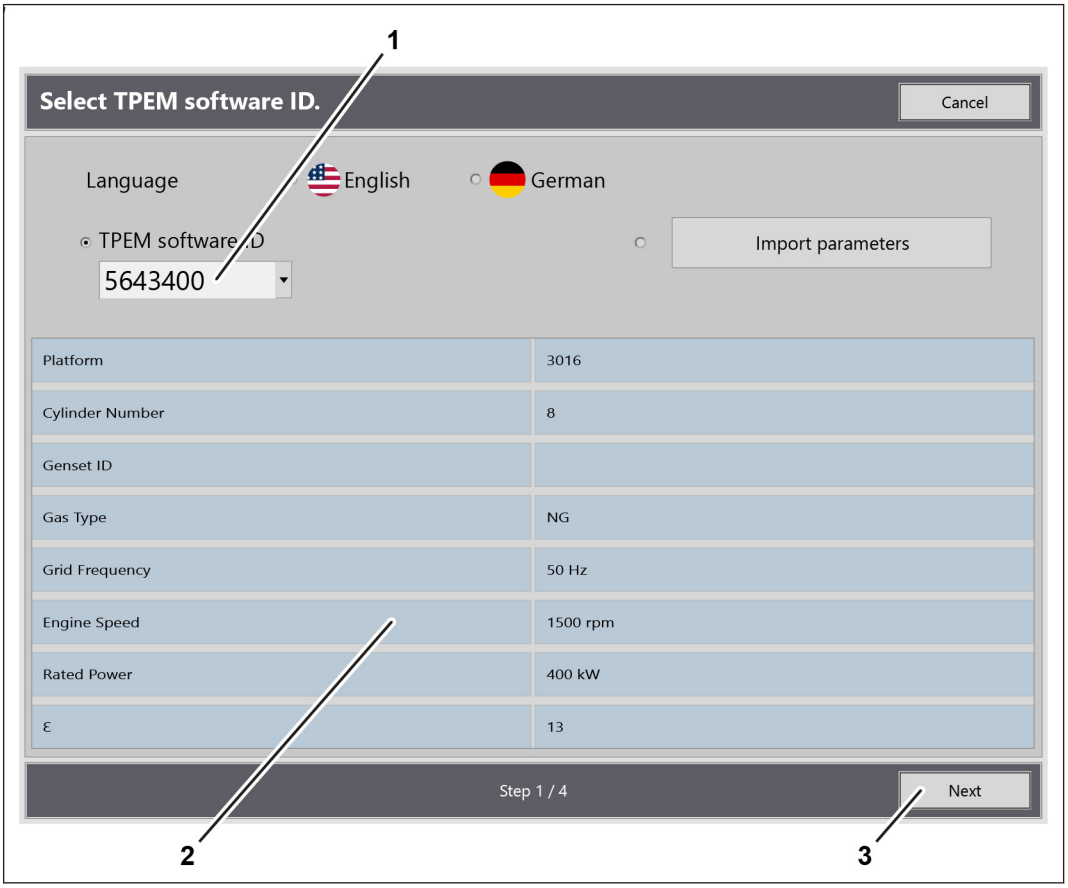
   → The TPEM software ID and the basic data will appear.



75193-001

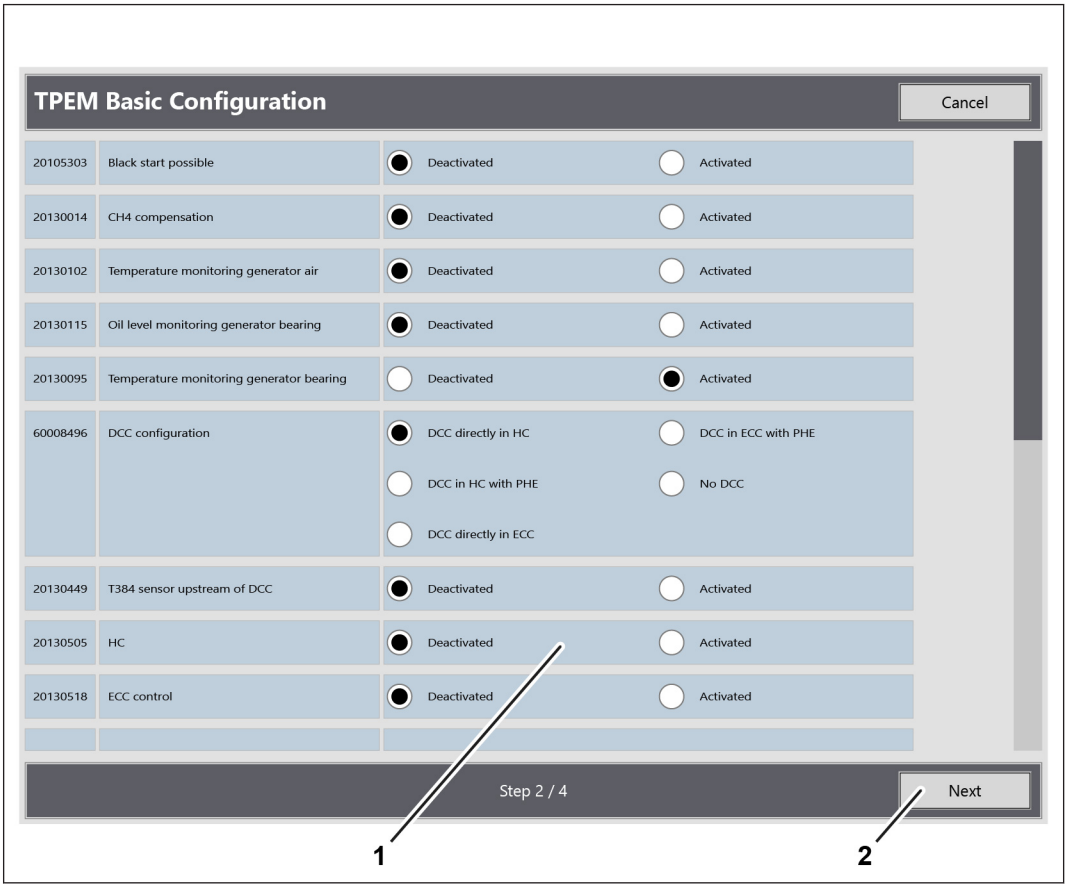
3. Option: Export the parameter set for the initial setup (⇒ Section: Export parameter set for the initial setup). Tap the `Import parameters` button (1). The window for selecting an initial setup parameter set will appear. Select the desired initial setup parameter set (2). Tap the `Import` button (3).

   → The TPEM software ID and the basic data will appear.



75307-001

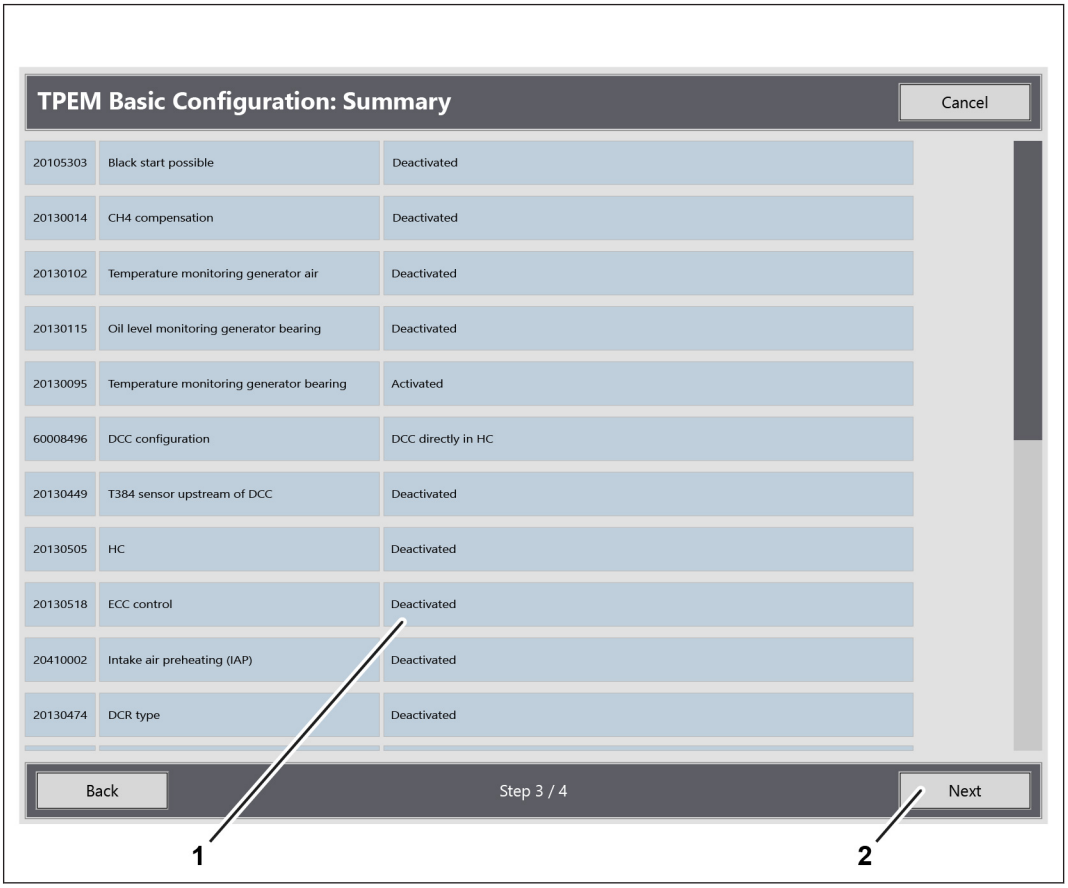
4. Check the TPEM software ID (1) and the basic data (2).
5. Tap the `Continue` button (3).
   → TPEM software ID (1) and basic data (2) will be applied.
   → The page for assignment of initial setup parameters appears.



75306-002

6. Check the parameter assignment of the initial setup parameters (1) and adjust if necessary.
7. Tap the `Continue` button (2).

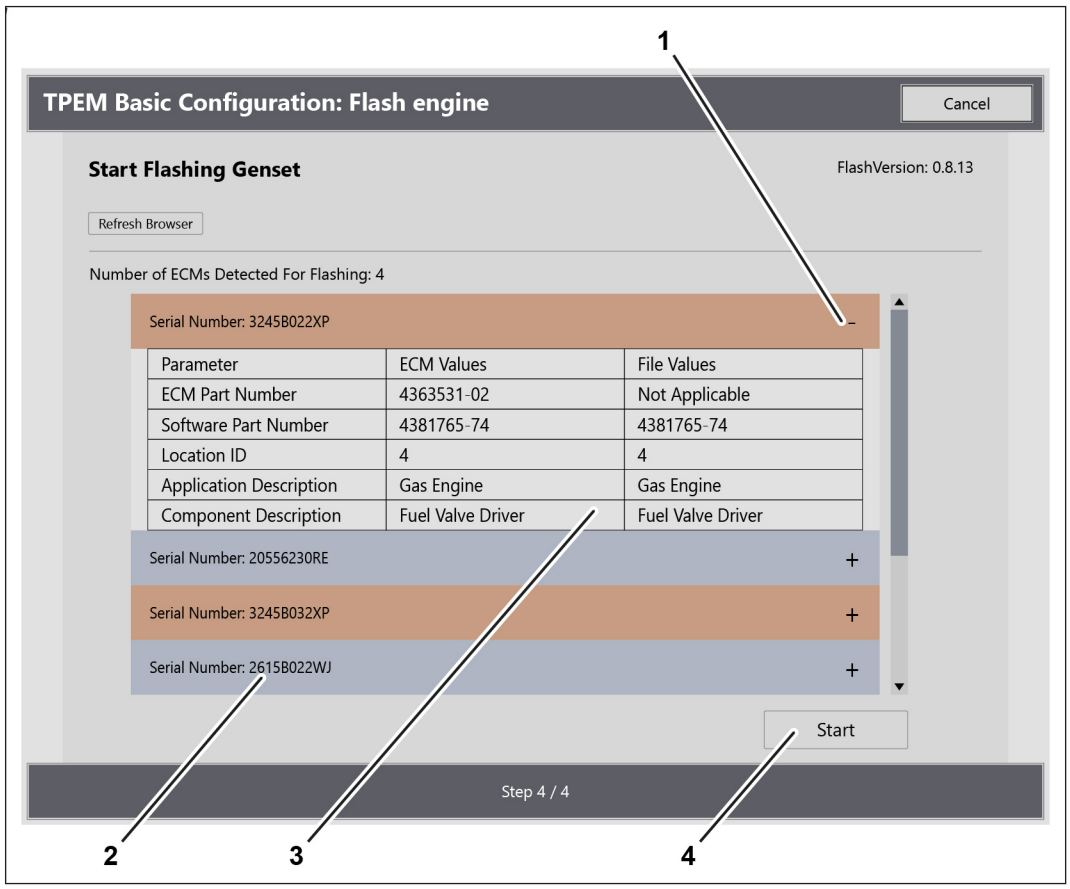
   → The page with the initial setup parameter summary appears.



75194-002

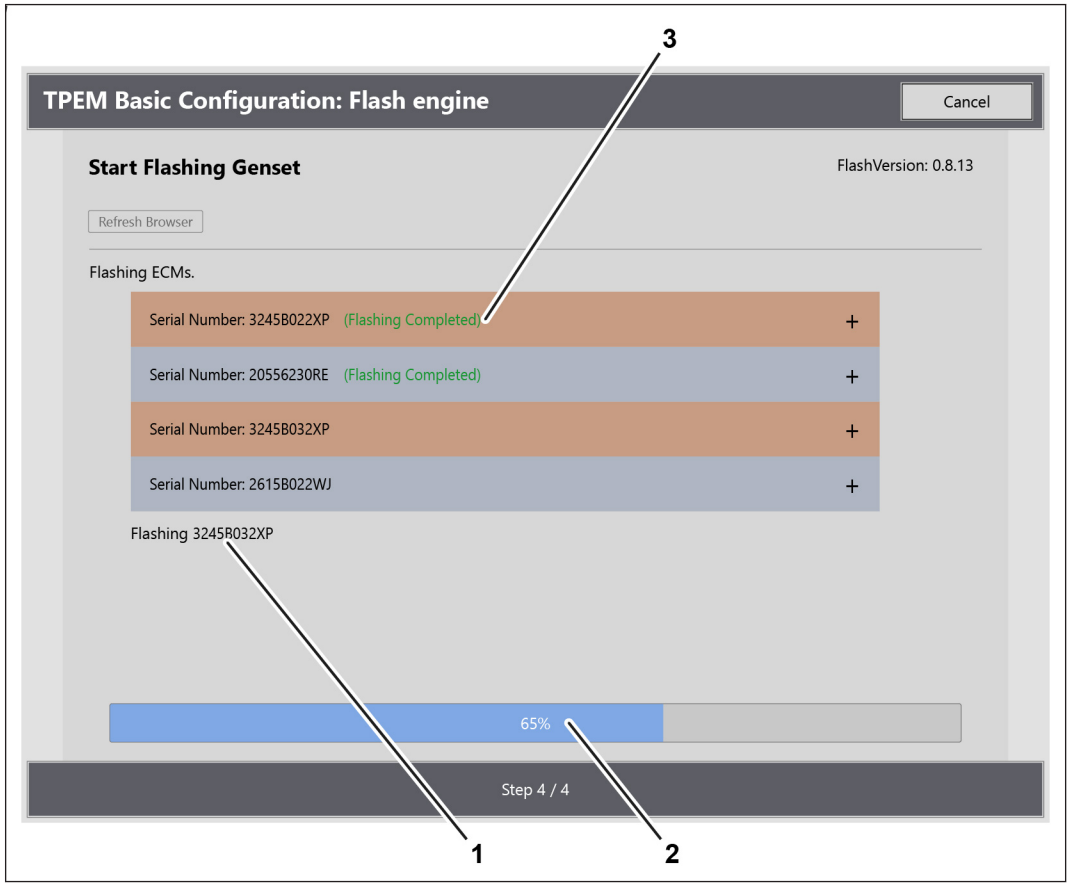
8. Check the summary of the initial setup parameters (1).
9. Tap the `Continue` button (2).

   → The page for flashing the engine control module appears. A search for connected engine control modules will be run and any ECMs that have been found will be displayed.



75322-001

10. Tap the + symbol to expand or the − symbol to collapse the view (1).
    → The details (3) of the engine control modules (2) will be shown or hidden.
11. Check the details (3) of the engine control modules (2).
12. Tap the `Start` (4) button.
    → Page with an overview of the flashing progress appears.



75324-001

13. The text (1) indicates the engine control module that is currently being flashed. The progress bar (2) shows the progress of the flashing process. If flashing was successful, a text (3) will appear. If all engine control modules were flashed, a page with a message regarding flashing will appear.
14. Tap the `Finish` button.

    → Initial setup is complete.

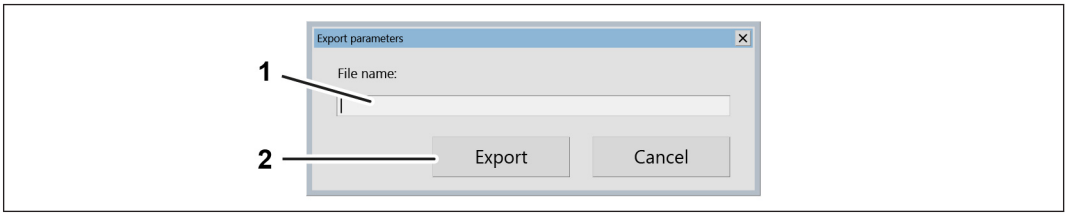
Exporting parameter set for the initial setup

Prerequisites

- TPEM USB token with authorization level 200 or higher is connected to the USB interface on the TPEM CC.

1. Open the Service menu.
2. In the Service menu, tap `Service` > `Export parameters` > `All parameter set`.

    → The window for exporting the initial setup parameter set will appear.



75302-001

3. Enter the file name in the field (1).

   → The file name is automatically appended with the TPEM Software ID and the text `AllParameters` when saved.

4. Tap the `Export` button (2).

   → The parameter set for the initial setup has been exported.

7.6 Parameterization

After the initial set up, values for the grid code parameters can be assigned. The grid code parameters can be exported as a parameter set from a parameterized genset and then imported to another genset.

Export grid code parameter set

Prerequisites

- TPEM USB token with authorization level 200 or higher is connected to the USB interface on the TPEM CC.

1. Open the Service menu.
2. In the Service menu, tap `Service` > `Export parameters` > `Grid code parameters`.
   → The grid code parameter set export window appears.

75305-001

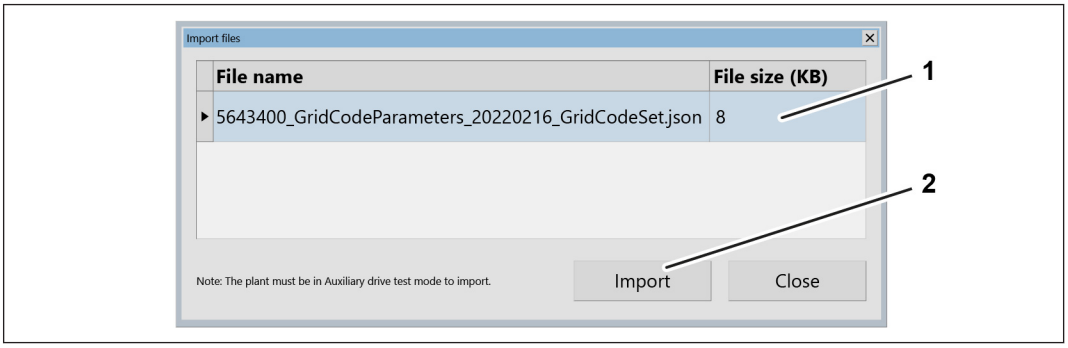
3. Enter the file name in the field (1).
   → The file name is automatically appended with the TPEM Software ID and the text `GridCodeParameters` when saved.
4. Tap the `Export` button (2).
   → The grid code parameter set has been exported.

Import grid code parameter set

Prerequisites

- Grid code parameter set is saved on the TPEM USB token.
- The genset is in `auxiliary drive test` mode.
- TPEM USB token with authorization level 200 or higher is connected to the USB interface on the TPEM CC.

1. Open the Service menu.
2. In the Service menu, tap `Service` > `Import parameters`.
   → The window for importing the grid code parameter set appears. The window shows all grid code parameter sets that are stored on the TPEM USB token.



75303-001

3. Tap the desired grid code parameter set in the list (1).
   → The desired grid code parameter set is selected.
4. Tap the `Import` button (2).
   → The selected grid code parameter set has been imported.

8 Operation

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8.1 Safety notes

WARNING!

Electric shock if live components are touched

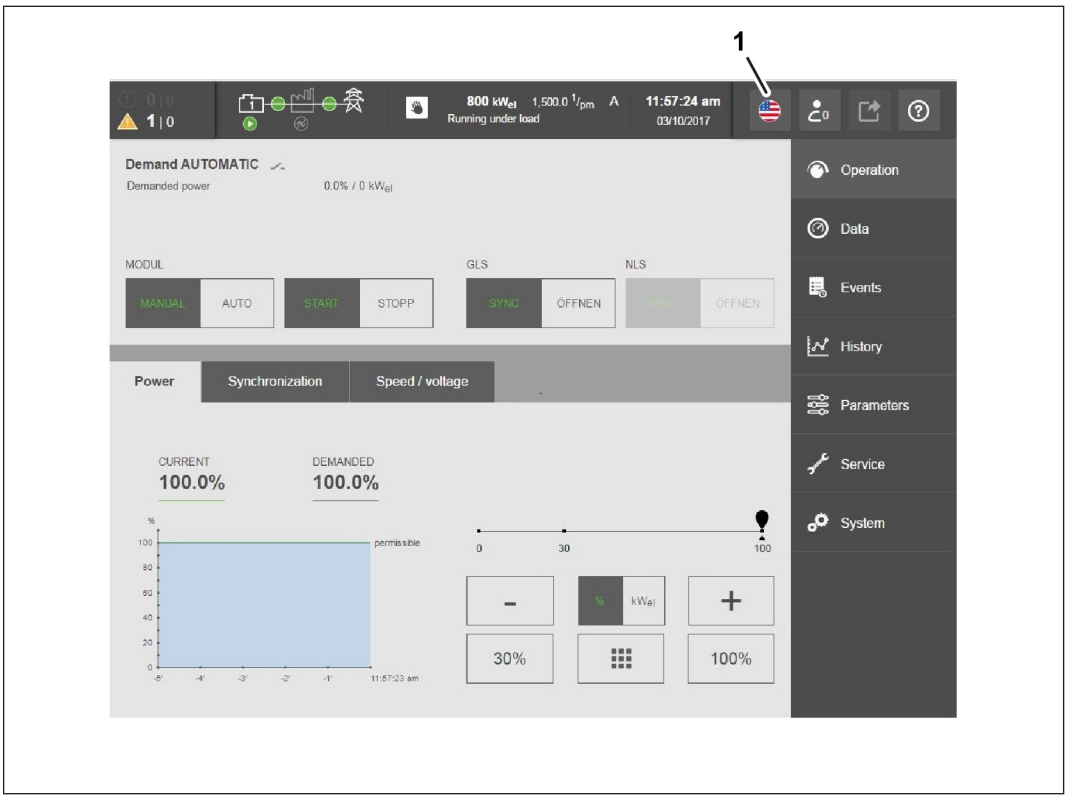
This can lead to severe injuries and even death.

- Only authorized specialist personnel may work on the electrical system.
- Turn off electrical power supply and secure against restarting:
  - Disconnect electrical system.
  - Secure against reconnection.
  - Check that equipment is de-energized.
  - Ground and short-circuit the electrical system.
  - Cover or cordon off adjacent components which are electrically live.

8.2 Introduction to operation of the TPEM system

The TPEM system is equipped with a TPEM Touch Panel (TPEM TP). The resolution is 1024 × 768 pixels. The operation and user guidance occurs via a touch-sensitive screen.

The following figures of the screen pages are examples. The image on the TPEM TP may deviate from this in some cases depending on the access authorization.



61053-004

1 "Switch language" button

8.2.1 Initial startup

Starting the software

If the TPEM Touch Panel is connected to the power supply, the software will start automatically.

Operating language

Communication with the user takes place either in German, English or a third, preset language. The switchover can take place on any page on the screen. The language can also be changed at any time during operation. You can, for instance, temporarily switch to a different language than that used by the site staff when carrying out service work.

Switching language

1. Tap on "Language selection" in the "Options" bar

   → The TPEM system switches between the preset languages. The languages are represented by a flag.

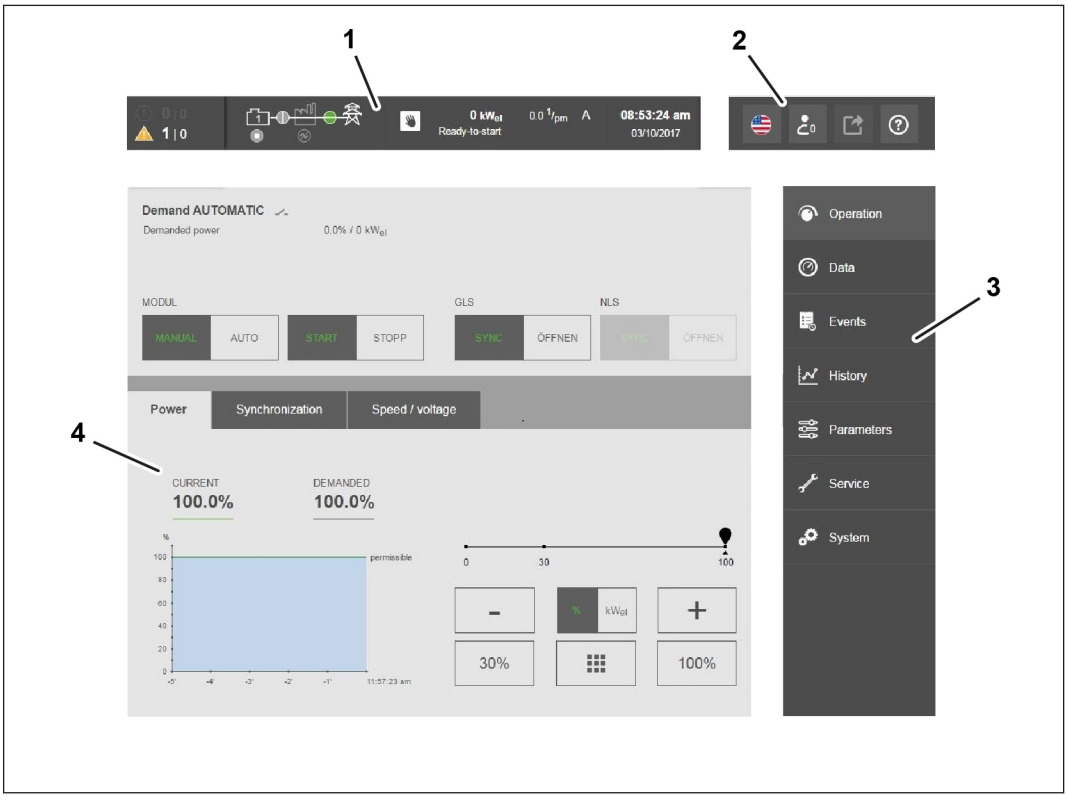
For further information on configurable languages, see

- Functional group "System" ⇒ "Languages" mask
  - Presetting language

System of units

The TPEM system uses the metric system of units.

8.2.2 Layout of the user interface



61056-004

1 Status bar
⇒ Section "Status bar"

2 Options bar
⇒ Section "Options bar"

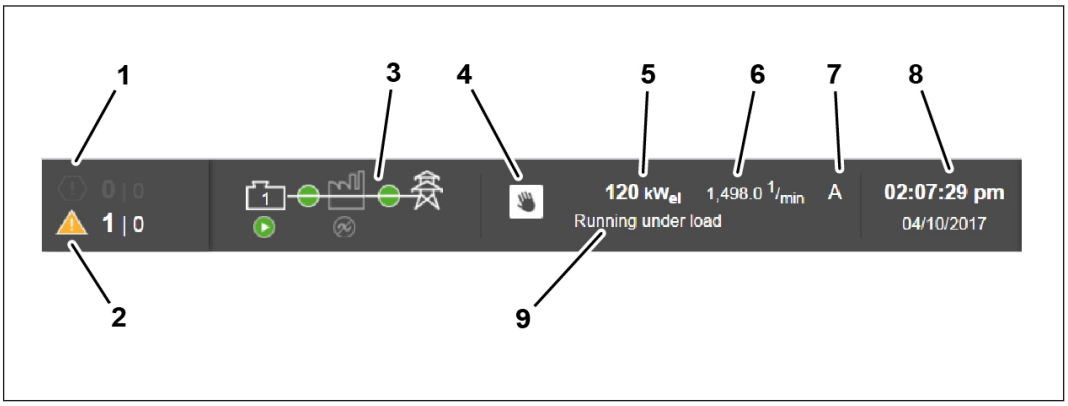
3 Buttons for function group selection
The start mask of the selected function group appears.

4 Dialog area
The display is dependent on context in accordance with the selected function group.

8.2.3 Status bar

The status bar constantly displays important data.

The status bar gives a quick overview of the current status of the genset.



65772-001

1 Display of alarms
Pending, unacknowledged alarms before the dash, still pending but acknowledged alarms after the dash. ⇒ Functional group `Messages`.

2 Display of warnings
Pending, unacknowledged warnings before the dash, still pending but acknowledged warnings after the dash. ⇒ Functional group `Messages`.

3 Status display for the selected module
⇒ Status display for the module components

4 Display of the operation mode,
Display options: Manual, Automatic, Test mode

5 Display for the current electrical power of the selected module

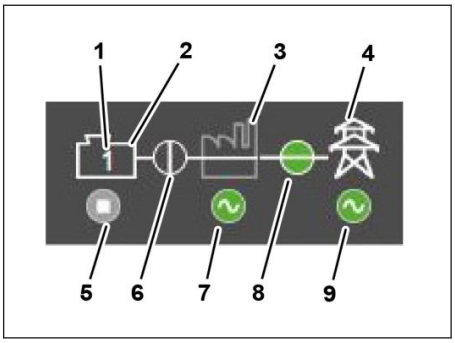
6 Display for the current speed of the selected module

7 Display for the selected gas type
Display options: A = gas type A, B = gas type B, A/B = dual gas operation

8 Display for the current time and date

9 Status display for the selected module
Display examples: Ready-to-start, idle, load run, relieving

Status display for the module components

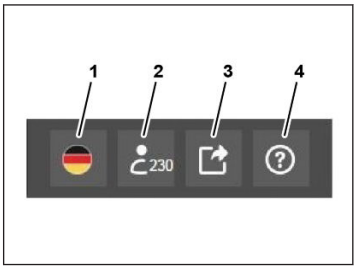


61258-004

1 Module number
2 Module symbol
3 Plant symbol
4 Mains symbol

Component		Status display				
5						
	Module	not running	Demand START	running	Demand STOP	not ready-to-start
6						
	GCB	open	Demand Close	closed	Demand Open	
7						
	Plant	Voltage or frequency not OK		Voltage and frequency OK		Voltage or frequency not OK, busbar under voltage
8						
	MCB	open	Demand Close	closed	Demand Open	
9						none Symbol display
	Mains	Voltage or frequency not OK		Voltage and frequency OK	Voltage not OK	Voltage and frequency monitored by LS5

8.2.4 Options bar



61243-003

1 "Switch language" button
Each tap on the button switches to one of the next preset languages. ⇒ Functional group "System" ⇒ "Languages" mask ⇒ Preset language

2 User display
Displays the authorization level of the inserted TPEM USB token.

3 "Data export" button ⇒ Data export

4 "Glossary" button ⇒ Glossary

8.2.5 Data export

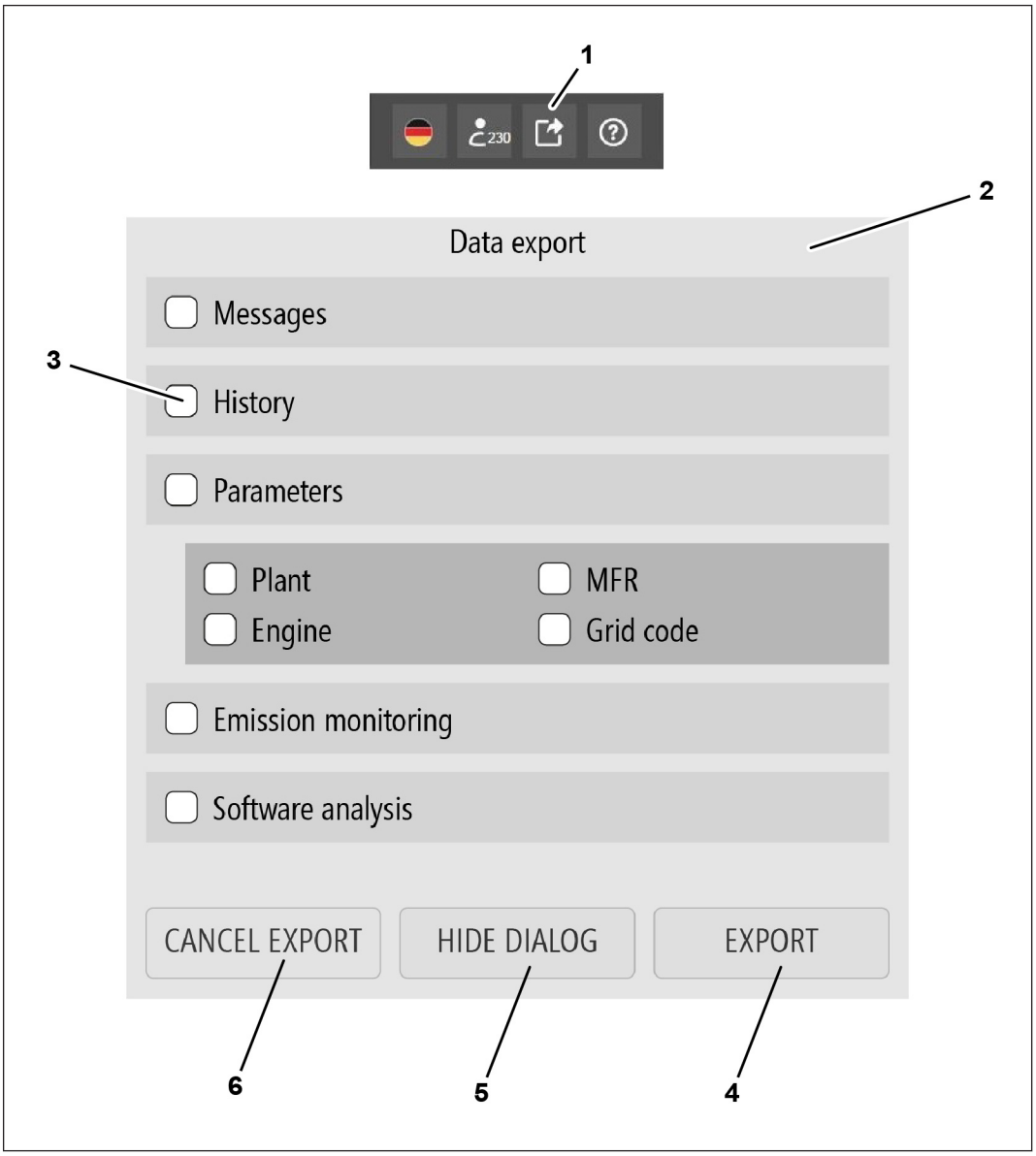
For exporting messages, histories, parameters, data on emission monitoring and log files for the software analysis. The data is exported as an encrypted zip file. For data export, an authorization level of 50 or higher is required. A TPEM USB token with integrated memory or a TPEM USB token without integrated memory in combination with a TPEM USB storage can be used as the storage medium. The exported data can be viewed in the Data Viewer of the TPEM Remote Client.

When parameters are exported, a CSV file and a PDF file are created. The CSV file is saved in the encrypted zip file and the PDF file is saved in a folder. The PDF file contains either all parameters or the selected parameter sets. The PDF file is created in the language that is set on the HMI. The CSV file contains the parameters in English, German and the third language set on the HMI. The HMI group and HMI subgroup are added during the export.

For further information on data export, see

- Operating Manual ⇒ TPEM Remote Client (DT) ⇒ Data export

Exporting data



65761-004

1. Connect the TPEM USB token with integrated memory or the TPEM USB token without integrated memory and the TPEM USB storage to the USB interface
2. Press the `Data export` (1) button
   → The `Data export` dialog menu (2) appears.
3. Select the checkboxes (3) for the desired data. The data of the parameters can be exported completely or partially, e.g. by selecting plant.
4. Press the `START EXPORT` (4) button
   → Display in the display area (4): `Download started`
   → The data is exported as an encrypted zip file to the connected TPEM USB token or to the TPEM USB storage.
   → Display after successful download: `Download completed`

5. Press the `HIDE DIALOG` (5) button

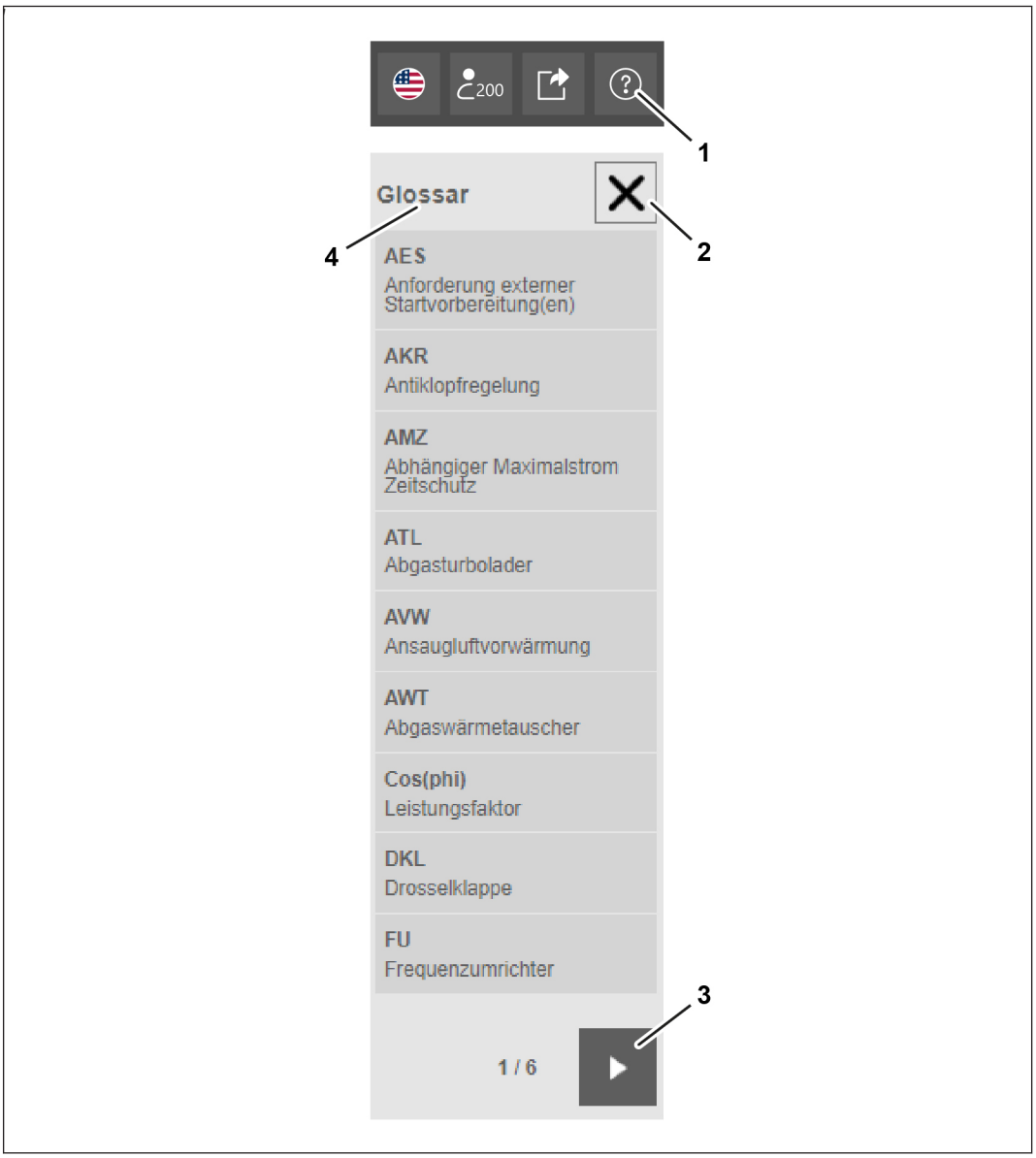
   → The `Data export` dialog menu is hidden

The data export can be aborted at any time. To do this press the `CANCEL EXPORT` (6) button.

8.2.6 Glossary

All the abbreviations used on the TPEM Touch Panel are explained in the glossary.

Call up glossary



67988-002

1. Press the `Glossary` button (1).

   → The `glossary` (4) appears.

2. Browse forward/backward with the arrow buttons (3).
3. Tap the "Close" button (2) to close the glossary.

8.2.7 Operation via TPEM Remote Client Desktop

The TPEM Remote Client Desktop (TPEM RC DT) is a piece of software for TPEM visualization on a computer. Required software version: 1.34.3.1 or later.

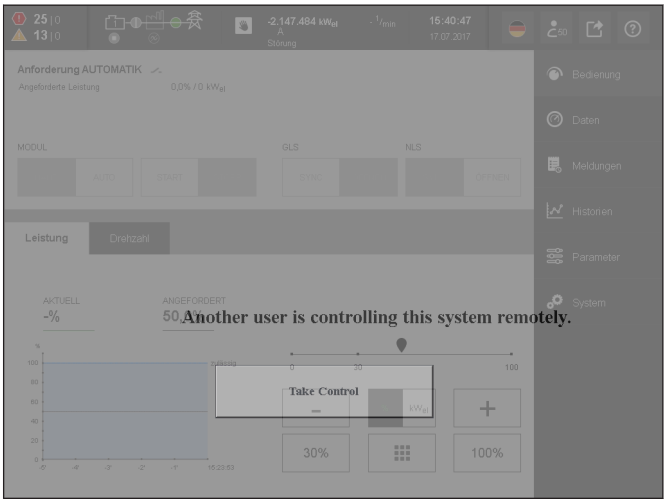
It is possible via a TPEM RC DT:

- For service: to perform remote diagnostics and remote maintenance of the plant
- For the operator: remote operation and monitoring of the plant

The remote access is realized via a router, the so-called TPEM Remote Plant Gateway, which displays the interface in the plant. The Remote Plant Gateway is installed in the TPEM Control Cabinet.

The remote access to the plant control is established using a secured connection (VPN tunnel).

If operation is to be controlled remotely, a token authentication is required via the USB interface. Remote access is communicated to the operator at the TPEM Touch Panel. The following message appears:



64306-001

The operator at the Touch Panel now has the option to exit the control at any time by clicking the `Take control` button. The connection is then severed. The following message then appears on the screen of the TPEM Remote Client: `Local touch panel user has taken the control. The connection will be closed.`

It is possible to connect to the TPEM Touch Panel via intranet access only with read permission and without token authentication. No message is displayed on the Touch Panel here.

For more information on the TPEM RC DT, see

- Operating Manual ⇒ TPEM Remote Client Desktop

8.3 Functional group "Operation"

In the functional group "Operation", you can find operating elements for switching between manual and automatic operation modes.

In order to start, synchronize or stop the module, the functional group in manual operation mode provides operating and display elements.

8.3.1 Manual operation mode

66230-003

1 `MODULE MANUAL` button
Activates the manual operation mode by tapping.
Active button: Black button, green writing

2 `MODULE AUTO` button
Activates the automatic operation mode by tapping.
Active button: Black button, green writing
In the automatic operation mode, the genset is started and stopped via an external demand signal.

3 `MODULE START` button
Starts the genset by tapping.
Active button: Black button, green writing

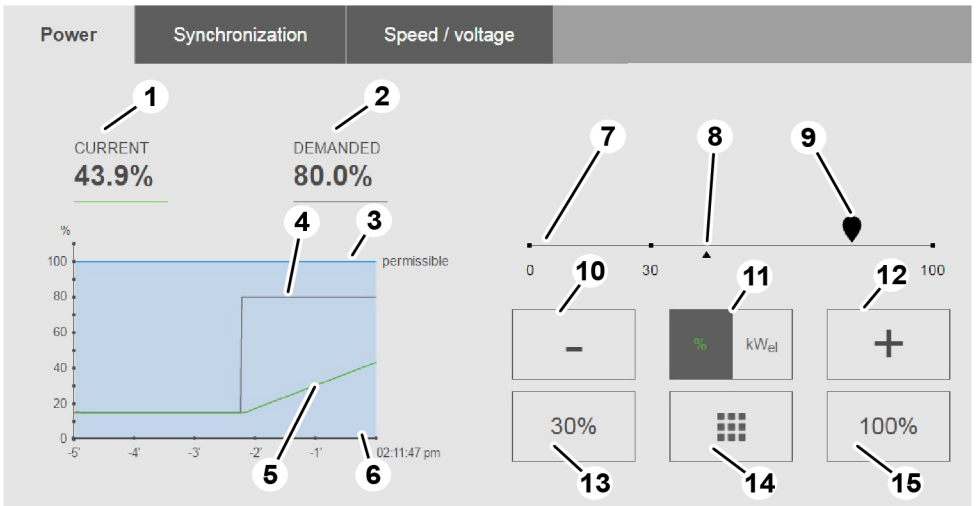
4 `MODULE STOP` button
Stops the running genset by tapping.
Active button: Black button, green writing

5 GCB SYNC button
Starts the synchronization by tapping. After synchronization the generator circuit breaker is closed.
Active button: Black button, green writing

6 OPEN GCB button
Relieves the genset by tapping. Opens the generator circuit breaker after relieving.
Active button: Black button, green writing

7 Mains circuit breaker buttons
Currently unavailable.

Mains parallel mode power influence



62421-004

1 CURRENT
Display of actual power.

2 DEMANDED
Display of demanded power.

3 Permissible
The light blue area below the line indicates the range of permissible power.
If the permissible power is limited to a value below 100 %, the reason for the power decrease is displayed as a text message.

4 Graphic display of the demanded power
Displays the curve of the demanded power in the time frame.

5 Graphic display of the actual power (green)
Displays the curve of the actual power in the time frame.

6 Power curve time scale
Display of demanded power and actual power of the last five minutes.

7 Power scale
Graphic display of the demanded power (above the scale) and the actual power (below the scale).

8 "Actual power" symbol
The symbol displays the actual power on the power scale (7).

9 "Demanded power" symbol
The symbol displays the demanded power on the power scale (7).

10 "Minus" button
Tapping the button reduces the demanded power by 5 % / 40 kWel

11 % / kWel
Switches between % and kWel as a leading variable in the displays and buttons.
Active button: Black button, green writing

12 "Plus" button
Tapping the button increases the demanded power by 5 % / 40 kWel.

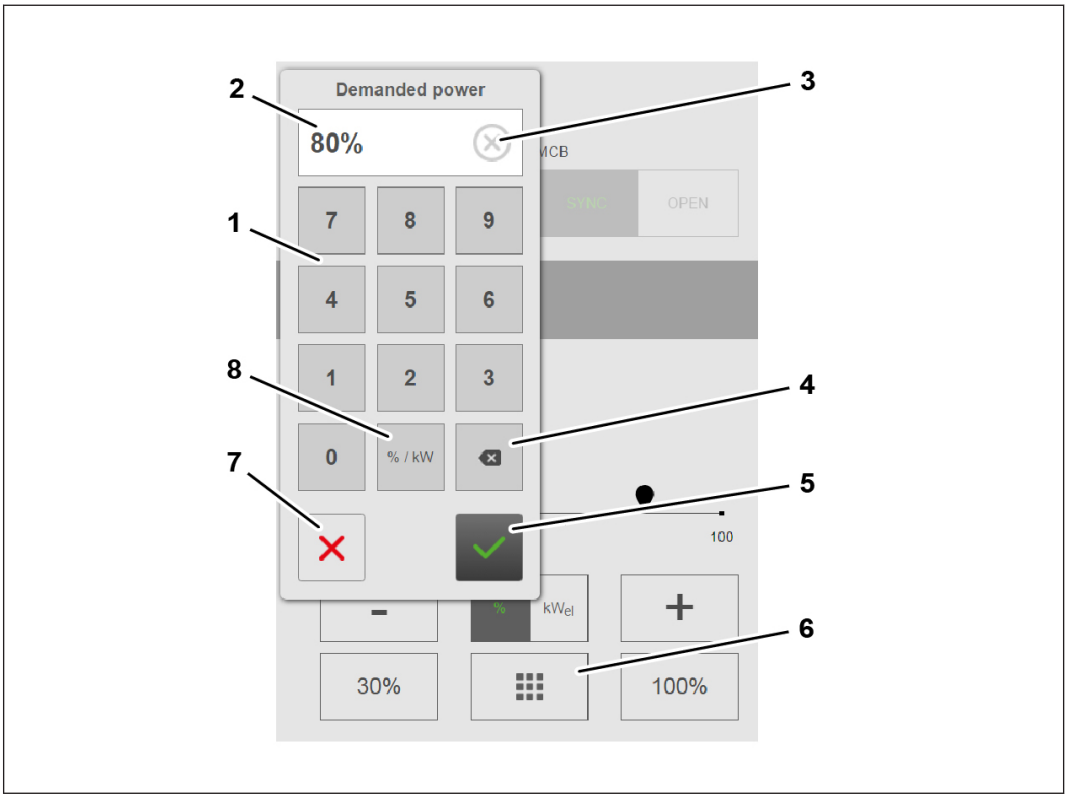
13 30 % / 240 kWel*
Tapping the button sets the demanded power to 30 % of the maximum power or 240 kWel.

14 Call up input mask
Tapping calls up the input mask.

15 100 % / 800 kWel*
Tapping the button sets the demanded power to 100 % of the maximum power or 800 kWel.

* The power rating is exemplary and depends on the genset used.

Power input mask



62420-002

1 Keypad
For entering the set power.

2 Display field and input field
For displaying and entering the demanded power.

3 Delete input value

4 Delete last input

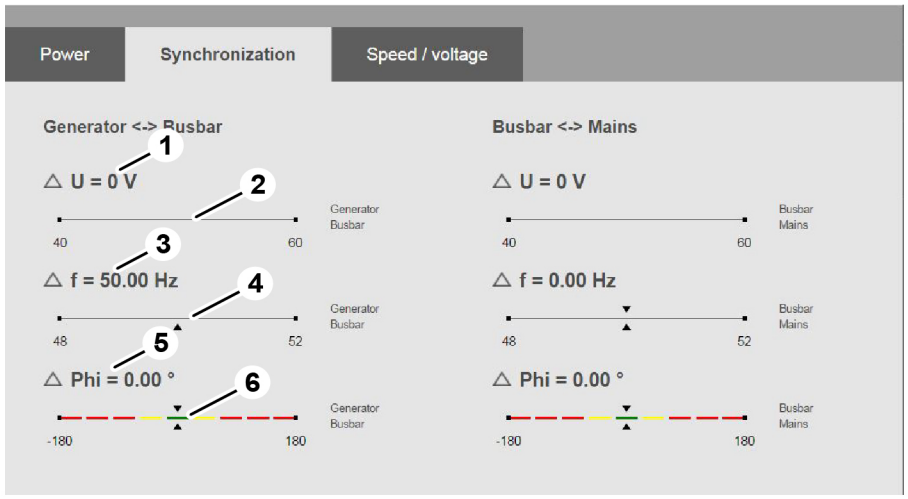
5 Accept input
Accepts the entered value as a set power and closes the input mask.

6 Call up input mask

7 Cancel input and close input mask
Cancels an input without accepting the setpoint value. Closes the input mask.

8 Switch over % / kW
For selecting whether the set power shall be entered as a percentage of the maximum power or as a kW value.

Synchronoscope displays



62419-003

The explanations 1 to 6 for the generator and busbar also apply similarly to the busbar and mains.

1 Display of voltage difference
Digital display of the voltage difference between the generator and busbar.

2 Voltage display
Graphic display of the voltage at the generator (above the scale) and the busbar (below) in the range of 320 V to 480 V.

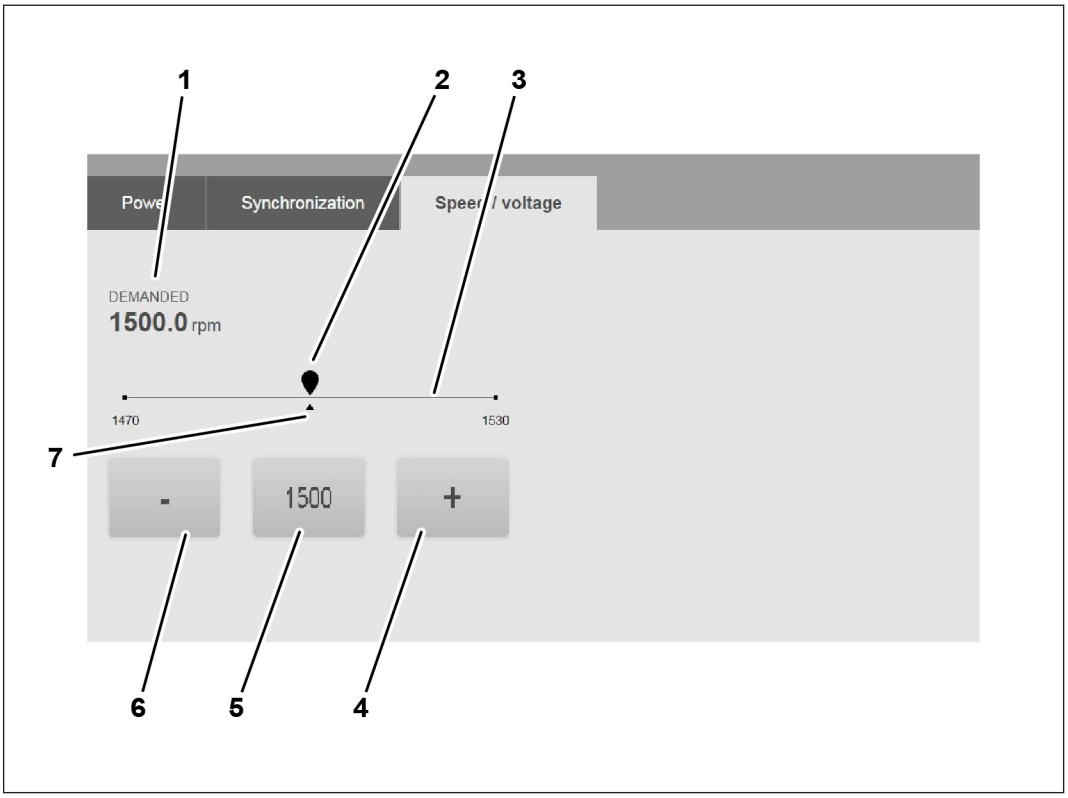
3 Frequency difference display
Digital display of the frequency difference between the generator and the busbar.

4 Frequency display
Graphic display of the frequency at the generator (above the scale) and the busbar (below) in the range of 48 Hz to 52 Hz.

5 Phase angle difference display
Digital display of the phase angle difference between the generator and the busbar.

6 Phase angle display
Graphic display of the phase angle at the generator (above the scale) and the busbar (below) in the range of -180 degrees to +180 degrees.

Island mode speed influence



62418-003

1 `Demanded`
Display of the demanded speed.

2 Demanded speed symbol
The symbol displays the set speed on the speed scale (3).

3 Speed scale display
Graphic display of the set speed (above the scale) and the demanded actual speed (below) in the range of 1470 rpm to 1530 rpm.

4 "Plus" button
Tapping the button increases the demanded speed by 0.5 rpm.

5 "1500" button
Tapping the button sets the demanded speed to 1500 rpm.

6 "Minus" button
Tapping the button reduces the demanded speed by 0.5 rpm.

/ Actual speed symbol
The symbol displays the actual speed on the speed scale (3)

8.3.2 Automatic operation mode

Starting the genset in automatic operation mode

The start demand and the power demand for the genset are given via a superior control.

1.	The superior control gives the TPEM system a start demand and a power demand.
2.	The TPEM system waits for a successful leakage check.
3.	The TPEM system waits for feedback from the digital input "Feedback for external starting preparations".
4.	The TPEM system starts the genset after a prelubrication phase.The genset runs in idle mode.
5.	The TPEM system closes the generator circuit breaker after successful synchronization.
6.	The TPEM system controls the genset output to the demanded value.

Shutting down the genset in automatic operation mode

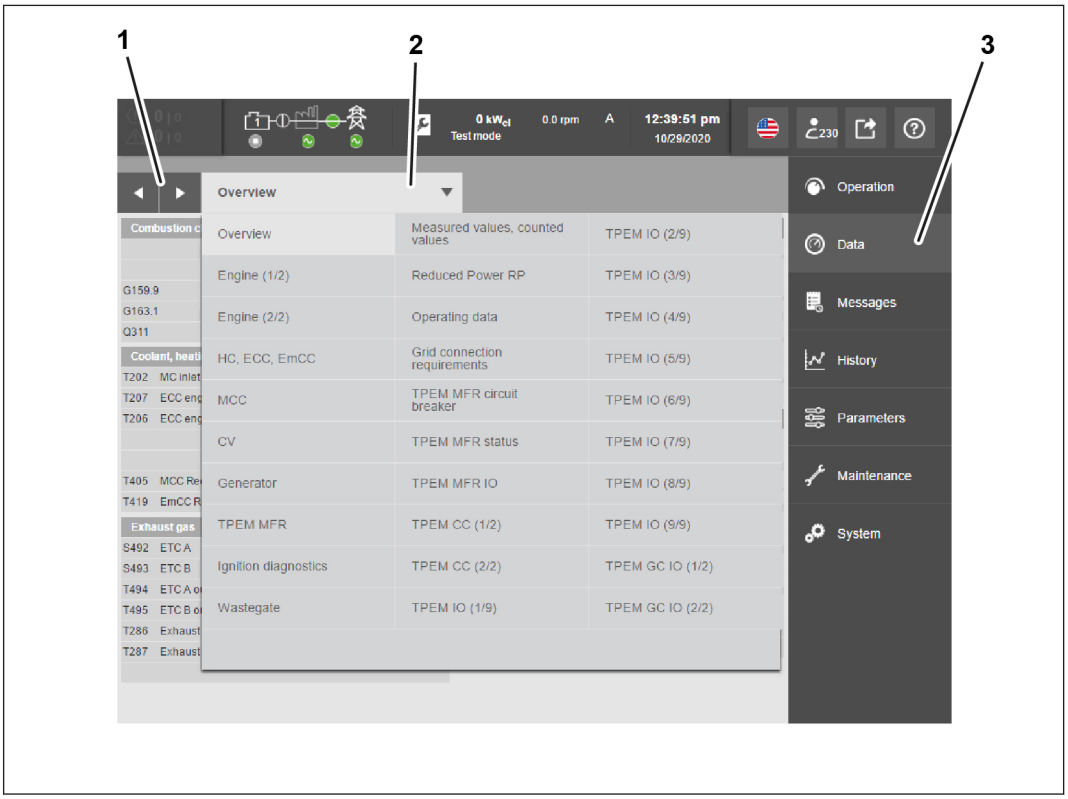
The demand for shutting down the genset is given by a superior control.

1.	The superior control gives the TPEM system the demand to shut down the genset.
2.	The TPEM system continuously decreases the genset output to just a few %.
2.	The TPEM system opens the generator circuit breaker.
3.	The TPEM system shuts down the genset.
4.	The coolant pumps run on until the genset has cooled down.

8.4 Functional group "Data"

The functional group `Data` condenses all the measured values of the module and presents the measured values clearly on several masks. Some of the data is supplemented by setpoint values and other relevant information and symbols.

The functional group `Data` allows a quick overview of the module's current status with its respective components.



61145-005

1 Arrow buttons for switching between the subgroups when pull-down menu is closed.

2 Pull-down menu "Subgroups", for selecting a subgroup.
The buttons activate other masks in which status displays and measured values are compiled in functional subgroups.
The "Overview" mask summarizes the most important data of the module.

3 `Data` button in the functional group selection

8.4.1 Selection of subassemblies

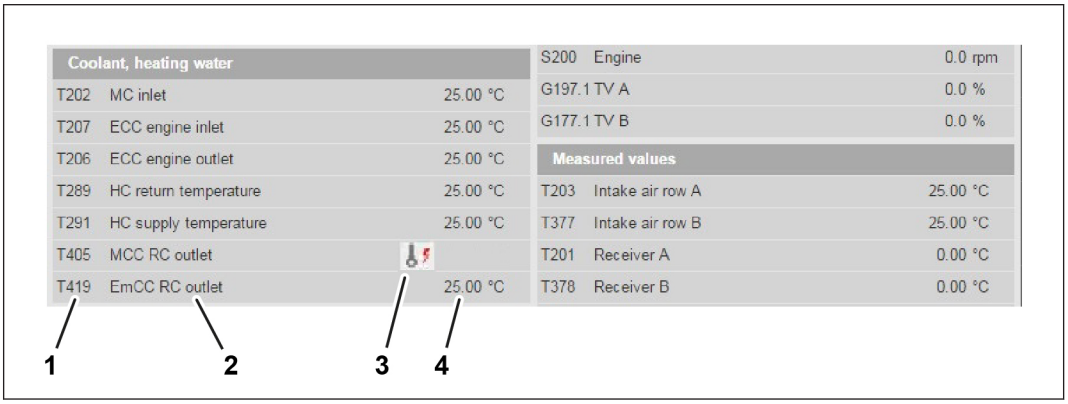
Selecting the functional group `Data` opens the homepage with the subassembly `Overview`.

A subassembly can be selected in one of two ways:

- Flicking through using the arrow buttons (1)
- Direct selection in the pull-down menu (2)

▶	Each tap on the arrow button advances one subassembly in the sequence of the pull-down menu.
◀	Each tap on the arrow button goes back one subassembly in the sequence of the pull-down menu.

8.4.2 Display measured values



66837-001

1 Measuring point number

2 Measuring point designation

3 Sensor error symbol

4 Measured value with unit

When a sensor error occurs:

- The sensor error symbol (3) appears
- The measured value and the unit disappear
- A corresponding error message appears

8.4.3 Display of flap positions and valve positions

In addition to data such as temperatures and pressures, positions of flaps and valves are also displayed.

Cabin ventilation, inlet air			Speed, Power		
T404	Supply air temperature	25.00 °C			
T604	Exhaust air temperature	40.00 °C			
T404.3	Supply air temperature setpoint value	24.0 °C			
T604.3	Exhaust air temperature setpoint value	35.0 °C	106	Generator circuit breaker	true
	Circulation flap position −		E198.6	Power limit	100.0 %
	Inlet flap position +		E198.5	Setpoint power	80.0 %
	Outlet flap position +		E198.2	Actual power	80.0 %
994	Frequency converter set speed	100.00 %	S200	Engine speed	1,498.0 $^{1}/_{min}$
T203	Inlet air cylinder row A temp.	25.00 °C	G197.1	Throttle valve A position	0.0 %
T377	Inlet air cyl. row B temp.	25.00 °C	G177.1	Throttle valve B position	0.0 %

66194-001

Symbol	Meaning
+	Limit stop, plus e.g. flap OPEN at limit stop
−	Limit stop, minus e.g. flap CLOSED at limit stop
<>	Intermediate state e.g. valve between the limit stops

8.4.4 Status displays for TPEM MFR circuit breaker, TPEM MFR status

The status displays for `TPEM MFR circuit breaker` and `TPEM MFR status` are available without TPEM USB token.

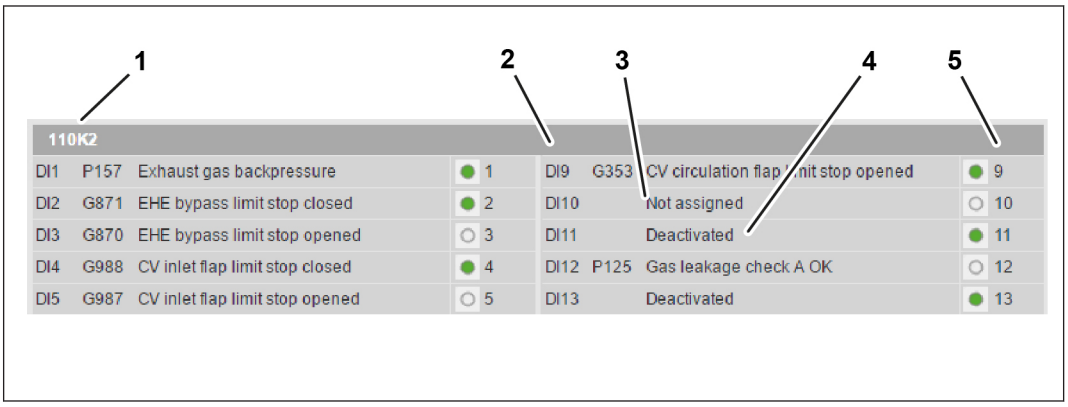
Generator				Busbar		
	Generator frequency	0.00 Hz		Busbar voltage	400.0 V
189	Generator voltage	0.0 V	150	Busbar frequency	50.00 Hz
	Generator rotating field, counterclockwise			Busbar rotating field, counterclockwise	
	Generator rotating field, clockwise			Busbar rotating field, clockwise	
Status circuit breaker				Dead busbar	
	MCB activated		**Mains**		
	MCB position feedback		233	Mains frequency	50.00 Hz
	MCB synchronization active			Mains rotating field, counterclockwise	
				Mains rotating field, clockwise	

73262-001

Symbol	Meaning
✓	Displayed voltage or frequency OK
✗	Displayed voltage or frequency not OK
	Circuit breaker opened
	Circuit breaker closed
●	Yes
○	No

8.4.5 Status displays for digital inputs, relay outputs

The status displays for `TPEM MFR IO`, `TPEM CC` and `TPEM IO` are available from token level 50.



73270-001

1 Terminal designation on the `TPEM IO Controller`

2 Number of the digital input or the relay output

3 `Not assigned`: Digital input is not used in the circuit diagram

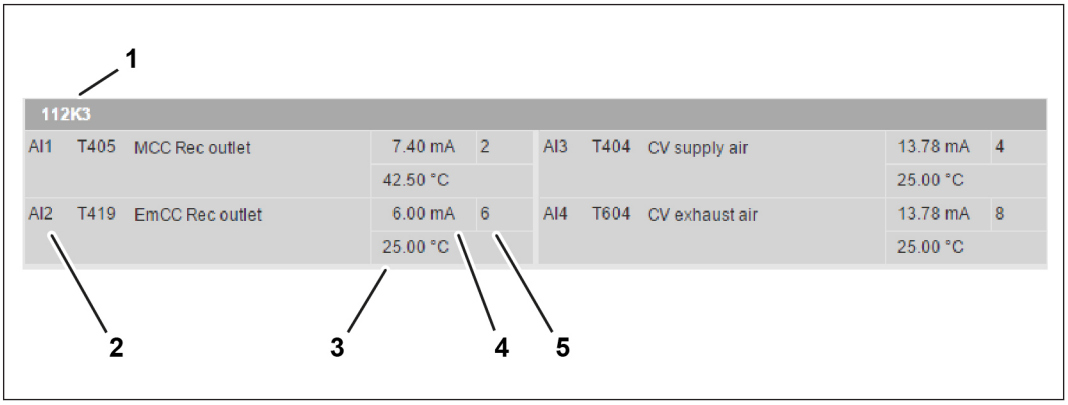
4 `Deactivated`: Digital input not parameterized

5 Contact number of the terminal

Symbol	Meaning
●	24 V voltage at input
○	0 V voltage at input

8.4.6 Status displays for analog inputs

The status displays for the `TPEM IO` are available from token level 50.



73271-001

1 Terminal designation on the `TPEM IO Controller`

2 Number of the analog input

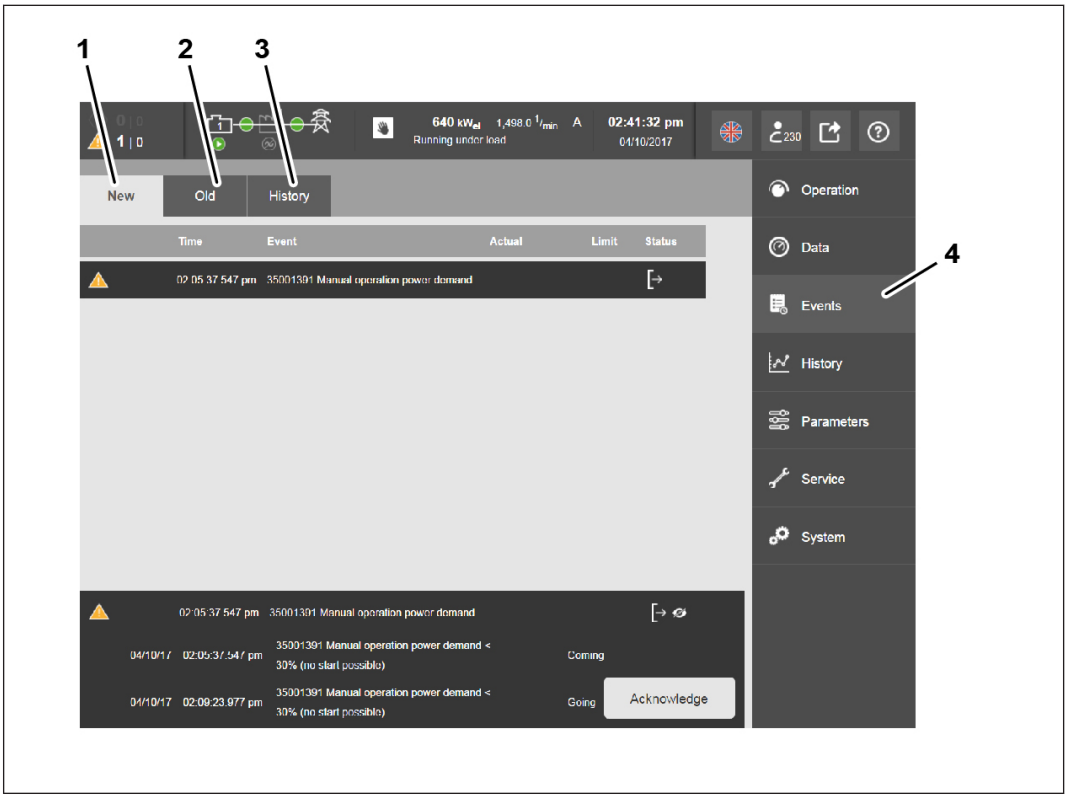
3 Value of physical size assigned to the analog signal

4 Analog signal in mA

5 Contact number of the terminal

8.5 Functional group "Messages"

Module operation is recorded completely in the functional group `Messages` via defined alarms, warnings and operating messages. By means of filters, groups of information can be presented in a targeted way.



63560-004

1 Submenu `New`
List of all events that have not yet been acknowledged. ⇒ Submenu `New`.

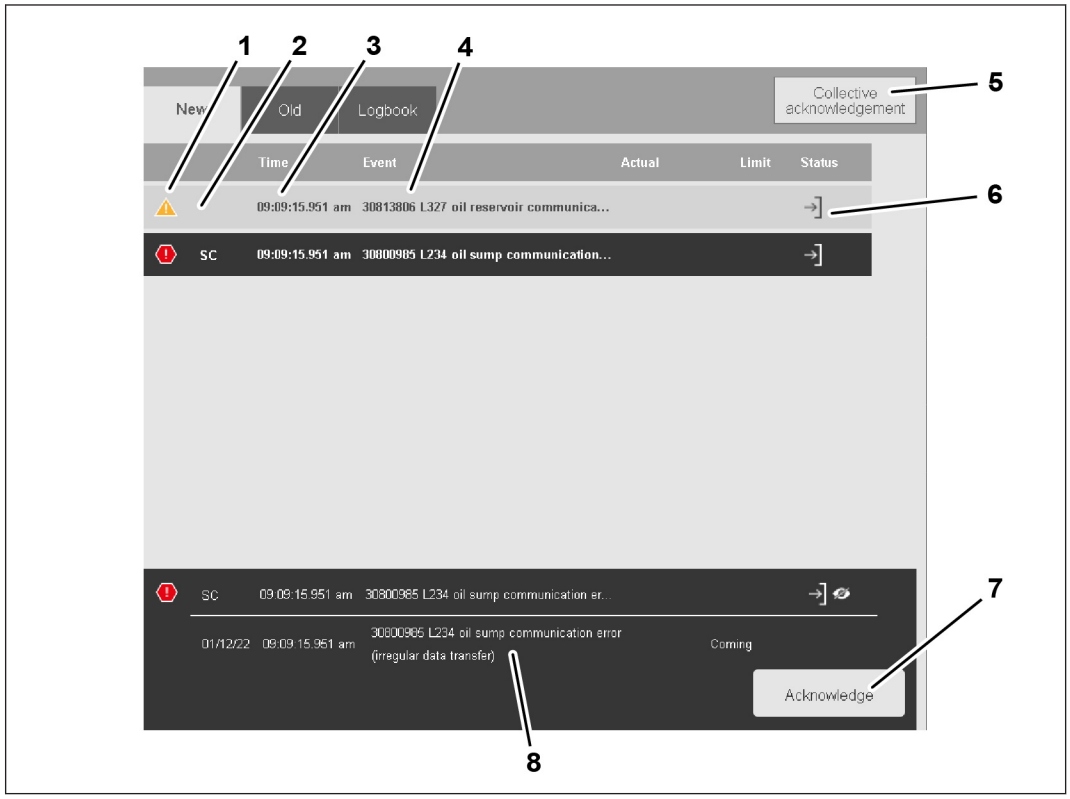
2 Submenu `Old`
List of all events that are present, but have been acknowledged. ⇒ Submenu `Old`.

3 Submenu `Logbook`
List of all events from the submenu `New` and `Old`. Events are summarized into days ⇒ Submenu `Logbook`.

4 `Messages` button in the functional group selection

8.5.1 Submenu `New`

List of all events that are present, but have not yet been acknowledged.



62508-003

1 Symbol for the event type ⇒ Submenu `Logbook`

2 Selected event (highlighted in black)

3 Time stamp of the event

4 Event text

5 Collective acknowledgement button

6 Symbol for the event status ⇒ Submenu `Logbook`

7 Acknowledge button: To acknowledge individual, selected events

8 Detailed information on the selected event

Collective acknowledgement

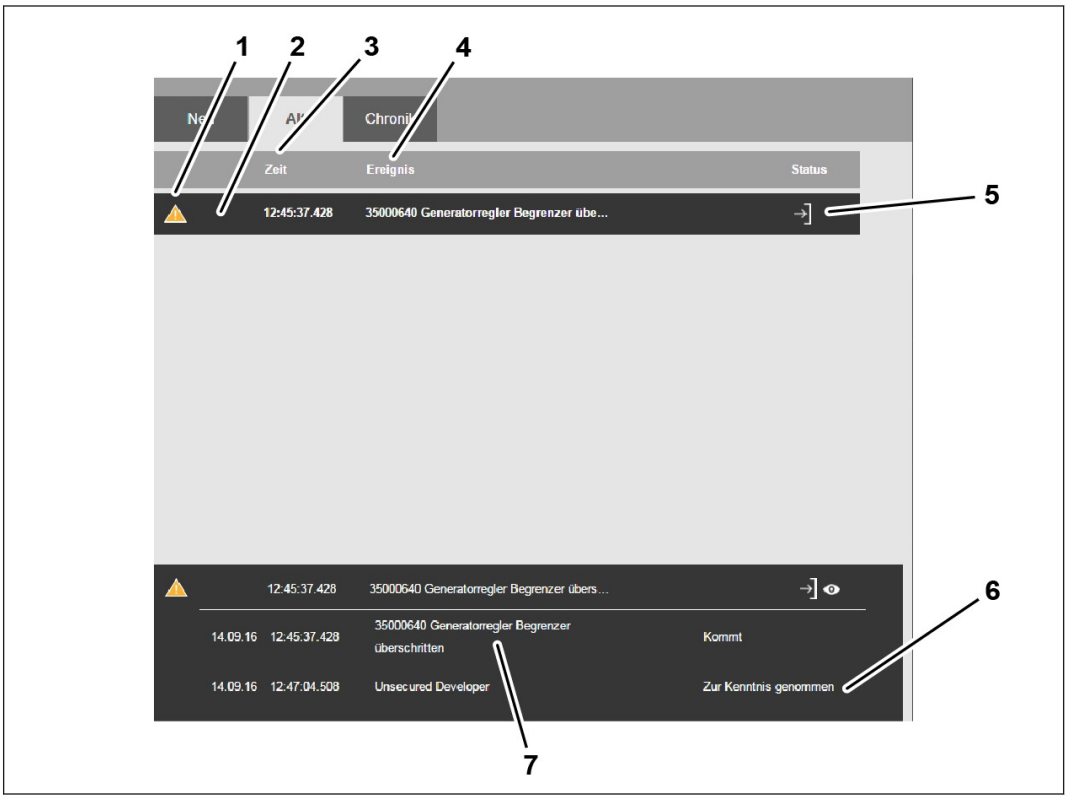
If parameter `20106687 Collective acknowledgement` is activated, the button `Collective acknowledgement` ⇒ TPEM Parameter description ⇒ General ⇒ Plant appears.

Button for acknowledgement of all displayed events. When pressed, the query `Acknowledge all warnings and alarms?` appears. When the `CONFIRM` button is pressed, all warnings and alarms are acknowledged.

If there are no pending warnings and alarms or all warnings and alarms have been acknowledged, the button `Collective acknowledgement` appears in light gray.

8.5.2 Submenu `Old`

List of all events that are present, but have been acknowledged. The events are summarized into days.



62509-002

1 Symbol for the event type ⇒ Submenu `Logbook`

2 Selected event (highlighted in black)

3 Time stamp of the event

4 Event text

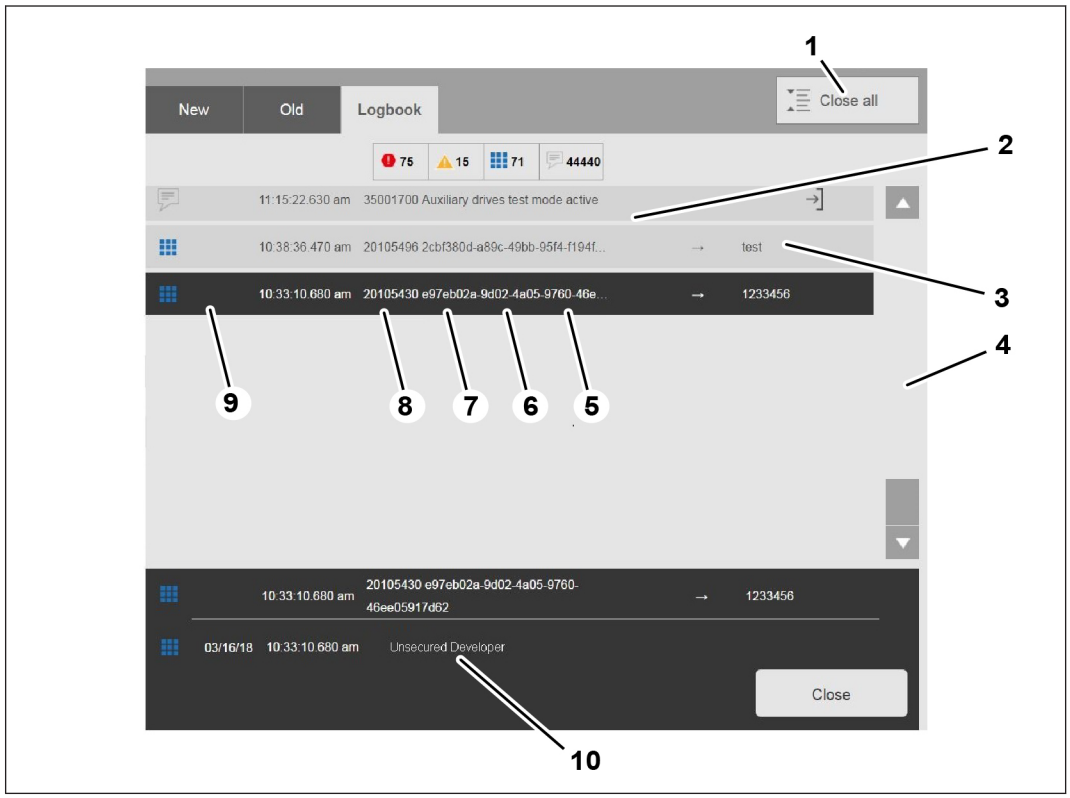
5 Symbol for the event status ⇒ Submenu `Logbook`

6 Display of `Event acknowledged`

7 Detailed information on the selected event

8.5.3 Submenu `Logbook`

List of all events from the submenu `New` and `Old` as well as parameter changes. Events are summarized into days.



62510-002

1 Open all / Close all
All events of all days are displayed.
All open events are closed.

2 For parameters: display of old parameter value

3 For parameters: display of new parameter value

4 Scroll bars

5 Column "Operating messages" ⇒ Event types

6 Column "Parameters" ⇒ Event types

7 Column "Alarm SC" ⇒ Event types

8 Column "Alarm" ⇒ Event types

9 Column "Date"
Summarizes all messages of a day. Shows the type and number of messages in columns 5 to 8.
The days are sorted by date. The most recent date is at the top. If more days are listed than can be shown in the display range, the older dates can be reached using the scroll bar.
Tapping in the area displays all the events of a day. Tapping in the area again closes the event list.

10 User display
Display of the serial number of the TPEM USB token with which the parameter value has been changed.

About columns 5 to 8

The symbol of the event type is in the header of the columns. The total number of events per event type is added using all data.

The number of events which have occurred per event type is stated by date in the individual columns.

Event types

Symbol	Event type	Explanation
	Parameters	A parameter was modified. If the parameter was changed by a user, the serial number of the connected TPEM USB token is displayed. If the parameter was changed with a software update, the serial number 00000000 is displayed.
	Operating message	Message that provides information on an event, e.g. that the pump is on or that a limit has been exceeded. The entry need **not** be acknowledged.
	Warning	Exceeding a limit without shutting down the genset. The entry must be acknowledged.
	Warning RP RP = Reduced Power	Exceeding a limit causes a reduction in power. Mains parallel mode: The power limit is reduced by 20 % based on the configured maximum power. Island mode: The power limit is immediately restricted to the actual power. If the power limit is exceeded, the genset shuts down with a corresponding message. The entry must be acknowledged.
	Alarm SC SC = Shutdown Controlled	Exceeding a limit causes a delayed shutdown of the genset. The power limit is immediately restricted to the actual power and set to 0 % after expiration of the delay time. The entry must be acknowledged.

Symbol	Event type	Explanation
	Alarm	Exceeding a limit causes an immediate shutdown of the genset. The auxiliary drives continue to supply the genset with power. The entry must be acknowledged.
	Alarm WO	Exceeding a limit causes an immediate shutdown of the genset without overrun of the auxiliary drives, e.g. with gas alarm step 2. The entry must be acknowledged.

Symbols status

Symbol	Status
	Event coming
	Event going
	Event not acknowledged
	Event acknowledged

8.5.4 Detailed information

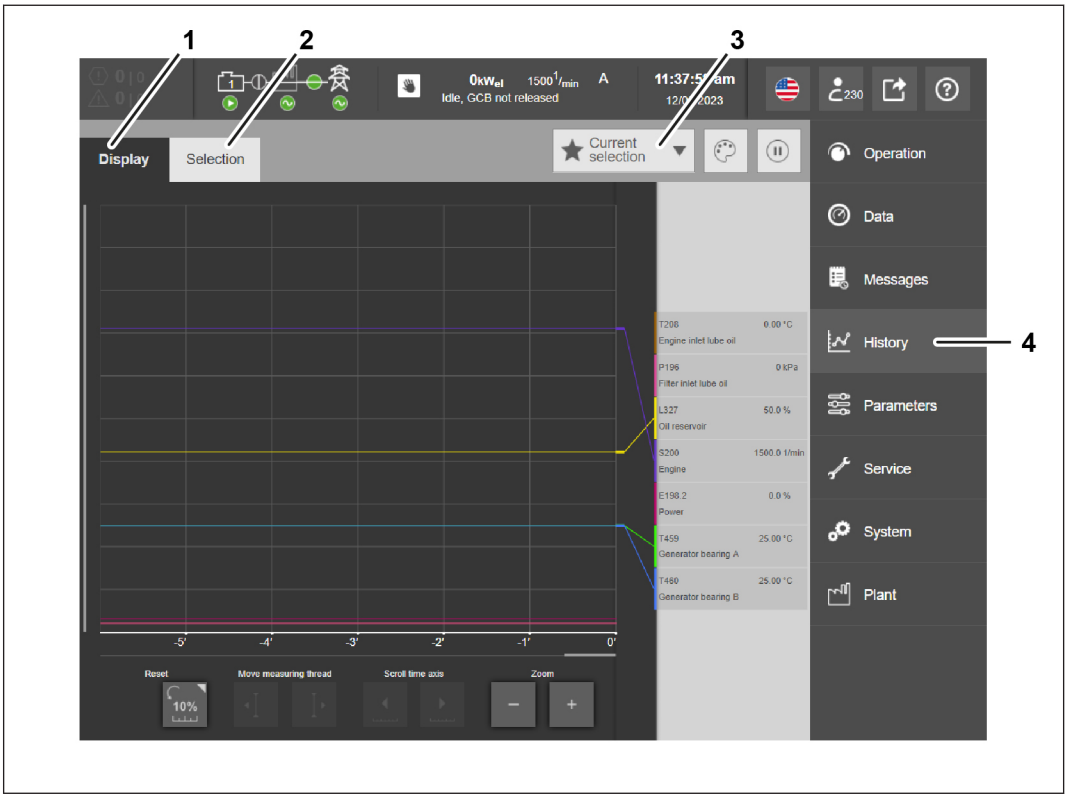
In the detailed view, supplementary information is stored for each event.

Type filters

Type filters restrict the presentation with regard to the event type. e.g. display of alarms only.

Tapping in the area of the event symbol of columns 6 to 10 activates the presentation of the event type (medium gray), tapping again deactivates the presentation (light gray).

8.6 Functional group "History"



75378-001

1 `Display` mask button

2 `Selection` mask button

3 "Favorites" pull-down menu

4 `History` button in the functional group selection

Measuring points can be selected and the corresponding history graphs displayed in the `History` functional group. The `Selection` mask determines which history graphs are shown. The `Display` mask shows the history graphs for the selected measured values.

The TPEM system records the history graphs for all measuring points independently of one another for the operating cycle and the short-term history. If a fault occurs, recording stops automatically after a specified wait time. 26 history graphs can be displayed.

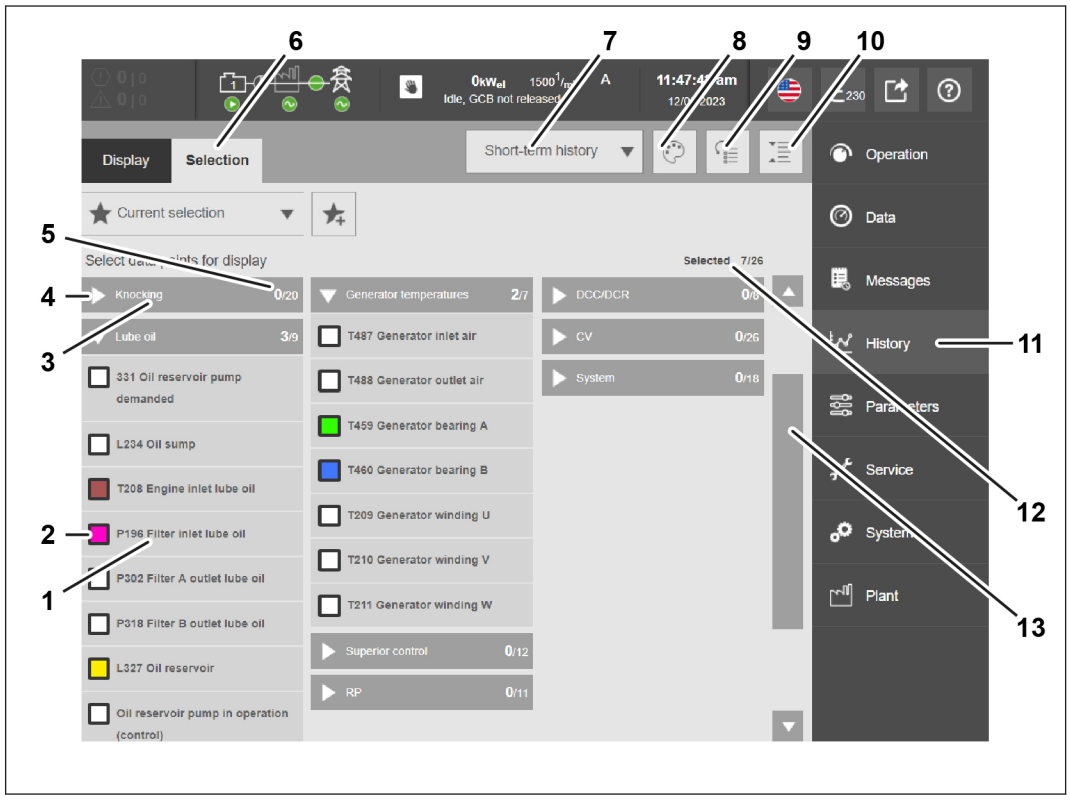
The following history types are available:

- Operating cycle: The instantaneous values are recorded for five minutes. The resolution is 80 ms (1 operating cycle = 2 crankshaft revolutions). The screen is updated every second.
- Short-term history: The instantaneous values are recorded for one hour. The resolution is 1 s. The screen is updated every second.
- Long-term history: The instantaneous values are recorded for eight days. The resolution is 2 minutes. The screen is updated every 3 minutes.

Favorites make it possible to quickly switch between defined groups of measuring points. 22 favorites can be created. A favorite can contain 26 measuring points. The name of the favorite, the measuring points it contains and the colors of the measuring points can be edited. Favorites can be selected in the "Favorites" pull-down menu. Favorites are saved on the TPEM TP depending on the TPEM USB token.

8.6.1 "Selection" mask

General functions



61156-004

1 Name of the measuring point

2 Measuring point checkbox
Clicking on the checkbox highlights the measuring point. The displayed color identifies the history graph in the `Display` mask. The colors of the measuring points are automatically assigned. The colors of the measuring points can be edited.

3 Selection group name

4 Selection group
Clicking in the area opens the selection group.

5 Number of selected measuring points from the possible measuring points in the selection group

6 `Selection` mask button

7 "History types" pull-down menu
The operating cycle, short-term history and long-term history are available for selection. The selected history type is displayed.

8 "Color selection chart" button

9 "Reset selection of measuring points" button. No history graphs are shown on the `Display` mask.

10 "Show/Hide selection of measuring points" button. Depending on the initial state, all measuring points are displayed or hidden. The function is independent of whether the measuring points are selected or not.

11 `History` button in the functional group selection

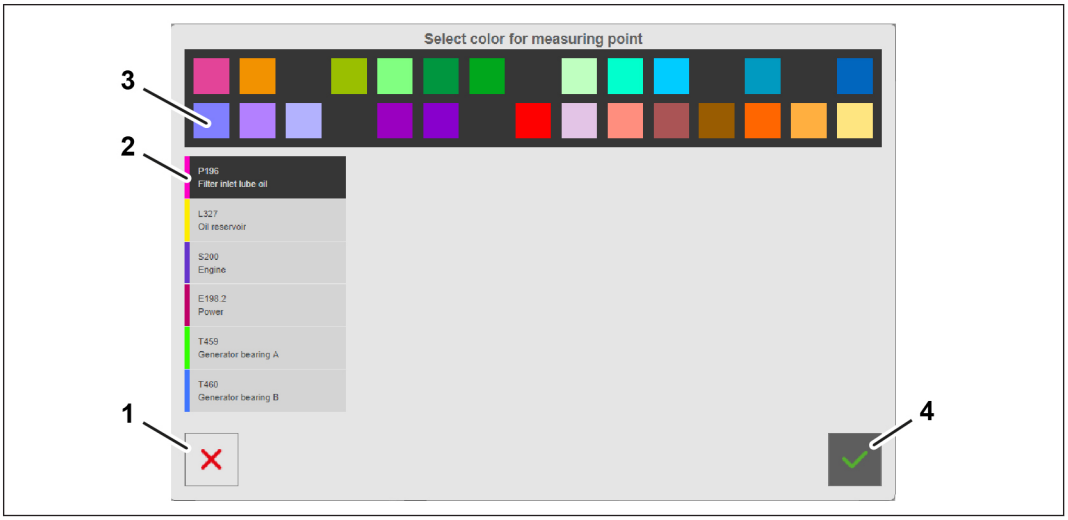
12 Display of the number of selected measuring points from the maximum possible measuring points

13 Scroll bar

One color from the color selection chart can be assigned to each measuring point. There are 30 colors available for the measuring points of the 26 history graphs. Each color can only be used once. Used colors are hidden from the color selection chart.

Assigning a color

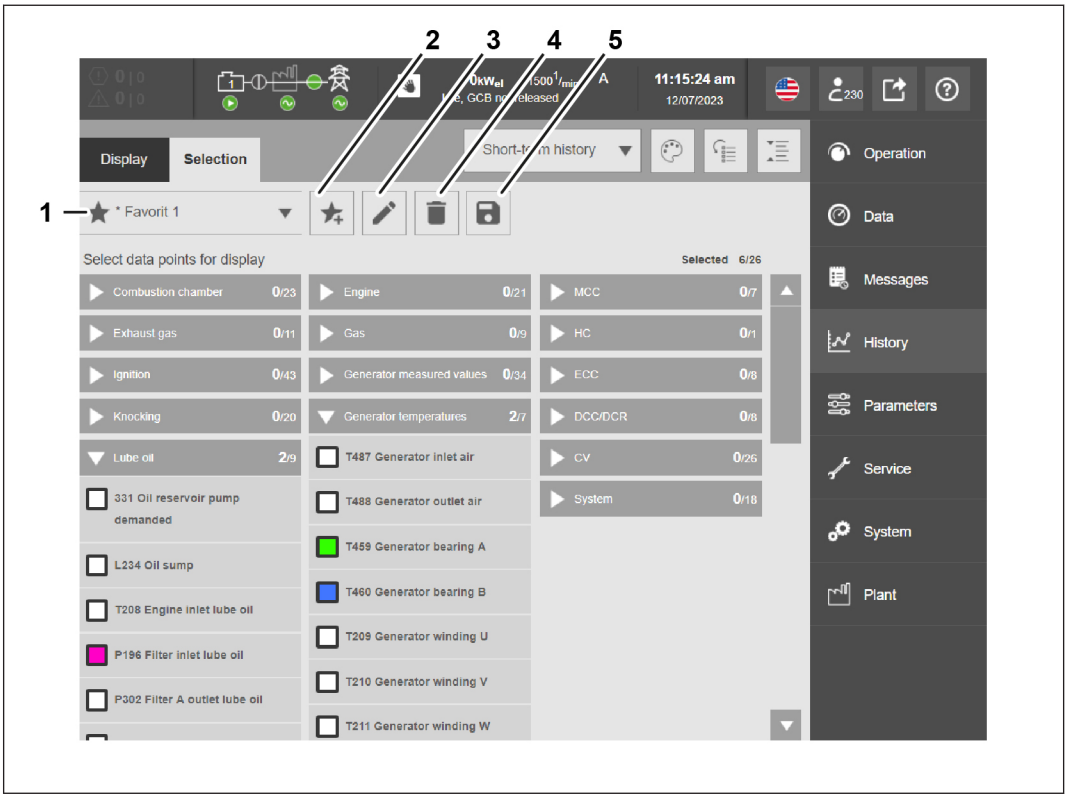
1. Press the "Color selection chart" button.
   → The color selection chart appears.
   → Below the color selection chart, all selected measuring points are shown with their currently assigned colors.



65765-002

2. Press the desired measuring point (2).
   → The background of the measuring point will be highlighted in black.
3. Press the desired color (3).
   → The measuring point takes on the selected color.
   → The selected color is hidden in the color selection chart.
4. Press the red cross (1) to cancel the color assignment or press the green tick (4) to adopt the color assignment.
   → The color selection chart is hidden.

Functions for favorites



75383-001

1 "Favorites" pull-down menu

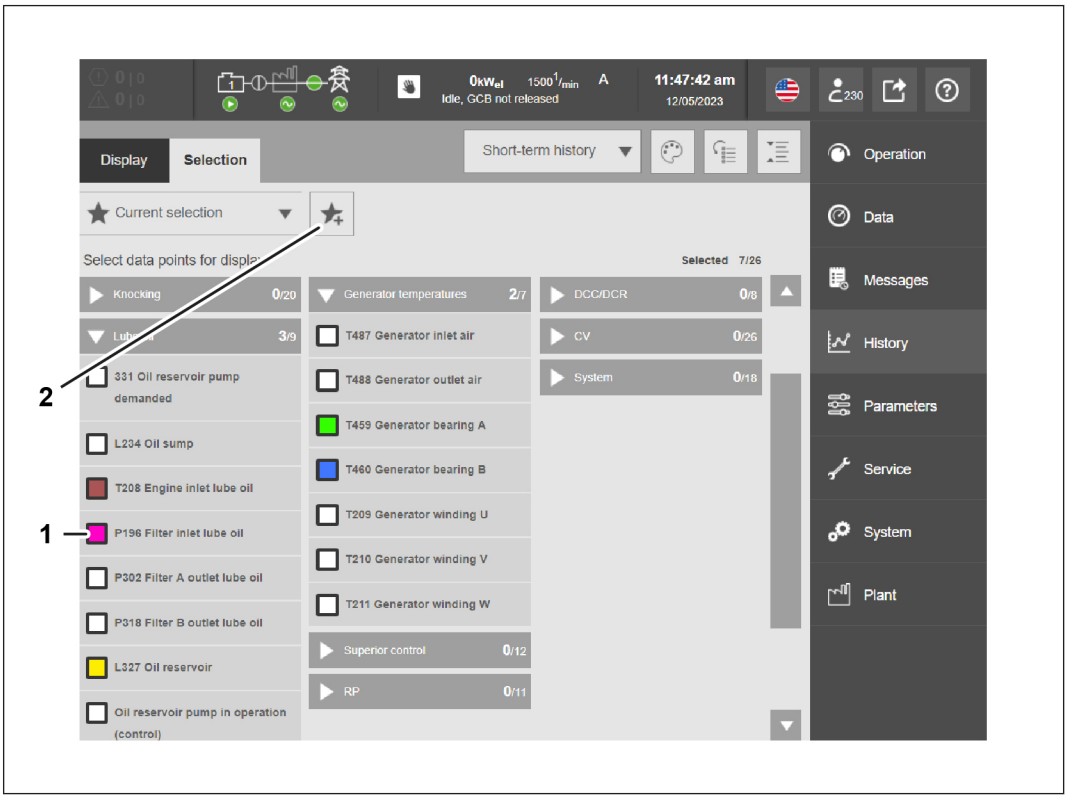
2 "Create favorite" button

3 "Edit favorite" button (only available for selected favorites)

4 "Delete favorite" button (only available for selected favorites)

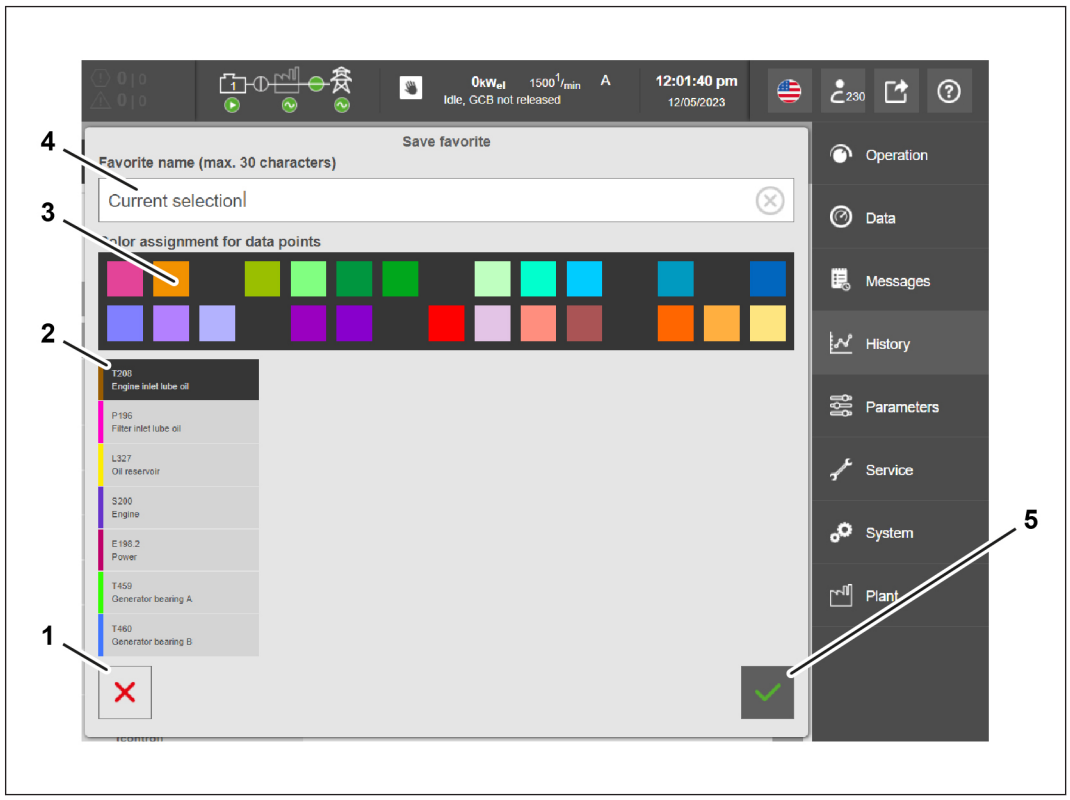
5 "Save favorite" button (only available when changes are made to a favorite)

Creating favorites



76236-001

1. Select measuring points (1).
   → The button required to create a favorite is activated.
2. Press button to create a favorite (2).
   → The window for creating a favorite appears.



75381-001

3. Press input field for names (4).

   → The keyboard appears.

4. Enter the name of the favorite.

   → The name can be up to 30 characters in length.

5. Press the red cross on the keyboard to cancel the process or press the green tick to adopt the name.

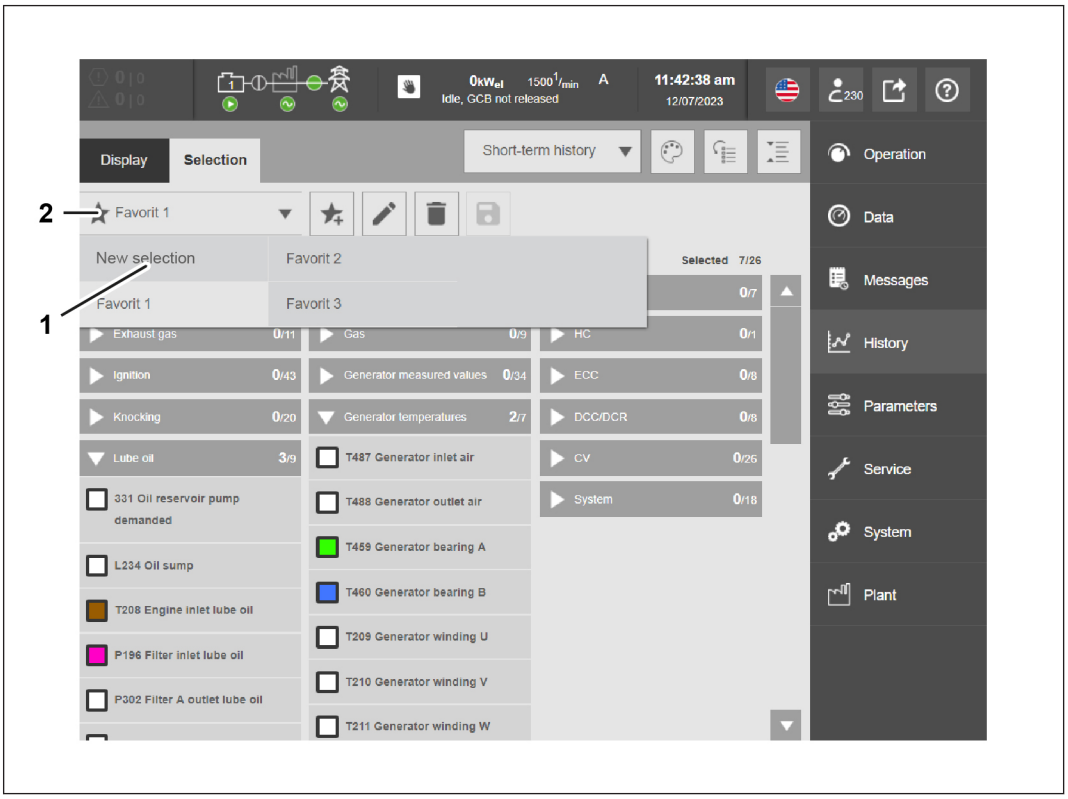
   → The keyboard disappears.

6. Assign colors (3) to the measured values (2) ⇒ "Assigning colors" section.

7. Press the red cross (1) to cancel the process or press the green tick (5) to create favorites.

   → When the green tick is pressed, the favorite is saved and can be selected from the `Favorites` pull-down menu.

Deselecting favorites



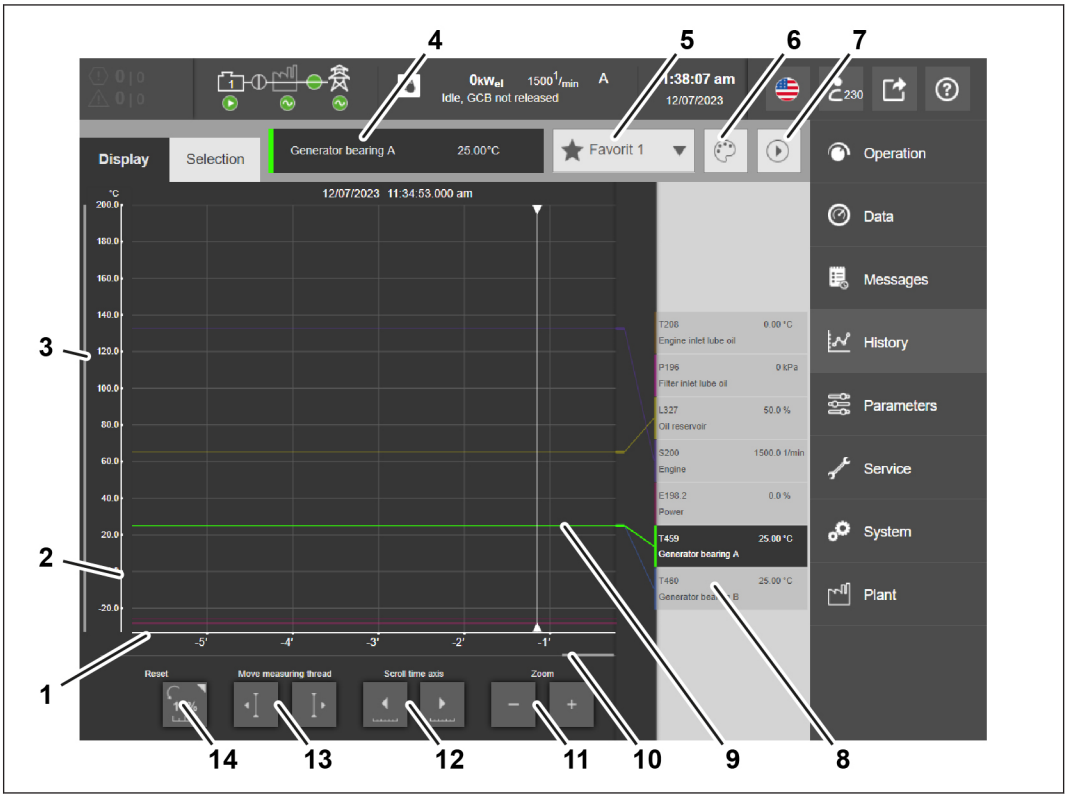
76238-001

1. Open `Selection` mask.
2. Press the pull-down menu "Favorites" (2).
3. Press `New selection` (1) in the pull-down menu.
   → The favorite and all measuring points are deselected.

Editing or deleting favorites

1. Select favorites in the `Favorites` pull-down menu.
   → The measuring points for the favorites are displayed.
2. Option: Add or delete measuring points by clicking on them.
3. Option: Edit the name of the favorite or the color of the measuring points. Press the "Edit favorites" button ⇒ create favorites.
4. Option: Delete favorites using the "Delete favorite" button.
5. Press the "Save favorite" button.
   → If the favorite has been edited, the "Save favorite" button is activated.
   → The favorite is saved and can be selected from the `Favorites` pull-down menu.

8.6.2 "Display" mask



61157-005

1 Time axis

2 Value axes for the history graphs

3 Value axes scroll indicator

4 Additional display of the selected measuring point

5 "Favorites" pull-down menu

6 "Color selection chart" button

7 "Activate and deactivate pause mode" button
⇒ Pause mode

8 "History graphs" legend
The legend displays the colors, numbers, names and current values for the measuring points. Pressing on a measuring point highlights the legend and the history graph.

9 History graphs for the selected measuring points

10 Scroll indicator time axis

11 `Zoom` buttons

12 `Scroll time axis` buttons (only active in pause mode)

13 `Move measuring thread` buttons (only active in pause mode)

14 `Reset` button, sets the time axis to the default setting for the selected history type in % of the respective maximum time ⇒ Pause mode

Value axes

When calling up the `Display` mask, the history graphs first appear without value axes, but with a default grid division in the display range. The display period corresponds to the recording period.

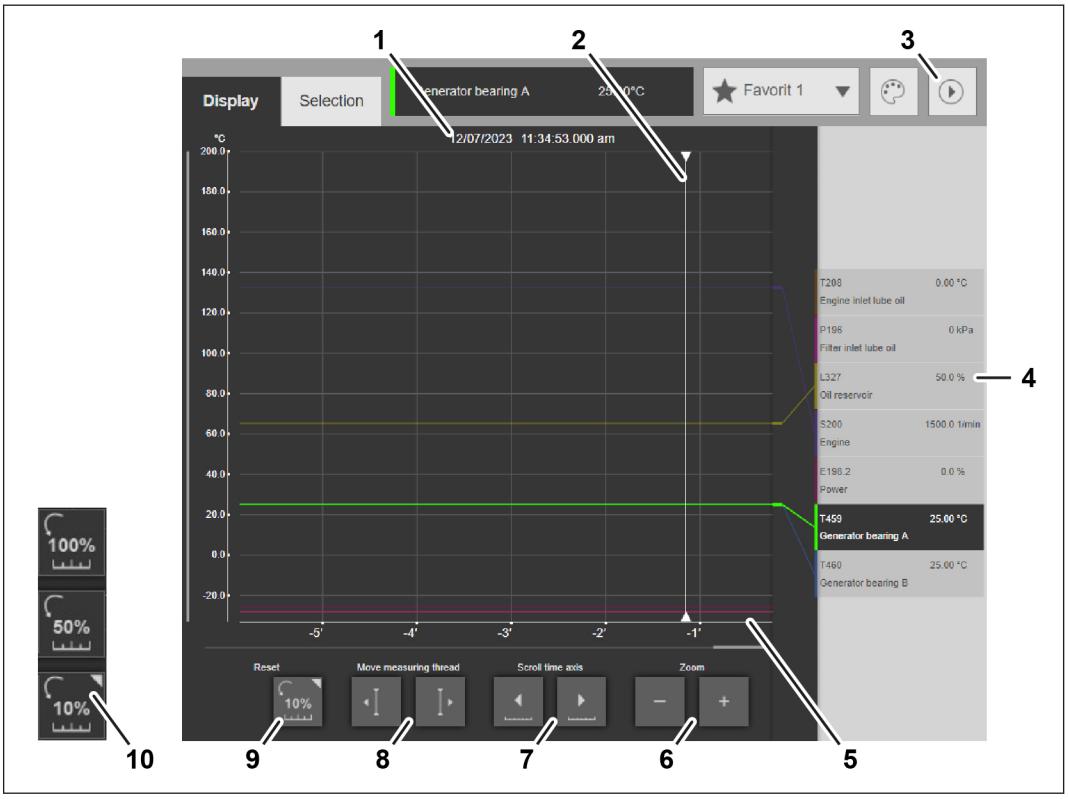
Pressing in the area of the "History graphs" legend displays the corresponding value axis. Several displayed value axes are shown adjacent to each other. The most recent value axis shown is on the right. The grid division of the display range is based on the value axis on the right.

Pressing in the area of the value axes hides the corresponding value axis.

Each value axis has the same color as the corresponding history graph. If a value axis relates to several history graphs, the value axis is shown in white.

Pause mode

In pause mode, the history graphs can be retraced with a measuring thread. Each measured value is indicated as a number with an exact time stamp at the measuring thread position.



62415-004

1 Date and time at the point of the measuring thread

2 Measuring thread

3 "Activate and deactivate pause mode" button

4 Measured values at the point of the measuring thread

5 Time axis

6 `Zoom` buttons

7 `Scroll time axis` buttons

8 `Move measuring thread` buttons

9 `Reset` button
Sets the time axis to the default setting for the selected history type in % of the respective maximum time.
Operating cycle: 20 %, short-term history: 10 %, long-term history: 25 %
Touching and holding or keeping the mouse button pressed opens the two buttons Time axis 50 % and Time axis 100 % ⇒ Position 10.

10 Time axis 50 % and Time axis 100 % buttons
The time axis is set to 50 % of the respective maximum time or 100 % of the respective maximum time.

Zooming into the display (using fingers)

1. Activate pause mode.
2. Touch the TPEM Touch Panel at the desired point of the display with one finger until the magnifying glass symbol appears.
3. Drag the rectangle that appears up to increase the size as required.

The process can be repeated or undone with the `Reset` (9) button.

The enlarged section can be moved left and right with the two `Scroll time axis` (7) buttons.

Zooming into the display (using the mouse)

1. Use the mouse to click the + symbol on the `Zoom` (6) buttons.
   → The display is magnified.

The process can be repeated or undone with the - symbol.

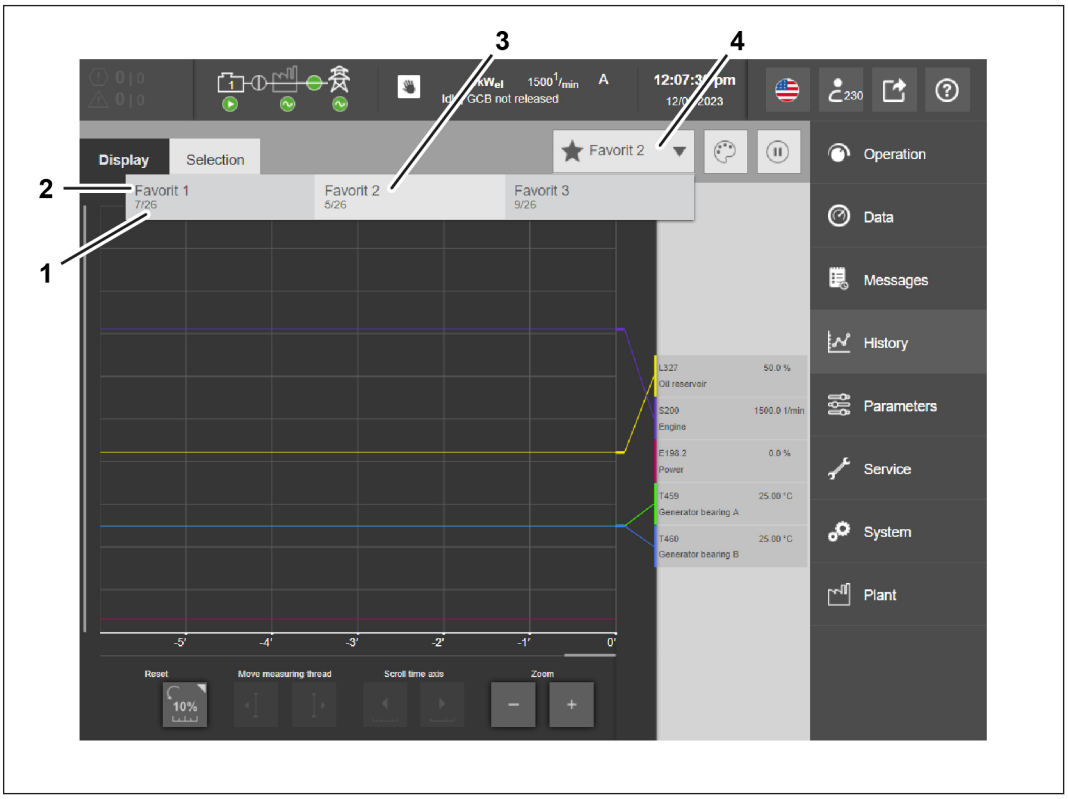
The process can also be undone with the `Reset` (9) button.

The enlarged section can be moved left and right with the two `Scroll time axis` (7) buttons.

Move measuring thread

1. Rough movement: Tap the desired point in the display.
   → The measuring thread jumps to this point.
2. Precise movement: Use the `Move measuring thread` (8) buttons to move the measuring thread left or right one measured value at a time.
   → The position of the measuring thread is displayed at (1).
   → The measured values for the position are displayed in the legend (4).

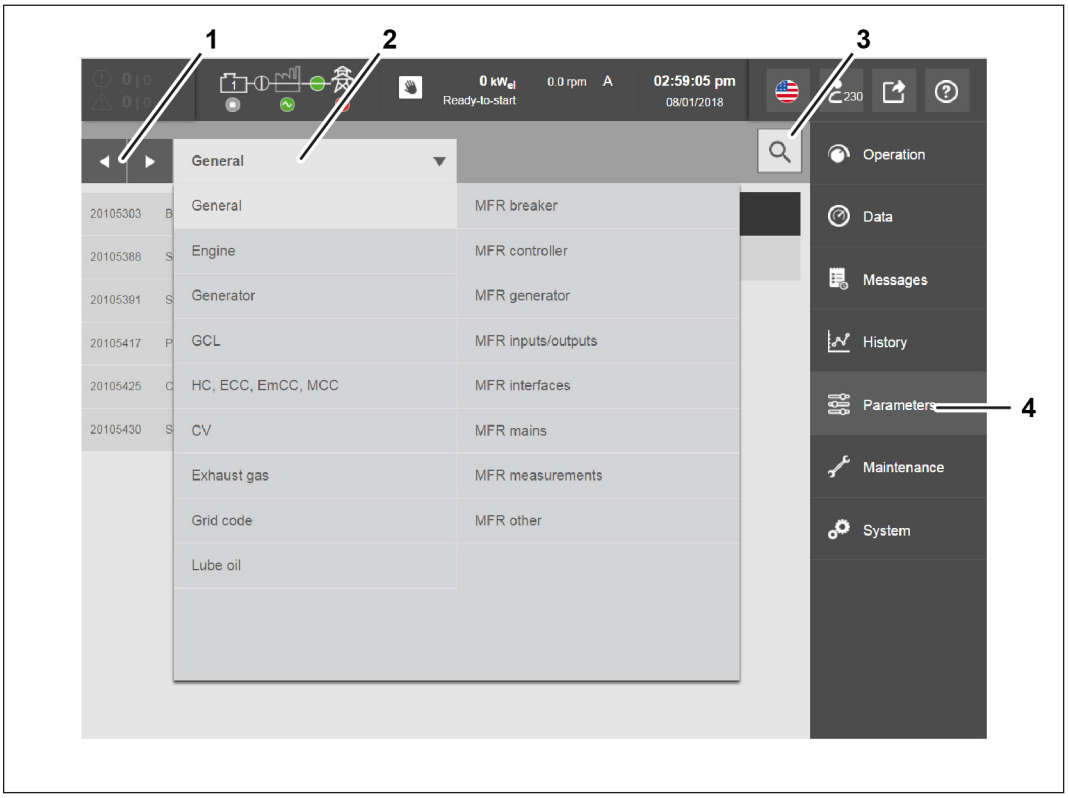
Selecting favorites



75380-001

1. Press the pull-down menu "Favorites" (4).
   - → The list with the available favorites appears.
   - → The selected favorite is highlighted in light gray (3).
   - → The name (2) and number of measured values (1) is displayed for each of the favorites.
2. Press the desired favorites.
   - → The list with the available favorites disappears.
   - → The measured values for the favorites are displayed.

8.7 Functional group "Parameters"



61051-004

1 Arrow buttons for switching between the subgroups when pull-down menu is closed

2 Pull-down menu for the subgroups
Tapping the buttons toggles between the individual masks. The `General` screen summarizes the most important parameters of the genset.

3 Button for searching for parameters

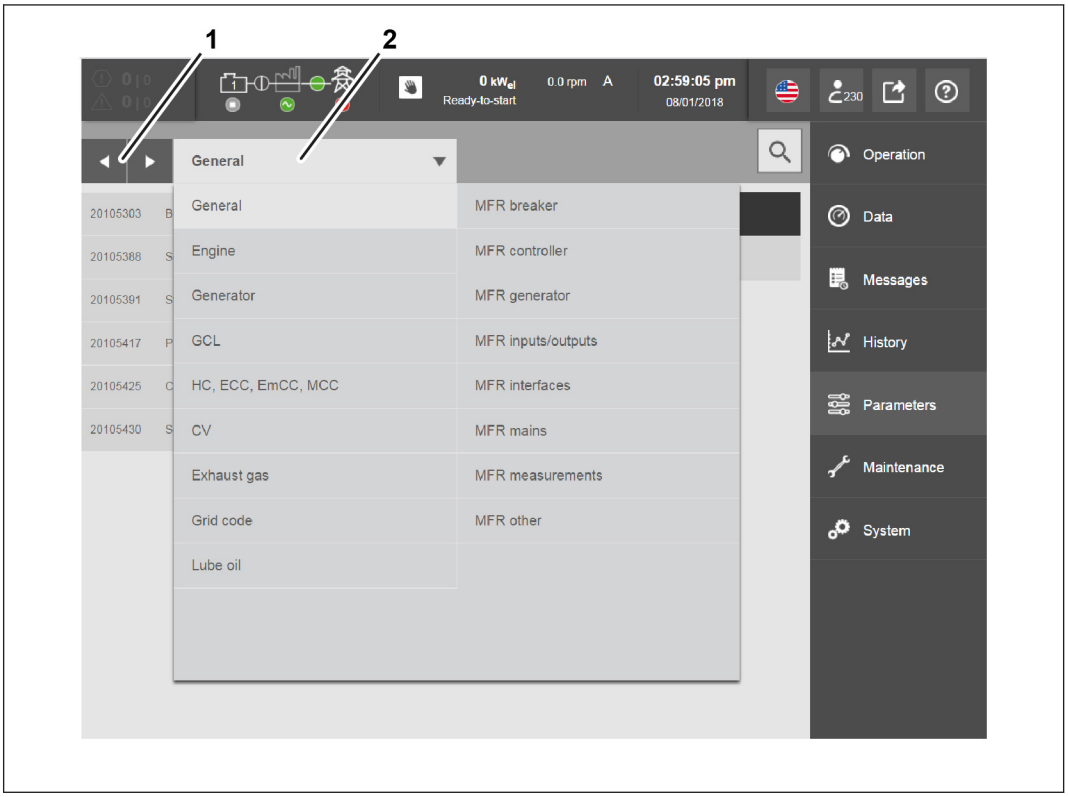
4 `Parameters` button in the functional group selection

The functional group `Parameters` allows you to display the parameters of the control with the current value and change these within defined limits.

The parameters are divided into various authorization levels.

The function and significance of all parameters, as well as the assignment to the authorization levels, are described in detail in a separate document, the "Parameter Description".

8.7.1 Selecting subgroups



75506-001

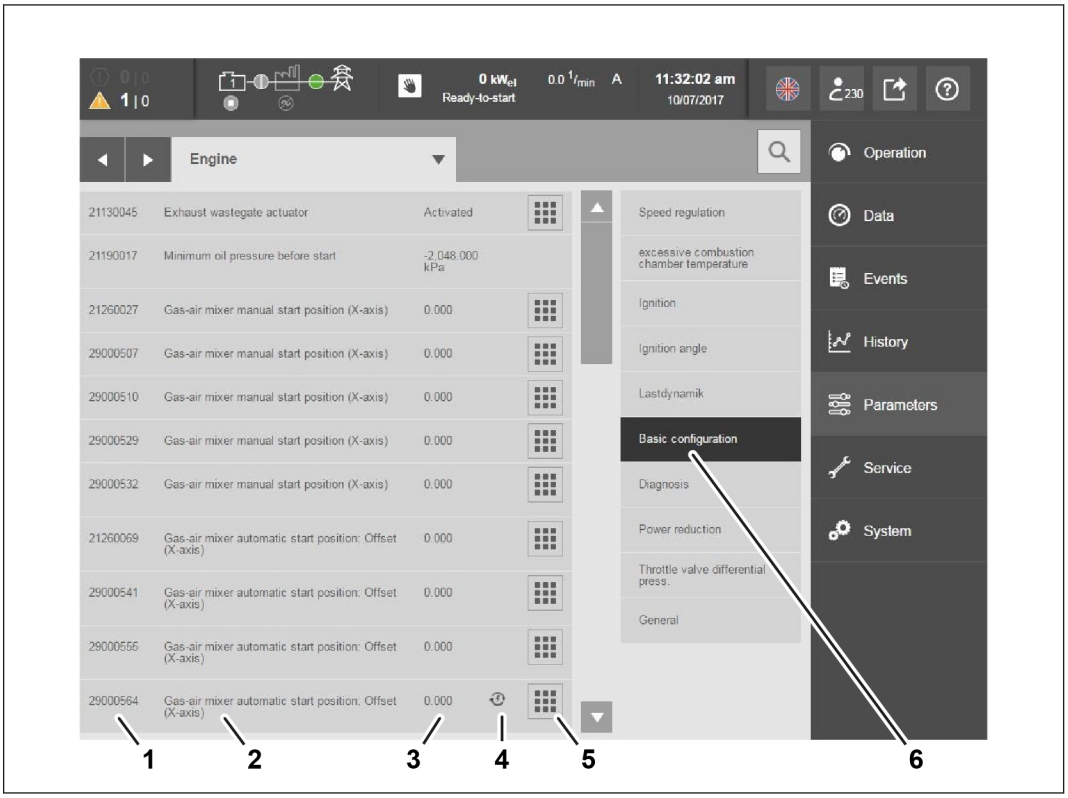
Selecting the `Parameters` functional group opens the start page with the subassembly `General`.

A subassembly can be selected in one of two ways:

- Flicking through using the arrow buttons (1)
- Direct selection in the pull-down menu (2)

▶	Each tap on the arrow button advances one subassembly in the sequence of the pull-down menu.
◀	Each tap on the arrow button goes back one subassembly in the sequence of the pull-down menu.

8.7.2 Elements of the subgroups



63463-003

1 Number of the parameter

2 Name of the parameter

3 Active value of the parameter

4 Shows that the parameter is being securely transferred to the control.

Shows that the parameter has not been transferred to the control.

5 Symbol showing that the parameter can be changed with the authorization level of the inserted TPEM USB token.

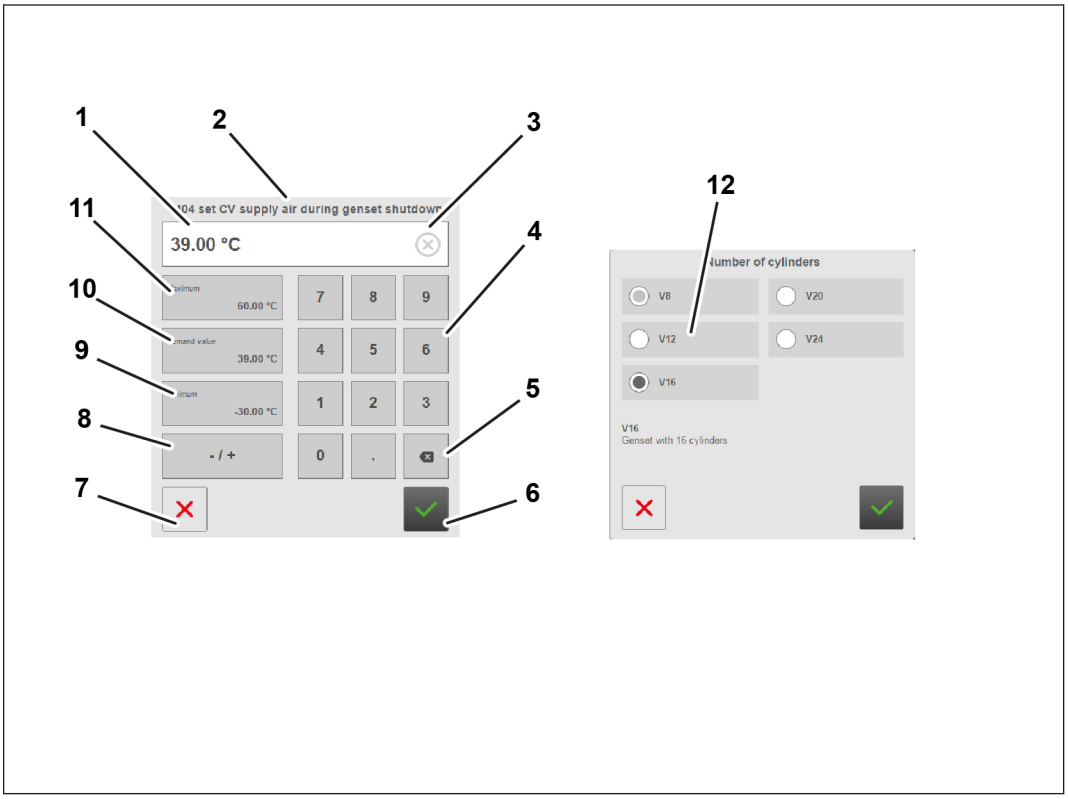
6 Selected submenu of the open subgroup

Tapping one of the areas 1 to 5 opens the dialog area of the corresponding parameter. Depending on the dialog area, the parameter value can be adjusted or a selection can be made.

8.7.3 Dialog area

Tapping the area of the parameter opens the dialog area.

Depending on the parameter, either the parameter value can be adjusted within the stated value range or a selection can be made.



61049-004

1 Display and input field
For displaying and entering the setpoint value.

2 Parameter name
Display of the selected parameter.

3 Set input value to "0"

4 Keypad
For entering the setpoint value.

5 Delete last input

6 Accept input
Accepts the entered value as a setpoint value and closes the dialog area.

7 Cancel input or close input mask
Cancels an input without accepting the setpoint value. Closes the dialog area.

8 Change mathematical sign
Negative sign: Enter setpoint value, then change the sign.

9 Minimum
Display the factory-set minimum value as a setpoint value. If the value falls below the minimum value, the display appears in red and the minimum field is given a red border.

10 Default value
Display the factory-set default value as a setpoint value.

11 Maximum
Display the factory-set maximum value as a setpoint value. If the maximum value is exceeded, the display appears in red and the maximum field is given a red border.

12 Selection option
To activate/deactivate parameters or to select an option.

8.7.4 Parameter search function

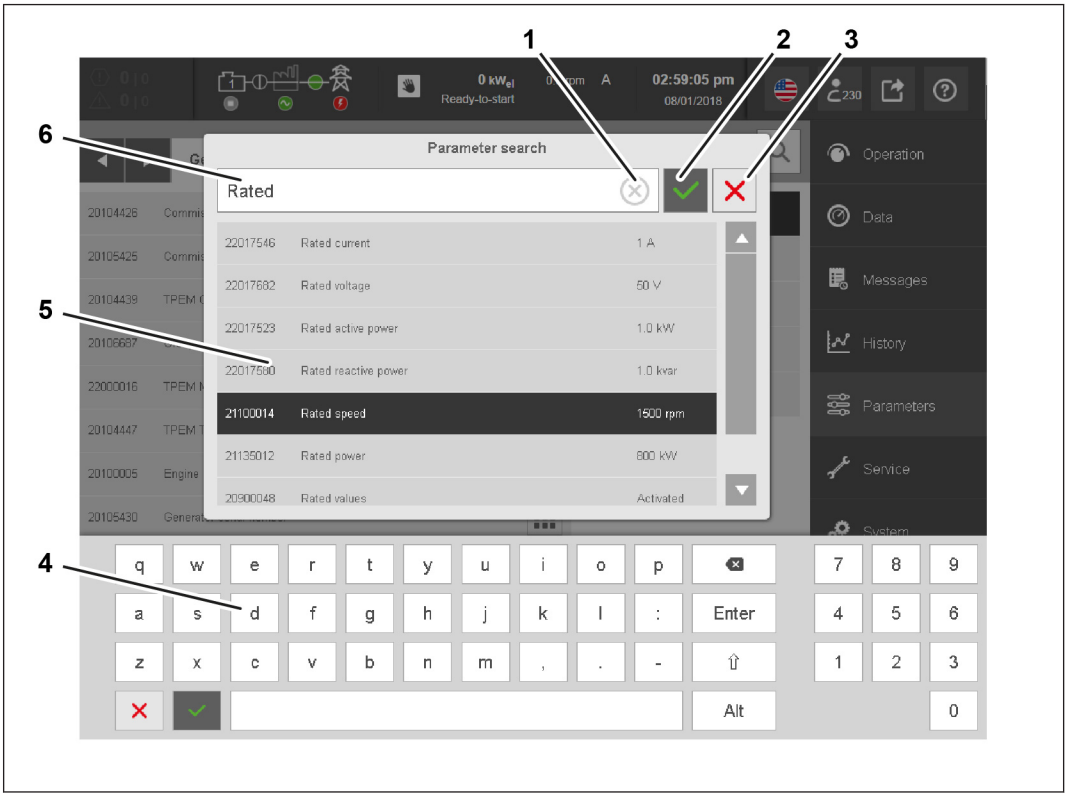
In the `Parameters` functional group, the parameters are divided by topic into subgroups and submenus. The search function makes it possible to search with search terms such as digits of the parameter numbers or parts of the parameter names.

The following symbols are relevant for the search function:

	Button for searching for parameters
	Button for deleting the search term
	Button for starting the search
	Button for ending the search

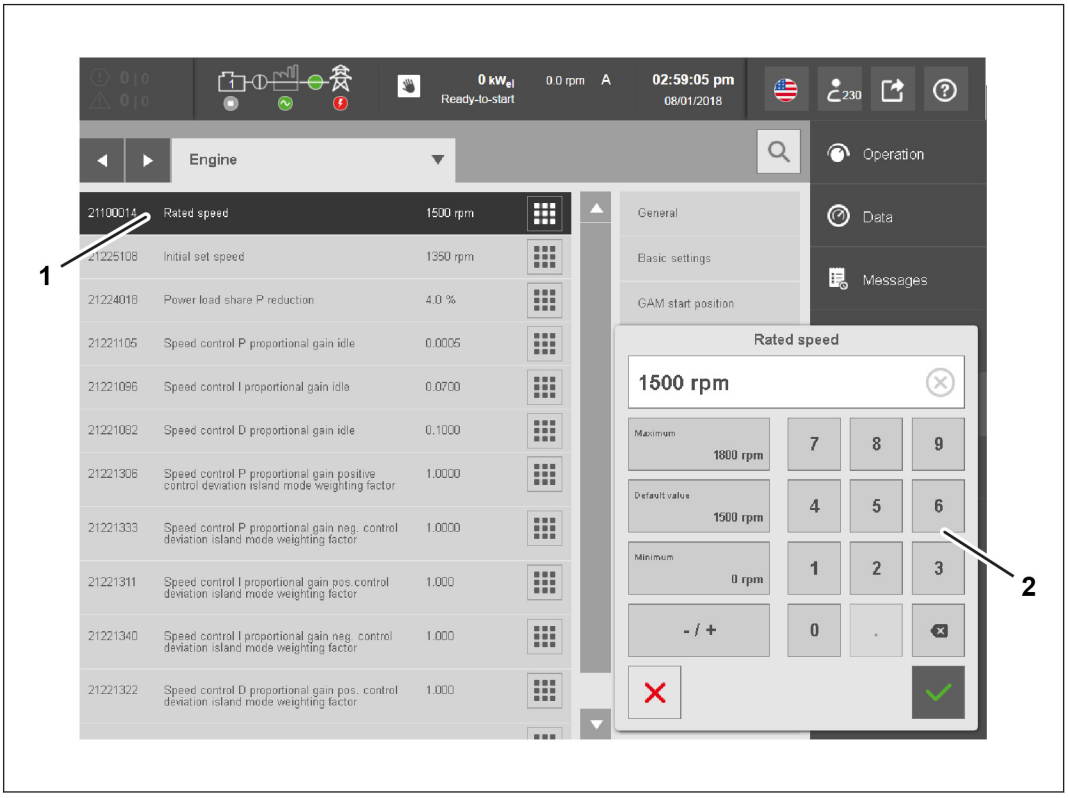
Parameter search

1. Tap the button for searching for parameters.
   → The search window opens. The keyboard appears.



75508-001

2. Enter the search term into the input field (6) using the keyboard (4).
   → For example, digits of the parameter number or parts of the parameter names can be entered.
   → The search results (5) are displayed as a list after pressing enter and updated if the entry is changed.
3. Select the desired parameter (5).
   → The parameter is highlighted in color.
   → The confirm button (2) is activated.
4. Option: Tap the button for deleting the search term (1).
   → The search term (6) and the search results (5) are deleted.
5. Option: End search process by pressing the cancel button (3).
6. Tap on the confirm button (2).



75509-001

→ The search window is closed.

→ The parameter (1) is displayed and highlighted in color.

→ The parameter dialog (2) opens.

8.7.5 Parameter values after software update

The set setpoint values are always accepted during a software update. However, acceptance is not always possible in all cases.

If, for example, the factory-set minimum value or maximum value was changed with the software update, it is possible that the originally set setpoint lies outside these limits after the software update. In this case, the standard value is not automatically accepted as the setpoint value.

All parameters marked after the software update require adjustment of the setpoints. In order to draw attention to the required adjustment, the subgroups in question are also marked with the symbol in the pull-down menu and the submenus in the subgroups. The symbol is visible in the subgroups and submenus for all authorization levels. This is also the case if the affected parameter is not visible due to an insufficient authorization level.

If a parameter has been changed with a software update, the serial number `00000000` is displayed in the functional group `History` instead of the serial number of a connected USB token.

68796-002

1 Identifies the subgroup

2 Marking the submenu

3 Identifies the parameter

8.7.6 Number range parameters

The parameters are assigned to different number ranges according to their function.

Number range	Parameters have a function for:
20XXXXXX	TPEM CC
21XXXXXX	TPEM CU
22XXXXXX	TPEM MFR

8.8 Functional group "Service"

75438-002

1 Arrow buttons for switching between the subgroups when pull-down menu is closed

2 Pull-down menu for the subgroups
Tapping the buttons toggles between the individual masks.

3 Module status display

4 Test mode status display

5 `On` button for activating the test mode

6 `Off` button for deactivating the test mode

7 `Service` button in the functional group selection

The following tests and information are available in the `Service` functional group:

- Auxiliary drive tests
- Idle tests
- Guided lube oil change
- Information on TPEM MFR communication
- Information on TPEM LS-5 communication

8.8.1 Test modes

Test modes `Engine stopped` and `Idle tests` are available. The test modes can be activated via the `On` button and deactivated via the `Off` button. The test mode `Engine stopped` must be activated for the auxiliary drive tests and the test mode `Idle tests` must be activated for the idle tests. When a test mode is activated, the status display of the module shows the name of the test mode.

If the following requirements are fulfilled, the test mode `Engine stopped` can be activated by the `On` button:

- Engine is stopped.
- `Manual` operation mode is selected.
- Generator circuit breaker is open.

When the `Engine stopped` test mode is activated, the status display for the `Engine stopped` module and the status display for the `Engine stopped` test mode are displayed.

If the following requirements are fulfilled, the test mode `Idle tests` can be activated by the `On` button:

- The engine is in idle mode.
- `Manual` operation mode is selected.
- Generator circuit breaker is open.

When the `Idle tests` test mode is activated, the status display for the `Idle tests` module and the status display for the `Idle tests` test mode are displayed.

8.8.2 Idle tests

The idle tests `Overspeed test shutdown` and `Overspeed` are available.

In the `Overspeed test shutdown` idle test, the speed is increased until the engine is stopped with an alarm. If the `Press and hold button` is continuously pressed, the speed is increased continuously by 15 rpm each second. If the `Press and hold` button is released, the speed is reduced continuously by 30 rpm per second until it reaches the rated speed. The speed can be increased to maximum 25 % over the rated speed (parameter `21100014 Rated speed`). The engine should be switched off with an alarm at 15 % over the rated speed.

In the `Overspeed` idle test, the engine runs for a defined duration and at a defined speed. The duration and speed can be adjusted in the mask. The test can run for up to 120 seconds. The speed can be increased to maximum 12.5 % over the rated speed (parameter `21100014 Rated speed`). The test runs automatically after starting and can be stopped in advance. The speed is increased for the test continuously by 15 rpm per second to the defined speed. When the defined speed ±5 rpm is reached, the time sequence starts. After the test, the speed is reduced continuously by 30 rpm per second until it reaches the rated speed.

For more information on the idle tests, see

- Separate Genset Operating Manual ⇒ Job cards

8.8.3 Auxiliary drive tests

When engine is running, the current status of the signal outputs of all auxiliary drives can be retrieved. When the engine is not running, the function of all auxiliary drives can be checked in the `Engine stopped` test mode.

For further information on the auxiliary drive tests, see

- Separate Genset Operating Manual ⇒ Job cards
  - B 0-1-6 Performing auxiliary drive test

8.8.4 TPEM communication

Updating TPEM MFR communication

Note

The control can display up to 32 MFR devices. The system status is updated for all devices (MFR, LS-5) simultaneously.

The `TPEM MFR communication` subgroup is only visible if the `CAN` option is selected for the parameter `22099241 Load share interface`.

73256-003

1. Tap the `Update` button (5).
   → The dialog area `Number of monitored TPEM MFRs` shows the number of currently monitored TPEM MFRs (6).
   → In the dialog area `Number of monitored TPEM MFRs`, a symbol displays the update.
   → In the dialog area `TPEM MFR communication`, a symbol (1) and text (2) display the actual status:

Symbol	Description	Function and meaning
	No feedback	Registered device not detected. Communication error in the network. This device is suspicious. This alert is only displayed on the affected TPEM (alarm for missing participants).
	Available	Registered device detected and monitored for missing participants.
No symbol	Not installed	Device not registered.
	Add genset	Not registered device detected. Device is not monitored for missing participants. System update from the user is necessary.

   → In the dialog area `TPEM MFR mode`, text (3) displays the current operation mode of the TPEM MFR:

Symbol	Description	Function and meaning
No symbol	Auto	Closing of the GCB demanded / GCB closed.
No symbol	Stop	Opening of the GCB demanded / GCB open.

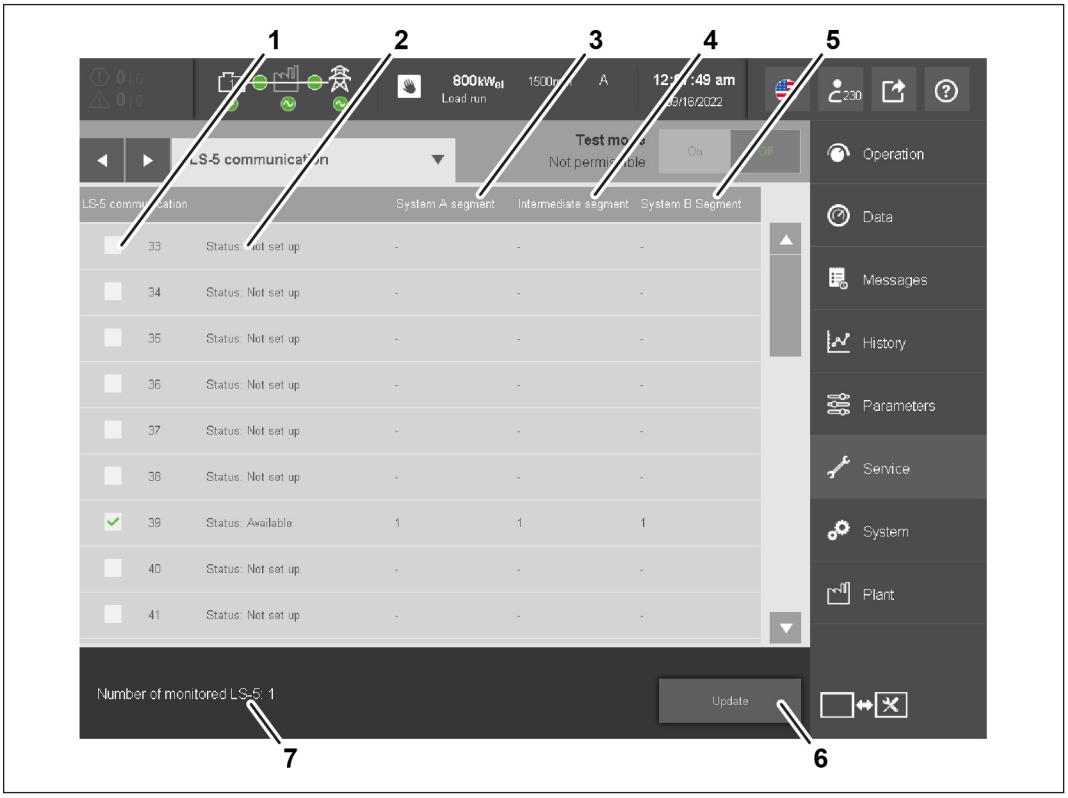
   → In the dialog area `Segment`, a digit (4) displays the genset.
2. Tap the `Test mode off` button.
   → The auxiliary drive test is ended.

Updating TPEM LS-5 communication

Note

The control can display up to 32 LS-5 devices. The system status is updated for all devices (LS-5, MFR) simultaneously.

The `TPEM LS-5 communication` subgroup is only visible if the `CAN` option is selected for the parameter `22099241 Load share interface`.



74540-002

1. Tap the `Update` button (6).
   - → The dialog area `Number of monitored TPEM LS-5s` shows the number of currently monitored TPEM LS-5s (7).
   - → In the dialog area `Number of monitored TPEM LS-5s`, a symbol displays the update.
   - → In the dialog area `TPEM LS-5 communication`, a symbol (1) and text (2) display the actual status:

Symbol	Status:	Function and meaning
	Not recognized	Registered device not detected. Communication error in the network. This device is suspicious. This alert is only displayed on the affected TPEM (alarm for missing participants).
	Available	Registered device detected and monitored for missing participants.
No symbol	Not set up	Device not registered.
	Add device	Not registered device detected. Device is not monitored for missing participants. System update from the user is necessary.

→ In the dialog area `Segment`, a text displays the numbers of segment A (3), B (5) and the intermediate segment (4).

2. Tap the `Test mode off` button.

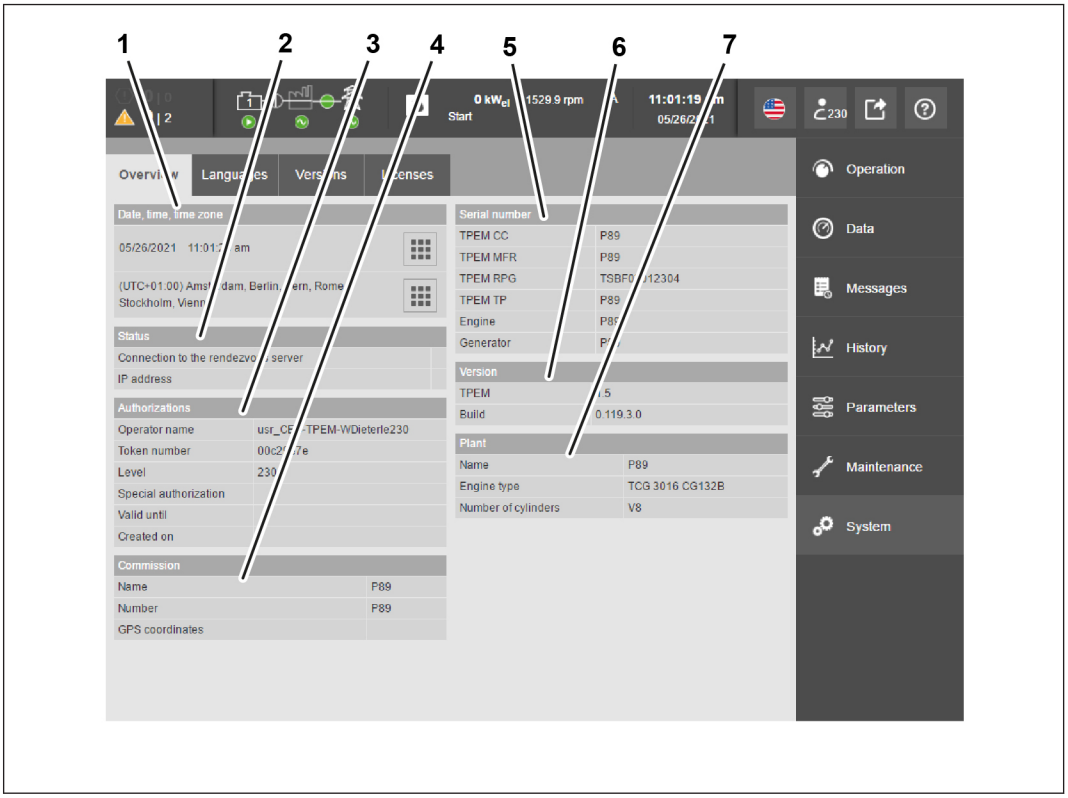
→ The auxiliary drive test is ended.

8.9 Functional group "System"

The functional group `System` includes the following subgroups:

- `Overview`: provides information on the plant and provides the option to set the date, user time and time zone
- `Languages`: for preselecting screen languages
- `Versions`: provides information on the software versions of the TPEM components
- `Licenses`: provides information on the software licenses of the TPEM components

8.9.1 Overview subgroup



67968-002

1 Date, time, time zone
Displays the date, the user time and the time zone. Date, user time and time zone can be set from authorization level 200.

2 Status
Shows status information on communication via modem and IAE.

3 Authorizations
Shows information about the operator's access authorization.

4 Commission
Displays commission data for precise identification of the plant.

5 Serial number
Indicates the serial numbers of hardware components.

6 Version
Indicates the version of the installed TPEM version.

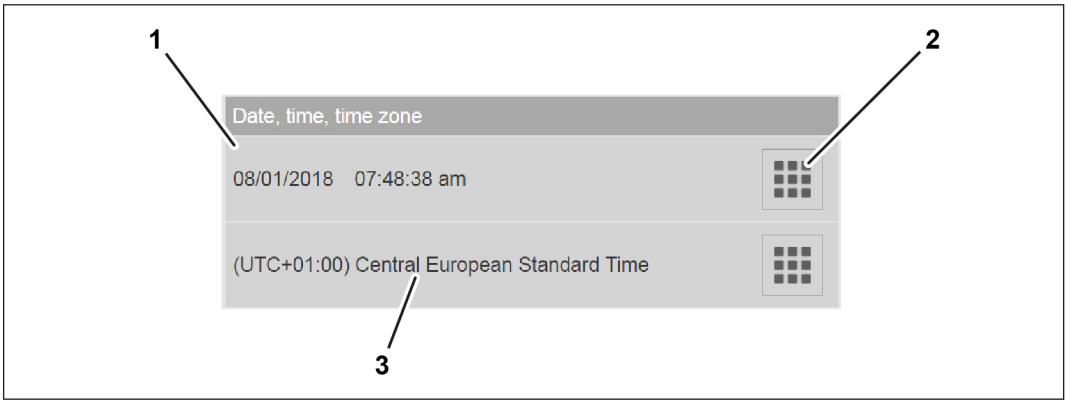
7 Plant
Shows information on name of the plant, engine type and number of cylinders.

Setting the date, time and time zone

In the factory settings, the reference time and the user time used by the operating system are identical.

If the installation location of the plant is in a different time zone, this can be adjusted accordingly. Switching from winter time to summer time and vice versa is done automatically.

Since the reference time is not updated automatically in a PC, for example, deviations between the user time and the time of the set time zone may occur over the course of time. The user time can be adjusted accordingly.



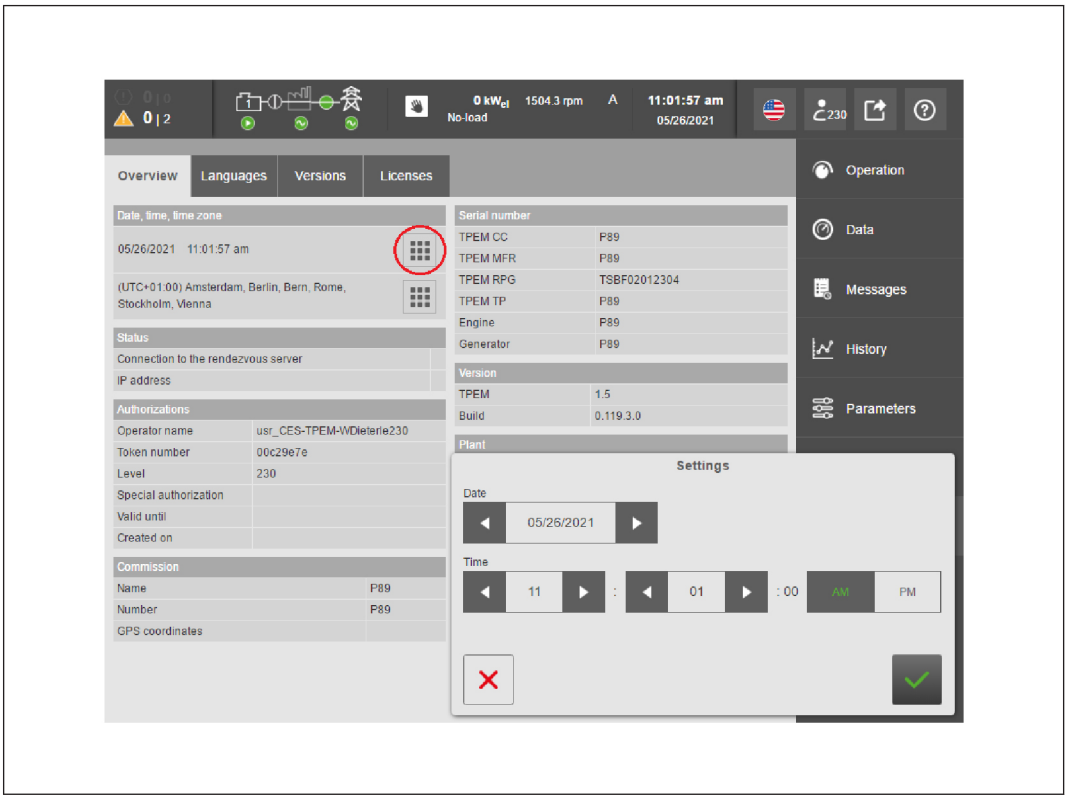
66841-002

1 Date, time
Displays the date and the user time. Date and user time can be set from authorization level 200.

2 Symbol showing that the parameter can be changed with the authorization level of the inserted TPEM USB token.

3 Time zone
Displays the set time zone. The time zone can be set from authorization level 200.

Setting the date and user time



66843-004

1. Tap on the date, time field
   → The input mask appears.
2. Tap on the desired arrow button
   → Date, hours or minutes are changed.
3. Tap on the green tick to close the mask or cancel the entry with the red cross
   → The input mask disappears.
   → The change is accepted or discarded depending on how the mask is closed.
   → An accepted change results in an entry in the functional group `Messages`.

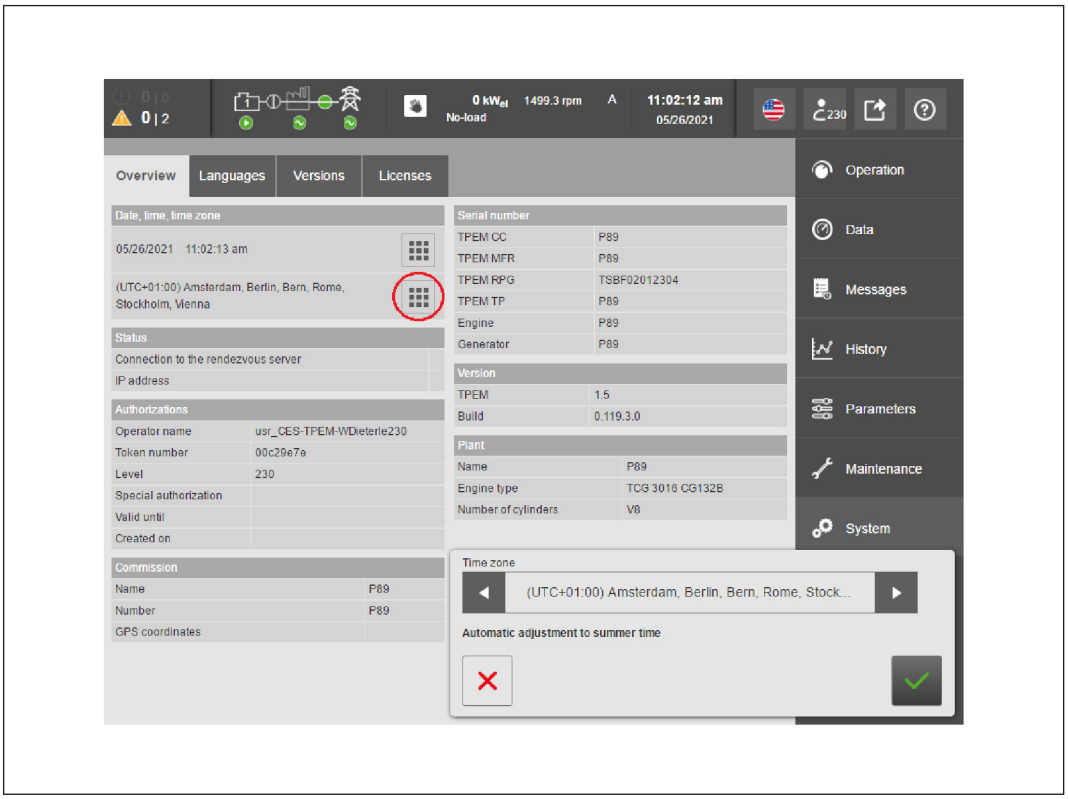
If an event occurs just before and an event occurs just after a time adjustment, the event sequence may appear to be incorrect.

Example:

The message "Pressure X too high" occurs with entry in the messages at 14:10. The following warning "Pressure X too high" occurs with entry in the messages at 14:15. Without a time correction, the warning occurs as expected after the message.

However, if a time correction of -10 minutes is made at 14:12, the warning will occur at 14:05. With a time correction, the warning is entered before the message is entered.

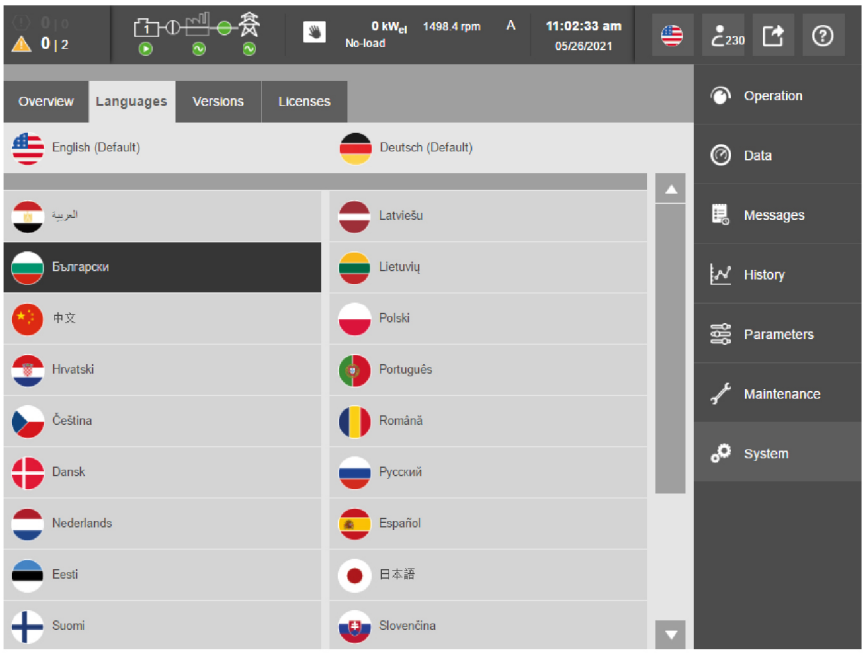
Setting the time zone



66853-004

1. Tap on the time zone field
   → The input mask appears.
2. Tap on the desired arrow button
   → The time zone is changed.
   → The time in the `Date, time` field is adjusted.
3. Tap on the green tick to close the mask or cancel the entry with the red cross
   → The input mask disappears.
   → The change is accepted or discarded depending on how the mask is closed.
   → An accepted change results in an entry in the functional group `Messages`.

8.9.2 Languages subgroup



67969-002

Language version and system of units

The desired language for the TPEM Touch Panel software is selected from the preset languages. Selection is possible on any page on the screen.

Several languages are available to the TPEM Touch Panel software depending on the order.

To be able to select a language for the software, it must be preset. A maximum of three languages can be preset. On the TPEM TP, German and English are preset at the factory as standard. On the TPEM RC TP, English is preset at the factory as standard.

The system of units for all languages is metric.

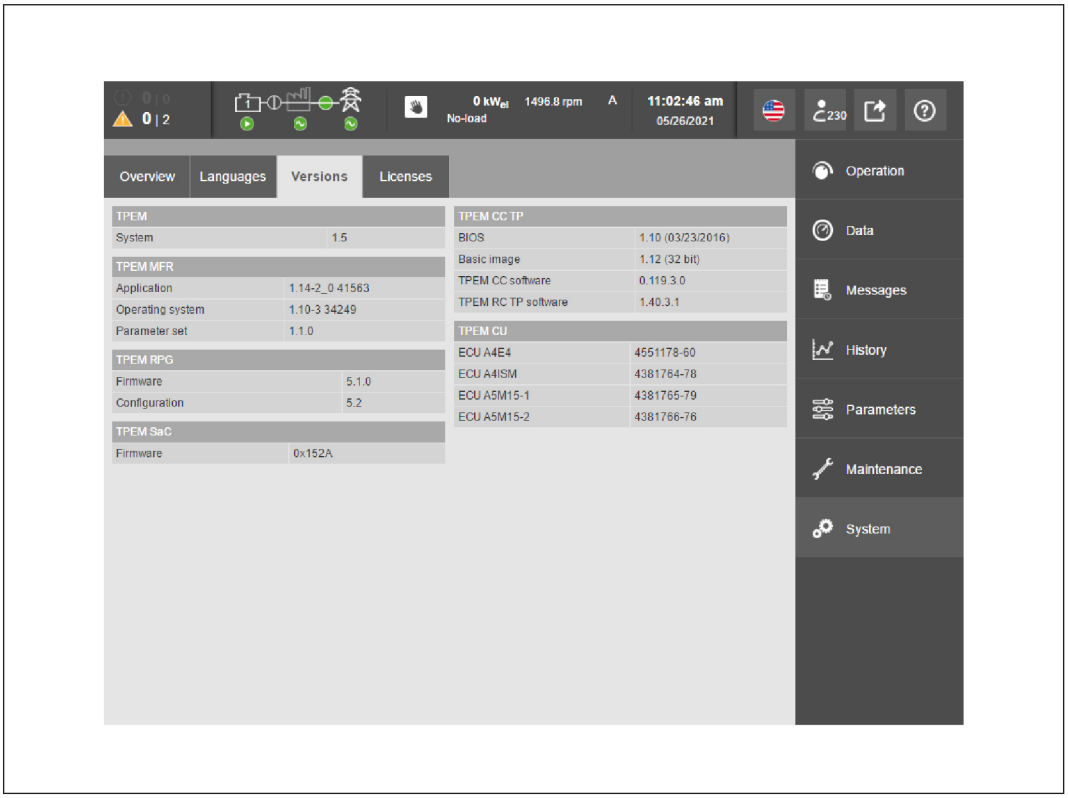
Select language:

1. Tap on "Language selection" in the "Options" bar
   → The language switches to the next preset language. Each tap switches to the next language. You can tap as many times as you like. The languages are represented by a language abbreviation and a flag.
   → The language is also changed automatically for the TPEM RC TP.

Presetting language:

1. Select `System` functional group, then the `Languages` subgroup
2. Tap on the desired language
   → The language appears highlighted in a dark color
   → The selected language can now be chosen on any page of the screen along with German and English.

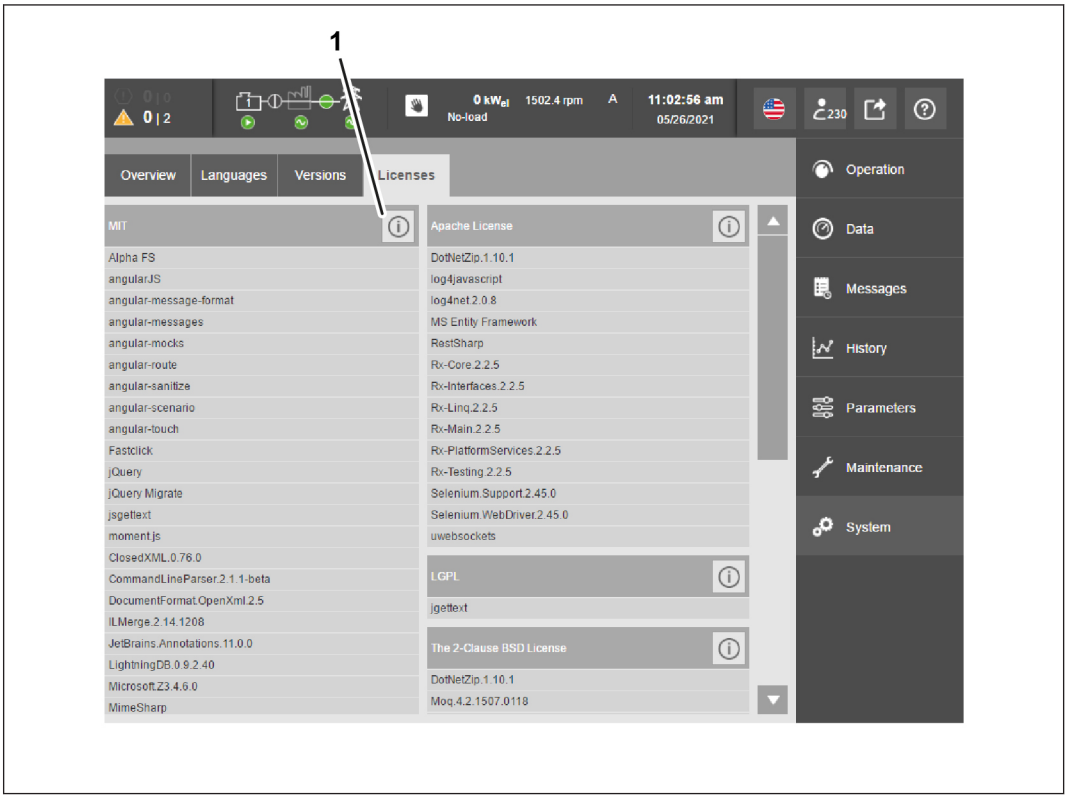
8.9.3 Versions subgroup



67970-002

The page of the screen shows the versions of all software components used.

8.9.4 Licenses subgroup



71386-001

1 Touching the information buttons displays the license texts. The license texts are available in English only.

The page of the screen shows the licenses of all software components used.

8.10 Functional group "Plant"

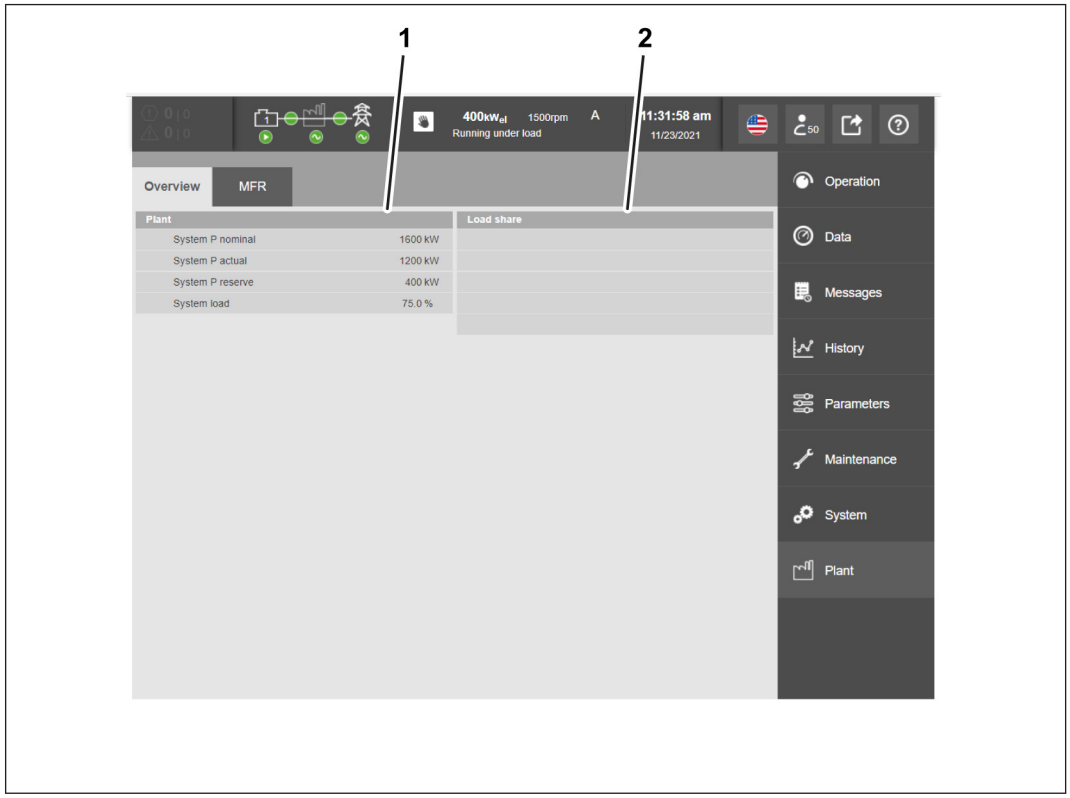
The functional group "Plant" with the submenu MFR is only visible if the option `CAN` is selected for parameter `22099241 Load share interface`.

The functional group includes the following submenus:

- `Overview`: provides information on the plant and the load share
- `MFR`: provides status information on the connected MFR devices
- `LS-5`: provides status information on the connected LS-5 devices

32 devices can be connected. Within this maximum number, any combination of MFR devices and LS-5 devices can be selected.

8.10.1 Overview submenu



74541-001

1 Plant
Displays the system power and system load of the plant.

2 Load share
The table provides additional information on the plant in load share mode 2.

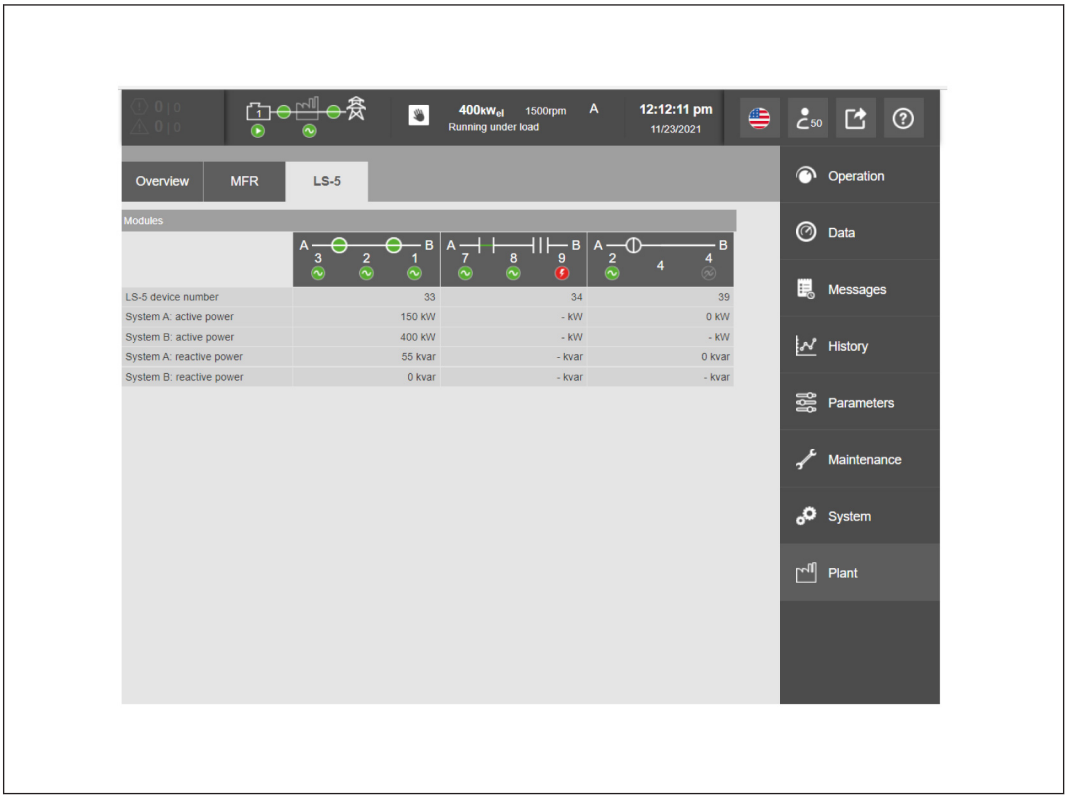
8.10.2 MFR submenu

74542-001

The submenu provides information on the load and operating state of the connected MFRs.

The submenu "MFR" is only visible if the option `CAN` is selected for parameter `22099241 Load share interface`.

8.10.3 LS-5 submenu



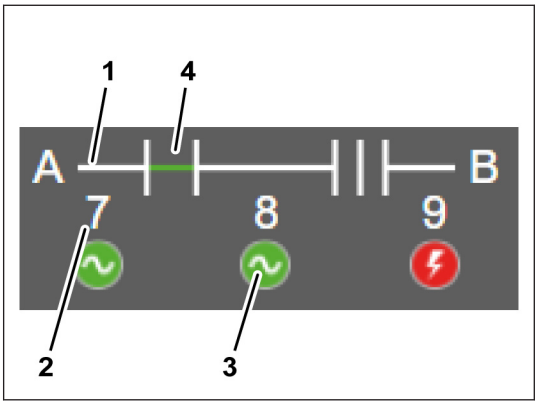
74543-001

The submenu provides information on the load and operating state of the connected LS-5s.

The LS-5 submenu is only visible if the `CAN` option is selected for the parameter `22099241 Load share interface` and if the `GLS/LS-5` option is selected for the parameter `22034449 Operation mode`.

Status bar

Status display of the individual LS-5 devices



74558-001

1 Segment

2 Segment number

3 Segment number symbol

4 Switch status symbol: CB= circuit breaker, TS = disconnection switch

Status display						
3						No symbol
	No voltage		Voltage in operating range		Voltage not OK	Undefined
4						No symbol
	CB open	CB closed	TS open	TS closed	TS not in use	Undefined

8.11 Superior control interfaces

8.11.1 Interface variants

Data and commands can be exchanged with the superior control via the following interface variants:

- Serial interface Modbus RTU

Note

For more information, see:

- Separate operating manual ⇒ TPEM Fieldbus Interface Modbus RTU

The interface consists of the following contacts and signals.

8.11.2 Superior control to the TPEM system

Name	Signal type "Input"	Explanation
Start or stop demand Note: Start demand only in conjunction with a power demand.	Contacts TPEM IO Controller	Only in automatic operating mode • Contact closed: The genset is demanded • Contact open: The genset is shut down
Black start	Contacts TPEM IO Controller	Signal is evaluated both in island mode and in mains parallel mode • Contact closed: Black start • Contact open: Normal start
Power demand Minimum > 30 %	Analog value 4 ... 20 mA TPEM IO Controller	Only in automatic operating mode with corresponding parameterization • Mains parallel mode: The TPEM system can receive the demanded power via the signal • Scaling on the TPEM Touch Panel via parameters • Island mode: The TPEM system ignores the signal

8.11.3 TPEM system to the superior control

Name	Signal type "Output"	Explanation
Automatic operation mode	Digital output of TPEM IO Controller	• logic 1 (+24 V): Automatic operating mode • logic 0 (0 V): Manual operating mode
Genset running	Digital output of TPEM IO Controller	• logic 1 (+24 V): Genset running • logic 0 (0 V): Genset stopped
Module running	Digital output of TPEM IO Controller	• logic 1 (+24 V): Module running • logic 0 (0 V): Module stopped
Generator circuit breaker (GCB) open	Digital output of TPEM IO Controller	• logic 1 (+24 V): GCB open • logic 0 (0 V): GCB closed
Mains circuit breaker (MCB) open	Digital output of TPEM IO Controller	• logic 1 (+24 V): MCB open • logic 0 (0 V): MCB closed
Collective alarm	Digital output of TPEM IO Controller	• logic 1 (+24 V): no collective alarm • logic 0 (0 V): Collective alarm: Open circuit breaker. This event must not lead to a fault feedback in the TPEM system, otherwise an interlock would occur that cannot be acknowledged.
Collective warning	Digital output of TPEM IO Controller	• logic 1 (+24 V): no collective warning • logic 0 (0 V): collective warning. If a warning with power decrease is pending, the output is deactivated.

8.12 Operation modes

8.12.1 Operation modes in overview

The control flow distinguishes between mains parallel mode, island mode, and island parallel mode.

In mains parallel mode, the TPEM system controls the power of the genset. In the partial load range there is an increase in temperature for the cooling circuits. Depending on the current actual power, the temperature setpoints for the cooling circuits are adjusted.

In island mode, the TPEM system controls the speed of the genset. In the case of low loads there is not an increase in temperature for the cooling circuits. The cooling circuit control regulates to a fixed value that corresponds to a power of 100 %.

In island parallel mode, the TPEM system controls the speed and the proportional load distribution to the individual gensets.

8.12.2 Mains parallel mode

The control flow in mains parallel mode distinguishes between manual and automatic operation modes.

Switching between manual and automatic is done via the "Operation" mask on the TPEM Touch Panel.

In automatic operation mode, demand signals from the superior control are evaluated.

The genset is controlled in manual operation mode via the "Operation" mask on the TPEM Touch Panel.

Automatic operation mode

The TPEM system offers three power demand types for the genset via a superior control.

Start demand and power demand are parameterized on the TPEM Touch Panel with parameter `20530006 Start demand type and power demand type`.

Demand type		Starting and shutting down the genset
1.	Analog Start and power demand via TPEM IO Controller.	Via a potential-free contact on TPEM IO Controller
2.	Serial Start demand via TPEM IO Controller, power demand via data bus connection.	Via a potential-free contact on TPEM IO Controller
3.	Contacts Start demand via TPEM IO Controller, power demand constant at 100 %.	Via a potential-free contact on TPEM IO Controller

Demand via potential-free contact, analog power demand or via data bus

Start	
1.	The superior control closes the potential-free contact "Demand" and presets a power demand of over 30 %. The demand can be transmitted via the analog signal 4 ... 20 mA or via the serial interface between the superior control and the TPEM system.
2.	The TPEM system waits for a successful leakage check. The TPEM system waits for feedback from the digital input "Feedback for external starting preparations".
3.	The TPEM system starts the genset after a prelubrication phase.
4.	The genset runs in idle mode.
5.	The generator circuit breaker is closed after successful synchronization.
6.	The TPEM system controls the genset power to the demanded value. As long as the demanded value is above 30 %, the TPEM system controls the power of the genset in the permissible range. The operation of the genset with power exceeding 40 % is only possible when the lube oil temperature exceeds 40 °C.

Shutdown	
1.	The superior control opens the potential-free contact "Demand" or presets a power below 30 %.
2.	The TPEM system continuously decreases the genset power to just a few %, after which the generator circuit breaker is opened.
3.	The TPEM system shuts down the genset.
4.	The coolant pumps run on until the genset has cooled down.

Demand only via potential-free contact

Start	
1.	The superior control closes the potential-free contact "Demand".
2.	The TPEM system waits for a successful leakage check. The TPEM system waits for feedback from the digital input "Feedback for external starting preparations".
3.	The TPEM system starts the genset after a prelubrication phase.
4.	The genset runs in idle mode.
5.	The generator circuit breaker is closed after successful synchronization.
6.	The TPEM system controls the genset power to the maximum permissible value. The operation of the genset with power exceeding 40 % is only possible when the lube oil temperature exceeds 40 °C.

Shutdown	
1.	The superior control opens the potential-free contact "Demand".
2.	The TPEM system continuously decreases the genset power to just a few %, after which the generator circuit breaker is opened.
3.	The TPEM system shuts down the genset.
4.	The coolant pumps run on until the genset has cooled down.

Manual operation mode

Note

In manual operation mode, the genset is controlled via the "Operation" mask on the TPEM Touch Panel.

Start	
1.	Start the genset with the `MODULE START` button.
2.	The TPEM system waits for a successful leakage check. The TPEM system waits for feedback from the digital input "Feedback for external starting preparations".
3.	The TPEM system starts the genset after a prelubrication phase.
4.	The genset runs in idle mode.
5.	Enable circuit breaker with `GCB SYNC` button. The generator circuit breaker is closed after successful synchronization.
6.	The TPEM system controls the genset power to 50 %.
7.	The setpoint value for the power can be adjusted with the "Power demand" buttons. The operation of the genset with power exceeding 40 % is only possible when the lube oil temperature exceeds 40 °C.

Shutdown	
1.	Switch off the genset by pressing the `MODULE STOP` button.
2.	The TPEM system continuously decreases the genset power to just a few %, after which the generator circuit breaker is opened.
3.	The TPEM system shuts down the genset.
4.	The coolant pumps run on until the genset has cooled down.

Note

Manual operation mode is also possible in island mode.Refer to the section "Island mode".

Opening the generator circuit breaker	
1.	Open the generator circuit breaker by pressing the `OPEN GCB` button.
2.	The TPEM system continuously decreases the genset power to just a few %, after which the generator circuit breaker is opened.
3.	The genset runs in idle mode.

8.12.3 Island mode

In island mode, the module is speed-controlled while being run.

Note

In "Island" operating mode, only the contact "Demand" is evaluated. The analog or serial demand is not important in this case.

Normal start with prelubrication

If voltage for supplying the pumps is already available, there is a possibility of performing a normal start. The voltage can be provided by an emergency power genset or another genset. The engine starts gently with start lubrication, pump flow and leakage check (optional).

Automatic operation mode

In island mode, the demand only occurs via the potential-free contact. The other processes take place in the same way as the mains parallel mode.

Note

If the potential-free contact "Demand" is open, the TPEM system gives the command to open the circuit breaker immediately.

Manual operation mode

Note

In manual operation mode, the genset is controlled via the "Operation" mask on the TPEM Touch Panel.

Start	
1.	Start the genset with the MODULE START button.
2.	The TPEM system waits for a successful leakage check. The TPEM system waits for feedback from the digital input "Feedback for external starting preparations".
3.	The TPEM system starts the genset after a prelubrication phase.
4.	The genset runs in idle mode.
5.	Enable circuit breaker with GCB SYNC button. The generator circuit breaker is closed after successful synchronization.
6.	The TPEM system maintains the genset at the specified speed.

Shutdown	
1.	Remove as much load as possible from the genset before shutting down. If the genset is shut down with too much load, an alarm sounds.
2.	Switch off the genset by pressing the MODULE STOP button.
3.	The TPEM system opens the generator circuit breaker.

Shutdown	
4.	The TPEM system shuts down the genset.
5.	The coolant pumps run on until the genset has cooled down.

Opening the generator circuit breaker	
1.	Open the generator circuit breaker by pressing the OPEN GCB button.
2.	The TPEM system opens the generator circuit breaker.
3.	The genset runs in idle mode.

8.12.4 Island parallel mode

In island parallel mode, multiple modules are synchronized to one another and operated with speed regulation.

For a controlled distribution of the active load and reactive load, the speed setpoint and voltage setpoint must be shifted accordingly.

The analog or serial demand is not important in this case.

Island parallel mode is only possible via an internal control or an external load distribution module.

Internal control

To ensure even distribution of active load and reactive load between the parallel gensets, the TPEM MFRs can exchange operating data via a CAN bus interface.

For more information on the TPEM MFR, see

- Separate operating manual ⇒ TPEM Multi Function Relay

External load distribution module

Active load distribution

To ensure the even distribution of the active load between the parallel gensets, the speed setpoint can be shifted by a superior control unit.

Digital inputs in the TPEM Control Cabinet

No.	ID	Designation	Feedback
101	---	Speed lower	No fault
102	---	Speed higher	No fault

Analog inputs in the TPEM Control Cabinet

No.	ID	Designation	Sensor	Feedback
---	---	Speed specification (frequency)	4 ... 20 mA = −10 % ... +10 %	No fault

Reactive load share

To ensure the even distribution of the reactive load between the parallel gensets, the voltage setpoint can be shifted by a superior control unit.

Digital inputs in the TPEM Control Cabinet

No.	ID	Designation	Feedback
101	---	Voltage adjustment lower	No fault
102	---	Voltage adjustment higher	No fault

Analog inputs in the TPEM Control Cabinet

No.	ID	Designation	Sensor	Feedback
---	---	Voltage adjustment specification	4 ... 20 mA = −10 % ... +10 %	No fault

Operation and requirement

The requirement of the single modules is identical to island mode with only one module.

Manual operation mode

Note

In manual operation mode, the genset is controlled via the "Operation" mask on the TPEM Touch Panel.

Starting the first module	
1.	Start the genset with the MODULE START button.
2.	The TPEM system waits for a successful leakage check. The TPEM system waits for feedback from the digital input "Feedback for external starting preparations".
3.	The TPEM system starts the genset after a prelubrication phase.
4.	The genset runs in idle mode.
5.	Enable circuit breaker with GCB SYNC button. The generator circuit breaker is closed after successful synchronization.
6.	The TPEM system maintains the genset at the specified speed.

Starting the second module and additional	
1 to 6	see: starting the first genset
7.	The superior control unit adjusts the specified speed and voltage to ensure stable load distribution across the gensets.

Shutting down a module	
1.	Remove as much load as possible from the genset to be shut down before shutting down. For this purpose, the superior control unit can shift load to the remaining gensets. If a genset is shut down with too much load, an alarm sounds.
2.	Switch off the genset by pressing the MODULE STOP button.
3.	The TPEM system opens the generator circuit breaker.
4.	The TPEM system shuts down the genset.
5.	The coolant pumps run on until the genset has cooled down.

Opening the generator circuit breaker	
1.	Open the generator circuit breaker by pressing the OPEN GCB button.
2.	The TPEM system opens the generator circuit breaker.
3.	The genset runs in idle mode.

8.12.5 Conduct in the event of a fault

The TPEM system records and saves all important events in the logbook.

The following event types provide information on faults:

- Warning
- Warning RP
- Alarm SC
- Alarm
- Alarm WO

The event types may cause a power decrease, controlled shutdown, or the immediate shutdown of the genset.

Power decrease or power limitation with Warning RP

The occurrence of a fault of the type Warning RP causes a power decrease in mains parallel mode. Based on the configured maximum power, the power limit is reduced by 20 %. In island mode, the permissible power is immediately limited to the actual power. If the power limit is exceeded, the genset shuts down with a corresponding message.

Logbook

The event is entered into the logbook as "Warning RP". The message must be acknowledged.

Immediate shutdown in the event of "Alarm" and "Alarm WO"

The occurrence of a fault of the type "Alarm" and "Alarm WO" leads to an immediate shutdown of the genset. The genset is shut down both in island mode and in mains parallel mode.

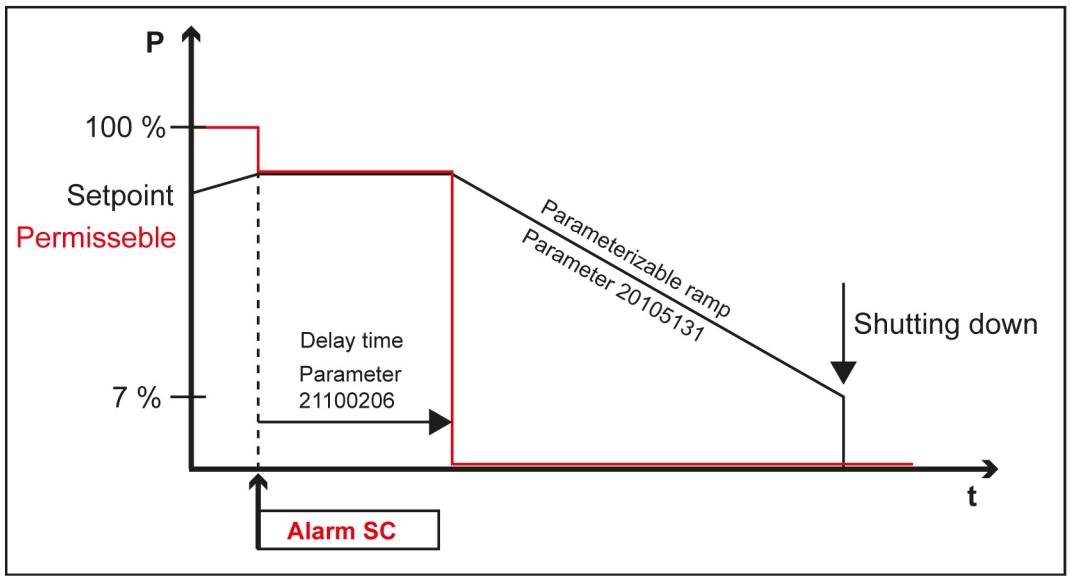
Logbook

The event is entered into the logbook as "Alarm" or "Alarm WO". The message must be acknowledged.

Controlled shutdown in event of "Alarm SC" in mains parallel mode

When running under load, a fault of the type "Alarm SC" leads to a controlled shutdown of the genset. When an "Alarm SC" occurs, the power limit is immediately restricted to the actual power. This prevents a further increase in power. After expiry of the delay time (e.g. five minutes), the power limit is reduced along a parameterizable ramp to 0 %. The setpoint power follows the power limit.

The genset is only shut down when the value of the actual power is below 7 %.



61071-005

The delayed shutdown enables the user of the plant to start a reserve genset.

Idle

If the genset is not running under load, each "Alarm SC" causes an immediate genset shutdown. With a pending "Alarm SC", the genset can neither be started nor operated idle.

Logbook

The message is entered into the logbook as "Alarm SC". The message must be acknowledged.

Note

If all events of the type "Alarm SC" can be acknowledged during shutdown, the power will be increased to the externally demanded power. The genset continues running under load.

Controlled shutdown in the event of "Alarm SC" in island mode

In island mode and in mains parallel mode, the functionality of the controlled shutdown is identical.

Load share

In island mode, the user of the plant must ensure that the power will be in the permissible range if an "Alarm SC" occurs. For multi-module plants, the superior control is able to distribute the load to other modules, for example.

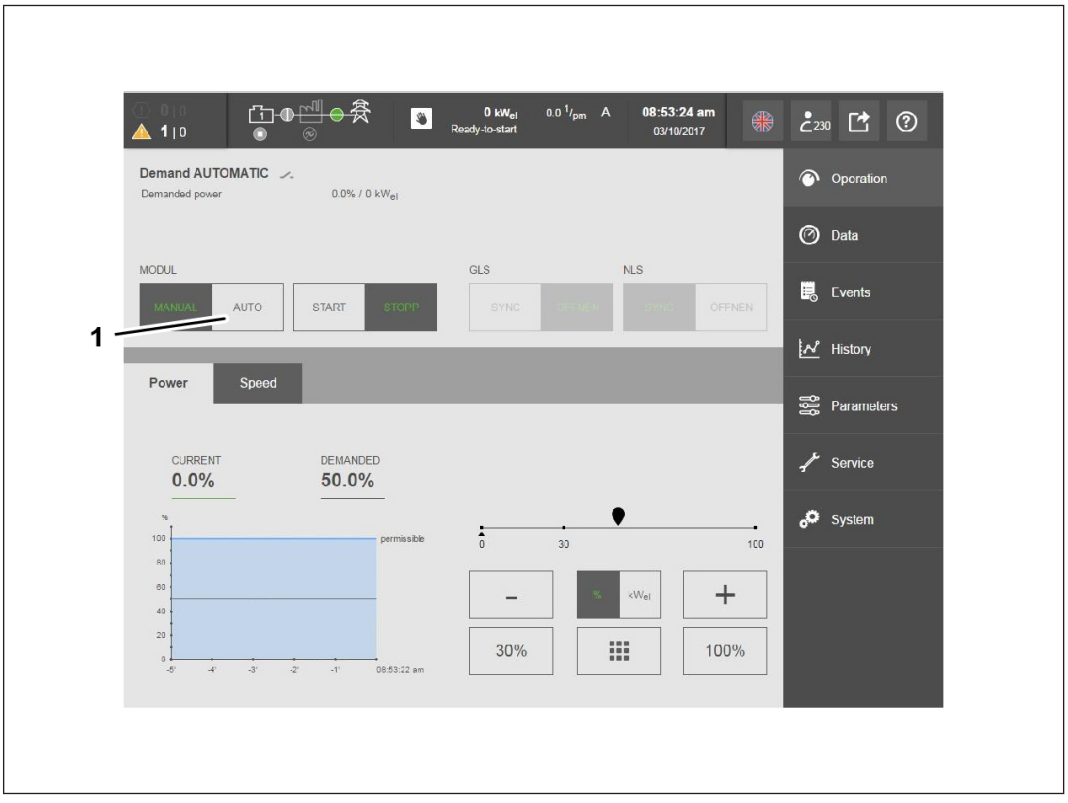
8.13 Starting the genset

Starting the genset in automatic operation mode

The start demand and the power demand for the genset are given via a superior control.

1.	The superior control gives the TPEM system a start demand and a power demand.
2.	The TPEM system waits for a successful leakage check.
3.	The TPEM system waits for feedback from the digital input "Feedback for external starting preparations".
4.	The TPEM system starts the genset after a prelubrication phase.The genset runs with no-load.
5.	The TPEM system closes the generator circuit breaker after successful synchronization.
6.	The TPEM system controls the genset output to the demanded value.

Select automatic operation mode



63407-002

1. Press the AUTO (1) button
   → The START button is not active
   → The GCB, MCB buttons and the buttons for demanding power and speed are not active

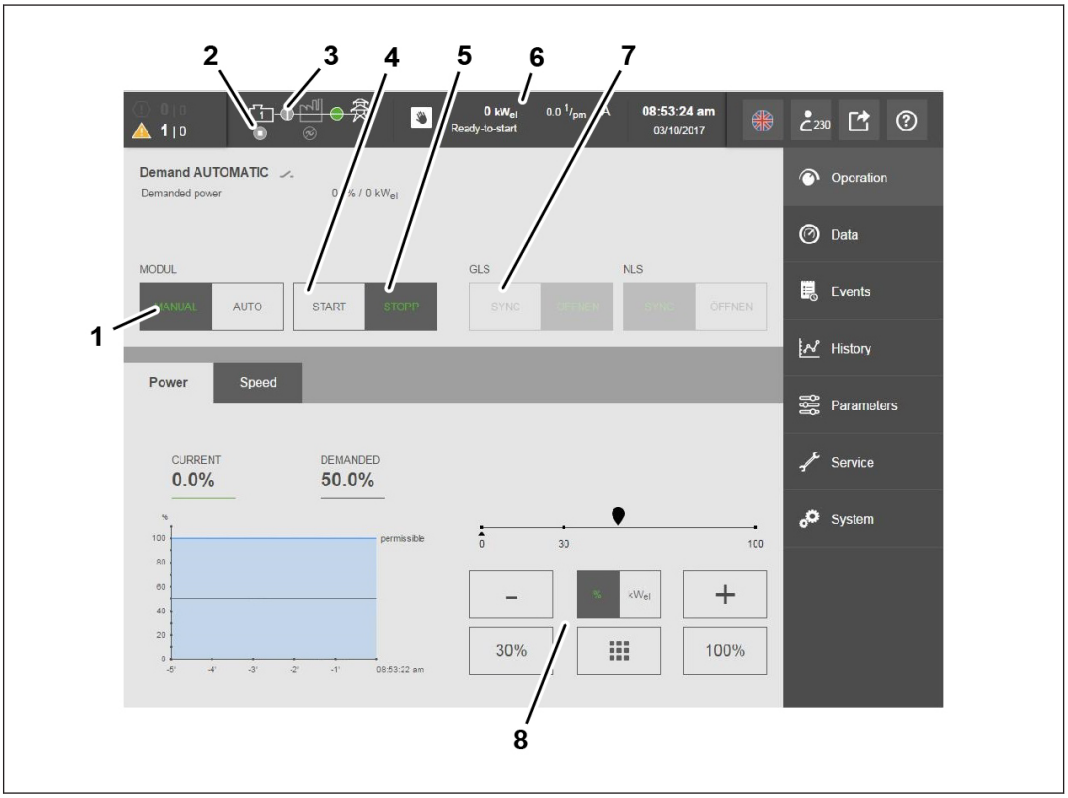
Starting the genset with prelubrication in manual operation mode

The genset is controlled via the "Operation" mask on the TPEM Touch Panel.

Requirements

- The gas main shut-off valve is open
- "Operation" mask is open
- Display in the status bar: `Ready-to-start`

Start the genset



63408-002

1. Press the `MANUAL` button (1)
   → The `START` (4) and `STOP` (5) buttons are activated.
2. Press the `START` button
   → Display in the status bar (6): `Start`.
   → The genset is prelubricated. The genset starts once the prelubrication is complete.
   → After successful startup: the module symbol (2) switches from not running to running, `No-load` display in the status bar
3. In the submenu `Power`, select the desired power with the buttons (8)

4. Press the GCB SYNC (7) button to synchronize
   → The GCB symbol (3) flashes
   → After successful synchronization: GCB symbol lights up green continuously (closed)
   → Running under load display with the selected power in the status bar

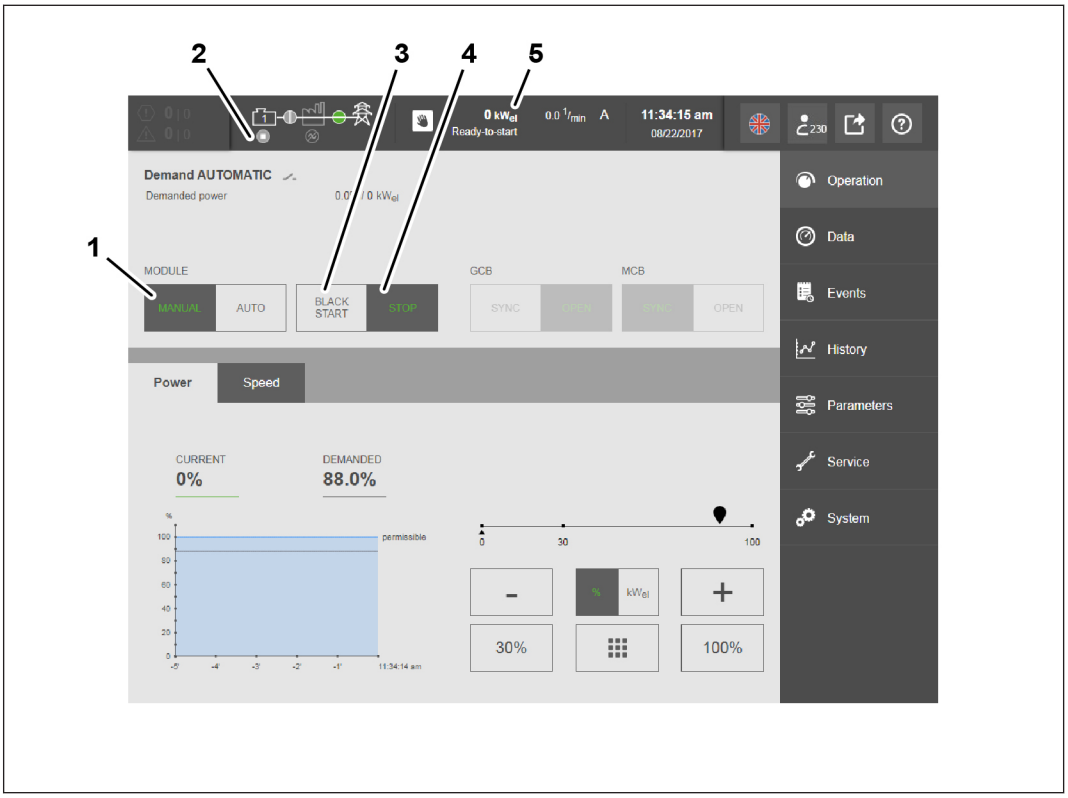
Black starting the genset in the manual operation mode

The genset is controlled via the "Operation" mask on the TPEM Touch Panel.

Requirements

- 24 V voltage supply available
- Parameter 20105303 Black start possible activated
- Demand contact 179 Black start closed
- "Operation" mask is open
- Display in the status bar: Ready-to-start

Start the genset



64026-004

1. Press the MANUAL button (1)
   → The buttons GENSET BLACK START (3) and GENSET STOP (4) are activated.

2. Press the GENSET BLACK START button
   → Display in the status bar (5): Black start.
   → After successful startup: the module symbol (2) switches from not running to running, No-load display in the status bar
3. Further operation takes place in the same way as with the normal start.

For more information on the black start, see

- Operating Manual ⇒ Structure and function
  – Black start

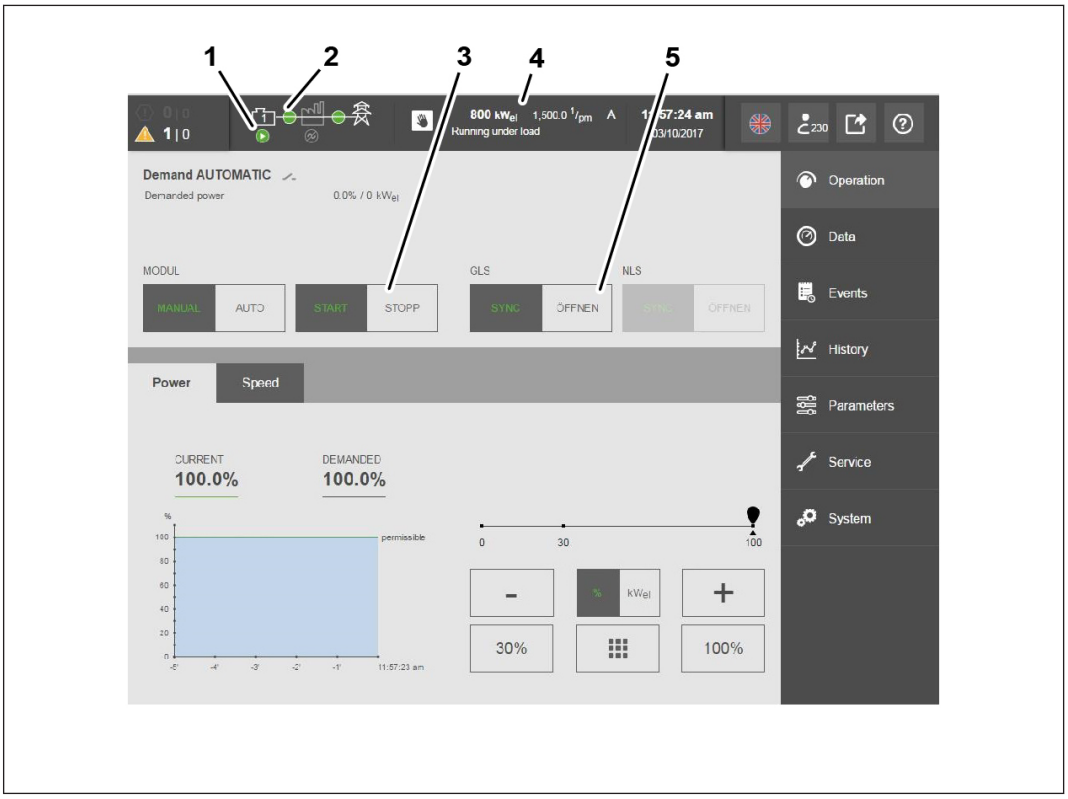
8.14 Stopping the genset

Stopping the genset in automatic operation mode

The demand for stopping the genset is given by a superior control.

1.	The superior control gives the TPEM system the demand to stop the genset.
2.	The TPEM system continuously decreases the genset output to just a few % load.
2.	The TPEM system opens the generator circuit breaker.
3.	The TPEM system stops the genset.
4.	The coolant pumps run on until the genset has cooled down.

Stopping the genset in manual operation mode



64341-003

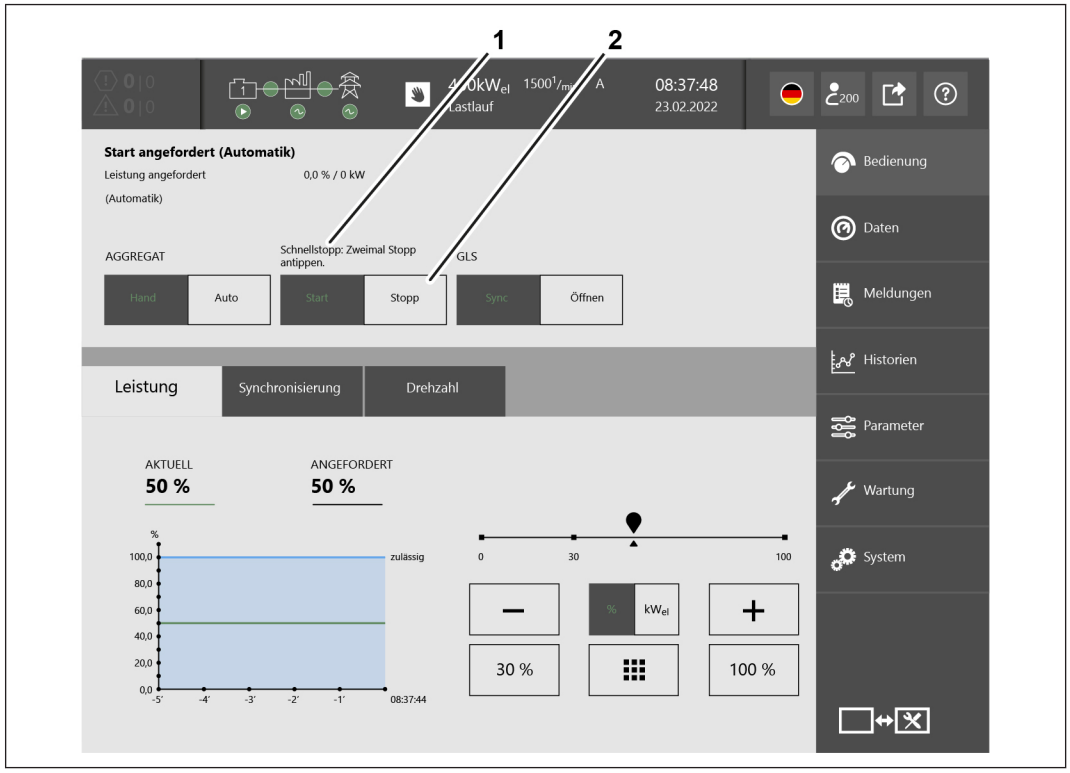
1. Press the `GCB OPEN` (5) button
   - → The GCB symbol (2) flashes.
   - → Display in the status bar (4): `Relieving`.
   - → After successful relief: the GCB symbol lights up continuously gray (opened), display in the status bar: `Idle` and the idle speed.

2. Press the `MODULE STOP` (3) button
   → The module symbol (1) flashes.
   → Display in the status bar: `Shutting down`.
   → After shutting down: module symbol lights up continuously gray (not running), display in the status bar: `Ready-to-start`.
   → The coolant pumps run on until the genset has cooled down.

Stopping the genset in manual operation mode using quick stop

Prerequisites

- Parameter `20106847 Quick stop` is parameterized to `Activated`.



75837-001

1. Press the `Stop` button (2).
   → The procedure for normally stopping the genset is started.
   → The following information (1) is displayed: `Quick stop: Press Stop.`
2. Press the `Stop` button (2).
   → The following information (1) is displayed: `Press Quick stop.`
   → The text of the button changes to `Quick Stop`.
   → The color of the button changes to red.

3. Press the `Quick Stop` button.
   → A message is generated.
   → If the button is not pressed, the genset is stopped normally.
   → When the genset is stopped, the button is reset to its original condition.

8.15 Stopping the genset in an emergency

References

- B 0-1-5 Visually inspecting the genset
- B 0-1-7 Performing test run and function run

Stopping the genset in an emergency:

1. Activate the emergency stop switch immediately
2. Inform those responsible at the operating site
3. Alert doctor and fire department
4. Keep people out of the danger zone
5. Initiate first aid measures
6. Switch off main switch and secure against restarting
7. Keep access routes clear for rescue vehicles

After rescue measures:

1. If required due to the severity of the emergency, inform the responsible authorities
2. Commission specialist personnel with the task of troubleshooting
3. Before starting, visually inspect the genset ⇒ Job card B 0-1-5
4. Before starting, perform a test run and function run ⇒ Job card B 0-1-7
5. Ensure that all safety devices are installed and functional

9 Troubleshooting

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9.1 Safety notes

Unless otherwise indicated, the operator may carry out the troubleshooting work described.

Only qualified specialist personnel may carry out certain work. Specific reference is made to this work in the description of the individual faults.

Only qualified electricians may carry out work on the electrical system.

Only qualified gas technicians may carry out work on the gas train.

Conduct in the event of faults

1. In the event of faults that pose an immediate danger to people or property, press the emergency stop switch immediately
2. Inform those responsible at the operating site of the fault
3. In case of troubleshooting in the danger zone, stop the genset normally and secure it against restarting ⇒ Job card B 0-0-10
4. Depending on the type of fault, have it rectified by authorized specialist personnel or fix it yourself ⇒ Section Rectify fault

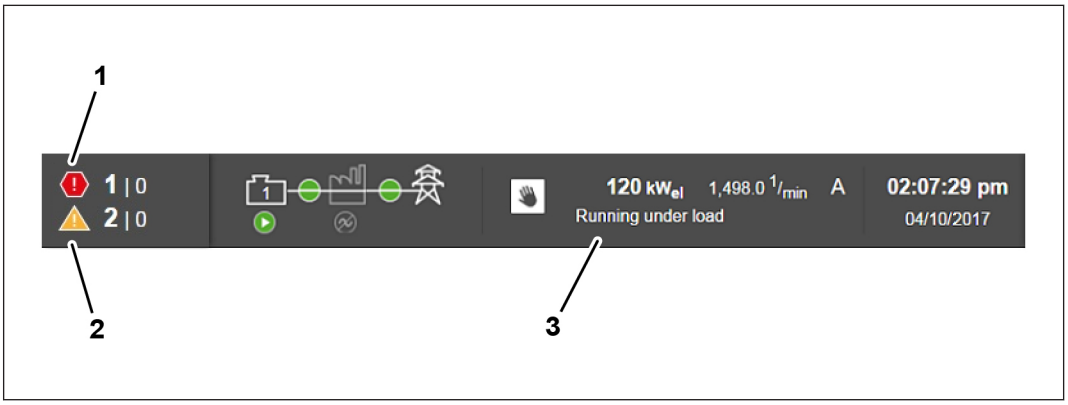
   → If necessary, commission the contact person: Service partner.

9.2 Fault displays

The TPEM Touch Panel displays all alarms and warnings as a text message.

There may be other acoustic or visual fault displays in the immediate vicinity of the genset. The operator is responsible for integrating the genset into the signal chain of the overall plant.

The status bar displays information regarding pending faults on every page of the screen.



62632-002

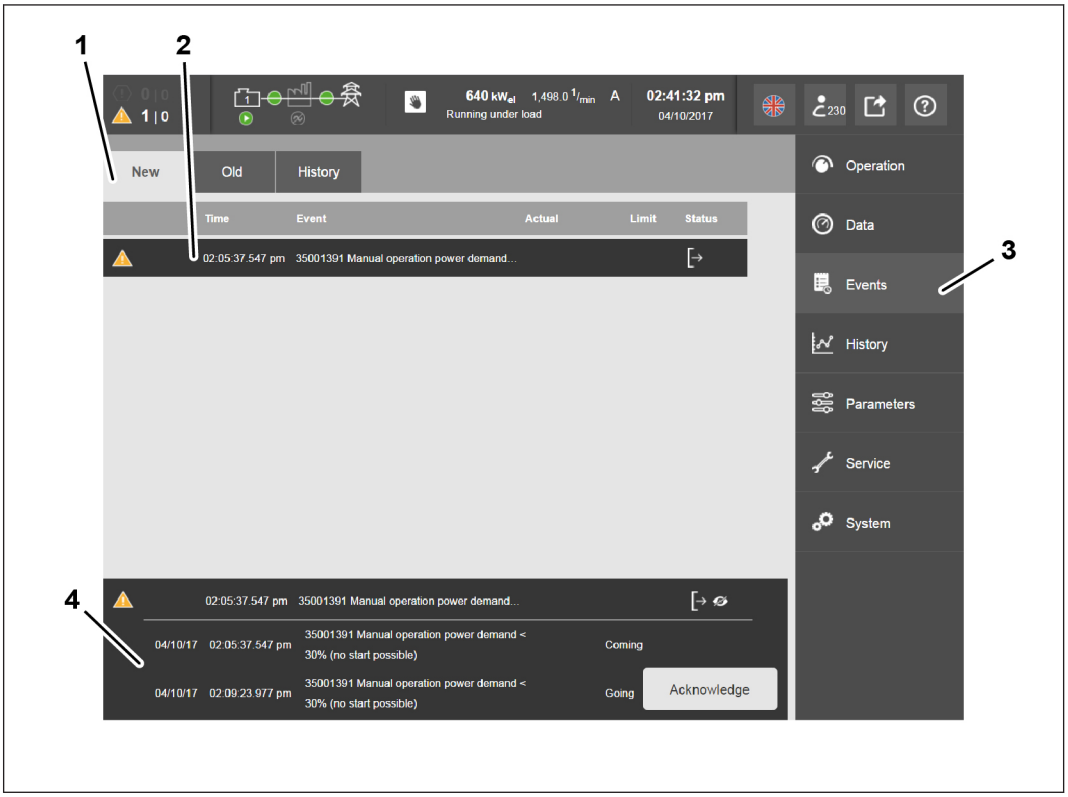
1 Display of alarms
Pending, unacknowledged alarms before the dash, still pending but acknowledged alarms after the dash. ⇒ Functional group `Messages`.

2 Display of warnings
Pending, unacknowledged warnings before the dash, still pending but acknowledged warnings after the dash. ⇒ Functional group `Messages`.

3 In the event of alarms and warnings whereby the genset cannot be started, the status display `Not ready-to-start` appears.

The TPEM stores supplementary information for each event.

9.2.1 Calling up fault displays



62617-003

1. Press the `Messages` (3) button
   → The `Messages` mask appears.
2. Press the `New` (1) button
   → The submenu displays all current messages.
3. Tap desired message (2)
   → The message is highlighted in black.
   → Additional information (4) appears in the lower area of the screen page.

For more information on the messages, see
Section `Messages`

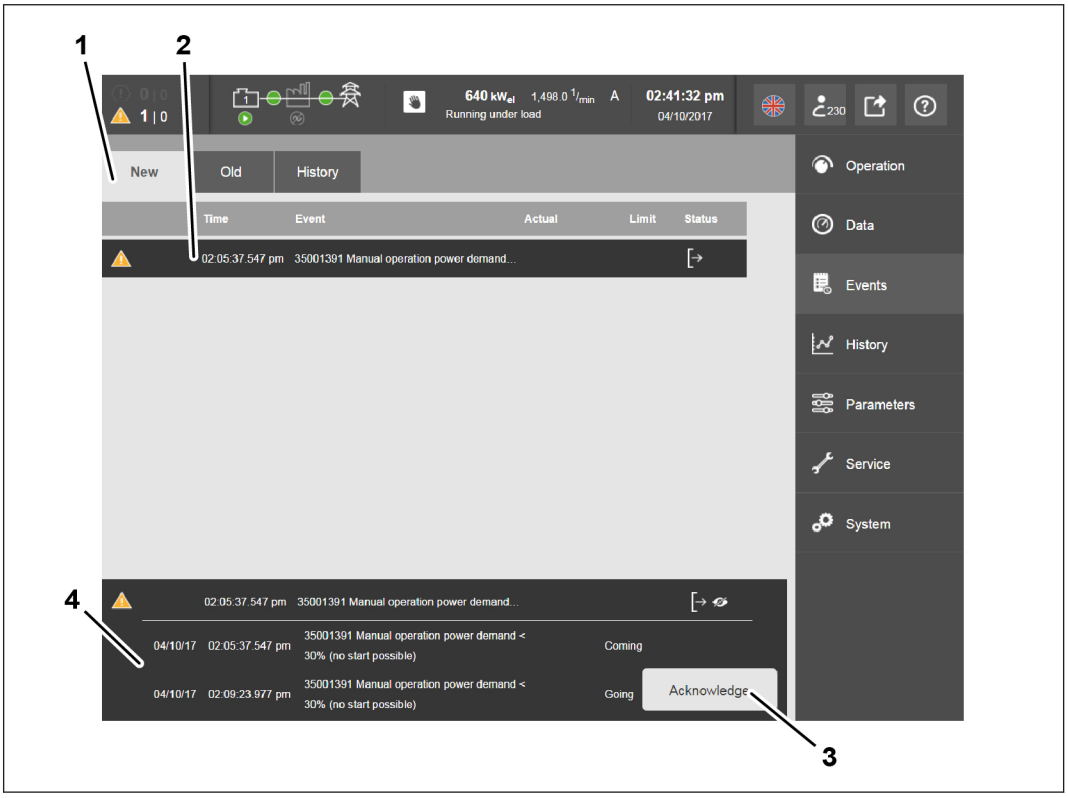
9.2.2 Acknowledging fault displays

Note

All warnings and alarms must be acknowledged in the functional group `Messages` in the submenu `New`. A collective acknowledgement of several events is not possible. The cause of the warning or alarm does not need to have been rectified in order to be acknowledged.

Note

When acknowledging messages on the HMI via remote access, the user performing the action assumes responsibility. Proper operation and regular servicing of the genset can only be ensured on site.



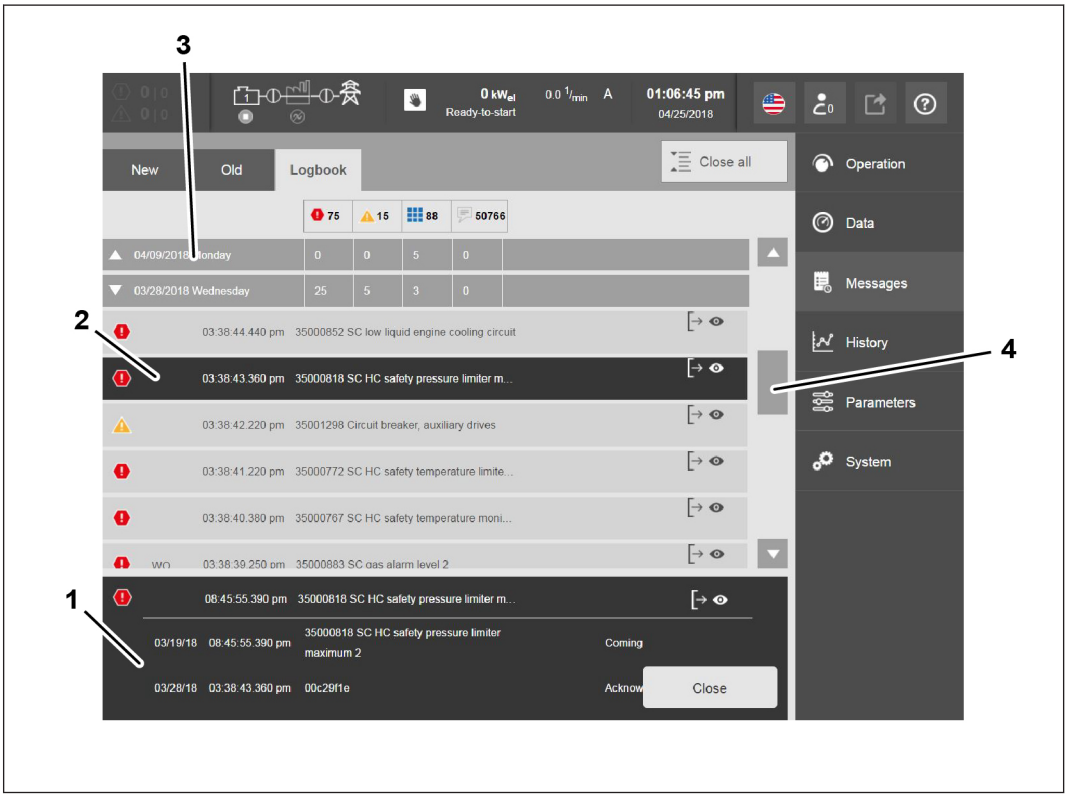
62621-003

1. Tap the desired message in the submenu `New` (1)
   → The selected message is highlighted in black (2).
   → Additional information (4) appears in the lower area of the screen page.
2. Tap the `Acknowledge` (3) button in the area of the additional information
   → The acknowledged symbol appears.
   → The selected message is moved into the submenu `Old`.
   → The submenu `New` no longer displays the message.

9.2.3 Show fault displays in the History mask

Note

The history fully records the operation of the module via defined alarms, warnings and operating messages. The history summarizes events into days.



62618-002

1. Navigate to the desired date (3) with the scroll bar (4)
2. Select date and tap in the date area (3)
   → All events of the selected day appear.
3. Tap desired event (2)
   → The event is highlighted in black.
   → Additional information (4) appears in the lower area of the screen page.

9.3 Rectifying faults

For troubleshooting, see

- Separate document ⇒ TPEM Troubleshooting

10 Appendix

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10.1 List of abbreviations

Abbreviation	Explanation
DES	Demand for external starting preparations
JC	Job card
AKC	Anti-knock control
DMT	Dependent maximum current time protection
ANSI	American National Standards Institute
ETC	Exhaust turbocharger
AVR	Alternator Voltage Regulator (generator controller)
IAP	Intake air preheating
EHE	Exhaust heat exchanger
BDEW	Bundesverband der Energie- und Wasserwirtschaft (German Association of Energy and Water Industries)
oh	Operating hours
CHPS	Combined heat and power station
BY	Exhaust bypass
CH4	CH_4 compensation
PF	Power factor
TV	Throttle valve
M levels	Maintenance levels
f	Frequency
FRT	Fault Ride Through
FC	Frequency converter
FUS	Frequency converter cabinet
GGB	Generator group breaker
MC	Mixture cooler
MCC	Mixture cooling circuit
MCC RDTR	Mixture cooling circuit recooler
GLF	Generator power field switch cabinet
GAM	Gas-air mixer
GCB	Generator circuit breaker
GTR	Gas train
AD test	Auxiliary drive test
h	Hour
HAS	Auxiliary drive switch cabinet

Abbreviation	Explanation
HP	High pressure
HC	Heating circuit
HC EHE ECC	Heating circuit with exhaust heat exchanger in engine cooling circuit
HT	High temperature
HVRT	High Voltage Ride Through
ILF	Integral local frequency control
IO	Input/Output
CAT	Catalytic converter
CPH	Coolant preheating
CL	Competence level
CHE	Coolant heat exchanger
LFSM	Limited frequency sensitive mode
CB (load step)	Circuit breaker
LVRT	Bridging of undervoltage (Low Voltage Ride Through)
MTDVM	Mains time-dependent voltage monitor
min	Minute
Max. / max.	Maximum
Min. / min.	Minimum
at least	at least
ECC	Engine cooling circuit
Grid code	Grid code requirements
DCC	Dump cooling circuit
DCC RDTR	Dump cooling circuit recooler
MCB	Mains circuit breaker
LT	Low temperature
P	Pressure
P diff	Differential pressure
PMV	Parameterizable measured value
PMC	Parameterizable controllers
PHE	Plate heat exchanger
TDC	Top dead center
PTFE	Polytetrafluorethylene
PHE	Plate heat exchanger
RAM	Remote Asset Monitoring

Abbreviation	Explanation
P&I diagram	Piping and instrumentation diagram
CV	Cabin ventilation
RP	Power decrease (Reduced power)
S	Speed
s	Second
busB	Busbar
SSOV	Safety shut-off valve
SC	Shutdown controlled
Act	Actuator
QCV	Quick closing valve
LHE	Lube oil heat exchanger
T	Temperature
TPEM	Total Plant and Energy Management
TPEM CB	TPEM Connection Box
TPEM CC	Switch cabinet TPEM Control Cabinet
TPEM CU	TPEM Control Unit
TPEM GC IO	TPEM Grid Code IO Controller
TPEM IO	TPEM IO Controller
TPEM MFR	TPEM Multi Function Relay
TPEM PLE	TPEM Product Link Elite
TPEM RC	TPEM Remote Client
TPEM RC DT	TPEM Remote Client Desktop
TPEM RC TP	TPEM Remote Client Touch Panel
TPEM RPG	TPEM Remote Plant Gateway
TPEM RVS	TPEM Rendezvous Server
TPEM SaC	TPEM Safety Chain
TPEM TP	TPEM Touch Panel
TPEM TSG	TPEM Troubleshooting Guide
TR	Technical Bulletin
UPF	Underpressure filter
BDC	Bottom dead center
PLP	Prelubrication pump
WG	Wastegate
WO	without auxiliary drives

Abbreviation	Explanation
IG	Ignition general
SP	Spark plug
DCR	Dual-core radiator

10.2 Changes with TPEM release 1.9

- Chapter 8 `Operation`
  - 8.6 Functional group `History`: Chapter revised, information on favorites added.