Technical Publication

ECS5 (MDEC)
for BR 2000
and BR 4000

Application Oil & Gas

Functional Description
Operating Instructions
Installation and Commissioning
Instructions

E532234/00E

DETROIT DIESEL

mtu

DaimlerChrysler Off-Highway

Wichtig – Important – Importante

Bitte die Karte „Inbetriebnahmemeldung“ abtrennen und ausgefüllt an MTU Friedrichshafen GmbH zurücksenden.

Die Informationen der Inbetriebnahmemeldung sind Grundlage für den vertraglich vereinbarten Logistik-Support (Gewährleistung, Ersatzteile etc.).

Please complete and return the “Commissioning Note” card below to MTU Friedrichshafen GmbH.

The Commissioning Note information serves as a basis for the contractually agreed logistic support (warranty, spare parts, etc.).

Veuillez séparer la carte “Signalisation de mise en service“ et la renvoyer à la MTU Friedrichshafen GmbH.

Les informations contenues dans la signalisation de mise en service constituent la base pour l'assistance en exploitation contractuelle (garantie, rechanges, etc.).

Rogamos separen la tarjeta “Aviso de puesta en servicio“ y la devuelvan rellenada a MTU Friedrichshafen GmbH.

Las informaciones respecto al aviso de puesta en servicio constituyen la base para el soporte logístico contractual (garantía, piezas de repuesto, etc.).

Ritagliare “Avviso di messa in servizio“ e rispedirlo debitamente compilato alla MTU Friedrichshafen GmbH.

Le informazioni ivi registrate sono la base per il supporto logistico contrattuale (garanzia, ricambi, ecc.).

É gentileza cortar o cartão "Participação da colocação em serviço", preenché-lo e devolvé-lo a MTU Friedrichshafen.

Os dados referentes à colocação em serviço representam a base para o suporte logístico (garantia, peças sobressalentes, etc.) estabelecido contratualmente.

Postcard

MTU Friedrichshafen GmbH
Department SCSD
88040 Friedrichshafen
GERMANY

Bitte in Blockschrift ausfüllen!
Please use block capitals!
Prière de remplir en lettres capitales!
¡A rellenar en letras de imprenta!
Scrivere in stampatello!
Favor preencher com letras de forma!

Motornr.: Engine No.: N° du moteur: N° de motor: Motore N.: No. do motor:	Auftragsnr.: MTU works order No.: N° de commande: N° de pedido: N. commessa: No. do pedido:
Motortyp: Engine model: Type du moteur: Tipo de motor: Motore tipo: Tipo do motor:	Inbetriebnahmedatum: Date put into operation: Mise en service le: Fecha de puesta en servicio: Messa in servizio il: Data da colocação em serviço:
Eingebaut in: Installation site: Lieu de montage: Lugar de montaje: Installato: Incorporado em:	Schiffstyp / Schiffshersteller: Vessel/type/class / Shipyard: Type du bateau / Constructeur: Tipo de buque / Constructor: Tipo di barca / Costruttore Tipo de embarcação/estaleiro naval:

Endabnehmer/Anschrift:
End user`s address:
Adresse du client final:
Dirección del cliente final:
Indirizzo del cliente finale:
Usuário final/endereço:

Bemerkung:
Remarks:
Remarques:
Observaciones:
Commento:
Observações:

Inbetriebnahme-meldung

Commissioning Note

Notice de mise en service

Aviso de puesta en servicio

Avviso di messa in servizio

Participação da colocação em serviço

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General Provisions

1 Safety

1.1 General conditions

General

In addition to the instructions in this publication, the applicable country-specific legislation and other compulsory regulations regarding accident prevention must be observed. This engine is a state-of-the art product and conforms with all applicable specifications and regulations. Nevertheless, persons and property may be at risk in the event of:

- Incorrect use
- Operation, maintenance and repair by unqualified personnel
- Modifications or conversions
- Non-compliance with the Safety Instructions

Correct use

The engine is intended exclusively for the application specified in the contract or defined at the time of delivery. Any other use is considered improper use. The manufacturer will accept no liability for any resultant damage. The responsibility is borne by the user alone.

Correct use also includes observation of and compliance with the maintenance specifications.

Modifications or Conversions

Modifications made by the customer to the engine may affect safety.

MTU will accept no liability or warranty claims for any damage caused by unauthorized modifications or conversions.

Spare parts

Only genuine MTU spare parts must be used to replace components or assemblies. In the event of any damage caused by the use of other spare parts, no liability nor warranty claims vis-à-vis the engine manufacturer will be accepted.

1.2 Personnel and organizational requirements

Personnel

Work on the engine must only be carried out by properly qualified and instructed personnel.

The specified legal minimum age must be observed.

Responsibilities of the operating, maintenance and repair personnel must be specified.

Organization

This publication must be issued to all personnel involved in operation, maintenance, repair or transportation.

It must be kept at hand near the engine and accessible at any time to all personnel involved in operation, maintenance, repair or transportation.

The personnel must be instructed on engine operation and repair by means of this publication, and in particular the safety instructions must be explained.

This is especially important for personnel who work on the engine only on an occasional basis. Such personnel must be given instructions repeatedly.

Working clothes and protective equipment

Wear proper work clothing for all work.

Depending on the kind of work, use additional protective equipment, e.g. protective goggles, gloves, helmet, apron.

Work clothing must be tight fitting so that it does not catch on rotating or projecting components.

Do not wear jewelry (e.g. rings, chains etc.).

1.3 Safety precautions when working on the engine

Safety precautions when putting the equipment into operation

Prior to initial operation, the product must have been installed correctly and approved according to MTU specifications.

Before putting the device or the system into operation, always ensure

- that all maintenance and repair work is completed
- that all loose components have been removed from rotating parts
- that nobody is standing in the danger zone of moving engine components.

Immediately after putting the device or system into operation, make sure that all control and display instruments as well as the signaling and alarm systems work properly.

Safety requirements for operators

Procedures for cases of emergency must be practised regularly.

The operator must be familiar with the controls and displays.

The operator must know the consequences of each operation to be carried out.

The operator must carry out the individual operations according to the documentation.

During operation, the displays and monitoring units must be permanently observed with regard to present operating status, violation of limit values and warning or alarm messages.

The following steps must be taken if a malfunction of the system is recognized or reported by the system:

- notify the supervisory personnel in charge
- analyze the message
- if required, carry out emergency operations e.g. emergency engine stop.

Engine operation

When the engine is running, always wear ear protectors.

Ensure that the engine room is well ventilated.

Mop up any leaked or spilt fluids and lubricants immediately or soak up with a suitable bonding agent.

Exhaust gases from combustion engines are poisonous. Inhalation of poisonous exhaust gases is a health hazard. The exhaust pipework must be free of leaks and discharge the gases to atmosphere.

During engine operation, do not touch battery terminals, generator terminals or cables.

Inadequate protection of electrical components can lead to electric shocks and serious injuries.

When the engine is running, never release coolant, oil, fuel, compressed-air or hydraulic lines.

Maintenance and repair

Strict adherence to the maintenance and repair schedule is an essential safety factor.

Never carry out maintenance and repair work with the engine running unless expressly instructed to do so. Lock-out/tag-out the engine to preclude undesired starting. Disconnect the battery when electrical starters are fitted. Close the main valve on the compressed-air system and vent the compressed air line when air starters are fitted. Post the "Do Not Start" sign in the operating room or affix it to the controlling device! Persons not involved must keep clear.

Never attempt to rectify faults or carry out repairs if you do not have the necessary experience or special tools required. Have maintenance and repair work carried out by qualified and authorized personnel only.

Use only proper, calibrated tools.

Do not work on engines or components which are only held by lifting equipment or crane. Always support by suitable means which conform with the applicable regulations before commencing maintenance or repair work.

Before barring the engine, make sure that nobody is standing in the danger zone. After completing work on the engine, check that all protective devices/safety guards have been installed and that all tools and loose parts have been removed from the engine.

Fluids emerging under high pressure can penetrate clothing and skin and may cause serious injury. Before starting work, relieve pressure in systems and H.P. lines which are to be opened.

Never bend a fuel line and do not install bent lines. Keep fuel injection lines and connections clean. Always seal connections with caps or covers if a line is removed or opened.

Take care not to damage fuel lines during maintenance and repair work. To tighten the connections when installing the lines, use the correct tightening torque and ensure that all retainers and dampers are installed correctly.

Ensure that all fuel injection lines and pressurized oil lines have sufficient distance to other components to avoid contact with them. Do not place fuel or oil lines near hot components, except when necessary for design reasons during installation.

Elastomers (e.g. "Viton" sealing rings) are stable under normal operating conditions. The material decomposes when exposed to fire or temperatures exceeding 300 °C. Hydrogen fluoride vapors are released in this case. The resulting acid leads to serious burning if it contacts the skin. Do not touch elastomeric seals if they have carbonized or resinous appearance. Wear protective gloves!

Take care with hot fluids in lines, pipes and chambers ⇒ Risk of injury!

Note cooling period for components which are heated for installation or removal ⇒ Risk of injury!

Never touch hot parts of the compressor and exhaust system ⇒ Risk of burning!

Take special care when removing ventilation or plugs from engine. In order to avoid discharge of highly pressurized liquids, hold a cloth over the screw or plug. It is even more dangerous if the engine has recently been shut down, as the liquids can still be hot.

Take special care when draining hot fluids. ⇒ Risk of injury!

When draining, collect fluids in a suitable container, mop up any spilt fluids or wipe or soak them with a suitable bonding agent.

When changing the engine oil or working on the fuel system, ensure that the engine room is adequately ventilated.

When working high on the engine, always use suitable ladders and work platforms. Make sure components are placed on stable surfaces.

In order to prevent back injuries when lifting heavy components adults, depending on age and sex, should only lift weights between max. 10 kg and 30 kg, therefore:

- Use lifting gear or seek assistance.
- Ensure that all chains, hooks, slings, etc. are tested and authorized, are sufficiently strong and that hooks are correctly positioned. Lifting eyes must not be unevenly loaded.

Welding work

Never carry out welding work on the engine or engine-mounted units.

Never use the engine as a ground connection. This prevents the welding current passing through the engine resulting in burnt/scorched bearings, sliding surfaces and tooth flanks which may lead to bearing seizure and/or other material damage.

Never route the welding lead over or near the wiring harnesses of MTU systems. The welding current may otherwise induce an interference voltage in the wiring harnesses which could conceivably damage the electrical system.

The welding unit ground connection must not be more than 60 cm from the weld point.

If components (e.g. exhaust manifold) are to be welded, they must be removed from the engine.

It is not necessary to remove the connector and the connections when carrying out welding operation on MTU electronics if the master switch for power supply is switched from "ON" to "OFF" and the wire is disconnected from the negative and positive poles on the battery.

Hydraulic installation and removal

Only the hydraulic installation and removal equipment specified in the work schedule and in the assembly instructions must be used.

The max. permissible push-on pressure specified for the equipment must not be exceeded.

The H.P. lines for hydraulic installation and removal are tested with 3800 bar.

Do not attempt to bend or apply force to lines.

Before starting work, pay attention to the following:

- Vent the hydraulic installation/removal tool, the pumps and the lines at the relevant points for the system to be used (e.g. open vent plugs, pump until bubble-free air emerges, close vent plugs).
- For hydraulic installation, screw on the tool with the piston retracted.
- For hydraulic removal, screw on the tool with the piston extended.

For a hydraulic installation/removal tool with central expansion pressure supply, screw spindle into shaft end until correct sealing is achieved.

During hydraulic installation and removal, ensure that nobody is standing in the immediate vicinity of the component to be installed/removed. As long as the system is under pressure, there is the risk that the component to be installed/removed may be suddenly released from the pressure connection.

Before use, the tools must be checked at regular intervals (crack test).

Working on electrical/electronic assemblies

Always obtain the permission of the person in charge before commencing maintenance and repair work or switching off any part of the electronic system required to do so.

De-energize the appropriate areas prior to working on assemblies. Any measures requiring a power supply are expressly defined as such at the appropriate place in the manual.

Gases released from the battery are explosive. Avoid sparks and naked flames. Do not allow battery acids to come in contact with skin or clothing. Wear protective goggles. Do not place tools on the battery. Before connecting the cable to the battery, check battery polarity. Battery pole reversal may lead to injury through the sudden discharge of acid or bursting of the battery body.

Do not damage wiring during removal work and when reinstalling wiring and ensure that during operation it is not damaged by contact with sharp objects, by rubbing against other component or by a hot surface.

Do not secure wiring to fluid-carrying lines.

On completion of the maintenance and repair work, any cables which have become loose must be correctly connected and secured.

On completion of all repair work, the component and system must be subjected to a function check. Separate testing of the repaired component without system integration is insufficient.

If wires are installed beside mechanical components and there is a risk of chafing, use cable clamps to properly support the wires.

For this purpose, no cable binders must be used as, during maintenance and / or repair work, the binders can be removed but not installed a second time.

Spare parts shall be properly stored prior to replacement, i.e. particularly protected against moisture. Defective electronic components and assemblies must be suitably packed when dispatched for repair, i.e. particularly protected against moisture and impact and wrapped in antistatic foil if necessary.

Working with laser equipment

When working with laser equipment, always wear special laser-protection goggles.

Laser equipment can generate extremely intensive, concentrated radiation by the effect of stimulated emission in the range of visible light or in the infrared or ultraviolet spectral range. The photochemical, thermal and optomechanical effects of the laser can cause damage. The main danger is irreparable damage to the eyes.

Laser equipment must be fitted with the protective devices necessary for safe operation according to type and application.

For conducting light-beam procedures and measurement work, only the following laser devices must be used:

- Laser devices of classes 1, 2 or 3A,
- Laser devices of class 3B, which have maximum output in the visible wavelength range (400 to 700 nm), a maximum output of 5 mW, and in which the beam axis and surface are designed to prevent any risk to the eyes.

Operation of electrical equipment

When operating electrical equipment, certain components of this equipment are live.

Noncompliance with the warning instructions given for this equipment may result in serious injury or damage to property.

1.4 Auxiliary materials, fire prevention and environmental protection

Fire prevention

Rectify any fuel or oil leaks immediately; even splashes of oil or fuel on hot components can cause fires - therefore always keep the engine in a clean condition. Do not leave cloths soaked with fluids and lubricants lying around on the engine. Do not store combustible fluids near the engine.

Do not weld pipes and components carrying oil or fuel. Before welding, clean with a non-combustible fluid.

When starting the engine with a foreign power source, connect the ground lead last and remove it first. To avoid sparks in the vicinity of the battery, connect the ground lead from the foreign power source to the ground lead of the engine or to the ground terminal of the starter.

Always keep suitable fire-fighting equipment (fire extinguishers) at hand and familiarize yourself with their use.

Noise

Noise can lead to an increased risk of accident if acoustic signals, warning shouts or noises indicating danger are drowned.

At all workplaces with a sound pressure level over 85 dB(A), always wear ear protectors (protective wadding, plugs or capsules).

Environmental protection

Dispose of used fluids, lubricants and filters in accordance with local regulations.

Manipulation of the injection control system can influence the engine performance and exhaust emissions. As a result, compliance with environmental regulations may no longer be guaranteed.

Only fuels of the specified quality required to achieve emission limits must be used.

In Germany, the VAwS (=regulations governing the use of plants that may affect water quality) is applicable, which means work must only be carried out by authorized specialist companies (MTU is an authorized specialist company).

Auxiliary materials

Use only fluids and lubricants that have been tested and approved by MTU.

Fluids and lubricants must be kept in suitable, properly designated containers. When using fluids, lubricants and other chemical substances, follow the safety instructions applicable to the product. Take care when handling hot, chilled or caustic materials. When using inflammable materials, avoid sparks and do not smoke.

Lead

- When working with lead or lead-containing pastes, avoid direct contact with the skin and do not inhale lead vapors.
- Adopt suitable measures to avoid the formation of lead dust!
- Switch on fume extraction system.
- After coming into contact with lead or lead-containing materials, wash hands!

Acids and alkaline solutions

- When working with acids and alkalis, wear protective goggles or face mask, gloves and protective clothing.
- Immediately remove clothing wetted by acids and alkalis!
- Rinse injuries with plenty of water!
- Rinse eyes immediately with eyedrops or clean tap water.

Painting

- When painting in other than spray booths equipped with extractors, ensure good ventilation. Make sure that adjacent work areas are not affected.
- No naked flames!
- No smoking.
- Observe fire prevention regulations!
- It is absolutely necessary to wear masks providing protection against paint and solvent fumes.

Liquid nitrogen

- Store liquid nitrogen only in small quantities and always in regulation containers without fixed covers.
- Do not bring liquid nitrogen in contact with the body (eyes, hands), as this causes frostbite and numbing.
- Wear protective clothing, gloves, closed shoes and protective goggles!

- Ensure the room is well ventilated. 88% contamination of breathing air with nitrogen will result in suffocation.
- Avoid all knocks and jars to the containers, fixtures or workpieces.

Compressed air

Compressed air is air compressed at excess pressure and is stored in tanks from which it can be extracted.

The pressure at which the air is kept can be read off at pressure gauges which must be connected to the compressed air tanks and the compressed air lines.

When working with compressed air, safety precautions must be constantly observed:

- Pay special attention to the pressure level in the compressed air network and pressure vessel!
- Connecting devices and equipment must either be designed for this pressure or, if the permitted pressure for the connecting elements is lower than the pressure required, a pressure reducing valve and safety valve (set to permitted pressure) must form an intermediate connection. Hose coupling and connections must be securely attached!
- Always wear protective goggles when blowing off tools or extracting chips!
- The snout of the air nozzle is provided with a protective disc (e.g. rubber disc), which prevents air-borne particles being reflected and thereby prevents injury to eyes.
- First shut off compressed air lines before compressed air equipment is disconnected from the supply line or before equipment or tool is to be replaced!
- Unauthorized use of compressed air, e.g. forcing flammable liquids (danger class AI, AII and B) out of containers, results in a risk of explosion!
- Forcing compressed air into thin-walled containers (e.g. containers made of tin, plastic and glass) for drying purposes or to check for leaks, results in a risk of explosion!
- Do not blow dirty clothing with compressed air when being worn on the body.

Used oil

Used oil may contain health-threatening combustion residues.

Rub barrier cream into hands!

Wash hands after contact with used oil.

1.5 Standards for warning notices in the publication

 **DANGER**	In the event of immediate danger. **Consequences: Death or serious injury.** • Preventive measures
 **WARNING**	In the event of possibly dangerous situations. **Consequences: Death or serious injury.** • Preventive measures
 **CAUTION**	In the event of dangerous situations. **Consequences: Slight injury or material damage.** • Preventive measures

Note: This publication contains especially emphasized safety instructions in accordance with the American standard ANSI Z535, which begin with one of the above signal words according to the degree of danger:

Warning notices

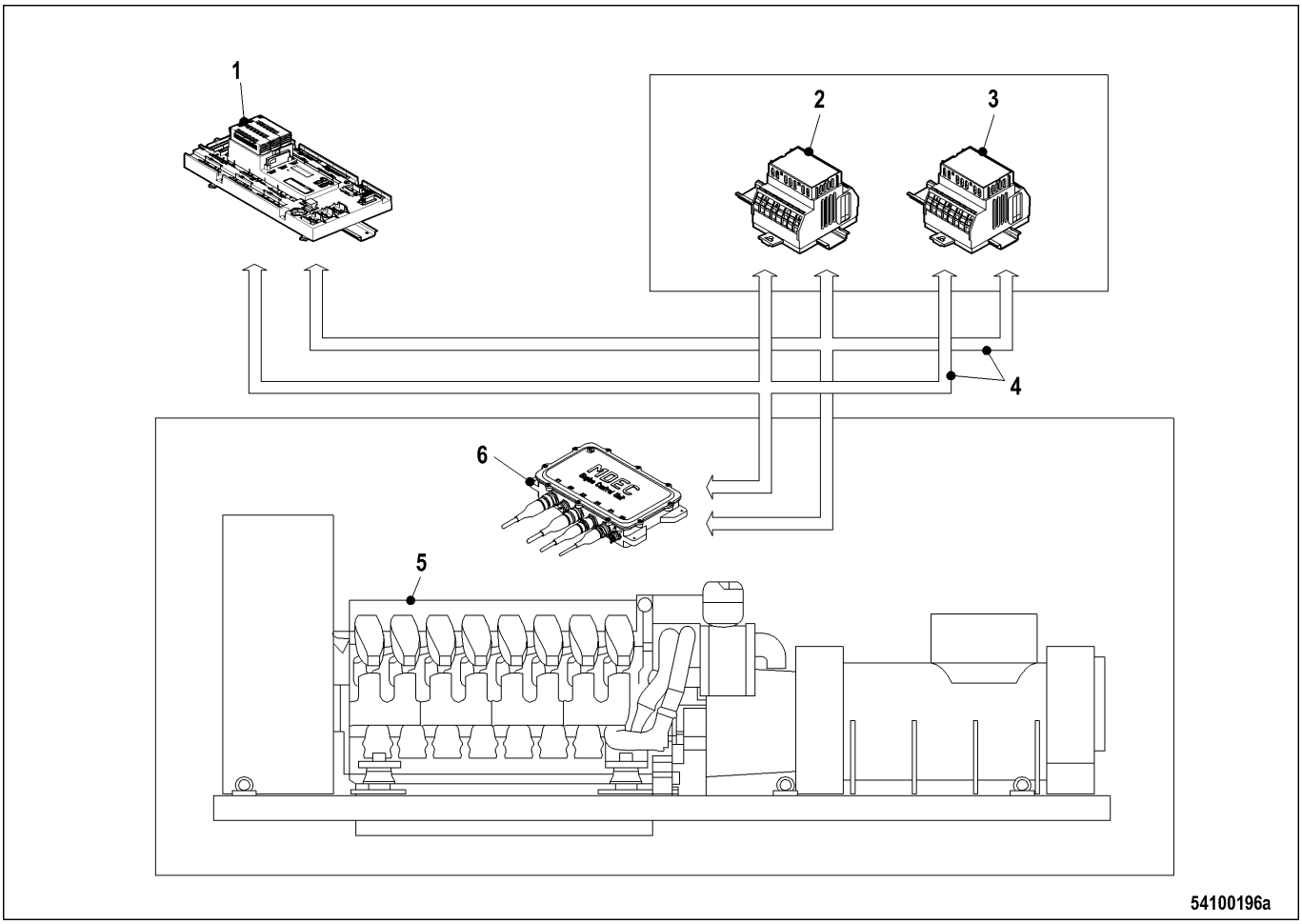
1. Read and become acquainted with all cautions and symbols before operating or repairing this product.
2. Pass on all safety instructions to your operating, maintenance, repair and transport personnel!

Functional Description

2 Design

2.1 Use

2.1.1 Use



1 Service and Automation Module (SAM)
2 Peripheral Interface Module 601 (option)
3 Peripheral Interface Module 602 (option)
4 CAN bus
5 Engine with generator
6 Engine governor

Up to 8 additional Peripheral Interface Modules can be connected for linking to higher-level systems.

Functions

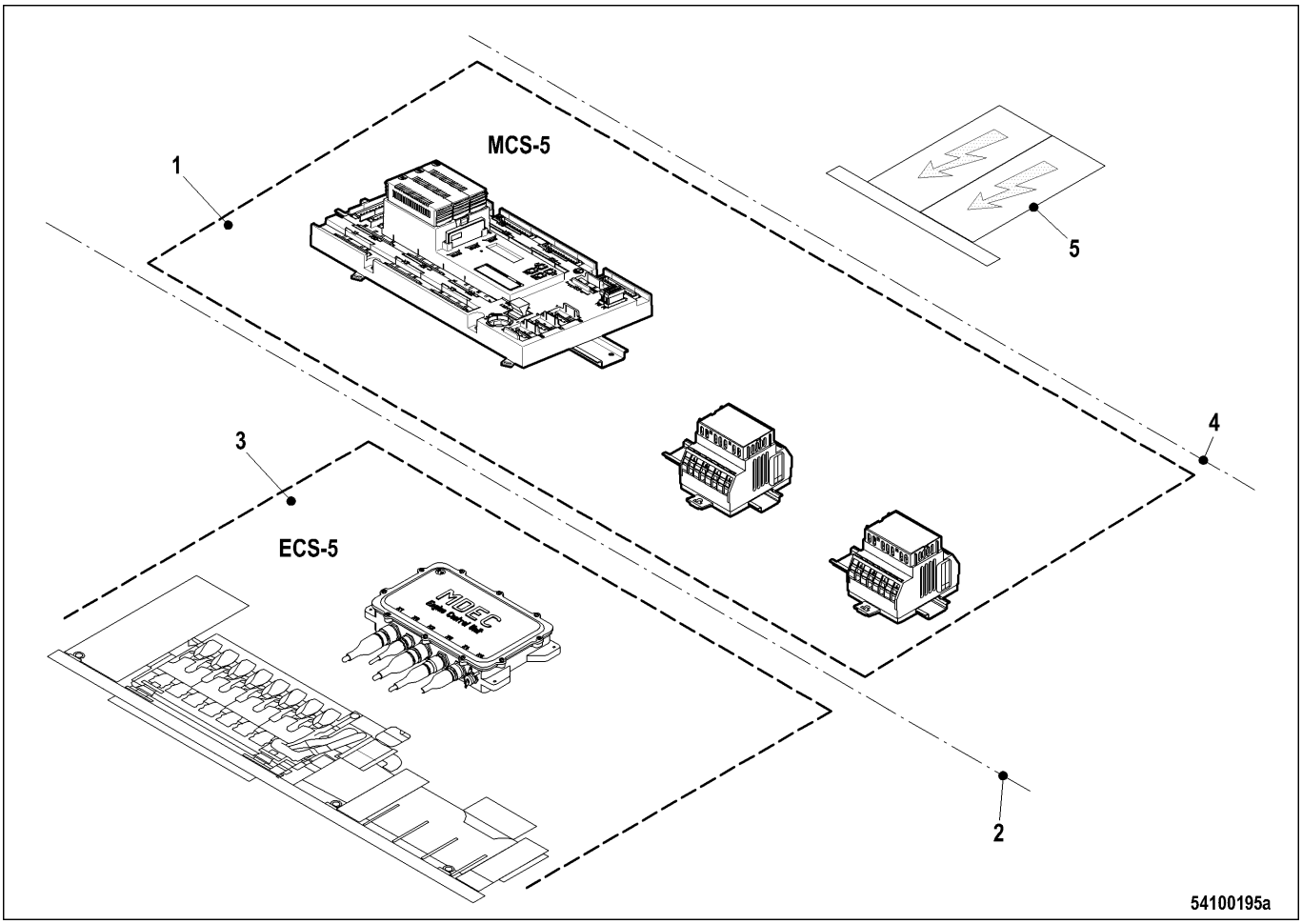
- Control of the engine.
- Monitoring of operating states.
- Closed-loop control of fuel injection and engine speed (depending on operating state).
- Indication of faulty operating states (display SAM (1)).

Features

- Electronic engine governing and control.
- Monitoring of inadmissible engine operating states.
- Display of fault messages and fault codes.
- Connecting cable for power supply to engine governor.
- Connecting cable for connection to a higher-level genset control system.

- Hardware interfaces to a higher-level control system (option).
- Inputs for plant sensors (option).
- Engine safety features including engine shutdown.
- Integral fault diagnosis system ITS.
- Integral load profile recorder.
- Speed droop switching possible with engine running.
- Straightforward engine governor replacement.
  - Engine and interface data stored in SAM.
  - Complete automatic software download following connection of a new, unprogrammed engine governor.

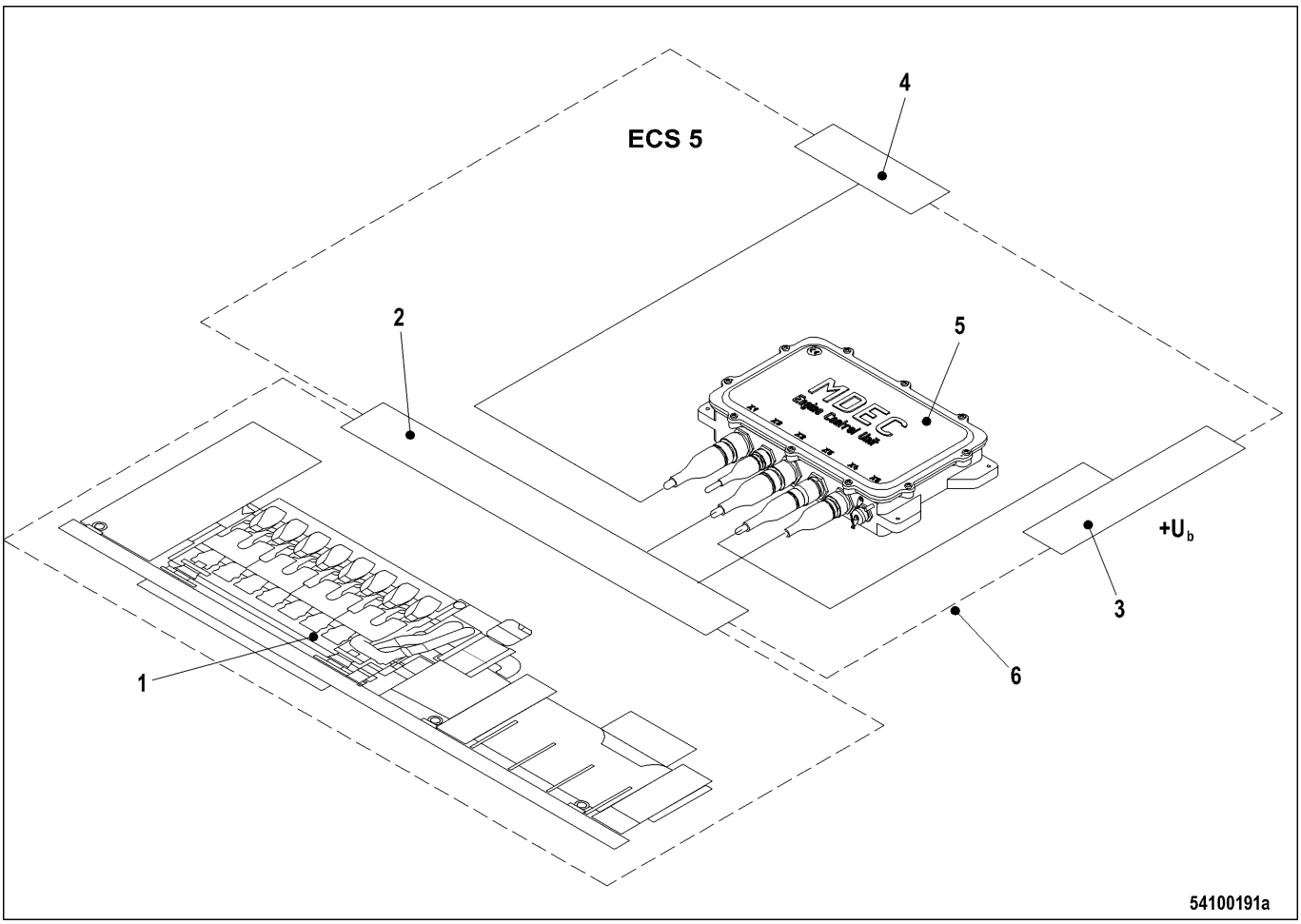
Design of the overall MDEC system



1 Monitoring and Control System MCS-5 (PIMs optional)
2 CAN bus between ECS-5 and MCS-5
3 Engine Control System ECS-5
4 RS422 interface and RS232 interface to an external controller
5 External controller

The design of the overall MDEC system comprising the ECS-5 and MCS-5 subsystems depends on customer requirements and the higher-level control system.

Design of Engine Control System ECS-5

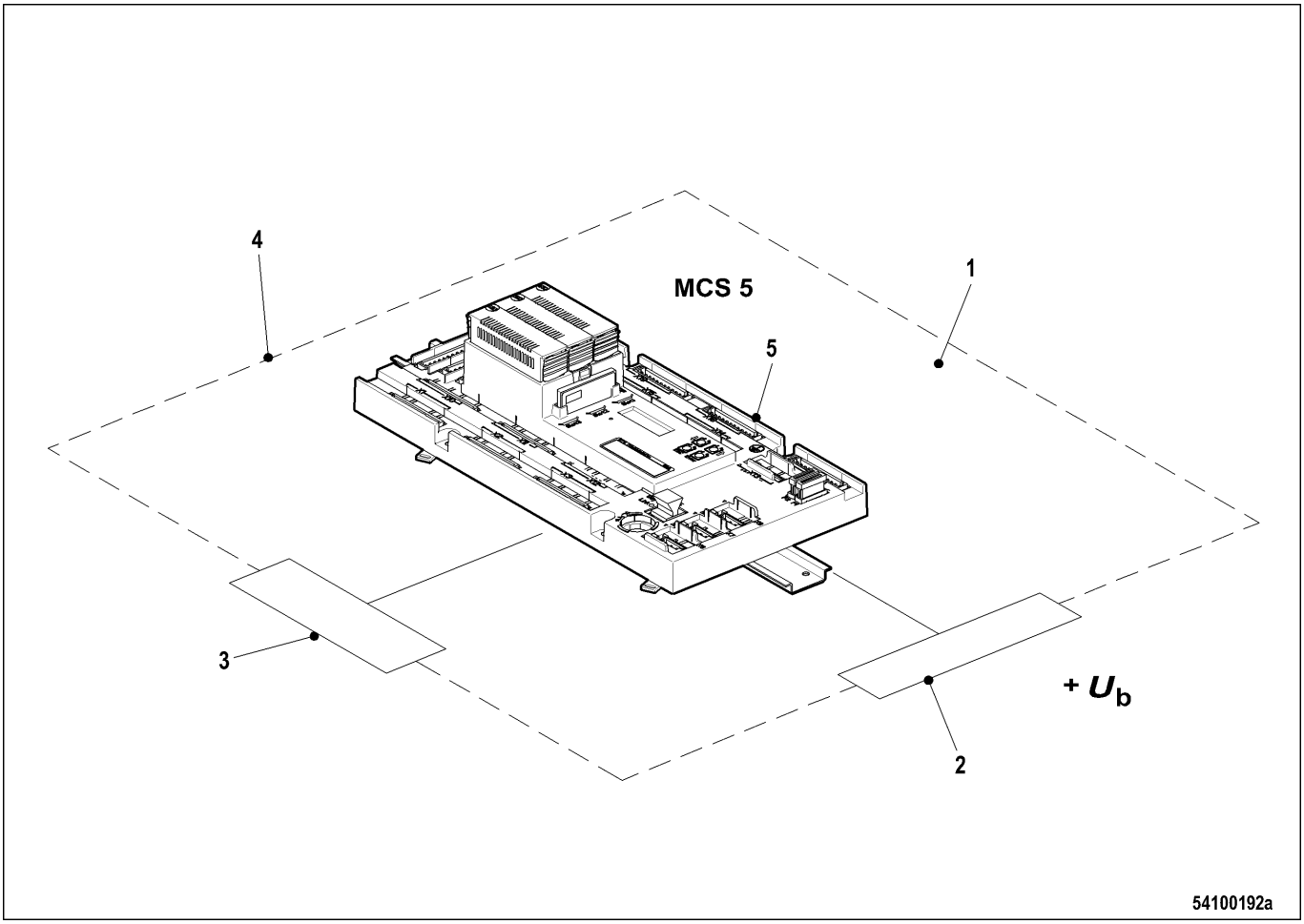


1 Engine with generator
2 Engine interface
3 Power supply +U_b
4 Signal connection to the MCS devices and the higher-level control systems
5 Engine governor
6 System boundary ECS-5

The Engine Control System comprises the following devices:

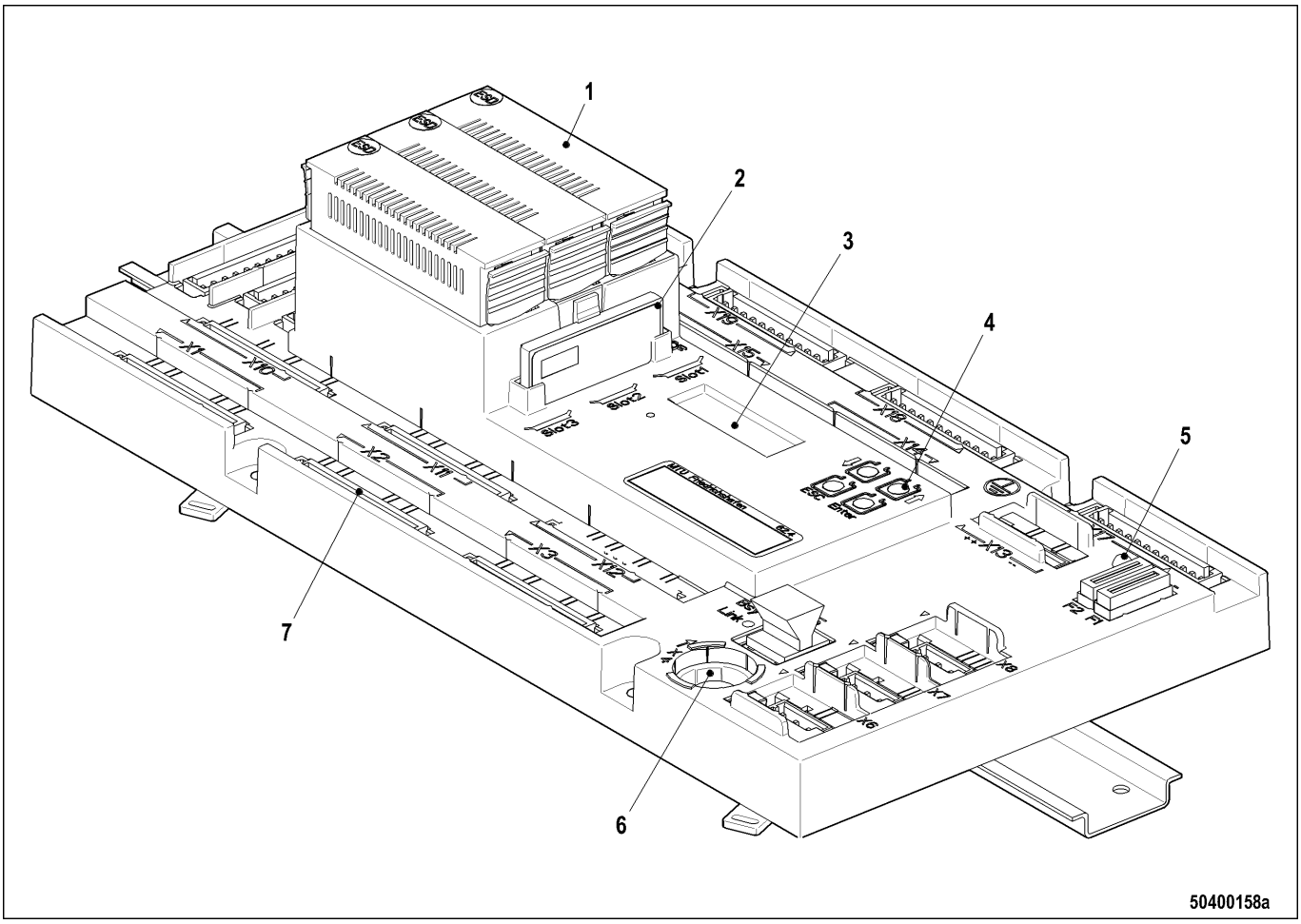
- Engine governor
- Sensors on engine
- Actuators on engine
- Injectors on engine
- Wiring harnesses on engine

Basic scope of Monitoring and Control System MCS-5



1 Monitoring and Control System MCS-5
2 Power supply $+U_b$
3 Signal connection to ECS devices
4 System boundary MCS-5
5 SAM

Service and Automation Module (SAM)



1 Module cassette, slots for additional I/O PIM cards
2 Compact flash memory card
3 Display for fault codes and minidialog
4 Control keys for minidialog
5 Diagnostic lamp
6 Interface for dialog unit
7 Connector with spring design

Functions

SAM functions

- Display of fault codes from engine governor and SAM (3).
- Backup function, engine life data are stored,
  - every hour,
  - after every engine stop
  - after every emergency engine stop.
- Interface for dialog unit.

Diagnosis

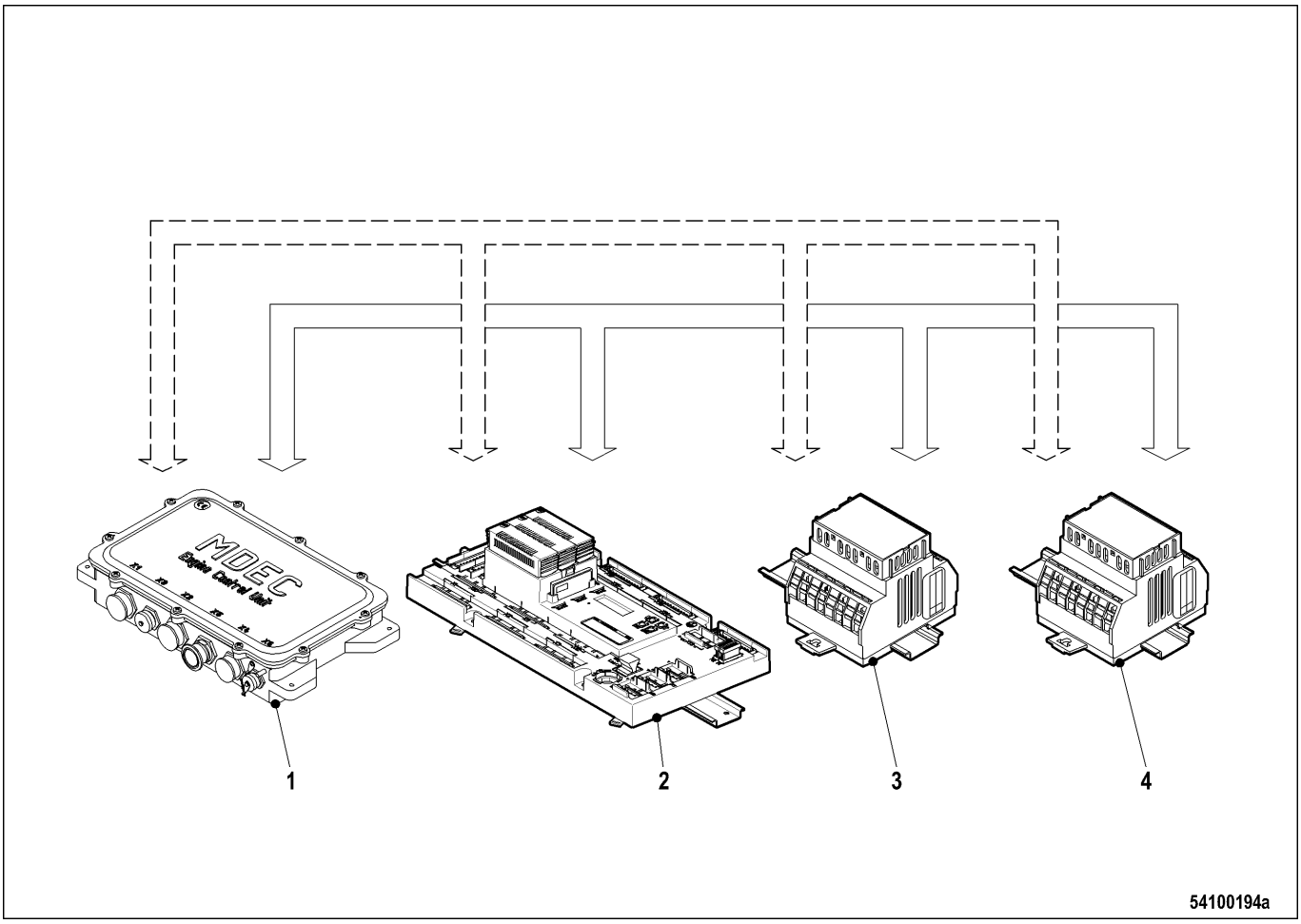
- Straightforward diagnosis by fault code display.
- Self-diagnosis by diagnostic lamp (5).
  - Steady = SAM is OK.
  - Flashing = SAM is faulty, contact Service.
  - Dark = Supply voltage missing.

Customer interface

- 24 binary outputs
- 3 PWM outputs
- 8 display outputs
- 28 channel binary input
- 10 analog inputs (e.g. PT100, 4–20 mA, 0-10 V, etc.)
- 4 frequency inputs
- 1 dialog interface

- Extendable with MCS 5 PIM I/O cards

Data connections



1 Engine governor
2 SAM
3 PIM 601 (option) serial interface / slave
4 PIM 602 (option) serial interface / master

Data transmission

The devices are equipped with a CAN bus for transmitting data between the individual subsystems. This CAN bus is in redundant design.

The CAN bus is a standardized automation technology field bus which allows various systems and devices to communicate with each other providing they are equipped with a CAN bus interface.

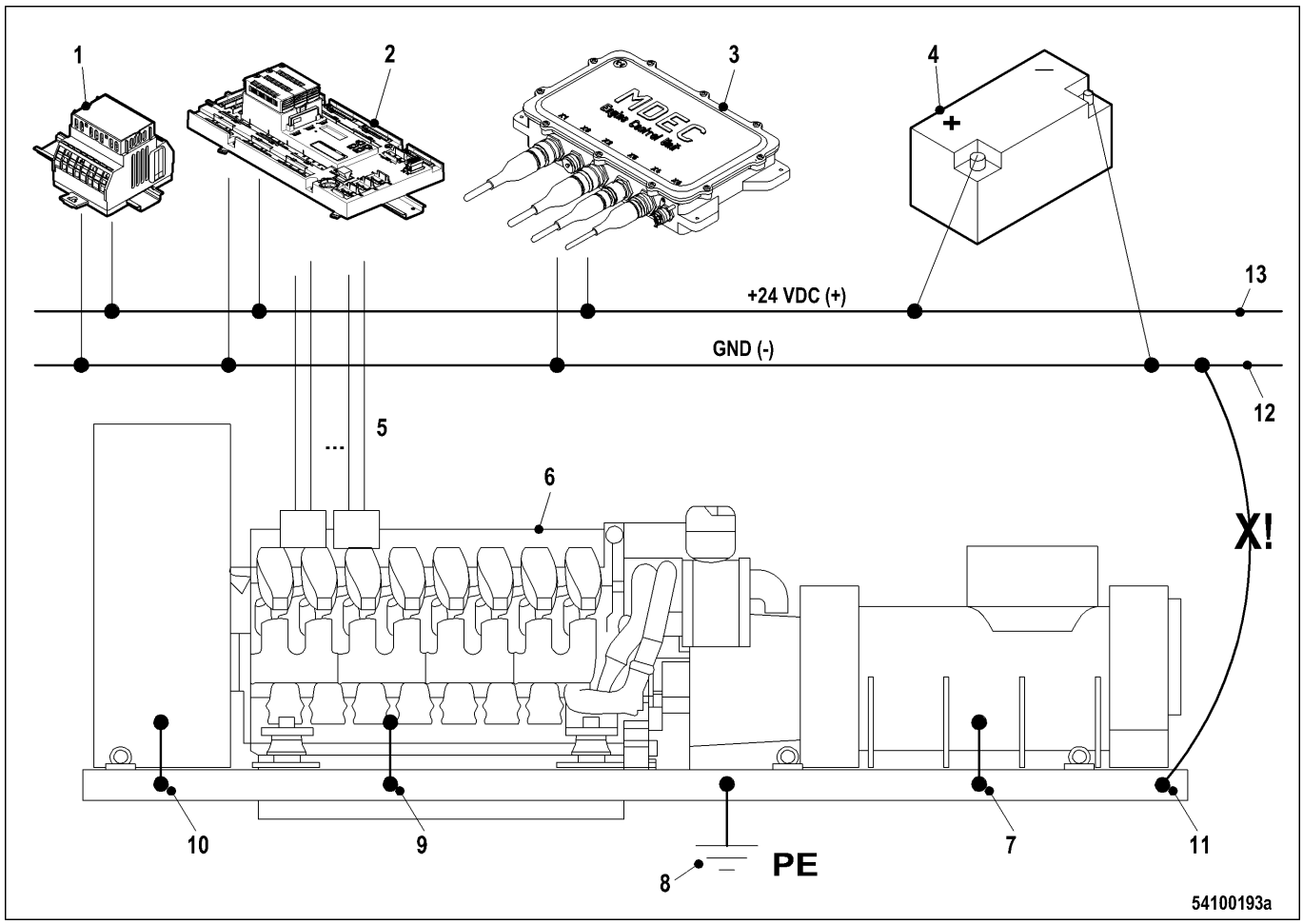
Tasks of the CAN bus:

CAN bus

Tasks:

- Receiving plant signals (desired speed) and commands from higher-level control systems.
- Outputting all measured values/limit values for the Monitoring and Control System.
- Outputting alarms for signaling and evaluation in the Monitoring and Control System.
- Outputting relevant signals for engine control.

Grounding



1 PIM
2 SAM
3 Engine governor
4 Battery
5 To engine sensors
6 Generating set
7 Equipotential bonding strip
8 Grounding
9 Equipotential bonding strip
10 Equipotential bonding strip
11 Mounting frame
12 GND (-)
13 +24 V VDC (+)
X! Inadmissible connection!

Grounding

Both the engine and the generator are connected to ground (8) via equipotential bonding strips (7, 9, 10) on the mounting frame (11).

EMC

EMC design of the overall system is based on a two-pole ungrounded power supply. This is particularly relevant to CE labeling as per EMC directive.

Ground connection

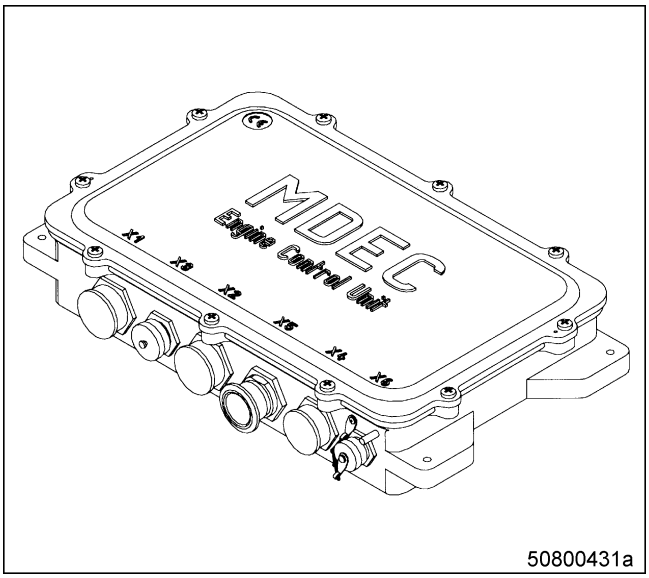
The ground of the power supply (battery negative) and all electronic devices (-) should not be connected to ground (8). The entire electronic system is electrically isolated from ground. This also applies to the sensors (5). All sensor signal lines and/or supply lines are not connected to the corresponding sensor housings.

Signal-to-noise ratio

Electrical isolation of the mechanical and electronic components significantly increases the signal-to-noise ratio. This high signal-to-noise ratio on all electrical lines is necessary for satisfactory transmission of all data on the CAN bus and also all analog and binary sensor signals.

2.1.2 ECS-5 – Use of devices

Engine governor



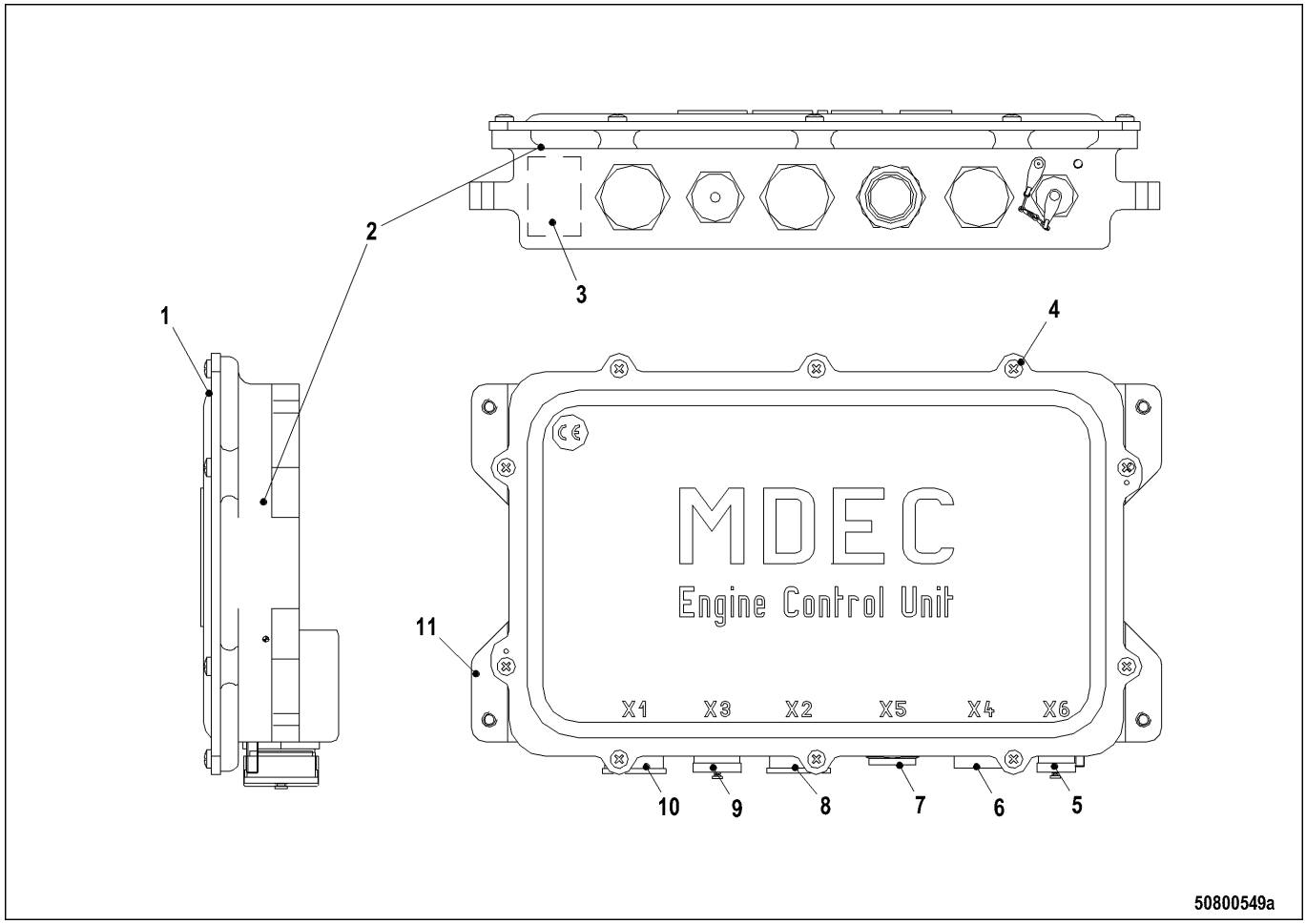
Central control and monitoring device for the engine

- Communication with other devices and higher-level systems via CAN bus.
- Control of injection system.
- Control of up to 20 injectors.
- Acquisition and evaluation of engine operating states.
- Monitoring of limit values.
- Self-monitoring and diagnosis,
  - integral status/fault display
  - fault memory
- Extensive I/O features:
  - Plant side 13 inputs, 10 outputs, 2 serial interfaces,
  - engine side 26 inputs, 26 outputs.
- Engine and plant-related setting variables in exchangeable memory modules.
- In case of inadmissible states and limit value violations: Initiation of power reduction, engine stop and emergency engine stop (configurable).
- Diagnosis via RS232 interface for dialog unit.

Software structure:

Name	Meaning
Download software	For downloading firmware and configuration data.
Dialog software	For the dialog with a PC or notebook.
Automation software for open-loop control.	E.g. to control injection quantity.
Automation software for monitoring.	E.g. for engine stop and emergency engine stop.
Communication software	For communication with other devices and via the CAN bus.

Hardware structure



Item.	Name	Meaning
1	Cover	–
2	Housing	–
3	Rating plate	Part and serial number Data record and engine number
4	Screws	–
5	Connector X6	Connection for dialog unit
6	Connector X4	Connection for injector wiring harness
7	Connector X5	Connection for power supply
8	Connector X2	Connection for sensor/actuator wiring harness
9	Connector X3	BR 2000: Not used BR 4000: HP controller
10	Connector X1	Connection for CAN bus
11	Mounting lugs	–

Technical data

Dimensions (width x height x depth)	455 mm x 277 mm x 91 mm Draw-out clearance: +230 mm
Weight	7 kg
Operating voltage	Rated voltage: 24 VDC Continuous voltage: 16.5 VDC to 32 VDC Temporarily restricted operation: 11 VDC to 36 VDC Residual ripple: Max. 8 V_{pp}
Power consumption	Max. 30 A
Heat loss	Max. 35 W
Operating temperature range	0 °C to +75 °C
Storage temperature range	–10 °C to +75 °C
Relative air humidity	0% to 95 % condensing
Degree of protection	IP 65 DIN 40 050
Shock	15 g/11 ms semi-sinusoidal shock
Vibration	2 Hz to 13 Hz: X_{pp}= ±1.6 mm 25 Hz to 100 Hz: a= ±4 g 100 Hz to 2000 Hz: Electrical noise 1.3 g rms
EMC	DIN EN 50081–2 DIN EN 50082–2 IEC 1000–4–2 IEC 1000–4–3 IEC 1000–4–4 IEC 1000–4–5 IEC 1000–4–6

2.2 Functions

2.2.1 MDEC – Functions

Control functions

Following engine functions are controlled:

- Engine start
- Engine stop
- Emergency start
- Restart response
- Sequences with activated “Override” function (safety system bypass).
- Nominal speed switching between two set values (optional operation as 50 Hz or 60 Hz genset).
- Injection quantity as a function of engine loading and speed.

Engine start

The starting sequence is controlled by the software integrated in the engine governor as follows.

1. Engine start
2. Start lockout time t>16 seconds.
   - Starting terminated if start lockout time is t<16.
3. Start interlock.
   - Start terminated if start interlock applied.
4. Emergency air-shutoff flaps open.
   - Start terminated if emergency air-shutoff flaps closed.

   .
5. Starter on.
6. Speed n>n1 (configurable) reached within t1 (configurable).
   - Start terminated if speed is n<n1 within t1. Start speed is too low “Start speed low”.

   .
7. Start injection quantity
8. Speed n>300 reached within t2 (configurable).
   - Start terminated if speed is n<300 within t2 (configurable). Start speed is too low “Run up speed low”.
9. Starter off.
10. Idling speed reached.
    - Start terminated if idling speed not reached, “Idle speed low”.
11. Engine running at idling speed.

Restart response

The response of the engine is determined by the following factors on receiving a start request when the engine is running down following a stop command:

- The engine immediately runs up to nominal speed if the engine speed is > 80 rpm;
- the engine is shut down if the engine speed is < 80 rpm. Restarting is only possible on expiry of the start lockout time.

Emergency start

The following start interlock criteria are bypassed when override is active on starting the engine:

- Low coolant temperature (configurable).
- High coolant temperature (configurable).
- Coolant level (configurable).

Engine stop

An engine stop is tripped by activation of binary input BE1 at the engine governor or by the engine protection system. Fuel is no longer injected as injector activation is disrupted.

Any starting procedure which has been initiated is interrupted.

Override (safety system bypass)

The “Override” feature is used to bypass safety functions tripped by limit value violations or sensor faults and to bypass start interlocks.

Operating states which would normally lead to engine shutdown are ignored when the “Override” function is activated. The following operating states can also be configured to shut the engine down in override mode:
- Coolant level
- Coolant temperature
- Coolant pressure
- Charge air coolant level
- Lube oil pressure
- Lube oil temperature

Monitoring functions

The engine management system for engines used in Oil&Gas applications fulfills the following monitoring tasks:
- Control of analog instruments;
  - engine speed (default)
  - engine lube oil pressure (default)
  - engine lube oil temperature (default)
  - engine coolant temperature (default)
- Transmission of all measurands, warnings and alarms to monitoring system via CAN bus.
- Automatic shutdown in case of limit value violations.

Refer to the measuring-point list for order-specific configuration data.

Engine monitoring can basically be divided into two different areas:
- Engine protection system, monitors the engine during operation,
- Safety system, generates automatic engine shutdown in case of limit value violation.

These two functional areas are constantly monitored by the internal “Integral Test System (ITS)” to ensure operational availability.

Engine protection system

The engine governor incorporates an integral engine protection system. It monitors the operational data of the engine.

Tasks of the engine protection system are:
- Safeguarding the engine from critical operating states.
- Signaling alarms to operating personnel.
- Restricting engine operation to remain within admissible operating values.

Action is taken such as warning, start interlock, power reduction or engine shutdown by reducing the quantity of fuel injected depending on the values measured.

Closed-loop control functions

Closed-loop engine control functions:
- Speed
- Injection control with mapped commencement of injection.
- Two adjustable speed droops.
- Desired speed via:
  - Analog or binary speed setting on the CAN bus.
  - Analog speed setting 0 V to 10 VDC / 0 V to 5 VDC / 4 mA to 20 mA.
  - Binary speed setting via Up/Down signal, frequency CAN bus.
  - Frequency speed setting.
- Acquisition of a load pulse signal (analog or CAN bus) in preparation for load application.
- HP fuel governor.

Speed - injection control

Functions of the closed-loop engine speed control integrated in the engine governor:
- Maintaining the desired engine speed under changing load conditions.
- Adjusting the engine speed when the setting is changed by the operator.

Additional tasks with an effect on closed-loop engine speed control:
- Setting a defined fuel injection quantity on starting the engine.
- Engine safety shutdown.
- Optimizing operation, exhaust emissions and fuel consumption.
- Protecting the engine against overloading.

Speed droop calculation

Speed droop influences the effective setpoint speed depending on engine power. Maximum, speed-dependent engine power is limited by the DBR curve. The setpoint speed is not influenced by speed droop at 100% power. The effective setpoint speed increases at lower power. This allows power to be balanced when operating a number of engines in a network.

Switchable speed droop

Two different speed droops may be selected at the engine governor for stationary genset engines. Which speed droop is active depends on whether the genset is running in isolated operation or in a parallel network with other gensets feeding a common busbar.

The speed droop is selected by a binary input (BE4) at the engine governor.

Speed droop is required to balance the load of coupled prime movers. Speed droop can be adjusted to meet plant requirements via the dialog unit.

Dynamic quantity limitation

Dynamic quantity limits protect the engine against overloading and optimize exhaust emission values. The engine governor determines the maximum injection quantity based on preset and stored engine performance maps.

Following limits are applied:

- Speed-sensitive fuel quantity limitation (DBR).
- Fuel quantity limitation as a function of fuel temperature.

Fixed quantity limitation

Fixed quantity limitations are used for power limitation and power reduction to protect the engine in case of:

- Electronic malfunctions.
- Supply voltage out of tolerance.

Fuel quantity control during engine start

The quantity of fuel injected during engine start increases along a time ramp from a set initial value to a specified value. This value is calculated by the function $q_{inject} = f_{(speed)}$. This limits the quantity of fuel injected as a function of speed. This fuel quantity limitation is effective until idling speed has been reached.

Cylinder cutout

Only half of the injectors are activated when cylinder cutout is active. The other half of the injectors are activated on expiry of a switchover time. This prevents white smoke being emitted when the engine is running.

Desired speed handling

The desired speed is the command variable for the engine speed control loop.

When the engine is started it runs up to an internally programmed desired speed (for 50 Hz network frequency: 1500 rpm, for 60 Hz network frequency: 1800 rpm).

Switching to an external speed setting takes place automatically once the nominal speed has been reached.

The following speed setting variants are possible:

- Desired speed setting via an analog input:

  The setpoint speed can be adjusted within a (configurable) range around the preset synchronous speed (depending on the set network frequency).

  In this case the voltage can either control the speed window only or cover the entire speed range.

  The internal setpoint speed follows the applied speed setting value along a configurable acceleration/deceleration curve (speed ramp). The setting value last applied is maintained or the engine is throttled back to idling speed should the applied signal fail.

  The response can be configured as desired:
  - Speed setting via CAN bus.
  - Speed setting via an analog speed setting input (0 V to 10 V).
  - Speed setting via an analog speed setting input (4 mA to 20 mA).
  - Frequency input.
- Setpoint processing via binary inputs “Setpoint speed up” (BE5)/ “Setpoint speed down” (BE6):

  The setpoint speed can be adjusted within a (configurable) range around the preset synchronous speed (depending on the set network frequency). Briefly actuating the appropriate optocoupler input for less than 0.3 s increases or decreases the setpoint speed by 1 rpm.

  The setpoint speed is automatically adjusted at a configurable rate if the input is activated for longer than 0.3 seconds.

Safety functions

Safety shutdowns

Safety shutdowns are initiated by the engine protection system in case of:

- Limit value violations;
- Sensor faults (depending of specific configuration).

This applies to the following measuring points:

- Engine speed/overspeed (configurable)
- Engine lube oil pressure (configurable)
- Coolant level (configurable)
- Charge-air coolant temperature (configurable)
- Coolant temperature (configurable)
- Charge-air temperature (configurable)
- Engine lube oil temperature (configurable)

All safety shutdowns can be suppressed by activating the “Override” input (BE8, default).

The occurrence of safety-relevant alarms is still logged when the “Override” input has been activated.

Fault number 500 is added to the current fault number.

Integral Test System (ITS)

The ITS monitors all important functions of the engine governor and connected electrical components:

- Electronics inside the engine governor itself,
- sensors,
- actuators,
- bus communication,
- power supply.

The ITS detects any faults which occur, pinpoints them and signals accordingly by combined alarms. Furthermore, a fault message is output via the CAN bus to a higher-level monitoring system (if applicable) and can visualized there for the operator.

Fault messages are stored in two memories:

- Chronological memory

  The fault message numbers are stored in a ring memory in chronological order of their occurrence or cancellation together with the hour meter reading. The ring memory stores the last 80 setting and cancellation procedures.
- Statistical memory

  Fault message occurrences are counted in a statistical memory.

  A counter counting up to max. 10 000 is set up for each fault message number .

Monitoring of engine governor electronics

The hardware and software of the engine governor is designed to allow faults in the electronic system to be detected to enable the operator to respond accordingly to such faults. Fault signals are also forwarded.

The temperature inside the engine governor housing is monitored. Should it rise above a limit value, a fault signal is output via the combined alarm output and the CAN bus to a higher-level monitoring system (if applicable) where it can be visualized for the operator.

Monitoring of sensors and actuators

The various sensor and actuator channels of the engine governor system are designed to tolerate faults to a large extent (e.g. short-circuit withstandability).

Faults such as broken wires, short circuit etc. are detected by plausibility checking and are output to a higher-level monitoring system (if applicable) in the form of a combined alarm.

Monitoring of bus communication

Bus communication is monitored by plausibility checking and timeout monitoring. Detected faults are output in the form of a combined alarm and, if possible, to a higher-level monitoring system (if applicable) via the CAN bus.

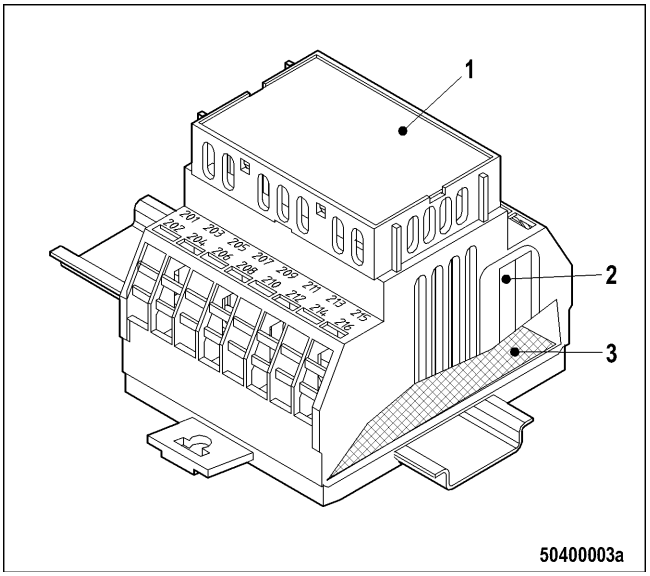
Overspeed test

Activating this input lowers the overspeed threshold such that the engine shuts down at any speed. This makes it possible to check that the overspeed shutdown function operates correctly.

2.2.2 Peripheral Interface Modules (PIMs)

PIMs for use with processor printed circuit board MPU 23 and MPU 27

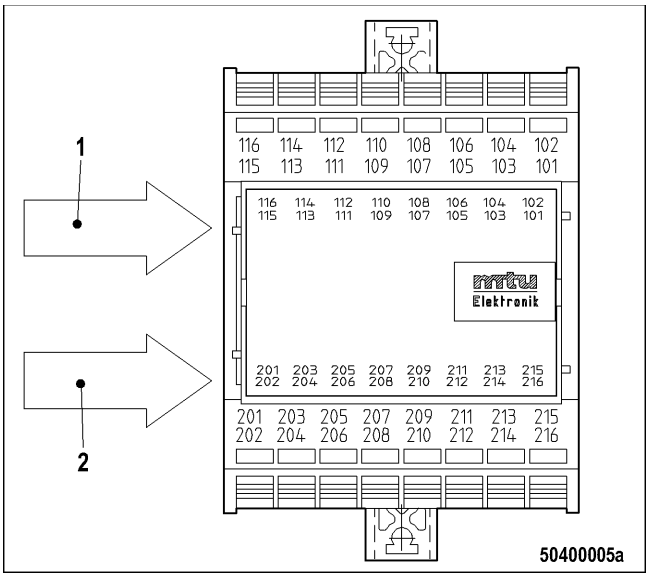
PIM design



1 Module cassette 1
2 Basic module 1
3 Printed circuit board

PIM 601/602 comprises:
- Module cassette 1 (1) to accommodate one MPU 23, MPU 27 and one PIM printed circuit board.
- Basic module 1 (2) with printed circuit board COB 1-0X (3).
- Printed Circuit Board SCB 3 (→ Page 31).

Slots and terminals



1 Slot 1
2 Slot 2

Slot 1 is reserved for the microprocessor card (MPU 23 and MPU 27). All other slots may be populated with PIM printed circuit boards.

Example: The "n" in "n09" stands for the slot and "09" designates the terminal. "209" means: Slot 2, terminal 9.

The following information is transmitted via the optional interface modules PIM 601 and PIM 602:
- Analog operational data

- Analog limit values
- Status messages
- Alarms
- Shutdowns

Function of PIM 601

Serial interface

- Computer coupling 512
- Procedure 3964 (R)
- RS232 or
- RS422
- MTU (SLAVE)

Function of PIM 602

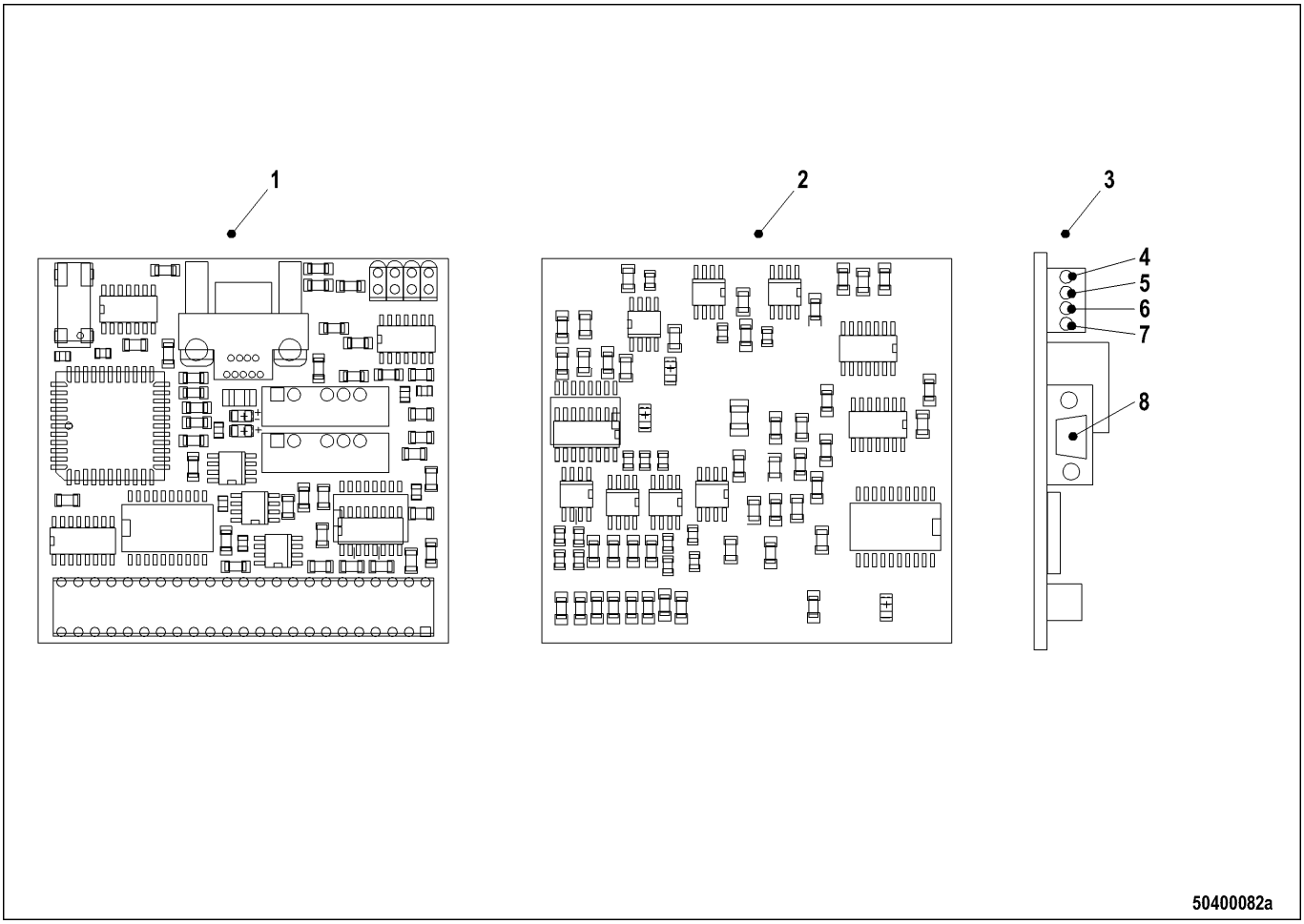
Serial interface

- Computer coupling 512
- Procedure 3964 (R)
- RS232 or
- RS422
- MTU (MASTER)

2.2.3 Printed circuit board SCB 3

Purpose and structure

Design



1 Component side
2 Conductor side
3 Plan view
4 LED (red) "Printed circuit board RESET"
5 LED (green) "Ready"
6 LED (yellow) "Interface 1" Receiving and transmitting line active"
7 LED (yellow) "Interface 2" Receiving and transmitting line active"
8 Connector RS232 interface

Features

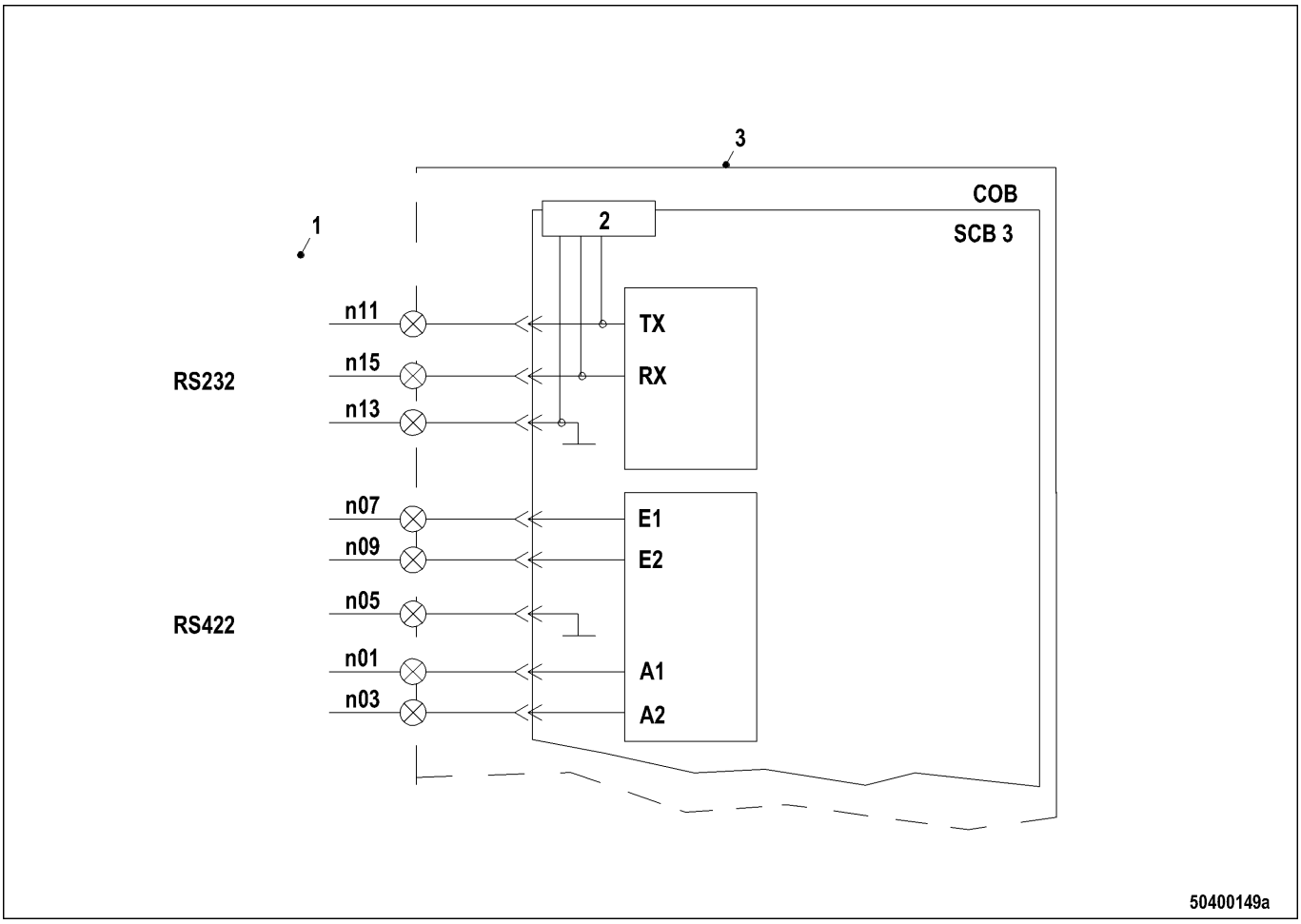
- 2 interfaces as per RS422 or RS232 standard
- Interface are electrically isolated

Use

SCB 3 is used as an interface extension (additional serial interfaces), as an interface converter or as an amplifier.

Function

SCB 3 is equipped with two serial transmission channels routed to the terminal strip of the PIM.



1 Transmission channel 1 2 Connector 3 Module housing with SCB 3

The software of MPU 23 or MPU 27 determines which interface is active on which transmission channel. Only one interface may be active for any one transmission channel.

- Transmission channel 1

  is equipped with a connection for a serial RS422 interface and a serial RS232 interface.

  The RS232 interface is connected via the terminals of the PIM or by a connector.

  When connected by the connector, the terminals of the RS232 interface are automatically switched off.
- Transmission channel 2

  is equipped with a connection for a serial RS422 interface and a serial RS232 interface.

MPU 23 or MPU 27 processes the data and controls the interface drivers.

Connection assignment

Relationship between SCB 3 and the terminals of the PIM.

Terminal	Designation
n01	Channel 1: O1 of RS422 interface
n02	Channel 2: O1 of RS422 interface
n03	Channel 1: O2 of RS422 interface
n04	Channel 2: O2 of RS422 interface
n05	Channel 1: Ground (GND) of RS422 interface
n06	Channel 2: Ground (GND) of RS422 interface
n07	Channel 1: I1 of RS422 interface
n08	Channel 2: I1 of RS422 interface
n09	Channel 1: I2 of RS422 interface
n10	Channel 2: I2 of RS422 interface
n11	Channel 1: TX of RS232 interface
n12	Channel 2: TX of RS232 interface
n13	Channel 1: Ground (GND) of RS232 interface
n14	Channel 2: Ground (GND) of RS232 interface
n15	Channel 1: RX of RS232 interface
n16	Channel 2: RX of RS232 interface

2.2.4 SAM – Technical data

Use

- Installation in enclosed control cabinets.
- Suitable for installation on mounting rails or screw-mounting on cabinet rear wall (fixed installation).
- Suitable for connecting wires or litz wires up to AWG16 (US) (1.5 mm^2).

Technical data

Term	Unit	Value
Installation position		As desired, however integral fault display should be legible.
Operating voltage	VDC	24 rated value (-50%; +30%)
Power consumption	W	Under 6 (0.25A at 24V) without additional load.
Degree of protection:		IP 40 as per DIN 40 050
Shock: Rail mounting Fixed installation		 10g, 11ms 30g, 11ms
Vibration: Rail mounting Fixed installation	 Hz Hz	 2 - 12.8:Xpp < ± 3mm 12.8 - 1000:a < 1g [rms] 2 - 12.8: Xpp < ± 3mm 12.8 - 100:a < 4g [rms]
Ambient temperature:	°C	-40 - +70 in circulating ambient air.
Storage temperature:	°C	-40 - +100
Relative humidity	%	5 - 97, no condensation.
Color:		Blue (RAL5015)
Material:	%	Polycarbonate reinforced with 10% fiberglass.
Dimensions:	mm	L x W x H (295 x 151 x 75)
Weight:	kg	Approx. 1.6

Note: Values stated above may be restricted when MCS 5 extension modules are used.

EMI/EMC – Electromagnetic interference (general)

The SAM has been tested according to the following standards and meets the relevant limit values:

Standard	Testing
EN 55011	(Conducted Emission) 10 kHz - 30 MHz Class A
EN 55011	(Radiated Emission) 30 MHz - 1 GHz
IEC-60533:1999	(Conducted Emission) 10 kHz - 30 MHz (type test)
EC-60533:1999	(Radiated Emission) 150 kHz - 2 GHz (type test)
EN 61000-4-2	(ESD interference immunity) ±8kV
EN 61000-4-3	(Radiated interference immunity) 80MHz - – 2GHz
EN 61000-4-4	(Burst interference immunity) ±2kV
EN 61000-4-5	(Surge interference immunity) ±1kV/±2kV
EN 50155	(Surge interference immunity) ±1.8kV
EN 61000-4-17	(LF conducted interference) 0.03 – 10 kHz / 3Veff
EN 61000-4-29	(Mains fluctuation / STANAG 1008)
IEC 60092-504	(Dielectric strength) 550VAC / 10mA
EN 50155	(Isolation) 500V / 10MOhm

Requirements for fulfillment of EMI/EMC limit values are as follows:

- The housing of the SAM must be connected to housing ground e.g. by a cable with a minimum cross-section of 2.5 mm^2. Cable length shall not exceed 10 cm.
- Twisted-conductor cables only shall be used to connect sensors and actuators. Maximum length of shall not exceed 5 m for unshielded cables and 50 m for shielded cables (providing that cable harness impedance allows).

Electrical requirements

Term	Unit	Value
Operating voltage:	V	24, -50% to +30% (+12 - +32) Admissible residual ripple less than 5% as per STANAG 1008. Note: The processor is automatically reset if the voltage falls below 7.
Power supply:	W	Below 7. Without activated loads at SAM outputs Additional output current on positive or negative conductor shall not exceed 10 A DC in total.
Current terminals:	mm	5.08 terminals (spring-cage terminals) • Wire diameter AWG14 (US) or 2.5 mm^2 recommended.
Electrical isolation:	V	• Supply ground is common reference potential (Common Ground) for all SAM electronics. This applies to the entire I/O range with the exception of certain electrically isolated channels. • SAM electronics ground is not connected to housing ground. • Signal cable shields must be connected to housing ground if applicable. • Maximum direct current isolating voltage is 500 unless otherwise stated.

Mechanical design

Term	Unit	Value
Installation position:		• Horizontal (to facilitate legibility of fault display and inscriptions on SAM housing). • Note that space is required to connect cabling at the top and bottom when installing the SAM in control cabinets. • The device heats up as a result of power loss. Heat from the SAM dissipates through the back wall. Ensure that heat can be conducted away from the back wall of the SAM to the mounting frame. Do not allow neighboring devices to additionally heat up the SAM.

Signal connections

The SAM module is easily replaced. The input and output signal cables are equipped with modular connectors. Common function channels are combined in groups.

The wires are connected using spring-cage terminal technology.

Two wires may be connected to one terminal when the wires are crimped in a double-wire ferrule. For example, a Phoenix AL-TWIN 2* 0.75-10 may be used.

Connector modules are plugged together. The connector modules are equipped with coding pins to preclude polarity reversal.

Terminals

Term	Unit	Value
Terminal strip modules:		WAGO spring-cage terminals
Current-carrying capacity (at 70 °C):	A	10 per contact
Measuring voltage:	V	250
Measuring surge voltage:	V	2500
Wire cross-sections:	mm^2	Up to 1.5 or AWG15
Clamping range:	mm^2	0.08 – 1.5 or AWG15

Note:
Power supply and CAN bus connections feature different terminals (RM 5.08) and wires AWG14 (2.5 mm^2).

2.2.5 SCB 3 – Technical data

General

Term	Unit	Value
Dimensions (H x W x D)	mm	59 x 63 x 15
Weight	kg	0.036
Input voltage	VDC	+5 (±5 %) from MPU 23 or MPU 27
Power consumption	mA	Less than 100
Power loss	mW	Less than 425

Data transmission

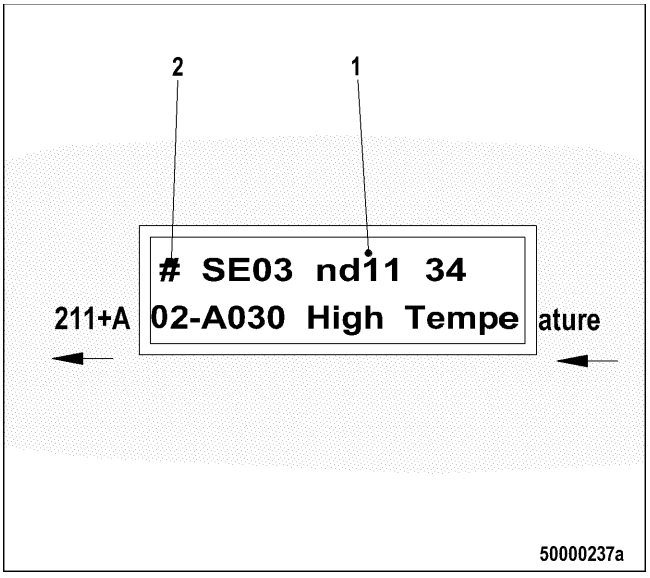
Term	Unit	Value
Bit serial		As per RS422 standard
Baud rate	kBd	1.2 to 19.2
Electrical isolation		With optocoupler.
Bit serial		As per RS232-Standard
Baud rate	kBd	1.2 to 19.2
Electrical isolation		With optocoupler.

Operating Instructions

3 Troubleshooting

3.1 Fault Messages

3.1.1 Fault indication on printed circuit board SAM



The structure of the display (1) is as follows:

- First line
  - Fault indication
    - # (2) = Alarm is no longer active, does not appear on next power-up,
      - A = Currently active alarms,
      - B = Alarm was active during the last hour,
      - C = Alarm was active during the last four hours,
      - C = Alarm was active during the last four to twelve hours,
      - E = Alarm was active more than twelve hours ago.

      .
    - Fault type (e.g. SE03).
    - Node number at which the fault occurred (e.g. nd11).
- Second line
  - Running text, providing more information about the fault currently displayed

Proceed to the next alarm by pressing key (↓ ↑).

Fault type – fault message text

SE No.	Fault message text
0	Sensor Temperature Defect
1	Temperature failure
2	Sensor Voltage Defect
3	Voltage failure
4	CAN Bus- 1 Error/Bus Defec
5	CAN Bus- 1 Overrun
6	CAN Bus- 2 Error/Bus Defec
7	CAN Bus- 2 Overrun
8	Temperature Compensation Error
9	I/O-Module Slot2 Defect
10	I/O-Module Slot3 Defect
11	I/O-Module Slot4 Defect
12	Serial Connection Lost
13	CAN Bus- 3 Error/Bus Defec
14	CAN Bus- 3 Overrun
15	S/A Bus Faulty
16	PAN 1 Defect
17	PAN 2 Defect
18	PAN 3 Defect
19	PAN 4 Defect
20	PAN 5 Defect
21	PAN 6 Defect
22	I/O-Module Slot1 Defect
23	I/O-Module Slot5 Defect
24	I/O-Module Slot6 Defect
25	I/O-Module Slot7 Defect
26	I/O-Module Slot8 Defect
27	Download Server Collision
28	not projected node

Engine governor fault codes and fault messages

Fault code	Fault message	Meaning	Action
005	L1 T-CHARGE AIR	Charge air temperature too high (1st limit value)	Reduce power.
009	L1 T-INTERCOOLER	Charge-air coolant temperature too high (1st limit value)	Reduce power.
015	L1 P-LUBE OIL	Oil pressure too low (1st limit value)	Check oil level, top up as necessary (→ Engine operating instructions).
016	L2 P-LUBE OIL	Oil pressure too low (2nd limit value) automatic engine shutdown.	1 Check oil level, top up as necessary (→ Engine operating instructions). 2 Attempt to restart engine (→ Engine operating instructions).
019	L1 T-EXHAUST A	Exhaust temperature engine A side too high (1st limit value)	1 Check cabling (→ Engine operating instructions); 2 Contact Service.
020	L2 T-EXHAUST A	Exhaust temperature engine A side too high (2nd limit value)	1 Check cabling (→ Engine operating instructions); 2 Contact Service.
021	L1 T-EXHAUST B	Exhaust temperature engine B side too high (1st limit value)	1 Check cabling (→ Engine operating instructions); 2 Contact Service.
022	L2 T-EXHAUST B	Exhaust temperature engine B side too high (2nd limit value)	1 Check cabling (→ Engine operating instructions); 2 Contact Service.
023	L1 COOLANT LEVEL	Coolant level too low (1st limit value)	Check coolant level in expansion tank (→ Engine operating instructions).
024	L2 COOLANT LEVEL	Coolant level too low (2nd limit value)	Check coolant level in expansion tank (→ Engine operating instructions).
025	L1 P-OILFILTER DIFF	Oil filter differential pressure too high (1st limit value)	Check oil filter (→ Engine operating instructions).
027	L1 LEVEL LEAKAGE FUEL	Leak fuel (1st limit value).	Check fuel system (→ Engine operating instructions).
030	ENGINE OVERSPEED	Engine overspeed; automatic emergency engine stop.	1 Acknowledge alarm. 2 Attempt to restart engine.
031	CHARGER 1 OVERSPEED1	ETC 1 – speed violation (1st limit value).	• Engine management system automatically reduces power. • Check air filter (→ Engine operating instructions).
032	CHARGER 1 OVERSPEED2	ETC 1 – speed violation. (2nd limit value)	• Engine management system automatically reduces power. • Check air filter (→ Engine operating instructions).
044	L1 LEVEL INTERCOOLER	Charge air coolant level too high/low (1st limit value violated).	Check coolant level (→ Engine operating instructions).

Fault code	Fault message	Meaning	Action
045	L2 LEVEL INTERCOOLER	Charge air coolant level too high/low (2nd limit value violated).	Check coolant level (→ Engine operating instructions).
051	L1 T-LUBE OIL	Oil temperature too high (1st limit value)	Reduce power.
052	L2 T-LUBE OIL	Lube oil temperature too high (2nd limit value)	1 Reduce power. 2 Check oil level (→ Engine operating instructions).
057	L1 P-COOLANT	Coolant pressure too low (1st limit value) .	Check coolant circuit
058	L2 P-COOLANT	Coolant pressure too low (2nd limit value)	• Automatic engine shutdown. • Check coolant level (→ Engine operating instructions).
065	L1 P-FUEL	Fuel inlet pressure too low (1st limit value)	(→ Engine operating instructions) • Check fuel lines for leakage. • Clean fuel prefilter. • Rinse fuel prefilter. • Replace fuel prefilter element . • Replace fuel filter.
066	L2 P-FUEL	Fuel inlet pressure too low (2nd limit value)	(→ Engine operating instructions) • Check fuel lines for leakage. • Clean fuel prefilter. • Rinse fuel prefilter. • Replace fuel prefilter element . • Replace fuel filter.
067	L1 T-COOLANT	Coolant temperature too high (1st limit value);	Reduce power.
068	L2 T-COOLANT	Coolant temperature too high (2nd limit value); automatic engine shutdown	1 Allow engine to cool down. 2 Contact Service • Check engine coolant cooler, clean if dirty (→ Engine Workshop Manual). 3 Restart engine.
089	ENGINE SPEED LOW	Engine speed has failed to reach 200 rpm. Stop is activated.	Check for additional messages.
100	EDM NOT VALID	Checksum error in Engine Data Module EDM/EEPROM 1.	Redundant design of EDM allows engine management system to remain operational.
101	IDM NOT VALID	Checksum error in Interface Data Module IDM/EEPROM 2.	Redundant design of EDM allows engine management system to remain operational.
102	INVALID FUEL CONS. 1	Invalid fuel consumption display, checksum error in EDM/EEPROM 1 (redundant data record 1).	Contact Service.

Fault code	Fault message	Meaning	Action
103	INVALID FUEL CONS. 2	Invalid fuel consumption display, checksum error in IDM/EEPROM 2 (redundant data record 2).	Contact Service.
104	OP HOURS1 NOT VALID	Checksum error of hour meter in EDM/EEPROM 1	Hour meter remains operational.
105	OP HOURS2 NOT VALID	Checksum error of hour meter in IDM/EEPROM 2	Hour meter remains operational.
106	ERR REC1 NOT VALID	Checksum error of fault memory in EDM/EEPROM 1 (redundant data record 1).	Faults are still recorded.
107	ERR REC2 NOT VALID	Checksum error of fault memory in IDM/EEPROM 2 (redundant data record 2).	Faults are still recorded.
118	L1 SUPPLY VOLT. LOW	Supply voltage too low (1st limit value)	Contact Service. • Check engine governor supply voltage.
119	L2 SUPPLY VOLT. LOW	Supply voltage too low (2nd limit value)	Contact Service. • Check engine governor supply voltage.
120	L1 SUPPLY VOLT. HIGH	Supply voltage too high (1st limit value).	Contact Service. • Check engine governor supply voltage.
121	L2 SUPPLY VOLT. HIGH	Supply voltage too high (2nd limit value); automatic engine shutdown (configurable):	Contact Service. • Check engine governor supply voltage.
122	L1 T-ELECTRONIC	Temperature in ECU housing too high (1st limit value)	1. Improve engine room ventilation. 2. Reduce engine power.
134	15V POS ECU DEFECT	Internal voltage (-15 VDC) faulty; automatic engine shutdown.	Replace engine governor (→ Engine operating instructions).
136	15V NEG ECU DEFECT	Internal voltage (-15 VDC) missing; automatic engine shutdown	Contact Service.
139	L1 TE BUFFER TEST	Temperature sensor supply voltage faulty.	Contact Service. • Check sensors; • replace engine governor.
140	TE BUF. ECU DEFECT	Temperature sensor supply voltage faulty.	Contact Service. • Check sensors; • replace engine governor.
142	BANK1 ECU DEFECT	Power output stage for control of solenoid valves on bank 1 is faulty; engine does not start.	Replace engine governor (→ Engine operating instructions).

Fault code	Fault message	Meaning	Action
144	BANK2 ECU DEFECT	Power output stage for control of solenoid valves on bank 2 is faulty; engine does not start.	Replace engine governor (→ Engine operating instructions).
145	15V_GOOD ECU DEFECT	Power supply is faulty; automatic engine shutdown.	Replace engine governor (→ Engine operating instructions).
146	L1 AD-TEST1 SUPPLY	A/D converter supply voltage too low.	Replace engine governor (→ Engine operating instructions).
147	AD-TEST1 ECU DEFECT	Electronics faulty; automatic engine shutdown.	Replace engine governor (→ Engine operating instructions).
148	L1 AD-TEST2 SUPPLY	A/D converter supply voltage too low.	Replace engine governor (→ Engine operating instructions).
149	AD-TEST2 ECU DEFECT	Internal electronics faulty; automatic engine shutdown.	Replace engine governor (→ Engine operating instructions).
150	L1 AD-TEST3 SUPPLY	Internal electronics faulty; automatic engine shutdown.	Replace engine governor (→ Engine operating instructions).
151	AD-TEST3 ECU DEFECT	Internal electronics faulty; automatic engine shutdown.	Replace engine governor (→ Engine operating instructions).
186	CAN 1 BUS OFF	CAN 1 in Bus-Off state: • Either short circuit on bus. • Or strong magnetic fields disrupting bus.	Contact Service. • Check CAN bus for short circuit, rectify short circuit as necessary. • Check shielding, improve shielding as necessary.
187	CAN 1 ERROR PASSIVE	CAN 1 in Error-Passive state, minor bus disruption or missing CAN node .	Contact Service. • Check that at least one CAN node is present. Check cabling as necessary. • Check shielding, improve shielding as necessary.
188	CAN 2 BUS OFF	CAN 2 in Bus-Off state: • Either short circuit on bus. • Or strong magnetic fields disrupting bus.	Contact Service. • Check CAN bus for short circuit, rectify short circuit as necessary. • Check shielding, improve shielding as necessary.
189	CAN 2 ERROR PASSIVE	CAN 2 in Error-Passive state, minor bus disruption or missing CAN node .	Contact Service. • Check that at least one CAN node is present. Check cabling as necessary. • Check shielding, improve shielding as necessary.
201	SD T-COOLANT	Sensor B06 faulty (coolant temperature).	1 Check cabling (→ Engine operating instructions); 2 Contact Service • Check sensor.
202	SD T-FUEL	Sensor B33 faulty (fuel temperature).	1 Check cabling (→ Engine operating instructions); 2 Contact Service • Check sensor.

Fault code	Fault message	Meaning	Action
203	SD T-CHARGE AIR	Sensor B09 faulty (charge air temperature) A-side.	1Check cabling (→ Engine operating instructions); 2Contact Service • Check sensor.
205	SD T-COOLANT INTERC.	Sensor fault (charge-air coolant temperature).	1Check cabling (→ Engine operating instructions); 2Contact Service • Check sensor.
206	SD T-EXHAUST A	Sensor B4.21 faulty (exhaust temperature) engine side A.	1Check cabling (→ Engine operating instructions); 2Contact Service • Check sensor.
207	SD T-EXHAUST B	Sensor B4.22 faulty (exhaust temperature) engine side B.	1Check cabling (→ Engine operating instructions); 2Contact Service • Check sensor.
208	SD P-CHARGE AIR	Sensor B10 faulty (charge-air pressure) A-side.	1Check cabling (→ Engine operating instructions); 2Contact Service • Check sensor.
211	SD P-LUBE OIL	Sensor B05 faulty (lube oil pressure).	1Check cabling (→ Engine operating instructions); 2Contact Service • Check sensor.
212	SD P-COOLANT	Sensor B16 faulty (coolant pressure).	1Check cabling (→ Engine operating instructions); 2Contact Service • Check sensor.
216	SD T-LUBE OIL	Sensor B07 faulty (lube oil temperature).	1Check cabling (→ Engine operating instructions); 2Contact Service • Check sensor.
219	SD T-INTAKE AIR	Sensor B03 faulty (intake air temperature).	1Check cabling (→ Engine operating instructions); 2Contact Service • Check sensor.
220	SD COOLANT LEVEL	Sensor F33 faulty (engine coolant level 1).	1Switch system off and back on; 2check fault message; 3check cabling (→ Engine operating instructions); 4Contact Service • Check sensor.
222	SD LEVEL LEAKAGE FUEL	Sensor fault (leak fuel).	1Check cabling (→ Engine operating instructions); 2Contact Service • Check sensor.
223	SD LEVEL INTERCOOLER	Sensor fault (charge air coolant level).	1Check cabling (→ Engine operating instructions); 2Contact Service • Check sensor.

Fault code	Fault message	Meaning	Action
229	SD ENG. SPEED SENSORS	Sensor fault crankshaft speed and camshaft speed.	1Check cabling (→ Engine operating instructions); 2Contact Service • Check sensor.
230	SD CRANKSHAFT SPEED	Sensor B13 faulty (crankshaft speed).	1Check cabling (→ Engine operating instructions); 2Contact Service • Check sensor.
231	SD CAMSHAFT SPEED	Sensor B1 faulty (camshaft speed).	1Check cabling (→ Engine operating instructions); 2Contact Service • Check sensor.
232	SD CHARGER SPEED 1	Sensor B44 faulty (ETC speed 1).	1Check cabling (→ Engine operating instructions); 2Contact Service • Check sensor.
240	SD P-FUEL	Sensor B34 faulty (fuel pressure).	1Check cabling (→ Engine operating instructions); 2Contact Service • Check sensor.
245	SD POWER SUPPLY	Sensor fault (ECU operating voltage).	Replace engine governor (→ Engine operating instructions).
246	SD T-ELECTRONIC	Temperature sensor for measuring electronics temperature faulty.	Replace engine governor (→ Engine operating instructions).
250	SD CAN SPEED DEMAND	Sensor fault (CAN setpoint speed).	Contact Service. • Check CAN communication.
266	SD SPEED DEMAND AN.	External speed setting faulty.	(→ Engine operating instructions) 1Check cabling 2Check speed setting.
267	SD SP. DEM. TEST BENCH	External test bench speed setting faulty.	Check potentiometer and cabling (→ Engine operating instructions).
270	SD SPEED DEMAND	Sensor fault frequency setting.	1Check cabling (→ Engine operating instructions); 2Contact Service • Check setpoint speed sensor.
301...310	TIMING CYLINDER (A1- A10)	Timing bank 1 (solenoid valve 1) ... Timing bank 1 (solenoid valve 10)	Replace injector if fault message occurs frequently (→ Engine operating instructions).
311...320	TIMING CYLINDER (B1- B10)	Timing bank 2 (solenoid valve 1) ... Timing bank 2 (solenoid valve 10)	Replace injector if fault message occurs frequently (→ Engine operating instructions).
321...330	WIRING CYLINDER (A1- A10)	Wiring bank 1 (solenoid valve 1) ... Wiring bank 1 (solenoid valve 10)	Contact Service. • Check solenoid valve.
331...340	WIRING CYLINDER (B1- B10)	Wiring bank 2 (solenoid valve 1) ... Wiring bank 2 (solenoid valve 10)	Contact Service. • Check solenoid valve.

Fault code	Fault message	Meaning	Action
341...350	OPEN_LOAD CYL. (A1- A10)	Open load bank 1 (solenoid valve 1) ... Open load bank 1 (solenoid valve 10)	Contact Service. • Check solenoid valve.
351...360	OPEN_LOAD CYL. (B1- B10)	Open load bank 2 (solenoid valve 1) ... Open load bank 2 (solenoid valve 10)	Contact Service. • Check solenoid valve.
361	POWER STAGE FAIL 1	Fault in ECU (solenoid valve output stage bank 1).	(→ Engine operating instructions) 1 Check solenoid valve cabling. 2 Replace engine governor.
362	POWER STAGE FAIL 2	Fault in ECU (solenoid valve output stage bank 2).	(→ Engine operating instructions) 1 Check solenoid valve cabling. 2 replace engine governor.
363	STOP STAGE FAIL 1	Fault in solenoid valve, cabling or ECU; automatic engine shutdown.	1 Check cabling (→ Engine operating instructions). 2 Attempt to restart engine.
364	STOP STAGE FAIL 2	Fault in solenoid valve, cabling or in ECU; automatic engine shutdown.	1 Check cabling (→ Engine operating instructions). 2 Attempt to restart engine
365	STOP MV-WIRING	Fault in solenoid valve cabling; automatic engine shutdown.	1 Check cabling (→ Engine operating instructions). 2 Attempt to restart engine.
371	TRAN.OUT1 ENGINE DEF	Binary transistor output engine 1 faulty.	(→ Engine operating instructions) • Check charger valve/cabling repair as necessary • Replace engine governor.
372	TRAN.OUT2 ENGINE DEF	Binary transistor output engine 2 faulty.	(→ Engine operating instructions) • Check air recirculation valve/cabling repair as necessary. • Replace engine governor.
373	TRAN.OUT3 ENGINE DEF	Binary transistor output engine 3 faulty.	-
374	TRAN.OUT4 ENGINE DEF	Binary transistor output engine 4 faulty.	-
381	TRAN.OUT1 PLANT DEF	Binary transistor output TAA 1 faulty.	Check cabling to plant.
382	TRAN.OUT2 PLANT DEF	Binary transistor output TAA 2 faulty.	Check cabling to plant.
383	TRAN.OUT3 PLANT DEF	Binary transistor output TAA 3 faulty.	Check cabling to plant.
384	TRAN.OUT4 PLANT DEF	Binary transistor output TAA 4 faulty.	Check cabling to plant.
385	TRAN.OUT5 PLANT DEF	Binary transistor output TAA 5 faulty.	Check cabling to plant.
386	TRAN.OUT6 PLANT DEF	Binary transistor output TAA 6 faulty.	Check cabling to plant.

Fault code	Fault message	Meaning	Action
390	MCR EXCEEDED	MCR violation	1 No action necessary if alarm only signaled temporarily; 2 contact Service if alarm signaled permanently.
392	L1 T-COOLANT RED	Redundant coolant temperature (1st limit value).	1 Check cabling (→ Engine operating instructions). 2 Contact Service • Check sensor.
393	L2 T-COOLANT RED	Redundant coolant temperature (2nd limit value).	1 Check cabling (→ Engine operating instructions). 2 Contact Service • Check sensor.
394	L1 P-LUBE OIL RED	Redundant lube oil pressure (1st limit value).	1 Check cabling (→ Engine operating instructions). 2 Contact Service • Check sensor.
395	L2 P-LUBE OIL RED	Redundant lube oil pressure (2nd limit value).	1 Check cabling (→ Engine operating instructions). 2 Contact Service • Check sensor.
396	TD COOLANT	Transmitter deviation coolant temperature.	1 Check cabling (→ Engine operating instructions). 2 Contact Service • Check sensor.
397	TD OIL PRESSURE	Transmitter deviation engine oil pressure.	1 Check cabling (→ Engine operating instructions). 2 Contact Service • Check sensor.

Installation and Initial Operation

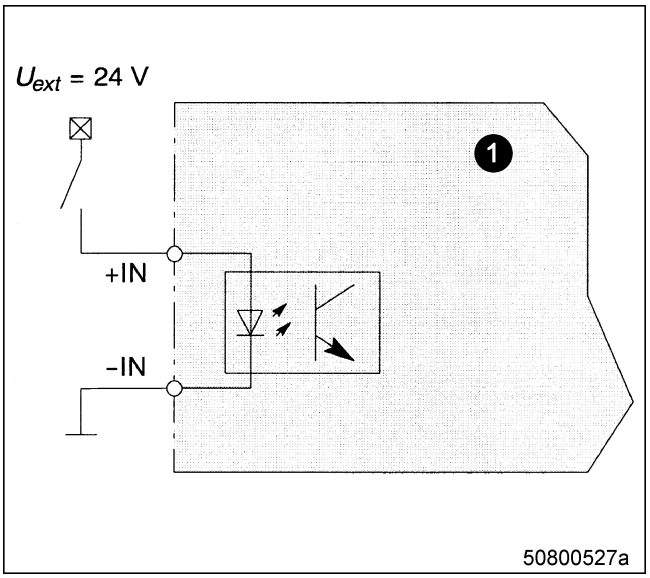
4 Assignment and Circuitry

4.1 Engine Governor

4.1.1 Engine governor channel circuitry

Engine governor channel circuitry

Binary inputs BE1 to BE9



1 Engine Control Unit ECU 4

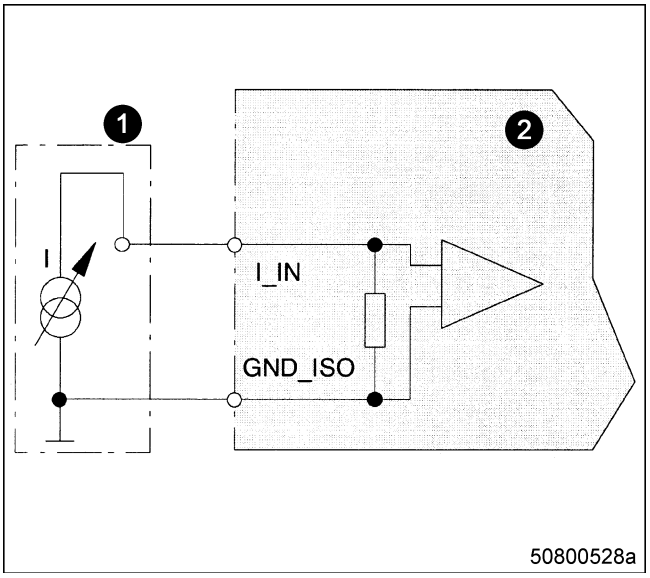
Function

Function	Source
Acquisition of binary signals.	Switches, pushbuttons, monitors, contacts.

Channel specification

Type	Isolated binary input, external supply.
Input signal	U_{In}(high) = 24 V (min. 8 V). U_{In}(low) = 0 V (max. 4 V).

Current input IUE 1



1 Current source, voltage source
2 Engine Control Unit ECU 4

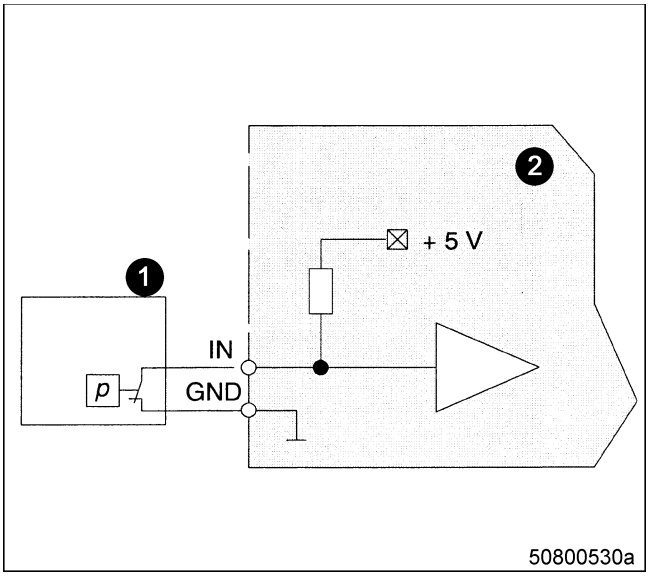
Function

Function	Source
Acquisition of a current signal (4 to 20 mA).	-

Measuring channel specification

Measuring range	I_{In} = 4 to 20 mA; Load: At 20 mA approx. 4 V; isolated. Or: UIn = 0 to 10 V

Binary sensor input NSE 1

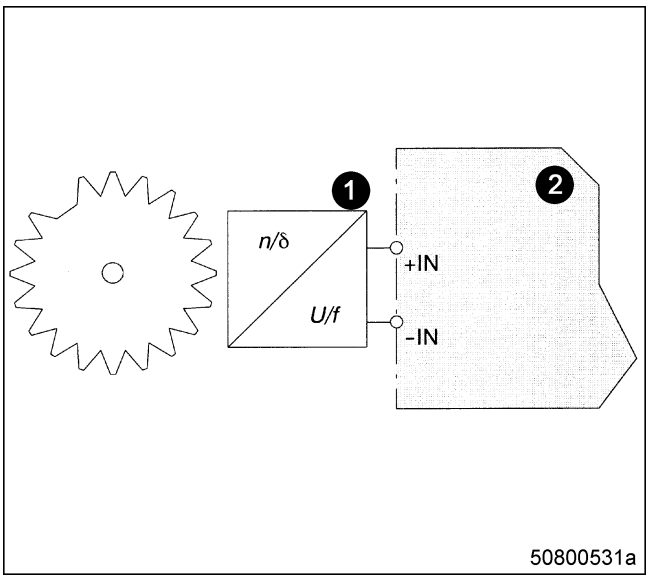


1 Monitor contact
2 Engine Control Unit ECU 4

Function

Function	Source
Lube oil differential pressure monitoring.	Lube oil differential pressure monitor

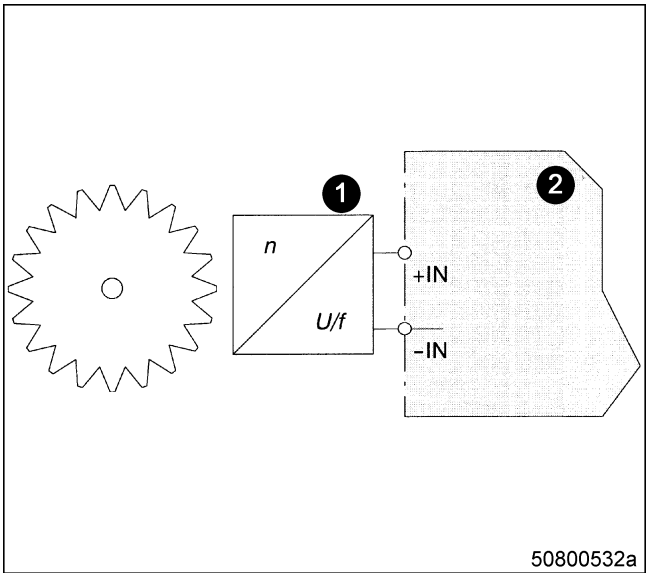
Pulse measuring inputs KW 1 and NW 1



1 Inductive sensor
2 Engine Control Unit ECU 4

Channel	Function	Sensor
KW1	Measuring of crankshaft angle and crankshaft speed.	Inductive sensor
NW1	Measuring of camshaft angle and camshaft speed.	Inductive sensor

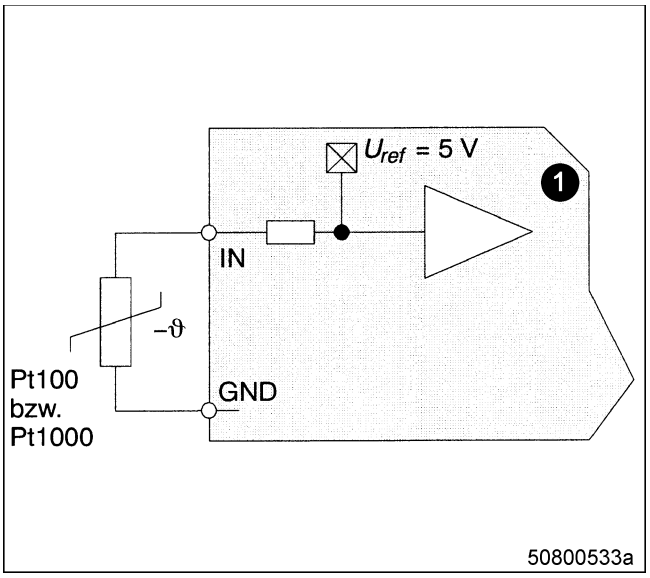
Speed measuring input DME 1, DME 2



1 Inductive sensor
2 Engine Control Unit ECU 4

Function	Sensor
Measuring of speeds (e.g. ETC).	Inductive sensor

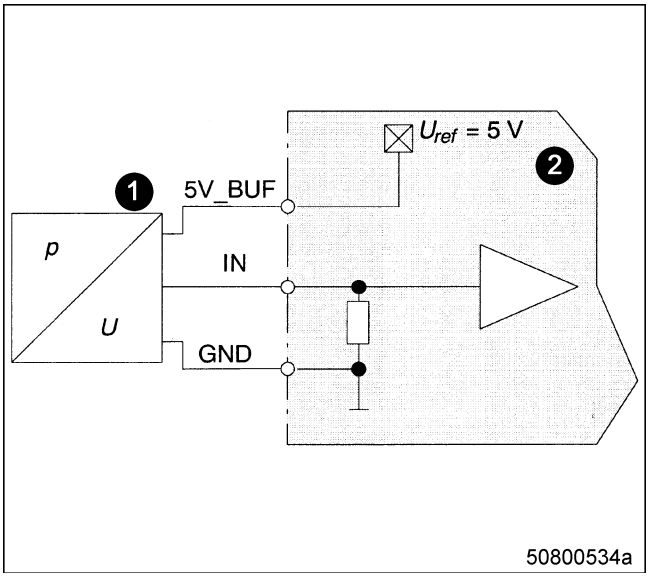
Temperature inputs TE 1 to TE 9



1 Engine Control Unit ECU 4

Function	Sensor
Temperature measuring	Temperature-dependent resistor Pt100/Pt1000 (exhaust gas temperatures are measured with Pt100).

Pressure inputs DE 1 to DE 7



1 Pressure sensor
2 Engine Control Unit ECU 4

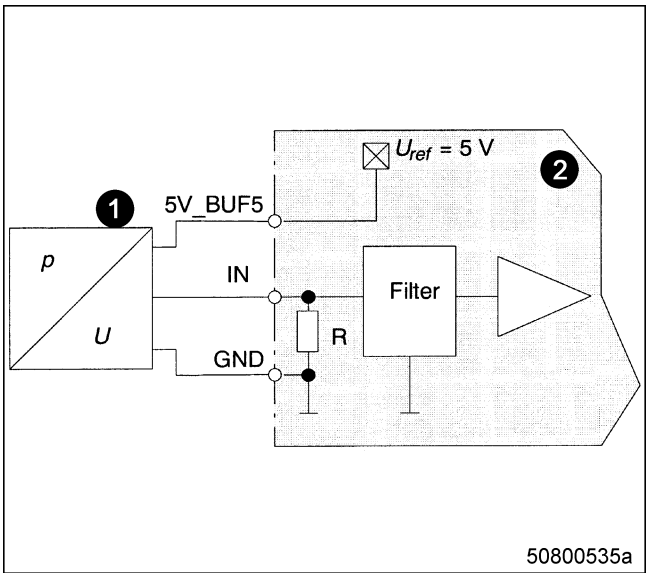
Function

Function	Sensor
Pressure range measuring	Relative pressure sensors (exception: The charge-air pressure sensor is an absolute pressure sensor).

Measuring channel specification

Measuring range	Sensor-dependent
Output signal U_O	0.5 to 4.5 VDC
Sensor supply	5 V ± 250 mV

Pressure measuring input HP pump DEH (rail pressure)



1 Pressure sensor
2 Engine Control Unit ECU 4

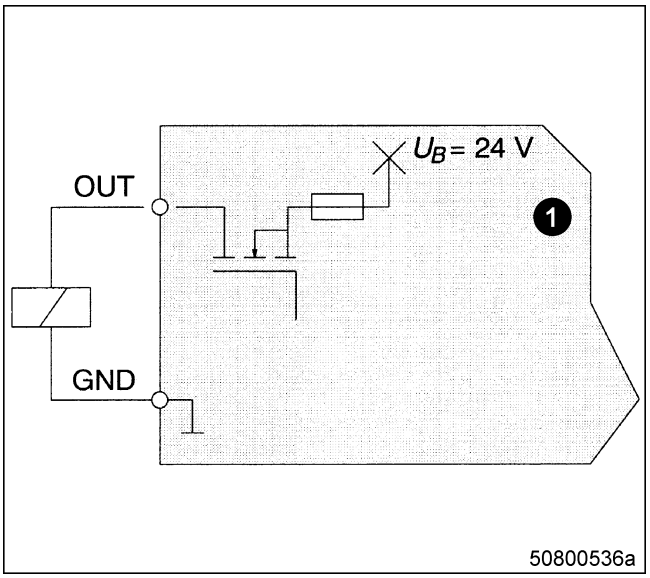
Function

Function	Sensor
Pressure measuring	Relative pressure sensor

Measuring channel specification

Measuring range	Sensor-dependent
Output signal U_O	0.5 to 4.5 VDC
Sensor supply	5 V ± 250 mV

Transistor outputs TAA 1 to TAA 6



1 Engine Control Unit ECU 4

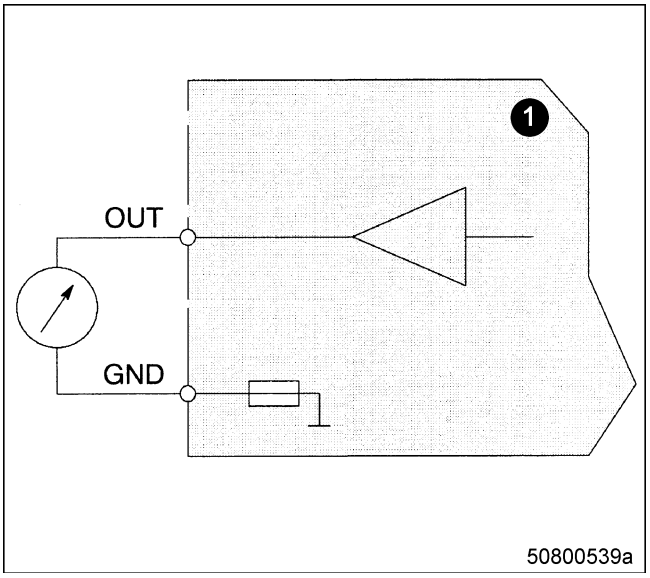
Function

Function	Sensor
Switching output	Plant

Channel specification

Channel	TAA1 to TAA6 positive-switching 24 VDC.
Output current	TAA1 to TAA4: I_O = 150 mA max. TAA5: I_O = 300 mA max. TAA6: I_O = 1 A max.

Voltage outputs UA 1 to UA 4



1 Engine Control Unit ECU 4

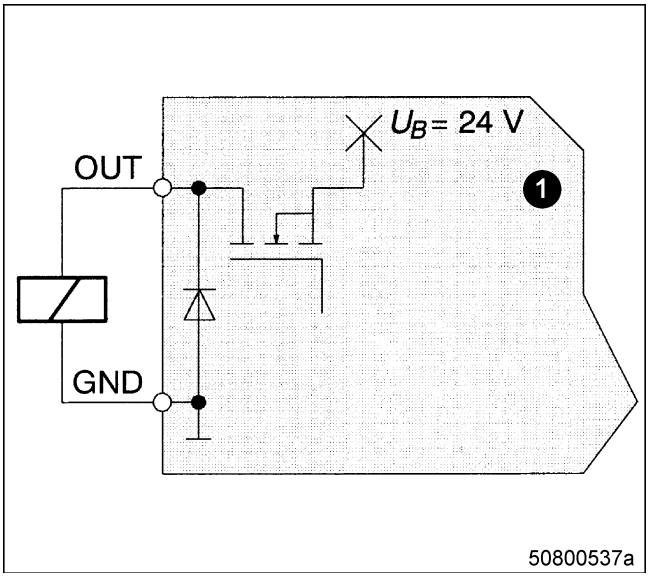
Function

Function	Sensor
Output voltage 0 to 10 V, e.g. for display instruments	Plant

Channel specification

Output voltage	U_O = 0 to 10 V
Output current	I_O = 5 mA max.

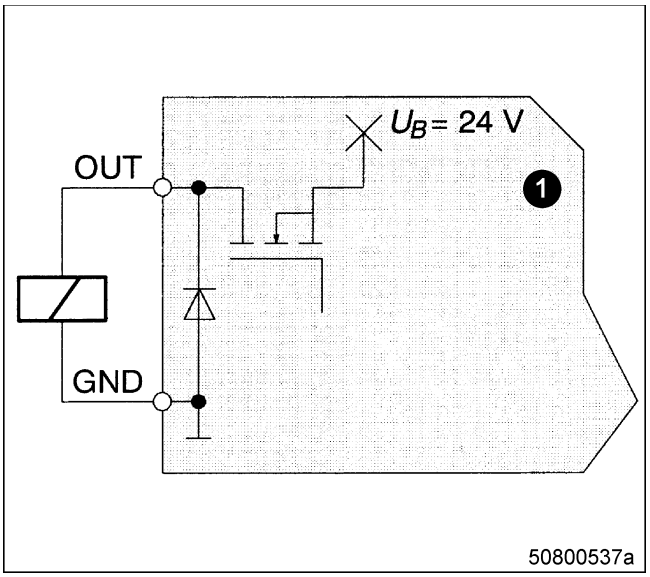
Transistor outputs TAM 1 to TAM 4



1 Engine Control Unit ECU 4

Function	Sensor
Switching output	Engine

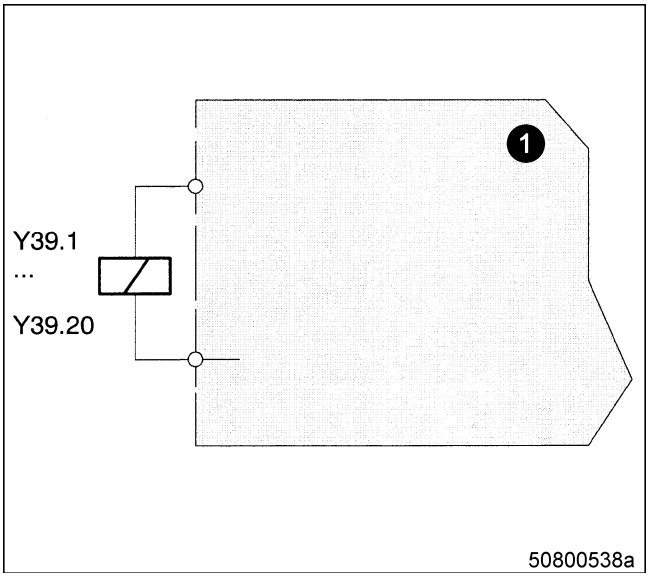
PWM output PDM 2



1 Engine Control Unit ECU 4

Function	Sensor
Switching output	Engine

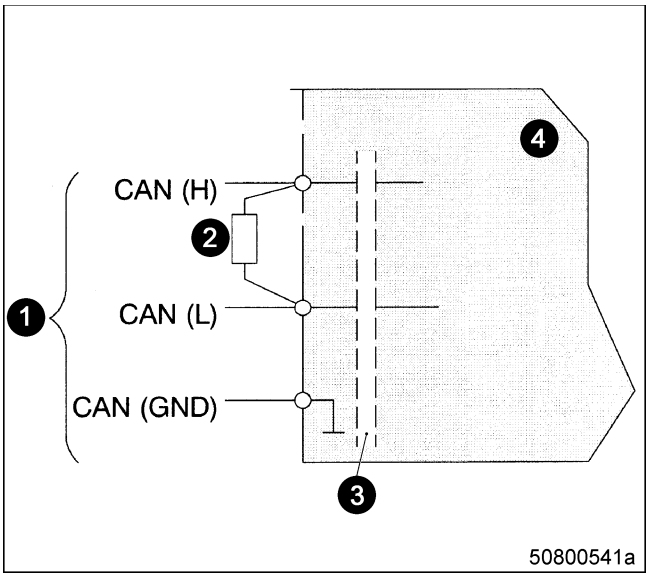
Solenoid valve outputs MVA 1 to MVA 20



1 Engine Control Unit ECU 4

Function	Sensor
Injector control	Injection solenoid valve

CAN bus interface



1 CAN bus
2 Terminator
3 Electrical isolation
4 Engine Control Unit ECU 4

Function

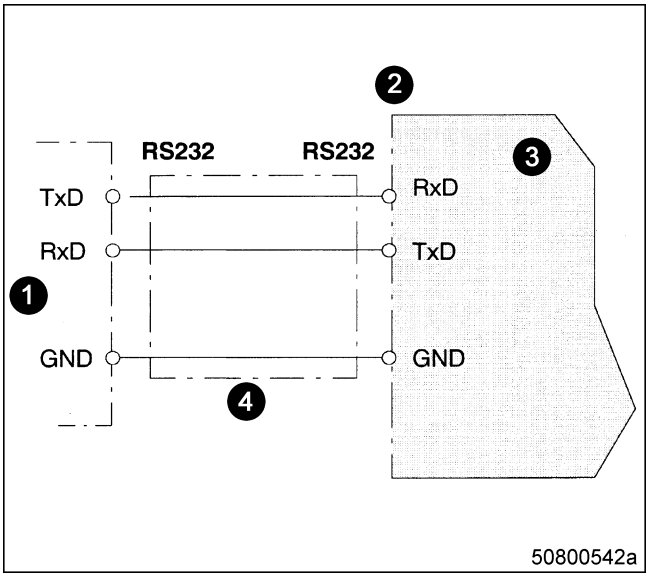
Channel	Function	Target
CAN1 / CAN2	Bus connection to external systems.	MCS

Channel specification

Physical level	ISO 11 898
CAN specification	Version 2.0 A
Data format	MTU-specific
Terminator	In connector (no bus disruption when connector disconnected)
Baud rate	125 kbaud
Electrical isolation	± 50 V

The CAN bus interfaces operate independently of each other.

Serial interface RS232



1 Dialog unit
2 Connector XC6
3 Engine Control Unit ECU 4
4 Dialog cable

Channel	Function	Target
RS232	Serial interface for data transmission between dialog unit and engine governor.	Dialog unit

4.1.2 MDEC governor assignment

Scope of delivery

Included in the scope of delivery are:

- SAM
- W004 MDEC connector X1 10 m long (15 m and 25 m available as an option).
- W003 (4x2.5 mm^2) MDEC connector X5 (15 m and 25 m available as an option).

The MDEC governor is protected by a 20 A automatic cutout via cable W003 connector X5.

The PIM modules are wired to a separate 10 A fuse (see MTU wiring diagram).

All control, display and communication signals are in interface cable W004 MDEC connector X1.

CAN 1 is transmitted to the PIM module(s) via conductors 48, 49, 50 and CAN 2 via conductors 51, 52, 53.

A 121 ohm CAN bus terminal resistor must be installed for CAN 1 and CAN 2 respectively at the last PIM module.

Terminal resistors for the MDEC governor are already fitted in cable W004 connector X1.

Digital MDEC inputs/outputs

Inputs

Observe input polarity.

BE1 Stop input	This input is inverted (line-break protected), i e 24 V DC must always be applied to BE1 for engine operation.
BE2 Cylinder cutout	The cylinder cutout function is deactivated via this input.
BE3 SISY override	Activating BE8 suppresses all VDS operation shutdown messages such as “Lube oil pressure too low”. The corresponding outputs such as Combined alarm red are still set.
BE4 Fixed speed	The fixed speed function is activated via this input.
BE5 Speed up	Binary input for speed up.
BE6 Speed down	Binary input for speed down.
BE7 Speed droop 2 / desired speed setting	Speed droop can be switched via this input with the engine running/at a standstill. Default speed droop setting in the governor: • 1 = 4% • 2 = 0%
BE8	Not used.
BE9	Not used.

Outputs

Observe max. output current-carrying capacity.

TAA1 Emergency stop	Transistor output for emergency stop.
TAA2 Automatic engine stop	Transistor output for automatic engine stop.
TAA3 Combined alarm	All warning messages (Limit1) are indicated here as a combined alarm.
TAA4 n > 300	Indication of engine speed > 300 rpm.
TAA5 SS T-coolant	Shutdown, coolant temperature too high.
TAA6 SS P-lube oil	Shutdown, lube oil pressure too low.

Analog MDEC inputs

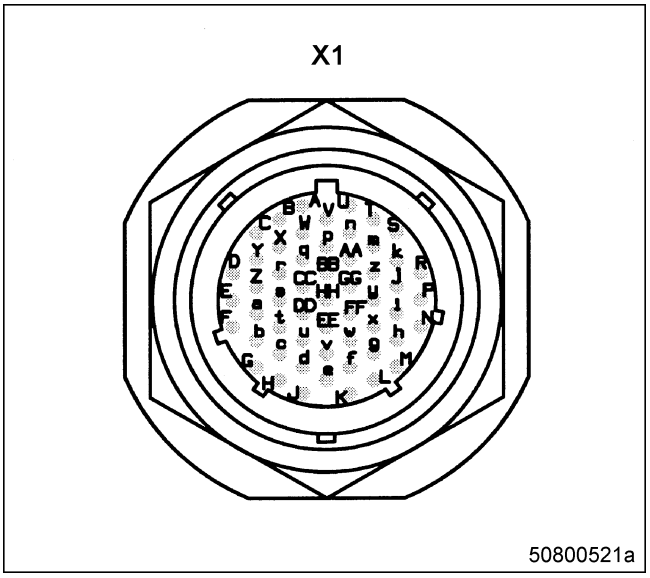
IEU1 = 0 to 10 V or 4 to 20 mA	It is possible to activate different analog desired speed settings for the MDEC governor. Default setting: • Characteristic curve 71 (50 Hz) in MDEC governor 0 to 10 V activated. Parameterized desired speed setting 4 to 20 mA must be changed if desired. Same applies to characteristic curve 72 (60 Hz).

4.2 Connector Assignment

4.2.1 Connector pin assignment

Connector pin assignment

Connector X1, view to socket



Connector X1

Connector type	VPT 06 GSE 22–55 P
Target	Plant wiring harness

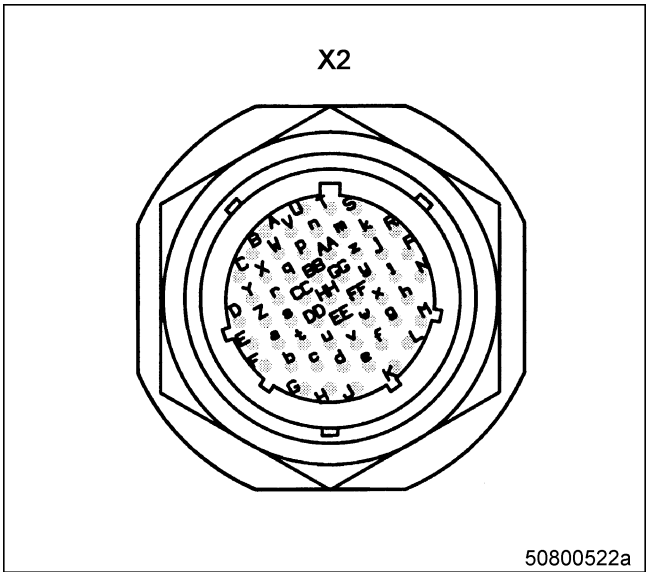
Pin assignment

Channel	Signal	Pin	Comments
IUE1	5V_ISO	BB	5 V / 20 mA electrically isolated
IUE1	U_IN	AA	0 V to 10 V
IUE1	I_IN	X	0 V to 23.7 mA
IUE1	GND_ISO	q	
IUE2	5V_ISO	b	5 V / 20 mA electrically isolated
IUE2	U_IN	r	0 V to 10 V
IUE2	I_IN	A	0 V to 23.7 mA
IUE2	GND_ISO	W	
UA1	OUT	HH	0 V to 10 V/ 8 mA
UA1	GND	GG	
UA2	OUT	DD	0 V to 10 V/ 8 mA

Channel	Signal	Pin	Comments
UA2	GND	CC	
UA3	OUT	t	0 V to 10 V/ 8 mA
UA3	GND	s	
UA4	OUT	Z	0 V to 10 V/ 8 mA
UA4	GND	Y	
BE1	+IN	h	U < 4 V = low / U > 8 V = high
BE1	-IN	g	Electrically isolated
BE2	+IN	x	U < 4 V = low / U > 8 V = high
BE2	-IN	w	Electrically isolated
BE3	+IN	R	U < 4 V = low / U > 8 V = high
BE3	-IN	P	Electrically isolated
BE4	+IN	j	U < 4 V = low / U > 8 V = high
BE4	-IN	i	Electrically isolated
BE5	+IN	FF	U < 4 V = low / U > 8 V = high
BE5	-IN	EE	Electrically isolated
BE6	+IN	v	U < 4 V = low / U > 8 V = high
BE6	-IN	u	Electrically isolated
BE7	+IN	f	U < 4 V = low / U > 8 V = high
BE7	-IN	e	Electrically isolated
BE8	+IN	d	U < 4 V = low / U > 8 V = high
BE8	-IN	c	Electrically isolated
BE9	+IN	N	U < 4 V = low / U > 8 V = high
BE9	-IN	M	Electrically isolated
FE1	GND	J	U < 1.5 V = low / U > 3.5 V = high
FE1	IN	H	Frequency input
TAA1	GND	V	24 V / 600 mA
TAA1	GND	U	

Channel	Signal	Pin	Comments
TAA2	OUT	p	24 V / 600 mA
TAA2	GND	n	
TAA3	OUT	T	24 V / 600 mA
TAA3	GND	S	
TAA4	OUT	z	24 V / 600 mA
TAA4	GND	y	
TAA5	OUT	m	24 V / 600 mA
TAA5	GND	k	
TAA6	OUT	L	24 V / 2 A
TAA6	GND	K	(Plant supply, coil instruments FZ)
CAN1	HIGH	G	Electrically isolated
CAN1	LOW	F	
CAN1	GND	E	
CAN2	HIGH	C	Electrically isolated
CAN2	LOW	B	
CAN2	GND	D	

Connector X2, view to socket



Connector X2

Connector type	VPT 06 GSE 22–55 PW
Target	Engine wiring harness

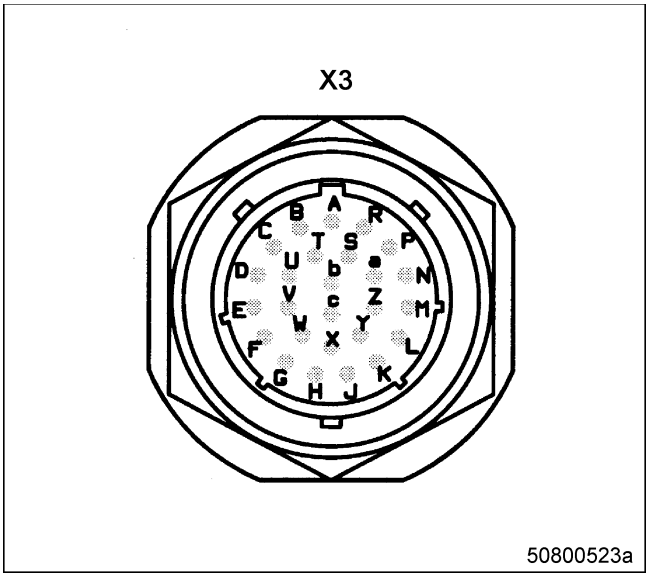
Pin assignment

Channel	Signal	Pin	Comments
TE1	IN	k	0 V to 5 V/ internal 2 k0 pullup to 5 V_TE_BUF
TE1	GND	z	
TE2	IN	N	0 V to 5 V/ internal 2 k0 pullup to 5 V_TE_BUF
TE2	GND	P	
TE5	IN	M	0 V to 5 V/ internal 2 k0 pullup to 5 V_TE_BUF
TE5	GND	g	
TE6	IN	y	0 V to 5 V/ internal 2 k0 pullup to 5 V_TE_BUF
TE6	GND	FF	
TE7	IN	w	0 V to 5 V/ internal 2 k0 pullup to 5 V_TE_BUF
TE7	GND	x	
TE8	IN	t	0 V to 5 V/ internal 2 k0 pullup to 5 V_TE_BUF
TE8	GND	a	
TE9	IN	E	0 V to 5 V/ internal 2 k0 pullup to 5 V_TE_BUF
TE9	GND	F	
DE1	5 V_BUF1	D	5 V / 20 mA
DE1	IN	Z	0 V to 5 V / internal 47k5 pulldown
DE1	GND	Y	
DE2	5 V_BUF1	r	5 V / 20 mA
DE2	IN	s	0 V to 5 V / internal 47k5 pulldown
DE2	GND	CC	
DE3	5 V_BUF2	BB	5 V / 20 mA
DE3	IN	GG	0 V to 5 V / internal 47k5 pulldown
DE3	GND	HH	
DE4	5 V_BUF2	d	5 V / 20 mA
DE4	IN	H	0 V to 5 V / internal 47k5 pulldown
DE4	GND	J	

Channel	Signal	Pin	Comments
DE5	5 V_BUF3	f	5 V / 20 mA
DE5	IN	v	0 V to 5 V / internal 47k5 pulldown
DE5	GND	e	
DE6	5 V_BUF3	EE	5 V / 20 mA
DE6	IN	DD	0 V to 5 V / internal 47k5 pulldown
DE6	GND	u	
DE7	5 V_BUF4	c	5 V / 20 mA
DE7	IN	G	0 V to 5 V / internal 47k5 pulldown
DE7	GND	b	
NSE1	24 V_NSE1	X	Sensor supply max. 300 mA
NSE1	IN	C	0 V to 5 V/ internal 47k5 pullup to 5 V_TE_BUF
NSE1	GND	B	
NSE2	24 V_NSE2	W	Sensor supply max. 300 mA
NSE2	IN	q	0 V to 5 V/ internal 47k5 pullup to 5 V_TE_BUF
NSE2	GND	V	
KW	+IN	m	U < 0 V = low / U > 400 mV = high
KW	-IN	S	
NW	+IN	T	U < 0 V = low / U > 400 mV = high
NW	-IN	n	
DME1	+IN	p	U < -400 mV = low / U > 400 mV = high
DME1	-IN	AA	
DME2	+IN	A	U < -400 mV = low / U > 400 mV = high
DME2	-IN	U	
PDM1	OUT	K	24 V / 3 A
PDM1	GND	L	
TAM1	OUT	R	24 V / 1.5 A

Channel	Signal	Pin	Comments
TAM1	GND	j	
TAM2	OUT	h	24 V / 1.5A
TAM2	GND	i	

Connector X3, view to socket



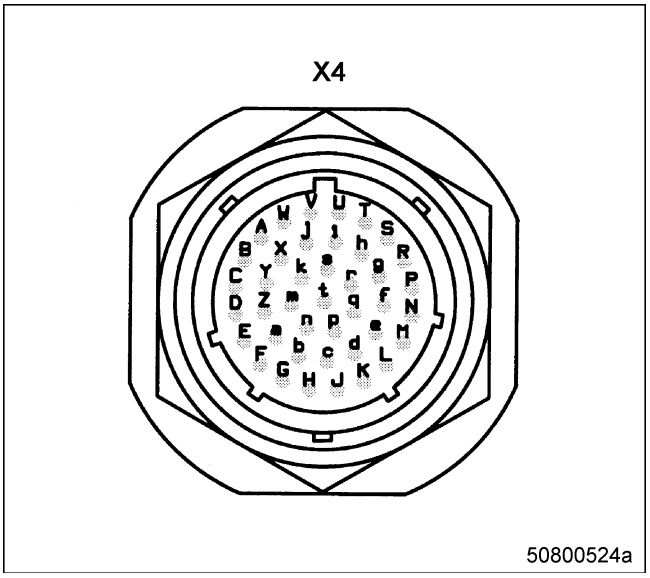
Connector X3

Connector type	VPT 06 GSE 16–26 P
Target	Engine wiring harness

Pin assignment

Channel	Signal	Pin	Comments
TE3	IN	b	0 V to 5 V/ internal 2 k0 pullup to 5 V_TE_BUF
TE3	GND	c	
TE4	IN	U	0 V to 5 V/ internal 2 k0 pullup to 5 V_TE_BUF
TE4	GND	V	
TE10	IN	E	0 V to 5 V/ internal 2 k0 pullup to 5 V_TE_BUF
TE10	GND	D	
DE8	5 V_BUF4	J	5 V / 20 mA
DE8	IN	Y	0 V to 5 V / internal 47k5 pulldown
DE8	GND	K	
DEH	5 V_BUF5	B	5 V / 20 mA
DEH	IN	T	0 V to 5 V / internal 47k5 pulldown/ TP2:20 Hz
DEH	GND	C	
NSE3	24 V_NSE3	A	Sensor supply max. 300 mA
NSE3	IN	R	0 V to 5 V/ internal 47k5 pullup to 5 V_TE_BUF
NSE3	GND	S	
PDM2	OUT	M	24 V / 3 A
PDM2	GND	N	
TAM3	OUT	L	24 V / 1.5 A
TAM3	GND	Z	
TAM4	OUT	P	24 V / 1.5 A
TAM4	GND	a	
EDM	TXD	X	RS232
EDM	RXD	H	RS232
EDM	GND	F	RS232
TA_EDM	24 V_OUT	G	EDM - supply / 2 A
TA_EDM	GND	W	

Connector X4, view to socket



Connector X4

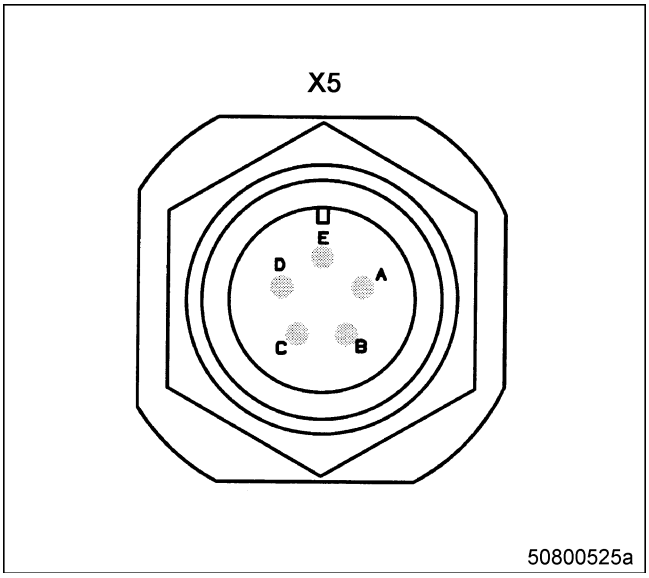
Connector type	VPT 06 GSE 21–41 PW
Target	Engine wiring harness (solenoid valves)

Pin assignment

Channel	Signal	Pin	Comments
MV1	HIGH	n	24 V / 20 A
MV1	LOW	m	Bank 1
MV2	HIGH	D	24 V / 20 A
MV2	LOW	C	Bank 1
MV3	HIGH	F	24 V / 20 A
MV3	LOW	E	Bank 1
MV4	HIGH	a	24 V / 20 A
MV4	LOW	Z	Bank 1
MV5	HIGH	H	24 V / 20 A
MV5	LOW	G	Bank 1
MV6	HIGH	s	24 V / 20 A
MV6	LOW	r	Bank 1
MV7	HIGH	Y	24 V / 20 A
MV7	LOW	X	Bank 1
MV8	HIGH	W	24 V / 20 A
MV8	LOW	V	Bank 1
MV9	HIGH	k	24 V / 20 A

Channel	Signal	Pin	Comments
MV9	LOW	j	Bank 1
MV10	HIGH	B	24 V / 20 A
MV10	LOW	A	Bank 1
MV11	HIGH	S	24 V / 20 A
MV11	LOW	R	Bank 2
MV12	HIGH	P	24 V / 20 A
MV12	LOW	N	Bank 2
MV13	HIGH	i	24 V / 20 A
MV13	LOW	h	Bank 2
MV14	HIGH	g	24 V / 20 A
MV14	LOW	f	Bank 2
MV15	HIGH	U	24 V / 20 A
MV15	LOW	T	Bank 2
MV16	HIGH	K	24 V / 20 A
MV16	LOW	J	Bank 2
MV17	HIGH	M	24 V / 20 A
MV17	LOW	L	Bank 2
MV18	HIGH	e	24 V / 20 A
MV18	LOW	d	Bank 2
MV19	HIGH	c	24 V / 20 A
MV19	LOW	b	Bank 2
MV20	HIGH	q	24 V / 20 A
MV20	LOW	p	Bank 2

Connector X5, view to socket



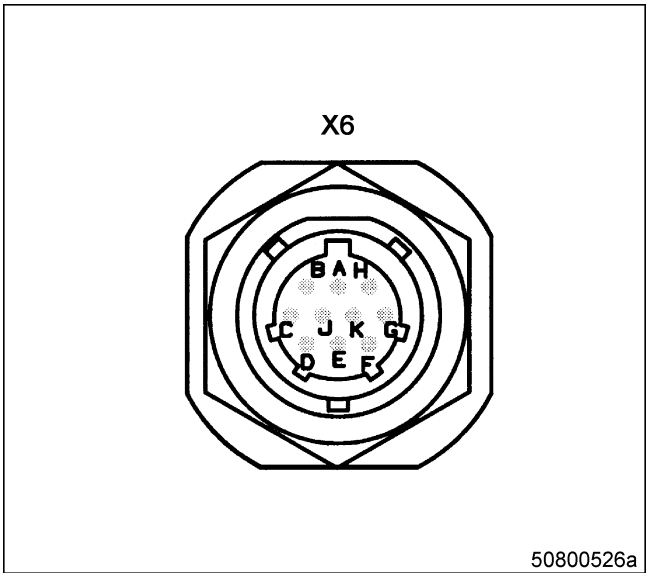
Connector X5

Connector type	CIR 06 G2 – 18 – 11 S
Target	Plant wiring harness (power supply)

Pin assignment

Channel	**Signal**	**Pin**	**Comments**
POWER	+24 V	A	U_{supp} = 24 V / 30 A
POWER	+24 V	D	
POWER	GND	B	
POWER	GND	C	
POWER	GND	E	

Connector X6, view to socket



Connector X6

Connector type	VPT 06 GSE 12-10 P
Target	Dialog unit

Pin assignment

Channel	Signal	Pin	Comments
POWER	+24 V	A	U_{supp} = 24 V / 30 A
POWER	+24 V	D	
POWER	GND	B	
POWER	GND	C	
POWER	GND	E	

Annex

5 Annex

5.1 Conversion tables

Length

Unit A	multiplied by factor	= Unit B
in	25.4	= mm
ft	0.3048	= m
yd	0.9144	= m
stat. mile	1.609	= km
nm	1.852	= km
yd	3	= ft
yd	36	= in

Unit B	multiplied by factor	= Unit A
mm	0.3937	= in
m	3.281	= ft
km	0.6215	= stat. mile

Area

Unit A	multiplied by factor	= Unit B
in^2	645.16	= mm^2
ft^2	0.0929	= m^2
yd^2	0.8361	= m^2
stat. $mile^2$	2.5889	= km^2

Unit B	multiplied by factor	Unit A
mm^2	0.00155	= in^2
m^2	10.7643	= ft^2
m^2	1.1960	= yd^2
km^2	0.3863	stat. $mile^2$

Volume

Unit A	multiplied by factor	= Unit B
in^3	16387	= mm^3
ft^3	0.02832	= m^3
yd^3	0.7646	= m^3
gallon (US)	3.787	= dm^3
gallon (Brit.)	4.546	= dm^3

Unit B	multiplied by factor	= Unit A
cm^3	0.06102	= in^3
m^3	35.31	= ft^3
dm^3	0.2642	= gallon (US)
dm^3	0.22	= gallon (Brit.)

Speed

Unit A	multiplied by factor	= Unit B
ft/s	0.3048	= m/s
stat. mile/h (mph)	1.609	= km/h
knot (Brit.)	1.852	= km/h

Unit B	multiplied by factor	= Unit B
m/s	3.281	= ft/s
km/h	0.6215	= stat. mile/h (mph)
km/h	0.54	= knot (Brit.)

Mass

Unit A	multiplied by factor	= Unit B
lb	0.4536	= kg
oz	28.35	= g
ton	1.016	= t

Unit B	multiplied by factor	= Unit A
g	0.03527	= oz
kg	2.205	= lb
t	0.9843	= ton

Force

Unit A	multiplied by factor	= Unit B
lb	0.4536	= kp
lb	4.4483	= N

Unit B	multiplied by factor	= Unit A
kp	2.205	= lb
N	0.101972	= kp
kp	9.80665	= N

Density

Unit A	multiplied by factor	= Unit B
lb s^2/ft^4	515.4	= kg/m^3

Unit B	multiplied by factor	= Unit A
kg/m^3	0.00194	= lb s^2/ft^4

Torque

Unit A	multiplied by factor	= Unit B
ft lb	1.3563	= Nm

Unit B	multiplied by factor	= Unit A
Nm	0.7373	= ft lb

Pressure

Unit A	multiplied by factor	= Unit B
lb/sq in (psi)	703.1	= kp/m^2 (mm WS)
lb/sq in (psi)	0.06895	= bar
lb/sq ft	47.883	= Pa
in QS	0.03386	= bar
in QS	345.3	= kp/m^2

Unit B	multiplied by factor	= Unit A
atm	760	= mm QS
atm	1.0133	= bar
atm	10332	= kp/m^2 (mm WS)
atm	1.0332	= kp/cm^2 (at)
atm	14.696	= lb/sq in
bar	14.503	= lb/sq in

Mass moment, 2nd grade

Unit A	multiplied by factor	= Unit B
ft lb s^2	1.3563	= kg m^2

Unit B	multiplied by factor	= Unit A
kg m^2	0.7373	= ft lb s^2

Energy

Unit A	multiplied by factor	= Unit B
ft lb	1.356	= J
kcal	4186.8	= J
BTU	1055	= J
CHU	1899	= J

Unit B	multiplied by factor	= Unit A
J	0.7376	= ft lb
J	0.0002389	= kcal
J	0.0009479	= BTU
J	0.00052656	= CHU

Power

Unit A	multiplied by factor	= Unit B
HP (horse power)	0.7355	= kW
HP	0.7457	= kW
BTU/s	1.055	= kW
kcal/h	1.163	= W
HP	550	= ft lb/s

Unit B	multiplied by factor	= Unit A
kW	1.36	= PS
kW	1.341	= HP
kW	0.9479	= BTU/s
W	0.8598	= kcal/h
ft lb/s	0.0018	= HP

Temperature

	Celsius	Kelvin	Fahrenheit	Réaumur
x°C		= x + 273.15 K	= 9/5x + 32 °F	= (4/5x) °R
x K	= x − 273, 15 °C		= 9/5(x − 273.15) + 32 °F	= 4/5 (x − 273.15) °R
x°F	= 5/9(x − 32) °C	=5/9 (x − 32) + 273.15 K		= 4/9 (x − 32) °R
x°R	= 5/4x °C	= (5/4x) + 273.15 K	= (9/4x) + 32 °F	

Fuel consumption

Unit A	multiplied by factor	= Unit B
mile/gal (US)	0.4251	= km/l
gal/mile (US)	2.3527	= l/km

Unit B	multiplied by factor	= Unit A
km/l	2.3527	= mile/gal (US)
l/km	0.4251	= gal/mile (US)

5.2 Abbreviations

Abbreviation	Meaning	Explanation
AL	Alarm	Alarm (general)
ANSI	American National Standards Institute	Umbrella organization administering and coordinating U.S. standards
ATL	Abgasturbolader	Exhaust turbocharger
BR	Baureihe	Series
CAN	Controller Area Network	Data bus system, bus standard
CPP	Controllable Pitch Propeller	
DIN	Deutsches Institut für Normung e. V.	German Standardization Organization, at the same time identifier of German standards ("Deutsche Industrie-Norm")
DIS	Display unit	
DL	Default Lost	Alarm: Default CAN bus failure
ECS	Engine Control System	
ECU	Engine Control Unit	Engine governor
EDM	Engine Data Module	
EMU	Engine Monitoring Unit	
FL	Fluids and Lubricants Specifications	MTU publication No. A01061/..
FPP	Fixed Pitch Propeller	
GCU	Gear Control Unit	
GMU	Gear Monitoring Unit	
HI	High	Alarm: Measured value exceeds 1st maximum limit
HIHI	High High	Alarm: Measured value exceeds 2nd maximum limit
HT	High Temperature	
ICFN	ISO - Continuous rating - Fuel stop power - Net	Power specification in accordance with DIN-ISO 3046-7
IDM	Interface Data Module	Memory module for interface data
IMO	International Maritime Organisation	
ISO	International Organization for Standardization	
KGS	Kraftgegenseite	Engine free end in accordance with DIN ISO 1204
KS	Kraftseite	Engine driving end in accordance with DIN ISO 1204
LCD	Liquid Crystal Display, Liquid Crystal Device	
LCU	Local Control Unit	LOP subassembly

Abbreviation	Meaning	Explanation
LED	Light Emitting Diode	
LMU	Local Monitoring Unit	LOP subassembly
LO	Low	Alarm: Measured value lower than 1st minimum limit
LOLO	Low Low	Alarm: Measured value lower than 2nd minimum limit
LOP	Local Operating Panel	
LOS	Local Operating Station	
MCD	Marine Control Drive	
MCS	Monitoring and Control System	
MG	Message	
MPU	Microprocessor Unit, Microprocessing Unit	
OT	Oberer Totpunkt	Top dead center
P-xyz	Pressure-xyz	Pressure measuring point xyz
PAN	Panel	Control panel
PCU	Propeller Control Unit	
PIM	Peripheral Interface Module	
RCS	Remote Control System	
RL	Redundancy Lost	Alarm: Redundant CAN bus failure
SAE	Society of Automotive Engineers	U.S. standardization organization
SAM	Service and Automation Module	
SD	Sensor Defect	Alarm: Sensor failure
SDAF	Shut Down Air Flaps	
SPC	Spare Parts Catalog	
SS	Safety System	Indicated alarm is initiated by the safety system
SSK	Schnellschlussklappe(n)	Emergency-air shutoff flap(s)
T-xyz	Temperature-xyz	Temperature measuring point xyz
TC	Tools Catalog	
TD	Transmitter Deviation	Alarm: Sensor comparison fault
UT	Unterer Totpunkt	Bottom dead center
VS	Voith Schneider	Voith-Schneider drive
WJ	Water Jet	Waterjet drive

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