MTU_Value*Service*
Technical Documentation

Electronic Engine
Control Unit ECU 8

Series 1600 V 10
Series 1600 V 12

Application: Genset

Functional Description

E532291/00E

Printed in Germany

Table of Contents

1 General

General requirements

General

In addition to the notices in this brochure, the valid, country-specific, statutory regulations on accident prevention and environmental protection are to be observed. This engine is built according to the current state of the art standards and valid regulations and rules. Nevertheless dangers to persons and property are still present if this engine is:

- • Not used properly
- • Operated, maintained and repaired by non-trained and unauthorized personnel
- • Modified or changed
- • Safety notices are not observed

Intended use

This engine is only to be used for the purpose stated in the contract or at the delivery. A different or additional use will be considered a “non-intended use”. The manufacturer assumes no responsibility for any damages resulting from a “non-intended use”. The user is solely responsible.

Intended use also includes observing the operating instructions and the maintenance and repairs specifications.

Modifications or changes

Any unauthorized modifications or changes to the engine affect the safety.

MTU assumes no responsibility and accepts no warranty claims for damages resulting from unauthorized modifications or changes.

Spare parts

Only MTU original parts may be used when exchanging or replacing components or assemblies.
Liability and warranty claims against the engine manufacturer for damage resulting from the use of non-OEM parts will be rejected.

Safety regulations for maintenance and repair work

Safety regulations for commissioning

The product must be properly installed and have passed the acceptance test according to the MTU regulations before it can be commissioned.

Each time the device or system is put into commission make sure

- That all maintenance and repair work are finished
- That all loose parts have been removed from rotating parts
- That no one is in the danger zone of moving parts

Right after placing the device or system into commission make sure that the controls and indicators and the monitoring, signaling and alarm systems are operating properly.

Safety regulations for operation

Regularly train and practice the operating procedures in case of emergencies

The operator must be familiar with the controls and indicators.

The operator must know the effects of each operating step performed.

The operator must carry out each operating step according to the documentation.

During operation the display instruments and monitoring groups must be constantly monitored with respect to the current operating states, the operating limits and any warnings and alarms.

If a problem with the system is detected or if the system reports a problem:

- The person(s) responsible is/are to be informed
- The messages is to be evaluated
- Any emergency actions are to be taken, if necessary, e.g. emergency engine stop

Engine operation

Always wear hearing protection when engine is running!

Make sure engine room is well ventilated!

Immediately wipe up any operating fluids that have leaked out or have been spilled; use a binding agent if necessary.

A combustion engine's exhaust is poisonous. Inhaling the exhaust is hazardous to your health.
Exhaust pipes must be air tight and routed to the open air.

Do not touch or come into contact with any battery terminals, generator terminals or cables while engine is running!

Improper insulation or grounding of electrical parts can lead to serious electrical shocks causing injury.

Absolutely do not loosen or open any water, oil, brake fluid, fuel, compressed air or hydraulic lines while the engine is running!

Maintenance and repairs

A major factor in safety is the compliance with the maintenance and repairs specifications.

Do not perform any maintenance or repair work while the engine is running, unless it is explicitly permitted. Secure the engine from being accidentally started. If an electrical starter is installed, disconnect the battery. If a compressed air starter is installed, close the main valve of the compressed air system and release pressure in the air line. Place a sign “Do not operate” in the operating room or at the controls! Keep all nonessential persons away!

Do not rectify any problems for which you do not have the proper knowledge or the special tools required! Maintenance and repair work should only be made by authorized and qualified personnel.

Only use appropriate and calibrated tools.

Do not work on engines or components that are only being held up by lifting equipment or by a crane. Always properly support these components with suitable equipment before starting any maintenance or repair work.

Before cranking engine make sure no one is in the danger zone of the engine. After finishing work on the engine, make sure all protective devices are reinstalled and that all tools and loose parts have been removed from the engine.

Fluids exiting at high pressures can penetrate through clothing and skin and cause serious injuries. Before starting any work, release the pressure in those systems that are to be worked on!

Never rebend any fuel injection lines and do not install any lines that have been rebent. Keep fuel injection lines and connections clean. When removing or opening lines, always close off the openings using suitable caps and plugs.

Make sure to not damage the fuel lines during maintenance and repair work. When installing lines always use the correct tightening torque and make sure that all brackets and dampers are installed properly.

Makes sure that all fuel injection lines and oil pressure lines have sufficient clearance so as to avoid any contact with other components. Do not install fuel or oil lines near hot components unless the design does not allow otherwise.

Elastomers (e.g. Viton sealing rings are safe at normal operating temperatures. If a fire occurs or if the temperature rises

above 300 °C, the materials will start to melt setting off hydrogen fluoride fumes, which is an acid. If this acid comes into contact with the skin, serious burns can occur. If elastomer seals appear burnt or glassy, do not tough them with unprotected hands! Wear protective gloves!

Be cautious with hot fluids in lines, pipes and spaces ⇒ Risk of burn injuries!

Observe the cool off times of components that are heated up for installation/removal Risk of burn injuries!

Do not touch or come into contact with the hot parts of the compressor and the exhaust system ⇒ Risk of burn injuries!

Be careful when removing vent screws or screw plugs from the engine. To prevent the fluid from escaping, hold a rag over the vent screw or stop plug. The risk of injury is greater if the engine was just turn off and the fluids are still hot.

Be careful when draining hot operating fluids. ⇒ Risk of scalding!

Drain the operating fluids into a suitable container and clean up any spilled fluids using a binding agent if necessary.

Make sure the engine room is well ventilated when changing any operating fluids or working on the fuel system!

For any work above body height use safety gear and work platforms.
Make sure engine parts are placed on stable surfaces!

To avoid back injuries when lifting components, adults should only lift between 10 to 30 kg depending on age and gender, therefore:

- Get help or use a lifting aid.
- Make sure that all chains, hooks, loops, etc. are tested and approved and have sufficient payload rating and that the hooks are correctly positioned. Lifting lugs may not be loaded laterally.

When carrying out maintenance and repair work on the engine, pay special attention to cleanliness. After finishing the maintenance and repair work, make sure that any loose parts have been removed.

Welding

Welding is prohibited on the engine or on installed assemblies!

Never use the engine as a ground connection for welding! This will prevent the welding current from being conducted through the engine causing burns to the mounts, bearings and gears, which in turn leads to bearing seizures or damage to the components.

Do not let the welding cables lie across or near the wiring harness of the MTU system. The welding current could cause a voltage to be induced in the wiring harness which could lead to damage to the electrical system.

The ground connection of the welder must be connected within 60 cm of the spot to be welded.

If parts of the engine have to be welded (e.g. exhaust pipe), they should be removed from the engine before welding.

The connector and connections for the MTU electronics do not have to be removed for welding work, if the main power switch has been turned to “OFF” and the battery has been disconnected at both the positive and negative terminals.

Pressing and pulling work

Only those devices specified in the work plan and the assembly instructions are to be used for pressing and pulling work.

The maximum pressure of the pressing and pulling device must not be exceeded when pressing on parts.

The high-pressure lines for the hydraulic pressing or pulling device have been tested with 3800 bar.

Do not bend or apply pressure to the lines when they are under pressure!

Before starting any pressing work, observe the following:

- Bleed the pressing and pulling device and the pump and the lines at the designated positions for each system used (e.g. open the bleed screw, pump oil until it is free of air bubbles, close bleed screw).
- When pressing parts on, install the device with the piston inserted.
- When pulling parts off, install the device with the piston removed.

On a pressing and pulling device with a central expansion supply line, screw the spindle into the shaft end until a sealing effect is reached.

During hydraulic pressing and pulling of parts, make sure that no one is near the parts being pressed on or pulled off. When the system is under pressure, there is always the danger that the part being pressed on will suddenly “fly off”.

Before the devices are used they are to be inspected and tested at regular intervals (crack tests).

Work on electric/electronic assemblies

Before starting any maintenance or repair work or before shutting off any parts of the electronics, get the approval of the manager responsible.

Turn off the power supply to the corresponding areas before starting any work on assemblies. If a specific measure requires a power supply, this is noted at the appropriate place in the document.

Gasses produced by the battery are explosive. For this reason avoid any sparks and open flames. Do not touch or come into contact with battery acid. Wear safety glasses. Do not place any tools on the battery. Before installing any cables on the battery, check for correct polarity. Crossing the polarity on the battery can lead to injuries caused by the sudden expulsion of acid or the bursting of the battery case.

Do not damage wires and cables during removal work. Reinstall wires and cables so that they are not damages during engine operation by coming into contact with sharp edges or hot surfaces or chafing against other parts.

Do not attached cables or wires to lines carrying fluids!

After finishing the maintenance or repair work reattach and retighten any wires or cables that have come loose!

A function check of the device or system must be made after any repairs. A check of just the repaired component is insufficient. The entire system connected must also be checked.

If cables or wires are in contact with components and there is the risk that they will chafe, they should be attached with cable clamps!

Cable ties should not be used to mount wires or cables because if they are removed during maintenance or repair work, there is a chance that they will not be reinstalled when the work is finished.

Spare parts must be properly stored before being used, i.e. especially protected against moisture. Faulty electronic parts or assemblies must be properly packaged for transport back for repairs, i.e. especially protected against moisture, shocks and wrapped in antistatic foil.

Working with laser devices

When working with laser equipment wear special safety glasses for laser applications!

Laser equipment can produce extremely intense, highly focused radiation by the effect of stimulated emission in the range of visible light or in the infrared or ultraviolet spectral ranges. The laser radiation can cause damage by photochemical, thermal or optomechanical effects. The main danger is of irreversible damage to eyes.

Laser equipment must be equipped with the necessary protective equipment meeting the requirements of the class and application of the laser.

Only the following laser equipment may be used for equisignal systems and survey work:

- Class 1, 2 or 3A laser equipment
- Class 3B laser equipment which only radiate in the visible wavebands (400 nm to 700 nm), have a maximum output of 5 mW and have a radiation axis or radiation surface that is set to prevent any hazards to the eyes.

Operation of electrical devices

When electrical devices are in operation certain parts are electrified.

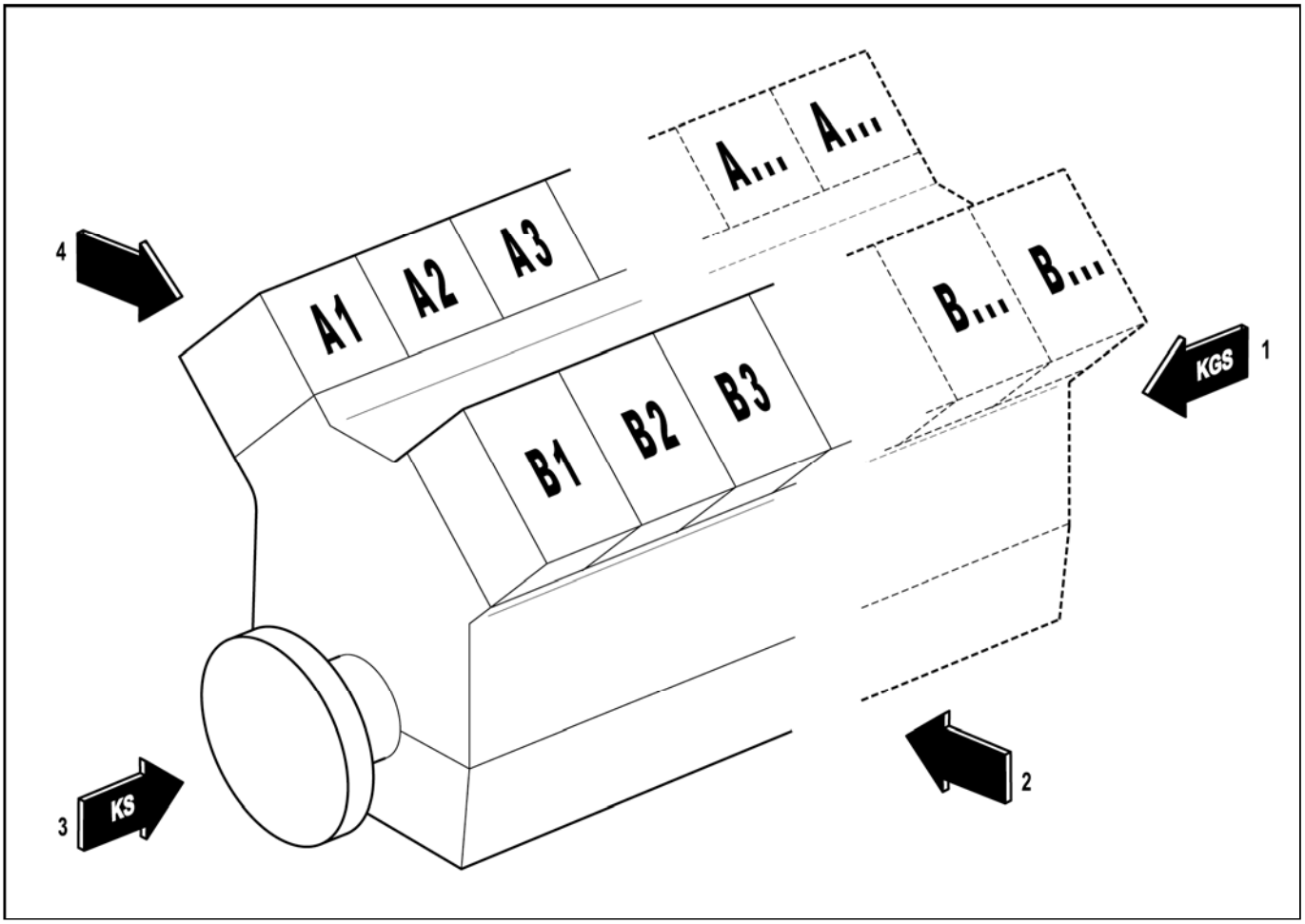
Failure to heed the warnings for these devices may result in serious injuries or damage to property.

Designation of the sides of the engine and the cylinders

The engine is always shown from the driving end (KS).

Cylinders are designated (according to DIN ISO 1204) with A for the left cylinder bank and with B for the right cylinder bank. Each cylinder bank is numbered started with no. 1 at the driving end (KS) of the engine.

Numbering of other components start with no. 1 at the driving end (KS) of the engine.

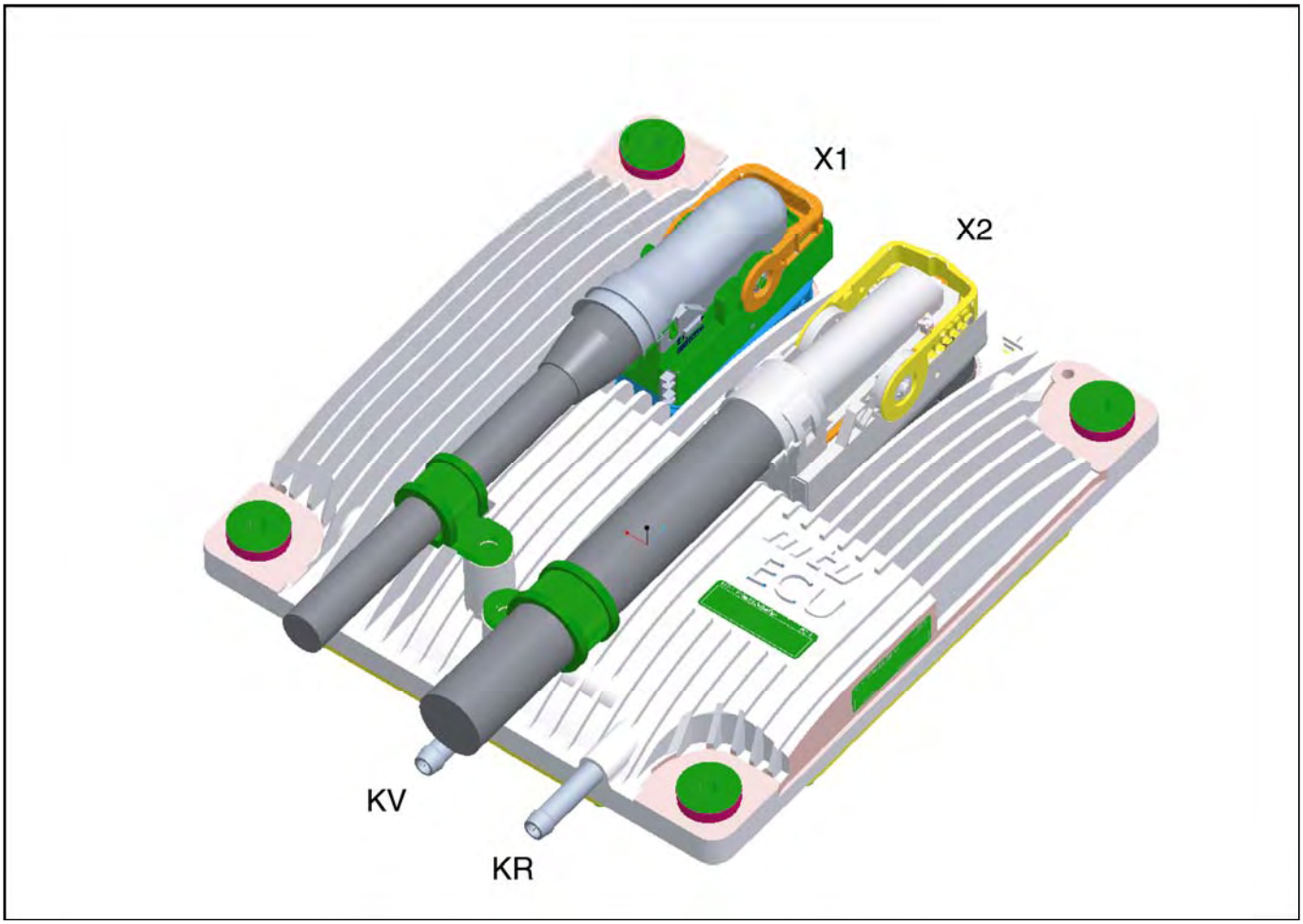


1 KGS = Free end
2 Right side of engine
3 KS = Driving end
4 Left side of engine

2 Overview

MTU ECU8 Engine Control Unit

Overview



X1 System wiring harness
X2 Engine wiring harness
KV Coolant supply line
KR Coolant return line

The ECU8 Engine Control Unit was specially developed for application in BR 1600 engines and can be used for 6R, 8V, 10V and 12V.

It is especially suitable for offroad applications like genset, C&I and railway applications.

The injector output stage is only suitable for Common Rail systems.
There are three current levels that can be set – Bootpeak/Boost/Hold current.

The housing is mounted to the engine on dampers.
The housing is designed with connections to the cooling system for applications at high ambient temperatures and heavy soiling.

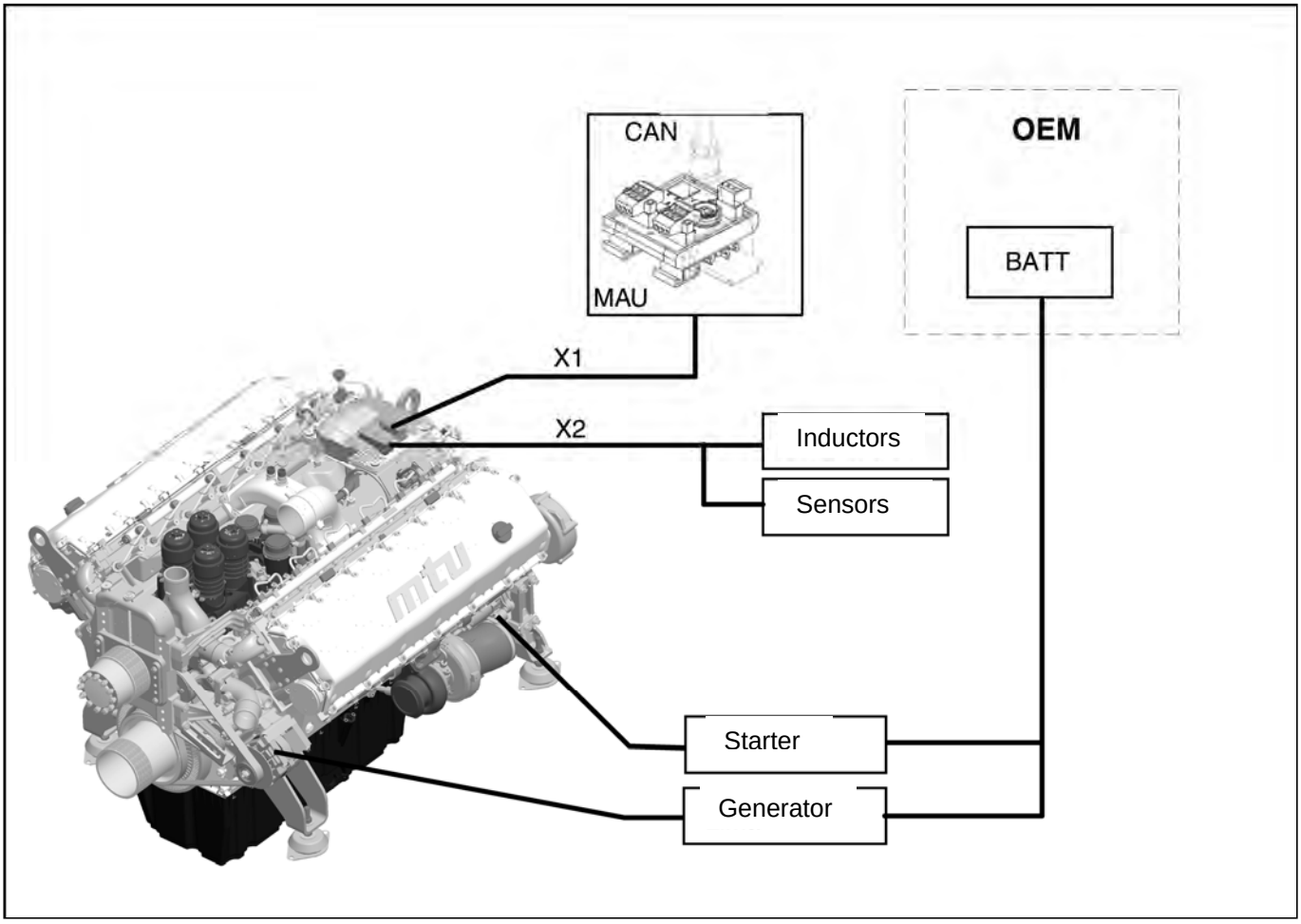
System devices

The basic equipment for genset is composed of the following devices

- ECU8
- MAU

The ECU8 Engine Control Unit has been adapted for the Common Rail technology in the BR 1600 engines.

Design



Functions:

BATT	Battery
MAU	Terminal box
X1	System wiring harness
X2	Engine wiring harness

Scope of delivery

2.2.1 MTU basic equipment

The following devices, assemblies and components are supplied in the basic equipment:

Engine sensors, actuators

All of the sensors and actuators necessary for the control of the Engine Control Unit are installed directly on the engine.

Engine wiring + injection wiring

Engine wiring harness for connecting all sensors to the Engine Control Unit ECU8

Connection of all injectors to the Engine Control Unit ECU8 (via Window Gasket)

ECU8 Engine Control Unit

Control, monitoring and regulation of the engine (installed on the engine)

Engine Control Unit connecting cable to system/power supply

Connecting cable from connector **X1** of ECU8, on one terminal strip.
The connecting cable has one open end and can be delivered in the following lengths:

- 6 m
- 10 m
- 15 m
- 25 m

24V DC power supply

The 24V DC power supply for the Engine Control Unit is connected via the terminal strip and the connecting cable **W1** and connector **X1**.

Starter, generator and other power consumers must be supplied via externally wired connections.

2.2.2 OEM parts

The OEM must supply the following parts:

- Displays, e.g. indicator lamps, display instruments for:
  - Engine speed
  - Lube-oil pressure
  - Lube-oil temperature
  - Coolant temperature
- Controls, e.g. pushbuttons for “Start”, “Stop”, “Override”, etc.
- Cables/wires for the 24V DC power supply of the starter, generator, etc.

External sensors

External sensors are optionally supplied for:

- Coolant sensor
- “Water in fuel” level switch
- “Oil filter pressure differential” sensor
- Lube-oil temperature

The sensors must be recorded and evaluated by the OEM.

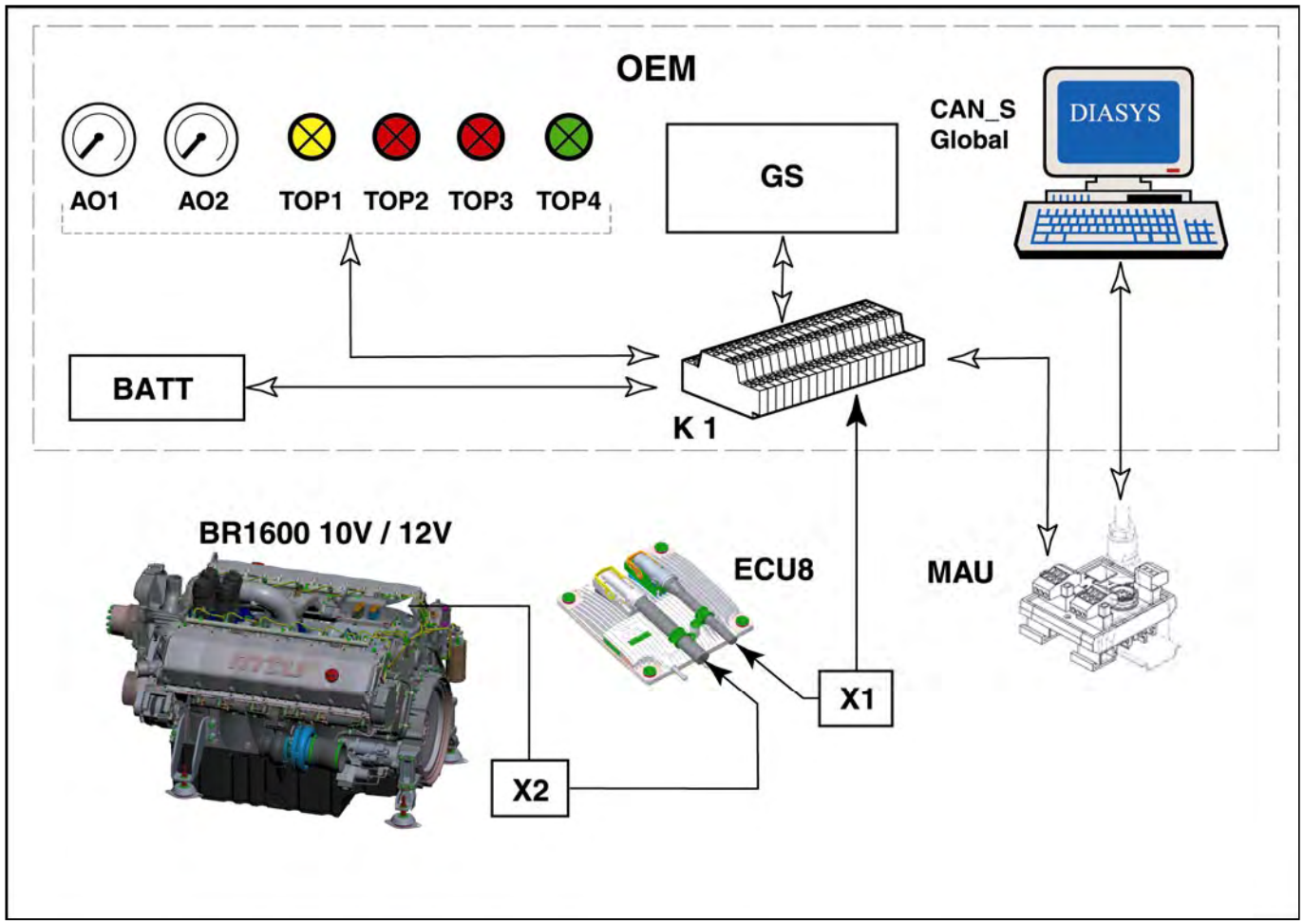
Connecting cables/wires for external sensors

Connection of all external sensors to the system by the OEM

Connectors for wiring to external sensors

Customer interface/operator's devices

2.3.1 System overview/customer interface



OEM
Display instruments (AO1, AO2)
Indicator lamps (TOP1 – TOP4)
External controls (DiaSys)
Terminal strip/control box (K1)
Battery (BATT)
Generator control (GS)

MTU
BR1600 10V / 12V Engine with ECU8
Wiring harnesses X1, X2 (internal engine wiring harness)
MAU

All of the devices/parts required by the operator to control and monitor the engine are included in the OEM scope of delivery.

Display instrument

There are 2 outputs for analog display instruments for displaying the engine operating values (AO1/AO2). They can be used for the following displays:

- Engine speed
- Coolant temperature
- Lube-oil pressure
- Lube-oil temperature

2.3.2 Other notes

The number of controls and indicators depends on the OEM's development and design.
This is also valid for the lettering and colors as well as for the arrangement of the controls and indicators.

The function of the controls and indicators are explained in the following table.

Pushbuttons

The following pushbuttons can be configured:

Channel	Name	Type	PV	Description/Function
DI7	START	Pushbutton		Pressing this pushbutton initiates the automatic engine start sequence.
DI1	ENGINE STOP	Pushbutton		Pressing this pushbutton triggers the engine stop process without shutting down the Engine Control Unit.
DI2	SWITCHOVER 50/60Hz	Switch		
DI3	IDLE/MODE	Pushbutton		Pressing this pushbutton sets the preselected fixed speed
DI4	ALARM RESET	Pushbutton		Pressing this pushbutton switches off the signaling of alarms. Pressing this pushbutton acknowledges the alarm.
DI5	SPEED UP	Pushbutton		Pressing this pushbutton = Increase engine speed
DI6	SPEED DOWN	Pushbutton		Pressing this pushbutton = Decrease engine speed
DI8	OVERRIDE	Pushbutton		Pressing this pushbutton triggers a temporary override of the safety system.

Alarm indicator lamps

The alarm indicator lamps supply information about the operating state of the engine.

Channel	Color	Lettering	Meaning/Function
TOP1	Yellow	YELLOW ALARM	Combined alarm indicator lamp lights up when a so-called “Yellow alarm” was triggered. The engine power may also be automatically reduced.
TOP2	Red	RED ALARM	Combined alarm indicator lamp lights up when a so-called “Red alarm” was triggered. The engine power may also have been automatically reduced.

Indicator lamp

The indicator lamp supplies information about the start-up state of the engine

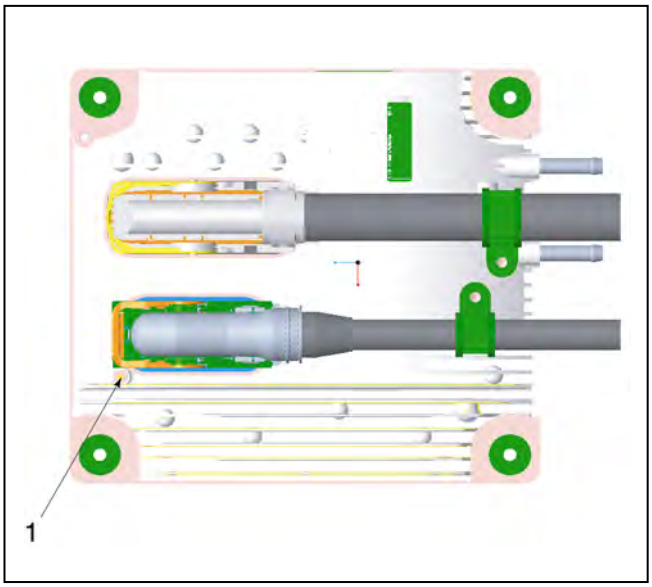
Channel	Color	Lettering	Meaning/Function
TOP3	Red	LUBE OIL STOP	Oil pressure too low
TOP4	Green	Starter ON	Actuation of starter

Diagnosis and tools

Self diagnosis

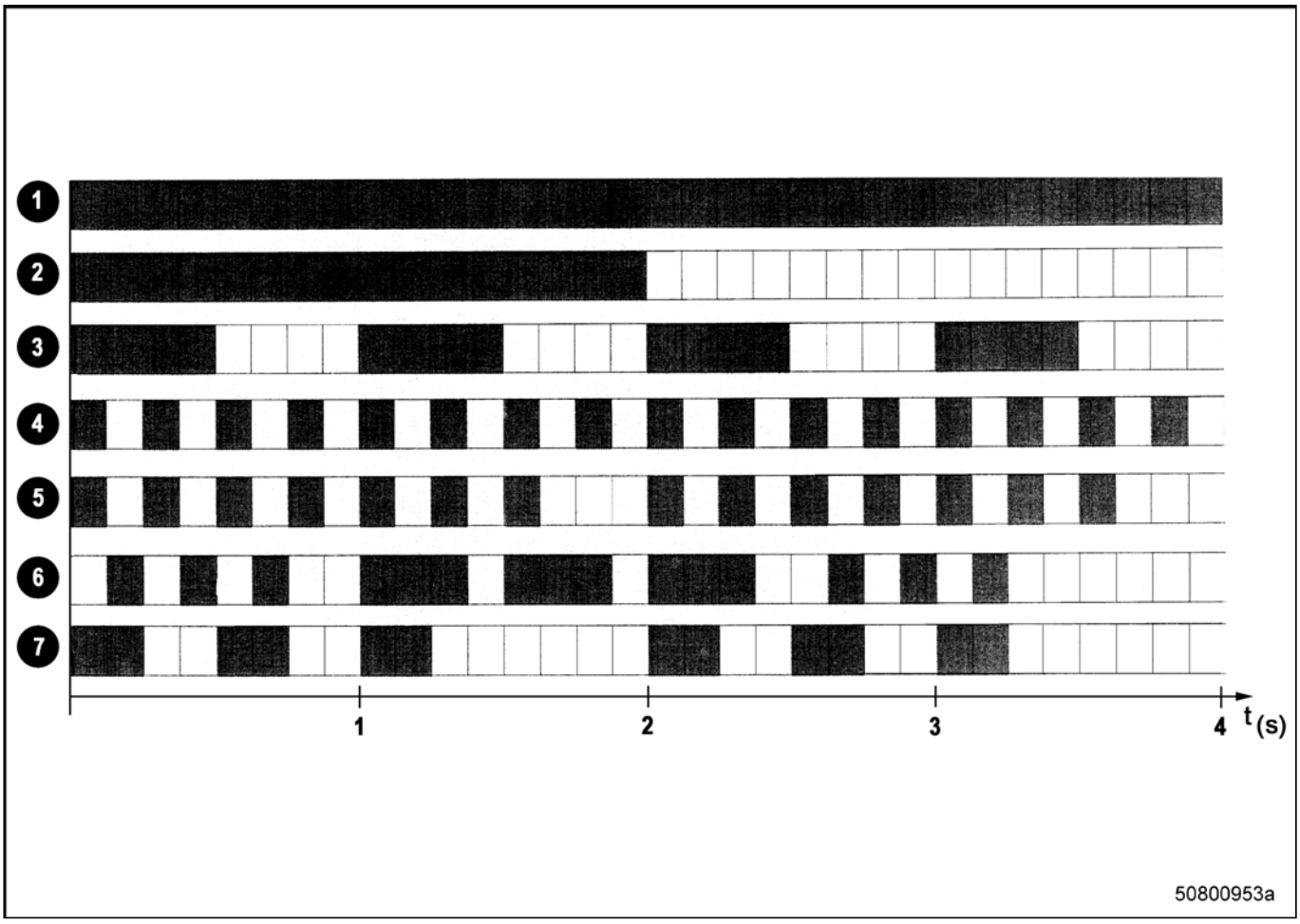
The ECU8 has a diagnosis lamp to aid the operator in detecting problems with the system.

Position of the diagnosis lamp on the ECU8 (1)



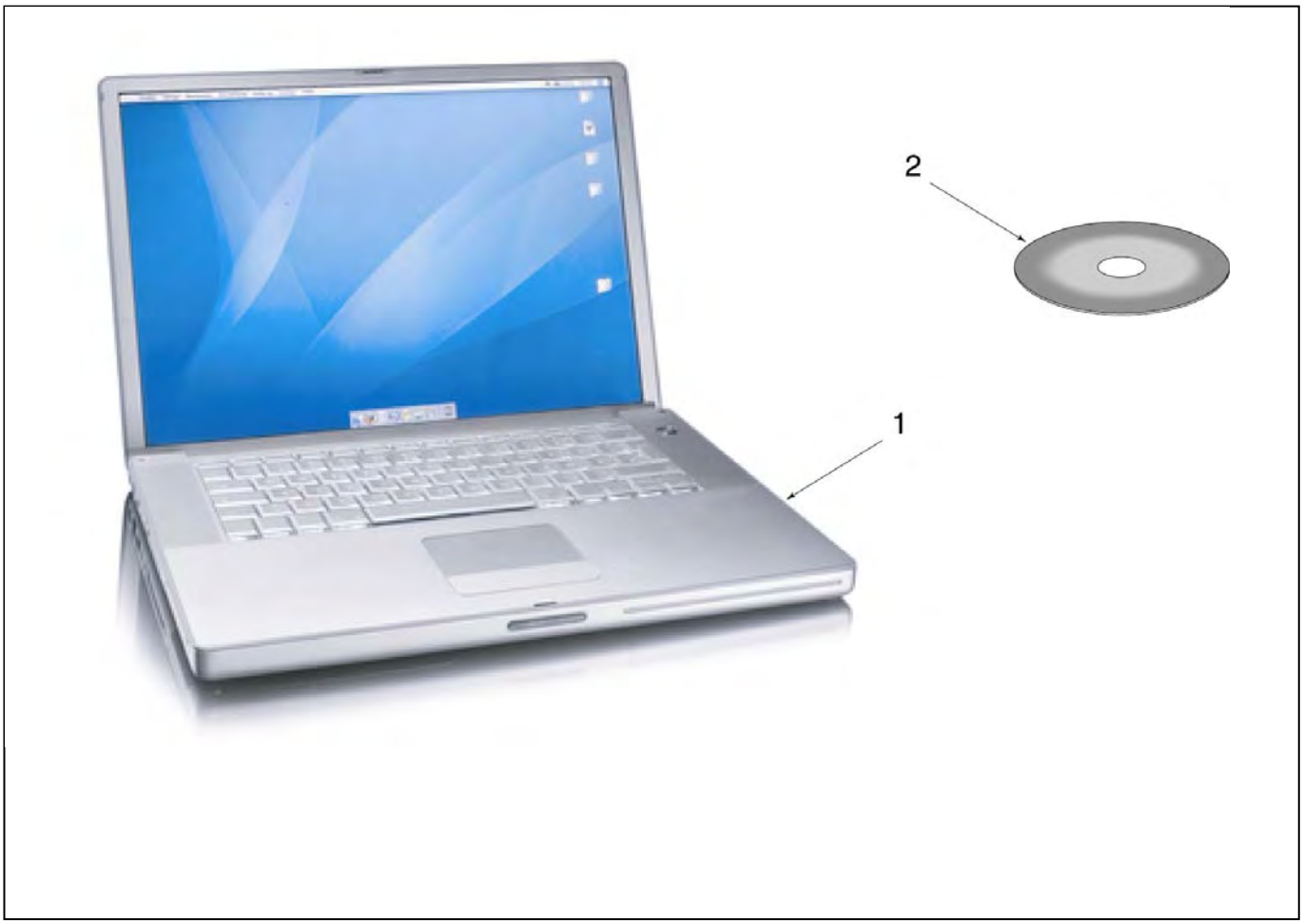
1 Diagnosis lamp

Flashing frequency



1	Control unit is ready	4	External RAM faulty
2	Application loader is active	5	External flash memory faulty
3	Internal error detected by ITS	6	No firmware
		7	Application crashed

Tools



1 Laptop
2 CD-ROM with DiaSys 2.40 software (SP1 or higher)

A more in depth diagnosis of the electronic system can be made using the DiaSys® dialog system, consisting of one laptop with the DiaSys® 2.53 SP1 or higher program, one user dongle and one CAN interface.

The main purpose of the dialog system is to change the settings in the ECU8.

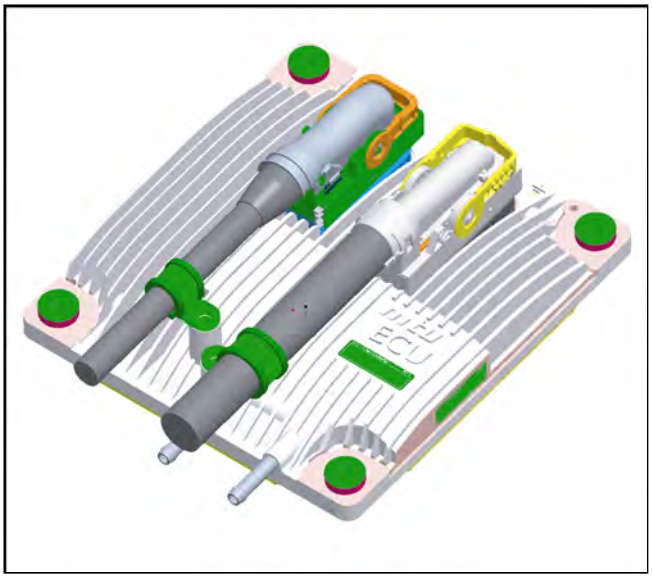
3 Devices

ECU (ADEC) Engine Control Unit

3.1.1 ECU8 – Purpose and functions

3.1.1.1 ECU8 Engine Control Unit

ECU8 Engine Control Unit



Central open- and closed loop control unit for the engine

- Implementation of the specifications of the monitoring, control and remote control systems as signals sent to the engine control
- Control of the injection system
- Control of other actuators on the engine
- Recording of sensors and evaluation of the operating states of the engine
- Monitoring of the limits and triggering an engine stop if states/limits become impermissible.
- Sending fault messages to the monitoring and control systems
- Downloading of settings for engine and system.
- Self-monitoring ITS
- Diagnosis with dialog unit (laptop)

3.1.1.2 Function of the ignition (IGI)/emergency stop (ESI)

Ignition input (IGI Tl.15)

The IGI input can be used for two functions:

1. ECU on/off, if device has power supply (Tl. 30).
2. Emergency stop function with “no-load current principle”

If this function is not used the input is switched to 24V (UBatt).

The user can turn the device ON/OFF with the IGI input as follows

- Input level = low to high - “wake”
  The ECU is activated and the microcontroller is booted and goes through its “start up” and maintains the power supply in “hold”.
- Input level = low to high - “power down”
  Shut off of the IOS (injector output stage) for all cylinders. This state is saved and can only be restored by the software. Saves all data and alarms “Data - Storage”. Shut off of internal power supplies.

The reaction of the ECU after the ESI is activated can be configured using the application SW (CAN message, etc.)

Emergency stop input (ESI)

An emergency stop of the engine by completely shutting off the power supply to the Engine Control Unit is NOT PERMITTED!!

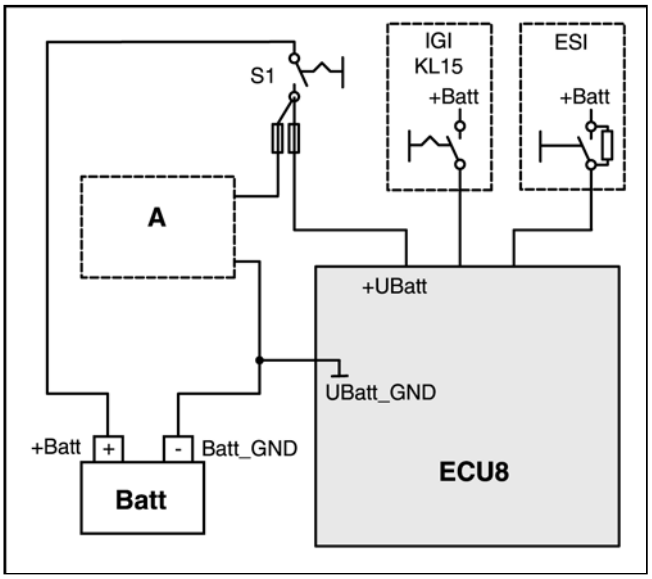
The ESI input is activated with a normally-open contact to UBatt (24V).
If this function is not used, the input remains unswitched.

The ESI input shuts off the IOS (injector output stage) directly by the hardware.
An immediate stop of the engine is thus possible. Engine data and alarms are saved in an external flash memory.

- Input level = low ->
  The ECU detects the input state as a discontinuity if a parallel resistance of 33kOhm ±10% is connected. The parameters of this function can be set in the SW.
- Input level = high ->
  Shut off of the IOS (injector output stage) for all cylinders. This state is saved and can only be restored by the software. “Open-circuit current principle”

The reaction of the ECU after the ESI can be configured in the SW (CAN message, ...)

Connection diagram and main functions of the IGI/ESI



ECU8	Engine Control Unit	S1	master switch
A	Other devices	IGI	Ignition start
B	Battery	ESI	Emergency stop

3.1.2 Installation on engine

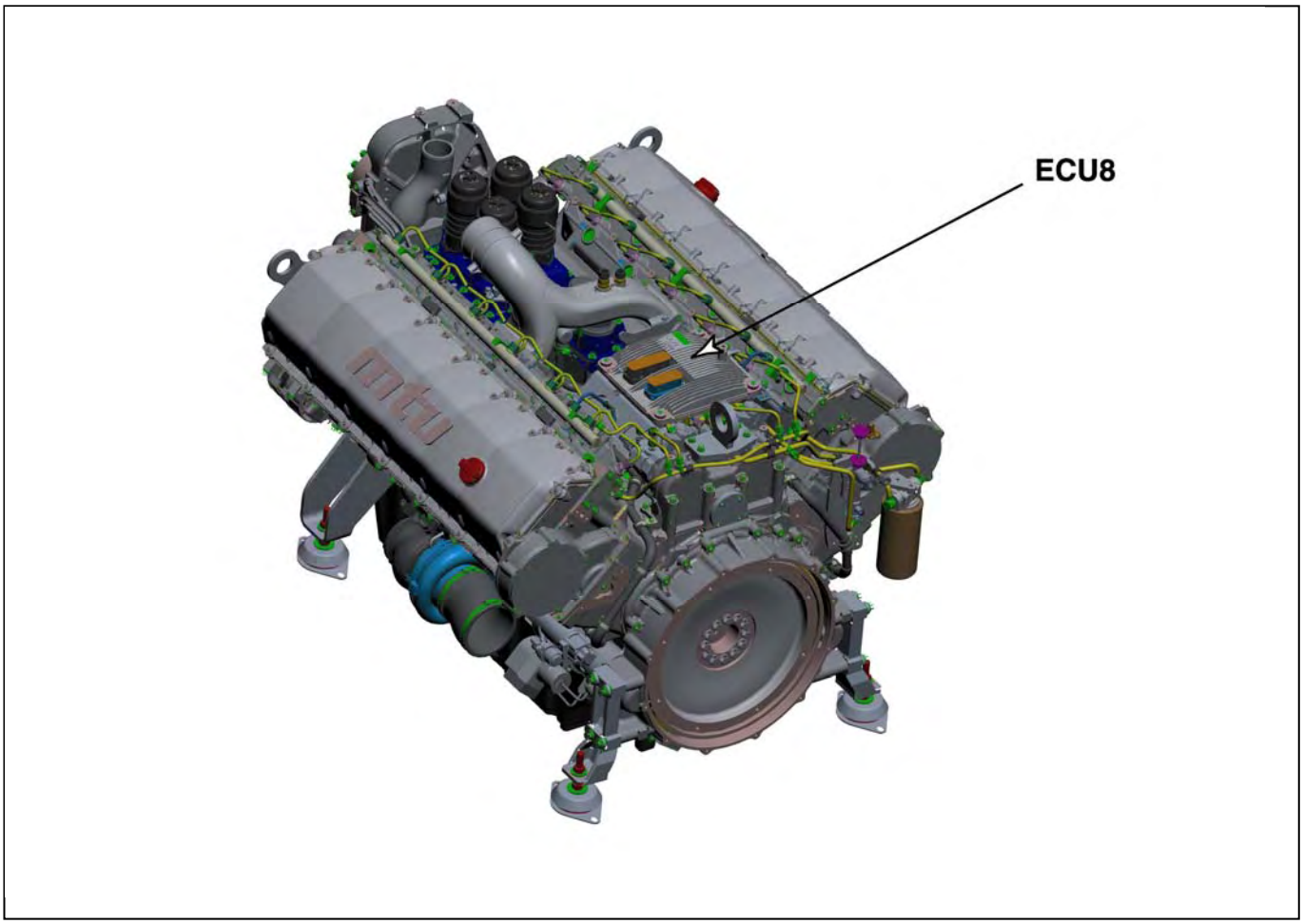
Specifications

The ECU8 (ADEC) Engine Control Unit is constructed with respect to the mechanical and thermal loads so that it can be directly mounted onto the engine (see specifications).

Ambient temperature –40°C to +80°C

Housing temperature range for extreme conditions with coolant flow (70°C coolant temp.) – 40°C to +120°C

Mechanical design/installation location



On 10V and 12 V engines the ECU8 control unit is mounted at the top of the engine in an easily accessible location facing in the direction of the driving end (KS).

The control unit cannot, however, be mounted away from the engine.

3.1.3 ECU8 specifications

Term	Unit	Value
Housing material		AlSi10Mg
Dimensions (length x width x height)	mm	298 x 272 x 93
Draw-out clearance	mm	74
Weight (without cable connections)	kg	4.5
Installation position		Any
Operating voltage	VDC	16.8V to **24**V to 32V (operation, injection without reduction in power) 14.4V to 16.8V (emergency operation, injection with reduction in power)
Power consumption	A	0.2 to 18 (typical) 33 max. at 24V (engine running) 10 mA with IGI off (ignition off) 0.2 A with IGI on (ignition on, engine off)
Heat output	W	45
Grounding		Must be made using a grounding strip
EMC protection		DIN ISO 7637-2 : 2002 (C&I International (SAEJ1113-13:2000)) DIN ISO 7637-3 : 1995 (C&I International) DIN ISO11452-2 : 2000 (SAEJ1113-21 : 1998), (CE Classification) EN 55011 : 2000 Curve A (CE Classification (industrial)) EN 55011 : 2000 Curve A (CE Classification (industrial) CISPR 11) EN 55025 : 2003 (Car, Marine (CISPR 11), SAEJ1113-41:2000) EN 50121-3-2 : 2001 (Rail Curve A + 10dB) EN 50155 (Rail) EN 55025 : 2003 (C&I International (CISPR 25)) EN 61000-4-2 : 2001 (IEC 61000-4-2), (Marine classified/Rail) EN 61000-4-4 : 2004 (IEC 61000-4-4), (Rail) EN 61000-4 : 2006 (IEC 61000-4-4), (Rail) EN 61000-4-5 : 2004 (IEC 61000-4-5), (Marine classified) EN 61000-4-6 : 2001 (IEC 61000-4-6), (Marine classified) EN 61000-4-17 : 2000 (Marine classified) EN 61000-6-2 (CE industrial) EN 13390 : 2000 (ISO13766), (C&I International) IEC 60533 : 1990 (Marine classified (CISPR 16)) IEC 60533 : 1999 (Marine classified (CISPR 16)) ISO 10605 : 2001 (C&I International (SAEJ1113-13:2000))
Dielectric strength		10 mΩ (IEC 60092-504) $U_{test} \geq 50$ VDC (ECU8 removed for test) 500 VDC as per EN 50155

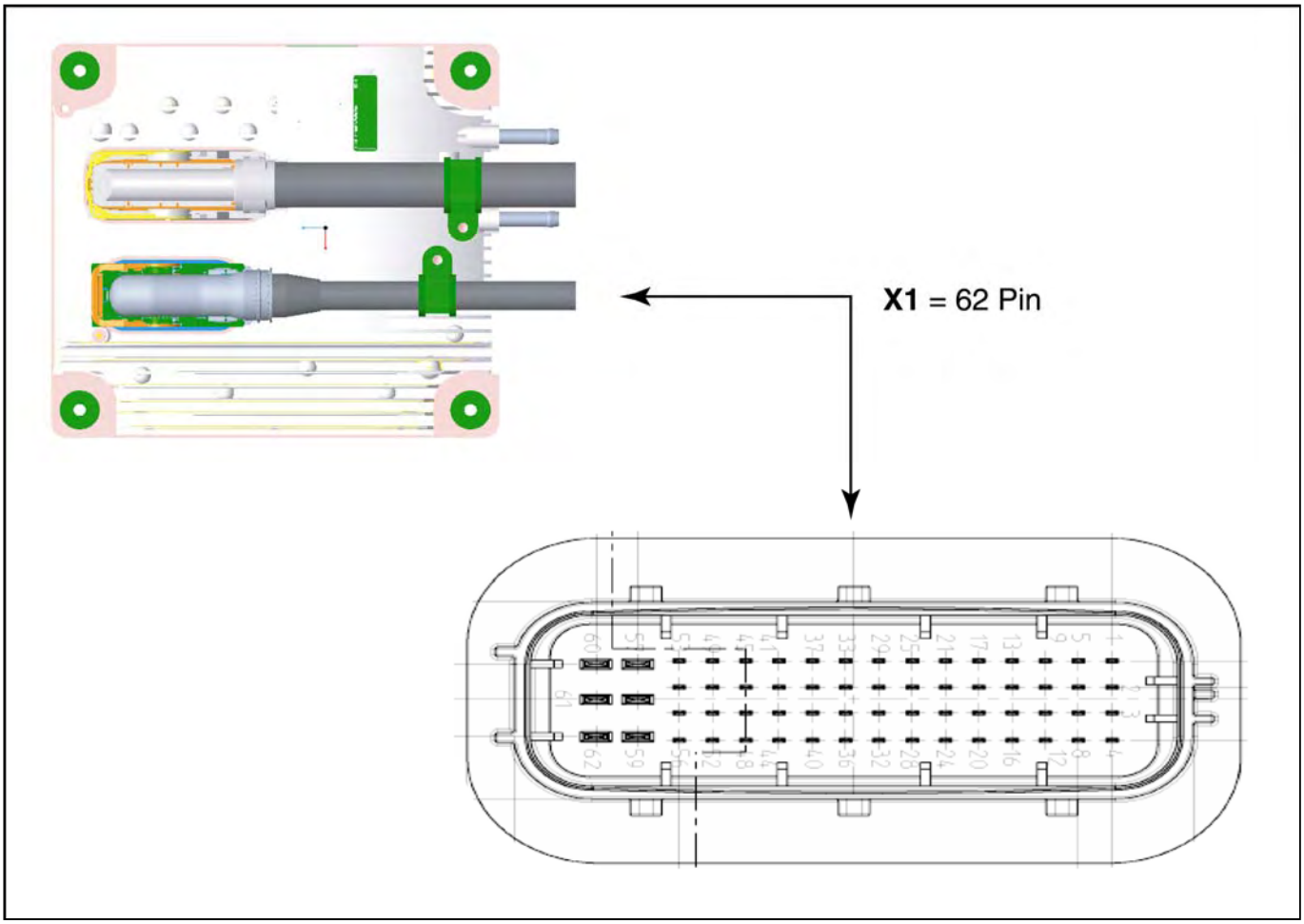
Term	Unit	Value
ESD protection		EN 61000-4-2 : 2001 (IEC 61000-4-2) EN 50121-3-2, EN50155 Rail IEC 60533 Civil Marine EN 61000-6-2 CE Industrial ISO 10605 : 2001 (C&I international)
Ambient temperature in operation	°C	- 40 to + 80 (up to 95°C max 60 minutes, with an air circulation of at least >2m/min)
Storage temperature	°C	- 40 to + 85
Housing temperature	°C	+ 105 max (cooled down to 75°C after 60 min)
Relative air humidity	%	0 to 95%, condensing
Degree of protection		Connected IP69K (IEC 60529, DIN 40050) Open (not connected) IP20 with connector caps IP54
Shock resistance		ICE 600-2-32 drop test ICE 68-2-27 (30g/11ms)
Vibrostability ECU housing noise		ICE 60068-2-6 (requirements for the x/y/z axis 5Hz to 2000Hz) 4.7 grms at 5Hz to 20Hz 4.7 grms at 20Hz to 150 Hz 4.7 grms at 150Hz to 300 Hz 4.7 grms at 300Hz to 1000 Hz 4.7 grms at 1000Hz to 2000 Hz
Resistance to chemicals		EN 60271-1-3-5 (MTU requirements: EU standards, diesel, bio diesel, oil, coolant)
MTBF	H	20,000 (at 75°C ambient temperature

Connector plug

3.2.1 Connector X1/connector to Engine Control Unit ECU8

Connector assignment

Pin assignment X1 (system cable) 62 pin (6 x MCP2.8; 54 x MCP1.5)



Latch: Bayonet latch over several tabs

This connector is the interface to the system.
The connector assignment of connector X1 is described in the following table. The short specification gives the most important properties of each channel.

Designation	Pin	Signal type	Short specification
CAN1_P	1	CAN1_P_H	50V isolated
CAN1_P	2	CAN1_P_L	
CAN1_P	5	CAN1_P_GND	
CAN2_P	3	CAN2_P_H	50V isolated
CAN2_P	4	CAN2_P_L	
CAN2_P	8	CAN2_P_GND	
DI1	10	DI1_H	<4V(<1.1mA) = low/>8V (>1.5mA) = high
Designation	**Pin**	**Signal type**	**Short specification**

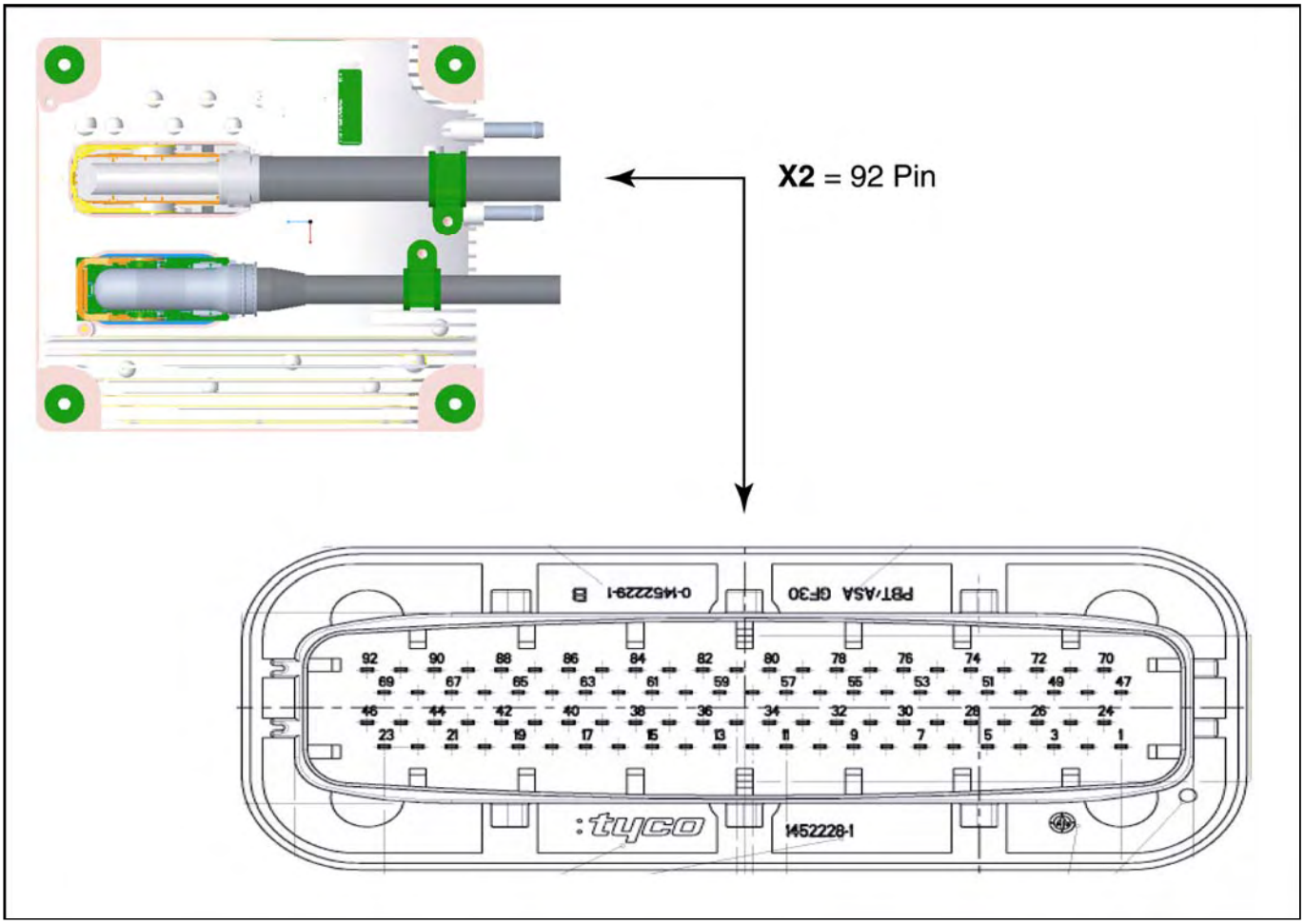
DI1	9	DI1_L	50V isolated
I2	14	DI2_H	<4V(<1.1mA) = low/>8V (>1.5mA) = high
DI2	13	DI2_L	50V isolated
DI3	18	DI3_H	<4V(<1.1mA) = low/>8V (>1.5mA) = high
DI3	17	DI3_L	50V isolated
DI4	22	DI4_H	<4V(<1.1mA) = low/>8V (>1.5mA) = high
DI4	21	DI4_L	50V isolated
DI5	26	DI5_H	<4V(<1.1mA) = low/>8V (>1.5mA) = high
DI5	25	DI5_L	50V isolated
DI6	30	DI6_H	<4V(<1.1mA) = low/>8V (>1.5mA) = high
DI6	29	DI6_L	
DI7	34	DI7_H	<4V(<1.1mA) = low/>8V (>1.5mA) = high
DI7	33	DI7_L	50V isolated
DI8	38	DI8_H	<4V(<1.1mA) = low/>8V (>1.5mA) = high
DI8	37	DI8_L	50V isolated
AI1_2	41	AI_2_5V	5V/24° ± 50V isolated to other potential
AI1	48	Al_U	0 to 10V (not isolated to AI2)
Al1	45	Al1_I	0 to 23.7mA (not isolated to AI2)
AI2	50	AI2_U	0 to 10V (not isolated to AI1)
AI2	49	AI2_UI	0 to 23.7mA (not isolated to AI1)
AI1_2	42	AI1_2_GND	AI_GND ± 50V isolated to other potential
AO1	40	AO1_OUT	0 to 10V/8mA
AO2	44	AO2_OUT	0 to 10V/8mA
AOI_2_FIP	35	AOI1_2_FIP_GND	GND
FIP	24	FIP_IN	0 to 5V or frequency input <xV low / >yV high I=?
TOP1	12	TOP1_OUT	24V/TOP1+ to +TOP4 = 3 A; max 1.5 A source/sink
TOP2	11	TOP2_OUT	24V/TOP1+ to +TOP4 = 3 A; max 1.5 A source/sink
TOP1_2	15	TOP1_2_GND	LGND (3A)
TOP3	20	TOP3_OUT	24V/TOP1+ to +TOP4 = 3 A; max 1.5 A source/sink
TOP4	19	TOP4_OUT	24V/TOP1+ to +TOP4 = 3 A; max 1.5 A source/sink
TOP3_4	16	TPO3_4_GND	LGND (3A)
FO	48	FO_OUT	24V/1.5 A sink to LGND/< 500Hz
	28	Nc	Nc
	28	Nc	Nc
	28	Nc	Nc
IGI	32	IGI_24V	24 V/10 mA (bridge to IGI_IN to disable IGI function)
IGI	31	IGI_IN	<4V (2mA) = low/>8V (4mA) = high
Designation	**Pin**	**Signal type**	**Short specification**

ESI	36	ESI_IN	<4V (2mA) = low/>8V (4mA) = high
ITS_OFF	39	ITS_OFF	Connect this pin to FGND-> ITS disabled
ITS_OFF	43	FGND	
	6	NC	NC
	7	Nc	NC
	47	NC	NC
	51	NC	NC
	52	NC	NC
	53	NC	NC
	54	NC	NC
	55	NC	NC
	56	NC	NC
POWER	59	+24V	24V/30A
POWER	58	+24V	24V/30A
POWER	62	+24V	24V/30A
POWER	57	+24V	GND/30A
POWER	61	+24V	GND/30A
POWER	60	+24V	GND/30A

3.2.2 Connector X2/Engine wiring harness

Connector assignment

Pin assignment X2 (engine wiring harness) 92 pins (92 x MCP1.5)



Latch: Bayonet latch over several tabs

Engine sensors are connected to this connector.
The connector assignment for connector X2 is shown in the following table. The short specification gives the most important properties of each channel.

Designation	Pin	Signal type	Short specification
ASI1	78	ASI1_H	
ASI1	56	ASI1_L	< 120mV = low/< 0mV = high
ASI2	77	ASI2_H	
ASI2	55	ASI2_L	< 120mV = low/< 0mV = high
CAN3_E	24	CAN3_E_GND	
CAN3_E	1	CAN3_E_H	50V isolated
CAN3_E	2	CAN3_E_L	
FI2	53	FI2_H	<-482mV = low/> 586mV = high
FI2	75	FI2_L	

Designation	Pin	Signal type	Short specification
FI1	54	FI1_H	<-482mV = low/> 586mV = high
FI1	76	FI1_L	
IO11	46	IO11_H	42 V/10 A
IO11	23	IO11_L	Bank 1
IO12	45	IO12_H	42V/10A
IO12	22	IO12_L	Bank 1
IO21	44	IO21_H	42V/10A
IO21	21	IO21_L	Bank 2
IO22	43	IO22_H	42V/10A
IO22	20	IO22_L	Bank 2
IO31	42	IO31_H	42V/10A
IO31	19	IO31_L	Bank 3
IO32	41	IO32_H	42V/10A
IO32	18	IO32_L	Bank 3
IO41	40	IO41_H	42V/10A
IO41	17	IO41_L	Bank 4
IO42	39	IO42_H	42V/10A
IO42	16	IO42_L	Bank 4
IO51	38	IO51_H	42V/10A
IO51	15	IO51_L	Bank 5
IO52	37	IO52_H	42V/10A
IO52	14	IO52_L	Bank 5
IO61	36	IO61_H	42V/10A
IO61	13	IO61_L	Bank 6
IO62	35	IO62_H	42V/10A
IO62	12	IO62_L	Bank 6
LSI1	31	LSI1_13V_5V_T8	Supply 13V/5V for LSI1 max 12 mA/channel tracker 8
LSI1	10	LSI1_IN	0 to 5 V/internal 47k5 pull down PI/pull up 3k32 LSI
LSI2	32	LSI1_13V_5V_T9	Supply 13V/5V for LSI1 max 12mA/channel tracker 9
LSI2	33	LSI2_IN	0 to 5V/internal 47k5 pull down PI/pull up 3k32 LSI (Data IN/OUT EI_module)
NSI1	11	NSI1_24V	24V/0.5°/Rmin 16k for OL detection
NSI1	34	NSI1_IN	0 to 5V/internal 47k5 pull down PI/pull up LSI
NSI1	30	NSI1_GND	GND
PHI1	73	PHI1_5V_T1	5V/12mA/tracker T1
PHI1	52	PHI1_GND	GND
PHI1	74	PHI1_IN	0 to 5V/internal 47k5 pull down

Designation	Pin	Signal type	Short specification
PHI2	71	PHI2_5V_T2	5V/12mA/tracker T2
PHI2	51	PHI2_GND	GND
PHI2	72	PHI2_IN	0 to 5V/internal 47k5 pull down
PI1	49	PI1_5V_T3	5V/12mA/tracker T3
PI1	50	PI1_GND	GND
PI1	70	PI1_IN	0 to 5V/internal 47k5 pull down
PI2	25	PI2_5V_T4	5V/12mA/tracker T4
PI2	26	PI2_GND	GND
PI2	3	PI2_IN	0 to 5V/internal 47k5 pull down
PI3	4	PI3_5V_T5	5V/12mA/tracker T5
PI3	27	PI3_GND	GND
PI3	5	PI3_IN	0 to 5V/internal 47k5 pull down
PI4	6	PI4_5V_T6	5V/12mA/tracker T6
PI4	28	PI4_GND	GND
PI4	7	PI4_IN	0 to 5V/internal 47k5 pull down
PI5	8	PI5_5V_T3	5V/12mA/tracker T7 for PI5 to 7 (48mA)
PI5	29	PI5_GND	GND
PI5	9	PI5_IN	0 to 5V/internal 47k5 pull down
PI6	47	PI6_IN	0 to 5V/internal 47k5 pull down
PI7	48	PI7_IN	0 to 5V/internal 47k5 pull down
PWM_CM1	91	PWM_CN1_GND	LGND (50m Ohm)
PWM_CM1	92	PWM_CN1_OUT	24V/3A with current measurement (CM)
PWM_CM2	68	PWM_CN2_GND	LGND (50m Ohm)
PWM_CM2	69	PWM_CN2_OUT	24V/3A/< 500Hz
PWM_CM3	67	PWM_CN3_GND	LGND (50m Ohm)
PWM_CM3	90	PWM_CN3_OUT	24V/3A/< 500Hz
PWM1	65	PWM1_GND	LGND
PWM1	88	PWM1_OUT	24V/3A/< 500Hz
PWM2	66	PWM2_GND	LGND
PWM2	89	PWM2_OUT	24V/3A/< 500Hz
TI1	64	TI1_GND	GND
TI1	87	TI1_IN	0 to 5V/internal 1k91 pull up to TI_BUF
TI2	63	TI2_GND	GND
TI2	86	TI2_IN	0 to 5V/internal 1k91 pull up to TI_BUF
DFI2	62	DFI2_IN	Internal 47k5 pull down/pull up 1.82k + diode -> 5V
TI3	85	TI3_IN	0 to 5V/internal 1k91 pull up to TI_BUF
Designation	**Pin**	**Signal type**	**Short specification**

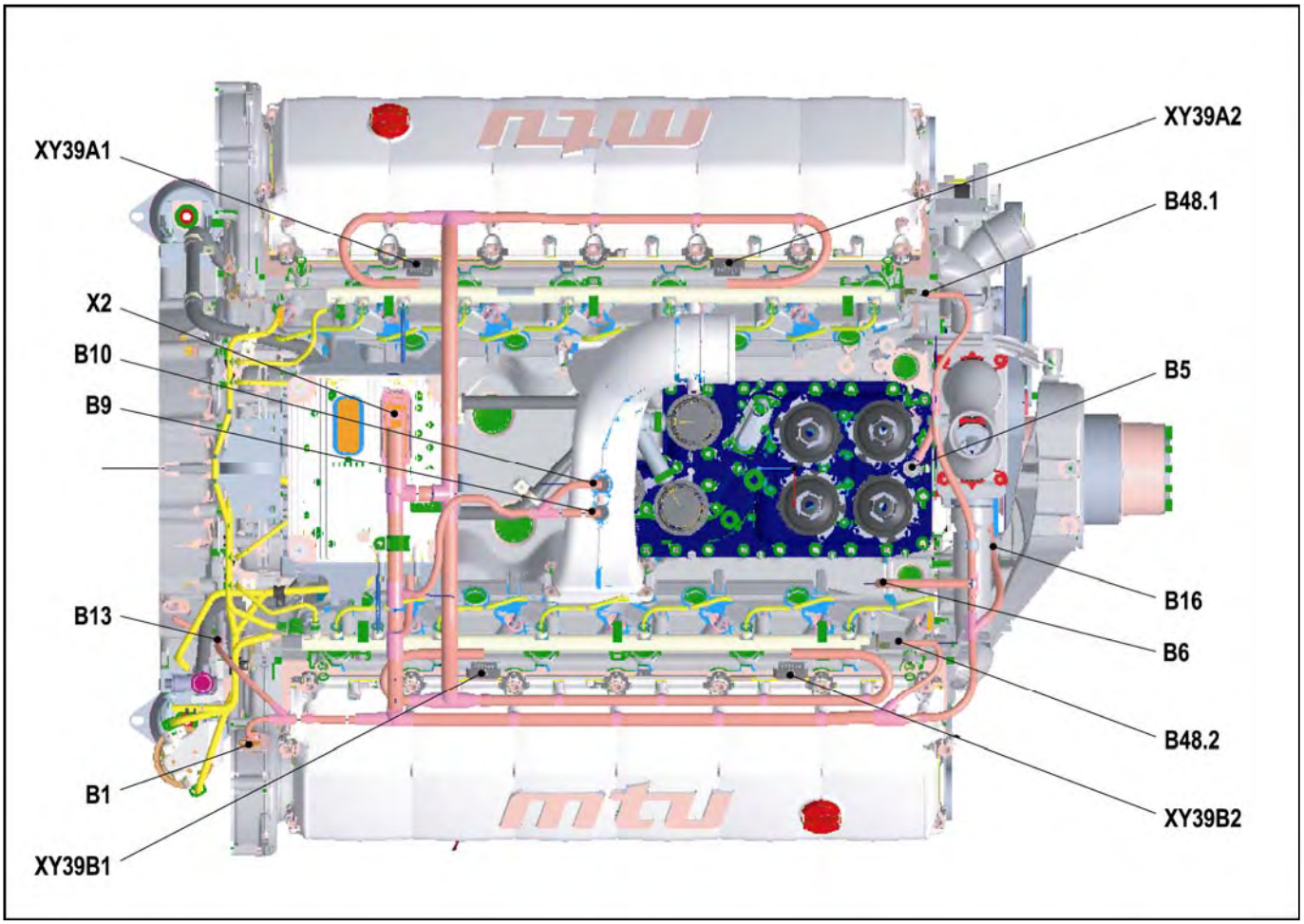
DFI1	61	DFI1_IN	Internal 47k5 pull down/pull up 1.82k + diode -> 5V
TI4	84	TI4_IN	0 to 5V/internal 1k91 pull up to TI_BUF
DFI1_2	60	DFI1_2_12v	Supply for DFI1/2 (12V/200mA)
TI5	83	TI5_IN	0 to 5V/internal 1k91 pull up to TI_BUF
TI6	82	TI6_IN	0 to 5V/internal 1k91 pull up to TI_BUF
TI7	81	TI7_IN	0 to 5V/internal 1k91 pull up to TI_BUF
TI8	59	TI8_IN	0 to 5V/internal 1k91 pull up to TI_BUF
PWM_CM4	58	PWM_CM4_GND	LGND (50m Ohm)
PWM_CM$	80	PWM_CM4_OUT	24V/3A/< 500Hz
TO1	57	TO1_GND	LGND
TO1	79	TO1_OUT	24V/1.5A

4 Sensors

Installation location of the sensors

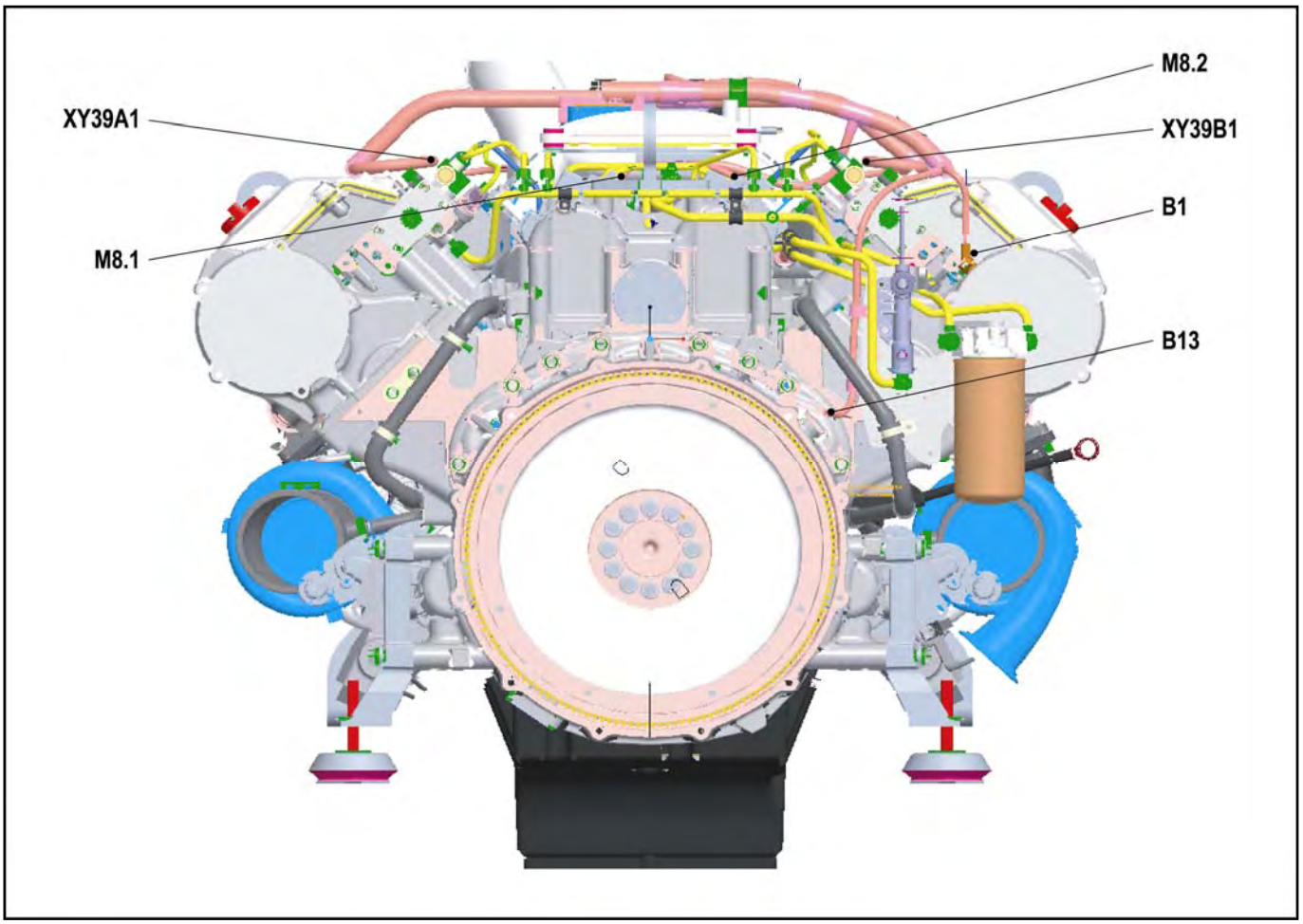
4.1.1 Sensors on engines BR1600 12V/BR1600 10V

Top side (plan view) BR1600 12V



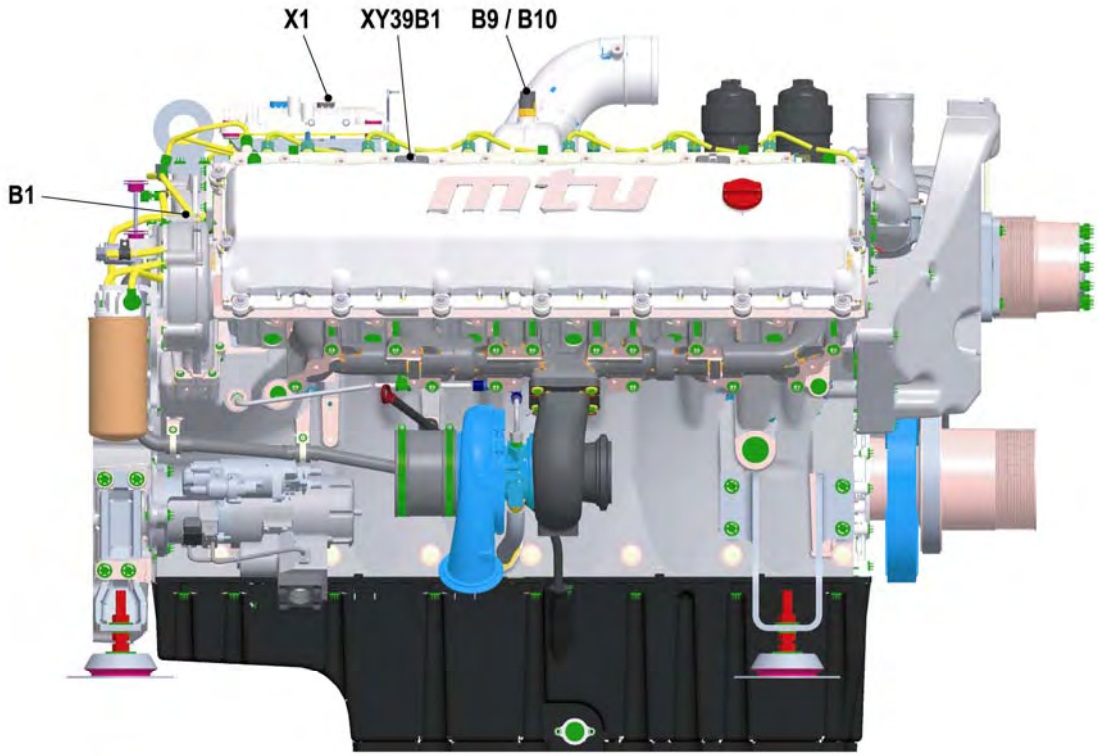
XY39A1	Injector connection A side 1	B6	Coolant temperature
XY39A2	Injector connection A side 2	B9	Charge-air temperature
XY39B1	Injector connection B side 1	B10	Charge-air pressure
XY39B2	Injector connection B side 2	B13	Crankshaft speed
X2	ECU connector engine wiring harness	B16	Coolant pressure
B1	Camshaft speed	B48.1	Fuel pressure A side
B5	Lube-oil pressure	B48.2	Fuel pressure B side

Free end (KGS)



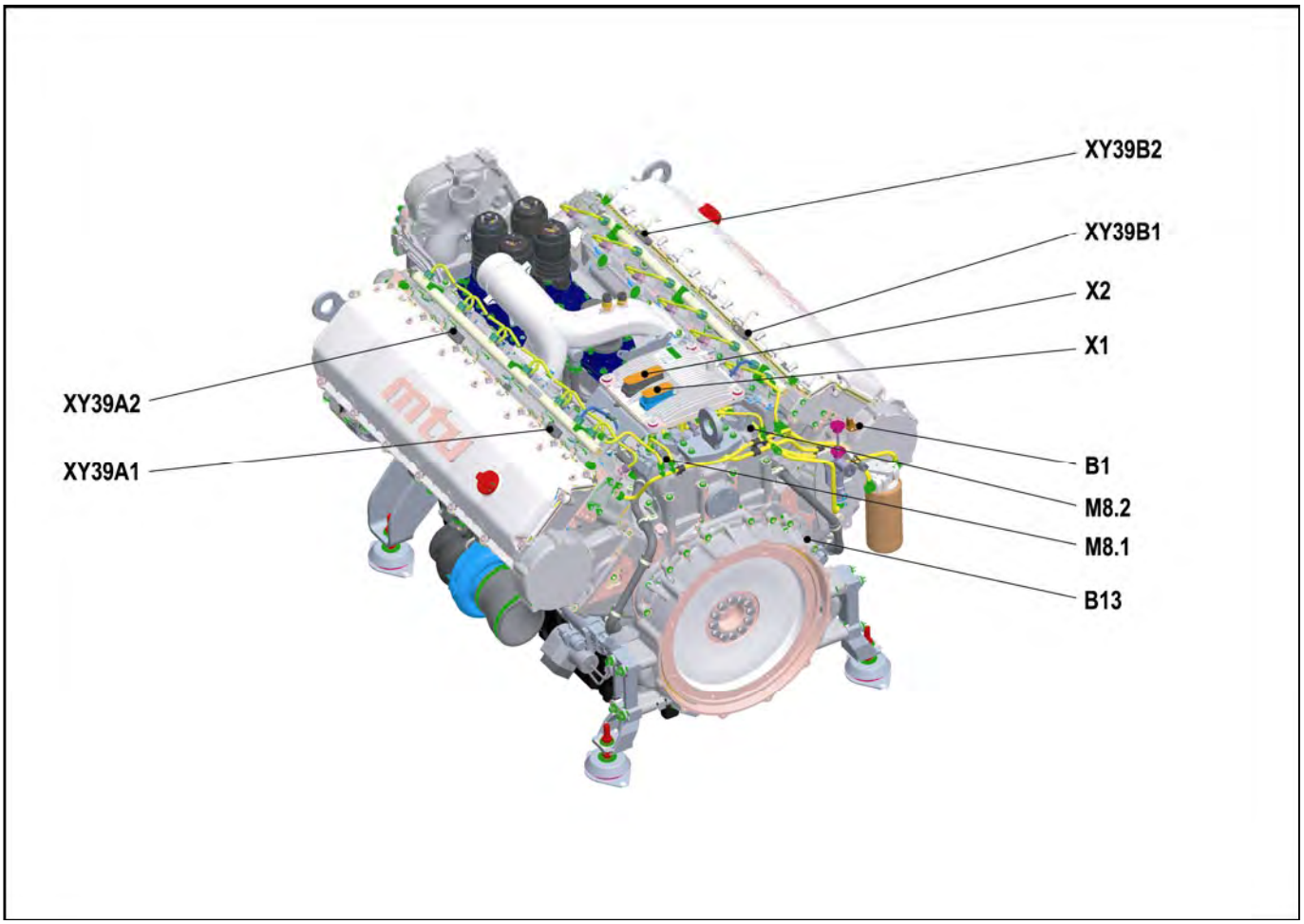
XY39A1	Injector connection A side 1
XY39B1	Injector connection B side 1
B1	Camshaft speed
B13	Crankshaft speed
M8.1	Fuel pump HDP A
M8.2	Fuel pump HDP B

Right engine side



XY39B1	Injector connection B side 1
B1	Camshaft speed
X2	ECU8 connector engine wiring harness
B9	Charge-air temperature
B10	Charge-air pressure

Top side diagonal as seen from driving end (KS)



B1	Camshaft speed
B13	Crankshaft speed
M8.1	Fuel pump HDP A
M8.2	Fuel pump HDP B
XY39A1	Injector connection A side 1
XY39A2	Injector connection A side 2
XY39B1	Injector connection B side 1
XY39B2	Injector connection B side 2
X1	ECU8 connector system cable
X2	ECU8 connector engine wiring harness

Sensors used

4.2.1 Sensor types

Various sensors are used to record the engine's operating values:

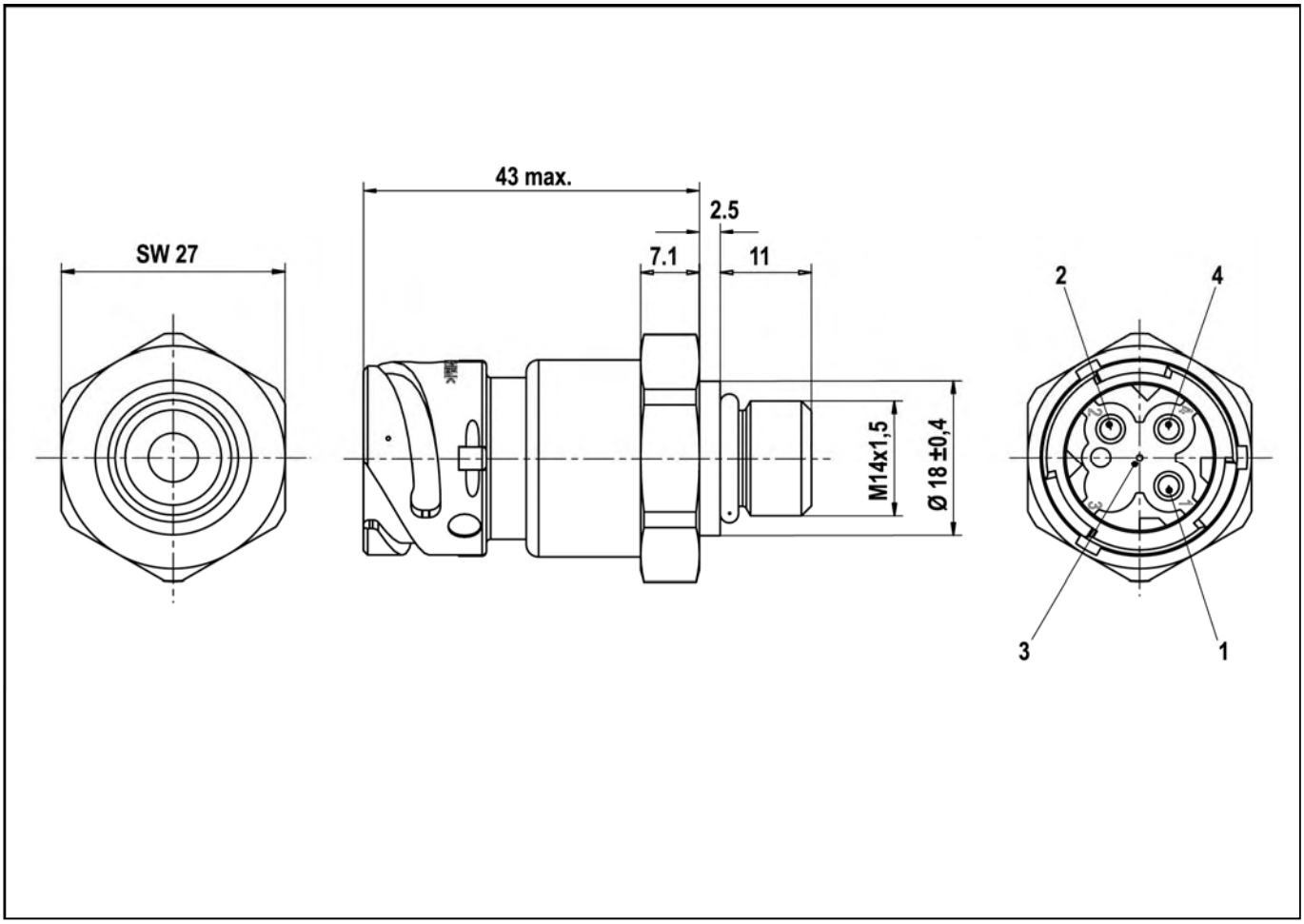
- Pressure sensors
- Temperature sensors
- Speed sensors

The following information is given in the subchapters for each sensor

- Equipment identifier of the sensor (e.g. B5)
- Mechanical design
- Use (measurand)
- Block diagram
- Connector with pin assignment

4.2.1.1 Pressure sensors

B5, B16 sensors (0 to 10 bar)
Mechanical design



Connections:

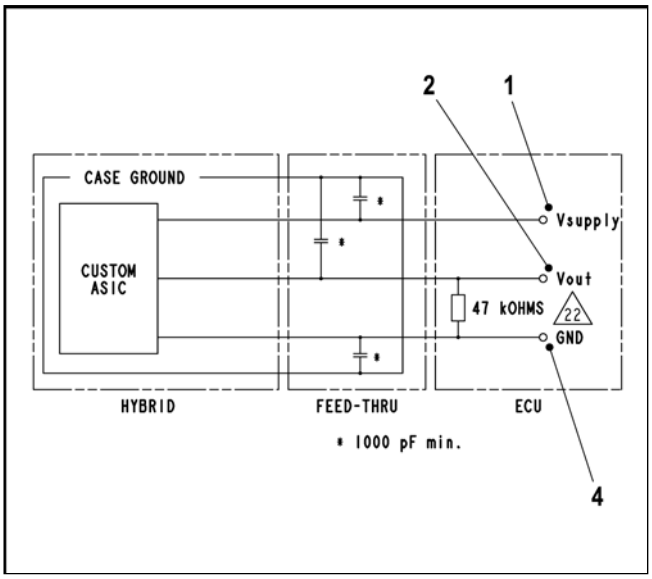
1	Supply voltage	3	Ventilation
2	Output voltage	4	GND

Use

The sensor is used for:

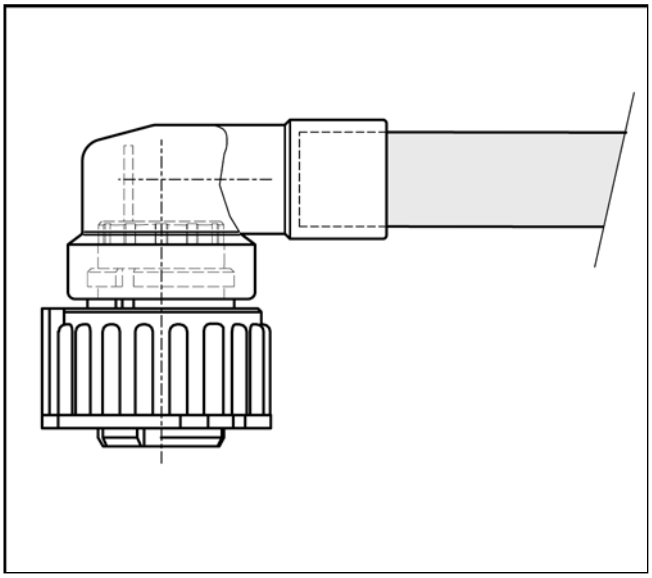
- B5 Lube-oil pressure
- B16 Coolant pressure

Block diagram



1 Supply voltage
2 Output voltage
4 GND

Connector



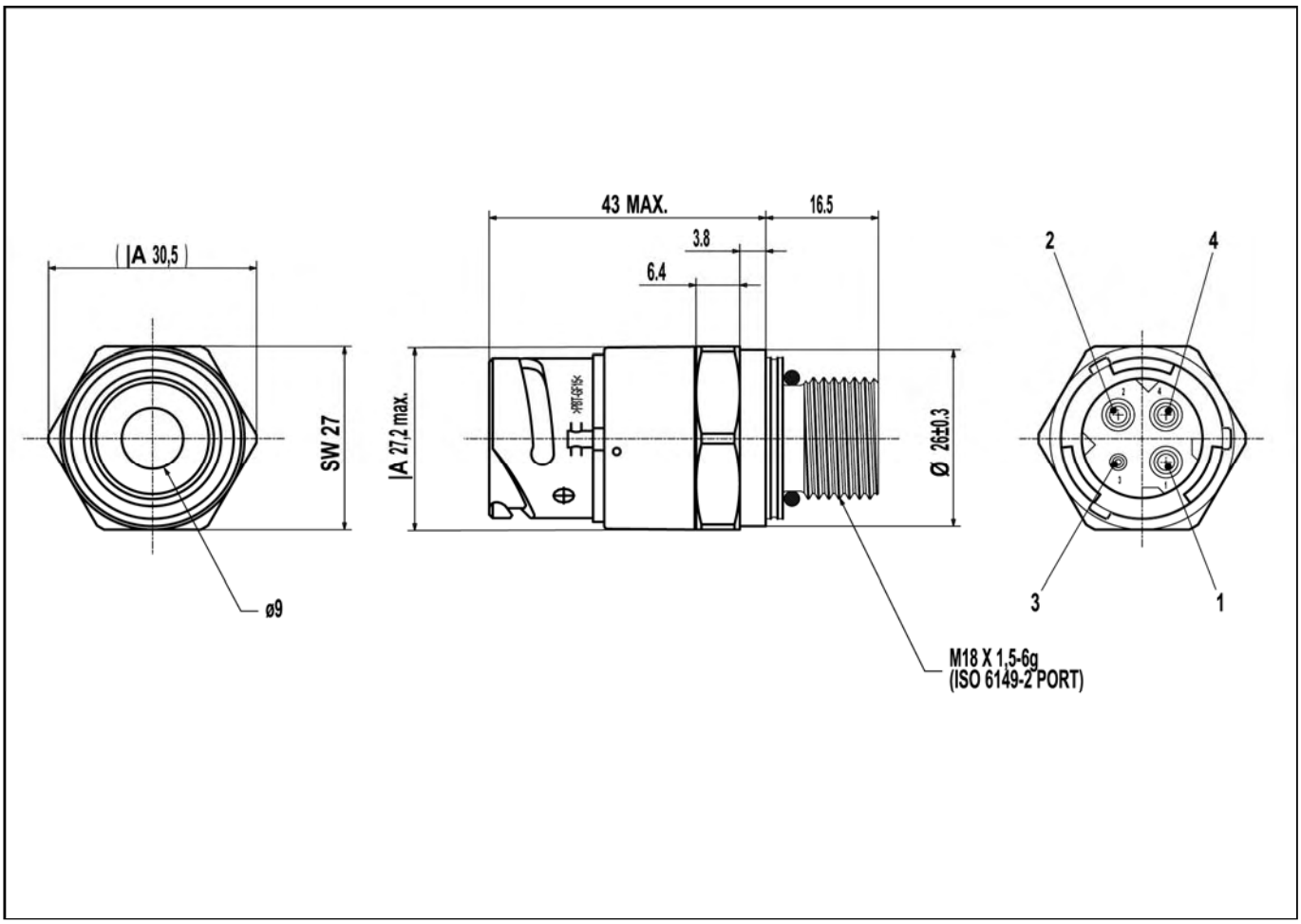
B5/B16 Connector

Connector pin assignment

Pin no.: Signal:

1 Supply voltage $+U_b$: 5 VDC
2 Output voltage $+U_a$: 0.5 to 4.5 VDC for 0 to 10 bar
3 Ventilation
4 GND (not connected to housing)

Sensor B10 (0 to 4.5 Bar)
Mechanical design



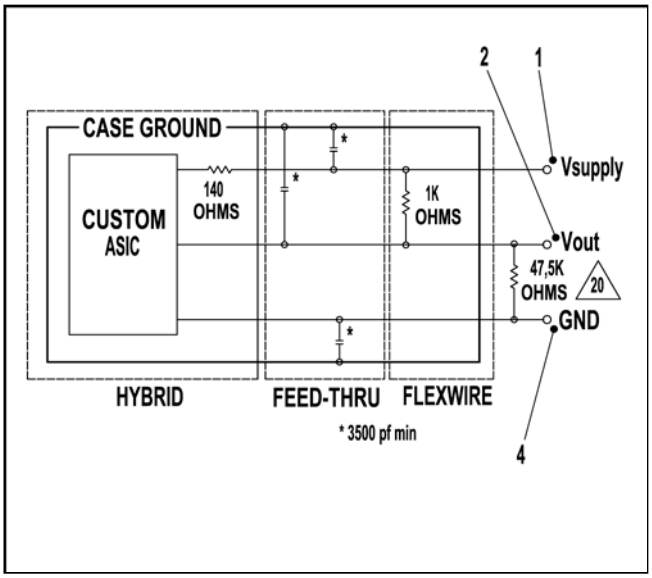
1 Supply voltage
2 Output voltage
3 Ventilation
4 GND

Use

The sensor is used for:

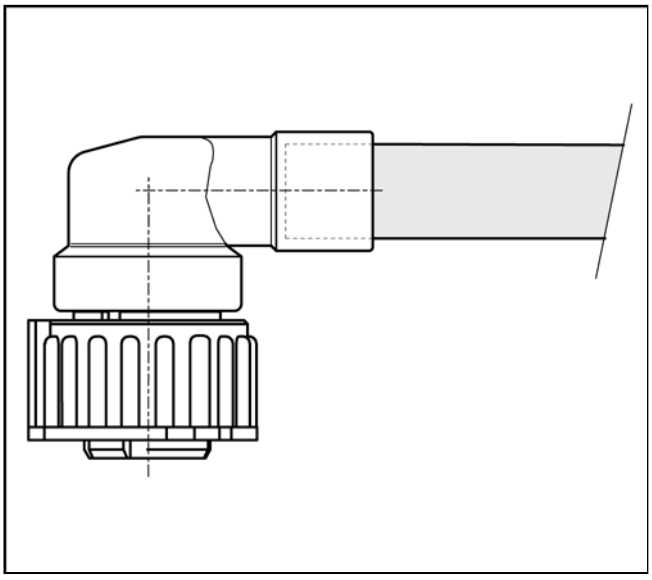
B10 Charge-air pressure

Block diagram



1 Supply voltage
2 Output voltage
4 GND

Connector

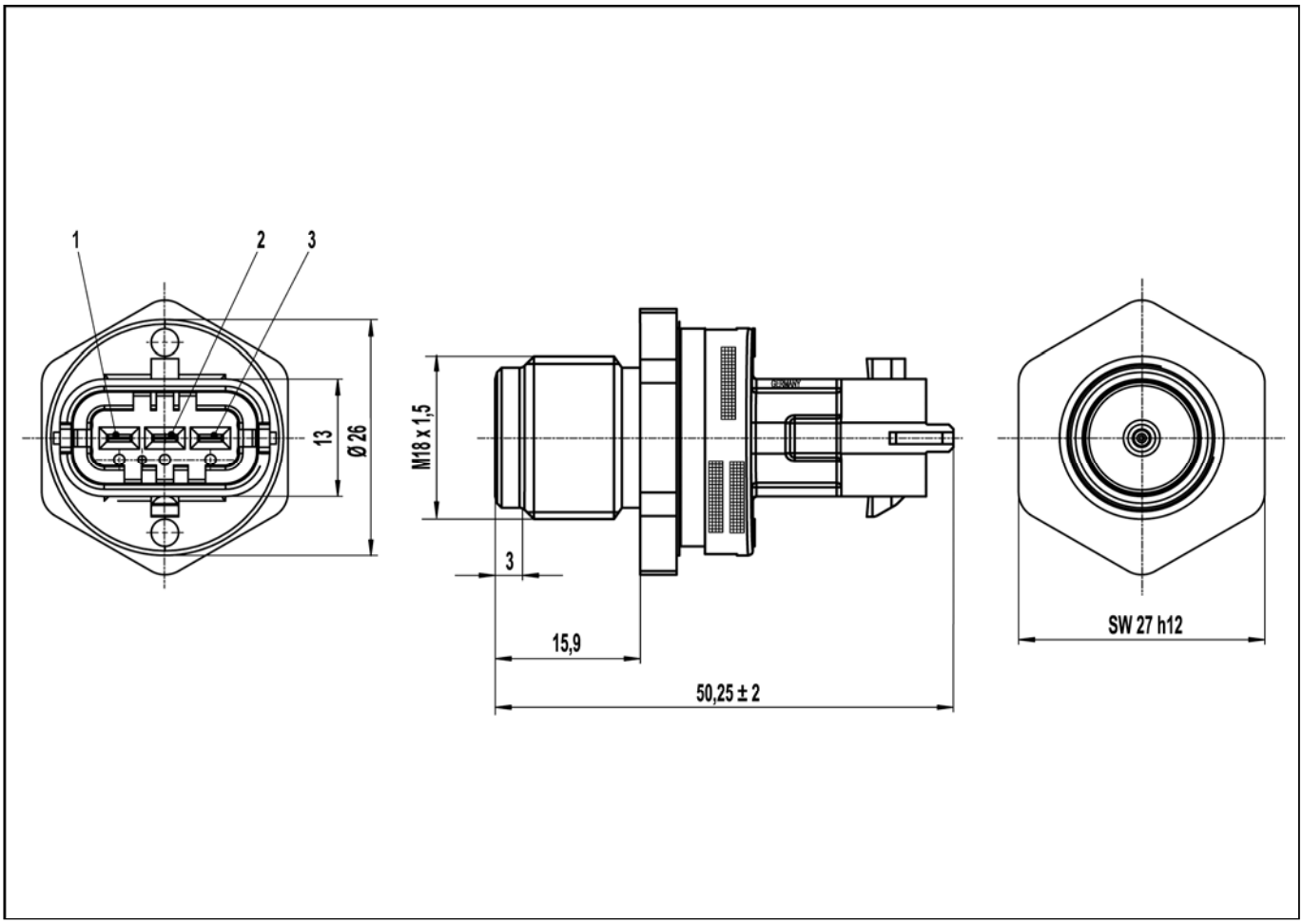


B10 Connector

Connector pin assignment

Pin no.: Signal:
1 Supply voltage $+U_b$: 5 VDC
2 Output voltage $+U_a$: 0.5 to 4.5 VDC for 0 to 4.5 bar
3 Ventilation
4 GND (not connected to housing)

B48.1, B48.2 Sensors (0 to 2000 Bar)
Mechanical design



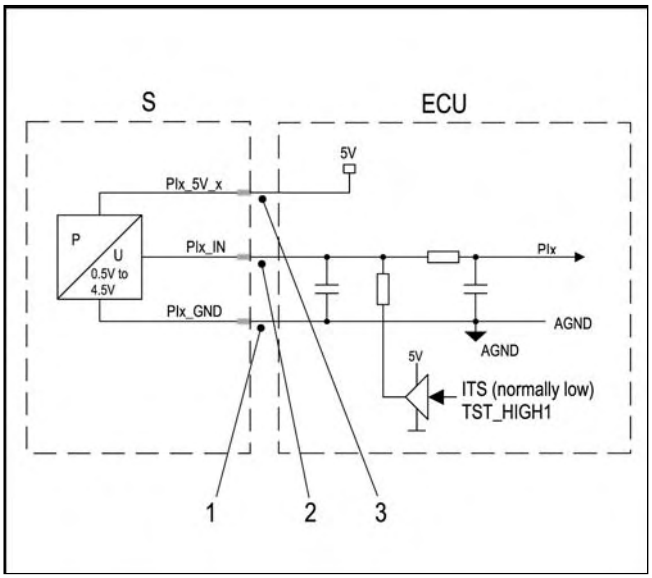
1 GND
2 Output
3 Supply voltage

Use

The sensor is used for:

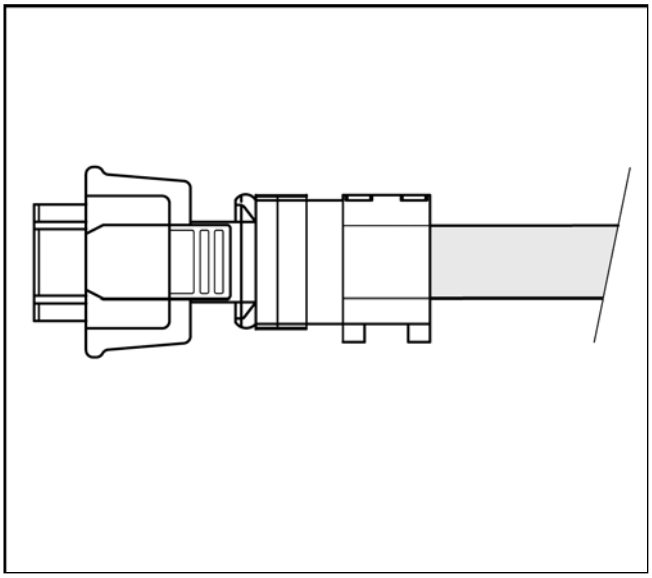
B48.1 Fuel high pressure
B48.2 Fuel high pressure

Block diagram



S Pressure sensor
ECU Engine Control Unit
1 GND
2 Output voltage
3 Supply voltage

Connector

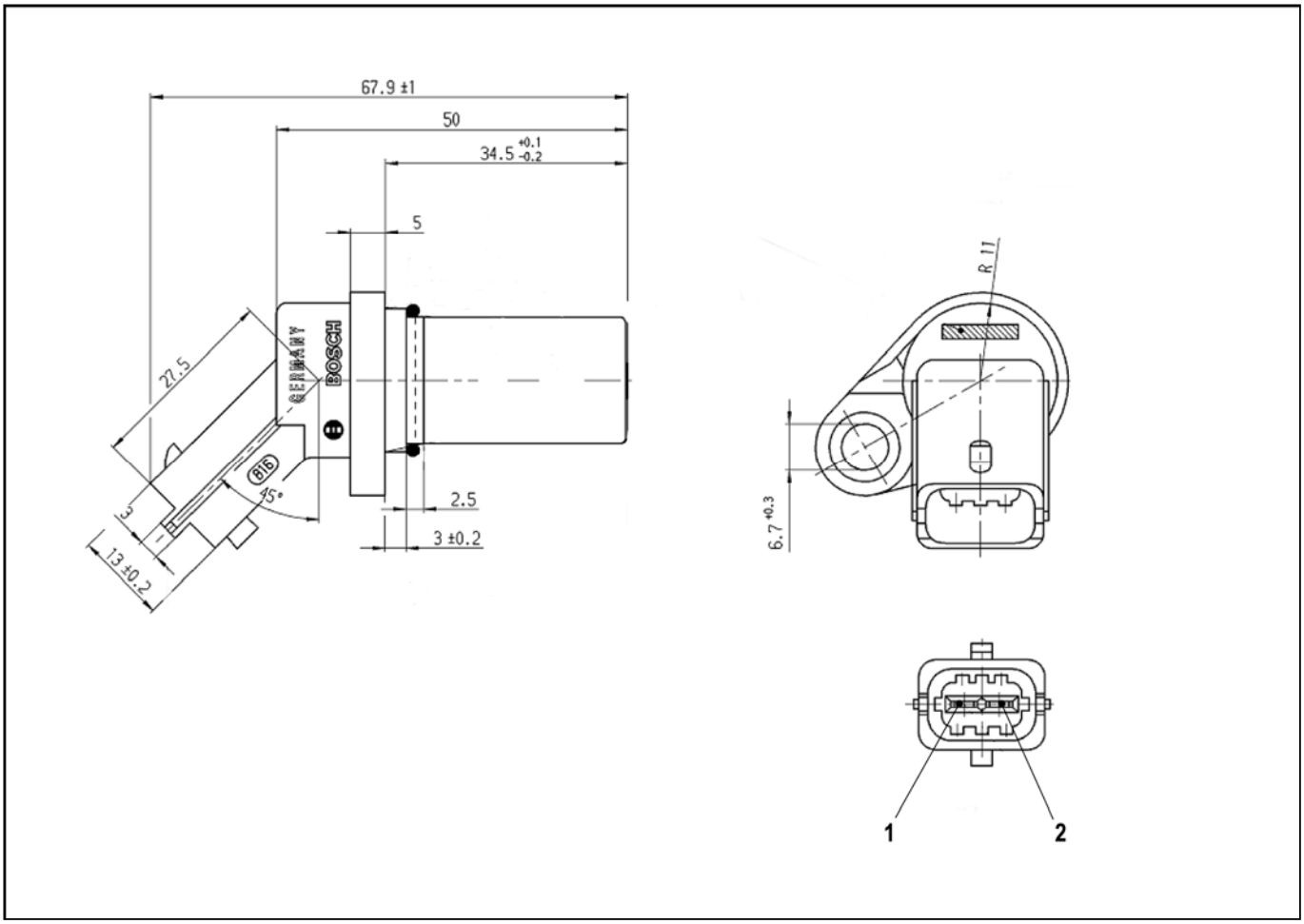


Connector pin assignment

Pin no.: Signal:
1 GND (not connected to housing)
2 Output voltage $+U_a$: 0.5 to 4.5 VDC for 0 to 2000 bar
3 Supply voltage $+U_b$: 5 VDC
4 Housing (ground)

4.2.1.2 Speed sensors

B1, B13 sensors (ASI angle input)
Mechanical design



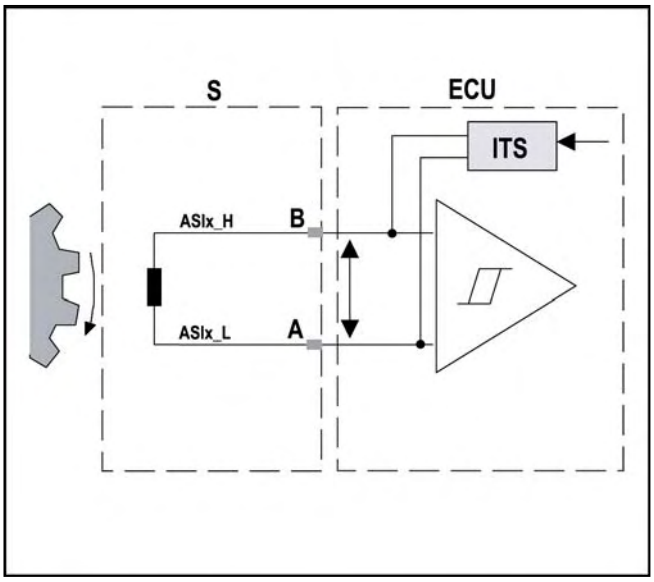
1 Connection B
2 Connection A

Use

The sensor is used for:

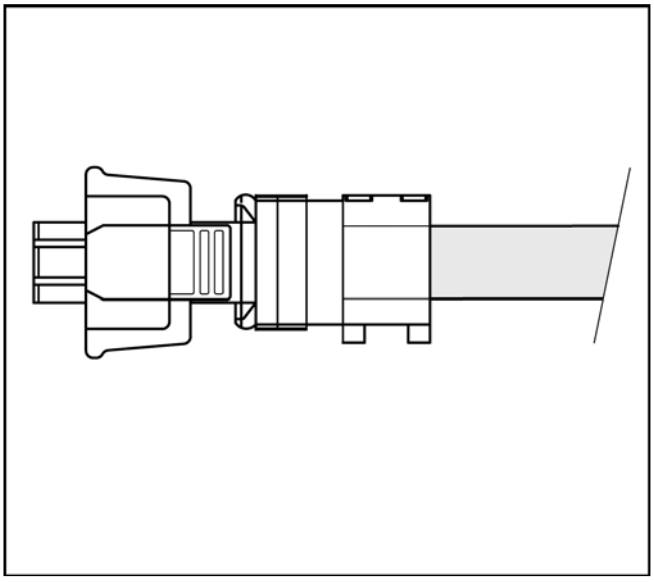
- B1 Camshaft speed
- B13 Crankshaft speed

Block diagram



S Sensor
ECU Engine Control Unit
ITS Fault detection OFF-LINE
A Analog signal
B Analog signal

Connector

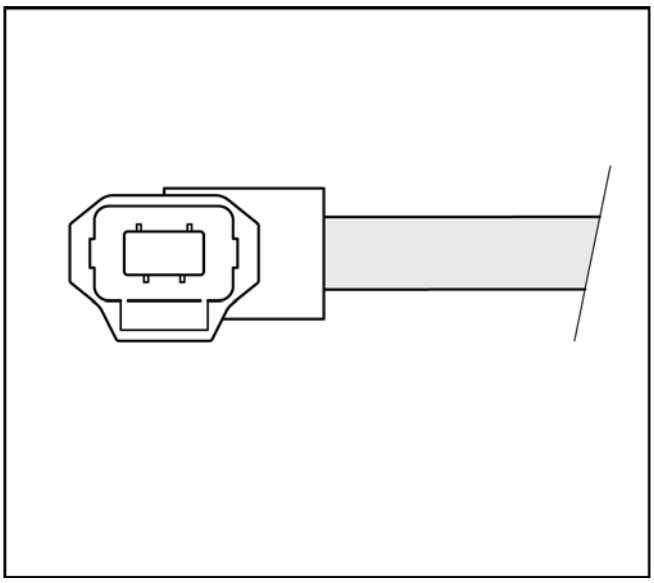


B1 Camshaft speed

Connector pin assignment

Pin no.:	Signal:
1	Black (analog signal)
2	Red (analog signal)

Connector plug



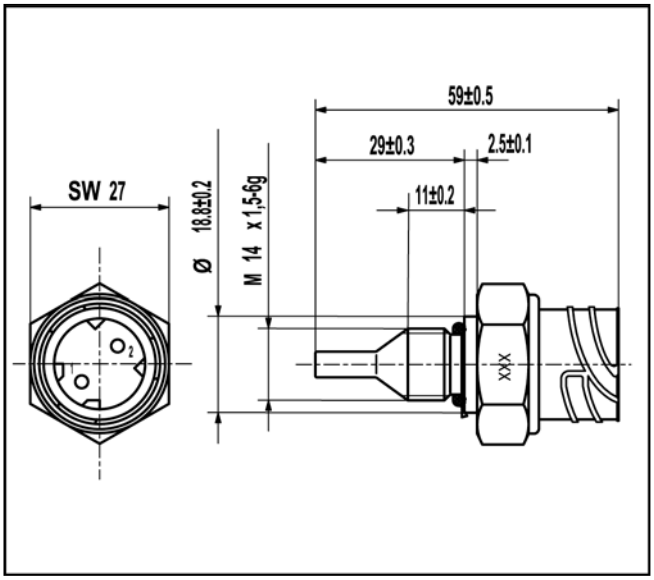
B13 Crankshaft speed

Connector pin assignment

Pin no.:	Signal:
1	Black (analog signal)
2	Red (analog signal)

4.2.1.3 Temperature sensors

B6, B9 sensors
Mechanical design

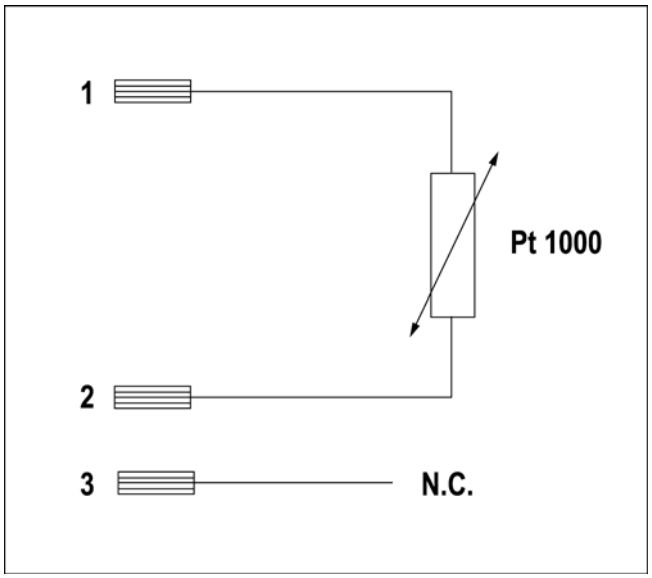


Use

The sensor is used for:

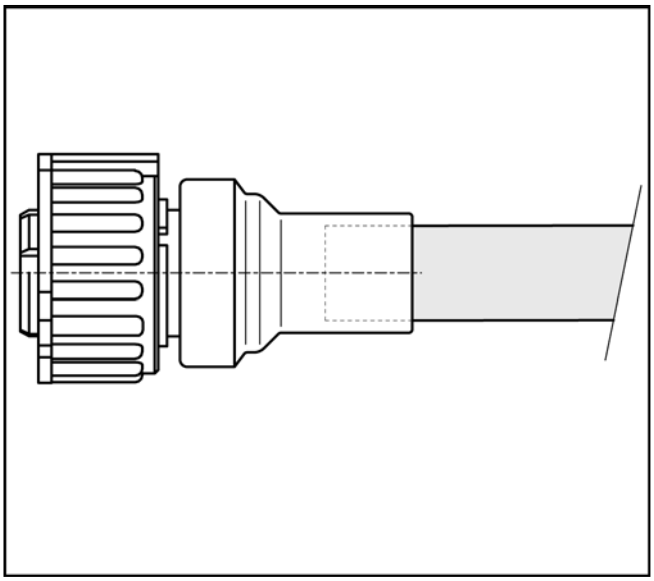
B6 Coolant temperature
B9 Charge-air temperature

Block diagram

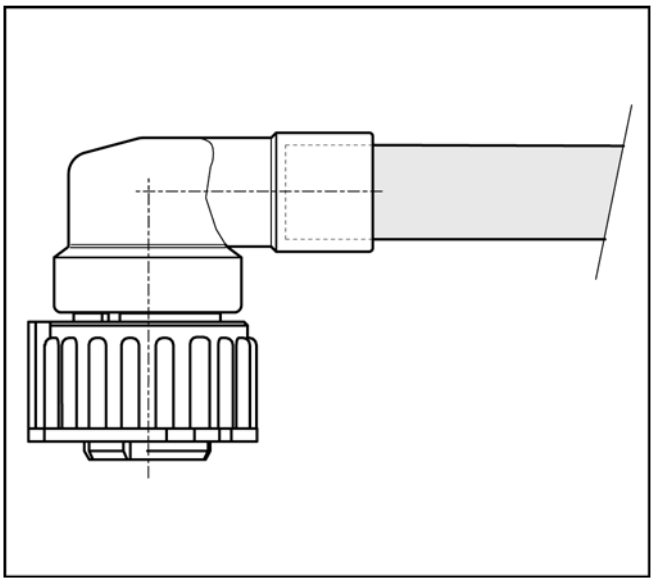


1 Input
2 GND

Connector plug



B6 Coolant temperature



B9 Charge-air temperature

Connector pin assignment

Pin no.:	Signal:
1	Pt 1000: 0° C: 1000 Ω to 100° C: 1385 Ω
2	GND

4.2.2 External sensors

Optionally there are 2 measuring points for external measurements:

LSI1 Water in fuel filter

LSI2 Coolant level

Sensors

The sensors used are level monitors which switch to ground when they detect that the level has gone over or under the specified level after a delay period.

If desired, MTU can optionally supply suitable sensors and wiring.

5 Wiring

Power supply

5.1.1 Power supply

General

The configuration of the power supply, including the start pushbutton, is the responsibility of the OEM.

For this reason this chapter will give recommendations for a simple wiring of the power distribution.

The following basic points must be observed for the power supply:

- Use a 2-pin master switch
- Secure all devices individually with circuit breakers
- Trip either a manual emergency stop, or through IGI, or ESI (see chap. 7.1)

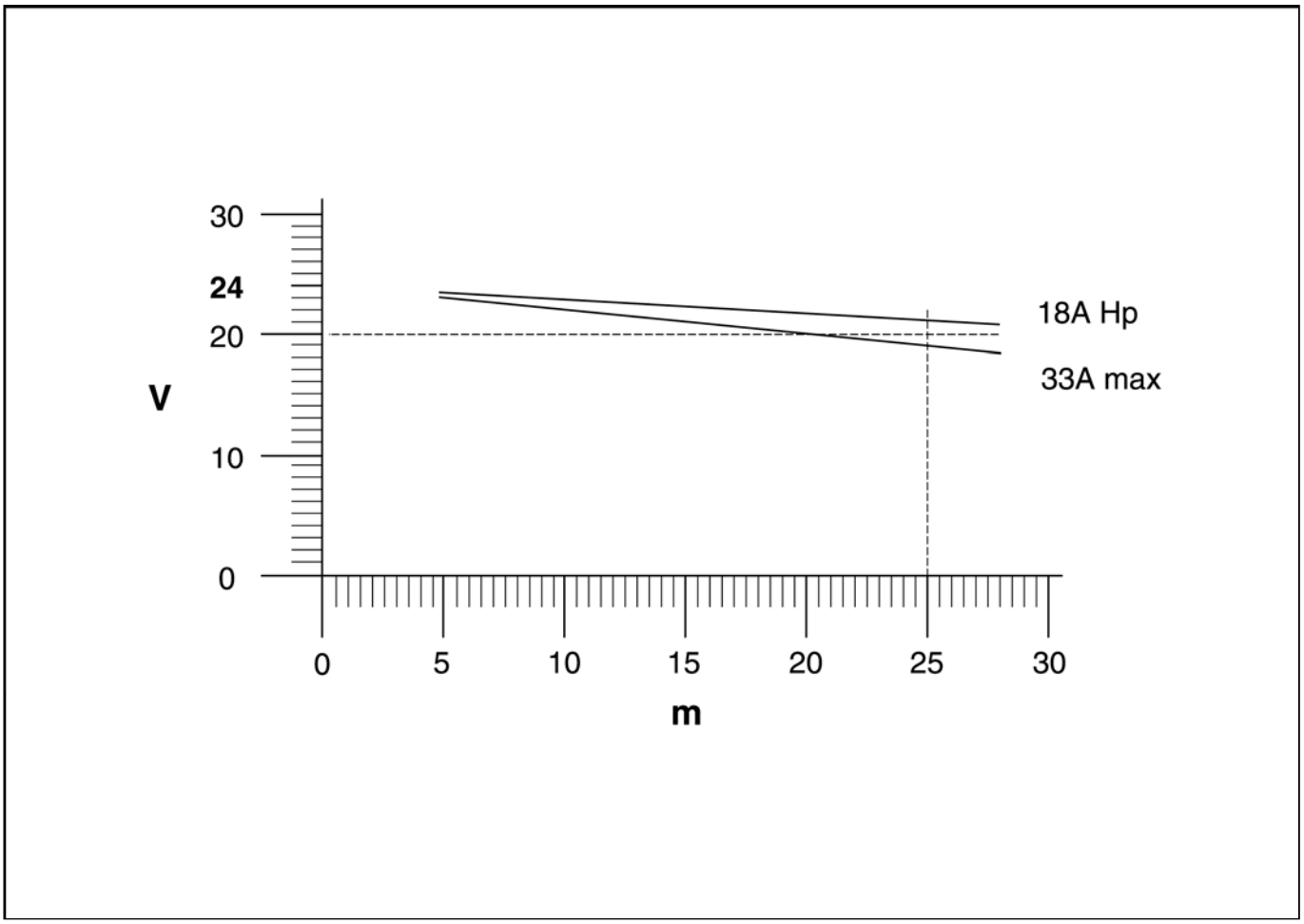
All of the above mentioned requirements are taken into account by the following recommendations. Basically all wire connections and their distribution must be made with terminal strips.

The cable length from the battery to the ECU8 including the terminal box may not exceed a max. 25 m.

6 pins in the connector (X1) are to be used for the power supply (6x2.5mm^2). The voltage drop between the battery and the ECU8 for 24V+ and GND lines depends on the load. Make sure that the ECU8 has a permanent voltage supply of at least 20V+ to the power supply pins. The average ECU8 current depends on the number of cylinders of the engine, the speed and the power consumers connected.

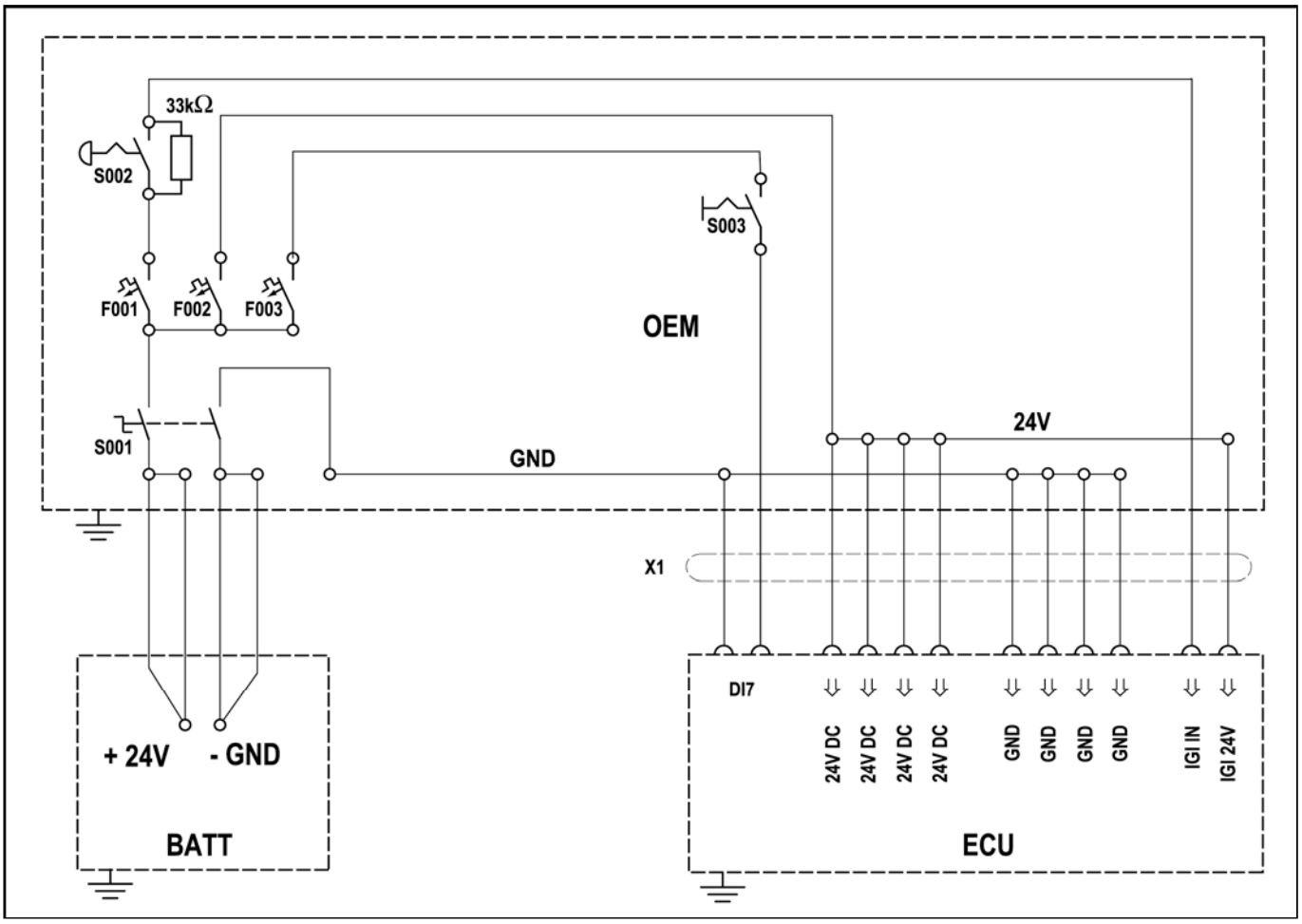
Note: If a terminal box is also integrated, then the corresponding voltage drop is also to be taken into account.

Example: Voltage drop for different cable lengths (taking into account Rcu and fuses):



Power consumption of ECU8 = max. 33 A

Example for the set up of the power supply (recommendation)



BATT Power supply F001-3 Limit switch S1 master switch
ECU Engine Control Unit ECU8 GND Ground S3 Start

Master switch

The master switch S001 is used to turn the power supply for the entire electronic engine management system on or off.

Circuit breakers

Circuit breakers are used in the following areas:

F001 6A Input IGI_IN on Engine Control Unit: Ignition on Input DI. on Engine Control Unit

F002 25A Power supply for Engine Control Unit

F003 6A Pushbutton/START

Pushbutton S003

Pressing the pushbutton activates the start command. The input DI7. of the Engine Control Unit is switched to 24V DC.

Emergency stop

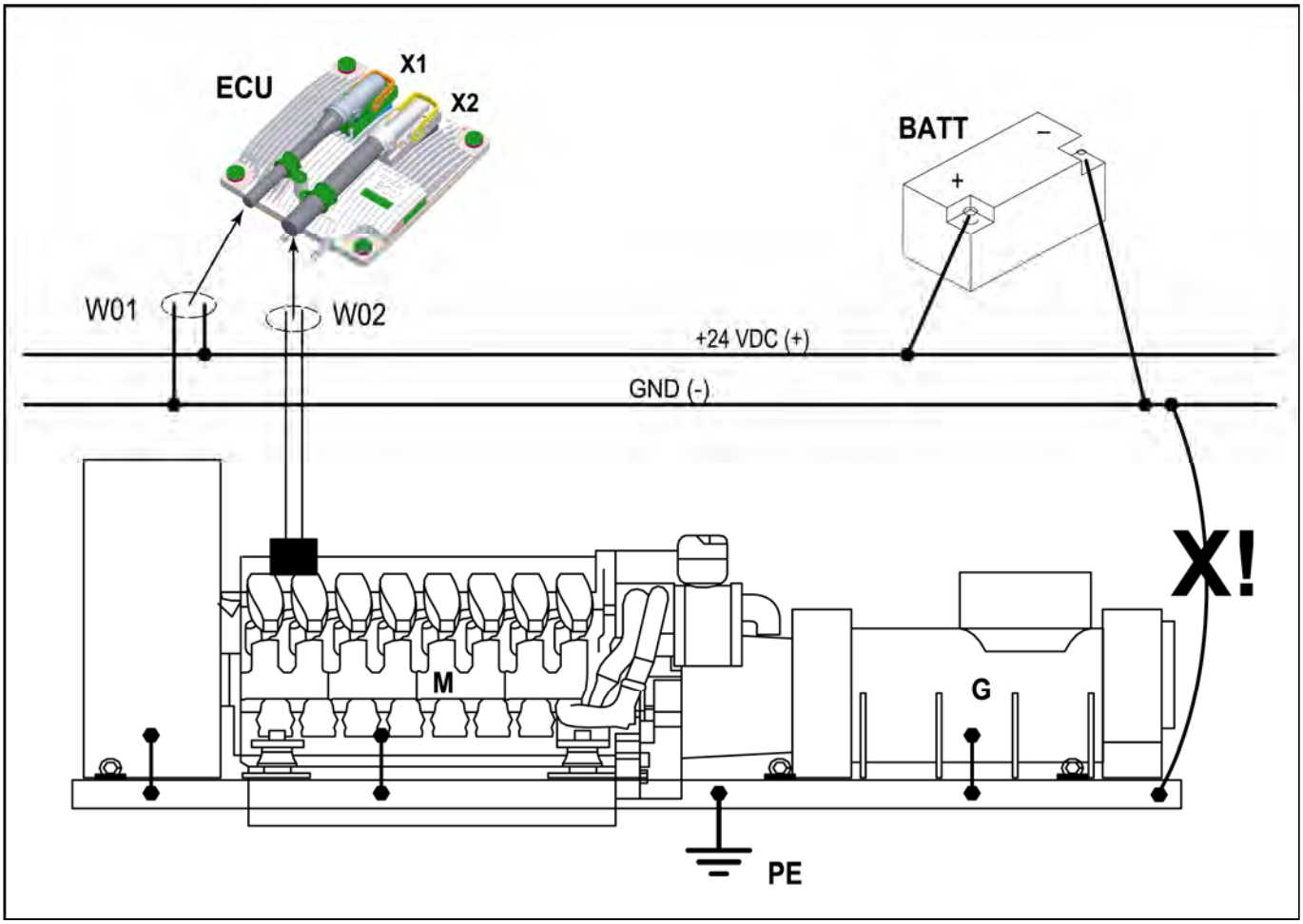
Performing an emergency stop by turning off the power supply to the Engine Control Unit is NOT PERMITTED.

Note: If, however, the engine is stopped in this manner, this process will be stored in the memory (counter). The next time the Engine Control Unit is turned on, alarm no. 549 “AL Power Interruption Detected” will be generated and saved in the fault memory.

5.1.2 Ground design

The ground must be designed to enable a complete separation between the generator ground and the ground of the power supply.

Ground design



W01	System cable	M	Engine	X1	System cable connector
W02	Engine wiring harness	G	Generator	X2	Engine wiring harness connector
ECU	ECU8 Engine Control Unit	BATT	Battery	PE	Ground connection

Important: The power supply ground (- GND) must not be connected at any point with the generator ground! The crossed out connection in the diagram must not be made!

The following ground connections are to be made:

- W01 cable/system connection: The shield of the cable to the system connection is connected via the connector X1 with the housing of the Engine Control Unit (factory).
  On the open side it must be connected to the housing in which the terminal strip and the customer's controls are installed (switchgear cabinet) (to be checked by the OEM).
- W02 cable/engine wiring harness: The shielding is connected to the Engine Control Unit via the engine wiring harness connector (ex-works).
- The engine must be grounded using a ground strap (PE). See “Grounding engines and systems” for the details about the design, cross section, etc.

5.1.3 CAN Bus

General

To maximize signal-to-noise ratio and hence maximum operational reliability, the wiring of the CAN bus must be carefully made according to the specification.

Note: A failure of the CAN bus will always lead to serious limitations or to the total failure of the engine. Therefore, the setup of the CAN bus is of central importance for the reliability of the whole system!

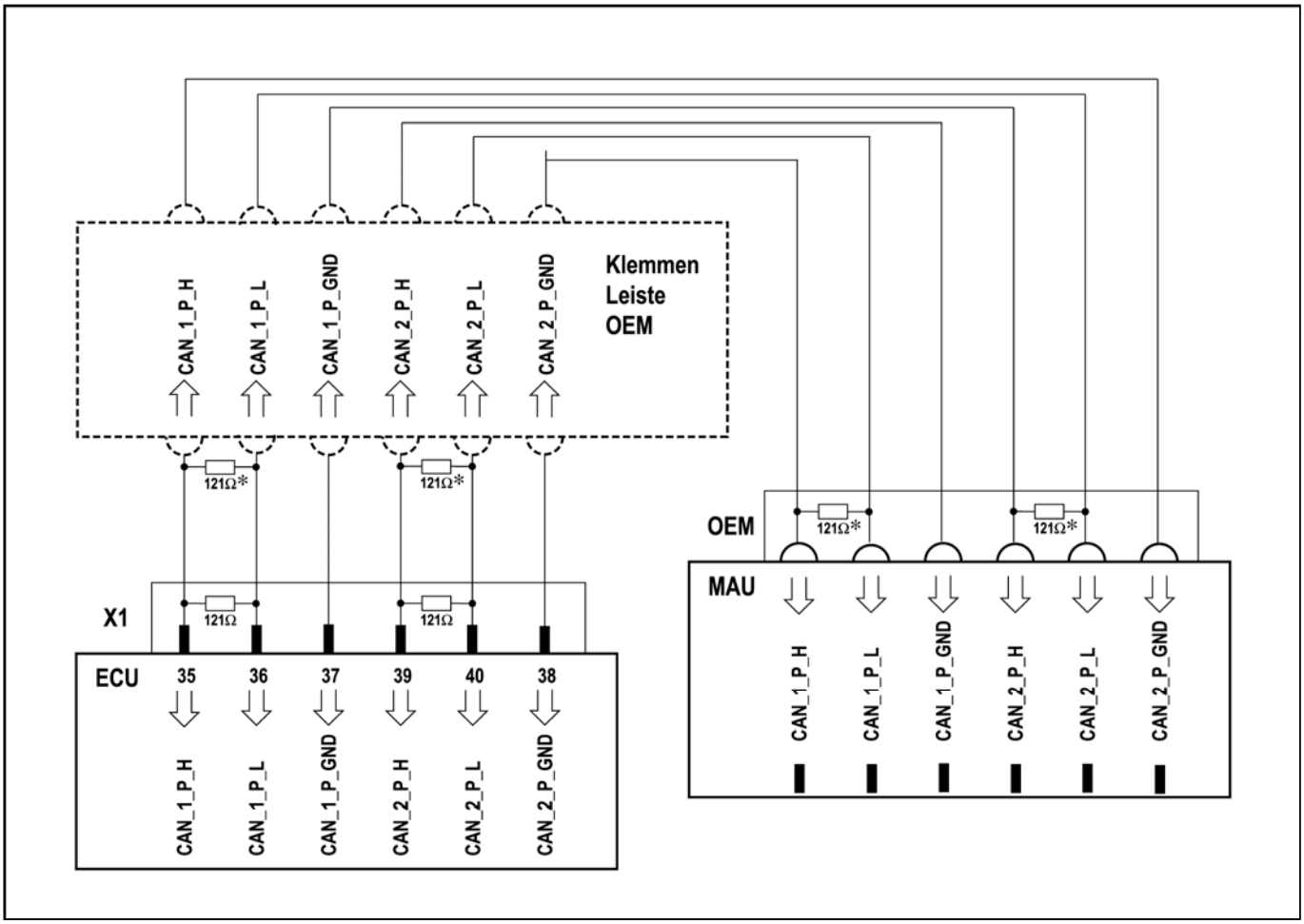
Wiring requirements

The cable used must at least possess the following electrical characteristics:

- Impedance Z: 120 Ω (± 10%)
- Specific resistance r_b: Max. 50Ω/m at 20°C
- Specific signal delay t_p: 5 ns/m
- Specific capacitance between the leads c_b: Max. 75 pF/m
- Specific capacitance of lead to ground c_s: Max. 110 pF/m

Block diagram

This diagram shows an example of the schematic setup of the CAN bus.



* Resistors may only be installed at the ends of the busses.
Either at the terminal strips or at the MAU.

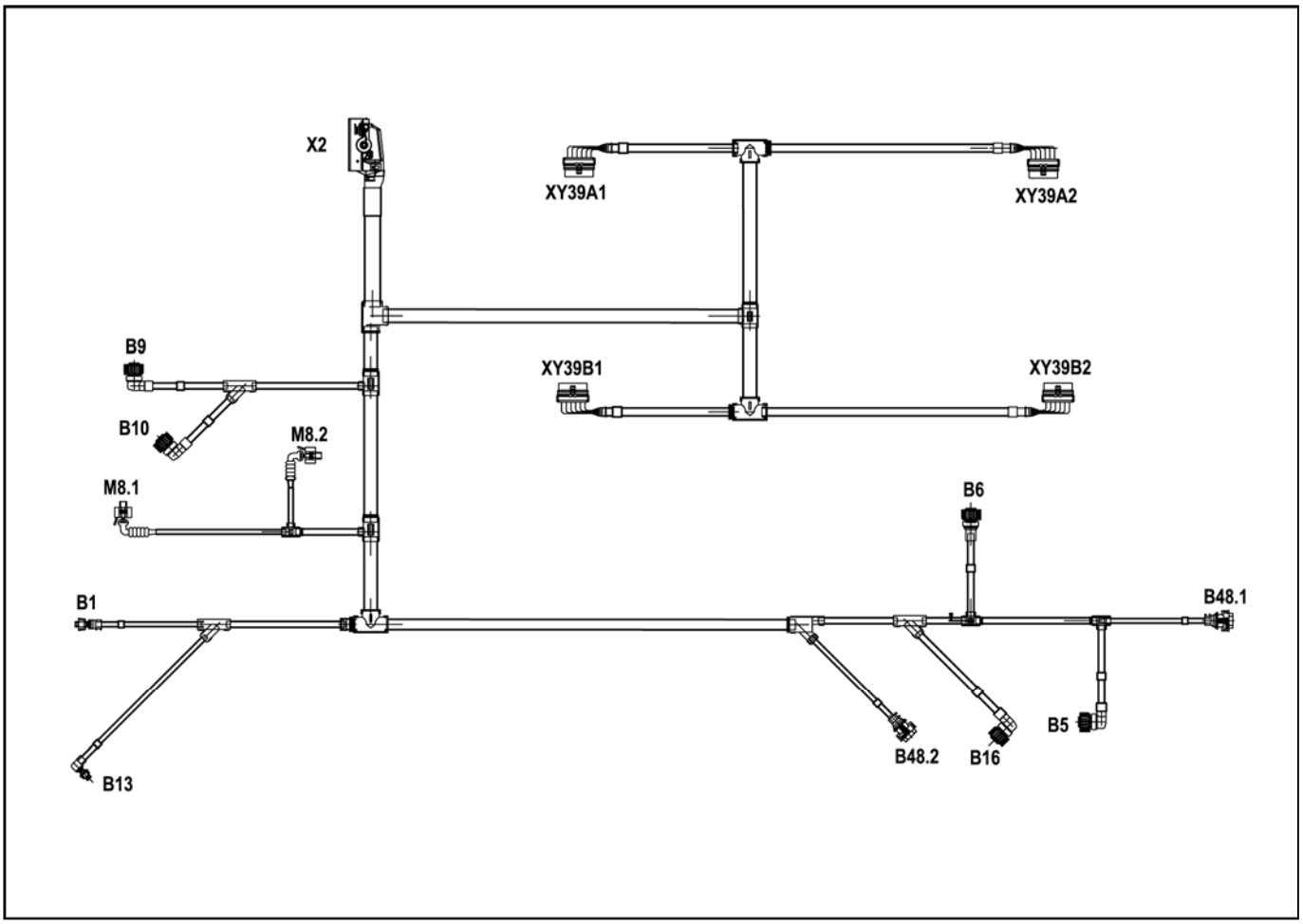
Please observe the following when connecting the CAN bus:

- Terminating resistor: One terminating resistor (120 Ω) is to be installed at each end of the CAN busses.
- The shielding of the bus cables (switchgear cabinet) is to be connected to the housing/cable gland of the switchgear cabinet.
  The (twisted) bus cable in the switchgear cabinet does not have to be grounded.
- CAN_GND connections: Theses connections must NOT be connected to the shielding, the operating voltage ground, or the vehicle ground!

Engine wiring harness

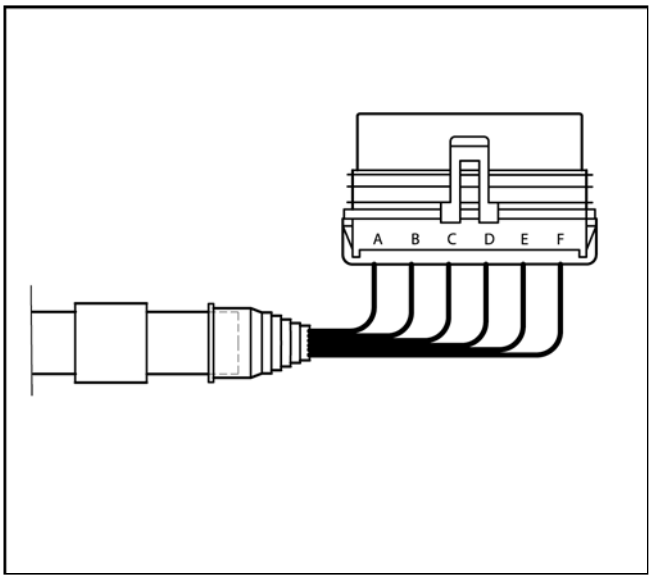
5.2.1 Sensor wiring harness

RB1600 10V (10-cylinder V engine) and RB1600 12V (12-cylinder V engine)



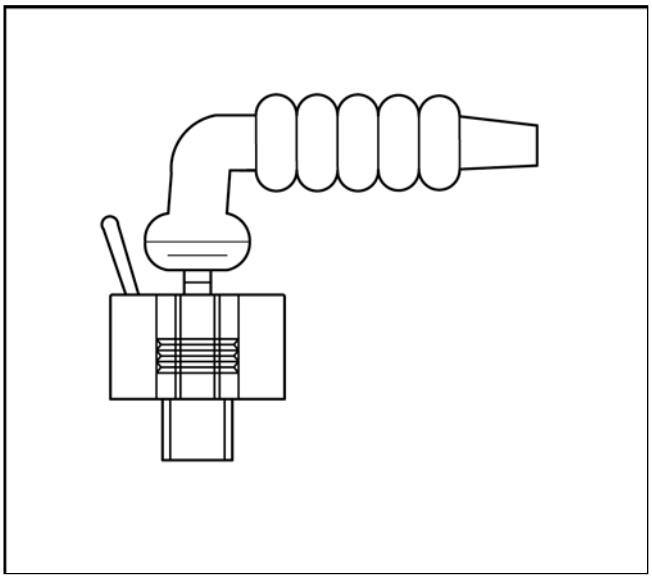
B1	Camshaft speed	B5	Lube oil pressure	B6	Coolant temperature
B9	Charge-air temperature	B10	Charge-air pressure	B13	Crankshaft speed
B16	Coolant pressure	B48.1	Fuel high pressure A	B48.2	Fuel high pressure B
M8.1	Fuel pump HDPA	M8.2	Fuel pump HDPB	XY39A1	Injector connection A1
XY39A2	Injector connection A2	XY39B1	Injector connection B1	XY39B2	Injector connection B2
X2	ECU8 connector				

XY39A1 to XY39B2 connectors



The injector wiring harness is connected to the XY39A1/XY39A2/XY39B/1XY39B2 connectors. The connections of the injector wiring harness are designed as “Window Gasket” and are located in the cylinder heads.

M8.1/M8.2 Connector



The purpose of this connector is to connect the following:

M8.1 Fuel pump HDPA
M8.2 Fuel pump HDPB

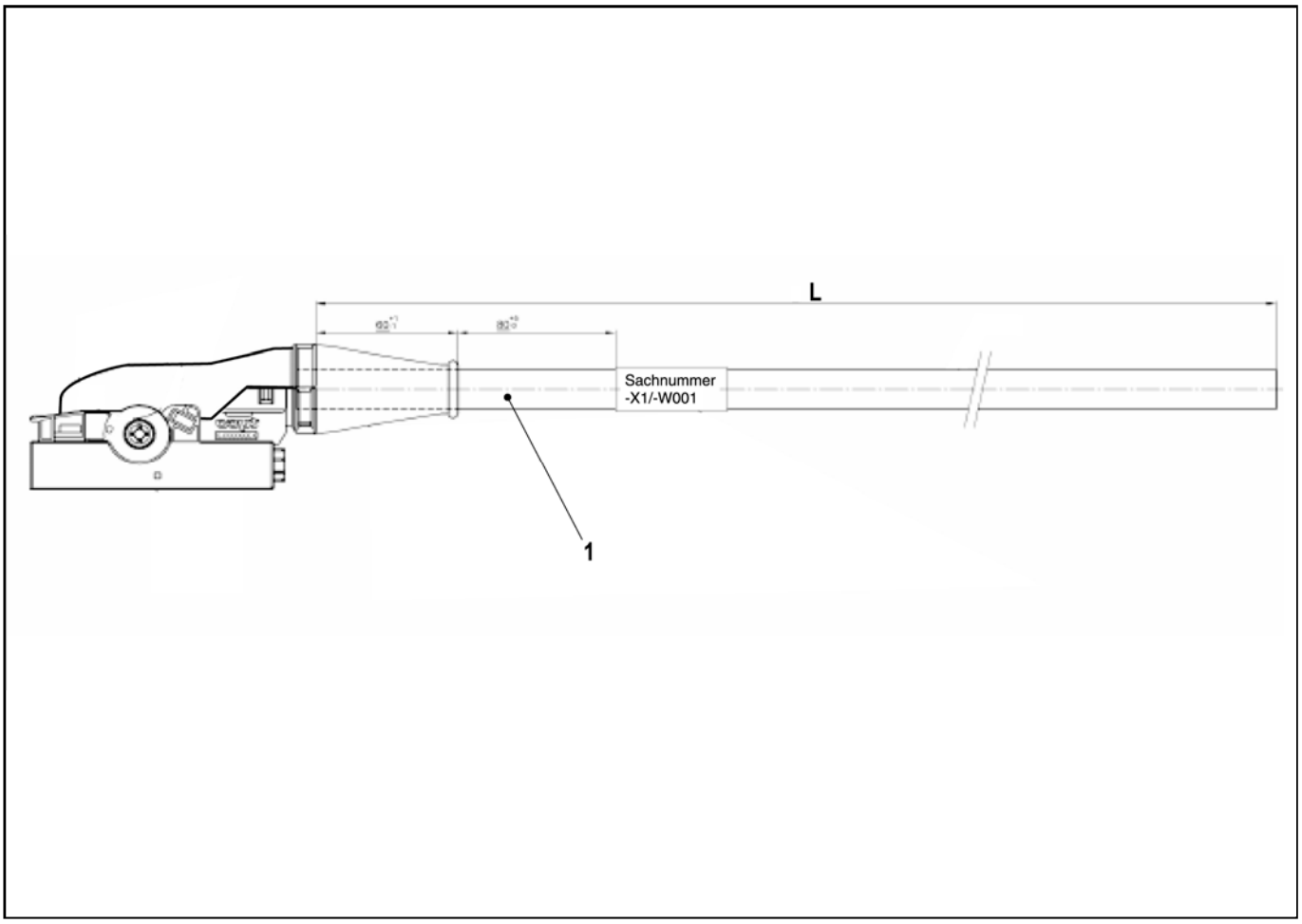
5.2.2 Injector wiring harness

The wiring harness used to connect the injectors is integrated into the cylinder heads (Window Gasket) and is installed at the factory.

System cable

5.3.1 System wiring harness

The wiring harness W01 is used to connect the ECU8 Engine Control Unit to the higher-level controls and the power supply (terminal strip)
. The wiring harness W01 has a 62-pin connector (X1) on one end. The open end must be connected to a terminal strip.



1 ECU8 W001 connection cable

The W001 cable is assigned as follows: See chap. 3.2.1

6 Inputs and outputs of the system

Overview of channel assignments

6.1.1 System side

The system side of the ECU8 Engine Control Unit is assigned as follows:

Channel	Assignment	Standard setting
POWER	Power supply/3x +24V/3x GND = Power for turning on the system (emergency stop by turning off power)	Yes
IGI	Ignition/Ubatt switch → Variant 1 emergency stop	Yes
ESI	Engine stop/emergency stop → Variant 2 emergency stop	Not used
DI1	Engine stop	Yes, GND
DI2	Speed droop	Yes
DI3	Idle/mode (fixed speed) or switchover 50/60Hz	Idle/mode (fixed speed)
DI4	Alarm reset	Yes
DI5	Speed up	Yes
DI6	Speed down	Yes
DI7	START	Yes
DI8	OVERRIDE	Yes
AI1	Speed demand (I)/speed demand (U)	Standard
AI2	Engine torque/demand (LSG)	Standard
FIP	Speed demand (speed setting)	(5Hz/rpm) optional
AO1	Coolant temp.	Yes
AO2	Lube oil pressure	Yes
FO	-	-
TOP1	YELLOW alarm	Yes
TOP12	RED alarm	Yes
TOP3	Lube oil stop	Yes
TOP4	Starter ON	Yes
CAN_P1	PCS5	Yes
CAN_P2	PCS5	Yes

7 Functions

ECU8 signals

Engine side - System side

The channels of the different inputs and outputs on the Engine Control Unit ECU8 are divided into 2 groups.

Engine-side channels

System-side channels

All engine-side channels are at connector X2. All of the sensors and actuators of the engine are connected to this factory installed wiring harness.

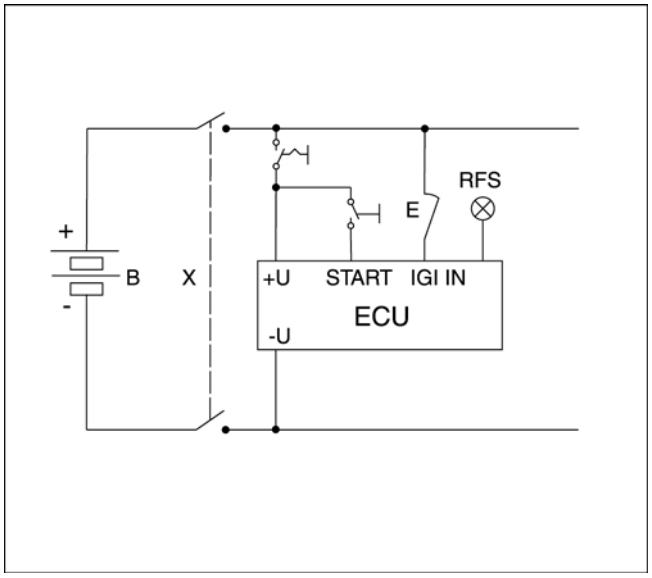
General information about the parameters

In the following sections the system-side channels and their functions/parameters will be described. Setting of the parameters is made by creating a data record.

Power supply

The power supply is connected to connector X1 (system-side wiring harness)

Schematic circuit diagram



	B	Battery
	+U	Engine Control Unit operating voltage
	RFS	Indicator lamp “Ready for Start”
’	V	Vehicle
	X	Battery master switch
	E	Emergency stop (NC contact)
	-U	GND

Ignition IGI input

Technical data

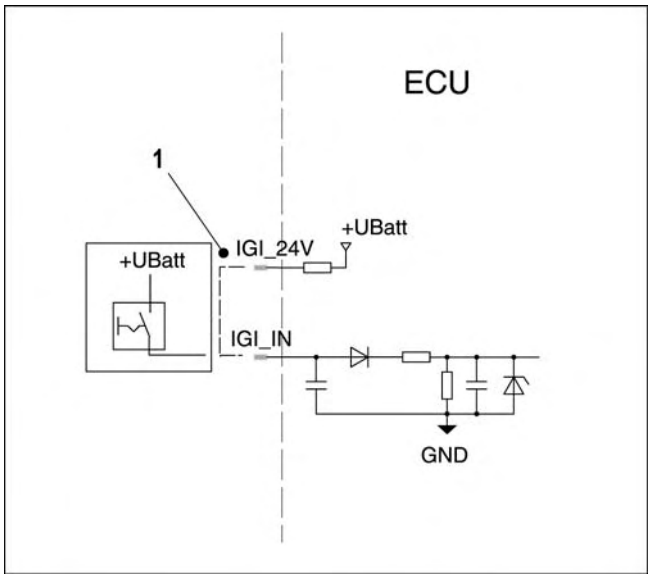
Control via:

Power supply + 24 V DC, $+U_{bat}$

Channel specification:

- Voltage 0 – 36 V DC
- Current approx. 4.8 mA at 24 V DC/~5k Ohm
- Electrical isolation: No

Schematic circuit diagram



+UBattOperating voltage 24 V DC
PD Power driver disable
MPC MPC port
DC/DC DC/DC converter
IGI_24V Ignition/+Ubatt switch/emergency stop
IGI_IN Ignition
GND Ground
DS Data memory (data storage algorithm)

Switching off the ignition function:
Bridge IGI_24V or +Ubat to IGI_IN.

Switching on the ECU8 with the ignition input IGI
1. A power supply of +Ubat (24 V) must be connected to the ECU8.
2. IGI input level 0V (<4V) ->
   >9V DC/DC converter will be activated
   > 11V the blocked output stage can be released by the SW!

Shutting off the ECU8 (with the ignition input IGI)
If the input level of the IGI falls under limit of < 4V, the output stages for the injectors will be shut off. Injection stops and the engine comes to an immediate stop.

Emergency stop input ESI

This channel offers another way of triggering an emergency stop.

The ESI input is activated with a normally open contact to UBatt (24V). If this function is not used, the input will not be switched!

Technical data

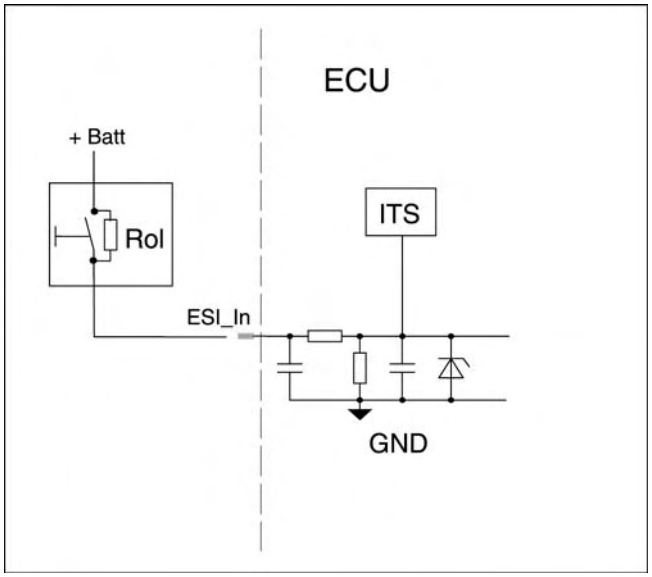
Control via:

Power supply + 24 V DC, $+U_{bat}$

Channel specification:

- Voltage 0 – 36 V DC
- Current approx. 4.8 mA at 24 V DC/~5k Ohm
- Electrical isolation: No
- Power interruption: Monitoring of the input voltage

Schematic circuit diagram



+Batt	Operating voltage 24 V DC
RoI	Monitoring of the input voltage (33kOhm ± 10%)
ITS	Fault detection (OFF_LINE)
PD	Power driver disable
MPC	MPC port
DC/DC	DC/DC converter
ESI_IN	Ignition 4.8 mA at 24 V DC/~ 5kOhm ± 10% (12 to 32V at 33kOhm ± 10%)
GND	Ground
DS	Data memory (data storage algorithm)

Detection of a power interruption:

The switch or the control electronics must send a current of 0.4 mA (12 to 32 V at 33kOhm ± 10%) to the ECU8 input to be able to detect a line break.

Activation of the emergency stop:

Activation of the emergency stop (Uin > 8 V) immediately shuts off the fuel injection which stops the engine.

DI 1 to 8 binary inputs

Technical data

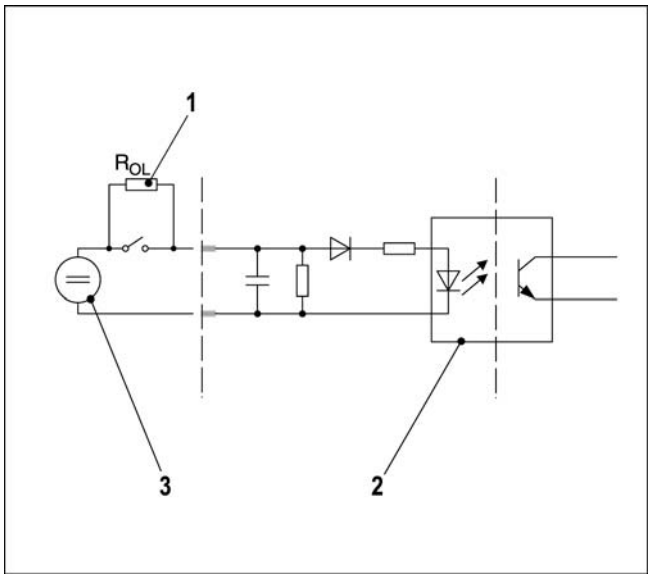
Channel specification:

Switches: External voltage or $+U_{batt}$
Input voltage 0 to 32 V DC
Low detection: U_{in} < 4 V
High detection: U_{in} > 8 V
Input impedance: 12.1 k Ohm
Input filter (fg/-3dB): 19Hz
Scanning frequency: < 1ms
Electrical isolation: 50 V DC
Line break monitoring: Current monitoring with ROL = 33 k Ohm ± 10%

Required settings

- Open line = line break monitoring active
- Logic: “Active high” or “Active low”

Schematic circuit diagram



1 Resistor for line break monitoring
2 Optocoupler
3 Inductive load (a free-wheeling diode must be installed for inductive loads)
4 Voltage source
Note: Line break monitoring is only possible if no load is connected parallel to input DI 1 to 8

D1 - Engine stop

Engine stop signal is activated when this input is shut off. This signal is saved until the engine is at stand still.

Parameters:

- Line break monitoring DI1: (2.9902.001)
- Logic DI1: (2.9910.015)
- Stop: saved: (2.7001.009)

DI 2 – Speed droop

For “genset” applications the frequency can be changed between 50 Hz/60 Hz using this input.

Parameters:

- Line break monitoring DI2: (2.9902.011)
- Logic DI2: (2.9910.025)

DI 3 – Increase idle speed/or switchover frequency

Switching on this input increases the idle speed to a predetermined (adjustable) value.

Parameters:

- Line break monitoring DI3: (2.9902.021)
- Logic DI3: (2.9910.035)

DI 4 – Reset alarm

Actuation of this input will reset saved alarms.

YELLOW and RED alarms are saved. These alarms will be signaled until they are reset with the “Reset alarm” command.

Parameters:

- Line break monitoring DI4: (2.9902.031)
- Logic DI4: (2.9910.045)

DI 5 – Increase engine speed (speed up)

When this input is activated the engine speed can be raised to any speed between idle speed and rated speed (max. speed).

Parameters:

- Line break monitoring DI5: (2.9902.041)
- Logic DI5: (2.9910.055)

DI 6 – Decrease engine speed (speed down)

When this input is activated the engine speed can be lowered to any speed between rated speed (max. speed) and idle speed.

Parameters:

- Line break monitoring DI6: (2.9902.051)
- Logic DI6: (2.9910.065)

DI 7 – Engine start

Actuation of this input activates the engine start program. This signal must be present for the entire start sequence. An interruption will lead to an abort of the start sequence

Parameters:

- Line break monitoring DI7: (2.9902.061)
- Logic DI7: (2.9910.075)

DI 8 – Override

The “Override” function is used to override certain safety functions. Otherwise, when limits are violated this would lead to a reduction in performance or an emergency stop of the engine. Note: Internal performance maps cannot be overridden!

Parameters:

- Line break monitoring DI8: (2.9902.071)
- Logic DI8: (2.9910.085)

AI 1 to 2 analog inputs

Technical data

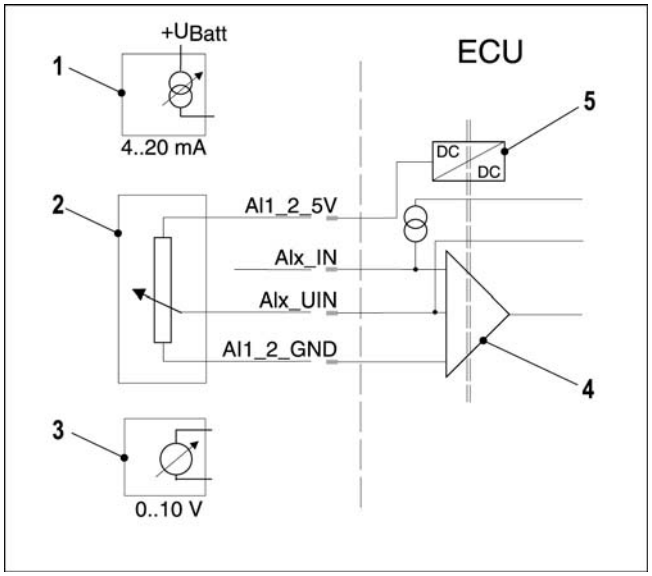
Channel specification

- Sensors: Current sources, voltage sources or potentiometer 1 to 5 k Ohm
- Power supply: 5 V ± 3% max. 50 mA
- Voltage input: 0 to 10 V DC (max. 13 V), input impedance 100 k Ohm, filter 200 Hz (fg/-3 dB)
- Current input: 0 to 25 mA ± 2% (max. 25 mA), load voltage 4.5 V at 20 mA
- Fault detection of voltage input: U > 10 V
- Fault detection of current input: I < 4 mA, I >20 mA (overcurrent shutoff ~ 40 mA)
- Electrical isolation: 50 V DC
- Dielectric strength 36 V DC

Required settings

- Configuration, voltage input/current input via the connection
- Scaling
- Function

Schematic circuit diagram



1. Control via current source
2. Control via resistance
3. Control via voltage source
4. Input amplifier
5. Power supply via potentiometer connection

AI 1 - Speed demand

The engine speed can be set between idle speed and rated speed (max. torque). This analog signal enables the speed to be set to a certain value. The following range can be used: 4 mA 0 V = idle speed, up to 20 mA/10 V = rated speed.
Changes in the speed are made in steps along a speed ramp that can be programmed as an acceleration ramp or a deceleration ramp.

Parameters:

- Configuration: (2.9900.001)
- Curves:
  - Voltage (2.0401.010)
  - Current: (2.0401.012)
  - Frequency: (2.0401.014)

AI 2 – Torque request

This signal is the torque specification for torque-controlled systems. This corresponds to the load specified in % for a fuel injection governor.

Parameters:

- Configuration: (2.9900.011)

Frequency input FIP

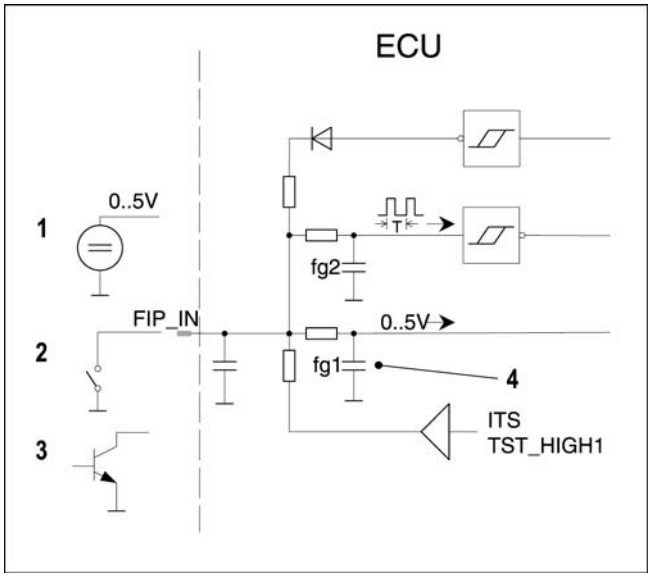
Channel specification/technical data

- Sensor: analog 0 to 5 V DC
- Frequency input
  - Input hysteresis: ≥ 2.2 V -> high/≤ 0.6 V -> low
  - Measuring range: 10 to 1000 Hz at 50%
  - Pull up resistor: 3.3 k Ohm to 5 V (adjustable)
  - Input filter (fg/-3 dB): 14.5 kHz
  - Fault detection: OFF-LINE (IST) yes/ON-LINE wire break via input voltage monitoring.
  - Overvoltage protection: ± 36 V (Important: install a free-wheeling diode for inductive loads!)
- 0 to 5 V DC input
  - Input resistor: 47k5 PULL-DOWN (basic setting)
  - Measuring range: 0 V < U input/< 5 V absolute
  - Measuring accuracy: ± 0.6% (0.4% absolute)/(w/o sensor worst case/95%)
  - Input filter (fg/-3 dB): 19 Hz
  - Resolution: 12 bit
  - Electrical isolation: None
  - Overvoltage protection: ± 36 V

Required settings

- PULL UP resistor on/off

Schematic circuit diagram



1. Control via current source
2. Control via switch
3. Control via transistor switch
4. Filter with fg 14.5 kHz

Transistor output TOP 1 to 4

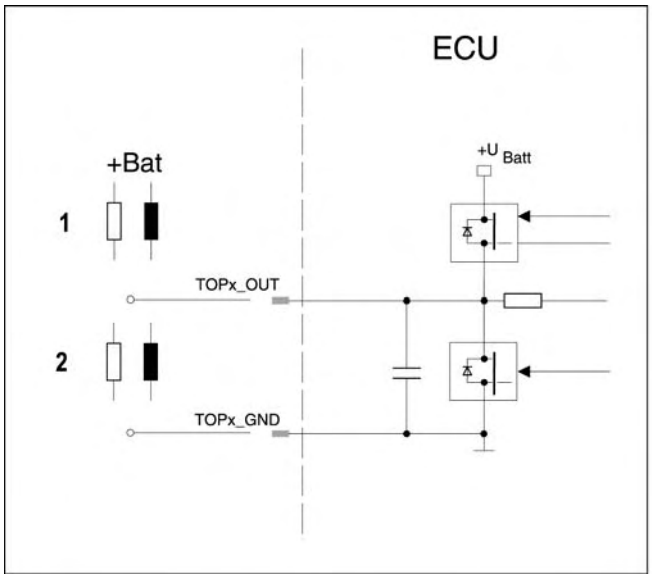
Channel specification/technical data

- Control of:
  - Lamps
  - Relays
  - Digital inputs
- Channel specification
  - Loads: 24 V DC consumers, valves
  - Output current DC: 1.4 A at 24 V On
  - Output voltage w/o load: ~ 5 V (high switch) ~ 0 V (low switch)
  - Switching frequency: max. ≤ 2 Hz
  - Load: max. 140 mH inductive
  - Electrical isolation: None
  - Short circuit recognition: Yes
  - Line break monitoring: switched off, only with R_load < 25 k Ohm
  - Overvoltage protection: up to 36 V (Important: install a free-wheeling diode for inductive loads!)

Required settings

- “Low switch” or “High switch”
- Line break monitoring on/off

Schematic circuit diagram



1. Inductive load
2. Ohm load

TOP 1 - Yellow alarm

This output switches as soon as a yellow alarm appears. If an additional alarm occurs this output switches off and then on again.

Parameters:

- Active level: (2.1050.005)
- “Low switch” or “High switch”: (2.1050.010)

TOP 2 - Red alarm

This output switches as soon as a red alarm appears. If an additional alarm occurs this output switches off and then on again.

Parameters:

- Active level: (2.1050.006)
- “Low switch” or “High switch”:(2.1050.011)

TOP 3 – Oil pressure too low (lube-oil stop)

This output switches as soon as the oil pressure falls below the minimum value (adjustable).

Parameters:

- Active level: (2.1050.007)
- “Low switch” or “High switch”:(2.1050.012)

TOP 4 – Starter on

This output registers the internal start sequence. When TOP4 is switched, the starter engages

Parameters:

- Active level: (2.1050.008)
- “Low switch” or “High switch”: (2.1050.013)

Analog outputs AO 1 to 2

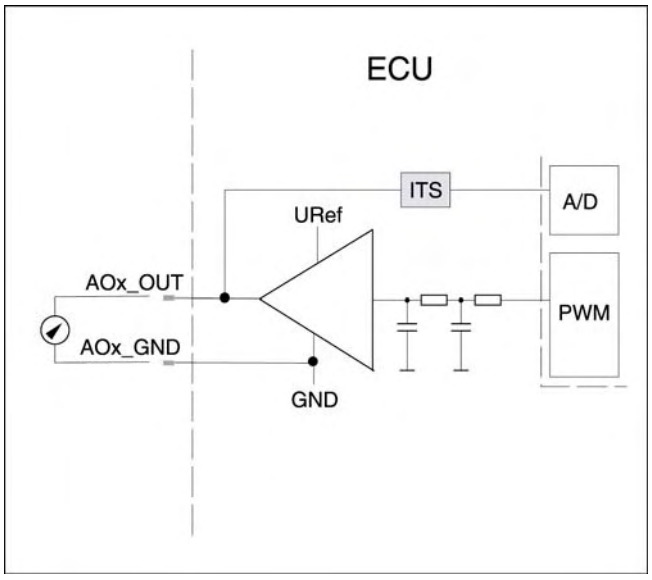
Channel specification/technical data

- Control of:
  - Display instrument
  - Analog inputs
- Channel specification
  - Output current: 0 to 8 mA at 10 V
  - Output voltage: 0 to 10 V DC
  - Output voltage w/o load: ~ 0 V
  - Short-circuit current: ~ 18 mA
  - Settling time: 11 ms at 0 to 8 mA
  - Electrical isolation: None
  - Line break monitoring: No
  - Overvoltage protection: up to 36 V DC

Required settings

None

Schematic circuit diagram



AO 1 – Cooling temperature

This signal can be used to activate a temperature display and to control the cooling fans.

Parameters:

- Voltage output: linear 0 to 100% (12 bit) - > * 0 to 9999 mV

AO 2 - Oil pressure

This signal can be used to actuation a pressure display.

CAN interfaces 1 to 2

Channel specification/technical data

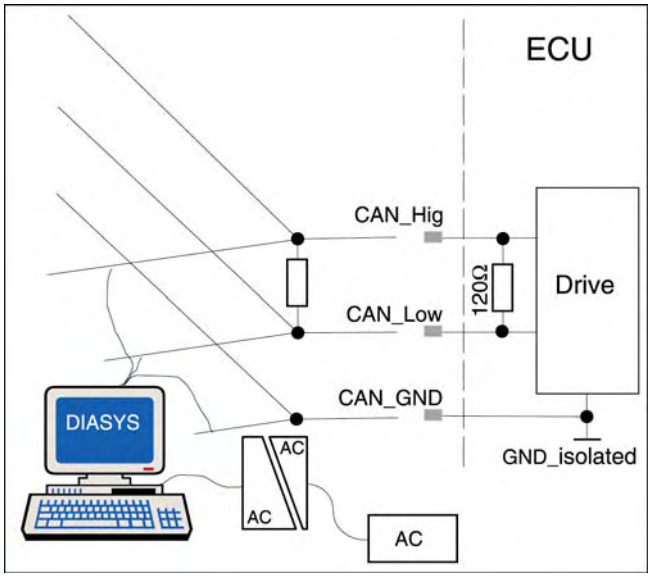
- Channel type: Serial interface, Controller Area Network (CAN)
- Control of:
  - CAN bus
  - Analog inputs
- Channel specification
  - High-speed CAN compatible with ISO 11898 (24 V)
  - CAN specification: Version 2.0B/11/29 bit bus structure (PCS-5 protocol)
  - Max. data rate: 1 Mbit/s
  - Max. bus length: 250 m
  - Terminating resistor: 120 Ohm (to be installed in cable)
  - Short circuit recognition/open circuit: by the CAN controller
  - Electrical isolation: 50 V DC to ECU GND and to CAN_1/CAN_2
  - Overvoltage protection: ± 36 V/50 V DC/12 kV ESD

Note: the terminating resistor 120 Ohm must be installed at the end of the line!

Required settings

None

Schematic circuit diagram



CAN	Controller Area Network	DC	direct current
GND	Ground	AC	Alternating current
ECU	Engine Control Unit		

CAN 1 – PCS5

This CAN interface is used to connect the Engine Control Unit to the other MTU or OEM devices through the CAN bus. This is the “Default bus”

CAN 2 – PCS5

This CAN interface is also used to connect the Engine Control Unit to the other MTU or OEM devices through the CAN bus. This is the “Redundant bus”

Appendix - Fault code list

No.	PR	Alarm	Meaning
3.00	2.0122.931	HI T-Fuel	Fuel temperature too high (limit value 1). (Alarm configuration parameter, for explanation see PR 2.8008.100)
4.00	2.0122.932	SS T-Fuel	Fuel temperature too high (limit value 2). (Alarm configuration parameter, for explanation see PR 2.8008.100)
5.00	2.0121.931	HI T-Charge Air	Charge-air temperature too high (limit value 1) ==> Check intercooler (Alarm configuration parameter, for explanations see PR 2.8008.100)
6.00	2.0121.932	SS T-Charge Air	Charge-air temperature too high (limit value 2) ==> Check intercooler (Alarm configuration parameter, for explanations see PR 2.8008.100)
15.00	2.0100.921	LO P-Lube Oil	Lube-oil pressure too low (limit value 1). (Alarm configuration parameter, for explanation see PR 2.8008.100)
16.00	2.0100.922	SS P-Lube Oil	Lube-oil pressure too low (limit value 2). (Alarm configuration parameter, for explanation see PR 2.8008.100)
19.00	2.0126.931	HI T-Exhaust A	Exhaust temperature (A side) too high (limit value 1). (Alarm configuration parameter, for explanation see PR 2.8008.100)
20.00	2.0126.932	SS T-Exhaust A	Exhaust temperature (A side) too high (limit value 2). (Alarm configuration parameter, for explanation see PR 2.8008.100)
21.00	2.0127.931	HI T-Exhaust B	Exhaust temperature (B side) too high (limit value 1). (Alarm configuration parameter, for explanation see PR 2.8008.100)
22.00	2.0127.932	SS T-Exhaust B	Exhaust temperature (B side) too high (limit value 2). (Alarm configuration parameter, for explanation see PR 2.8008.100)
23.00	2.0152.921	LO Coolant Level	Coolant level too low (limit value 1) ==> Check coolant level in expansion tank (Alarm configuration parameter, for explanations see PR 2.8008.100)
25.00	2.0154.931	HI P-Diff. Lube Oil	Differential oil pressure at oil filter too high (limit value 1). (Alarm configuration parameter, for explanation see PR 2.8008.100)
26.00	2.0154.932	SS P-Diff. Lube Oil	Differential oil pressure at oil filter to high (limit value 2). (Alarm configuration parameter, for explanation see PR 2.8008.100)
30.00	2.2510.932	SS Engine Overspeed	Engine overspeed (limit value 2). (Alarm configuration parameter, for explanation see PR 2.8008.100)
31.00	2.3011.931	HI ETC1 Overspeed	Speed of primary turbocharger too high (limit value 1). (Alarm configuration parameter, for explanation see PR 2.8008.100)

No.	PR	Alarm	Meaning
32.00	2.3012.932	SS ETC1 Overspeed	Speed of primary turbocharger too high (limit value 2). (Alarm configuration parameter, for explanation see PR 2.8008.100)
33.00	2.0114.931	HI P-Diff. Fuel	Differential oil pressure at fuel filter too high (limit value 1). (Alarm configuration parameter, for explanation see PR 2.8008.100)
34.00	2.0114.932	SS P-Diff. Fuel	Differential oil pressure at fuel filter too high (limit value 2). (Alarm configuration parameter, for explanation see PR 2.8008.100)
36.00	2.3013.931	HI ETC2 Overspeed	Speed of 1st secondary turbocharger too high (limit value 1). (Alarm configuration parameter, for explanation see PR 2.8008.100)
37.00	2.3013.912	SS ETC2 Overspeed	Speed of 1st secondary turbocharger too high (limit value 2). (Alarm configuration parameter, for explanation see PR 2.8008.100)
51.00	2.0125.931	HI T-Lube Oil	Lube oil temperature too high (limit value 1). (Alarm configuration parameter, for explanation see PR 2.8008.100)
52.00	2.0125.932	SS T-Lube Oil	Lube oil temperature too high (limit value 2). (Alarm configuration parameter, for explanation see PR 2.8008.100)
57.00	2.0101.921	LO P-Coolant	Coolant pressure too low (limit value 1) ==> Check cooling circuit (Alarm configuration parameter, for explanations see PR 2.8008.100)
58.00	2.0101.922	SS P-Coolant	Coolant pressure too low (limit value 2) ==> Engine stop or reduction of injection quantity ==> Check cooling circuit (Alarm configuration parameter, for explanations see PR 2.8008.100)
59.00	2.0120.933	SS T-Coolant L3	Coolant temperature too high/too low (limit value 3). (Alarm configuration parameter, for explanation see PR 2.8008.100)
60.00	2.0120.934	SS T-Coolant L4	Coolant temperature too high/too low (limit value 4). (Alarm configuration parameter, for explanation see PR 2.8008.100)
65.00	2.0102.921	LO P-Fuel	Fuel supply pressure too low (limit value 1) ==> Check filter, fuel low-pressure side (Alarm configuration parameter, for explanations see PR 2.8008.100)
66.00	2.0102.922	SS P-Fuel	Fuel supply pressure too low (limit value 2) ==> Check filter (low-pressure side) (Alarm configuration parameter, for explanations see PR 2.8008.100)
67.00	2.0120.931	HI T-Coolant	Coolant temperature too high (limit value 1) ==> Check coolant circuit (Alarm configuration parameter, for explanations see PR 2.8008.100)
68.00	2.0120.932	SS T-Coolant	Coolant temperature too high (limit value 2) ==> Check coolant circuit (Alarm configuration parameter, for explanations see PR 2.8008.100)

No.	PR	Alarm	Meaning
81.00	1.8004.046	AL System Leaks	Pressure gradient in rail is too low when starting or too high when stopping (==> High-pressure system leaks, air in system) (Alarm configuration parameter, for explanations see PR 2.8008.100)
82.00	2.0104.931	HI P-Fuel (Common Rail)	Rail pressure > set value => DBR reduction, start of injection retarded (==> HP fuel control block sticks or wiring of HP fuel control block) (Alarm configuration parameter, for explanations see PR 2.8008.100)
83.00	2.0104.921	LO P-Fuel (Common Rail)	Rail pressure < set value => DBR reduction (==> HP fuel control block is faulty or leak in high-pressure system) (Alarm configuration parameter, for explanations see PR 2.8008.100)
89.00	2.2500.030	SS Engine Speed Low	Engine stalls. The engine speed falls below the limit value of parameter 2.2500.027 (speed limit before engine stalls) and no engine stop command has been given. When this state occurs, the engine is stopped for safety reasons. (Alarm configuration parameter, for explanation see PR 2.8008.100)
90.00	2.1090.925	SS Idle Speed Not Reached	Idle speed not reached ==> Start termination ==> Observe messages (Alarm configuration parameter, for explanations see PR 2.8008.100)
91.00	2.1090.924	SS Disengage Speed Not Reached	Starting speed not reached ==> Start termination ==> Observe messages (Alarm configuration parameter, for explanations see PR 2.8008.100)
92.00	2.1090.923	SS Starter Speed Not Reached	Starter speed not reached ==> Start termination ==> Starter does not turn or turns too slowly (Alarm configuration parameter, for explanations see PR 2.8008.100)
93.00	2.1090.922	SS T-Preheat	Preheating temperature too low (limit value 2) ==> Coolant temperature for engine start too low ==> Engine starter lockout (Alarm configuration parameter, for explanations see PR 2.8008.100)
94.00	2.1090.921	LO T-Preheat	Preheating temperature too low (limit value 1) ==> Coolant temperature for engine start too low (Alarm configuration parameter, for explanations see PR 2.8008.100)
95.00	2.1090.920	AL Prelube Fault	Prelube fault. (Alarm configuration parameter, for explanation see PR 2.8008.100)
102.00	1.8004.624	AL Counter Faulty	Counter faults. (Alarm configuration parameter, for explanation see PR 2.8008.100)
104.00	1.8004.623	AL Operating Hours Counter Faulty	Run-time meter faulty. (Alarm configuration parameter, for explanation see PR 2.8008.100)
118.00	2.0140.921	LO ECU Power Supply	Power supply too low (limit value 1) ==> Check batteries/generator (Alarm configuration parameter, for explanations see PR 2.8008.100)
119.00	2.0140.922	LOLO ECU Power Supply	Power supply too low (limit value 2) ==> Check batteries/generator (Alarm configuration parameter, for explanations see PR 2.8008.100)

No.	PR	Alarm	Meaning
120.00	2.0140.931	HI ECU Power Supply	Power supply too high (limit value 1) ==> Check batteries/generator (Alarm configuration parameter, for explanations see PR 2.8008.100)
121.00	2.0140.932	HIHI ECU Power Supply	Power supply too high (limit value 2) ==> Check batteries/generator (Alarm configuration parameter, for explanations see PR 2.8008.100)
122.00	2.0132.921	HI T-ECU	Temperature of electronics too high (limit value 1). (Alarm configuration parameter, for explanation see PR 2.8008.100)
141.00	1.1088.007	AL Power Too High	This alarm is triggered if the average of the power has exceeded the specified maximum value give by PR1.1088.001 in that last 24 hours. (Alarm configuration parameter, for explanation see PR 2.8008.100)
142.00	1.1088.006	AL MCR 1 Hour Exceeded	The alarm is triggered if the MCR was exceeded for longer than 1 hour in the last 12 hours. (Alarm configuration parameter, for explanation see PR 2.8008.100)
176.00	2.4000.004	AL LifeData Not Available	No (suitable) LifeData backup system available, after waiting time after ECU reset. ==> Backup system has no LifeData function or CAN bus has been interrupted to backup system. (Alarm configuration parameter, for explanation see PR 2.8008.100)
177.00	2.4000.006	AL LifeData Restore Incomplete	This fault message is generated if a CRC is faulty (is given for each module) during the restore-data upload (in the ADEC) or if the upload is incomplete. (Alarm configuration parameter, for explanation see PR 2.8008.100)
180.00	2.0500.680	AL CAN1 Node Failure	Connection to a node on CAN bus 1 has failed. ==> Check the devices connected to the CAN (Alarm configuration parameter, for explanations see PR 2.8008.100)
181.00	2.0500.681	AL CAN2 Node Failure	Connection to a node on CAN bus 2 has failed. ==> Check the devices connected to the CAN (Alarm configuration parameter, for explanations see PR 2.8008.100)
182.00	2.0500.682	AL CAN Incorrectly Parameterized	Incorrect parameters set in data record. (Alarm configuration parameter, for explanation see PR 2.8008.100)
183.00	2.0500.683	AL CAN No PU Data	A CAN mode has been selected that initiates communications with help of the PU data module. The required PU data module is, however, not present or not valid. ==> Check the devices connected to the CAN (Alarm configuration parameter, for explanations see PR 2.8008.100)
184.00	2.0500.684	AL CAN PU Data Flash Fault	A program error occurred while trying to copy a received PU data module to the flash module. ==> Electronics service (Alarm configuration parameter, for explanations see PR 2.8008.100)

No.	PR	Alarm	Meaning
186.00	2.0500.686	AL CAN1 Bus Off	CAN controller 1 is in “Bus-Off” mode. => Automatic switchover to CAN2. ==> Possible causes are e.g. short circuit, major interruptions or Baud rate incompatibility. (Alarm configuration parameter, for explanation see PR 2.8008.100)
187.00	2.0500.687	AL CAN1 Error Passive	CAN controller 1 signaled a warning. ==> Possible causes are e.g. no node, minor interruptions or temporary bus overload. (Alarm configuration parameter, for explanation see PR 2.8008.100)
188.00	2.0500.688	AL CAN2 Bus Off	CAN controller 2 is in “Bus-Off” mode. => Automatic switchover to CAN 1. ==> Possible causes are e.g. short circuit, major interruptions or Baud rate incompatibility. (Alarm configuration parameter, for explanation see PR 2.8008.100)
189.00	2.0500.689	AL CAN2 Error Passive	CAN controller 2 signaled a warning. ==> Possible causes are e.g. no node, minor interruptions or temporary bus overload. (Alarm configuration parameter, for explanation see PR 2.8008.100)
201.00	1.8004.570	SD T-Coolant	Coolant temperature sensor faulty. ==> Short circuit or wire break ==> Check sensor and wiring (B6) and replace if necessary. (Alarm configuration parameter, for explanation see PR 2.8008.100)
202.00	1.8004.572	SD T-Fuel	Fuel temperature sensor faulty. ==> Short circuit or wire break ==> Check sensor and wiring (B33) and replace if necessary. (Alarm configuration parameter, for explanation see PR 2.8008.100)
203.00	1.8004.571	SD T-Charge Air	Charge-air temperature sensor faulty. ==> Short circuit or wire break ==> Check sensor and wiring (B9) and replace if necessary. (Alarm configuration parameter, for explanation see PR 2.8008.100)
206.00	1.8004.576	SD T-Exhaust A	Exhaust temperature sensor on A side is faulty. ==> Short circuit or wire break ==> Check sensor and wiring (B4.21) and replace if necessary. (Alarm configuration parameter, for explanation see PR 2.8008.100)
207.00	1.8004.577	SD T-Exhaust B	Exhaust temperature sensor on B side is faulty. ==> Short circuit or wire break ==> Check sensor and wiring (B4.22) and replace if necessary. (Alarm configuration parameter, for explanation see PR 2.8008.100)
208.00	1.8004.566	SD P-Charge Air	Charge-air pressure sensor faulty. ==> Short circuit or wire break ==> Check sensor and wiring (B10) and replace if necessary. (Alarm configuration parameter, for explanation see PR 2.8008.100)
211.00	1.8004.563	SD P-Lube Oil	Lube-oil sensor faulty. ==> Short circuit or wire break ==> Check sensor and wiring (B5) and replace if necessary. (Alarm configuration parameter, for explanation see PR 2.8008.100)

No.	PR	Alarm	Meaning
212.00	1.8004.564	SD P-Coolant	Coolant pressure sensor faulty. ==> Short circuit or wire break ==> Check sensor and wiring (B16) and replace if necessary. (Alarm configuration parameter, for explanation see PR 2.8008.100)
215.00	1.8004.567	SD P-HD	Rail pressure sensor faulty. ==> High pressure regulator in emergency operation ==> Short circuit or wire break ==> Check sensor and wiring (B48) and replace if necessary. (Alarm configuration parameter, for explanation see PR 2.8008.100)
216.00	1.8004.575	SD T-Lube Oil	Lube-oil temperature sensor faulty. ==> Short circuit or wire break ==> Check sensor and wiring (B7) and replace if necessary. (Alarm configuration parameter, for explanation see PR 2.8008.100)
219.00	1.8004.573	SD T-Intake Air	Intake air temperature sensor faulty. ==> Short circuit or wire break ==> Check sensor and wiring (B3) and replace if necessary. (Alarm configuration parameter, for explanation see PR 2.8008.100)
220.00	1.8004.584	SD Coolant Level	Coolant level sensor faulty. ==> Short circuit or wire break ==> Check sensor and wiring (F33) and replace if necessary. (Alarm configuration parameter, for explanation see PR 2.8008.100)
221.00	1.8004.585	SD P-Diff. Lube Oil	Differential pressure sensor for lube oil faulty. ==> Short circuit or wire break ==> Check sensor and wiring (F25) and replace if necessary. (Alarm configuration parameter, for explanation see PR 2.8008.100)
222.00	1.8004.582	SD Leak Fuel Level	Sensor for leak-off fuel level faulty. ==> Short circuit or wire break ==> Check sensor and wiring (F46) and replace if necessary. (Alarm configuration parameter, for explanation see PR 2.8008.100)
227.00	1.8004.620	SD Oil Pressure Ahead Of Filter	Sensor for lube-oil pressure ahead of filter faulty. ==> Short circuit or wire break ==> Check sensor and wiring (B5.3) and replace if necessary. (Alarm configuration parameter, for explanation see PR 2.8008.100)
228.00	1.8004.595	SD P-Fuel Ahead Of Filter	Fuel pressure sensor faulty. ==> Short circuit or wire break ==> Check sensor and wiring (B5.3) and replace if necessary. (Alarm configuration parameter, for explanation see PR 2.8008.100)
229.00	1.8004.562	AL Stop Camshaft Sensor Faulty	Engine stop due to a faulty camshaft sensor (and a fault in the crankshaft sensor on the previous cycle). Check sensor and wiring to connector B1 and replace if necessary. After restarting engine the fault is rectified. (Alarm configuration parameter, for explanation see PR 2.8008.100)
230.00	1.8004.498	SD Crankshaft	Crankshaft sensor faulty. ==> Short circuit or wire break ==> Check sensor and wiring (B13) and replace if necessary. After restarting engine the fault is rectified. (Alarm configuration parameter, for explanation see PR 2.8008.100)

No.	PR	Alarm	Meaning
231.00	1.8004.499	SD Camshaft	Camshaft sensor faulty. ==> Short circuit or wire break ==> Check sensor and wiring (B1) and replace if necessary. After restarting engine the fault is rectified. (Alarm configuration parameter, for explanation see PR 2.8008.100)
232.00	1.3011.128	SD Charger Speed 1	Speed sensor of main charger faulty. ==> Short circuit or wire break ==> Check sensor and wiring (B44.1) and replace if necessary. (Alarm configuration parameter, for explanation see PR 2.8008.100)
239.00	1.8004.598	SD P-Diff. Fuel	Differential pressure sensor for fuel faulty. ==> Only occurs in connection with the SD alarms Fuel Ahead of Filter or Fuel Behind Filter (Alarm configuration parameter, for explanations see PR 2.8008.100)
240.00	1.8004.565	SD P-Fuel	Fuel pressure sensor faulty. ==> Short circuit or wire break ==> Check sensor and wiring (B34) and replace if necessary. (Alarm configuration parameter, for explanation see PR 2.8008.100)
245.00	2.8006.589	SD ECU Power Supply	Internal ECU fault. ==> Electronics faulty (Alarm configuration parameter, for explanations see PR 2.8008.100)
266.00	2.8006.586	SD Speed Demand	Analog speed demand signal faulty. ==> Short circuit or wire break ==> Check speed demand sensor and wiring and replace if necessary. (Alarm configuration parameter, for explanation see PR 2.8008.100)
269.00	2.8006.588	SD Filtered Analog Load Pulse	Filtered analog load pulse not present. ==> Short circuit or wire break ==> Check wiring and replace if necessary. (Alarm configuration parameter, for explanation see PR 2.8008.100)
270.00	2.8006.590	SD Frequency Input	Frequency input faulty. ==> Short circuit or wire break (Alarm configuration parameter, for explanations see PR 2.8008.100)
321.00	1.8004.520	AL Cylinder A1 Wiring	Short circuit fault in the injector wiring for cylinder A1. Result: Misfire. => Rectify the short circuit in the injector solenoid (positive to negative) e.g. by replacing injector. Fault rectified: each time engine is restarted. (Alarm configuration parameter, for explanation see PR 2.8008.100)
322.00	1.8004.521	AL Cylinder A2 Wiring	Short circuit fault in the injector wiring for cylinder A2. Result: Misfire. => Rectify the short circuit in the injector solenoid (positive to negative) e.g. by replacing injector. Fault rectified: each time engine is restarted. (Alarm configuration parameter, for explanation see PR 2.8008.100)
323.00	1.8004.522	AL Cylinder A3 Wiring	Short circuit fault in the injector wiring for cylinder A3. Result: Misfire. => Rectify the short circuit in the injector solenoid (positive to negative) e.g. by replacing injector. Fault rectified: each time engine is restarted. (Alarm configuration parameter, for explanation see PR 2.8008.100)

No.	PR	Alarm	Meaning
324.00	1.8004.523	AL Cylinder A4 Wiring	Short circuit fault in the injector wiring for cylinder A4. Result: Misfire. => Rectify the short circuit in the injector solenoid (positive to negative) e.g. by replacing injector. Fault rectified: each time engine is restarted. (Alarm configuration parameter, for explanation see PR 2.8008.100)
325.00	1.8004.524	AL Cylinder A5 Wiring	Short circuit fault in the injector wiring for cylinder A5. Result: Misfire. => Rectify the short circuit in the injector solenoid (positive to negative) e.g. by replacing injector. Fault rectified: each time engine is restarted. (Alarm configuration parameter, for explanation see PR 2.8008.100)
326.00	1.8004.525	AL Cylinder A6 Wiring	Short circuit fault in the injector wiring for cylinder A6. Result: Misfire. => Rectify the short circuit in the injector solenoid (positive to negative) e.g. by replacing injector. Fault rectified: each time engine is restarted. (Alarm configuration parameter, for explanation see PR 2.8008.100)
331.00	1.8004.530	AL Cylinder B1 Wiring	Short circuit fault in the injector wiring for cylinder B1. Result: Misfire. => Rectify the short circuit in the injector solenoid (positive to negative) e.g. by replacing injector. Fault rectified: each time engine is restarted. (Alarm configuration parameter, for explanation see PR 2.8008.100)
332.00	1.8004.531	AL Cylinder B2 Wiring	Short circuit fault in the injector wiring for cylinder B2. Result: Misfire. => Rectify the short circuit in the injector solenoid (positive to negative) e.g. by replacing injector. Fault rectified: each time engine is restarted. (Alarm configuration parameter, for explanation see PR 2.8008.100)
333.00	1.8004.532	AL Cylinder B3 Wiring	Short circuit fault in the injector wiring for cylinder B3. Result: Misfire. => Rectify the short circuit in the injector solenoid (positive to negative) e.g. by replacing injector. Fault rectified: each time engine is restarted. (Alarm configuration parameter, for explanation see PR 2.8008.100)
334.00	1.8004.533	AL Cylinder B4 Wiring	Short circuit fault in the injector wiring for cylinder B4. Result: Misfire. => Rectify the short circuit in the injector solenoid (positive to negative) e.g. by replacing injector. Fault rectified: each time engine is restarted. (Alarm configuration parameter, for explanation see PR 2.8008.100)
335.00	1.8004.534	AL Cylinder B5 Wiring	Short circuit fault in the injector wiring for cylinder B5. Result: Misfire. => Rectify the short circuit in the injector solenoid (positive to negative) e.g. by replacing injector. Fault rectified: each time engine is restarted. (Alarm configuration parameter, for explanation see PR 2.8008.100)

No.	PR	Alarm	Meaning
336.00	1.8004.535	AL Cylinder B6 Wiring	Short circuit fault in the injector wiring for cylinder B6. Result: Misfire. => Rectify the short circuit in the injector solenoid (positive to negative) e.g. by replacing injector. Fault rectified: each time engine is restarted. (Alarm configuration parameter, for explanation see PR 2.8008.100)
341.00	1.8004.540	AL Cylinder A1 Open Circuit	Open circuit fault in the injector wiring for cylinder A1. Result: Misfire. => Check injection wiring for breaks and rule out any breaks in the solenoid valve (e.g. by replacing injector). Fault rectified: after each working cycle. (Alarm configuration parameter, for explanation see PR 2.8008.100)
342.00	1.8004.541	AL Cylinder A2 Open Circuit	Open circuit fault in the injector wiring for cylinder A2. Result: Misfire. => Check injection wiring for breaks and rule out any breaks in the solenoid valve (e.g. by replacing injector). Fault rectified: after each working cycle. (Alarm configuration parameter, for explanation see PR 2.8008.100)
343.00	1.8004.542	AL Cylinder A3 Open Circuit	Open circuit fault in the injector wiring for cylinder A3. Result: Misfire. => Check injection wiring for breaks and rule out any breaks in the solenoid valve (e.g. by replacing injector). Fault rectified: after each working cycle. (Alarm configuration parameter, for explanation see PR 2.8008.100)
344.00	1.8004.543	AL Cylinder A4 Open Circuit	Open circuit fault in the injector wiring for cylinder A4. Result: Misfire. => Check injection wiring for breaks and rule out any breaks in the solenoid valve (e.g. by replacing injector). Fault rectified: after each working cycle. (Alarm configuration parameter, for explanation see PR 2.8008.100)
345.00	1.8004.544	AL Cylinder A5 Open Circuit	Open circuit fault in the injector wiring for cylinder A5. Result: Misfire. => Check injection wiring for breaks and rule out any breaks in the solenoid valve (e.g. by replacing injector). Fault rectified: after each working cycle. (Alarm configuration parameter, for explanation see PR 2.8008.100)
346.00	1.8004.545	AL Cylinder A6 Open Circuit	Open circuit fault in the injector wiring for cylinder A6. Result: Misfire. => Check injection wiring for breaks and rule out any breaks in the solenoid valve (e.g. by replacing injector). Fault rectified: after each working cycle. (Alarm configuration parameter, for explanation see PR 2.8008.100)

No.	PR	Alarm	Meaning
351.00	1.8004.550	AL Cylinder B1 Open Circuit	Open circuit fault in the injector wiring for cylinder B1. Result: Misfire. => Check injection wiring for breaks and rule out any breaks in the solenoid valve (e.g. by replacing injector). Fault rectified: after each working cycle. (Alarm configuration parameter, for explanation see PR 2.8008.100)
352.00	1.8004.551	AL Cylinder B2 Open Circuit	Open circuit fault in the injector wiring for cylinder B2. Result: Misfire. => Check injection wiring for breaks and rule out any breaks in the solenoid valve (e.g. by replacing injector). Fault rectified: after each working cycle. (Alarm configuration parameter, for explanation see PR 2.8008.100)
353.00	1.8004.552	AL Cylinder B3 Open Circuit	Open circuit fault in the injector wiring for cylinder B3. Result: Misfire. => Check injection wiring for breaks and rule out any breaks in the solenoid valve (e.g. by replacing injector). Fault rectified: after each working cycle. (Alarm configuration parameter, for explanation see PR 2.8008.100)
354.00	1.8004.553	AL Cylinder B4 Open Circuit	Open circuit fault in the injector wiring for cylinder B4. Result: Misfire. => Check injection wiring for breaks and rule out any breaks in the solenoid valve (e.g. by replacing injector). Fault rectified: after each working cycle. (Alarm configuration parameter, for explanation see PR 2.8008.100)
355.00	1.8004.554	AL Cylinder B5 Open Circuit	Open circuit fault in the injector wiring for cylinder B5. Result: Misfire. => Check injection wiring for breaks and rule out any breaks in the solenoid valve (e.g. by replacing injector). Fault rectified: after each working cycle. (Alarm configuration parameter, for explanation see PR 2.8008.100)
356.00	1.8004.555	AL Cylinder B6 Open Circuit	Open circuit fault in the injector wiring for cylinder B6. Result: Misfire. => Check injection wiring for breaks and rule out any breaks in the solenoid valve (e.g. by replacing injector). Fault rectified: after each working cycle. (Alarm configuration parameter, for explanation see PR 2.8008.100)
361.00	1.8004.496	AL Injector Output Stage Low	Internal electronics fault (electronics are probably faulty -> Start ITS). If ITS diagnosis “Electronics OK”, observe messages (e.g. wiring fault). If “1.1020.021” bit (Power Stage Failure: Stop Engine) is set, an engine stop will also occur. (Alarm configuration parameter, for explanation see PR 2.8008.100)

No.	PR	Alarm	Meaning
362.00	1.8004.497	AL Injector Output Stage High	Internal electronics fault (electronics are probably faulty -> Start ITS). If ITS diagnosis “Electronics OK”, observe messages (e.g. wiring fault). If “1.1020.021” bit (Power Stage Failure: Stop Engine) is set, an engine stop will also occur. (Alarm configuration parameter, for explanation see PR 2.8008.100)
363.00	1.8004.560	AL Stop Injector Output Stage	Internal electronics fault (electronics are probably faulty -> Start ITS). If ITS diagnosis “Electronics OK”, observe messages (e.g. wiring fault). If “1.1020.021” bit (Power Stage Failure: Stop Engine) is set, an engine stop will also occur. (Alarm configuration parameter, for explanation see PR 2.8008.100)
365.00	1.8004.561	AL Stop MV Wiring GND	Injector wiring fault. If “1.1020.021” bit (Power Stage Failure: Stop Engine) is set, an engine stop will also occur. Possible causes: 1. Short circuit of injector positive connection 1 or several injectors are short-circuited to GND 2. Short circuit of injector negative connection 1 or several injectors are short-circuited to GND. -> Check wiring and replace wiring harness if necessary. (Alarm configuration parameter, for explanation see PR 2.8008.100)
371.00	1.8004.634	AL Wiring TO 1	Short circuit or line break at transistor output 1 (TO 1). (Alarm configuration parameter, for explanation see PR 2.8008.100)
381.00	2.8006.638	AL Wiring TOP 1	Short circuit or line break at transistor output 1 system-side (TOP 1). (Alarm configuration parameter, for explanation see PR 2.8008.100)
382.00	2.8006.639	AL Wiring TOP 2	Short circuit or line break at transistor output 2 system-side (TOP 2). (Alarm configuration parameter, for explanation see PR 2.8008.100)
383.00	2.8006.640	AL Wiring TOP 3	Short circuit or line break at transistor output 3 system-side (TOP 3). (Alarm configuration parameter, for explanation see PR 2.8008.100)
384.00	2.8006.641	AL Wiring TOP 4	Short circuit or line break at transistor output 4 system-side (TOP 4). (Alarm configuration parameter, for explanation see PR 2.8008.100)
390.00	1.1085.009	AL MCR Exceeded	DBR/MCR function: MCR (continuous max. rate) was exceeded. (Alarm configuration parameter, for explanation see PR 2.8008.100)
400.00	2.8006.625	AL Open Load Digital Input 1	Open circuit at digital input 1. ==> Wiring faulty or no resistance through switch (Alarm configuration parameter, for explanations see PR 2.8008.100)
401.00	2.8006.626	AL Open Load Digital Input 2	Open circuit at digital input 2. ==> Wiring faulty or no resistance through switch (Alarm configuration parameter, for explanations see PR 2.8008.100)

No.	PR	Alarm	Meaning
402.00	2.8006.627	AL Open Load Digital Input 3	Open circuit at digital input 3. ==> Wiring faulty or no resistance through switch (Alarm configuration parameter, for explanations see PR 2.8008.100)
403.00	2.8006.628	AL Open Load Digital Input 4	Open circuit at digital input 4. ==> Wiring faulty or no resistance through switch (Alarm configuration parameter, for explanations see PR 2.8008.100)
404.00	2.8006.629	AL Open Load Digital Input 5	Open circuit at digital input 5. ==> Wiring faulty or no resistance through switch (Alarm configuration parameter, for explanations see PR 2.8008.100)
405.00	2.8006.630	AL Open Load Digital Input 6	Open circuit at digital input 6. ==> Wiring faulty or no resistance through switch (Alarm configuration parameter, for explanations see PR 2.8008.100)
406.00	2.8006.631	AL Open Load Digital Input 7	Open circuit at digital input 7. ==> Wiring faulty or no resistance through switch (Alarm configuration parameter, for explanations see PR 2.8008.100)
407.00	2.8006.632	AL Open Load Digital Input 8	Open circuit at digital input 8. ==> Wiring faulty or no resistance through switch (Alarm configuration parameter, for explanations see PR 2.8008.100)
408.00	2.8006.633	AL Open Load Emergency Stop Input ESI	Open circuit at input for emergency stop. ==> Wiring faulty or no resistance through switch (Alarm configuration parameter, for explanations see PR 2.8008.100)
410.00	2.0141.921	LO U-PDU	Injector voltage too low (limit value 1). (Alarm configuration parameter, for explanation see PR 2.8008.100)
411.00	2.0141.922	LOLO U-PDU	Injector voltage too low (limit value 2). (Alarm configuration parameter, for explanation see PR 2.8008.100)
412.00	2.0141.931	HI U-PDU	Injector voltage too high (limit value 1). (Alarm configuration parameter, for explanation see PR 2.8008.100)
413.00	2.0141.932	HIHI U-PDU	Injector voltage too high (limit value 2). (Alarm configuration parameter, for explanation see PR 2.8008.100)
414.00	2.0156.931	HI Level Water Fuel Prefilter	Water level in fuel prefilter too high (limit value 1) ==> Empty fuel prefilter (Alarm configuration parameter, for explanations see PR 2.8008.100)
417.00	1.8004.594	SD Level Water Fuel Prefilter	Sensor for water level of fuel prefilter faulty. ==> Short circuit or wire break ==> Check sensor and wiring and replace if necessary. (Alarm configuration parameter, for explanation see PR 2.8008.100)

No.	PR	Alarm	Meaning
438.00	2.0116.921	LO P-Fuel 2 (Common Rail)	Rail pressure < set value => DBR reduction (==> HP fuel control block is faulty or leak in high-pressure system) (Alarm configuration parameter, for explanations see PR 2.8008.100)
439.00	2.0116.931	HI P-Fuel 2 (Common Rail)	Rail pressure > set value => DBR reduction, start of injection retarded (==> HP fuel control block sticks or wiring of HP fuel control block) (Alarm configuration parameter, for explanations see PR 2.8008.100)
441.00	1.8004.047	AL System 2 Leaks	Pressure gradient in rail is too low when starting or too high when stopping (==> High-pressure system leaks, air in system) (Alarm configuration parameter, for explanations see PR 2.8008.100)
444.00	1.8004.578	SD U-PDU	Sensor for injector output stage faulty. ==> ECU7 internal error. Replace ECU7. (Alarm configuration parameter, for explanation see PR 2.8008.100)
445.00	1.8004.580	SD P-Ambient Air	Ambient air sensor faulty. (Alarm configuration parameter, for explanation see PR 2.8008.100)
446.00	1.8004.599	SD P-HD2	Rail pressure sensor faulty. ==> High pressure regulator in emergency operation ==> Short circuit or wire break ==> Check sensor and wiring (B48) and replace if necessary. (Alarm configuration parameter, for explanation see PR 2.8008.100)
448.00	2.0103.931	HI P-Charge Air	Charge-air pressure too high (limit value 1). (Alarm configuration parameter, for explanation see PR 2.8008.100)
449.00	2.0103.932	SS P-Charge Air	Charge-air pressure too high (limit value 2). (Alarm configuration parameter, for explanation see PR 2.8008.100)
450.00	2.8006.592	SD Filling Signal in Percent	Input signal for start/end torque faulty. ==> Short circuit or wire break ==> Check signal transmitter and replace if necessary. After restarting engine the fault is rectified. (Alarm configuration parameter, for explanation see PR 2.8008.100)
454.00	2.7000.011	SS Power Limit Active	Power reduction activated. (Alarm configuration parameter, for explanation see PR 2.8008.100)
470.00	1.8004.587	SD T-ECU	Temperature sensor for ECU faulty. ==> Short circuit or wire break ==> Check sensor and wiring and replace if necessary. (Alarm configuration parameter, for explanation see PR 2.8008.100)
472.00	2.8006.593	AL Stop SD	Engine stopped because channel has a “Faulty sensor”. (Alarm configuration parameter, for explanation see PR 2.8008.100)
474.00	2.8006.655	AL Wiring FO	Line break or short circuit at channel FO. (Alarm configuration parameter, for explanation see PR 2.8008.100)
475.00	1.8010.009	AL CR Engine Shutoff Trigger	Crash recorder is triggered by an engine shutoff. (Alarm configuration parameter, for explanation see PR 2.8008.100)

No.	PR	Alarm	Meaning
476.00	1.8010.007	AL Crash Rec. Init. Fault	Initiation fault of crash recorder. (Alarm configuration parameter, for explanation see PR 2.8008.100)
478.00	2.8006.001	AL Combined Alarm Yellow (System)	Combined alarm YELLOW from system. (Alarm configuration parameter, for explanation see PR 2.8008.100)
479.00	2.8006.002	AL Combined Alarm Red (System)	Combined alarm RED from system. (Alarm configuration parameter, for explanation see PR 2.8008.100)
480.00	2.0291.921	AL Ext. Engine Protection	External engine protection function active. (Alarm configuration parameter, for explanation see PR 2.8008.100)
510.00	2.7002.010	AL Override Operated	Override operated. (Alarm configuration parameter, for explanation see PR 2.8008.100)
515.00	2.1090.926	AL Starter Not Engaged	Starter at POM could not be engaged. => Repeat start. If the number of automatic start attempts in PR 2.1090.134 has been reached, start is terminated. Check POM, starter and wiring. (Alarm configuration parameter, for explanation see PR 2.8008.100)
543.00	2.0555.005	AL More Than One FDH Slave	There is more than one device activated as a backup for the FDH. (Alarm configuration parameter, for explanation see PR 2.8008.100)
544.00	2.0555.003	AL Configuration Changed	This fault becomes active in cases where the system configuration has been changed e.g due to replacement of an ECU or SAM. This fault remains until either this process is reversed or data has been transferred by an active maintenance case. The fault is then automatically deleted. (Alarm configuration parameter, for explanation see PR 2.8008.100)
549.00	2.7001.952	AL Power Interrupt Detected	This is an alarm from the emergency stop counter. The power supply of the ECU was turned off while engine was running. This can lead to excessive pressure in the high-pressure system which could damage the engine. (Alarm configuration parameter, for explanation see PR 2.8008.100)
555.00	2.0555.001	AL Call MTU Field Service	This fault is active when a maintenance case is performed by the field data handling (FDH) function of the ECU and changes are made to the engine parameters. This fault will still remain active after turning the system off and on until a valid authorization code has been entered using the display and pushbuttons control of the SAM. This authorization code can be ordered through the Internet using a special process. (Alarm configuration parameter, for explanation see PR 2.8008.100)
576.00	1.1075.083	AL ESCM Override	The corrected MCR or DBR/MCR curve exceeded. Engine overload! (Alarm configuration parameter, for explanation see PR 2.8008.100)
594.00	1.1301.900	AL L1 UDV Faulty	Yellow alarm pressure relief valve of first rail.

No.	PR	Alarm	Meaning
595.00	1.1301.901	AL L2 UDV Faulty	Red alarm pressure relief valve of first rail.
598.00	1.1302.900	AL L1 UDV Faulty	Yellow alarm pressure relief valve of second rail.
599.00	1.1302.901	AL L2 UDV Faulty	Red alarm pressure relief valve of second rail.
610.00	1.1301.902	AL HP Fuel Control Block 1 Wiring	Line break or short circuit at PEM channel of HP fuel control block. (Alarm configuration parameter, for explanation see PR 2.8008.100)
611.00	1.1302.902	AL HP Fuel Control Block 2 Wiring	Line break or short circuit at PEM channel of HP fuel control block 2 (Alarm configuration parameter, for explanation see PR 2.8008.100)
612.00	1.1301.903	AL Pressure Regulating Valve 1 Wiring	Line break or short circuit at PWM channel of pressure regulating valve (Alarm configuration parameter, for explanations see PR 2.8008.100)
613.00	1.1302.903	AL Pressure Regulating Valve 2 Wiring	Line break or short circuit at PEM channel of pressure regulating valve 2. (Alarm configuration parameter, for explanation see PR 2.8008.100)