Technical Publication

MDEC
Engine Control System
BR 2000 / BR 4000
Stationary generator engines

- **Structure and function**
- **Operation**
- **Maintenance and repair**
- **Operating personnel**
- **Plant personnel**

Documentation Parts 1, 2, 3

E 531 711 / 01 E

DETROIT DIESEL

mtu

DaimlerChrysler Off-Highway

MTU assuring you:

- **ISO 9001 certification**
  Quality assurance in design/development, production, installation and service
- **CE conformity**
  - Guideline 73/23/EEC – Low voltage guideline –
    dated February 19, 1973 with amendment dated July 22, 1993
    (guideline 93/68/EEC)
  - Guideline 89/336/EEC – Guideline on electromagnetic compatibility –
    dated May 3, 1989 with amendment dated April 28, 1992
    (guideline 92/31/EEC)

    CE conformity is influenced if the product is installed incorrectly, an assembly or system is misused and/or genuine MTU components are not used.

General information about documentation

Documentation structure

Documentation Part	Title/contents	Target group(s)
1	Structure and function	Operating personnel etc.
2	Operation	Operating personnel
3	Maintenance and repair	Plant personnel
4	Service manual	Electronic service personnel
5	Illustrated parts catalog	Operating personnel, electronic service personnel, logistics personnel
6	Plant-specific configuration	Electronic service personnel, installation personnel, start-up personnel
7	Mechanical and electrical installation	Installation personnel (electromechanical/mechatronic engineer)
8	Initial start-up	Start-up personnel

Note: Not all parts of the documentation are written for every product.

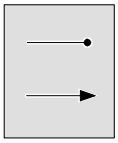
Required knowledge

To understand each part of the documentation, we recommend reading the preceding parts, if applicable.

Reference numbers and reference lines

Details in figures are provided with reference numbers and reference lines if necessary.

If reference is made in the text to a detail provided with a reference number, the figure number and, separated by an oblique, the reference number of the detail are written in brackets. Example: (5/2) means fig. 5, reference number 2.



A point at the end of the reference line means that the detail is visible in the figure.

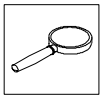
An arrow at the end of the reference line indicates that the detail cannot be seen in the figure.

Symbols

The symbols used in safety notes are defined in the chapter “Safety requirements”.

This symbol indicates cross-references to other manuals.

This symbol indicates important information.



This symbol indicates detailed information.

Further troubleshooting or fault rectification requires mechanical work to be performed on other assemblies or equipment with reference to the relevant documentation.

Further troubleshooting or fault rectification requires work to be performed on the engine with reference to the engine documentation.

Rectification of a fault marked with this symbol either requires the customer's service personnel or service personnel provided by MTU. The affected assembly may have to be sent to MTU for repairs.
Such a fault cannot be repaired by operating personnel.

Some of the chapters in this manual contain structured task descriptions. The symbols used here are explained at the relevant points by associated sub-titles.

ID numbers

Some of the chapters in this manual contain structured task and activity descriptions. Each task and each activity is assigned an unambiguous identification number (ID no.). This number is structured as follows *X-X-XXX-xxxx* whereby:

1st figure:	Either "T" for "Task" or "A" for "Activity"
2nd figure:	System affected (examples: "M" for MCS, "R" for RCS)
3rd – 5th figure:	Unit or assembly (generally corresponding to MTU type designations, whereby version numbers are omitted)
6th – 9th figure:	Serial number (when 1st – 5th figures are identical)

Asterisks ("wildcards") "N" (for none) may be used for the 1st to 5th figures when a task/activity is generally applicable to all systems/devices.

Qualification of users of the manual

Abbreviations are used in the manual to indicate qualification of personnel who may carry out the tasks/activities concerned. The abbreviations refer to the course types available in the MTU training program for the product concerned and have the following meaning:

E1	The user must have completed a course aimed at operating personnel or have equivalent knowledge. No metrological requirements are made.
E2	The user must have completed a course aimed at plant personnel or have equivalent knowledge.
E3	The user must have completed a course aimed at service personnel (electronics).
E4	The user must have completed a course aimed at start-up personnel (electronics).

Part 1

Structure and function

(This page intentionally blank)

Table of contents

1	**Structure and function**	**1**
1.1	Use	1
1.2	Features	2
1.3	Structure	3
1.3.1	Structure of Engine Control System ECS-5	4
1.3.2	Structure of Monitoring and Control System MCS-5	5
1.3.2.1	Basic scope of the MCS-5 of the MDEC for stationary generator engines	5
1.3.2.2	The devices of Engine Control System ECS-5	6
1.3.2.2.1	Engine Control Unit ECU	6
1.3.2.3	MCS-5 options of the MDEC for stationary generator engines	8
1.3.2.3.1	Peripheral Interface Modules	8
1.3.2.3.2	Display DIS	10
1.3.2.3.3	Analog display instruments	11
1.3.2.4	The devices of Monitoring and Control System MCS-5	12
1.3.2.4.1	Peripheral Interface Module PIM A 511	12
1.3.2.4.2	Peripheral Interface Module PIM A 512	14
1.3.2.4.3	Peripheral Interface Module PIM A 513	15
1.3.2.4.4	Peripheral Interface Module PIM A 515	16
1.3.2.4.5	Peripheral Interface Module PIM A 516	17
1.3.2.4.6	Peripheral Interface Module PIM A 517	18
1.3.2.4.7	Peripheral Interface Module PIM A 519	19
1.3.2.4.8	Display DIS	20
1.3.2.4.9	Display instruments	22
1.3.3	Data connections	23
1.3.4	Power supply	24
1.3.5	Earthing	24
1.3.6	Technical data	25
1.4	Functions	26
1.4.1	Operating functions on display DIS (option)	26
1.4.2	Display functions	27
1.4.2.1	Display functions of fault code display FCB in PIM A 511	27
1.4.2.2	Display functions of display DIS (option)	28
1.4.2.3	Display functions on the man-machine interface of the display (option)	29
1.4.2.3.1	General screen page structure	30
1.4.2.3.2	Overview page structure	33
1.4.2.3.3	System page stucture	34
1.4.2.3.4	Graphic page structure	35

Table of contents *(cont.)*

1.4.2.3.5 Measuring point list structure 36
1.4.2.3.6 Contrast page structure 37
1.4.2.3.7 Service page structure 38
1.4.2.3.8 Alarm page structure 39
1.4.2.3.9 Help page structure 42
1.4.2.4 Display functions of the display instruments (option) 43
1.4.3 Acquisition functions 44
1.4.3.1 Plant signals 44
1.4.3.1.1 Signals to Engine Control Unit ECU 44
1.4.3.1.2 Signals at PIM A 519 44
1.4.3.2 Engine signals 46
1.4.3.2.1 Sensors 46
1.4.3.2.2 Sensors on the engine 47
1.4.4 Control functions 50
1.4.4.1 Engine start 51
1.4.4.1.1 Normal engine start 51
1.4.4.1.2 Engine restart 52
1.4.4.1.3 Emergency engine start 52
1.4.4.2 Engine stop 53
1.4.4.3 Override 53
1.4.4.4 50 Hz/60 Hz switching on bi-frequency engines 53
1.4.4.5 Load pulse 53
1.4.5 Monitoring functions 54
1.4.5.1 Engine safety system 54
1.4.5.2 Combined alarm signalling 55
1.4.6 Regulating functions 56
1.4.6.1 Speed/injection regulation 56
1.4.6.2 Idle speed governor – maximum speed governor – fuel governor 57
1.4.6.3 Common Rail injection system (series 4000 only) 58
1.4.6.4 PLN injection system (series 2000 only) 59
1.4.6.5 Angle measuring/determining engine timing 60
1.4.6.6 Speed droop 61
1.4.6.6.1 Speed droop calculation 61
1.4.6.6.2 Switchable speed droop 61
1.4.6.7 Power limitation (quantity limitation) 63
1.4.6.7.1 Dynamic quantity limitation 63
1.4.6.7.2 Fixed quantity limitation 63
1.4.6.7.3 Fuel quantity control during engine starting 63
1.4.6.8 Speed setpoint handling 64

Table of contents *(cont.)*

1.4.7 Safety features 65
1.4.7.1 Safety shutdowns 65
1.4.7.1.1 Integral Test System (ITS) 67
1.4.7.1.2 Monitoring of the electronics in the Engine Control Unit ECU 67
1.4.7.1.3 Sensor/actuator monitoring 68
1.4.7.1.4 Bus communication monitoring 68
1.4.7.2 Overspeed test 68

(This page intentionally blank)

1 Structure and function

1.1 Use

Engine Control System MDEC for stationary generator engines is used for engine series MTU/DDC BR 4000 and DDC/MTU BR 2000. Engine management system MDEC primarily fulfills the following tasks:

- Controlling the diesel engine
- Monitoring the operating states
- Regulating feeding or speed of the diesel engine (depending of the appropriate operating state)
- Indicating incorrect operating states via fault codes (PIM A 511)

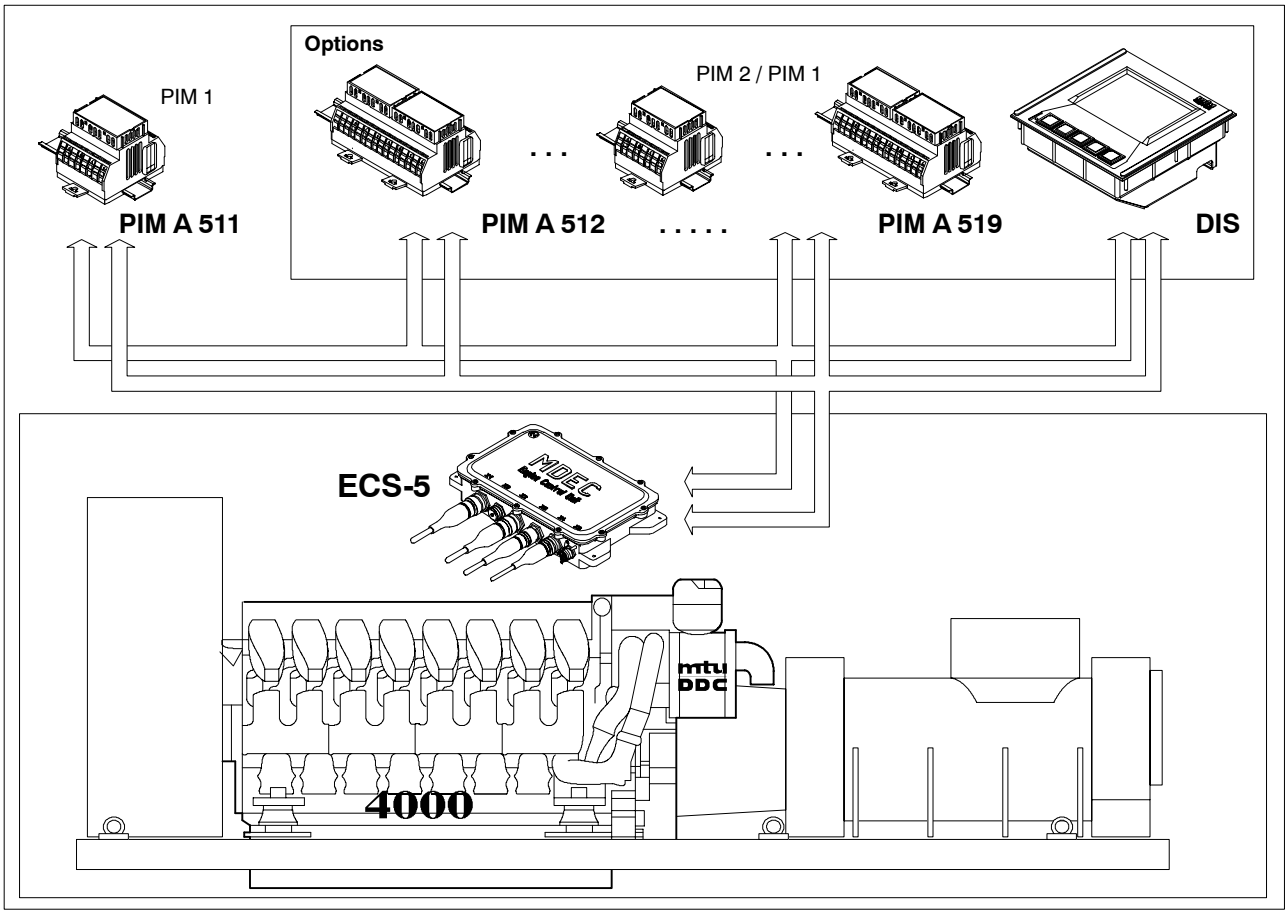


Fig. 1 : Engine Control System MDEC for stationary generator engines for genset control and monitoring

As many as 8 additional PIM Peripheral Interface Modules can be connected to superordinate systems (option). A display DIS (option) gives information about operating states in the form of bargraphs and text and signals malfunctions in the form of messages.

1.2 Features

Engine Control System MDEC for stationary generator engines has the following essential features:

- Can be used for engine series 2000 and 4000
- Electronic engine regulation and control
- Engine monitoring for inadmissible operating states
- Fault code display
- Connection cable for power supply of the individual devices
- Connection cable for connecting a superordinate genset control unit
- CAN bus connection to a superordinate genset control unit (option)
- Hardware interfaces to a superordinate genset control unit (option)
- Inputs for plant sensors (option)
- Indication of engine operating states and faults in plain text via LC display (option)
- Analog displays (option)
- Speed or feeding regulator depending on operating state
- Features to protect the engine leading as far as shutdown
- Integral fault diagnosis system ITS
- Integral load profile recorder
- Fully-automatic start sequence control
- 50 Hz or 60 Hz operation possible
- Speed droop switchover possible during engine operation

1.3 Structure

The structure of an overall MDEC system for stationary generator engines comprising the two sub-systems ECS-5 and MCS-5 depends on customer requirements and the superordinate genset control unit. The various sub-systems and their component parts are represented schematically in the figure below (fig. 2).

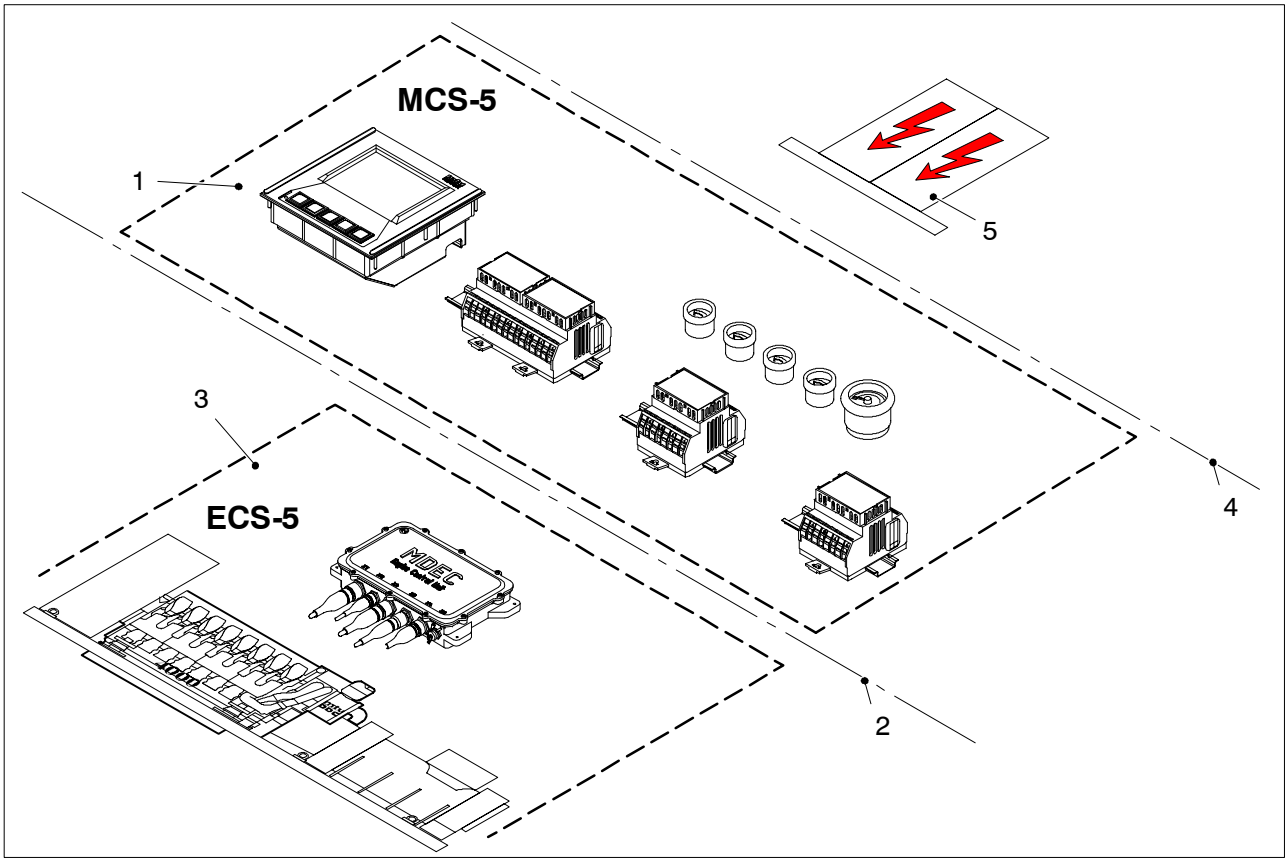


Fig. 2 : Typical configuration for an MDEC

Pos.	Name	Meaning
2/1	MCS-5	Monitoring and Control System
2/2	CAN	Demarcation lines between the systems ECS-5 and MCS-5
2/3	ECS-5	Engine Control System
2/4	RS422	Demarcation lines between the system MCS-5 and an external emergency power controller
2/5	System	External emergency power controller

1.3.1 Structure of Engine Control System ECS-5

Engine Control System ECS-5 consists of the following devices:

- Engine Control Unit ECU
- Engine sensors
- Engine actuators
- Engine injectors
- Engine cable harnesses

Note: The function of the Engine Control System ECS-5 remains the same with regard to Monitoring and Control System MCS-5 and its scope.

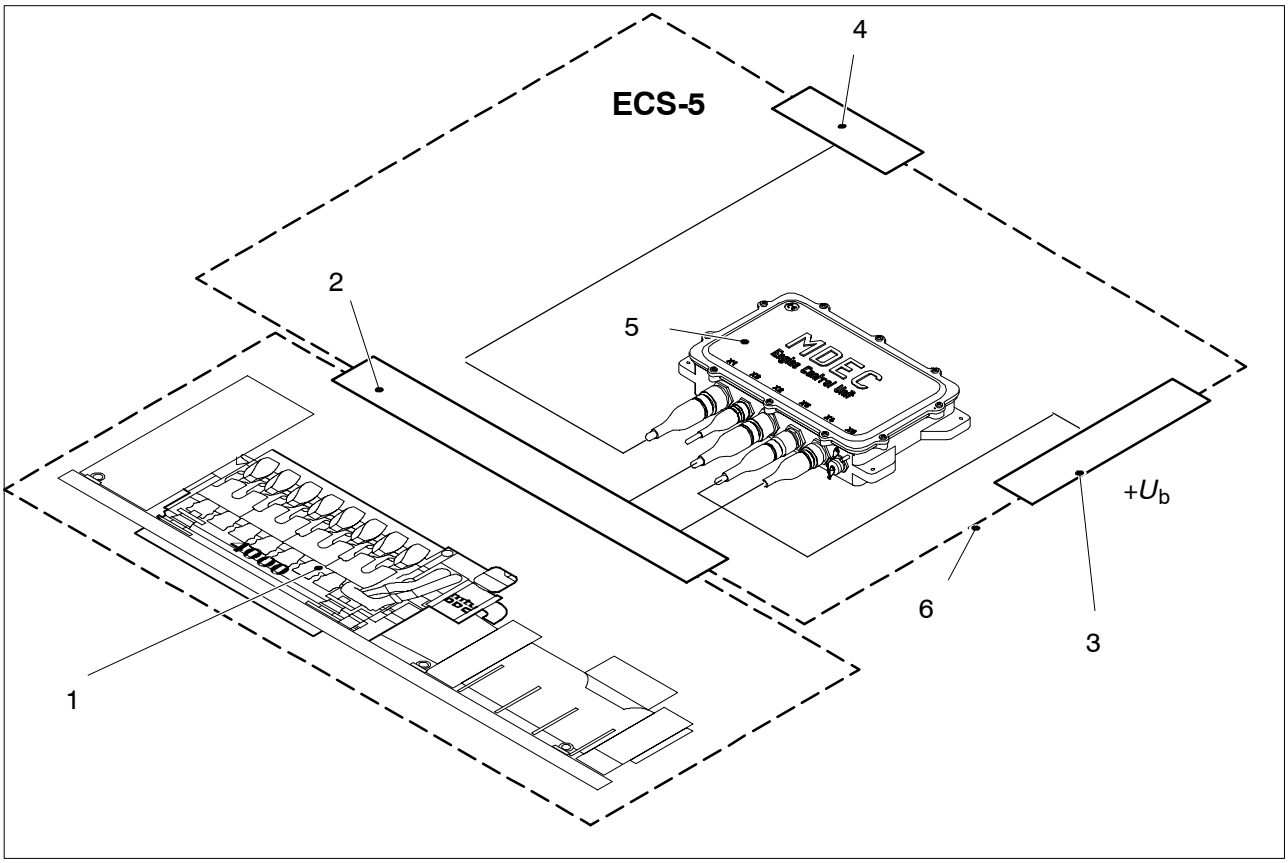


Fig. 3 : Structure of Engine Control System ECS-5

Pos.	Name	Meaning
3/1	Engine	
3/2	Engine interface	Engine cable harnesses for sensors and final control elements
3/3	+U_b	Power supply
3/4		Signal connection to MCS-5 devices and superordinate control units if applicable
3/5	ECU	Engine Control Unit
3/6	System demarcation line	ECS-5 sub-system

1.3.2 Structure of Monitoring and Control System MCS-5

1.3.2.1 Basic scope of the MCS-5 of the MDEC for stationary generator engines

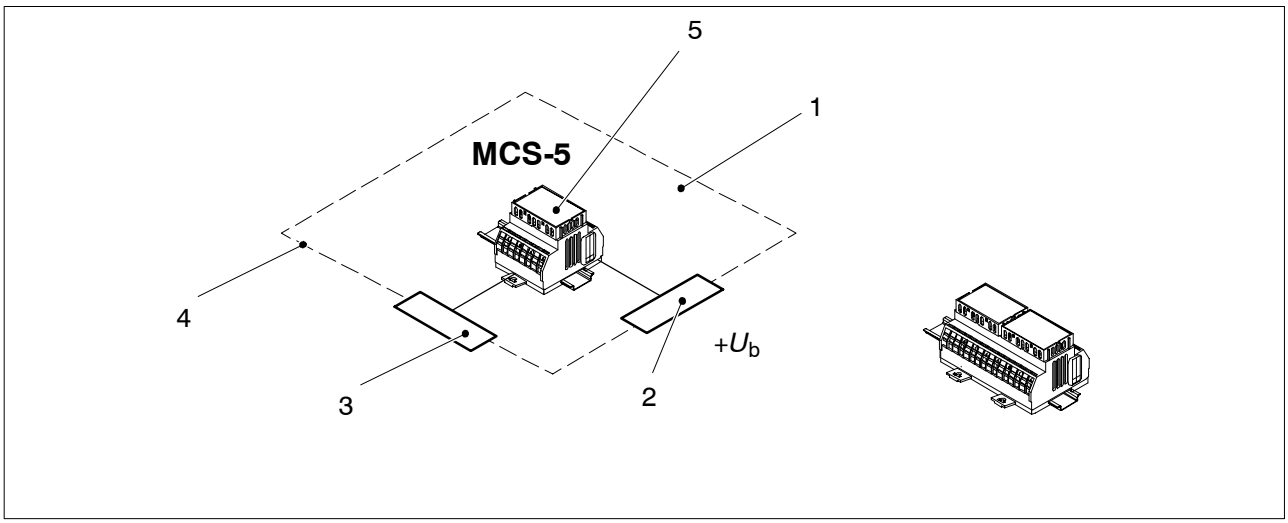


Fig. 4 : Basic scope of the MCS-5 of the MDEC for stationary generator engines

Pos.	Name	Meaning
4/1	MCS-5	
4/2	+U_b	Power supply
4/3		Signal connection to ECS-5 devices
4/4	System demarcation line	MCS-5 sub-system
4/5	PIM A 511	Peripheral Interface Module PIM 1 for fault code display

1.3.2.2 The devices of Engine Control System ECS-5

1.3.2.2.1 Engine Control Unit ECU

Use

The ECU assembly is a speed and injection governor for DDC/MTU series 2000 and 4000 engines. It is located directly on the engine.

Engine Control Unit ECU features:

- Control of PLN type (pump – line – nozzle) mapped individual injection systems for BR 2000 or of CR systems (Common Rail) for BR 4000 engines
- Up to 20 injection valves/injectors can be controlled
- Communication with other devices and the superordinate system is realized via CAN bus
- Self-monitoring and diagnosis
  - Integral status/fault indication
  - Fault memory
- Extensive I/O features:
  - Plant side: 13 inputs, 10 outputs, 2 serial interfaces
  - Engine side: 26 inputs, 26 outputs
- Engine and plant-specific variables in replaceable memory modules
- Diagnosis via RS232 interface for dialog unit

Structure

Engine Control Unit ECU is enclosed in a diecast housing with a screw-fitted cover.

Four mounting lugs are used to secure Engine Control Unit ECU on the engine mounting plate. The cover is attached to the housing by means of 10 Phillips screws.

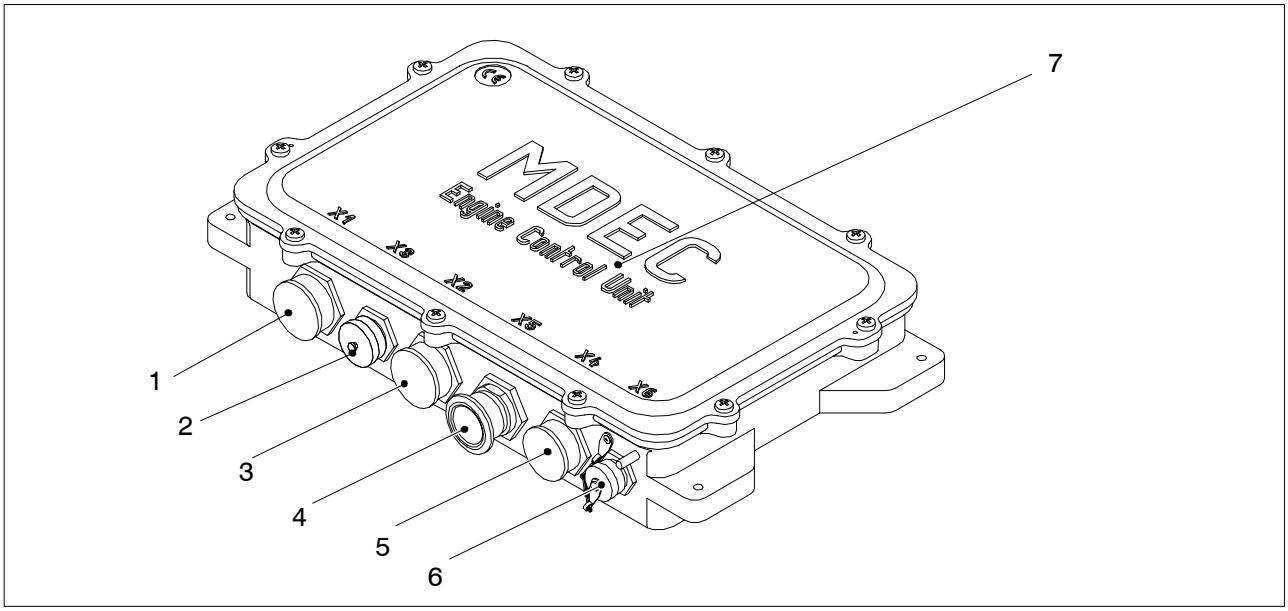


Fig. 5 : Engine Control Unit ECU

Pos.	Name	Meaning
5/1	Connector X1	Can bus connection
5/2	Connector X3	BR 2000: Not used* BR 4000: High-pressure controller
5/3	Connector X2	Engine cable harness connection
5/4	Connector X5	Operating voltage connection
5/5	Connector X4	Engine cable harness connection
5/6	Connector X6	Connection for dialog unit (optional), Notebook
5/7	Cover	–

Technical data

Dimensions *(W x H x D)*	Approx. 455 mm x 91 mm x 277 mm (without connectors) (depth + approx. 230 mm for connectors)
Operating voltage	Nominal voltage: 24 VDC Continuous voltage: 16.5 VDC ... 32 VDC Temporarily restricted operation: 11 VDC ... 36 VDC Residual ripple: Max. 8 V_{pp}
Power consumption	Max. 30 A (depending on operating state and system scope)
Operating temperature range	0 °C … +75 °C
Storage temperature range	–10 °C … +75 °C
Installation position	At the engine
Relative humidity	0 % to max. 95 %, non-condensing
Shock	15 *g*/11 ms
Vibrostability	
Frequency 2 Hz … 25 Hz:	x_{pp} = 1.6 mm
Frequency 25 Hz … 100 Hz:	$a = \pm 4\ g$
Frequency 100 Hz … 2000 Hz:	Noise 1.3 *g* rms
EMC	DIN EN 50081-2 and DIN EN 50082-2 IEC1000-4-2 IEC1000-4-3 IEC1000-4-4 IEC1000-4-5 IEC1000-4-6
Degree of protection	IP 65 DIN 40 050
Colour	As engine
Weight	7 kg

1.3.2.3 MCS-5 options of the MDEC for stationary generator engines

A range of options are available to allow engine management system MDEC to be adapted to suit customer-specific requirements. These options can be divided into three categories:

- Additional Peripheral Interface Modules for signal acquisition and output (these modules can be combined as required)
- A large display to indicate operating states in plain text
- Analog display instruments

CAUTION

Parameters in the ECU must be modified if additional PIMs are ordered and retrofitted after initial delivery (altered configuration).

The new (additional) devices can otherwise not be detected by the system.

1.3.2.3.1 Peripheral Interface Modules

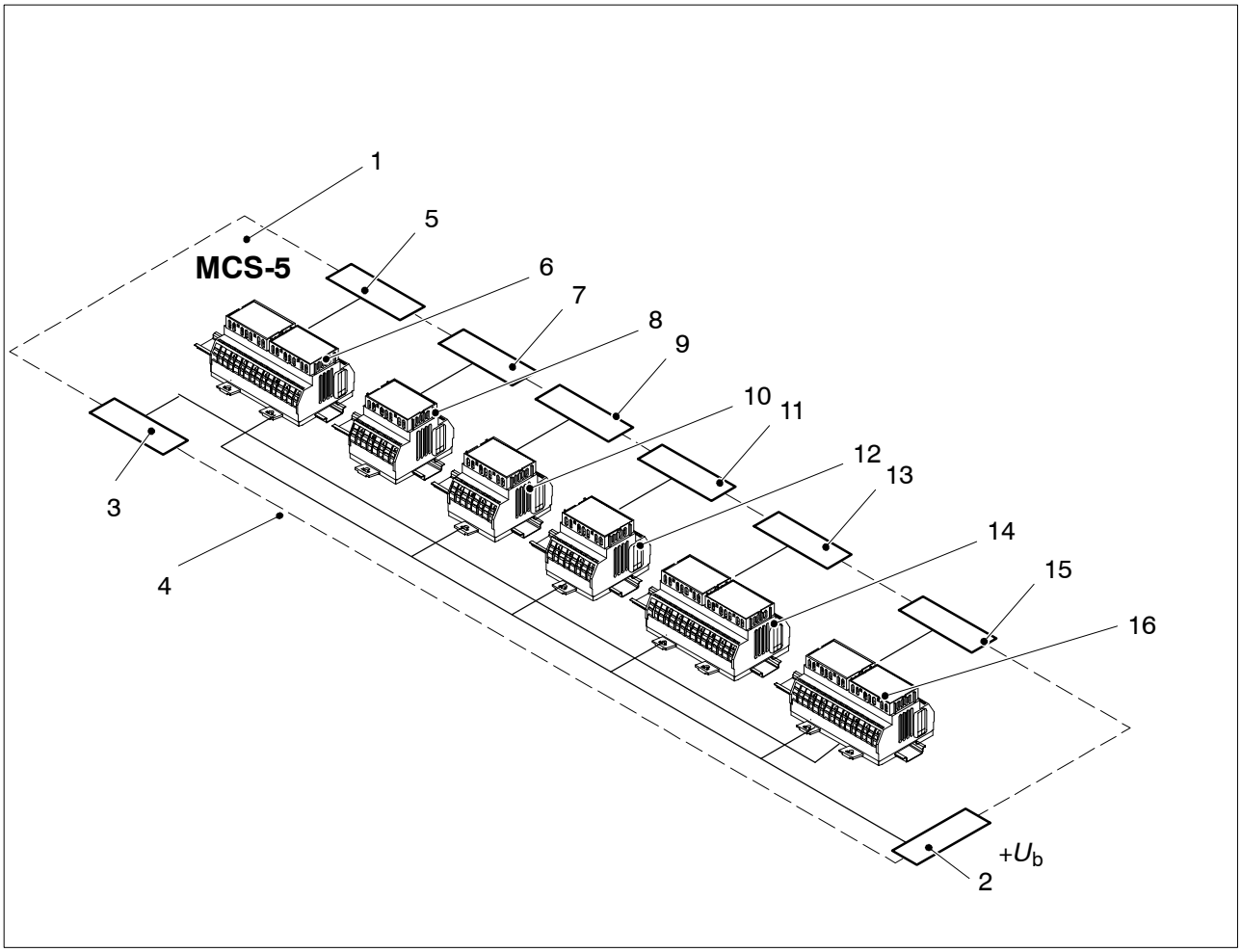


Fig. 6 : All optional Peripheral Interface Modules for the MCS-5 of the MDEC for stationary generator engines

Pos.	Name	Meaning
6/1	MCS-5	
6/2	$+U_b$	Power supply
6/3		Signal connection to ECS-5 devices
6/4	System demarcation line	MCS-5 sub-system
6/5	Interface	For superordinate genset control: Relay outputs for shutdown and combined alarms
6/6	PIM A 512	Peripheral Interface Module PIM 2 with relay outputs
6/7	Interface	For superordinate genset control: Transistor outputs for warnings and alarms as well as shutdowns
6/8	PIM A 513	Peripheral Interface Module PIM 1 with transistor outputs
6/9	Interface	For superordinate genset control: RS 422 / RS 232
6/10	PIM A 515	Peripheral Interface Module PIM 1 with serial CAN interface
6/11	Interface	For superordinate genset control: Transistor outputs for warnings and alarms (Limit 1 and Limit 2)
6/12	PIM A 516	Peripheral Interface Module PIM 1 with transistor outputs
6/13	Interface	For superordinate genset control: Relay outputs for warnings and alarms
6/14	PIM A 517	Peripheral Interface Module PIM 2 with relay outputs
6/15	Interface	For superordinate genset control: Inputs for temperature sensors (Pt100) and pressure sensors (0 ... 10 bar), binary outputs with switching signals for limit value violations
6/16	PIM A 519	Peripheral Interface Module PIM 2 with inputs and outputs for external sensors and for switching signals

Note: PIM 1: Small design with one cassette and space for two printed circuit boards.
PIM 2: Large design with two cassettes and space for four printed circuit boards.

1.3.2.3.2 Display DIS

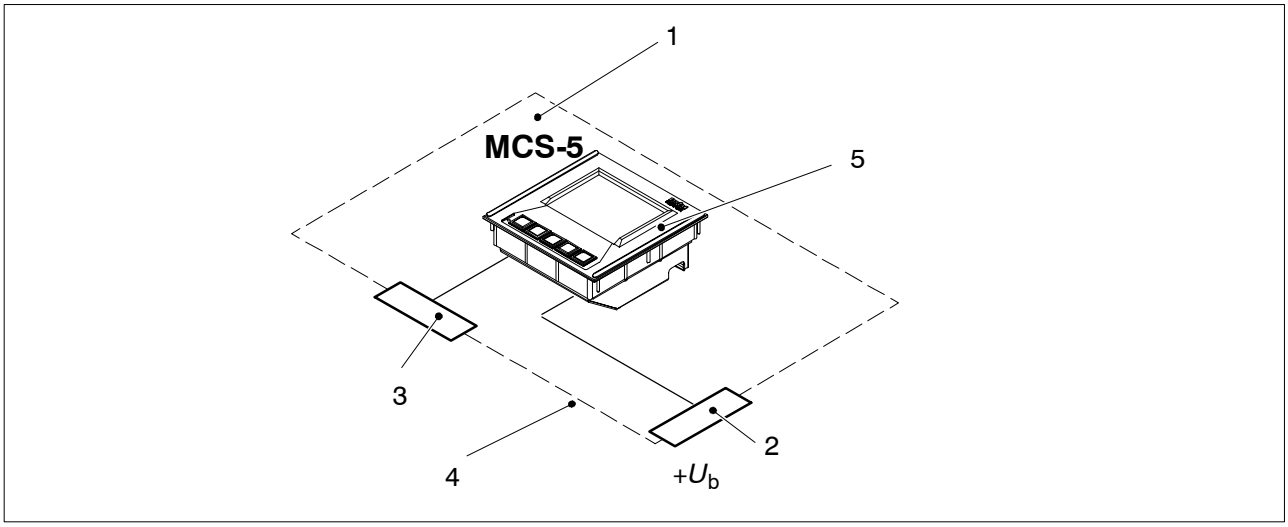


Fig. 7 : Display, option

Pos.	Name	Meaning
7/1	MCS-5	
7/2	+U_b	Power supply
7/3		Signal connection to ECS-5 devices
7/4	System demarcation line	MCS-5 sub-system
7/6	DIS	Display

1.3.2.3.3 Analog display instruments

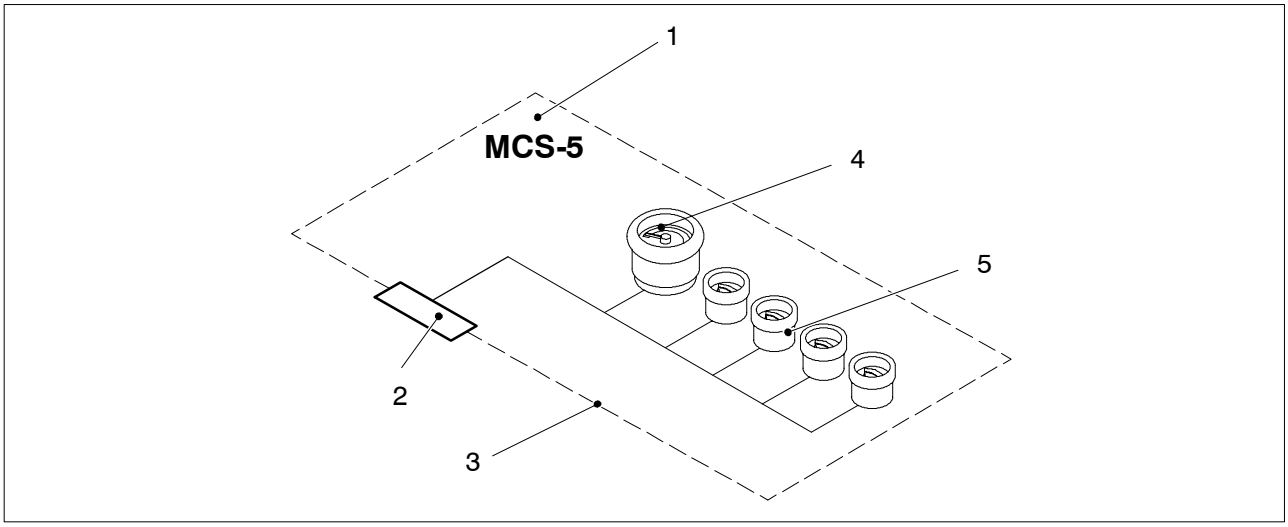


Fig. 8 : Analog display instruments, option

Pos.	Name	Meaning
8/1	MCS-5	
8/2		Signal connection to ECS-5 devices (ECU analog outputs)
8/3	System demarcation line	MCS-5 sub-system
8/4	Display instrument	Engine speed
8/5	Display instruments	Engine operating data

Note: The display instruments can be combined as desired.

1.3.2.4 The devices of Monitoring and Control System MCS-5

1.3.2.4.1 Peripheral Interface Module PIM A 511

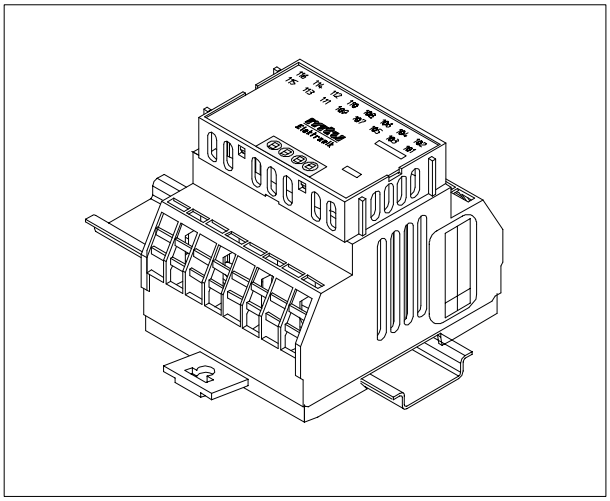


Fig. 9 : PIM A 511

Use

Peripheral Interface Module PIM A 511 is used to display ECU internal fault codes. Indication is realized by a four-figure 7-segment display. Alarms are recorded over a period of 12 hours. They are divided into four groups depending on the time they are received:

1. Current alarms
2. Alarms within the last hour
3. Alarms within the last 4 hours
4. Alarms within the last 12 hours

Furthermore, binary information can be output via two relay contacts.

Structure

A type 1 Peripheral Interface Module (2 slots) is used. The slots are assigned as follows:

Slot	Printed circuit board
1	MPU 23 with CCB 1 (option)
2	FCB

Technical data

Insallation position	As desired
Operating voltage	24 VDC, –25 % to +30 % Residual ripple less than 5 %, in accordance with STANAG 1008
Power consumption	Less than 0.10 A (depending on printed circuit boards used)
Connection cross-section	0.1 x 2.5 mm^2
Protection	IP 20 as per DIN 40 050
Shock	10 *g*, 11 ms
Vibrostability	
Hat rail mounting	2 Hz … 12.8 Hz: X_{pp} = 3 mm 12.8 … 100 Hz: $a = \pm 1\ g$
Screw mounting	2 Hz … 25 Hz: X_{pp} = 3.2 mm 25 Hz … 100 Hz: $a = \pm 4\ g$

Ambient temperature	–30 °C … +70 °C
Storage temperature	–35 °C … +70 °C
Relative humidity	0 % … 97 %, non-condensing
Colour	Blue (RAL 5015)
Material	Fibre-glass reinforced polycarbonate (PC)
PIM 1	
Dimensions (*H* x *W* x *D*)	75 mm x 70 mm x 90 mm
Number of terminals	32
Weight	Approx. 0.3 kg (configured)
PIM 2	
Dimensions (*H* x *W* x *D*)	75 mm x 140 mm x 90 mm
Number of terminals	64
Weight	Approx. 0.6 kg (configured)

Note: Refer to Printed circuit board catalog MCS-5, document no. E 531 439 for details of the pin assignment of the cassettes and the printed circuit boards inserted in them and information about channel assignment.

1.3.2.4.2 Peripheral Interface Module PIM A 512

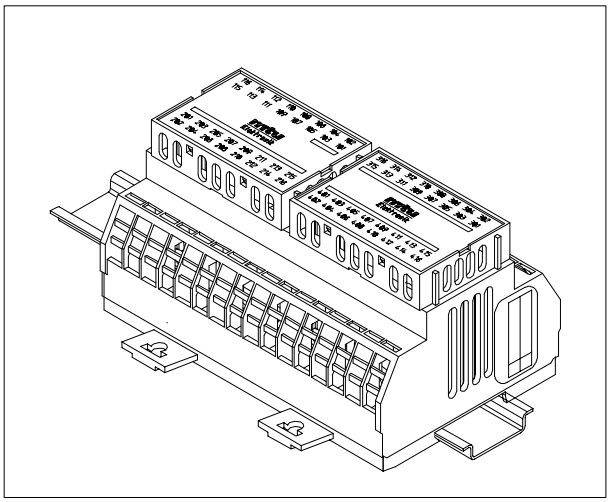


Fig. 10 : PIM A 512

Use

Peripheral Interface Module PIM A 512 is used to output the following information via relay contacts:

- Overspeeding
- Lube oil pressure shutdown
- Coolant temperature shutdown
- Coolant level shutdown
- Charge air shutdown
- Combined red alarm
- Combined yellow alarm
- Nominal speed reached

Structure

A type 2 Peripheral Interface Module (4 slots) is used. The slots are assigned as follows:

Slot	Printed circuit board
1	MPU 23 with CCB 1 (option)
2	free
3	BOB 1
4	BOB 1

Technical data

The technical data of PIM A 511 described in chap. 1.3.2.4.1 applies to all PIMs.

1.3.2.4.3 Peripheral Interface Module PIM A 513

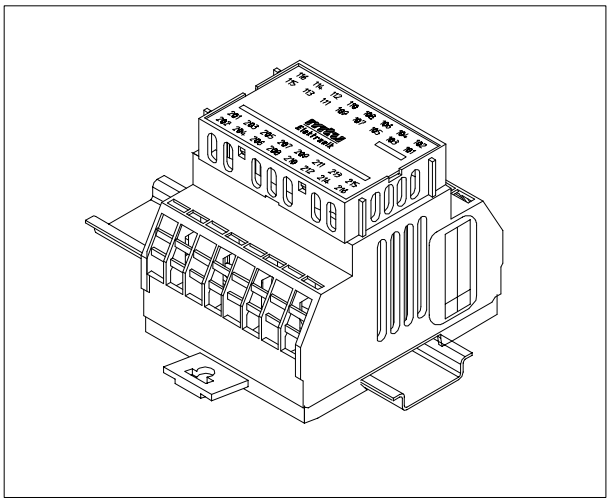


Fig. 11 : PIM A 513

Use

The 14 transistor outputs (+24 VDC positive switching) of Peripheral Interface Module PIM A 513 are used to output the following information:

1. Warning, coolant temperature too high
2. Warning, charge air temperature too high
3. Shutdown, charge air temperature too high
4. Shutdown, coolant level too low
5. Shutdown, charge air coolant level too low
6. Warning, charge air coolant level too low
7. Warning, lube oil temperature too high
8. Warning, lube oil pressure too low
9. Not used
10. Preheating temperature not reached
11. ECU is faulty
12. Engine running
13. High fuel pressure combined alarm
14. Nominal speed reached

Structure

A type1 Peripheral Interface Module (2 slots) is used. The slots are assigned as follows:

Slot	Printed circuit board
1	MPU 23 with CCB 1 (option)
2	BOB 2

Technical data

The technical data of PIM A 511 described in chap. 1.3.2.4.1 applies to all PIMs.

1.3.2.4.4 Peripheral Interface Module PIM A 515

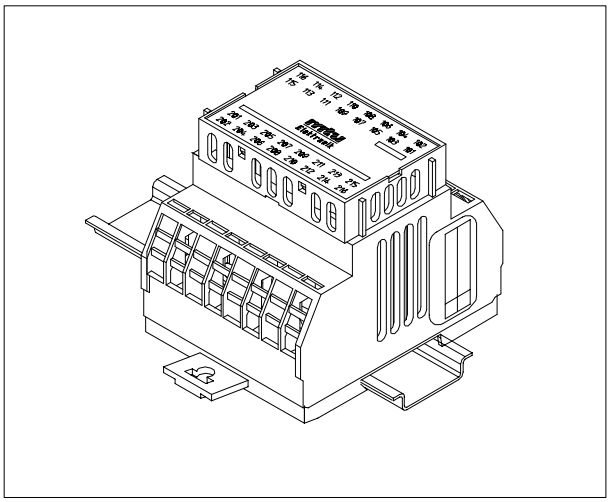


Fig. 12 : PIM A 515

Use

Peripheral Interface Module PIM A 515 is a serial interface coupler. The CAN bus signals are converted here to the signal level of an RS422 interface and an RS232 interface. Signals can only be output here.

Structure

A type 1 Peripheral Interface Module (2 slots) is used. The slots are assigned as follows:

Slot	Printed circuit board
1	MPU 23 with CCB 1 (option)
2	SCB 3

Technical data

The technical data of PIM A 511 described in chap. 1.3.2.4.1 applies to all PIMs.

The measured values transmitted and the interface protocol are explained in document no. E 531 966.

1.3.2.4.5 Peripheral Interface Module PIM A 516

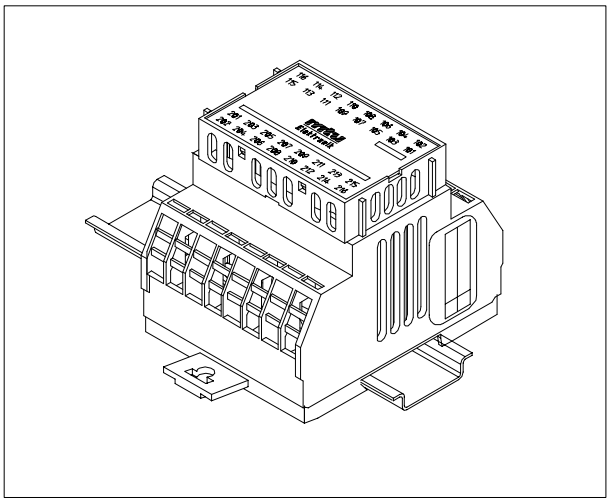


Fig. 13 : PIM A 516

Use

The 14 transistor outputs (+24 VDC negative switching) of Peripheral Interface Module PIM A 516 are used to output the following information:

1. Warning, coolant temperature too high
2. Warning, charge are temperature too high
3. Shutdown, charge air temperature too high
4. Shutdown, coolant level too low
5. Shutdown, charge air coolant level too low
6. Warning, charge air coolant level too low
7. Warning, lube oil temperature too high
8. Warning, lube oil pressure too low
9. Not used
10. Preheating temperature not reached
11. ECU is faulty
12. Engine running
13. High fuel pressure combined alarm
14. Nominal speed reached

Structure

A type 1 Peripheral Interface Module (2 slots) is used. The slots are assigned as follows:

Slot	Printed circuit board
1	MPU 23 with CCB 1 (option)
2	BOB 3

Technical data

The technical data of PIM A 511 described in chap. 1.3.2.4.1 applies to all PIMs.

1.3.2.4.6 Peripheral Interface Module PIM A 517

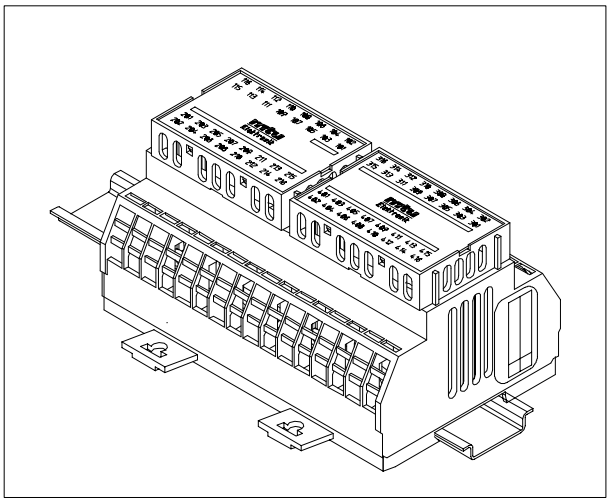


Fig. 14 : PIM A 517

Use

Peripheral Interface Module PIM A 517 is used to output the following information via relay contacts:
Slot 2:
1. ECU is faulty
2. High fuel pressure combined alarm
3. Warning, lube oil pressure too low
4. Warning, lube oil temperature too high

Slot 3:
5. Warning, coolant temperature too high
6. Warning, coolant temp. charge air too low
7. Warning, charge air temperature too high
8. Shutdown, charge air temperature too high

Slot 4:
9. Shutdown, coolant level charge air too low
10. Preheating temperature not reached
11. Nominal speed reached

Structure

A type 2 Peripheral Interface Module (4 slots) is used. The slots are assigned as follows:

Slot	Printed circuit board
1	MPU 23 with CCB 1 (option)
2	BOB 1
3	BOB 1
4	BOB 1

Technical data

The technical data of PIM A 511 described in chap. 1.3.2.4.1 applies to all PIMs.

1.3.2.4.7 Peripheral Interface Module PIM A 519

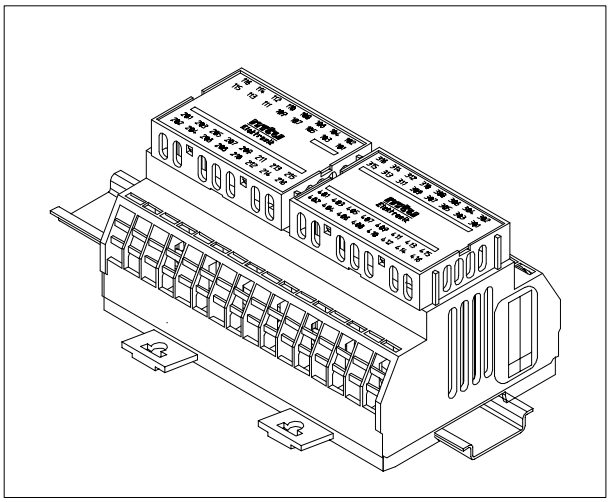


Fig. 15 : PIM A 517

Use

Peripheral Interface Module PIM A 518 is used to output and acquire the following information:
Slot 2:
1. Pressure instrument control
2. Temperature instrument control
3. Four binary inputs

Slot 3:
4. Two pressure inputs 0 ... 10 bar (4...20 mA)
5. Two Pt100 temperature inputs

Slot 4:
6. Limit value violation of measured values
4. and 5. (limit 1 and limit 2)

Note: This PIM is intended to acquire plant signals. Limit values related to these measured values are set as parameters in the ECU.

Structure

A type 2 Peripheral Interface Module (4 slots) is used. The slots are assigned as follows:

Slot	Printed circuit board
1	MPU 23 with CCB 1 (option)
2	IIB 1
3	AIB 1
4	BOB 1

Technical data

The technical data of PIM A 511 described in chap. 1.3.2.4.1 applies to all PIMs.

1.3.2.4.8 Display DIS

Use

The display is a decentralized information and monitoring device. It is used to indicate engine operating states, alarms and system information.

Displayed data (measured values, alarms etc.) are transmitted to the display from the Monitoring and Control System (MCS-5) via the field bus.

The display panel is designed for flush-mounting.

The monochrome LCD has a screen diagonal of 5.7” and is based on STN technology with a resolution of 320 x 240 pixels. Integral background illumination facilitates reading even in poor ambient light conditions. Brightness and contrast are adjustable and regulated by temperature. Navigation on the various levels and pages is realized by means of 5 function keys.

Structure

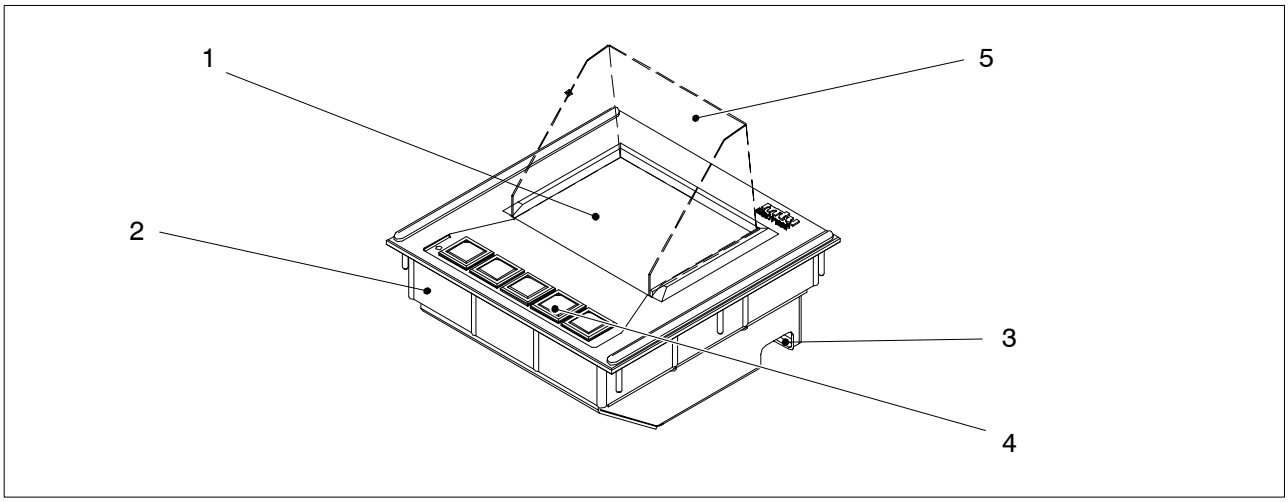


Fig. 16 : Monitoring and Control System display for enclosed control consoles

Pos.	Name	Meaning
16/1	Window	LCD display field
16/2	Housing cover	To protect the electronics
16/3	Aperture	To allow cable entry
16/4	F1 ... F5	Function keys for user interface operation
16/5	Shade	Shade attached with Velcro for use when exposed to direct sunlight, can be removed

Technical data

Type	DIS 7-01
Dimensions *(W* x *H* x *D)*	220 mm x 224 mm x 98 mm
Weight	1.9 kg
Operating voltage U_o	24 VDC
Tolerance	–50 %, –30 %
Residual ripple	In accordance with STANAG 1008, IEC 68, MIL-STD 704
Power consumption	15 W at 24 V
Storage temperature	–20 °C … +70 °C
Operational ambient temperature	0 °C … +55 °C
Relative humidity	0 % … 97 %, non-condensing
Degree of protection as per DIN 40 050	
Front	IP 65
Rear	IP 10
Shock	15 *g*, duration 11 ms (semi-sinusoidal shock)
Vibrostability	
Frequency 2 Hz ... 12.8 Hz	x_{pp} = ±1.5 mm
Frequency 12.8 Hz ... 100 Hz	*a* = ±1 *g*
EMC	IEC 801, degree of severity 3 VDE 0875, group 3

1.3.2.4.9 Display instruments

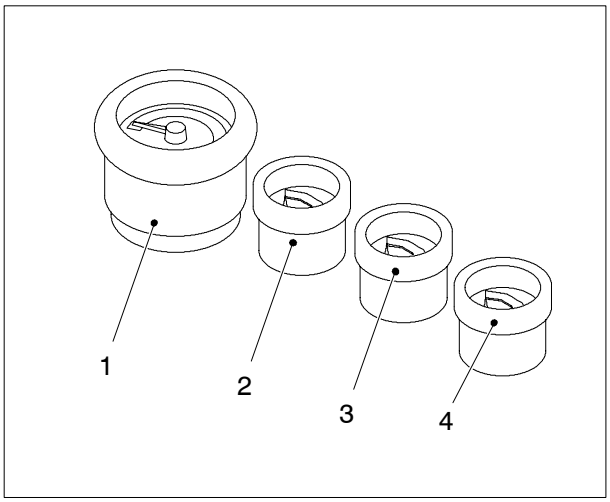


Fig. 17 : Display instruments

Use

Three different types of instrument are used to display the following engine operating data:

- Engine speed (17/1)
- Engine oil pressure (17/2)
- Engine coolant temperature (17/3)
- Coolant temperature (17/4)

Structure

VDO pointer-type instruments are used. These have white digits on a black background and feature background illumination (red backlighting). The speed instrument comes from the ∅ 85 mm series, the other three from the ∅ 52 mm series.

Technical data

Dimensions *(∅ x D)*	Speed instrument: 105 mm x 71 mm Pressure and temperature instruments: 62 mm x 60 mm
Illumination operating voltage	24 VDC, –25 %/+30 %
Measuring mechanism power consumption	4 mA … 20 mA (pressure and temperature)
Speed instrument	Input 0 … 10 V
Operating temperature range	–20 °C … +70 °C
Storage temperature range	–30 °C … +85 °C
Installation position	0° ... 90° as desired, preferably horizontal
Relative humidity	5 % … 98 % at 55 °C, condensation admissible
Degree of protection	Front IP 65 DIN 40 050
Colour	Black

1.3.3 Data connections

The devices of the overall MDEC system for stationary generator engines are equipped with a CAN bus to transmit data between the various sub-systems. This bus is redundant (i.e. two are provided).

The CAN bus is a standard automation technology field bus allowing various systems and devices to communicate providing they are equipped with a CAN bus interface.

The tasks of the CAN bus are:

- Receiving plant signals (set speed value) and commands from the superordinate generator system
- Output of all measured values/limit values for Monitoring and Control System MCS-5
- Alarm output for signalling and evaluation in Monitoring and Control System MCS-5
- Output of signals relevant to engine control

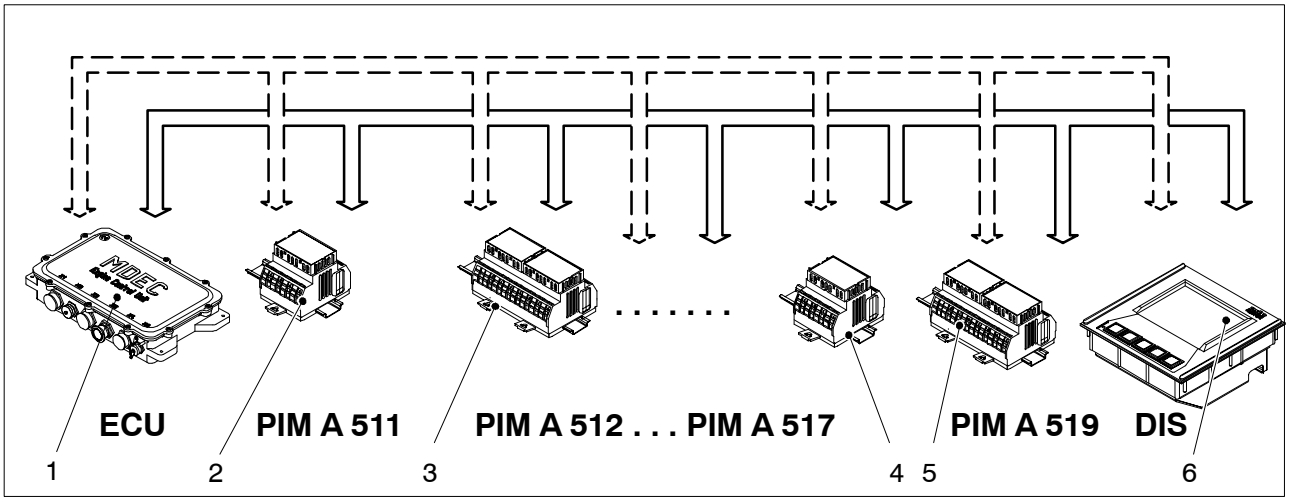


Fig. 18 : Data connections of devices in the overall MDEC system for stationary generator engines

Pos.	Name	Meaning
18/1	ECU	Engine Control Unit
18/2	PIM A 511	Fault code display
18/3	PIM A 512 to PIM A 517	Signal output
18/4		
18/5	PIM A 519	Signal input and output
18/6	DIS	Display

1.3.4 Power supply

The $+U_b$ power supply for all the devices in the overall MDEC system for stationary generator engines is supplied directly to the appropriate device terminals and the ECU connector.

1.3.5 Earthing

Both the engine and the alternator are connected to earth (PE) via an equipotential bonding strip on the skid.

The ground of the power supply and all electronic devices (–) is *not* connected to earth (PE). The entire electronic system is electrically isolated from the earth. This also applies to the sensors. All sensor signal lines and/or supply lines are *not* connected to the housing of the individual sensors. This means that no electrical connection is established between the engine/alternator and the battery negative terminal.

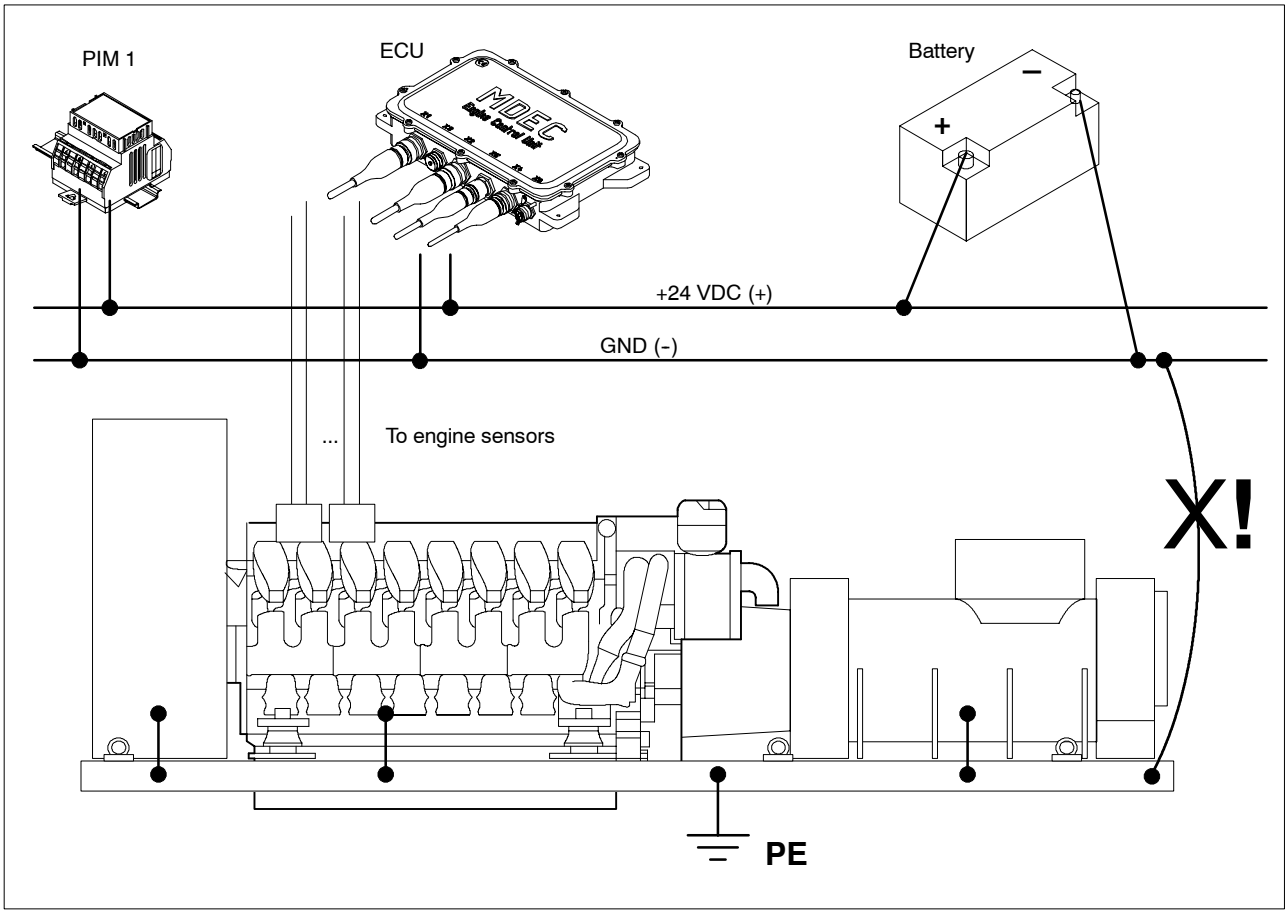


Fig. 19 : Earthing concept

Note: The connection marked by a cross in fig. 19 must not be established under any circumstances.

A considerably better signal-to-noise ratio is achieved by electrically isolating the mechanical and electronic components. This good signal-to-noise ratio on all electrical lines is necessary to ensure trouble-free transmission of all data on the CAN bus and also all the analog/binary sensor signals.

1.3.6 Technical data

Operating voltage	24 VDC, –25 %/+30 % Residual ripple less than 5 %
Power consumption	Depending on system design (number and type of options used), refer to the descriptions of the various devices, the total power consumption is the sum of the power consumed by the individual devices
EMI/EMC	IEC 801/EN 50081-2/EN 50082-2
Isolation resistance	IEC 92-504 (>10 MΩ/50 VDC) Assemblies incorporating electronic components shall be removed for the duration of the test.

1.4 Functions

1.4.1 Operating functions on display DIS (option)

Engine management system MDEC for stationary generator engines is operated via the display in Monitoring and Control System MCS-5.

Note: Display DIS only shows information about the operating state of the engine and the overall MDEC engine management system. The luminous pushbuttons on the display are only used to operate the man-machine interface.

Whether other operating functions (engine start and stop etc.) can be directly activated at the MDEC engine management system depends on the configuration of the system.

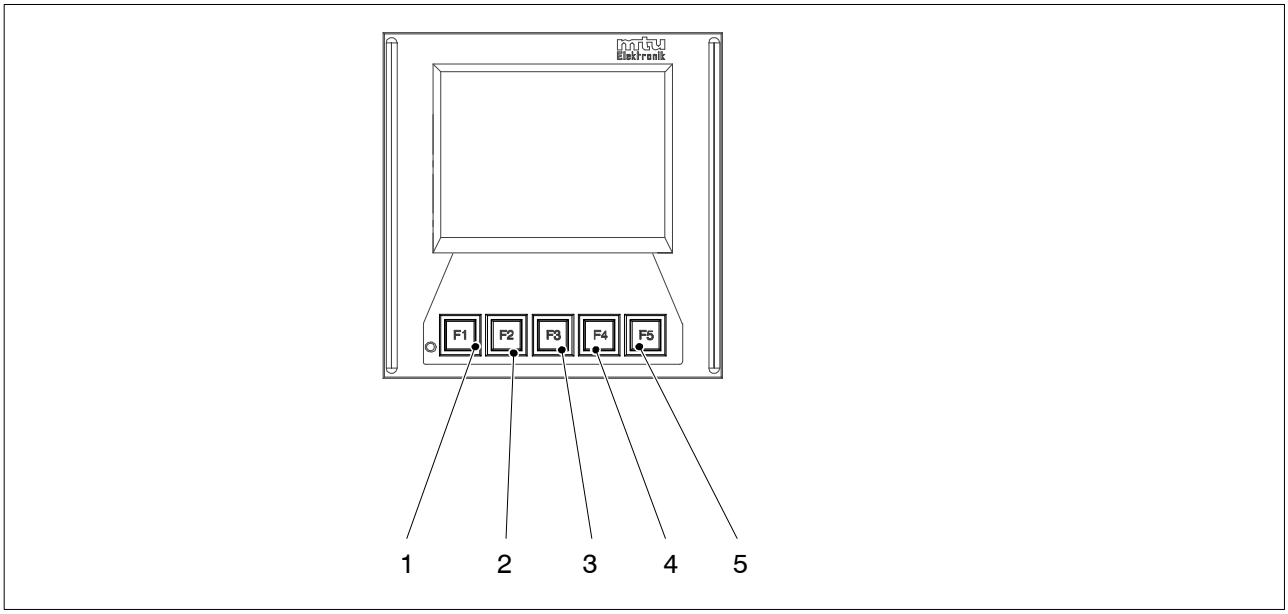


Fig. 20 : Controls for Monitoring and Control System MCS-5

Pos.	Function name	Meaning
20/1	Function key F1	Function keys F1 to F5 to operate the man-machine interface and for alarm acknowledgement and dimming; the functions activated by the various luminous pushbuttons vary and are indicated graphically on the display.
20/2	Function key F2	
20/3	Function key F3	
20/4	Function key F4	
20/5	Function key F5	

1.4.2 Display functions

1.4.2.1 Display functions of fault code display FCB in PIM A 511

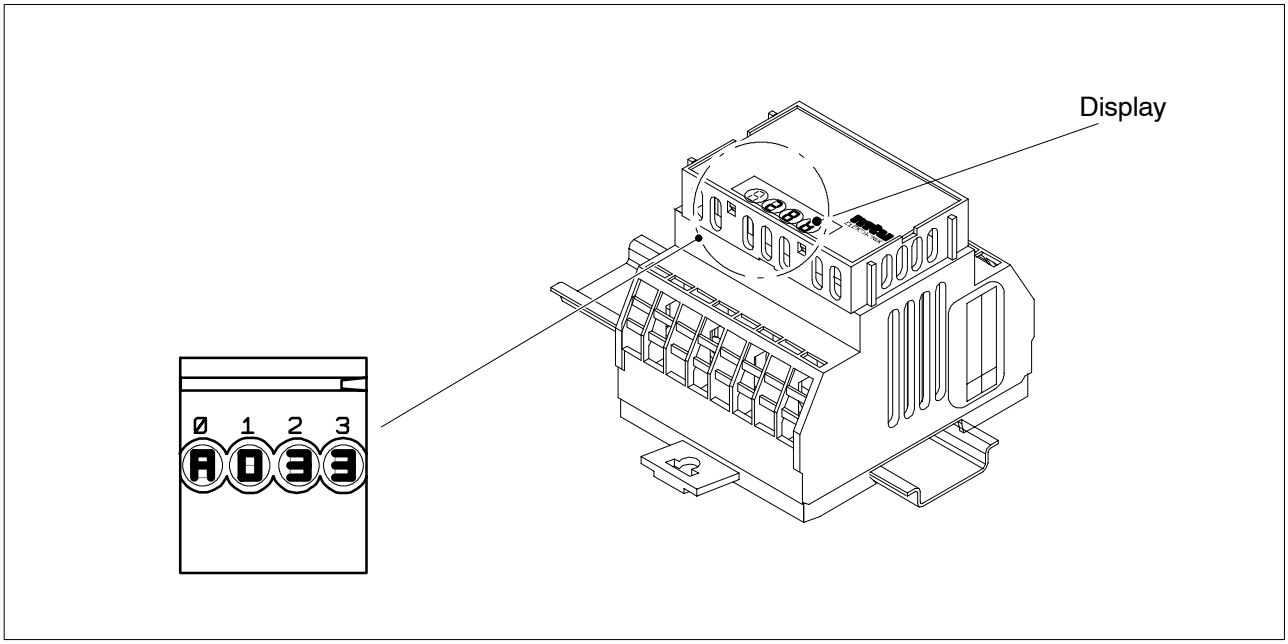


Fig. 21 : Display on printed circuit board FCB in Peripheral Interface Module PIM A 511

The fault codes generated by the ECU are shown on the display in PIM A 511 (see fig. 21).

The four digits indicating faults related to the ECU concerned have the following meaning:

- The first digit indicates that a fault has occurred
  (in the example in fig. 21: **A**).
  The meaning of the letters is as follows:
  - **A** The fault is new.
  - **B** The fault is no longer new, it occurred within the last operating hour.
  - **C** The fault occurred between one and four operating hours ago.
  - **D** The fault occurred between four and twelve operating hours ago.
- The second to fourth digits on the display indicate the three-figure fault code
  (see table in part 3 of this manual, example in fig. 21: **033**).

Note: Faults which occurred more than twelve hours ago are deleted automatically.

1.4.2.2 Display functions of display DIS (option)

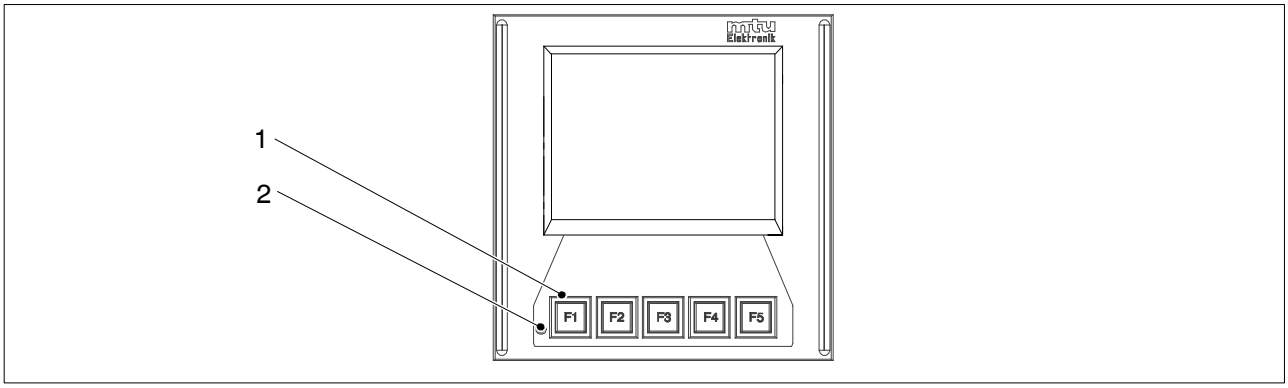


Fig. 22 : Display DIS

Detailed information about the drive is shown on the display (22/1) of Monitoring and Control System MCS-5. The display is menu-guided and can be controlled using the pushbuttons underneath the screen.

Menu structure is illustrated in chap. 1.4.2.3, fig. 23 on page 29.

A green LED (22/2) to the left of the function keys indicates the following operating states:

LED state	**Meaning**
Dark	No operating voltage.
Lit	Normal operation, project data loaded, no fault.
Flashes slowly (at approx. 2 Hz)	Field bus communication faulty or disrupted (CAN timeout), both CAN buses have failed. The display panel has no project data.
Flashes rapidly (at approx. 8 Hz)	Watchdog active. System in hardware reset state.

1.4.2.3 Display functions on the man-machine interface of the display (option)

The following menu structure is used on the DIS:

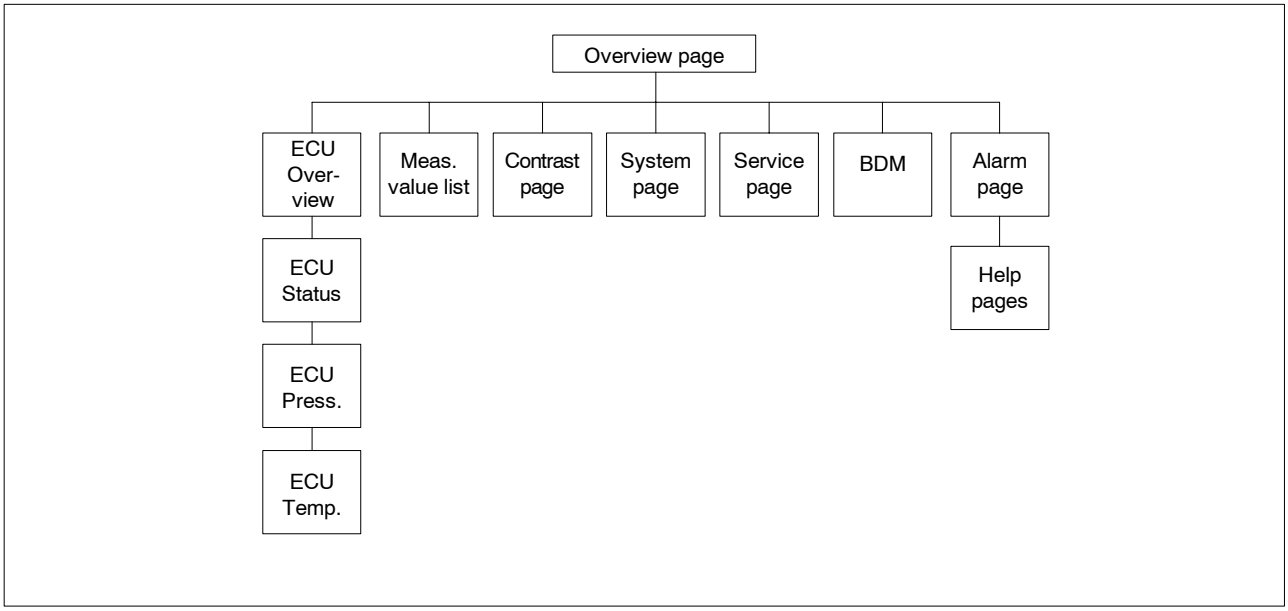


Fig. 23 : Menu structure

Screen page	Meaning	Type
Overview page	Overview of available screen pages	Overview page
ECU Overview	Graphic representation of measured values	Graphic page
ECU Status	Graphic representation of measured values	Graphic page
ECU Press.	Graphic representation of measured values	Graphic page
ECU Temp.	Graphic representation of measured values	Graphic page
Meas. value list	Displays measured values as text	Measured value list
Contrast page	For brightness and contrast adjustment	Contrast page
System page	System information	System page
Service page		Service page
BDM	Backup Data Module page, download	Text page
Alarm page	Display and state of alarms	Alarm page
Help pages	Online help	Help pages

1.4.2.3.1 General screen page structure

The screen pages are divided into the following areas:

- Status bar
- Central display area
- Key assignment display

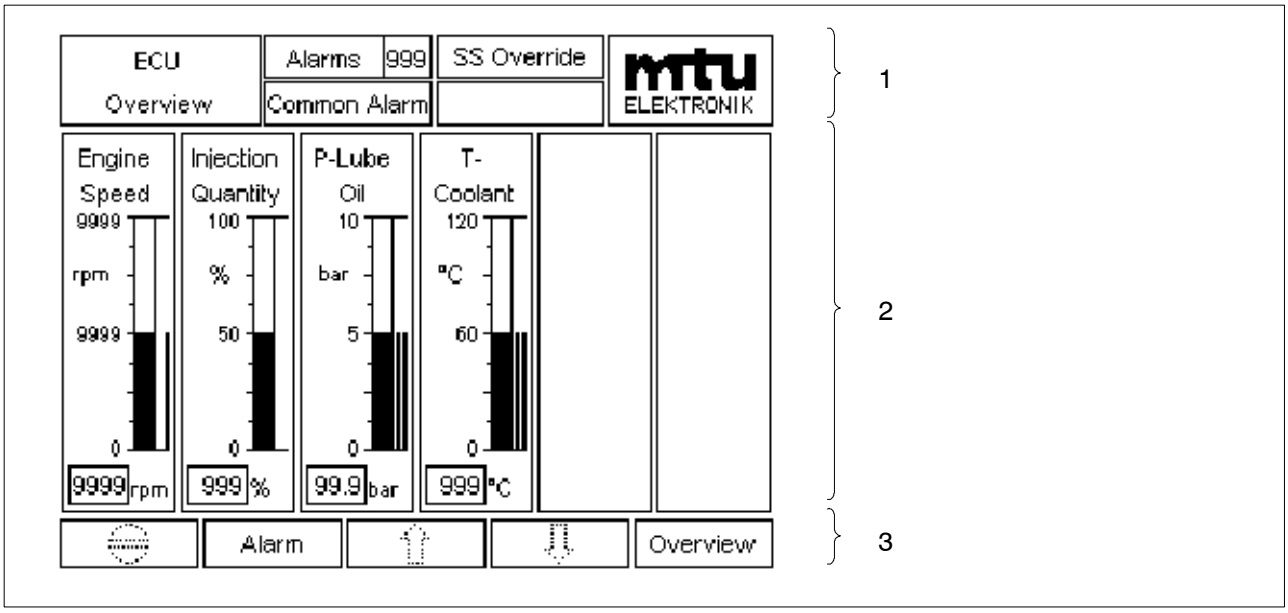


Fig. 24 : General screen page structure (example)

Pos.	Name	Meaning
24/1	Status bar	Display status information, e.g. number of alarms waiting to be processed
24/2	Central display area	Display of measured values, messages etc.
24/3	Function key assignment	Indicates function key assignment on the selected screen page

Status bar

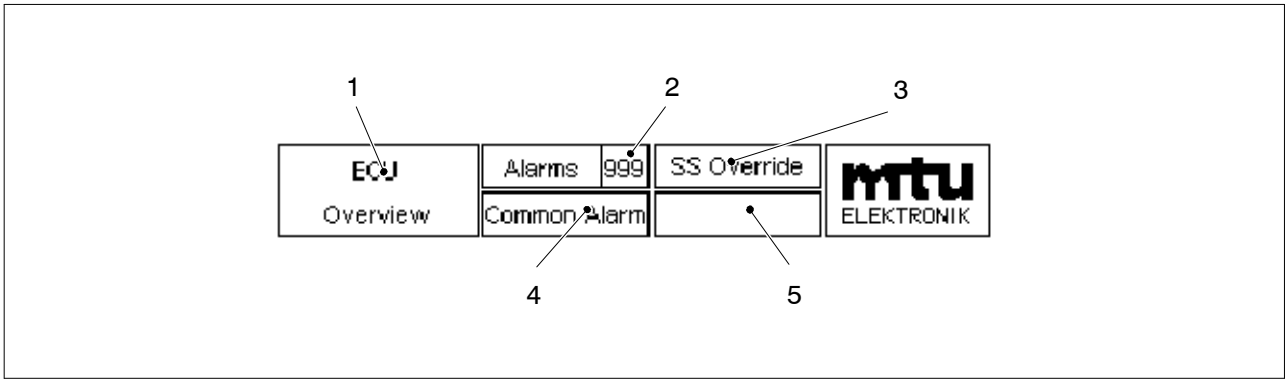


Fig. 25 : Status bar structure (example)

Pos.	Name	Meaning
25/1	Page designation	Name of the selected screen page
25/2	No. of alarms display field	Number of alarms waiting to be processed
25/3	Safety system override display field	A message is displayed when safety system override is active (safety features disabled), otherwise this field remains blank.
25/4	Common alarm display field	A message is displayed if a common alarm is received, otherwise this field remains blank.
25/5	System status display field	A message is displayed if a system status is received, otherwise the field remains blank. The following messages are displayed: • Initialization • Bus error • Bootup (connection) • Download (project data loading)

Central display area

The central display area is used to display the following pages:

- Overview page
- Graphic pages
  - Measured values in graphic representation
- Measured value list
  - Measured values in alphanumeric representation
- Alarm page
  - Alarm messages in alphanumeric representation
- Help pages
  - Alarm message structure
- Contrast page
  - LCD display adjustment
- Service page
  - Display and modification of system settings
- System page
  - System status and software version in alphanumeric representation
- Parameter page
- Status page

Function key assignment

Local Operating Station LOS is equipped with 5 function keys (F1 to F5) for navigation and alarm acknowledgement. The function keys are assigned various functions depending on the page selected on-screen.

1.4.2.3.2 Overview page structure

The pages which are available for selection in a menu are shown in the central display area at the Overview page.

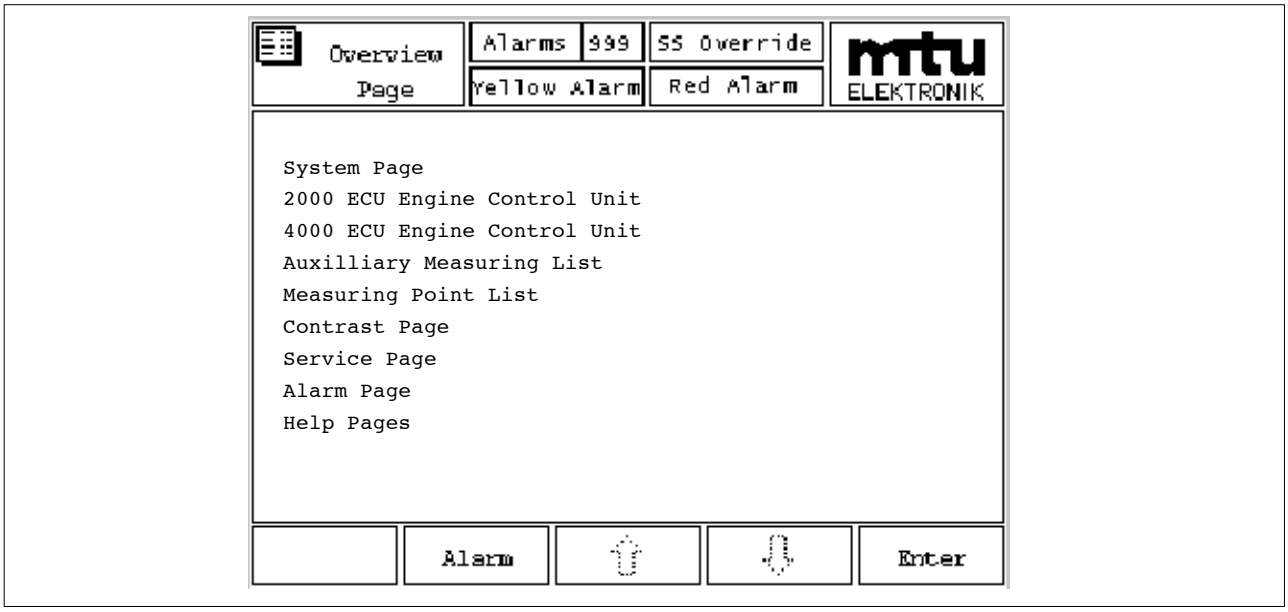


Fig. 26 : Overview page structure (example)

1.4.2.3.3 System page stucture

The central display area of the System page is used to display system status and software version.

The System page opens automatically when a system error occurs.

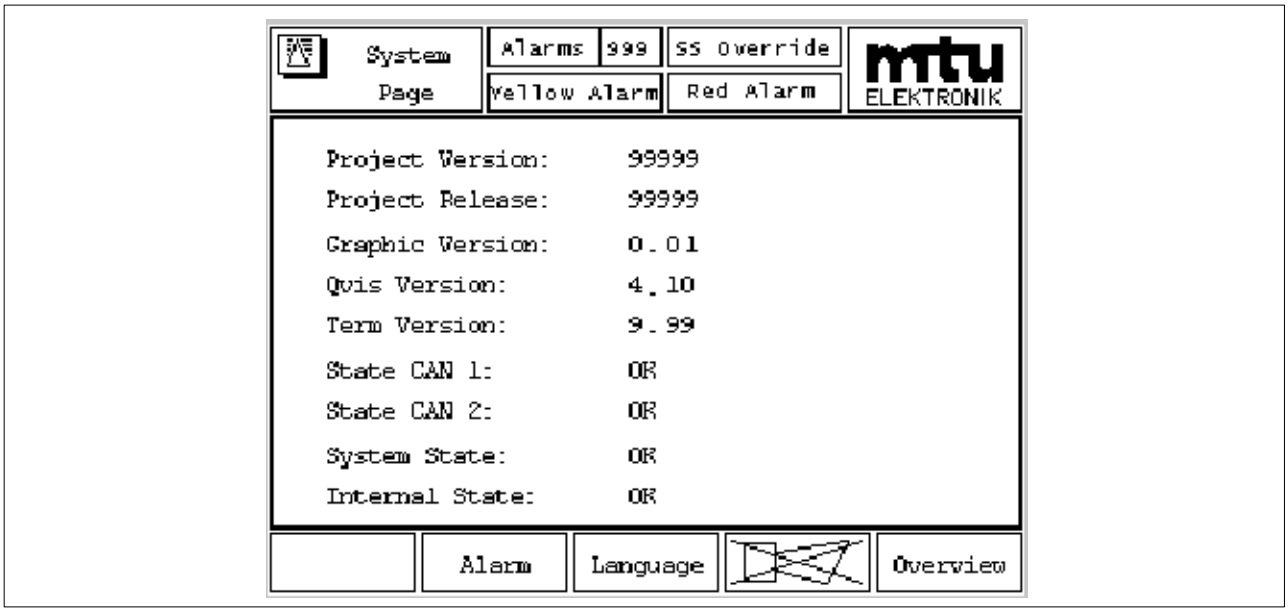


Fig. 27 : System page structure (example)

System variable	Display/input
Project Version:	Project version internal counter
Project Release:	Project release internal counter
Graphic Version:	Version number of the order-dependent application software developed with QVis
Qvis Version:	QVis version number used to develop the application software
Term Version:	Version number of the function software
State CAN 1:	Default CAN bus status
State CAN 2:	Redundant CAN bus status (option)
System State:	Entire system status
Internal State:	Display DIS status

1.4.2.3.4 Graphic page structure

The current operating values of a plant such as engine speed, injection quantity, lube oil pressure and coolant temperature are shown on the ECU overview in the Graphic page display field.

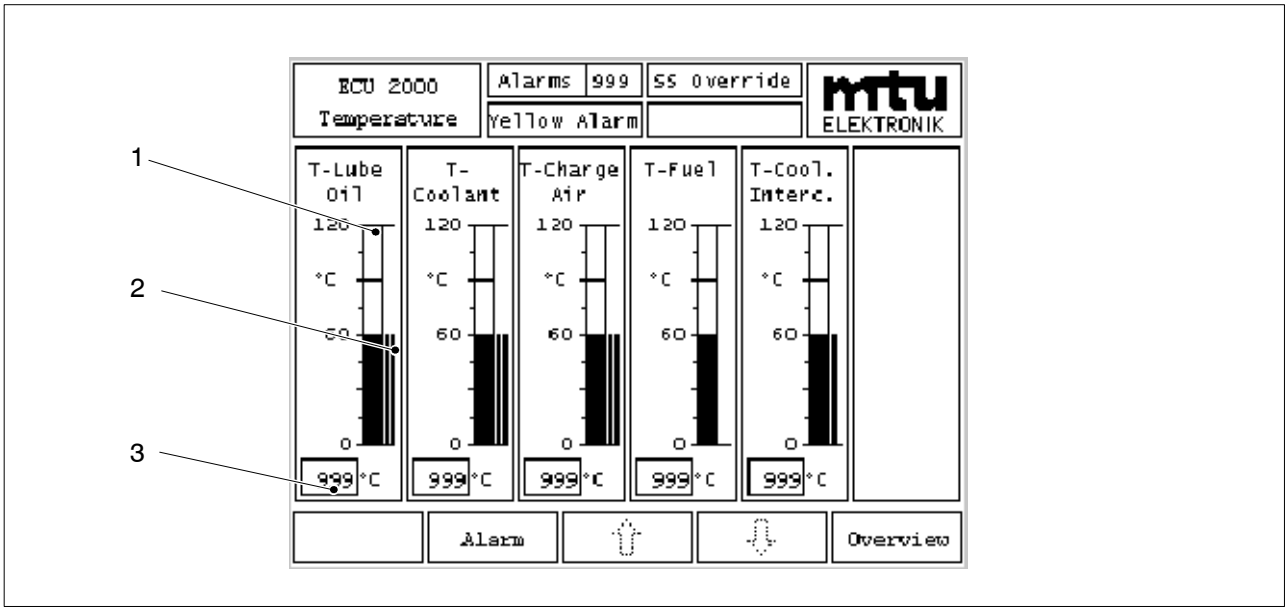


Fig. 28 : Graphic page structure

Pos.	Name	Meaning
28/1	Measured value bargraph	Bar size increases proportionally to the increase in the measured value
28/2	Limit value bargraph	Bar size increases proportionally to the increase in limit value
28/3	Numerical display field	Measured value is represented numerically

If a measured value is not within a valid range, one of the following messages is displayed in place of the numerical measured value:

- SD Sensor Defect
- MD Missing Data
- ## Measured value out of display range

Bargraphs are no longer displayed in such cases.

1.4.2.3.5 Measuring point list structure

Project-related measured values are represented alphanumerically in the display field of the measuring point list, these are not shown on the graphic pages.

Invalid measured values are identified as follows:

- SD Sensor Defect
- MD Missing Data
- ## Measured value out of display range

This state is indicated on the Alarm page.

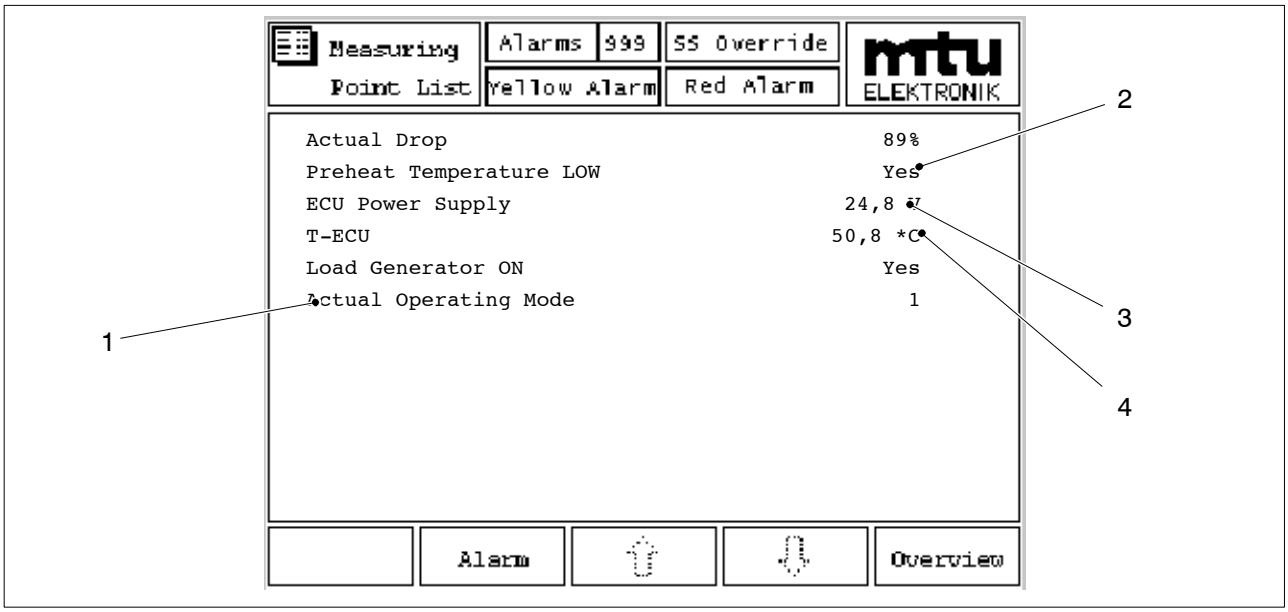


Fig. 29 : Measuring point list structure (example)

Pos.	Name	Meaning
29/1	Designation	Designation of the measured value
29/2	Binary value	Indicates the state of a binary value, e.g. “YES” or “NO”
29/3	Analog value	Indicates an analog measured value, e.g. 24.8 Volt
29/4	Unit	Unit of the displayed value, e.g. °C.

1.4.2.3.6 Contrast page structure

Bargraphs for brightness and contrast are shown in the central display area of the Contrast page together with the information that simultaneously pressing function keys F1 and F5 (within 3 seconds) resets the LC display to the default factory settings.

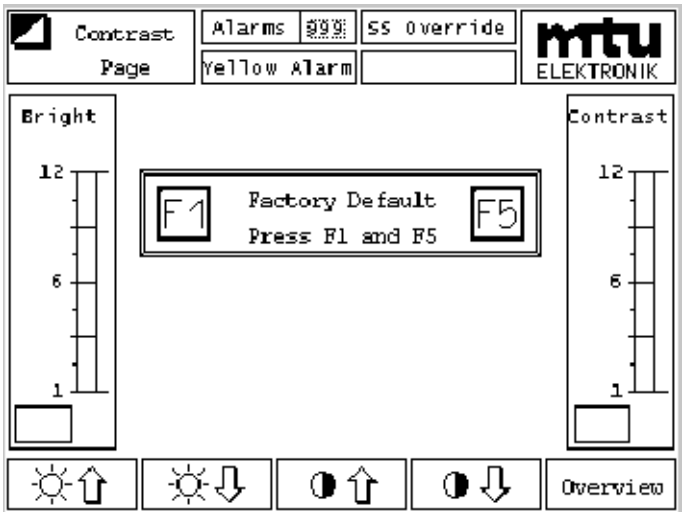


Fig. 30 : Contrast page structure (example)

The brightness of the keypad to the right of the display is also adjusted by pressing the two function keys F1 and F2. It is possible to offset display brightness and function key brightness on the Service page.

1.4.2.3.7 Service page structure

The central display area of the Service page is used to display (display mode) and modify system settings (edit mode).

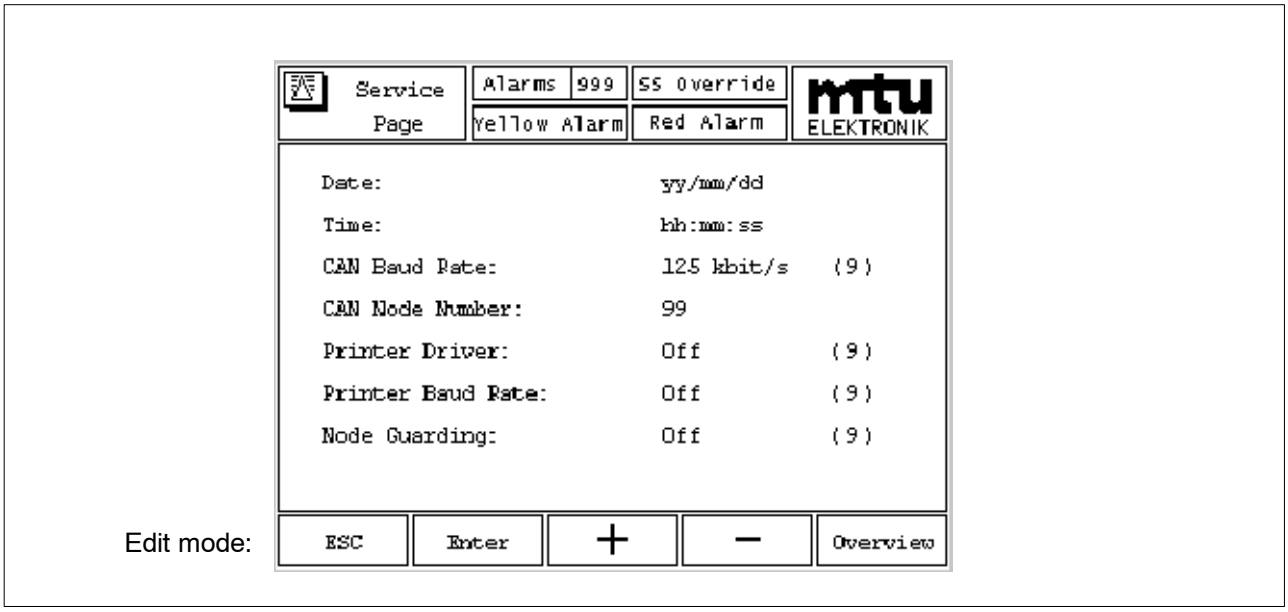


Fig. 31 : Service page structure (example)

System variables	Display/settings
Date:	Current date
Time:	Current time
CAN Baud Rate:	125 kbit/s (default) 250 kbit/s
CAN Node Number:	1 … 31
Printer Driver:	On / Off = Activate/deactive printer function
Printer Baud Rate:	Set transmission speed of the printer interface
Node Guarding:	Off = Node monitoring inactive Active = Node monitoring active

1.4.2.3.8 Alarm page structure

The alarms are displayed in the order of their occurrance in the central display area of the Alarm page.

Alarm names appear in the first column, alarm status in the second column (UNACK for unacknowledged, ACK for acknowledged) and the type of alarm in the third column (yellow, red).

New alarms are displayed at the bottom of the alarm list with status UNACK (unacknowledged). Entries flash in this state. When the alarm has been acknowledged, alarm status changes to ACK (acknowledged). The flashing entry is now displayed steadily. Alarms remain in the list as long as they apply.

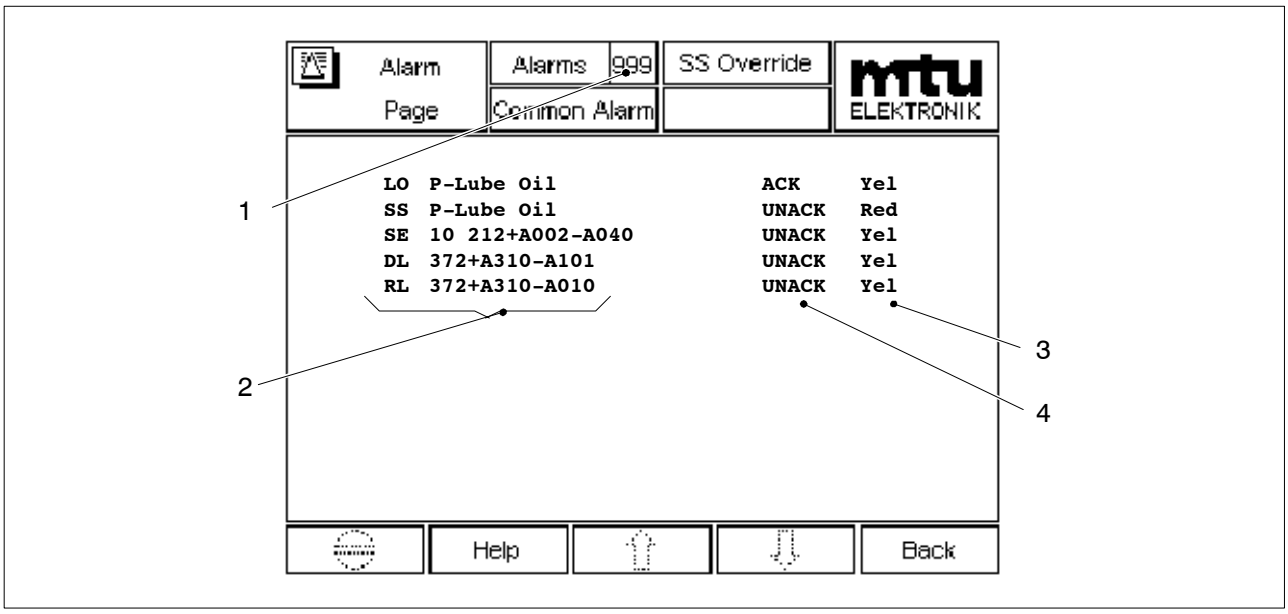


Fig. 32 : Alarm page structure (example)

Pos.	Name	Meaning
32/1	Number	Indicates the total number of alarms waiting to be processed.
32/2	Designation	Alarm designation
32/3	Alarm type	Type of alarm, e.g. “Yel” for Yellow (prewarning, 1st limit value violated).
32/4	Alarm status	Alarm status, e.g. “ACK” for Acknowledge

The following standard abbreviations are used to name alarms:

Column number on Alarm page	Entry	Meaning
1	AL …	“Alarm”, warning or alarm caused by a binary signal
	LO …	“Low”, warning or alarm due to low limit value violation
	HI …	“High”, warning or alarm due to high limit value violation
	TD …	“Transmitter Deviation”, warning or alarm due to excessive deviation between the analog values of two redundant sensors
	SD …	“Sensor Defective”, warning or alarm due to sensor failure
	SF …	“Switch Fault”, warning or alarm due to inadmissible combination of states of two complementary switches
	SS …	“Security Shutdown”, alarm which leads to emergency engine shutdown
	MG …	“Message”, message from an external system (e.g. engine management system)
	SE …	“System Error”, warning due to a system error
	DL …	“Default Lost”, warning due to node failure on the default field bus
	RL …	“Redundancy Lost”, warning due to node failure on the redundant field bus
	PB …	“Push Button”, status display due to activation of certain control pushbuttons

Column number on Alarm page	Entry	Meaning
2	UNACK	“Unacknowledged Alarm”, warning, alarm or message from an external system is active and unacknowledged
	UNACK_ALM (printout only)	“Unacknowledged Alarm”, warning, alarm or message from an external system is active and unacknowledged
	UNACK_RTN (printout only)	“Unacknowledged Return”, warning, alarm or message from an external system was cancelled without acknowledgement
	ACK	“Acknowledged Alarm”, warning, alarm or message from an external system is active and acknowledged
	ACK_ALM (printout only)	“Acknowledged Alarm”, warning, alarm or message from an external system is active and acknowledged
	ACK_RTN (printout only)	“Acknowledged Return”, warning or alarm disappeared after acknowledgement
3	Yel	“Yellow”, warning from MCS-5 or a message from an external system (e.g. engine management system)
	Red	“Red”, Alarm from MCS-5

1.4.2.3.9 Help page structure

Alarm message structure is explained in the central display area of the Help pages.

System error numbers and the associated system error designations are listed on Help page 1.

The abbreviations and associated descriptions of the various types of message are listed on Help page 2 to 4.

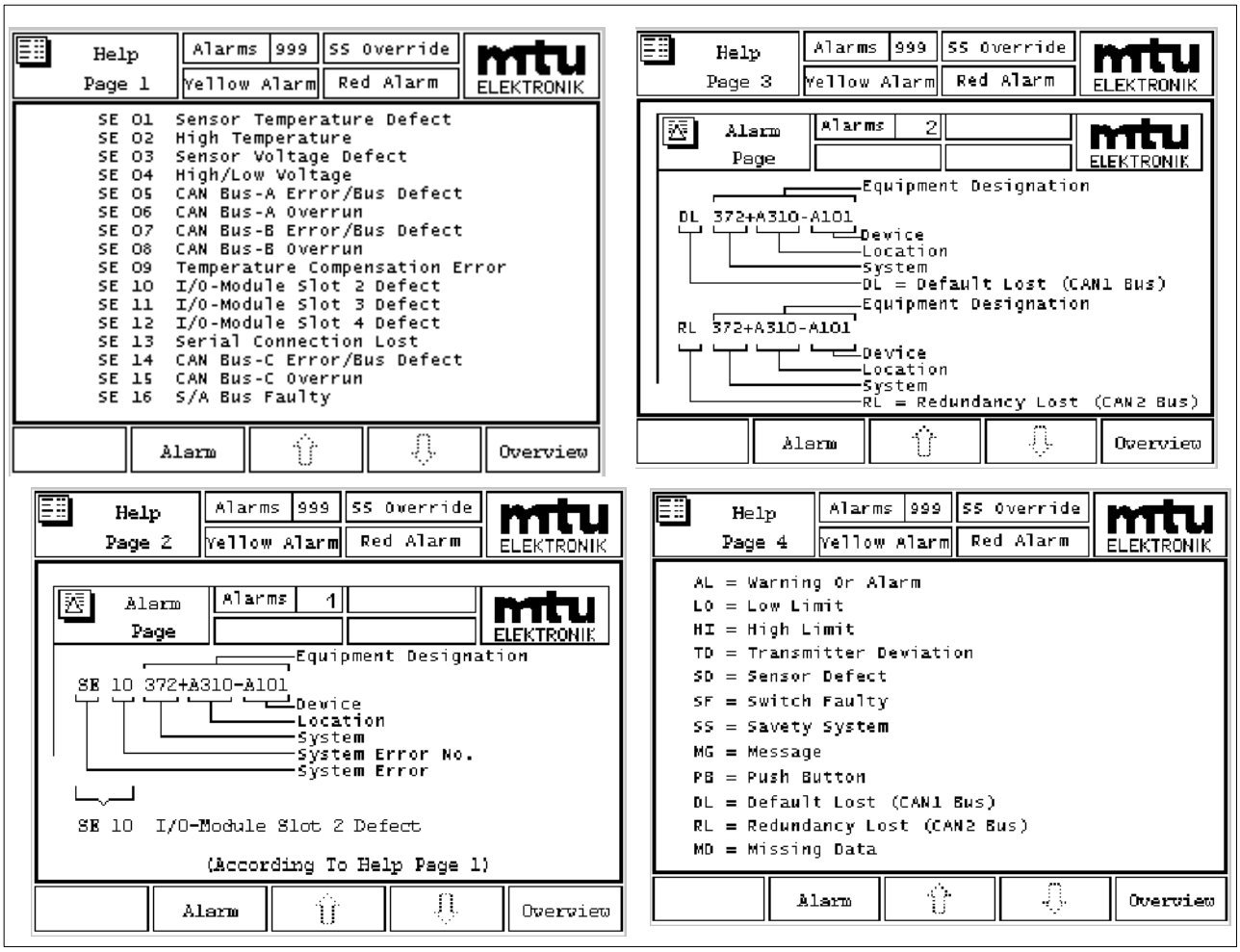


Fig. 33 : Help pages structure (example)

1.4.2.4 Display functions of the display instruments (option)

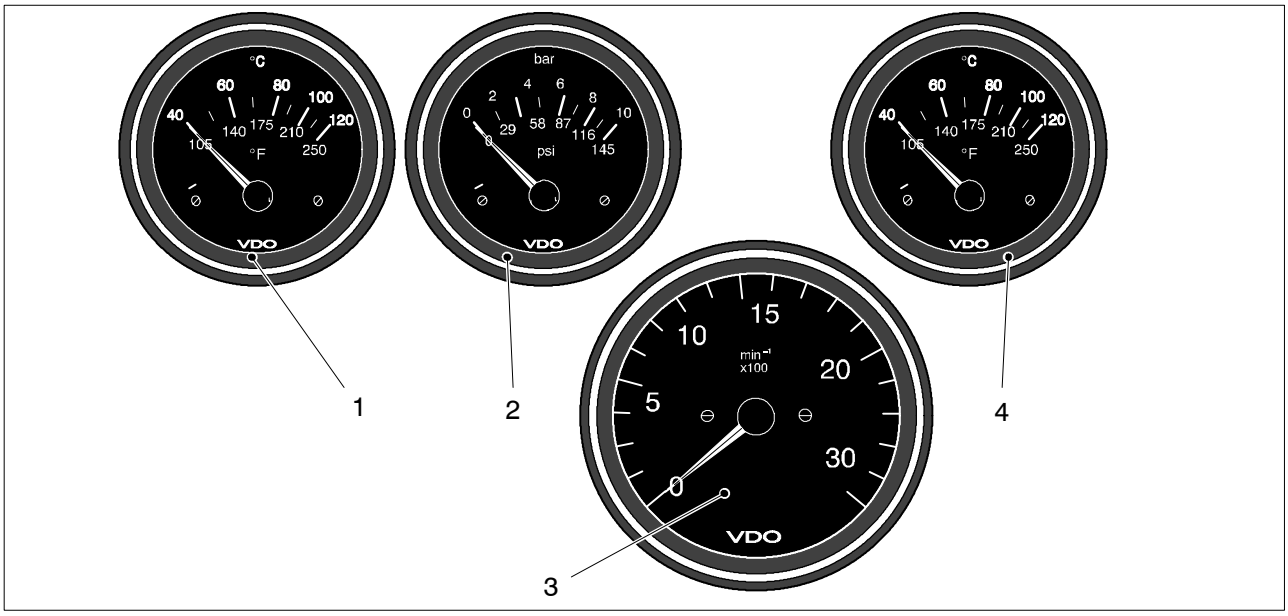


Fig. 34 : Monitoring and Control System MCS-5 display instruments (example)

Pos.	Function name	Meaning
34/1	Coolant temperature	Coolant temperature display
34/2	Lube oil pressure	Engine lube oil pressure display
34/3	Engine speed	Engine speed and operating hours display
34/4	Lube oil temperature	Lube oil temperature display

1.4.3 Acquisition functions

1.4.3.1 Plant signals

1.4.3.1.1 Signals to Engine Control Unit ECU

The following plant signals are acquired by the ECU of the MDEC engine management system for stationary generator engines:

Signal	ECU channel
Engine stop	BE 1
Switchover 50 Hz/60 Hz	BE 2
Alarm reset	BE 3
Speed droop switchover/set speed demand switchover	BE 4
Speed up	BE 5
Speed down	BE 6
Overspeed test	BE 7
Override	BE 8
Engine stop	BE 9
Set speed (analog) 0 V ... 10 V/4 mA ... 20 mA	IUE 1
Load pulse (analog) 0 mA ... 20 mA	IUE 2

1.4.3.1.2 Signals at PIM A 519

The following plant signals are acquired by Peripheral Interface Module PIM A 519 (option):

Signal	PIM channel
Input 1, plant switching signal, free assignment	BE1 slot 2
Input 2, plant switching signal, free assignment	BE2 slot 2
Input 3, plant switching signal, free assignment	BE3 slot 2
Input 4, plant switching signal, free assignment	BE4 slot 2
Output 1, pressure display instrument, free assignment	INST 1 slot 2
Output 2, pressure display instrument, free assignment	INST 2 slot 2
Output 1, temperature display instrument, free assignment	INST 3 slot 2

Signal	PIM channel
Output 2, temperature display instrument, free assignment	INST 4 slot 2
Input 1, plant pressure sensor, free assignment	4 ... 20 mA chan. 1 slot 3
Input 2, plant pressure sensor, free assignment	4 ... 20 mA chan. 2 slot 3
Input 1, plant temperature sensor, free assignment	Pt100 chan. 1 slot 3
Input 2, plant temperature sensor, free assignment	Pt100 chan. 2 slot 3
Alarm from input 1, plant switching signal	BIN OUT 1 slot 4
Alarm from input 2, plant switching signal	BIN OUT 2 slot 4
Alarm from input 3, plant switching signal	BIN OUT 3 slot 4
Alarm from input 4, plant switching signal	BIN OUT 4 slot 4
First limit value at input 1 plant pressure sensor violated	BIN OUT 5 slot 4
Second limit value at input 1 plant pressure sensor violated	BIN OUT 6 slot 4
First limit value at input 2 plant pressure sensor violated	BIN OUT 7 slot 4
Second limit value at input 2 plant pressure sensor violated	BIN OUT 8 slot 4
First limit value at input 1 plant temperature sensor violated	BIN OUT 9 slot 4
Second limit value at input 1 plant temperature sensor violated	BIN OUT 10 slot 4
First limit value at input 2 plant temperature sensor violated	BIN OUT 11 slot 4
Second limit value at input 2 plant temperature sensor violated	BIN OUT 12 slot 4

1.4.3.2 Engine signals

1.4.3.2.1 Sensors

The following engine signals are acquired by the ECU of the MDEC engine management system for stationary generator engines:

Sensor	Signal	BR 2000	BR 4000
B1	Camshaft speed	✓	✓
B5	Lube oil pressure	✓	✓
B6	Coolant temperature	✓	✓
B7	Lube oil temperature	✓	✓
B9	Charge air temperature	✓	✓
B10	Charge air pressure	✓	✓
B13	Crankshaft speed	✓	✓
B26	Intercooler coolant temperature		✓
B34	Fuel pressure, low-pressure side		✓
F57	Intercooler coolant level		✓
B33	Fuel temperature, high-pressure side	✓	✓
B48	Fuel pressure, high-pressure side		✓
F33	Engine coolant level	✓	✓

1.4.3.2.2 Sensors on the engine

	Engine coolant temperature	Charge air temperature	Coolant temperature LLK	Lube oil temperature	Low-pressure fuel	Lube oil pressure	Charge air pressure	Coolant level ILLK	Fuel temperature	High-pressure fuel	Engine coolant level	Crankshaft speed	Camshaft speed
BR2000	B6 to TE1	B9 to TE2	–	B7 to TE7	–	B5 to DE5	B10 to DE7	–	B33 to TE6	–	F33 to NSE 1	B13 to KW1	B1 to NW1
BR4000	B6 to TE1	B9 to TE2	B26 to TE6	B7 to TE7	B34 to DE3	B5 to DE5	B10 to DE7	F57 to NSE 2	B33 to TE3	B48 to DEH	F33 to NSE 1	B13 to KW1	B1 to NW1
Measured variable	Temperature	Temperature	Temperature	Temperature	Pressure	Pressure	Pressure	Level	Temperature	Pressure	Level	Speed	Speed
Sensors	Fig. 36	Fig. 36	Fig. 36	Fig. 36	Fig. 39	Fig. 37	Fig. 38	–	Fig. 36	Fig. 40	Fig. 41	Fig. 35	Fig. 35
Limit value 1 BR2000	97 °C	****	–	103 °C	–	5.5 bar*	–	–	–	–	–	**	**
Limit value 2 BR2000	102 °C	****	–	–	–	5.0 bar*	–	–	–	–	–	**	**
Limit value 1 BR4000	95 °C	67 °C	67 °C	95 °C	***	3.8 bar*	–	–	–	–	–	**	**
Limit value 2 BR4000	97 °C	70 °C	70 °C	–	***	3.3 bar*	–	–	–	–	–	**	**

Note: * Speed-dependent, see oil pressure monitoring curve 17.
** Limit values: BR2000 50 Hz: Limit value 2 at 1800 rpm
BR2000 60 Hz: Limit value 2 at 2100 rpm
BR4000 50 Hz: Limit value 2 at 1700 rpm
BR4000 60 Hz: Limit value 2 at 2000 rpm
*** Speed-dependent, see curve 15.
**** At 1500 rpm limit value 1 at 70°C;
**** Consumption optimized limit value 1 at 75°C, limit value 2 at 80°C

Speed sensors

Use	Type	Sensor range	Electr. signal	Number
Camshaft speed	Type 1	80 – 2800 rpm	0 – 80 V_{pp} AC	1
Crankshaft speed	Type 1	80 – 2800 rpm	0 – 80 V_{pp} AC	1

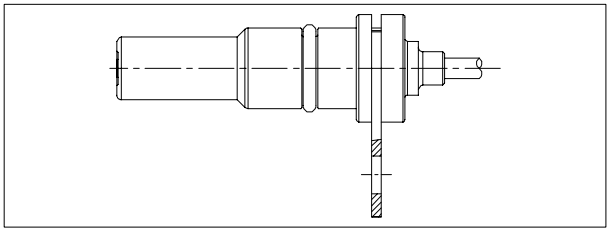


Fig. 35 : Structure of type 1

Temperature sensors

Use	Type	Sensor range	Electr. signal	Number
Coolant temperature	Type 1	–40 °C to +150 °C	Pt1000	1
Charge air temperature	Type 1	–40 °C to +150 °C	Pt1000	1
Lube oil temperature	Type 1	–40 °C to +150 °C	Pt1000	1
Fuel temperature	Type 1	–40 °C to +150 °C	Pt1000	1

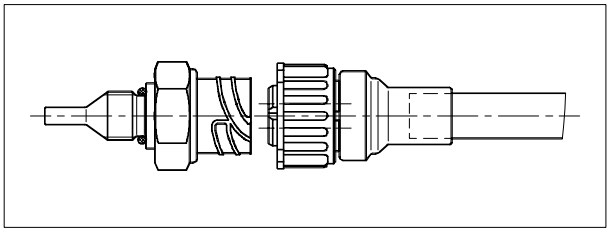


Fig. 36 : Type 1

Pressure sensors

Use	Type	Sensor range	Electr. signal	Number
Lube oil pressure	Type 1	0 – 10 bar relative	0.5 – 4.5 VDC	1
Charge air pressure	Type 2	0.5 – 4.5 bar absolute	0.5 – 4.5 VDC	1
Fuel pressure after filter	Type 4	0 – 15 bar relative	0.5 – 4.5 VDC	1
High pressure fuel	Type 6	0 – 1600 bar relative	0.5 – 4.5 VDC	1

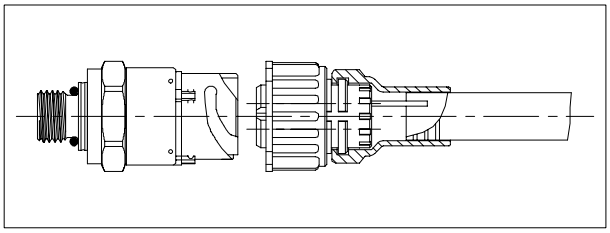


Fig. 37 : Type 1

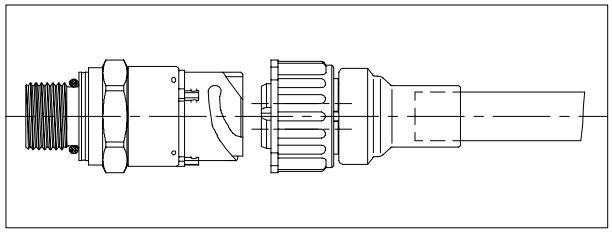


Fig. 38 : Type 2

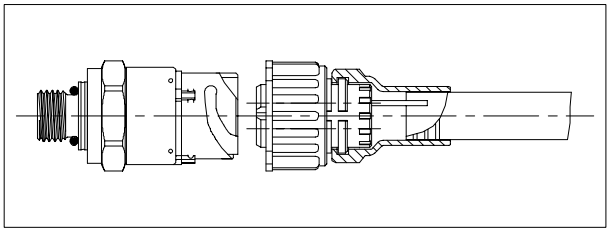


Fig. 39 : Type 4

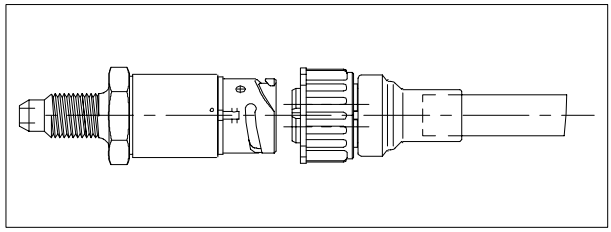


Fig. 40 : Type 6

Monitors

Use	Type	Sensor range	Electr. signal	Number
Coolant level	Type 3	–	Binary (/ GND)	1

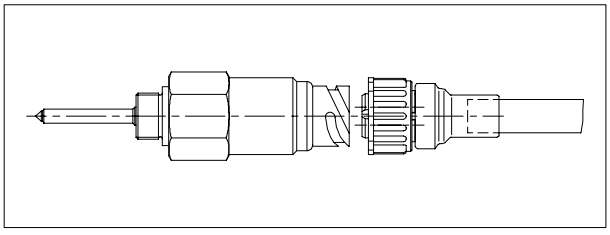


Fig. 41 : Type 3

1.4.4 Control functions

The MDEC engine management system for stationary generator engines is responsible for the following engine control functions:

- Start sequence control
- Stop control
- Emergency start control
- Controlling processes when the “Override” function is active
- Switching over the nominal speed between two preset values (e.g. to operate optionally as a 50 Hz or 60 Hz genset)
- Control of the injection quantity as a function of engine loading and speed

1.4.4.1 Engine start

1.4.4.1.1 Normal engine start

The start sequence is controlled by the software integrated in Engine Control Unit ECU.

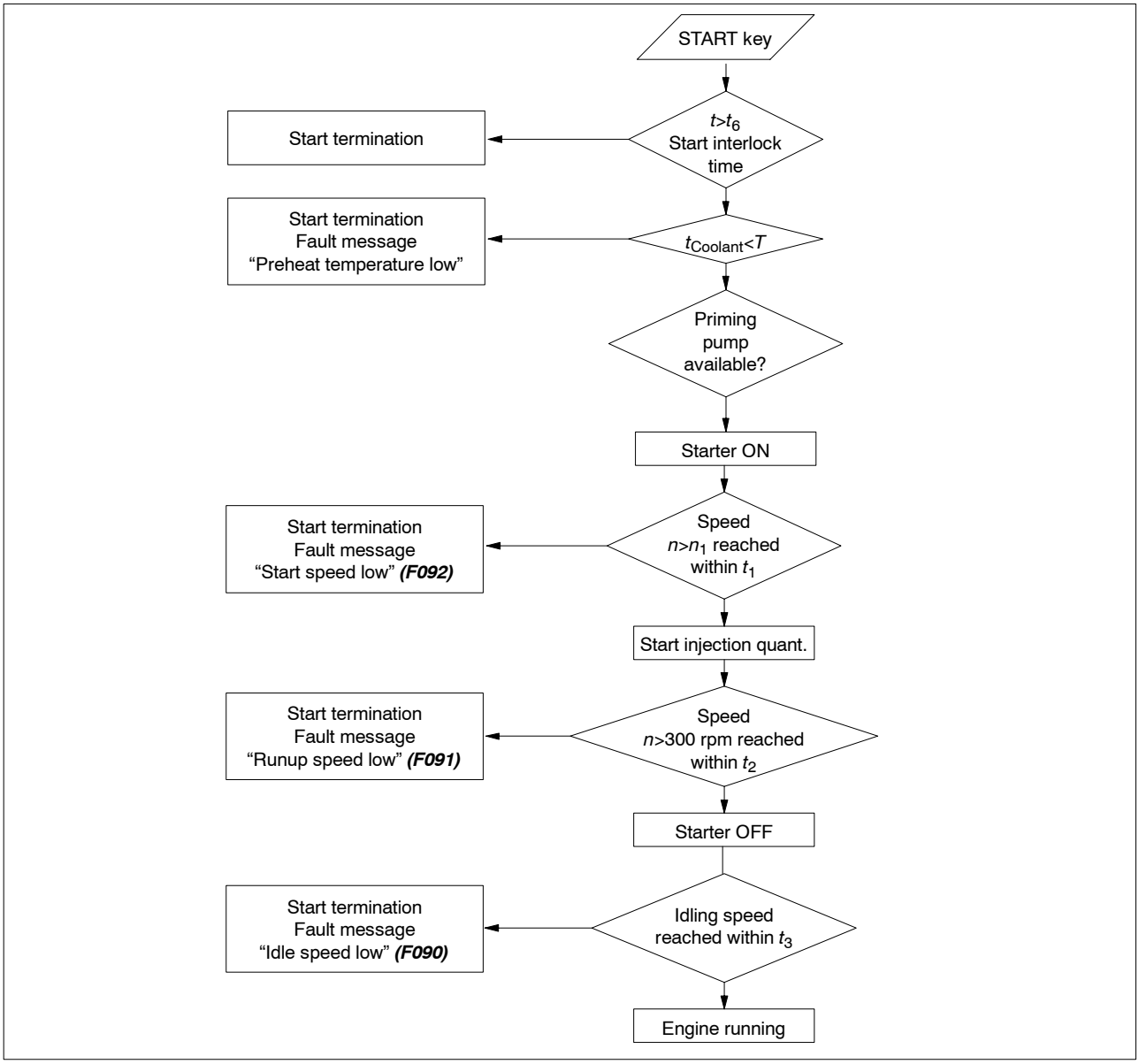


Fig. 42 : Start sequence flowchart

Engine Control Unit ECU commences injection as soon as the engine has crossed a defined speed threshold on the starter and no stop command is received from the plant.

Engine starting can be initiated by activating the appropriate input on Engine Control Unit ECU.

1.4.4.1.2 Engine restart

The term “Restart” is used for a repeated engine start request which is received when the engine is running down following a stop command. The response of the engine in this case depends on the speed at which it is running when the new start request is received:

- The engine immediately runs back up to nominal speed when n > 300 rpm.
- The engine is brought to a standstill when n < 300 rpm and the dwell time t_6 (see figs. 42 and 43) is then allowed to expire. An engine start as depicted in fig. 42 is then executed (after a new start request!).

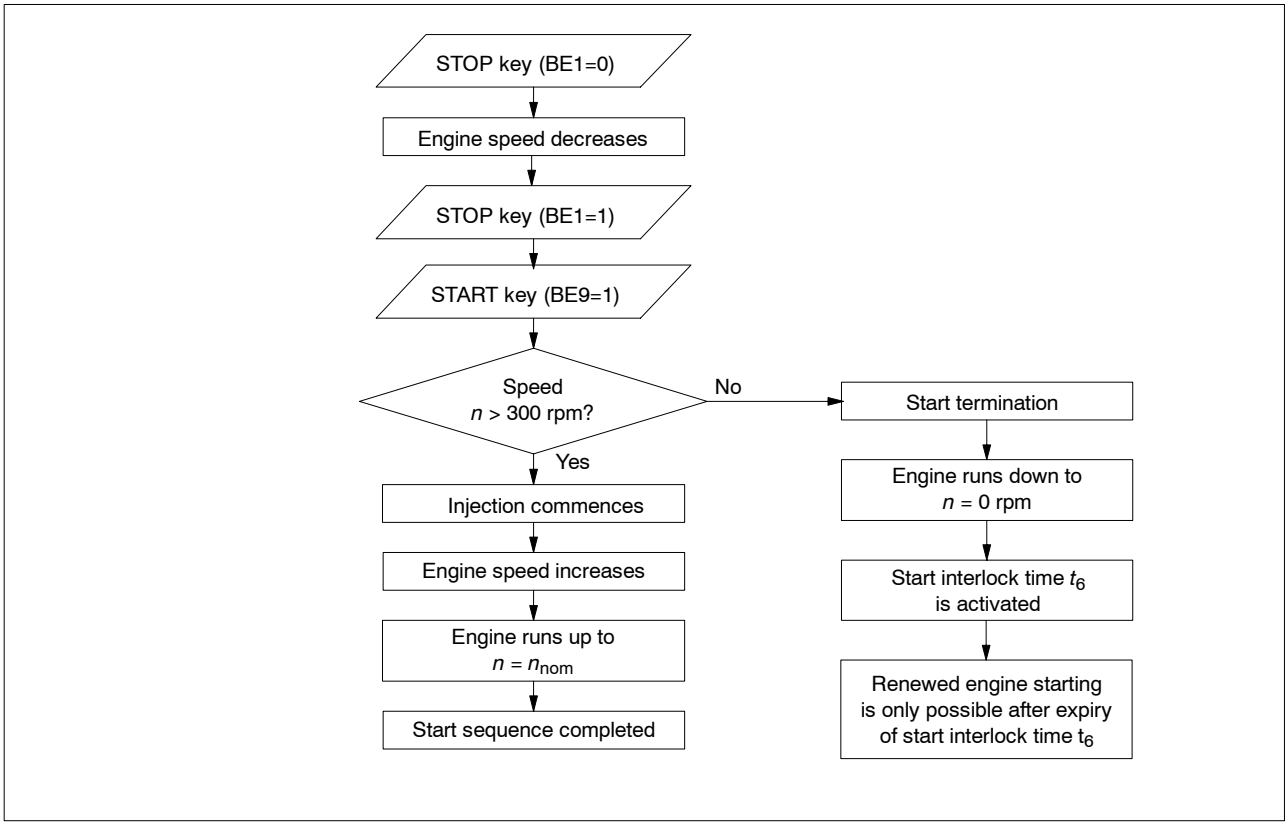


Fig. 43 : Restart flowchart

1.4.4.1.3 Emergency engine start

Start interlocking due to the criteria listed below is bypassed when the engine is started with override active (emergency start):

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

1.4.4.2 Engine stop

Engine stopping is initiated by activating the appropriate binary input on the Engine Control Unit ECU or by the engine safety system. The injection valves are no longer active and no more fuel is injected.

Any attempt to initiate starting is interrupted.

1.4.4.3 Override

The “Override” function is used to bypass safety features which are tripped in case of limit value violation or sensor defect (see chap. 1.4.7.1) and to bypass start interlocks (see chap. 1.4.4.1.3).

When the “Override” function is activated, operating states which would normally lead to engine shutdown are ignored (exception: Overspeeding always leads to engine shutdown).

1.4.4.4 50 Hz/60 Hz switching on bi-frequency engines

The mains frequency can be changed prior to engine starting in order to widen the genset’s field of application. The nominal speed is then set as follows:

- Mains frequency 50 Hz: Nominal speed 1500 rpm
- Mains frequency 60 Hz: Nominal speed 1800 rpm

CAUTION

Switching over is only possible when the engine is at a standstill!

The appropriate maps and parameters must have been programmed in the Engine Control Unit to allow switching and the engine must be suitably equipped (hardware).

1.4.4.5 Load pulse

A “Load pulse” signal can be acquired and evaluated in order to improve dynamic speed response to sudden, significant loading (input IUE 2 on ECU).

If the load changes very quickly, this signal adjusts the amount of fuel injected before the speed changes as a result of increased loading.

The “Load pulse” signal can be set either as a binary signal (in this case the amount of fuel injected is increased at a constant rate regardless of the degree of loading) or as an analog signal (the amount of fuel increases in proportion with the change in loading on the basis of a 0 mA ... 20 mA signal).

1.4.5 Monitoring functions

Engine management system MDEC for stationary generator engines fulfills the following monitoring tasks:

- Controlling analog displays (option) for
  - Engine speed
  - Engine lube oil pressure
  - Engine lube oil temperature
  - Engine coolant temperature
- Transmission of all measured values, warnings and alarms to the Monitoring and Control System via CAN bus
- Automatic shutdown in case of limit value violation

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

The engine monitoring system can be basically divided into two separate areas:

- An engine safety system which monitors the engine during operation (see chap. 1.4.5.1)
- A safety system which shuts down the engine in case of limit value violation (see chap. 1.4.7)

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

1.4.5.1 Engine safety system

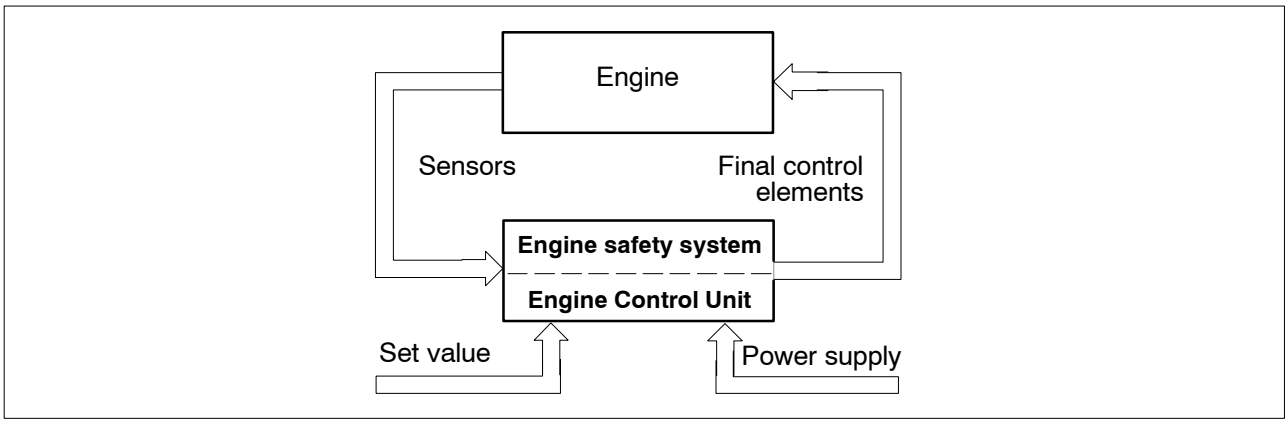


Fig. 44 : Engine Control Unit and engine safety system

The Engine Control Unit ECU incorporates an integral engine safety system. This monitors the engine operating values.

Tasks of the engine safety system are:

- Protecting the engine from assuming critical operating states
- Warning operating personnel
- Restricting engine operation to admissible operating values

Depending on the values measured, activities such as warning, start interlock, power reduction or engine shutdown by feeding reduction are carried out.

Possible activities of the engine safety system are:

- Outputting a fault message number via a Peripheral Interface Module PIM (option)
- Output of combined alarms (RED or YELLOW) and individual alarms
- Dynamic feeding limitation
- Engine stop by feeding reduction

1.4.5.2 Combined alarm signalling

Depending on the engine operating state, two different combined alarms can be generated and output (via the CAN bus and via one transistor output on Engine Control Unit ECU respectively):

- Combined alarm YELLOW (warning)

  This signal is activated when critical operating states are reached which require the operator to pay close attention.

- Combined alarm RED (shutdown)

  This signal is activated when operating states are reached which would destroy the engine if allowed to persist; the engine is automatically shut down to prevent this.

Alarms leading to engine shutdown are saved. The corresponding messages at the binary outputs remain unchanged until they are reset by activating the “Alarm Reset” binary input.

A fault message is also output if the engine safety system detects failure of a sensor signal. The type of fault message depends on the fault(s) which have occurred.

1.4.6 Regulating functions

Engine management system MDEC for stationary generator engines realizes the following engine regulating functions:

- Speed governor/feeding governor (depending on operating state)
- Injection regulation for solenoid valve-controlled injection with mapped injection start control
- Two adjustable speed droops (speed droop 1/speed droop 2 which can be switched via BE 4)
- Set speed value via
  - Analog or binary speed settings on the CAN bus
  - 0 V ... 10 VDC analog speed setting (configurable)/4 mA ... 20 mA/0 ... 5 V
  - Binary speed setting via up/down signal, frequency and CAN Bus
  - Frequency speed setting
- Acquisition of a load pulse signal (analog or binary) to prepare for load imposition
- High pressure fuel governor

1.4.6.1 Speed/injection regulation

The integral **engine speed governor** in Engine Control Unit ECU realizes the following functions:

- Maintaining the desired engine speed under changing load conditions
- Adjusting the engine speed when changed by the operator

Other tasks of Engine Control Unit ECU having an effect on speed governing are:

- Setting a defined injection fuel quantity for engine starting
- Engine safety shutdown
- Optimizing operation, exhaust emission values and fuel consumption
- Protecting the engine against overloading

The engine governor incorporates safety features to protect the engine, e.g. power limitation by restricting the amount of fuel injected depending on certain operating values and conditions.

1.4.6.2 Idle speed governor - maximum speed governor - feeding governor

Depending on the current operating state, the governor in the Engine Control Unit operates as:

- All-speed governor (only after engine starting)
- Idle speed governor
- Feeding governor
- Maximum speed governor

After engine starting, the speed runs up along a (programmed) speed ramp (all-speed governor) when the feeding quantity Q_{Input} set at IUE1 is less than the feeding quantity $Q_{Speed\ governor}$ calculated by the speed governor. Q_{Input} is active if the feeding quantity $Q_{Speed\ governor}$ is greater than Q_{Input}.

Note: If the engine is started in the absence of a signal at IUE1, the idle speed governor takes over after the engine has run up to speed.

If the feeding quantity Q_{Input} set at IUE1 exceeds the sum resulting from the feeding quantity $Q_{Speed\ governor}$ calculated by the idle speed governor and a hysteresis quantity $Hyst_{Idle\ governor}$, the ECU automatically switches over to operation as a feeding governor whereby feeding Q is equivalent to Q_{Input}.

If the actual speed n_{ACT} exceeds the effective maximum speed when running (maximum speed + speed droop), the governor in the ECU operates as a maximum speed governor.

If the feeding quantity Q_{Input} set at IUE1 decreases in maximum speed governor operation to a value below the difference resulting from the calculated feeding quantity $Q_{Speed\ governor}$ and a hysteresis quantity $Hyst_{Max.\ governor}$, the ECU automatically switches back to operation as a feeding governor whereby feeding Q is equivalent to Q_{Input}.

If the actual speed n_{ACT} now falls below the effective idling speed in operation (idling speed + speed droop), the governor in the ECU operates as an idle speed governor and regulates the idling speed.

Note: The transition between these various forms of governing takes place automatically when the generator is running and cannot be influenced. The setting criteria are adjusted via measuring point 178.

- Idling speed in 50 Hz operation
- Idling speed in 60 Hz operation
- Maximum speed in 50 Hz operation
- Maximum speed in 60 Hz operation
- Activation of idle speed – maximum speed governor

It is possible to display the currently active operating mode via measuring point 179.

1.4.6.3 Common Rail injection system (series 4000 only)

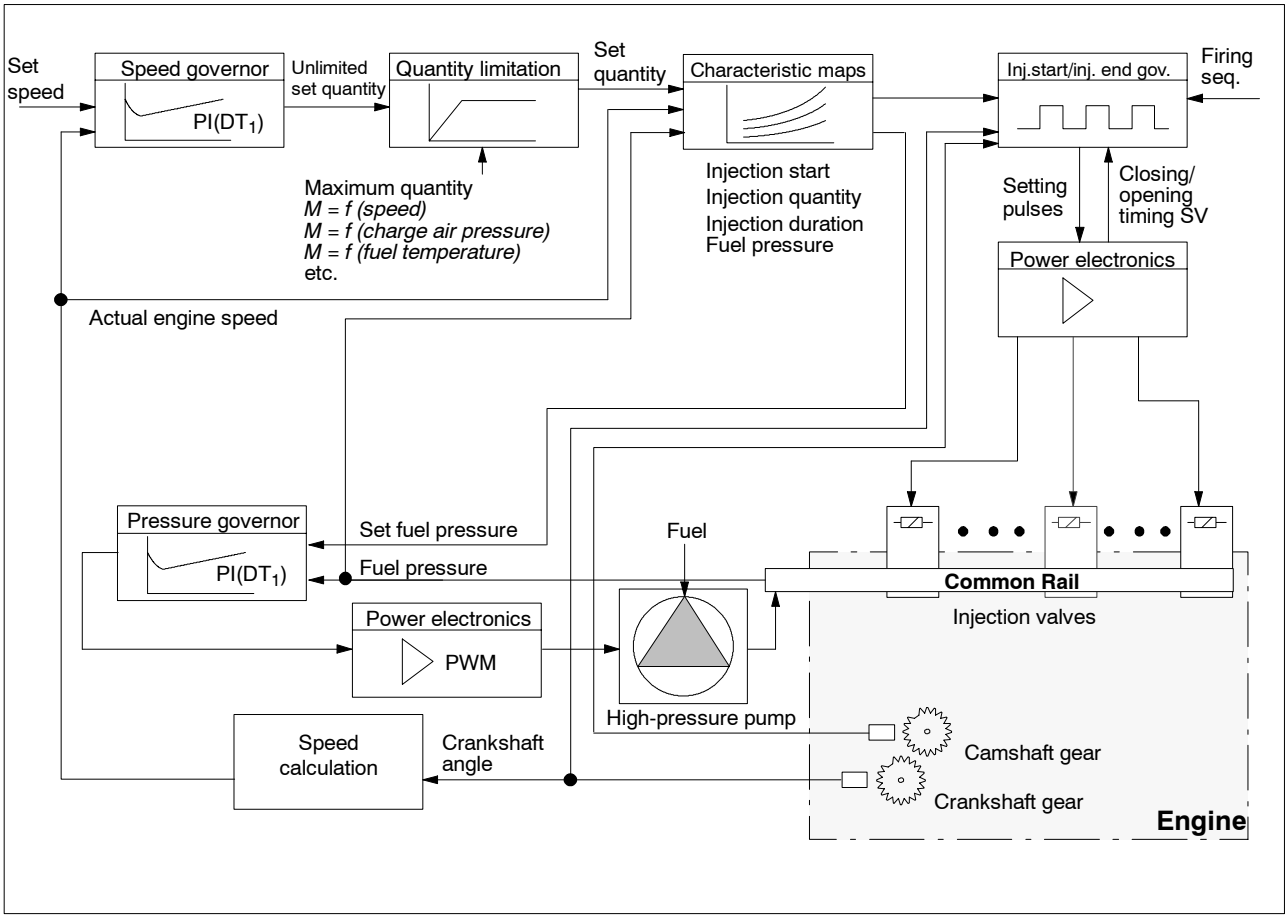


Fig. 45 : Control loop

The speed governor compares the speed setting with the current engine speed. It adapts its output signal (set injection quantity) to compensate the difference in case of deviation. The PID characteristics ensure a fast response to changes and precise speed setting.

Dynamic quantity limitation depending on the operating point protects the engine against overloading.

The set quantity after quantity limitation represents the input signal for the mapped injection start/injection end governor. The power electronics control the injection valves of the individual cylinders in accordance with these settings. The injection pressure of the Common Rail system is also regulated by the Engine Control Unit ECU.

1.4.6.4 PLN injection system (series 2000 only)

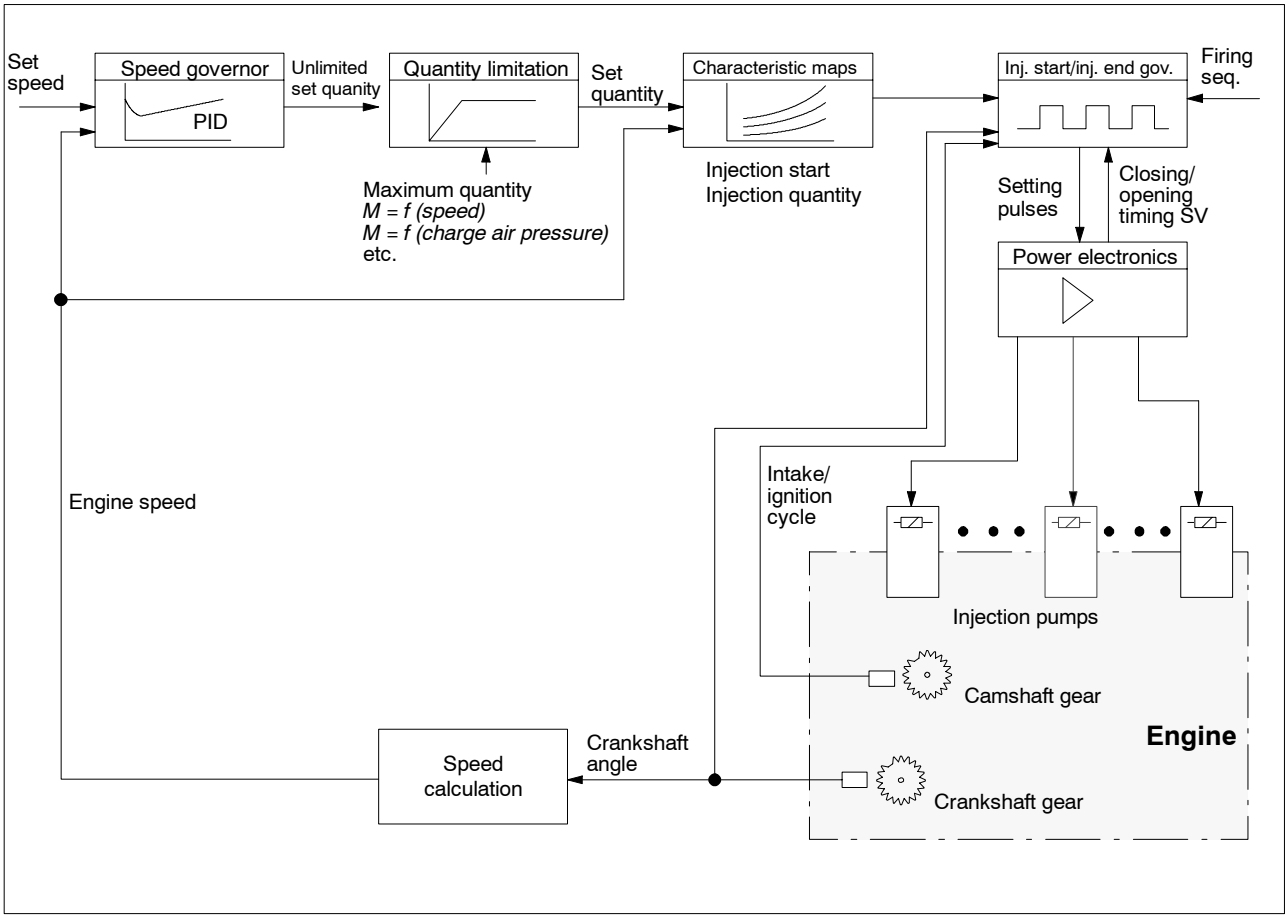


Fig. 46 : Control loop

The speed governor compares the speed setting with the current engine speed. It adapts its output signal (set injection quantity) to compensate the difference in case of deviation. The PID characteristics ensure a fast response to changes and precise speed setting.

Dynamic quantity limitation depending on the operating point protects the engine against overloading.

The set quantity after quantity limitation represents the input signal for the mapped injection start/injection end governor. The power electronics control the injection valves of the individual cylinders in accordance with these settings.

1.4.6.5 Angle measuring/determining engine timing

The timing is defined in the electronics on the basis of information from angle measuring sensors on two measuring gears. One measuring gear is mechanically coupled to the crankshaft and one to the camshaft.

The crankshaft sensor detects the precise angle of the crankshaft under normal operating conditions in order to determine the injection timing and thus derive the engine speed.

The camshaft sensor allows the intake and ignition cycles to be differentiated in normal operation.

Crankshaft:

The measuring gear on the crankshaft turns at the same speed as the engine. A pulse is generated in the inductive sensor (channel KW1) by each tooth on the measuring gear. The angle of the crankshaft can be determined by counting the pulses from the sensor. Counting is synchronized by a tooth gap (i.e. a pulse missing at the sensor) at a defined angle.

Camshaft:

The measuring gear on the camshaft turns at half the speed of the engine. Engine Control Unit ECU only evaluates the tooth gap in governing mode.

The electronics differentiate between the intake and ignition cycle of cylinder A1 with the help of this tooth gap.

1.4.6.6 Speed droop

1.4.6.6.1 Speed droop calculation

Speed droop influences the effective set speed depending on engine output. The maximum, speed-dependent engine output is limited by the DBR curve. Speed droop does not influence the set speed at the 100% output point. The effective set speed increases at lower outputs. This means that several engines operating in a network can be harmonized in this way.

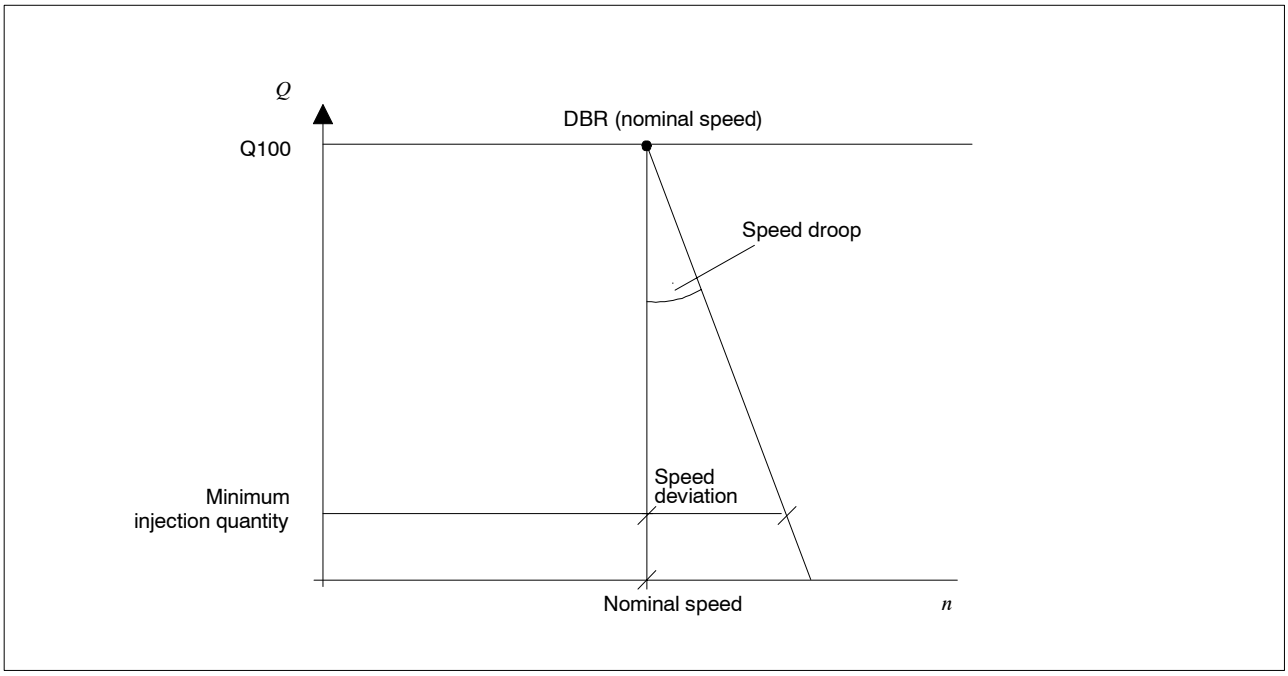


Fig. 47 : Speed droop

1.4.6.6.2 Switchable speed droop

Two different speed droops can be selected on Engine Control Unit ECU for genset applications. The choice of which speed droop is to be active depends on whether the genset operates on a “standalone” basis (i.e. independently) or whether it supplies a common busbar operating in parallel with other gensets in a network.

The speed droop can be selected by a binary input (BE 4) on Engine Control Unit ECU.

Fig. 48 illustrates the principle engine governing range and the effects of adjustable speed droop (load-dependent adjustment of the set speed value).

Speed droop is also used in order to balance loading on coupled drives. The speed droop is set individually for each plant and can be modified using the dialog unit.

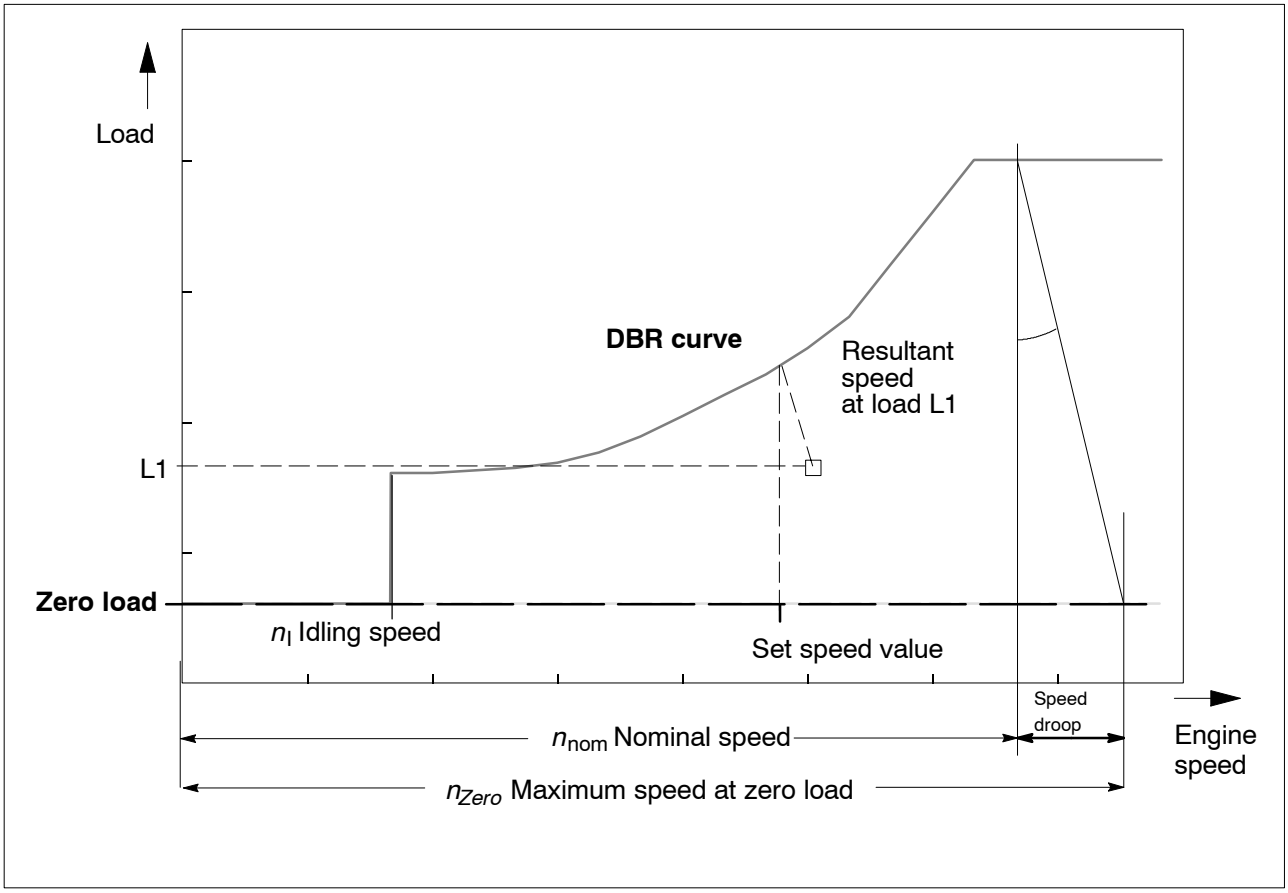


Fig. 48 : Graphic representation of the speed adjusting range and speed droop

Speed droop is defined as the relative change in speed when the engine is unloaded. Speed droop is referenced to nominal speed (= maximum speed at maximum power output). Every point in the operating range is influenced by a change in loading (see chap. 1.4.6.6.1).

$$\text{Speed droop} = \frac{\text{Maximum speed (zero load) } n_{Zero} - \text{Nominal speed } n_{nom}}{\text{Nominal speed } n_{nom}} \times 100\ \%$$

Note: A sudden increase in speed is prevented by the “Switch constant speed” function on switching over the speed droop.

1.4.6.7 Power limitation (quantity limitation)

1.4.6.7.1 Dynamic quantity limitation

Dynamic quantity limitation, i.e. variable limitation of the fuel injected, is used to protect the engine against overloading and to optimize exhaust emission values. Engine Control Unit ECU determines the maximum injection quantity on the basis of preset and stored characteristic engine maps.

Limitations are:

- Speed-dependent fuel quantity limitation (DBR)
- Fuel quantity limitation as a function of fuel temperature
- Fuel quantity limitation in case of charger overspeeding

1.4.6.7.2 Fixed quantity limitation

Fixed quantity limitation is used to limit or reduce the power in order to protect the engine in case of

- Electronic fault
- Supply voltage out of range

1.4.6.7.3 Fuel quantity control during engine starting

The amount of fuel injected during engine starting increases from a preset initial value up to a defined value via a time ramp. The value is calculated using the function $q_{Inject} = f_{(speed)}$. The amount of fuel injected is thus limited as a function of speed in this way. This fuel quantity limitation is effective until idling speed is reached for the first time.

1.4.6.8 Speed setpoint handling

The speed setting (= speed setpoint) is the control variable for the engine speed control loop.

An internally programmed speed setpoint is approached when the engine is started (at a network frequency of 50 Hz: 1500 rpm; at a network frequency of 60 Hz: 1800 rpm).
Switching over to an external speed setting takes place automatically when the nominal speed has been reached.

The speed can be set in the following ways:

- Speed setting via an analog input:

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

  The voltage can either control only the speed window (e.g. 1 V ... 9 V changes the speed between 1400 rpm and 16000 rpm) or may cover the entire speed range (e.g. 1 V ... 9 V would adjust the speed between 800 rpm and 2000 rpm, in this case, however, all values which would lead to a speed below the lower limit or above the upper limit are ignored, i.e. the speed is adjusted between 1400 rpm and 1600 rpm with a voltage of between 5.0 V and 5.33 V in this case).

  The internal set speed follows the speed setting value applied via a configurable acceleration and deceleration curve (speed ramp). Should the signal fail, the last setting is retained or the engine is throttled back to idling speed.
  This response can be configured as desired.
  - Speed setting via CAN bus
  - Speed setting via an analog speed setting input (0 V ... 10 V), (0 ... 5 V)
  - Speed setting via an analog speed setting input (4 mA ... 20 mA)
  - Frequency input
- Setpoint processing via binary inputs “Set speed up” (BE 5)/“Set speed down” (BE 6):

  The set speed can also be adjusted within a (configurable) range around the set synchronizing speed (depending on the network frequency which is set) in this case. Briefly activating the corresponding optocoupler input for less than 0.3 s increases or decreases the set speed by 1 rpm.
  The set speed is adjusted automatically at a configurable rate if the input is activated for more than 0.3 s (e.g. at approx. 10 rpm per second).

1.4.7 Safety features

1.4.7.1 Safety shutdowns

Safety shutdowns are activated by the engine safety system in case of

- Limit value violation
- Sensor defect (depending on configuration)

This applies to the following measuring points:

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

The scope of measuring points may deviate from the standard settings depending on the order.

Note: All safety shutdowns (with the exception of overspeeding) can be suppressed by activating “Override” input (BE 8).

The occurrance of alarms which are relevant to safety is recorded even when the “Override” input is active.

Engine Control Unit ECU response to high coolant temperature

The “Coolant temperature alarm” output is activated if the coolant temperature exceeds T_{Limit1} and a “Combined red alarm” is signalled.

Note: The switchgear controller must open the generator switch when the “Combined red alarm” is signalled (to be configured by the client).

The engine can now be left to cool down in the course of a certain (configurable) period of time. The engine is shut down when this time has expired. Furthermore, the temperature is monitored for any further increase in temperature during the cooling down phase. The engine is shut down immediately if a (configurable) difference in temperature is exceeded.

The “Combined red alarm” output is activated in case of sensor fault. The cooling down phase commences and the engine is subsequently shut down.

The engine is shut down immediately if the coolant temperature exceeds $T_{Limit12}$.

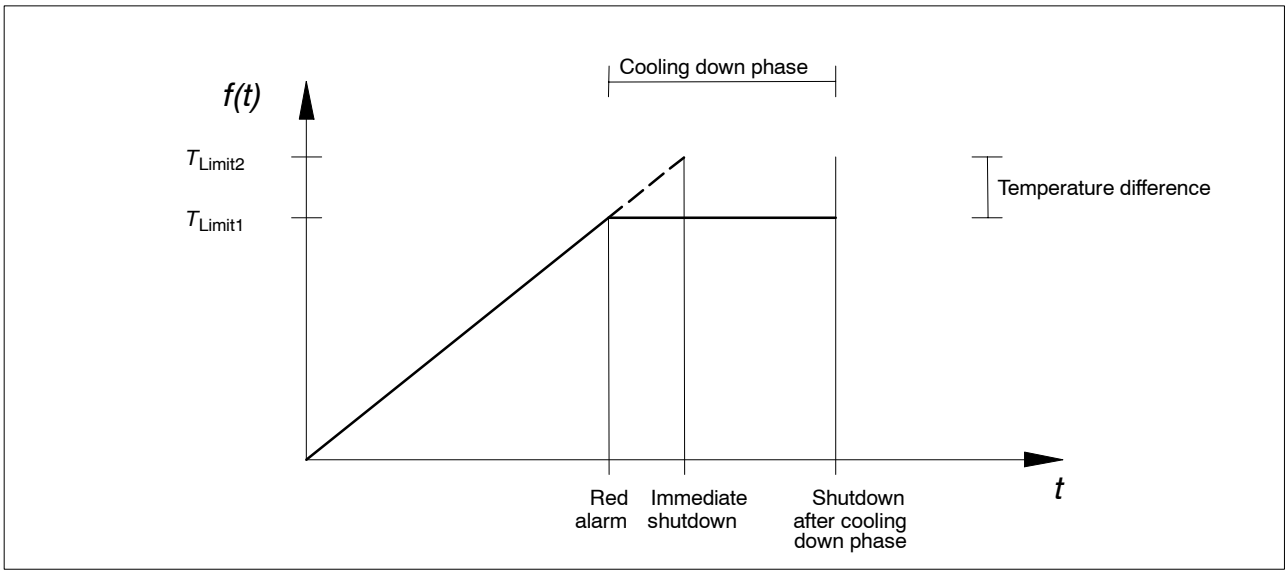


Fig. 49 : Response of Engine Control Unit ECU to high coolant temperature

1.4.7.1.1 Integral Test System (ITS)

The Integral Test System ITS monitors all vital functional areas of Engine Control Unit ECU and the connected electrical and electronic components:

- Electronics of the actual engine governor inside Engine Control Unit ECU
- Sensors
- Actuators
- Bus communication
- Power supply

The ITS detects faults as they occur, pinpoints them and signals them by means of combined alarms. Furthermore, a fault message is output via the CAN bus to a superordinate Monitoring and Control System (if applicable) where it can be displayed to the operator.

Faults which have occurred are stored for evaluation at a later date. They can be read out using the dialog unit.

Fault messages are stored in two memories:

- **Chronological memory**
  The fault message numbers are stored chronologically in the order of their appearance or disappearance together with the operating hours counter reading in a ring memory. The ring memory stores the last 80 setting and clearing processes.
- **Statistical memory**
  The appearance of fault messages is also counted in a statistical memory.
  A counter which can count up to max. 10000 is provided for each fault message number.

1.4.7.1.2 Monitoring of the electronics in the Engine Control Unit ECU

The hardware and software of Engine Control Unit ECU is designed to allow fault detection in the electronic system so that the operator can respond appropriately to these faults. Fault signals are also passed on.

The temperature inside the housing of Engine Control Unit ECU is monitored. Should the temperature rise above a limit value, the fault is signalled via the combined alarm output and on the CAN bus to a superordinate Monitoring and Control System (if applicable).

1.4.7.1.3 Sensor/actuator monitoring

The various sensor and actuator channels of the engine management system are designed to tolerate faults (e.g. short-circuit) as far as possible.

Faults such as wire break, short-circuit etc. are detected by a plausibility check and signalled to a superordinate Monitoring and Control System (if applicable) by means of a combined alarm.

1.4.7.1.4 Bus communication monitoring

Bus communication is monitored by plausibility and timeout checks. Any faults which are detected are signalled by means of a combined alarm and, if possible, on the CAN bus to a superordinate Monitoring and Control System (if applicable).

1.4.7.2 Overspeed test

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

Part 2

Operation

(This page intentionally blank)

Table of contents

2 Operation 1

2.1 Safety requirements 1

2.2 Operating a display 3

2.3 Other operating procedures 5

(This page intentionally blank)

2 Operation

2.1 Safety requirements

I M P O R T A N T :

These safety requirements shall be read and observed by all personnel involved in operation, care, maintenance, repair, installation or commissioning of the products described.

Furthermore, the following shall be observed:

- The safety requirements (if provided) in other relevant MTU manuals
- Warning and safety information and operating and limit values attached to the products as required
- National accident prevention and safety standards
- Appropriate regulations usual in the industry
- The safety notes (if provided) in the text of this manual

Conventions for safety notes in the text

Where necessary, this manual includes highlighted safety notes indicated by a signal word. These safety notes shall be observed to avoid injury or damage.

DANGER

This type of note indicates a danger which may lead to **injury** or **death.**

CAUTION

This type of note indicates a danger which may lead to **damage** or **destruction** of the product described or another part of the system.

Intended use and user qualifications

All devices and system components may only be put to their intended use.

Operation, maintenance, repair, installation and commissioning shall only be performed by qualified and authorized personnel.

Safety requirements for commissioning

Before first using the electronic product, it must be installed in accordance with the instructions and approved to MTU specifications.

Whenever the device or system is taken into operation

- All maintenance and repair work must have been completed
- Any loose parts must have been removed from rotating machine components
- All personnel must be clear of the danger zone represented by moving parts

Immediately after taking the device or system into operation, the control and display elements as well as the monitoring, signalling and alarm systems must be tested for proper operation.

Safety requirements for operation

The emergency procedures must be practiced on a regular basis.

The operator must be familiar with the control and display elements.

The operator must know the effects of any action he/she performs.

The operator must proceed with the individual steps as specified in the documentation.

During operation, the display elements and monitoring assemblies must be supervised with respect to current operating states, violation of limit values as well as warnings and alarm messages.

If a fault in the system is detected or signalled by the system, the appropriate steps must be taken immediately and the fault reported to the person in charge.

Every message must be evaluated immediately. Emergency countermeasures shall be taken immediately as required, e.g. emergency engine stopping.

2.2 Operating a display

Information about operating states of the propulsion line and the overall electronic system (i.e. Engine Control System ECS-5 and Monitoring and Control System MCS-5) can be called up on a number of screen pages on the display.

Operation of the display is menu-guided using the five function keys F1 to F5 underneath the display. Their respective functions vary depending on menu context.

Symbols displayed above the keys on the user interface indicate the current function of the function key directly below (see fig. 50).

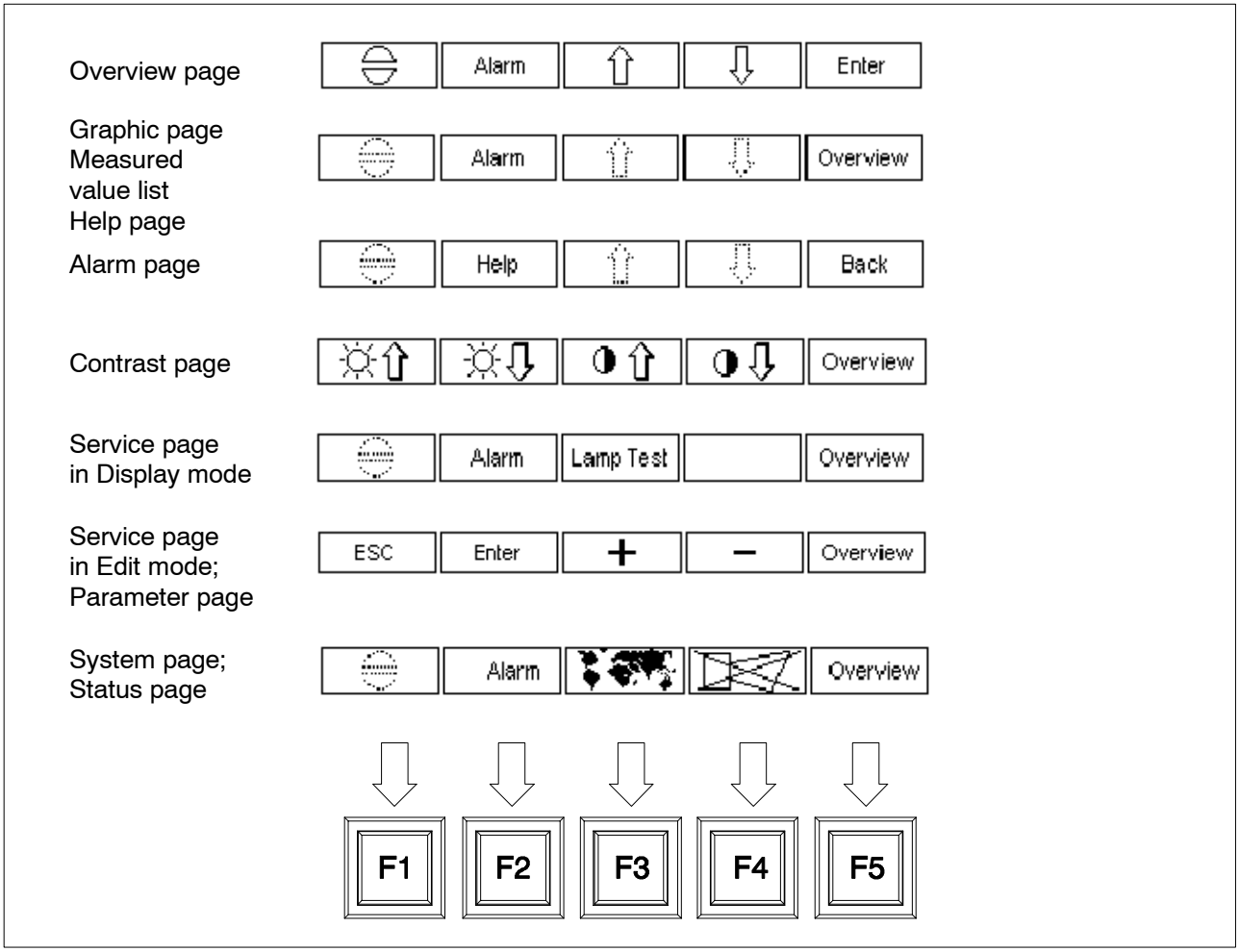
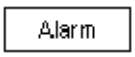
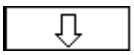
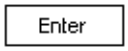
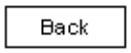
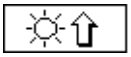
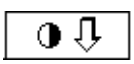
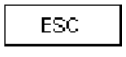


Fig. 50 : Function key assignment

Meaning of the symbols

The various symbols have the following meanings:

Symbol	Key	Description
	F1	Acknowledges alarms (shown on the display)
	F2	Opens the Alarm page
	F3	Scrolls `Up` to select a menu option on the Overview page Scrolls `Up` page-by-page on graphic pages, Measured value list, Help page and Alarm page A dotted arrow indicates that the function key is inactive
	F4	Scrolls `Down` to select a menu option on the Overview page Scrolls `Down` page-by-page on graphic pages, Measured value list, Help page and Alarm page A dotted arrow indicates that the function key is inactive
	F5 F2	Opens the selected menu option on the Overview page On the Service page in Edit mode: Selects the input fields. The selected input field is represented inversely. This indicates that the input value is activated for processing
	F5	Opens the Overview page
	F2	Opens the Help page
	F5	Returns from the Alarm page to the previously selected page
	F1	`Increase brightness` Increases the brightness of the LCD background illumination, key illumination of function keys F1 to F5 and the LED for the operating state indicator in stages
	F2	`Decrease brightness` Decreases the brightness of the LCD background illumination, key illumination of function keys F1 to F5 and the LED for the operating state indicator in stages
	F3	`Increase contrast` Increases the contrast of the LCD display in stages
	F4	`Decrease contrast` Decreases the contrast of the LCD display in stages
	F1	Changes made to the activated variables are not saved in the memory and the input field is exited

Symbol	Key	Description
+	F3	Increases the input value
–	F4	Decreases the input value
Lamp Test	F3	Lamp test, all luminous pushbuttons and indicators on Local Operating Station LOS light up brightly
	F3	Language switching (e.g. German/English) The texts are stored in 2 languages
	F4	`Horn off` Silences the horn connected to the relay output if it is sounding

2.3 Other operating procedures

Other operating procedures depend on the system environment and the user interface involved.

Refer to the overall system documentation of the entire genset for details of these procedures.

(This page intentionally blank)

Part 3

Maintenance and repair

(This page intentionally blank)

Table of contents

3	**Maintenance and repair**	**1**
3.1	Safety requirements	1
3.2	General information about this manual	3
3.2.1	Task duration and personnel qualification	3
3.2.2	Terminology	3
3.2.3	Structure	4
3.3	Tools, expedients and consumables	5
3.3.1	For care and maintenance	5
3.3.2	For repair	5
3.3.3	Troubleshooting devices	6
3.4	Malfunctions	8
3.4.1	Safety instructions	8
3.4.2	Fault displays	9
3.4.2.1	Replacing Engine Control Unit ECU	40
3.4.2.1.1	Removing the housing of Engine Control Unit ECU from the engine	42
3.4.2.1.2	Opening the cover on Engine Control Unit ECU	43
3.4.2.1.3	Transferring memory modules in Engine Control Unit ECU	44
3.4.2.1.4	Fitting the cover on Engine Control Unit ECU	46
3.4.2.1.5	Mounting the housing of Engine Control Unit ECU on the engine	47
3.4.2.2	Using the MDEC simulator	49
3.5	Maintenance	51
3.5.1	Maintenance overview	51
3.5.2	Visual inspection, mechanical testing and cleaning	52
3.5.2.1	Cleaning device(s) externally	53
3.5.2.2	Checking device(s) externally	53
3.6	Structure of Engine Control Unit ECU 4	54
3.6.1	External structure	54
3.6.2	Internal structure	56

(This page intentionally blank)

3 Maintenance and repair

3.1 Safety requirements

I M P O R T A N T :

These safety requirements shall be read and observed by all personnel involved in operation, care, maintenance, repair, installation or commissioning of the products described.

Furthermore, the following shall be observed:

- The safety requirements (if provided) in other relevant MTU manuals
- Warning and safety information and operating and limit values attached to the products as required
- National accident prevention and safety standards
- Appropriate regulations usual in the industry
- The safety notes (if provided) in the text of this manual

Conventions for safety notes in the text

Where necessary, this manual includes highlighted safety notes indicated by a signal word. These safety notes shall be observed to avoid injury or damage.

DANGER

This type of note indicates a danger which may lead to **injury** or **death.**

CAUTION

This type of note indicates a danger which may lead to **damage** or **destruction** of the product described or another part of the system.

Intended use and user qualifications

All devices and system components may only be put to their intended use.

Operation, maintenance, repair, installation and commissioning shall only be performed by qualified and authorized personnel.

Safety requirements for maintenance and repair

Maintenance and repair work shall be performed exactly and on schedule to ensure constant readiness and reliability of the product.

Authorization must be obtained from the person in charge prior to commencing maintenance and repair work and switching off parts of the electronic system required for this.

Prior to working on assemblies, the power supply of the appropriate areas must be switched off and secured against unauthorized switching on.
Any measures requiring power supply are expressly defined as such at the appropriate place in the manual.

Maintenance and repair work shall be performed in accordance with the instructions in the manual by authorized personnel.

Suitable tools, special MTU tools if necessary, shall be used for maintenance and repair work.

Genuine spare parts only may be used to replace defective components or assemblies. The manufacturer accepts no liability whatsoever for damage caused by using other spare parts. The manufacturer's warranty shall also be voided in such cases.

The manufacturer shall not be held liable if unauthorized changes or modifications are made to the product and the warranty shall be voided.

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

Inform the MTU service department or its representative in case of damage which cannot be rectified by plant personnel.

On completion of maintenance and repair work, ensure that no superfluous parts (tools etc.) remain inside the device or system.

On completion of repair work, the device or system must be subjected to appropriate checks to verify functionality. Separate testing of the repaired component without system integration is inadequate.

When working on the engine, suitable measures shall be taken to prevent accidental starting.

3.2 General information about this manual

Refer to order-specific documents (e.g. drawings) if necessary in case of deviations from the information provided in this manual.

3.2.1 Task duration and personnel qualification

Information about task duration is only intended to serve as a guide and is based on the work being carried out under normal working conditions. The amount of time required may deviate from the times stated in some cases.

The abbreviations explained in the preface to this manual are used to specify the minimum qualifications for users carrying out the work described.

Familiarity with the contents of Part 1 of this manual is pre-requisite.

3.2.2 Terminology

The following terms are used in this manual:

- **Task:**
  A group comprising several activities – not necessarily in a specific order results in the task being fulfilled.
- **Activity:**
  Sequence of steps to be carried out in a specific order. The result of each activity is a part of the superordinate task.
- **Step:**
  The sequential execution of certain steps forms a superordinate activity.
- **Work:**
  Generic term for tasks, activities and steps.

3.2.3 Structure

The chapters in this manual describing specific work are structured as shown in fig. 51.

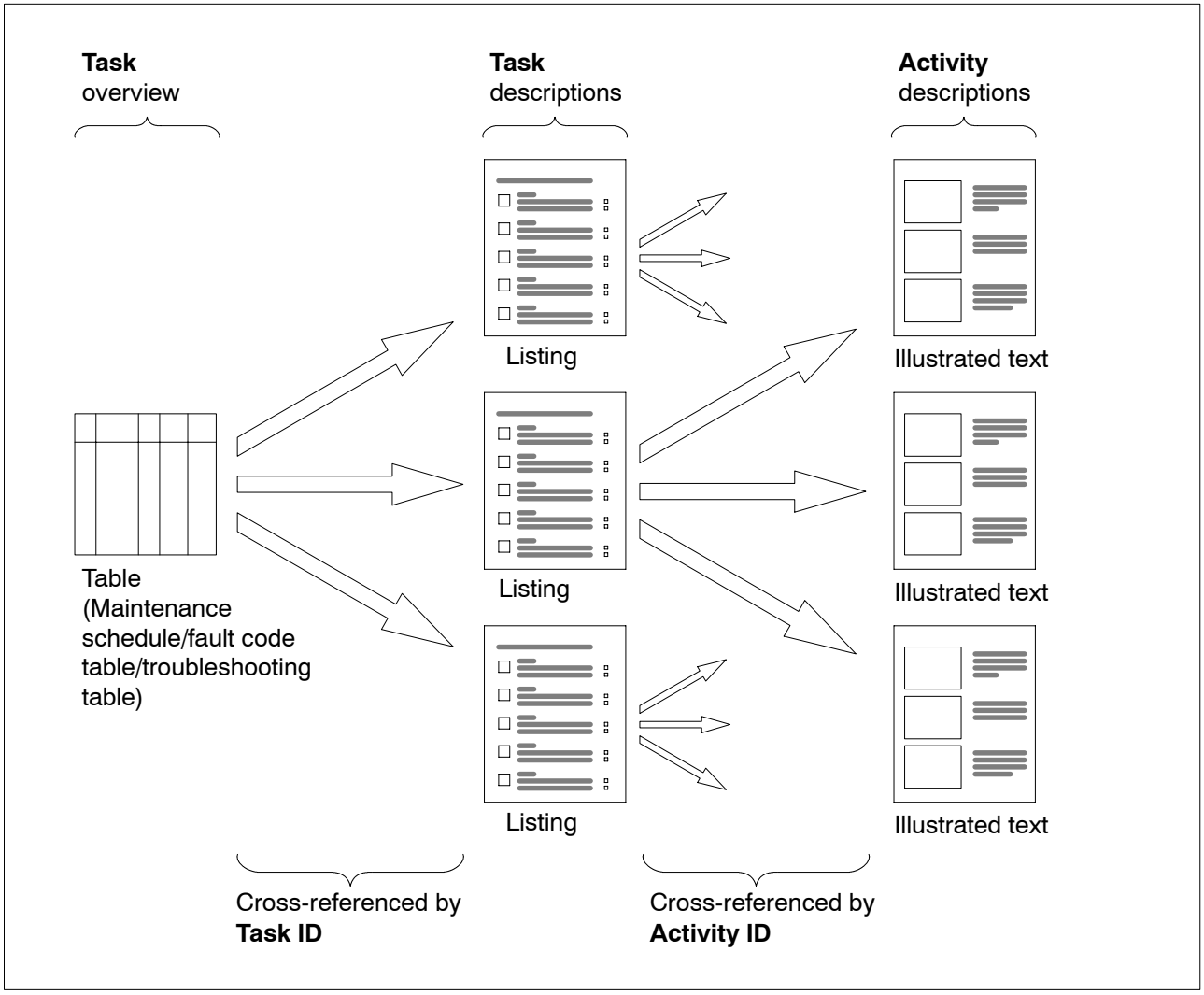


Fig. 51 : Structure of the sub-chapters and terminology

Checkboxes are provided on the right margin of task description pages allowing each item to be checked off.

Note: Task and activity descriptions are modular and often formulated in general terms (e.g. for a plant with several control consoles). The information provided must be applied to the plant concerned by analogy.

3.3 Tools, expedients and consumables

3.3.1 For care and maintenance

The following tools, expedients and consumables are required to perform the care and maintenance work described:

- Lint-free cleaning cloths (e.g. soft paper towels)
- Cleaning agent for synthetic surfaces (non-corrosive, non-abrasive, solvent-free and grease-dissolving)

3.3.2 For repair

The following tools, expedients and consumables are required to perform the repair work described:

- Tool kit SME 4-01 (see MTU manual “Tool kit SME 4-01, Part 5”)
- Cable ties in various lengths
- Self-adhesive insulating tape

3.3.3 Troubleshooting devices

The following (optional) devices facilitate troubleshooting on engine management system MDEC for stationary generator engines:

- MDEC simulator (see fig. 52)
- Dialog unit (see fig. 53)

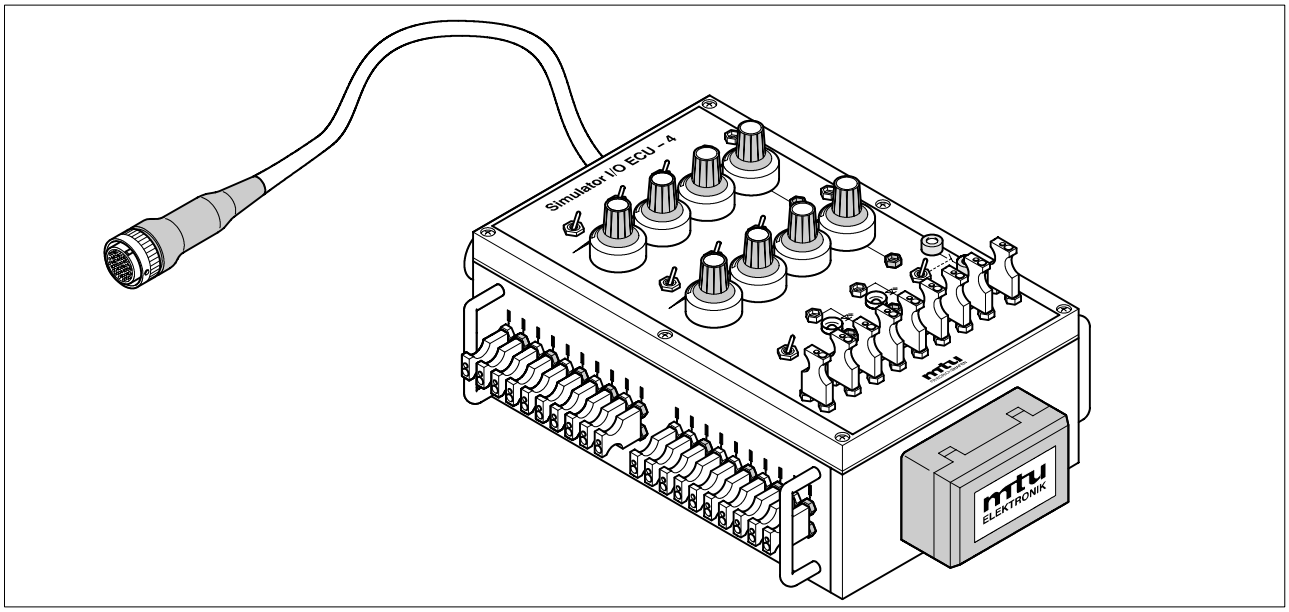


Fig. 52 : MDEC simulator for connector X2

The use of the MDEC simulator is described in MTU document “ECS-5 Testing and simulation device ECU-4 (X2)”, document no. E 532 085.

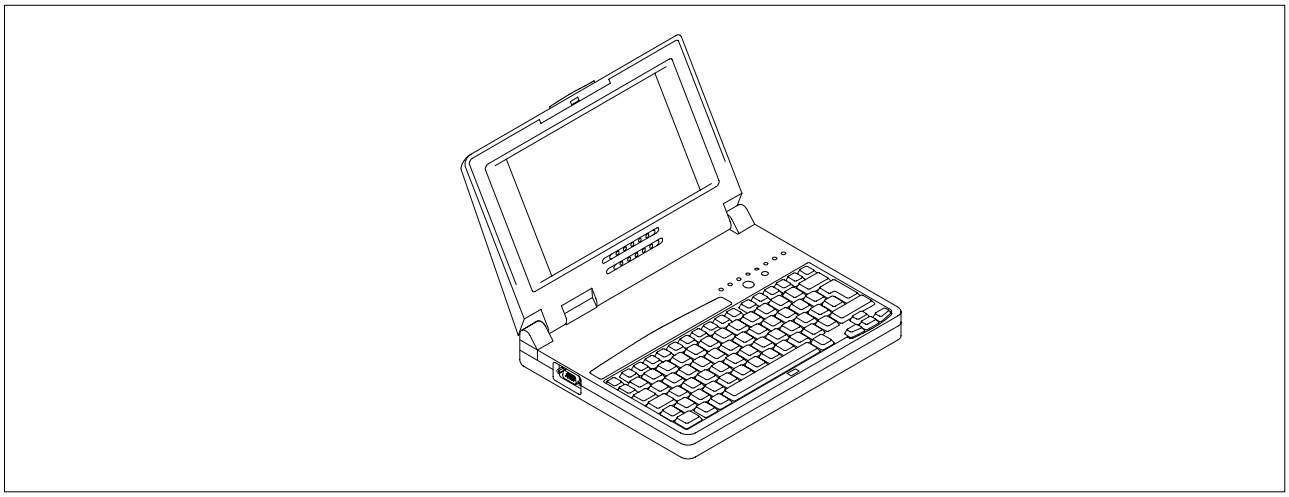


Fig. 53 : Dialog unit

Use of the dialog unit is described in MTU documentation “DiaSys 2.xx”, document no. E 531 920.

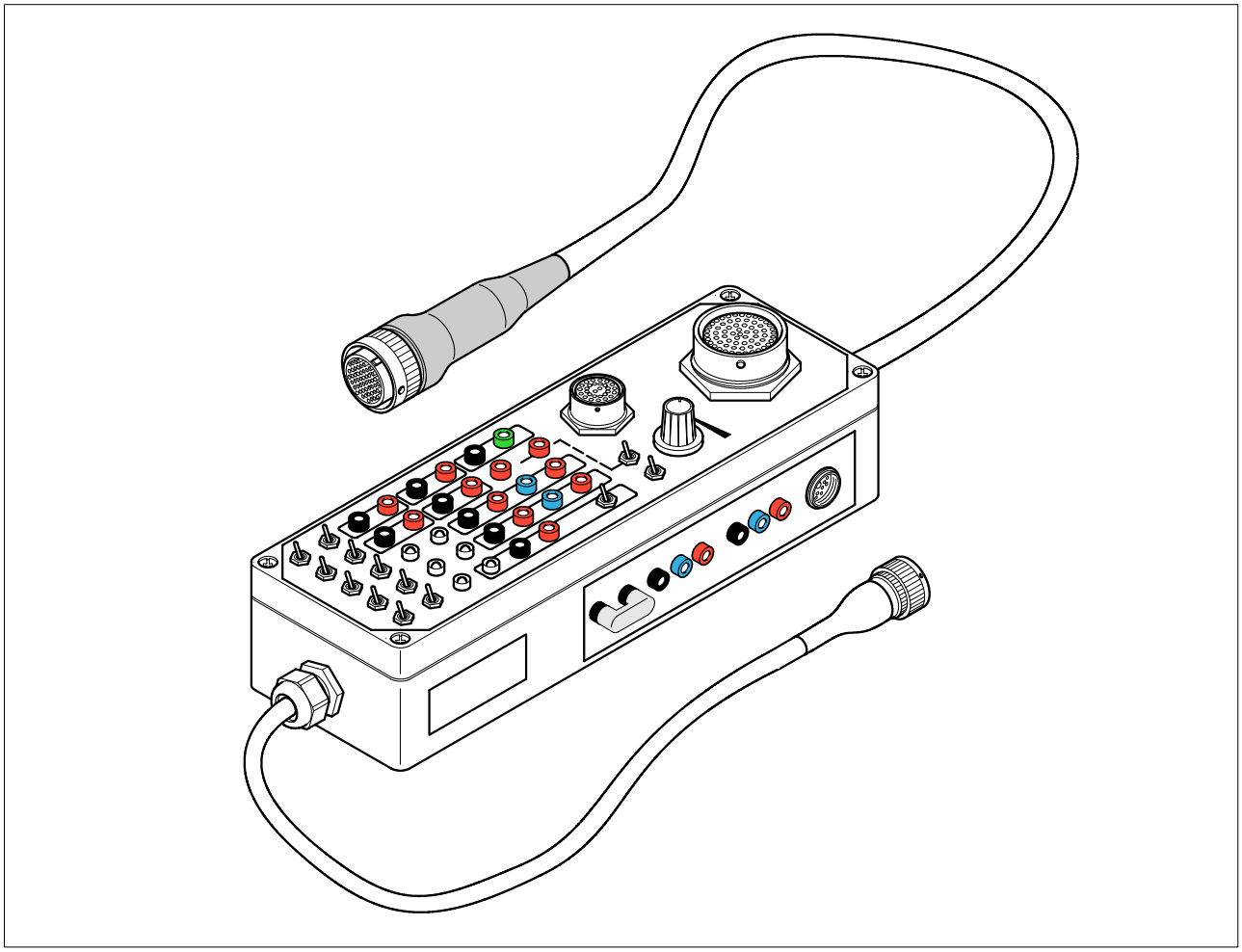


Fig. 54 : MDEC simulator for connector X1

Note: The MDEC simulator for X1 is used in a similar way to the MDEC simulator for connector X2. However, the cable from connector X6 must also be looped through the simulator to provide the power supply.

Detailed information about this simulator is provided in MTU documentation “Service and workshop equipment catalog”, document no. E 531 759.

3.4 Malfunctions

3.4.1 Safety instructions

DANGER

Injury hazard!
Before commencing repair work, always:
Stop the engine and **lock out to preclude starting!**

DANGER

System failure possible!
Short-circuits caused by carrying out repair work on devices with the operating voltage switched on may result in total system failure during operation. The engine can no longer be started as a result.
Therefore:
Always switch off the **operating voltages** for all devices and **lock out to preclude switching on** before commencing repair work!

DANGER

Total system failure possible!
Leaking devices of the overall system may lead to sudden system failure. The engine can no longer be started as a result.
Therefore: Ensure that no water ingresses the housings on carrying out repair work and use seals as intended.

3.4.2 Fault displays

Faults in the overall MDEC system are indicated at the devices of the MCS-5 sub-system as follows:

- Fault code numbers (generated inside Engine Control Unit ECU) on a 4-figure 7-segment display in PIM A 511
- Plain text fault display in the form of text messages on display DIS (option)

CAUTION

Rectify faults as soon as possible even if they would appear to be insignificant in order to avoid impairing operation of the plant or system failure.

Always check the following points first if a fault occurs when the overall system is switched on:

- Is it a phantom fault (e.g. because the system is in Local mode)?
- Have all the necessary requirements for the operating procedure, or for the control procedure of a superordinate system, during which the fault occurs been fulfilled?
- Does a fault message appear on the display in PIM A 511 ?
  If so, countermeasures can be determined by consulting the appropriate fault code table.

Table

The number of the fault code on the display is listed in the first column “No.” in the table.

The precise text message is listed in the second column “Fault display” in the table. This corresponds with the fault code displayed on the DIS display (option).

The message is explained in the third column “Meaning/cause” and the reason for the message is explained.

The fourth column “Counteraction” in the table lists measures which can be taken on-site by the operator or other information about how to proceed.

The last two columns indicate which fault can appear for which series.

Malfunctions which may be caused by mechanical fault are referenced to the engine documentation with “➧ Engine documentation”.

“➧ Electronics service” indicates that further testing and rectification are a matter for trained service personnel or experienced users with access to the appropriate documents (e.g. wiring diagrams).

Note: “➧ Engine documentation” refers to the “Operating instructions for engine series 2000”, Part E and Part G.

No.	Fault display	Meaning/cause	Counteraction	2000	4000
000	*(Not used)*				
001	*(Not used)*				
002	*(Not used)*				
003	*(Not used)*				
004	*(Not used)*				
005	L1 T-CHARGE AIR	Charge air temperature too high (first limit value overshot)	➧ Engine documentation	✓	✓
006	L2 T-CHARGE AIR	Charge air temperature too high (second limit value overshot)	➧ Engine documentation	✓	✓
007	*(Not used)*				
008	*(Not used)*				
009	L1 T-INTERCOOLER	Charge air coolant temperature too high (Limit1 overshot)	➧ Engine documentation	✓	✓
010	*(Not used)*				
011	*(Not used)*			✓	
012	*(Not used)*				
013	*(Not used)*				
014	*(Not used)*				
015	L1 P-LUBE OIL	Lube oil pressure too low (first limit value undershot)	➧ Engine documentation	✓	✓
016	L2 P-LUBE OIL	Lube oil pressure too low (second limit value undershot) → engine stop	➧ Engine documentation	✓	✓
017	*(Not used)*				
018	*(Not used)*				
019	*(Not used)*				
020	*(Not used)*				
021	*(Not used)*				
022	*(Not used)*				

No.	Fault display	Meaning/cause	Counteraction	2000	4000
023	L1 COOLANT LEVEL	Coolant level too low, message appears simultaneously with no. 24	Check coolant level in expansion tank ➧ Engine documentation	✓	✓
024	L2 COOLANT LEVEL	Coolant level too low, message appears simultaneously with no. 23	Check coolant level in expansion tank ➧ Engine documentation	✓	✓
025	*(Not used)*				
026	*(Not used)*				
027	*(Not used)*				
028	*(Not used)*				
029	*(Not used)*				
030	ENGINE OVERSPEED	Engine overspeed → emergency stop	Restart the engine, eliminate cause of overspeeding	✓	✓
031					
032	*(Not used)*				
033	L1 P-FUELFILTER DIFF	Fuel differential pressure too high	Check filter ➧ Engine documentation	✓	
034	*(Not used)*				
035	*(Not used)*				
036	*(Not used)*				
037	*(Not used)*				
038	*(Not used)*				
039	*(Not used)*				
040	*(Not used)*				
041	*(Not used)*				
042	*(Not used)*				
043	*(Not used)*				
044	L1 LEVEL INTER-COOLER	Charge air coolant level too low, message appears simultaneously with no. 45	Check coolant level ➧ Engine documentation		✓
045	L2 LEVEL INTER-COOLER	Charge air coolant level too low, message appears simultaneously with no. 44	Check coolant level ➧ Engine documentation		✓

No.	Fault display	Meaning/cause	Counteraction	2000	4000
046	*(Not used)*				
047	*(Not used)*				
048	*(Not used)*				
049	*(Not used)*				
050	*(Not used)*				
051	L1 T-LUBE OIL	Lube oil temperature too high (first limit value overshot)	➧ Engine documentation	✓	✓
052	L2 T-LUBE OIL	Lube oil temperature too high (second limit value overshot)	➧ Engine documentation	✓	✓
053	*(Not used)*				
054	*(Not used)*				
055	*(Not used)*				
056	*(Not used)*				
057	*(Not used)*				
058	*(Not used)*				
059	*(Not used)*				
060	*(Not used)*				
061	*(Not used)*				
062	*(Not used)*				
063	*(Not used)*				
064	*(Not used)*				
065	L1 P-FUEL	Fuel infeed pressure too low (first limit value undershot)	Check low pressure fuel side ➧ Engine documentation		✓
066	L2 P-FUEL	Fuel infeed pressure too low (second limit value undershot)	Check low pressure fuel side ➧ Engine documentation		✓
067	L1 T-COOLANT	Coolant temperature too high (first limit value overshot); warning	➧ Engine documentation	✓	✓
068	L2 T-COOLANT	Coolant temperature too high (second limit value overshot); shutdown	➧ Engine documentation	✓	✓

No.	Fault display	Meaning/cause	Counteraction	2000	4000
069	L1 T-EXTERN 1	Alarm 'First limit value violated' for ext. temperature channel 1	The measured value is read in via the CAN. The alarm is handled in MDEC.	✓	✓
070	L2 T-EXTERN 1	Alarm 'Second limit value violated' for ext. temperature channel 1	The measured value is read in via the CAN. The alarm is handled in MDEC.	✓	✓
071	L1 T-EXTERN 2	Alarm 'First limit value violated' for ext. temperature channel 2	The measured value is read in via the CAN. The alarm is handled in MDEC.	✓	✓
072	L2 T-EXTERN 2	Alarm 'Second limit value violated' for ext. temperature channel 2	The measured value is read in via the CAN. The alarm is handled in MDEC.	✓	✓
073	L1 P-EXTERN 1	Alarm 'First limit value violated' for ext. pressure channel 1	The measured value is read in via the CAN. The alarm is handled in MDEC.	✓	✓
074	L2 P-EXTERN 1	Alarm 'Second limit value violated' for ext. pressure channel 1	The measured value is read in via the CAN. The alarm is handled in MDEC.	✓	✓
075	L1 P-EXTERN 2	Alarm 'First limit value violated' for ext. pressure channel 2	The measured value is read in via the CAN. The alarm is handled in MDEC.	✓	✓
076	L2 P-EXTERN 2	Alarm 'Second limit value violated' for ext. pressure channel 2	The measured value is read in via the CAN. The alarm is handled in MDEC.	✓	✓
077	LIM EXT.COOLANT LEV.	Alarm from external coolant level monitor	The measured value is read in via the CAN. The alarm is handled in MDEC.	✓	✓
078	LIM INTERCOOLER LEV.	Alarm from external charge air coolant level monitor	The measured value is read in via the CAN. The alarm is handled in MDEC.	✓	✓
079	L Bin-EXTERN 3	Alarm from external binary channel 3 (plant)	The measured value is read in via the CAN. The alarm is handled in MDEC.	✓	✓
080	L Bin-EXTERN 4	Alarm from external binary channel 4 (plant)	The measured value is read in via the CAN. The alarm is handled in MDEC.	✓	✓

No.	Fault display	Meaning/cause	Counteraction	2000	4000
081	RAIL LEAKAGE	Low pressure gradient on starting or high pressure gradient on stopping	High pressure system leaking, air in the system ➧ Engine documentation		✓
082	RAIL PRESSURE HIGH	Rail pressure above set value → DBR reduction, injection start later	Interface transformer malfunction or interface transformer wiring B48 ➧ Engine documentation		✓
083	RAIL PRESSURE LOW	Rail pressure below set value → DBR reduction	Interface transformer faulty or leakage in the high pressure system ➧ Engine documentation Message also appears when very large generators are in use and the rundown time exceeds 20 s ➧ Fault irrelevant		✓
084	*(Not used)*				
085	*(Not used)*				
086	*(Not used)*				
087	*(Not used)*				
088	*(Not used)*				
089	ENGINE SPEED LOW	Engine speed has fallen below 200 rpm → engine stop		✓	✓
090	IDLE SPEED LOW	Fault message during starting, idling speed not reached within the time defined in MP 169.05 (counting starts when speed limit in MP 170.04 is exceeded) → start termination	Check for further messages	✓	✓
091	RUN UP SPEED LOW	Fault message during starting, runup speed (MP 170.04) not reached within the time defined in MP 169.04 (counting starts on exceeding the speed limit 80 rpm) → start termination	Check for further messages	✓	✓

No.	Fault display	Meaning/cause	Counteraction	2000	4000
092	START SPEED LOW	Start error message, starter speed (MP 169.02) not reached within the time defined in MP 169.03 (counting starts when the starter is activated) → start termination	Check for further messages	✓	✓
093	PREHEAT TEMP. LIMIT2	Coolant preheating temperature too low (second limit value undershot) → start termination when MP 170.19 “No Start Break Preheat” is not set	Preheating temperature not reached	✓	✓
094	PREHEAT TEMP. LIMIT1	Coolant preheating temperature too low (first limit value undershot)	Preheating temperature not reached	✓	✓
095	*(Not used)*				
096	*(Not used)*				
097	*(Not used)*				
098	*(Not used)*				
099	DUMMY FAILURE	Dummy			✓
100	EDM NOT VALID	Measuring point data checksum error in EDM	◗ Electronics service	✓	✓
101	IDM NOT VALID	Measuring point data checksum error in IDM	◗ Electronics service	✓	✓
102	INVALID FUEL CONS. 1	Accumulated fuel consumption checksum error in EDM (redundant data record 1)	◗ Electronics service	✓	✓
103	INVALID FUEL CONS. 2	Accumulated fuel consumption checksum error in EDM (redundant data record 2)	◗ Electronics service	✓	✓
104	OP HOURS1 NOT VALID	Operating hours counter checksum error in EDM	◗ Electronics service	✓	✓
105	OP HOURS2 NOT VALID	Operating hours counter checksum error in IDM	◗ Electronics service	✓	✓

No.	Fault display	Meaning/cause	Counteraction	2000	4000
106	**ERR REC1 NOT VALID**	Fault memory checksum error in EDM (redundant data record 1)	➧ Electronics service	✓	✓
107	**ERR REC2 NOT VALID**	Fault memory checksum error in EDM (redundant data record 2)	➧ Electronics service	✓	✓
108	*(Not used)*				
109	*(Not used)*				
110	*(Not used)*				
111	*(Not used)*				
112	*(Not used)*				
113	*(Not used)*				
114	*(Not used)*				
115	*(Not used)*				
116	*(Not used)*				
117	*(Not used)*				
118	**L1 SUPPLY VOLT. LOW**	If the supply voltage is below set lower limit value 1 (MP 101.01) the value calculated from the DBR curve is multiplied by 0.8 and injection start is delayed by 5°	Check battery/generator	✓	✓
119	**L2 SUPPLY VOLT. LOW**	If the supply voltage is below set lower limit value 2 (MP 101.03) the value calculated from the DBR curve is multiplied by 0.8 and injection start is delayed by 5°	Check battery/generator	✓	✓
120	**L1 SUPPLY VOLT. HIGH**	If the supply voltage is above set upper limit value 1 (MP 102.01) the value calculated from the DBR curve is multiplied by 0.8 and injection start is delayed by 5°	Check battery/generator	✓	✓

No.	Fault display	Meaning/cause	Counteraction	2000	4000
121	L2 SUPPLY VOLT. HIGH	If the supply voltage is above the set upper limit value 2 (MP 102.03) the engine is stopped, if configured (in MP 102.14 = T)	Check battery/generator	✓	✓
122	L1 T-ELECTRONIC	ECU temperature too high (first limit value exceeded)	Check electronics environment (heat accumulation)	✓	✓
123	*(Not used)*				
124	*(Not used)*				
125	*(Not used)*				
126	*(Not used)*				
127	*(Not used)*				
128	*(Not used)*				
129	*(Not used)*				
130	*(Not used)*				
131	*(Not used)*				
132	*(Not used)*				
133	*(Not used)*				
134	15V POS ECU DEFECT	Internal electronics failure → engine stop due to electronics failure	Replace Engine Control Unit ECU See ID: T-E-G24-0001 Page 40	✓	✓
135	*(Not used)*				
136	15V NEG ECU DEFECT	Internal electronics failure → engine stop due to electronics failure	Replace Engine Control Unit ECU See ID: T-E-G24-0001 Page 40	✓	✓

No.	Fault display	Meaning/cause	Counteraction	2000	4000
137	L1 5V BUFFER TEST	This fault can have various causes: 1. Pressure sensor fault 2. Sensor wiring 3. Internal electronics failure	Fault analysis for internal electronic fault: Disconnect connectors X2 and X3, ECU is faulty if fault message remains. Fault analysis of pressure sensors: Disconnect pressure sensors one after the other and pinpoint which sensor causes the fault. If both measures prove unsuccessful the fault lies in the cable harness.	✓	✓
138	SENSORPOWERDEFECT	This fault can have various causes: 1. Pressure sensor fault 2. Sensor wiring 3. Internal electronics failure	Fault analysis for internal electronic fault: Disconnect connectors X2 and X3, ECU is faulty if fault message remains. Fault analysis of pressure sensors: Disconnect pressure sensors one after the other and pinpoint which sensor causes the fault. If both measures prove unsuccessful the fault lies in the cable harness.	✓	✓
139	L1 TE BUFFER TEST	Internal electronics failure → Sensor defect – alarm for dependent sensors, temperature values are set to default values	1. Sensor defect ➧ Electronics service 2. Electronics faulty Replace Engine Control Unit ECU See ID: T-E-G24-0001 Page 40	✓	✓
140	TE BUF. ECU DEFECT	Internal electronics failure → Sensor defect – alarm for dependent sensors, temperature values are set to default values	1. Sensor defect ➧ Electronics service 2. Electronics faulty Replace Engine Control Unit ECU See ID: T-E-G24-0001 Page 40	✓	✓
141	*(Not used)*				

No.	Fault display	Meaning/cause	Counteraction	2000	4000
142	BANK1 ECU DEFECT	Internal electronics failure → engine does not start, electronics faulty, test with engine at standstill only	Replace Engine Control Unit ECU See ID: T-E-G24-0001 Page 40	✓	✓
143	*(Not used)*				
144	BANK2 ECU DEFECT	Internal electronics failure → engine does not start, electronics faulty, test with engine at standstill only	Replace Engine Control Unit ECU See ID: T-E-G24-0001 Page 40	✓	✓
145	15V_GOOD ECU DEFECT	Internal electronics fault → engine stop due to electronics failure	Replace Engine Control Unit ECU See ID: T-E-G24-0001 Page 40	✓	✓
146	*(Not used)*				
147	AD-TEST1 ECU DEFECT	Internal electronics failure → engine stop due to electronics failure	Replace Engine Control Unit ECU See ID: T-E-G24-0001 Page 40	✓	✓
148	*(Not used)*				
149	AD-TEST2 ECU DEFECT	Internal electronics failure → engine stop due to electronics failure	Replace Engine Control Unit ECU See ID: T-E-G24-0001 Page 40	✓	✓
150	*(Not used)*				
151	AD-TEST3 ECU DEFECT	Internal electronics failure → engine stop due to electronics failure	Replace Engine Control Unit ECU See ID: T-E-G24-0001 Page 40	✓	✓
152	*(Not used)*				
153	*(Not used)*				
154	*(Not used)*				
155	*(Not used)*				
156	*(Not used)*				
157	*(Not used)*				
158	*(Not used)*				
159	*(Not used)*				
160	*(Not used)*				

No.	Fault display	Meaning/cause	Counteraction	2000	4000
161	*(Not used)*				
162	*(Not used)*				
163	*(Not used)*				
164	*(Not used)*				
165	*(Not used)*				
166	*(Not used)*				
167	*(Not used)*				
168	*(Not used)*				
169	*(Not used)*				
170	**MI MODULE FAIL**	Module in maintenance indicator faulty or missing	Check whether the MI is properly installed ➧ Electronics service	✓	✓
171	**MI NOT ACTIVE**	Maintenance indicator no longer active	Check whether the MI is properly installed ➧ Electronics service	✓	✓
172	*(Not used)*				
173	**MODULE WRITE LIMIT**	EEPROM write limit reached	➧ Electronics service	✓	✓
174	*(Not used)*				
175	*(Not used)*				
176	*(Not used)*				
177	*(Not used)*				
178	*(Not used)*				
179	*(Not used)*				
180	**CAN1 NODE LOST**	At least one Alive PDU on CAN 1 monitored by the ECU is missing → connected device out of order		✓	✓
181	**CAN2 NODE LOST**	At least one Alive PDU on CAN 2 monitored by the ECU is missing → connected device out of order		✓	✓
182	*(Not used)*				

No.	Fault display	Meaning/cause	Counteraction	2000	4000
183	CAN NO PU-DATA	A CAN mode is selected in which communication is initialized with the help of the PU data module. However, the required PU data module is missing or invalid.	Test the devices connected to the CAN Download again via BDM ➧ Electronics service	✓	✓
184	CAN PU-DATA EE-FAIL	A programming error occurred in one or both modules on attempting to copy a received PU data module in both EEPROM modules.	➧ Electronics service	✓	✓
185	CAN LESS MAILBO-XES	Insufficient receiving mail-boxes ready on one or both CAN controllers on initializing the receiving identifiers.	➧ Electronics service	✓	✓
186	CAN1 BUS OFF	CAN controller 1 in bus off state → automatic switching to CAN 2	Causes are e.g. short-circuit, major disruptions or baud rate incompatibility	✓	✓
187	CAN1 ERROR PAS-SIVE	CAN controller 1 has signalled a warning	Causes are e.g. missing nodes, minor disruptions or temporary bus overloading	✓	✓
188	CAN2 BUS OFF	CAN controller 2 in bus off state → automatic switching to CAN 1	Causes are e.g. short-circuit, major disruptions or baud rate incompatibility	✓	✓
189	CAN2 ERROR PAS-SIVE	CAN controller 2 has signalled a warning	Causes are e.g. missing nodes, minor disruptions or temporary bus overloading	✓	✓
190	*(Not used)*				
191	*(Not used)*				
192	*(Not used)*				
193	*(Not used)*				
194	*(Not used)*				
195	*(Not used)*				
196	*(Not used)*				

No.	Fault display	Meaning/cause	Counteraction	2000	4000
197	*(Not used)*				
198	*(Not used)*				
199	*(Not used)*				
200	*(Not used)*				
201	SD T-COOLANT	Sensor defect (coolant temperature)	Short-circuit or wire breakage, check sensor and wiring to B6 ➧ Electronics service	✓	✓
202	SD T-FUEL	Sensor defect (fuel temperature)	Short-circuit or wire breakage, check sensor and wiring to B33 ➧ Electronics service	✓	✓
203	SD T-CHARGE AIR	Sensor defect (charge air temperature)	Short-circuit or wire breakage, check sensor and wiring to B9 ➧ Electronics service	✓	✓
204	*(Not used)*				
205	SD T-COOLANT INTERC.	Sensor defect (charge air coolant temperature)	Short-circuit or wire breakage, check sensor and wiring to B26 ➧ Electronics service	✓	✓
206	*(Not used)*				
207	*(Not used)*				
208	SD P-CHARGE AIR	Sensor defect (charge pressure)	Short-circuit or wire breakage, check sensor and wiring to B10 ➧ Electronics service	✓	✓
209	*(Not used)*				
210	*(Not used)*				
211	SD P-LUBE OIL	Sensor defect (lube oil pressure)	Short-circuit or wire breakage, check sensor and wiring to B5 ➧ Electronics service	✓	✓
212	*(Not used)*				
213	*(Not used)*				
214	*(Not used)*				

No.	Fault display	Meaning/cause	Counteraction	2000	4000
215	SD P-RAIL FUEL	Sensor defect (Rail pressure) → high pressure governor emergency operation	Short-circuit or wire breakage, check sensor and wiring to B48 ◗ Electronics service		✓
216	SD T-LUBE OIL	Sensor defect (lube oil temperatur)	Short-circuit or wire breakage, check sensor and wiring to B7 ◗ Electronics service	✓	✓
217	*(Not used)*				
218	*(Not used)*				
219	*(Not used)*				
220	SD COOLANT LEVEL	Sensor defect (coolant level)	Short-circuit or wire breakage, check sensor and wiring to F33 ◗ Electronics service **Note:** If a sensor cable connector has been temporarily disconnected and then reconnected (e.g. next to the ECU), this fault message is signalled for a further approx. 60 min. The fault can be immediately cleared by switching the system off and back on.	✓	✓
221	*(Not used)*				
222	*(Not used)*				
223	SD LEVEL INTER-COOLER	Sensor defect (charge air coolant level)	Short-circuit or wire breakage, check sensor and wiring to F57 ◗ Electronics service **Note:** If a sensor cable connector has been temporarily disconnected and then reconnected (e.g. next to the ECU), this fault message is signalled for a further approx. 60 min. The fault can be immediately cleared by switching the system off and back on.		✓
224	*(Not used)*				

No.	Fault display	Meaning/cause	Counteraction	2000	4000
225	*(Not used)*				
226	*(Not used)*				
227	*(Not used)*				
228	*(Not used)*				
229	**SD ENG.SPEED SENSORS**	Sensor defect crankcase speed and sensor defect camshaft speed	Compare alarms 230 and 231	✓	✓
230	**SD CRANKSHAFT SPEED**	Sensor defect (crankshaft speed)	Short-circuit or wire breakage, check sensor and wiring to B13 ➧ Electronics service	✓	✓
231	**SD CAMSHAFT SPEED**	Sensor defect (camshaft speed)	Short-circuit or wire breakage, check sensor and wiring to B1 ➧ Electronics service	✓	✓
232	*(Not used)*				
233	*(Not used)*				
234	*(Not used)*				
235	*(Not used)*				
236	*(Not used)*				
237	*(Not used)*				
238	*(Not used)*				
239	*(Not used)*				
240	**SD P-FUEL**	Sensor defect (fuel pressure)	Short-circuit or wire breakage, check sensor and wiring to B34 ➧ Electronics service		✓
241	*(Not used)*				
242	*(Not used)*				
243	*(Not used)*				
244	*(Not used)*				

No.	Fault display	Meaning/cause	Counteraction	2000	4000
245	SD POWER SUPPLY	Internal ECU failure	Electronics faulty Replace Engine Control Unit ECU See ID: T-E-G24-0001 Page 40	✓	✓
246	SD T-ELECTRONIC	Internal ECU failure	Electronics faulty Replace Engine Control Unit ECU See ID: T-E-G24-0001 Page 40	✓	✓
247	*(Not used)*				
248	*(Not used)*				
249	*(Not used)*				
250	SD CAN SPEED DEMAND	Sensor defect CAN (Speed Demand) → no set speed signal, the speed is either set to a fault value (MP 180.05) or remains set to the actual speed depending on the setting at MP 180.14.		✓	✓
251	*(Not used)*				
252	*(Not used)*				
253	*(Not used)*				
254	*(Not used)*				
255	*(Not used)*				
256	*(Not used)*				
257	*(Not used)*				
258	*(Not used)*				
259	*(Not used)*				
260	*(Not used)*				
261	*(Not used)*				
262	*(Not used)*				
263	*(Not used)*				
264	*(Not used)*				

No.	Fault display	Meaning/cause	Counteraction	2000	4000
265	*(Not used)*				
266	SD SPEED DEMAND AN.	Sensor defect (analog speed setting) → speed is set to a fault value or remains set to the actual speed (adjustable, MP 180.14)	Short-circuit or wire breakage, check set speed transmitter and wiring ◗ Electronics service	✓	✓
267	SD SP.DEM.TEST BENCH	**Used in test stand mode only:** Sensor defect (analog speed setting) → speed is set to a fault value or remains set to the actual speed (adjustable, MP 180.14)	Short-circuit or wire breakage, check set speed transmitter and wiring ◗ Electronics service	✓	✓
268	*(Not used)*				
269	*(Not used)*				
270	*(Not used)*				
271	SD T-EXTERN 1	Missing Data CAN (T-EXTERN 1)	◗ Electronics service (external device faulty)	✓	✓
272	SD T-EXTERN 2	Missing Data CAN (T-EXTERN 2)	◗ Electronics service (external device faulty)	✓	✓
273	SD P-EXTERN 1	Missing Data CAN (P-EXTERN 1)	◗ Electronics service (external device faulty)	✓	✓
274	SD P-EXTERN 2	Missing Data CAN (P-EXTERN 2)	◗ Electronics service (external device faulty)	✓	✓
275	SD EXT.COOLANT LEVEL	Missing Data CAN (EXT.COOLANT LEVEL)	◗ Electronics service (external device faulty)	✓	✓
276	SD INTERCOOLER LEVEL	Missing Data CAN (charge air coolant level)	◗ Electronics service (external device faulty)	✓	✓
277	SD BIN-EXTERN 3	Missing Data CAN (BIN-EXTERN 3)	◗ Electronics service (external device faulty)	✓	✓
278	SD BIN-EXTERN 4	Missing Data CAN (BIN-EXTERN 4)	◗ Electronics service (external device faulty)	✓	✓
279	*(Not used)*				
280	*(Not used)*				
281	*(Not used)*				
282	*(Not used)*				
283	*(Not used)*				

No.	Fault display	Meaning/cause	Counteraction	2000	4000
284	*(Not used)*				
285	*(Not used)*				
286	*(Not used)*				
287	*(Not used)*				
288	*(Not used)*				
289	*(Not used)*				
290	*(Not used)*				
291	*(Not used)*				
292	*(Not used)*				
293	*(Not used)*				
294	*(Not used)*				
295	*(Not used)*				
296	*(Not used)*				
297	*(Not used)*				
298	*(Not used)*				
299	*(Not used)*				
300	*(Not used)*				
301	**TIMING CYLINDER A1**	Cylinder A1: –FPGA fault status = 2 –Time-of-flight t < 600 µs –Time-of-flight t > 1400 µs	Replace solenoid valve if this occurs frequently ➧ Engine documentation	✓	✓
302	**TIMING CYLINDER A2**	Cylinder A2: –FPGA fault status = 2 –Time-of-flight t < 600 µs –Time-of-flight t > 1400 µs	Replace solenoid valve if this occurs frequently ➧ Engine documentation	✓	✓
303	**TIMING CYLINDER A3**	Cylinder A3: –FPGA fault status = 2 –Time-of-flight t < 600 µs or –Time-of-flight t > 1400 µs	Replace solenoid valve if this occurs frequently ➧ Engine documentation	✓	✓
304	**TIMING CYLINDER A4**	Cylinder A4: –FPGA fault status = 2 –Time-of-flight t < 600 µs –Time-of-flight t > 1400 µs	Replace solenoid valve if this occurs frequently ➧ Engine documentation	✓	✓

No.	Fault display	Meaning/cause	Counteraction	2000	4000
305	TIMING CYLINDER A5	Cylinder A5: –FPGA fault status = 2 –Time-of-flight *t* < 600 µs –Time-of-flight *t* > 1400 µs	Replace solenoid valve if this occurs frequently ➧ Engine documentation	✓	✓
306	TIMING CYLINDER A6	Cylinder A6: –FPGA fault status = 2 –Time-of-flight *t* < 600 µs –Time-of-flight *t* > 1400 µs	Replace solenoid valve if this occurs frequently ➧ Engine documentation	✓	✓
307	TIMING CYLINDER A7	Cylinder A7: –FPGA fault status = 2 –Time-of-flight *t* < 600 µs –Time-of-flight *t* > 1400 µs	Replace solenoid valve if this occurs frequently ➧ Engine documentation	✓	✓
308	TIMING CYLINDER A8	Cylinder A8: –FPGA fault status = 2 –Time-of-flight *t* < 600 µs –Time-of-flight *t* > 1400 µs	Replace solenoid valve if this occurs frequently ➧ Engine documentation	✓	✓
309	TIMING CYLINDER A9	Cylinder A9: –FPGA fault status = 2 –Time-of-flight *t* < 600 µs –Time-of-flight *t* > 1400 µs	Replace solenoid valve if this occurs frequently ➧ Engine documentation	✓	✓
310	TIMING CYLINDER A10	Cylinder A10: –FPGA fault status = 2 –Time-of-flight *t* < 600 µs –Time-of-flight *t* > 1400 µs	Replace solenoid valve if this occurs frequently ➧ Engine documentation	✓	✓
311	TIMING CYLINDER B1	Cylinder B1: –FPGA fault status = 2 –Time-of-flight *t* < 600 µs –Time-of-flight *t* > 1400 µs	Replace solenoid valve if this occurs frequently ➧ Engine documentation	✓	✓
312	TIMING CYLINDER B2	Cylinder B2: –FPGA fault status = 2 –Time-of-flight *t* < 600 µs –Time-of-flight *t* > 1400 µs	Replace solenoid valve if this occurs frequently ➧ Engine documentation	✓	✓
313	TIMING CYLINDER B3	Cylinder B3: –FPGA fault status = 2 –Time-of-flight *t* < 600 µs –Time-of-flight *t* > 1400 µs	Replace solenoid valve if this occurs frequently ➧ Engine documentation	✓	✓
314	TIMING CYLINDER B4	Cylinder B4: –FPGA fault status = 2 –Time-of-flight *t* < 600 µs –Time-of-flight *t* > 1400 µs	Replace solenoid valve if this occurs frequently ➧ Engine documentation	✓	✓
315	TIMING CYLINDER B5	Cylinder B5: –FPGA fault status = 2 –Time-of-flight *t* < 600 µs –Time-of-flight *t* > 1400 µs	Replace solenoid valve if this occurs frequently ➧ Engine documentation	✓	✓

No.	Fault display	Meaning/cause	Counteraction	2000	4000
316	**TIMING CYLINDER B6**	Cylinder B6: –FPGA fault status = 2 –Time-of-flight t < 600 µs –Time-of-flight t > 1400 µs	Replace solenoid valve if this occurs frequently ➧ Engine documentation	✓	✓
317	**TIMING CYLINDER B7**	Cylinder B7: –FPGA fault status = 2 –Time-of-flight t < 600 µs –Time-of-flight t > 1400 µs	Replace solenoid valve if this occurs frequently ➧ Engine documentation	✓	✓
318	**TIMING CYLINDER B8**	Cylinder B8: –FPGA fault status = 2 –Time-of-flight t < 600 µs –Time-of-flight t > 1400 µs	Replace solenoid valve if this occurs frequently ➧ Engine documentation	✓	✓
319	**TIMING CYLINDER B9**	Cylinder B9: –FPGA fault status = 2 –Time-of-flight t < 600 µs –Time-of-flight t > 1400 µs	Replace solenoid valve if this occurs frequently ➧ Engine documentation	✓	✓
320	**TIMING CYLINDER B10**	Cylinder B10: –FPGA fault status = 2 –Time-of-flight t < 600 µs –Time-of-flight t > 1400 µs	Replace solenoid valve if this occurs frequently ➧ Engine documentation	✓	✓
321	**WIRING CYLINDER A1**	Cabling fault cylinder A1 → misfiring	SV short-circuit or +SV line shorted to electronic ground (Requirement: Engine block grounded) Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓
322	**WIRING CYLINDER A2**	Cabling fault cylinder A2 → misfiring	SV short-circuit or +SV line shorted to electronic ground (Requirement: Engine block grounded) Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓
323	**WIRING CYLINDER A3**	Cabling fault cylinder A3 → misfiring	SV short-circuit or +SV line shorted to electronic ground (Requirement: Engine block grounded) Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓

No.	Fault display	Meaning/cause	Counteraction	2000	4000
324	WIRING CYLINDER A4	Cabling fault cylinder A4 → misfiring	SV short-circuit or +SV line shorted to electronic ground (Requirement: Engine block grounded) Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓
325	WIRING CYLINDER A5	Cabling fault cylinder A5 → misfiring	SV short-circuit or +SV line shorted to electronic ground (Requirement: Engine block grounded) Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓
326	WIRING CYLINDER A6	Cabling fault cylinder A6 → misfiring	SV short-circuit or +SV line shorted to electronic ground (Requirement: Engine block grounded) Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓
327	WIRING CYLINDER A7	Cabling fault cylinder A7 → misfiring	SV short-circuit or +SV line shorted to electronic ground (Requirement: Engine block grounded) Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓
328	WIRING CYLINDER A8	Cabling fault cylinder A8 → misfiring	SV short-circuit or +SV line shorted to electronic ground (Requirement: Engine block grounded) Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓

No.	Fault display	Meaning/cause	Counteraction	2000	4000
329	**WIRING CYLINDER A9**	Cabling fault cylinder A9 → misfiring	SV short-circuit or +SV line shorted to electronic ground (Requirement: Engine block grounded) Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓
330	**WIRING CYLINDER A10**	VCabling fault cylinder A10 → misfiring	SV short-circuit or +SV line shorted to electronic ground (Requirement: Engine block grounded) Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓
331	**WIRING CYLINDER B1**	Cabling fault cylinder B1 → misfiring	SV short-circuit or +SV line shorted to electronic ground (Requirement: Engine block grounded) Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓
332	**WIRING CYLINDER B2**	Cabling fault cylinder B2 → misfiring	SV short-circuit or +SV line shorted to electronic ground (Requirement: Engine block grounded) Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓
333	**WIRING CYLINDER B3**	Cabling fault cylinder B3 → misfiring	SV short-circuit or +SV line shorted to electronic ground (Requirement: Engine block grounded) Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓

No.	Fault display	Meaning/cause	Counteraction	2000	4000
334	WIRING CYLINDER B4	Cabling fault cylinder B4 → misfiring	SV short-circuit or +SV line shorted to electronic ground (Requirement: Engine block grounded) Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓
335	WIRING CYLINDER B5	Cabling fault cylinder B5 → misfiring	SV short-circuit or +SV line shorted to electronic ground (Requirement: Engine block grounded) Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓
336	WIRING CYLINDER B6	Cabling fault cylinder B6 → misfiring	SV short-circuit or +SV line shorted to electronic ground (Requirement: Engine block grounded) Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓
337	WIRING CYLINDER B7	Cabling fault cylinder B7 → misfiring	SV short-circuit or +SV line shorted to electronic ground (Requirement: Engine block grounded) Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓
338	WIRING CYLINDER B8	Cabling fault cylinder B8 → misfiring	SV short-circuit or +SV line shorted to electronic ground (Requirement: Engine block grounded) Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓

No.	Fault display	Meaning/cause	Counteraction	2000	4000
339	WIRING CYLINDER B9	Cabling fault cylinder B9 → misfiring	SV short-circuit or +SV line shorted to electronic ground (Requirement: Engine block grounded) Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓
340	WIRING CYLINDER B10	Cabling fault cylinder B10 → misfiring	SV short-circuit or +SV line shorted to electronic ground (Requirement: Engine block grounded) Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓
341	OPEN_LOAD CYL. A1	Fault (interruption) in cabling of cylinder A1 → misfiring	Check cabling and solenoid valve for interruption Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓
342	OPEN_LOAD CYL. A2	Fault (interruption) in cabling of cylinder A2 → misfiring	Check cabling and solenoid valve for interruption Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓
343	OPEN_LOAD CYL. A3	Fault (interruption) in cabling of cylinder A3 → misfiring	Check cabling and solenoid valve for interruption Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓
344	OPEN_LOAD CYL. A4	Fault (interruption) in cabling of cylinder A4 → misfiring	Check cabling and solenoid valve for interruption Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓
345	OPEN_LOAD CYL. A5	Fault (interruption) in cabling of cylinder A5 → misfiring	Check cabling and solenoid valve for interruption Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓

No.	Fault display	Meaning/cause	Counteraction	2000	4000
346	OPEN_LOAD CYL. A6	Fault (interruption) in cabling of cylinder A6 → misfiring	Check cabling and solenoid valve for interruption Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓
347	OPEN_LOAD CYL. A7	Fault (interruption) in cabling of cylinder A7 → misfiring	Check cabling and solenoid valve for interruption Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓
348	OPEN_LOAD CYL. A8	Fault (interruption) in cabling of cylinder A8 → misfiring	Check cabling and solenoid valve for interruption Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓
349	OPEN_LOAD CYL. A9	Fault (interruption) in cabling of cylinder A9 → misfiring	Check cabling and solenoid valve for interruption Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓
350	OPEN_LOAD CYL. A10	Fault (interruption) in cabling of cylinder A10 → misfiring	Check cabling and solenoid valve for interruption Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓
351	OPEN_LOAD CYL. B1	Fault (interruption) in cabling of cylinder B1 → misfiring	Check cabling and solenoid valve for interruption Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓
352	OPEN_LOAD CYL. B2	Fault (interruption) in cabling of cylinder B2 → misfiring	Check cabling and solenoid valve for interruption Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓

No.	Fault display	Meaning/cause	Counteraction	2000	4000
353	OPEN_LOAD CYL. B3	Fault (interruption) in cabling of cylinder B3 → misfiring	Check cabling and solenoid valve for interruption Replace solenoid valve or cable harness ◗ Engine documentation	✓	✓
354	OPEN_LOAD CYL. B4	Fault (interruption) in cabling of cylinder B4 → misfiring	Check cabling and solenoid valve for interruption Replace solenoid valve or cable harness ◗ Engine documentation	✓	✓
355	OPEN_LOAD CYL. B5	Fault (interruption) in cabling of cylinder B5 → misfiring	Check cabling and solenoid valve for interruption Replace solenoid valve or cable harness ◗ Engine documentation	✓	✓
356	OPEN_LOAD CYL. B6	Fault (interruption) in cabling of cylinder B6 → misfiring	Check cabling and solenoid valve for interruption Replace solenoid valve or cable harness ◗ Engine documentation	✓	✓
357	OPEN_LOAD CYL. B7	Fault (interruption) in cabling of cylinder B7 → misfiring	Check cabling and solenoid valve for interruption Replace solenoid valve or cable harness ◗ Engine documentation	✓	✓
358	OPEN_LOAD CYL. B8	Fault (interruption) in cabling of cylinder B8 → misfiring	Check cabling and solenoid valve for interruption Replace solenoid valve or cable harness ◗ Engine documentation	✓	✓
359	OPEN_LOAD CYL. B9	Fault (interruption) in cabling of cylinder B9 → misfiring	Check cabling and solenoid valve for interruption Replace solenoid valve or cable harness ◗ Engine documentation	✓	✓

No.	Fault display	Meaning/cause	Counteraction	2000	4000
360	OPEN_LOAD CYL. B10	Fault (interruption) in cabling of cylinder B10 → misfiring	Check cabling and solenoid valve for interruption Replace solenoid valve or cable harness ➧ Engine documentation	✓	✓
361	POWER STAGE FAIL 1	Internal electronics failure (if fault permanently applied) → possible quantity limitation	PA circuit faulty or free-wheeling transistor short-circuit Replace Engine Control Unit ECU See ID: T-E-G24-0001 Page 40	✓	✓
362	POWER STAGE FAIL 2	Internal electronics failure (if fault permanently applied) → possible quantity limitation	PA circuit faulty or free-wheeling transistor short-circuit Replace Engine Control Unit ECU See ID: T-E-G24-0001 Page 40	✓	✓
363	STOP POWER STAGE 1	Internal electronics failure (FPGA messages 4,5,9,11,12) → engine stop	1. SV line shorted to electronic ground by resistance less than 1 Ohm (engine block applied to electronic ground) Replace cable harness ➧ Engine documentation 2. Electronics faulty Replace Engine Control Unit ECU See ID: T-E-G24-0001 Page 40	✓	✓
364	STOP POWER STAGE 2	Internal electronics failure (FPGA messages 4,5,9,11,12) → engine stop	1. SV line shorted to electronic ground by resistance less than 1 Ohm (engine block applied to electronic ground) Replace cable harness ➧ Engine documentation 2. Electronics faulty Replace Engine Control Unit ECU See ID: T-E-G24-0001 Page 40	✓	✓

No.	Fault display	Meaning/cause	Counteraction	2000	4000
365	**STOP MV-WIRING**	Solenoid valve wiring fault → engine stop	SV line shorted to electronic ground (engine block applied to electronic ground) Replace cable harness ➧ Engine documentation	✓	✓
366	*(Not used)*				
367	*(Not used)*				
368	*(Not used)*				
369	*(Not used)*				
370	*(Not used)*				
371	*(Not used)*				
372	*(Not used)*				
373	*(Not used)*				
374	*(Not used)*				
375	*(Not used)*				
376	*(Not used)*				
377	*(Not used)*				
378	*(Not used)*				
379	*(Not used)*				
380	*(Not used)*				
381	**TRAN.OUT1 PLANT DEF**	TAA1 faulty	1. Wire breakage or short-circuit Replace cable harness ➧ Engine documentation 2. Electronics faulty Replace Engine Control Unit ECU See ID: T-E-G24-0001 Page 40	✓	✓

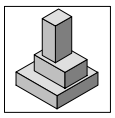
No.	Fault display	Meaning/cause	Counteraction	2000	4000
382	TRAN.OUT2 PLANT DEF	TAA2 faulty	1. Wire breakage or short-circuit Replace cable harness ➧ Engine documentation 2. Electronics faulty Replace Engine Control Unit ECU See ID: T-E-G24-0001 Page 40	✓	✓
383	TRAN.OUT3 PLANT DEF	TAA3 faulty	1. Wire breakage or short-circuit Replace cable harness ➧ Engine documentation 2. Electronics faulty Replace Engine Control Unit ECU See ID: T-E-G24-0001 Page 40	✓	✓
384	TRAN.OUT4 PLANT DEF	TAA4 faulty	1. Wire breakage or short-circuit Replace cable harness ➧ Engine documentation 2. Electronics faulty Replace Engine Control Unit ECU See ID: T-E-G24-0001 Page 40	✓	✓
385	TRAN.OUT5 PLANT DEF	TAA5 faulty	1. Wire breakage or short-circuit Replace cable harness ➧ Engine documentation 2. Electronics faulty Replace Engine Control Unit ECU See ID: T-E-G24-0001 Page 40	✓	✓

No.	Fault display	Meaning/cause	Counteraction	2000	4000
386	TRAN.OUT6 PLANT DEF	TAA6 faulty	1. Wire breakage or short-circuit Replace cable harness ➧ Engine documentation 2. Electronics faulty Replace Engine Control Unit ECU See ID: T-E-G24-0001 Page 40	✓	✓
387	*(Not used)*				
388	*(Not used)*				
389	*(Not used)*				
390	*(Not used)*				
391	*(Not used)*				
392	*(Not used)*				
393	*(Not used)*				
394	*(Not used)*				
395	*(Not used)*				
396	*(Not used)*				
397	*(Not used)*				
398	*(Not used)*				
399	*(Not used)*				

3.4.2.1 Replacing Engine Control Unit ECU

ID no.: T-E-G24-0001

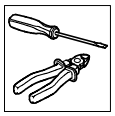
Duration: 15 min Qualification: E1



System components/devices

OK ?

- Engine Control Unit ECU on the engine ❒
- New Engine Control Unit ECU ❒
- Suitably programmed memory modules as necessary (see below) ❒



Equipment

OK ?

- A set of screwdrivers ❒
- A set of Allen wrenches ❒
- Connector pliers ❒

Additional safety notes

OK ?

- There are two memory modules in Engine Control Unit ECU. One contains a data record which is only valid for the engine for which this particular ECU is used. The other contains data about the system (so-called plant data). It is absolutely vital that these memory modules be transferred from the old ECU to the new ECU. The engine is not properly controlled if these instructions are ignored and an incorrect data record is used. ❒
- The operating voltage must be switched off. ❒

List of activities

		ID no.	OK ?
1.	Switching off the operating voltage.	---	❒
2.	Removing the housing of Engine Control Unit ECU from the engine.	A-E-G24-0001 Page 42	❒
3.	Opening the cover on Engine Control Unit ECU.	A-P-ECU-0006 Page 43	❒
4.	Transferring memory modules in Engine Control Unit ECU.	A-E-ECU-0011 Page 44	❒
5.	Fitting the cover on Engine Control Unit ECU.	A-P-ECU-0007 Page 46	❒
6.	Mounting the housing of Engine Control Unit ECU on the engine.	A-E-G24-0002 Page 47	❒
7.	Performing function testing.	---	❒

Additional information

OK ?

- Inform MTU customer service if a fault message appears indicating an invalid data record after replacing the ECU. A valid data record must be programmed in this case (specialist personnel!) or suitably programmed modules ordered and inserted.

CAUTION

Destruction by electrostatic charging

(C)MOS components and assemblies equipped with (C)MOS components can be destroyed by electrostatic charging. Therefore:

- Personnel, tools and the work surfaces must be electrostatically discharged by contact with grounded metal parts prior to contact with electronic components or assemblies.
- Avoid touching electronic components or assemblies with non-conductive materials.
- Never change components or assemblies when live.

3.4.2.1.1 Removing the housing of Engine Control Unit ECU from the engine

ID no.: A-E-G24-0001

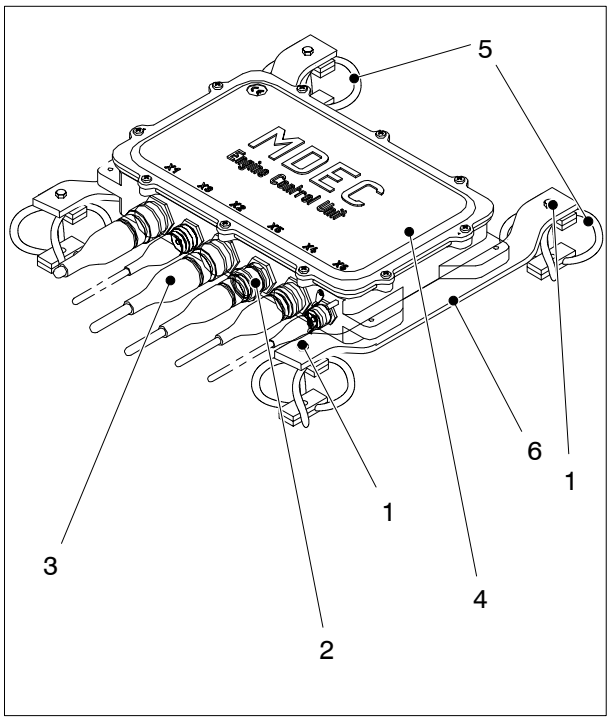


Fig. 55 : Engine Control Unit ECU 4 on the engine

Engine Control Unit ECU 4 (55/4) is located directly on the engine. It is screwed on by means of various adapter brackets (55/6) which are connected to the engine via cable shock absorbers (55/5).

Note: The fixing method and the materials used depend on the engine concerned and its application. Fig. 55 is merely an example.

Proceed as follows to remove Engine Control Unit ECU:

1. Undo the connectors on the side (55/3) one after the other:
2. Turn the bayonet nut (55/2) of the connector counterclockwise.
3. Pull the connector off the housing.
4. Remove all connectors from Engine Control Unit ECU 4/S in the same way.

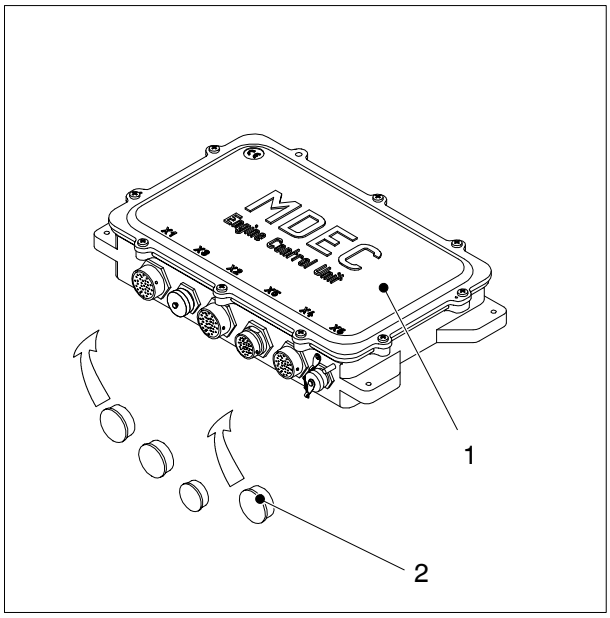


Fig. 56 : Removing Engine Control Unit ECU 4

5. Unscrew and remove the four hex-head bolts (55/1) which connect the housing of Engine Control Unit ECU 4 (55/4) to the adapter brackets (55/6) (the hex-head bolts are screwed into a thread on the cable shock absorbers).
6. Now remove the housing of Engine Control Unit ECU 4 (56/1) from the engine.
7. Close off the connector sockets using (plastic) caps (56/2) whenever the housing of Engine Control Unit ECU 4 is not mounted on the engine and no plugs are connected in order to protect the connector sockets from dirt.

3.4.2.1.2 Opening the cover on Engine Control Unit ECU

ID no.: A-E-ECU-0002

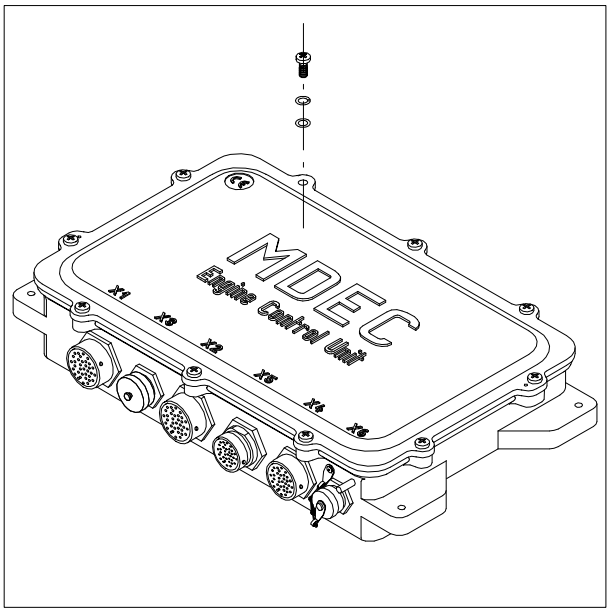


Fig. 57 : Opening the cover

1. Place Engine Control Unit ECU such that the sockets are facing towards you.
2. The cover is secured to the housing of Engine Control Unit ECU by ten Phillips screws, undo these screws one after the other using a Phillips screwdriver.
3. There is a plain washer and a spring washer under each screw; ensure that these parts are not lost or fall into the housing during removal.

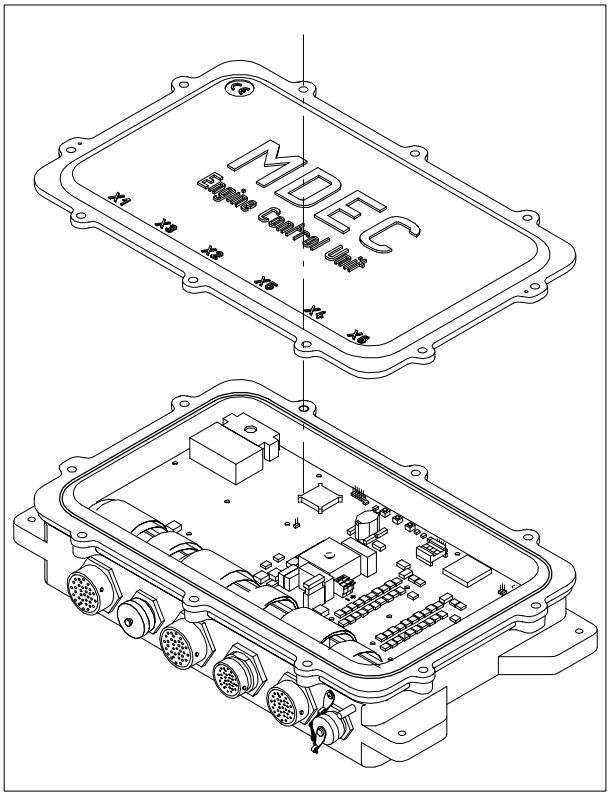


Fig. 58 : Lifting off the cover

4. Lift off the cover; take care not to damage the seal (sticking to the cover etc.).

3.4.2.1.3 Transferring memory modules in Engine Control Unit ECU

ID no.: A-E-ECU-0011

CAUTION

Danger of engine damage!

The data stored in these memory modules always applies to a specific engine (*not a type of engine,* but one *specific* engine having its own unique engine no.).

In extreme cases, mixing up the data modules may incur engine damage, the engine is not controlled properly in any case when an incorrect data module is inserted.

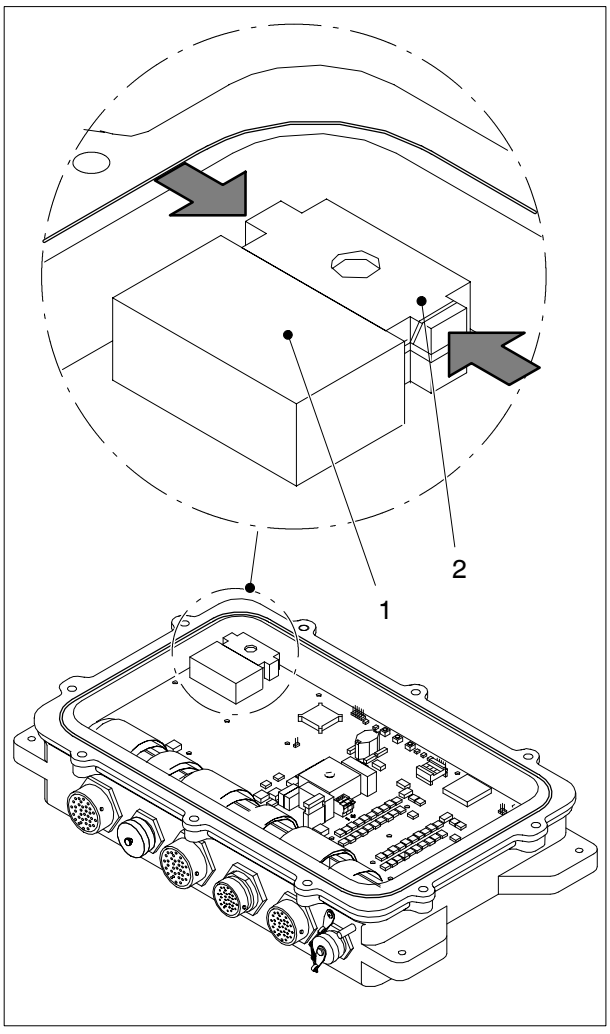


Fig. 59 : Data modules in Engine Control Unit ECU

First remove the two data modules (engine data and program memory EDM, 59/1 and interface data IDM 59/2) from the old ECU.
Proceed as follows:

1. Take hold of data module MEM 6-01 (59/1) with two fingers and pull it up off printed circuit board ECB 4-01.
2. Press the two catches on the snap-in clips of data module MEM 7 (59/2) at the back together in the direction indicated by the arrow using thumb and forefinger.
3. Pull the data module up out of its socket.
4. Remove the two (unprogrammed!) data modules from the new ECU in the same way.
5. Install the two data modules from the old ECU in the new ECU; proceed in accordance with steps 6. through 8.

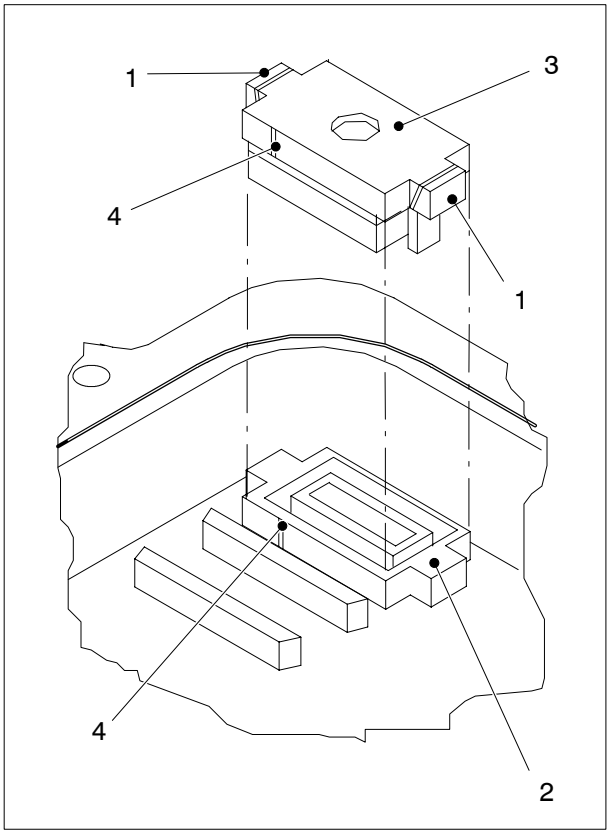


Fig. 60 : Inserting Interface Data Module IDM (MEM 7)

CAUTION

Check polarity!
There is a line (60/4) marking pin 1 on the Interface Data Module IDM and its socket; these two lines must match up.

6. Press the data module (60/3) at the back into the socket on printed circuit board ECB 4-01 (60/2) until the snap-in clips (60/1) engage.
7. Place the data module MEM 6-01 (61/1) at the front on the two connector strips (61/2) on printed circuit board ECB 4-01.

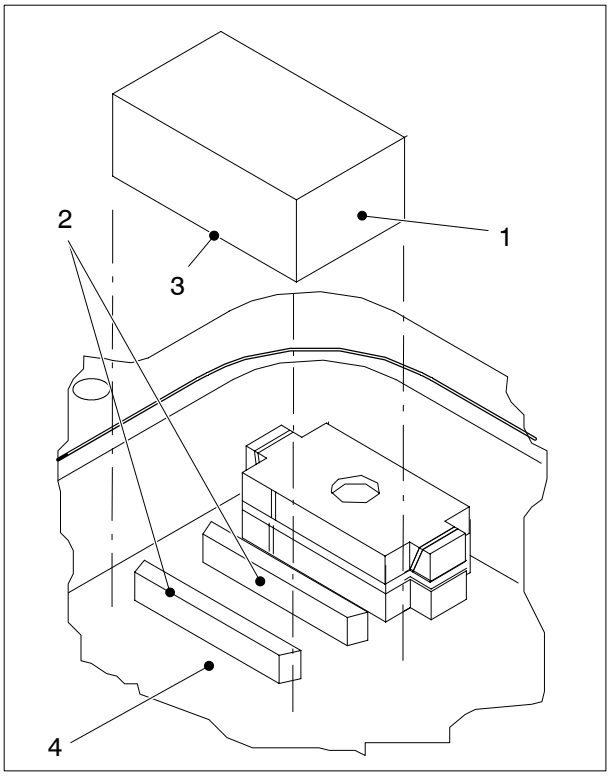


Fig. 61 : Inserting engine data and program memory module EDM (MEM 6-01)

CAUTION

Check polarity!
Data module MEM 6-01 (61/1) cannot be pressed into the connector strips if it is incorrectly positioned. Turn it through 180° in this case.
Forcing the module into the connector strips will destroy it.

8. Carefully press data module MEM 6-01 (61/1) into the connector strips as far as it will go.

3.4.2.1.4 Fitting the cover on Engine Control Unit ECU

ID no.: A-E-ECU-0006

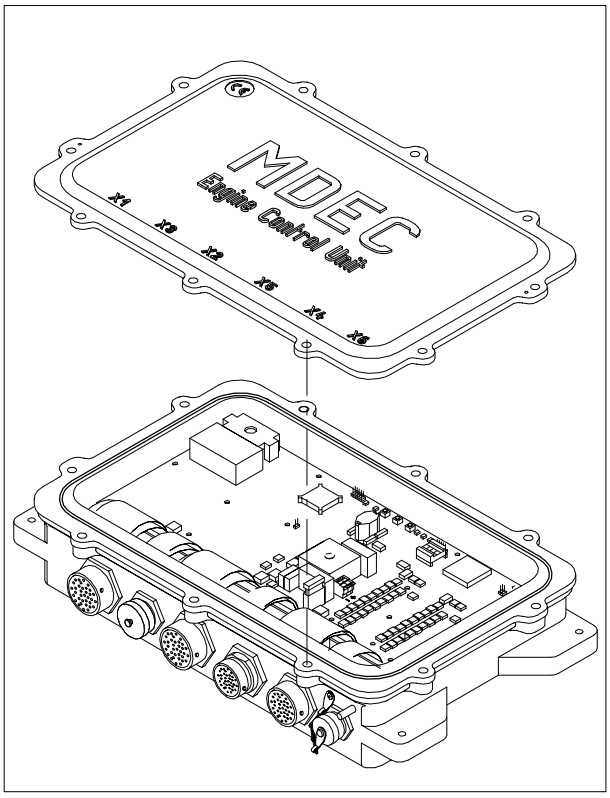


Fig. 62 : Fitting the cover

1. Check that the round seal is not damaged, otherwise replace it.
2. Ensure that the seal is properly seated in the groove in the housing all the way round.
3. Fit the cover on the housing of Engine Control Unit ECU ensuring that it is the right way round; place the cover on the housing such that the connector designations face the side on which the connectors are actually located.

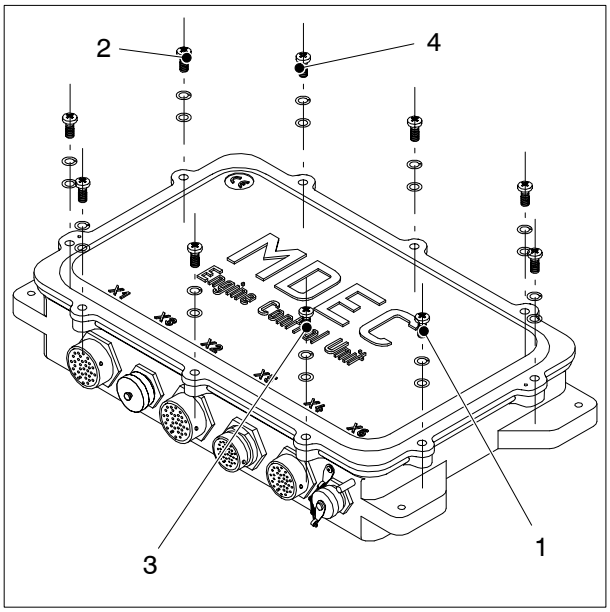


Fig. 63 : Tightening down the cover

4. Screw in the ten screws together with their respective plain washers and spring washers and tighten by hand.
5. Tighten up diagonally opposed screws consecutively (see example in fig. 63, first tighten screw (63/1), then screw (63/2) before continuing with screw (63/3) followed by screw (63/4), etc.).

3.4.2.1.5 Mounting the housing of Engine Control Unit ECU on the engine

ID no.: A-E-G24-0002

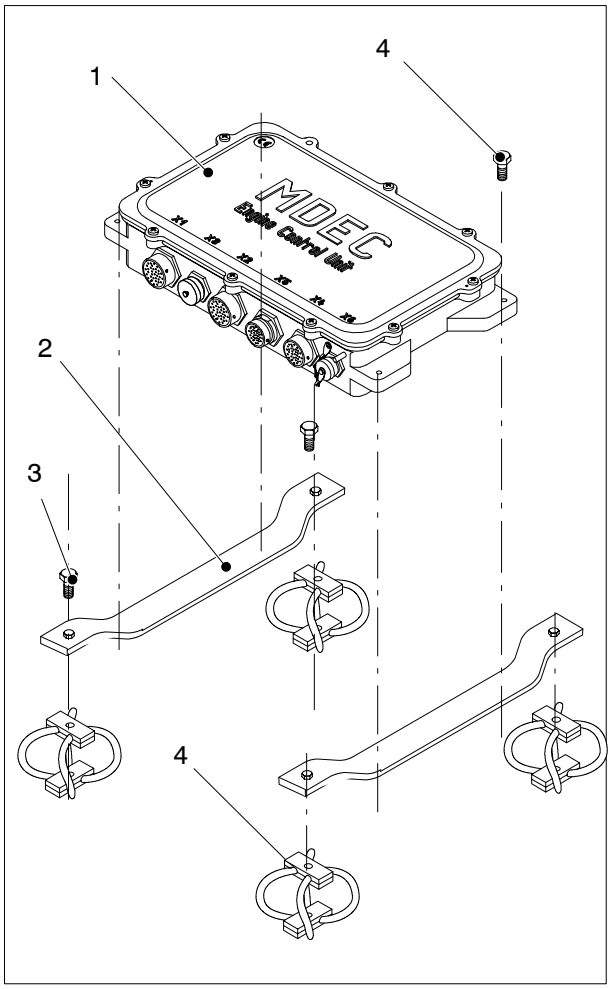


Fig. 64 : Engine Control Unit ECU 4 dismounted

1. If the four hex-head bolts (64/3) have been undone, screw them through the appropriate adapter brackets (64/2) by hand into the thread on the cable shock absorbers (64/4).

Note: The fixing method and the materials used depend on the engine concerned and its application. Fig. 64 is merely an example.

2. Tighten all four bolts with a suitable open-end wrench.
3. Place the Engine Control Unit (64/1) with the adapter brackets (64/2) on the cable shock absorbers (64/4).
4. Insert the four hex-head bolts (64/4) through the bores in the ECU and tighten them in the threads in the adapter brackets (64/2) by hand.
5. Tighten all four bolts using a suitable open-end wrench.

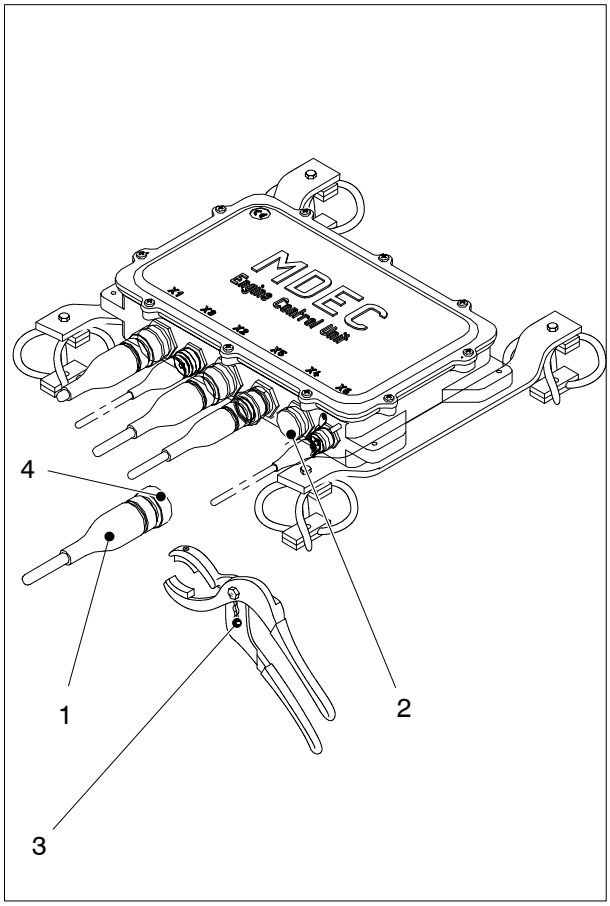


Fig. 65 : Engine Control Unit ECU 4 on the engine

6. Fit the first connector (65/1) of a cable harness on the corresponding connector socket (65/2) on Engine Control Unit ECU 4.
7. Turn the bayonet union nut (65/4) clockwise using connector pliers (65/3) until it locks into place.

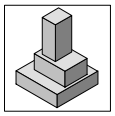
CAUTION

Do not tighten by hand!
Tightening bayonet union nuts by hand is inadequate. There is a risk of the lock not engaging properly and the connector coming loose during engine operation. For this reason, **always use connector pliers** to turn the union nuts!

3.4.2.2 Using the MDEC simulator

ID no.: T-E-G24-0002

Duration: 60 min Qualification: E1



System components/devices

OK ?

- Engine Control Unit ECU on the engine ❒
- MDEC simulator ❒

Additional safety notes

OK ?

- The engine must never be started when the simulator is connected. ❒
- The operating voltage must be switched off to connect the simulator. ❒

List of activities

		ID no.	OK ?
1.	Switch off the voltage.	---	❒
2.	Disconnect connector X2 of the cable harness on the ECU.	---	❒
3.	Connect the MDEC simulator connector to socket X2 on the ECU.	---	❒
4.	Switch on the operating voltage.	---	❒
5.	Various operating states can be simulated by adjusting the values set on the simulator. This allows you to check that the system detects these operating states correctly and responds appropriately (fault code output on PIM A 511, emergency stop by switching off the ECU operating voltage, etc.).	---	❒

The ECU channels are assigned as follows:

Sensor	Signal	ECU channel	BR 2000	BR 4000
B1	Camshaft speed	NW1	✓	✓
B5	Lube oil pressure	DE5	✓	✓
B6	Coolant temperature	TE1	✓	✓
B7	Lube oil temperature	TE7	✓	✓
B9	Charge air temperature	TE2	✓	✓
B10	Charge air pressure	DE7	✓	✓
B13	Crankshaft speed	KW1	✓	✓
B26	Intercooler coolant temperature	TE6		✓
B34	Fuel pressure low-pressure side	DE3		✓

Sensor	Signal	ECU channel	BR 2000	BR 4000
F57	Intercooler coolant level	NSE1		✓
B33	Fuel temperature high-pressure side	TE3	✓	✓
B48	Fuel pressure high-pressure side	DEH		✓
F33	Engine coolant level	NSE3	✓	✓

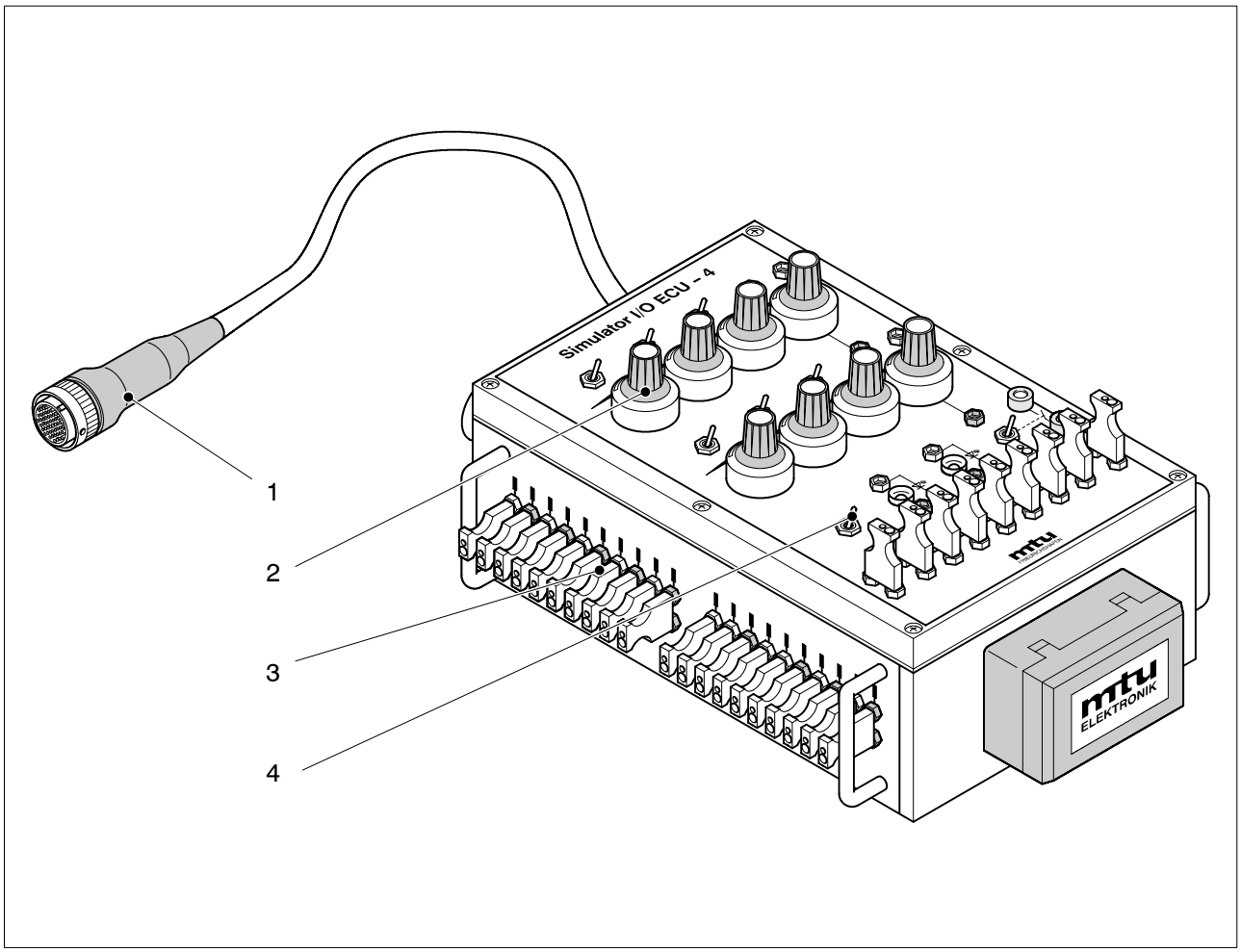


Fig. 66 : MDEC simulator

1 Connector X2
2 Potentiometer for setting analog values
3 Jumper plugs to simulate line interruption and for tapping signals (e.g. for purposes of testing)
4 Toggle switch

3.5 Maintenance

3.5.1 Maintenance overview

Periodic maintenance work on the Engine Control System

Column 2 in table 1 lists the intervals for routine maintenance work.

The maintenance intervals are adapted to the engine maintenance system.

Maintenance of electronic components by **operating personnel** (operators and plant personnel) is restricted to maintenance echelons W1 to W3. Refer to Part E of the engine documentation for details of the intervals (depending on operating hours or time).

Order	Inter-val	Task designation	Quali-ficat.	Dur./ min	Task ID	Page	Additional information/remarks
1	W1	Visual inspection, mechanical testing and cleaning	E1	20	T-M-G24-0003	52	Repair any faulty devices

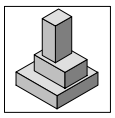
Tab. 1 : Maintenance table

Note: See fig. 51 for details of structure and navigation in this chapter.

3.5.2 Visual inspection, mechanical testing and cleaning

ID no.: T-M-G24-0003

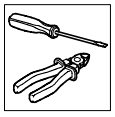
Duration: 20 min Qualification: E1



System components/devices

OK ?

- Engine Control Unit ❒
- Peripheral Interface Module PIM A 511 ❒
- Display DIS (option) ❒
- Further Peripheral Interface Modules PIM A 51x (option) ❒
- Wiring ❒



Equipment

OK ?

- Lint-free cleaning cloths (e.g. soft paper towels) ❒
- Cleaning agent for synthetic surfaces (non-corrosive), non-abrasive, solvent-free and grease-dissolving ❒

Pre-requisites

OK ?

- Overall system switched off ❒

Additional information

OK ?

- Be careful not to damage cabling when cleaning. ❒
- Reconnect cables disconnected for purposes of testing or cleaning properly. ❒

List of activities

ID no. **OK ?**

This sequence is recommended.

1. Cleaning device(s) externally if dirty. A-N-NNN-0016 Page 53 ❒
2. Checking device(s) externally. A-N-NNN-0017 Page 53 ❒

3.5.2.1 Cleaning device(s) externally

ID no.: A-N-NNN-0016

1. Clean all listed devices with the recommended expedients.
2. Renew illegible identification and inscriptions on all listed devices.

3.5.2.2 Checking device(s) externally

ID no.: A-N-NNN-0017

1. Check all listed devices externally for dirt.
2. Check all listed devices externally for visible mechanical damage.
3. Check the following:
   - No signs of moisture ingress in the housing
4. Check firm seating of all installed devices, tighten screws as necessary etc.
5. Check firm seating of connectors, cable glands, cable terminals etc. on all installed devices, engage properly or secure as necessary.

3.6 Structure of Engine Control Unit ECU 4

3.6.1 External structure

Engine Control Unit ECU 4 is enclosed in a diecast housing with a screw-fitted cover.

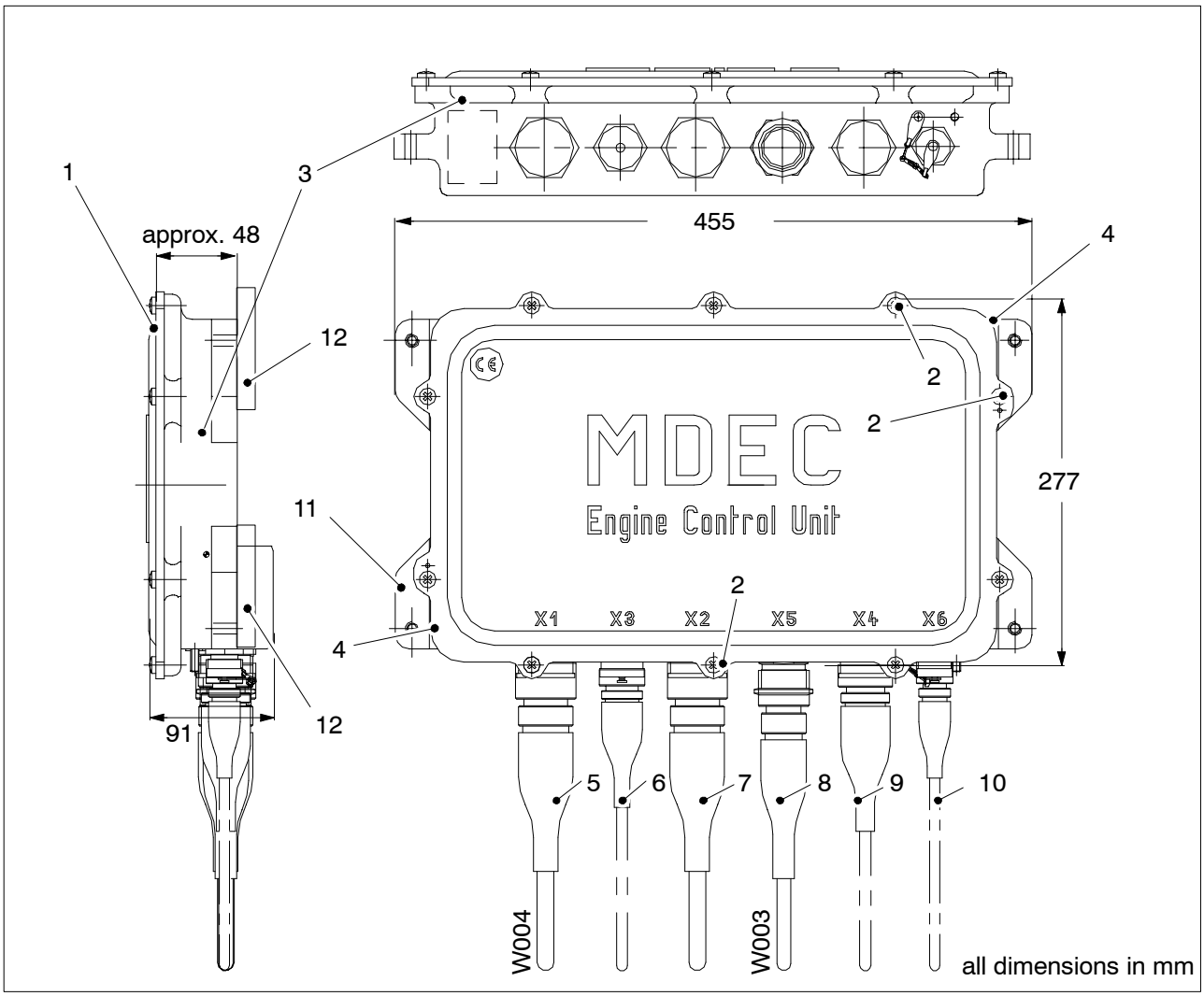


Fig. 67 : Mechanical structure

1 Cover
2 Cover screws
3 Housing
4 Seals
5 Plant connection plug
6 Cable harness connection plug
7 Extended sensor scope connection plug
8 Power supply (plant) connection plug
9 Cable harness connection plug
10 Dialog unit connection plug
11 Mounting lugs
12 Mounting plates

Four mounting lugs are used to secure Engine Control Unit ECU on the engine mounting plate. The cover is attached to the housing by means of 10 Phillips screws.

The housing is sealed by means of a round cord between the cover and the bottom part of the housing.

The connections for the plant, power supply, dialog unit and the cable harnesses are written on the housing cover. Pre-cut system cables and cable harnesses are connected to these connectors (X1 ... X6, see table below).

Electrical connections are established by means of bayonet connectors. A dust cap protects connector X6 which is not used when the engine is operational.

Dialog device connector X6 is only used for temporary connection of the dialog unit for purposes of servicing.

Precut cable harnesses equipped with connectors are used to connect engine sensors and actuators. The connectors are coded using different inserts to preclude misconnection. Connections of lines which are not in use are insulated.

Connection	**Meaning**
Connector X1 System cable W003	Plant connection (system cable to plant)
Connector X2 Cable harness W2	Connection for engine side I cable harness for sensors/actuators
Connector X3 Cable W3	Connection for engine side II cable harness for sensors/actuators
Connector X4 Cable harness W4	Connection for solenoid valve cable harness; the number of solenoid valves provided depends on the number of engine cylinders
Connector X5 System cable W005	Power supply connection (system cable to plant)
Connector X6 Dialog cable	Connection for dialog unit

3.6.2 Internal structure

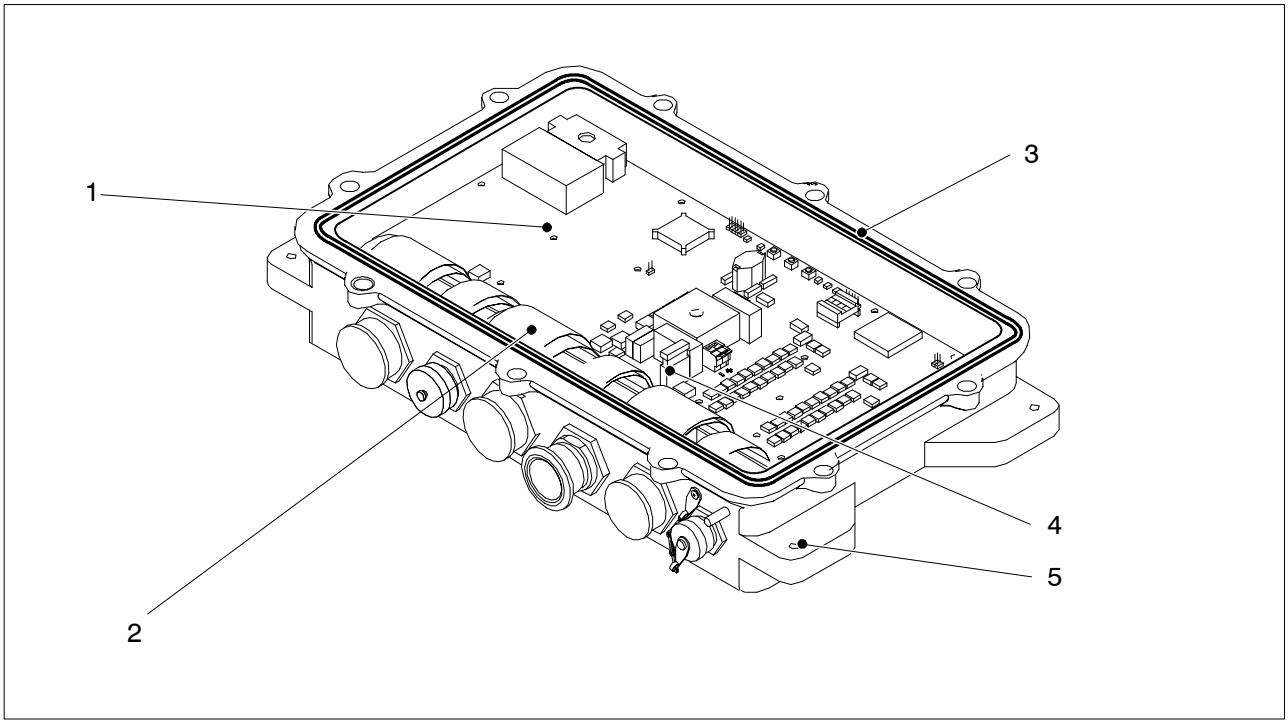


Fig. 68 : Internal structure of Engine Control Unit ECU (cover removed)

1 Printed circuit board ECB 4-01
2 Connecting cable
3 Round cord seal
4 Flat fuse
5 Housing

Printed circuit board ECB 4-01 inside the housing incorporates all electronic components (with the exception of the smoothing capacitor).

The replacable flat fuse (30 A) protects the power supply of the entire Engine Control Unit ECU 4.

Engine Control Unit ECU has no internal wiring with the exception of the capacitor connection in order to optimize operational reliability and simplify maintenance and repair.

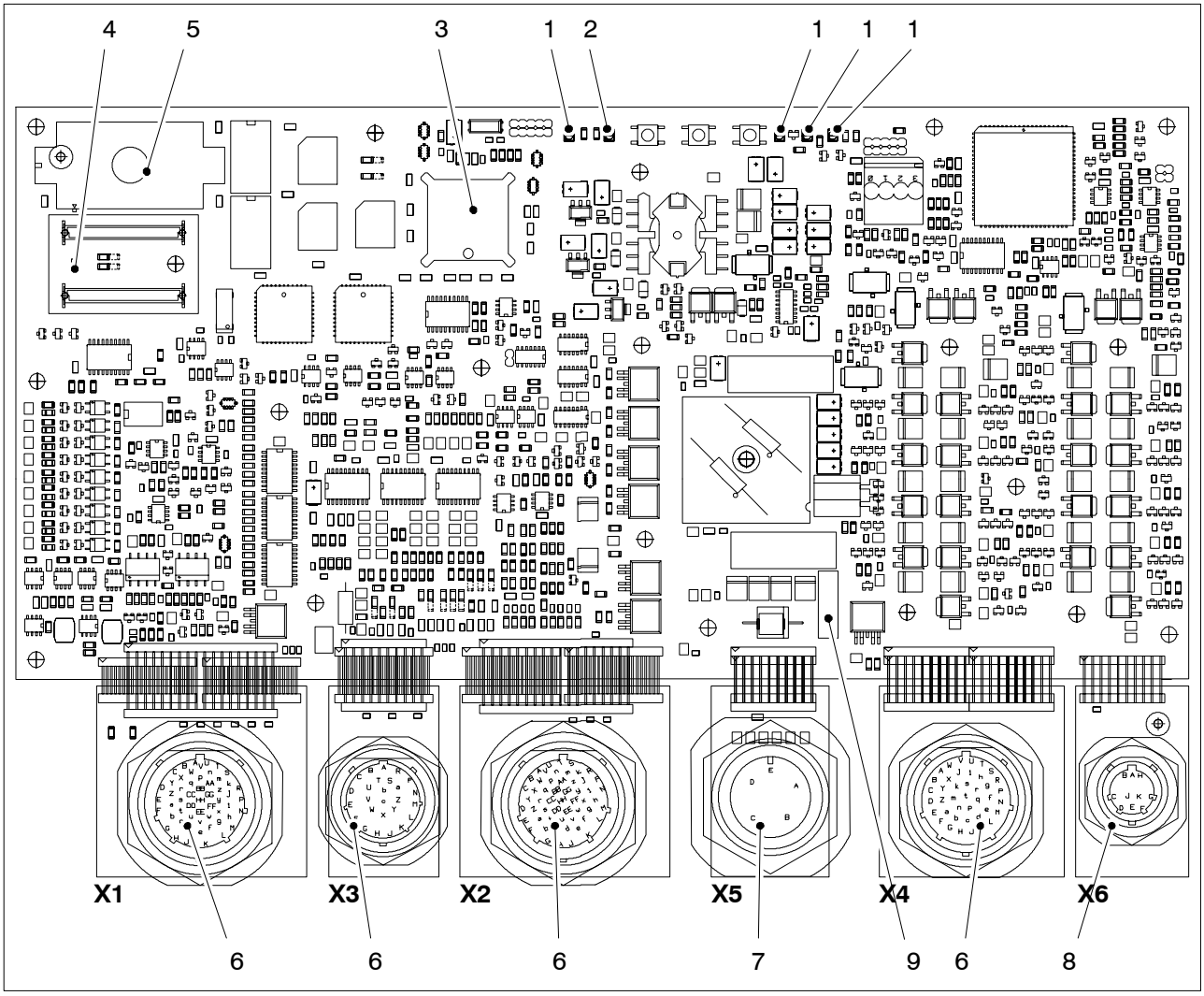


Fig. 69 : Configuration of the electronic components on printed circuit board ECB 4-01

1 LED power supply (+24 VDC, +15 VDC, –15 VDC, +5 VDC)
2 LED RESET
3 Processor
4 Engine data and program memory module EDM (MEM 6)
5 Interface data module IDM
6 Engine cable harness and plant connector
7 Power supply connector
8 Dialog unit connector
9 Fuse 30 A

The two data modules simply snap into place to facilitate replacement. The data modules are different in shape and can therefore not be confused.

(This page intentionally blank)

A Abbreviations

BR	Baureihe, series
CAN	Controller Area Network (bus system)
DIS	Display
DL	Default Lost
ECS	Engine Control System
ECU	Engine Control Unit
EMU	Engine Monitoring Unit
EMC	Electromagnetic Compatibility
ETC 2	Exhaust Turbocharger no. 2
FMEA	Failure Mode and Effects Analysis
GND	Ground
ITS	Integral Test System
kB	Kilobaud
LCD	Liquid Cristal Display
mbar	Millibar
MCS	Monitoring and Control System
MD	Missing Data
min	Minute
NiCr Ni	Nickel-Chrome Nickel
P	Pressure
PAN	Panel

Abbreviations *(cont.)*

RCS	Remote Control System
RL	Redundancy Lost
rpm	Revolutions per minute
SD	Sensor Defect
SISY	Sicherheitssystem, safety system
SS	Safety System
SYS	System
V	Volt
VAC	Volt Alternating Current
VDC	Volt Direct Current

B Connector pin assignment

Connector X1: Connector type: VPT 06 GSE 22–55 P
Target: Cable harness, plant

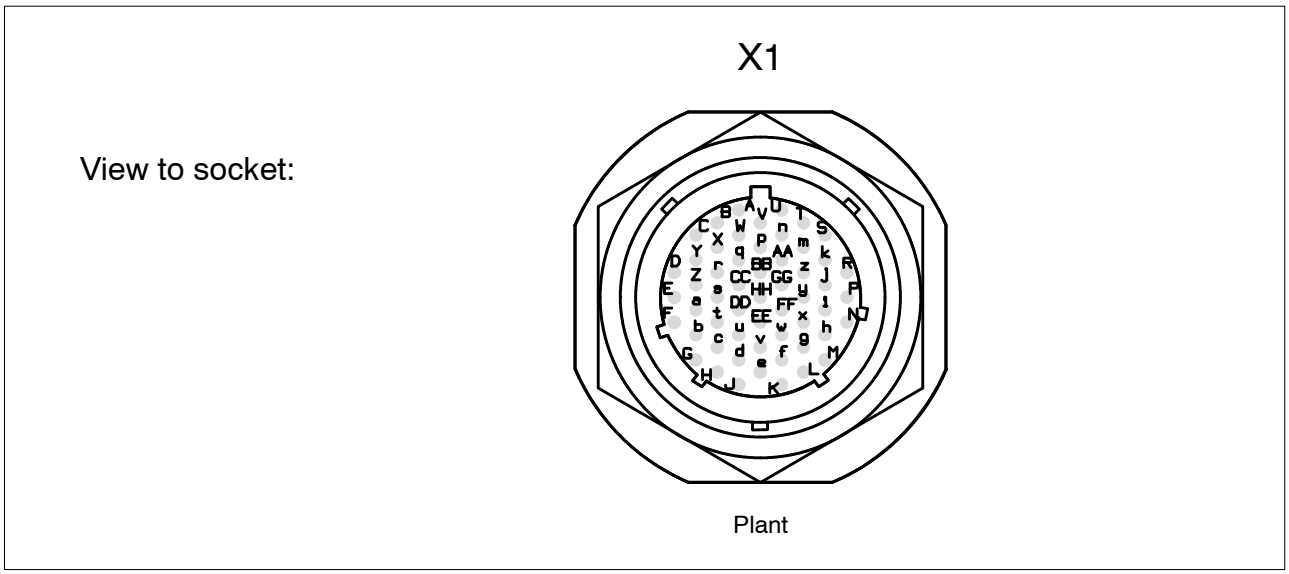


Fig. 70 : Pins connector X1

Channel	Signal	Pin	Comments
IUE1	5V_ISO	BB	5 V/20 mA electrically isolated
IUE1	U_IN	AA	0 V ... 10 V
IUE1	I_IN	X	0 V ... 23.7 mA
IUE1	GND_ISO	q	
IUE2	5V_ISO	b	5 V/20 mA electrically isolated
IUE2	U_IN	r	0 V ... 10 V
IUE2	I_IN	a	0 V ... 23.7 mA
IUE2	GND_ISO	W	
UA1	OUT	HH	0 V ... 10 V/8 mA
UA1	GND	GG	
UA2	OUT	DD	0 V ... 10 V/8 mA
UA2	GND	CC	
UA3	OUT	t	0 V ... 10 V/8 mA
UA3	GND	s	
UA4	OUT	Z	0 V ... 10 V/8 mA

Channel	Signal	Pin	Comments
UA4	GND	Y	
BE1	+IN	h	*U* <4 V = low / *U* > 8 V = high
BE1	–IN	g	Electrically isolated
BE2	+IN	x	*U* <4 V = low / *U* > 8 V = high
BE2	–IN	w	Electrically isolated
BE3	+IN	R	*U* <4 V = low / *U* > 8 V = high
BE3	–IN	P	Electrically isolated
BE4	+IN	j	*U* <4 V = low / *U* > 8 V = high
BE4	–IN	i	Electrically isolated
BE5	+IN	FF	*U* <4 V = low / *U* > 8 V = high
BE5	–IN	EE	Electrically isolated
BE6	+IN	v	*U* <4 V = low / *U* > 8 V = high
BE6	–IN	u	Electrically isolated
BE7	+IN	f	*U* <4 V = low / *U* > 8 V = high
BE7	–IN	e	Electrically isolated
BE8	+IN	d	*U* <4 V = low / *U* > 8 V = high
BE8	–IN	c	Electrically isolated
BE9	+IN	N	*U* <4 V = low / *U* > 8 V = high
BE9	–IN	M	Electrically isolated
FE1	IN	J	*U* <1.5V = low / *U* > 3.5V = high
FE1	GND	H	Frequency input
TAA1	OUT	V	24 V/600 mA
TAA1	GND	U	
TAA2	OUT	p	24 V/600 mA
TAA2	GND	n	
TAA3	OUT	T	24 V/300 mA
TAA3	GND	S	
TAA4	OUT	z	24 V/300 mA
TAA4	GND	y	

Channel	Signal	Pin	Comments
TAA5	OUT	m	24 V/300 mA
TAA5	GND	k	
TAA6	OUT	L	24 V/2 A
TAA6	GND	K	(Plant supply, moving-coil instruments FZ)
CAN1	HIGH	G	Electrically isolated
CAN1	LOW	F	
CAN1	GND	E	
CAN2	HIGH	C	Electrically isolated
CAN2	LOW	B	
CAN2	GND	D	

Note: Refer to Appendix B for detailed schematic input circuitry of the ECU (“Channel” designation in column 1).

Connector X2: Connector type: VPT 06 GSE 22-55 PW
Target: Cable harness, engine

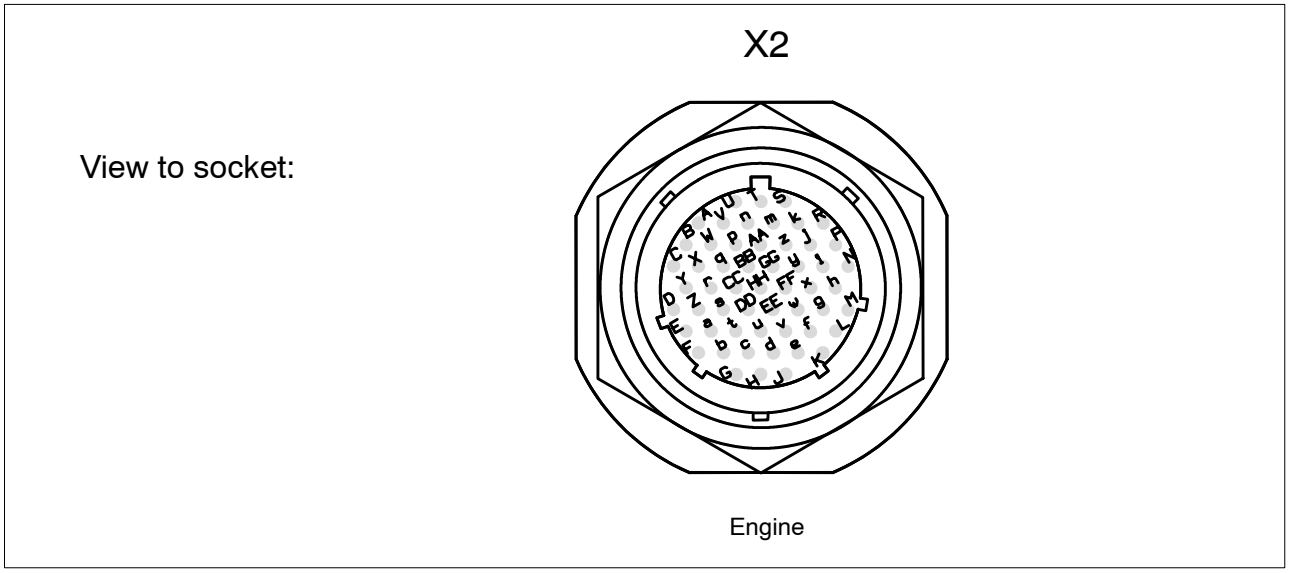


Fig. 71 : Pins connector X2

Channel	Signal	Pin	Comments
TE1	IN	k	0 V ... 5 V/internal 2k0 pullup to 5V_TE_BUF
TE1	GND	z	
TE2	IN	N	0 V ... 5 V/internal 2k0 pullup to 5V_TE_BUF
TE2	GND	P	
TE5	IN	M	0 V ... 5 V/internal 2k0 pullup to 5V_TE_BUF
TE5	GND	g	
TE6	IN	y	0 V ... 5 V/internal 2k0 pullup to 5V_TE_BUF
TE6	GND	FF	
TE7	IN	w	0 V ... 5 V/internal 2k0 pullup to 5V_TE_BUF
TE7	GND	x	
TE8	IN	t	0 V ... 5 V/internal 1k0 pullup to 5V_TE_BUF
TE8	GND	a	
TE9	IN	E	0 V ... 5 V/internal 1k0 pullup to 5V_TE_BUF
TE9	GND	F	
DE1	5V_BUF1	D	5 V/20 mA
DE1	IN	Z	0 V ... 5 V/internal 47k5 pulldown

Channel	Signal	Pin	Comments
DE1	GND	Y	
DE2	5V_BUF1	r	5 V/20 mA
DE2	IN	s	0 V ... 5 V/internal 47k5 pulldown
DE2	GND	CC	
DE3	5V_BUF2	BB	5 V/20 mA
DE3	IN	GG	0 V ... 5 V/internal 47k5 pulldown
DE3	GND	HH	
DE4	5V_BUF2	d	5 V/20 mA
DE4	IN	H	0 V ... 5 V/internal 47k5 pulldown
DE4	GND	J	
DE5	5V_BUF3	f	5 V/20 mA
DE5	IN	v	0 V ... 5 V/internal 47k5 pulldown
DE5	GND	e	
DE6	5V_BUF3	EE	5 V/20 mA
DE6	IN	DD	0 V ... 5 V/internal 47k5 pulldown
DE6	GND	u	
DE7	5V_BUF4	c	5 V/20 mA
DE7	IN	G	0 V ... 5 V/internal 47k5 pulldown
DE7	GND	b	
NSE1	24 V_NSE1	X	Sensor supply max. 300 mA
NSE1	IN	C	0 V ... 5 V/internal 47K5 pullup to 5V_TE_BUF
NSE1	GND	B	
NSE2	24 V_NSE2	W	Sensor supply max. 300 mA
NSE2	IN	q	0 V ... 5 V/internal 47K5 pullup to 5V_TE_BUF
NSE2	GND	V	
KW	+IN	m	U <0 V = low / U > 400 mV = high
KW	–IN	S	
NW	+IN	T	U <0 V = low / U > 400 mV = high
NW	–IN	n	

Channel	Signal	Pin	Comments
DME1	+IN	p	*U* <–400 mV = low / *U* > 400 mV = high
DME1	–IN	AA	
DME2	+IN	A	*U* <–400 mV = low / *U* > 400 mV = high
DME2	–IN	U	
PDM1	OUT	K	24 V/3 A
PDM1	GND	L	
TAM1	OUT	R	24 V/1.5 A
TAM1	GND	j	
TAM2	OUT	h	24 V/1.5 A
TAM2	GND	i	

Note: Refer to Appendix B for detailed schematic input circuitry of the ECU (“Channel” designation in column 1).

Connector X3: Connector type: VPT 06 GSE 16-26 P
Target: Cable harness, engine

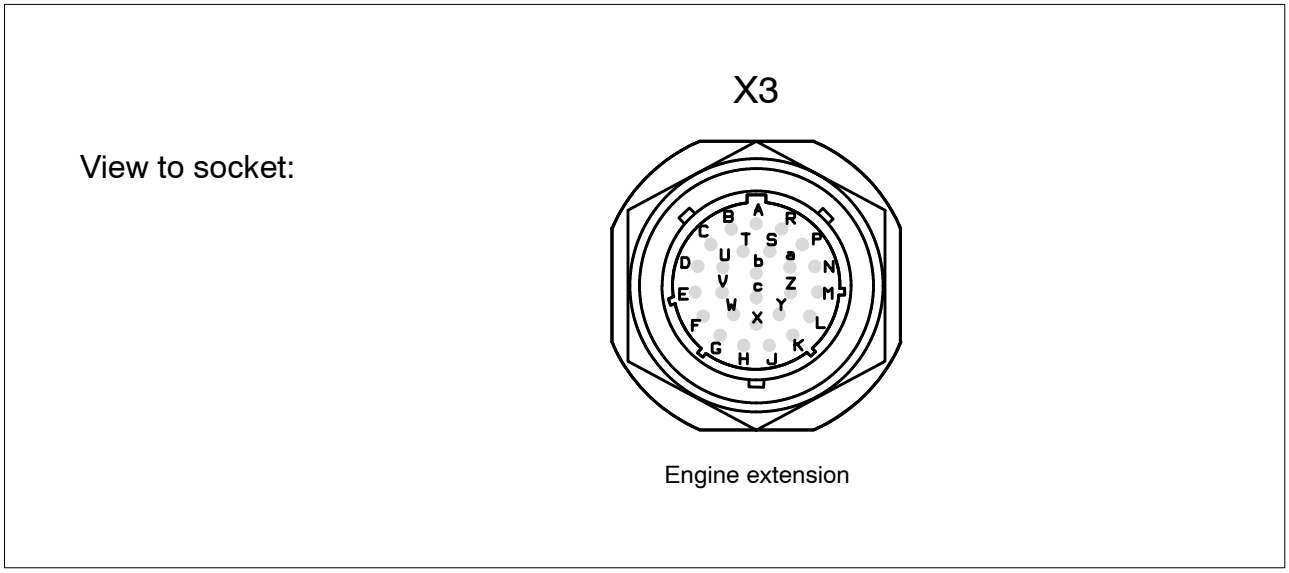


Fig. 72 : Pins connector X3

Channel	Signal	Pin	Comments
TE3	IN	b	0 V ... 5 V/internal 2k0 pullup to 5V_TE_BUF
TE3	GND	c	
TE4	IN	U	0 V ... 5 V/internal 2k0 pullup to 5V_TE_BUF
TE4	GND	V	
TE10	IN	E	0 V ... 5 V/internal 2k0 pullup to 5V_TE_BUF
TE10	GND	D	
DE8	5V_BUF4	J	5 V/20 mA
DE8	IN	Y	0 V ... 5 V/internal 47k5 pulldown
DE8	GND	K	
DEH	5V_BUF5	B	5 V/20 mA
DEH	IN	T	0 V ... 5 V/internal 47k5 pulldown/TP2 : 20Hz
DEH	GND	C	
NSE3	24 V_NSE3	A	Sensor supply max. 300mA
NSE3	IN	R	0 V ... 5 V/internal 47K5 pullup to 5V_TE_BUF
NSE3	GND	S	
PDM2	OUT	M	24 V/3 A

Channel	Signal	Pin	Comments
PDM2	GND	N	
TAM3	OUT	L	24 V/1.5 A
TAM3	GND	Z	
TAM4	OUT	P	24 V/1.5 A
TAM4	GND	a	
EDM	TXD	X	RS232
EDM	RXD	H	RS232
EDM	GND	F	RS232
TA_EDM	24 V_OUT	G	EDM supply/2 A
TA_EDM	GND	W	

Note: Refer to Appendix B for detailed schematic input circuitry of the ECU (“Channel” designation in column 1).

Connector X4: Connector type: VPT 06 GSE 20–41 PW
Target: Cable harness, engine (solenoid valves)

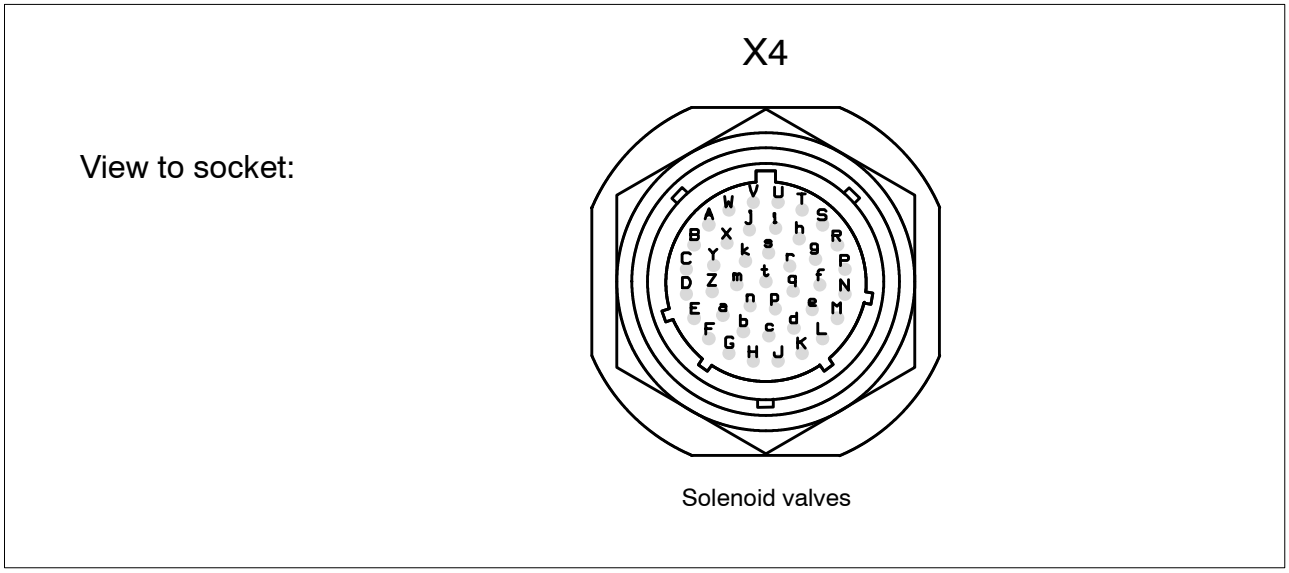


Fig. 73 : Pins connector X4

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

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

Note: Refer to Appendix B for detailed schematic input circuitry of the ECU (“Channel” designation in column 1).

Connector X5: Connector type: CIR 06 G2 – 18–11 S
Target: Cable harness, plant (power supply)

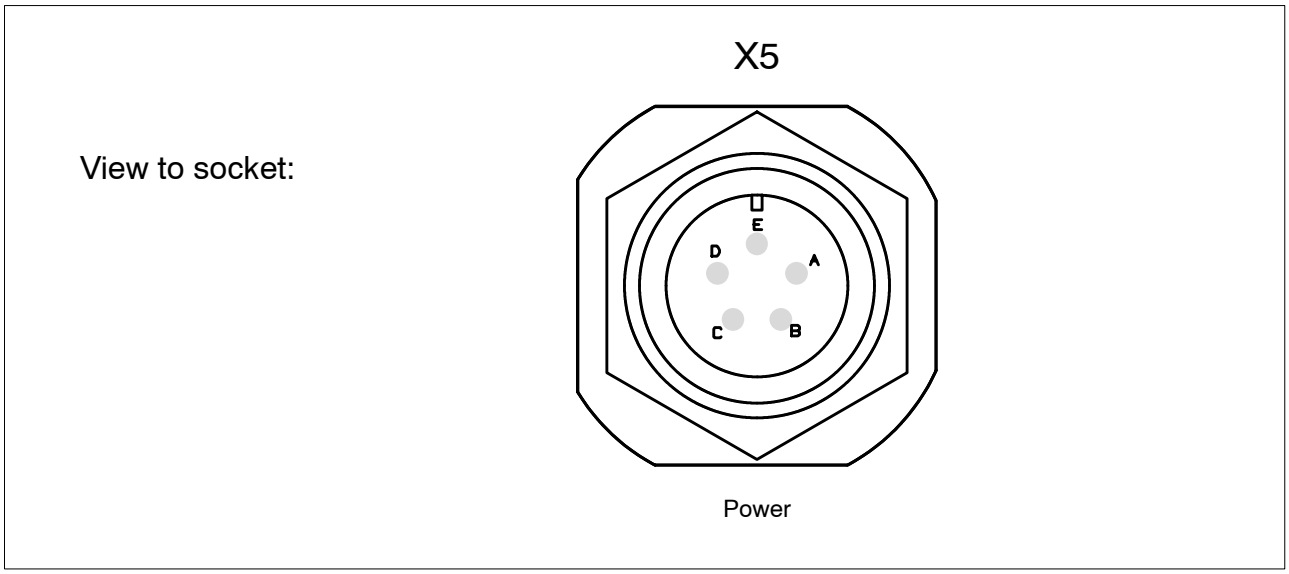


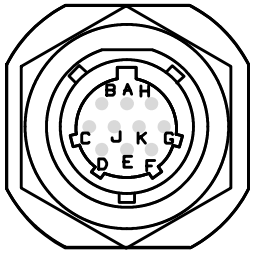
Fig. 74 : Pins connector X5

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

Connecto X6: Connector type: VPT 06 GSE 12-10 P
Target: Dialog unit

View to socket:

X6



Dialog

Fig. 75 : Pins connector X6

Channel	Signal	Pin	Comments
DIALOG	TXD	B	RS232
DIALOG	RXD	A	RS232
DIALOG	GND	F	RS232
TAD	24 V_OUT	G	Dialog unit supply (max. 3 A)
TAD	GND	H	

C ECU channel input circuitry

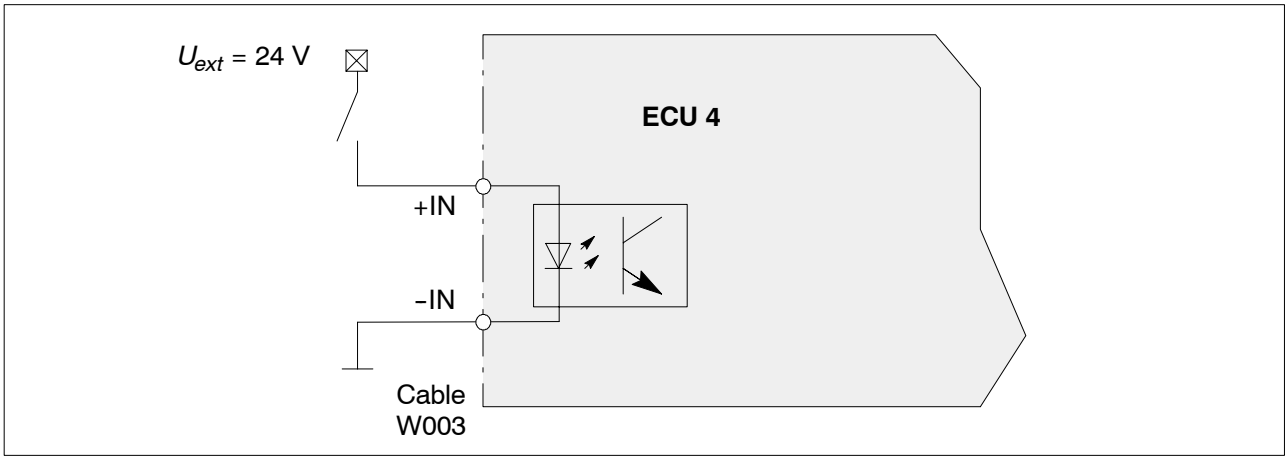


Fig. 76 : Binary input BE schematic

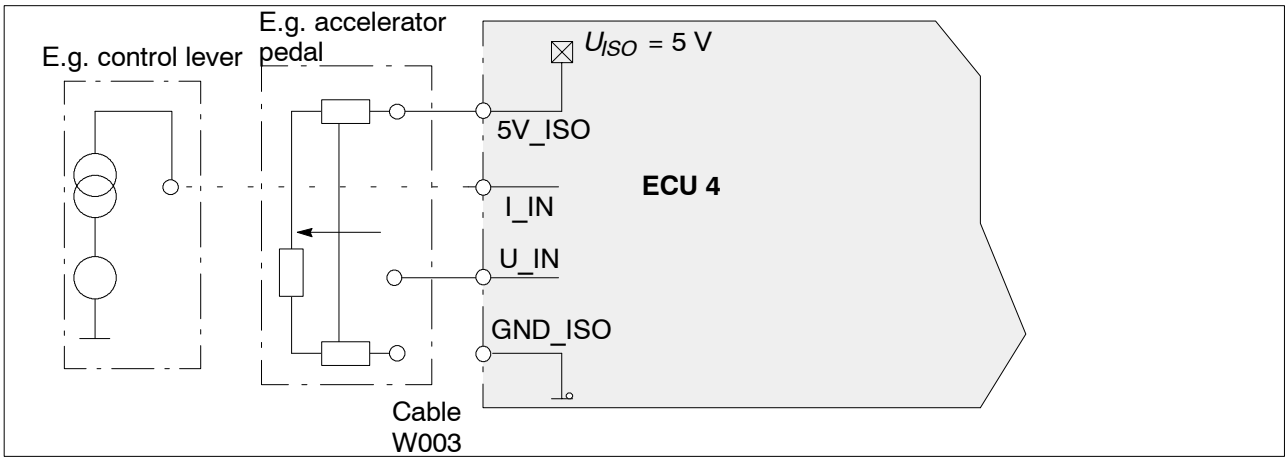


Fig. 77 : Voltage/power input IUE schematic

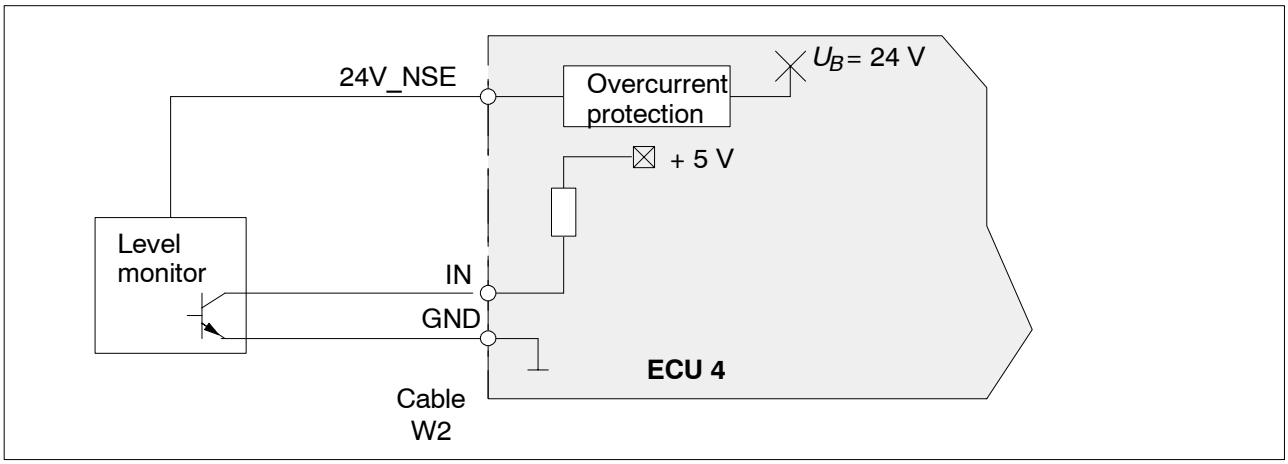


Fig. 78 : Level switching input NSE schematic

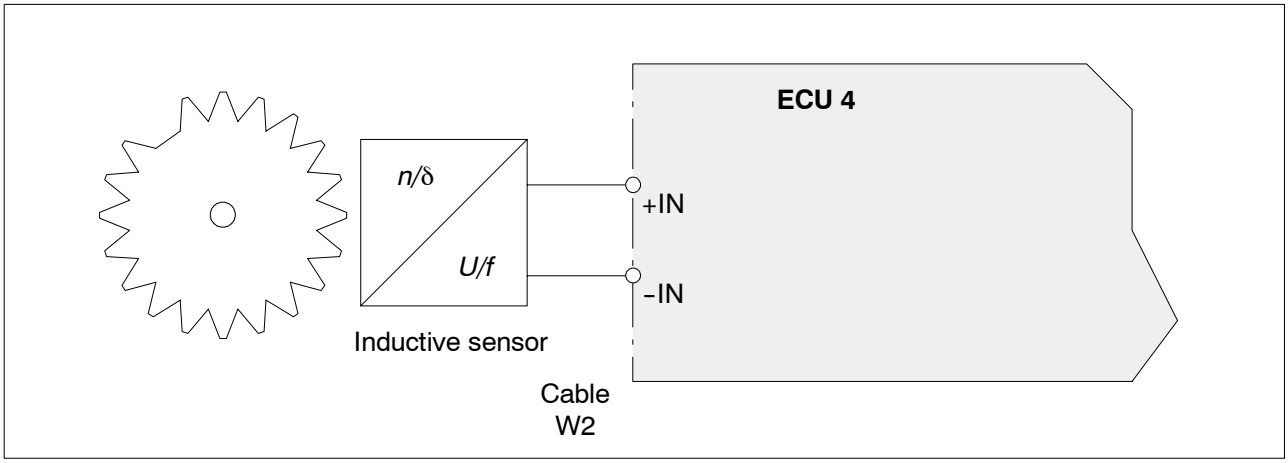


Fig. 79 : Angle measuring input KW1/NW1 schematic

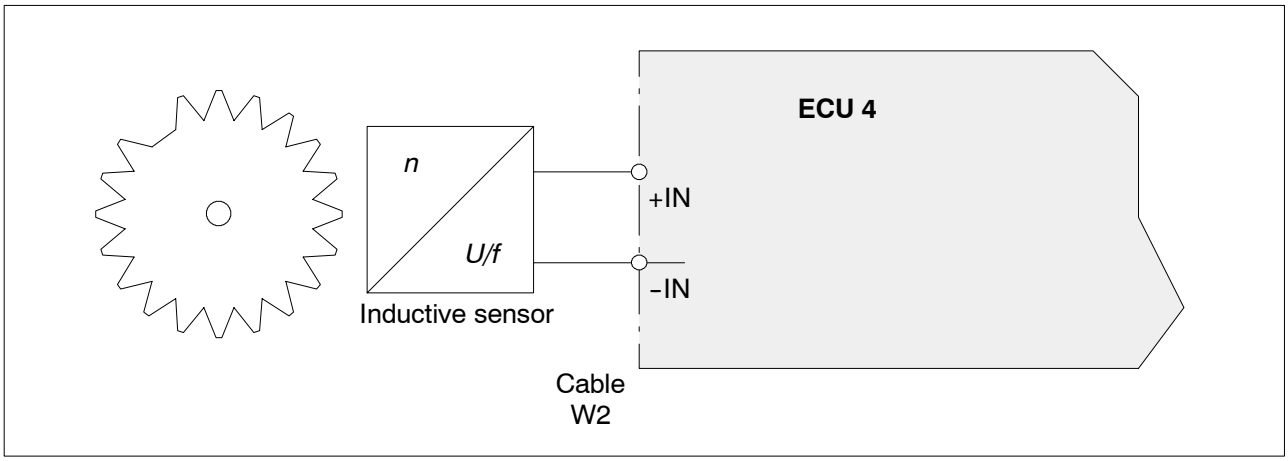


Fig. 80 : Speed measuring input DME schematic

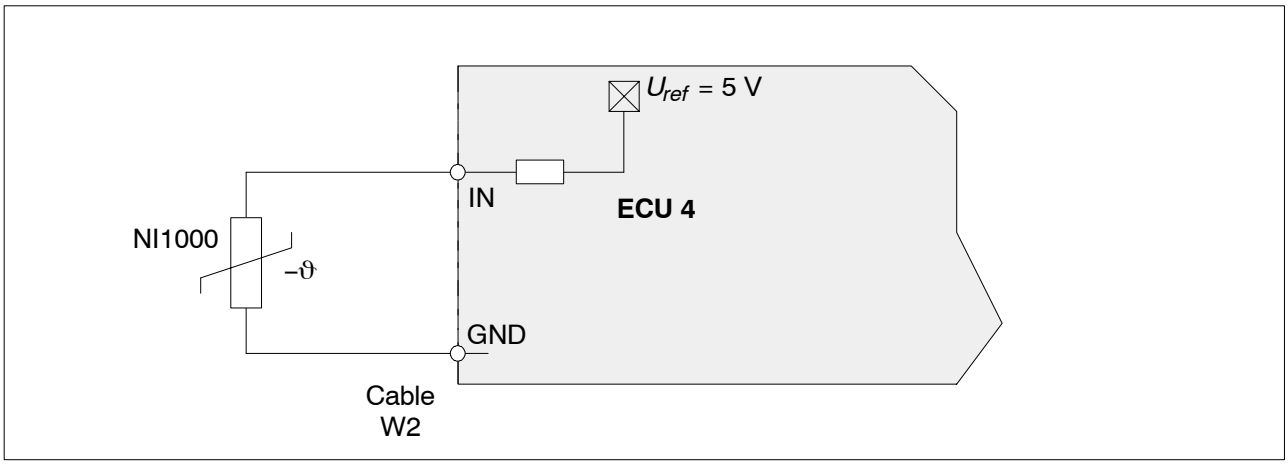


Fig. 81 : Temperature measuring input TE schematic

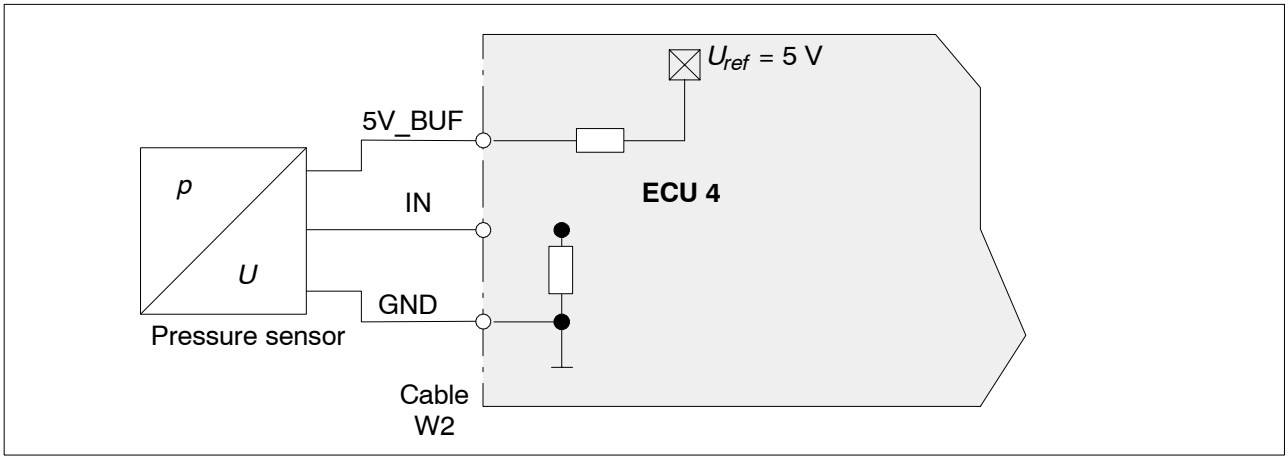


Fig. 82 : Pressure measuring input DE schematic

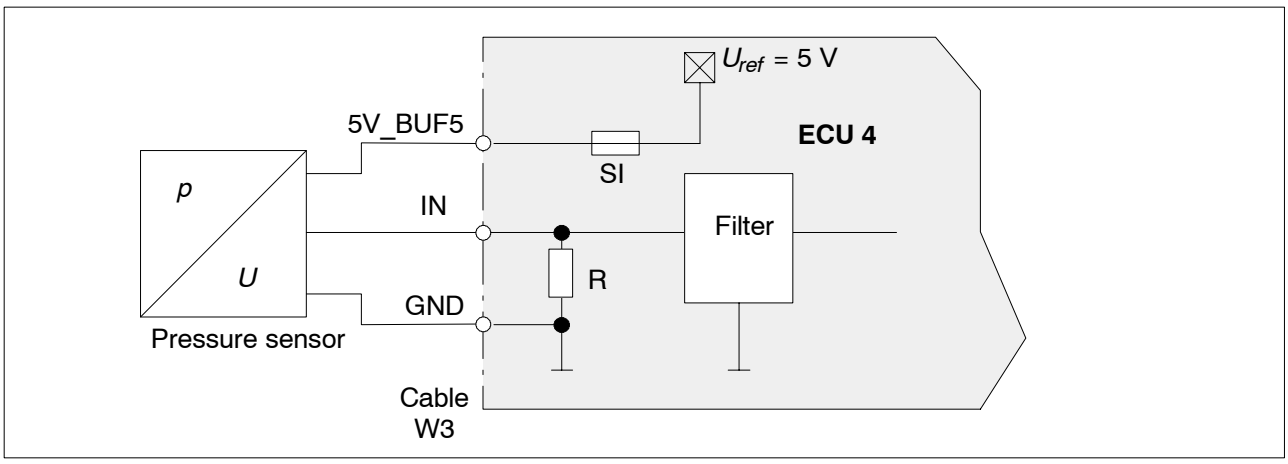


Fig. 83 : Pressure measuring input DEH schematic

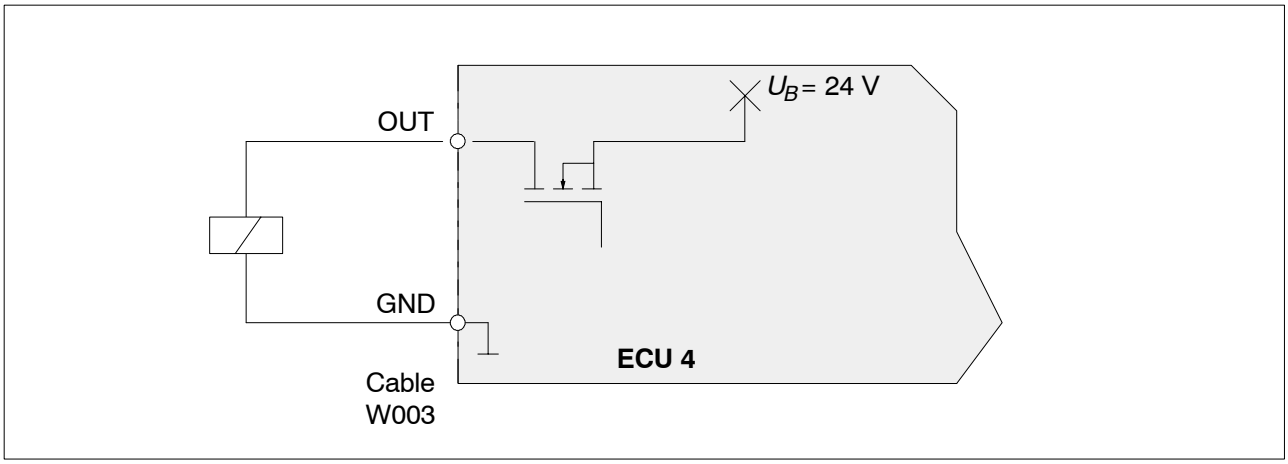


Fig. 84 : Transistor output TAA schematic

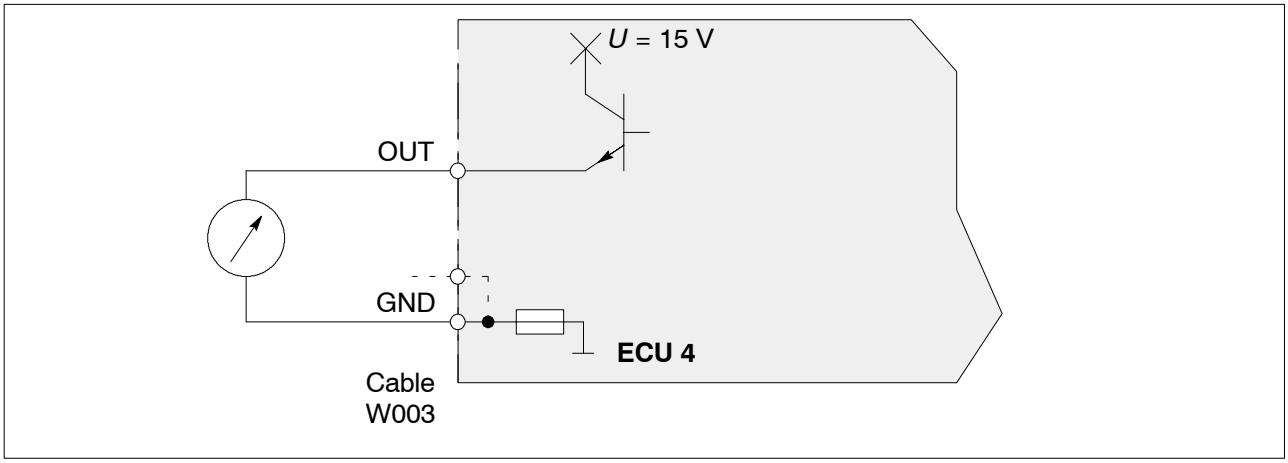


Fig. 85 : Transistor output TAA schematic

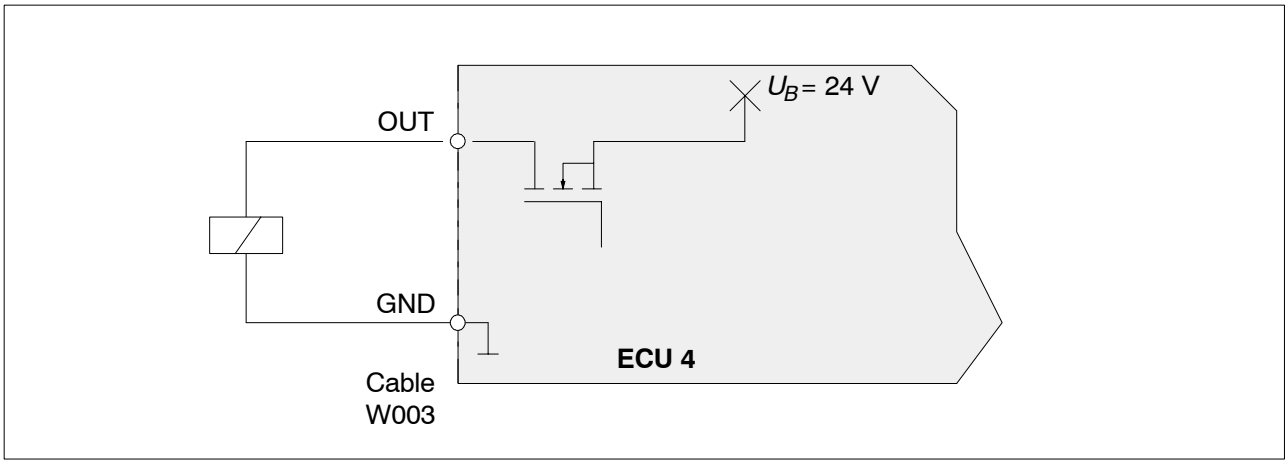


Fig. 86 : Transistor output TAM schematic

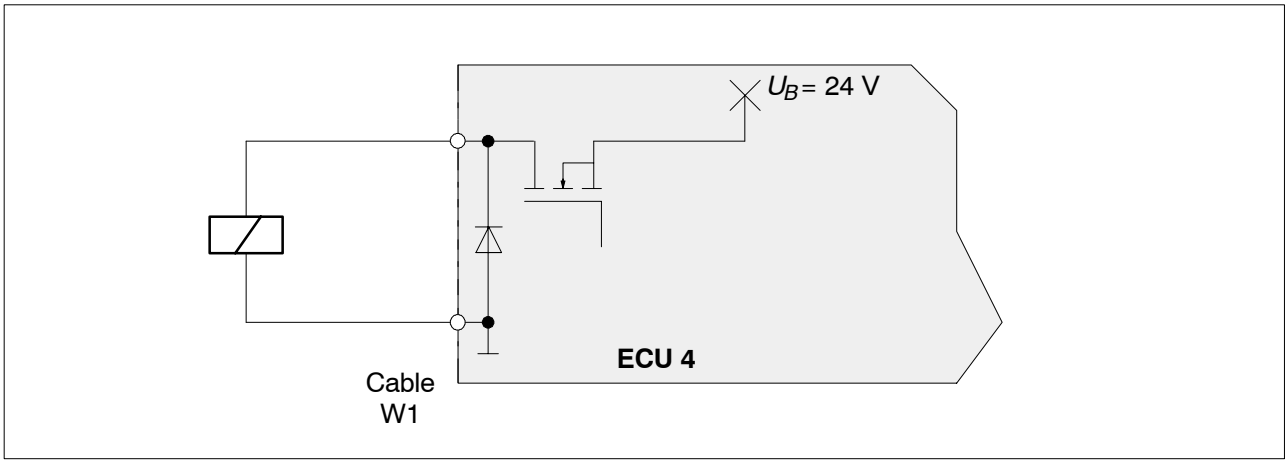


Fig. 87 : Output PDM schematic

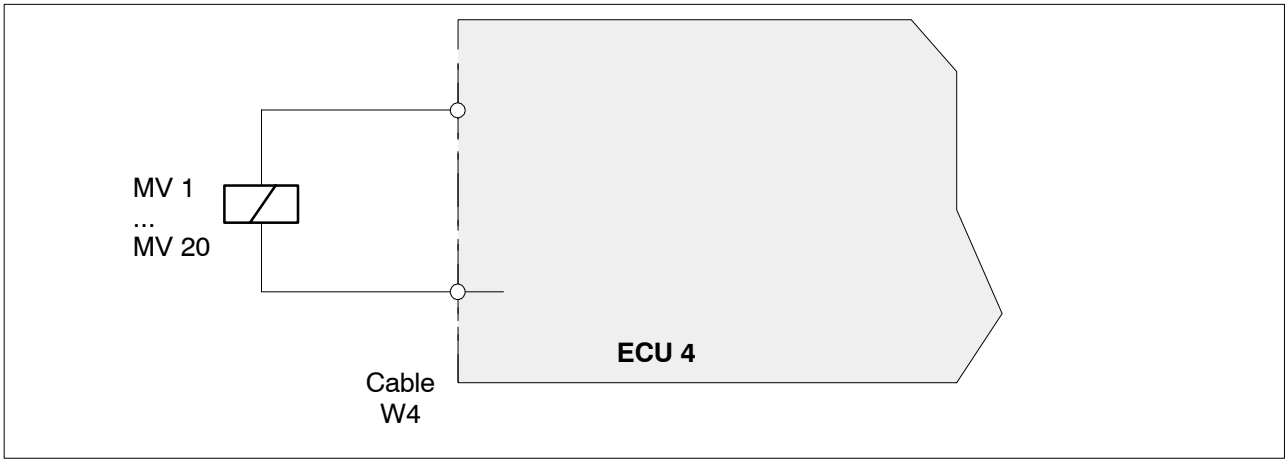


Fig. 88 : Solenoid valve output MVA (injector control) schematic

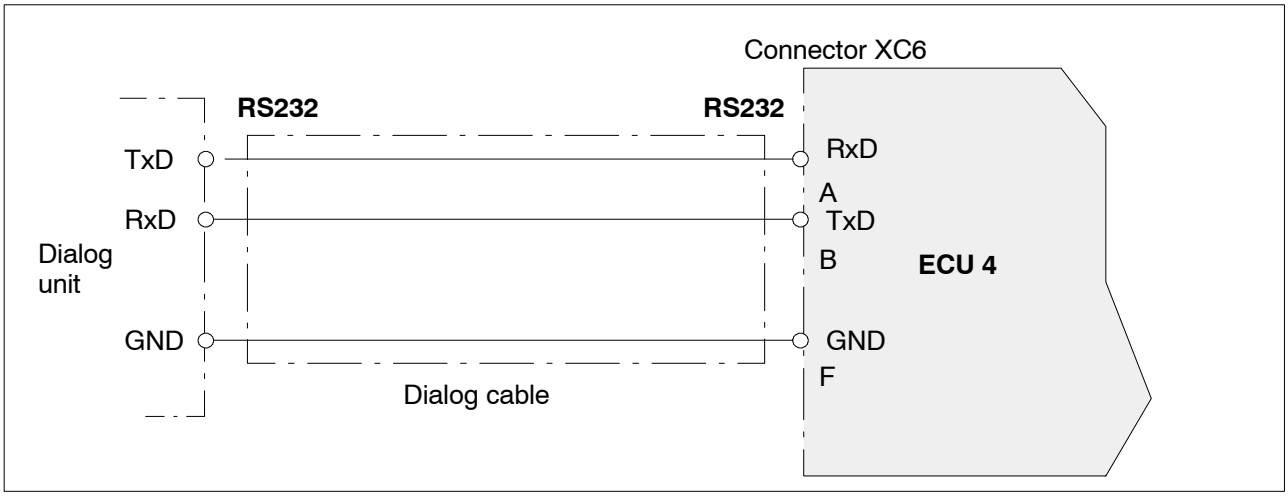


Fig. 89 : Dialog unit connection schematic

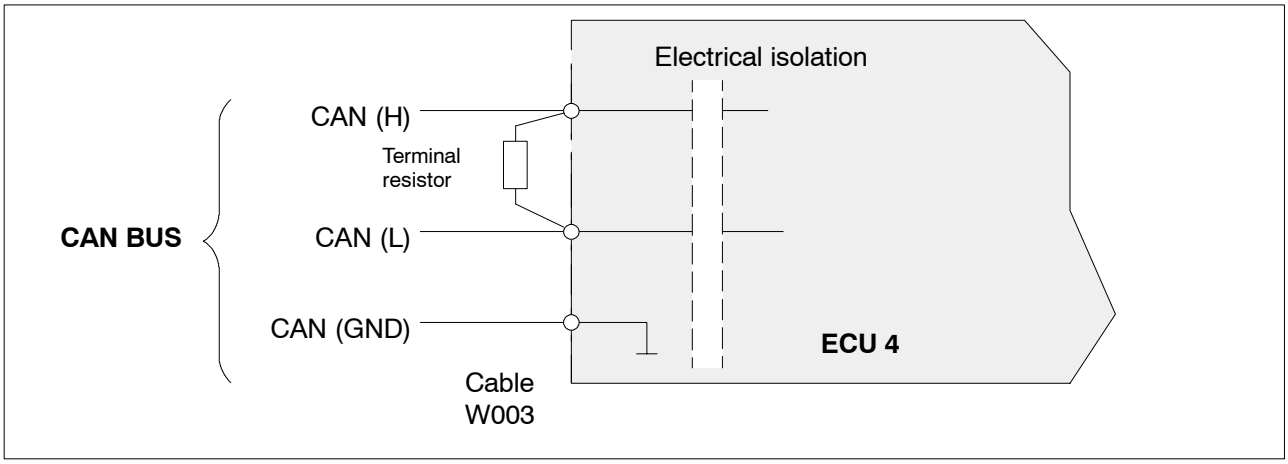


Fig. 90 : CAN bus interface schematic

(This page intentionally blank)