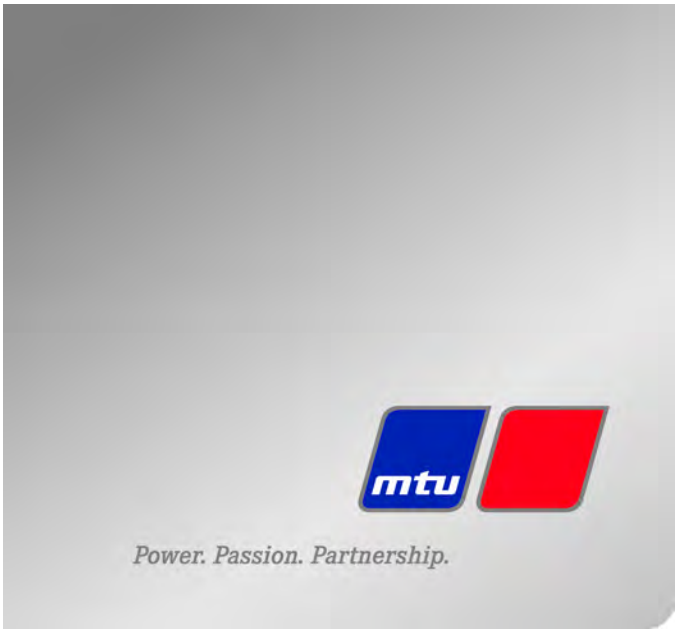
Operating Instructions

Diesel engine
12V 4000 M53R
16V 4000 M53R

MS150036/02E



Printed in Germany

This handbook is provided for use by maintenance and operating personnel in order to avoid malfunctions or damage during operation.

Subject to alterations and amendments.

Table of Contents

1 Safety

1.1 Important provisions for all products

Nameplate

The product is identified by nameplate, model designation or serial number and must match with the information on the title page of this manual.

Nameplate, model designation or serial number can be found on the product.

General information

This product may pose a risk of injury or damage in the following cases:
- Incorrect use
- Operation, maintenance and repair by unqualified personnel
- Modifications or conversions
- Noncompliance with the safety instructions and warning notices

Correct use

The product is intended exclusively for the application specified in the contract or defined at the time of delivery.

This means that the equipment must be operated:
- Within the permissible operating parameters in accordance with the (→ Technical data)
- With fluids and lubricants approved by the manufacturer in accordance with the (→ Fluids and Lubricants Specifications of the manufacturer)
- With spare parts approved by the manufacturer in accordance with the (→ Spare Parts Catalog/MTU contact/Service partner)
- In the original as-delivered configuration or in a configuration approved by the manufacturer in writing (including engine control/parameters)
- In compliance with all safety regulations and in adherence with all warning notices in this manual
- In accordance with the maintenance requirements over the entire service life of the product (→ Maintenance Schedule)
- In compliance with the maintenance and repair instructions contained in this manual, in particular with regard to the specified tightening torques
- With the exclusive use of technical personnel trained in commissioning, operation, maintenance and repair
- By contracting only workshops authorized by the manufacturer to carry out repair and overhaul

Any other use is considered improper use and increases the risk of personnel injury or material damage in product operation. The manufacturer will accept no liability for such damage.

Modifications or conversions

Unauthorized modifications to the product compromise safety.

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

Spare parts

Only genuine spare parts must be used to replace components or assemblies.

The manufacturer will accept no liability or warranty claims for any damage caused by the use of other spare parts.

1.2 Personnel and organizational requirements

Organizational measures of the operator

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

Keep this manual handy in the vicinity of the product such that it is accessible to operating, maintenance, repair and transport personnel at all times.

Use this manual as a basis for instructing personnel on product operation and repair, whereby the safety-relevant instructions, in particular, must be read and understood.

This is particularly important in the case of personnel who only occasionally perform work on or around the product. This personnel must be instructed repeatedly.

Personnel requirements

All work on the product shall be carried out by trained and qualified personnel only.
- Training at the Training Center of the manufacturer
- Qualified personnel specialized in mechanical and plant engineering

The operator must define the responsibilities of the personnel involved in operation, maintenance, repair and transport.

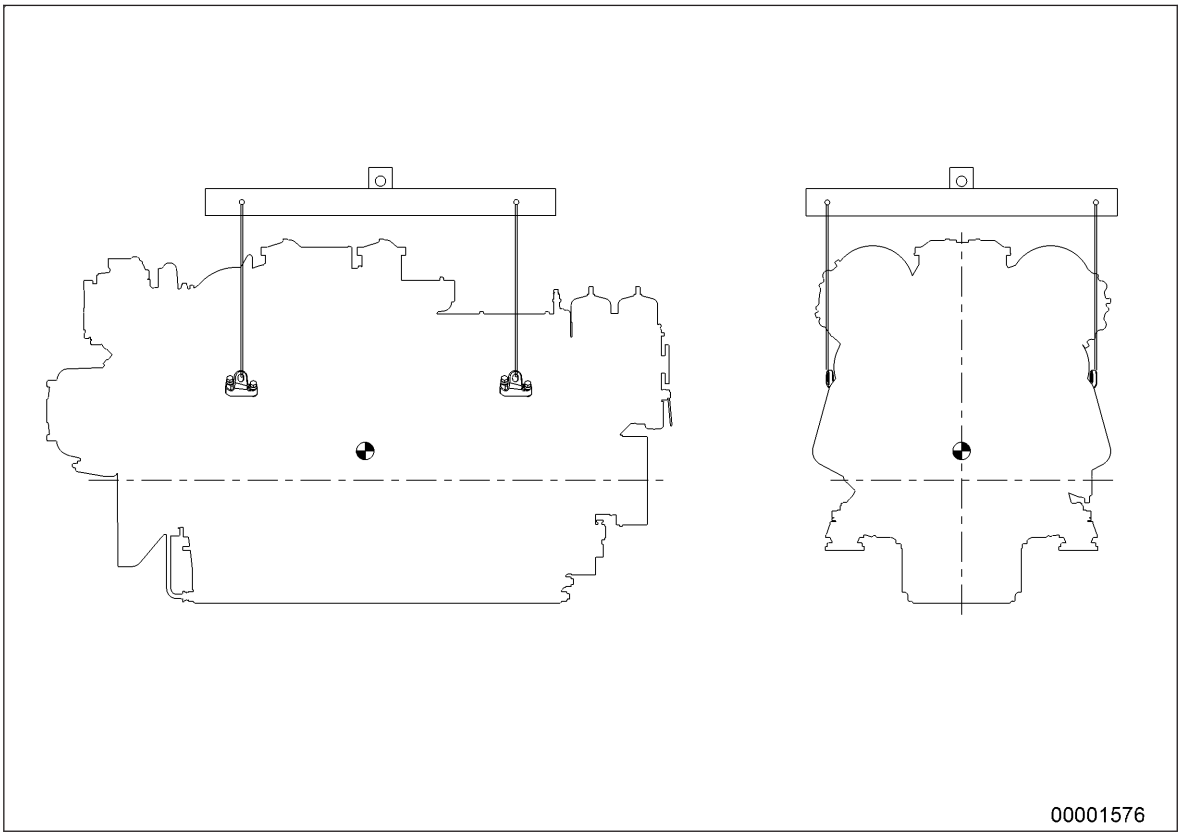
Working clothes and personal protective equipment

Wear proper protective clothing for all work.

When working, always wear the necessary personal protective equipment (e.g. ear protectors, protective gloves, goggles, breathing protection). Observe the information on personal protective equipment in the respective activity description.

1.3 Transport

Transport



Only use the lifting eyes provided to lift the engine.

The lifting eyes are designed for the transport of engine only, not for the transport of drive units (engine and transmission).

Only use transport and lifting devices approved by MTU.

The engine must only be transported in installation position, max. permissible diagonal pull 10°.

Take the engine's center of gravity into account.

In the case of special packaging with aluminum foil, suspend the engine on the lifting eyes of the transport pallet or transport with equipment for heavy loads (forklift truck).

Install the crankshaft locking device and the locking screws for the engine mounts prior to engine transportation.

Secure the engine against tilting during transport. The engine must be especially secured against slipping or tilting when going up or down inclines and ramps.

Setting the engine down after transport

Only set down engine on a firm, level surface.

Make sure that the consistency and load-bearing capacity of the ground or support surface is adequate.

Never place an engine on the oil pan, unless expressively authorized by MTU on a case-to-case basis to do so.

1.4 Safety regulations for maintenance and repair work

Safety regulations prior to maintenance and repair work

Have maintenance or repair work carried out by qualified and authorized personnel only.

Allow the product to cool down to less than 50°C before starting maintenance work (risk of explosion of oil vapors, fluids and lubricants, risk of burning).

Before starting work, relieve pressure in systems and compressed-air lines which are to be opened. Use suitable containers of adequate capacity to catch fluids and lubricants.

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

Never carry out maintenance and repair work with the product in operation, unless:
- Expressly permitted to do so following a written procedure.
- The product is running in the low load range and only for as long as absolutely necessary.

Secure the product against unintentional starting, e.g. with start interlock.

Attach “Do not operate” sign in the operating area or to control equipment.

Disconnect the battery. Lock contactors.

Close the main valve on the compressed-air system and vent the compressed-air line when pneumatic starters are fitted.

Disconnect the control equipment from the product.

The following applies to starters with copper-beryllium alloy pinions:
- Wear breathing protection of filter class P3 during maintenance work. Do not blow out the interior of the flywheel housing or the starter with compressed air. Clean the flywheel housing inside with a class H dust extraction device.
- Observe the safety data sheet.

Safety regulations during maintenance and repair work

Take special care when removing ventilation or plug screws from the product. Cover the screw or plug with a rag to prevent fluids escaping under pressure.

Take care when draining hot fluids and lubricants (risk of burning).

Use only proper and calibrated tools. Observe the specified tightening torques during assembly or disassembly.

Carry out work only on assemblies or plants which are properly secured.

Never use lines for climbing.

Keep fuel injection lines and connections clean.

Always seal connections with caps or covers if a line is removed or opened.

Take care not to damage lines, in particular fuel lines, during maintenance and repair work.

Ensure that all retainers and dampers are installed correctly.

Ensure that all fuel injection and pressurized oil lines are installed with enough clearance to prevent contact with other components. Do not place fuel or oil lines near hot components.

Do not touch elastomeric seals if they have carbonized or resinous appearance unless hands are properly protected.

Note cooling time for components which are heated for installation or removal (risk of burning).

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

Ensure particular cleanness during maintenance and repair work on the product. After completion of maintenance and repair work, make sure that no unattached parts are in/on the product (e.g. cloths and cable ties).

Safety regulations after completion of maintenance and repair work

Before barring, make sure that nobody is standing in the danger zone of the product.

Check that all guards have been reinstalled and that all tools and loose parts have been removed after working on the product (in particular, the barring tool).

Welding work

Welding operations on the product or mounted units are not permitted. Cover the product when welding in its vicinity.

Before starting welding work:
- Switch off the power supply master switch.
- Disconnect the battery.
- Separate the electrical ground of electronic equipment from the ground of the unit.

No other maintenance or repair work must be carried out in the vicinity of the product while welding is going on. Risk of explosion or fire due to oil vapors and highly flammable fluids and lubricants.

Do not use product as ground terminal.

Never position the welding power supply cable adjacent to, or crossing wiring harnesses of the product. The welding current may otherwise induce an interference voltage in the wiring harnesses which could conceivably damage the electrical system.

Remove parts (e.g. exhaust pipes) which are to be welded from the product beforehand.

Hydraulic installation and removal

Check satisfactory function and safe operating condition of tools, jigs and fixtures to be used. Use only the specified jigs and fixtures for hydraulic removal/installation procedures.

Observe the max. permissible force-on pressure specified for the jig/fixture.

Do not attempt to bend or apply force to lines.

Before starting work, pay attention to the following:
- Vent the hydraulic installation/removal jig, the pumps and the lines at the relevant points for the equipment to be used (e.g. open vent plugs, pump until bubble-free air emerges, close vent plugs).
- For hydraulic installation, screw on the jig with the piston retracted.
- For hydraulic removal, screw on the jig with the piston extended.

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

During hydraulic installation and removal, ensure that nobody is standing in the immediate vicinity of the component to be installed/removed.

Working with batteries

Observe the safety instructions of the battery manufacturer when working with batteries.

Gases emanating from the battery are explosive. Avoid sparks and naked flames.

Do not allow electrolyte to come in contact with skin or clothing.

Wear goggles and protective gloves.

Never place tools on the battery.

Before connecting the cable to the battery, check the battery polarity. Battery pole reversal may lead to injury through the sudden discharge of acid or bursting of the battery body.

Working on electrical and electronic assemblies

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

De-energize the appropriate areas prior to working on assemblies.

Do not damage cabling during removal work. When reinstalling ensure that wiring is not damaged during operation by contact with sharp objects, by rubbing against other components or by a hot surface.

Do not secure cables on lines carrying fluids.

Do not use cable straps to secure cables.

Always use connector pliers to tighten union nuts on connectors.

Subject the device as well as the product to a function check on completion of all repair work. In particular, check the function of the engine emergency stop feature.

Store spare parts properly prior to replacement, i.e. protect them against moisture in particular. Pack defective electronic components and assemblies in a suitable manner when dispatched for repair, i.e. protected, in particular, against moisture and impact and wrapped in antistatic foil if necessary.

Working with laser equipment

When working with laser equipment, always wear special laser-protection goggles (hazard due to heavily focused radiation).

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

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

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

1.5 Fire prevention and environmental protection, fluids and lubricants, auxiliary materials

Fire prevention

Rectify any fuel or oil leaks immediately. Oil or fuel on hot components can cause fires – therefore always keep the product in a clean condition. Do not leave rags saturated with fluids and lubricants on the product. Do not store combustible materials near the product.

Do not carry out welding work on pipes and components carrying oil or fuel. Before welding, clean with a nonflammable fluid.

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

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

Noise

Noise can lead to an increased risk of accidents if it makes it more difficult to hear audible signals, warning calls or noises indicating danger.

Wear ear protectors in workplaces with a sound pressure level in excess of 85dB (A).

Environmental protection and disposal

Modification or removal of any mechanical/electronic components or the installation of additional components including the execution of calibration processes that might affect the emission characteristics of the product are prohibited by emission regulations. Emission control units/systems may only be maintained, exchanged or repaired if the components used for this purpose are approved by the manufacturer. Noncompliance with these guidelines will invalidate the design type approval issued by the emissions regulation authorities. The manufacturer does not accept any liability for violations of the emission regulations. The maintenance schedules of the manufacturer must be observed over the entire life cycle of the product.

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

Within the EU, batteries can be returned free of charge to the manufacturer where they will be properly recycled.

Consumable fluids and materials

The Fluids and Lubricants Specifications will be amended or supplemented as necessary. Prior to operation, make sure that the latest version is used. The latest version can be found on the website on the "Technical Info" or "Spare Parts and Service" tabs at http://www.mtu-online.com.

Consumable fluids and materials may also be hazardous or toxic. When using fluids, lubricants, consumables and other chemical substances, follow the safety regulations that apply to the product. Take special care when using hot, chilled or caustic substances. When using flammable materials, prevent them coming into contact with ignition sources and do not smoke.

Used oil

Used oil contains combustion residues that are harmful to health.

Rub barrier cream into hands.

Wash hands after contact with used oil.

Lead

- Adopt suitable measures to avoid the formation of lead dust.
- Switch on extraction system.
- When working with lead or pastes that contain lead, avoid direct contact with the skin. Do not inhale lead vapors.
- Wash hands after contact with lead or lead-containing substances.

Compressed air

Observe special safety precautions when working with compressed air:

- Unauthorized use of compressed air, e.g. forcing flammable liquids (hazard class AI, AII and B) out of containers, risks causing an explosion.
- Wear goggles when blowing dirt off workpieces or blowing away swarf.
- Blowing compressed air into thin-walled containers (e.g. containers made of sheet metal, plastic or glass) for drying purposes or to check for leaks risks bursting them.
- Pay special attention to the pressure in the compressed air system or pressure vessel.
- Assemblies or products to be connected must either be designed for that pressure, or, if the permissible pressure is lower than the system pressure, a pressure reducing valve and safety valve (set to the permissible pressure) must be connected between the assemblies/products and the system.
- Hose couplings and connections must be securely attached.
- Provide the snout of the air nozzle with a protective disk (e.g. rubber disk).
- First shut off compressed air lines before compressed air device is disconnected from the supply line, or before device or tool is to be replaced.
- Carry out leak test in accordance with the specifications.

Paints and varnishes

- Observe the relevant safety data sheet for all materials.
- When painting in areas other than spray booths equipped with extractors, ensure good ventilation. Make sure that neighboring work areas are not adversely affected.
- There must be no naked flames in the vicinity.
- No smoking.
- Observe fire prevention regulations.
- Always wear a mask providing protection against paint and solvent vapors.

Liquid nitrogen

- Observe the relevant safety data sheet for all materials.
- Store liquid nitrogen only in small quantities and always in regulation containers (without gas-tight caps).
- Avoid body contact (eyes, hands).
- Wear protective clothing, protective gloves, closed shoes and safety goggles.
- Make sure that working area is well ventilated.
- Avoid knocking or jolting the containers, valves and fittings or workpieces in any way.

Acids/alkaline solutions/urea (AdBlue®, DEF)

- Observe the relevant safety data sheet for all materials.
- When working with acids and alkaline solutions, wear goggles or face mask, gloves and protective clothing.
- Do not inhale vapors.
- If urea solution is swallowed, rinse out mouth and drink plenty of water.
- If spilled onto clothing, remove the affected clothing immediately.
- After contact with skin, rinse affected parts of the body with plenty of water.
- Rinse eyes immediately with eyedrops or clean tap water. Seek medical attention as soon as possible.

1.6 Standards for safety notices in the text

DANGER 	In the event of immediate danger. **Consequences: Death, serious or permanent injury!** • Remedial action.
WARNING 	In the event of a situation involving potential danger. **Consequences: Death, serious or permanent injury!** • Remedial action.
CAUTION 	In the event of a situation involving potential danger. **Consequences: Minor or moderate injuries!** • Remedial action.
NOTICE 	In the event of a situation involving potentially adverse effects on the product. **Consequences: Material damage!** • Remedial action. • Additional product information.

Safety notices

▶ This manual with all safety instructions and safety notices must be issued to all personnel involved in operation, maintenance, repair or transportation.

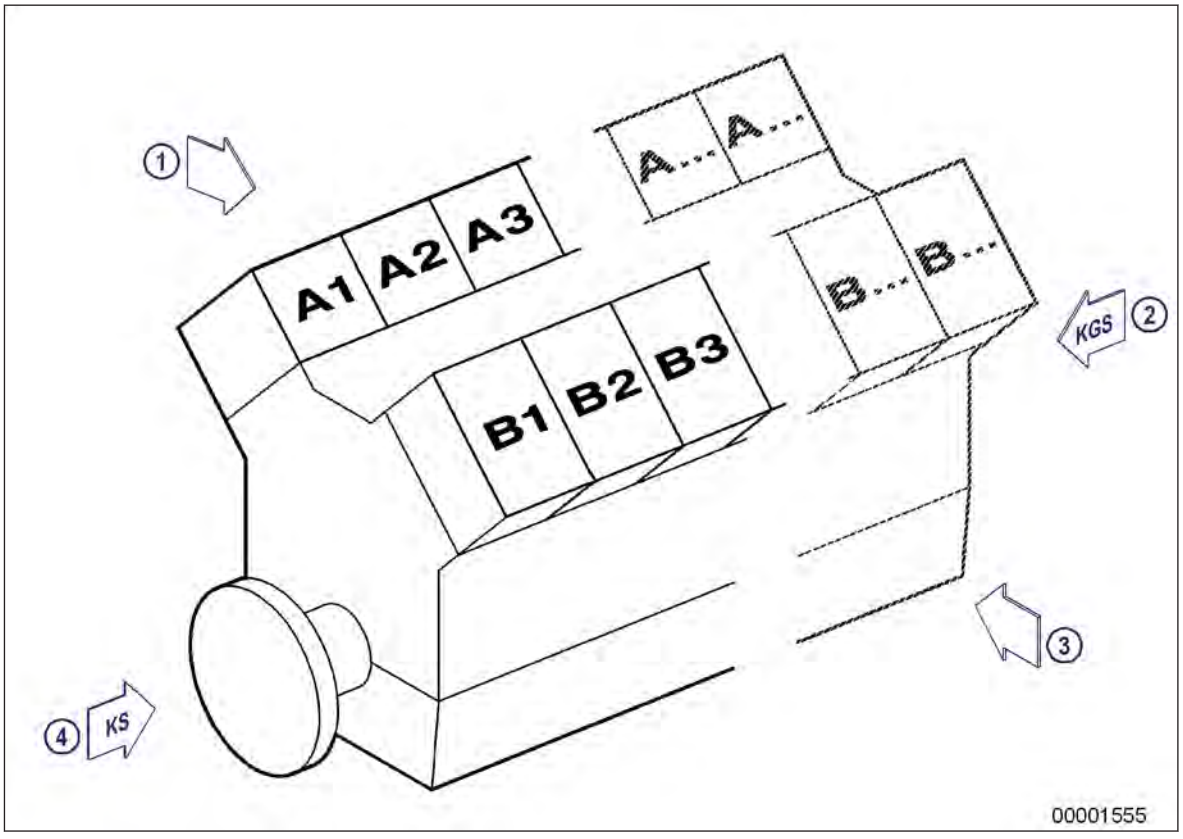
2 General Information

2.1 Engine side and cylinder designations

Engine sides are always designated as viewed from the driving end (KS) (4).

For designation of the cylinders (to DIN ISO 1204) the letter "A" (1) is used to refer to the cylinders on the left-hand side of the engine and the letter "B" (3) to refer to the cylinders on the right-hand side. The cylinders of each bank are numbered consecutively, starting with No. 1 at the driving end.

The numbering of other engine components also starts with no. 1 at the driving end.



1 Left-hand side of engine
2 Free end
3 Right-hand side of engine
4 Driving end

2.2 Product description

Description of the engine

Engine

The engine is a liquid-cooled four-stroke diesel engine, rotating counterclockwise (seen from driving end), with direct injection, sequential turbocharging and charge air cooling.

The engine is monitored by an engine control and monitoring system (ADEC).

Fuel system

Electronically controlled common-rail-injection system with HP pump, pressure accumulator (rail) and single injectors with integrated individual store.

The electronic control unit controls
- Injection start
- Injection quantity
- Injection pressure

Exhaust system

The exhaust system is equipped with triple-walled, water-cooled exhaust lines.

The triple-walled design permits
- low surface temperature,
- reduced amount of heat to be dissipated by the coolant,
- absolute gas-tightness.

Turbocharging

Sequential turbocharging with internal, engine-coolant-controlled charge air cooling. The right-hand exhaust turbocharger is cut-in and cut-out on 12V and 16V engines with electronically-controlled, hydraulically-actuated flaps.

Cooling system

Split-circuit engine coolant system with remote or engine-mounted heat exchanger.

Heating of the charge air in idle and low-load operation prevents white smoke formation.

Seawater flows only through engine coolant cooler and fuel cooler as well as the raw water pump (if fitted).

Service block

The service components are mounted at the auxiliary PTO end.

The layout permits easy access for maintenance.

Service-components:
- Raw-water pump (if fitted), coolant pump
- Centrifugal lube oil filter
- Coolant expansion tank (only on engines with engine-mounted heat exchanger)
- Coolant filter

Electronic system

Electronic control and monitoring system with integrated security and test system with interfaces to remote control system (RCS) and to monitoring system (MCS).

Engine Interface Module (EIM)

The Engine Interface Module (EIM) is the central connection box on the engine. It covers the complete minimum scope of a marine engine. It does not comprise control elements of components requiring maintenance.

Functions:
- Starter control (start repetition, tooth alignment, starter protection)
- Monitoring of the battery-charging generator
- Open bus interface to the plant (SAE J1939)
- Emergency stop function with line break monitoring
- Redundant supply voltage input
- Emergency shut-off flap control (option)
- Key switch logic
- Interface to ECU and EMU
- MCS5 dialog interface
- Control of an MTU lube-oil priming pump (power components in separate MTU PPC Box)
- Connection facility for an MTU Local Operating Station (LOS)

Serial RS422 interface for diagnosis

The engine interface comprises two parts. The first part of signals is integrated in the engine wiring harness with a 62-pole Tyco connector X52. The second part refers to signals associated with higher currents. These signals are led out via M threaded bolts and also integrated in the engine wiring harness.

Functions
- ECU supply
- EMU supply
- Plant signals (ECU7 connector X1)
- Bus interface (2x MCS5 CAN)
- CAN dialog output (1xMCS5 CAN)
- Emergency stop from EMU and ECU
- Electric starter
- Terminal 45 starter A/B (engaged)
- Pneumatic starter
- Starting-air pressure valve
- Start-air pressure sensor
- Barring gear (1 and 2)
- Battery-charging generator (with exciter control)
- Optional emergency air shut-off flaps
- Activation signal to air shut-off flaps 1+2
- Feedback signal from air shut-off flaps 1+2

Electronic engine governor (ECU)

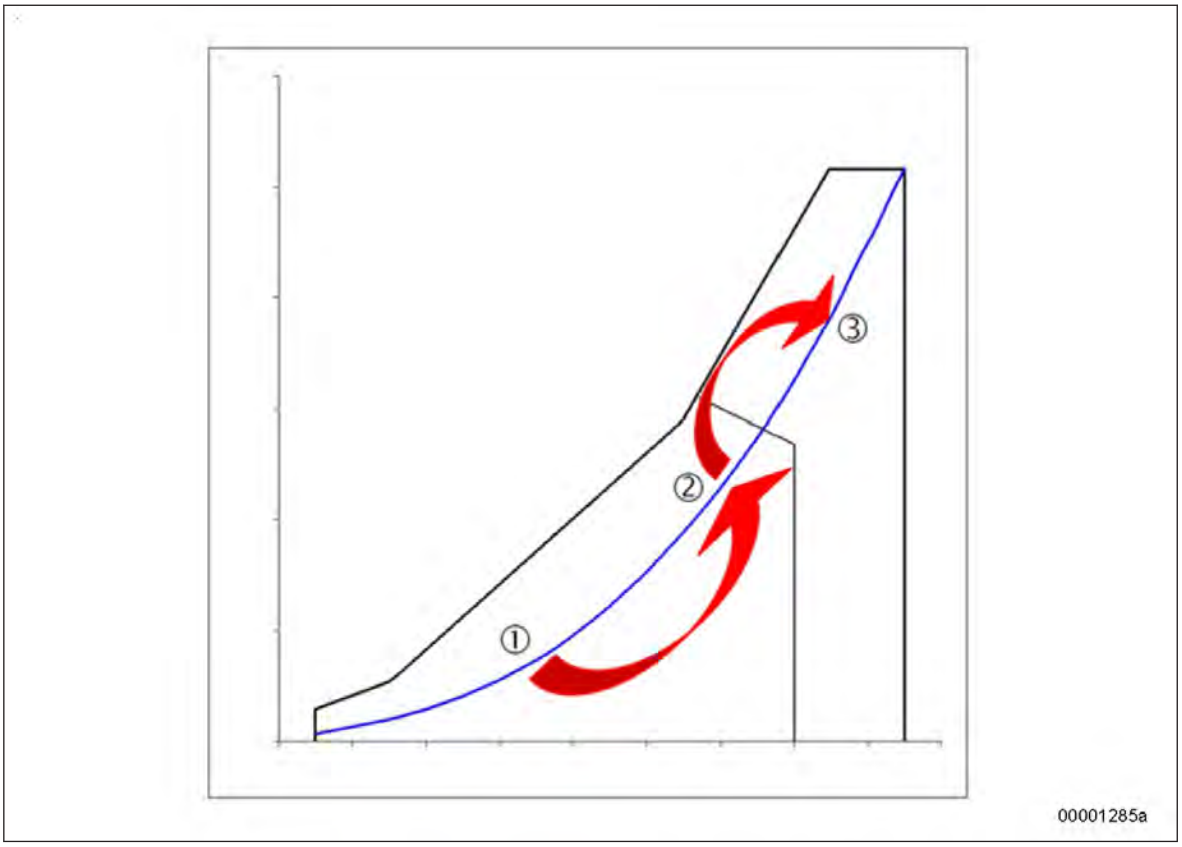
Functions:
- Engine speed control with fuel and speed limitation dependent on engine status and operating conditions
- Control of sequential turbocharging, cylinder bank cut-out and air recirculation function.
- Data processing logistics for analog and binary signals
- Interface for data transfer to CAN field bus for remote control and ship-side monitoring

Electronic Engine Monitoring Unit (EMU)

Functions:
- Data processing logistics for analog and binary signals
- Interface for data transfer to CAN field bus for remote control and ship-side monitoring

Low-load operation

Performance diagram



1 Low-load operation 2 Cleaning cycle 3 ditto

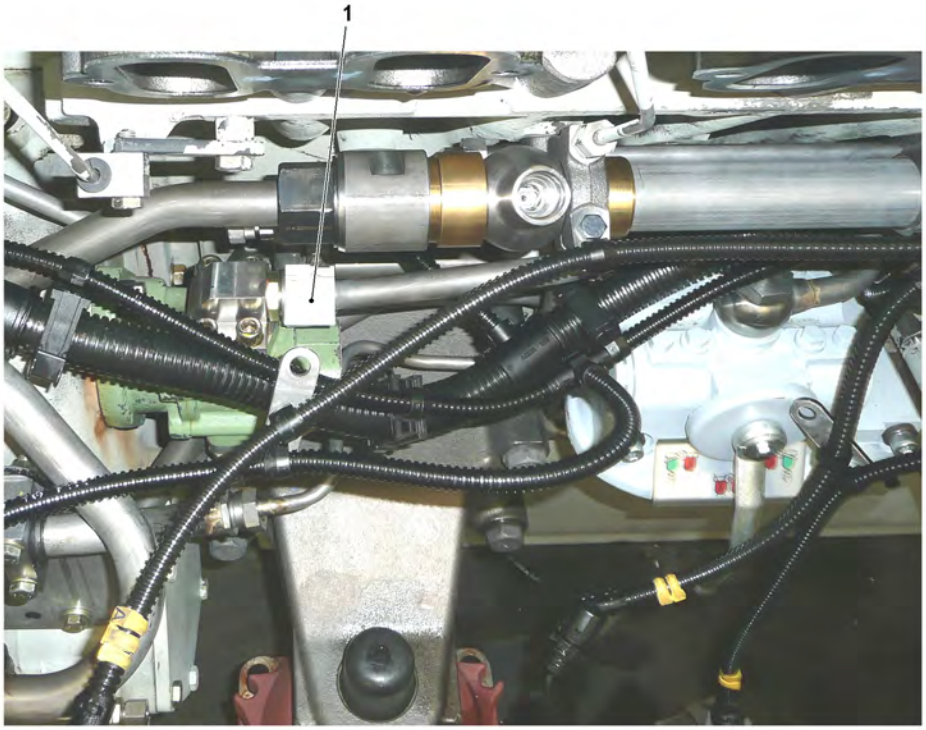
MTU Series 4000M53R engines may be operated in low-load operation. State-of-the-art design and equipment features, e.g. TE coolant circuit, sequential turbocharging, jacketed, coolant-cooled exhaust lines, Common Rail fuel injection and cylinder cut-out allow engine operation at low load.

Nevertheless, low-load operation at engine load below 15% of the nominal rating is permitted for max. 100 hours. In order to avoid inadmissible oil carbon and/or carbon particle deposits in the engine, it is recommended to carry out a cleaning cycle for at least 20 minutes after extended low-load operation periods. During the cleaning cycle, engine speed (power) must be increased step by step until all turbochargers are running. The figure shows the basic speed/power run-up procedure for the cleaning cycle to be carried out.

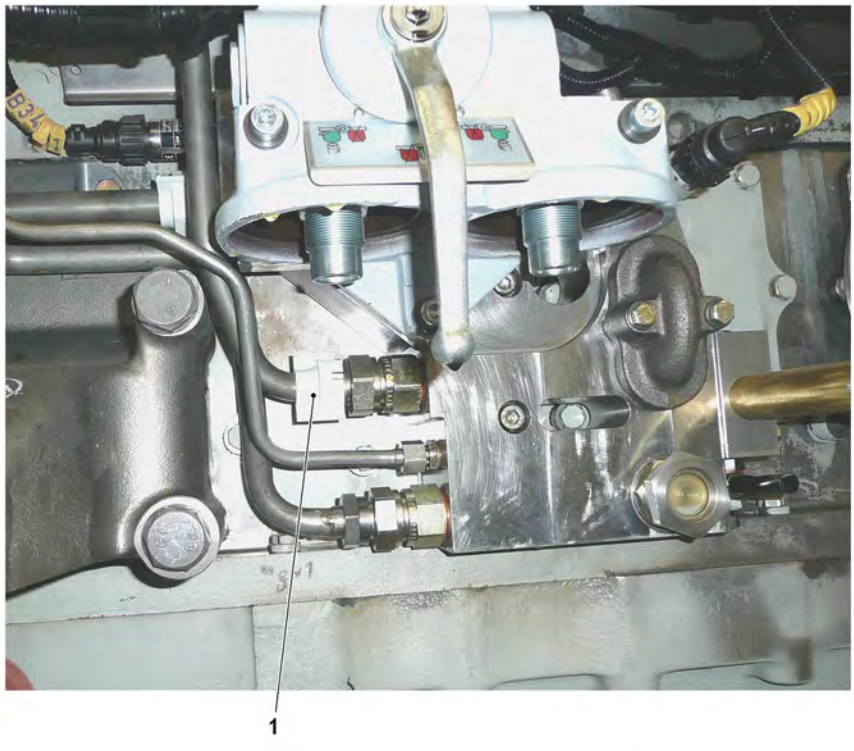
SOLAS – Fire protection specifications

Fuel system, fuel lines with fuel pressure >1.8 bar

All lines with SOLAS-compliant covers for pipe connections, according to MTU standard MTN5233, are shown.



1 Fuel line after LP pump

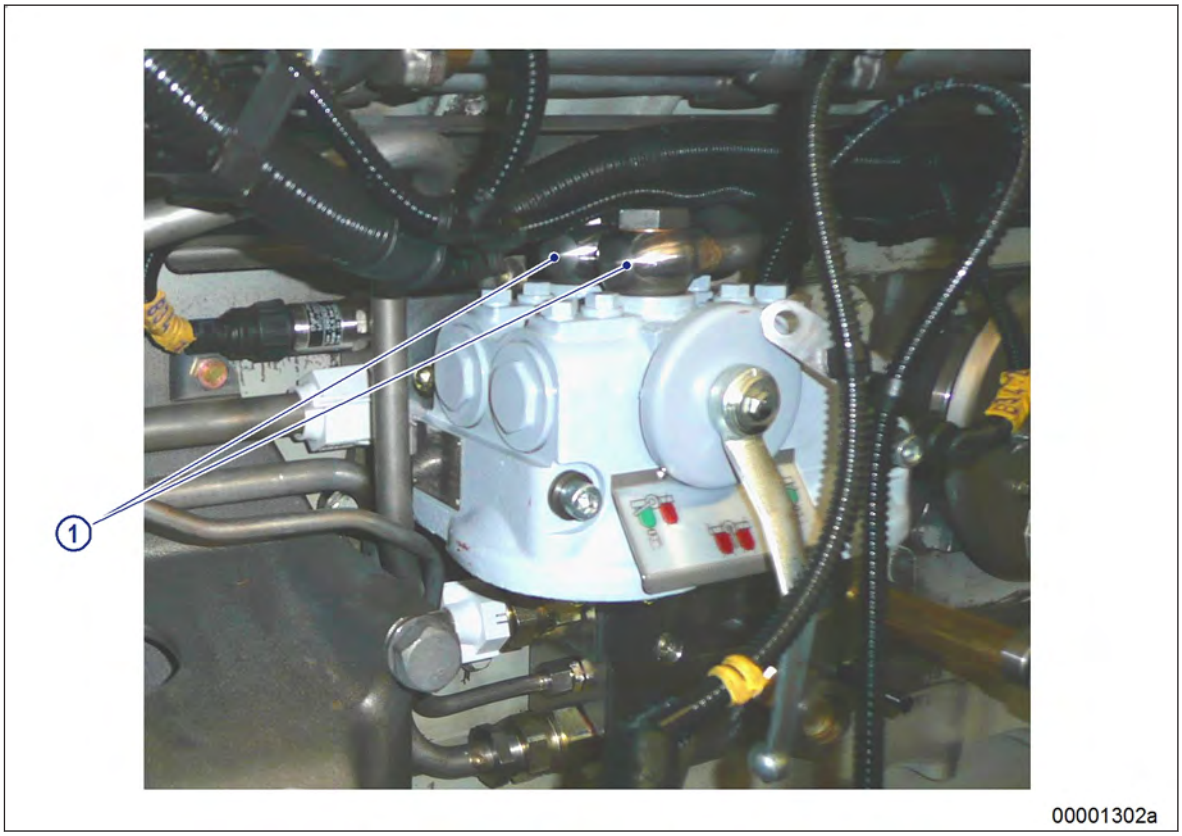


1 Fuel line to fuel filter head retainer

1 Fuel line from fuel filter head

1 Fuel line on HP pump

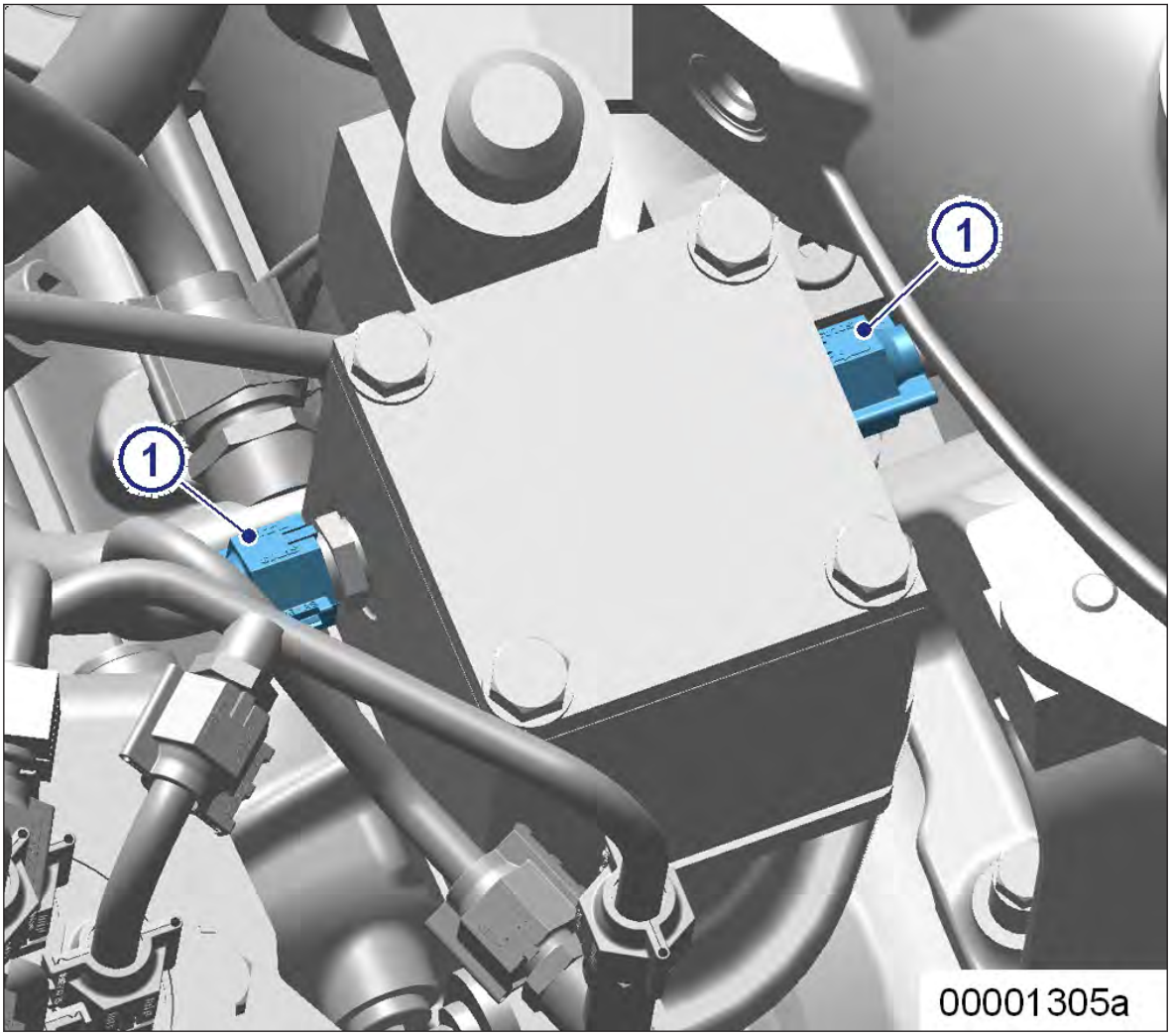
1 Fuel line on fuel filter head



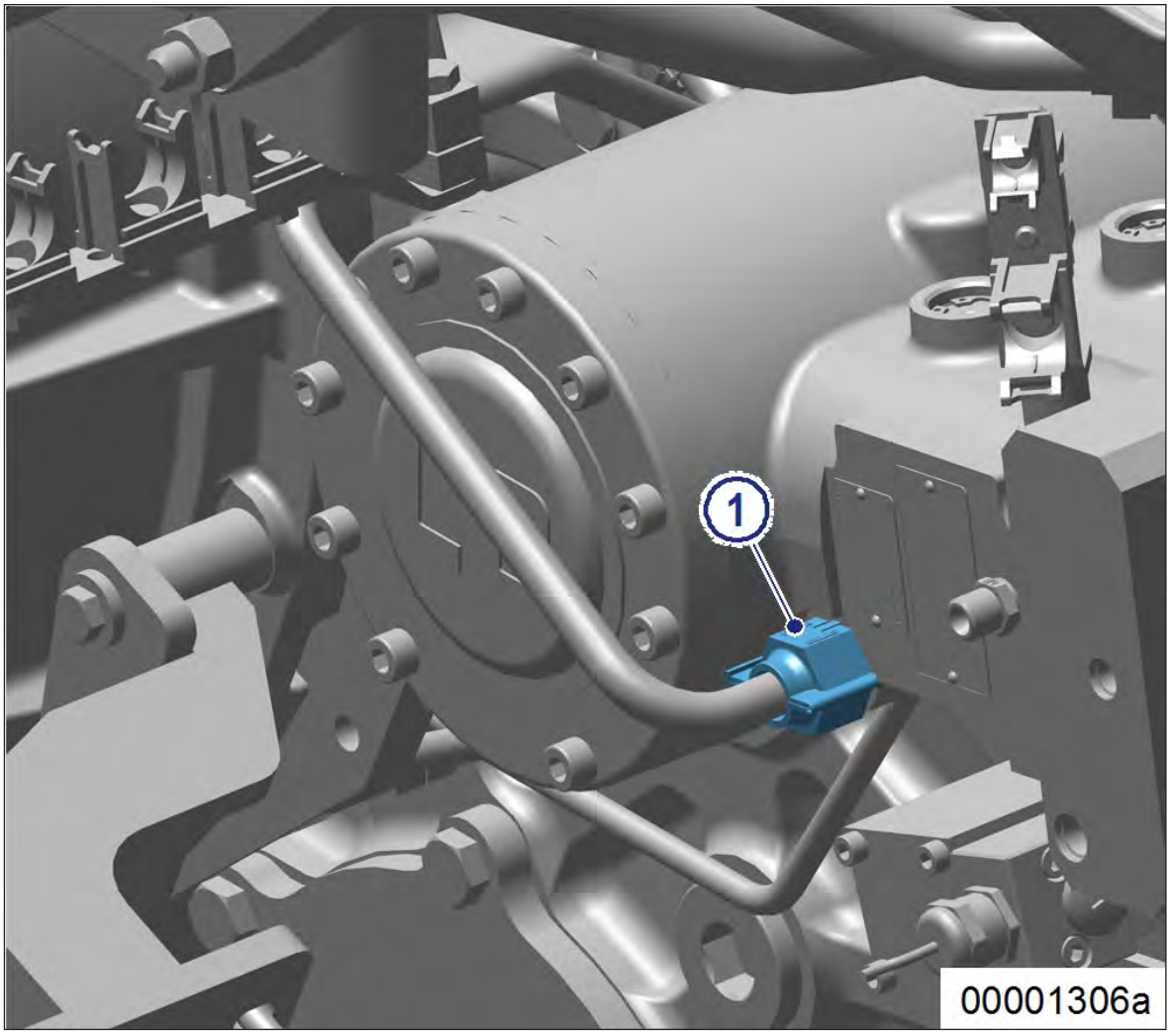
1 Fuel line on fuel filter head

Lube oil system, oil lines with oil pressure >1.8 bar

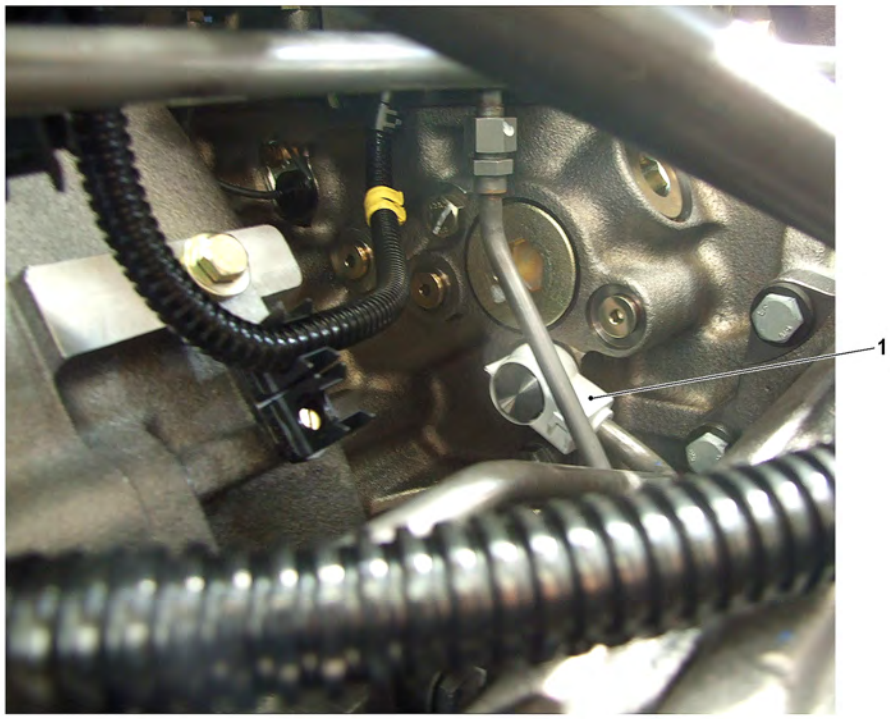
All lines with SOLAS-compliant covers for pipe connections, according to MTU standard MTN5233, are shown.



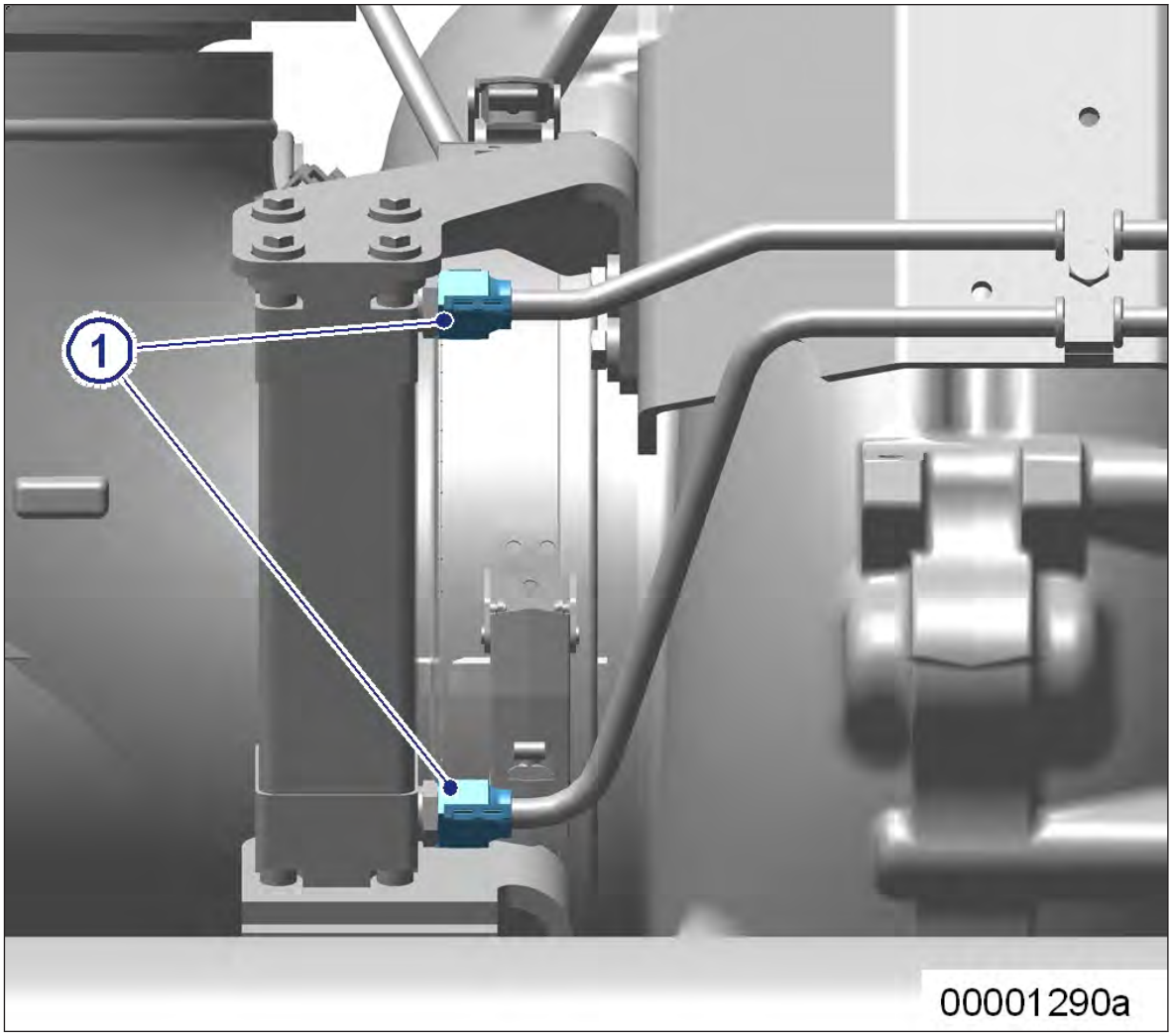
1 Oil supply for recirculation valve



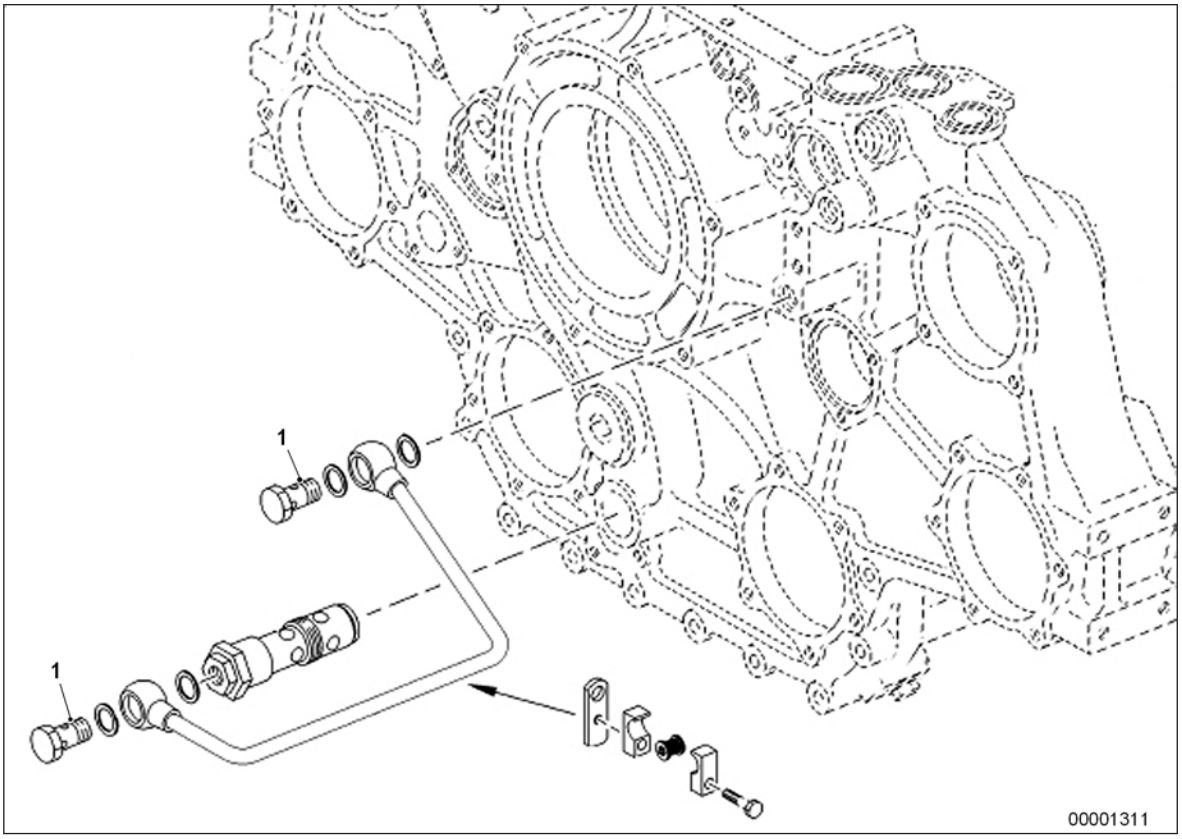
1 Oil supply line on HP pump



1 Oil supply line of HP pump on equipment carrier

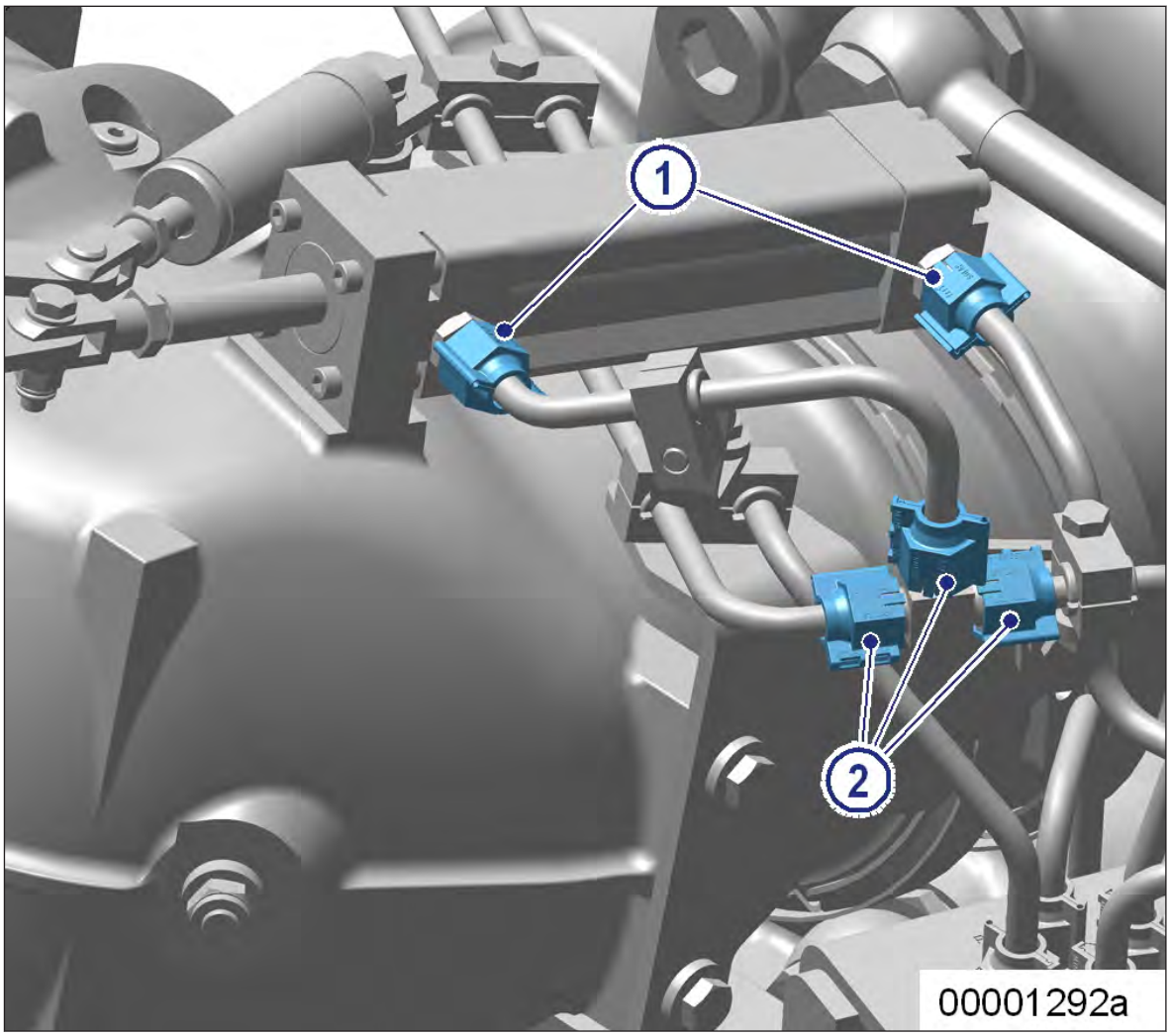


1 Oil supply for actuating cylinder of turbocharger B1 exhaust flap



1 Oil supply on equipment carrier

Engines with horizontal air intake



1 Oil supply for actuating cylinder of turbocharger B1 air flap

2 Oil supply for T-piece of flap control

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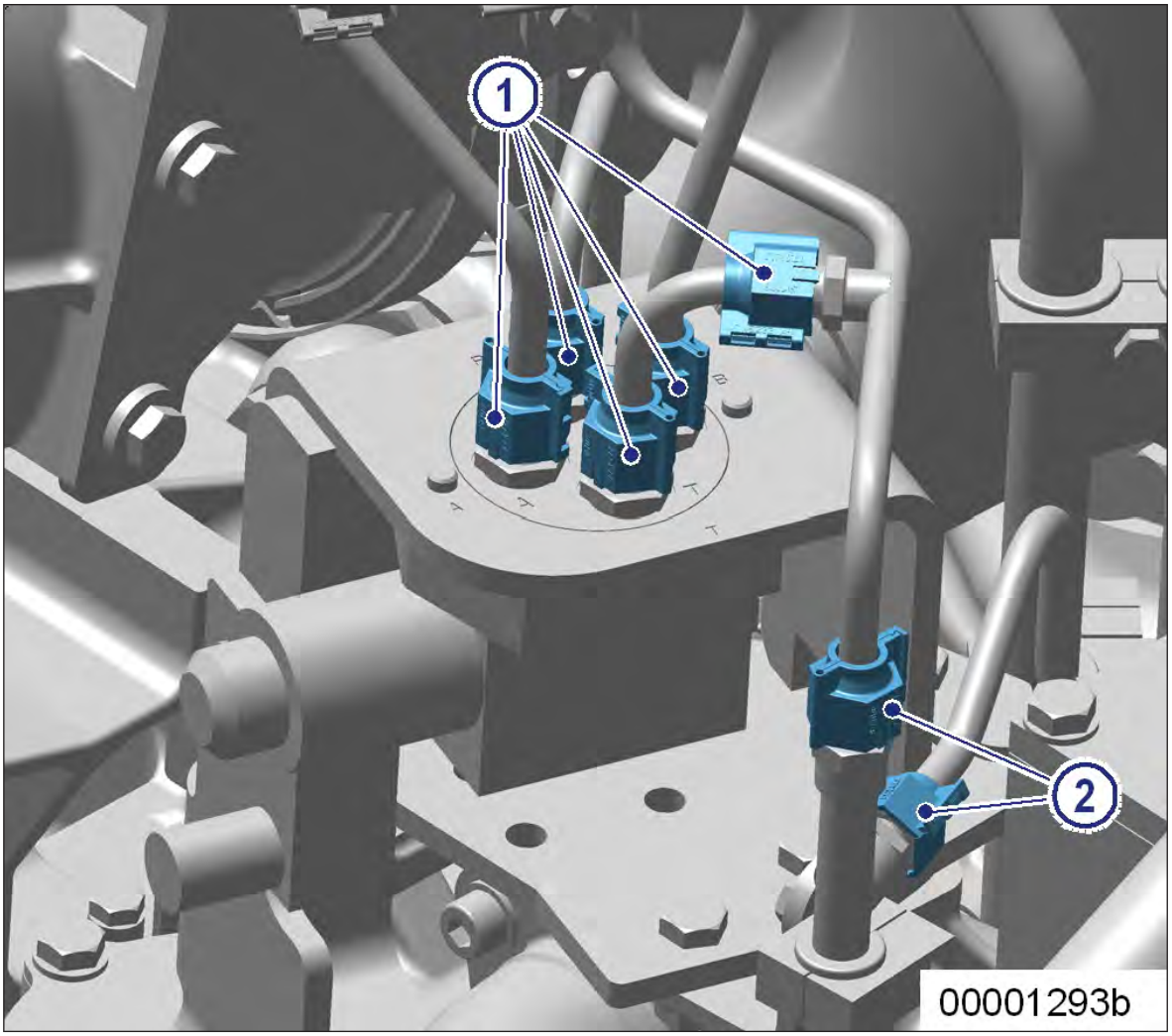
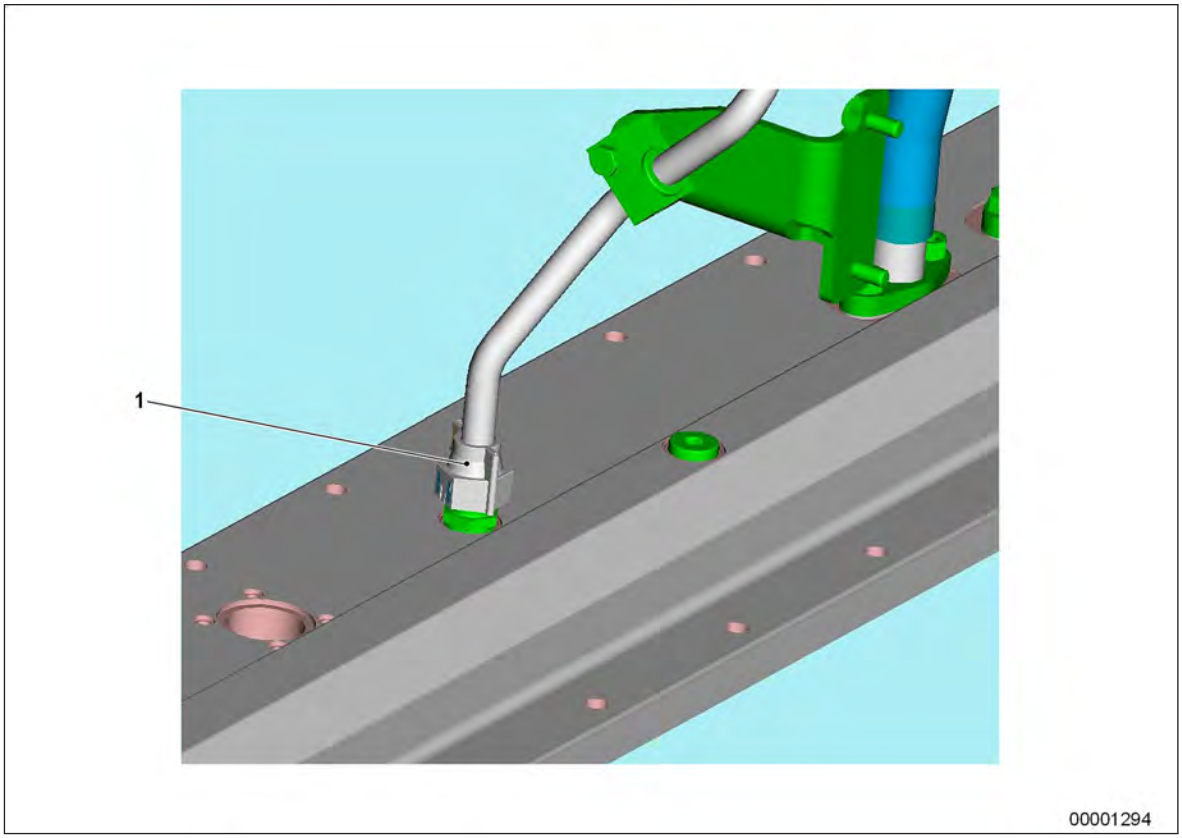
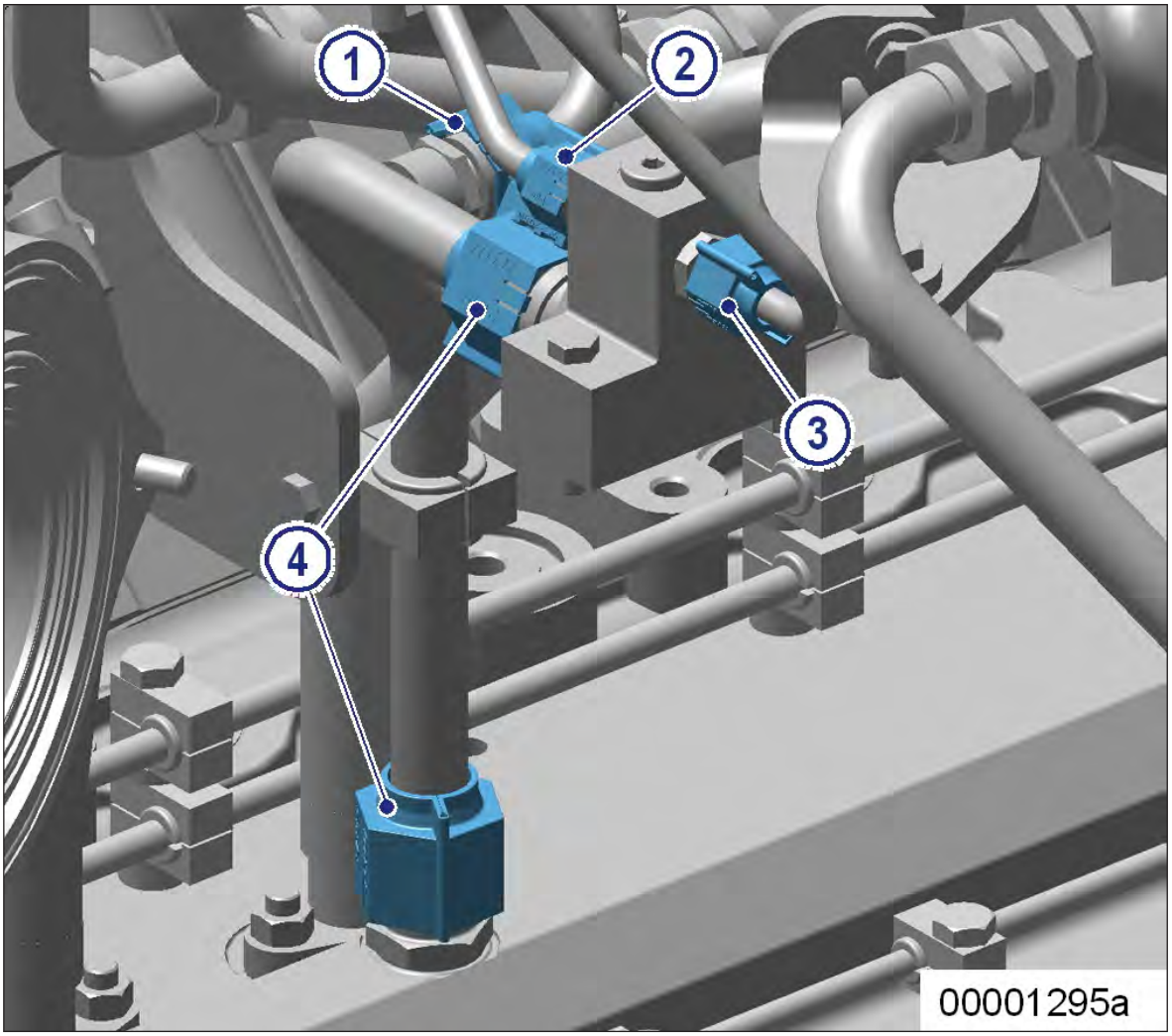


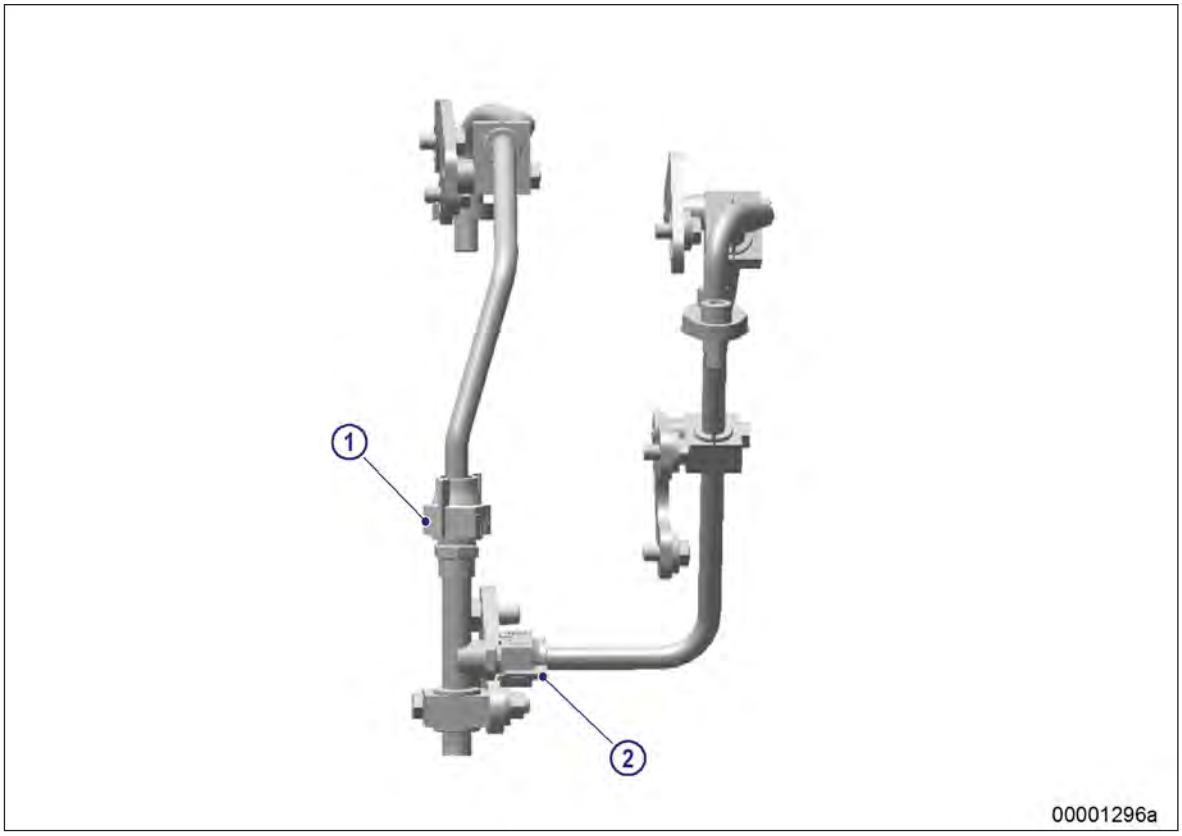
1 Oil supply to distributor 2 Oil return



1 Oil return



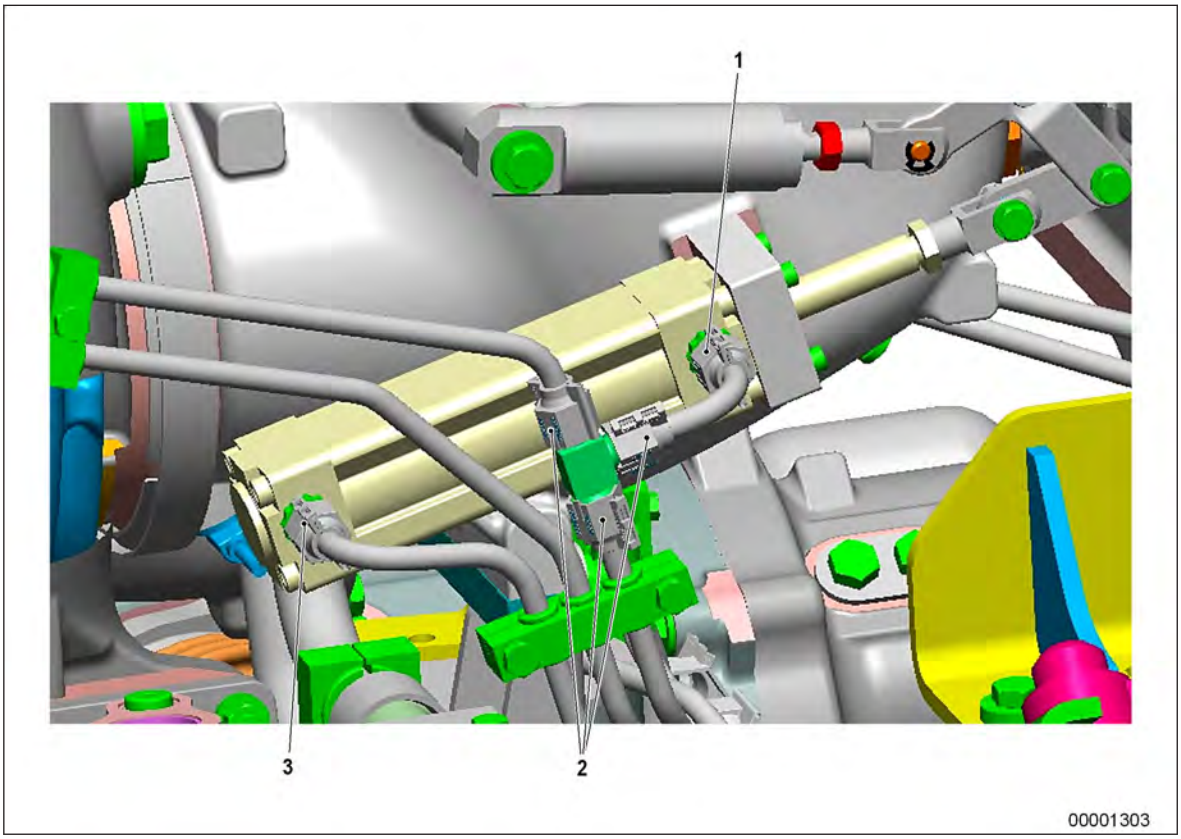
1 Oil line to flap control
2 Oil line to recirculation valve
3 Oil line from main oil gallery
4 Oil line to ETC



1 ETC oil supply

2 ETC oil supply

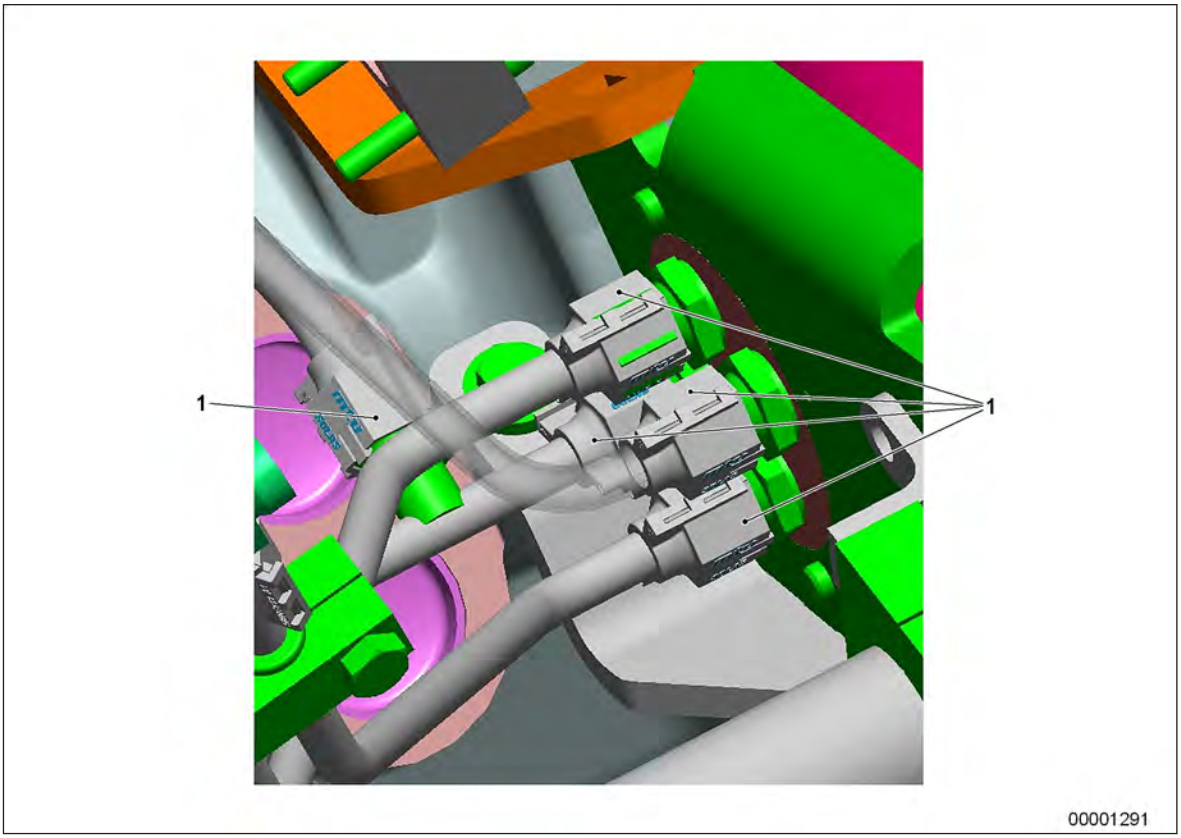
Engines with vertical air intake



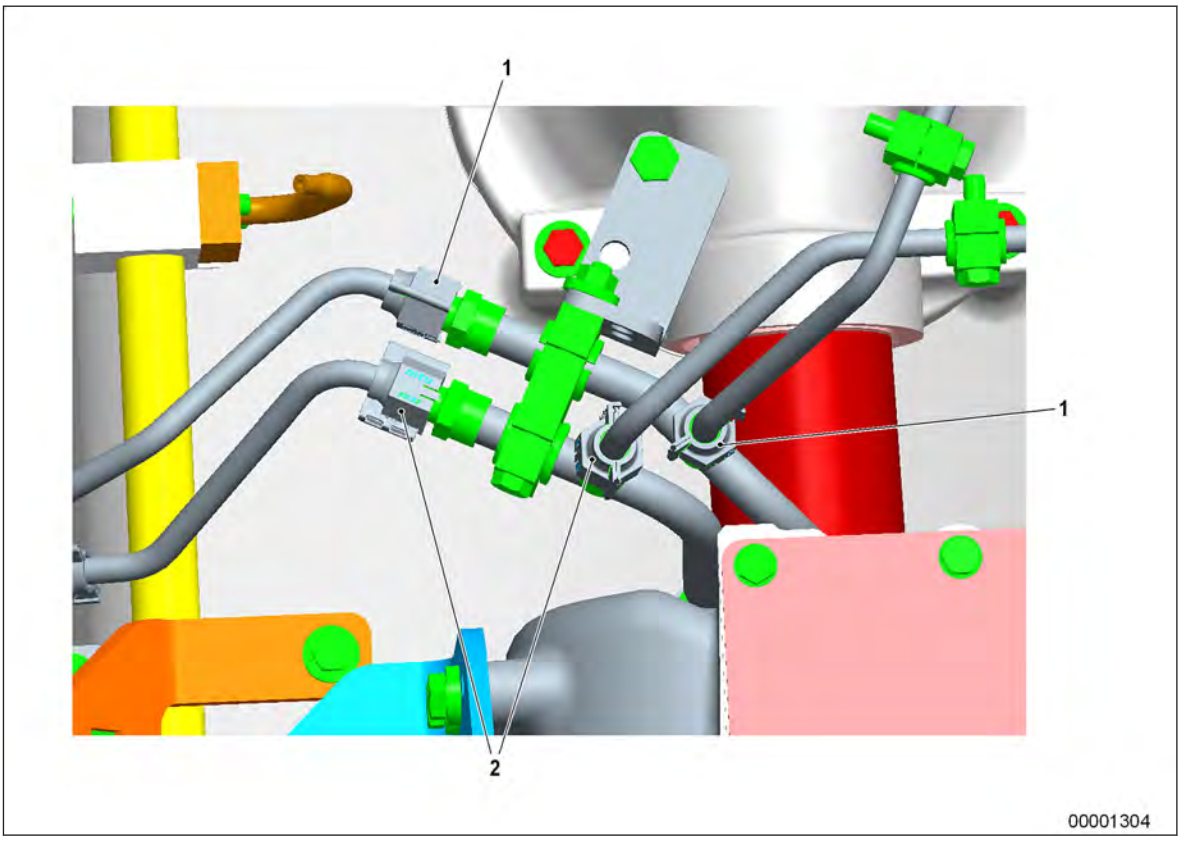
1 Oil supply for actuating cylinder of turbocharger B1 air flap

2 Oil supply for T-piece of flap control

3 Oil supply for actuating cylinder of turbocharger B1 air flap

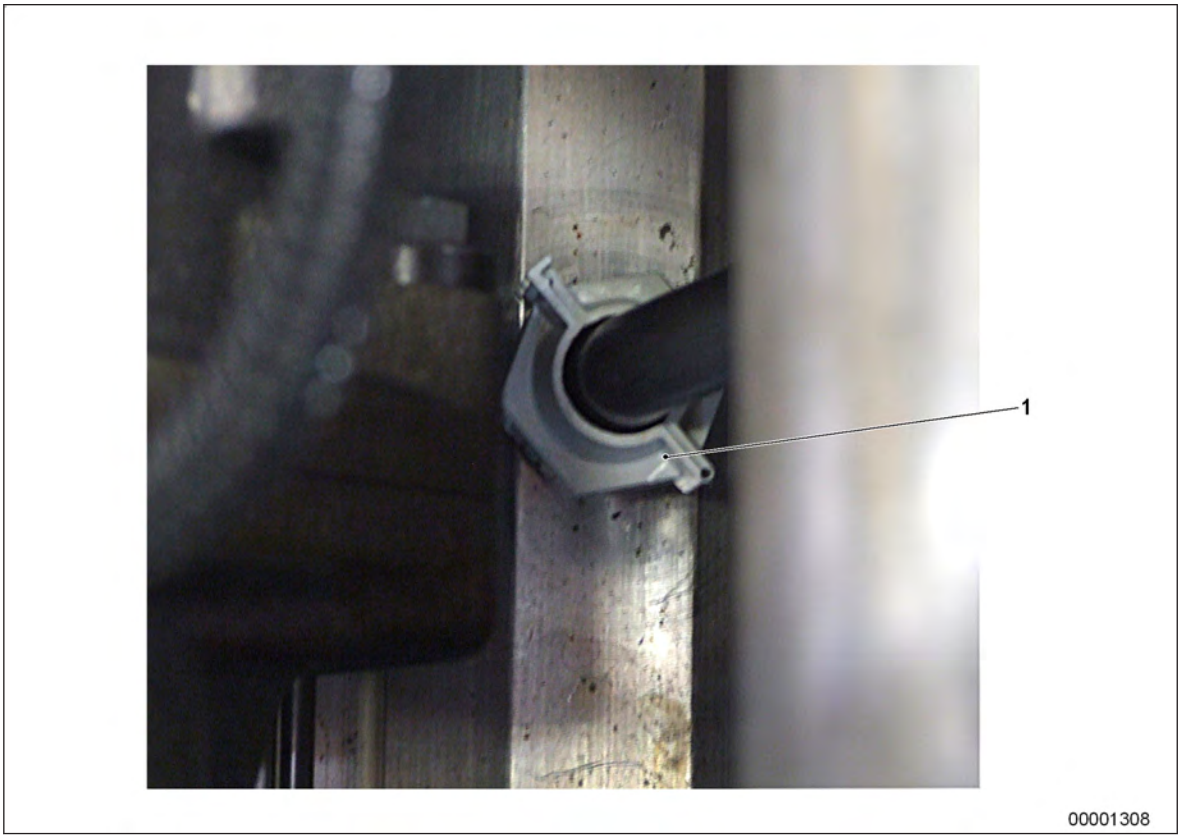


1 Oil supply to distributor of flap control, B-side

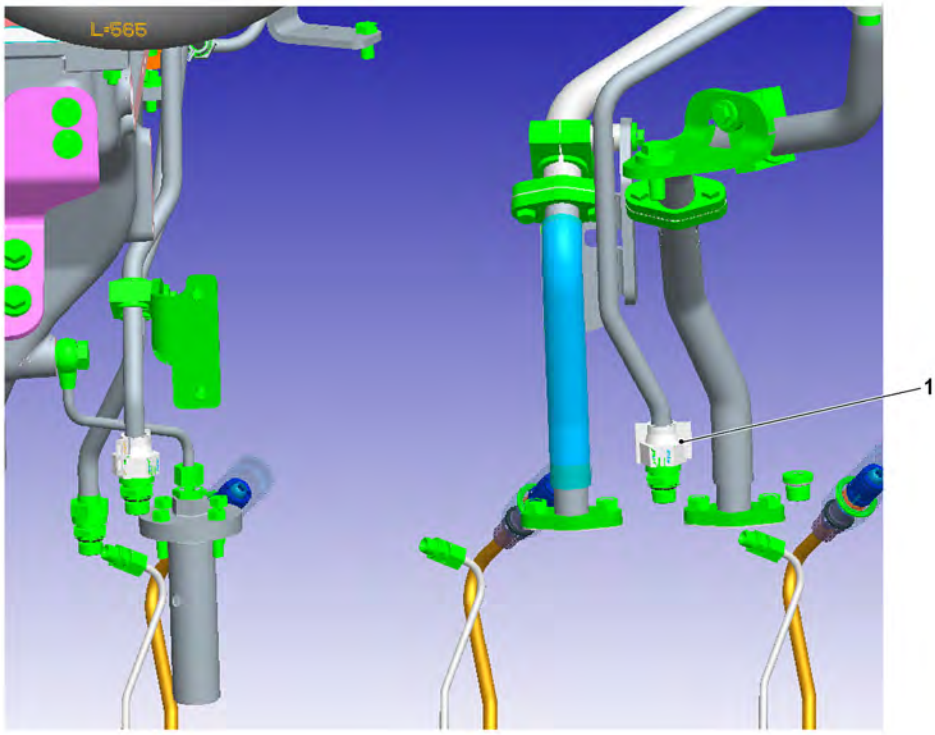


1 Oil lines for B-side flap control from main oil gallery

2 Oil lines for B-side flap control to main oil gallery

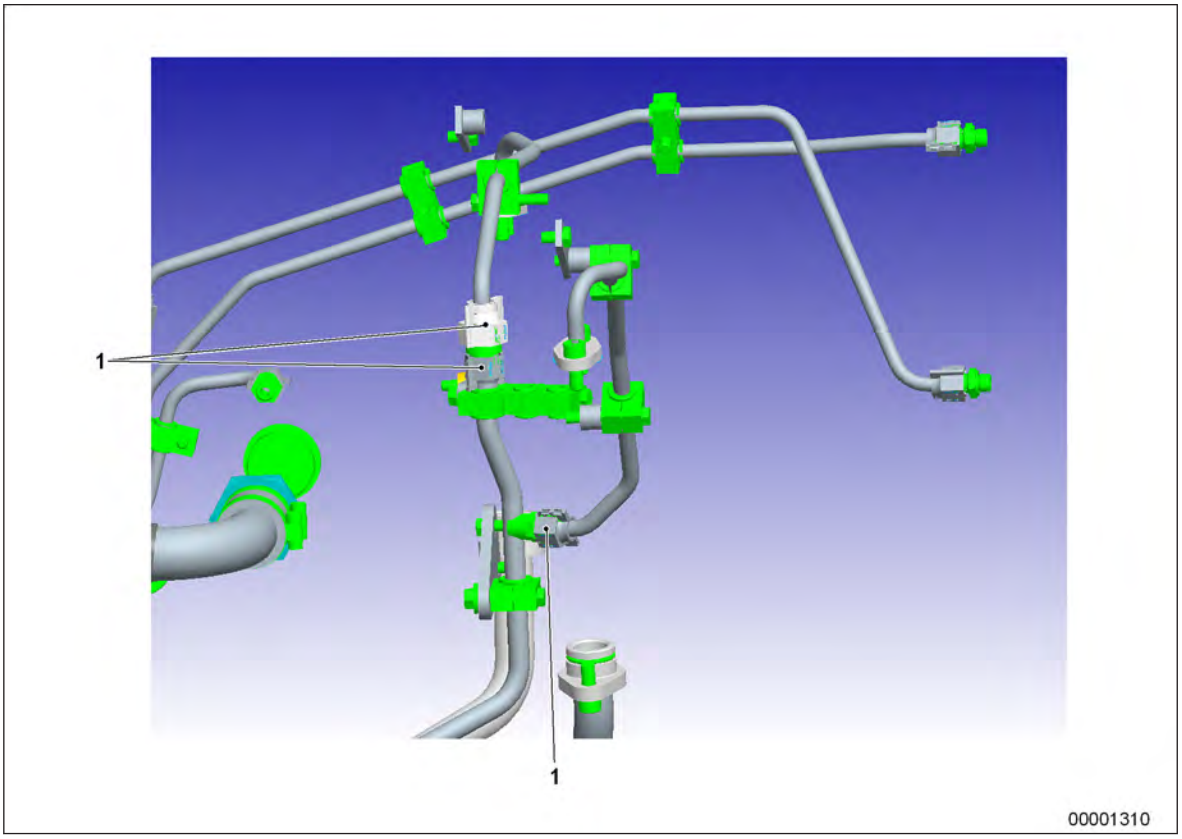


1 Oil supply for flap control to main oil gallery in engine Vee, engine free end



1 Turbocharger oil supply connection to main oil gallery in engine Vee

TIM-ID: 0000045751 - 001

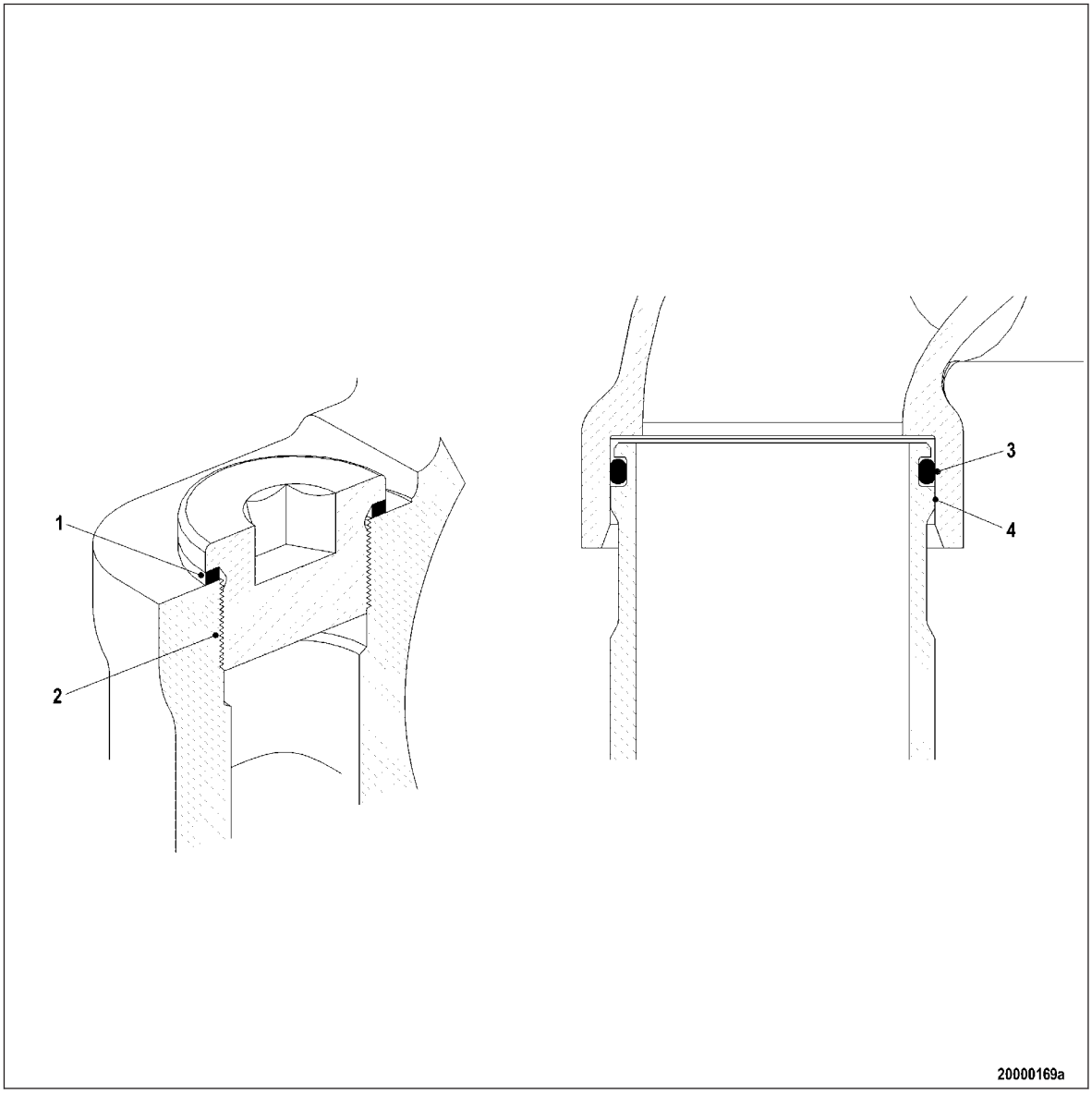


1 Oil supply on distribution point of turbocharger oil supply on engine free end

1 Cover on oil filter cartridge

Special connections

In case of leakage, the following connection types are spray-protected even without a cover and have been confirmed compliant with SOLAS by GL and DNV.



Plug-in pipe union

The sleeve (4) covers the joint to prevent lateral spray.

Only leak-off along the line is possible, the pressure is decreases significantly if an O-ring (3) defect occurs.

The connection is confirmed as compliant with SOLAS by DNV and GL.

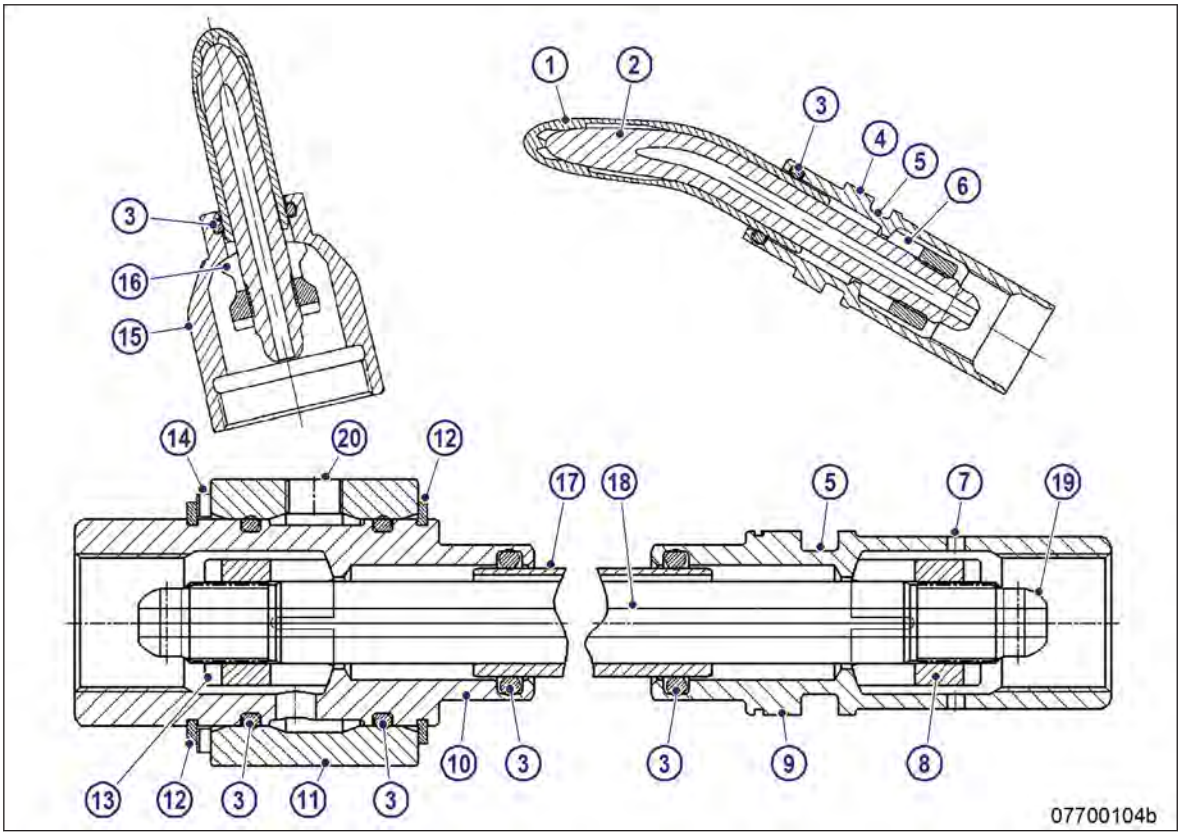
Plugs and sensors

Screw-in plugs (2) are sealed toward the outside either with a copper sealing ring (1), according to DIN, or an O-ring (ISO).

In case of a loose thread or a defective sealing ring (2), the liquid first has to pass the thread.

The pressure is so greatly reduced by this and the faulty sealing ring (2) that any leakage is not under pressure.

HP connections



1 Jacket pipe
2 HP fuel line
3 O-ring
4 Union nut
5 Recess for O-ring
6 Thrust ring
7 Leakage overflow bore
8 Thrust ring
9 Union nut
10 Union nut
11 Connecting piece
12 Snap ring
13 Thrust ring
14 Compensating disks
15 Union nut
16 Thrust ring
17 HP line outer pipe
18 Internal pipe of HP line
19 Ball-type seal area
20 Leak-fuel connection

HP connections

The HP fuel line is sealed by the thrust ring (8).

If leakage in the area of the thrust ring (8) or the HP line (5) occurs, the emerging fuel is routed to the leakage chamber.

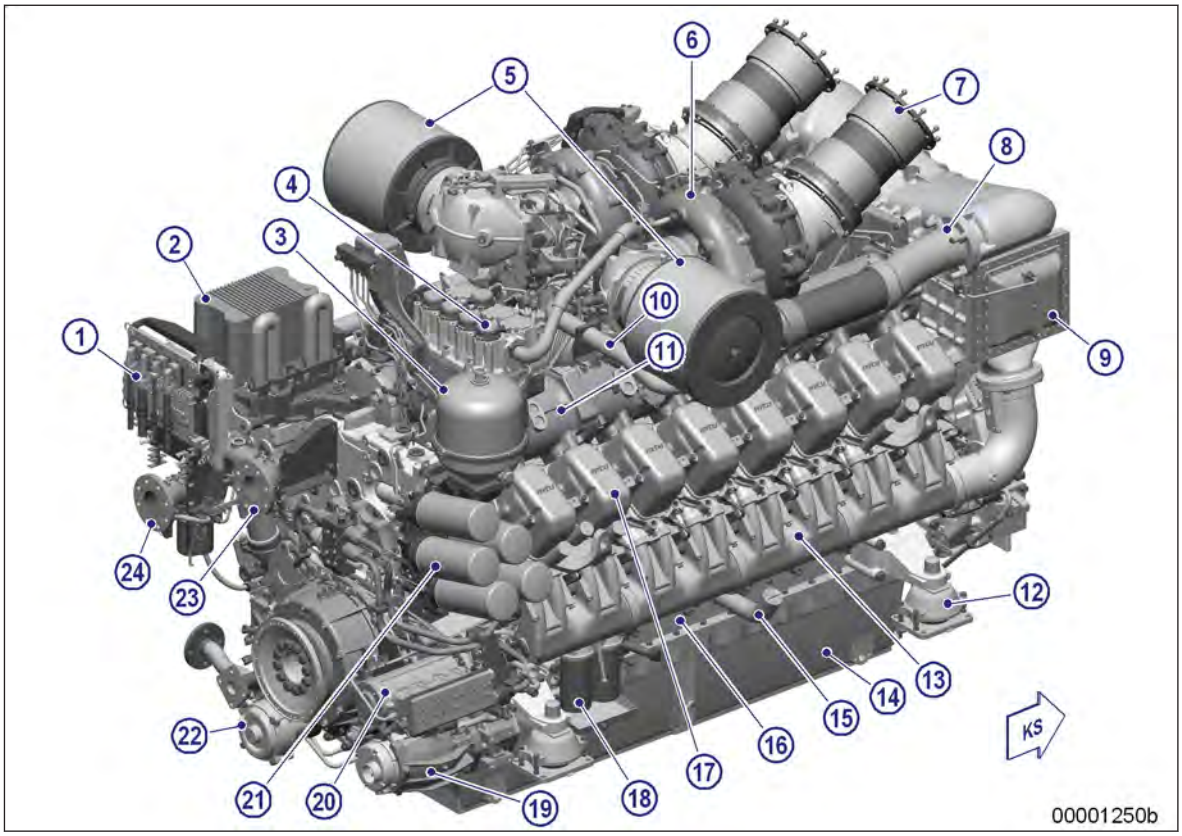
The leaking fuel is drained off without pressure via the leakage overflow-bore (7). The leakage chamber is sealed toward the outside by the O-rings (3).

This prevents leakage egress.

The connection is confirmed as compliant with SOLAS by DNV and GL.

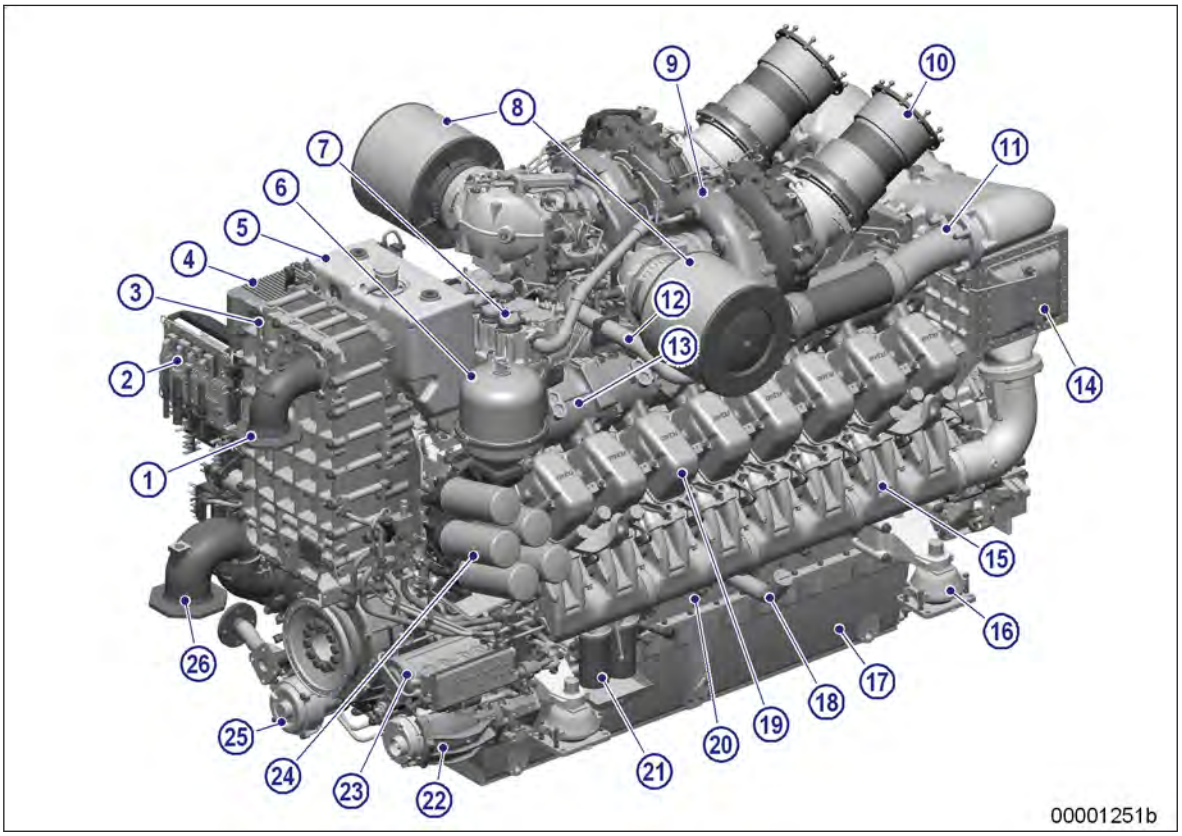
2.3 Engine layout

Engines with remote heat exchanger and horizontal air intake



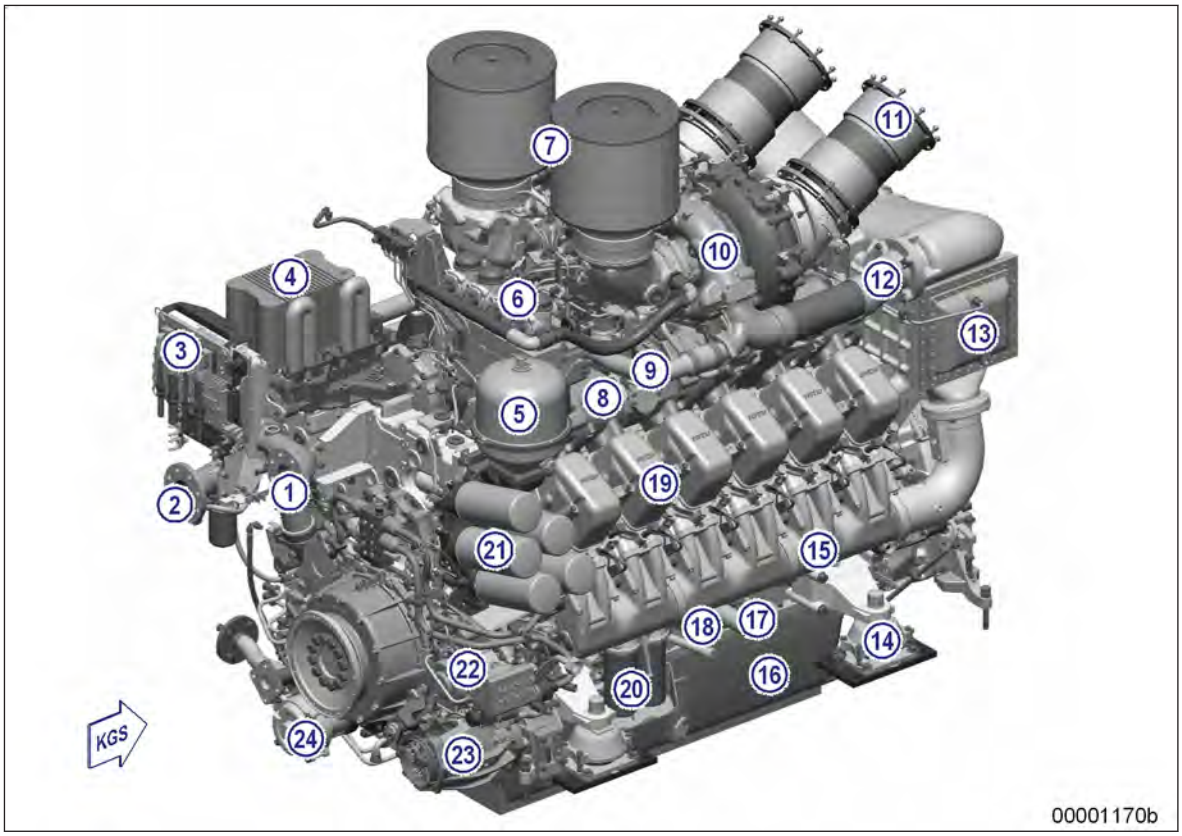
1 Engine management and monitoring
2 Oil cooler
3 Centrifugal oil filter
4 Crankcase breather
5 Dry-type air filter
6 Exhaust turbocharger
7 Exhaust outlet
8 Air pipe to charge-air cooler
9 Charge-air cooler
10 Recirculation line
11 Exhaust manifold
12 Engine mounts
13 Charge-air line
14 Oil pan
15 Oil filler neck
16 Crankcase
17 Cylinder head
18 Fuel filter
19 Battery-charging generator
20 HP fuel pump
21 Oil filter
22 Bilge pump (option)
23 Coolant outlet to remote cooling system
24 Coolant inlet from remote cooling system
KGS Free end

Engines with engine-mounted heat exchanger and horizontal air intake



1 Raw-water outlet
2 Engine management and monitoring
3 Plate-core heat exchanger
4 Oil cooler
5 Coolant expansion tank
6 Centrifugal oil filter
7 Crankcase breather
8 Dry-type air filter
9 Exhaust turbocharger
10 Exhaust outlet
11 Air pipe to charge-air cooler
12 Recirculation line
13 Exhaust manifold
14 Charge-air cooler
15 Charge-air line
16 Engine mounts
17 Oil pan
18 Oil filler neck
19 Cylinder head
20 Crankcase
21 Fuel filter
22 Battery-charging generator
23 HP fuel pump
24 Oil filter
25 Bilge pump (option)
26 Raw-water inlet
KGS Free end

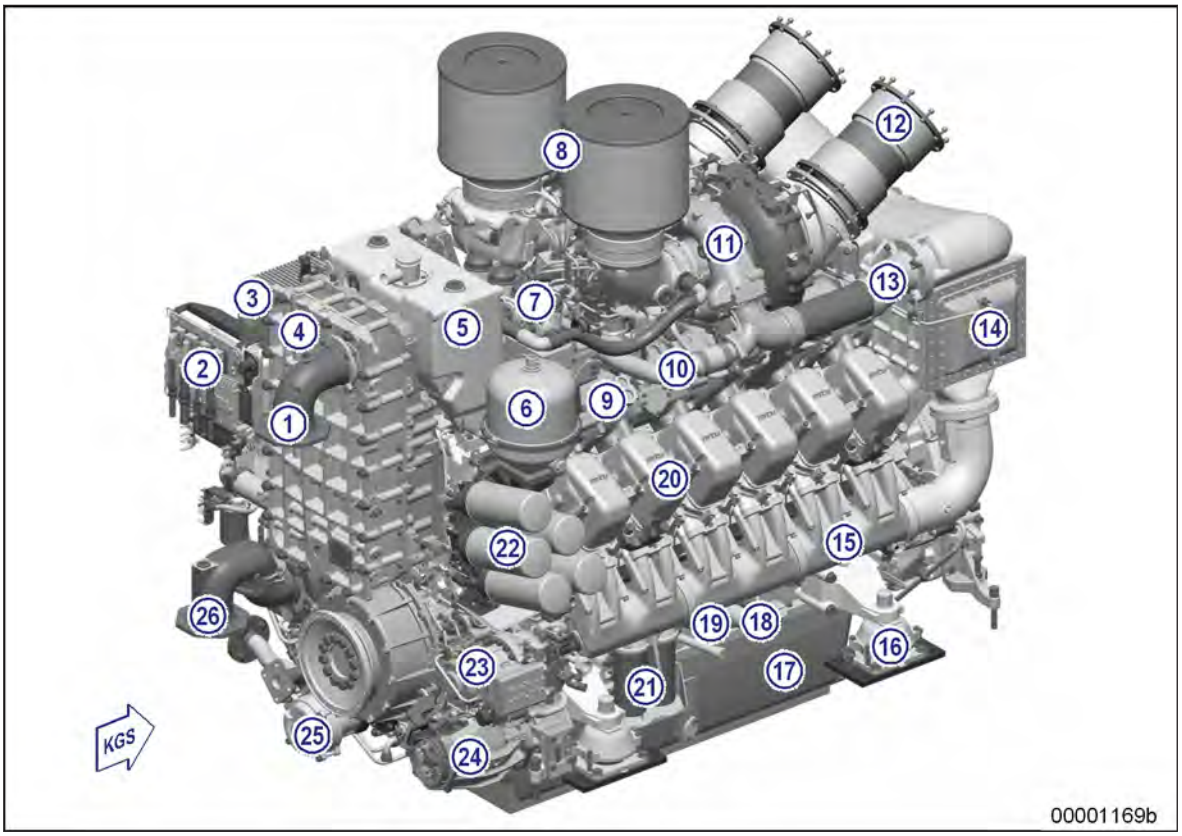
Engines with remote heat exchanger and vertical air intake



1 Coolant outlet to remote cooling system
2 Coolant inlet from remote cooling system
3 Engine management and monitoring
4 Oil cooler
5 Centrifugal oil filter
6 Crankcase breather
7 Dry-type air filter
8 Exhaust manifold
9 Recirculation line
10 Exhaust turbocharger
11 Exhaust outlet
12 Air pipe to charge-air cooler
13 Charge-air cooler
14 Engine mounts
15 Charge-air line
16 Oil pan
17 Oil filler neck
18 Crankcase
19 Cylinder head
20 Fuel filter
21 Oil filter
22 HP fuel pump
23 Battery-charging generator
24 Bilge pump (option)
KGS Free end

Illustration is also valid for 16V engines.

Engines with engine-mounted heat exchanger and vertical air intake



1 Raw-water outlet
2 Engine management and monitoring
3 Oil cooler
4 Plate-core heat exchanger
5 Coolant expansion tank
6 Centrifugal oil filter
7 Crankcase breather
8 Dry-type air filter
9 Exhaust manifold
10 Recirculation line
11 Exhaust turbocharger
12 Exhaust outlet
13 Air pipe to charge-air cooler
14 Charge-air cooler
15 Charge-air line
16 Engine mounts
17 Oil pan
18 Oil filler neck
19 Crankcase
20 Cylinder head
21 Fuel filter
22 Oil filter
23 HP fuel pump
24 Battery-charging generator
25 Bilge pump (option)
26 Raw-water inlet
KGS Free end

Illustration is also valid for 16V engines.

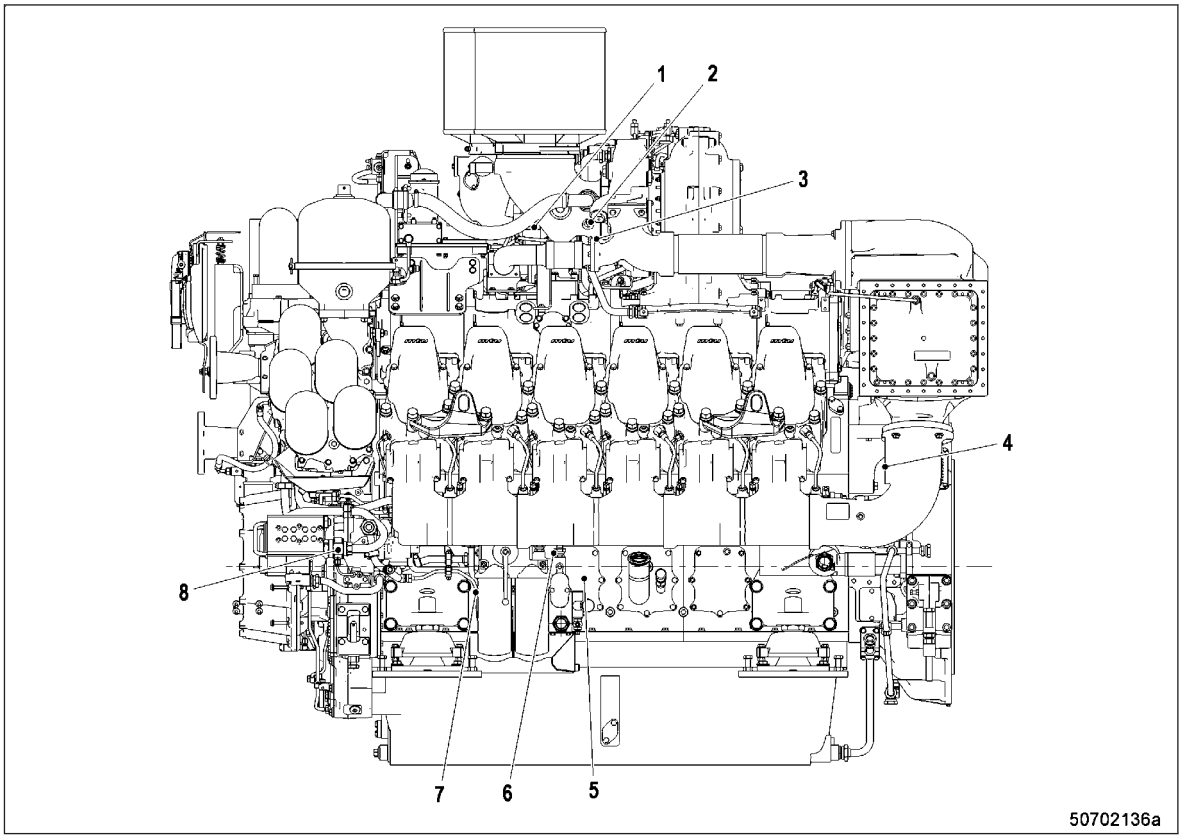
Engine model designation

Key to the engine model designations 12/16V 4000 Mxy z	
12, 16	Number of cylinders
V	Cylinder arrangement: V-engine
4000	Series
M	Application (M= Marine)
x	Application load profile (0, 1, 2, 3...9)
y	Design index (0, 1, 2, 3...9)
z	R (power / speed reduction) L (enhanced power / speed) S (60 Hz) F (50 Hz)

2.4 Sensors, actuators and injectors on 12V engines – Overview

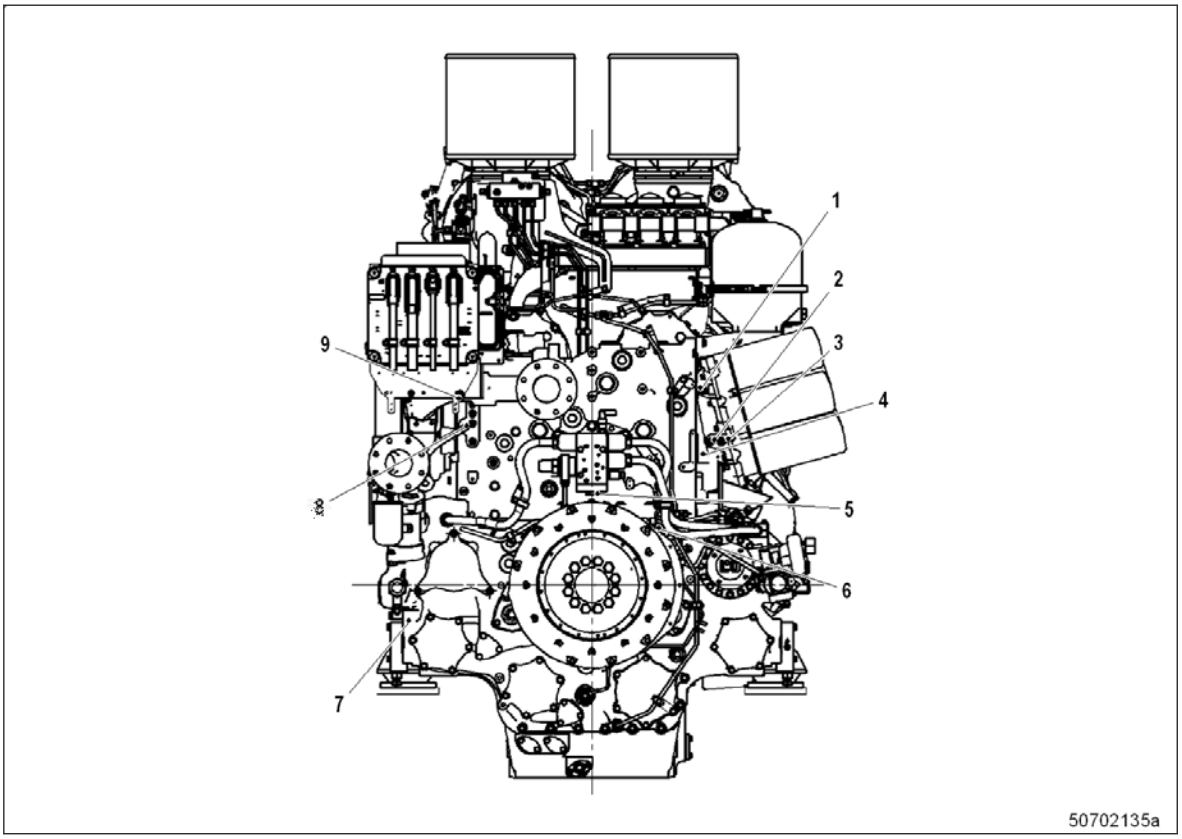
Engines with vertical air intake, remote heat exchanger

12 V 4000 M engine, left engine side



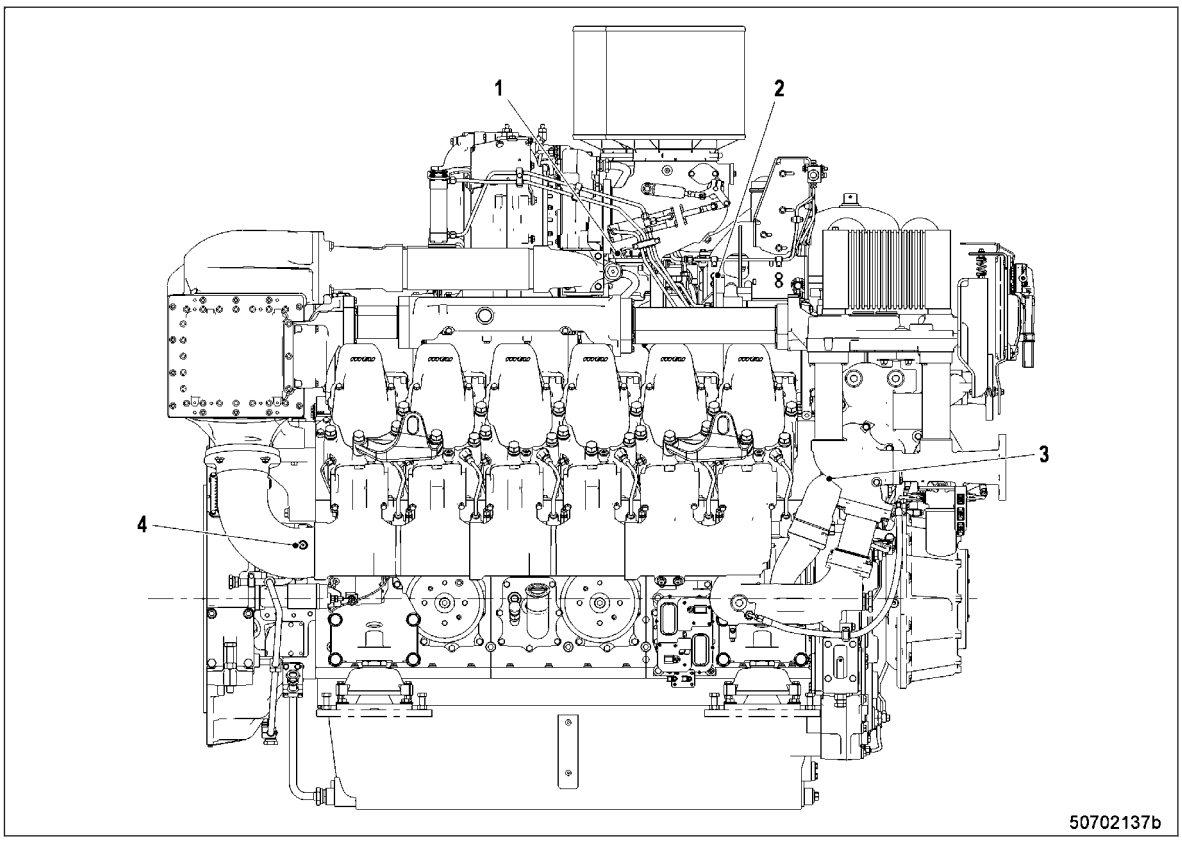
1 B49/Y26 (charge-air temperature before recirculation valve)/(recirculation valve A)
2 B3 (intake air temperature)
3 B44.1 (turbocharger A speed)
4 B10 (charge-air pressure)
5 B34.3 (fuel pressure before filter) (only if supplementary fuel filter is fitted)
6 B34.2 (fuel pressure before filter)
7 B34.1 (fuel pressure after filter)
8 F46 (leak fuel level)

12 V 4000 M engine, free end



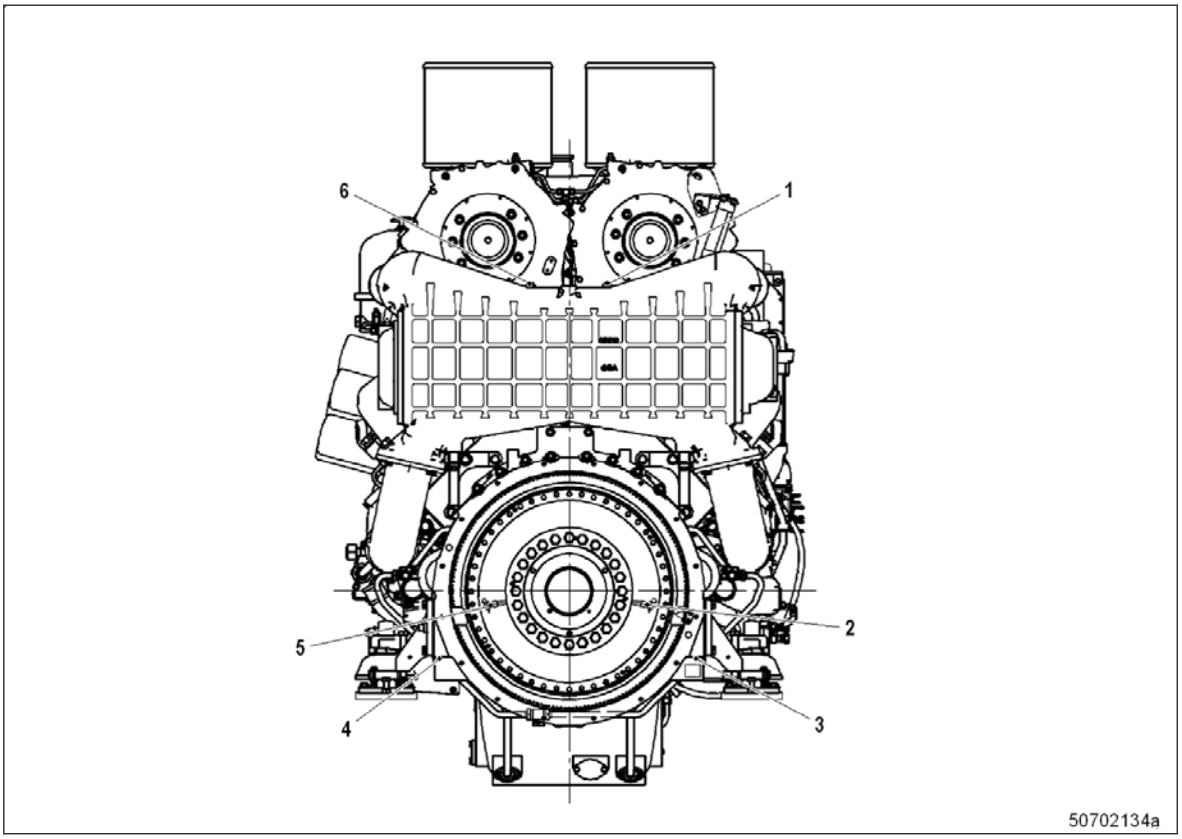
1 B7 (lube oil temperature)
2 B5.3 (lube-oil pressure before filter)
3 B5.1 (lube-oil pressure after filter)
4 B33 (fuel temperature in common rail)
5 B48 (fuel pressure in common rail)
6 B1 (camshaft speed)
7 B54 (oil refill pump pressure) (optional)
8 B6.2 (coolant temperature) (optional)
9 B6 (coolant temperature)

12 V 4000 M engine, right engine side



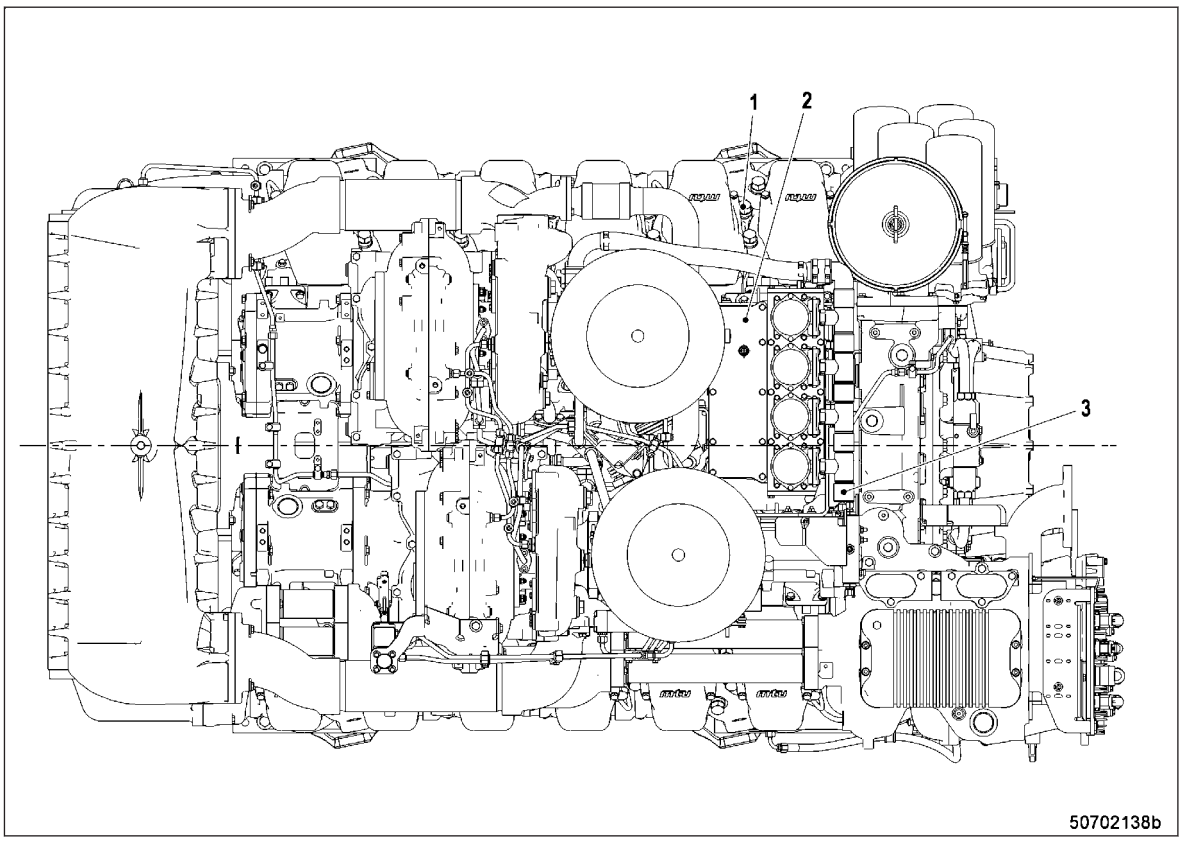
1 B44.2 (turbocharger B speed)
2 Y27 (turbocharger control valve)
3 B16 (coolant pressure)
4 B9 (charge-air temperature)

12 V 4000 M engine, driving end



1 B4.22 (exhaust temperature, B bank)
2 B13 (crankshaft speed)
3 S37.2 (safety switch)
4 S37.1 (safety switch)
5 B13.2 (crankshaft speed) (optional)
6 B4.21 (exhaust temperature, a bank)

12 V 4000 M engine, top view



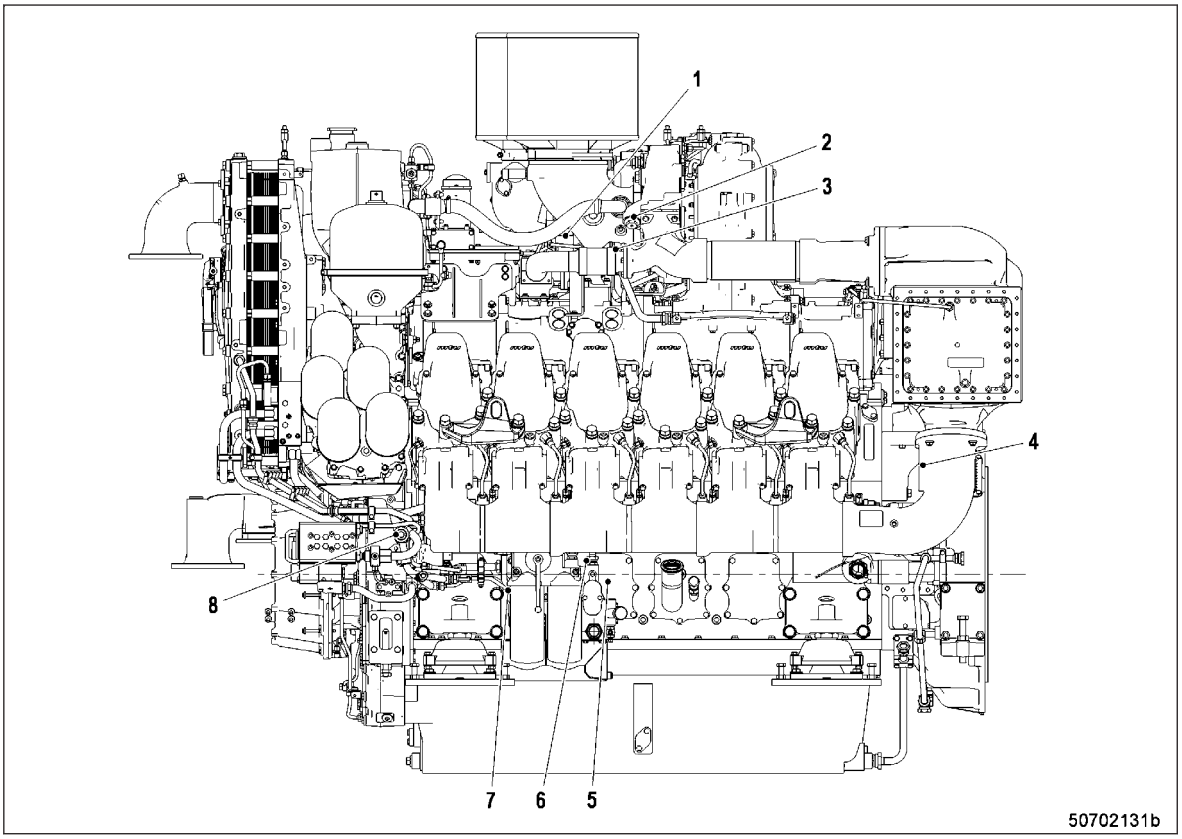
1 B4 (cylinder exhaust temperature A1-A6, B1-B6) (optional)

2 B50 (crankcase pressure)

3 B33 (alternatively) (fuel temperature in common rail)

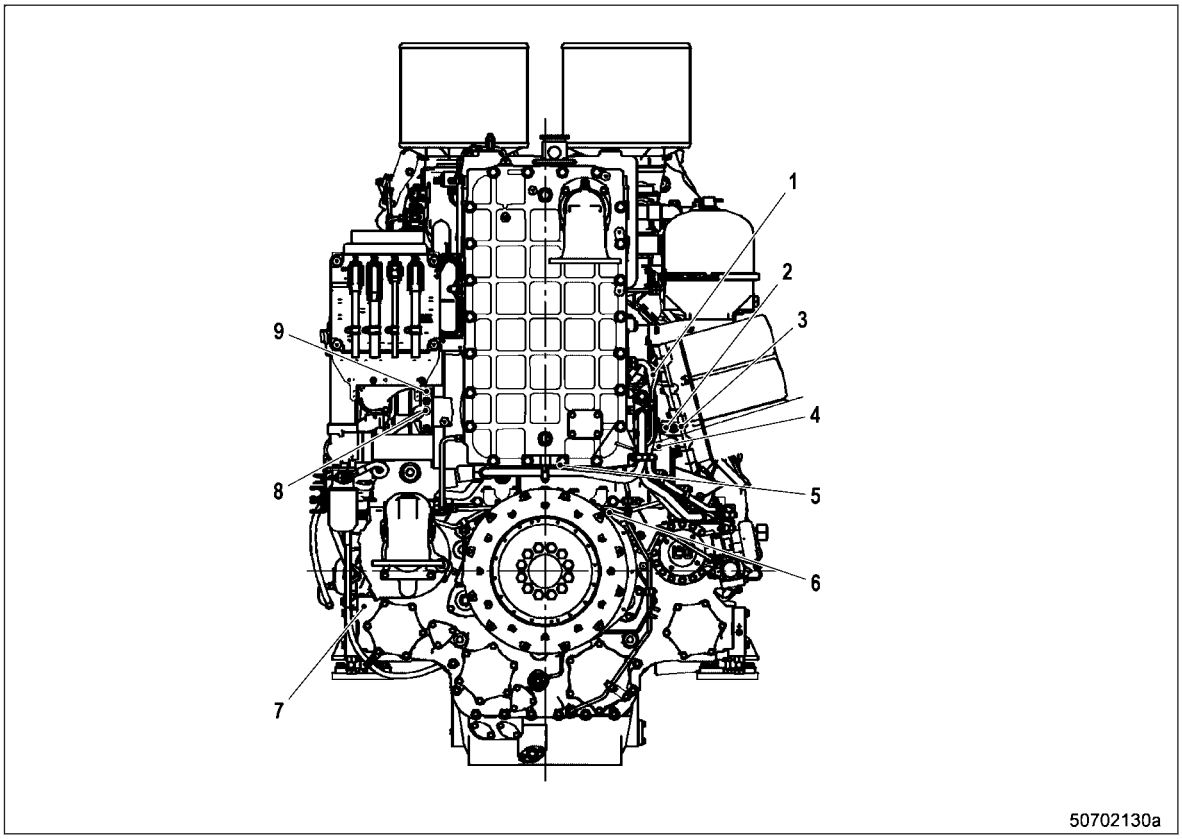
Engines with vertical air intake, engine-mounted heat exchanger

12 V 4000 M engine, left engine side



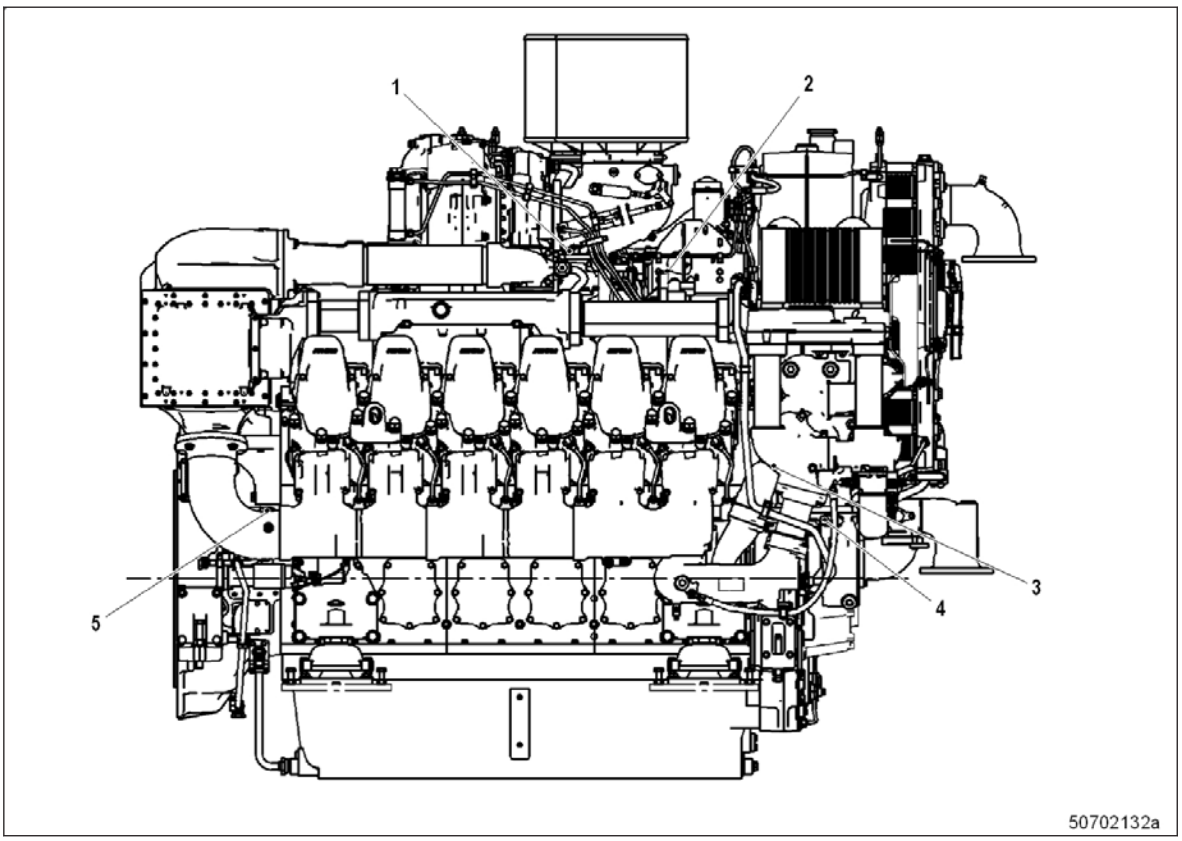
1 B49/Y26 (charge-air temperature before recirculation valve)/(recirculation valve A)
2 B3 (intake air temperature)
3 B44.1 (turbocharger A speed)
4 B10 (charge-air pressure)
5 B34.3 (fuel pressure before filter) (only if supplementary fuel filter is fitted)
6 B34.2 (fuel pressure before filter)
7 B34.1 (fuel pressure after filter)
8 F46 (leak fuel level)

12 V 4000 M engine, free end



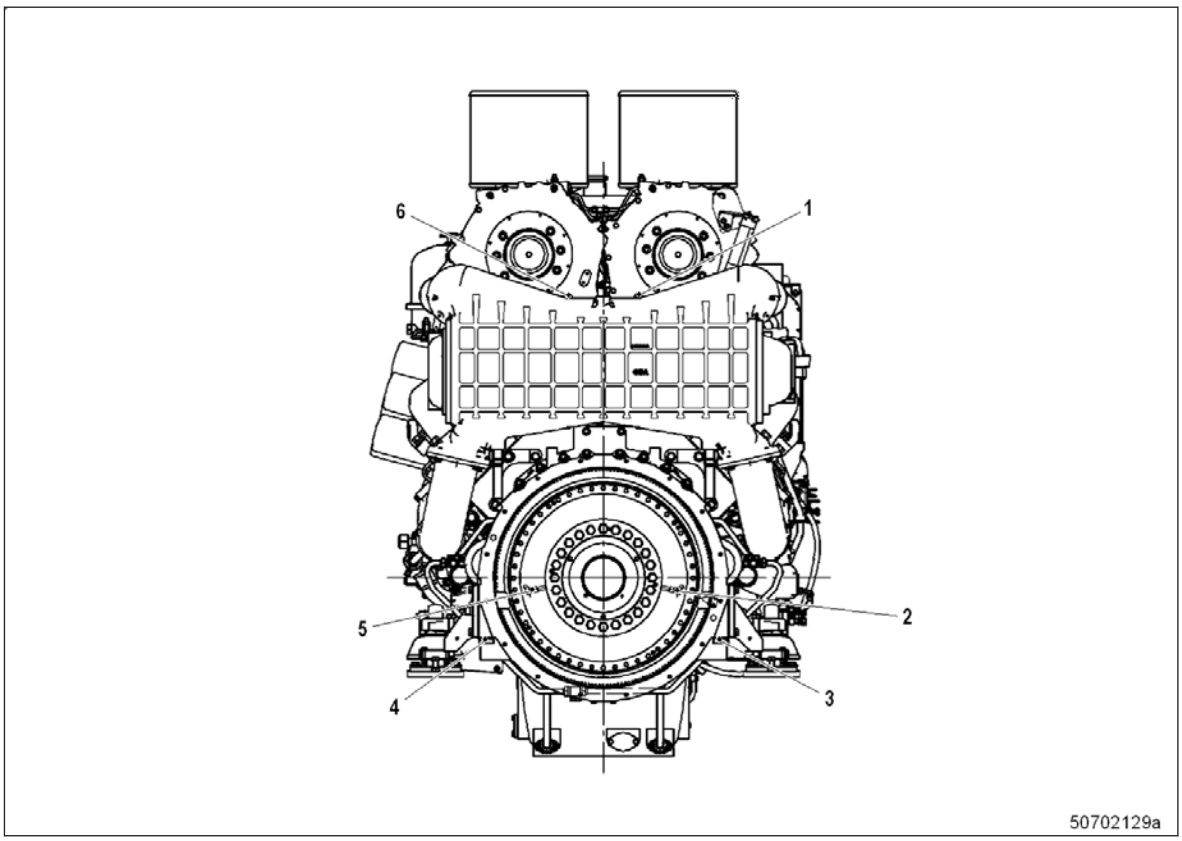
1 B7 (lube oil temperature)
2 B5.3 (lube-oil pressure before filter)
3 B5.1 (lube-oil pressure after filter)
4 B33 (fuel temperature in common rail)
5 B48 (fuel pressure in common rail)
6 B1 (camshaft speed)
7 B54 (oil refill pump pressure) (optional)
8 B6.2 (coolant temperature) (optional)
9 B6 (coolant temperature)

12 V 4000 M engine, right engine side



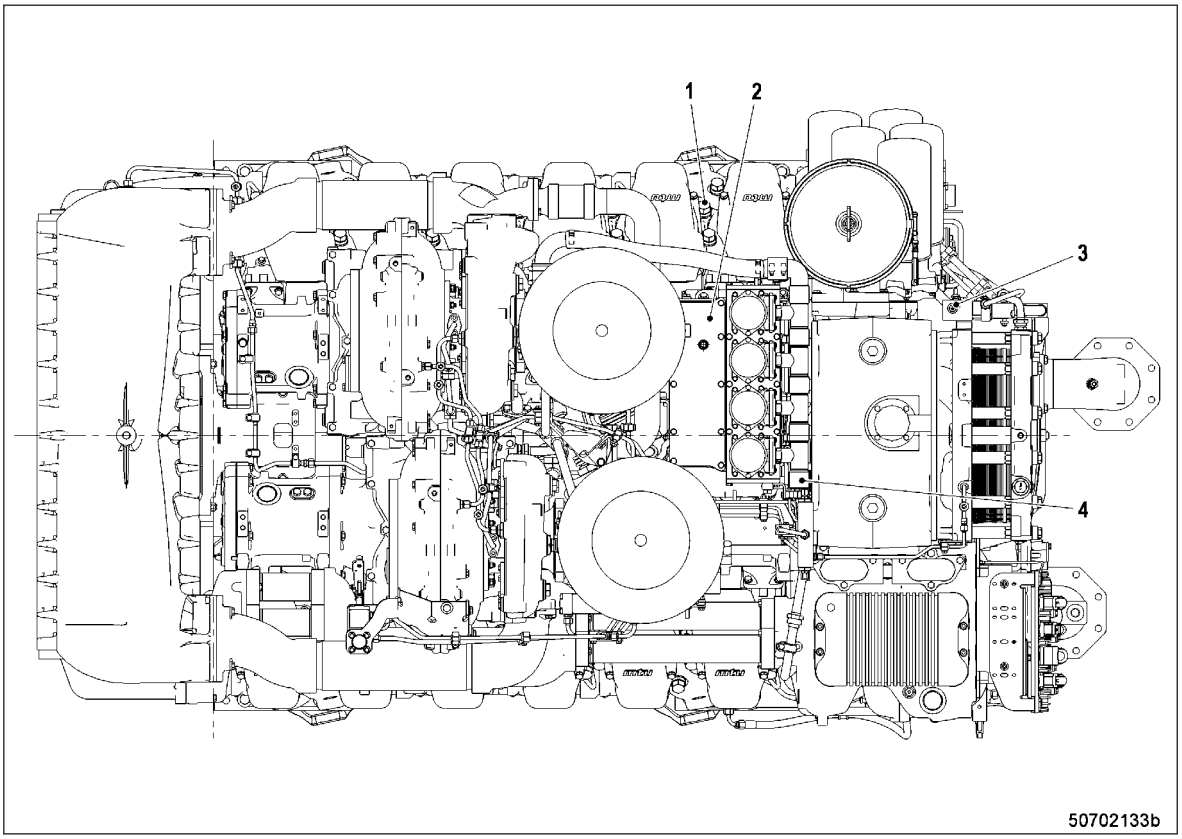
1 B44.2 (turbocharger B speed)
2 Y27 (turbocharger control valve)
3 B16 (coolant pressure)
4 B21 (raw-water pressure) (optional)
5 B9 (charge-air temperature)

12 V 4000 M engine, driving end



1 B4.22 (exhaust temperature, B bank)
2 B13 (crankshaft speed)
3 S37.2 (safety switch)
4 S37.1 (safety switch)
5 B13.2 (crankshaft speed) (optional)
6 B4.21 (exhaust temperature, a bank)

12 V 4000 M engine, top view

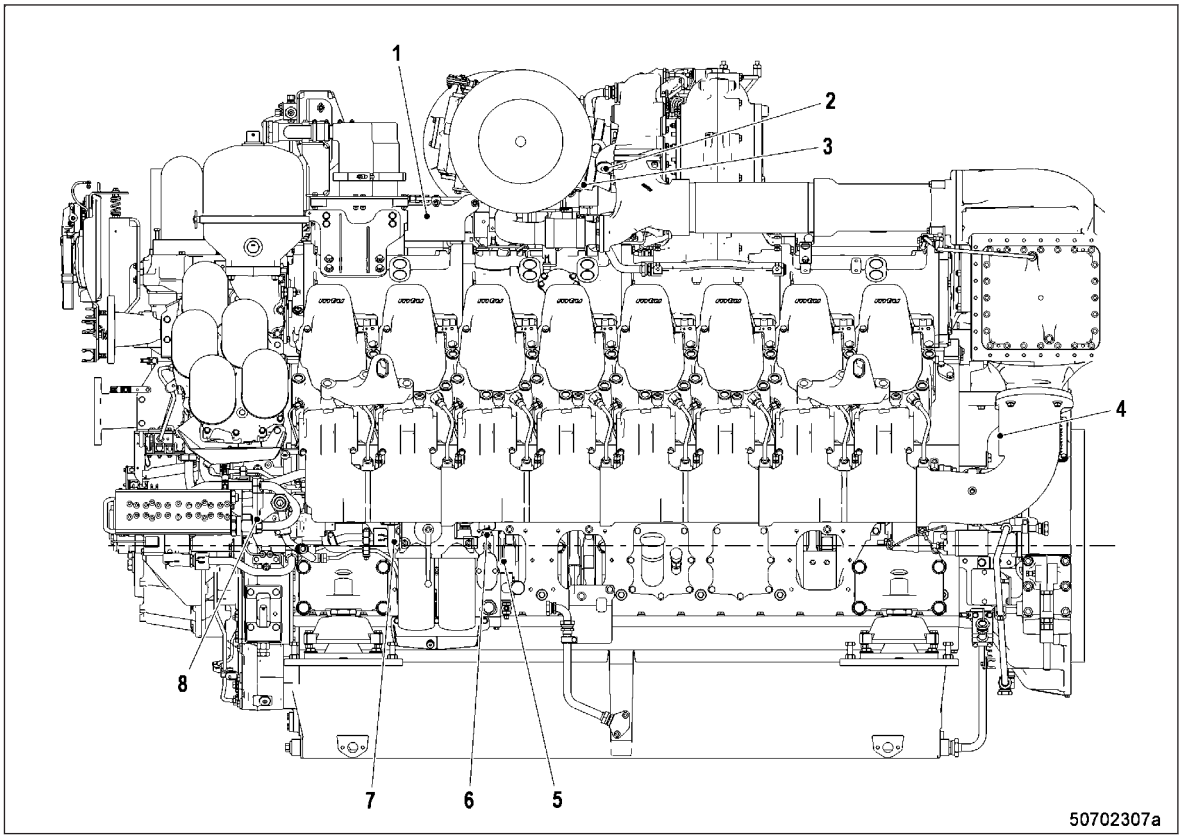


1 B4 (cylinder exhaust temperature A1-A6, B1-B6) (optional)
2 B50 (crankcase pressure)
3 B33 (alternatively) (fuel temperature in common rail)
4 F33 (coolant level)

2.5 Sensors, actuators and injectors on 16V engines – Overview

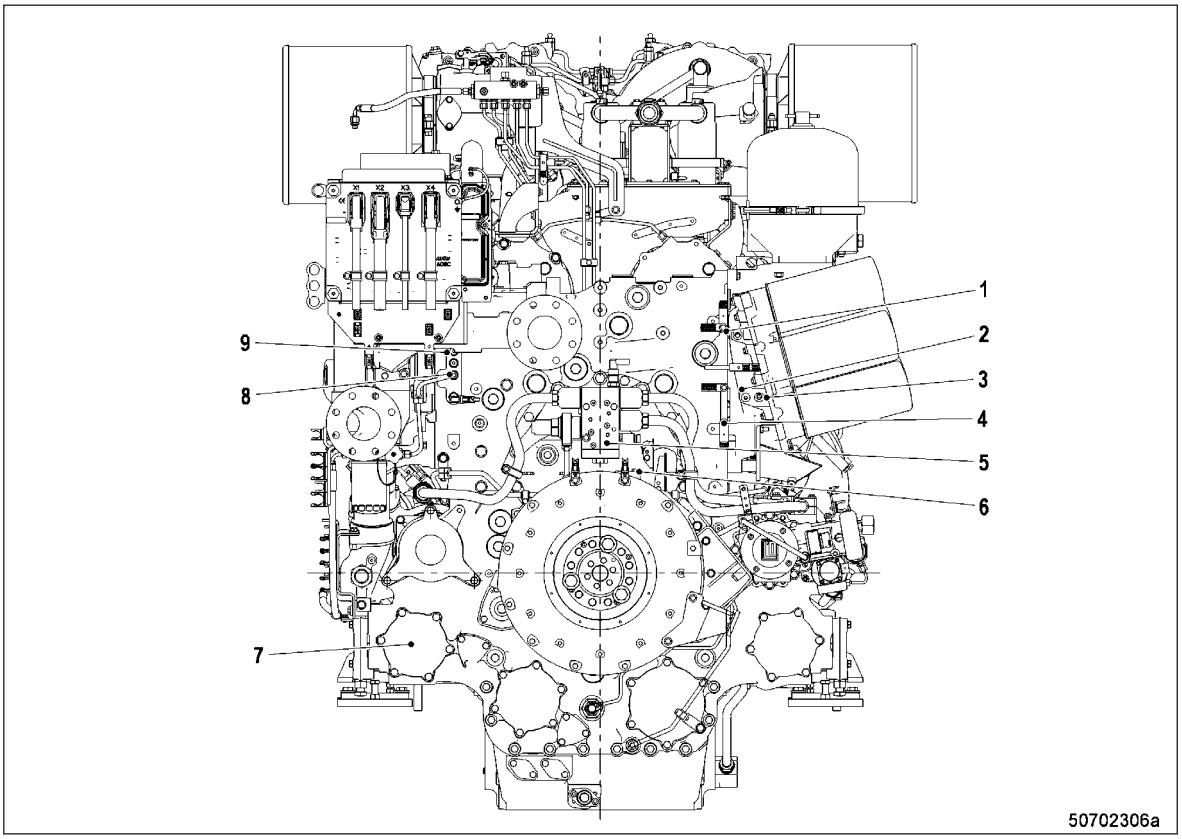
Engines with horizontal air intake, remote heat exchanger

16V 4000 M engine, left engine side



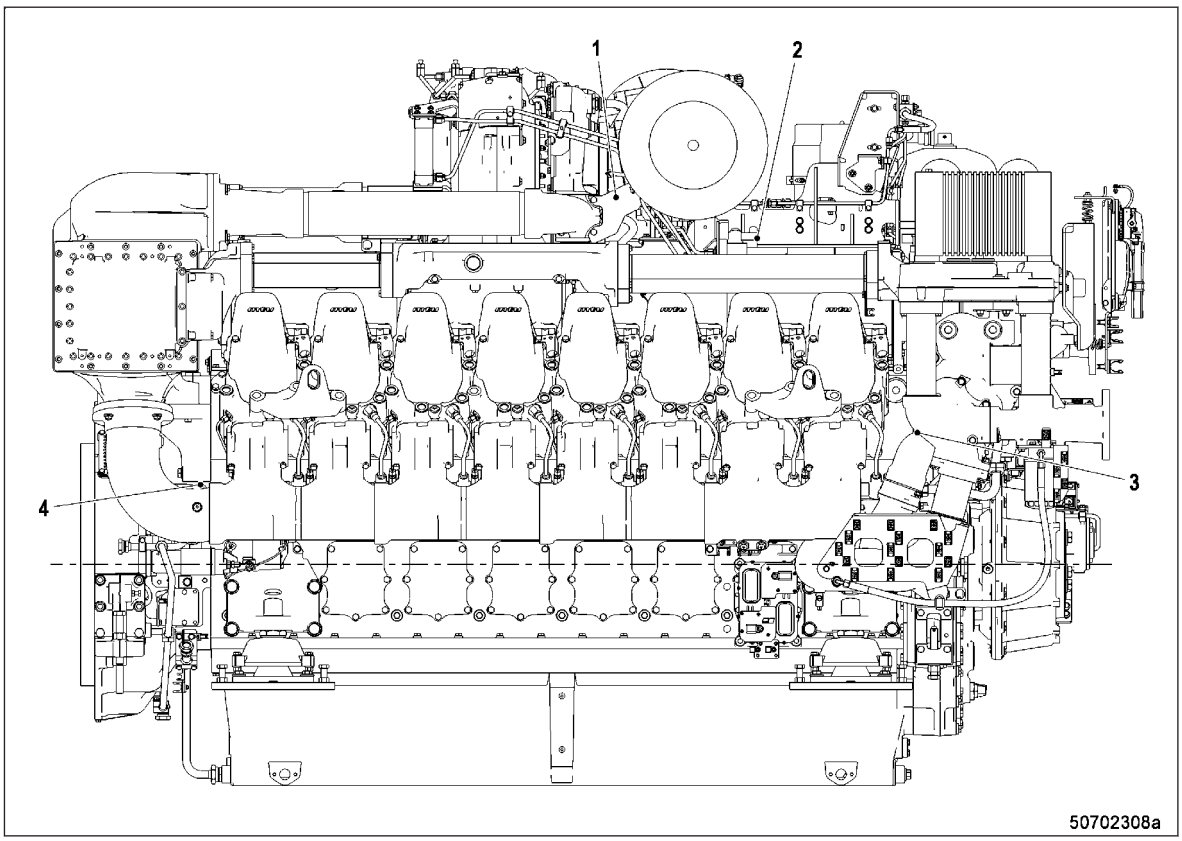
1 B50 (crankcase pressure)
2 B3 (intake air temperature)
3 B44.1 (turbocharger A speed)
4 B10 (charge-air pressure)
5 B34.3 (fuel pressure before filter) (only if supplementary fuel filter is fitted)
6 B34.2 (fuel pressure before filter)
7 B34.1 (fuel pressure after filter)
8 F46 (leak fuel level)

16V 4000 M engine, free end



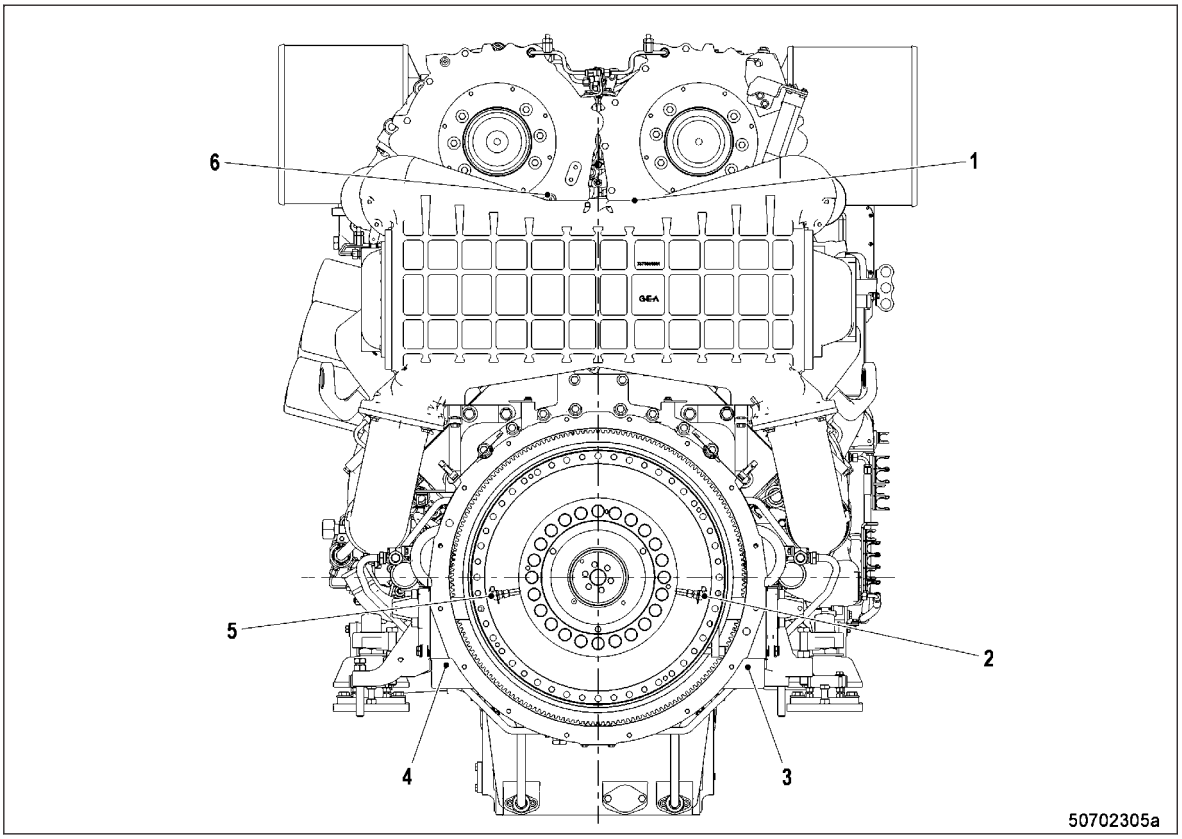
1 B7 (lube oil temperature)
2 B5.3 (lube oil pressure before filter)
3 B5.1 (lube oil pressure after filter)
4 B33 (fuel temperature in common rail)
5 B48 (fuel pressure in common rail)
6 B1 (camshaft speed)
7 B54 (oil refill pump pressure) (optional)
8 B6.2 (coolant temperature) (optional)
9 B6 (coolant temperature)

16V 4000 M engine, right engine side



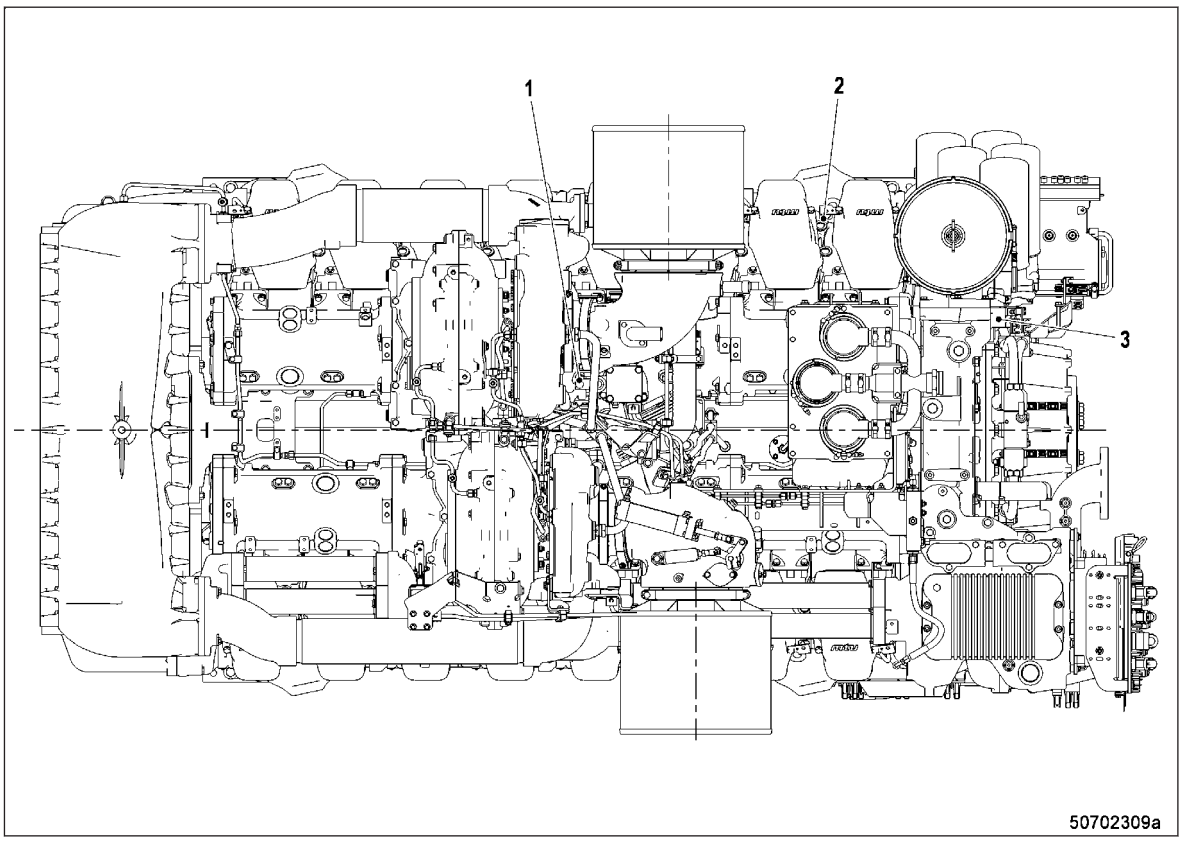
1 B44.2 (turbocharger B speed)
2 Y27 (turbocharger control valve)
3 B16 (coolant pressure)
4 B9 (charge-air temperature)

16V 4000 M engine, driving end



1 B4.22 (exhaust temperature, B bank)
2 B13 (crankshaft speed)
3 S37.2 (safety switch)
4 S37.1 (safety switch)
5 B13.2 (crankshaft speed) (optional)
6 B4.21 (exhaust temperature, a bank)

16V 4000 M engine, engine top



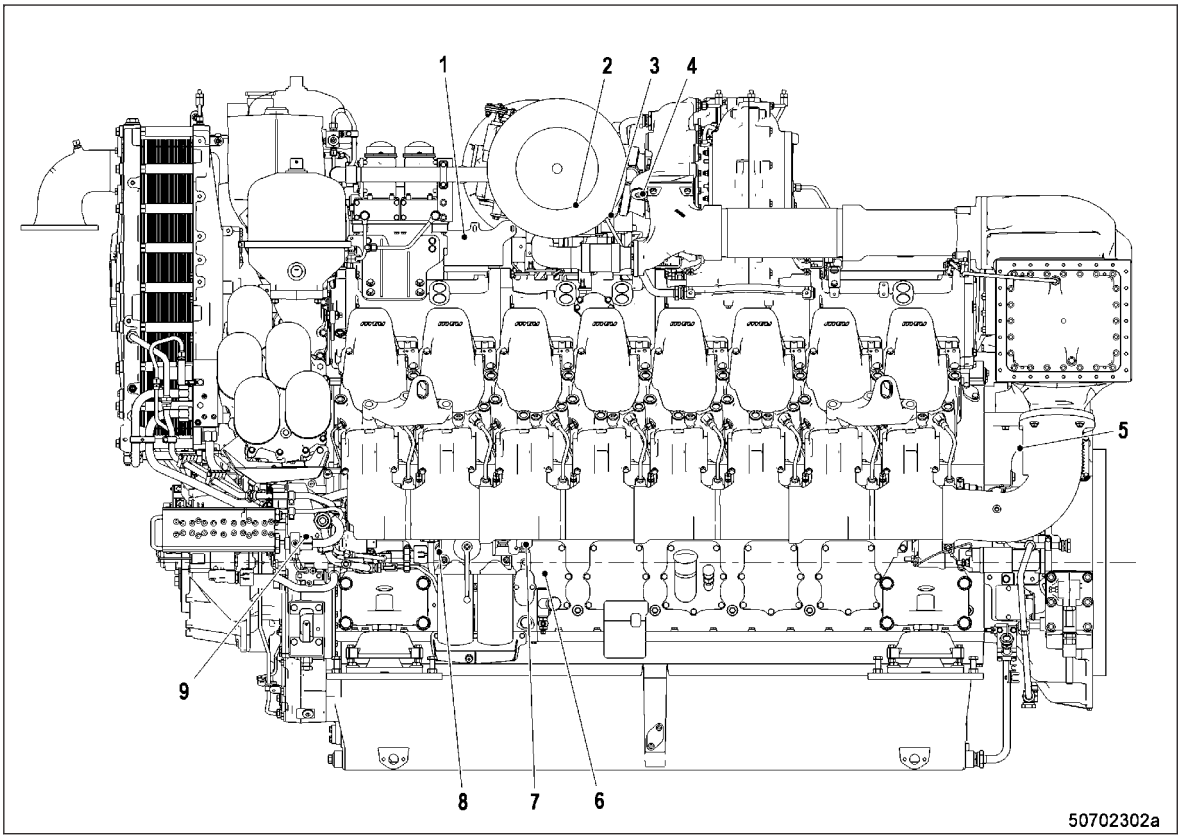
1 B49/Y26 (charge-air temperature before recirculation valve)/(recirculation valve A)

2 B4 (cylinder exhaust temperature A1-A6, B1-B8) (optional)

3 B33 (alternatively) (fuel temperature in common rail)

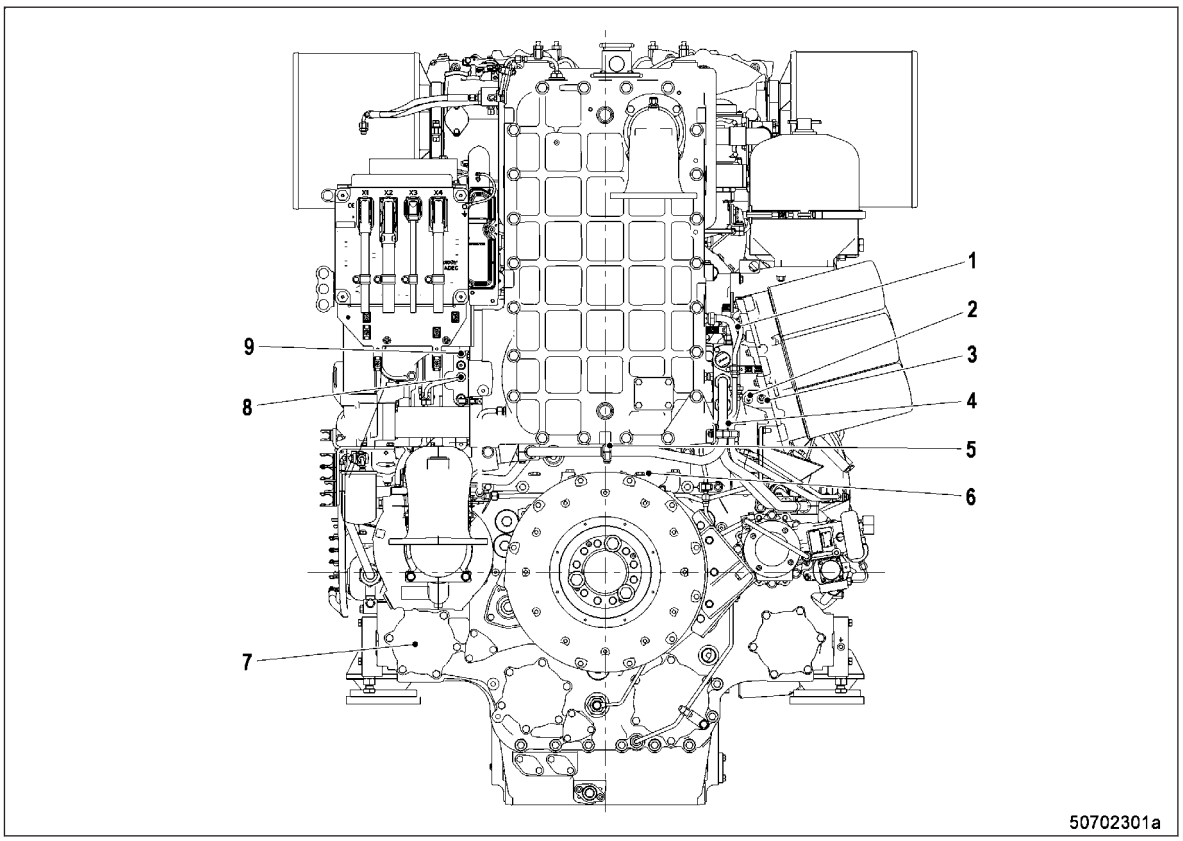
Engines with horizontal air intake, engine-mounted heat exchanger

16V 4000 M engine, left engine side



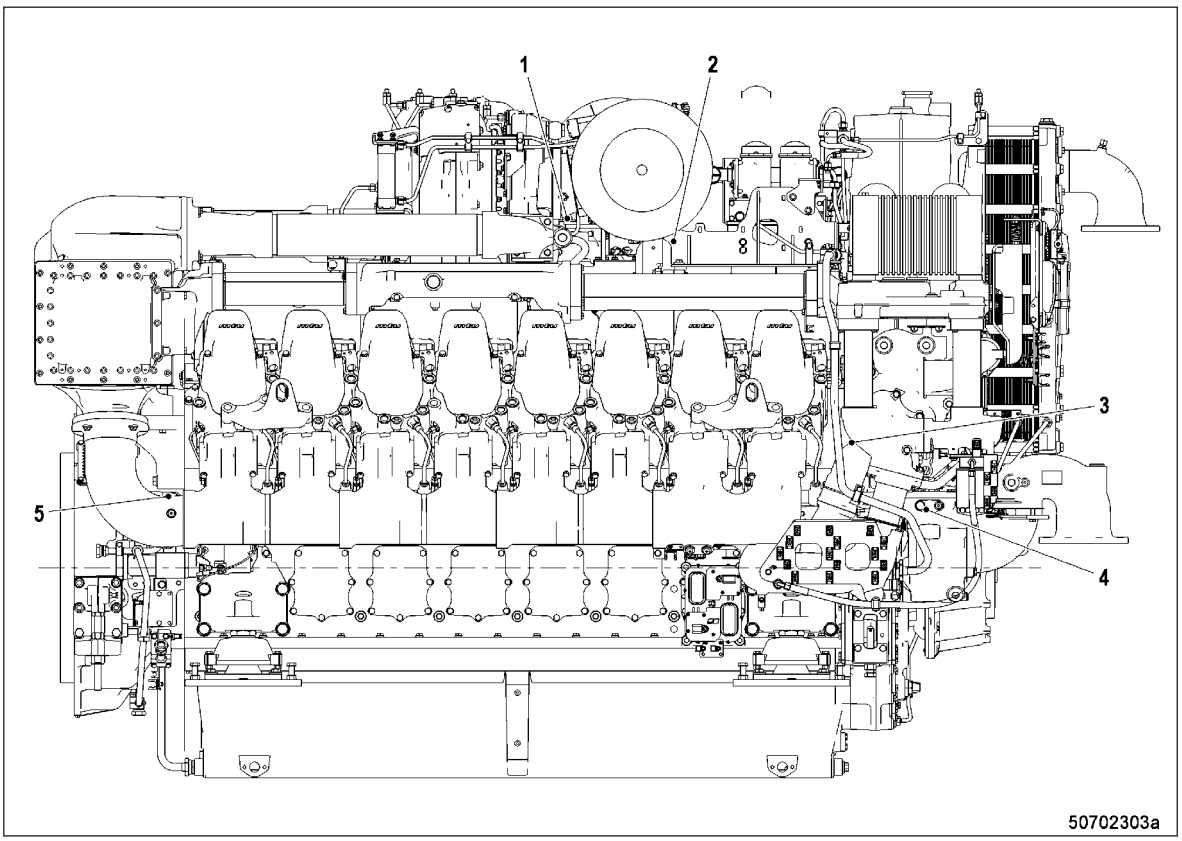
1 B50 (crankcase pressure)
2 B49/Y26 (charge-air temperature before recirculation valve)/(recirculation valve A)
3 B44.1 (turbocharger A speed)
4 B3 (intake air temperature)
5 B10 (charge-air pressure)
6 B34.3 (fuel pressure before filter) (only if supplementary fuel filter is fitted)
7 B34.2 (fuel pressure before filter)
8 B34.1 (fuel pressure after filter)
9 F46 (leak fuel level)

16V 4000 M engine, free end



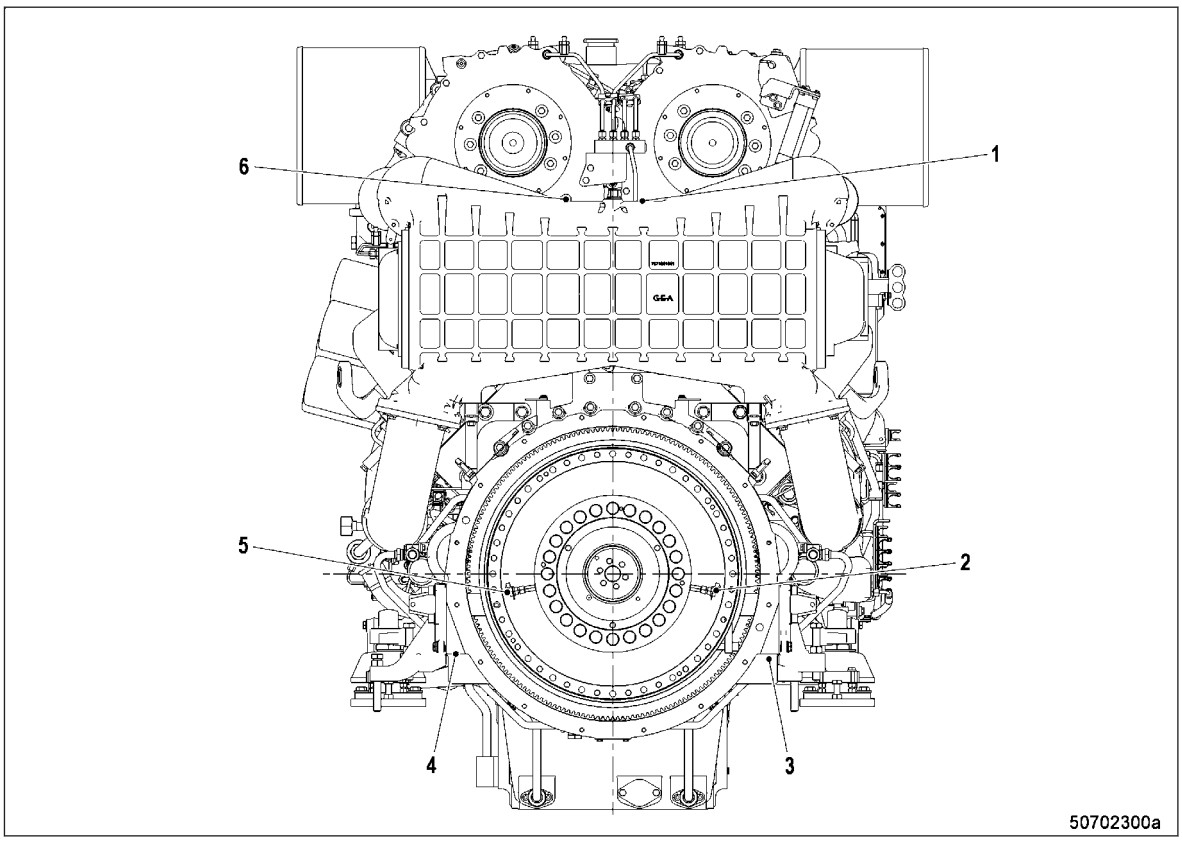
1 B7 (lube oil temperature)
2 B5.3 (lube oil pressure before filter)
3 B5.1 (lube oil pressure after filter)
4 B33 (fuel temperature in common rail)
5 B48 (fuel pressure in common rail)
6 B1 (camshaft speed)
7 B54 (oil refill pump pressure) (optional)
8 B6.2 (coolant temperature) (optional)
9 B6 (coolant temperature)

16V 4000 M engine, right engine side



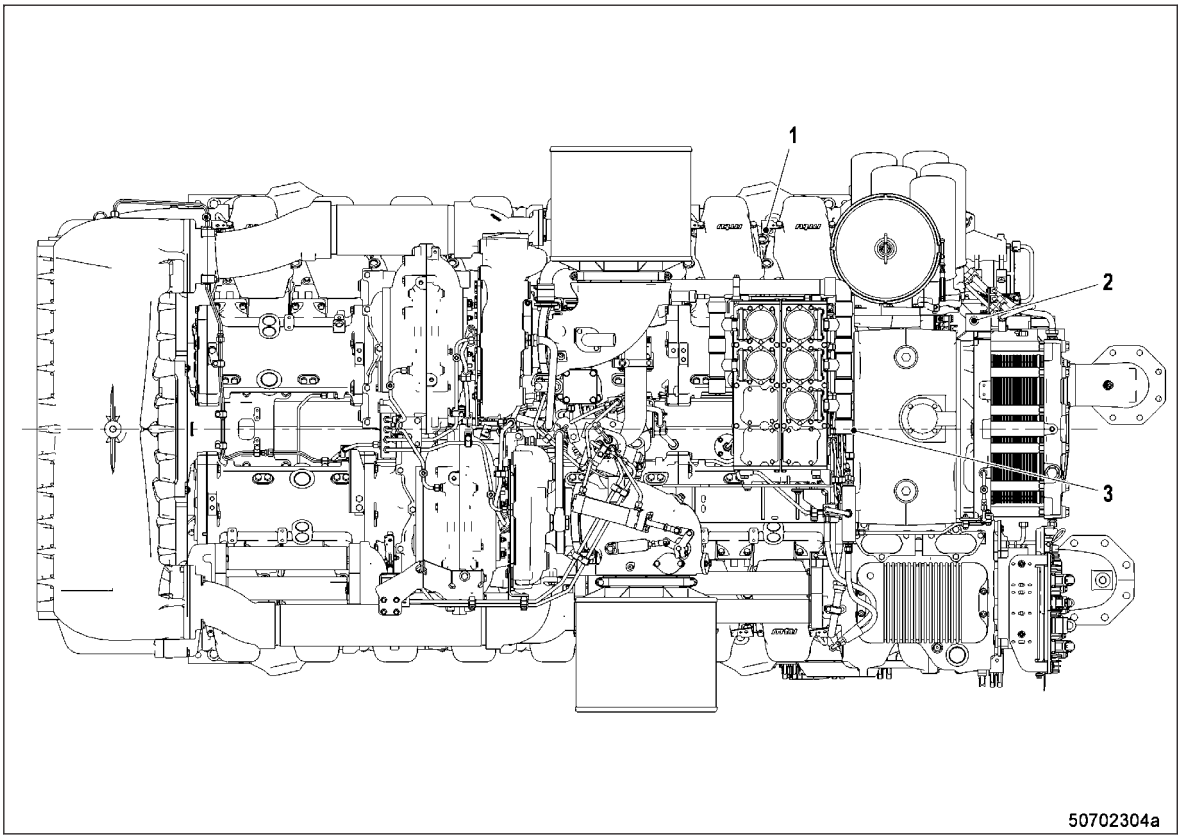
1 B44.2 (turbocharger B speed)
2 Y27 (turbocharger control valve)
3 B16 (coolant pressure)
4 B21 (raw-water pressure) (optional)
5 B9 (charge-air temperature)

16V 4000 M engine, driving end



1 B4.22 (exhaust temperature, B bank)
2 B13 (crankshaft speed)
3 S37.2 (safety switch)
4 S37.1 (safety switch)
5 B13.2 (crankshaft speed) (optional)
6 B4.21 (exhaust temperature, a bank)

16V 4000 M engine, engine top



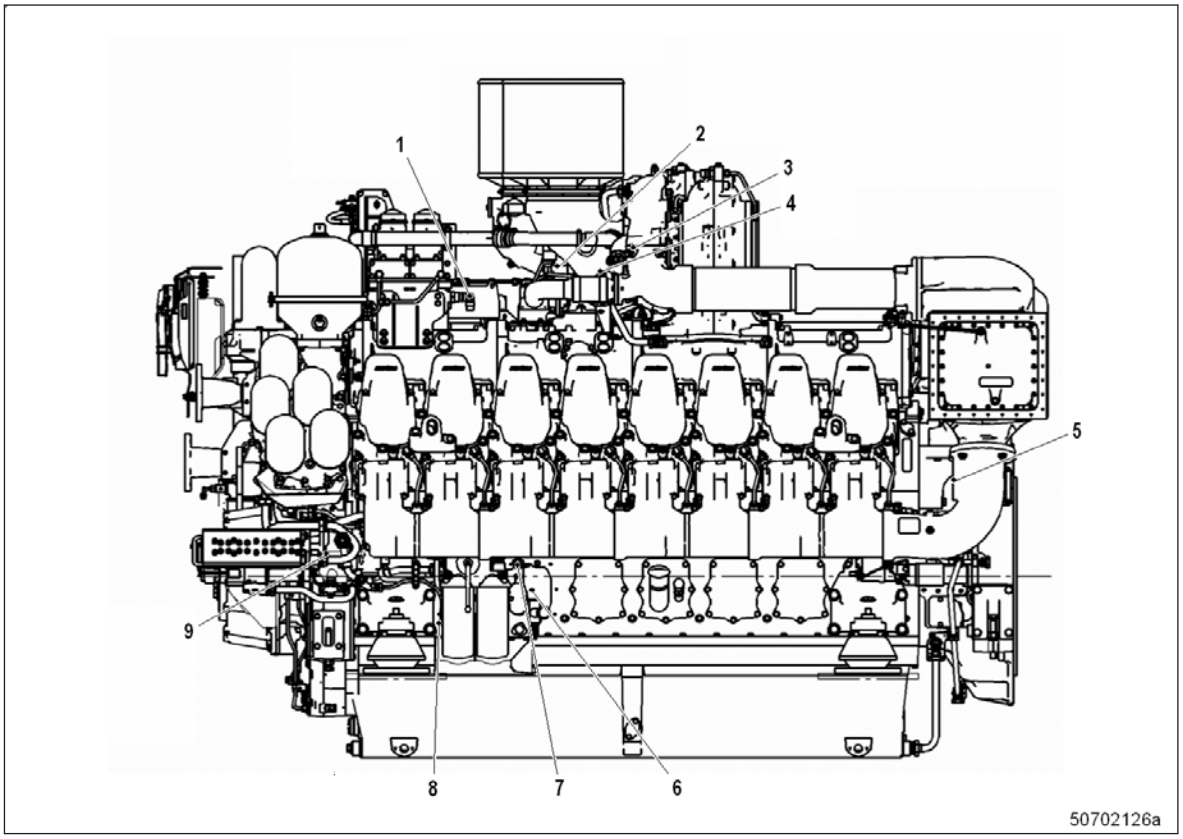
1 B4 (cylinder exhaust temperature A1-A6, B1-B8) (optional)

2 B33 (alternatively) (fuel temperature in common rail)

3 F33 (coolant level)

Engines with vertical air intake, remote heat exchanger

16V 4000 M engine, left engine side



1 B50 (crankcase pressure)
2 B49/Y26 (charge-air temperature before recirculation valve)/(recirculation valve A)
3 B3 (intake air temperature)
4 B44.1 (turbocharger A speed)
5 B10 (charge-air pressure)
6 B34.3 (fuel pressure before filter) (only if supplementary fuel filter is fitted)
7 B34.2 (fuel pressure before filter)
8 B34.1 (fuel pressure after filter)
9 F46 (leak fuel level)

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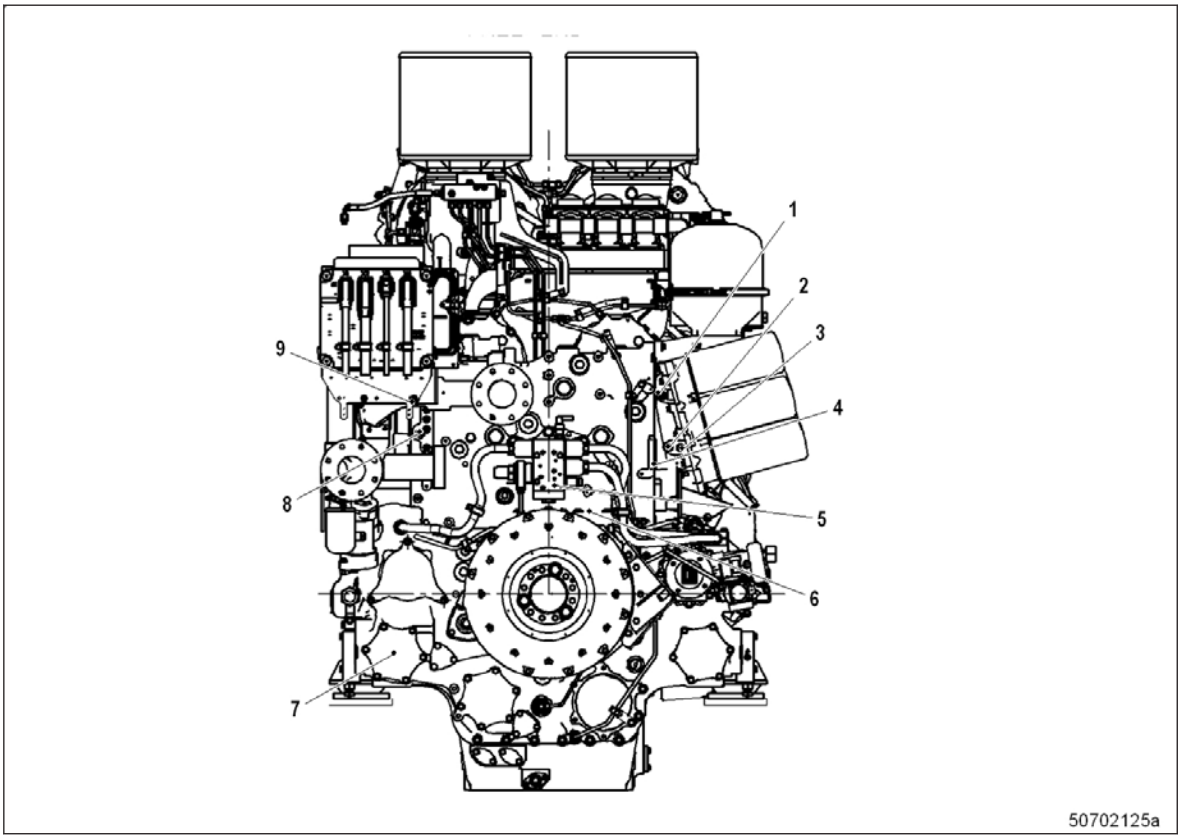
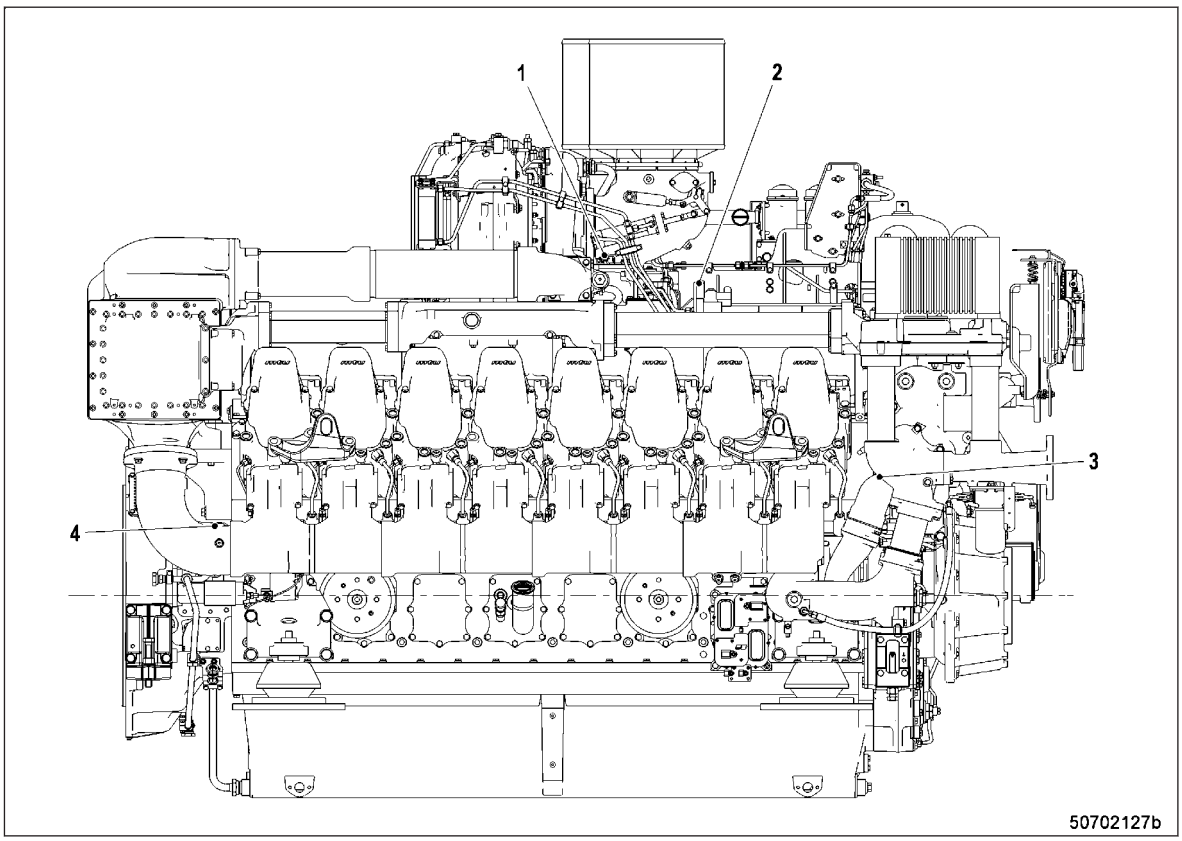
16V 4000 M engine, free end



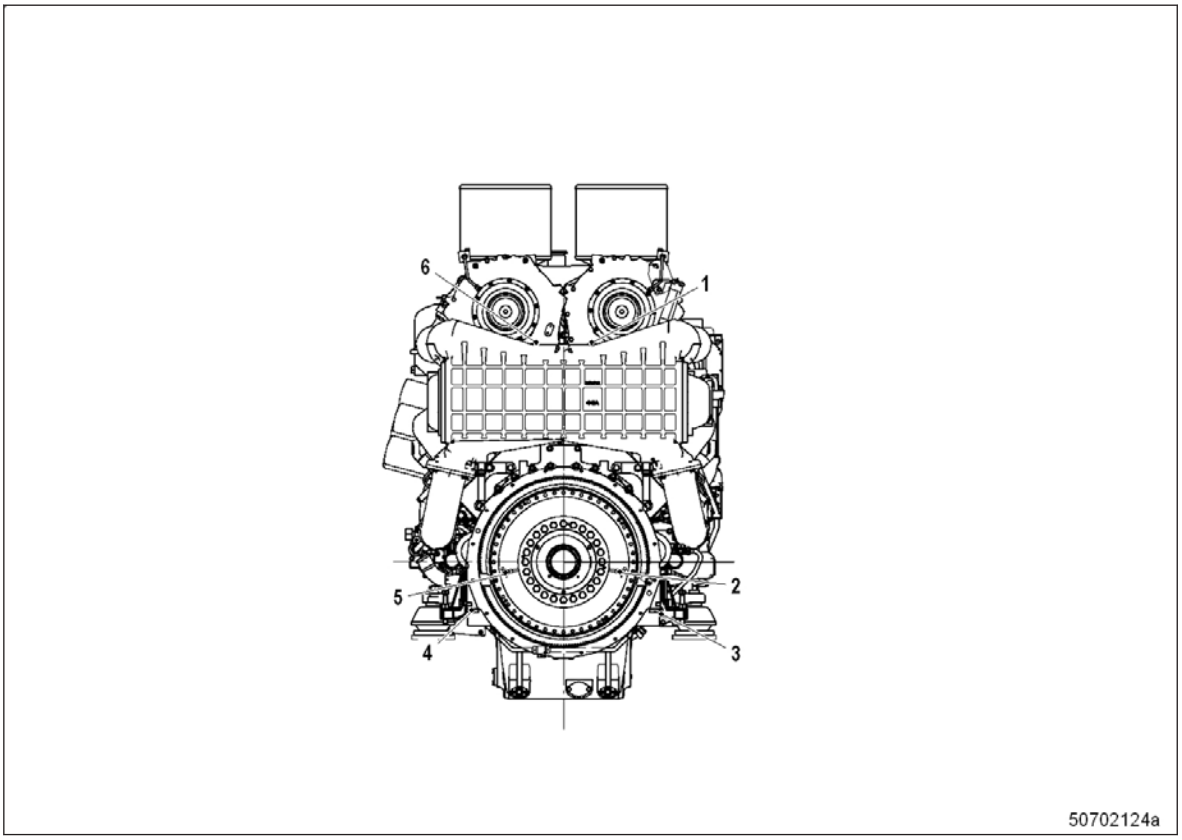
1 B7 (lube oil temperature)
2 B5.3 (lube-oil pressure before filter)
3 B5.1 (lube-oil pressure after filter)
4 B33 (fuel temperature in common rail)
5 B48 (fuel pressure in common rail)
6 B1 (camshaft speed)
7 B54 (oil refill pump pressure) (optional)
8 B6.2 (coolant temperature) (optional)
9 B6 (coolant temperature)

16V 4000 M engine, right engine side



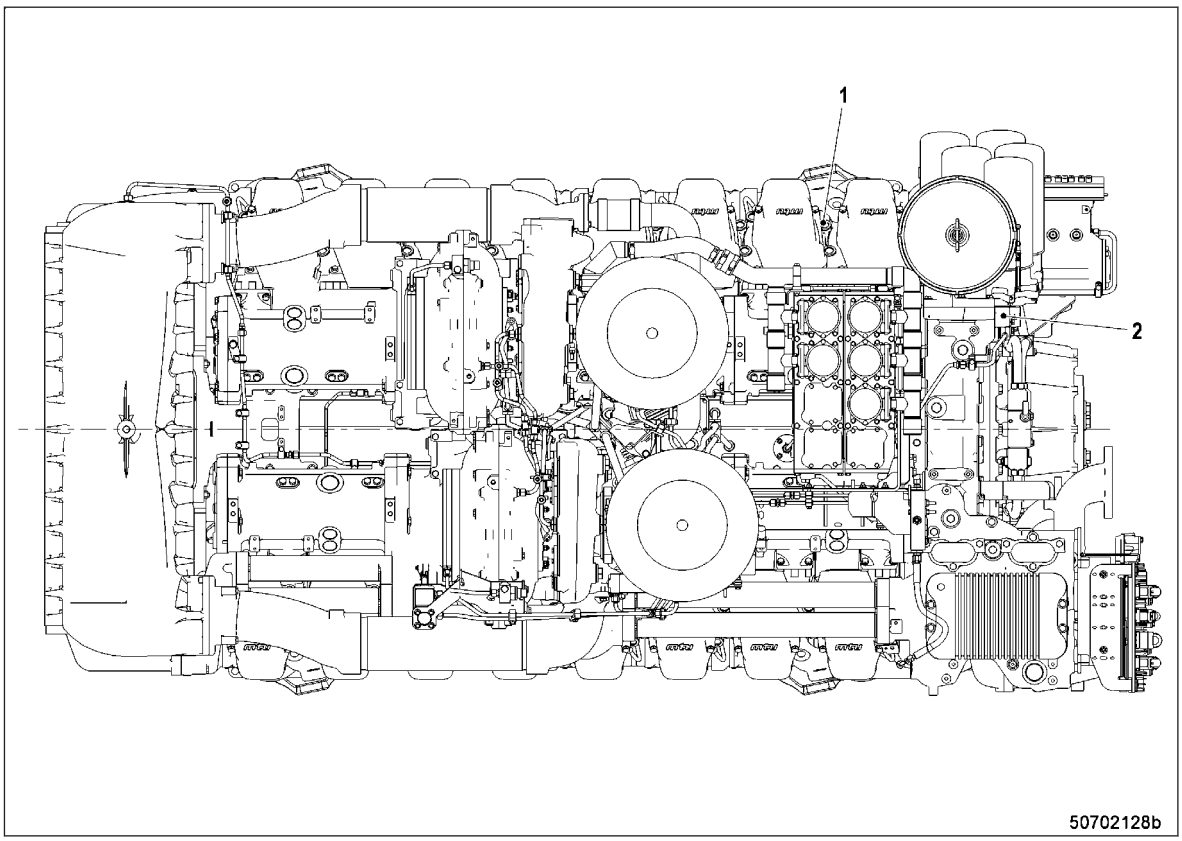
1 B44.2 (turbocharger B speed)
2 Y27 (turbocharger control valve)
3 B16 (coolant pressure)
4 B9 (charge-air temperature)

16V 4000 M engine, driving end



1 B4.22 (exhaust temperature, B bank)
2 B13 (crankshaft speed)
3 S37.2 (safety switch)
4 S37.1 (safety switch)
5 B13.2 (crankshaft speed) (optional)
6 B4.21 (exhaust temperature, a bank)

16V 4000 M engine, engine top

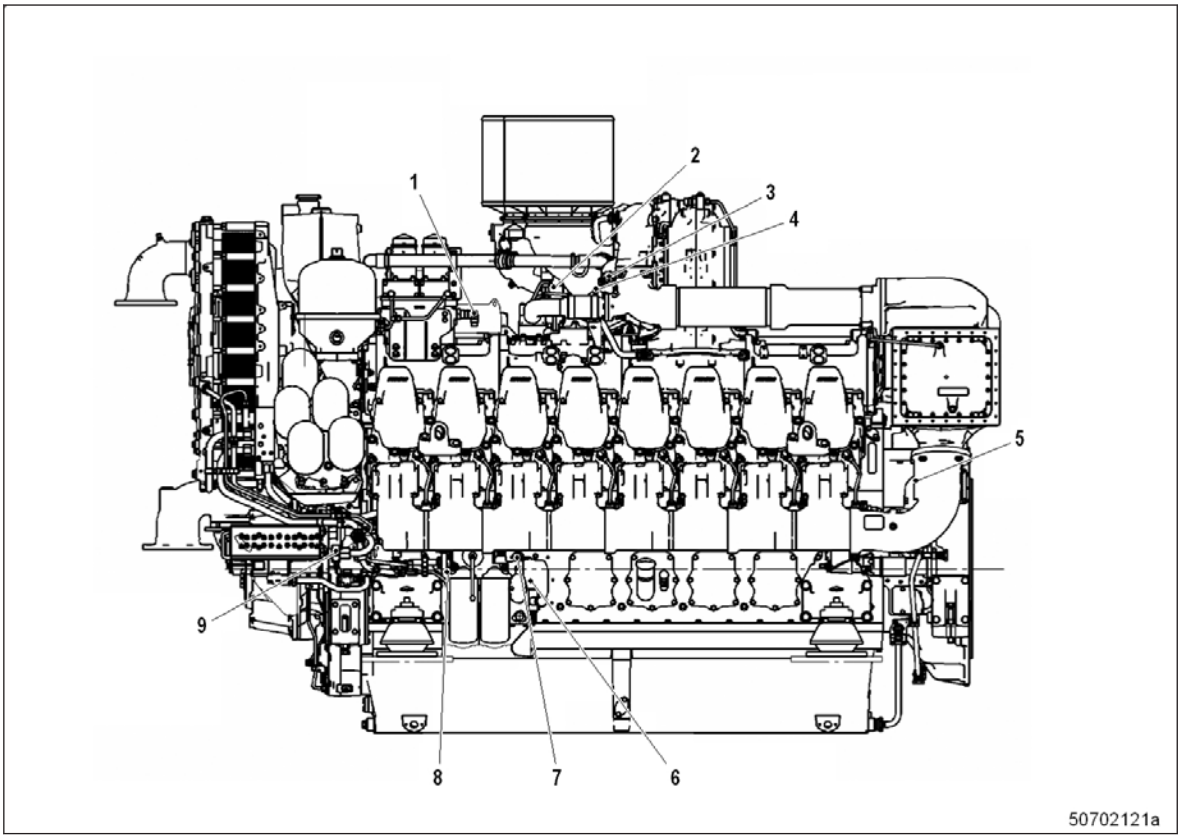


1 B4 (cylinder exhaust temperature A1-A6, B1-B8) (optional)

2 B33 (alternatively) (fuel temperature in common rail)

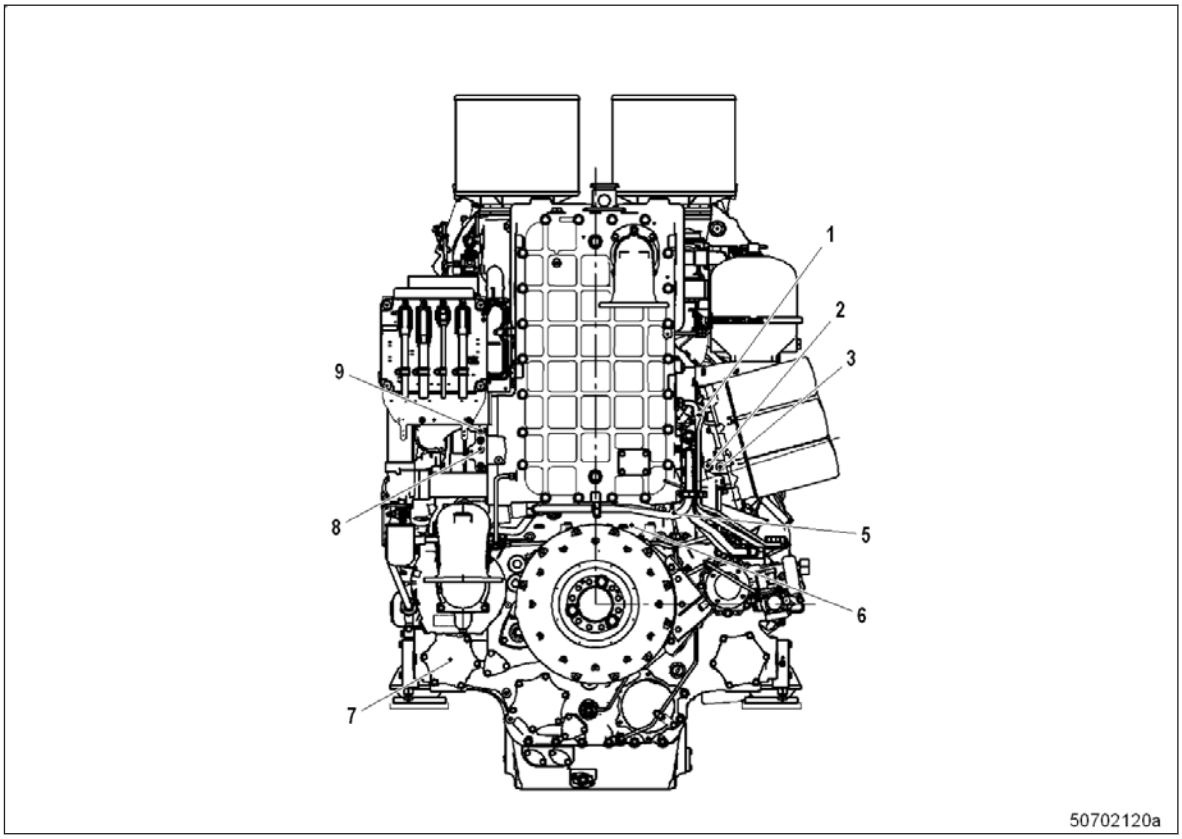
Engines with vertical air intake, engine-mounted heat exchanger

16V 4000 M engine, left engine side



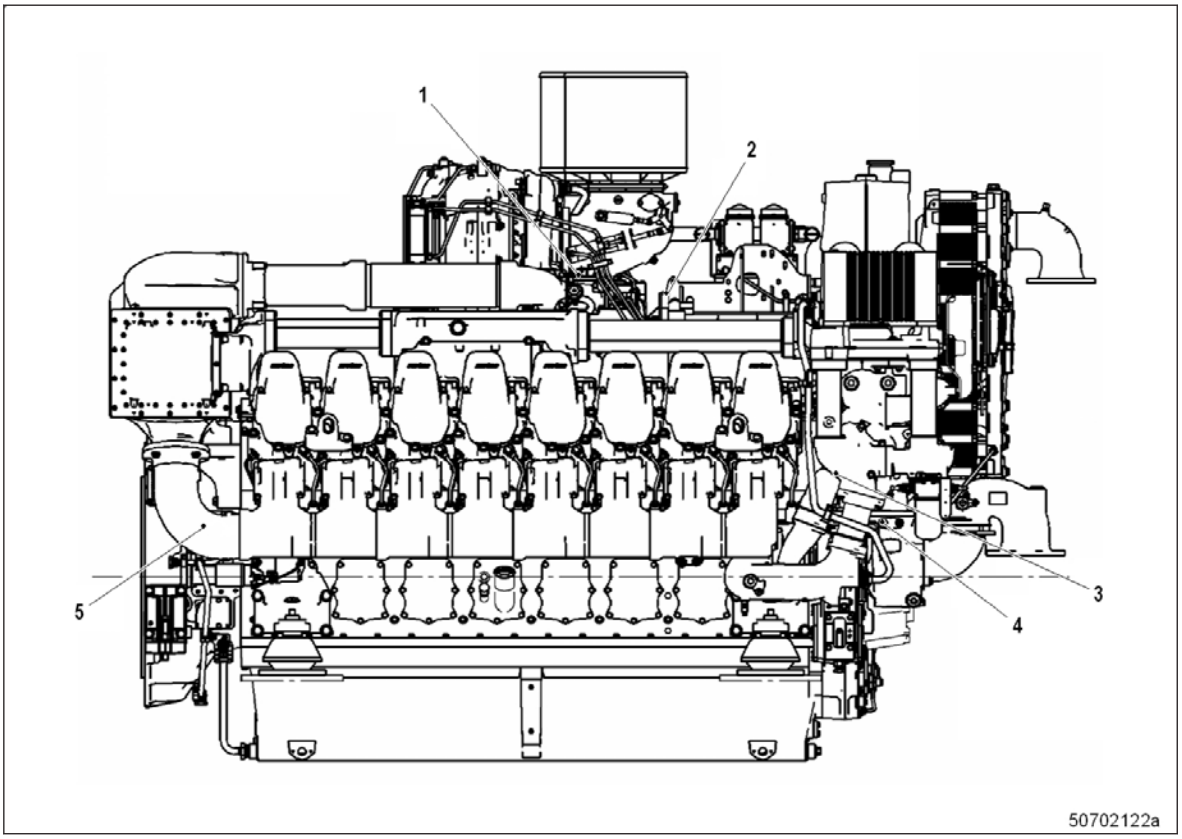
1 B50 (crankcase pressure)
2 B49/Y26 (charge-air temperature before recirculation valve)/(recirculation valve A)
3 B3 (intake air temperature)
4 B44.1 (turbocharger A speed)
5 B10 (charge-air pressure)
6 B34.3 (fuel pressure before filter) (only if supplementary fuel filter is fitted)
7 B34.2 (fuel pressure before filter)
8 B34.1 (fuel pressure after filter)
9 F46 (leak fuel level)

16V 4000 M engine, free end



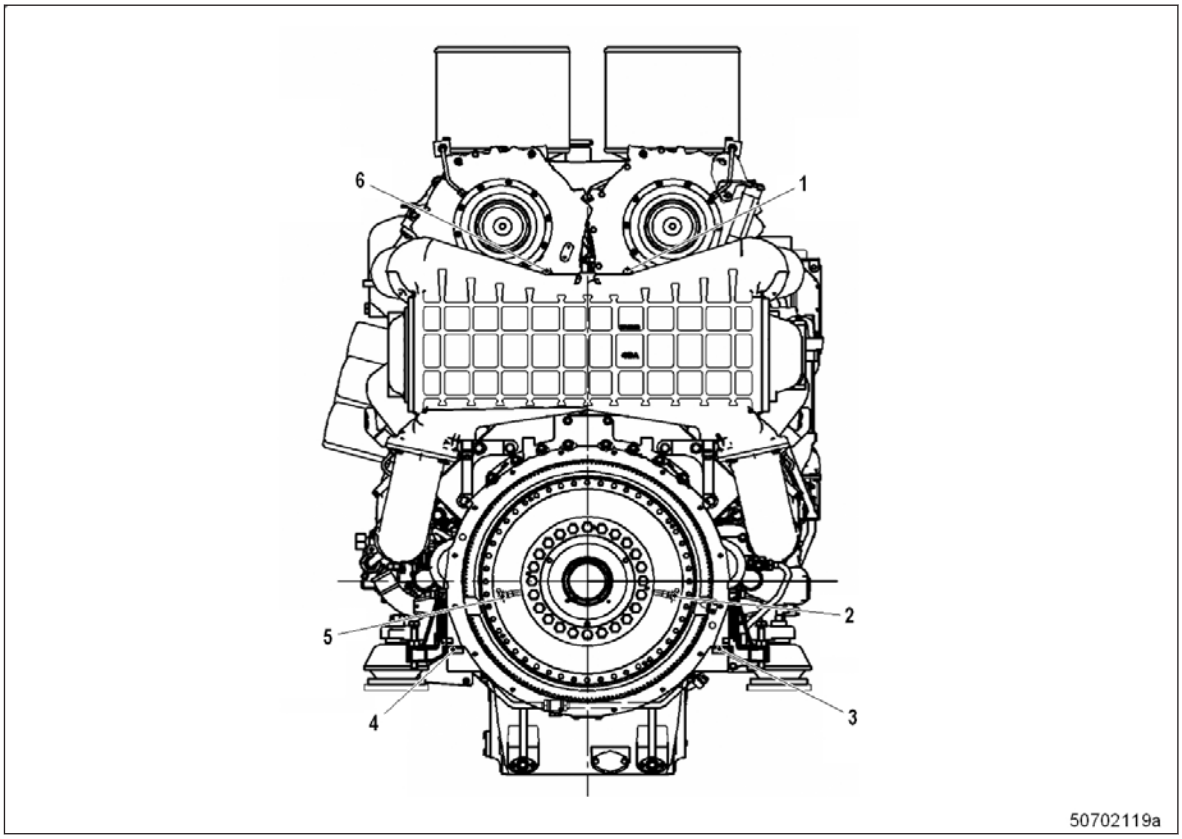
1 B7 (lube oil temperature)
2 B5.3 (lube-oil pressure before filter)
3 B5.1 (lube-oil pressure after filter)
4 B33 (fuel temperature in common rail)
5 B48 (fuel pressure in common rail)
6 B1 (camshaft speed)
7 B54 (oil refill pump pressure) (optional)
8 B6.2 (coolant temperature) (optional)
9 B6 (coolant temperature)

16V 4000 M engine, right engine side



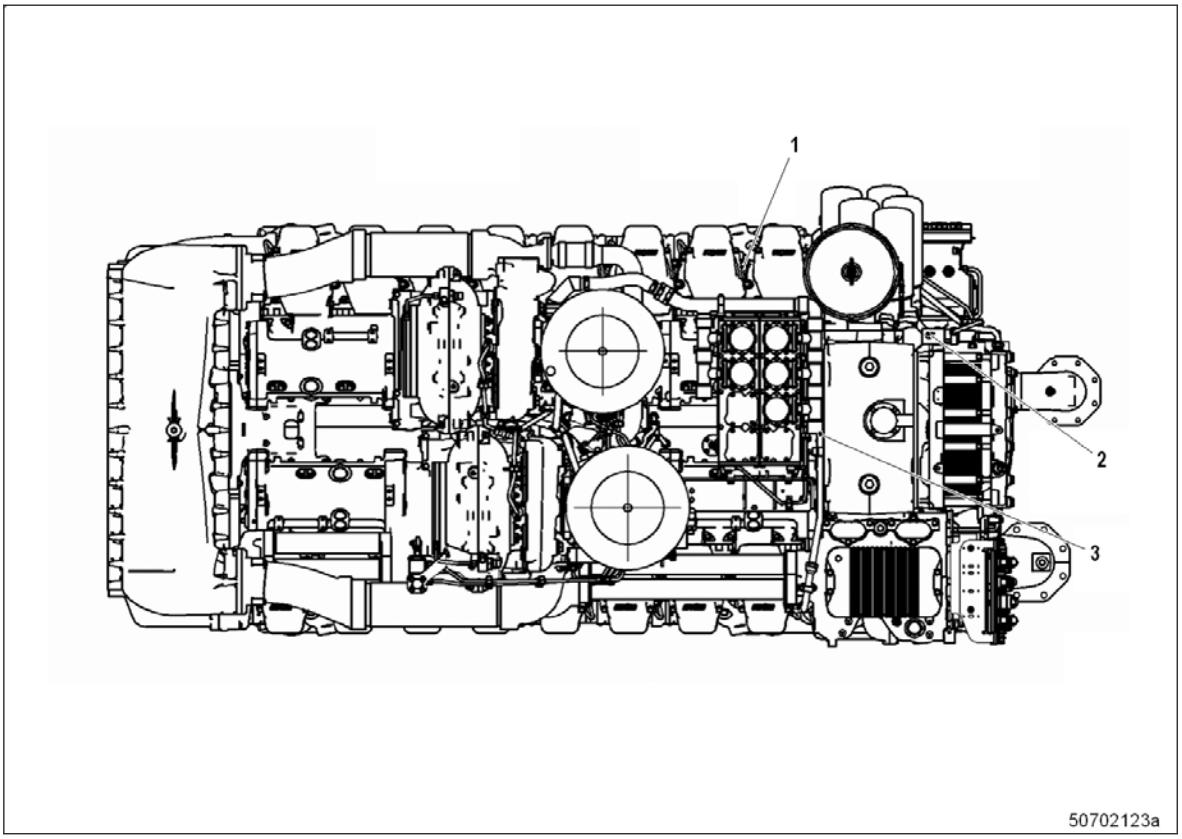
1 B44.2 (turbocharger B speed)
2 Y27 (turbocharger control valve)
3 B16 (coolant pressure)
4 B21 (raw-water pressure) (optional)
5 B9 (charge-air temperature)

16V 4000 M engine, driving end



1 B4.22 (exhaust temperature, B bank)
2 B13 (crankshaft speed)
3 S37.2 (safety switch)
4 S37.1 (safety switch)
5 B13.2 (crankshaft speed) (optional)
6 B4.21 (exhaust temperature, a bank)

16V 4000 M engine, engine top



1 B4 (cylinder exhaust temperature A1-A6, B1-B8) (optional)

2 B33 (alternatively) (fuel temperature in common rail)

3 F33 (coolant level)

3 Technical Data

3.1 12V 4000 M53R engine data

Explanation:

DL Ref. value: Continuous power
BL Ref. value: Fuel stop power
A Design value
G Guaranteed value
r Guideline value
L Limit up to which the engine can be operated without changes, e.g. power setting
N Not yet defined value
- Not applicable
X Applicable
* Not yet verified value

ENGINE DATA

Engine model			12V 4000 M53R Engine-mounted heat exchanger		12V 4000 M53R Remote heat exchanger	
Application group			1A	1A	1A	1A
Intake air temperature		°C	25	45	25	45
Charge air coolant temperature		°C	-	-	-	-
Raw water inlet temperature		°C	25	32	25	32
Barometric pressure		mbar	1000	1000	1000	1000
Site altitude above sea level		M	100	100	100	100

POWER-RELATED DATA (power ratings are net brake power as per ISO 3046)

Engine model			12V 4000 M53R Engine-mounted heat exchanger		12V 4000 M53R Remote heat exchanger	
Rated engine speed	A	rpm	1600	1600	1600	1600
Fuel stop power ISO 3046	A	kW	1140	1140	1140	1140

GENERAL CONDITIONS (for maximum power)

Engine model			12V 4000 M53R Engine-mounted heat exchanger		12V 4000 M53R Remote heat exchanger	
Intake depression (new filter)	A	mbar	15	15	15	15
Intake depression, max.	L	mbar	30	30	30	30

MODEL RELATED DATA (basic design)

Engine model			12V 4000 M53R Engine-mounted heat exchanger		12V 4000 M53R Remote heat exchanger	
Cylinder arrangement: V angle		Degrees (°)	90	90	90	90
Bore		mm	170	170	170	170
Stroke		mm	210	210	210	210
Displacement, cylinder		Liters	4.77	4.77	4.77	4.77
Displacement, total		Liters	57.2	57.2	57.2	57.2
Number of inlet valves per cylinder			2	2	2	2
Number of exhaust valves per cylinder			2	2	2	2

RAW WATER CIRCUIT (open circuit)

Engine model			12V 4000 M53R Engine-mounted heat exchanger		12V 4000 M53R Remote heat exchanger	
Raw water pump: Inlet pressure, min.	L	bar	-0.4	-0.4	–	–
Raw water pump: Inlet pressure, max.	L	bar	1.0	1.0	–	–
Pressure loss in off-engine raw-water system, max.	L	bar	1.0	1.0	–	–

LUBE OIL SYSTEM

Engine model			12V 4000 M53R Engine-mounted heat exchanger		12V 4000 M53R Remote heat exchanger	
Lube oil operating temperature before engine, from	r	°C	81	82	81	82
Lube oil operating temperature before engine, to	r	°C	89	90	89	90
Lube oil operating pressure before engine, from	r	bar	5.1	5.1	5.1	5.1
Lube oil operating pressure before engine, to	r	bar	6.1	6.1	6.1	6.1
Lube oil operating pressure (low idle) (meas. point: before engine)	r	bar	2.5	2.5	2.5	2.5

FUEL SYSTEM

Engine model			12V 4000 M53R Engine-mounted heat exchanger		12V 4000 M53R Remote heat exchanger	
Fuel pressure at engine inlet connection, min. (when engine is starting)	L	bar	-0.1	-0.1	-0.1	-0.1
Fuel pressure at engine inlet connection, min. (when engine is running),	L	bar	-0.3	-0.3	-0.3	-0.3
Fuel pressure at engine inlet connection, max. (when engine is starting)	L	bar	1.5	1.5	1.5	1.5

GENERAL OPERATING DATA

Engine model			12V 4000 M53R Engine-mounted heat exchanger		12V 4000 M53R Remote heat exchanger	
Firing speed, from	r	rpm	80	80	80	80
Firing speed, to	r	rpm	120	120	120	120

STARTER (electric)

Engine model			12V 4000 M53R Engine-mounted heat exchanger		12V 4000 M53R Remote heat exchanger	
Rated starter voltage (standard design)	r	V=	24	24	24	24

STARTER (pneumatic / hydraulic)

Engine model			12V 4000 M53R Engine-mounted heat exchanger		12V 4000 M53R Remote heat exchanger	
Starting air pressure before starter motor, min.	r	bar	8	8	8	8
Starting air pressure before starter motor, max.	r	bar	10	10	10	10

INCLINATIONS, STANDARD OIL SYSTEM (Reference: waterline)

Engine model			12V 4000 M53R Engine-mounted heat exchanger		12V 4000 M53R Remote heat exchanger	
Longitudinal inclination, continuous max., driving end down (Option: max. operating inclinations)	L	Degrees (°)	15	15	15	15
Longitudinal inclination, temporary max. driving end down (option: max. operating inclinations)	L	Degrees (°)	22.5	22.5	22.5	22.5
Longitudinal inclination, continuous max. driving end up (option: max. operating inclinations)	L	Degrees (°)	10	10	10	10
Transverse inclination continuous max. (Option: max. operating inclinations)	L	Degrees (°)	22.5	22.5	22.5	22.5

CAPACITIES

Engine model			12V 4000 M53R Engine-mounted heat exchanger		12V 4000 M53R Remote heat exchanger	
Engine coolant capacity, engine side (with cooling equipment)	r	Liters	305	305	–	–
Engine oil capacity, initial filling (standard oil system) (Option: max. operating inclinations)	r	Liters	265	265	265	265

Engine model			12V 4000 M53R Engine-mounted heat exchanger		12V 4000 M53R Remote heat exchanger	
Oil pan capacity dipstick mark min. (standard oil system) (design: max. operating inclinations)	L	Liters	195	195	195	195
Oil pan capacity dipstick mark max. (standard oil system) (design: max. operating inclinations)	L	Liters	235	235	235	235

WEIGHTS / MAIN DIMENSIONS

Engine model			12V 4000 M53R Engine-mounted heat exchanger		12V 4000 M53R Remote heat exchanger	
Engine dry weight (with mounted standard accessories, w/o coupling)	r	kg	7640	7640	7240	7240

NOISE

Engine model			12V 4000 M53R Engine-mounted heat exchanger		12V 4000 M53R Remote heat exchanger	
Exhaust noise, unsilenced, BL (free-field sound pressure level Lp, 1m distance, ISO 6798, +3dB(A) tolerance)	r	dB(A)	108*	108*	108*	108*
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798+2dB(A) tolerance)	r	dB(A)	102*	102*	102*	102*

3.2 16V 4000 M53R engine data

Explanation:

DL Ref. value: Continuous power
BL Ref. value: Fuel stop power
A Design value
G Guaranteed value
r Guideline value
L Limit up to which the engine can be operated without changes, e.g. power setting
N Not yet defined value
- Not applicable
X Applicable

			Heat exchanger engine-mounted		Heat exchanger remote	
Application group			1A	1A	1A	1A
Intake air temperature		°C	25	45	25	45
Charge air coolant temperature		°C	-	-	-	-
Raw water inlet temperature		°C	25	32	25	32
Barometric pressure		mbar	1000	1000	1000	1000
Site altitude above sea level		M	100	100	100	100

POWER-RELATED DATA (power ratings are net brake power as per ISO 3046)

			Heat exchanger engine-mounted		Heat exchanger remote	
Rated engine speed	A	rpm	1600	1600	1600	1600
Fuel stop power ISO 3046	A	kW	1520	1520	1520	1520

GENERAL CONDITIONS (for maximum power)

			Heat exchanger engine-mounted		Heat exchanger remote	
Intake depression (new filter)	A	mbar	15	15	15	15
Intake depression, max.	L	mbar	30	30	30	30

MODEL RELATED DATA (basic design)

			Heat exchanger engine-mounted		Heat exchanger remote	
Cylinder arrangement: V angle		Degrees (°)	90	90	90	90
Bore		mm	170	170	170	170
Stroke		mm	210	210	210	210
Displacement, cylinder		Liters	4.77	4.77	4.77	4.77
Displacement, total		Liters	76.3	76.3	76.3	76.3
Number of inlet valves per cylinder			2	2	2	2
Number of exhaust valves per cylinder			2	2	2	2

TIM-ID: 0000010854 - 002

RAW WATER CIRCUIT (open circuit)

			Heat exchanger engine-mounted		Heat exchanger remote	
Raw water pump: Inlet pressure, min.	L	bar	-0.4	-0.4	–	–
Raw water pump: Inlet pressure, max.	L	bar	1.0	1.0	–	–
Pressure loss in off-engine raw-water system, max.	L	bar	1.0	1.0	–	–

LUBE OIL SYSTEM

			Heat exchanger engine-mounted		Heat exchanger remote	
Lube oil operating temperature before engine, from	r	°C	82	82	82	82
Lube oil operating temperature before engine, to	r	°C	90	90	90	90
Lube oil operating pressure before engine, from	r	bar	5.2	5.2	5.2	5.2
Lube oil operating pressure before engine, to	r	bar	6.2	6.2	6.2	6.2
Lube oil operating pressure (low idle) (meas. point: before engine)	r	bar	2.5	2.5	2.5	2.5

FUEL SYSTEM

			Heat exchanger engine-mounted		Heat exchanger remote	
Fuel pressure at engine inlet connection, min. (when engine is starting)	L	bar	-0.1	-0.1	-0.1	-0.1
Fuel pressure at engine inlet connection, min. (when engine is running),	L	bar	-0.3	-0.3	-0.3	-0.3
Fuel pressure at engine inlet connection, max. (when engine is starting)	L	bar	1.5	1.5	1.5	1.5
Fuel supply flow, max.	A	Liter/min				

GENERAL OPERATING DATA

			Heat exchanger engine-mounted		Heat exchanger remote	
Firing speed, from	r	rpm	80	80	80	80
Firing speed, to	r	rpm	120	120	120	120

STARTER (electric)

			Heat exchanger engine-mounted		Heat exchanger remote	
Rated starter voltage (standard design)	r	V=	24	24	24	24

STARTER (pneumatic / hydraulic)

			Heat exchanger engine-mounted		Heat exchanger remote	
Starting air pressure before starter motor, min.	r	bar	8	8	8	8
Starting air pressure before starter motor, max.	r	bar	9	9	9	9

INCLINATIONS, STANDARD OIL SYSTEM (Reference: waterline)

			Heat exchanger engine-mounted		Heat exchanger remote	
Longitudinal inclination, continuous max., driving end down (Option: max. operating inclinations)	L	Degrees (°)	15	15	15	15
Longitudinal inclination, temporary max. driving end down (option: max. operating inclinations)	L	Degrees (°)	22.5	22.5	22.5	22.5
Longitudinal inclination, continuous max. driving end up (option: max. operating inclinations)	L	Degrees (°)	10	10	10	10
Longitudinal inclination, temporary max. driving end up (option: max. operating inclinations)	L	Degrees (°)				
Transverse inclination continuous max. (Option: max. operating inclinations)	L	Degrees (°)	22.5	22.5	22.5	22.5
Transverse inclination, temporary max. (option: max. operating inclinations)	L	Degrees (°)				

CAPACITIES

			Heat exchanger engine-mounted		Heat exchanger remote	
Engine coolant capacity, engine side (with cooling equipment)	r	Liters	350	350	–	–
Engine oil capacity, initial filling (standard oil system) (Option: max. operating inclinations)	r	Liters	280	280	280	280
Oil change quantity max. (standard oil system) (design: max. operating inclinations)	r	Liters				
Oil pan capacity dipstick mark min. (standard oil system) (design: max. operating inclinations)	L	Liters	210	210	210	210
Oil pan capacity dipstick mark max. (standard oil system) (design: max. operating inclinations)	L	Liters	250	250	250	250

TIM-ID: 0000010854 - 002

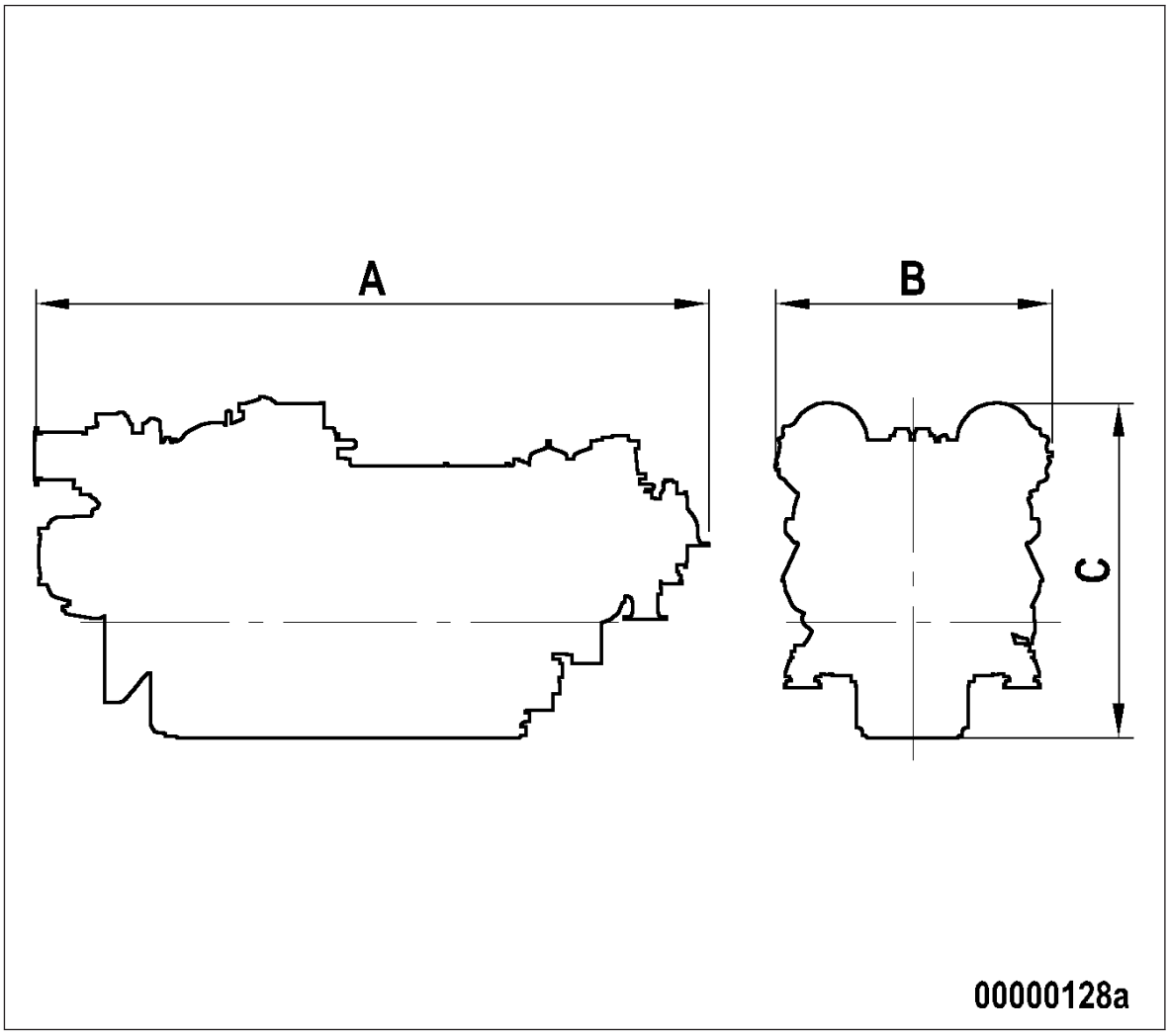
WEIGHTS / MAIN DIMENSIONS

			Heat exchanger engine-mounted		Heat exchanger remote	
Engine dry weight (with mounted standard accessories, w/o coupling)	r	kg	9020	9020	8590	8590

NOISE

			Heat exchanger engine-mounted		Heat exchanger remote	
Exhaust noise, unsilenced, BL (free-field sound pressure level Lp, 1m distance, ISO 6798, +3dB(A) tolerance)	r	dB(A)	109	109	109	109
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798+2dB(A) tolerance)	r	dB(A)				

3.3 Engine - Main dimensions



Engines with horizontal air intake

With remote heat exchanger

Engine model	Length (A)	Width (B) without silencer	Width (B) with silencer	Height (C)
16V 4000 M53R	approx. 3108 mm	approx. 1690 mm	approx. 1850 mm	approx. 2064 mm

With engine-mounted heat exchanger

Engine model	Length (A)	Width (B) without silencer	Width (B) with silencer	Height (C)
16V 4000 M53R	approx. 3388 mm	approx. 1690 mm	approx. 1850 mm	approx. 2064 mm

TIM-ID: 0000045752 - 001

Engines with vertical air intake

With remote heat exchanger

Engine model	Length (A)	Width (B)	Height (C) without silencer	Height (C) with silencer
12V 4000 M53R	approx. 2628 mm	approx. 1602 mm	approx. 2368 mm	approx. 2448 mm
16V 4000 M53R	approx. 3108 mm	approx. 1602 mm	approx. 2361 mm	approx. 2441 mm

With engine-mounted heat exchanger

Engine model	Length (A)	Width (B)	Height (C) without silencer	Height (C) with silencer
12V 4000 M53R	approx. 2857 mm	approx. 1602 mm	approx. 2368 mm	approx. 2448 mm
16V 4000 M53R	approx. 3388 mm	approx. 1602 mm	approx. 2361 mm	approx. 2441 mm

3.4 Firing order

Cylinders	Firing order
12 V	A1-B5-A5-B3-A3-B6-A6-B2-A2-B4-A4-B1
16 V	A1-A7-B4-B6-A4-B8-A2-A8-B3-B5-A3-A5-B2-A6-B1-B7

4 Operation

4.1 Controls

Automation system controls

Refer to automation system operating instructions

4.2 Putting the engine into operation after extended out-of-service periods (>3 months)

Preconditions

☑ Engine is stopped and starting disabled.

☑ MTU Preservation and Represervation Specifications (A001070/..) are available.

Putting the engine into operation after extended out-of-service-periods (>3 months)

Item	Task
Engine	Depreserve (→ Preservation and Represervation Specifications A001070/..).
Lube oil system	Check engine oil level (→ Page 176); Preheat engine oil if required.
Fuel prefilter	Prime with fuel (→ Page 161)
Fuel prefilter, pressure gauge	Align adjustable pointer with position of pressure indicator (→ Page 156).
HP fuel pump	Only for engines without oil priming pump: Fill HP fuel pump with new engine oil (→ Page 144).
Raw-water pump (if located above waterline (only applicable to engines with engine-mounted heat exchanger or with optional remote heat exchanger))	Prime with water (approx. 3 – 4 l).
Coolant circuit	If engine is out of service for more than one year, change engine coolant (→ Page 193).
Coolant circuit	Check coolant level (→ Page 192).
Coolant circuit	Preheat coolant with preheating unit.
Engine control system	Refer to automation system operating instructions.
ECU	Check plug connections (→ Page 226).
EMU	Check plug connections (→ Page 227)
EIM	Check plug connections (→ Page 228).

4.3 Putting the engine into operation after scheduled out-of-service-period

Preconditions

☑ Engine is stopped and starting disabled.

Putting into operation

Item	Task
Lube oil system	Check engine oil level (→ Page 176); Preheat engine oil if required.
Coolant system	Check coolant level (→ Page 192).
Coolant system	Preheat coolant with preheating unit.
Fuel prefilter	Drain (→ Page 157); Check that suction-side pressure indicated at the fuel prefilter pressure gauge is within the limit (→ Page 156).
Engine control system	Refer to automation system operating instructions.
ECU	Check plug connections (→ Page 226).
EIM	Check plug connections (→ Page 228).
EMU	Check plug connections (→ Page 227).

4.4 Starting the engine

Start the engine via the automation system

Refer to automation system operating instructions

4.5 Operational checks

DANGER

Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING

High level of engine noise when the engine is running.
Risk of damage to hearing!
- Wear ear protectors.

Operational checks

Item	Measure
Engine under load Engine at nominal speed	Check engine visually for leaks and general condition; Check air pipework between air filter and exhaust turbocharger for leaks and damage. Check for abnormal running noise, vibration, and exhaust color (→ Page 101).
Charge-air cooler	Check condensate drain (→ Page 171).
Air filter	Check signal ring position of service indicator (→ Page 174). Replace air filter (→ Page 172), if the signal ring is completely visible in the service indicator control window.
HP fuel pump	Check relief bores for fuel discharge (→ Page 145).
HT coolant pump	Check relief bore for oil and coolant discharge and obstructions (→ Page 199).
Fuel prefilter (optional)	Check reading on differential pressure gauge (→ Page 174); Drain water and contaminants (→ Page 159).
Raw water pump (only on engines with engine-mounted or optional remote heat exchanger)	Check relief bore for oil and coolant discharge and obstructions (→ Page 205).
Bilge pump (optional)	Check relief bore for oil and coolant discharge and obstructions (→ Page 208).

4.6 Tasks after extended out-of-service periods (>3 weeks)

Tasks after extended out-of-service periods (>3 weeks)

Note: Operate fuel treatment system for at least 5 minutes.

1. Start up fuel treatment system (→ Page 90).
2. Shut down fuel treatment system (→ Page 94).

4.7 Checks prior to start-up

Checks prior to start-up

1. Check tank and the entire pipework for cleanness. If microorganisms are detected:
   a) Clean affected components.
   b) Disinfect affected components with biocides (→ MTU Fluids and Lubricants Specifications A001061/..).
2. Close drain valves on housing.
3. Open all supply and discharge valves.
4. Switch on fuel treatment system (→ Page 93).
5. Check direction of rotation of pump.
6. Vent bypass and fuel lines of the system.
   a) Open ball valve for pressure tank.
   b) Open ball valve for overflow tank.
   c) Close ball valve at the inlet to the fuel treatment system.

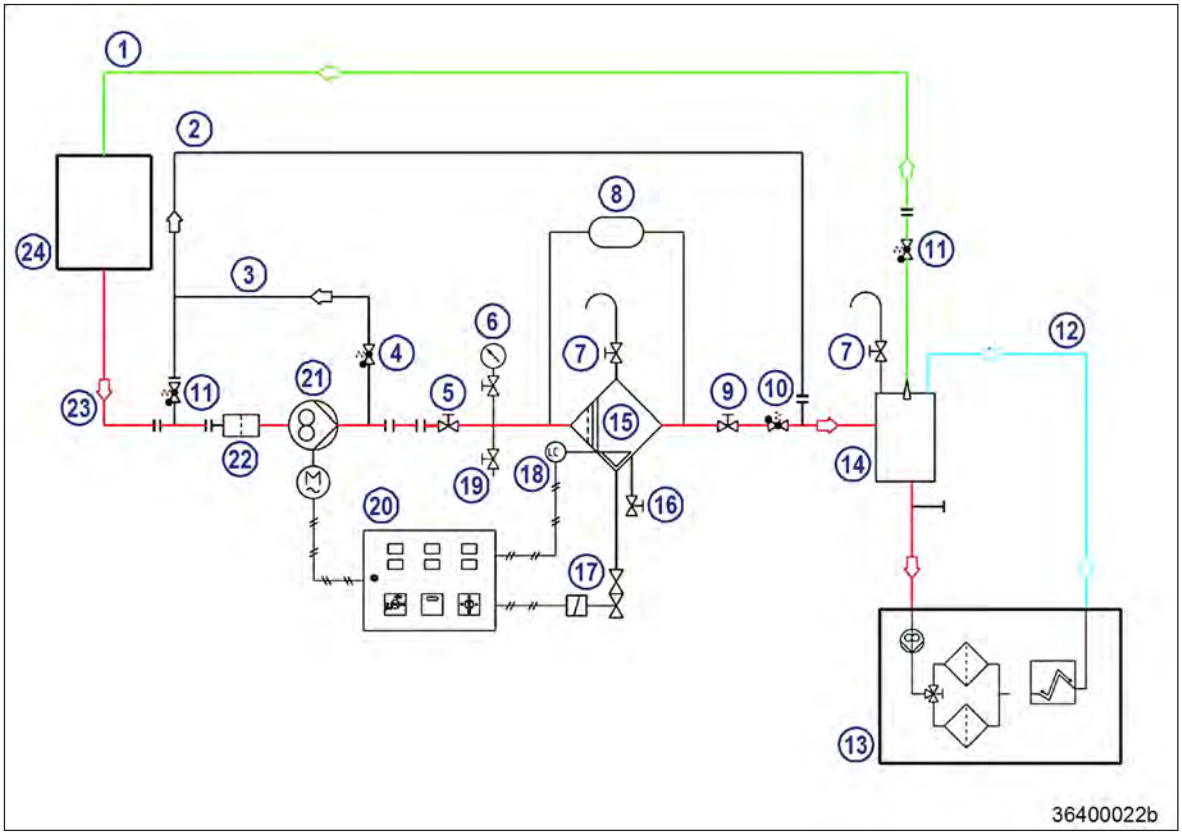
Result: Bypass line is vented via the overflow tank.

   d) Open ball valve at the inlet to the fuel treatment system.
7. Check the fuel treatment system for leaks.

Result: The fuel treatment system is ready for operation.

4.8 Fuel treatment system - Putting into operation

Overview of fuel treatment system



1 Pressure-free overflow
2 Bypass 1
3 Bypass 2
4 Safety valve, 3 bar
5 Ball valve, inlet
6 Pressure gage
7 Ventilation, sample extraction
8 Differential pressure gage
9 Ball valve, outlet
10 Check valve 700 mbar
11 Check valve 5 mbar
12 Return to overflow container
13 Engine
14 Overflow container
15 Water separator filter
16 Ball valve, drain
17 Automatic water drain
18 Water level electrode
19 Ball valve, sample extraction, inlet
20 Switchgear cabinet
21 Pump
22 Coarse filter
23 Fuel supply from tank
24 Tank

Switching on fuel treatment system

1. Switch on fuel treatment system (→ Page 93).
2. Check differential pressure at differential pressure gage (8). Differential pressure in a new system: 0.1 bar to 0.3 bar.

Result: If no differential pressure is measured, the coalescer filter element is probably being bypassed.

1. Remove coalescer filter element (→ Page 213).
2. Check sealing surfaces on coalescer filter element and in the pressure tank.

Initial operation: HAT

1. Replace fuel filter on engine (→ Page 154).

Note: Determine the suction pressure upstream of the engine-mounted fuel delivery pump.

2. Install pressure gage in fuel supply line from Yard fuel system to engine.
3. Switch on fuel treatment system and operate it for some minutes (→ Page 93).

Result: The fuel is drawn from tank (24), cleaned by the water separator filter (15) and then routed via overflow tank (14) back to tank (24). Water that collects in the tank is separated.

4. Start engine (→ Page 86).
5. Run engine at idling speed.
6. Check suction pressure (see technical data of the engine) at the engine-mounted fuel delivery pump.

Note: If the suction pressure is within the permissible limits and engine operation is satisfactory.

7. Increase engine speed to 1000 rpm and monitor suction pressure.
8. Check suction pressure at the engine-mounted fuel delivery pump.

Result: If the values are within the limits specified by the manufacturer, the system is ready to start filter replacement simulation with the engine running as part of the Harbor Acceptance Tests.

Simulation of filter replacement with the engine running: HAT

1. Switch on fuel treatment system (→ Page 93).
2. Start engine (→ Page 86).
3. Run engine at idling speed.
4. Close ball valve (5) at inlet to fuel treatment system.

Result: The pressure upstream of the fuel treatment system increases until the overflow valve at the pump unit opens and fuel flows through bypass (3) and bypass (2).

5. Open ball valve (19) .

Result: Fuel emerges. If no fuel emerges:

- Open ball valve (5) at inlet to fuel treatment system.
- No function of bypasses (2) and (3); carry out functional test of bypasses (2) and (3) .

6. Check suction pressure (see technical data of the engine) at the fuel delivery pump.

Note: If the suction pressure is within the permissible limits and engine operation is satisfactory.

7. Increase engine speed to 1000 rpm and monitor suction pressure.

Result: If all engine operating values are within the specified limits, open ball valve (5) at inlet to fuel treatment system.

Simulation of power failure (emergency): HAT

1. Switch on fuel treatment system (→ Page 93).
2. Start engine (→ Page 86).
3. Run engine at idling speed.
4. Switch off pump (21) at switchgear cabinet (20).

Result: The engine-mounted fuel delivery pump draws fuel via bypass (2) directly from tank (24).

5. Check suction pressure at the engine-mounted fuel delivery pump.

Note: If the suction pressure is within the permissible limits and engine operation is satisfactory.

6. Increase engine speed to 1000 rpm and monitor suction pressure.

Result: If the suction pressure is within the specified limits, simulation was successful.

Simulation of power failure (emergency): SAT

1. Switch on fuel treatment system (→ Page 93).
2. Start engine (→ Page 86).
3. Run engine at idling speed.
4. Switch off pump (21) at switchgear cabinet (20).

Result: The engine-mounted fuel delivery pump draws fuel via bypass (2) directly from tank (24).

5. Check suction pressure at the engine-mounted fuel delivery pump.

Note: If the suction pressure is within the permissible limits and engine operation is satisfactory.

6. Operate engine at full load and monitor suction pressure.

Result: If the suction pressure is within the specified limits, simulation was successful.

4.9 Fuel treatment system – Switching on

Preconditions

☑ The on-board power supply is switched on.

NOTICE

Risk of damage to engine/system.
Risk of severe damage to property!
- Before switching on, ensure that the engine/system is ready for operation.
- Before switching on, ensure that all housings are closed.
- Before switching on, ensure that no work is in progress anywhere on the entire system.

Fuel treatment system – Switching on

1. Carry out checks prior to start-up (→ Page 89).
2. Switch on master switch on switchgear cabinet.

Result: Signal lamp “Control voltage present” lights up.

3. Switch on switch for pump.

Result: Signal lamp “Pump running” lights up.

4.10 Fuel treatment system – Shutdown

Shutting down fuel treatment system

1. Press the illuminated pushbutton "Water drain" on the switch cabinet until water discharge from the outlet stops.
2. Switch off fuel treatment system.
3. Close ball valve at the inlet to the fuel treatment system.
4. Close ball valve at the outlet of the fuel treatment system.
5. Open drain valve until pressure has escaped from fuel treatment system.

4.11 Stopping the engine

Stopping the engine via the automation system

Refer to automation system operating instructions

4.12 Emergency engine stop

NOTICE

An emergency stop causes extreme stress to the engine plant.
Risk of overheating, damage to components!
- Initiate emergency stop only in emergency situations.

Emergency stop

1. Refer to automation system operating instructions.
2. Follow instructions.

4.13 After stopping the engine

Preconditions

☑ MTU Preservation and Re-preservation Specifications (A001070/..) are available.

After stopping the engine

Item	Measure
Coolant circuit	Drain coolant (→ Page 194) if: • freezing temperatures are expected and the engine is to remain out of service for an extended period, but engine coolant has no antifreeze additive; • the engine room is not heated; • the coolant is not kept at a suitable temperature; • the antifreeze concentration is insufficient for the engine-room temperature; • antifreeze concentration is 50% and engine-room temperature is below -40 °C.
Raw water (only on engines with engine-mounted heat exchanger)	Drain • if freezing temperatures are expected and the engine is to remain out of service for an extended period.
Engine control system	Switch off.
Air intake and exhaust system	**Out-of-service-period > 1 week** • Seal engine on air and exhaust sides. **Out-of-service-period > 1 month** • Preserve engine (→ MTU Preservation and Re-preservation specifications A001070/..).

4.14 Plant – Cleaning

Preconditions

☑ Engine is stopped and starting disabled.

☑ Operating voltage is not applied.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Steam jet cleaner	-	1
Cleaner (Hakupur 312)	30390	1

WARNING

Compressed air gun ejects a jet of pressurized air.
Risk of injury to eyes and damage to hearing, risk of rupturing internal organs!
- Never direct air jet at people.
- Always wear safety goggles/face mask and ear defenders.

WARNING

Steam jet cleaner ejects jet of pressurized water.
Risk of injury to eyes and scalding!
- Never direct water jet at people.
- Wear protective clothing, protective gloves and safety goggles/face mask.

NOTICE

Cleaning agents should not be left to take effect for too long.
Damage to components is possible!
- Observe manufacturer's instructions.

NOTICE

Blowing down product with compressed air.
Entry of dirt and damage to components is possible!
- Do not aim compressed air gun directly at seals or electronic components such as connectors or ECUs.

Plant – Cleaning

1. Carry out plant cleaning only in areas where an appropriate oil separator is provided (environmental protection).
2. Prior to putting the cleaning unit into operation, read the Operating Instructions of the water/steam jet unit carefully and observe the safety precautions.
3. For external cleaning of the plant with water or steam-jet cleaners:
   - The pressure of the high-pressure jet (cleaning jet) must not exceed 50 bar.
   - A minimum distance between spray nozzle and plant of 1 m must be observed.
   - The temperature of the cleaning medium must not exceed 80°C.
4. For external cleaning with high-pressure jet, use a flat-mouth nozzle only.

Note: Never aim compressed air directly at electronic components.

5. Carry out external cleaning as follows:
   a) Seal all openings in a suitable way.
   b) Remove coarse dirt.
   c) Spray on cleaner sparingly and leave it for 1 to 5 minutes.
   d) Use the high-pressure jet to remove the loosened dirt.
   e) Dry engine with compressed air.

5 Maintenance

5.1 Maintenance task reference table [QL1]

The maintenance tasks and intervals for this product are defined in the Maintenance Schedule. The Maintenance Schedule is a stand-alone publication.

The task numbers in this table provide reference to the maintenance tasks specified in the Maintenance Schedule.

Task	Option	Maintenance tasks	
W0500		Check engine oil level.	(→ Page 176)
W0501		Visually inspect engine for leaks and general condition.	(→ Page 87)
W0502	X	Check intercooler drain(s).	(→ Page 171)
W0503		Check service indicator of air filter.	(→ Page 174)
W0504		Check relief bores of HP fuel pump .	(→ Page 87)
W0505		Check relief bores of water pump(s)	(→ Page 199)
W0506		Check engine for abnormal running noises, exhaust color and vibrations.	(→ Page 87)
W0507	X	Drain water and contaminants from fuel prefilter.	(→ Page 87)
W0508	X	Check reading on differential pressure gage of fuel prefilter.	(→ Page 87)
W1001		Replace fuel filter or fuel filter element	(→ Page 154)
W1005		Replace air filter.	(→ Page 172)
W1006		Replace injection valves/injectors.	(→ Page 146)
W1008		Replace engine oil filter when changing engine oil, or when the interval (years) is reached, at the latest.	(→ Page 183)
W1009	X	Check layer thickness of the oil residue, clean out and replace filter sleeve, together with every oil change, at the latest.	(→ Page 185)
W1011		Perform endoscopic examination.	(→ Page 135)
W1016		Check condition of coupling.	(→ Page 206)
W1029		Inspect for tightness and damage of air duct between air filter and exhaust turbocharger.	(→ Page 87)
W1036		Replace coolant filter.	(→ Page 201)
W1076		Clean compressor wheel.	(→ Page 163)
W1207		Check valve clearance, adjust if necessary. ATTENTION! First adjustment after 1,000 operating hours	(→ Page 140)
W1244	X	Check function of rod electrode.	(→ Page 211)
W1245	X	Check alarm function of differential pressure gauge.	(→ Page 210)
W1246	X	Check pump capacity.	(→ Page 212)
W1463		Check general condition of engine mounting (visual inspection).	(→ Page 207)
W1494	X	Replace filter element of fuel prefilter and sealing ring depending on degree of contamination, when the limit (years) is reached, at the latest.	(→ Page 161)

Task	Option	Maintenance tasks	
W1495	X	Replace intermediate fuel filter or filter element.	(→ Page 213)
W1713		Injector: Reset drift compensation parameters (CDC).	(→ Page 235)
W1714	X	Check and clean oil indicator filter.	(→ Page 181)

Table 1: Maintenance task reference table [QL 1]

6 Troubleshooting

6.1 Troubleshooting

Engine does not turn when starter is actuated

Cause	Corrective action
Battery low or faulty	▶ Charge or replace (see separate documentation).
Battery: Cable connections faulty	▶ Check firm seating of cable connections (see separate documentation).
Engine cabling or starter faulty	▶ Check firm seating of cable connections, contact Service.
Engine cabling defective	▶ Check (→ Page 224).
Loose plug connections on engine governor	▶ Check plug connections (→ Page 226).
Loose plug connections on Engine Interface Module (EIM)	▶ Check plug connections (→ Page 228).
Fuse F1 (→ Page 215)in engine wiring harness defective (fuse lamp on EIM flashes with relevant flashing code)	▶ Check fuse (replace if required) and re-start the system by actuating the key switch.
Running gear blocked (engine cannot be barred manually)	▶ Contact Service.

Engine turns on starting but does not fire

Cause	Corrective action
Poor rotation by starter: Battery low or faulty	▶ Charge or replace battery (see separate documentation).
Engine cabling defective	▶ Check (→ Page 224).
Engine governor defective	▶ Contact Service.

Engine fires unevenly

Cause	Corrective action
Injector faulty	▶ Replace (→ Page 146).
Engine cabling defective	▶ Check (→ Page 224).
Engine governor defective	▶ Contact Service.

Engine does not reach nominal speed

Cause	Corrective action
Easy-change fuel filter clogged	▶ Replace (→ Page 154).
Air supply: Air filter clogged	▶ Check signal ring position of service indicator (→ Page 174).
Fuel injection: Injector faulty	▶ Replace (→ Page 146).
Engine cabling defective	▶ Check (→ Page 224).
Engine: Overload	▶ Contact Service.

Engine speed not steady

Cause	Corrective action
Fuel injection: Injector faulty	▶ Replace (→ Page 146).
Speed transmitter defective	▶ Contact Service.
Engine governor defective	▶ Contact Service.

Charge-air temperature too high

Cause	Corrective action
Incorrect coolant concentration	▶ Check (MTU test kit).
Intercooler dirty	▶ Contact Service.
Engine room: Air-intake temperature too high	▶ Check fans and air supply/ventilation ducts.

Charge-air pressure too low

Cause	Corrective action
Air supply: Air filter clogged	▶ Check signal ring position of service indicator (→ Page 174).
Intercooler dirty	▶ Contact Service.
Exhaust turbocharger defective	▶ Contact Service.

Coolant leaks at intercooler

Cause	Corrective action
Intercooler leaky, major coolant discharge	▶ Contact Service.

Black exhaust gas

Cause	Corrective action
Air supply: Air filter clogged	▶ Check signal ring position of service indicator (→ Page 174).
Fuel injection: Injector faulty	▶ Replace (→ Page 146).
Engine: Overload	▶ Contact Service.

Blue exhaust gas

Cause	Corrective action
Too much oil in engine	▶ Drain engine oil (→ Page 177).
Oil separator or oil-preseparator of crankcase breather clogged	▶ Replace.
Exhaust turbocharger, cylinder head, piston rings, cylinder liner defective	▶ Contact Service.

White exhaust gas

Cause	Corrective action
Engine is not at operating temperature	▶ Run engine to reach operating temperature.
Intercooler leaky	▶ Contact Service.

6.2 Fuel treatment system – Troubleshooting

Illuminated pushbutton 'water alarm' is lit.

Cause	Corrective action
When the maximum water level is reached, the water level electrode opens the water drain valve and water is discharged. If the opening period of the valve exceeds a preset limit (4 minutes), the pump will switch off and an alarm is initiated.	1. Press illuminated pushbutton 'Water alarm' for acknowledgment. 2. In addition to the automatic water drain function, water can also be drained manually. To do so, press the illuminated pushbutton 'Water drain' to open the drain valve.

Signal lamp 'Pump fault' is lit.

Cause	Corrective action
The drive motor is equipped with an overload protection. If the maximum permissible current consumption is exceeded, e.g. in case of a blockage or dry-running, the motor protection relay triggers and the pump is switched off.	▶ Reset motor protection relay.

Signal lamp 'Pre-alarm' is lit.

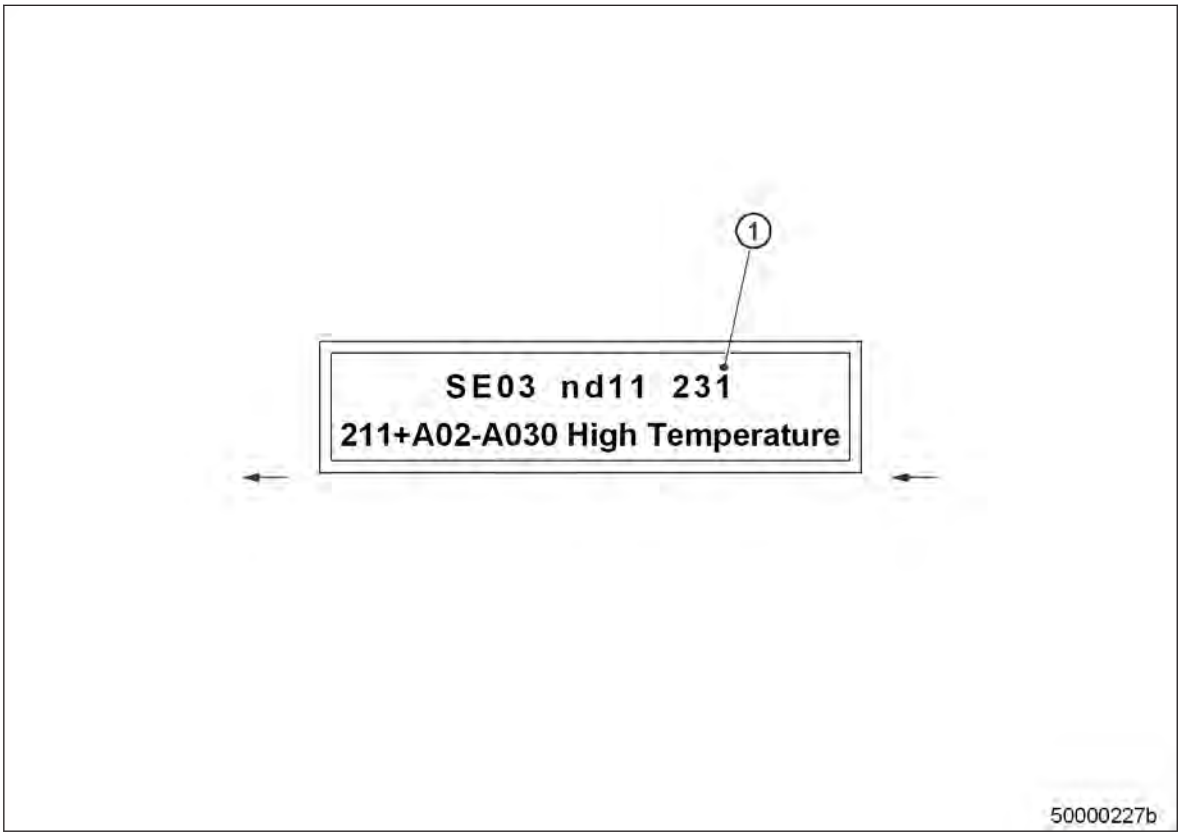
Cause	Corrective action
The differential pressure exceeded 1.3 bar.	▶ Replace coalescer filter element (→ Page 213).

Illuminated pushbutton 'Replace filter element' is lit.

Cause	Corrective action
The max. permissible differential pressure of 1.5 bar was exceeded. If the coalescer filter element is not replaced, pressure will increase further and the safety valve will open. Fuel will be led via the bypass directly into the overflow tank.	1. Replace coalescer filter element (→ Page 213). 2. Press illuminated pushbutton 'Replace filter element' for acknowledgment.

6.3 Engine governor ADEC (ECU 7) fault messages for Series 4000 engines, marine application

The fault code numbers are generated by the engine governor and transmitted to the display below (if fitted).



The fault code (1) comprises 3 digits.

Fault messages may also be caused by faulty sensors/actuators. Contact Service to have sensors/actuators tested and replaced as necessary if troubleshooting as described in the table (→ Page 106) proves unsuccessful.

For explanations of alarm configuration parameters, refer to PR 2.8008.100.

Fault code list (→ Page 106).

6.4 ADEC engine governor - Fault codes

29 – HI ETC Idle Speed too High

ZKP-Number: 18.004.206

Cause	Corrective action
Idle speed of one of the secondary turbochargers is too high.	▶ Contact Service.

38 – AL ETC Speed Deviation

ZKP-Number: 18.004.205

Cause	Corrective action
Speeds of one of the secondary turbochargers deviates from primary turbocharger speed.	1. Reduce power. 2. Contact Service.

39 – AL ETC2 CutIn Failure

ZKP-Number: 18.004.204

Cause	Corrective action
ETC2 could not be cut in.	1. Reduce power. 2. Contact Service.

81 – AL Rail Leakage

ZKP-Number: 18.004.046

Cause	Corrective action
Pressure gradient in rail is too low during starting or too high during stopping (HP system leaky or air in the system)	▶ Contact Service.

102 – AL Cons. Counter Defect

ZKP-Number: 18.004.624

Cause	Corrective action
Consumption meter faulty.	▶ Contact Service.

104 – AL Eng Hours Counter Defect

ZKP-Number: 18.004.623

Cause	Corrective action
Hourmeter faulty.	▶ Contact Service.

141 – AL Power too high

ZKP-Number: 11.088.007

Cause	Corrective action
This alarm occurs if the average value of power over the last 24 hours exceeded the maximum value specified in PR1.1088.001.	▶ Reduce power.

142 – AL MCR exceeded 1 hour

ZKP-Number: 11.088.006

Cause	Corrective action
This alarm occurs if the MCR was exceeded for more than 1 hour within the last 12 hours.	▶ Reduce power.

201 – SD T-Coolant

ZKP-Number: 18.004.570

Cause	Corrective action
Coolant temperature sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B6), replace as necessary. 2. Error cleared after restarting the engine.

202 – SD T-Fuel

ZKP-Number: 18.004.572

Cause	Corrective action
Coolant temperature sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B33), replace as necessary. 2. Error cleared after restarting the engine.

203 – SD T-Charge Air

ZKP-Number: 18.004.571

Cause	Corrective action
Charge-air temperature sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B9), replace as necessary. 2. Error cleared after restarting the engine.

204 – SD Level Lube Oil

ZKP-Number: 18.004.602

Cause	Corrective action
lube oil level sensor faulty; Short circuit or wire break	▶ Check sensor and cabling, replace as necessary.

205 – SD T-Coolant Intercooler

ZKP-Number: 18.004.574

Cause	Corrective action
Intercooler coolant temperature sensor faulty; Short circuit or wire break	▶ Check sensor and cabling (B26), replace as necessary.

206 – SD T-Exhaust A

ZKP-Number: 18.004.576

Cause	Corrective action
Exhaust temperature sensor on A-side faulty; Short circuit or wire break	▶ Check sensor and cabling (B4.21), replace as necessary.

207 – SD T-Exhaust B

ZKP-Number: 18.004.577

Cause	Corrective action
Exhaust temperature sensor on B-side faulty; Short circuit or wire break	▶ Check sensor and cabling (B4.22), replace as necessary.

208 – SD P-Charge Air

ZKP-Number: 18.004.566

Cause	Corrective action
Charge-air pressure sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B10), replace as necessary. 2. Error cleared after restarting the engine.

211 – SD P-Lube Oil

ZKP-Number: 18.004.563

Cause	Corrective action
Lube oil pressure sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B5), replace as necessary. 2. Error cleared after restarting the engine.

212 – SD P-Coolant

ZKP-Number: 18.004.564

Cause	Corrective action
Coolant pressure sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B16), replace as necessary. 2. Error cleared after restarting the engine.

213 – SD P-Coolant Intercooler

ZKP-Number: 18.004.569

Cause	Corrective action
Intercooler coolant pressure sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B43), replace as necessary. 2. Error cleared after restarting the engine.

214 – SD P-CrankCase

ZKP-Number: 18.004.568

Cause	Corrective action
Crankcase pressure sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B50), replace as necessary. 2. Error cleared after restarting the engine.

215 – SD P-HD

ZKP-Number: 18.004.567

Cause	Corrective action
Rail pressure sensor faulty; high-pressure regulator emergency mode; Short circuit or wire break	1. Check sensor and cabling (B48), replace as necessary. 2. Error cleared after restarting the engine.

216 – SD T-Lube Oil

ZKP-Number: 18.004.575

Cause	Corrective action
Lube oil temperature sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B7), replace as necessary. 2. Error cleared after restarting the engine.

219 – SD T-Intake Air

ZKP-Number: 18.004.573

Cause	Corrective action
Intake air temperature sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B3), replace as necessary. 2. Error cleared after restarting the engine.

220 – SD Level Coolant Water

ZKP-Number: 18.004.584

Cause	Corrective action
Coolant level sensor faulty; Short circuit or wire break	1. Check sensor and cabling (F33), replace as necessary. 2. Error cleared after restarting the engine.

221 – SD P-Diff-Lube Oil

ZKP-Number: 18.004.585

Cause	Corrective action
Lube oil differential pressure sensor faulty; Short circuit or wire break	1. Check sensor and cabling (F25), replace as necessary. 2. Error cleared after restarting the engine.

222 – SD Level Leakage Fuel

ZKP-Number: 18.004.582

Cause	Corrective action
Leak-off fuel level sensor faulty; Short circuit or wire break	1. Check sensor and cabling (F46), replace as necessary. 2. Error cleared after restarting the engine.

223 – SD Level Coolant Intercooler

ZKP-Number: 18.004.583

Cause	Corrective action
Coolant level sensor of intercooler faulty; Short circuit or wire break	1. Check sensor and cabling (F57), replace as necessary. 2. Error cleared after restarting the engine.

227 – SD P-Lube Oil before Filter

ZKP-Number: 18.004.620

Cause	Corrective action
Sensor for lube oil pressure before filter faulty; Short circuit or wire break	1. Check sensor and cabling (B5.3), replace as necessary. 2. Error cleared after restarting the engine.

228 – SD P-Fuel before Filter

ZKP-Number: 18.004.595

Cause	Corrective action
Fuel pressure sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B5.3), replace as necessary. 2. Error cleared after restarting the engine.

229 – AL Stop Camshaft Sensor Defect

ZKP-Number: 18.004.562

Cause	Corrective action
Engine shutdown due to camshaft sensor fault (and a prior crankshaft sensor fault in the same operating cycle).	1. Check connector and cabling to sensor B1, replace as necessary. 2. Error cleared after restarting the engine.

230 – SD Crankshaft Speed

ZKP-Number: 18.004.498

Cause	Corrective action
Crankshaft sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B13), replace as necessary. 2. Error cleared after restarting the engine.

231 – SD Camshaft Speed

ZKP-Number: 18.004.499

Cause	Corrective action
Camshaft sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B1), replace as necessary. 2. Error cleared after restarting the engine.

232 – SD Charger 1 Speed

ZKP-Number: 13.011.128

Cause	Corrective action
Speed sensor of primary turbocharger faulty; Short circuit or wire break	1. Check sensor and cabling (B44.1), replace as necessary. 2. Error cleared after restarting the engine.

233 – SD Charger 2 Speed

ZKP-Number: 13.011.129

Cause	Corrective action
Speed sensor of secondary turbocharger faulty; Short circuit or wire break	1. Check sensor and cabling (B44.2), replace as necessary. 2. Error cleared after restarting the engine.

239 – SD P-Diff Fuel

ZKP-Number: 18.004.598

Cause	Corrective action
Fuel differential pressure sensor faulty; occurs only in combination with alarm "SD P-Fuel before Filter" or "SD P-Fuel after Filter".	▶ Note further fault messages. Pressure sensor before or after filter is faulty.

240 – SD P-Fuel

ZKP-Number: 18.004.565

Cause	Corrective action
Fuel pressure sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B34), replace as necessary. 2. Error cleared after restarting the engine.

241 – SD T-Umblasen

ZKP-Number: 18.004.581

Cause	Corrective action
Recirculation temperature sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B49), replace as necessary. 2. Error cleared after restarting the engine.

242 – SD T-Coolant (R)

ZKP-Number: 18.004.622

Cause	Corrective action
Redundant coolant temperature sensor faulty; Short circuit or wire break	1. Check sensor and cabling, replace as necessary. 2. Error cleared after restarting the engine.

244 – SD P-Lube Oil (R)

ZKP-Number: 18.004.621

Cause	Corrective action
Redundant lube oil pressure sensor faulty; Short circuit or wire break	1. Check sensor and cabling, replace as necessary. 2. Error cleared after restarting the engine.

301 – AL Timing Cylinder A1

ZKP-Number: 18.004.500

Cause	Corrective action
Time-of-flight measuring fault of injector in cylinder A1: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

302 – AL Timing Cylinder A2

ZKP-Number: 18.004.501

Cause	Corrective action
Time-of-flight measuring fault of injector in cylinder A2: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

303 – AL Timing Cylinder A3

ZKP-Number: 18.004.502

Cause	Corrective action
Time-of-flight measuring fault of injector in cylinder A3: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

304 – AL Timing Cylinder A4

ZKP-Number: 18.004.503

Cause	Corrective action
Time-of-flight measuring fault of injector in cylinder A4: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

305 – AL Timing Cylinder A5

ZKP-Number: 18.004.504

Cause	Corrective action
Time-of-flight measuring fault of injector in cylinder A5: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

306 – AL Timing Cylinder A6

ZKP-Number: 18.004.505

Cause	Corrective action
Time-of-flight measuring fault of injector in cylinder A6: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

307 – AL Timing Cylinder A7

ZKP-Number: 18.004.506

Cause	Corrective action
Time-of-flight measuring fault of injector in cylinder A7: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

308 – AL Timing Cylinder A8

ZKP-Number: 18.004.507

Cause	Corrective action
Time-of-flight measuring fault of injector in cylinder A8: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

309 – AL Timing Cylinder A9

ZKP-Number: 18.004.508

Cause	Corrective action
Time-of-flight measuring fault of injector in cylinder A9: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

310 – AL Timing Cylinder A10

ZKP-Number: 18.004.509

Cause	Corrective action
Time-of-flight measuring fault of injector in cylinder A10: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

311 – AL Timing Cylinder B1

ZKP-Number: 18.004.510

Cause	Corrective action
Time-of-flight measuring fault of injector B1: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

312 – AL Timing Cylinder B2

ZKP-Number: 18.004.511

Cause	Corrective action
Time-of-flight measuring fault of injector B2: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

313 – AL Timing Cylinder B3

ZKP-Number: 18.004.512

Cause	Corrective action
Time-of-flight measuring fault of injector B3: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

314 – AL Timing Cylinder B4

ZKP-Number: 18.004.513

Cause	Corrective action
Time-of-flight measuring fault of injector B4: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

315 – AL Timing Cylinder B5

ZKP-Number: 18.004.514

Cause	Corrective action
Time-of-flight measuring fault of injector B5: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

316 – AL Timing Cylinder B6

ZKP-Number: 18.004.515

Cause	Corrective action
Time-of-flight measuring fault of injector B6: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

317 – AL Timing Cylinder B7

ZKP-Number: 18.004.516

Cause	Corrective action
Time-of-flight measuring fault of injector B7: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

318 – AL Timing Cylinder B8

ZKP-Number: 18.004.517

Cause	Corrective action
Time-of-flight measuring fault of injector B8: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

319 – AL Timing Cylinder B9

ZKP-Number: 18.004.518

Cause	Corrective action
Time-of-flight measuring fault of injector B9: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

320 – AL Timing Cylinder B10

ZKP-Number: 18.004.519

Cause	Corrective action
Time-of-flight measuring fault of injector B10: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

321 – AL Wiring Cylinder A1

ZKP-Number: 18.004.520

Cause	Corrective action
Short-circuit in injector cabling to cylinder A1. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

322 – AL Wiring Cylinder A2

ZKP-Number: 18.004.521

Cause	Corrective action
Short-circuit in injector cabling to cylinder A2. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

323 – AL Wiring Cylinder A3

ZKP-Number: 18.004.522

Cause	Corrective action
Short-circuit in injector cabling to cylinder A3. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

324 – AL Wiring Cylinder A4

ZKP-Number: 18.004.523

Cause	Corrective action
Short-circuit in injector cabling to cylinder A4. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

325 – AL Wiring Cylinder A5

ZKP-Number: 18.004.524

Cause	Corrective action
Short-circuit in injector cabling to cylinder A5. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

326 – AL Wiring Cylinder A6

ZKP-Number: 18.004.525

Cause	Corrective action
Short-circuit in injector cabling to cylinder A6. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

327 – AL Wiring Cylinder A7

ZKP-Number: 18.004.526

Cause	Corrective action
Short-circuit in injector cabling to cylinder A7. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

328 – AL Wiring Cylinder A8

ZKP-Number: 18.004.527

Cause	Corrective action
Short-circuit in injector cabling to cylinder A8. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

329 – AL Wiring Cylinder A9

ZKP-Number: 18.004.528

Cause	Corrective action
Short-circuit in injector cabling to cylinder A9. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

330 – AL Wiring Cylinder A10

ZKP-Number: 18.004.529

Cause	Corrective action
Short-circuit in injector cabling to cylinder A10. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

331 – AL Wiring Cylinder B1

ZKP-Number: 18.004.530

Cause	Corrective action
Cabling fault in injector cabling to cylinder B1. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

332 – AL Wiring Cylinder B2

ZKP-Number: 18.004.531

Cause	Corrective action
Cabling fault in injector cabling to cylinder B2. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

333 – AL Wiring Cylinder B3

ZKP-Number: 18.004.532

Cause	Corrective action
Cabling fault in injector cabling to cylinder B3. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

334 – AL Wiring Cylinder B4

ZKP-Number: 18.004.533

Cause	Corrective action
Cabling fault in injector cabling to cylinder B4. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

335 – AL Wiring Cylinder B5

ZKP-Number: 18.004.534

Cause	Corrective action
Cabling fault in injector cabling to cylinder B5. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

336 – AL Wiring Cylinder B6

ZKP-Number: 18.004.535

Cause	Corrective action
Cabling fault in injector cabling to cylinder B6. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

337 – AL Wiring Cylinder B7

ZKP-Number: 18.004.536

Cause	Corrective action
Cabling fault in injector cabling to cylinder B7. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

338 – AL Wiring Cylinder B8

ZKP-Number: 18.004.537

Cause	Corrective action
Cabling fault in injector cabling to cylinder B8. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

339 – AL Wiring Cylinder B9

ZKP-Number: 18.004.538

Cause	Corrective action
Cabling fault in injector cabling to cylinder B9. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

340 – AL Wiring Cylinder B10

ZKP-Number: 18.004.539

Cause	Corrective action
Cabling fault in injector cabling to cylinder B10. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

341 – AL Open Load Cylinder A1

ZKP-Number: 18.004.540

Cause	Corrective action
Disruption fault in injector cabling to cylinder A1. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

342 – AL Open Load Cylinder A2

ZKP-Number: 18.004.541

Cause	Corrective action
Disruption fault in injector cabling to cylinder A2. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

343 – AL Open Load Cylinder A3

ZKP-Number: 18.004.542

Cause	Corrective action
Disruption fault in injector cabling to cylinder A3. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

344 – AL Open Load Cylinder A4

ZKP-Number: 18.004.543

Cause	Corrective action
Disruption fault in injector cabling to cylinder A4. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

345 – AL Open Load Cylinder A5

ZKP-Number: 18.004.544

Cause	Corrective action
Disruption fault in injector cabling to cylinder A5. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

346 – AL Open Load Cylinder A6

ZKP-Number: 18.004.545

Cause	Corrective action
Disruption fault in injector cabling to cylinder A6. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

347 – AL Open Load Cylinder A7

ZKP-Number: 18.004.546

Cause	Corrective action
Disruption fault in injector cabling to cylinder A7. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

348 – AL Open Load Cylinder A8

ZKP-Number: 18.004.547

Cause	Corrective action
Disruption fault in injector cabling to cylinder A8. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

349 – AL Open Load Cylinder A9

ZKP-Number: 18.004.548

Cause	Corrective action
Disruption fault in injector cabling to cylinder A9. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

350 – AL Open Load Cylinder A10

ZKP-Number: 18.004.549

Cause	Corrective action
Disruption fault in injector cabling to cylinder A10. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

351 – AL Open Load Cylinder B1

ZKP-Number: 18.004.550

Cause	Corrective action
Disruption fault in injector cabling to cylinder B1. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

352 – AL Open Load Cylinder B2

ZKP-Number: 18.004.551

Cause	Corrective action
Disruption fault in injector cabling to cylinder B2. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

353 – AL Open Load Cylinder B3

ZKP-Number: 18.004.552

Cause	Corrective action
Disruption fault in injector cabling to cylinder B3. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

354 – AL Open Load Cylinder B4

ZKP-Number: 18.004.553

Cause	Corrective action
Disruption fault in injector cabling to cylinder B4. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

355 – AL Open Load Cylinder B5

ZKP-Number: 18.004.554

Cause	Corrective action
Disruption fault in injector cabling to cylinder B5. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

356 – AL Open Load Cylinder B6

ZKP-Number: 18.004.555

Cause	Corrective action
Disruption fault in injector cabling to cylinder B6. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

357 – AL Open Load Cylinder B7

ZKP-Number: 18.004.556

Cause	Corrective action
Disruption fault in injector cabling to cylinder B7. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

358 – AL Open Load Cylinder B8

ZKP-Number: 18.004.557

Cause	Corrective action
Disruption fault in injector cabling to cylinder B8. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

359 – AL Open Load Cylinder B9

ZKP-Number: 18.004.558

Cause	Corrective action
Disruption fault in injector cabling to cylinder B9. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

360 – AL Open Load Cylinder B10

ZKP-Number: 18.004.559

Cause	Corrective action
Disruption fault in injector cabling to cylinder B10. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

361 – AL Power Stage Low

ZKP-Number: 18.004.496

Cause	Corrective action
Internal electronic fault (electronics possibly faulty). If bit "1.1020.021" (Power Stage Failure: Stop Engine) is set, engine will be shut down as additional measure.	▶ Start ITS. If the ITS diagnosis result is "electronics OK", note further fault messages (e.g. cabling faults).

362 – AL Power Stage High

ZKP-Number: 18.004.497

Cause	Corrective action
Internal electronic fault (electronics possibly faulty). If bit "1.1020.021" (Power Stage Failure: Stop Engine) is set, engine will be shut down as additional measure.	▶ Start ITS. If the ITS diagnosis result is "electronics OK", note further fault messages (e.g. cabling faults).

363 – AL Stop Power Stage

ZKP-Number: 18.004.560

Cause	Corrective action
Internal electronic fault (electronics possibly faulty). If bit "1.1020.021" (Power Stage Failure: Stop Engine) is set, engine will be shut down as additional measure.	▶ Start ITS. If the ITS diagnosis result is "electronics OK", note further fault messages (e.g. cabling faults).

365 – AL Stop MV-Wiring Ground

ZKP-Number: 18.004.561

Cause	Corrective action
Injector cabling fault. If bit "1.1020.021" (Power Stage Failure: Stop Engine) is set, engine will be shut down as additional measure. Possible causes: 1. Short circuit of positive connection of one or more injectors to ground 2. Short circuit of negative connection of one or more injectors to ground	▶ Check wiring, replace wiring harness as necessary.

371 – AL Wiring TO 1

ZKP-Number: 18.004.634

Cause	Corrective action
Short circuit or wire break on transistor output 1 (TO 1).	1. Check charger valve/cabling, repair as necessary. 2. Replace engine governor

372 – AL Wiring TO 2

ZKP-Number: 18.004.635

Cause	Corrective action
Short circuit or wire break on transistor output 2 (TO 2).	1. Check air recirculation valve/cabling, repair as necessary 2. Replace engine governor

373 – AL Wiring TO 3

ZKP-Number: 18.004.636

Cause	Corrective action
Short circuit or wire break on transistor output 3 (TO 3).	▶ Check wiring of charger valve 2 (marine engine)

374 – AL Wiring TO 4

ZKP-Number: 18.004.637

Cause	Corrective action
Short circuit or wire break on transistor output 4 (TO 4).	▶ Check wiring of charger valve 3 (marine engine)

390 – AL MCR exceeded

ZKP-Number: 11.085.009

Cause	Corrective action
DBR/MCR feature: MCR (maximum continuous rating) was exceeded.	1. If the alarm occurs temporarily, no action required. 2. If the alarm is permanently active, contact Service.

396 – TD T-Coolant Sensor Deviation

ZKP-Number: 10.480.193

Cause	Corrective action
Maximum deviation of coolant temperature values from sensors	1. Check sensor and cabling, replace as necessary. 2. Contact Service.

397 – TD P-Oil Sensor Deviation

ZKP-Number: 10.480.293

Cause	Corrective action
Maximum deviation of lube oil pressure values from sensors	1. Check sensor and cabling, replace as necessary. 2. Contact Service.

417 – SD Level Water Fuel Prefilter

ZKP-Number: 18.004.594

Cause	Corrective action
Water level sensor in fuel prefilter faulty; Short circuit or wire break	▶ Check sensor and cabling, replace as necessary.

419 – SD T-Coolant b.Engine

ZKP-Number: 18.004.604

Cause	Corrective action
Coolant inlet temperature sensor faulty; Short circuit or wire break	▶ Check sensor and cabling (B3), replace as necessary.

444 – SD U-PDU

ZKP-Number: 18.004.578

Cause	Corrective action
Injector power stage sensor defect; Internal fault in ECU 7.	▶ Replace ECU 7.

445 – SD P-Ambient Air

ZKP-Number: 18.004.580

Cause	Corrective action
Ambient air pressure sensor faulty.	1. Check pressure sensor and cabling, replace as necessary. 2. Replace engine governor.

464 – SD P-AUX 1

ZKP-Number: 18.004.589

Cause	Corrective action
Analog input signal for Aux 1 pressure faulty; Short circuit or wire break	▶ Check pressure sensor and cabling, replace as necessary.

468 – SD T-AUX 1

ZKP-Number: 18.004.579

Cause	Corrective action
Analog input signal for Aux 1 temperature faulty;	1. Check signal transmitter and cabling, replace as necessary. 2. Replace engine governor.

469 – SD AUX 1

ZKP-Number: 18.004.590

Cause	Corrective action
Analog input signal for Aux 1 faulty; Short circuit or wire break	▶ Check signal transmitter and cabling, replace as necessary.

470 – SD T-ECU

ZKP-Number: 18.004.587

Cause	Corrective action
Temperature sensor for ECU faulty; Short circuit or wire break	▶ Check sensor and cabling, replace as necessary.

471 – SD Coil Current

ZKP-Number: 18.004.592

Cause	Corrective action
Control of HP fuel control block faulty; Short circuit or wire break	▶ Check sensor and cabling, replace as necessary.

473 – AL Wiring PWM_CM2

ZKP-Number: 18.004.593

Cause	Corrective action
Cable break or short circuit on channel PWM_CM2.	1. Check cabling. 2. Contact Service.

475 – AL CR Trigger Engine Stop

ZKP-Number: 18.010.009

Cause	Corrective action
Activated if the crash recorder was triggered due to an engine stop.	1. Determine cause of trigger/engine stop and rectify. 2. Contact Service.

476 – AL Crash Rec. Init. Error

ZKP-Number: 18.010.007

Cause	Corrective action
Crash recorder initialization error.	1. Check setting with DiaSys. 2. Contact Service.

482 – SD T-Exhaust C

ZKP-Number: 18.004.596

Cause	Corrective action
Exhaust temperature sensor on A-side faulty; Short circuit or wire break	▶ Check sensor and cabling (B4.23), replace as necessary.

483 – SD T-Exhaust D

ZKP-Number: 18.004.597

Cause	Corrective action
Exhaust temperature sensor on A-side faulty; Short circuit or wire break	▶ Check sensor and cabling (B4.24), replace as necessary.

492 – AL ETC4 CutIn Failure

ZKP-Number: 18.004.202

Cause	Corrective action
ETC4 could not be cut in.	▶ Check control valve on ETC 4.

493 – AL ETC3 CutIn Failure

ZKP-Number: 18.004.203

Cause	Corrective action
ETC3 could not be cut in.	▶ Check control valve on ETC 3.

500 – AL Wiring POM Starter 1

ZKP-Number: 14.500.900

Cause	Corrective action
A wiring fault was detected in the connection between starter 1 and POM. This may be a missing consumer, a wire break, or a short circuit.	▶ Check connection between POM and starter.

501 – AL Wiring POM Starter 2

ZKP-Number: 14.500.901

Cause	Corrective action
A wiring fault was detected in the connection between starter 2 and POM. This may be a missing consumer, a wire break, or a short circuit.	▶ Check connection between POM and starter.

502 – AL Open Load POM Alternator

ZKP-Number: 14.500.902

Cause	Corrective action
Open load was detected at the connection of the battery-charging generator on the POM.	▶ Check connection between POM and starter.

503 – AL Battery Not Charging

ZKP-Number: 14.500.903

Cause	Corrective action
The battery-charging generator does not charge the battery.	▶ Check battery-charging generator and cabling.

504 – AL CAN POM Node Lost

ZKP-Number: 14.500.904

Cause	Corrective action
POM missing on CAN bus.	▶ Check connection and POM. If alarm occurs in combination with alarm 508, the resistor in the POM cabling is missing.

506 – AL Low Starter Voltage

ZKP-Number: 14.500.906

Cause	Corrective action
battery voltage is too low to accomplish a starting procedure.	▶ Check battery-charging generator and cabling.

507 – AL POM Error

ZKP-Number: 14.500.907

Cause	Corrective action
A general POM error occurred.	▶ Replace POM.

508 – AL Wrong POM-ID

ZKP-Number: 14.500.908

Cause	Corrective action
POM transmits an unexpected ID number. If alarm occurs in combination with alarm 504, the resistor in the POM cabling is missing.	▶ Check POM wiring harness.

519 – Oillevel Calibration Error

ZKP-Number: 10.158.921

Cause	Corrective action
Error when writing the calibration value into the Flash or SD memory of the level sensor; associated PV: AL Group 6 Mot Bit 11	1. Check sensor and cabling, replace as necessary. 2. Contact Service.

525 – SD P-Lube Oil (R2)

ZKP-Number: 18.004.638

Cause	Corrective action
Redundant lube oil pressure sensor faulty; Short circuit or wire break	▶ Check sensor and cabling, replace as necessary.

526 – SD T-Coolant (R2)

ZKP-Number: 18.004.639

Cause	Corrective action
Redundant coolant temperature sensor faulty; Short circuit or wire break	▶ Check sensor and cabling, replace as necessary.

527 – TD EngineSpd. Sensor Deviation

ZKP-Number: 10.480.093

Cause	Corrective action
Maximum deviation of speed sensors	1. Check cabling of speed sensors. Observe additional messages. 2. Contact Service.

528 – SD Engine Speed 3rd Sensor

ZKP-Number: 12.500.102

Cause	Corrective action
Redundant crankshaft sensor faulty; Short circuit or wire break	▶ Check sensor and cabling, replace as necessary.

576 – AL ESCM Override

ZKP-Number: 11.075.083

Cause	Corrective action
Violation of corrected MCR or DBR/MCR curve. Engine overload!	▶ Reduce power.

577 – SD T-Lube Oil Pan

ZKP-Number: 10.137.900

Cause	Corrective action
Temperature sensor in oil pan defective; Short circuit or wire break	▶ Check sensor and cabling, replace as necessary.

582 – AL Emergency Stop Failed

ZKP-Number: 11.005.006

Cause	Corrective action
This alarm occurs if the engine fails to come to a standstill within a specified (by parametrization) a period of time after the emergency stop signal was output.	▶ The delay between the emergency stop signal and this alarm signal is set in parameter 1.1005.4.

588 – SD P-Oil Refill Pump

ZKP-Number: 10.159.910

Cause	Corrective action
Pressure sensor faulty; Short circuit or wire break	▶ Check sensor and cabling, replace as necessary.

596 – AL Develop PR Set

ZKP-Number: 18.004.645

Cause	Corrective action
The parameter set used is a test parameter set.	▶ The alarm remains active until a series-production parameter set was installed.

600 – SD T-Exhaust A+B

ZKP-Number: 18.004.646

Cause	Corrective action
SD T-Exhaust A and T-Exhaust B	▶ Check sensor and cabling, replace as necessary.

601 – SD ETC1+ETC2

ZKP-Number: 13.011.227

Cause	Corrective action
SD ETC1 and ETC2	▶ Check sensor and cabling, replace as necessary.

625 – SD P-Fuel before Prefilter

ZKP-Number: 18.004.600

Cause	Corrective action
Analog input signal for pressure before prefilter faulty; Short circuit or wire break	1. Check pressure sensor and cabling, replace as necessary. 2. Error cleared after restarting the engine.

7 Task Description

7.1 Engine

7.1.1 Engine - Barring manually

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

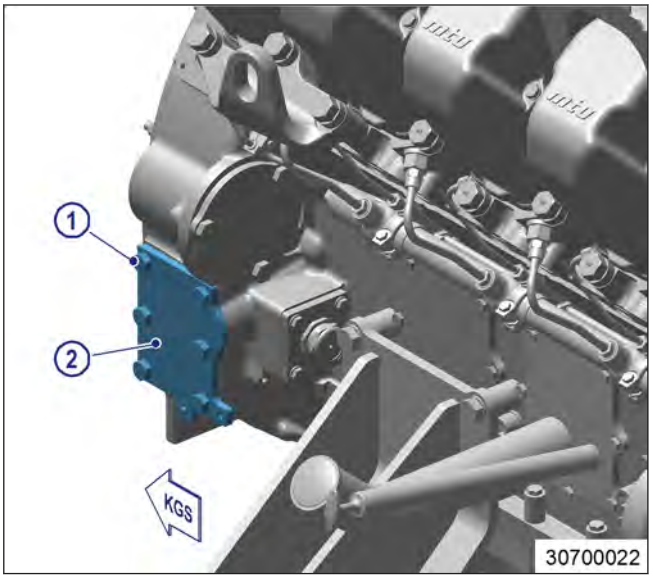
Designation / Use	Part No.	Qty.
Barring device	F6555766	1
Ratchet with extension	F30006212	1

DANGER

Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Before cranking the engine, make sure that there are no persons in the engine's danger zone.
- After finishing work on the engine, make sure that all safety devices are put back in place and all tools removed from the engine.

Barring engine manually

1. Release screws (1) and remove end cover (2) from flywheel housing.



TIM-ID: 0000000917 - 010

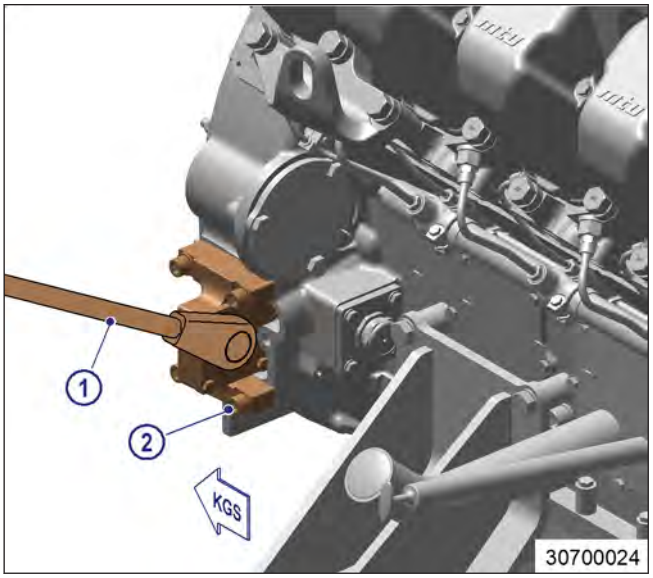
2. Engage barring device (2) in ring gear of flywheel and mount on flywheel housing.
3. Fit ratchet (1) onto barring device (2).

Note: No resistance other than compression resistance must be encountered.

4. Rotate crankshaft in engine direction of rotation.

Result: If the resistance exceeds the normal compression resistance, contact Service.

5. Barring device is removed by same procedure in reverse.



7.1.2 Engine - Barring with starting system

Barring using the automation system

Refer to automation system operating instructions

7.2 Cylinder Liner

7.2.1 Cylinder liner – Endoscopic examination

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Rigid endoscope	Y20097353	1

Preparatory steps

1. Remove cylinder head cover (→ Page 143).
2. Remove injector (→ Page 147).

Positioning crankshaft at BDC

1. Using barring gear, turn crankshaft until crankshaft journal of the cylinder to be inspected has reached BDC.
2. Insert endoscope into cylinder liner through injector seat.

Cylinder liner – Endoscopic examination

Findings	Action
• Thin carbon coating on circumference of carbon scraper ring • Slight localized additive deposits at top edge • Singular smooth areas at lower edge • Carbon deposits on circumference in clearance between top piston ring and bottom edge of carbon scraper ring • First signs of marks left by top piston ring • Bright mark on entire circumference • Consistent honing pattern without objections • First signs of marks left by lower cooling bores • Running pattern seems darker	No action required
• Dark areas with even or varying degrees of discoloration • Beginning and end of the discoloration are not sharply defined and do not cover the entire stroke area • Dark areas in the upper section of the cooling bore, remaining circumference without objections • Piston rings without objections	Further endoscopic examination required as part of maintenance work
• On the entire circumference, apart from light areas of discoloration (that do not impair operation) clearly darker stripes that start at the top piston ring • Heat discoloration in the direction of stroke and honing pattern damage • Heat discoloration of piston rings	Cylinder liner must be replaced; Service must be contacted

1. Compile endoscopy report using the table.
2. Use technical terms for description of the liner surface (→ Page 137).
3. Depending on findings:
   - do not take any action or
   - carry out a further endoscopic examination as part of maintenance work or
   - contact Service; cylinder liner must be replaced.

Final steps

1. Install injector (→ Page 147).
2. Install cylinder head cover (→ Page 143).

7.2.2 Instructions and comments on endoscopic and visual examination of cylinder liners

Terms used for endoscopic examination

Use the terms listed below to describe the condition of the cylinder-liner surface in the endoscopic examination report.

Findings	Explanations/Action
Minor dirt scores	Minor dirt scores can occur during the assembly of a new engine (honing products, particles, broken-off burrs). Removed cylinders clearly show such scoring on the running surface under endoscope magnification. Cannot be felt with the fingernail. Findings not critical.
Single scores	Clearly visible scores caused by hard particles. They usually start in the TDC area and cross through the hone pattern in the direction of stroke. Findings not critical.
Scored area	These areas consist of scores of different length and depth next to one another. In most cases, they are found at the 6-o'clock and 12-o'clock positions (inlet/ exhaust) along the transverse engine axis. Findings not critical.
Smoothened area	Smoothened areas are on the running surface but almost the whole honing pattern is still visible. Smoothened areas appear brighter and more brilliant than the surrounding running surface. Findings not critical.
Bright area	Bright areas are on the running surface and show local removal of the honing pattern. Grooves from honing process are not visible any more.
Discoloration	This is caused by oxidation (surface discoloration through oil or fuel) and temperature differences around the liner. It appears rather darker within the honed structure in contrast to the bright metallic running surface. The honing pattern is undisturbed. Discolorations extend in stroke direction and may be interrupted. Findings not critical.
Corrosion fields / spots	Corrosion fields / spots result from water (condensed water) with the valves in the overlap (open) position. They are clearly visible due to the dark color of the honing groove bottom. This corrosion is not critical unless there is corrosion pitting.
Black lines	Black lines are a step towards heat discoloration. They are visible as a clear discoloration from TDC to BDC in the running surface and the start of localized damage to the honing pattern. Cylinder liners with a large number of black lines around the running surface have limited service life and should be replaced.
Burn mark	This is caused by a malfunction in the liner / ring tribosystem. Usually they run over the whole ring-travel area (TDC/BDC), starting at the first TDC-ring and becoming more visible from the second TDC-ring 2 onwards and less pronounced from TDC-ring 1. The honing pattern is usually no longer visible and displays a clearly defined (straight) edge to the undisturbed surface. The damaged surface is usually discolored. The circumferential length varies. Liners with burn marks, or heat discoloration, starting in TDC-ring 1 have to be replaced.
Seizure marks, scuffing	Irregular circumference lengths and depths. Can be caused either by the piston skirt or the piston crown. Material deposits on the liner (smear), heavy discoloration. Severe, visible scoring. Replace liner.

Evaluation of findings and further measures

The findings in the start phase of oxidation discoloration and heat discoloration are similar. A thorough investigation and compliance with the above evaluation criteria allow an unambiguous evaluation. To avoid unnecessary disassembly work, it is recommended that another inspection be carried out after further operation of the engine.

7.3 Valve Drive

7.3.1 Valve gear - Lubrication

Preconditions

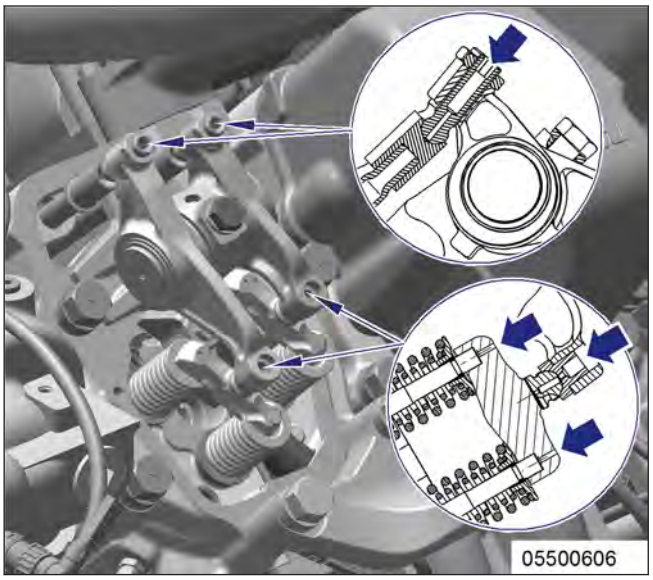
☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine oil		

Valve gear – Lubrication

1. Remove cylinder head covers (→ Page 143).
2. Fill oil chambers of valve bridges with oil.
3. Fill oil chambers of rocker arms and adjusting screws with oil.
4. Install cylinder head covers (→ Page 143).



7.3.2 Valve clearance – Check and adjustment

Preconditions

☑ Engine is stopped and starting disabled.

☑ Engine coolant temperature is max. 40 °C.

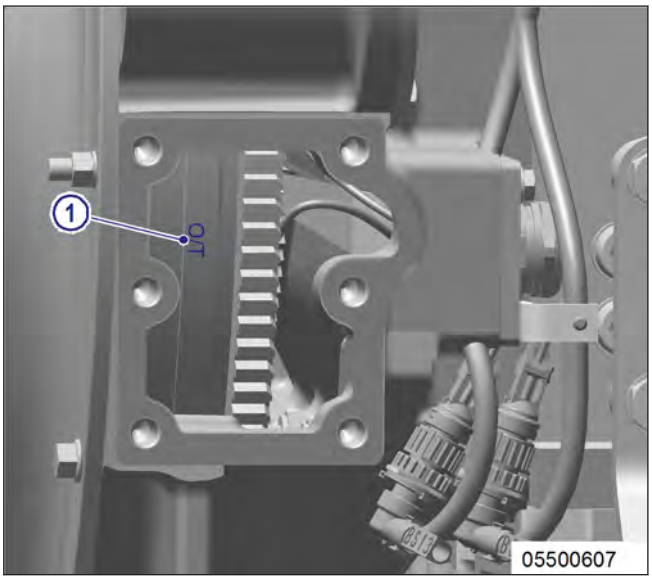
☑ Valves are closed.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Feeler gauge	Y20010128	1
Torque wrench, 60-320 Nm	F30047446	1
Socket wrench, 24 mm	F30039526	1
Engine oil		

Preparatory steps

1. Remove cylinder head cover (→ Page 143).
2. Install barring gear (→ Page 132).
3. The TDC mark (1) (if fitted) on the flywheel must not be used for reference.



4. Rotate crankshaft with barring tool in engine direction of rotation until marking 'TDC-A1' and pointer are aligned.

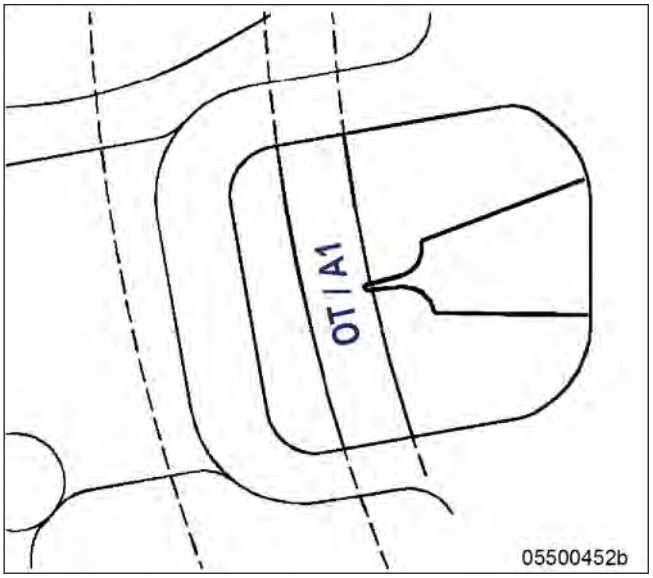


Diagram for 12V engines (two crankshaft positions)

1 Cylinder A1 is in firing TDC
2 Cylinder A1 is in overlap TDC
I Inlet valve
X Exhaust valve

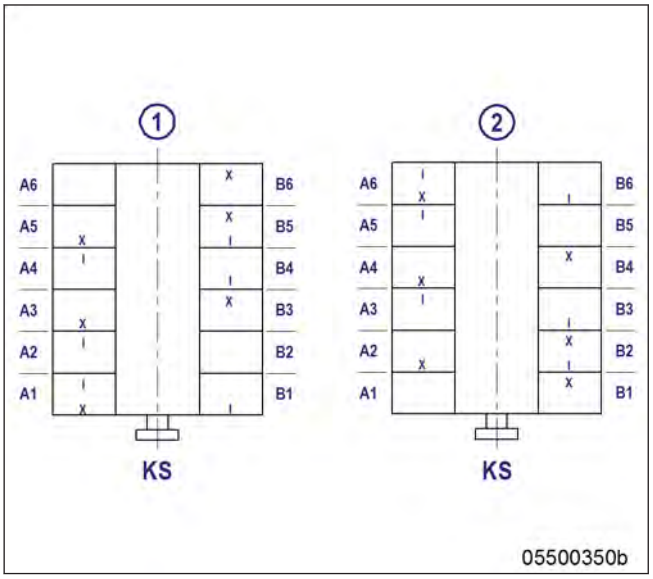
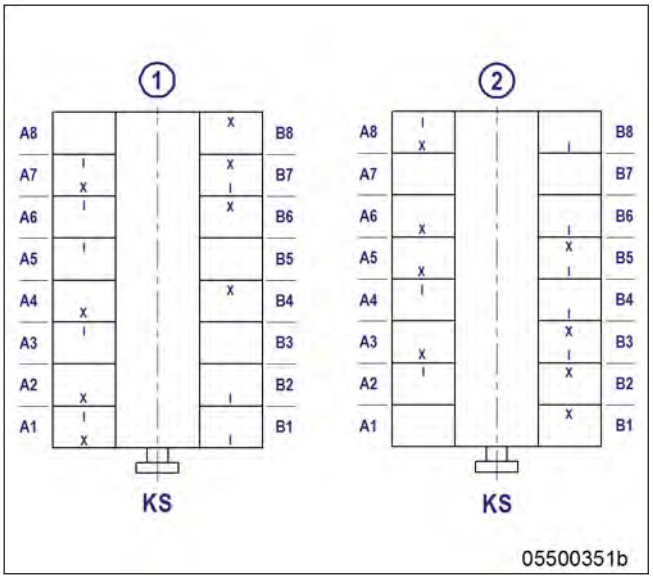


Diagram for 16V engines (two crankshaft positions)

1 Cylinder A1 is in firing TDC
2 Cylinder A1 is in overlap TDC
I Inlet valve
X Exhaust valve



Checking valve clearance in two crankshaft positions

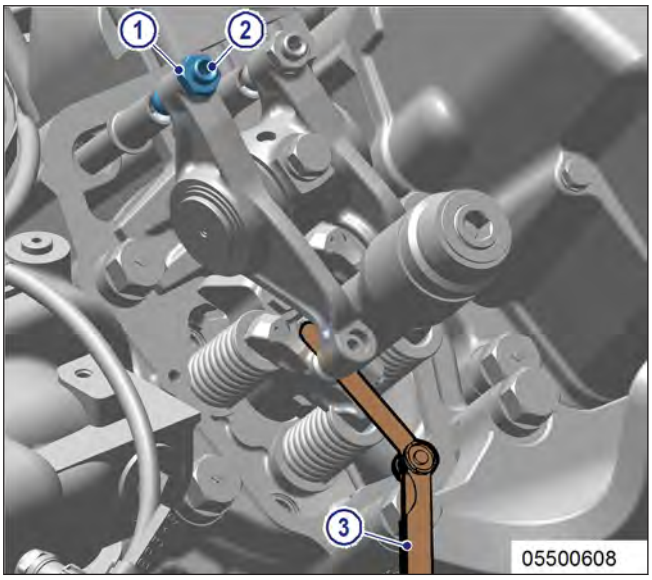
1. Check TDC position of piston in cylinder A1:
   - If the rocker arms are unloaded on cylinder A1, the piston is in firing TDC.
   - If the rocker arms are loaded on cylinder A1, the piston is in overlap TDC.
2. Check valve clearance with cold engine:
   - Inlet valves (long rocker arm) = 0.2 mm
   - Exhaust valves (short rocker arm) = 0.5 mm
3. Check all valve clearances at two crankshaft positions (firing and overlap TDC for cylinder A1) as per diagram.
4. Use feeler gauge to determine the distance between valve bridge and rocker arm.
5. If the deviation from the reference value exceeds 0.1 mm, adjust valve clearance.

Valve clearance adjustment

1. Release locknut (1).
2. Insert feeler gauge (3) between valve bridge and rocker arm.
3. Using Allen key, set adjusting screw (2) so that the specified valve clearance is provided.

Note: Feeler gauge must just pass through the gap.

4. Pull feeler gauge (3) between valve bridge and rocker arm.



5. Tighten locknut (1) to the specified tightening torque, holding adjusting screw (2) firmly.

Name	Size	Type	Lubricant	Value/Standard
Locknut	M16 x 1.5	Tightening torque	(Engine oil)	90 Nm + 9 Nm

6. Replace or rectify adjusting screws and/or locknuts which do not move freely.
7. Check valve clearance.

Final steps

1. Remove barring gear (→ Page 132).
2. Install cylinder head cover (→ Page 143).
3. Enable engine start.

7.3.3 Cylinder head cover - Removal and installation

Preconditions

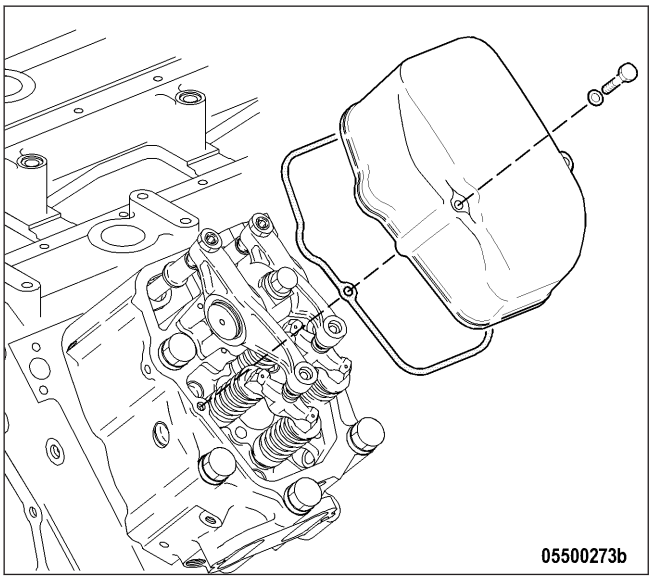
☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Gasket	(→ Spare Parts Catalog)	

Removing cylinder head cover

1. Clean very dirty cylinder head covers prior to removal.
2. Remove screws.
3. Remove cylinder head cover with gasket from cylinder head.



Installing cylinder head cover

1. Clean mating face.
2. Check condition of gasket, replace if necessary.
3. Place gasket and cylinder head cover on cylinder head.
4. Install cylinder head cover.

7.4 Injection Pump / HP Pump

7.4.1 HP pump - Filling with engine oil

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine oil		

WARNING

Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

WARNING

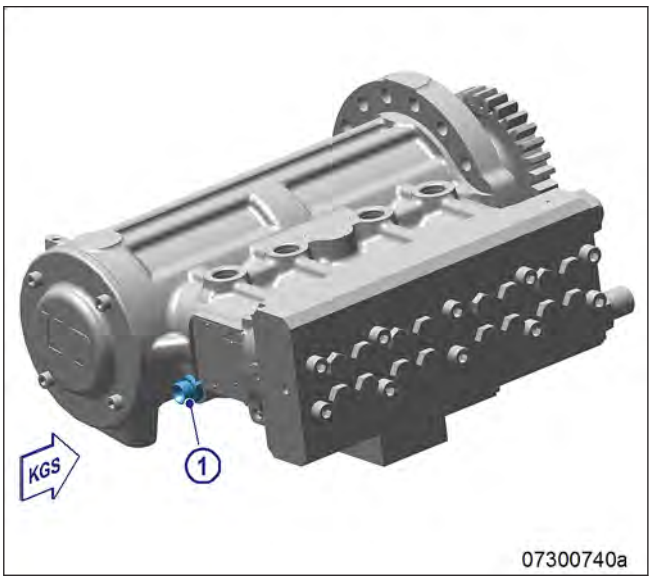
Oils/oil vapors are combustible/explosive.
Risk of fire and explosion!
- Avoid open flames, electric sparks and ignition sources.
- Do not smoke.

NOTICE

HP fuel pump not filled with engine oil.
Damage to components, major material damage!
- Ensure that th HP fuel pump is filled with engine oil before it is installed or put into operation.

Filling HP pump

1. Remove plug screw (1).
2. Use pump oiler to fill HP pump with engine oil until engine oil emerges.
3. Install plug screw (1).



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7.4.2 HP pump – Relief bore check

DANGER

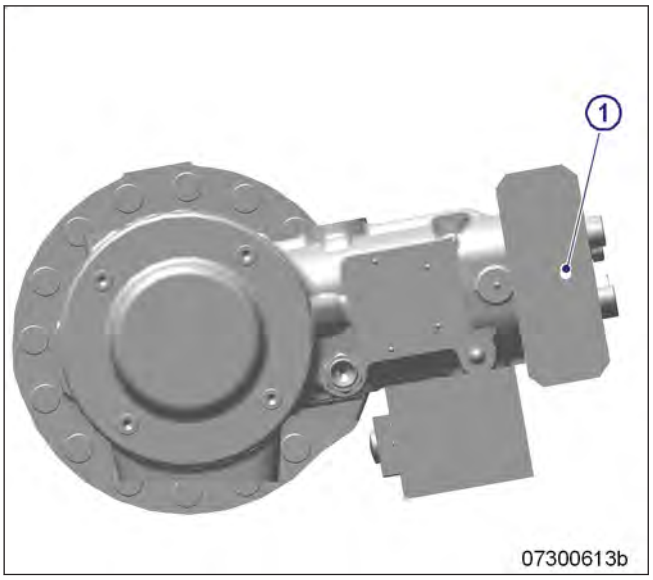
Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING

High level of engine noise when the engine is running.
Risk of damage to hearing!
- Wear ear protectors.

HP pump – Relief bore check

1. Visually inspect relief bore (1) for fuel discharge.
2. For jacketed HP lines, leakage is indicated by the yellow combined alarm.
3. If fuel discharge is found or indicated, contact Service.



7.5 Injection Valve / Injector

7.5.1 Injector - Replacement

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Injector	(→ Spare Parts Catalog)	

Replacing injector

▶ Remove injector and install new injector (→ Page 147).

7.5.2 Injector - Removal and installation

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Installation/removal tool	F6789889	1
Milling cutter	F30452739	1
Torque wrench, 0.5-5 Nm	0015384230	1
Torque wrench, 10-60 Nm	F30452769	1
Ratchet	F30027340	1
Torque wrench, 60-320 Nm	F30452768	1
Ratchet	F30027341	1
Assembly paste (Optimoly Paste White T)	40477	1
Grease (Kluthe Hakuform 30-10/Emulgier)	X00029933	1
Engine oil		
O-ring	(→ Spare Parts Catalog)	

WARNING

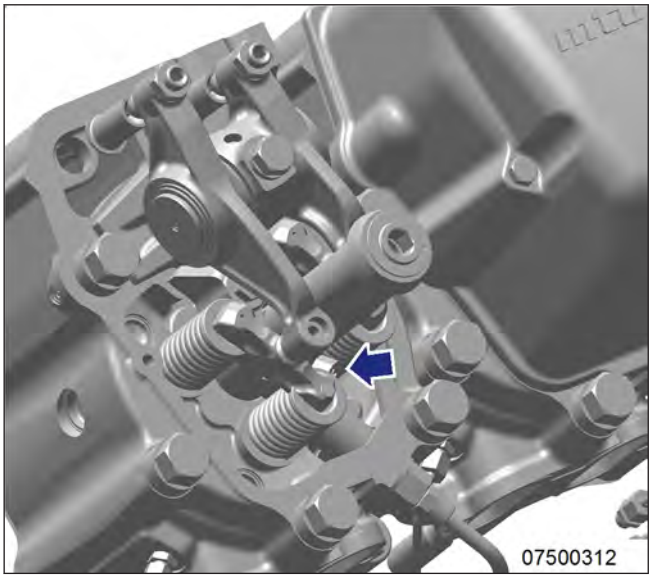
Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Preparatory steps

1. Shut off fuel supply to engine.
2. Remove cylinder head cover (→ Page 143).

Removing injector

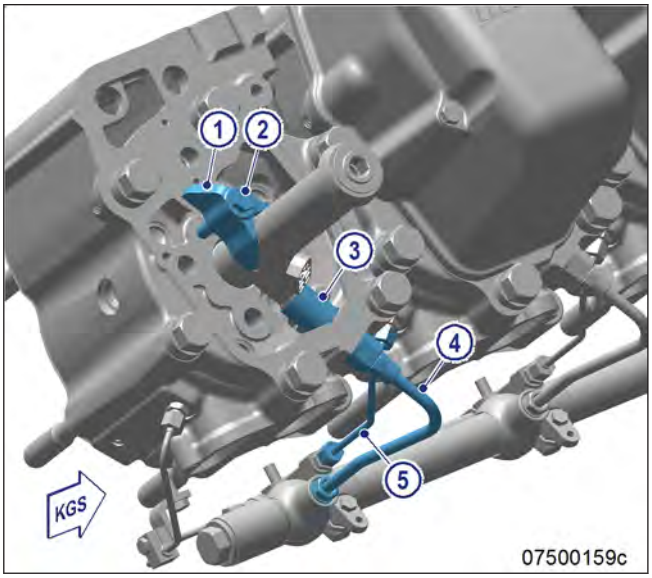
1. Disconnect connectors on injector.



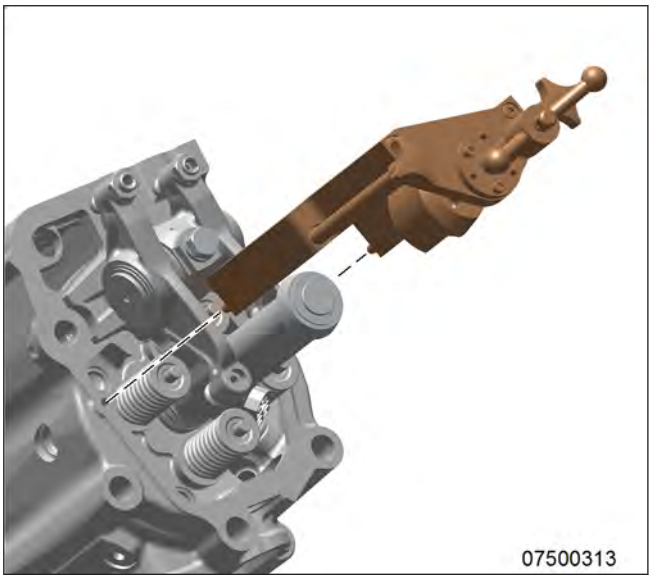
2. Remove HP fuel line (4).
3. Remove return line (5).

Note: While the adapter is removed, the injector is drained.

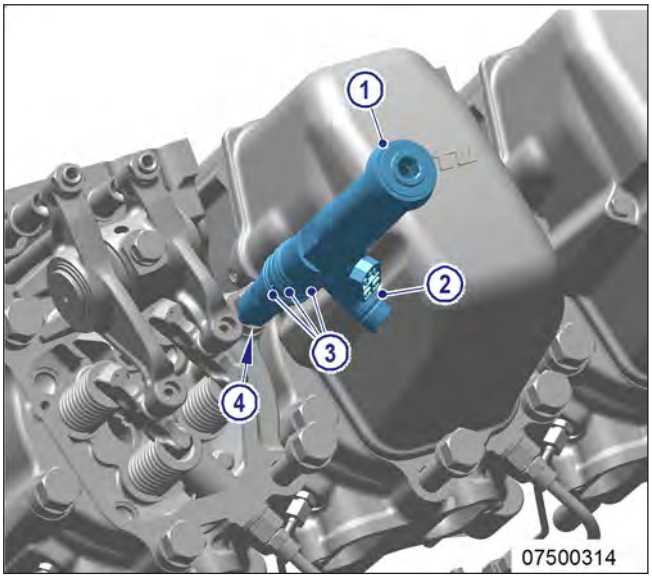
4. Remove adapter (3).
5. Remove screw (2) and take off hold-down clamp (1).



6. Install installation/removal tool on cylinder head.
7. Remove injector with installation/removal tool.
8. Remove installation/removal tool.

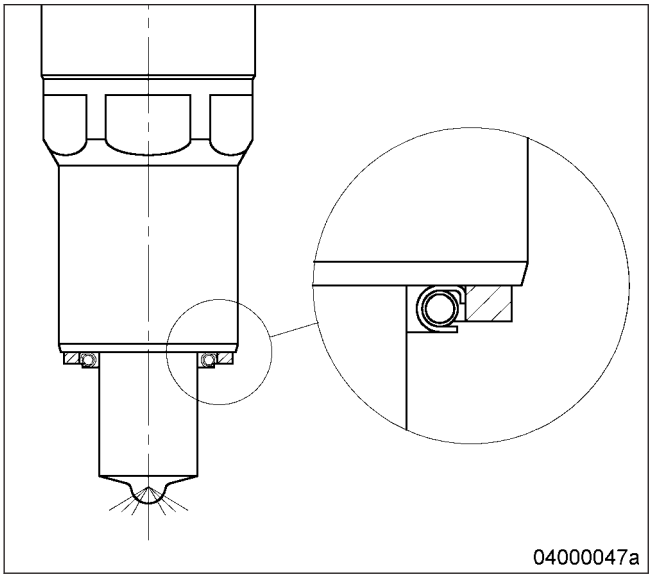


9. Remove sealing ring (4) from injector or use a self-made hook to take it out of the cylinder head.
10. Remove O-rings (3), O-ring (2) and damper ring (1) from injector.
11. Clean all mating and sealing surfaces.
12. Cover all connections and bores, or seal with suitable plugs.

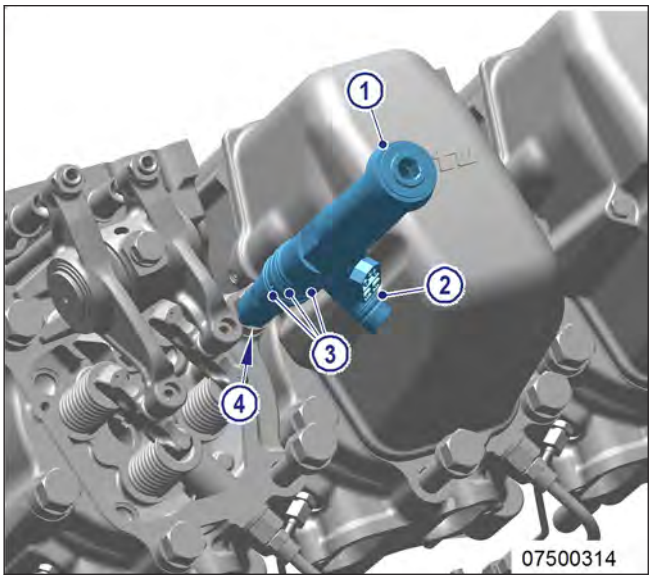


Installing injector

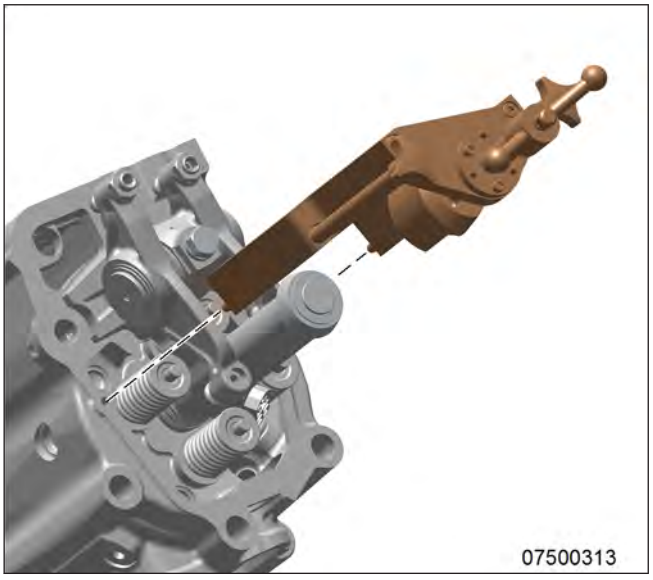
1. Remove plug before installing the injector. (Do not remove the plug from the HP line before installing the adapter.)
2. Coat injector with assembly paste at the seat of the nozzle retaining nut.
3. Fit new sealing ring (included in the scope of supply of the injector) with grease on injector, observe installation position of sealing ring.



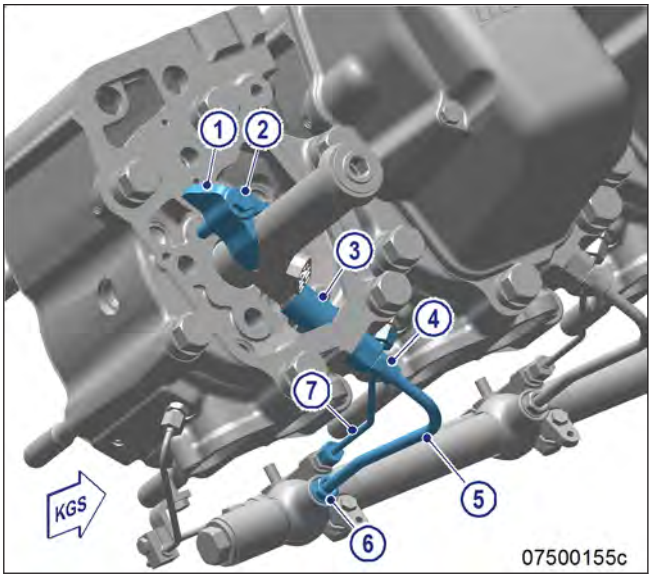
4. Fit new O-rings (3) (included in the scope of supply of the injector), O-ring (2) and damping ring (1) onto the injector and coat with grease.
5. Remove oil carbon from sealing face on cylinder head and protective sleeve with milling cutter.
6. Insert injector into cylinder head, ensuring that the HP line adapter is correctly aligned.



7. Press in injector with installation/removal tool.
8. Remove installation/removal tool.



9. Coat bolt mating face (2) and thread with engine oil.



10. Fit hold-down clamp (1) in the correct position and use torque wrench to tighten screw (2) to the specified initial tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw	M12	Preload torque	(Engine oil)	5 Nm to 10 Nm

Note: Ensure special cleanness.

11. Coat thread and sealing cone of adapter (3) with engine oil.

12. Install adapter (3) and use torque wrench to tighten to the specified initial tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Adapter		Preload torque	(Engine oil)	5 Nm to 10 Nm

13. Tighten screw (2) with torque wrench to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw	M12	Tightening torque		100 Nm + 10 Nm

14. Tighten adapter (3) with torque wrench to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Adapter		Tightening torque		100 Nm + 10 Nm

15. Install return line (7).

Note: Ensure special cleanness.

16. Coat thread and sealing cone of HP line (5) with engine oil.

Note: Two HP line versions (single- and double-walled) with different torques as described below.

17. Mount single-walled HP line (5) and use torque wrench to tighten to the specified torque. Tightening sequence:
    1 Rail (6)
    2 Adapter (4)

Name	Size	Type	Lubricant	Value/Standard
Union nut / thrust screw		Tightening torque		30 Nm + 5 Nm

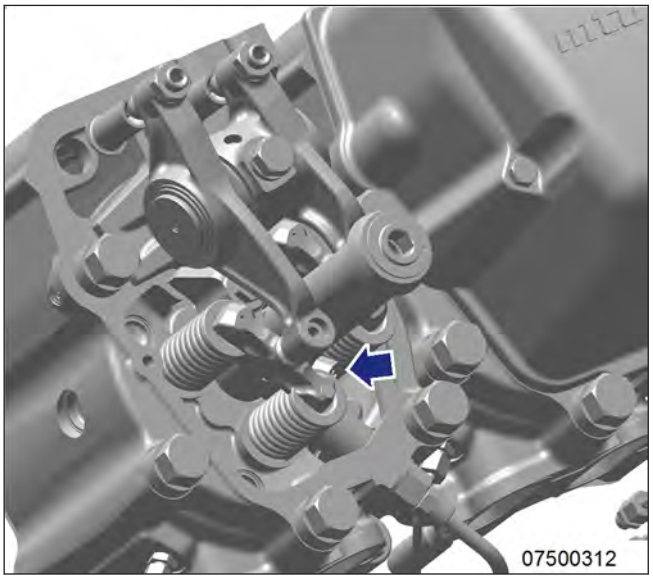
18. Mount double-walled HP line (5) and use torque wrench to tighten to the specified torque. Tightening sequence:
    1 Adapter (4)
    2 Rail (6)

Name	Size	Type	Lubricant	Value/Standard
Union nut / thrust screw		Tightening torque		40 Nm + 5 Nm

19. Fit connectors on injector.

Note: Failure to reset drift compensation (CDC) will void the emissions certification.

20. Reset drift compensation (CDC) with DiaSys® (→ E531920/...). If DiaSys® is not available, contact Service.

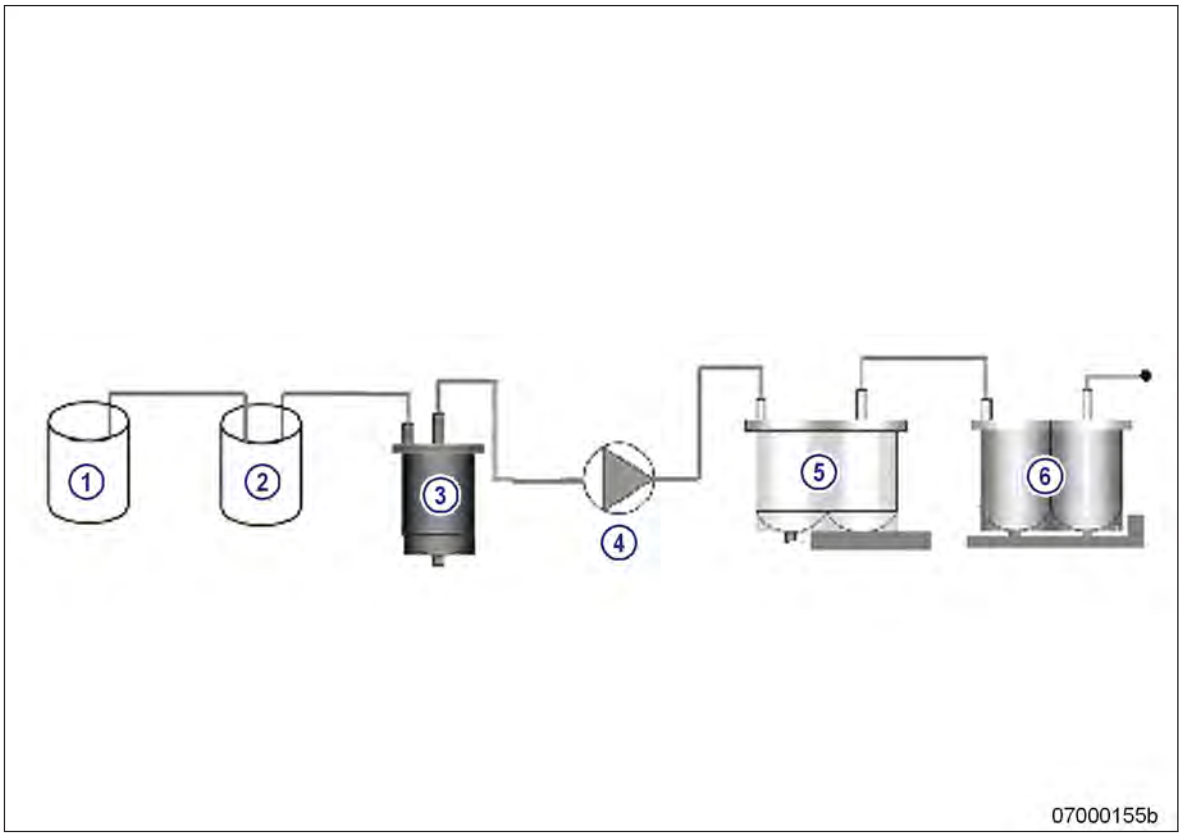


Final steps

1. Install cylinder head cover (→ Page 143).
2. Open fuel supply to engine.

7.6 Fuel Filter

7.6.1 Supplementary fuel filter – Overview



1 Storage tank
2 Day tank
3 Passive standard prefilter with water separator
4 LP pump
5 Supplementary fuel filter
6 Main engine filter

7.6.2 Additional fuel filter - Replacement

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Filter wrench	F30379104	1
Diesel fuel		
Easy-change filter	(→ Spare Parts Catalog)	
Synthetic ring	(→ Spare Parts Catalog)	

DANGER

Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING

Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

WARNING

High level of engine noise when the engine is running.
Risk of damage to hearing!
- Wear ear protectors.

NOTICE

Damage to component!
Severe material damage!
- For filter replacement with the engine running, operate the engine at low engine load.
- The filter which is to be replaced must be cut out for a brief period only.

Additional fuel filter – Replacement

1. Replace additional fuel filter with the engine stopped (→ Page 154).
2. Replace additional fuel filter with the engine running (→ Page 154).

7.6.3 Fuel filter - Replacement

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Filter wrench	F30379104	1
Diesel fuel		
Easy-change filter	(→ Spare Parts Catalog)	
Synthetic ring	(→ Spare Parts Catalog)	

DANGER

Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING

Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

WARNING

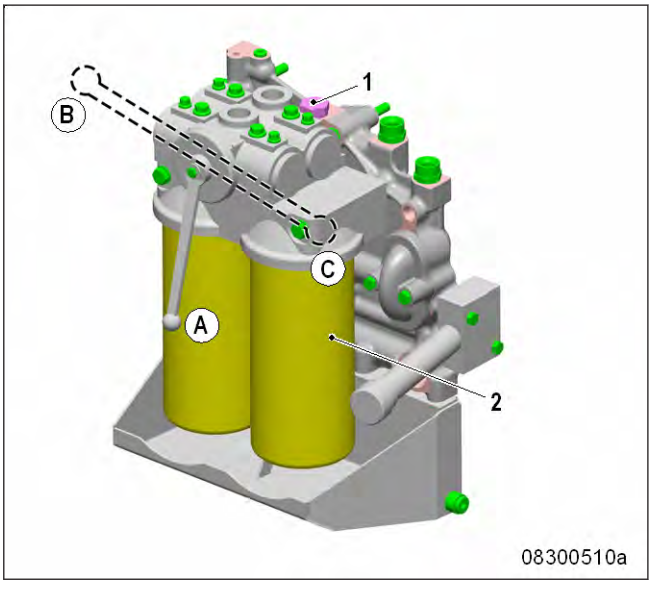
High level of engine noise when the engine is running.
Risk of damage to hearing!
- Wear ear protectors.

NOTICE

Damage to component!
Severe material damage!
- For filter replacement with the engine running, operate the engine at low engine load.
- The filter which is to be replaced must be cut out for a brief period only.

Replacing fuel filter with the engine stopped

A Both filters cut in
B Left filter cut out
C Right filter cut out
1 Fuel vent
2 Fuel filter



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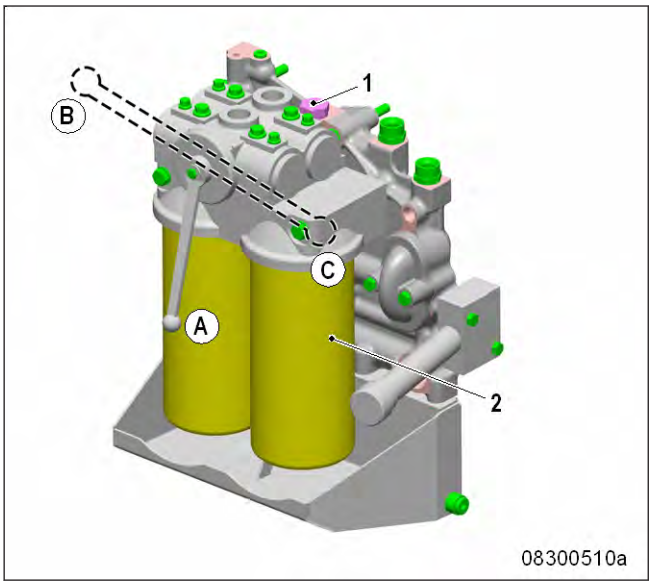
1. Cut out the filter to be replaced.
2. Unscrew cut-out easy-change filter with filter wrench.
3. Clean sealing surface on filter head.
4. Check seal on new easy-change filter and moisten with fuel.
5. Fit SOLAS shield (→ Page 15).
6. Screw on easy-change filter and tighten by hand.
7. Set three-way cock to normal operating position (both filters cut in).
8. Replace other fuel filters in the same way.
9. Vent fuel system (1).

Replacing fuel filter with the engine running

1. Cut out the filter to be replaced.
2. Unscrew cut-out easy-change filter with filter wrench.
3. Clean sealing surface on filter head.
4. Check seal on new easy-change filter and moisten with fuel.
5. Fit SOLAS shield (→ Page 15).
6. Screw on easy-change filter and tighten by hand.
7. Set three-way cock to normal operating position (both filters cut in).
8. Replace other fuel filters in the same way.



7.6.4 Fuel prefilter – Differential pressure check and adjustment of gauge

DANGER

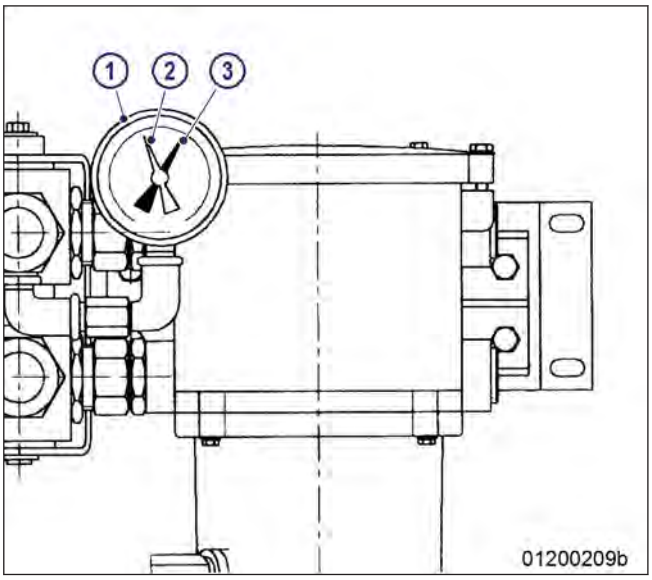
Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING

High level of engine noise when the engine is running.
Risk of damage to hearing!
- Wear ear protectors.

Setting adjustable pointer of differential pressure gauge

1. After installation of a new filter element, align adjustable pointer (2) with pressure-indicating pointer (3) of pressure gauge (1).
2. Verify that differential pressure is within the limit.



Fuel prefilter – Checking differential pressure

1. With the engine running at full load or rated power, read off pressure at gauge (1).
2. If differential pressure as indicated between position of adjustable pointer (2) and pressure-indicating pointer (3) of pressure gauge is ≥ 0.3 bar, flush filter element of the cut-in filter (→ Page 159).

7.6.5 Fuel prefilter - Draining

Preconditions

☑ Engine is stopped and starting disabled.

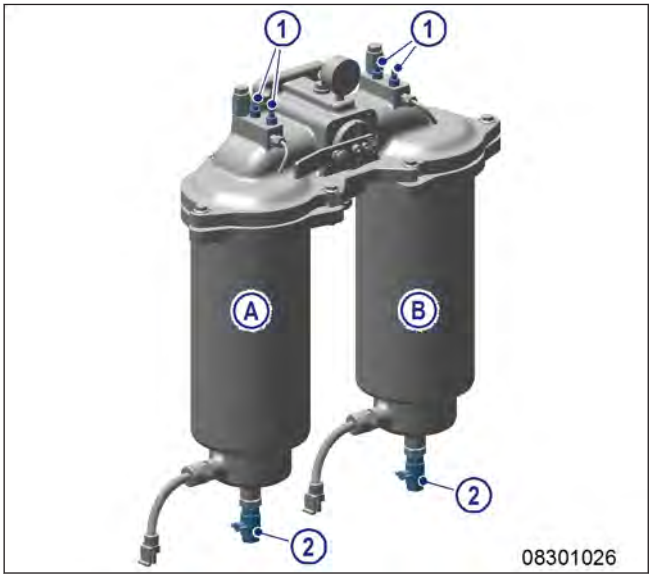
WARNING

Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

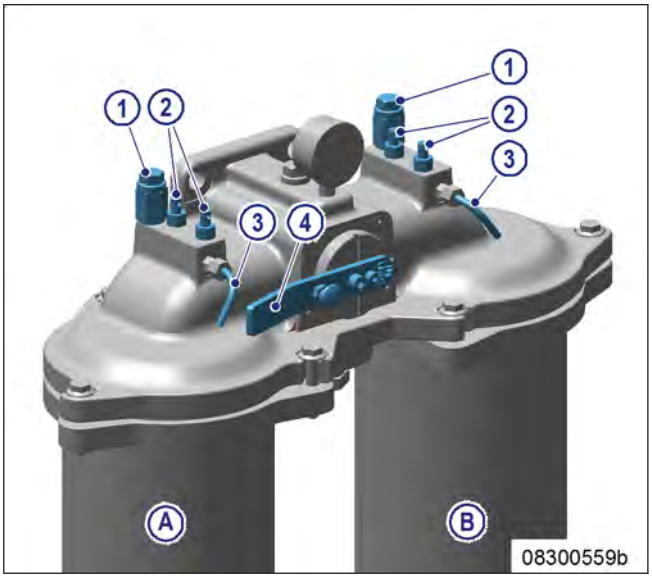
Draining fuel prefilter

1. Cut out the filter to be replaced (A or B).
   1 Filter A cut out
   2 Filter B cut out

2. Open vent plug (1) of filter to be drained.
3. Open drain valve (2).
4. Drain water and contaminants from filter until pure fuel emerges.
5. Close drain cock (2).



6. Connect filling pump to filling connection (1) on the suction side of the filter.
7. Open vent valve (2) and fill with fuel until fuel emerges from the vent pipe (3).
8. Close vent valve (2).
9. Open rotary slide valve (4) a little (by approx. 30°) and open vent valve(s) (2), until fuel emerges from the vent pipe (3).
10. Close vent valve(s) (2).
11. Turn rotary slide valve (4) back to locked position.



7.6.6 Fuel prefilter - Flushing

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Diesel fuel		

DANGER

Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING

Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

WARNING

High level of engine noise when the engine is running.
Risk of damage to hearing!
- Wear ear protectors.

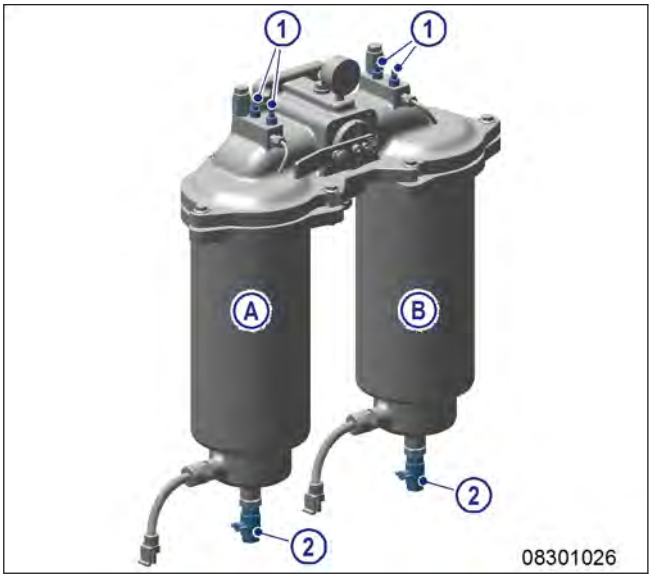
Flushing fuel prefilter

1. Cut out dirty filter.
   1 Filter A cut out
   2 Filter B cut out

2. Open vent plug (1) of filter to be flushed.
3. Open drain valve (2) and drain fuel.

Result: Fuel flows from filtered side back to the unfiltered side, flushing the filter deposits downwards out of the filter.

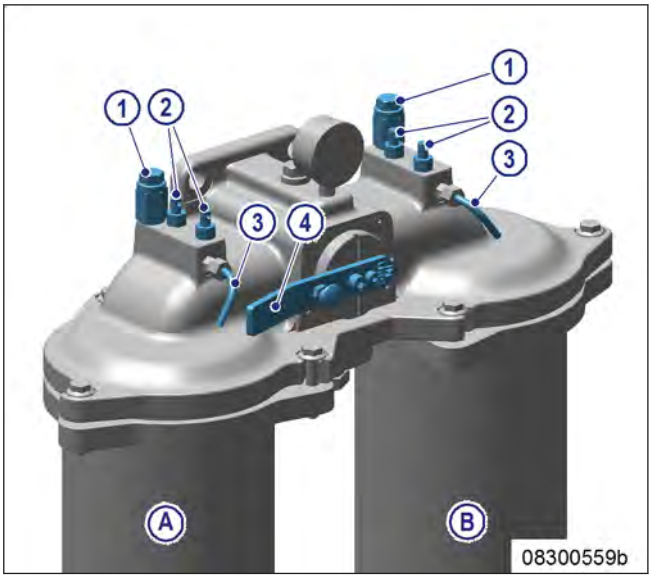
4. Close vent plug (1) and drain valve (2).



Fuel prefilter – Filling with fuel

1. Stop engine (→ Page 95) and disable engine start.
2. Connect filling pump to filling connection (1) on the suction side of the filter.
3. Open vent valve (2) and fill with fuel until fuel emerges from the vent pipe (3).
4. Close vent valve (2).
5. Open rotary slide valve (4) a little (by approx. 30°) and open vent valve(s) (2), until fuel emerges from the vent pipe (3).
6. Close vent valve(s) (2).
7. Turn rotary slide valve (4) back to locked position.
8. Check differential pressure (→ Page 156).

Result: Replace filter element in fuel prefilter (→ Page 161) if flushing did not improve differential pressure.



7.6.7 Fuel prefilter with water separator - Filter element replacement

Preconditions

☑ Engine is stopped and starting disabled.

☑ System is at atmospheric pressure.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 10-60 Nm	F30510423	1
Ratchet adapter	F30027340	1
Filter element	(→ Spare Parts Catalog)	
O-ring	(→ Spare Parts Catalog)	

WARNING

Tank is pressurized.
Risk of eye injuries resulting from fluid escaping under high pressure!
- Open tank slowly.
- Wear goggles or safety mask.

WARNING

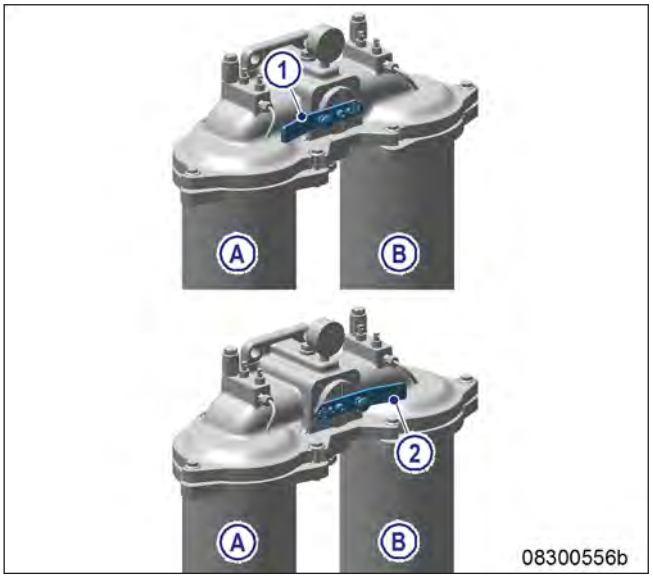
Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

WARNING

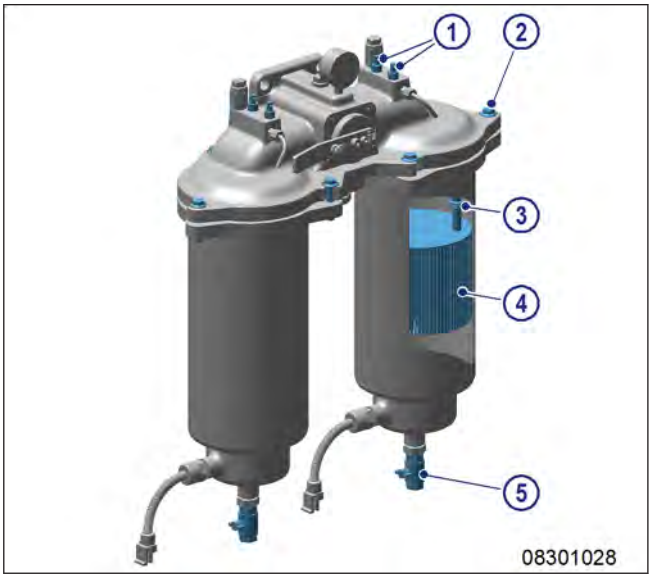
Component is hot.
Risk of burning!
- Wear protective gloves.

Fuel prefilter with water separator – Filter element replacement

1. Cut out the filter to be replaced (A or B).
   1 Filter A cut out
   2 Filter B cut out



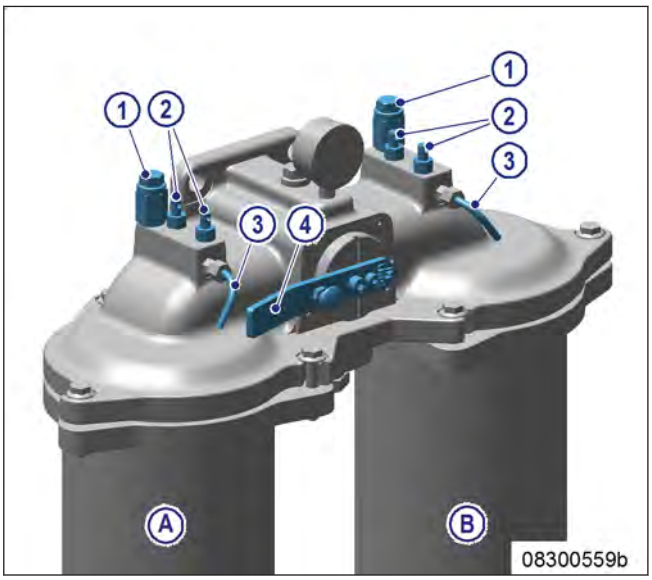
2. Open vent valve (1) of the filter to be replaced.
3. Open drain valve (5) and drain fuel.
4. Loosen screws (3) and screw out filter housing (A or B).
5. Remove filter element (4).
6. Insert new filter element in filter housing.
7. Fit O-ring.
8. Reinstall filter housing (A or B) with filter element (4).



9. Tighten screws (6 or 3) to specified torque (max. half a turn per screw) using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque		40 Nm

10. Connect filling pump to filling connection (1) on the suction side of the filter.
11. Open vent valve (2) and fill with fuel until fuel emerges from the vent pipe (3).
12. Close vent valve (2).
13. Open rotary slide valve (4) a little (by approx. 30°) and open vent valve(s) (2), until fuel emerges from the vent pipe (3).
14. Close vent valve(s) (2).
15. Turn rotary slide valve (4) back to locked position.



7.7 Exhaust Turbocharger

7.7.1 Compressor wheel - Cleaning

Preconditions

☑ Engine is stopped and starting disabled

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 10-60 Nm	F30452769	1
Ratchet adapter	F30027340	1
Cleaning agent	40377	1
Engine oil		
Engine coolant		
Sealing rings	(→ Spare Parts Catalog)	3
Sealing rings	(→ Spare Parts Catalog)	4

WARNING

Chemical substances.
Risk of irritation and chemical burns!
- Always obey manufacturer's instructions for use!

CAUTION

Incorrect installation of components and lines.
Damage to component!
- Ensure that components/lines are installed so that they are never under tension or strain.
- Ensure correct installation position of components.

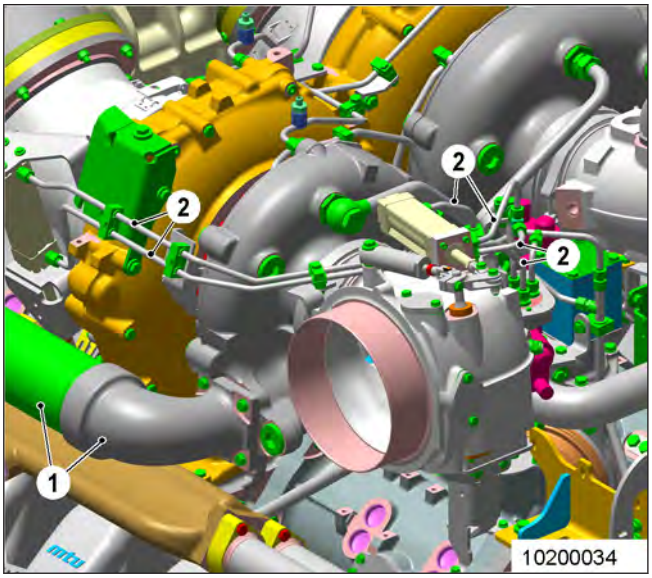
CAUTION

Unsuitable cleaning tool.
Damage to component!
- Observe manufacturer's instructions.
- Use appropriate cleaning tool.

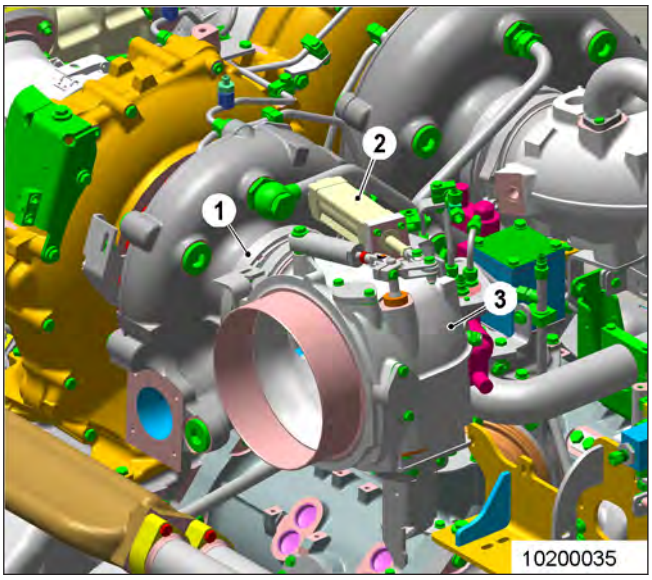
Preparatory steps – Horizontal air intake

1. Drain engine coolant (→ Page 194).
2. Remove air filter (→ Page 173).
3. Seal all openings with suitable covers.

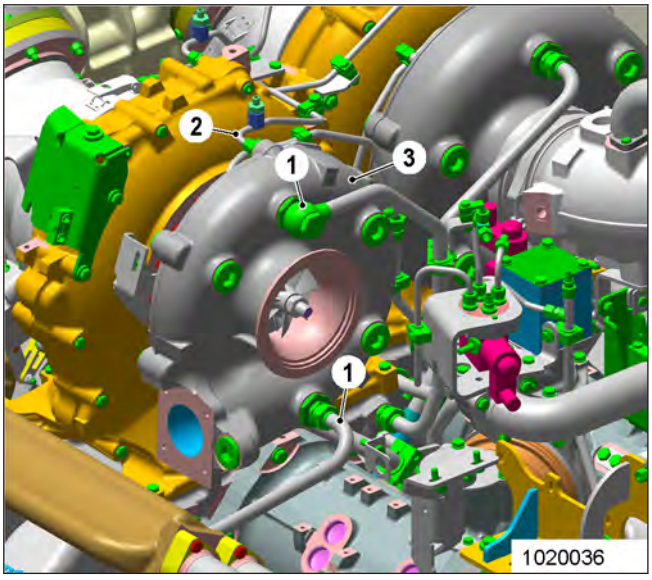
4. Remove charge-air pipework (1) from exhaust turbocharger to intercooler.
5. Remove oil lines (2).



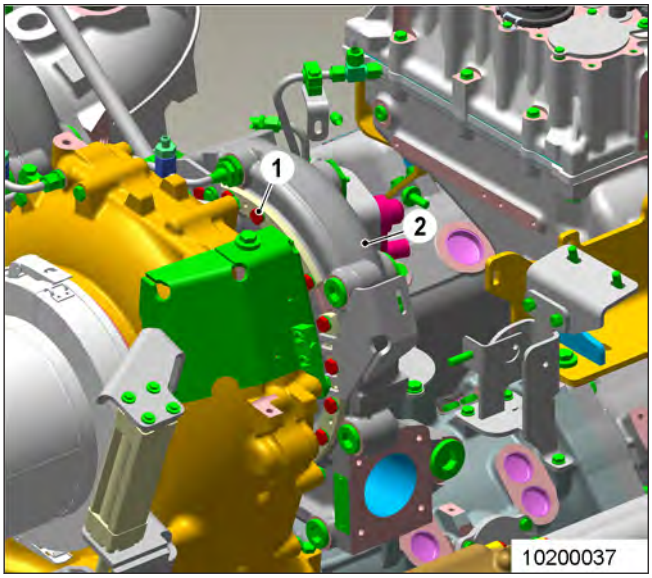
6. Loosen clamp (1).
7. Remove intake housing (3) with actuating cylinder (2).



8. Remove coolant lines (1) from compressor housing (3).
9. Remove coolant ventilation line (2) from compressor housing (3).



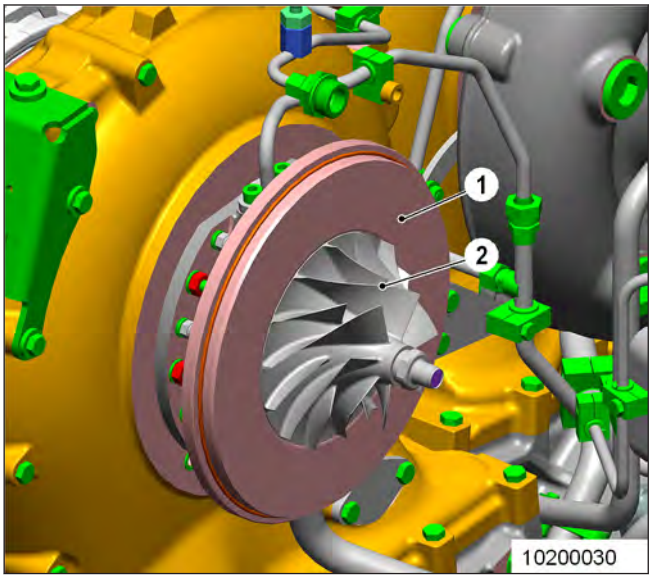
10. Undo screws (1).
11. Remove compressor housing (2).



Cleaning compressor wheel

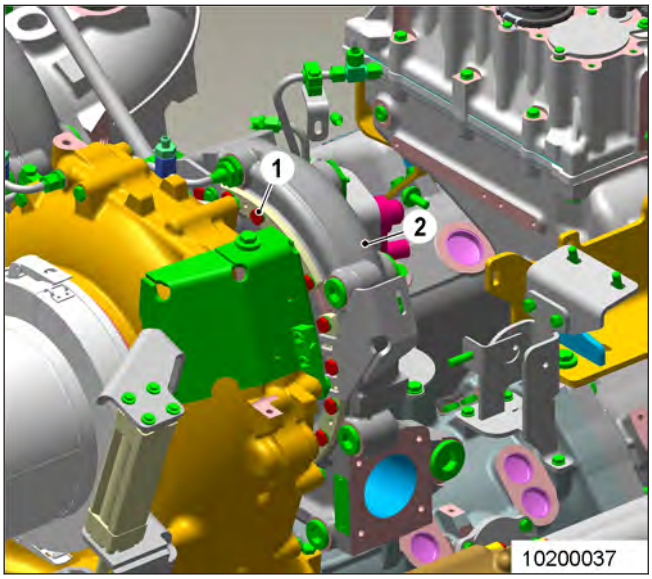
Note: Do not use wire brush, scraper or similar tools for cleaning!

1. Clean compressor housing with a smooth paint brush or brush.
2. Clean compressor wheel (2) and bearing housing (1).
3. Thoroughly remove cleaner from all components.
4. Fit new sealing rings between bearing housing/compressor housing and plug-in sleeves if necessary.



Final steps – Horizontal air intake

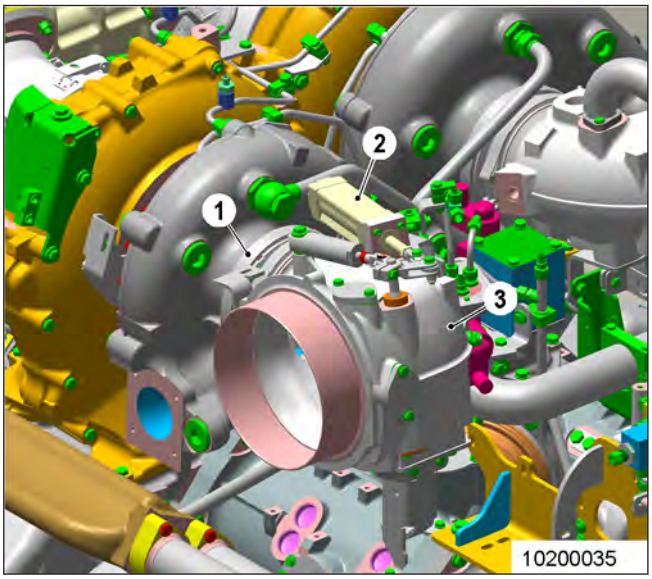
1. Install compressor housing (2).



2. Tighten screws (1) to specified torque using a torque wrench.

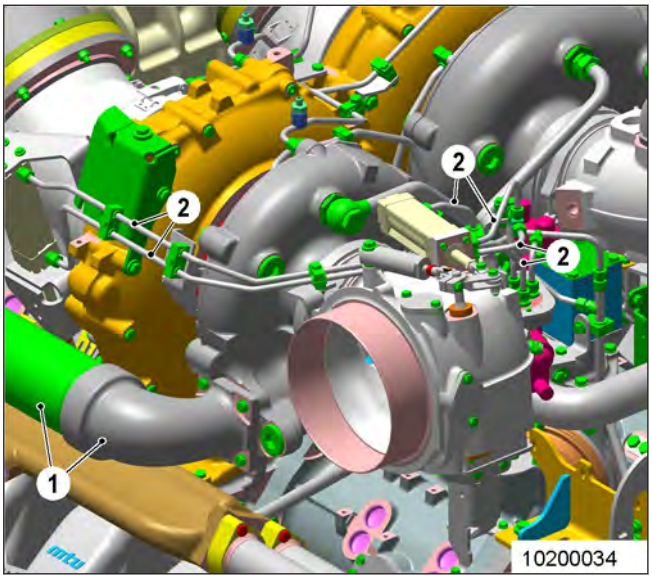
Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque	(Engine oil)	20 Nm + 2.5 Nm

3. Install coolant ventilation line and coolant lines on compressor housing.
4. Install intake housing (3) with actuating cylinder (2).



5. Align clamp (1) and tighten to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Clamp		Tightening torque		15 Nm + 2 Nm



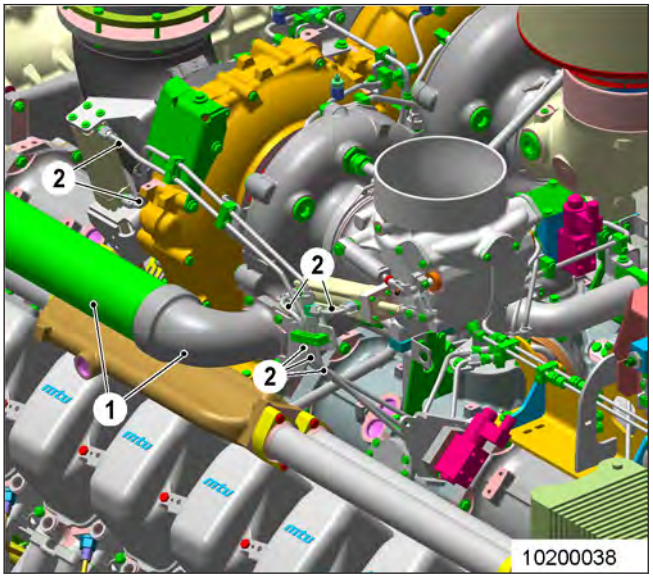
6. Install oil lines (2). Tighten threaded adapter at actuating cylinder to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Threaded adapter	10 G 1/4 A	Tightening torque	(Engine oil)	40 Nm + 4 Nm

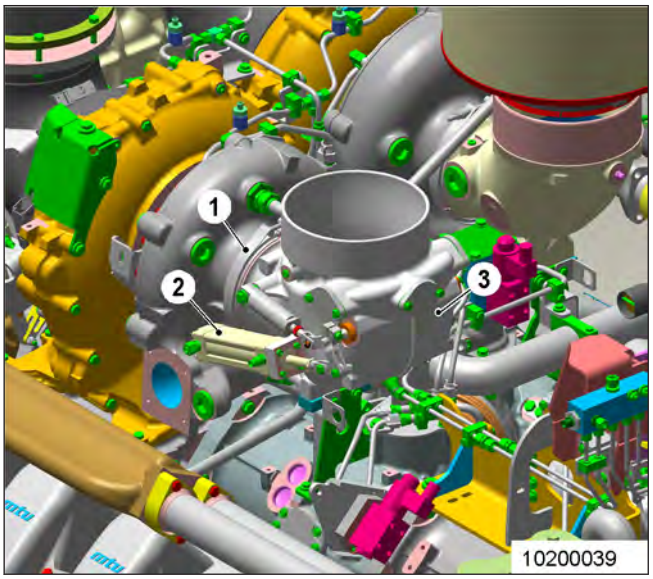
7. Install charge-air pipework (1) between exhaust turbocharger and intercooler.
8. Install air filter (→ Page 173).
9. Fill with engine coolant (→ Page 197).

Preparatory steps – Vertical air intake

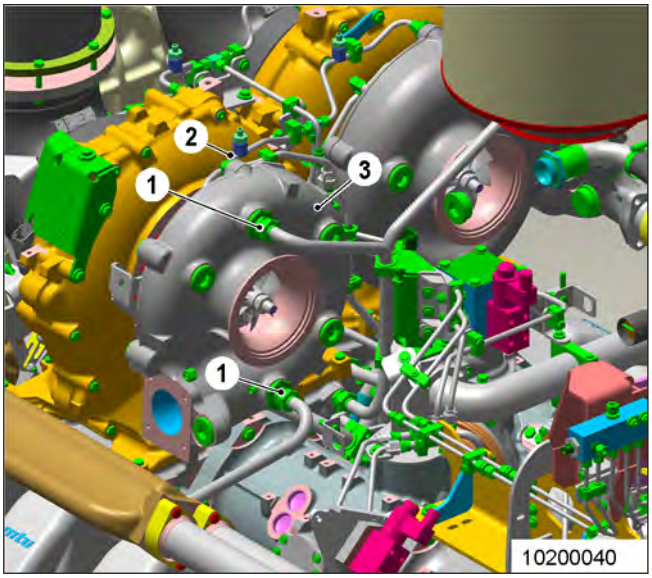
1. Drain engine coolant (→ Page 194).
2. Remove air filter (→ Page 173).
3. Seal all openings with suitable covers.
4. Remove charge-air pipework (1) from exhaust turbocharger to intercooler.
5. Remove oil lines (2).



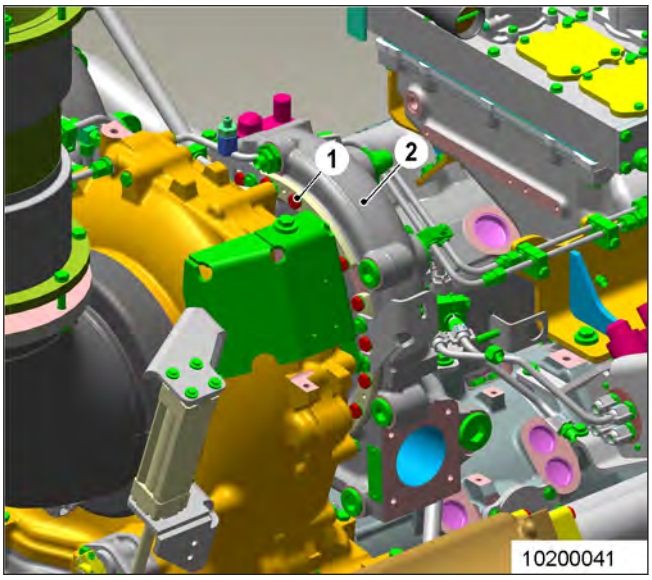
6. Loosen clamp (1).
7. Remove intake housing (3) with actuating cylinder (2).



8. Remove coolant lines (1) from compressor housing (3).
9. Remove coolant ventilation line (2) from compressor housing (3).



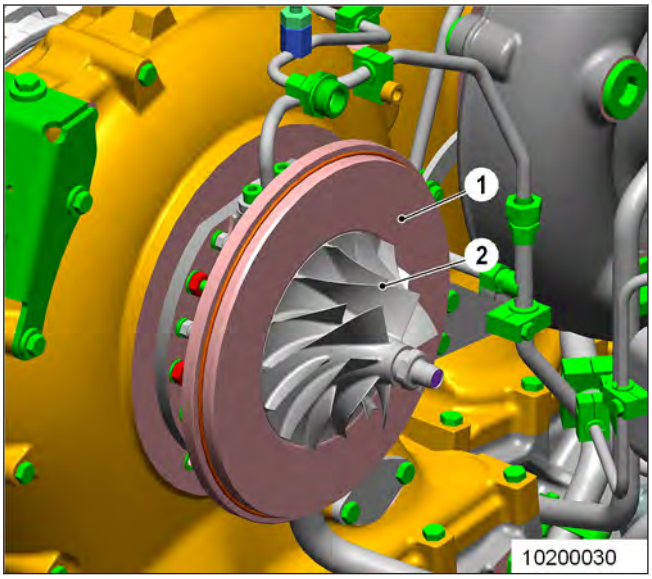
10. Undo screws (1).
11. Remove compressor housing (2).



Cleaning compressor wheel

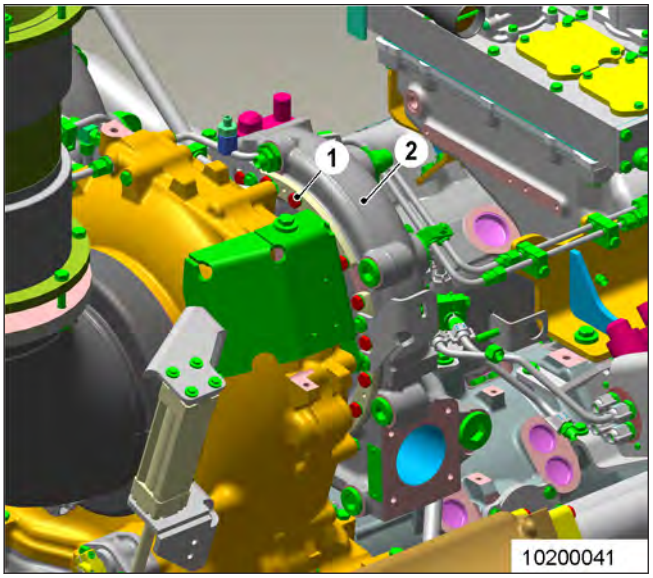
Note: Do not use wire brush, scraper or similar tools for cleaning!

1. Clean compressor housing with a smooth paint brush or brush.
2. Clean compressor wheel (2) and bearing housing (1).
3. Thoroughly remove cleaner from all components.
4. Fit new sealing rings between bearing housing/compressor housing and plug-in sleeves if necessary.



Final steps – Vertical air intake

1. Install compressor housing (2).

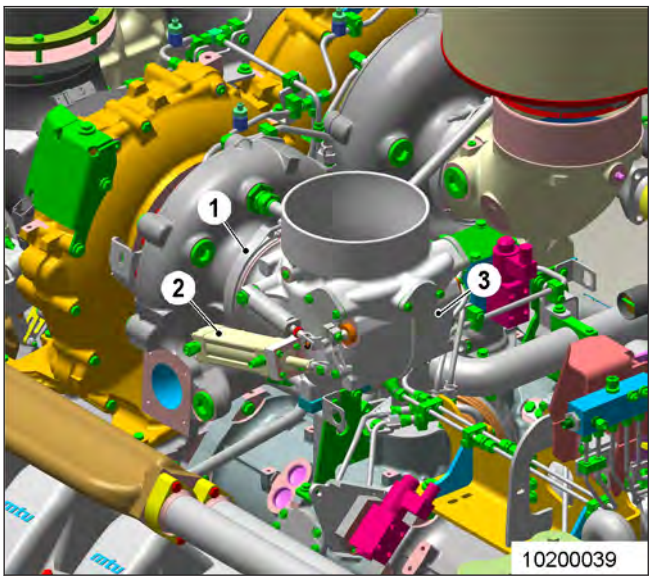


2. Tighten screws (1) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque	(Engine oil)	20 Nm + 2.5 Nm

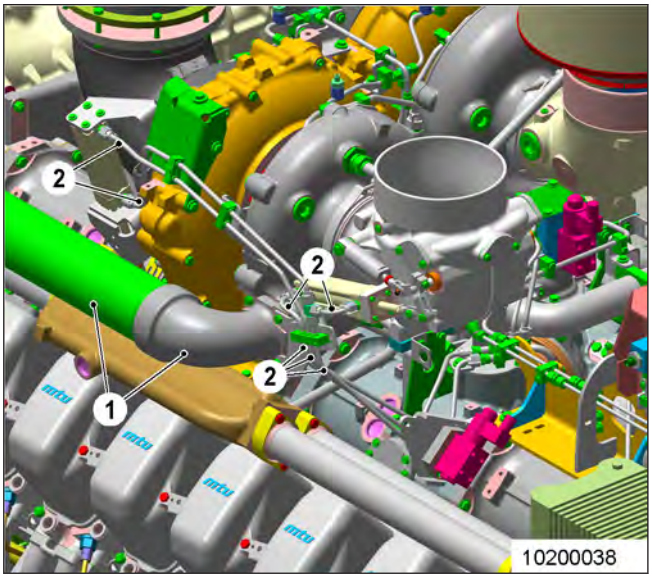
3. Install coolant ventilation line and coolant lines on compressor housing.

4. Install intake housing (3) with actuating cylinder (2).



5. Align clamp (1) and tighten to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Clamp		Tightening torque		15 Nm + 2 Nm



6. Install oil lines (2). Tighten threaded adapter at actuating cylinder to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Threaded adapter	10 G 1/4 A	Tightening torque	(Engine oil)	40 Nm + 4 Nm

7. Install charge-air pipework (1) between exhaust turbocharger and intercooler.
8. Install air filter (→ Page 173).
9. Fill with engine coolant (→ Page 197).

7.8 Charge-Air Cooling

7.8.1 Charge-air cooler – Checking condensate drain for water discharge and obstruction

DANGER

Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING

High level of engine noise when the engine is running.
Risk of damage to hearing!
- Wear ear protectors.

WARNING

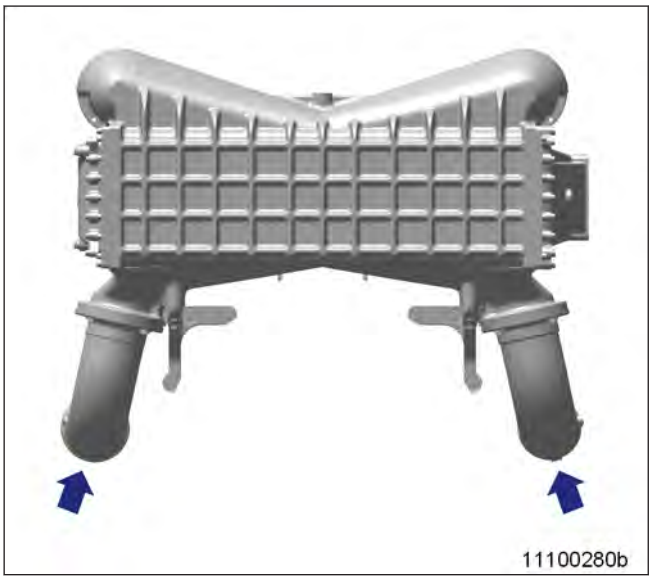
Compressed air gun ejects a jet of pressurized air.
Risk of injury to eyes and damage to hearing, risk of rupturing internal organs!
- Never direct air jet at people.
- Always wear safety goggles/face mask and ear defenders.

Charge-air cooler – Checking condensate drain for water discharge and obstruction

1. With the engine running, check if air emerges from drain bore(s) on the left and right sides on engine driving end.

Result: If no air emerges:
- Clean condensate drain bore(s).
- Blow out with compressed air.

2. If a large amount of coolant is continuously discharged, the charge-air cooler is leaking. Contact Service.



Emergency measures prior to engine start with a leaking charge-air cooler

1. Remove injectors (→ Page 147).
2. Bar engine manually (→ Page 132).
3. Bar engine with starting system to blow out combustion chambers (→ Page 132).
4. Install injectors (→ Page 147).

7.9 Air Filter

7.9.1 Air filter – Replacement

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Air filter	(→ Spare Parts Catalog)	

Replacing the air filter

1. Remove old air filter and install new air filter (→ Page 173).
2. Reset signal ring of contamination indicator (→ Page 174).

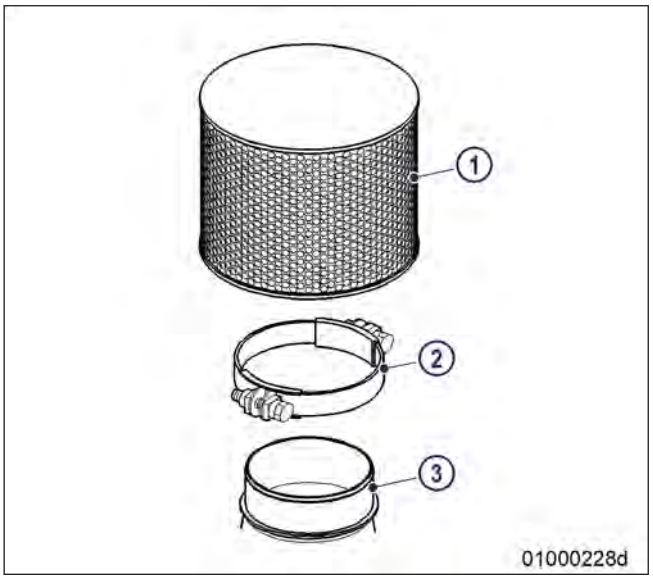
7.9.2 Air filter - Removal and installation

Preconditions

☑ Engine is stopped and starting disabled.

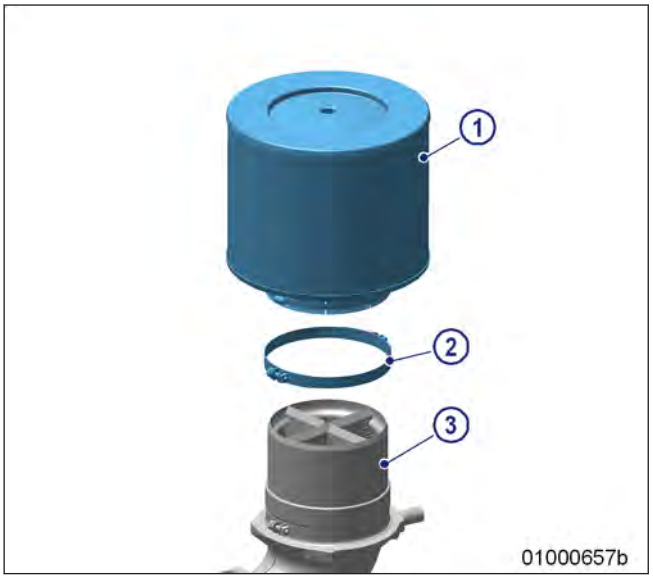
Air filter

1. Loosen clamp (2).
2. Remove air filter (1) and clamp (2) from connecting flange of housing (3).
3. Verify that there are no objects in the flange of the intake housing (3) and clean it.
4. Attach air filter (1) with clamp (2) onto intake housing (3).
5. Tighten clamp (2).



Air filter with intake silencer

1. Loosen clamp (2).
2. Remove air filter (1) and clamp (2) from intake silencer (3).
3. Clean intake silencer (3) and check for obstructions.
4. Attach air filter (1) with clamp (2) onto intake silencer (1).
5. Tighten clamp (2).



7.10 Air Intake

7.10.1 Service indicator - Signal ring position check (optional)

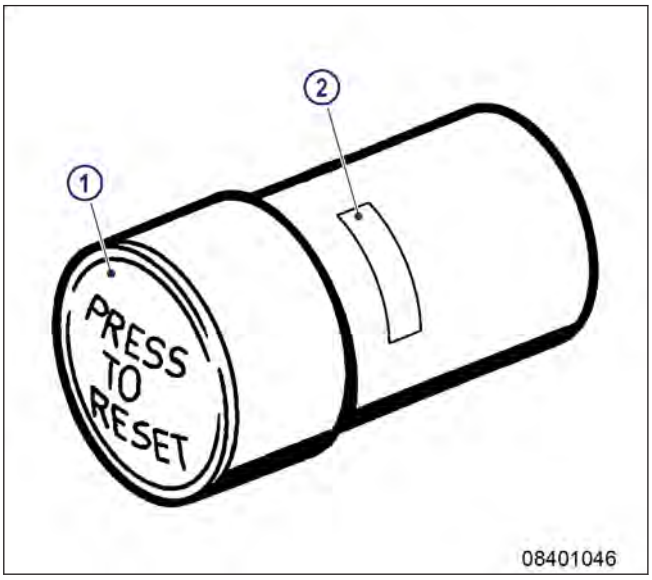
Preconditions

☑ Engine is stopped and starting disabled.

Checking signal ring position

1. If the signal ring is completely visible in the control window (2), replace air filter (→ Page 172).
2. After installation of new filter, press reset button (1).

Result: Engaged piston with signal ring moves back to initial position.



7.11 Starting Equipment

7.11.1 Starter – Condition check

Preconditions

☑ Engine is stopped and starting disabled.

Checking starter condition

1. Check securing screws of starter for secure seating and tighten if required.
2. Check wiring (→ Page 224).

7.12 Lube Oil System, Lube Oil Circuit

7.12.1 Engine oil - Level check

Preconditions

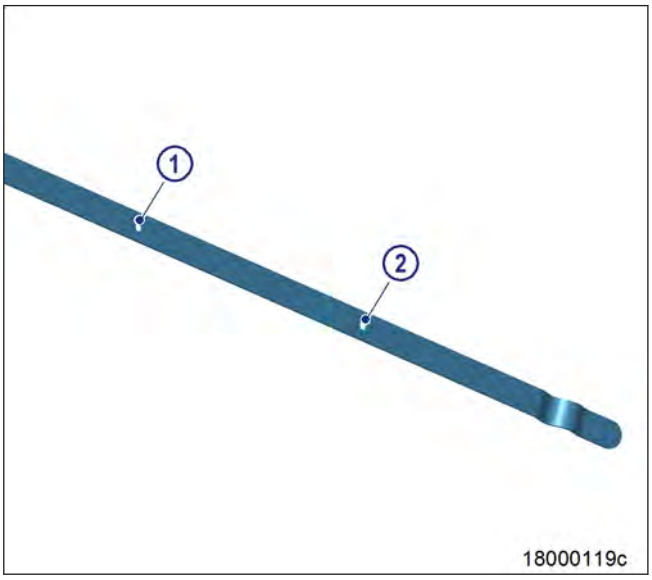
☑ Engine is stopped and starting disabled.

Oil level check prior to engine start

1. Withdraw dipstick from guide tube and wipe it.
2. Insert dipstick into guide tube to stop, withdraw after approx. 10 seconds and check oil level.

Note: After extended standstill, the oil level may exceed the mark (1) by up to 2 cm. This can be caused by oil flowing from e.g. oil filter or heat exchanger back to the oil pan.

3. The oil level must reach mark (1) or exceed mark (1) by up to 2 cm.
4. Top up with oil to mark (1) as necessary (→ Page 177).
5. Insert dipstick into guide tube up to the stop.



Oil level check after the engine is stopped

1. 5 minutes after stopping the engine, remove oil dipstick from the guide tube and wipe it.
2. Insert dipstick into guide tube to stop, withdraw after approx. 10 seconds and check oil level.
3. Oil level must be between marks (1) and (2).
4. Top up with oil to mark (1) as necessary (→ Page 177).
5. Insert dipstick into guide tube up to the stop.

7.12.2 Engine oil - Change

Preconditions

☑ Engine is stopped and starting disabled.

☑ Engine is at operating temperature.

☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 40-200 Nm	F30027337	1
Ratchet adapter	F30027341	1
Engine oil		
Sealing ring	(→ Spare Parts Catalog)	

WARNING

Hot oil.
Oil can contain combustion residues which are harmful to health.
Risk of injury and poisoning!
- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

Oil change without semirotary hand pump: Draining oil via drain plug(s) on oil pan

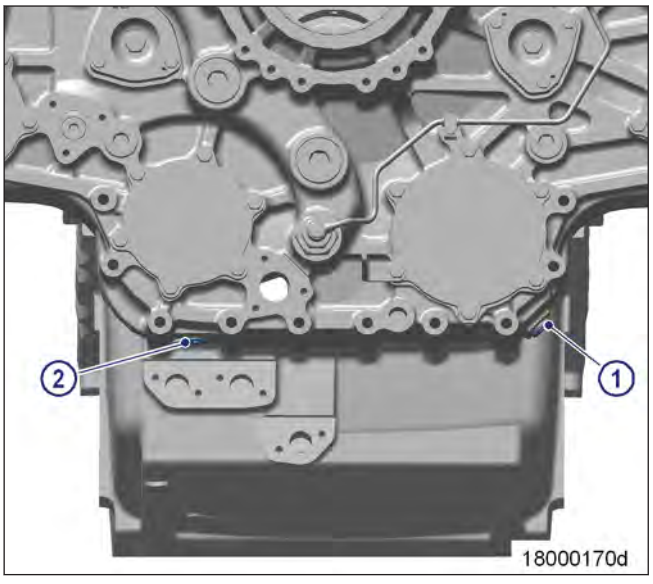
1. Provide a suitable container to collect the oil.
2. Remove drain plug(s) and drain oil.
3. Install drain plug(s) with new sealing ring.

Oil change with semirotary hand pump: Oil extraction

1. Provide a suitable container to collect the oil.
2. Draw all oil from oil pan using the semirotary hand pump.

Draining residual oil at gearcase

1. Provide a suitable container to collect the oil.
2. Remove drain plugs (1) and (2) and drain oil:
   - Approx. 12 liters at (1)
   - Approx. 5 liters at (2)
3. Install drain plug(s) with new sealing ring.

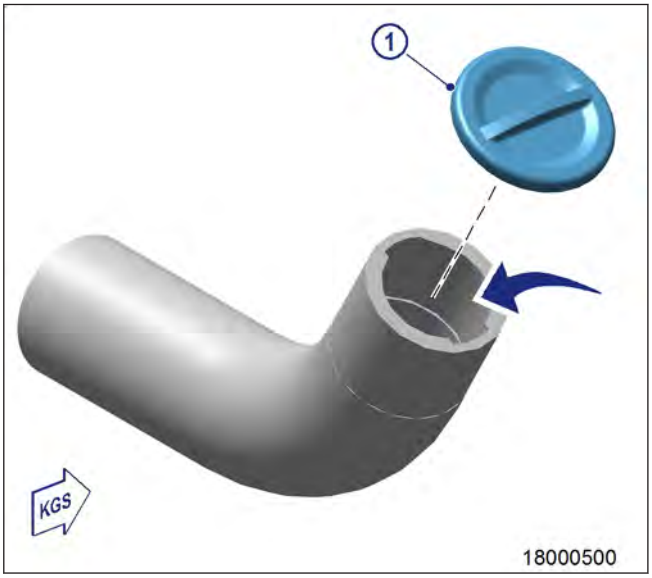


4. Tighten drain plugs (1) and (2) to specified torque using a torque wrench:

Name	Size	Type	Lubricant	Value/Standard
Screw	M26x1.5	Tightening torque	(Engine oil)	100 Nm+10 Nm

Filling with new oil

1. Open cap on filler neck.
2. Pour oil in at filler neck up to 'max.' mark at oil dipstick.
3. Close cap on filler neck.
4. Check engine oil level (→ Page 176).
5. Turn engine with starting system after oil change (→ Page 134).



7.12.3 Engine oil – Sample extraction and analysis

Preconditions

☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
MTU test kit	5605892099/00	1

DANGER

Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING

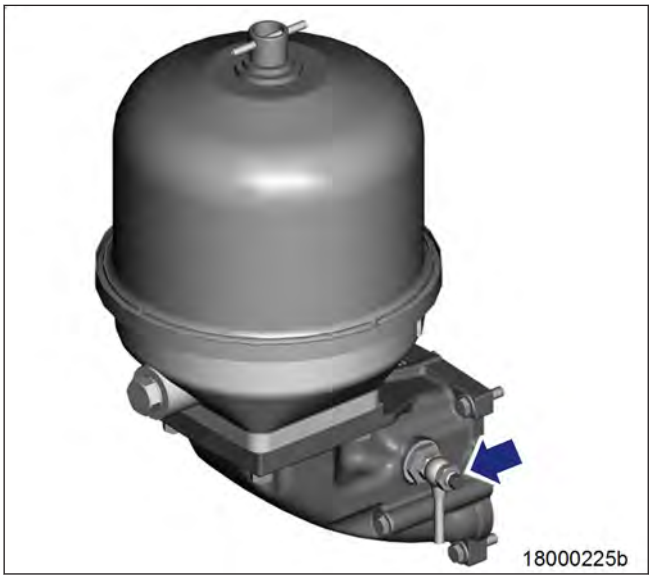
Hot oil.
Oil can contain combustion residues which are harmful to health.
Risk of injury and poisoning!
- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

WARNING

High level of engine noise when the engine is running.
Risk of damage to hearing!
- Wear ear protectors.

Engine oil – Sample extraction and analysis

1. With the engine running at operating temperature, open screw on centrifugal oil filter carrier by 1 to 2 rotations.
2. Drain approx. 2 liters engine oil to flush out the oil sludge.
3. Drain approx. 1 liter engine oil into a clean container.
4. Close screw.
5. Using the equipment and chemicals in the MTU test kit, analyze the engine oil for:
   - Dispersion capability (spot test);
   - Water content;
   - Dilution by fuel.



Engine oil – Sample extraction and analysis (engines with switchable oil filter)

1. With the engine running at operating temperature, open screw on flange of centrifugal oil filter by 1 to 2 rotations.
2. Drain approx. 2 liters engine oil to flush out the oil sludge.
3. Drain approx. 1 liter engine oil into a clean container.
4. Close screw.
5. Using the equipment and chemicals in the MTU test kit, analyze the engine oil for:
   - Dispersion capability (spot test);
   - Water content;
   - Dilution by fuel.

TIM-ID: 0000014113 - 005

7.13 Oil Filtration / Cooling

7.13.1 Checking oil indicator filter

Preconditions

☑ Engine shut down and secured against being restarted.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Cleaner (Snow-White 11-0)	40460	1
Cleaning agent (Hakupur 312)	30390	1
Engine oil		
Strainer	(→ Spare Parts Catalog)	
Square-section ring	(→ Spare Parts Catalog)	
O-ring	(→ Spare Parts Catalog)	

WARNING

Hot oil.
Oil can contain combustion residues which are harmful to health.
Risk of injury and poisoning!
- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

WARNING

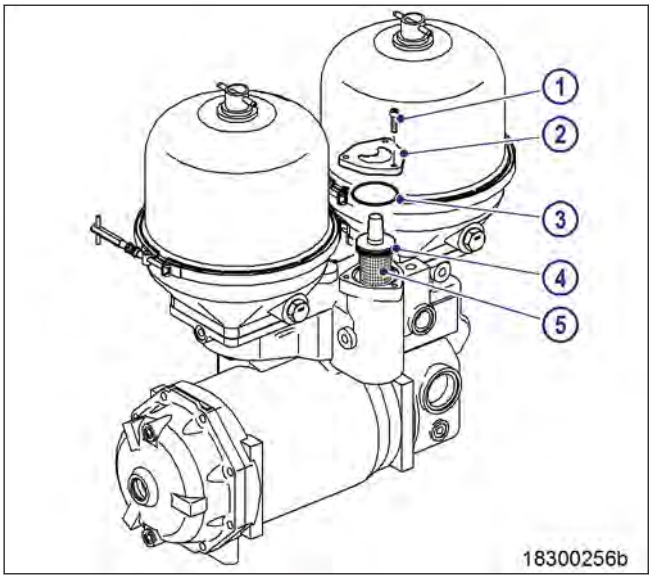
Compressed air gun ejects a jet of pressurized air.
Risk of injury to eyes and damage to hearing, risk of rupturing internal organs!
- Never direct air jet at people.
- Always wear safety goggles/face mask and ear defenders.

NOTICE

Inappropriate cleaning tool.
Risk of damage to component!
- Observe manufacturer's instructions.
- Use appropriate cleaning tool.

Removing strainer

1. Clean oil indicator filter before dismantling it.
2. Remove screws (1).
3. Take off cover (2) andh O-ring (3).
4. Remove strainer (5) from housing and allow oil to drip into container.



Cleaning strainer

1. Shake coarse contamination out of strainer (5).
2. Clean all metallic parts with cleaner (Snow-White 11-0), then rinse with cleaner (Hakupur 312).
3. Use a soft brush to remove stubborn deposits from strainer if required. When doing so, take care not to damage the mesh.
4. Blow out strainer (5) with compressed air from inside.

Checking strainer

Item	Findings	Action
Strainer	Metallic residues	• Clean • Monitor engine operation • Check strainer daily • Notify Service
Strainer	Damaged	Fit new part
Square-section ring	Damaged	Fit new part
O-ring	Damaged	Fit new part

Installing strainer

1. Coat square-section ring (4) on strainer (5) with engine oil and install strainer (5).
2. Insert strainer into housing.
3. Fill housing with new engine oil.
4. Coat O-ring (3) with engine oil and fit in filter housing.
5. Fit cover (2) and secure with screws (1) and washers.

7.13.2 Engine oil filter - Replacement

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Filter wrench	F30379104	
Engine oil		
Oil filter	(→ Spare Parts Catalog)	

DANGER

Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING

High level of engine noise when the engine is running.
Risk of damage to hearing!
- Wear ear protectors.

WARNING

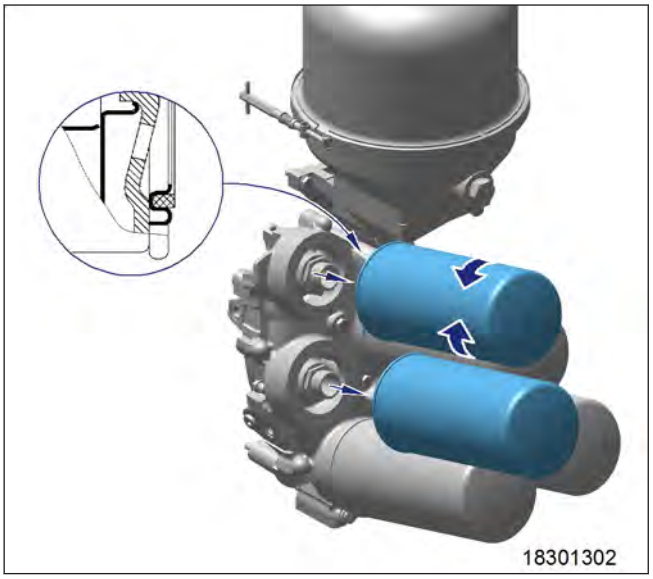
Hot oil.
Oil can contain combustion residues which are harmful to health.
Risk of injury and poisoning!
- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

NOTICE

Damage to component!
Severe material damage!
- For filter replacement with the engine running, operate the engine at low engine load.
- The filter which is to be replaced must be cut out for a brief period only.

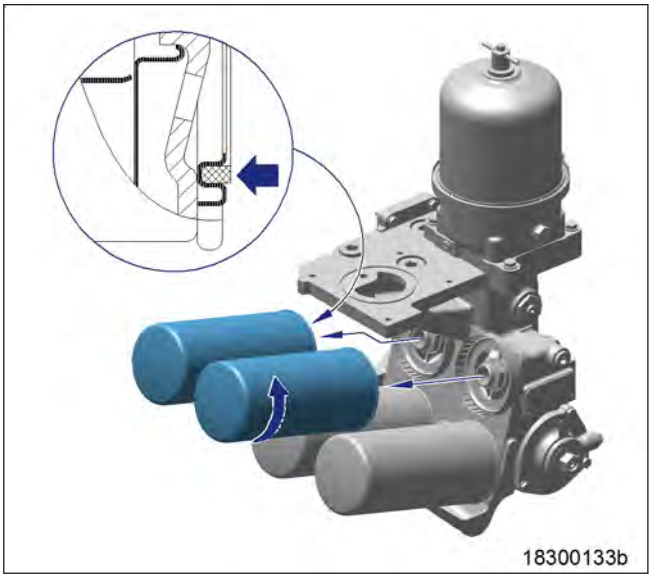
Replacing engine oil filter

1. Stop engine (→ Page 95) and disable engine start.
2. Unscrew oil filter using filter wrench.
3. Clean sealing surface on connecting piece.
4. Check condition of new oil filter sealing ring and moisten it with oil.
5. Screw on and tighten new oil filter by hand.
6. Replace other oil filters in the same way.
7. Turn engine with starting system after every oil change and filter replacement (→ Page 134).
8. Check oil level (→ Page 176).



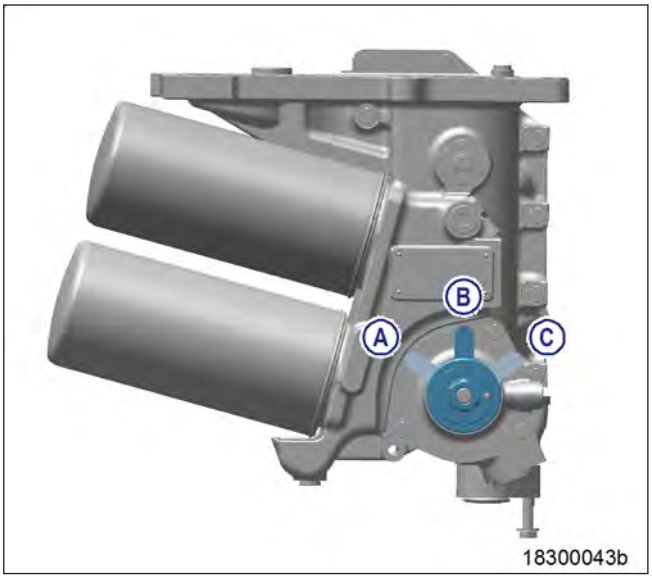
Oil filter with diverter (option): Oil filter replacement with the engine stopped

1. Stop engine (→ Page 95) and disable engine start.
2. Unscrew oil filter using oil filter wrench.
3. Clean sealing surface on connecting piece.
4. Check condition of new oil filter sealing ring and moisten it with oil.
5. Fit SOLAS shield (→ Page 15).
6. Screw on and tighten new oil filter by hand.
7. Replace other oil filters in the same way.
8. Turn engine with starting system after every oil change and filter replacement (→ Page 134).
9. Check oil level (→ Page 176).

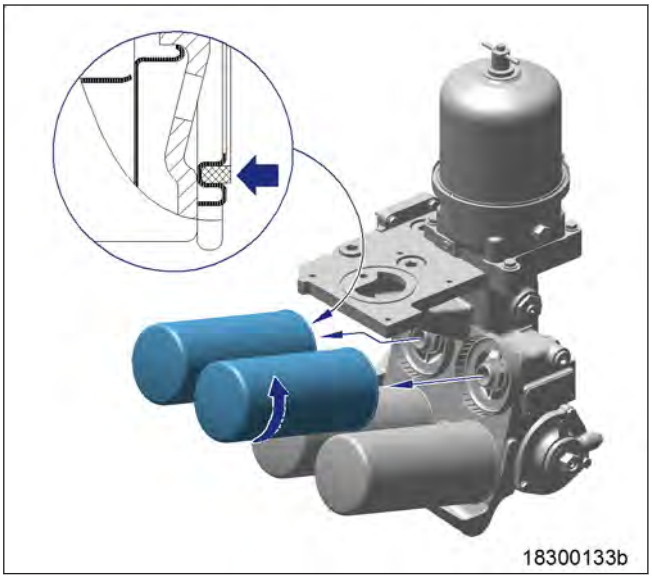


Oil filter with diverter (option): Oil filter replacement with the engine running

1. To cut out the filter to be replaced, set the three-way cock to the corresponding position.
   - Position A: Lower filters cut out
   - Position B: Both filters cut in (normal operating position)
   - Position C: Upper filters cut out.



2. Unscrew oil filter using oil filter wrench.
3. Clean sealing surface on connecting piece.
4. Check condition of new oil filter sealing ring and moisten it with oil.
5. Fit SOLAS shield (→ Page 15).
6. Screw on and tighten new oil filter by hand.
7. Replace other oil filters in the same way.
8. Check oil level (→ Page 176).



7.13.3 Centrifugal oil filter – Cleaning and filter sleeve replacement

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 6-50 Nm	F30027336	1
Filter wrench	F30379104	1
Cleaner Hakutex 60		
Grease (Kluthe Hakuform 30-10/emulsifier)	X00029933	1
Filter sleeve	(→ Spare Parts Catalog)	
Sealing ring	(→ Spare Parts Catalog)	
Sealing ring	(→ Spare Parts Catalog)	
Sealing ring	(→ Spare Parts Catalog)	

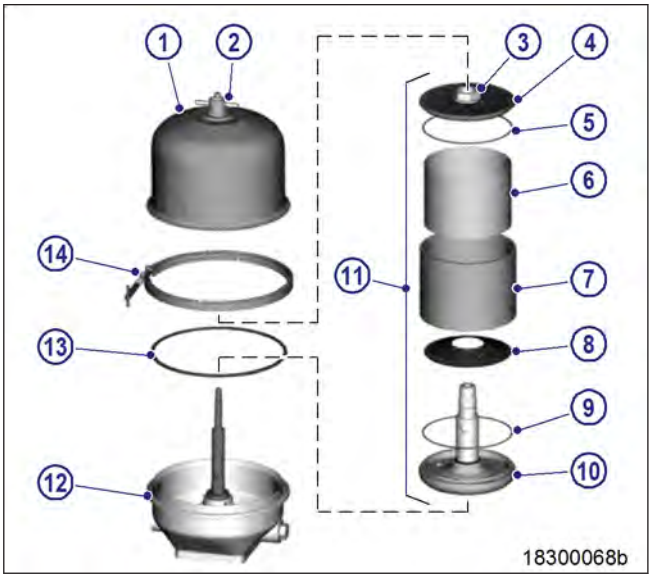
WARNING

Hot oil.
Oil can contain combustion residues which are harmful to health.
Risk of injury and poisoning!
- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

WARNING

Compressed air gun ejects a jet of pressurized air.
Risk of injury to eyes and damage to hearing, risk of rupturing internal organs!
- Never direct air jet at people.
- Always wear safety goggles/face mask and ear defenders.

Centrifugal oil filter – Cleaning and filter sleeve replacement



1. Remove clamp (14).
2. Release Tommy nut (2) and take off cover (1).
3. Carefully lift rotor (11), allow oil to drain and remove from housing.
4. Holding the rotor (11) firmly, release rotor cover nut (3).
5. Take off rotor cover (4).
6. Remove filter sleeve (6).
7. Measure layer thickness of oil residues on filter sleeve (6).

Result: If the oil residues exceed the maximum layer thickness of 45 mm, shorten the maintenance interval.

8. Disassemble rotor tube (7), conical disk (8) and rotor base (10).
9. Wash rotor cover (4), rotor tube (7), conical disk (8) and rotor base (10) with cold cleaner.
10. Blow out with compressed air.
11. Check sealing ring (9), fit new one if necessary.
12. Assemble rotor tube (7), conical disk (8) and rotor base (10) with sealing ring (9).
13. Insert new filter sleeve (6) in rotor tube (7) with the smooth paper surface facing the outer wall.
14. Check sealing ring (5), fit new one if necessary.
15. Mount rotor cover (4) with sealing ring (5).
16. Tighten rotor cover nut (3) with torque wrench to the specified torque.

Name	Size	Type	Lubricant	Value/Standard
Nut		Tightening torque		35 Nm to 45 Nm

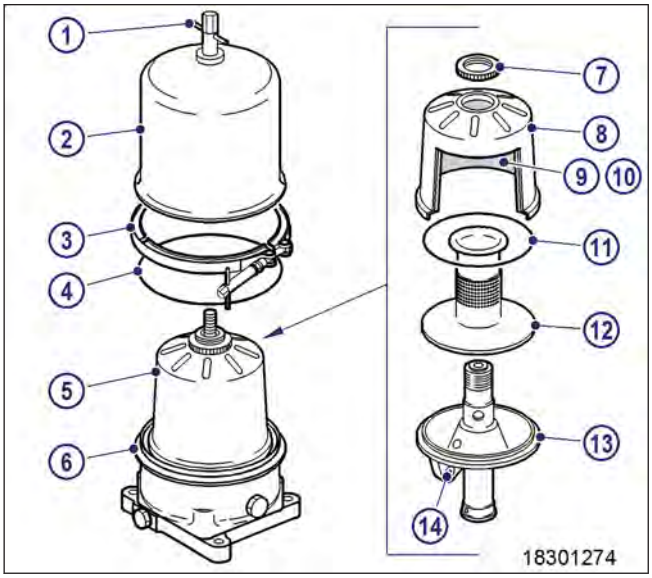
17. Place rotor (11) in housing (12) and check for ease of movement.
18. Check sealing ring (13), fit new one if necessary.
19. Fit sealing ring (13) on housing (12).
20. Fit hood (1).
21. Tighten Tommy nut (2) by hand.
22. Install clamp (14) and tighten with torque wrench to the specified torque.

Name	Size	Type	Lubricant	Value/Standard
Clamp		Tightening torque		8 Nm to 10 Nm

23. Tighten cover nut (2) with torque wrench to the specified torque.

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque		5 Nm to 7 Nm

Cleaning centrifugal oil filter and replacing filter sleeve (engines with switchable oil filter)



1. Undo and remove screw (1).
2. Remove clamp (3) and take off hood (2).
3. Carefully remove rotor (5) from housing.
4. Hold rotor assembly (5) firmly in position with filter wrench and undo knurled nut (7).
5. Take off rotor cap (8).
6. Remove filter sleeve (9), stiffener plate (10) and sealing ring (11).
7. Measure thickness of oil residues on filter sleeve.
8. If maximum layer thickness of oil residues exceeds 30 mm, shorten maintenance interval.
9. Remove standpipe (12) from lower rotor section (13).
10. Wash hood (2), rotor cap (8), stiffener plate (10), standpipe (12), lower rotor section (13) and nozzles (14) with cleaner and blow out with compressed air. Do not use sharp objects for cleaning.
11. Check nozzles (14) for obstructions.
12. Push standpipe (12) onto rotor lower section (13).
13. Insert new filter sleeve (9) with stiffener plate (10) into rotor cap (8), ensuring that the smooth surface of the filter sleeve (9) faces the rotor cap (8).
14. Check sealing ring (11), replace if necessary. Coat sealing ring with grease and insert in groove of rotor cap (8).
15. Place rotor cap (8) onto standpipe (12).
16. Hold rotor assembly (5) firmly in position with filter wrench and tighten knurled nut (7).
17. Lubricate bearings of rotor (5), insert in housing (6) and check for ease of movement.
18. Check sealing ring (4), replace if necessary. Fit sealing ring on housing (6).
19. Fit hood (2).
20. Tighten screw (1) by hand.
21. Install clamp (3) and tighten to specified torque using a torque wrench:

Name	Size	Type	Lubricant	Value/Standard
Clamp		Tightening torque		6 Nm + 1 Nm

22. Tighten screw (1) to specified torque using a torque wrench:

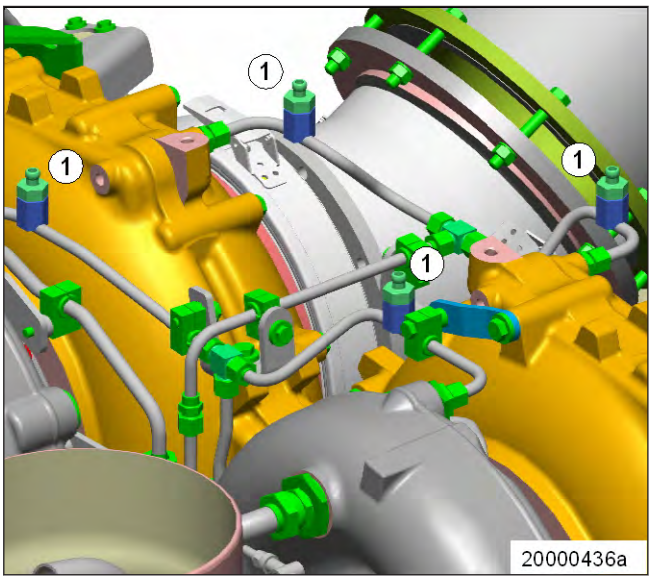
Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque		6 Nm + 1 Nm

7.14 Coolant Circuit, General, High-Temperature Circuit

7.14.1 Drain and vent points

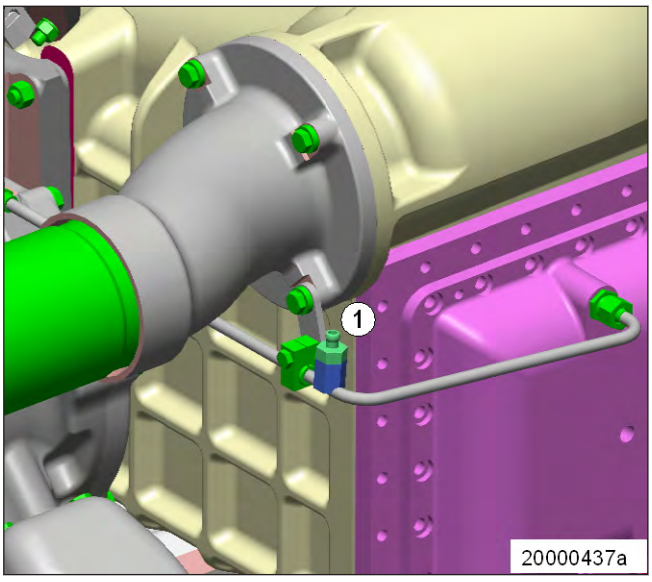
Coolant line on ETC

1 Vent point



Coolant line to intercooler

1 Vent point



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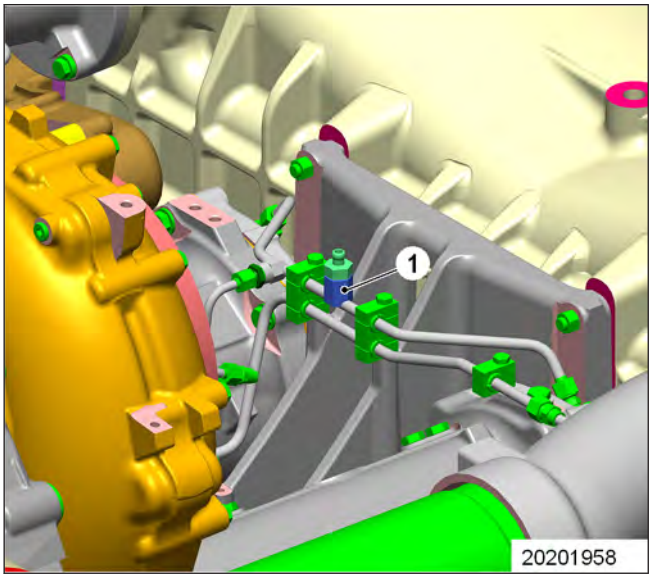
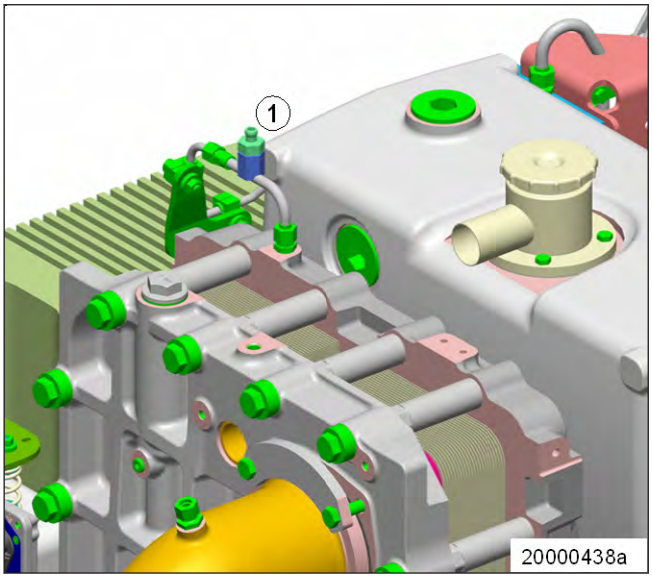
1 Vent point



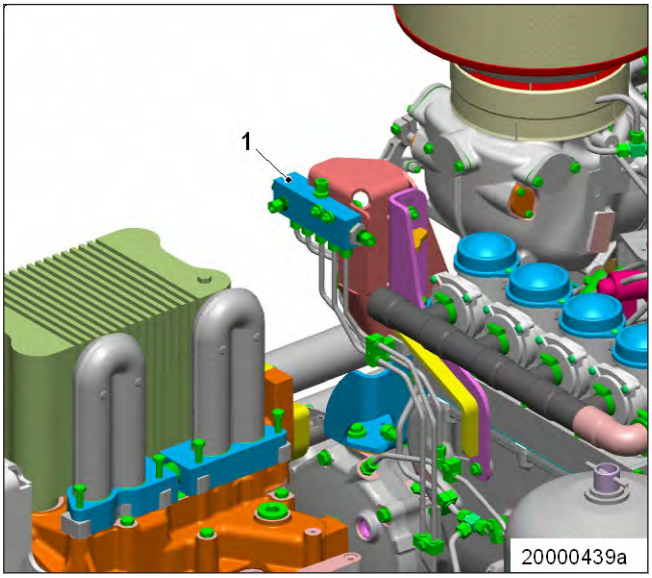
Coolant line to raw water cooler

1 Vent point



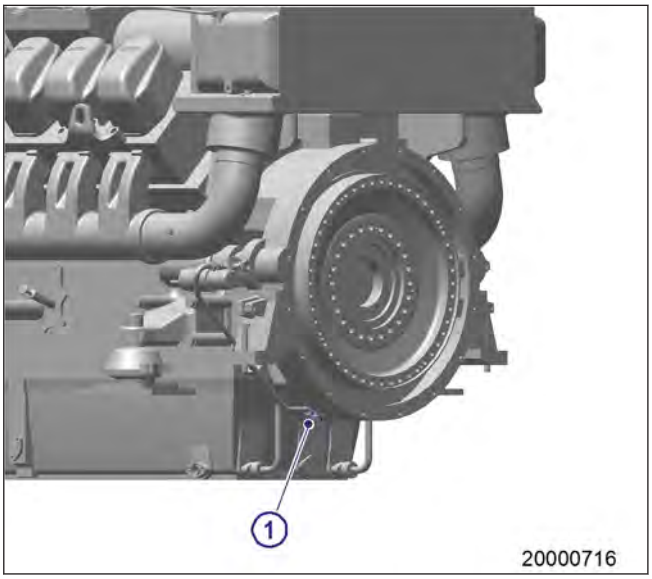
Vent line – Distribution cross

1 Vent point



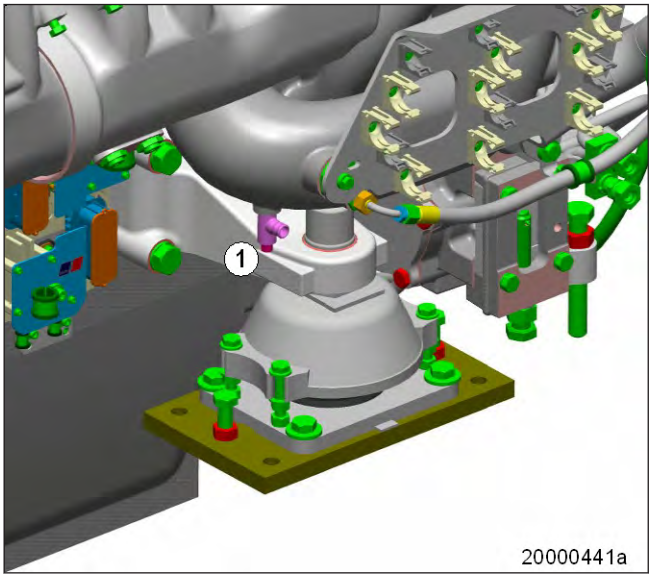
Coolant drain point, engine driving end

1 Drain point



Coolant drain point, engine free end

1 Drain point



7.14.2 Engine coolant level – Check

Preconditions

☑ Engine is stopped and starting disabled.

☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

WARNING

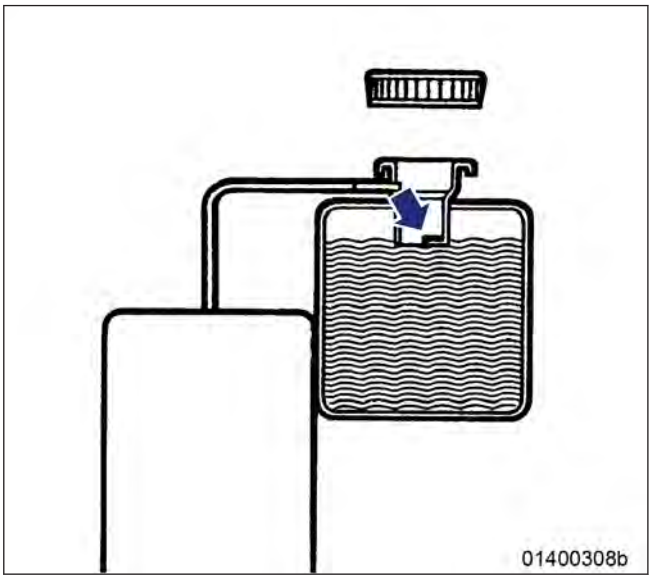
Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Checking engine coolant level at filler neck:

1. Turn breather valve on coolant expansion tank (for engines with remote heat exchanger: the expansion tank is part of the remote cooling system) counterclockwise up to the first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Check coolant level (coolant must be visible at the bottom edge of the cast-in eye in the filler neck).

Checking engine coolant level at external cooler:

1. Check coolant level (coolant must be visible at marker plate).
2. Top up with treated coolant as necessary (→ Page 197).
3. Check and clean breather valve.
4. Set breather valve onto filler neck and close it.



Checking engine coolant level by means of level sensor:

1. Switch on engine control system and check readings on the display.
2. Top up with treated coolant as necessary (→ Page 197).

7.14.3 Engine coolant - Change

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Coolant		

Engine coolant change

1. Drain engine coolant (→ Page 194).
2. Fill with engine coolant (→ Page 197).

7.14.4 Engine coolant - Draining

Preconditions

☑ Engine is stopped and starting disabled.

WARNING

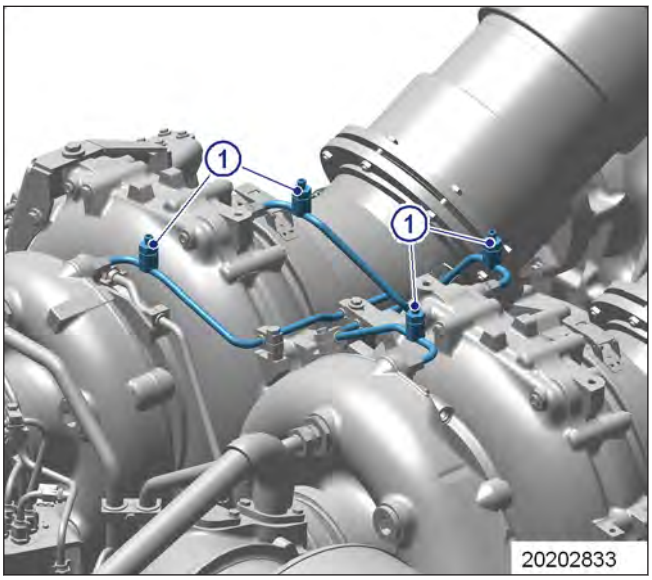
Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Preparatory steps

1. Provide an appropriate container to drain the coolant into.
2. Switch off preheating unit.

Engine coolant – Draining

1. Turn breather valve on expansion tank (for engines with remote heat exchanger: the expansion tank is part of the remote cooling system) counterclockwise up to the first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Draw off precipitated corrosion inhibitor oil from the expansion tank through filler neck.
4. Open vent valves on carrier housing (1).



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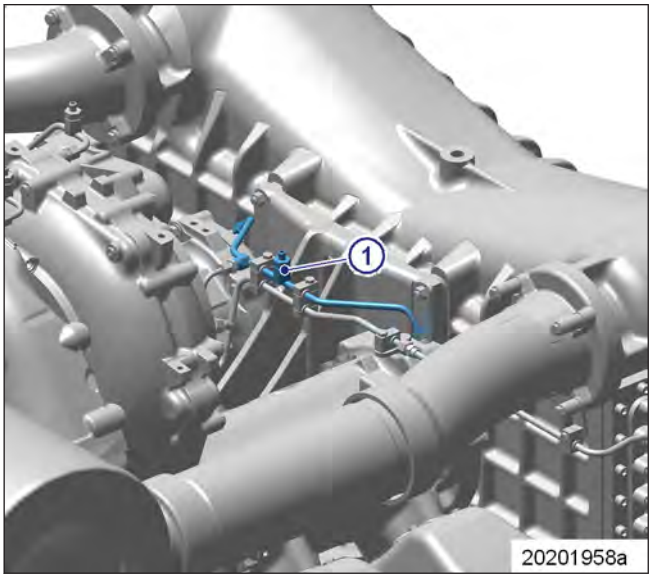
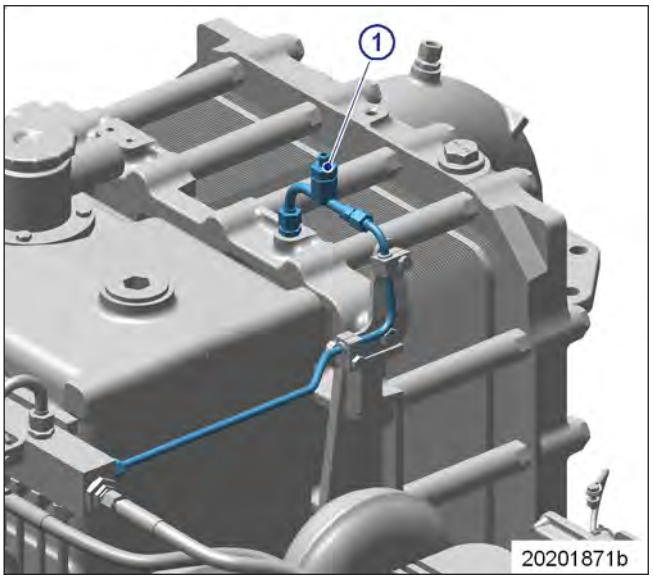
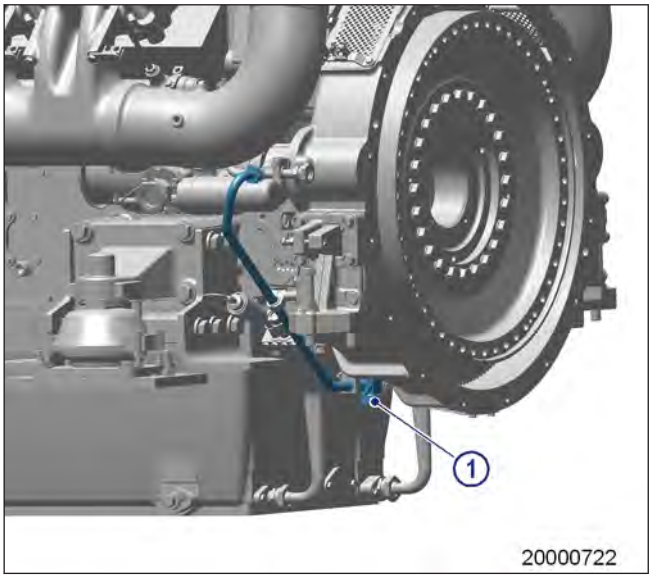
5. Open vent valve on exhaust pipework (driving end) (1).



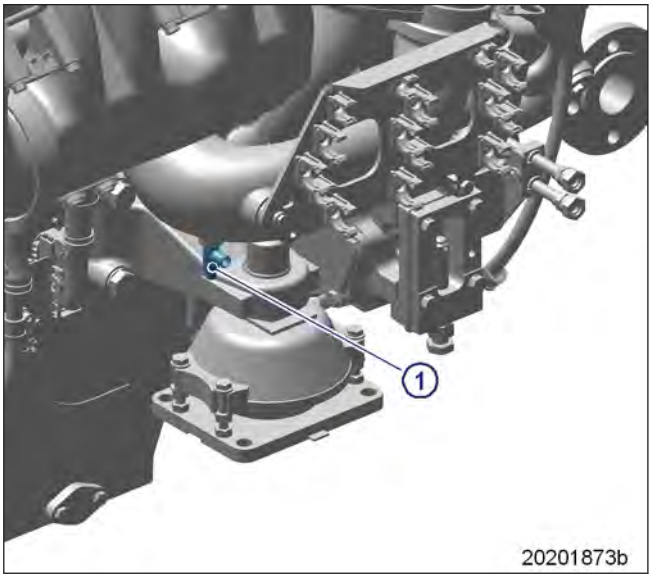
6. Open vent valve on seawater cooler (1) (or remote heat exchanger).



7. Open drain plug (1) and drain coolant at crankcase.



8. Open drain screw (1) and drain coolant on coolant pump elbow.



Final steps

1. Seal all open vent and drain points.
2. Set breather valve onto filler neck and close it.

7.14.5 Engine coolant – Filling

Preconditions

☑ Engine is stopped and starting disabled.

☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine coolant		

WARNING

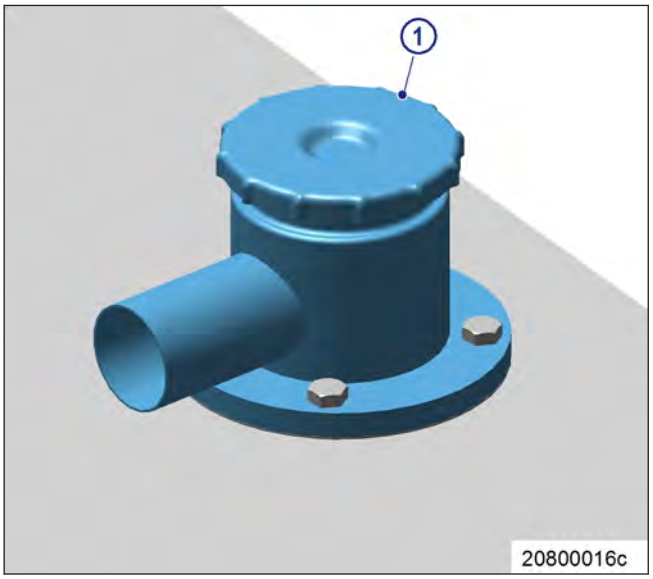
Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

NOTICE

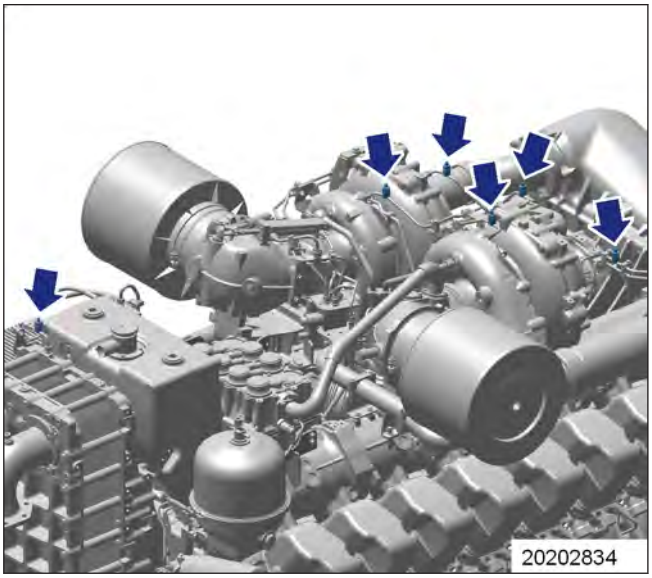
Cold coolant in hot engine can cause thermal stress.
Possible formation of cracks in the engine!
- Fill / top up coolant only into cold engine.

Preparatory steps

1. Turn breather valve on expansion tank (for engines with remote heat exchanger: the expansion tank is part of the remote cooling system) counterclockwise up to the first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.



Filling coolant through filler neck



1. Open vent points on charge-air cooler, exhaust turbochargers and on plate-core heat exchanger (arrows).
2. Fill coolant through the filler neck of the expansion tank (for engines with remote heat exchanger: the expansion tank is part of the remote cooling system) until the coolant level at the top edge of the filler neck remains constant.
3. When coolant emerges from the vent points, close vent points one by one, proceeding from the lowest point upwards.
4. Check proper condition of breather valve and clean sealing faces if required.
5. Set breather valve onto filler neck and turn until the first stop.
6. Start engine (→ Page 86).
7. After 10 seconds of running the engine without load, shut down the engine (→ Page 95).
8. Turn breather valve counterclockwise and remove.
9. Check coolant level (→ Page 192) and top up engine coolant as required:
   a) Repeat the steps from starting the engine (→ Step 6) until no coolant needs to be topped up any more.
   b) Check proper condition of breather valve and clean sealing faces if required.
   c) Set breather valve onto filler neck and close it.

Final steps

1. Start the engine and run it without load for some minutes.
2. Check coolant level (→ Page 192) and top up engine coolant as required.

7.14.6 HT coolant pump - Relief bore check

DANGER

Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING

High level of engine noise when the engine is running.
Risk of damage to hearing!
- Wear ear protectors.

HT coolant pump – Relief bore check

1. Check relief bore for oil and coolant discharge.
2. Stop engine (→ Operating instructions electronic system) and disable engine start.
3. Clean the relief bore with a wire if it is dirty.
   - Permissible engine coolant discharge: up to 10 drops per hour;
   - Permissible oil discharge: up to 5 drops per hour.
4. If discharge exceeds the specified limits, contact Service.

7.14.7 Engine coolant – Sample extraction and analysis

Preconditions

☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
MTU test kit	5605892099/00	1

DANGER

Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING

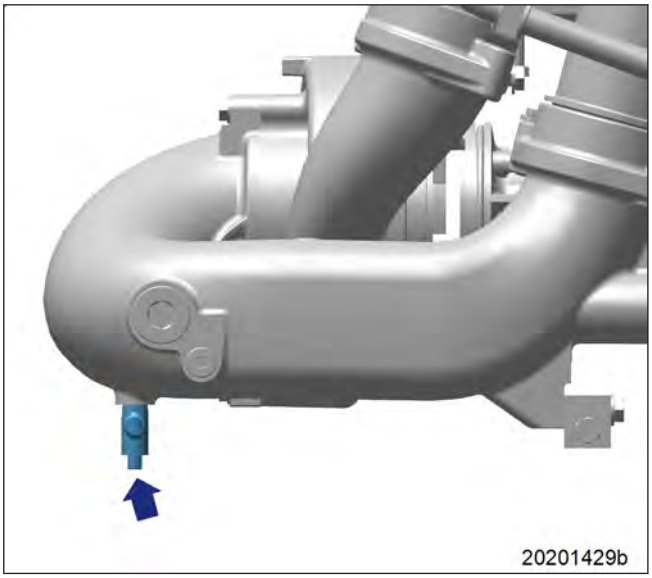
Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

WARNING

High level of engine noise when the engine is running.
Risk of damage to hearing!
- Wear ear protectors.

Engine coolant – Sample extraction and analysis

1. Open drain valve (arrow) with the engine running.
2. Flush sampling point by draining approx. 1 liter coolant.
3. Drain approx. 1 liter of engine coolant into a clean container.
4. Close drain valve (arrow).
5. Use the equipment and chemicals of the MTU test kit to check the coolant for:
   - Antifreeze concentration
   - Corrosion inhibitor concentration
   - pH value
6. Engine coolant change intervals (→ MTU Fluids and Lubricants Specifications).



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7.14.8 Engine coolant filter - Replacement

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

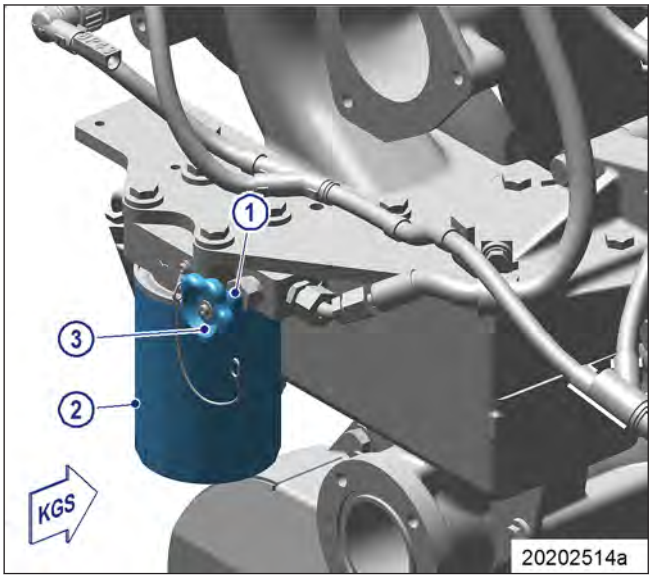
Designation / Use	Part No.	Qty.
Filter wrench	F30379104	1
Engine oil		
Engine coolant filter	(→ Spare Parts Catalog)	

WARNING

Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

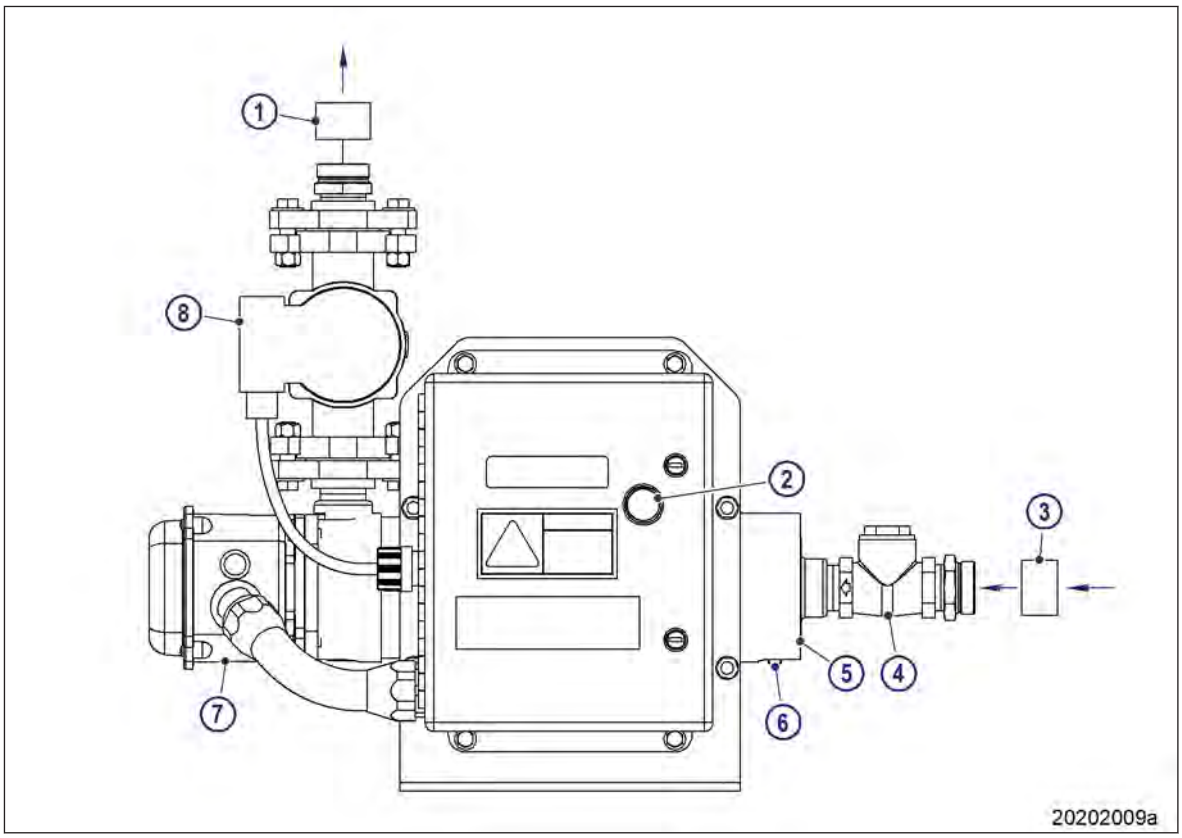
Engine coolant filter – Replacement

1. Remove locking device (1).
2. Close shut-off cock (3).
3. Remove engine coolant filter (2) with filter wrench.
4. Clean sealing surface on connecting piece.
5. Coat seal on new engine coolant filter (2) with engine oil.
6. Screw on engine coolant filter (2) and tighten hand-tight.
7. Open shut-off cock (3).
8. Install locking device (1).



7.14.9 Preheating unit

Hotstart preheating unit



1 Plastic cap (drain)
2 On/Off switch
3 Plastic cap (supply line)
4 Shutoff valve
5 Continuous flow heater
6 Vent valve
7 Thermostat
8 Circulation pump

Cylinders	Nominal voltage / frequency	Heating power kW
12 V	230 V / 50 Hz	9
	400 V / 50 Hz	9
	230 V / 60 Hz	9
	440 V / 60 Hz	9
16 V	230 V / 50 Hz	12
	400 V / 50 Hz	12
	230 V / 60 Hz	12
	440 V / 60 Hz	12

Function

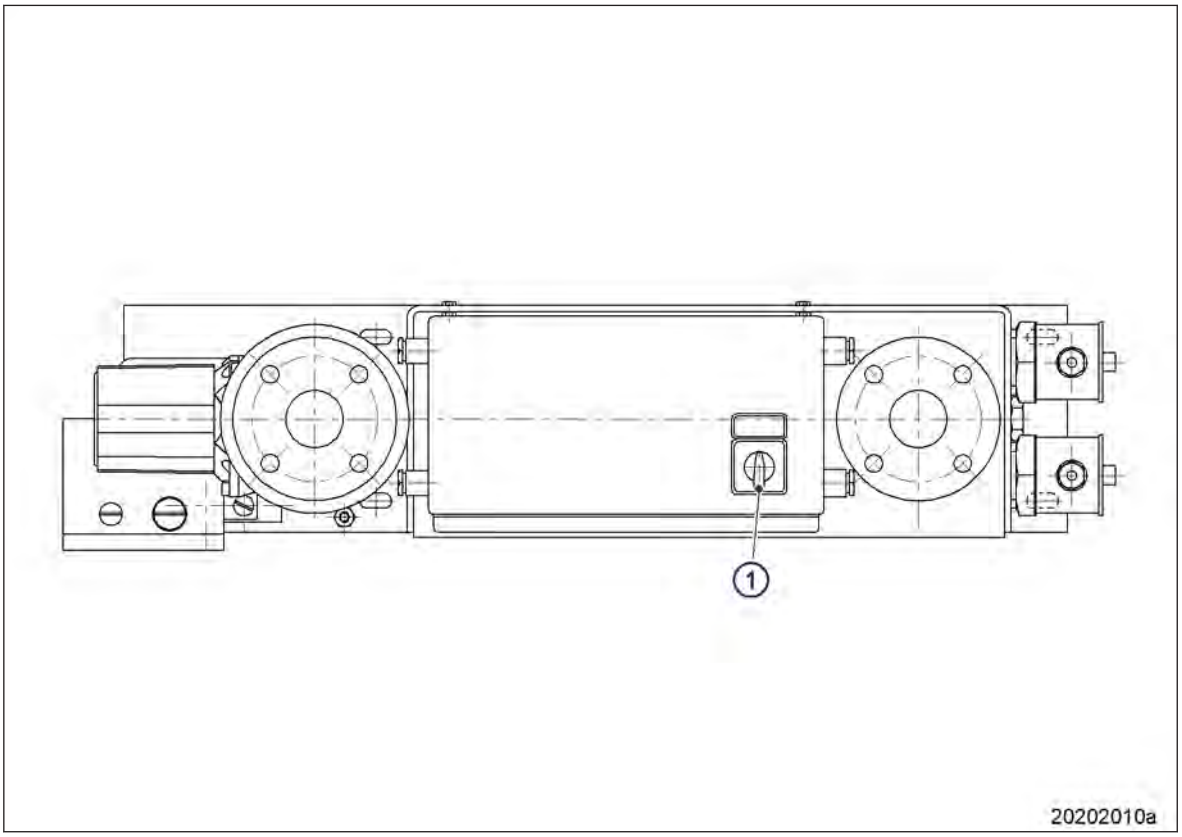
The preheating unit is intended to warm up the engine coolant. The circulating pump (8) ensures the circulation of the preheated engine coolant through the engine.

The continuous flow heater (5) comprises a heating element. The thermostat (7) switches off the preheating unit via contactors when the engine coolant temperature has reached the setting of the thermostat (7).

In the event of excessive coolant temperature, the temperature limiter of the thermostat (7) opens the control loop. The preheating unit is switched off.

The unit must be reset manually after the fault has been rectified.

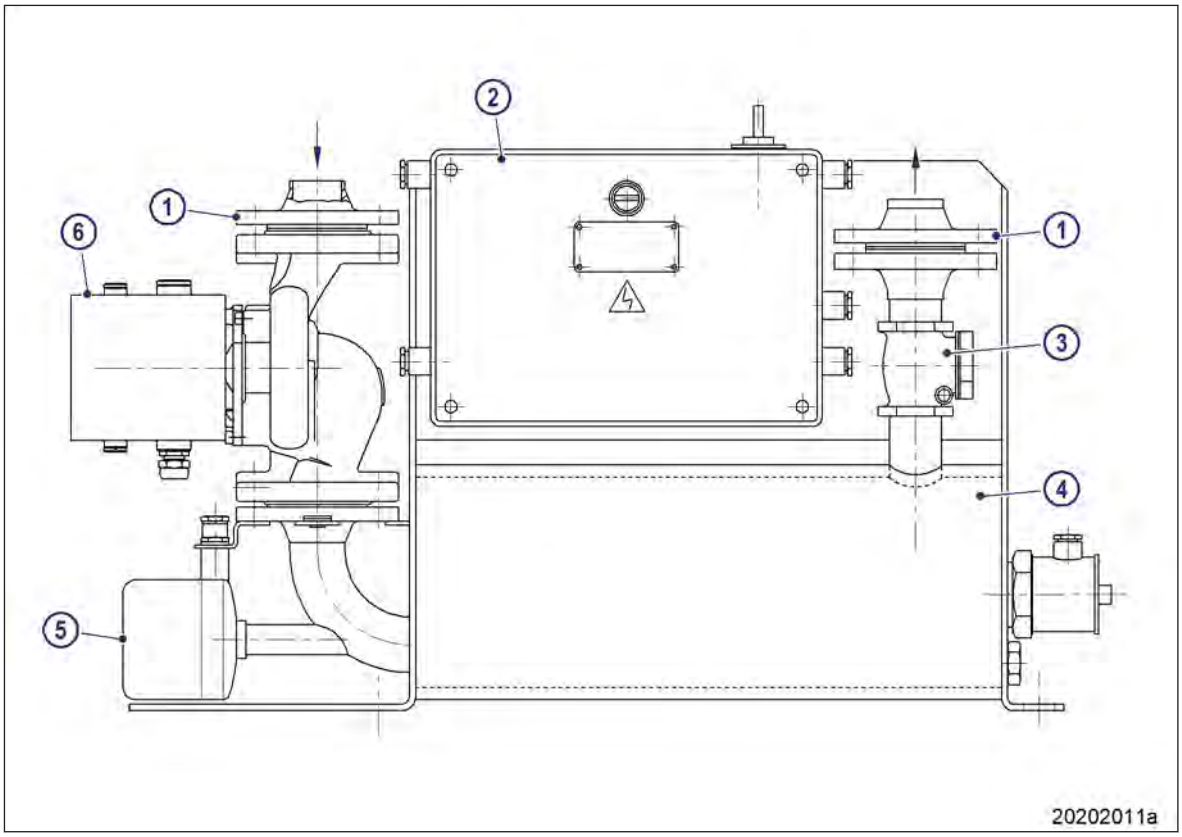
Hilzinger preheating unit



1 On/Off switch

Cylinders	Nominal voltage / frequency	Heating power kW
12 V and 16 V	230 V / 50 Hz	9
	400 V / 50 Hz	9
	230 V / 60 Hz	9
	440 V / 60 Hz	9

Hilzinger preheating unit, side view



1 Flange (supply and return)
2 Junction box
3 Non-return flap
4 Continuous flow heater
5 Thermostat
6 Circulation pump

Function

The preheating unit is intended to warm up the engine coolant. The circulation pump (6) ensures the circulation of the preheated coolant through the engine.

The continuous flow heater (4) comprises a heating element. A non-return flap (3) prevents coolant from flowing through the preheating unit when the engine is running.

When the coolant temperature has reached the value of the thermostat setting (5), the thermostat (5) switches off the preheating unit via contactors.

In the event of excessive coolant temperature, the temperature limiter of the thermostat (5) opens the control loop. The preheater is switched off.

The unit must be reset manually after the fault has been rectified.

7.15 Raw Water Pump with Connections

7.15.1 Raw water pump - Relief bore check

DANGER

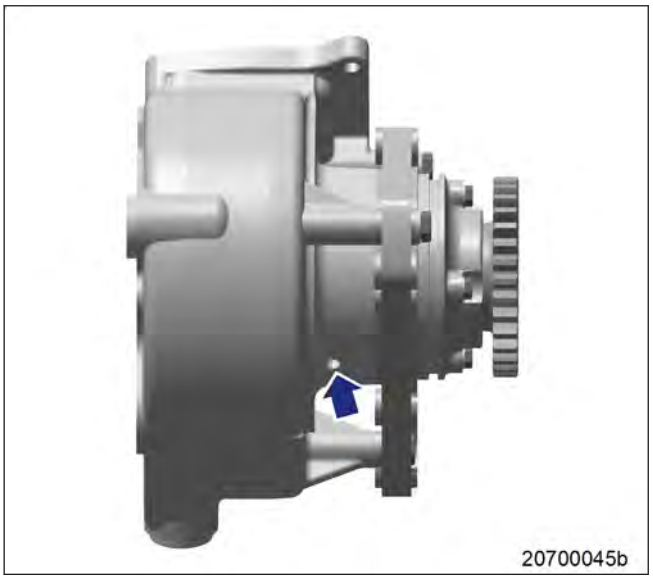
Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING

High level of engine noise when the engine is running.
Risk of damage to hearing!
- Wear ear protectors.

Raw water pump – Relief bore check

1. Check relief bore for oil and coolant discharge.
2. Stop engine (→ Page 95) and disable engine start.
3. Clean the relief bore with a wire if it is dirty.
   - Permissible engine coolant discharge: up to 10 drops per hour;
   - Permissible oil discharge: up to 5 drops per hour.
4. If discharge exceeds the specified limits, contact Service.



7.16 Battery-Charging Generator

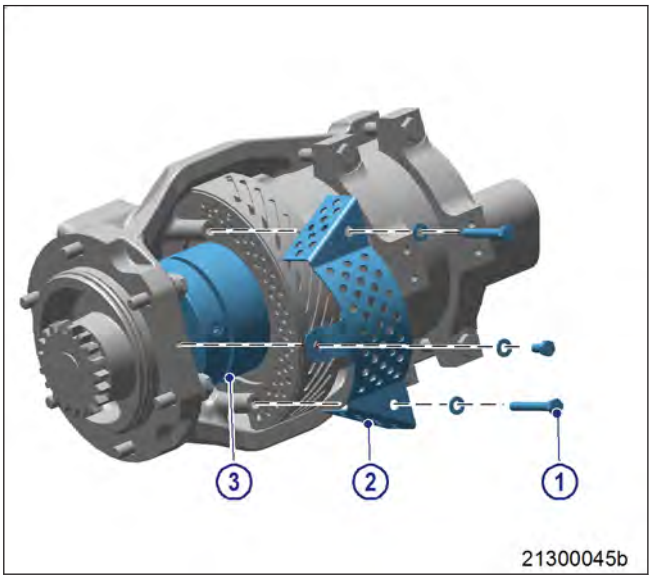
7.16.1 Battery-charging generator drive – Coupling condition check

Preconditions

☑ Engine is stopped and starting disabled.

Battery-charging generator drive – Coupling condition check

1. Remove screws (1).
2. Remove protective cover (2).
3. Check resilient coupling (3) for cracks and plastic deformation.
4. If there is serious deformation or crack formation, contact Service.
5. Install protective cover (2) with screws (1).



7.17 Engine Mounting / Support

7.17.1 Engine mounting - Checking securing screws for firm seating

Preconditions

☑ Engine is stopped and starting disabled.

Engine mounting, checking securing screws for firm seating

1. Check securing screws for firm seating.
2. Tighten loose threaded connections.

7.18 Auxiliary PTO

7.18.1 Bilge pump - Relief bore check

DANGER

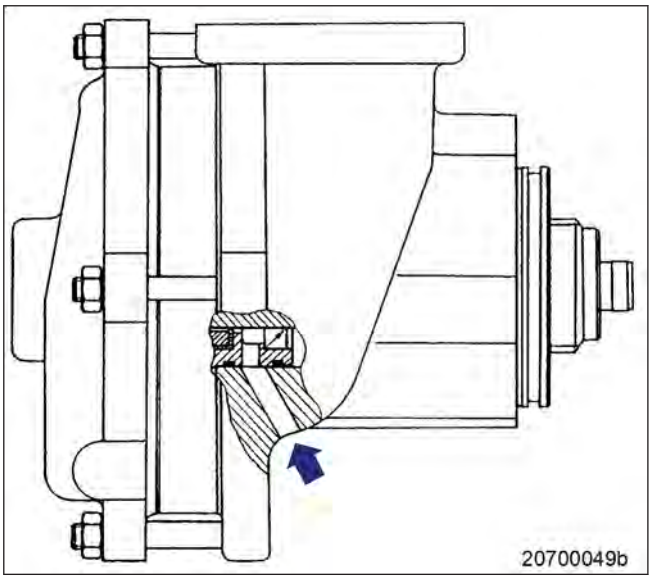
Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING

High level of engine noise when the engine is running.
Risk of damage to hearing!
- Wear ear protectors.

Bilge pump – Relief bore check

1. Check relief bores for oil and water discharge.
2. Stop engine (→ Page 95) and disable engine start.
3. Clean relief bores with a wire if dirty.
   - Permissible water discharge: up to 10 drops per hour;
   - Permissible oil discharge: up to 5 drops per hour
4. If discharge exceeds the specified limits: Contact Service.



7.19 Fuel Supply System

7.19.1 Water drain valve – Check

Water drain valve – Check

1. Open water drain valve.
2. Check water outlet for obstructions.
3. Close water drain valve.

7.19.2 Differential pressure gauge - Check

WARNING

Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Checking differential pressure gauge

1. Switch on fuel treatment system (→ Page 93).
2. Set the alarm points at the differential pressure gauge to zero.

Result: Alarm is initiated with preset delay.

3. Reset the alarm points at the differential pressure gauge to the specified values.

7.19.3 Water level probe (3-in-1 rod electrode) – Check

Preconditions

☑ System is put out of operation and emptied.

WARNING

Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Checking water level probe (3-in-1 rod electrode)

1. Disconnect connector from water level probe.
2. Unscrew water level probe.
3. Disconnect connector from water level probe.
4. Immerse water level probe into a tank filled with water until water level reaches the thread.
5. Switch system on.

Result: Water drain valve opens.

6. Leave water level probe in tank.

Result: Alarm must be triggered with the preset delay.

7. Switch off the system.
8. Disconnect connector from water level probe.
9. Remove water level probe from tank.
10. Screw in water level probe.
11. Connect connector for water level probe.
12. Fill and vent the system then put it into operation.

7.19.4 Pump capacity - Check

WARNING

Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Pump capacity – Check

1. Install suitable pressure gauge at the neck of the intake side of the pump.
2. Check pump pressure.
   a) Switch on fuel treatment system (→ Page 93).

Note: The pressure limiting valve at the pump might respond and open. Audible noise is caused by overflowing fuel and can be disregarded.

   b) Close ball valve at the outlet of the fuel treatment system.
   c) Check pressure at the pressure gauge in the inlet to the fuel treatment system and note down.
3. Check pump pressure with reduced suction.
   a) Reduce suction pressure of pump to -0.8 bar with the shutoff valve at the pump intake side.
   b) Check pressure at the pressure gauge in the inlet to the fuel treatment system and note down.
   c) Open ball valve at inlet and outlet of fuel treatment system.
4. Calculate wear limit.

Example:	
Measured value (normal condition).	3 bar
Measured value (reduced suction condition).	2.6 bar
If the measured value (reduced suction condition) is 10% lower than the measured value (normal condition), the wear limit is reached. Repair pump (contact Service).	

7.19.5 Coalescer filter element – Replacement

Preconditions

☑ System is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 6-50 Nm	F30027336	1
Ratchet	F30027339	1
Diesel fuel		
Engine oil		
Coalescer filter element	(→ Spare Parts Catalog)	
Gasket	(→ Spare Parts Catalog)	

WARNING

Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

NOTICE

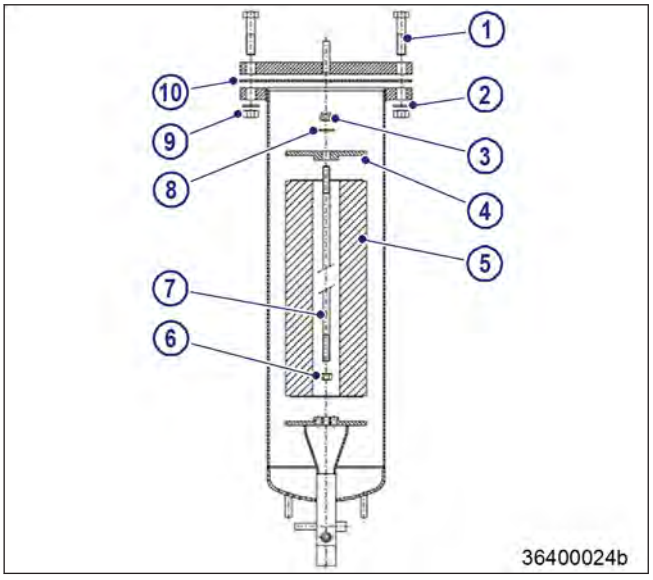
Contamination of components.
Damage to component!
- Observe manufacturer's instructions.
- Check components for special cleanliness.

NOTICE

Incorrect installation of components and lines.
Damage to component!
- Ensure that components/lines are installed so that they are never under tension or strain.
- Ensure correct installation position of components.

Coalescer filter element – Replacement

1. Close ball valve at the inlet and outlet of the fuel treatment system.
2. Open drain valve.
3. Drain fuel.
4. Close drain valve.
5. Remove nuts (9) and washers (2).
6. Remove screws (1).
7. Remove cover with gasket (10).
8. Remove nut (3), washer (8) and end plate (4).
9. Remove coalescer filter element (5).
10. Catch fuel as it runs out.
11. Clean housing with a non-linting cloth, rinse with fuel if required.
12. Check housing for corrosion.
13. Clean housing sealing surfaces.
14. Install coalescer filter element (5).
15. Install end plate (4), washer (8) and nut (3).



16. Tighten nut (3) to specified tightening torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Nut	M16	Tightening torque	(Engine oil)	30 Nm +3 Nm

17. Fit gasket (10).
18. Install cover.
19. Install screws (1), washers (2) and nuts (9).
20. Tighten nuts (9).
21. Open ball valve at the inlet and outlet of the fuel treatment system.

Result: The fuel treatment system is ready for operation.

7.20 Wiring (General) for Engine/Gearbox/Unit

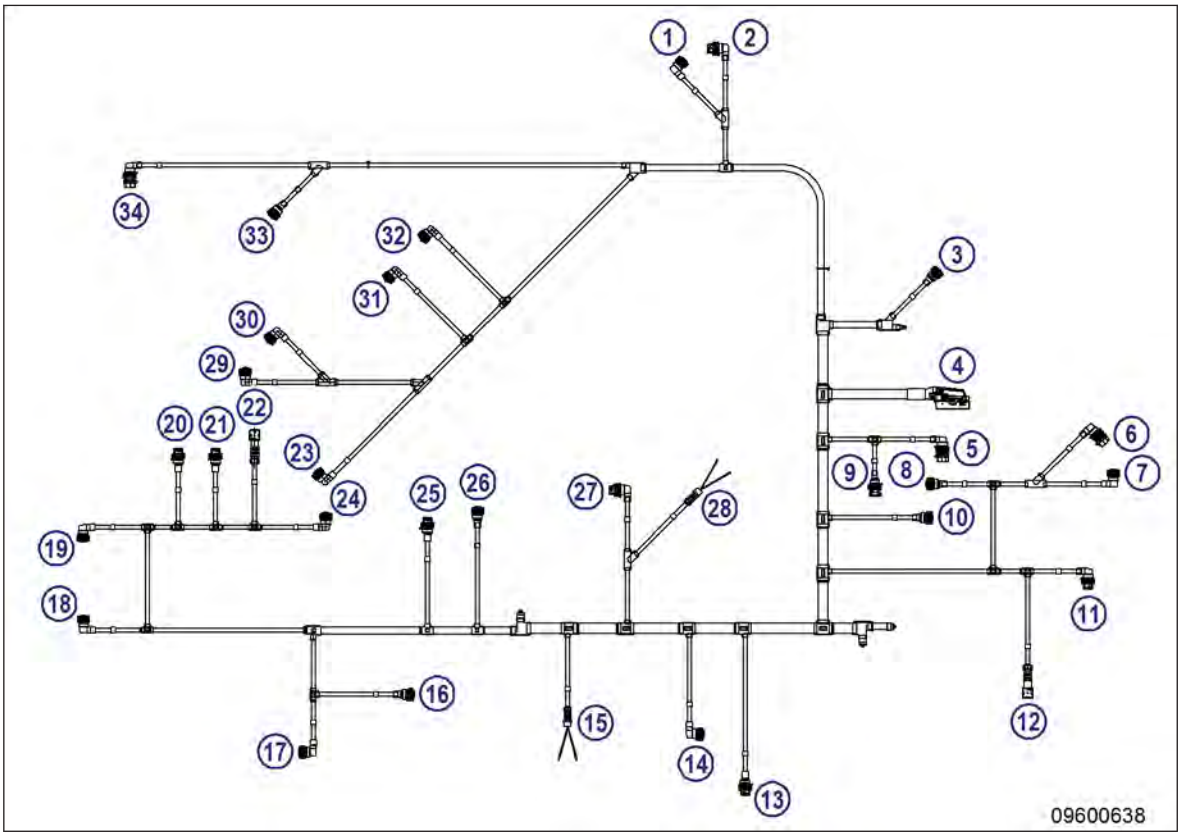
7.20.1 Engine wiring harness - Overview

Engine wiring harnesses – Terminal assignment

Description	Terminal assignment	
Sensors	B1	Camshaft speed
	B3	Intake air temperature
	B4.21	Exhaust temperature, A side
	B4.22	Exhaust temperature, B-side
	B4A1 to B4AX	Cyliner exhaust temperature, engine A side
	B4B1 to B4BX	Cyliner exhaust temperature, engine B side
	B5.1	Oil pressure downstream of filter
	B5.2	Lube oil pressure
	B5.3	Oil pressure upstream of filter
	B6	Coolant temperature
	B6.2	Coolant temperature
	B7	Oil temperature
	B9	Charge-air temperature
	B10	Charge-air pressure
	B13	Crankshaft speed
	B13.2	Crankshaft speed
	B16	Coolant pressure
	B21	Raw water pump pressure
	B33	Fuel temperature
	B34.1	Fuel pressure downstream of filter
	B34.2	Fuel pressure upstream of filter
	B34.3	Fuel pressure upstream of external filter
	B44.1	Rotation speed, turbocharger A
	B44.2	Rotation speed, turbocharger B
	B48	HP fuel pressure
	B49	Charge air before recirculation
	B50	Crankcase pressure
	B54	Replenishment pump pressure
Level monitor	F33	Coolant level
	XF33	Coolant level adaptation
	XXF33	Coolant level, outer skin cooling
	F46	Fuel overflow level
Pump	M8	Fuel pump
Limit switch	S37.1	Start lockout A
	S37.2	Start lockout B

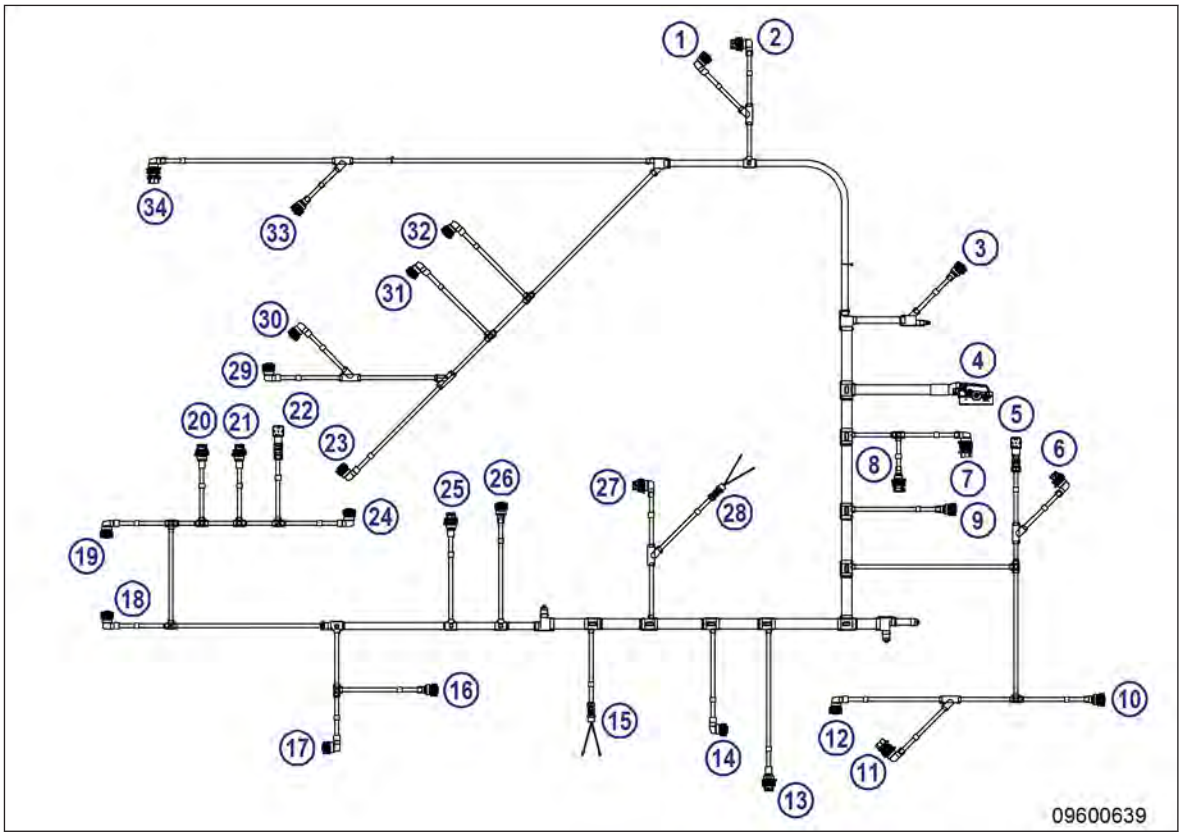
Description	Terminal assignment	
Adaptation	X1	ECU-7 module
	X2	ECU-7 module
	X3	ECU power
	X4	ECU-7 module
	X11	ECU power
	X12	EMU
	X37	Start interlock
	X52	EIM
	XB19	Starting-air pressure
	XD1	Dialog
	XY1	Starting system
	XG03	Alternator
Valves	Y26	Charge-air recirculation
	Y27	Turbocharger
Injectors	Y39A1 to Y39AX	Engine A side
	Y39B1 to Y39BX	Engine B side

Engine wiring harness for sensors, 12V engine



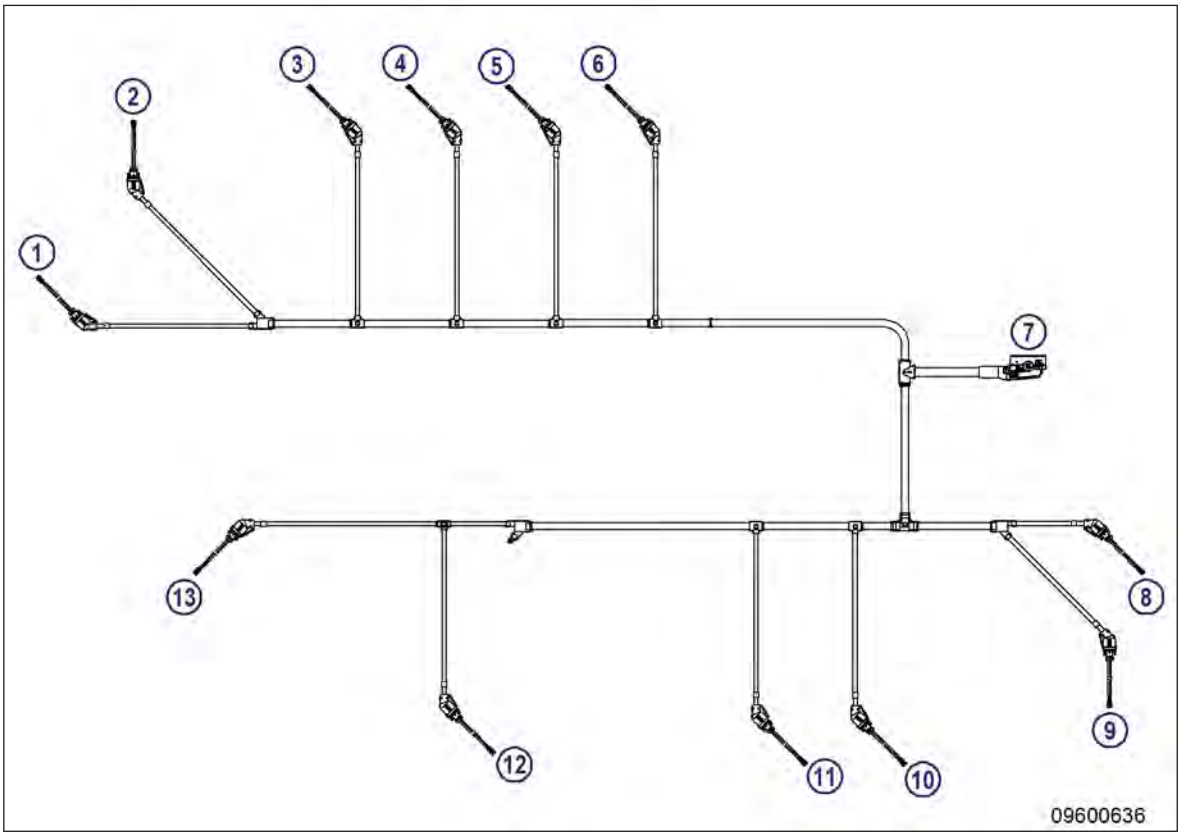
1	M8	13	B4.22	25	B4.21
2	B1	14	B9	26	B10
3	B6	15	S37.1	27	B13
4	X2	16	B34.3	28	S37.2
5	X37	17	B34.2	29	B7
6	XXF33	18	B34.1	30	B5.1
7	F33	19	B50	31	B48
8	B16	20	B49	32	B33
9	XF33	21	B44.1	33	F46
10	B54	22	Y26	34	XG03
11	B44.2	23	B5.3		
12	Y27	24	B3		

Engine wiring harness for sensors, 16V engine



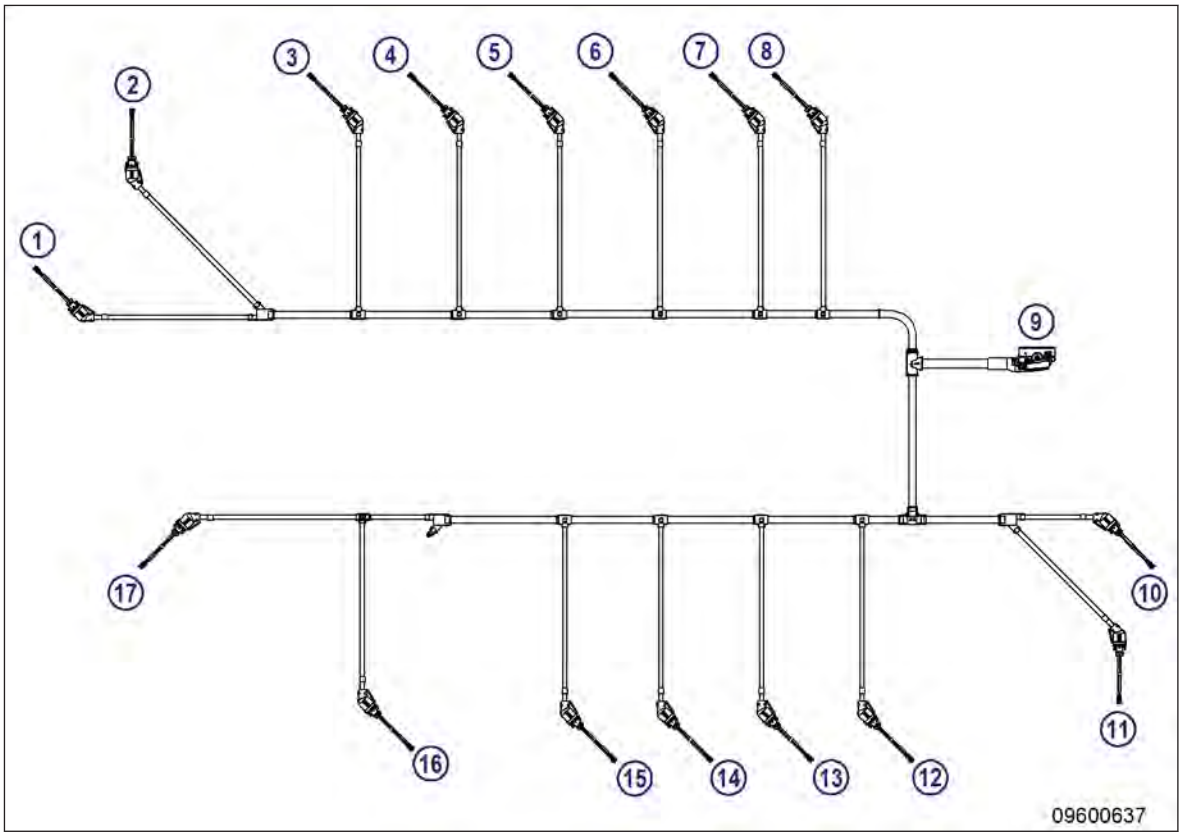
1	M8	13	B4.22	25	B4.21
2	B1	14	B9	26	B10
3	B6	15	S37.1	27	B13
4	X2	16	B34.3	28	S37.2
5	Y27	17	B34.2	29	B7
6	B44.2	18	B34.1	30	B5.1
7	X37	19	B50	31	B48
8	XF33	20	B49	32	B33
9	B54	21	B44.1	33	F46
10	B16	22	Y26	34	XG03
11	XXF33	23	B5.3		
12	F33	24	B3		

Engine wiring harness for injectors, 12V engine



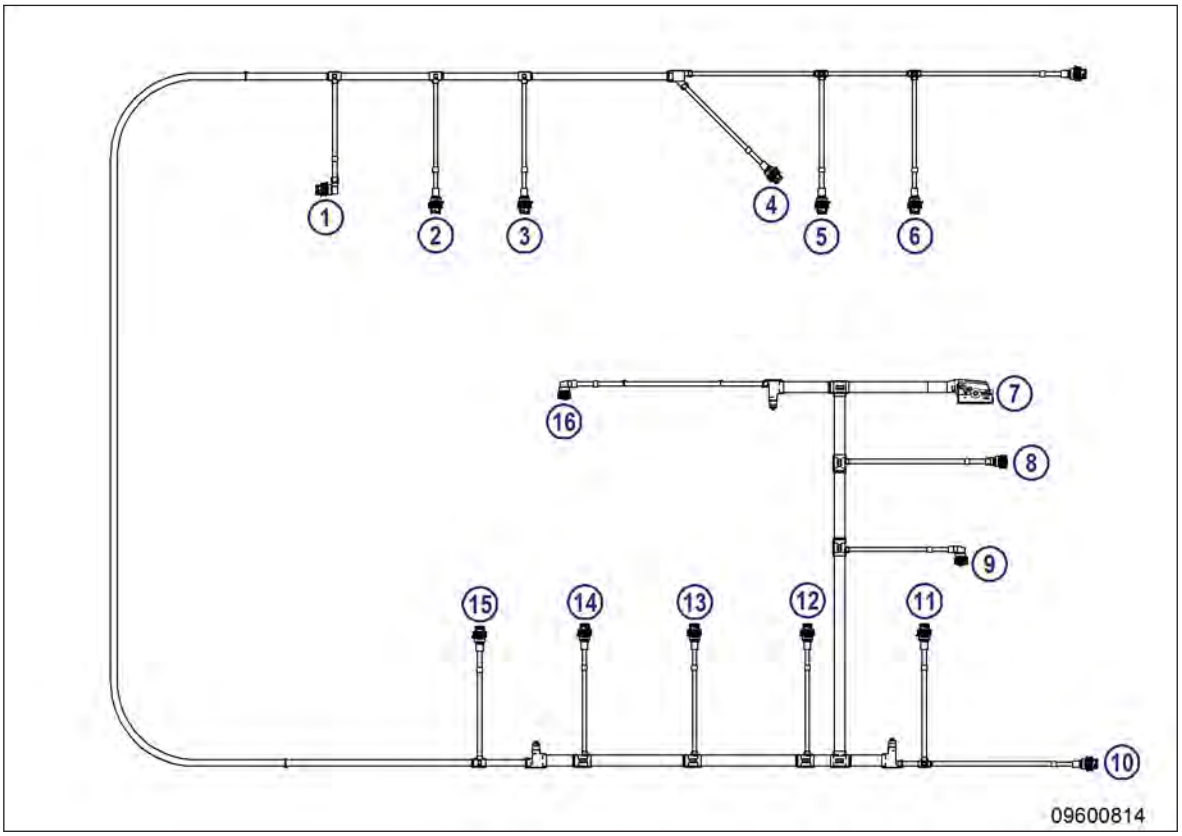
1 Y39A1	6 Y39A6	11 Y39B3
2 Y39A2	7 X4	12 Y39B2
3 Y39A3	8 Y39B6	13 Y39B1
4 Y39A4	9 Y39B5	
5 Y39A5	10 Y39B4	

Engine wiring harness for injectors, 16V engine



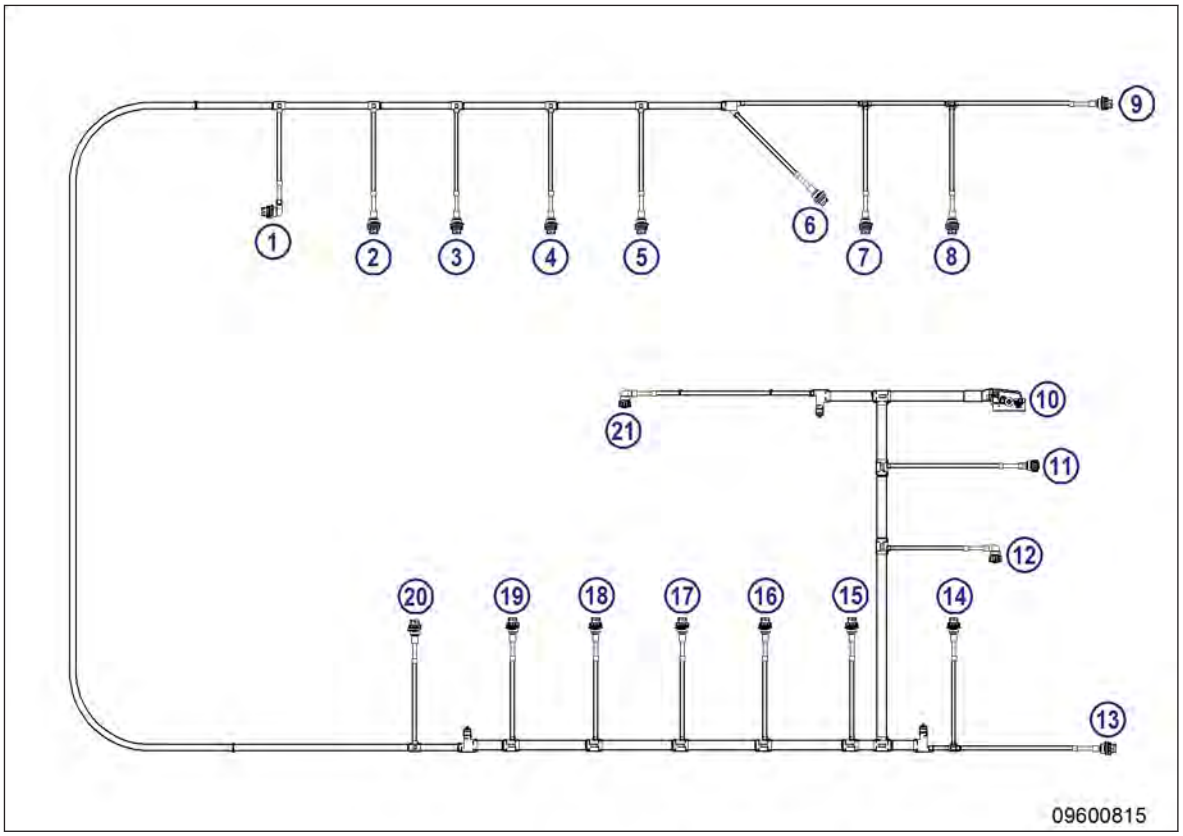
1 Y39A1	7 Y39A7	13 Y39B5
2 Y39A2	8 Y39A8	14 Y39B4
3 Y39A3	9 X4	15 Y39B3
4 Y39A4	10 Y39B8	16 Y39B2
5 Y39A5	11 Y39B7	17 Y39B1
6 Y39A6	12 Y39B6	

Wiring harness for engine-mounted sensors, 12V engine



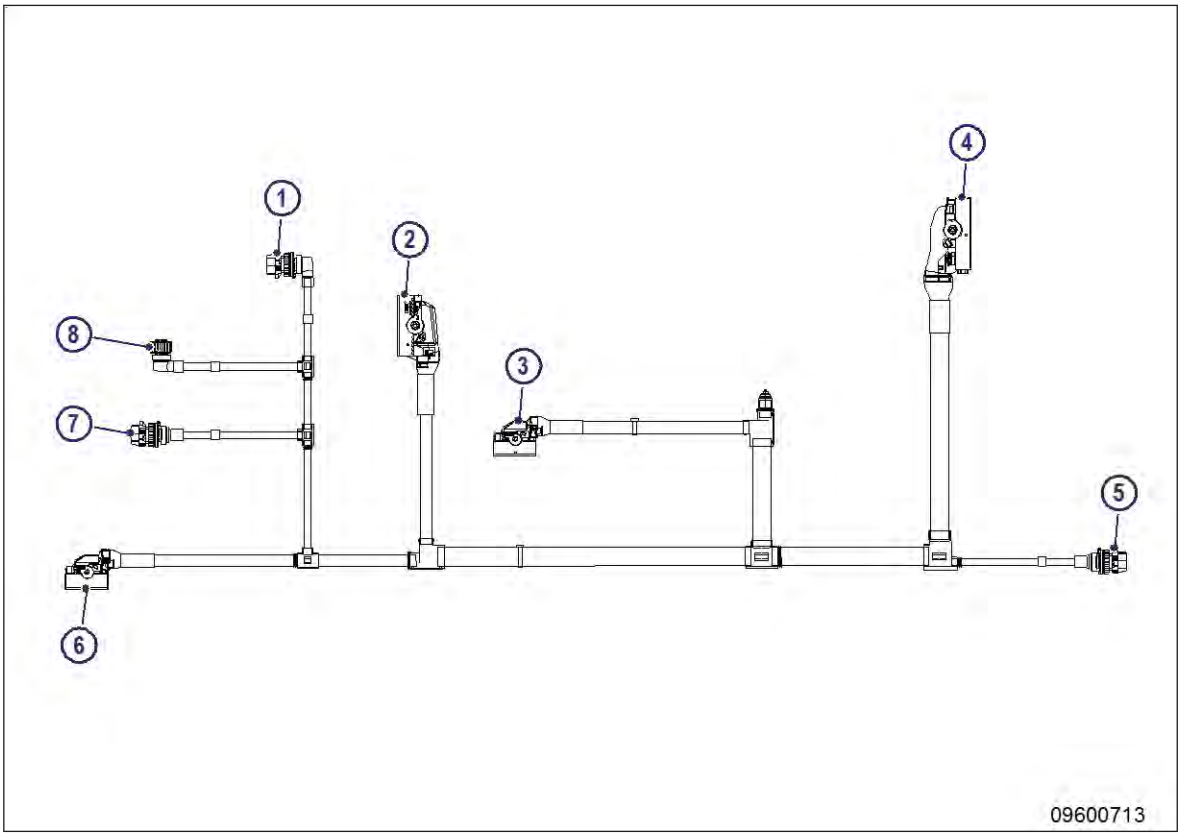
1 B13.2
2 B4A1
3 B4A2
4 B4A3
5 B4A4
6 B4A5
7 X12
8 B6.2
9 B21
10 B4B6
11 B4B5
12 B4B4
13 B4B3
14 B4B2
15 B4B1
16 B5.2

Wiring harness for engine-mounted sensors, 16V engine



1 B13.2	8 B4A7	15 B4B6
2 B4A1	9 B4A8	16 B4B5
3 B4A2	10 X12	17 B4B4
4 B4A3	11 B6.2	18 B4B3
5 B4A4	12 B21	19 B4B2
6 B4A5	13 B4B8	20 B4B1
7 B4A6	14 B4B7	21 B5.2

Wiring harness for engine interface



1 XD1
2 X1
3 X3
4 X52
5 XY1
6 X11
7 XB19
8 X37

7.20.2 Engine wiring - Check

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Isopropyl alcohol	X00058037	1

Checking engine wiring

1. Check securing screws of cable clamps on engine and tighten loose threaded connections.
2. Ensure that cables are fixed in their clamps and cannot swing freely.
3. Check that cable clamps are firm, tighten loose cable clamps.
4. Replace faulty cable clamps.
5. Visually inspect the following electrical line components for damage:
   - Connector housing
   - Contacts
   - Sockets
   - Cables and terminals
   - Plug-in contacts

Result: Contact Service if cable conductors are damaged.

Note: Close male connectors that are not plugged in with the protective cap supplied.

6. Clean dirty connector housings, sockets and contacts using isopropyl alcohol.
7. Ensure that all sensor connectors are securely engaged.

7.21 Accessories for (Electronic) Engine Governor / Control System

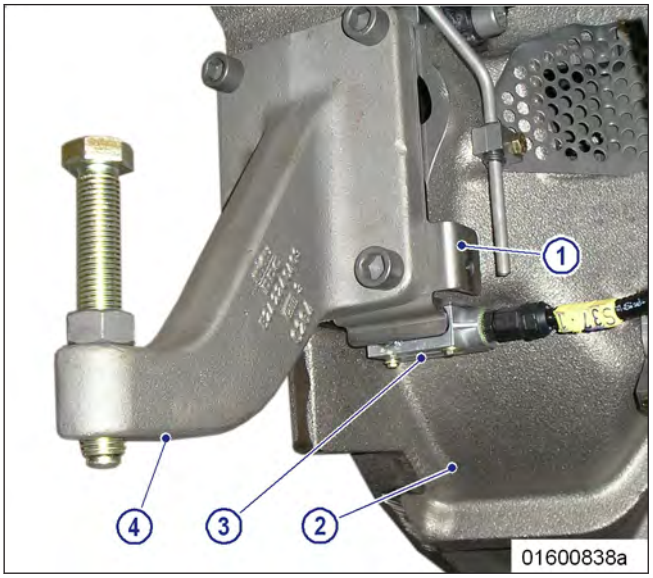
7.21.1 Limit switch for start interlock - Check

Preconditions

☑ Engine is stopped and starting disabled.

Note: In the OFF position, the limit switch initiates a start interlock, i.e. the engine cannot be started.

Checking limit switch for start interlock



1. Check whether switches (3) and guard plate (1) with engine support (4) are installed on both sides of flywheel housing (2).
2. Check whether both switches (3) are actuated.
3. If switches (3) and/or guard plate (1) with engine support (4) is/are not installed:
   - Screw on guard plate (1) with engine support (4).
   - Then screw on switch (3), ensuring that the switch (3) is actuated by the guard plate (1).
4. If switch (3) and guard plate (1) are installed, but switch (3) is in the OFF position:
   - Make certain that the guard plate (1) at the side of the switch (3) is not distorted.
   - Release guard plate (1) and screw on such that the switch (3) is actuated.

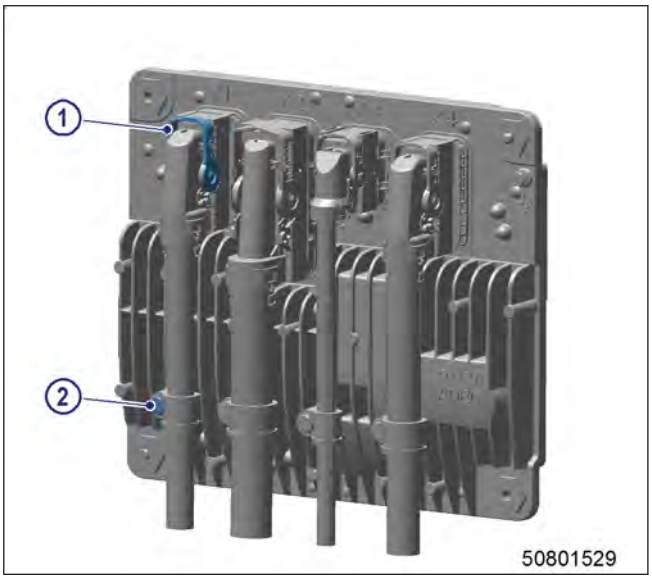
7.21.2 Engine Control Unit ECU 7 – Checking plug connections

Preconditions

☑ Engine is stopped and starting disabled.

Check plug connections on ECU 7

1. Check all connectors on ECU for firm seating. Ensure that the clips (1) are engaged.
2. Check screws (2) of cable clamps on ECU for firm seating. Ensure that cable clamps are not faulty.



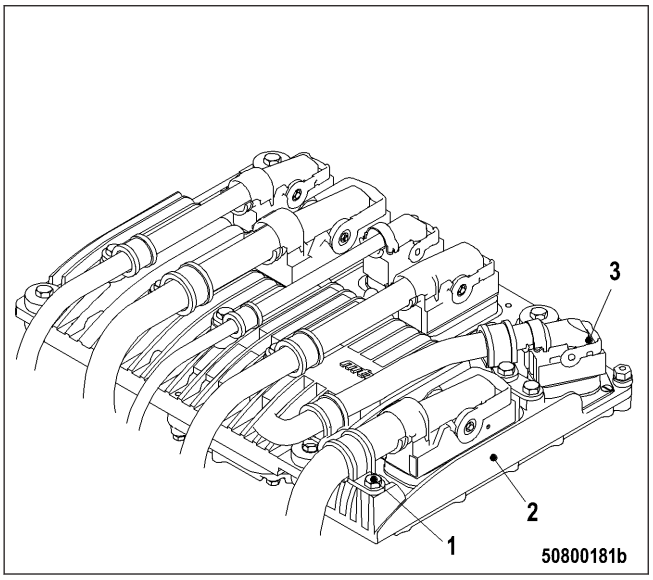
7.21.3 Engine monitoring unit EMU - Plug connection check

Preconditions

☑ Engine is stopped and starting disabled.

Checking EMU plug connections

1. Check both connectors on EMU (2) for firm seating. Make sure that frames (3) are engaged.
2. Check screws (1) of cable clamps on EMU (2) for firm seating. Make sure that cable clamps are not defective.



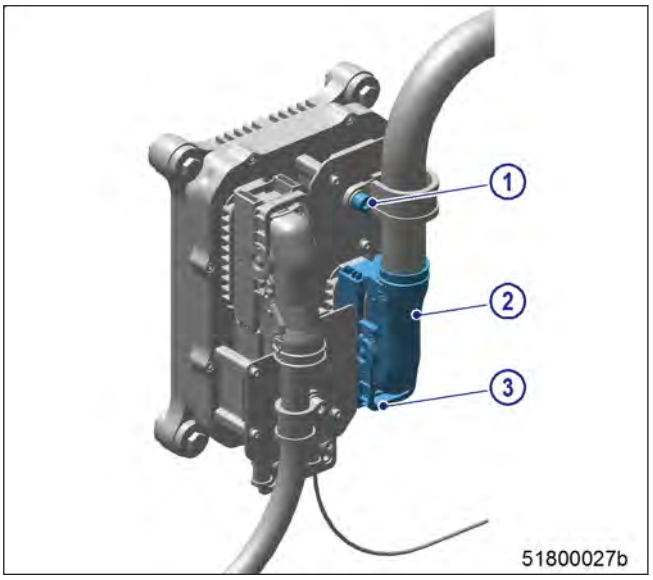
7.21.4 Interface module EIM plug connections – Check

Preconditions

☑ Engine is stopped and starting disabled.

Checking EIM plug connections

1. Check both Tyco plugs (62-pole) (2) on EIM for firm seating. Ensure that clips (3) are engaged.
2. Check screws (1) of cable clamps on EIM for firm seating. Ensure that cable clamps are not faulty.



7.21.5 Engine Control Unit ECU 7 - Removal and installation

Preconditions

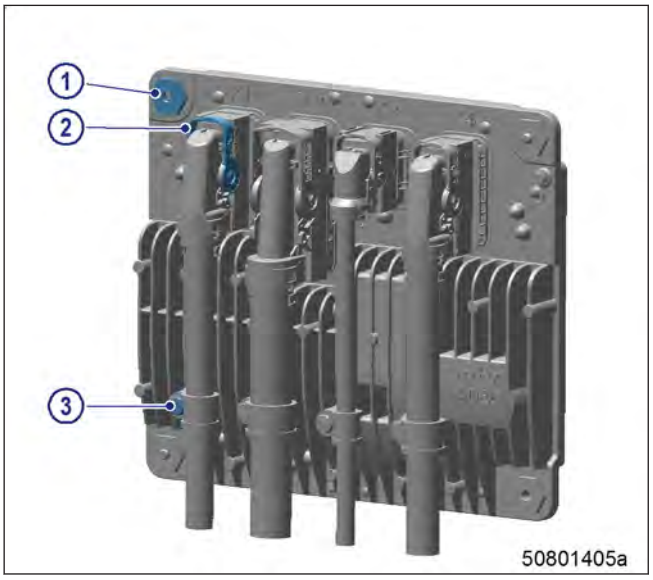
☑ Engine is stopped and starting disabled.

NOTICE

Wrong engine governor installed.
Engine damage!
- When reassembling an engine, make sure that the governor with the data record for the given engine is installed.

Removing Engine Control Unit from engine

1. Note or mark assignment of cables and connectors.
2. Remove all screws (3).
3. Undo clips (2) on connectors.
4. Remove all male connectors.
5. Remove screws (1).
6. Take off Engine Control Unit.



Installing Engine Control Unit on engine

1. Install in reverse order. Ensure correct assignment of connectors and sockets.
2. Check resilient mount before installing.

Result: If resilient mount is porous or defective then replace it.

7.21.6 EMU 7 - Removal and installation

Preconditions

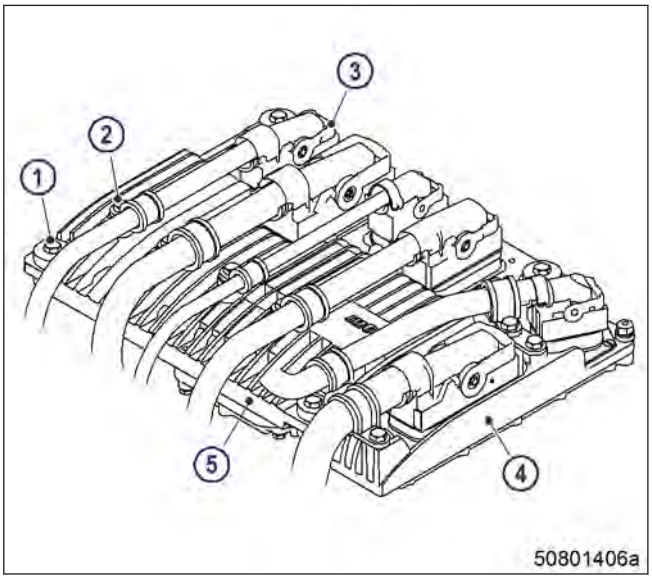
☑ Engine is stopped and starting disabled.

NOTICE

Wrong engine governor installed.
Engine damage!
- When reassembling an engine, make sure that the governor with the data record for the given engine is installed.

Removing ECU with EMU from engine

1. Note or mark assignment of cables and connectors.
2. Remove all screws (2).
3. Undo latches (3) of the connectors.
4. Disconnect all connectors.
5. Remove screws (1).
6. Remove ECU (5) with EMU (4).



Removing EMU

1. Unscrew screws on base of EMU (4).
2. Remove EMU (4) from ECU (5).

Installing EMU

1. Place EMU (4) on ECU (5).
2. Screw in and tighten screws on base of EMU (4).

Installing ECU with EMU on engine

1. Install in reverse order. Ensure correct assignment of connectors and sockets in so doing.
2. Check resilient mount before installing.

Result: Replace resilient mount if porous or defective.

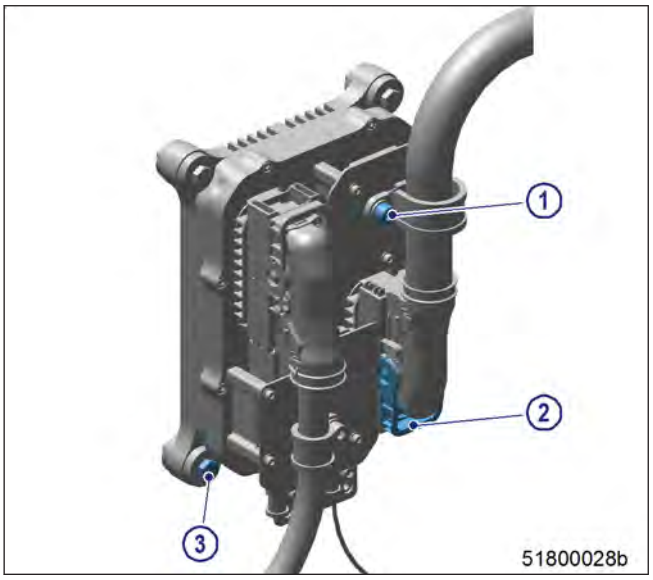
7.21.7 Engine Interface Module EIM – Removal and installation

Preconditions

☑ Engine is stopped and starting disabled.

Removing EIM from the engine

1. Note or mark assignment of cables and connectors.
2. Unscrew all screws (1).
3. Undo clips (2) on connectors.
4. Disconnect all connectors.
5. Unscrew power and starter cable.
6. Remove screws (3).
7. Take off EIM.



Installing EIM on the engine

1. Install in reverse order. When doing so, observe correct assignment between cables and plugs.
2. Check seal before installing.

Result: Replace seal if porous or defective.

Downloading software

1. The new EIM still does not have appropriate FSW and parameter/descriptor module (the diagnostic lamp (DILA) indicates flashing code 4 when the power supply is connected, (→ Page 232)).
2. The FSW and the parameter/descriptor module must first be downloaded from the central database (CDB) based on the relevant engine number using the DiaSys software tool, and then loaded in the EIM.

7.21.8 Diagnostic features of EIM

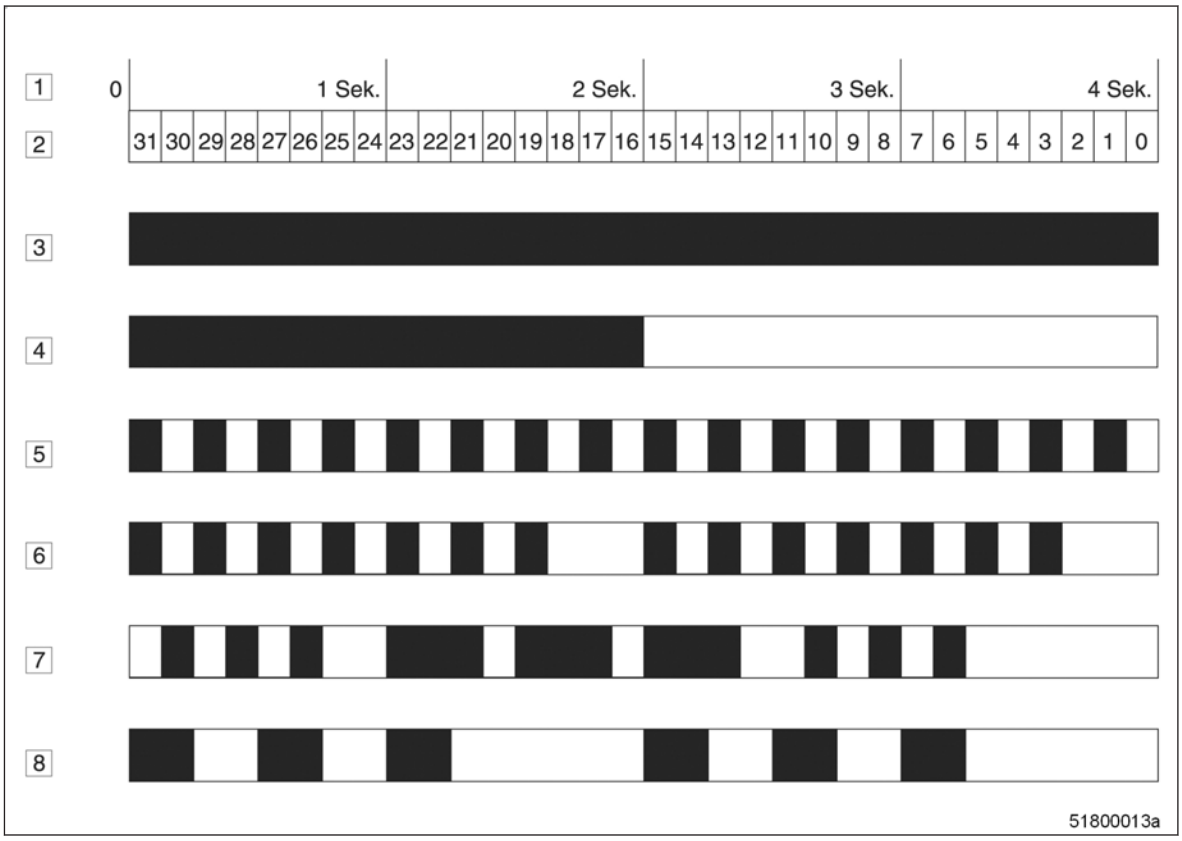
Diagnostic lamp (DILA)

A diagnostic lamp (LED, blue) is integrated in the housing of the Engine Interface Module (EIM).

It indicates the operating status of the EIM.

Functions of diagnostic lamp DILA	
DILA lights	Engine Interface Module (EIM) is OK
DILA dark	EIM supply voltage missing or diagnostic lamp activation is faulty.
DILA flashes	Hardware or software fault in the Engine Interface Module.

The diagnostic lamp (DILA) signals the following states:



1 Time in seconds
2 Timing: 1/8 s
3 Ready for operation
4 Application loader active
5 External RAM faulty
6 External FLASH faulty
7 No firmware
8 Application crashed

Fuse lamp (SILA)

A second indicator is the fuse lamp.

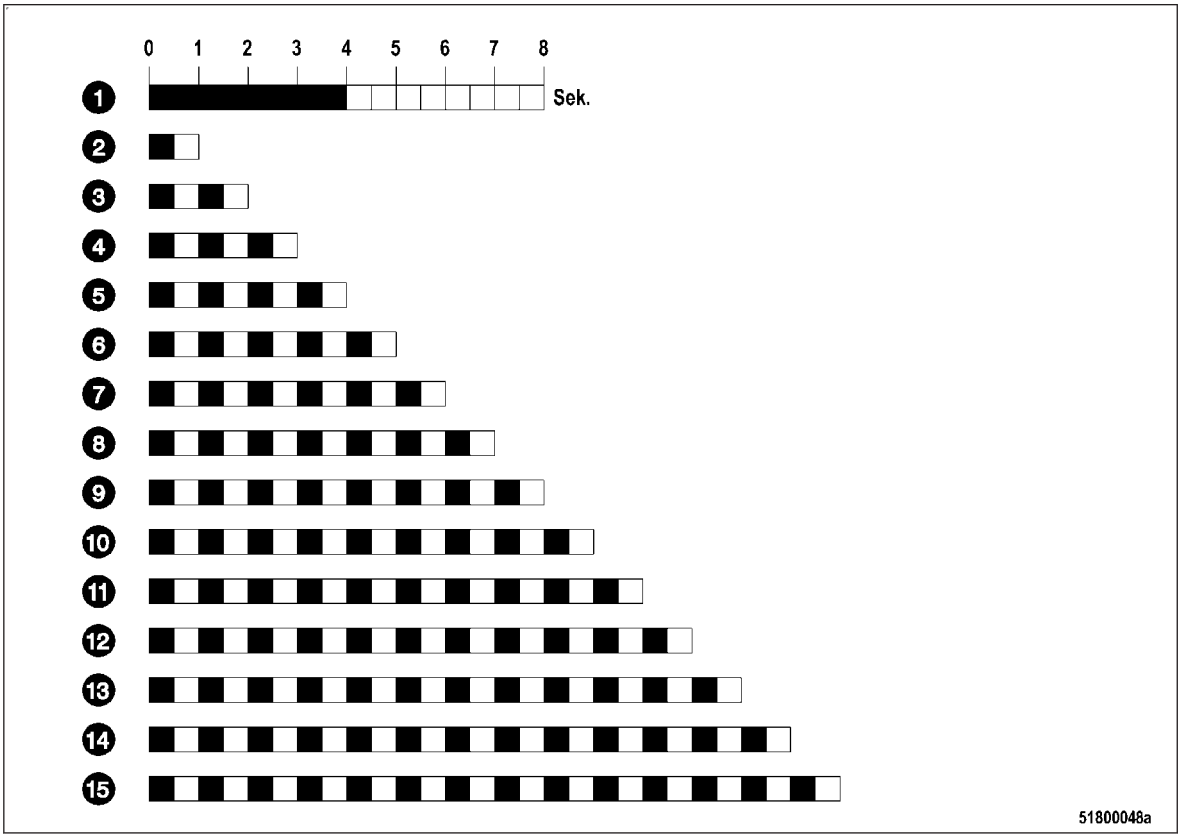
This is also integrated in the housing of the Engine Interface Module. It indicates the status of the fuses.

An orange LED is provided to allow diagnosis of a “tripped fuse” fault directly at the unit as it is often difficult to pinpoint a fault in the field without cabling diagrams.

This LED is activated by the controller.

Functions of fuse lamp SILA	
SILA dark	Norma operating state.
SILA flashes orange	One or more fuses have tripped.

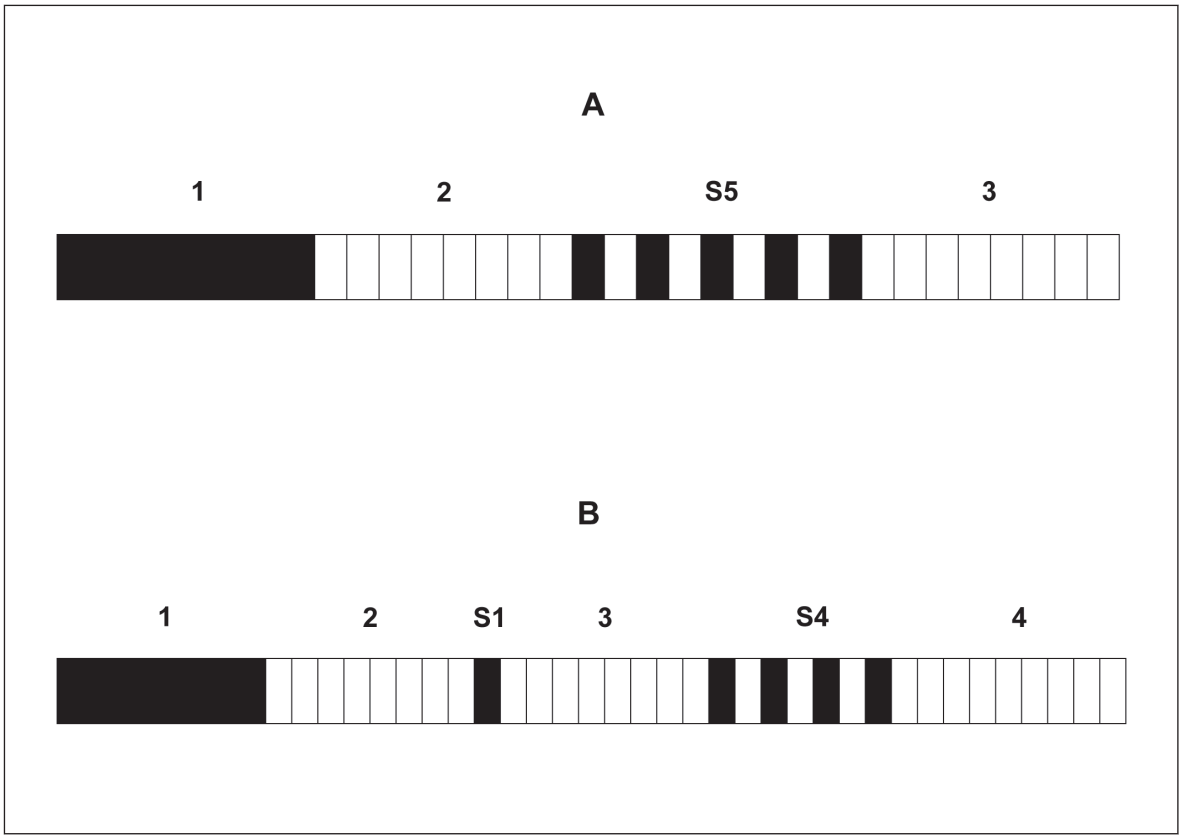
The fuse lamp (SILA) signals the following states:



1 Preamble
2 ECU current path failed (S1)
3 MCS current path failed (S2)
4 EMU current path failed (S3)
5 Starter voltage: Terminal 30, 31 not connected and PR 10.0600.001 has value 1 or 2 (S4)
6 VSP current path failed (S5)
7 SLD current path failed (S6)
8 DDV current path failed (S7)
9 Gear monitoring current path failed (S8)
10 Emergency stop current path failed – 24V internal (S9)
11 ES pushbutton current path failed – 24V external (S10)
12 Key switch current path failed (S11)
13 SDAF 1+2 current path failed (S12)
14 PIM current path failed (S13)
15 Spare current path failed (S14)

The failed current paths are signaled consecutively following the preamble (LED on for 4 seconds (1)). There is a pause lasting 4 seconds in between.

Sample flashing sequences



A Fuse S5 failure (1/2 second steps)

B Fuse S1 and fuse S4 failure (1/2 second steps)

Note:

These bit sequences are transmitted constantly.

Information about the status of the current paths of the EIM is also provided in the CAN message "Status internal power supply".

7.21.9 CDC parameters - Reset

Preconditions

☑ Engine is stopped and starting disabled.

Note: Failure to reset drift compensation (CDC parameters) will void the emissions certification.

Resetting CDC parameters with DiaSys®

▶ (→ Dialog system DiaSys® E531920/..).

Resetting CDC parameters without DiaSys®

▶ If no DiaSys® is available, contact Service.

8 Appendix A

8.1 Abbreviations

Abbreviation	Meaning	Explanation
ADEC	Advanced Diesel Engine Control	Engine governor
AL	Alarm	Alarm (general)
ANSI	American National Standards Institute	Governing body for US American standards
ETC	Exhaust turbocharger	
BR	Baureihe (Series)	
BV	Betriebsstoffvorschrift	Fluids and Lubricants Specifications, MTU Publication No. A01061/..
CAN	Controller Area Network	Data bus system, bus standard
CDC	Calibration Drift Compensation	Setting for drift correction with DiaSys in engine governor
CPP	Controllable Pitch Propeller	
DILA	Diagnostic lamp	on EIM
DIN	Deutsches Institut für Normung e. V.	German Standardization Organization, at the same time identifier of German standards ("Deutsche Industrie-Norm")
DIS	Display unit	Display panel
DL	Default Lost	Alarm: Default CAN bus failure
ECS	Engine Control System	Engine management system
ECU	Engine Control Unit	Engine governor
EDM	Engine Data Module	Memory module for engine data
EIM	Engine Interface Module	Interface to engine monitoring system
EMU	Engine Monitoring Unit	
SPC	Spare Parts Catalog	
FPP	Fixed Pitch Propeller	
GCU	Gear Control Unit	
GMU	Gear Monitoring Unit	
HAT	Harbor Acceptance Test	
HI	High	Alarm: Measured value exceeds 1st maximum limit
HIHI	High High	Alarm: Measured value exceeds 2nd maximum limit
HT	High Temperature	
ICFN	ISO - Continuous rating - Fuel stop power - Net	Power specification in accordance with DIN-ISO 3046-7
IDM	Interface Data Module	Memory module for interface data
IIG	Initial Injector Equalization	Entering of injector code with DiaSys in engine governor
IMO	International Maritime Organization	
ISO	International Organization for Standardization	International umbrella organization for all national standardization institutes
KGS	Kraftgegenseite	Engine free end in accordance with DIN ISO 1204

Abbreviation	Meaning	Explanation
KS	Kraftseite	Engine driving end in accordance with DIN ISO 1204
LCD	Liquid Crystal Display, Liquid Crystal Device	
LCU	Local Control Unit	LOP subassembly
LED	Light Emitting Diode	
LMU	Local Monitoring Unit	LOP subassembly
LO	Low	Alarm: Measured value lower than 1st minimum limit
LOLO	Low Low	Alarm: Measured value lower than 2nd minimum limit
LOP	Local Operating Panel	Control console, control panel
LOS	Local Operating Station	
MCS	Monitoring and Control System	
MG	Message	
MPU	Microprocessor Unit, Microprocessing Unit	Microprocessor (unit)
TDC	Top Dead Center	
P-xyz	Pressure-xyz	Pressure measuring point xyz
PAN	Panel	Operating panel
PCU	Propeller Control Unit	
PIM	Peripheral Interface Module	
RCS	Remote Control System	
RL	Redundancy Lost	Alarm: Redundant CAN bus failure
SAE	Society of Automotive Engineers	U.S. standardization organization
SAT	Sea Acceptance Test	
SD	Sensor Defect	Alarm: Sensor failure
SDAF	Shut Down Air Flaps	Emergency-air shutoff flap(s)
SILA	Fuse lamp	on EIM
SOLAS	International Convention for the Safety of Life at Sea	
SS	Safety System	Indicated alarm is initiated by the safety system
SSK	Emergency-air shutoff flap(s)	
T-xyz	Temperature-xyz	Temperature measuring point xyz
TD	Transmitter Deviation	Alarm: Sensor comparison fault
BDC	Bottom Dead Center	
VS	Voith Schneider	Voith-Schneider drive
WJ	Water Jet	Water jet drive
TC	Tool Catalog	
ZKP	Zugehörigkeit-Kategorie-Parameter	Numbering plan for ADEC ECU signals

8.2 MTU contact persons/service partners

Our worldwide sales network with its subsidiaries, sales offices, representatives and customer service centers ensures fast and direct support on site and the high availability of our products.

Local support

Experienced and qualified specialists place their knowledge and expertise at your disposal.

For locally available support, go to the MTU Internet site: http://www.mtu-online.com

24h hotline

With our 24h hotline and the outstanding flexibility of our service staff, we are always ready to assist you – either during operation, for preventive maintenance, corrective work in case of malfunction or changed operating conditions, or for spare parts supply.

Your contact person in our Customer Assistance Center:

E-mail: info@mtu-online.com

Tel.: +49 7541 9077777

Fax: +49 7541 9077778

Asia/Pacific: +65 6100 2688

North and Latin America: +1 248 560 8000

Spare parts service

Fast, simple and correct identification of spare parts for your drive system or vehicle fleet. The right spare part at the right time at the right place.

With this aim in mind, we can call on a globally networked spares logistics system, a central warehouse at headquarters and on-site stores at our subsidiary companies, agencies and service workshops.

Your contact at Headquarters:

E-mail: spare.parts@mtu-online.com

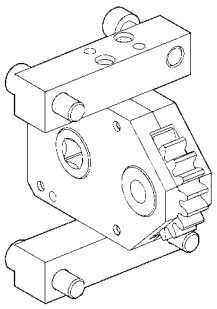
Tel.: +49 7541 908555

Fax: +49 7541 908121

9 Appendix B

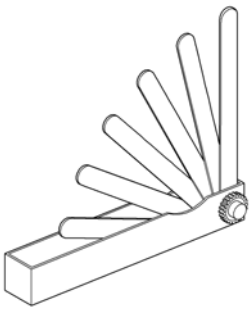
9.1 Special Tools

Barring device



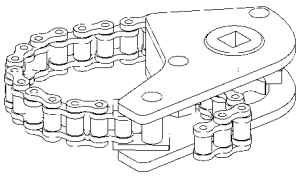
Part No.:	F6555766
Qty.: Used in:	1 7.1.1 Engine – Barring manually (→ Page 132)

Feeler gauge



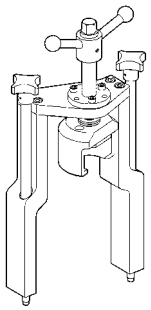
Part No.:	Y20010128
Qty.: Used in:	1 7.3.2 Valve clearance – Check and adjustment (→ Page 140)

Filter wrench



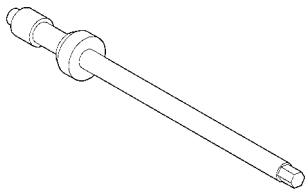
Part No.:	F30379104
Qty.: Used in:	1 7.6.2 Additional fuel filter – Replacement (→ Page 153)
Qty.: Used in:	1 7.6.3 Fuel filter – Replacement (→ Page 154)
Qty.: Used in:	7.13.2 Engine oil filter – Replacement (→ Page 183)
Qty.: Used in:	1 7.13.3 Centrifugal oil filter – Cleaning and filter sleeve replacement (→ Page 185)
Qty.: Used in:	1 7.14.8 Engine coolant filter – Replacement (→ Page 201)

Installation/removal tool



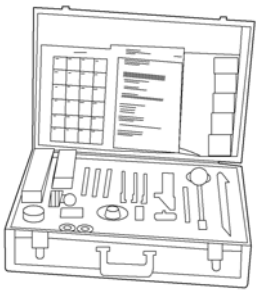
Part No.:	F6789889
Qty.:	1
Used in:	7.5.2 Injector – Removal and installation (→ Page 147)

Milling cutter



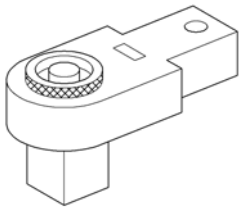
Part No.:	F30452739
Qty.:	1
Used in:	7.5.2 Injector – Removal and installation (→ Page 147)

MTU test kit



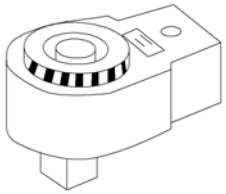
Part No.:	5605892099/00
Qty.:	1
Used in:	7.12.3 Engine oil – Sample extraction and analysis (→ Page 179)
Qty.:	1
Used in:	7.14.7 Engine coolant – Sample extraction and analysis (→ Page 200)

Ratchet



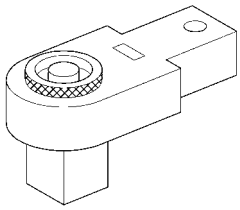
Part No.:	F30027340
Qty.:	1
Used in:	7.5.2 Injector – Removal and installation (→ Page 147)

Ratchet



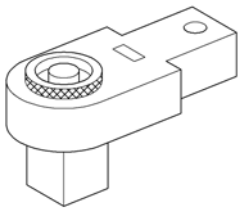
Part No.:	F30027341
Qty.:	1
Used in:	7.5.2 Injector – Removal and installation (→ Page 147)

Ratchet



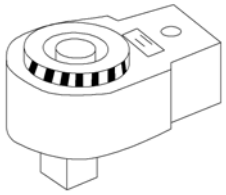
Part No.:	F30027339
Qty.:	1
Used in:	7.19.5 Coalescer filter element – Replacement (→ Page 213)

Ratchet adapter



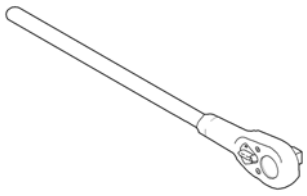
Part No.:	F30027340
Qty.:	1
Used in:	7.6.7 Fuel prefilter with water separator – Filter element replacement (→ Page 161)
Qty.:	1
Used in:	7.7.1 Compressor wheel – Cleaning (→ Page 163)

Ratchet adapter



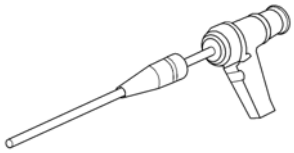
Part No.:	F30027341
Qty.:	1
Used in:	7.12.2 Engine oil – Change (→ Page 177)

Ratchet with extension



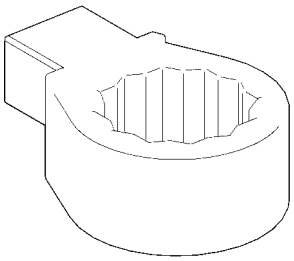
Part No.:	F30006212
Qty.:	1
Used in:	7.1.1 Engine – Barring manually (→ Page 132)

Rigid endoscope



Part No.:	Y20097353
Qty.:	1
Used in:	7.2.1 Cylinder liner – Endoscopic examination (→ Page 135)

Socket wrench, 24 mm

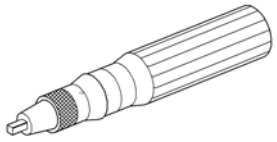


Part No.:	F30039526
Qty.:	1
Used in:	7.3.2 Valve clearance – Check and adjustment (→ Page 140)

Steam jet cleaner

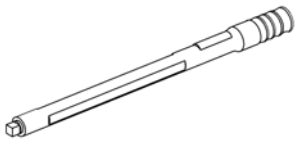
Part No.:	-
Qty.:	1
Used in:	4.14 Plant – Cleaning (→ Page 98)

Torque wrench, 0.5-5 Nm



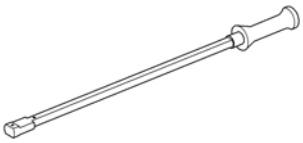
Part No.:	0015384230
Qty.:	1
Used in:	7.5.2 Injector – Removal and installation (→ Page 147)

Torque wrench, 10-60 Nm



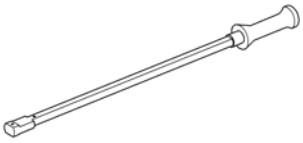
Part No.:	F30510423
Qty.:	1
Used in:	7.6.7 Fuel prefilter with water separator – Filter element replacement (→ Page 161)

Torque wrench, 10-60 Nm



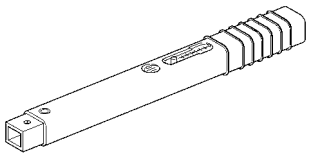
Part No.:	F30452769
Qty.:	1
Used in:	7.7.1 Compressor wheel – Cleaning (→ Page 163)

Torque wrench, 10-60 Nm



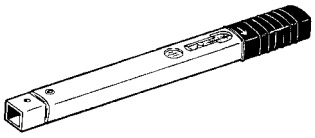
Part No.:	F30452769
Qty.:	1
Used in:	7.5.2 Injector – Removal and installation (→ Page 147)

Torque wrench, 40-200 Nm



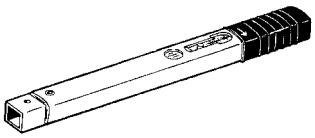
Part No.:	F30027337
Qty.:	1
Used in:	7.12.2 Engine oil – Change (→ Page 177)

Torque wrench, 6-50 Nm



Part No.:	F30027336
Qty.:	1
Used in:	7.13.3 Centrifugal oil filter – Cleaning and filter sleeve replacement (→ Page 185)

Torque wrench, 6-50 Nm

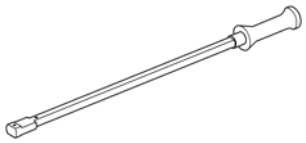


Part No.:	F30027336
Qty.:	1
Used in:	7.19.5 Coalescer filter element – Replacement (→ Page 213)

Torque wrench, 60-320 Nm

Part No.:	F30047446
Qty.:	1
Used in:	7.3.2 Valve clearance – Check and adjustment (→ Page 140)

Torque wrench, 60-320 Nm



Part No.:	F30452768
Qty.:	1
Used in:	7.5.2 Injector – Removal and installation (→ Page 147)

9.2 Index

V

W