

Operating Instructions

Diesel engine

12 V 4000 C13, C13R, C13L

12 V 4000 C23, C23R

16 V 4000 C13, C13R, C13L

16 V 4000 C23, C23R

M015695/03E



Power. Passion. Partnership.

Printed in Germany

© 2013 Copyright MTU Friedrichshafen GmbH

This Publication is protected by copyright and may not be used in any way whether in whole or in part without the prior written permission of MTU Friedrichshafen GmbH. This restriction also applies to copyright, distribution, translation, microfilming and storage or processing on electronic systems including data bases and online services.

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	5
1.2 Personnel and organizational requirements	6
1.3 Transport	7
1.4 Crankshaft transport locking device	8
1.5 Crankshaft transportation lock - For transport with flange-mounted generator	10
1.6 Safety regulations for startup and operation	12
1.7 Safety regulations for maintenance and repair work	13
1.8 Fire prevention and environmental protection, fluids and lubricants, auxiliary materials	16
1.9 Standards for safety notices in the text	18

2 General Information

2.1 Engine side and cylinder designations	19
2.2 Engine layout	20
2.3 Sensors and actuators - Overview	21

3 Technical Data

3.1 12/16 V 4000 C13/13R/13L engine data: Application group 5A, optimized fuel consumption	25
3.2 12/16 V 4000 C13/13R/13L engine data: Application group 5A, optimized exhaust emissions (EPA Stage 2)	32
3.3 12/16 V 4000 C23/23R engine data: Application group 5B, optimized fuel consumption	39
3.4 12/16 V 4000 C23/23R engine data: Application group 5B, optimized exhaust emissions (EPA Stage 2)	43
3.5 Firing order	47
3.6 Main engine dimensions	48

4 Operation

4.1 Preparations for recommissioning the engine after extended out-of-service periods (>3 months)	49
4.2 Putting the engine into operation after scheduled out-of-service-period	50
4.3 Starting the engine in manual mode	51
4.4 Stopping the engine in manual mode	52
4.5 After shutting down the engine	53
4.6 Plant cleaning	54

5 Maintenance

5.1 Maintenance task reference table [QL1]	55
--	----

6 Troubleshooting

6.1 Troubleshooting	56
6.2 Fault messages of the engine governor ADEC (ECU 7) for series 4000 C&I engines	59

7 Task Description

7.1 Engine	78
7.1.1 Cranking engine manually	78
7.1.2 Engine - Barring with starting system	80
7.2 Cylinder Liner	81
7.2.1 Cylinder liner - Endoscopic examination	81
7.2.2 Instructions and comments on endoscopic and visual examination of cylinder liners	83
7.3 Crankcase Breather	85
7.3.1 Crankcase breather - Oil separator element replacement, diaphragm check and replacement	85
7.4 Running Gear	87
7.4.1 Grounding device - Carbon brush check	87
7.4.2 Grounding device - Carbon brush replacement	89
7.5 Valve Drive	90
7.5.1 Valve gear - Lubrication	90
7.5.2 Valve clearance - Check and adjustment	91
7.5.3 Cylinder head cover - Removal and installation	95
7.6 Injection Pump / HP Pump	96
7.6.1 HP pump - Filling with engine oil	96
7.7 Injection Valve / Injector	97
7.7.1 Injector - Replacement	97
7.7.2 Injector - Removal and installation	98
7.8 Fuel System	103
7.8.1 Fuel system - Venting	103
7.9 Fuel Filter	104
7.9.1 Fuel filter - Replacement	104
7.9.2 Draining fuel prefilter	105
7.9.3 Fuel prefilter - Draining	106
7.10 Charge-Air Cooling	107
7.10.1 Intercooler - Checking condensate drain for coolant discharge and obstructions	107
7.11 Air Intake	108
7.11.1 Service indicator - Signal ring position check	108
7.12 Starting Equipment	109

7.12.1 Starter - Condition check	109	7.17 Belt Drive	139
7.13 Lube Oil System, Lube Oil Circuit	110	7.17.1 Drive belt - Condition check	139
7.13.1 Checking engine oil level	110	7.18 Battery-Charging Generator	140
7.13.2 Checking engine oil level	111	7.18.1 Alternator - Removing and refitting	140
7.13.3 Engine oil - Change	112	7.18.2 Battery-charging generator - Check	142
7.13.4 Engine oil - Sample extraction and analysis	114	7.18.3 Battery-charging generator drive - Drive belt tension adjustment	143
7.14 Oil Filtration / Cooling	115	7.18.4 Battery-charging generator - Drive belt and belt tensioner replacement	144
7.14.1 Automatic oil filter - Oil filter candles replacement	115	7.19 Fan Drive	146
7.14.2 Oil indicator filter - Cleaning and check	118	7.19.1 Fan drive - Drive belt tension check / adjustment	146
7.14.3 Centrifugal oil filter - Cleaning and filter-sleeve replacement	120	7.19.2 Fan drive - Drive belt replacement	148
7.15 Coolant Circuit, General, High-Temperature Circuit	122	7.20 Wiring (General) for Engine/Gearbox/Unit	149
7.15.1 Engine coolant - Level check	122	7.20.1 Engine wiring - Check	149
7.15.2 Engine coolant - Change	123	7.21 Accessories for (Electronic) Engine Governor / Control System	150
7.15.3 Draining engine coolant	124	7.21.1 Engine governor and connectors - Cleaning	150
7.15.4 Engine coolant - Filling	126	7.21.2 Engine governor plug connections - Check	151
7.15.5 Engine coolant pump - Checking pressure relief port	129		
7.15.6 Engine coolant filter - Replacement	130	8 Appendix A	
7.15.7 Engine coolant - Sample extraction and analysis	131	8.1 Abbreviations	152
7.16 Low-Temperature Circuit	132	8.2 MTU contact persons/service partners	154
7.16.1 Charge-air coolant - Level check	132	9 Appendix B	
7.16.2 Charge-air coolant - Change	133	9.1 Special Tools	155
7.16.3 Draining charge-air coolant	134	9.2 Index	162
7.16.4 Charge-air coolant - Filling	135		
7.16.5 Charge-air coolant pump - Checking pressure relief port	138		

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 (→ product 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 (→ applicable Spare Parts Catalog)
- 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 instructions and in adherence to 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

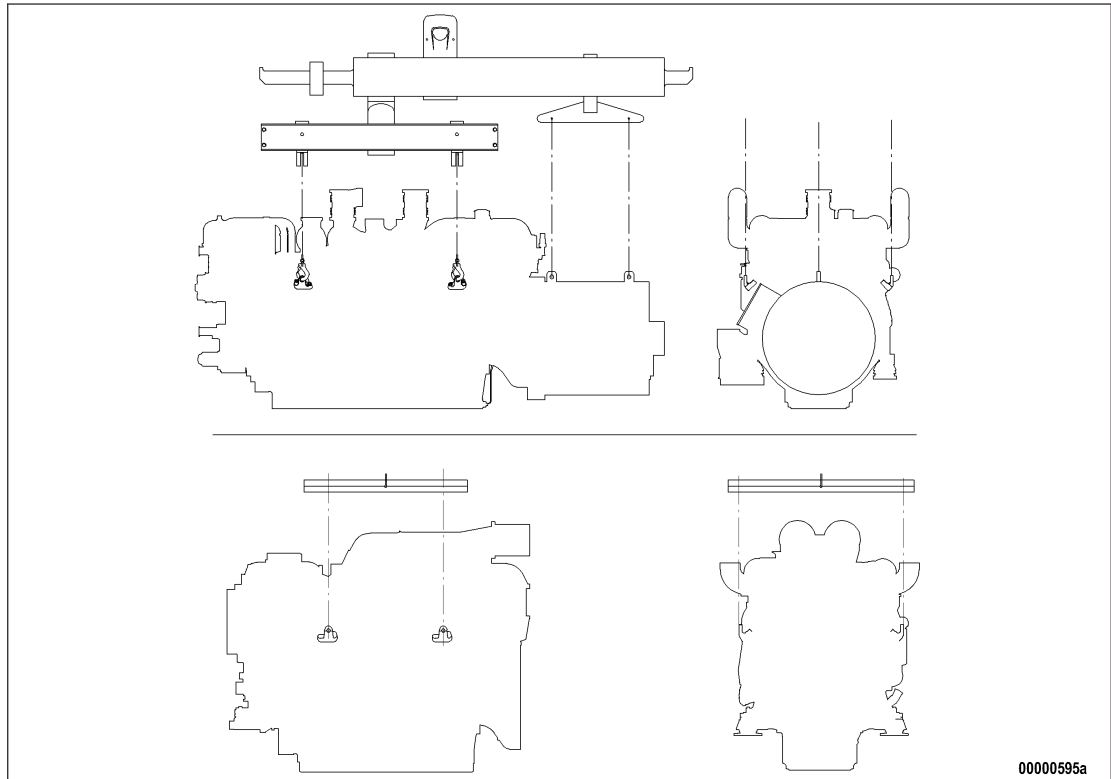
The operator must define the responsibilities of the personnel involved in operation, maintenance, repair and transport.

Working clothes and protective equipment

Wear proper protective clothing for all work.

1.3 Transport

Transport



Always use the lifting eyes on the engine and generator/gearbox when transporting gensets.

Always use the lifting eyes on the engine when transporting an engine separately.

Only use transport and lifting devices approved by MTU.

The engine/genset must only be transported in installation position: maximum permissible diagonal pull 10°.

Remove any loose parts on the genset.

Raise the engine/genset slowly. The lifting ropes or chains must not make contact with the engine or its components. Readjust lifting device as necessary.

Pay attention to the center of gravity of the engine/genset.

For special packaging with aluminium foil: Suspend the engine/genset by the lifting eyes on the bearing pedestal or transport by means of handling equipment (forklift truck) capable of bearing the load.

Fit the crankshaft transportation lock on the engine and fit the engine mount locking devices prior to transport.

Secure the engine/genset such as to preclude tipping during transport. Secure such as to preclude slipping and tipping when driving up or down inclines and ramps.

Placement after transport

Place the engine/genset on a firm, flat surface only.

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

Never set an engine down on the oil pan unless expressly authorized to do so by MTU on a case-to-case basis.

1.4 Crankshaft transport locking device

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 10-60 Nm	F30452769	1
Torque wrench, 60-320 Nm	F30452768	1
Engine oil		

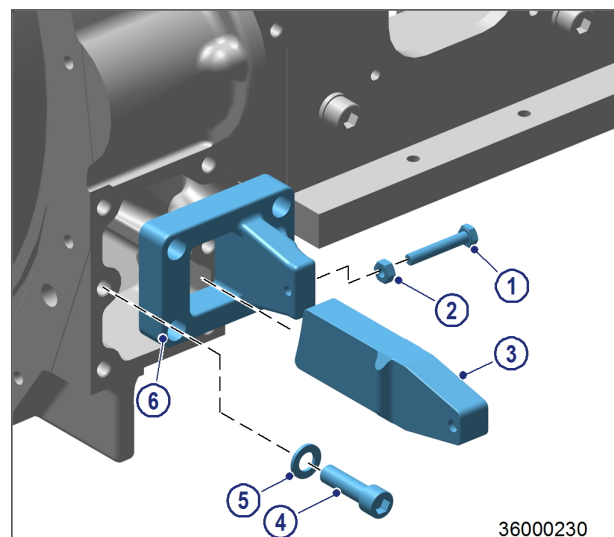
Transport locking device

Note: The locking device on both ends protects the crankshaft bearings from shocks and vibration damage during engine transport.

For installation and removal of the transport locking device, follow the instructions below:

1. The transport locking device must remain installed on both ends as long as possible during engine installation in order to avoid damage.
2. Prior to every engine transport, the transport locking device must be reinstalled on both sides according to the instructions.
3. If the engine is to be moved together with the generator, the transport locking device for the generator must also be installed.
4. Always use the screws supplied with or installed in the transport locking device to secure it on the engine.
5. Starting or barring the engine is allowed only with the transport locking device removed. If the generator is already mounted on the engine, ensure that the transport locking device of the generator is also removed.
6. Attach these instructions, clearly visible, to the engine.

Fitting the transport locking device on driving end (KS)



Note: Attach plate (6) only to the upper part of the openings.

1. Secure the two plates (6) with screws (4) and washers (5) at the bores on both sides of the flywheel housing and tighten to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw	M16	Tightening torque	(Engine oil)	250 Nm +25 Nm

TMA-ID: 0000035999 - 002

2. Screw locknut (2) onto screw (1) up to the end of the thread.
3. The long end of holder (3) must face downwards. Push holder (3) through the plate openings (6).

Note: The holders (3) must lock the flywheel only, not the ring gear.

4. Install screw (1) into the bore of holder (1) until the holder (1) is locked in position.

Note: Tighten screw (1) alternately on both sides of the flywheel housing.

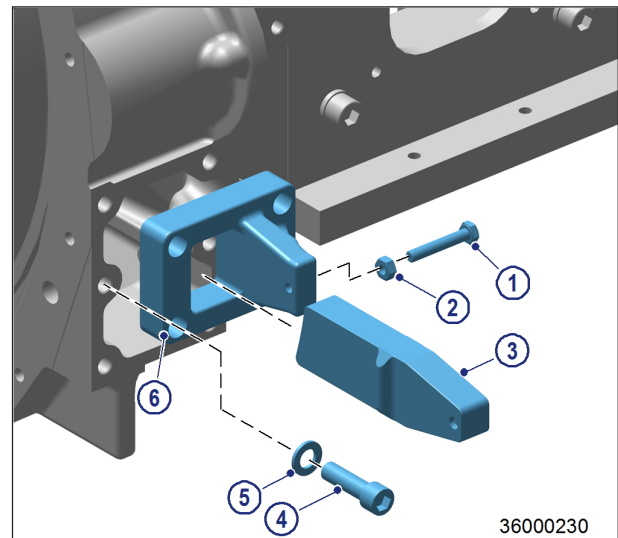
5. Tighten screw (1) alternately to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw	M10	Tightening torque	(Engine oil)	30 Nm +3 Nm

6. Fit locknut (2) of screw (1) on plate (6) and secure.

Removing the transport locking device from driving end (KS)

1. Release the locknut (2) on both sides of the flywheel housing, remove screw (1) and take off the two holders (3).
2. Unscrew screws (4) and remove together with washers (5) and plate (6).
3. Store the removed parts of the transport locking device together with this documentation carefully for possible reuse.



1.5 Crankshaft transportation lock - For transport with flange-mounted generator

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 10-60 Nm	F30452769	1
Ratchet	F30027340	1
Engine oil		

Transportation lock

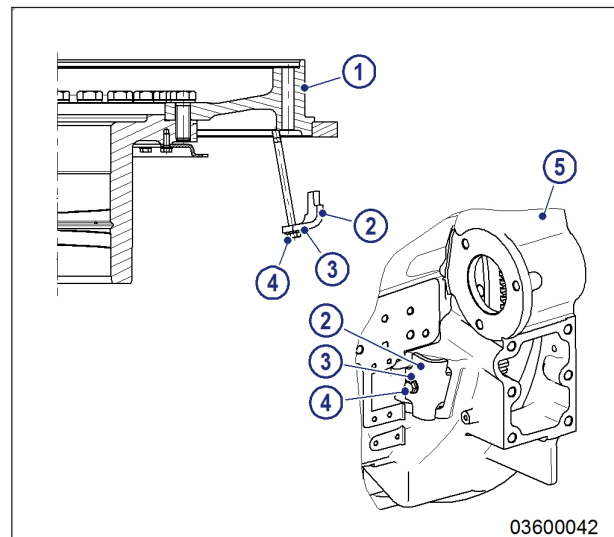
Note: The transportation lock on the engine protects the crankshaft bearings from potential damage caused by shocks and vibration when transporting the genset.

For installation and removal of the transportation lock, follow the instructions below:

1. The transportation lock must remain in place on the engine for as long as possible during installation of the genset in order to prevent damage.
2. The engine must never be started or cranked with the transportation lock in place. Make sure that the transportation lock on the generator is also removed.
3. The transportation lock must always be refitted on the engine according to the instructions whenever the genset is transported. The generator transportation lock should also be installed.

Removing transportation lock on driving end (KS)

1. Unscrew screw (4) on both sides of the flywheel housing (5).
2. Remove retainer (2) and washer (3).
3. Remove guard plate from flywheel housing.
4. Store the removed parts safely so that they are ready for reuse when required.



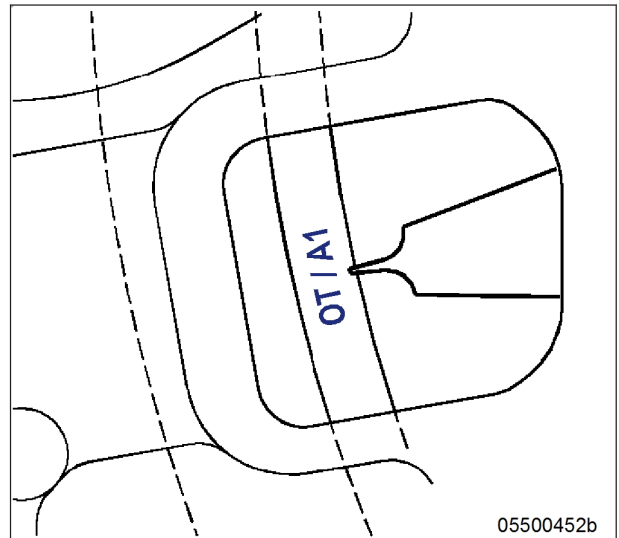
Installing the transportation lock on driving end (KS)

Note: Keep guard plate and screws on the engine. They must be refitted when the transportation lock has been removed.

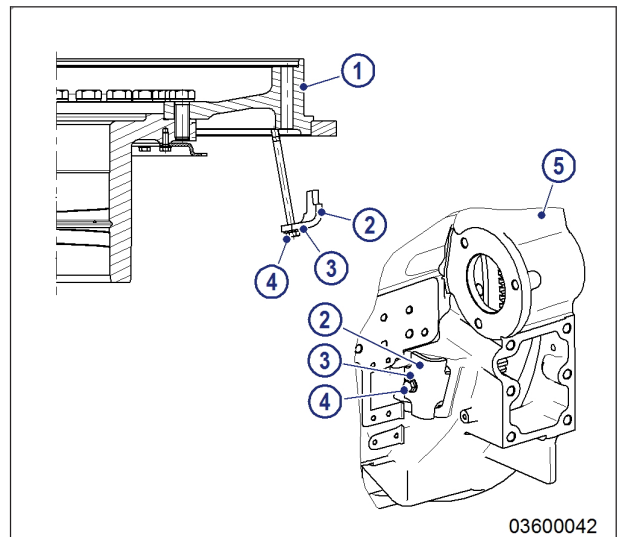
1. Remove guard plate from flywheel housing.
2. Install barring device (→ Page 78).

TTM-ID: 0000040647 - 002

3. Turn crankshaft to bring cylinder A1 to TDC position.



4. Check the threads on both sides of the fly-wheel (1) for ease of movement.
5. Fit retainer (2) together with screw (4) and washer (3) through the opening in the fly-wheel housing (5).



- Note: Tighten screw (4) in three steps.
6. Tighten screw (4) on each side alternately to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw	M10	Tightening torque	(Engine oil)	50 Nm +5 Nm

1.6 Safety regulations for startup and operation

Safety regulations for startup

Install the product correctly and carry out acceptance in accordance the manufacturer's specifications before putting the product into service.

Before the product is put into operation for the first time, all official authorizations must be available and commissioning preconditions met.

When putting the product into operation, always ensure

- that all maintenance and repair work has been completed;
- that all loose parts have been removed from rotating machine components;
- that no-one is present in the danger zone of rotating machine components.

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

Safety regulations for equipment operation

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

The operator must be familiar with the consequences of any operations performed.

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

Malfunctions and emergency stop

The procedures for cases of emergency, in particular, emergency stop, must be practiced regularly.

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

- Inform supervisor(s) in charge,
- Analyze the message,
- If required, carry out emergency operations e.g. emergency stop.

Operation

The following conditions must be fulfilled before starting the product:

- Wear ear protection.
- Ensure that the engine room is well ventilated.
- Do not inhale the exhaust gases of the product.
- Ensure that the exhaust system is free of leaks and that the gases are discharged to atmosphere.
- Mop up any leaked or spilt fluids and lubricants immediately or soak up with a suitable binding agent.
- Protect battery terminals, generator terminals or cables against accidental contact.

Operation of electrical equipment

When electrical equipment is in operation, certain components of these appliances are electrically live.

Observe the safety instructions for these devices.

TIM-ID: 0000040533 - 001

1.7 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 engine room is adequately ventilated.

Never carry out maintenance and repair work with the product in operation.

Carry out function checks on a product in operation only if expressly permitted to do so.

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 circuit breakers.

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 additional instructions apply to starters with beryllium copper pinion:

- Breathing protection of filter class P2 must be applied during maintenance work to avoid health hazards caused by the beryllium-containing pinion. 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 as an additional measure.

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 loose objects 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 the function and safe operating condition of tools and fixtures to be used. Use only the specified devices for hydraulic removal/installation procedures.

Observe the max. permissible push-on pressure specified for the equipment.

Do not attempt to bend or apply force to lines.

Before starting work, pay attention to the following:

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

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

TIM-ID: 0000040535 - 001

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 binders 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 fitted with the protective devices necessary for safe operation according to type and application.

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

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

1.8 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 cloths soaking 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 accident if acoustic signals, warning shouts or noises indicating danger are drowned.

Wear ear protectors in work areas 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 as well as 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 lead to forfeiture of the operating permit issued by the emission monitoring 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 are subjected to proper recycling procedures.

Auxiliary materials, fluids and lubricants

The Fluids and Lubricants Specifications will be amended or supplemented as necessary. Prior to operation, make sure that the latest version is used. The applicable version may be downloaded at: <http://www.mtu-online.com/mtu/mtu-valuecare/mtu-valueservice-Technische-Dokumentation>.

Auxiliary materials, fluids and lubricants might be hazardous goods or toxic substances. When using fluids, lubricants, auxiliary materials and other chemical substances, follow the safety instructions that apply to the product. Take special care when using hot, chilled or caustic materials. When using flammable materials, avoid contact with ignition sources and do not smoke.

Used oil

Used oil contains harmful combustion residue.

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 lead-containing compounds, avoid direct contact to the skin and 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 (danger class A1, A11 and B) out of containers, results in a risk of explosion.
- Wear goggles when blowing off components or blowing away chips.
- Forcing compressed air into thin-walled containers (e.g. containers made of tin, plastic and glass) for drying purposes or to check for leaks, results in a risk of bursting.
- Pay special attention to the pressure level in the compressed air network or pressure vessel.
- Assemblies or products to be connected must either be designed for this pressure, or, if the permitted pressure for the connecting elements is lower than the pressure required, a pressure reducing valve and safety valve (set to permitted pressure) must form an intermediate connection.
- Hose 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 equipment is disconnected from the supply line, or before the equipment or tool is to be replaced.
- Carry out leak test in accordance with the specifications.

Paints and lacquers

- Observe the relevant safety data sheet for all materials.
- When carrying out painting work outside the spray stands provided with fume extraction systems, ensure that the area is well ventilated. Make sure that neighboring work areas are not impaired.
- Avoid open 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 specified containers (without fixed covers).
- Avoid body contact (eyes, hands).
- Wear protective clothing, protective gloves, closed shoes and protective goggles.
- Make sure that working area is well ventilated.
- Avoid all knocks and jars to the containers, fixtures or workpieces.

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

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

1.9 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.

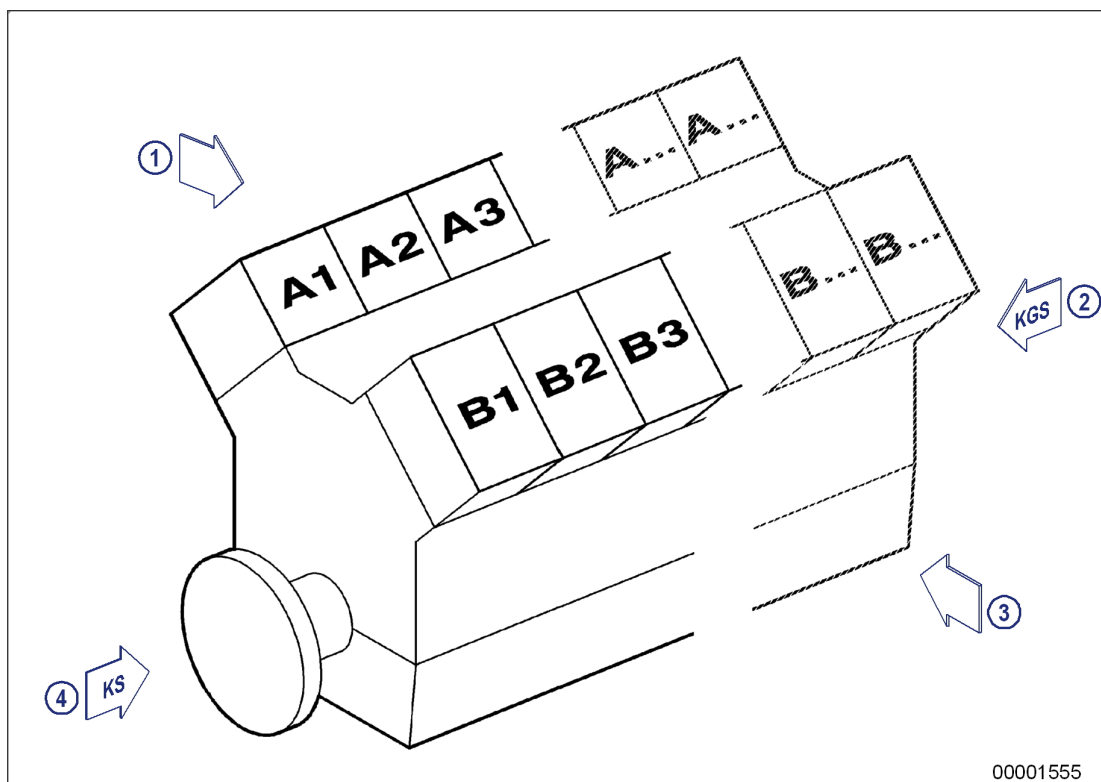
2 General Information

2.1 Engine side and cylinder designations

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

The cylinders of the left engine side are designated "A" and those of the right side "B" (as per DIN ISO 1204). The cylinders of each bank are numbered consecutively, starting with No. 1 at the driving end.

Other components are numbered in the same way, i.e. starting with No. 1 on driving end.



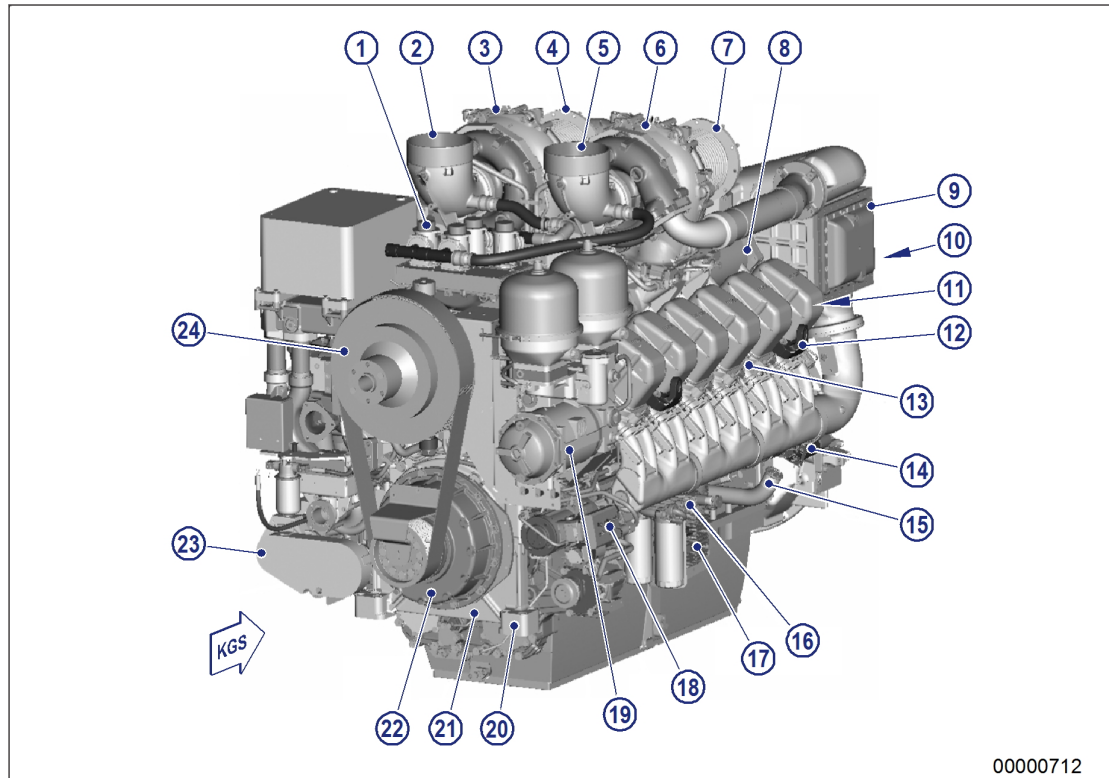
1 Left engine side
2 KGS = Free end

3 Right engine side
4 KS = Driving end

00001555

2.2 Engine layout

Illustration is valid for 16V 4000 Cxyz engines



- | | | |
|------------------------|---------------------|-------------------------------|
| 1 Crankcase breather | 9 Intercooler | 17 Engine governor |
| 2 Air intake | 10 Flywheel | 18 HP fuel pump |
| 3 Exhaust turbocharger | 11 Valve gear | 19 Automatic oil filter |
| 4 Exhaust outlet | 12 Lifting eye | 20 Engine mounting/support |
| 5 Air intake | 13 Cylinder head | 21 Gear train |
| 6 Exhaust turbocharger | 14 Starter | 22 Vibration damper |
| 7 Exhaust outlet | 15 Oil filler neck | 23 Battery-charging generator |
| 8 Coolant system | 16 Fuel filter head | 24 Fan drive |

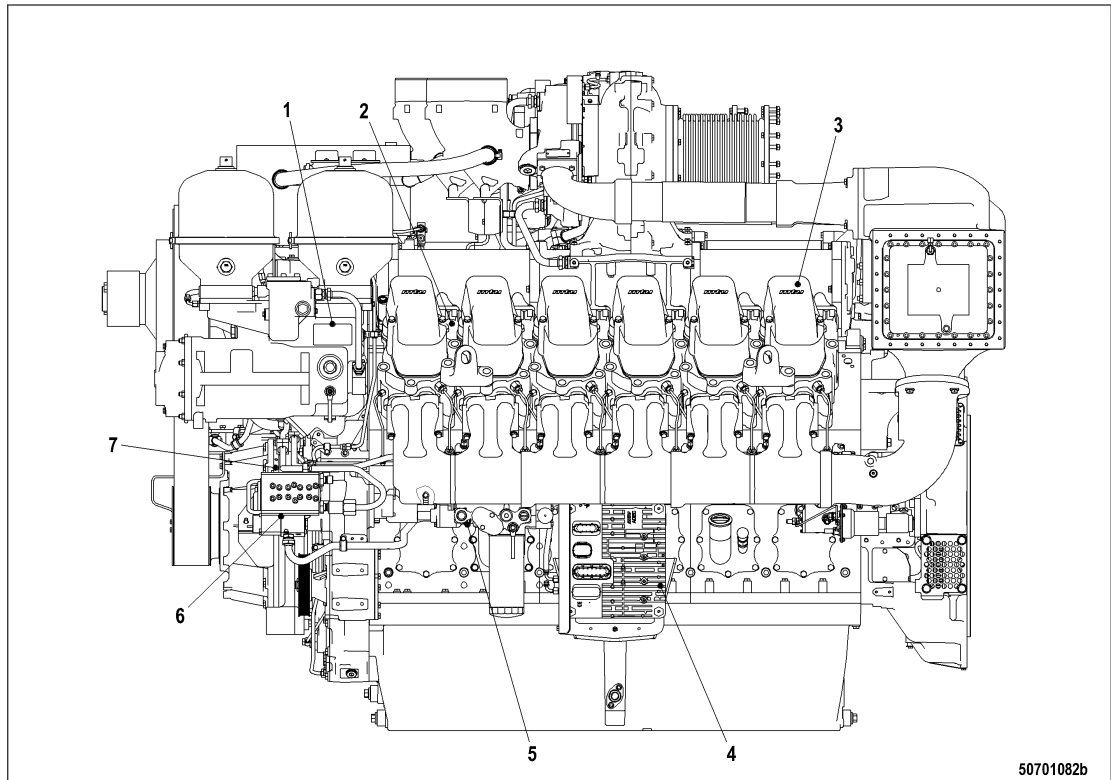
Engine model designation

Key to the engine model designation 12/16V 4000 Cxyz	
12/16	Number of cylinders
V	Cylinder arrangement: Vee engine
4000	Series
C	Application
x	Application segment (1,2)
y	Design index (3)
z	R (reduced power / speed) L (enhanced power / speed)

TMA-ID: 0000002074 - 004

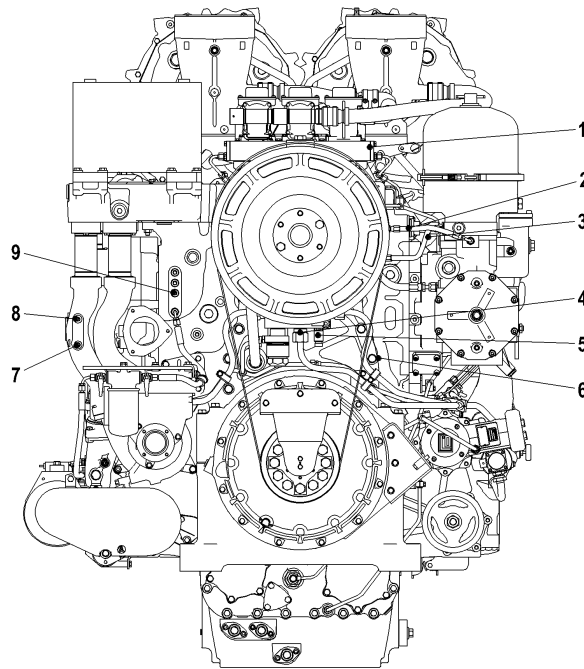
2.3 Sensors and actuators - Overview

Illustration also applies to 16V 4000 Cx3 engines



- | | | |
|--|--------------------------------------|------------------------------|
| 1 B07 (lube oil temperature) | 4 ADEC (ECU 7) | 7 M8 (HP fuel pump actuator) |
| 2 Sensors for cylinder exhaust temperature B4.1 through B4.8 (A-bank) (optional only for 16 V) | 5 B34 (fuel pressure after filter) | |
| 3 Injectors Y39.1 to Y39.6 (A-bank) | 6 B48 (fuel pressure in common rail) | |

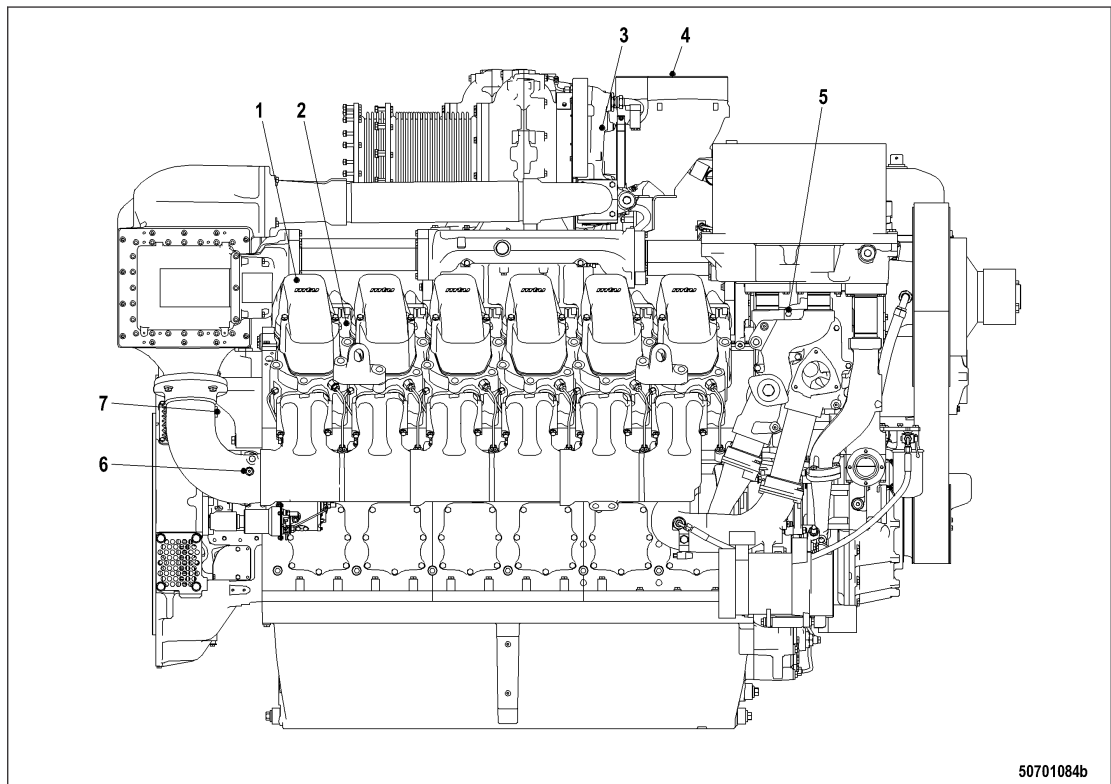
The injectors are underneath the cylinder head covers of the cylinder. Injector replacement and necessary activities (→ Page 97).



50701083a

- | | | |
|---|---|--|
| 1 B50 (crankcase pressure) | 4 B33 (fuel temperature in common rail) | 7 B43 (charge-air coolant pressure) |
| 2 B05.3 (lube oil pressure before filter) | 5 B01 (camshaft speed) | 8 B26 (charge-air coolant temperature) |
| 3 B05 (lube oil pressure after filter) | 6 B48 (fuel pressure in common rail) | 9 B06 (engine coolant temperature) |

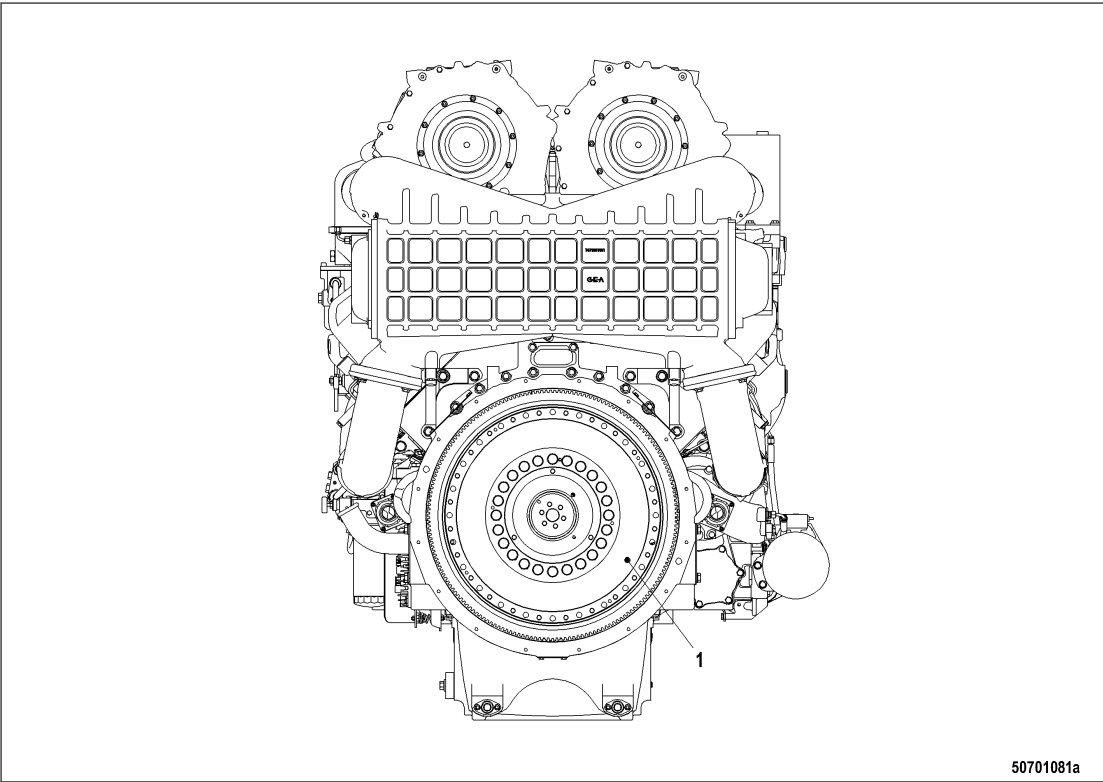
TMA-ID: 0000012925 - 002



50701084b

- | | | |
|--|--------------------------------|--------------------------------|
| 1 Injectors Y39.11 to Y39.16 (B-bank) | 4 B03 (intake air temperature) | 7 B09 (charge-air temperature) |
| 2 Sensors for cylinder exhaust temperature B4.11 through B4.18 (B-bank) (optional only for 16 V) | 5 B16 (coolant pressure) | |
| 3 B44 (turbocharger speed) | 6 B10 (charge-air pressure) | |

The injectors are underneath the cylinder head covers of the cylinder. Injector replacement and necessary activities (→ Page 97).



1 B13 (crankshaft speed)

50701081a

3 Technical Data

3.1 12/16 V 4000 C13/13R/13L engine data: Application group 5A, optimized fuel consumption

Explanation:

DL Ref. value: Continuous power

BL Ref. value: Fuel stop power

A Design value

G Guaranteed value

R Guideline value

L Limit value, up to which the engine can be operated, without change (e.g. of power setting)

N Not yet defined value

- Not applicable

X Applicable

REFERENCE CONDITIONS

Engine model			12V 4000C13 R	12V 4000C13	12V 4000C13L	16V 4000C13 R	16V 4000C13	16V 4000C13L
Application group			5A	5A	5A	5A	5A	5A
Intake air temperature		°C	25	25	25	25	25	25
Charge-air coolant temperature		°C	45	45	45	45	45	45
Raw-water inlet temperature		°C	-	-	-	-	-	-
Barometric pressure		mbar	1000	1000	1000	1000	1000	1000
Site altitude above sea level		m	100	100	100	100	100	100

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

Number of cylinders			12V	12V	12V	16V	16V	16V
Rated engine speed	A	rpm	1800	1800	1800	1800	1800 1900	1800 1900
Net brake power (w/o fan) (fuel stop power ISO 3046)	A	kW	1193	1343	1425	1492	1750	1865

TMA-ID: 0000002875-002

GENERAL CONDITIONS (for maximum power)

Number of cylinders			12V	12V	12V	16V	16V	16V
Intake depression (new filter)	A	mbar	30	30	30	30	30	30
Intake depression, max.	L	mbar	50	50	50	50	50	50
Exhaust overpressure	A	mbar	65	65	65	65	65	65
Exhaust overpressure, max.	L	mbar	85	85	85	85	85	85
Fuel temperature at engine inlet connection	R	°C	25	25	25	25	25	25
Fuel temperature at engine inlet connection, max (w/o power reduction)	L	°C	60	60	60	60	60	60

CONSUMPTION

Number of cylinders			12V	12V	12V	16V	16V	16V
Lube oil consumption after 100 h runtime (B = hourly fuel consumption)	R	% of B	0.3	0.3	0.3	0.3	0.3	0.3

MODEL-RELATED DATA (basic design)

Number of cylinders			12V	12V	12V	16V	16V	16V
Number of cylinders			12	12	12	16	16	16
Cylinder arrangement: V angle		degrees	90	90	90	90	90	90
Bore		mm	170	170	170	170	170	170
Stroke		mm	210	210	210	210	210	210
Cylinder displacement		Liters	4.77	4.77	4.77	4.77	4.77	4.77
Total displacement		Liters	57.2	57.2	57.2	76.3	76.3	76.3
Number of inlet valves per cylinder			2	2	2	2	2	2
Number of exhaust valves per cylinder			2	2	2	2	2	2

TMA-ID: 0000002875-002

COMBUSTION AIR / EXHAUST GAS

Number of cylinders			12V	12V	12V	16V	16V	16V
Charge-air pressure before cylinder	R	bar abs	2.2	2.4	2.5	2.3	2.5 2.6	2.7 2.8
Exhaust temperature after turbo-charger	R	°C	440	440	440	390	395 390	400 380

COOLANT SYSTEM (HT circuit)

Number of cylinders			12V	12V	12V	16V	16V	16V
Coolant temperature (at engine connection: outlet to cooling equipment)	A	°C	100	100	100	100	100	100
Coolant temperature after engine, warning	R	°C	102	102	102	102	102	102
Coolant temperature after engine, shutdown	L	°C	104	104	104	104	104	104
Coolant antifreeze content, max.	L	%	50	50	50	50	50	50
Coolant pump: inlet pressure, max.	L	bar	2.5	2.5	2.5	2.5	2.5	2.5
Thermostat: Starts to open	R	°C	79	79	79	79	79	79
Thermostat: Fully open	R	°C	92	92	92	92	92	92

COOLANT SYSTEM (LT circuit)

Number of cylinders			12V	12V	12V	16V	16V	16V
Coolant temperature (at engine connection: outlet to cooling equipment)	R	°C	51	52	53	53	55 52	56 55
Coolant temperature difference after/before inter-cooler, min.	L	°C	4	5	6	6	8 10	9 11
Coolant temperature difference after/before inter-cooler, max.	L	°C	12	13	14	14	16 18	17 19

T/M-ID: 0000002875-002

Number of cylinders			12V	12V	12V	16V	16V	16V
Coolant antifreeze content, max.	L	%	50	50	50	50	50	50
Charge-air temperature after intercooler, max.	L	°C	80	80	80	80	80	80
Thermostat: Starts to open	R	°C	38	38	38	38	38	38
Thermostat: Fully open	R	°C	51	51	51	51	51	51

LUBE OIL SYSTEM

Number of cylinders			12V	12V	12V	16V	16V	16V
Lube oil operating temperature before engine, from	R	°C	92	92	92	92	92	92
Lube oil operating temperature before engine, to	R	°C	95	95	95	95	95	95
Lube oil temperature before engine, alarm	R	°C	97	97	97	97	97	97
Lube oil temperature before engine, shutdown	L	°C	99	99	99	99	99	97
Lube oil operating pressure before engine (measurement block)	R	bar	6.4	6.4	6.4	5.0	5.0	5.0
Lube oil operating pressure (low idle) (meas. point: before engine)	R	bar	2.6	2.6	2.6	2.0	2.0	2.0

T1M-ID: 0000002875-002

FUEL SYSTEM

Number of cylinders			12V	12V	12V	16V	16V	16V
Fuel pressure at engine inlet connection, min. (when engine is starting)	L	bar	-0.1	-0.1	-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	-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	1.5	1.5

GENERAL OPERATING DATA

Number of cylinders			12V	12V	12V	16V	16V	16V
Coolant preheating: preheating temperature (min.)	R	°C	40	40	40	40	40	40

INCLINATIONS, STANDARD OIL SYSTEM (reference: waterline)

Number of cylinders			12V	12V	12V	16V	16V	16V
Longitudinal inclination, continuous max. driving end down (option: max. operating inclinations)	L	degrees	15	15	15	15	15	15
Longitudinal inclination, continuous max. driving end up (option: max. operating inclinations)	L	degrees	15	15	15	15	15	15
Transverse inclination, continuous max. (option: max. operating inclinations)	L	degrees	15	15	15	15	15	15

T1M4D-000002875-002

CAPACITIES

Number of cylinders			12V	12V	12V	16V	16V	16V
Engine coolant, engine side (without cooling equipment)	R	Liters	212	212	212	260	260	260
Charge-air coolant, engine side	R	Liters	47	47	47	50	50	50
Engine oil on initial filling (standard oil system) (option: max. operating inclinations)	R	Liters	245	245	245	300	300	300
Oil pan capacity at dipstick mark "min." (standard oil system) (option: max. operating inclinations)	L	Liters	150	150	150	210	210	210
Oil pan capacity at dipstick mark "max." (standard oil system) (option: max. operating inclinations)	L	Liters	190	190	190	240	240	240

WEIGHTS (basic design, dry engine)

Number of cylinders			12V	12V	12V	16V	16V	16V
Engine dry weight (with attached standard accessories, without coupling)	R	kg	7000	7000	7000	8100	8100	8100

ACOUSTICS

Number of cylinders			12V	12V	12V	16V	16V	16V
Exhaust noise, un-silenced, BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	dB(A)	106	106	107	108	109	110
Exhaust noise, un-silenced - BL (sound power level LW, ISO 6798)	R	dB(A)	118	119	119	120	122	122

T1M-ID: 0000002875 - 002

Number of cylinders			12V	12V	12V	16V	16V	16V
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level L_p , 1m distance, ISO 6798)	R	dB(A)	103	104	105	105	108	108
Engine surface noise with attenuated intake noise (filter), BL (sound power level L_W , ISO 6798)	R	dB(A)	121	123	123	124	127	127

3.2 12/16 V 4000 C13/13R/13L engine data: Application group 5A, optimized exhaust emissions (EPA Stage 2)

Explanation:

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

REFERENCE CONDITIONS

Engine model			12V 4000C13 R	12V 4000C13	12V 4000C13L	16V 4000C13 R	16V 4000C13	16V 4000C13L
Application group			5A	5A	5A	5A	5A	5A
Intake air temperature		°C	25	25	25	25	25	25
Charge-air coolant temperature		°C	45	45	45	45	45	45
Raw-water inlet temperature		°C	-	-	-	-	-	-
Barometric pressure		mbar	1000	1000	1000	1000	1000	1000
Site altitude above sea level		m	100	100	100	100	100	100

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

Number of cylinders			12V	12V	12V	16V	16V	16V
Rated engine speed	A	rpm	1800	1800	1800	1800	1800	1800 1900
Net brake power (w/o fan) (fuel stop power ISO 3046)	A	kW	1193	1343	1425	1492	1750	1865

GENERAL CONDITIONS (for maximum power)

Number of cylinders			12V	12V	12V	16V	16V	16V
Intake depression (new filter)	A	mbar	30	30	30	30	30	30
Intake depression, max.	L	mbar	50	50	50	50	50	50
Exhaust overpressure	A	mbar	65	65	65	65	65	65

TMA-ID: 0000002924 - 002

Number of cylinders			12V	12V	12V	16V	16V	16V
Exhaust overpressure, max.	L	mbar	85	85	85	85	85	85
Fuel temperature at engine inlet connection	R	°C	25	25	25	25	25	25
Fuel temperature at engine inlet connection, max (w/o power reduction)	L	°C	60	60	60	60	60	60

CONSUMPTION

Number of cylinders			12V	12V	12V	16V	16V	16V
Lube oil consumption after 100 h runtime (B = hourly fuel consumption)	R	% of B	0.3	0.3	0.3	0.3	0.3	0.3

MODEL-RELATED DATA (basic design)

Number of cylinders			12V	12V	12V	16V	16V	16V
Number of cylinders			12	12	12	16	16	16
Cylinder arrangement: V angle		degrees	90	90	90	90	90	90
Bore		mm	170	170	170	170	170	170
Stroke		mm	210	210	210	210	210	210
Cylinder displacement		Liters	4.77	4.77	4.77	4.77	4.77	4.77
Total displacement		Liters	57.2	57.2	57.2	76.3	76.3	76.3
Number of inlet valves per cylinder			2	2	2	2	2	2
Number of exhaust valves per cylinder			2	2	2	2	2	2

TM-ID: 0000002924 - 002

COMBUSTION AIR / EXHAUST GAS

Number of cylinders			12V	12V	12V	16V	16V	16V
Charge-air pressure before cylinder	R	bar abs	2.4	2.6	2.8	2.6	2.9	3.0 3.1
Exhaust temperature after turbo-charger	R	°C	440	440	450	390	400	405 380

COOLANT SYSTEM (HT circuit)

Number of cylinders			12V	12V	12V	16V	16V	16V
Coolant temperature (at engine connection: outlet to cooling equipment)	A	°C	100	100	100	100	100	100
Coolant temperature after engine, warning	R	°C	102	102	102	102	102	102
Coolant temperature after engine, shutdown	L	°C	104	104	104	104	104	104
Coolant antifreeze content, max.	L	%	50	50	50	50	50	50
Coolant pump: inlet pressure, max.	L	bar	2.5	2.5	2.5	2.5	2.5	2.5
Thermostat: Starts to open	R	°C	79	79	79	79	79	79
Thermostat: Fully open	R	°C	92	92	92	92	92	92

COOLANT SYSTEM (LT circuit)

Number of cylinders			12V	12V	12V	16V	16V	16V
Coolant temperature (at engine connection: outlet to cooling equipment)	R	°C	53	54	55	55	57	57 56
Coolant temperature difference after/before inter-cooler, min.	L	°C	6	7	8	8	10	10 8
Coolant temperature difference after/before inter-cooler, max.	L	°C	14	15	16	16	18	18 16

T1M-ID: 0000002924 - 002

Number of cylinders			12V	12V	12V	16V	16V	16V
Coolant antifreeze content, max.	L	%	50	50	50	50	50	50
Charge-air temperature after intercooler, max.	L	°C	80	80	80	80	80	80
Thermostat: Starts to open	R	°C	38	38	38	38	38	38
Thermostat: Fully open	R	°C	51	51	51	51	51	51

LUBE OIL SYSTEM

Number of cylinders			12V	12V	12V	16V	16V	16V
Lube oil operating temperature before engine, from	R	°C	92	92	92	92	92	92
Lube oil operating temperature before engine, to	R	°C	95	95	95	95	95	95
Lube oil temperature before engine, alarm	R	°C	97	97	97	97	97	97
Lube oil temperature before engine, shutdown	L	°C	99	99	99	99	99	99
Lube oil operating pressure before engine (measurement block)	R	bar	6.4	6.4	6.4	5.0	5.0	5.0
Lube oil operating pressure (low idle) (meas. point: before engine)	R	bar	2.6	2.6	2.6	2.0	2.0	2.0

FUEL SYSTEM

Number of cylinders			12V	12V	12V	16V	16V	16V
Fuel pressure at engine inlet connection, min. (when engine is starting)	L	bar	-0.1	-0.1	-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	-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	1.5	1.5

GENERAL OPERATING DATA

Number of cylinders			12V	12V	12V	16V	16V	16V
Coolant preheating: preheating temperature (min.)	R	°C	40	40	40	40	40	40

INCLINATIONS, STANDARD OIL SYSTEM (reference: waterline)

Number of cylinders			12V	12V	12V	16V	16V	16V
Longitudinal inclination, continuous max. driving end down (option: max. operating inclinations)	L	degrees	15	15	15	15	15	15
Longitudinal inclination, continuous max. driving end up (option: max. operating inclinations)	L	degrees	15	15	15	15	15	15
Transverse inclination, continuous max. (option: max. operating inclinations)	L	degrees	15	15	15	15	15	15

T1M-ID: 0000002924 - 002

CAPACITIES

Number of cylinders			12V	12V	12V	16V	16V	16V
Engine coolant, engine side (without cooling equipment)	R	Liters	212	212	212	260	260	260
Charge-air coolant, engine side	R	Liters	47	47	47	50	50	50
Engine oil on initial filling (standard oil system) (option: max. operating inclinations)	R	Liters	245	245	245	300	300	300
Oil pan capacity at dipstick mark "min." (standard oil system) (option: max. operating inclinations)	L	Liters	150	150	150	210	210	210
Oil pan capacity at dipstick mark "max." (standard oil system) (option: max. operating inclinations)	L	Liters	190	190	190	240	240	240

WEIGHTS (basic design, dry engine)

Number of cylinders			12V	12V	12V	16V	16V	16V
Engine dry weight (with attached standard accessories, without coupling)	R	kg	7000	7000	7000	8100	8100	8100

ACOUSTICS

Number of cylinders			12V	12V	12V	16V	16V	16V
Exhaust noise, un-silenced, BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	dB(A)	106	107	108	108	109	110
Exhaust noise, un-silenced - BL (sound power level LW, ISO 6798)	R	dB(A)	119	120	120	121	122	122

T1M-ID: 0000002924 - 002

Number of cylinders			12V	12V	12V	16V	16V	16V
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level L_p , 1m distance, ISO 6798)	R	dB(A)	103	105	106	107	106	109
Engine surface noise with attenuated intake noise (filter), BL (sound power level L_W , ISO 6798)	R	dB(A)	122	124	124	126	125	127

3.3 12/16 V 4000 C23/23R engine data: Application group 5B, optimized fuel consumption

Explanation:

DL Ref. value: Continuous power

BL Ref. value: Fuel stop power

A Design value

G Guaranteed value

R Guideline value

L Limit value, up to which the engine can be operated, without change (e.g. of power setting)

N Not yet defined value

- Not applicable

X Applicable

REFERENCE CONDITIONS

Engine model			12V 4000C23 R	12V 4000C23	16V 4000C23 R	16V 4000C23
Application group			5B	5B	5B	5B
Intake air temperature		°C	25	25	25	25
Charge-air coolant temperature		°C	45	45	45	45
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)

Number of cylinders			12V	12V	16V	16V
Rated engine speed	A	rpm	1800	1800 1900	1800 1900	1800
Net brake power (w/o fan) (fuel stop power ISO 3046)	A	kW	1510	1680	2013	2240

GENERAL CONDITIONS (for maximum power)

Number of cylinders			12V	12V	16V	16V
Intake depression (new filter)	A	mbar	30	30	30	30
Intake depression, max.	L	mbar	50	50	50	50
Exhaust overpressure	A	mbar	65	65	65	65
Exhaust overpressure, max.	L	mbar	85	85	85	85
Fuel temperature at engine inlet connection	R	°C	25	25	25	25
Fuel temperature at engine inlet connection, max (w/o power reduction)	L	°C	60	60	60	60

CONSUMPTION

Number of cylinders			12V	12V	16V	16V
Lube oil consumption after 100 h runtime (B = hourly fuel consumption)	R	% of B	0.3	0.3	0.3	0.3

TMA-ID: 0000002957 - 002

MODEL-RELATED DATA (basic design)

Number of cylinders			12V	12V	16V	16V
Number of cylinders			12	12	16	16
Cylinder arrangement: V angle		degrees	90	90	90	90
Bore		mm	170	170	170	170
Stroke		mm	210	210	210	210
Cylinder displacement		Liters	4.77	4.77	4.77	4.77
Total displacement		Liters	57.2	57.2	76.3	76.3
Number of inlet valves per cylinder			2	2	2	2
Number of exhaust valves per cylinder			2	2	2	2

COMBUSTION AIR / EXHAUST GAS

Number of cylinders			12V	12V	16V	16V
Charge-air pressure before cylinder	R	bar abs	2.7	2.9	2.9	3.2
Exhaust temperature after turbocharger	R	°C	440	440	410 380	410 380

COOLANT SYSTEM (HT circuit)

Number of cylinders			12V	12V	16V	16V
Coolant temperature (at engine connection: outlet to cooling equipment)	A	°C	100	100	100	100
Coolant temperature after engine, warning	R	°C	102	102	102	102
Coolant temperature after engine, shut-down	L	°C	104	104	104	104
Coolant antifreeze content, max.	L	%	50	50	50	50
Coolant pump: inlet pressure, max.	L	bar	2.5	2.5	2.5	2.5
Thermostat: Starts to open	R	°C	79	79	79	79
Thermostat: Fully open	R	°C	92	92	92	92

COOLANT SYSTEM (LT circuit)

Number of cylinders			12V	12V	16V	16V
Coolant temperature (at engine connection: outlet to cooling equipment)	R	°C	54	56	57	60
Coolant temperature difference after/before intercooler, min.	L	°C	7	9	11	13
Coolant temperature difference after/before intercooler, max.	L	°C	15	17	19	21
Coolant antifreeze content, max.	L	%	50	50	50	50
Charge-air temperature after intercooler, max.	L	°C	80	80	80	80
Thermostat: Starts to open	R	°C	38	38	38	38
Thermostat: Fully open	R	°C	51	51	51	51

TMA-ID: 0000002957 - 002

LUBE OIL SYSTEM

Number of cylinders			12V	12V	16V	16V
Lube oil operating temperature before engine, from	R	°C	92	92	92	92
Lube oil operating temperature before engine, to	R	°C	95	95	95	95
Lube oil temperature before engine, alarm	R	°C	97	97	97	97
Lube oil temperature before engine, shut-down	L	°C	99	99	99	99
Lube oil operating pressure before engine (measurement block)	R	bar	6.4	6.4	5.0	5.0
Lube oil operating pressure (low idle) (meas. point: before engine)	R	bar	2.6	2.6	2.0	2.0

FUEL SYSTEM

Number of cylinders			12V	12V	16V	16V
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

Number of cylinders			12V	12V	16V	16V
Coolant preheating: preheating temperature (min.)	R	°C	40	40	40	40

INCLINATIONS, STANDARD OIL SYSTEM (reference: waterline)

Number of cylinders			12V	12V	16V	16V
Longitudinal inclination, continuous max. driving end down (option: max. operating inclinations)	L	degrees	15	15	15	15
Longitudinal inclination, continuous max. driving end up (option: max. operating inclinations)	L	degrees	15	15	15	15
Transverse inclination, continuous max. (option: max. operating inclinations)	L	degrees	15	15	15	15

CAPACITIES

Number of cylinders			12V	12V	16V	16V
Engine coolant, engine side (without cooling equipment)	R	Liters	212	212	260	260
Charge-air coolant, engine side	R	Liters	47	47	50	50
Engine oil on initial filling (standard oil system) (option: max. operating inclinations)	R	Liters	245	245	300	300

TMA-ID: 0000002957 - 002

Number of cylinders			12V	12V	16V	16V
Oil pan capacity at dipstick mark "min." (standard oil system) (option: max. operating inclinations)	L	Liters	150	150	210	210
Oil pan capacity at dipstick mark "max." (standard oil system) (option: max. operating inclinations)	L	Liters	190	190	240	240

WEIGHTS (basic design, dry engine)

Number of cylinders			12V	12V	16V	16V
Engine dry weight (with attached standard accessories, without coupling)	R	kg	7000	7000	8100	8100

ACOUSTICS

Number of cylinders			12V	12V	16V	16V
Exhaust noise, unsilenced, BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	dB(A)	107	108	110	111
Exhaust noise, unsilenced - BL (sound power level LW, ISO 6798)	R	dB(A)	120	121	122	123
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	dB(A)	105	108	109	109
Engine surface noise with attenuated intake noise (filter), BL (sound power level LW, ISO 6798)	R	dB(A)	124	126	128	128

T1M-ID: 0000002957 - 002

3.4 12/16 V 4000 C23/23R engine data: Application group 5B, optimized exhaust emissions (EPA Stage 2)

Explanation:

DL Ref. value: Continuous power

BL Ref. value: Fuel stop power

A Design value

G Guaranteed value

R Guideline value

L Limit value, up to which the engine can be operated, without change (e.g. of power setting)

N Not yet defined value

- Not applicable

X Applicable

REFERENCE CONDITIONS

Engine model			12V 4000C23 R	12V 4000C23	16V 4000C23 R	16V 4000C23
Application group			5B	5B	5B	5B
Intake air temperature		°C	25	25	25	25
Charge-air coolant temperature		°C	45	45	45	45
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)

Number of cylinders			12V	12V	16V	16V
Rated engine speed	A	rpm	1800 1900	1800 1900	1800 1900	1800
Net brake power (w/o fan) (fuel stop power ISO 3046)	A	kW	1510	1680	2013	2240

GENERAL CONDITIONS (for maximum power)

Number of cylinders			12V	12V	16V	16V
Intake depression (new filter)	A	mbar	30	30	30	30
Intake depression, max.	L	mbar	50	50	50	50
Exhaust overpressure	A	mbar	65	65	65	65
Exhaust overpressure, max.	L	mbar	85	85	85	85
Fuel temperature at engine inlet connection	R	°C	25	25	25	25
Fuel temperature at engine inlet connection, max (w/o power reduction)	L	°C	60	60	60	60

CONSUMPTION

Number of cylinders			12V	12V	16V	16V
Lube oil consumption after 100 h runtime (B = hourly fuel consumption)	R	% of B	0.3	0.3	0.3	0.3

TM4D-000002983-002

MODEL-RELATED DATA (basic design)

Number of cylinders			12V	12V	16V	16V
Number of cylinders			12	12	16	16
Cylinder arrangement: V angle		degrees	90	90	90	90
Bore		mm	170	170	170	170
Stroke		mm	210	210	210	210
Cylinder displacement		Liters	4.77	4.77	4.77	4.77
Total displacement		Liters	57.2	57.2	76.3	76.3
Number of inlet valves per cylinder			2	2	2	2
Number of exhaust valves per cylinder			2	2	2	2

COMBUSTION AIR / EXHAUST GAS

Number of cylinders			12V	12V	16V	16V
Charge-air pressure before cylinder	R	bar abs	2.9	3.2 3.4	3.2 3.3	3.4
Exhaust temperature after turbocharger	R	°C	440 425	440	410	410

COOLANT SYSTEM (HT circuit)

Number of cylinders			12V	12V	16V	16V
Coolant temperature (at engine connection: outlet to cooling equipment)	A	°C	100	100	100	100
Coolant temperature after engine, warning	R	°C	102	102	102	102
Coolant temperature after engine, shut-down	L	°C	104	104	104	104
Coolant antifreeze content, max.	L	%	50	50	50	50
Coolant pump: inlet pressure, max.	L	bar	2.5	2.5	2.5	2.5
Thermostat: Starts to open	R	°C	79	79	79	79
Thermostat: Fully open	R	°C	92	92	92	92

COOLANT SYSTEM (LT circuit)

Number of cylinders			12V	12V	16V	16V
Coolant temperature (at engine connection: outlet to cooling equipment)	R	°C	56 55	58 57	59	62
Coolant temperature difference after/before intercooler, min.	L	°C	9 7	11 7	12	15
Coolant temperature difference after/before intercooler, max.	L	°C	17 15	19 15	20	23
Coolant antifreeze content, max.	L	%	50	50	50	50
Charge-air temperature after intercooler, max.	L	°C	80	80	80	80
Thermostat: Starts to open	R	°C	38	38	38	38
Thermostat: Fully open	R	°C	51	51	51	51

TMA-ID: 0000002983 - 002

LUBE OIL SYSTEM

Number of cylinders			12V	12V	16V	16V
Lube oil operating temperature before engine, from	R	°C	92	92	92	92
Lube oil operating temperature before engine, to	R	°C	95 96	95 96	95	95
Lube oil temperature before engine, alarm	R	°C	97 98	97 98	97	97
Lube oil temperature before engine, shut-down	L	°C	99 100	99 100	99	99
Lube oil operating pressure before engine (measurement block)	R	bar	6.4 6.2	6.4 6.9	5.0	5.0
Lube oil operating pressure (low idle) (meas. point: before engine)	R	bar	2.6	2.6	2.0	2.0

FUEL SYSTEM

Number of cylinders			12V	12V	16V	16V
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

Number of cylinders			12V	12V	16V	16V
Coolant preheating: preheating temperature (min.)	R	°C	40	40	40	40

INCLINATIONS, STANDARD OIL SYSTEM (reference: waterline)

Number of cylinders			12V	12V	16V	16V
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	N	N	N	N
Longitudinal inclination, continuous max. driving end up (option: max. operating inclinations)	L	degrees	15	15	15	15
Transverse inclination, continuous max. (option: max. operating inclinations)	L	degrees	15	15	15	15

TMA-ID: 0000002983 - 002

CAPACITIES

Number of cylinders			12V	12V	16V	16V
Engine coolant, engine side (without cooling equipment)	R	Liters	212	212	260	260
Charge-air coolant, engine side	R	Liters	47	47	50	50
Engine oil on initial filling (standard oil system) (option: max. operating inclinations)	R	Liters	245	245	300	300
Oil pan capacity at dipstick mark "min." (standard oil system) (option: max. operating inclinations)	L	Liters	150	150	210	210
Oil pan capacity at dipstick mark "max." (standard oil system) (option: max. operating inclinations)	L	Liters	190	190	240	240

WEIGHTS (basic design, dry engine)

Number of cylinders			12V	12V	16V	16V
Engine dry weight (with attached standard accessories, without coupling)	R	kg	7000	7000	8100	8100

ACOUSTICS

Number of cylinders			12V	12V	16V	16V
Exhaust noise, unsilenced, BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	dB(A)	108	109	111	112
Exhaust noise, unsilenced - BL (sound power level LW, ISO 6798)	R	dB(A)	121	122	123	125
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	dB(A)	109	108	100	109
Engine surface noise with attenuated intake noise (filter), BL (sound power level LW, ISO 6798)	R	dB(A)	125	126	128	128

T1M-ID: 0000002983 - 002

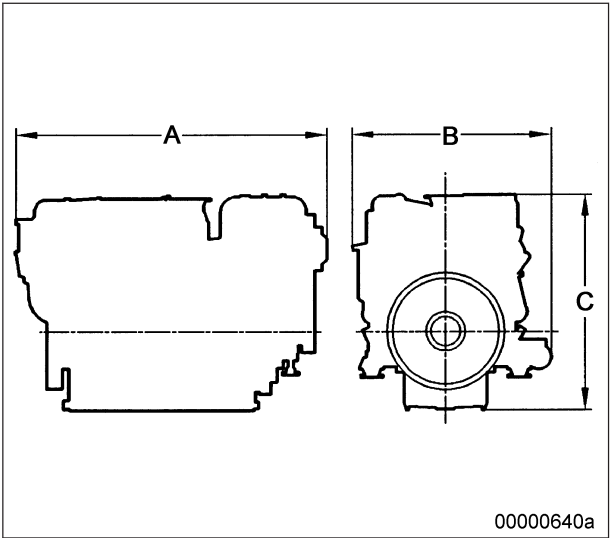
3.5 Firing order

Firing order

Number of cylinders	Firing order
8V	A1-B4-A4-A2-B3-A3-B2-B1
12V	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
20 V	A1-B5-A8-B7-A5-B2-A7-B10-A2-B3-A10-B6-A3-B4-A6-B9-A4-B1-A9-B8

3.6 Main engine dimensions

Main engine dimensions



Length (A) 12V	approx. 2810 mm
Length (A) 16V	approx. 3280 mm
Width (B) 12V, 16V	approx. 1585 mm
Height (C) 12V, 16V	approx. 2027 mm

4 Operation

4.1 Preparations for recommissioning the engine after extended out-of-service periods (>3 months)

Preconditions

- ☑ Engine shut down and secured against being restarted.
- ☑ MTU Corrosion-proofing and Reproofing Regulations (A001070/..) are available.

Recommissioning after long out-of-service periods (>3 months)

Item	Action
Engine	Remove corrosion-proofing (→ MTU Corrosion-proofing and Reproofing Regulations A001070/..).
Valve gear	Lubricate valve gear every ≥ 6 months (→ Page 90).
Oil lubrication system	Check engine oil level (→ Page 110). Crank engine using starting system (→ Page 80).
Fuel prefilter	Fill with fuel (if fitted).
Coolant system	If engine has been out of service for more than 1 year, change engine coolant (→ Page 123). Change charge-air coolant (→ Page 133).
Coolant system	Check engine coolant level (→ Page 122); Check charge-air coolant level (→ Page 132).
Coolant system	Preheat coolant with coolant preheating unit (if available).
Engine Control Unit	Check electrical connections (→ Page 151).
High-pressure fuel pump	Only on engines without oil priming pump Fill HP fuel pump with fresh engine oil (→ Page 96).

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

Preconditions

☒ Engine is stopped and starting disabled.

Startup

Item	Action
Lube oil system	Check engine oil level (→ Page 110).
Coolant circuit	Check engine coolant level (→ Page 122); Check charge-air coolant level (→ Page 132).
Coolant circuit	Preheat coolant with coolant preheating unit (if applicable).
Engine control system	Put into operation.

4.3 Starting the engine in manual mode

Preconditions

- ☒ Engine is not under load.
- ☒ External start interlock is not activated.

DANGER 	Unguarded rotating and moving engine components. Risk of serious injury – danger to life! • Before barring or starting the engine, make sure that nobody is in the danger zone.
WARNING 	Engine noise above 85 dB (A). Risk of damage to hearing! • Wear ear protectors.

Preparation

Item	Action
Operating mode switch (if applicable)	Switch to manual mode.
Coolant preheating unit (if applicable).	Switch ON.

Starting the engine

Item	Action
Switchgear cabinet, operator station etc. (depending on manufacturer).	1. If no coolant preheater is fitted, make sure that the coolant temperature is $> 40^{\circ}\text{C}$. 2. Press start button. • Automatic starting procedure is performed; • Engine speed instrument indicates increasing speed; • After the starting sequence is completed, engine is running at idle speed.

4.4 Stopping the engine in manual mode

Preconditions

- ☑ Engine is not under load.
- ☑ Engine is running in manual mode.

CAUTION



Stopping the engine when it is running at full load causes extreme stress to the engine.

Risk of overheating, damage to components!

- Before stopping the engine, operate it at idle speed until operating temperatures decrease and stable values are indicated.

Preparation

Item	Action
Engine	Operate engine at idling speed for approx. 5 minutes.

Stopping the engine

Item	Action
Switch cabinet, operator station etc. (depending on manufacturer)	Press stop button. • Automatic stopping sequence is executed.

4.5 After shutting down the engine

Preconditions

☑ MTU Corrosion-proofing and Reproofing Regulations (A001070/..) are available.

After shutting down the engine

Item	Action
Coolant system	Drain coolant (→ Page 124), (→ Page 134), 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; • coolant is not preheated; • antifreeze concentration is 50 % and outside temperature is below -40 °C.
Engine control system	Switch off.
Air intake and exhaust system	Out-of-service period > 1 week: Seal off engine's intake and exhaust systems. Out-of-service period > 1 month: Corrosion-proof engine (→ MTU Corrosion-proofing and Reproofing Regulations A001070/..).

4.6 Plant cleaning

Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ Operating voltage is not present.

Special tools, Material, Spare parts

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

WARNING



Compressed air

Risk of injury!

- Do not direct compressed-air jet at persons.
- Wear protective goggles / safety mask and ear protectors.

WARNING



Water jet.

Risk of injury and scalding!

- Do not direct water jet at persons.
- Wear protective clothing, gloves, and goggles / safety mask.

CAUTION



Excessive reaction time of cleaning agents on components.

Damage to component!

- Observe manufacturer's instructions.
- Wear protective clothing, gloves, and goggles / safety mask.

NOTICE



Dry with compressed air.

Damage to component!

- Never aim compressed air directly at electronic components.

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. During external cleaning of the plant with water/steam-jet units, 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.
5. Carry out external cleaning as follows:
 - a) Seal all openings in a suitable fashion.
 - 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.

Note: Never aim compressed air directly at electronic components.
e) Dry engine.

TIM-ID: 0000010171 - 024

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 oil level with dipstick. Check oil level at sight glass.	(→ Page 110) (→ Page 111)
W0501		Visually inspect engine for leaks and general condition.	-
W0502	X	Check intercooler drain(s).	(→ Page 107)
W0503		Check signal ring position of service indicator on air filter.	(→ Page 108)
W0505		Check relief bores of coolant pump(s).	(→ Page 129) (→ Page 138)
W0506		Check engine for abnormal running noises, exhaust color and vibrations.	(→ Page 56)
W0507	X	Drain water and contaminants from fuel prefilter.	(→ Page 105)
W0508	X	Check reading on differential pressure gage of fuel prefilter.	-
W0525		Check battery-charging generator for contamination, clean as necessary.	(→ Page 142)
W1001		Replace fuel filter or fuel filter element.	(→ Page 104)
W1006		Replace fuel injectors.	(→ Page 97)
W1009	X	Check layer thickness of the oil residue, clean out and replace filter sleeve, accomplish at every engine oil change, at the latest.	(→ Page 120)
W1011		Perform endoscopic examination.	(→ Page 81)
W1036		Replace coolant filter.	(→ Page 130)
W1047		Check and clean oil indicator filter.	(→ Page 118)
W1207		Check valve clearance, adjust as necessary. Attention! First adjustment after 1,000 operating hours.	(→ Page 91)
W1209		Disassemble battery-charging generator and clean thoroughly with compressed air.	(→ Page 140)
W1241		Check condition of belt drive and replace if necessary; adjust belt tension.	(→ Page 139)
W1697	X	Check carbon brushes on flywheel, replace if necessary.	(→ Page 87)
W1698	X	Replace carbon brushes on flywheel.	(→ Page 89)
W1713		Injector: Reset drift compensation (CDC) parameters.	(→ Page 98)

Table 1: Maintenance task reference table [QL1]

6 Troubleshooting

6.1 Troubleshooting

Engine does not turn over when starter is operated

Component	Cause	Action
Battery	Discharged or defective	Charge or replace (see manufacturer's documentation).
	Cable connections defective	Check if cable connections are properly secured (see manufacturer's documentation).
Starter	Engine wiring or starter faulty	Check if cable connections are properly secured, contact Service.
Engine wiring	Faulty	Check (→ Page 149).
Engine/alternator control system	Assemblies or connectors possibly loose	Perform visual inspection (see manufacturer's documentation).
Engine Control Unit	Electrical connections may be loose	Check electrical connections (→ Page 151).
Engine	Jammed (cannot be cranked by hand)	Notify Service.

Engine turns over when started but does not fire

Component	Cause	Action
Starter	Lacks power: battery discharged or defective	Charge or replace battery (see manufacturer's documentation).
Engine wiring	Faulty	Check (→ Page 149).
Fuel system	Air in fuel system	Bleed fuel system (→ Page 103).
Engine Control Unit	Faulty	Notify Service.

Engine fires unevenly

Component	Cause	Action
Fuel injection system	Injector defective	Replace (→ Page 97).
Engine wiring	Faulty	Check (→ Page 149).
Fuel system	Air in fuel system	Bleed fuel system (→ Page 103).
Engine Control Unit	Faulty	Notify Service.

Engine fails to reach rated speed

Component	Cause	Action
Fuel supply	Fuel prefilter clogged	Replace
	Fuel filter clogged	Replace (→ Page 104).
Air supply	Air filter clogged	Clean.
Fuel injection system	Injector defective	Replace (→ Page 97).
Engine wiring	Faulty	Check (→ Page 149).
Engine	Overloaded	Notify Service.

TIM-ID: 0000002541 - 002

Engine speed not steady

Component	Cause	Action
Fuel injection system	Injector defective	Replace (→ Page 97).
Speed sensor	Defective	Notify Service.
Fuel system	Air in fuel system	Bleed fuel system (→ Page 103).
Engine Control Unit	Defective	Notify Service.

Charge air temperature too high

Component	Cause	Action
Engine coolant	Incorrect coolant concentration	Check (MTU test kit).
Intercooler	Dirty	Notify Service.
Engine room	Air-intake temperature too high	Check fans and air intake/exhaust pipes.

Charge-air pressure too low

Component	Cause	Action
Air supply	Air filter clogged	Clean.
Intercooler	Dirty	Notify Service.
Turbocharger	Defective	Notify Service.

Coolant leakage from intercooler

Component	Cause	Action
Intercooler	Leaking, significant coolant loss	Notify Service.

Black smoke from exhaust

Component	Cause	Action
Air supply	Air filter clogged	Clean.
Fuel injection system	Injector defective	Replace (→ Page 97).
Engine	Overloaded	Notify Service.

Blue smoke from exhaust

Component	Cause	Action
Engine oil	Too much oil in engine	Drain engine oil (→ Page 112).
	Oil separator on crankcase venting system dirty	Replace (→ Page 85).
Turbocharger, cylinder head, piston rings, cylinder liner	Defective	Notify Service.

White smoke from exhaust

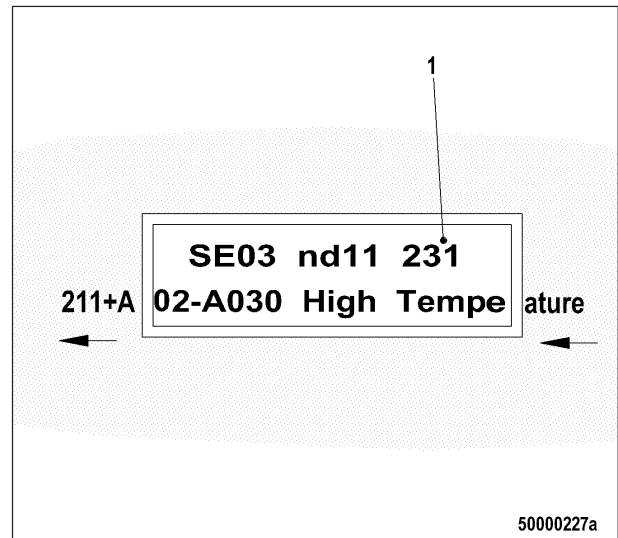
Component	Cause	Action
Engine	Not at operating temperature	Run engine to reach operating temperature.
Fuel system	Water in fuel	Check fuel system at fuel prefilter

TM-ID: 000002541 - 002

Component	Cause	Action
		Drain water from fuel prefilter.
Intercooler	Leaking	Notify Service.

6.2 Fault messages of the engine governor ADEC (ECU 7) for series 4000 C&I engines

The fault code numbers are generated by the Engine Control Unit and transmitted to the display.



The fault code (1) comprises three digits.

Fault messages can also be caused by faulty sensors/actuators. Contact Service to have sensors/actuators checked and replaced as necessary if the troubleshooting measures listed in the table below prove unsuccessful.

The table below lists possible fault codes:

Fault code No.	Full designation	Meaning	Action	Related parameter No.
003	HI T-Fuel	Preliminary warning: Fuel temperature too high.	Contact Service.	2.0122.93 1
004	SS T-Fuel	Main warning: Fuel temperature too high; engine shutdown.	Contact Service.	2.0122.93 2
005	HI T-Charge Air	Preliminary warning: Charge-air temperature too high	1. Reduce power. 2. Check intercooler.	2.0121.93 1
006	SS T-Charge Air	Main warning: Charge-air temperature too high; engine shutdown.	1. Reduce power. 2. Check intercooler.	2.0121.93 2
009	AL L1 T-Coolant Inter-cooler	Charge-air coolant temperature too high (1st limit value).	Reduce power.	2.0124.93 1
010	AL L2 T-Coolant Inter-cooler	Main warning: Charge-air coolant temperature too high; engine shutdown.	Reduce power.	2.0124.93 2
015	LO P-Lube Oil	Oil pressure too low (1st limit value).	Check oil level, top up as necessary (→ Page 110).	2.0100.92 1

Fault code No.	Full designation	Meaning	Action	Related parameter No.
016	SS P-Lube Oil	Oil pressure too low (2nd limit value), automatic engine shutdown.	1. Check oil level, top up as necessary(→ Page 110). 2. Attempt to re-start engine (→ Page 51).	2.0100.92 2
019	HI T-Exhaust A	Exhaust temperature bank A to high (1st limit value).	1. Check cabling(→ Page 149) ; 2. Contact Service.	2.0126.93 1
020	SS T-Exhaust A	Exhaust temperature bank A to high (2nd limit value).	1. Check cabling(→ Page 149) ; 2. Contact Service.	2.0126.93 2
021	HI T-Exhaust B	Exhaust temperature bank B to high (1st limit value).	1. Check cabling(→ Page 149) ; 2. Contact Service.	2.0127.93 1
022	SS T-Exhaust B	Exhaust temperature bank B to high (2nd limit value).	1. Check cabling(→ Page 149) ; 2. Contact Service.	2.0127.93 2
023	LO Coolant Level	Coolant level too low (1st limit value).	Check coolant level in expansion tank(→ Page 122) .	2.0152.92 1
024	SS Coolant Level	Coolant level too low (2nd limit value).	Check coolant level in expansion tank(→ Page 122) .	2.0152.91 2
025	HI P-Diff. Lube Oil	Oil filter differential pressure too high (1st limit value).	Replace oil filter candles (→ Page 115).	2.0154.93 1
026	SS P-Diff. Lube Oil	Alarm configuration limit value 1; prewarning: differential pressure at oil filter too high.	Replace oil filter candles (→ Page 115).	2.0154.93 2
027	HI Leak Fuel Level	Leak fuel (1st limit value).	1. Check fuel system. 2. Contact Service.	2.0151.93 1
029	HI ETC2 Speed	ETC 2 idling speed too high	Contact Service.	1.8004.20 6
030	SS Engine Overspeed	Engine overspeed; automatic engine shutdown.	1. Acknowledge alarm. 2. Attempt to re-start engine.	2.2510.93 2
031	HI ETC1 Overspeed	Alarm configuration limit value 1; preliminary warning: Speed of primary turbocharger too high.	Contact Service.	2.3011.93 1
032	SS ETC1 Overspeed	ETC 1 – speed exceeded (2nd limit value)	Automatic power reduction by engine control system.Check air filter.	2.3012.93 2

T1M-ID: 0000033642 - 001

Fault code No.	Full designation	Meaning	Action	Related parameter No.
036	HI ETC2 Overspeed	Alarm configuration limit value 1; preliminary warning: Speed of secondary turbo-charger too high.	1. Reduce power. 2. Contact Service.	2.3013.93 1
037	SS ETC2 Overspeed	Alarm configuration limit value 2; main warning: Speed of secondary turbocharger too high. Fuel limitation to a fixed value.	1. Reduce power. 2. Contact Service.	2.3013.91 2
038	AL ETC Synchro Fault	Synchronization error between exhaust turbocharger 1 and 2.	1. Reduce power. 2. Contact Service.	1.8004.20 5
039	AL ETC2 Cut-in Failure	ETC2 failed to cut in.	1. Reduce power. 2. Contact Service.	1.8004.20 4
044	L1 Coolant Level Inter-cooler	Charge air coolant level too high/low (1st limit value not attained).	Check coolant level (→ Page 132).	2.0153.92 1
051	HI T-Lube Oil	Oil temperature too high (1st limit value).	Reduce power.	2.0125.93 1
052	SS T-Lube Oil	Lube oil temperature too high (2nd limit value).	1. Reduce power. 2. Check engine oil level (→ Page 110).	2.0125.93 2
057	LO P-Coolant	Coolant pressure too low (1st limit value).	Check coolant circuit.	2.0101.92 1
058	SS P-Coolant	Coolant pressure too low (2nd limit value).	Automatic engine shutdown. Check coolant level (→ Page 122).	2.0101.92 2
063	HI P-Crankcase	Preliminary warning: Crankcase pressure too high.	1. Reduce power. 2. Replace filter element of oil separator (→ Page 85).	2.0106.93 1
064	SS P-Crankcase	Main warning: Crankcase pressure too high; engine shutdown.	1. Contact Service. 2. Replace filter element of oil separator (→ Page 85).	2.0106.93 2
065	LO P-Fuel	Fuel supply pressure too low (1st limit value).	Check fuel lines for leaks. Clean fuel prefilter. Flush fuel prefilter. Replace fuel prefilter filter element. Replace fuel filter (→ Page 104).	2.0102.92 1
066	SS P-Fuel	Fuel supply pressure too low (2nd limit value).	Check fuel lines for leaks. Clean fuel prefilter.	2.0102.92 2

Fault code No.	Full designation	Meaning	Action	Related parameter No.
			Flush fuel prefilter. Replace fuel prefilter filter element. Replace fuel filter (→ Page 104).	
067	HI T-Coolant	Coolant temperature too high (1st limit value).	Reduce power.	2.0120.93 1
068	SS T-Coolant	Coolant temperature too high (2nd limit value), automatic engine shutdown.	1. Allow the engine to cool down; 2. Contact Service. 3. Check engine coolant cooler, clean if dirty. 4. Restart engine (→ Page 51).	2.0120.93 2
081	AL System Leaky	Pressure gradient in rail is too low during starting or too high during stopping; (HP system leaky, air in system).	Contact Service.	1.8004.04 6
082	HI P-Fuel (Common Rail)	Rail pressure > reference value; DBR fuel limitation, start of injection readjusted towards late; (suction restrictor of HP fuel block jamming or HP fuel control block wiring faulty)	Contact Service.	2.0104.93 1
083	LO P-Fuel (Common Rail)	Rail pressure < reference value; DBR fuel limitation; (suction restrictor of HP fuel control block defective or leakage in HP fuel system)	Contact Service.	2.0104.92 1
085	HI T-Recirculation	Preliminary warning: Recirculation temperature too high.	Reduce power.	2.0128.93 1
086	HII T-Recirculation	Main warning: Recirculation temperature too high.	Reduce power.	2.0128.93 2
089	AL Stalling Engine	Engine speed did not attain 200 rpm. A stop is activated.	Note further messages.	2.2500.03 0
090	SS No Idling Speed	Alarm configuration limit value; Idling speed was not attained.	Contact Service.	2.1090.92 5
091	SS No Runup Speed	Alarm configuration limit value; Runup speed was not attained.	Contact Service.	2.1090.92 4

T/M-ID: 0000033642 - 001

Fault code No.	Full designation	Meaning	Action	Related parameter No.
092	SS No Starter Speed	Alarm configuration limit value; Starter speed was not attained; Termination of starting sequence; Starter rotates too slowly or does not rotate at all.	Contact Service.	2.1090.923
093	SS T-Preheat	Alarm configuration limit value 2; Main warning: Preheating temperature too low; coolant temperature too low for engine start; engine start interlock active.	Check preheater.	2.1090.922
094	LO T-Preheat	Alarm configuration limit value 1; Preheating temperature too low; coolant temperature too low for engine start.	Check preheater.	2.1090.921
095	AL Oil Priming Fail	Alarm configuration; oil priming failure.	Check oil priming system.	2.1090.920
102	AL Consumption Meter Faulty	Invalid fuel consumption display, checksum error in EDM/EEPROM 1 (redundant data record 1).	Contact Service.	1.8004.624
104	AL Eng Hours Counter Defect	Checksum error of the hour meter in the EDM/EEPROM 1.	Contact Service.	18004.623
118	LO ECU Supply Voltage	Supply voltage too low (1st limit value).	Check ECU supply voltage. Contact Service.	2.0140.921
119	LOLO ECU Supply Voltage	Supply voltage too low (2nd limit value).	Check ECU supply voltage. Contact Service.	2.0140.922
120	HI ECU Supply Voltage	Supply voltage too high (1st limit value).	Check ECU supply voltage. Contact Service.	2.0140.931
121	HIHI ECU Supply Voltage	Supply voltage too high (2nd limit value); automatic engine shutdown (dependent on application engineering).	Check ECU supply voltage. Contact Service.	2.0140.932
122	HI T-ECU	Temperature in the ECU housing too high (1st limit value).	1. Improve engine room ventilation. 2. Reduce power.	2.0132.921
134	15V POS ECU DEFECT	Internal voltage (-15 V DC) defective; automatic engine shutdown.	Replace ECU.	-
136	15V NEG ECU DEFECT	Internal voltage (-15 V DC) missing; automatic engine shutdown.	Contact Service.	-

Fault code No.	Full designation	Meaning	Action	Related parameter No.
139	L1 TE BUFFER TEST	Supply voltage of temperature sensors faulty.	Contact Service. Check sensors; Replace ECU.	-
140	TE BUF. ECU DEFECT	Supply voltage of temperature sensors faulty.	Contact Service. Check sensors; Replace ECU.	-
142	BANK1 ECU DEFECT	Power output stage for solenoid valve activation on bank 1 faulty; engine does not start.	Replace ECU.	-
144	BANK2 ECU DEFECT	Power output stage for solenoid valve activation on bank 2 faulty; engine does not start.	Replace ECU.	-
145	15V_GOOD ECU DEFECT	Voltage supply is defective; automatic engine shutdown.	Replace ECU.	-
146	L1 AD-TEST1 SUPPLY	Supply voltage of A/D converter too low.	Replace ECU.	-
147	AD-TEST1 ECU DEFECT	Electronic fault; automatic engine shutdown.	Replace ECU.	-
148	L1 AD-TEST2 SUPPLY	Supply voltage of A/D converter too low.	Replace ECU.	-
149	AD-TEST2 ECU DEFECT	Internal electronic fault; automatic engine shutdown.	Replace ECU.	-
150	L1 AD-TEST3 SUPPLY	Internal electronic fault; automatic engine shutdown.	Replace ECU.	-
151	AD-TEST3 ECU DEFECT	Internal electronic fault; automatic engine shutdown.	Replace ECU.	-
176	AL LifeData Not Avail	Alarm configuration; No (appropriate) LifeData backup system available, ECU reset after expiration of time-out period.	Contact Service.	2.4000.004
177	AL LifeData Restore Incomplete	Alarm configuration; This error message is generated if a CRC is faulty during a data upload to ADEC (indicated for each indiv. module).	Contact Service.	2.4000.006
180	AL CAN1 Node Failure	Alarm configuration; Connection to one node on CAN bus 1 failed.	Contact Service.	2.0500.680
181	AL CAN2 Node Failure	Alarm configuration; Connection to one node on CAN bus 2 failed.	Contact Service.	2.0500.681
182	AL CAN Incorr. Parametriz.	Alarm configuration; Incorrect parameter values entered in data record.	Contact Service.	2.0500.682

TMM-ID: 0000033642 - 001

Fault code No.	Full designation	Meaning	Action	Related parameter No.
183	AL CAN No PU-Data	Alarm configuration; The selected CAN mode initializes communication by means of the PU data module. However, the necessary PU data module is not present or is invalid.	Contact Service.	2.0500.683
184	AL CAN PU Data Flash Error	Alarm configuration; A programming error occurred when attempting to copy a received PU data module into the Flash module.	Contact Service.	2.0500.684
186	AL CAN1 Bus Off	CAN 1 in Bus-Off state: Either short circuit on bus. Or massive magnetic fields disrupting the bus.	Contact Service. Check CAN bus for short circuit, rectify short circuit as necessary. Check shielding, improve shielding as necessary.	2.0500.686
187	AL CAN1 Error Passive	CAN 1 in Error-Passive state, minor bus disruption or CAN station missing.	Contact Service. Check that at least one CAN station is available. Check cabling as necessary. Check shielding, improve shielding as necessary.	2.0500.687
188	AL CAN2 Bus Off	CAN 2 in Bus-Off state: Either short circuit on bus. Or massive magnetic fields disrupting the bus.	Contact Service. Check CAN bus for short circuit, rectify short circuit as necessary. Check shielding, improve shielding as necessary.	2.0500.688
189	AL CAN2 Error Passive	CAN 2 in Error-Passive state, minor bus disruption or CAN station missing.	Contact Service. Check that at least one CAN station is available. Check cabling as necessary. Check shielding, improve shielding as necessary.	2.0500.689
190	AL EMU Parameter Not Supported	Alarm configuration; EMU parameters are not supported.	Contact Service.	2.0500.690
201	SD T-Coolant	Sensor B06 defective (coolant temperature).	1. Check cabling. 2. Replace if necessary.	1.8004.570

Fault code No.	Full designation	Meaning	Action	Related parameter No.
202	SD T-Fuel	Sensor B33 defective (fuel temperature).	1. Check cabling. 2. Replace if necessary.	1.8004.57 2
203	SD T-Charge Air	Sensor B09 faulty (charge-air temperature) A side.	1. Check cabling. 2. Replace if necessary.	1.8004.57 1
204	SD T-Coolant Intercooler	Sensor defective B26 (charge air coolant temperature).	1. Check cabling. 2. Replace if necessary.	1.8004.57 4
205	SD T-Exhaust A	Sensor B4.21 faulty (exhaust temperature) engine A side.	1. Check cabling 2. Replace if necessary.	1.8004.57 6
206	SD T-Exhaust B	Sensor B4.22 faulty (exhaust temperature) engine B side.	1. Check cabling. 2. Replace if necessary.	1.8004.57 7
208	SD P-Charge Air	SD alarm configuration, charge-air pressure sensor (B10) faulty, short circuit or wire break.	Check sensor and cabling, replace as necessary. Error cleared after re-starting the engine.	1.8004.56 6
211	SD P-Lube Oil	Sensor B05 defective (lube oil pressure).	1. Check cabling. 2. Replace if necessary.	1.8004.56 3
212	SD P-Coolant	Sensor B16 defective (coolant pressure).	1. Check cabling. 2. Replace if necessary.	1.8004.56 4
213	SD P-Coolant Intercooler	Sensor B43 faulty (intercooler coolant pressure).	1. Check cabling. 2. Replace if necessary.	1.8004.56 9
214	SD P-CrankCase	Sensor B50 faulty (crankcase pressure).	1. Check cabling. 2. Replace if necessary.	1.8004.56 8
215	SD P-HD	Sensor B48 faulty (rail pressure, HP regulator); emergency mode active.	1. Check cabling. 2. Replace if necessary.	1.8004.56 7
216	SD T-Lube Oil	Sensor B07 faulty (lube oil temperature).	1. Check cabling. 2. Replace if necessary.	1.8004.57 5
219	SD T-Intake Air	Sensor B03 faulty (intake air temperature).	1. Check cabling. 2. Replace if necessary.	1.8004.57 3
220	SD Coolant Level	Sensor F33 faulty (coolant level 1).	1. Switch system OFF and ON again; 2. Check error message; 3. Check cabling 4. Contact Service. 5. Check sensor.	1.8004.58 4

T/M-ID: 0000033642 - 001

Fault code No.	Full designation	Meaning	Action	Related parameter No.
221	SD Diff Lube Oil	Sensor F25 faulty (lube oil differential pressure).	1. Check sensor and wiring. 2. Replace if necessary. Error cleared after restarting the engine.	1.8004.585
222	SD Leak-Fuel Level	Sensor F46 faulty (leak fuel).	1. Check sensor and wiring. 2. Replace if necessary. 3. Contact Service.	1.8004.582
223	SD Intercooler Coolant Level	Sensor F57 defective (charge air coolant level).	1. Check sensor and wiring. 2. Contact Service.	1.8004.583
227	SD P-Oil bef. Filter	SD alarm configuration; Sensor B5.3 (lube oil pressure before filter) faulty; short circuit or wire break.	Check sensor and cabling, replace as necessary. Error cleared after re-starting the engine.	1.8004.620
229	AL Stop Sensor Defect Camshaft	Crankshaft and camshaft speed sensor faulty.	1. Check cabling. 2. Contact Service.; Check sensor.	1.8004.562
230	SD crankshaft	Sensor B13 faulty (crankshaft speed).	1. Check sensor and wiring. 2. Contact Service.	1.8004.498
231	SD camshaft	Sensor B1 faulty (camshaft speed).	1. Check sensor and wiring. 2. Contact Service.	1.8004.499
232	SD ETC Speed 1	Sensor B44 faulty (turbocharger speed 1).	1. Check sensor and wiring. 2. Contact Service.	1.3011.128
233	SD ETC Speed 2	Sensor B44.2 faulty (turbocharger speed 2).	1. Check sensor and wiring. 2. Contact Service.	1.3011.129
240	SD P-Fuel	Sensor B34 faulty (fuel pressure).	1. Check sensor and wiring. 2. Contact Service.	1.8004.565
241	SD T-Recirculation	Sensor B49 faulty (recirculation temperature).	1. Check sensor and wiring. 2. Contact Service.	1.8004.581
242	SD T-Coolant Redundant	Redundant coolant temperature sensor faulty.	1. Check sensor and wiring. 2. Contact Service.	1.8004.622
244	SD Oil Press. Redundant	SD alarm configuration; Redundant lube oil pressure sensor faulty; Short circuit or wire break	Check sensor and cabling, replace as necessary. Error cleared after re-starting the engine.	1.8004.621

Fault code No.	Full designation	Meaning	Action	Related parameter No.
245	SD ECU Supply Voltage	Sensor fault (ECU operating voltage).	Replace ECU.	2.8006589
266	SD Speed Setting	External speed setting faulty.	1. Check cabling. 2. Check speed setting.	2.8006.586
269	SD Loadp. Analog Filt.	SD alarm configuration; Filtered analog signal of load pulse missing; short circuit or wire break.	Check cabling, replace as necessary. Error cleared after restarting the engine.	2.8006.588
270	SD Frequency Input	Frequency setting sensor faulty.	1. Check cabling. 2. Contact Service.; Check setpoint speed transmitter.	2.8006.590
301	TIMING CYLINDER(A1-A10)	Timing bank 1 (solenoid valve 1) ... Timing bank 1 (solenoid valve 10)	Replace injector concerned if the fault message appears frequently (→ Page 97).	1.8004.500
302	-	-	-	1.8004.501
303	-	-	-	1.8004.502
304	-	-	-	1.8004.503
305	-	-	-	1.8004.504
306	-	-	-	1.8004.505
307	-	-	-	1.8004.506
308	-	-	-	1.8004.507
309	-	-	-	1.8004.508
310	-	-	-	1.8004.509
311	TIMING CYLINDER(B1-B10)	Timing Bank 2 (solenoid valve 1) ... Timing Bank 2 (solenoid valve 10)	Replace injector concerned if the fault message appears frequently (→ Page 97).	1.8004.510
312	-	-	-	1.8004.511
313	-	-	-	1.8004.512
314	-	-	-	1.8004.513

TMM-ID: 0000033642 - 001

Fault code No.	Full designation	Meaning	Action	Related parameter No.
315	-	-	-	1.8004.514
316	-	-	-	1.8004.515
317	-	-	-	1.8004.516
318	-	-	-	1.8004.517
319	-	-	-	1.8004.518
320	-	-	-	1.8004.519
321	WIRING CYLINDER(A1-A10)	Wiring bank 1 (solenoid valve 1) ... Wiring bank 1 (solenoid valve 10)	1. Check solenoid valve. 2. Contact Service.	1.8004.520
322	-	-	-	1.8004.521
323	-	-	-	1.8004.522
324	-	-	-	1.8004.523
325	-	-	-	1.8004.524
326	-	-	-	1.8004.525
327	-	-	-	1.8004.526
328	-	-	-	1.8004.527
329	-	-	-	1.8004.528
330	-	-	-	1.8004.529
331	WIRING CYLINDER(B1-B10)	Wiring bank 2 (solenoid valve 1) ... Wiring bank 2 (solenoid valve 10)	1. Check solenoid valve. 2. Contact Service.	1.8004.530
332	-	-	-	1.8004.531
333	-	-	-	1.8004.532
334	-	-	-	1.8004.533
335	-	-	-	1.8004.534
336	-	-	-	1.8004.535

TWM-ID: 0000033662 - 001

Fault code No.	Full designation	Meaning	Action	Related parameter No.
337	-	-	-	1.8004.536
338	-	-	-	1.8004.537
339	-	-	-	1.8004.538
340	-	-	-	1.8004.539
341	OPEN_LOAD CYL.(A1-A10)	Open Load Bank 1 (solenoid valve 1) ... Open Load Bank 1 (solenoid valve 10)	1. Check solenoid valve. 2. Contact Service.	1.8004.540
342	-	-	-	1.8004.541
343	-	-	-	1.8004.542
344	-	-	-	1.8004.543
345	-	-	-	1.8004.544
346	-	-	-	1.8004.545
347	-	-	-	1.8004.546
348	-	-	-	1.8004.547
349	-	-	-	1.8004.548
350	-	-	-	1.8004.549
351	OPEN_LOAD CYL.(B1-B10)	Open Load Bank 2 (solenoid valve 1) ... Open Load Bank 2 (solenoid valve 10)	1. Check solenoid valve. 2. Contact Service.	1.8004.550
352	-	-	-	1.8004.551
353	-	-	-	1.8004.552
354	-	-	-	1.8004.553
355	-	-	-	1.8004.554
356	-	-	-	1.8004.555
357	-	-	-	1.8004.556
358	-	-	-	1.8004.557

TMM-ID: 0000033642 - 001

Fault code No.	Full designation	Meaning	Action	Related parameter No.
359	-	-	-	1.8004.558
360	-	-	-	1.8004.559
361	AL Injector Power Stage Low	Alarm configuration; Internal electronic fault (electronics possibly faulty: start ITS). Check additional messages if ITS indicates diagnosis "Electronics OK" (e.g. cabling faulty).	1. Check solenoid valve cabling. 2. Replace ECU.	1.8004.496
362	AL Injector Power Stage High	Alarm configuration; Internal electronic fault (electronics possibly faulty: start ITS). Check additional messages if ITS indicates diagnosis "Electronics OK" (e.g. cabling faulty).	1. Check solenoid valve cabling. 2. Replace ECU.	1.8004.497
363	AL Stop Injector Power Stage	Alarm configuration; Internal electronic fault (electronics possibly faulty: start ITS).	1. Check cabling. 2. Attempt to re-start engine.	1.8004.560
365	AL Stop Solenoid Valve Grounding	Alarm configuration; Injector cabling faulty. If bit "1.1020.021" (Power Stage Failure: Stop Engine) is set, engine will be shut down as additional measure. 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 .	1. Check cabling. 2. Attempt to re-start engine.	1.8004.561
371	AL Wiring TO 1	Alarm configuration; Short circuit or wire break on transistor output 1 (TO 1).	1. Check turbo-charger valve/cabling, repair as necessary 2. Replace ECU.	1.8004.634
372	AL Wiring TO 2	Alarm configuration; Short circuit or wire break on transistor output 2 (TO 2).	1. Check recirculation valve/cabling, repair as necessary 2. Replace ECU.	1.8004.635
373	AL Wiring TO 3	Alarm configuration; Short circuit or wire break on transistor output 3 (TO 3).	-	1.8004.636
374	AL Wiring TO 4	Alarm configuration; Short circuit or wire break on transistor output 4 (TO 4).	-	1.8004.637
381	AL Wiring TOP 1	Alarm configuration; Short circuit or wire break on transistor output, plant-side 1 (TOP 1).	Check cabling to plant.	2.8006.638

Fault code No.	Full designation	Meaning	Action	Related parameter No.
382	AL Wiring TOP 2	Alarm configuration; Short circuit or wire break on transistor output, plant-side 2 (TOP 2).	Check cabling to plant.	2.8006.639
383	AL Wiring TOP 3	Alarm configuration; Short circuit or wire break on transistor output, plant-side 3 (TOP 3).	Check cabling to plant.	2.8006.640
384	AL Wiring TOP 4	Alarm configuration; Short circuit or wire break on transistor output, plant-side 4 (TOP 4).	Check cabling to plant.	2.8006.641
390	AL MCR exceeded	Alarm configuration; DBR/MCR function: MCR exceeded.	1. If alarm is only temporary, no action required; 2. <if alarm is continuously active, contact Service.	1.1085.009
392	HI T-Coolant Redundant	Alarm configuration limit value 1; Preliminary warning: Redundant coolant temperature reading too high.	1. Check cabling. 2. Contact Service.	2.0129.931
393	SS T-Coolant Redundant	Alarm configuration limit value 1; Main warning: Redundant coolant temperature reading too high; engine shutdown.	1. Check sensor and wiring. 2. Contact Service.	2.0129.932
394	LO P-Lube Oil Redundant	Alarm configuration limit value 1; Preliminary warning: Redundant lube oil pressure reading too low.	1. Check sensor and wiring. 2. Contact Service.	2.0112.921
395	SS P-Lube Oil Redundant	Alarm configuration limit value 2; Main warning: Redundant lube oil pressure reading too low.	1. Check sensor and wiring. 2. Contact Service.	2.0112.922
396	AL T-Coolant Max Deviation	Alarm configuration; Maximum coolant temperature deviation.	1. Check sensor and wiring. 2. Contact Service.	1.8004.626
397	AL P-Oil Max Deviation	Alarm configuration; Maximum lube oil pressure deviation.	1. Check sensor and wiring. 2. Contact Service.	1.8004.625
400	AL Open Load Digital Input 1	Alarm configuration; Line disruption on digital input 1; Cabling faulty or no resistance over switch.	1. Check cabling. 2. Contact Service.; 3. Check input of target device.	2.8006.625
401	AL Open Load Digital Input 2	Alarm configuration; Line disruption on digital input 2; Cabling faulty or no resistance over switch.	1. Check cabling. 2. Contact Service.; Check input of target device.	2.8006.626

T1M-ID: 0000033642 - 001

Fault code No.	Full designation	Meaning	Action	Related parameter No.
402	AL Open Load Digital Input 3	Alarm configuration; Line disruption on digital input 3; Cabling faulty or no resistance over switch.	1. Check cabling. 2. Contact Service.; Check input of target device.	2.8006.627
403	AL Open Load Digital Input 4	Alarm configuration; Line disruption on digital input 4; Cabling faulty or no resistance over switch.	1. Check cabling. 2. Contact Service.; Check input of target device.	2.8006.628
404	AL Open Load Digital Input 5	Alarm configuration; Line disruption on digital input 5; Cabling faulty or no resistance over switch.	1. Check cabling. 2. Contact Service.; Check input of target device.	2.8006.629
405	AL Open Load Digital Input 6	Alarm configuration; Line disruption on digital input 6; Cabling faulty or no resistance over switch.	1. Check cabling. 2. Contact Service.; Check input of target device.	2.8006.630
406	AL Open Load Digital Input 7	Alarm configuration; Line disruption on digital input 7; Cabling faulty or no resistance over switch.	1. Check cabling. 2. Contact Service.; Check input of target device.	2.8006.631
407	AL Open Load Digital Input 8	Alarm configuration; Line disruption on digital input 8; wiring defective or no resistance through the switch.	1. Check cabling. 2. Contact Service.; Check input of target device.	2.8006.632
408	AL Open Load Em. Stop Input ESI	Alarm configuration; Line disruption on the input for emergency stop; Cabling faulty or no resistance over switch.	1. Check cabling. 2. Contact Service.; Check input of target device.	2.8006.633
410	LO U-PDU	Alarm configuration limit value 1; Preliminary warning: Injector voltage too low.	1. Check cabling. 2. Check power supply. 3. Contact Service.	2.0141.921
411	LOLO U-PDU	Alarm configuration limit value 2; Main warning: Injector voltage too low.	1. Check cabling. 2. Check power supply. 3. Contact Service.	2.0141.922
412	HI U-PDU	Alarm configuration limit value 1; Preliminary warning: Injector voltage too high.	1. Check cabling. 2. Check power supply. 3. Contact Service.	2.0141.931
413	HIHI U-PDU	Alarm configuration limit value; Main warning: Injector voltage too high.	1. Check cabling. 2. Check power supply. 3. Contact Service.	2.0141.932
414	HI Water Level Fuel Pre-filter	Alarm configuration limit value 1; Warning: water level in fuel prefilter too high.	Drain water.	2.0156.931

Fault code No.	Full designation	Meaning	Action	Related parameter No.
415	LO P-Coolant Intercooler	Alarm configuration limit value 1; Preliminary warning: Coolant pressure in intercooler too low.	Top up coolant (→ Page 135).	2.0107.92 1
416	SS P-Coolant Intercooler	Alarm configuration limit value 2; Main warning: Coolant pressure in intercooler too low. engine shutdown.	Top up coolant (→ Page 135).	2.0107.92 2
417	SD Water Level Fuel Prefilter	SD alarm configuration; Sensor for water level in fuel prefilter faulty; short circuit or wire break.	Check sensor and cabling, replace as necessary. Error cleared after re-starting the engine.	1.8004.59 4
420	L1 Aux 1	Alarm configuration limit value 1; Input signal of Aux 1 has exceeded/not attained limit value 1, depending on configuration.	Determine cause of limit value violation and rectify fault.	2.0160.92 1
421	L2 Aux 1	Alarm configuration limit value 1; Input signal of Aux 1 has exceeded/not attained limit value 2, depending on configuration.	Determine cause of limit value violation and rectify fault.	2.0160.92 2
428	L1 T-Aux 1	Alarm configuration limit value 1; Preliminary warning: Temperature signal of Aux 1 has exceeded / not attained limit value 1, depending on configuration.	Determine cause of limit value violation and rectify fault.	2.0130.92 1
440	L1 P-Aux 1	Alarm configuration limit value 1; Preliminary warning: Pressure signal of Aux 1 has exceeded / not attained limit value 1, depending on configuration.	Determine cause of limit value violation and rectify fault.	2.0110.92 1
442	L2 P-Aux 1	Alarm configuration limit value 2; Preliminary warning: Pressure signal of Aux 1 has exceeded / not attained limit value 2, depending on configuration.	Determine cause of limit value violation and rectify fault.	2.0110.93 1
444	SD U-PDU	SD alarm configuration; Injector power stage sensor defect; Internal fault in ECU7.	Replace ADEC (ECU 7).	1.8004.57 8
445	SD P-Ambient Air	SD alarm configuration; Ambient air pressure sensor faulty.	Replace ECU.	1.8004.58 0
448	HI P-Charge Air	Alarm configuration limit value 1; Preliminary warning: Charge-air pressure too high.	Contact Service.	2.0103.93 1

T1M-ID: 0000033642 - 001

Fault code No.	Full designation	Meaning	Action	Related parameter No.
449	SS P-Charge Air	Alarm configuration limit value 2; Main warning: Charge-air pressure too high.	Contact Service.	2.0103.932
450	SD Feed Signal Percent	SD alarm configuration; Input signal for initial/final torque faulty; Short circuit or wire break	Check signal transmitter and cabling, replace as necessary. Error cleared after restarting the engine.	2.8006.592
454	SS Power Reduction Active	Alarm configuration; Power reduction is active.	1. Note further fault messages. 2. Determine and rectify reason for power reduction.	2.7000.011
455	AL Aux 1 Plant L1	Alarm configuration limit value 1; Input signal of Aux 1 (plant side) has exceeded/not attained limit value 1, depending on configuration.	Determine cause of limit value violation and rectify fault.	2.8006.650
456	AL Aux 1 Plant L2	Alarm configuration limit value 2; Input signal of Aux 1 (plant side) has exceeded/not attained limit value 2, depending on configuration.	Determine cause of limit value violation and rectify fault.	2.8006.651
460	AL Exhaust EMU High	Alarm configuration limit value; EMU exhaust gas temperature value too high.	1. Check cabling. 2. Contact Service.	2.8006.652
461	AL Exhaust EMU Low	Alarm configuration limit value; EMU exhaust gas temperature value too low.	1. Check cabling. 2. Contact Service.	2.8006.653
462	AL Coolant EMU L1	Alarm configuration limit value; EMU coolant temperature value too high / low.	Check configuration with DiaSys.	2.8006.654
463	SD AUX 2	SD alarm configuration; Analog input signal for Aux 2 faulty; Short circuit or wire break	Check signal transmitter and cabling, replace as necessary. Error cleared after restarting the engine.	1.8004.591
464	SD P-AUX 1	SD alarm configuration; Analog input signal for Aux 1 pressure faulty; Short circuit or wire break	Check pressure sensor and cabling. Error cleared after restarting the engine.	1.8004.589

T/M-ID: 0000033662 - 001

Fault code No.	Full designation	Meaning	Action	Related parameter No.
465	SD P-AUX 2	SD alarm configuration; Analog input signal for Aux 2 pressure faulty; Short circuit or wire break	Check pressure transmitter and cabling, replace as necessary. Error cleared after restarting the engine.	1.8004.588
466	SD T-AUX 2	SD alarm configuration; Analog input signal for Aux 2 temperature faulty; Short circuit or wire break	Check temperature sensor and cabling, replace as necessary. Error cleared after restarting the engine.	1.8004.586
467	L2 T-Aux 1	Alarm configuration limit value 2; Preliminary warning: Temperature signal of Aux 1 has exceeded / not attained limit value 2, depending on configuration.	Determine cause of limit value violation and rectify fault.	2.0130.922
468	SD T-AUX 1	SD alarm configuration; Analog input for Aux 1 temperature faulty.	Replace ECU.	1.8004579
469	SD AUX 1	SD alarm configuration; Analog input signal for Aux 1 faulty; Short circuit or wire break	Check signal transmitter and cabling, replace as necessary. Error cleared after restarting the engine.	1.8004.590
470	SD T-ECU	SD alarm configuration; Temperature sensor for ECU faulty; Short circuit or wire break	Check sensor and cabling, replace as necessary. Error cleared after restarting the engine.	1.8004.587
471	SD HP Fuel Control Block	SD alarm configuration; Control of HP fuel control block faulty; Short circuit or wire break	Check sensor and cabling, replace as necessary. Error cleared after restarting the engine.	1.8004.592
472	AL Stop SD	Alarm configuration; Engine shutdown, since all shutdown channels have "sensor faulty".	1. Check cabling. 2. Contact Service.	2.8006.593
473	AL Cabling PWM_CM2	Alarm configuration; Cable break or short circuit on channel PWM_CM2.	1. Check cabling. 2. Contact Service.	1.8004.593
474	AL Cabling FO	Alarm configuration; Cable break or short circuit on channel FO.	1. Check cabling. 2. Contact Service.	2.8006.655
475	AL CR Engine Shutdown Trigger	Alarm configuration; activated when crash recorder triggered by an engine shutdown	Determine and rectify cause of triggering / engine shutdown.	1.8010.009

TMA-ID: 0000033642 - 001

Fault code No.	Full designation	Meaning	Action	Related parameter No.
476	AL Crash Rec. Init. Error	Alarm configuration; Initialization error of crash recorder.	Check settings with DiaSys.	1.8010.007
478	AL Comb. Alarm Yellow (Plant)	Alarm configuration; Combined alarm YELLOW from plant.	Note further fault messages.	2.8006.001
479	AL Comb. Alarm Red (Plant)	Alarm configuration; Combined alarm RED from plant.	Note further fault messages.	2.8006.002
480	AL Lim Ext. Plant Bin	Alarm configuration limit value; input signal has exceeded / not attained limit, depending on configuration.	Determine cause of limit value violation and rectify fault.	2.0291.921

7 Task Description

7.1 Engine

7.1.1 Cranking engine manually

Preconditions

- ☑ Engine shut down and secured against being restarted.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Cranking tool	F6555766	1
Cranking tool	F6783293	1
Adapter	F6558528	1
Ratchet with extension	F30006212	1

DANGER



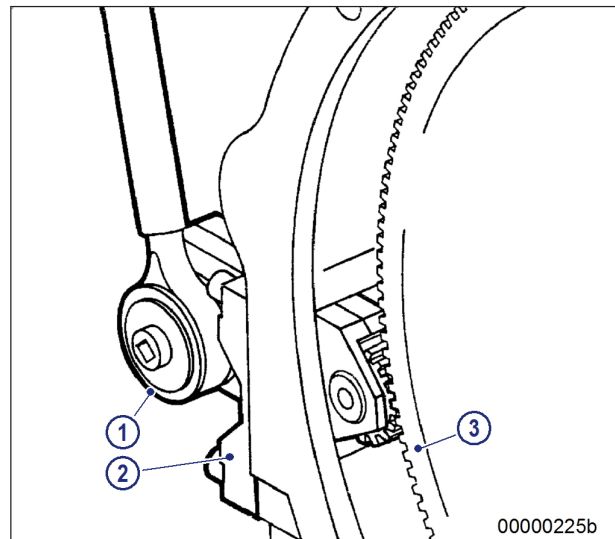
Unguarded rotating and moving engine components.

Risk of serious injury – Danger to life!

- Before barring the engine, ensure that nobody is in the danger zone.

Cranking engine manually (tool mounted on side)

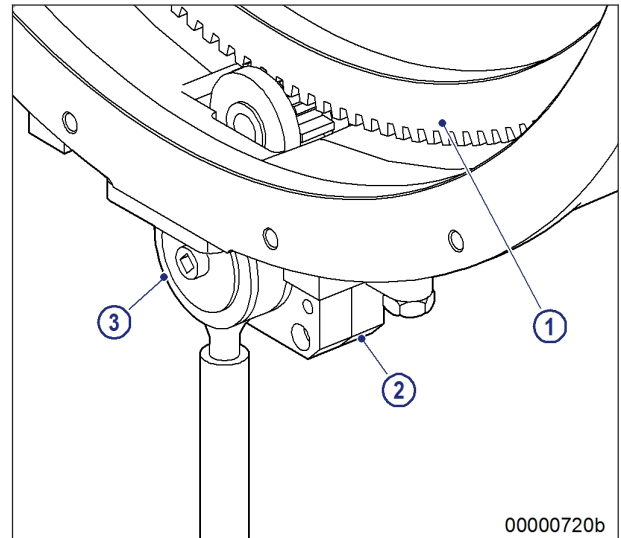
1. Remove guard plate.
2. Engage cranking tool (2) in ring gear (3) and mount on flywheel housing.
 - Use cranking tool F6555766.
3. Fit ratchet (1) onto cranking tool (2).
4. Rotate crankshaft in normal direction of engine rotation; apart from the normal compression resistance, there should be no resistance.
5. Cranking tool is removed by same procedure in reverse.



TIM-ID: 000002521 - 005

Cranking engine manually (tool mounted underneath)

1. Remove grounding device or guard plate.
2. Engage cranking tool (2) in ring gear (1) and mount on flywheel housing.
 - For 12/16V engines, use cranking tool F6555766 with adapter F6558528.
 - For 20V engines, use cranking tool F6783293.
3. Fit ratchet (3) onto cranking tool (2).
4. Rotate crankshaft in normal direction of engine rotation; apart from the normal compression resistance, there should be no resistance.
5. Cranking tool is removed by same procedure in reverse.



7.1.2 Engine – Barring with starting system

DANGER



Unguarded rotating and moving engine components.

Risk of serious injury – danger to life!

- Before barring or starting the engine, ensure that nobody is in the danger zone.
- After working on the engine, check that all protective devices have been reinstalled and all tools removed from the engine.

Engine – Barring with starting system

1. Release latch of connector X4.
2. Remove connector from engine governor.
3. Bar engine in unloaded condition: Press START button.
4. Let the crankshaft rotate until oil pressure is indicated.
5. Engine start is automatically interrupted when specified starting period has passed. If necessary, re-start the engine after approx. 20 seconds.
6. Connect connector X4 to engine governor and latch in position.

TIM-ID: 000000918-004

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.
Barring device	F6555766	1
Ratchet with extension	F30006212	1
Endoscope	Y20097353	1

Preparatory steps

1. Remove cylinder head cover (→ Page 95).
2. Remove injector (→ Page 98).

Positioning crankshaft at BDC

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

Cylinder liner endoscopic examination

Findings	Measure
• Thin carbon coating on carbon scraper ring • Slight localized additive deposits at top edge • Localized smooth areas at bottom edge • Carbon deposits on entire circumference 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 • Faultless, even honing pattern • 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 cannot be faulted • Piston rings cannot be faulted	Further endoscopic examination required as part of maintenance work.
• On the entire circumference, apart from light areas of discoloration (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.

TIM-ID: 000003304 - 004

1. Compile endoscopy report using the table.
2. Use technical terms for description of the liner surface (→ Page 83).
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 98).
2. Install cylinder head cover (→ Page 95).

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	Measure
Light scoring	Minor dirt scores can occur during the assembly of a new engine (honing products, particles, broken-off burrs). Removed cylinders clearly exhibit 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 honing pattern in the direction of stroke. Findings not critical.
Scored area	These areas consist of scores of different lengths and depths 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 changes to 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.
Polished area	Polished areas are on the running surface and show local removal of the honing pattern. Grooves from the honing process are not visible any more. New cylinder liners must be fitted in the following cases Polished area: covers more than 20% of the entire piston running surface, covers more than 30° of the circumference and extends over more than 50% of piston stroke, is wider than 15 mm over the entire piston stroke.
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. Cylinders with a number of black lines around the running surface have limited service life and should be replaced.
Discolorations (Heat)	These are caused by a disturbance 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 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.

TMA-ID: 000000285 - 003

Findings	Measure
	Liners with heat discoloration starting in the TDC-ring 1 have to be replaced.
Seizures, Seizure marks	Seizure marks are of irregular circumferential length and depth. Can be caused by either the piston skirt or the piston crown. Material deposits on the liner (smears) show heavy discoloration and scoring. Replace liner.

Evaluation of findings and further measures

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

7.3 Crankcase Breather

7.3.1 Crankcase breather – Oil separator element replacement, diaphragm check and 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
Ratchet	F30027340	1
Engine oil		
Filter element	(→ Spare Parts Catalog)	
Diaphragm	(→ Spare Parts Catalog)	
Gasket	(→ Spare Parts Catalog)	

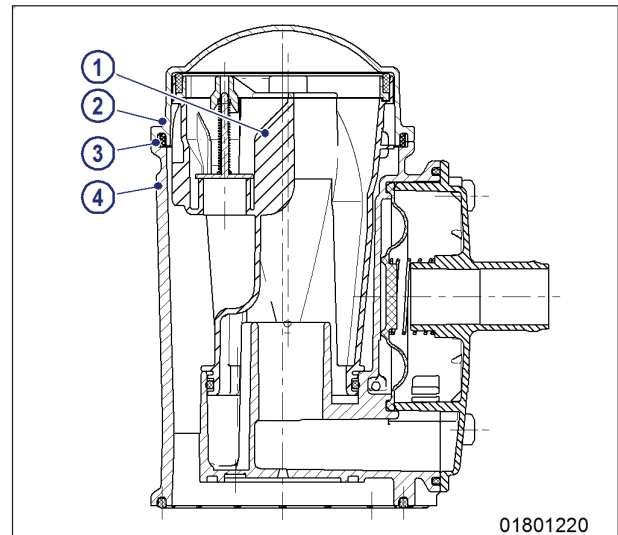
WARNING



- 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.

Replacing oil separator element

1. Remove cover (2) with O-ring (3).
2. Remove filter element (1) from housing (4).
3. Insert new filter element in housing (4).
4. Install cover (2) with new O-ring.



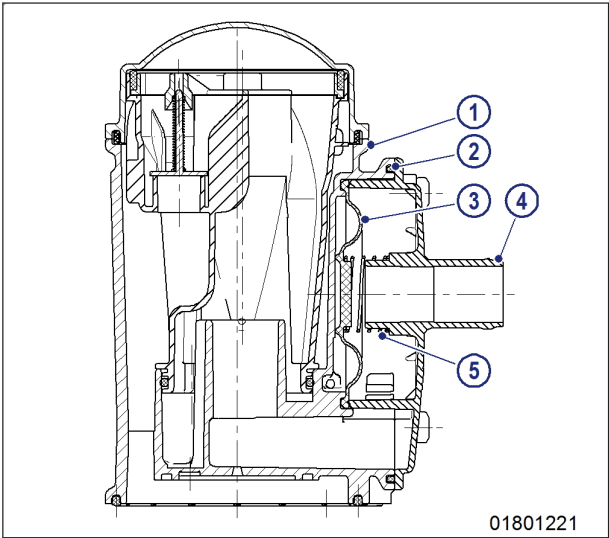
5. Use torque wrench to tighten the screws of cover (2) to the specified torque.

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque	(Engine oil)	10 Nm –2 Nm

6. Replace further oil separator elements in the same way.

Checking diaphragm

- 1. Remove cover (4).
- 2. Remove spring (5), gasket (2) and diaphragm (3).
- 3. Check diaphragm (3) for damage, fit new diaphragm if used one is damaged.
- 4. Install diaphragm (3) on housing (1).
- 5. Install new seal (2) and spring (5) together with cover (4).



- 6. Use torque wrench to tighten the screws of cover (4) to the specified torque.

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque	(Engine oil)	10 Nm –2 Nm

- 7. Check diaphragms in further oil separators in the same way.

7.4 Running Gear

7.4.1 Grounding device – Carbon brush check

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Cold cleaner (Hakutex 60)	50602	
Carbon brush	(→ Spare Parts Catalog)	

WARNING



Compressed air

Risk of injury!

- Do not direct compressed-air jet at persons.
- Wear protective goggles / safety mask and ear protectors.

NOTICE



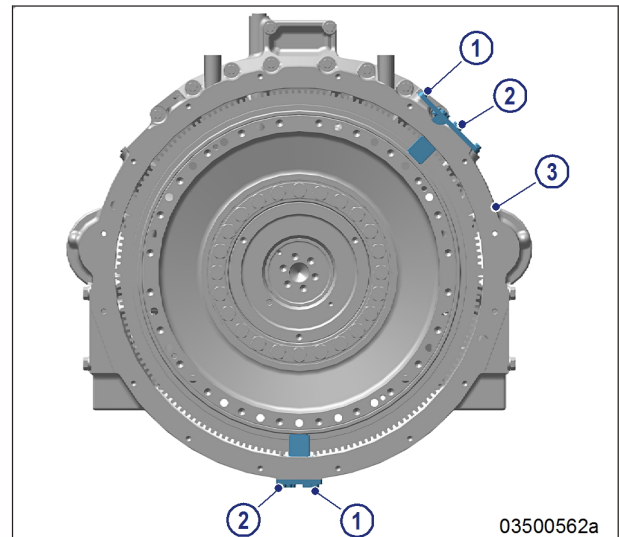
Unsuitable cleaning tools.

Damage to component!

- Observe manufacturer's instructions.
- Use appropriate cleaning tool.

Remove grounding assembly

1. Remove screws (1) with washers.
2. Remove grounding device (2) from flywheel housing (3).



Checking grounding device

Item	Findings	Action
Carbon brush	Damaged Wear limit 45 mm (new condition 60 mm)	Fit new part(→ Page 89) Fit new part(→ Page 89)
Press carbon brush against spring pressure Spring	broken, damaged	Fit new part(→ Page 89)
Running surface on adapter	contaminated, corroded	Clean

Cleaning running surface on adapter

1. Clean running surface of carbon brushes on adapter with cold cleaner.
2. Remove stubborn deposits with soft brush.
3. Blow out adapter with compressed air.

Installing grounding device

1. Check mounting surface on flywheel housing for cleanness.
2. Install grounding device on flywheel housing and secure with screws.

7.4.2 Grounding device - Carbon brush replacement

Preconditions

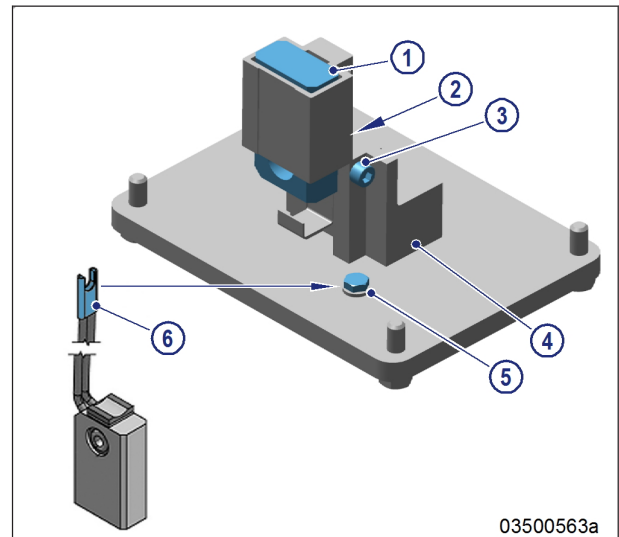
- ☑ Engine shut down and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Loctite 270	40083	
Carbon brush	(→ Spare Parts Catalog)	2

Replace carbon brush

1. Loosen screw (5).
 2. Disconnect cable (6) from screw (5).
 3. Loosen screws (3).
 4. Remove screws (2).
 5. Remove carbon brush (1) from grounding device (4).
 6. Fit new carbon brush (1) in grounding device (4).
 7. Tighten screws (2) by hand.
 8. Insert screws (3) as far as the stop and tighten screws lightly.
 9. Tighten screws (2).
- Note: Apply Loctite 270 only to threads.
10. Secure cable (6) with screw (5).



7.5 Valve Drive

7.5.1 Valve gear – Lubrication

Preconditions

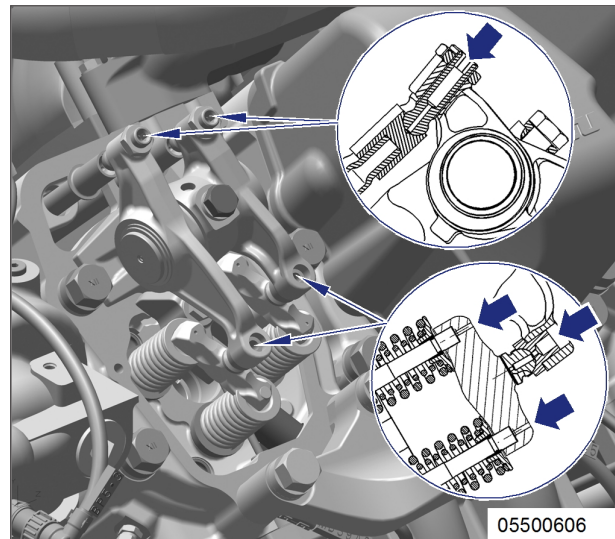
- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine oil		

Valve gear – Lubrication

1. Remove cylinder head covers (→ Page 95).
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 95).



7.5.2 Valve clearance – Check and adjustment

Preconditions

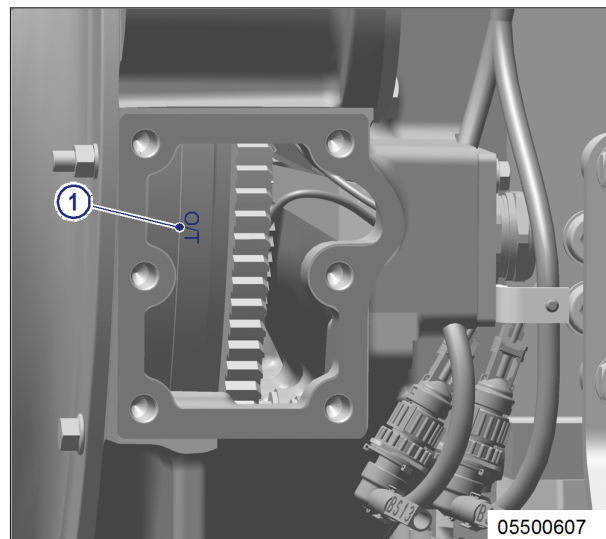
- ☒ Engine shut down and starting disabled.
- ☒ Engine coolant temperature is max. 40 °C.
- ☒ Valves are closed.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Feeler gauge	Y20098771	1
Torque wrench, 60-320 Nm	F30452768	1
Box wrench socket, 24 mm	F30039526	1
Engine oil		

Preparatory steps

1. Remove cylinder head cover (→ Page 95).
2. Install barring device (→ Page 78).
3. The OT (TDC) marking (1) (if fitted) on the flywheel must not be used for reference.



4. Rotate crankshaft with barring device in direction of engine rotation until the "OT-A1" marking and pointer are aligned.

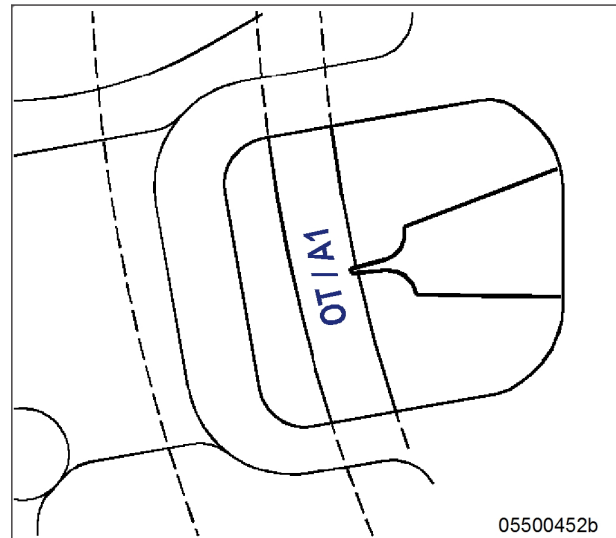


Diagram for 8V engines (two crankshaft positions)

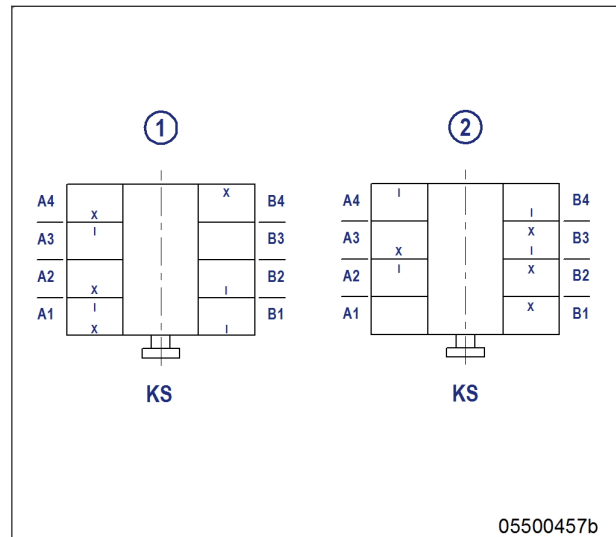
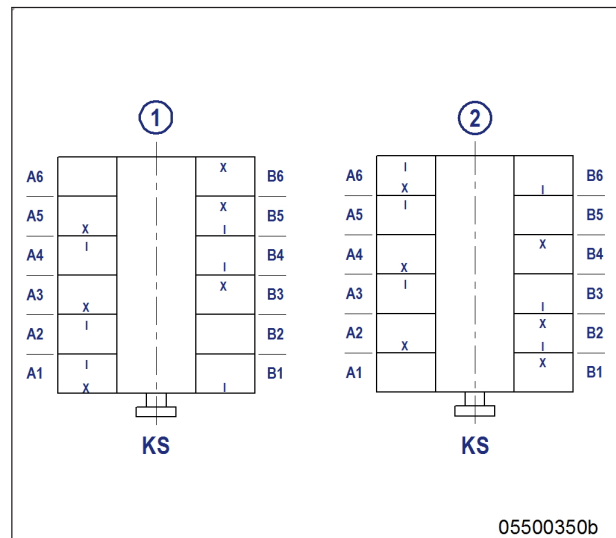


Diagram for 12V engines (two crankshaft positions)



TMA-ID: 000000922 - 010

Diagram for 16V engines (two crankshaft positions)

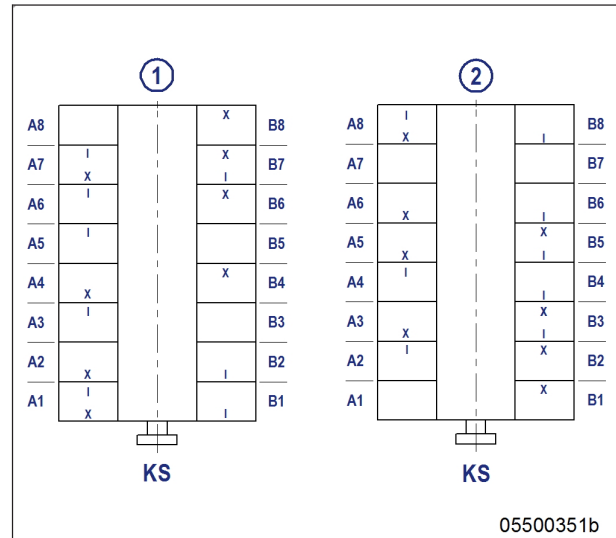
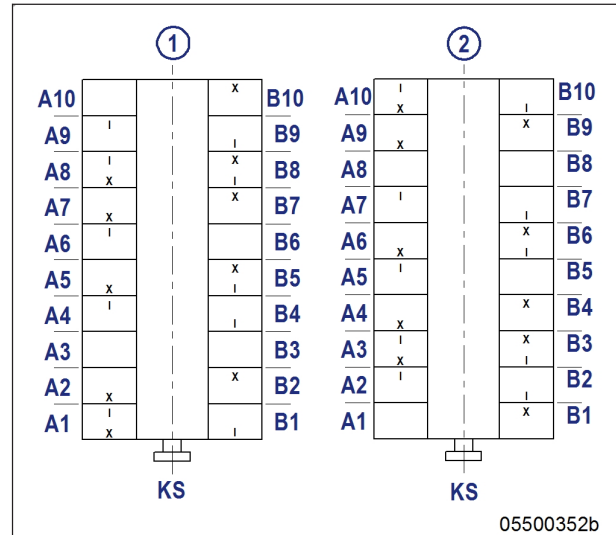


Diagram for 20V engines (two crankshaft positions)

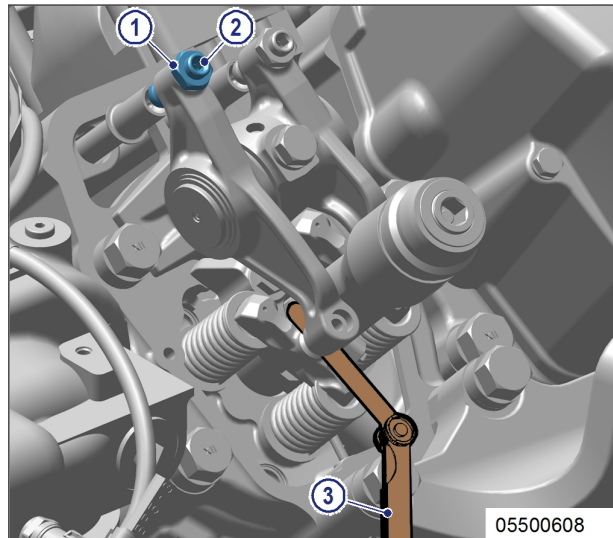


Checking valve clearance at two crankshaft positions

- 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 under load on cylinder A1, the piston is in overlap TDC.
- Check valve clearance with cold engine:
 - Inlet (long rocker arm) = 0.2 mm $\pm$ 0.05 mm
 - Exhaust (short rocker arm) = 0.5 mm $\pm$ 0.05 mm
- Check all valve clearances in two crankshaft positions (firing TDC and overlap TDC of cylinder A1) as per diagram.
 - Cylinder A1 is in firing TDC
 - Cylinder A1 is in overlap TDC
 - Inlet valve
 - Exhaust valve
- Use feeler gauge to determine the distance between valve bridge and rocker arm.
- If the deviation from the set value exceeds 0.1 mm, adjust valve clearance.

Adjusting valve clearance

1. Release locknut (1).
2. Insert feeler gauge (3) between valve bridge and rocker arm.
3. Use Allen key to set adjusting screw (2) so that the specified valve clearance is established.
4. Feeler gauge (3) must just pass through gap.



5. Tighten locknut (1) with torque wrench to the specified tightening torque, holding the adjusting screw (2) to prevent it from turning.

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 device (→ Page 78).
2. Install cylinder head cover (→ Page 95).

7.5.3 Cylinder head cover – Removal and installation

Preconditions

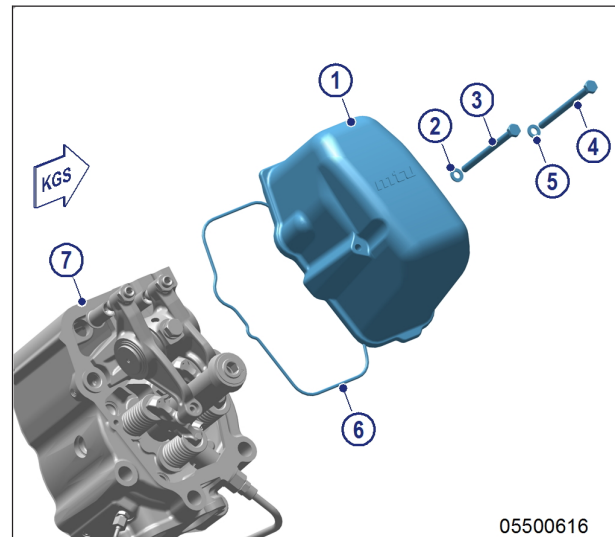
- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Grease (Kluthe Hakuform 30-10/Emulgier)	X00029933	1
O-ring	(→ Spare Parts Catalog)	

Removing cylinder head cover

1. Clean very dirty cylinder head covers (1) prior to removal.
2. Remove screws (3, 4) with washers (2, 5).
3. Take off cylinder head cover (1) with O-ring (6) from cylinder head (7).



Installing cylinder head cover

1. Clean mounting surface.
2. Check O-ring (6) for damage, replace if necessary.
3. Coat O-ring (6) with grease.
4. Position O-ring (6) in groove of cylinder head cover (1).
5. Fit cylinder head cover (1) on cylinder head (7).
6. Install cylinder head cover (1) with screws (3, 4) and washers (2, 5).

7.6 Injection Pump / HP Pump

7.6.1 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



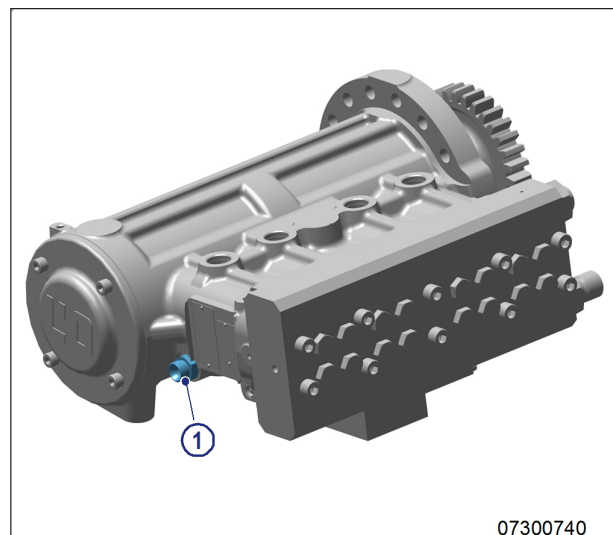
HP fuel pump not filled with engine oil.

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).



07300740

TTM-ID: 0000001640 - 010

7.7 Injection Valve / Injector

7.7.1 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 98).

7.7.2 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!

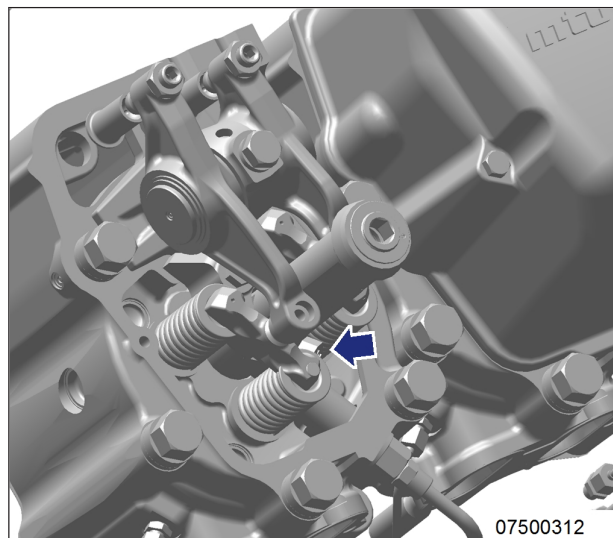
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Preparatory steps

1. Shut off fuel supply to engine.
2. Remove cylinder head cover (→ Page 95).

Removing injector

1. Disconnect cable connector on injector.

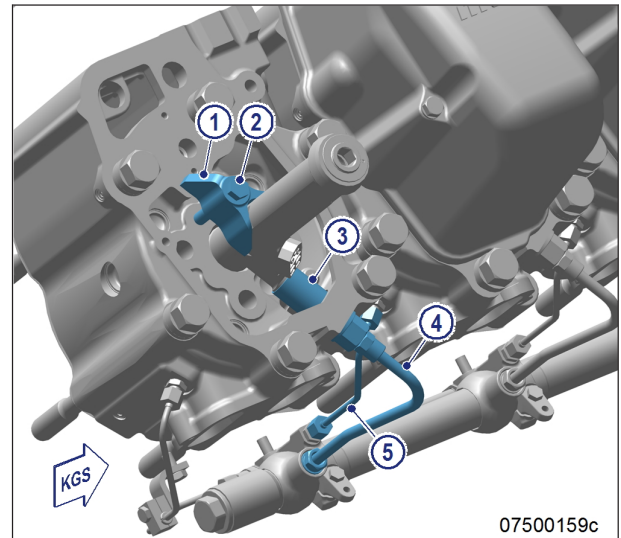


TTM-ID: 000000925 - 008

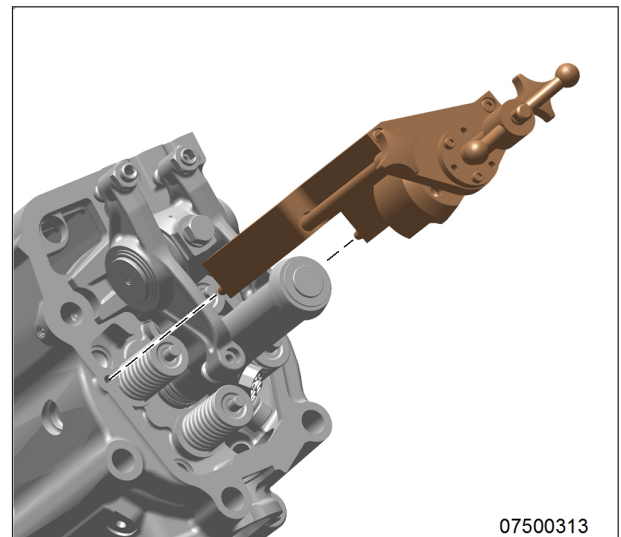
2. Remove HP fuel line (4).
3. Remove return line (5).

Note: The injector accumulator will be emptied when removing the adapter.

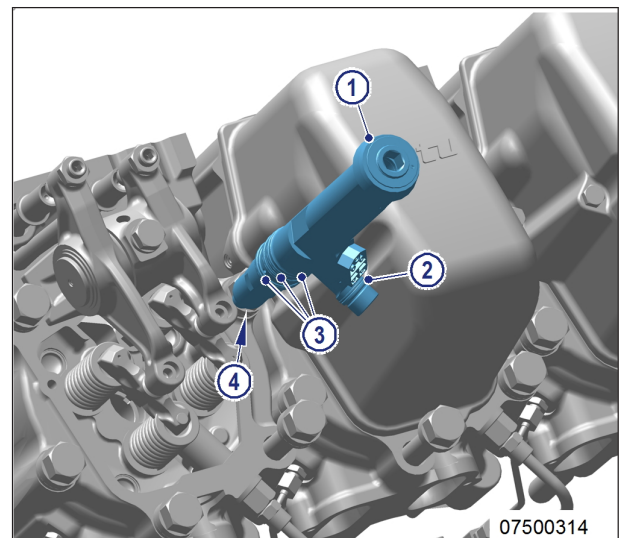
4. Remove adapter (3).
5. Remove screw (2) and take off hold-down clamp (1).



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

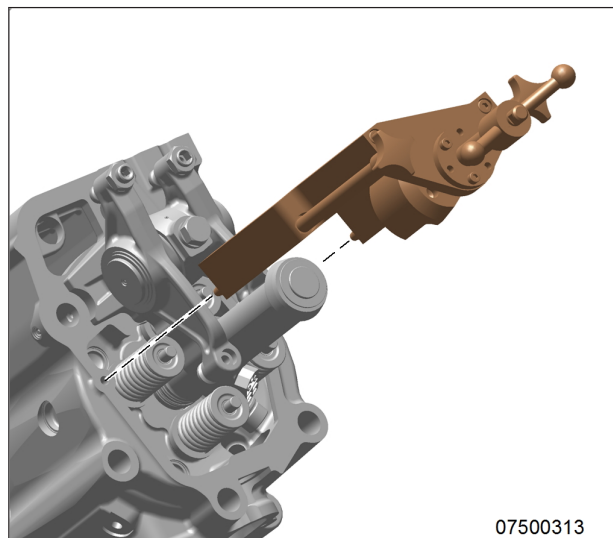
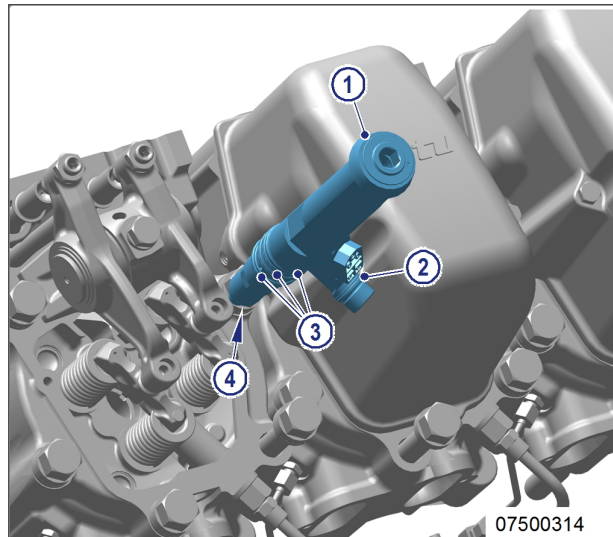
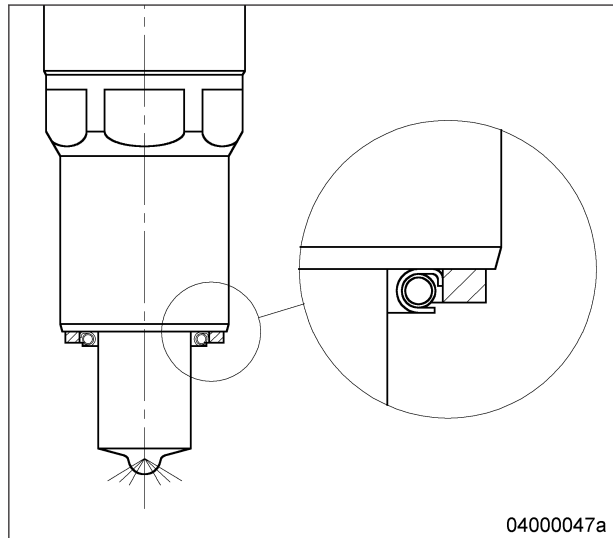


9. Remove sealing ring (4) from injector or use a self-made hook to take it out of the cylinder head.
10. Remove O-rings (3), O-ring (2) and damper ring (1) from injector.
11. Clean all mating and sealing surfaces.
12. Cover all connections and bores, or seal with suitable plugs.



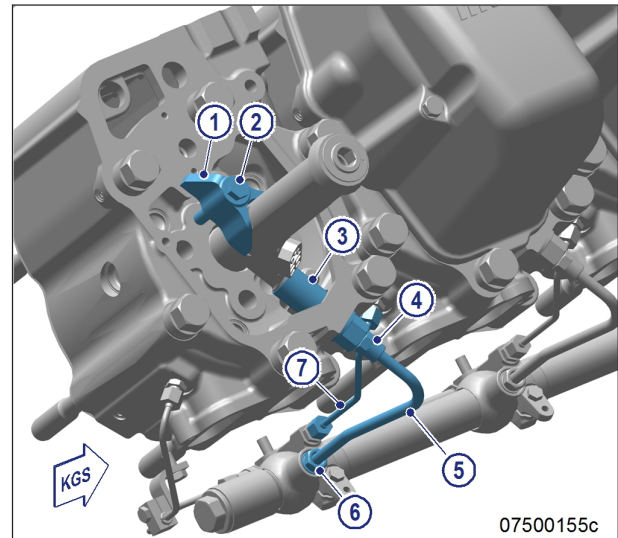
Installing injector

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 clamping 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. Use installation/removal tool to press in injector.
8. Remove installation/removal tool.



TMA-ID: 000000925 - 008

9. Coat screw head 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.

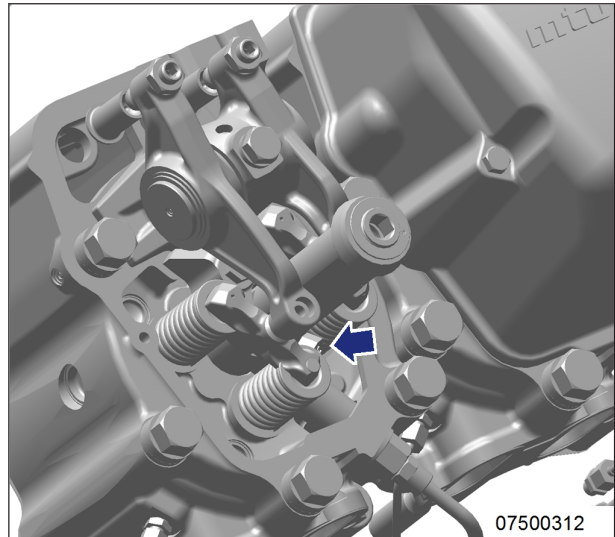
17. Mount single-walled HP line (5) and use torque wrench to tighten to the specified torque. Tightening sequence:
 - 1 Rail (6)
 - 2 Adapter (4)

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 cable connector onto 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 95).
2. Open fuel supply to engine.

7.8 Fuel System

7.8.1 Fuel system – Venting

Preconditions

- ☒ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Diesel fuel		

WARNING



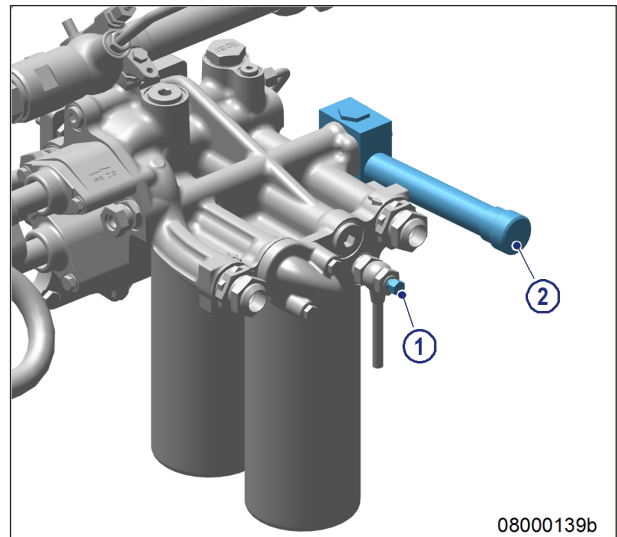
Fuels are combustible.

Risk of fire and explosion!

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Venting LP fuel system

1. Open vent plug (1).
2. Unlock fuel priming pump (2), screw out handle by turning it counterclockwise.
3. Operate the pump with the handle (2) until bubble-free fuel emerges from the vent plug (1).
4. Close vent plug (1).
5. Screw in handle by turning it clockwise.
6. Verify that fuel priming pump (2) is locked: Handle must be tightened.



08000139b

7.9 Fuel Filter

7.9.1 Fuel 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		
Easy-change filter	(→ Spare Parts Catalog)	

WARNING



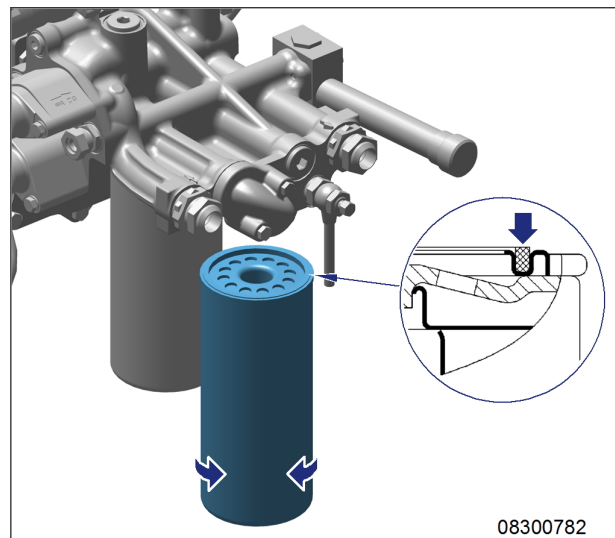
Fuels are combustible.

Risk of fire and explosion!

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Fuel filter – Replacement

1. Remove easy-change filter using filter wrench.
2. Clean sealing face on filter head.
3. Apply a thin coat of oil to the seal on the easy-change filter (arrowed).
4. Screw on the easy-change filter by hand until the seal is in contact and tighten hand-tight.
5. Replace the other easy-change filters in the same way.
6. Vent fuel system (→ Page 103).



TIM-ID: 000000927 - 006

7.9.2 Draining fuel prefilter

Preconditions

- ☑ Engine shut down and secured against being restarted.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Diesel fuel		

WARNING



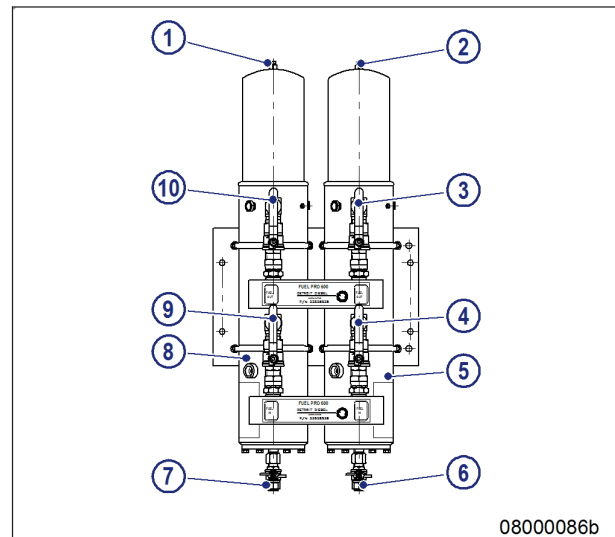
Fuels are combustible.

Risk of fire and explosion!

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Draining fuel prefilter

1. Shut off the filter unit (5/8) to be changed at valves (3) and (4) or (9) and (10).
2. Open bleed screw (1) or (2) on filter to be drained.
3. Open drain valve (6) or (7).
4. Drain water and dirt from the filter until clean fuel emerges.
5. Close drain valve (6) or (7).
6. Open fuel return line (3) or (10).
7. Open fuel inlet (4) or (9).
8. Close bleed screw (1) or (2) on filter to be drained when clean fuel emerges.



08000086b

7.9.3 Fuel prefilter – Draining

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Diesel fuel		

WARNING



Fuels are combustible.

Risk of fire and explosion!

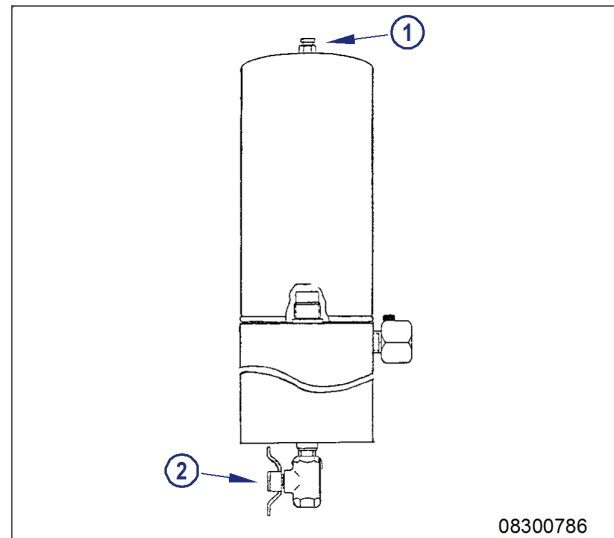
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Preparatory steps

1. Shut off fuel supply to the engine.
2. Provide suitable container to collect escaping fuel.

Fuel prefilter – Draining

1. Open vent plug (1).
2. Open drain valve (2).
3. Drain water and dirt until clean fuel emerges.
4. Close drain cock (2).
5. Close vent plug (1).



Final steps

- Open up fuel supply to engine.

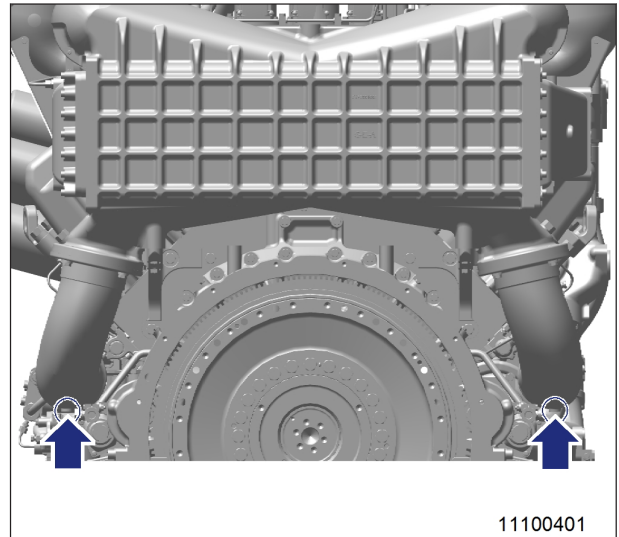
7.10 Charge-Air Cooling

7.10.1 Intercooler – Checking condensate drain for coolant discharge and obstructions

DANGER 	Unguarded rotating and moving engine components. Risk of serious injury – danger to life! • Take special care when working on a running engine.
WARNING 	Engine noise above 85 dB (A). Risk of damage to hearing! • Wear ear protectors.
WARNING 	Compressed air Risk of injury! • Do not direct compressed-air jet at persons. • Wear protective goggles / safety mask and ear protectors.

Intercooler – Checking condensate drain for coolant discharge and obstructions

1. With the engine running, check that air blows out of the condensate drain hole(s) on the left and right sides of the engine at the main PTO end. If no air blows out:
 - Clean condensate drain hole(s)
 - Blow through with compressed air
2. If a large amount of coolant is continuously discharged, the intercooler is leaking; contact Service.



Emergency measures prior to starting engine with a leaking intercooler

1. Remove injectors (→ Page 98).
2. Crank engine manually (→ Page 78).
3. Crank engine using starting system to blow combustion chambers clear (→ Page 80).
4. Refit injectors (→ Page 98).

7.11 Air Intake

7.11.1 Service indicator - Signal ring position check

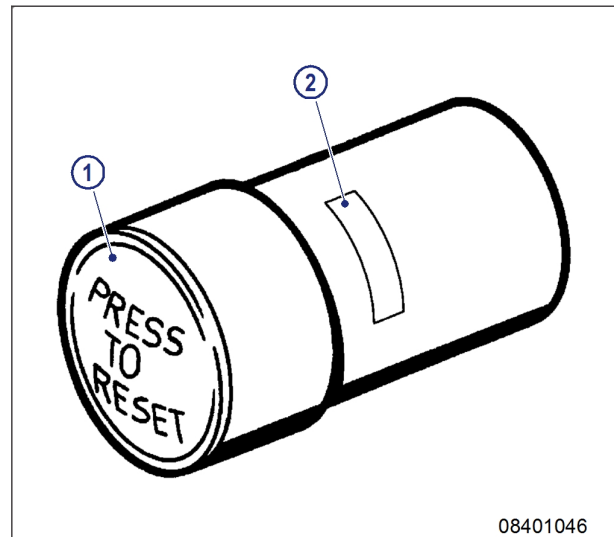
Preconditions

- ☑ 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.
2. After installation of new filter, press reset button (1).

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



7.12 Starting Equipment

7.12.1 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 149).

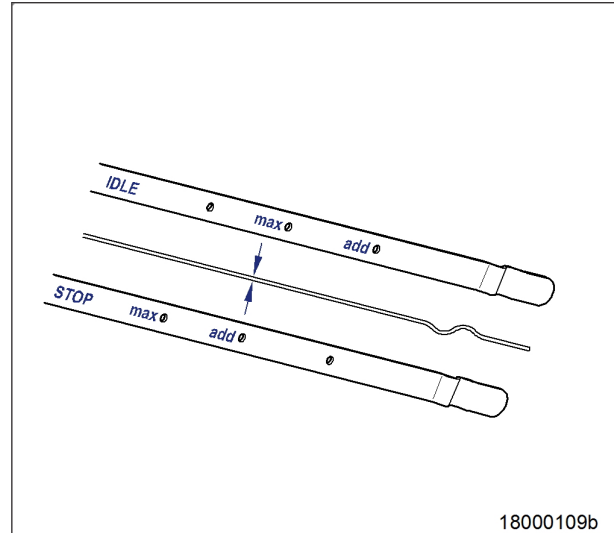
7.13 Lube Oil System, Lube Oil Circuit

7.13.1 Checking engine oil level

Checking oil level before starting engine

1. Withdraw oil dipstick from guide tube and wipe it clean.
2. Insert dipstick into guide tube and push fully home, withdraw after approx. 10 seconds. Check oil level on oil dipstick side marked "5 Min. after Stop".

- Note: After extended out-of-service periods, the oil level may be up to 2 cm above the "max." mark. This might be caused by engine oil flowing from oil filter and heat exchanger back into the oil pan.
3. The oil level must reach the "max." mark or exceed it by up to 2 cm.
 4. If necessary, top up to "max." mark (→ Page 112).
 5. Insert oil dipstick into guide tube and push fully home.



Checking engine oil level with the engine running

1. After the engine has run for approx. 10 minutes at a constant speed of 900 rpm, withdraw oil dipstick from guide tube and wipe it.
2. Insert dipstick into guide tube and push fully home, withdraw after approx. 10 seconds. Check oil level on the dipstick side marked "IDLE".
3. Oil level must not be lower than the "add" mark.
4. If necessary, top up to "max." mark (→ Page 112).

Checking oil level after engine has been shut down

1. 5 minutes after stopping the engine, remove oil dipstick from the guide tube and wipe it.
2. Insert dipstick into guide tube and push fully home, withdraw after approx. 10 seconds. Check oil level on oil dipstick side marked "5 Min. after Stop".
3. Oil level must be between "add." and "max." marks.
4. If necessary, top up to "max." mark (→ Page 112).
5. Insert oil dipstick into guide tube and push fully home.

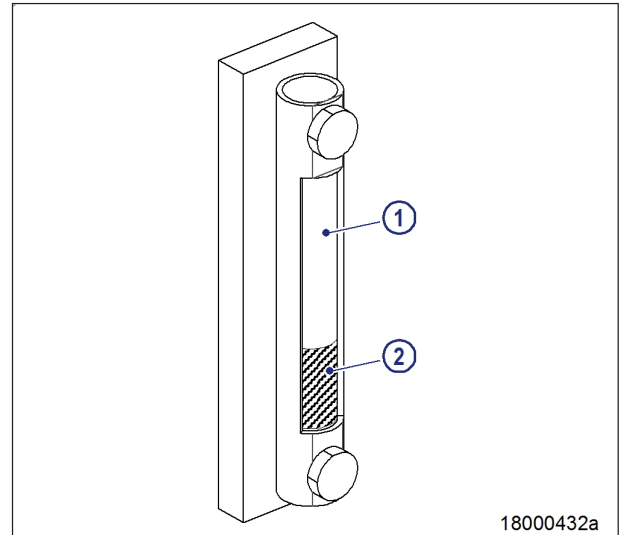
7.13.2 Checking engine oil level

Preconditions

- ☑ Engine shut down and secured against being restarted.

Checking engine oil level at oil sight glass

1. The oil level (2) can be checked visually in advance at the oil sight glass (1).
2. A correct reading of the engine oil level is only possible with the oil dipstick (→ Page 110).



7.13.3 Engine oil – Change

Preconditions

- ☑ Engine shut down 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, 40-200Nm	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.

Procedure without pump: Draining oil at drain plug(s) on oil pan

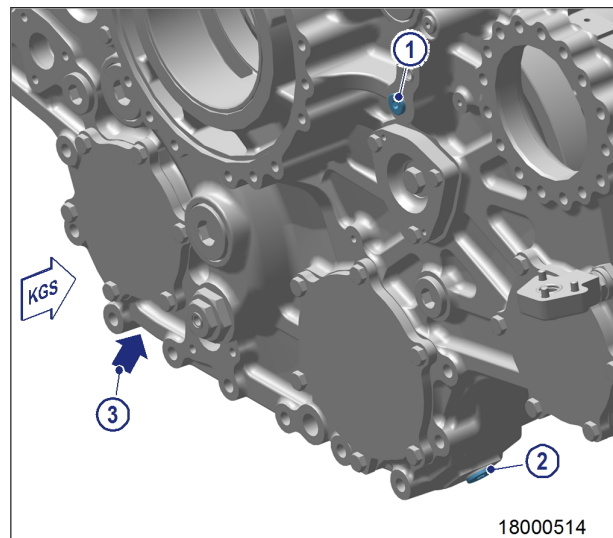
1. Provide a suitable container in which to collect the engine oil.
2. Remove drain plug(s) and drain engine oil.
3. Install drain plug(s) with new sealing ring.

Procedure with pump: Extracting engine oil

1. Provide a suitable container in which to collect the engine oil.
2. Extract all oil from oil pan using the pump.

Draining residual oil from equipment carrier (only with unscheduled engine oil change)

1. Provide a suitable container in which to collect the engine oil.
2. Remove drain plug (1) and drain oil (approx. 7 liters) from oil heat exchanger and oil filter.
3. Remove drain screws (2) and (3) and drain engine oil:
 - (2) approx. 12 liters
 - (3) approx. 5 liters
4. Install drain screws(s) with new sealing ring.



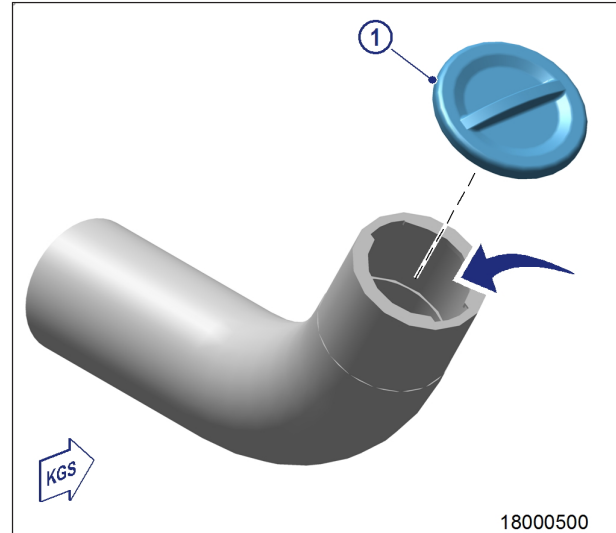
TTM-ID: 0000006152 - 008

5. Tighten drain screws (2) and (3) with torque wrench to the specified torque.

Name	Size	Type	Lubricant	Value/Standard
Screw	M26 x 1.5	Tightening torque	(Engine oil)	100Nm + 10Nm

Filling with new engine oil

1. Open cover 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 110).



7.13.4 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



Unguarded rotating and moving engine components.
Risk of serious injury – danger to life!
• Take special care when working on a running engine.

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.

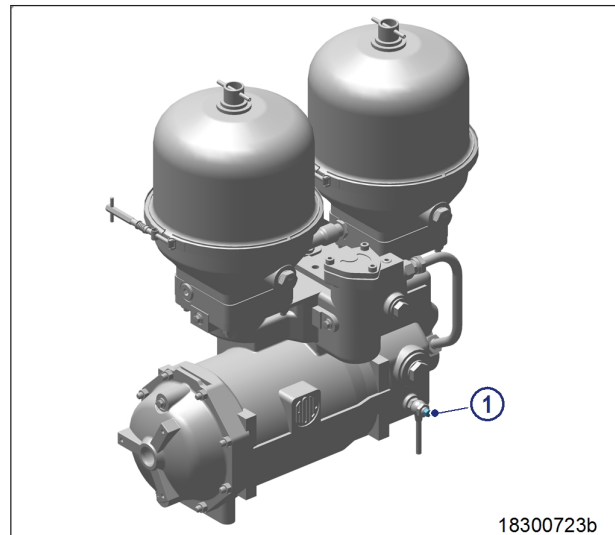
WARNING



Engine noise above 85 dB (A).
Risk of damage to hearing!
• Wear ear protectors.

Engine oil sample extraction and analysis

1. With the engine running at operating temperature, open screw (1) on automatic 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 (1).
5. Using the equipment and chemicals in the MTU test kit, analyze the engine oil for:
 - Dispersing capacity (spot test);
 - Water content;
 - Dilution by fuel.



TM-ID: 000006172 - 002

7.14 Oil Filtration / Cooling

7.14.1 Automatic oil filter – Oil filter candles replacement

Preconditions

- ☒ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Grease (Kluthe Hakuform 30-10/Emulgier)	X00058060	1
Engine oil		
O-ring	(→ Spare Parts Catalog)	
Oil filter candles	(→ 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.

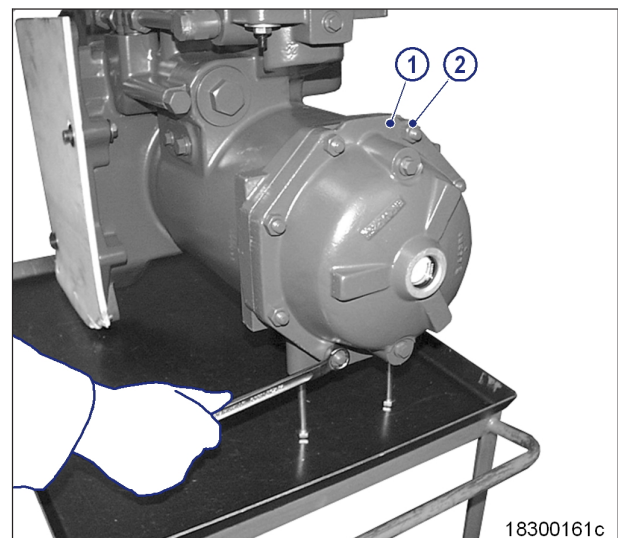
NOTICE



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

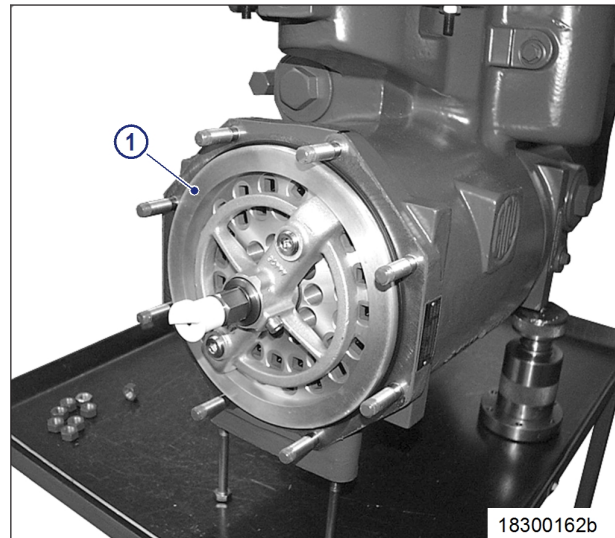
Removing oil filter candles

1. Remove nuts (2) from oil filter cover (1).
2. Remove oil filter cover.

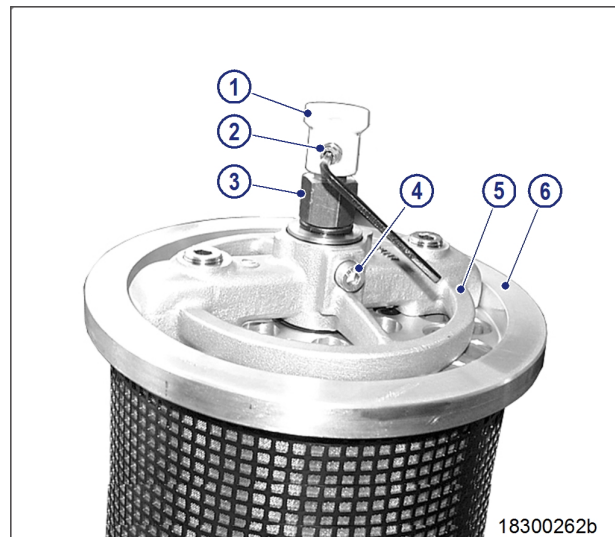


18300161c

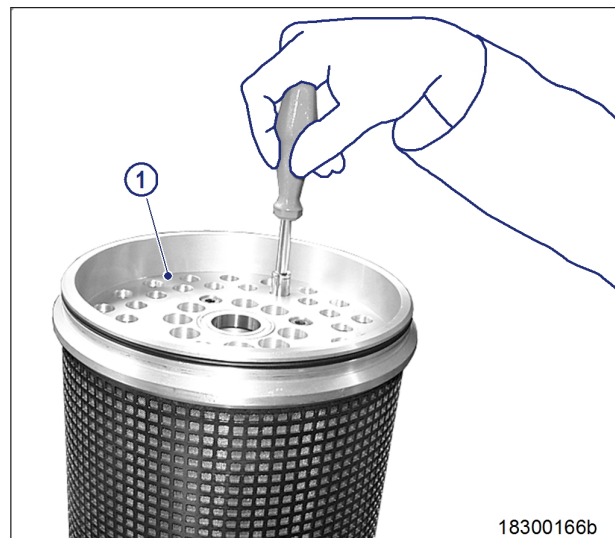
3. Pull out oil filter element (1).
4. Remove O-ring.



5. Remove screw (2).
6. Pull out plastic spinner (1) with spring.
7. Remove nut (3).
8. Take off spring washer and washer.
9. Remove screw (4).
10. Remove flushing arm (5) from screen plate (6).



11. Turn filter element by 180° and use appropriate tool to push out filter candles (1).
12. Turn filter insert by 180° and insert new filter candles (1) with chamfer facing downwards.



TMA-ID: 0000029294 - 007

Installing oil filter candles

1. Install in reverse order of removal.
2. Additionally, the following instructions are to be observed:
 - Replace all seals with new parts
 - Coat O-rings with grease
 - Insert O-rings in grooves
 - Pay attention to installation position of fillister-head screw to slot in shaft.

7.14.2 Oil indicator filter – Cleaning and check

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Cleaner (Snow-White 11-0)	40460	1
Cleaner (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
- Risk of injury!**
- Do not direct compressed-air jet at persons.
 - Wear protective goggles / safety mask and ear protectors.

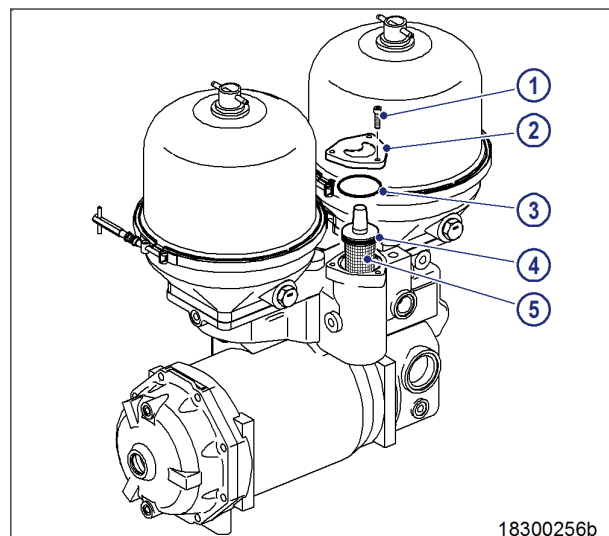
NOTICE



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

Removing strainer

1. Clean oil indicator filter before disassembling it.
2. Remove screws (1).
3. Take off cover (2) with O-ring (3).
4. Take strainer (5) from filter housing.



TTM-ID: 0000006402 - 004

18300256b

Checking strainer

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

Cleaning strainer

1. Wash strainer (5) with cleaner.
2. Remove stubborn deposits with soft brush.
3. Blow out strainer (5) with compressed air from inside.

Installing strainer

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

7.14.3 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
Cold cleaner (Hakutex 60)	X00056750	1
Filter sleeve	(→ 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

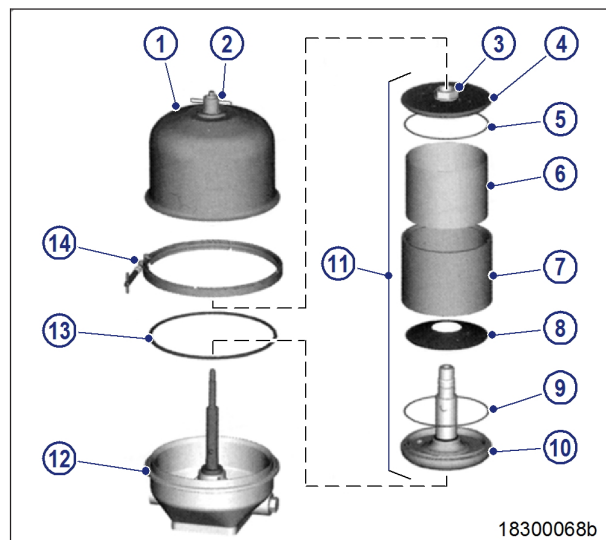


Compressed air
Risk of injury!

- Do not direct compressed-air jet at persons.
- Wear protective goggles / safety mask and ear protectors.

Centrifugal oil filter – Cleaning and filter-sleeve replacement

1. Remove clamp (14).
2. Release cover screw (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 thickness of oil residues on filter sleeve (6).
8. If maximum layer thickness of oil residues exceeds 45 mm, shorten maintenance interval.
9. Disassemble rotor tube (7), conical disk (8) and rotor base (10).
10. Wash rotor cover (4), rotor tube (7), conical disk (8) and rotor base (10) with cold cleaner.
11. Blow out with compressed air.
12. Check sealing ring (9), fit new one if necessary.
13. Assemble rotor tube (7), conical disk (8) and rotor base (10) with sealing ring (9).
14. Insert new filter sleeve (6) in rotor tube (7) with the smooth paper surface facing the wall.
15. Check sealing ring (5), fit new one if necessary.
16. Mount rotor cover (4) with sealing ring (5).
17. Tighten rotor cover nut (3) with torque wrench to the specified torque.



18300068b

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

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

24. Tighten cover screw (2) with torque wrench to the specified torque.

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

7.15 Coolant Circuit, General, High-Temperature Circuit

7.15.1 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!

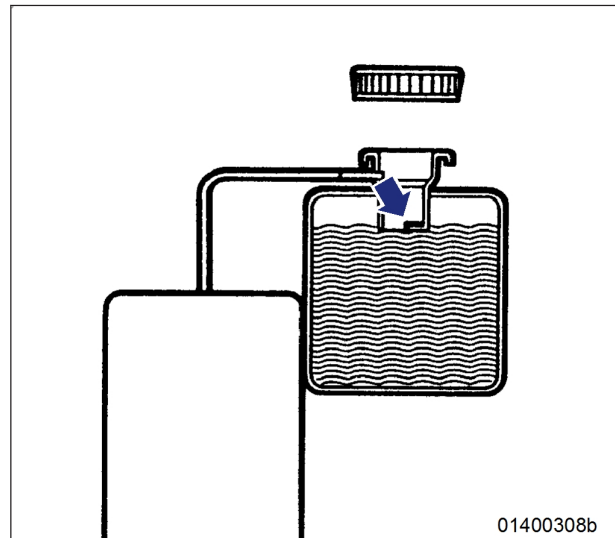
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Checking engine coolant level at filler neck:

1. Turn breather valve on coolant expansion tank counterclockwise to the first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Check engine coolant level (coolant must be visible at the bottom edge of the filler neck's cast eye).

Checking engine coolant level at remote cooler:

1. Check engine coolant level (coolant must be visible at marker plate).
2. Top up engine coolant if necessary (→ Page 126).
3. Check and clean breather valve.
4. Place breather valve on filler neck and close.



Checking engine coolant level via level sensor:

1. Switch on engine control system and check readings on the display.
2. Top up engine coolant if necessary (→ Page 126).

TTM-ID: 000000937 - 012

7.15.2 Engine coolant – Change

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Coolant		

Engine coolant – Change

1. Drain engine coolant (→ Page 124).
2. Fill with engine coolant (→ Page 126).

7.15.3 Draining engine coolant

Preconditions

- ☑ Engine shut down and secured against being restarted.

WARNING



Coolant is hot and under pressure.

Risk of injury and scalding!

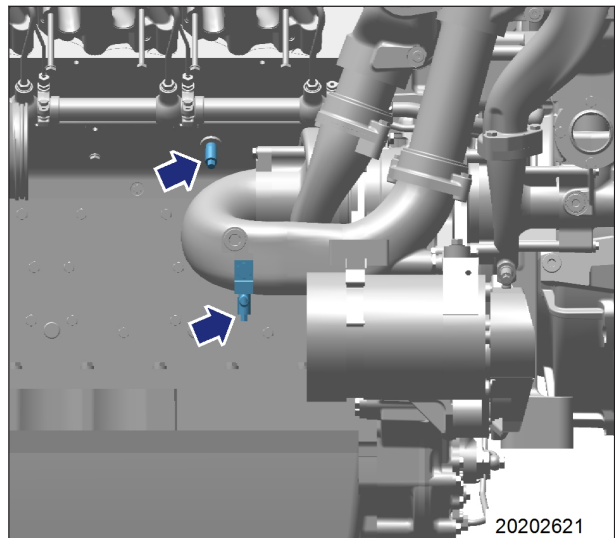
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Preparatory steps

1. Have a suitable container ready to catch the coolant.
2. Switch off preheating unit.

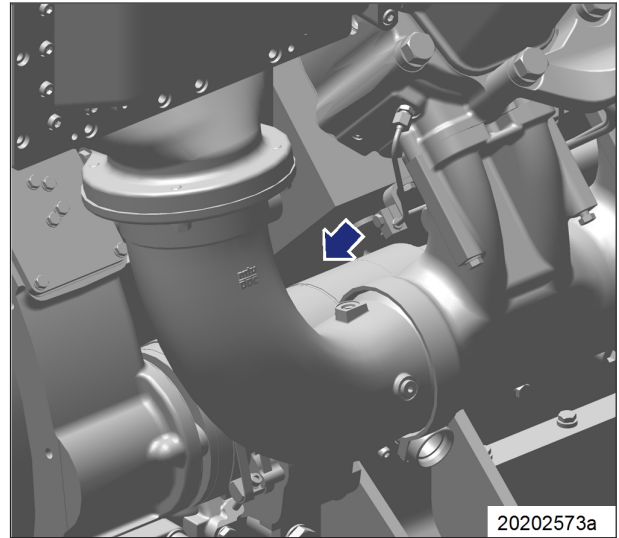
Draining engine coolant

1. Turn pressure cap on coolant expansion tank counterclockwise until the first stop and allow pressure to escape.
2. Continue to turn pressure cap counterclockwise and remove.
3. Draw off separated corrosion inhibitor fluid in expansion tank through the filler neck.
4. Open drain valves and/or drain plugs and drain coolant at the following points:
 - On the preheating unit
 - On the coolant pump elbow (arrowed)
 - On the crankcase, left and right sides (arrowed)



TTM-ID: 000006739 - 006

5. Open the drainage point on the main PTO end of the crankcase, on the left or right side (arrowed) and drain off the engine coolant.
6. Close off all open drain points.
7. Place pressure cap on filler neck and close.



Concluding operations

- Switch on preheater.

7.15.4 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



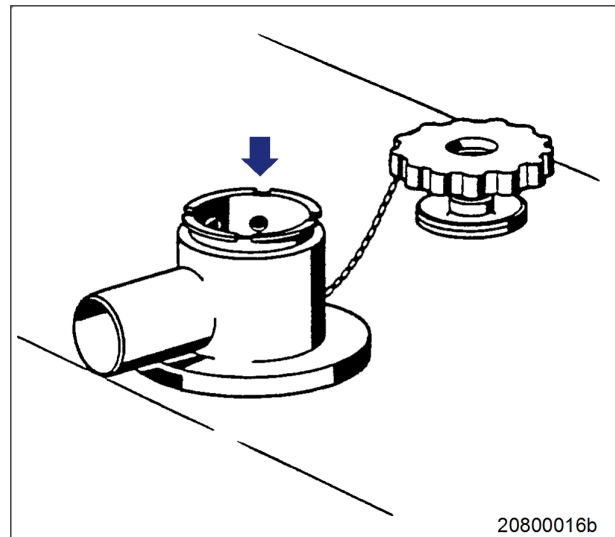
Cold coolant in hot engine can cause thermal stress.

Formation of cracks in components!

- Fill / top up coolant only into cold engine.

Preparatory steps

1. Turn breather valve of filler neck on coolant expansion tank counterclockwise to first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.

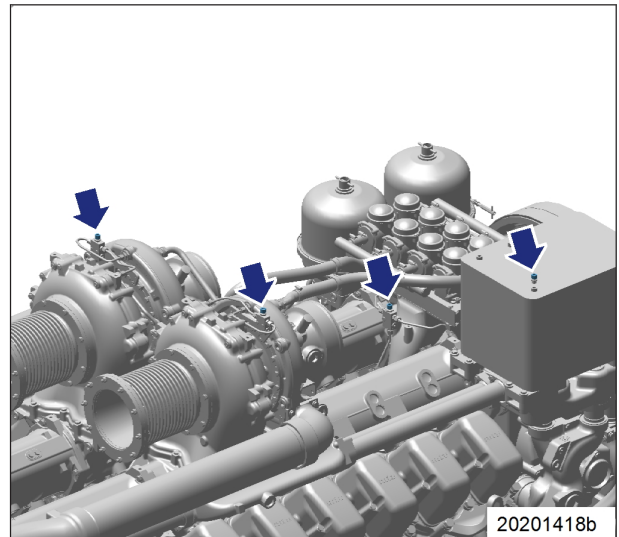
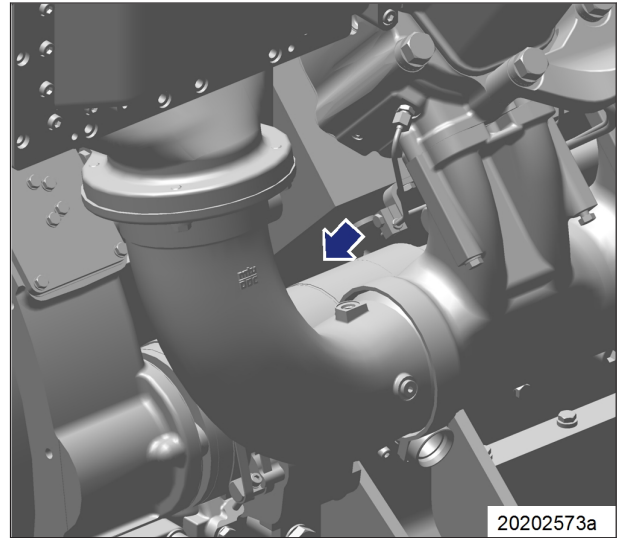


20800016b

TM-ID: 0000006720 - 005

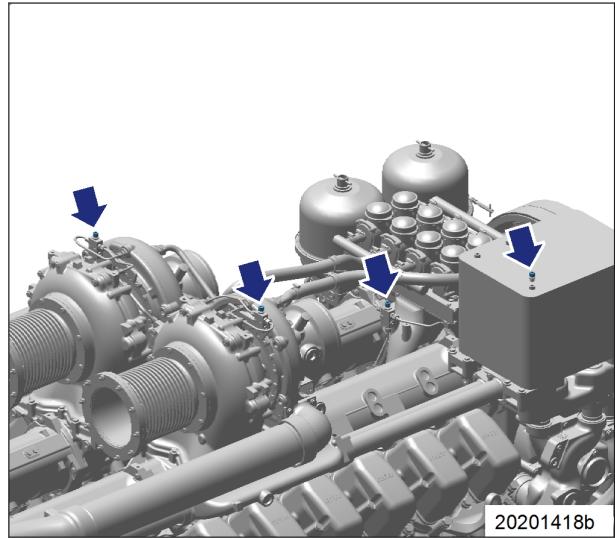
Filling with coolant using a pump

1. Connect a suitable pump with a hose to drain valve at main PTO end (arrowed).
2. Open vent points on distributor, oil heat exchanger and exhaust turbochargers (arrows).
3. Open drain valve and pump coolant into engine at 0.5 bar minimum.
4. When coolant emerges from the vent points, close vent points one by one, proceeding from the lowest point upwards.
5. Fill expansion tank until overflow edge is reached.
6. Close drain valve.
7. Check proper condition of breather valve and clean sealing faces if required.
8. Place breather valve on filler neck and close.
9. Start engine (→ Page 51).
10. After running the engine for 10 seconds under zero load, stop engine (→ Page 52).
11. Turn breather valve of filler neck on coolant expansion tank counterclockwise to first stop and allow pressure to escape.
12. Continue to turn breather valve counterclockwise and remove.
13. Check coolant level (→ Page 122) and top up engine coolant as required:
 - a) Add coolant to expansion tank until the coolant level remains constantly at the top edge of the filler neck.
 - b) Place breather valve on filler neck and close.
 - c) Repeat the steps from "Start engine" (→ Step 9) until coolant no longer needs to be topped up.
 - d) Disconnect pump and hose.



Alternatively: Filling with coolant through filler neck

1. Open vent points on distributor, oil heat exchanger and exhaust turbochargers (arrows).
2. Add coolant to expansion tank until the coolant level at top edge of 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 51).
7. After running the engine for 10 seconds under zero load, stop engine (→ Page 52).
8. Turn breather valve counterclockwise and remove.
9. Check coolant level (→ Page 122) and top up engine coolant as required:
 - a) Repeat the steps from "Start engine" (→ Step 6) until coolant no longer needs to be topped up.
 - b) Check proper condition of breather valve and clean sealing faces if required.
 - c) Place breather valve on filler neck and close.



Final steps

1. Start the engine and run it under zero load for several minutes.
2. Check coolant level (→ Page 122) and top up engine coolant as required.

7.15.5 Engine coolant pump – Checking pressure relief port

DANGER



Unguarded rotating and moving engine components.

Risk of serious injury – danger to life!

- Take special care when working on a running engine.

WARNING



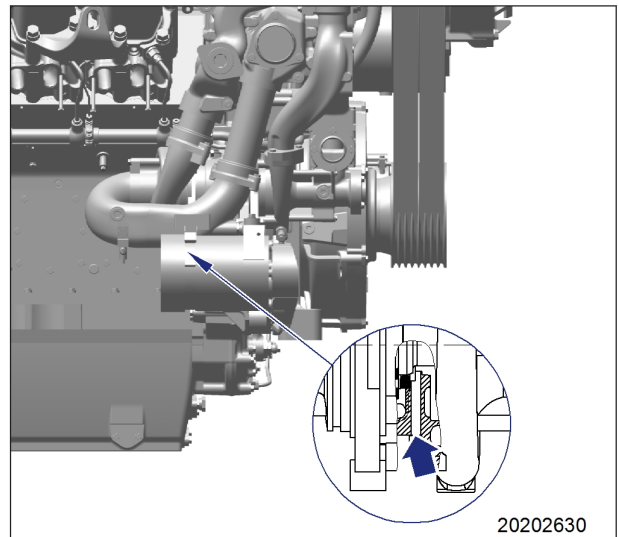
Engine noise above 85 dB (A).

Risk of damage to hearing!

- Wear ear protectors.

Engine coolant pump – Checking pressure relief port

1. Check pressure relief port for oil and coolant discharge.
2. Shut down engine (→ Page 52) and secure against being restarted, observe general “Maintenance and Repair” safety instructions.
3. Clean the pressure relief port with a wire if it is dirty.
 - Permissible 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.



7.15.6 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		
Coolant filter	(→ Spare Parts Catalog)	

WARNING



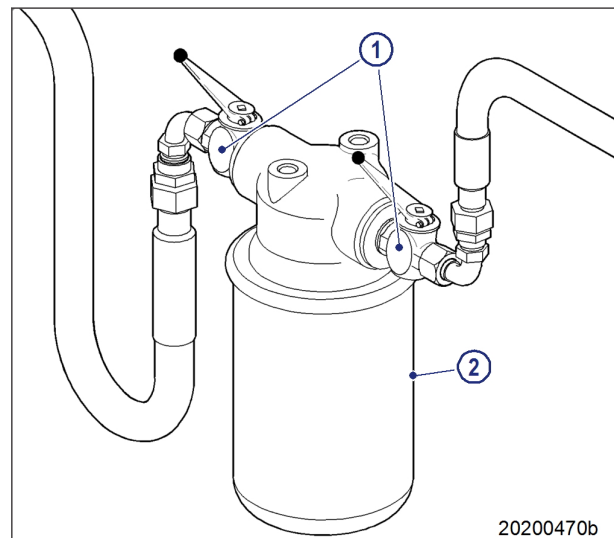
Coolant is hot and under pressure.

Risk of injury and scalding!

- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Replacing engine coolant filter

1. Close shutoff cocks (1).
2. Remove engine coolant filter (2) with filter wrench.
3. Clean the sealing surface on the connecting piece.
4. Coat gasket on new engine coolant filter with engine oil.
5. Screw on engine coolant filter and tighten hand-tight.
6. Open shutoff cocks (1).



20200470b

TM-ID: 0000004858 - 008

7.15.7 Engine coolant – Sample extraction and analysis

Preconditions

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

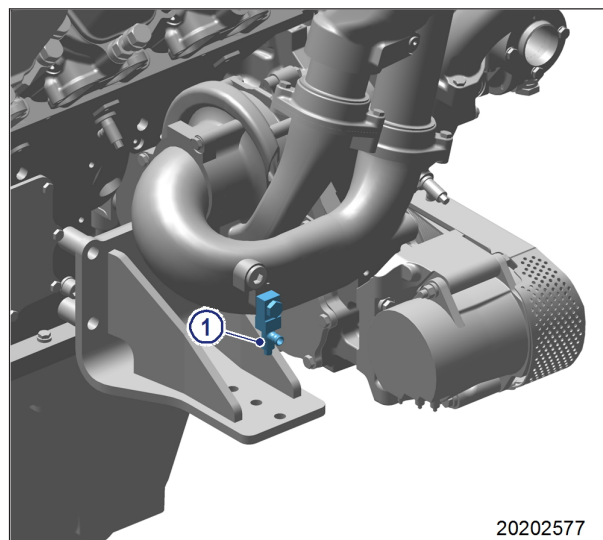
Special tools, Material, Spare parts

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

DANGER 	Unguarded rotating and moving engine components. Risk of serious injury – danger to life! • Take special care when working on a running engine.
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 	Engine noise above 85 dB (A). Risk of damage to hearing! • Wear ear protectors.

Engine coolant – Sample extraction and analysis

1. With the engine running, open drain valve (1).
2. Flush sample-extraction point by draining approx. 1 liter coolant.
3. Drain approx. 1 liter coolant into a clean container.
4. Close drain valve (1).
5. Using the equipment and chemicals of the MTU test kit, check the coolant for:
 - Antifreeze concentration
 - Corrosion inhibitor concentration
 - pH value.
6. For engine coolant change intervals, (→ MTU Fluids and Lubricants Specifications (A001061/..)).



7.16 Low-Temperature Circuit

7.16.1 Charge-air coolant – Level check

Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

WARNING



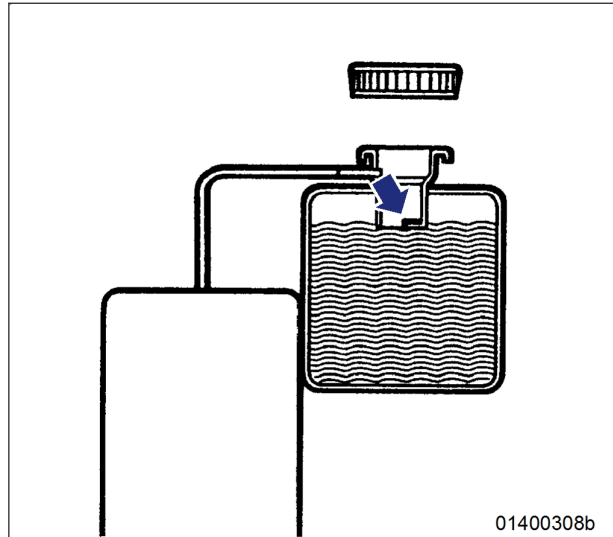
Coolant is hot and under pressure.

Risk of injury and scalding!

- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Checking charge-air coolant level at filler neck:

1. Turn breather valve on coolant expansion tank counterclockwise 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 marking plate).
4. Top up coolant if necessary (→ Page 135).
5. Check proper condition of breather valve, clean sealing faces if required.
6. Fit breather valve and close it.



Checking charge-air coolant level by means of level sensor:

1. Switch on engine control system and check display (coolant level is automatically monitored by engine control system).
2. Top up coolant if necessary (→ Page 135).

TTM-ID: 0000000042 - 007

7.16.2 Charge-air coolant – Change

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Coolant		

Charge-air coolant – Change

1. Drain charge-air coolant (→ Page 134).
2. Fill with charge-air coolant (→ Page 135).

7.16.3 Draining charge-air coolant

Preconditions

- ☑ Engine shut down and secured against being restarted.

Special tools, Material, Spare parts

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

WARNING



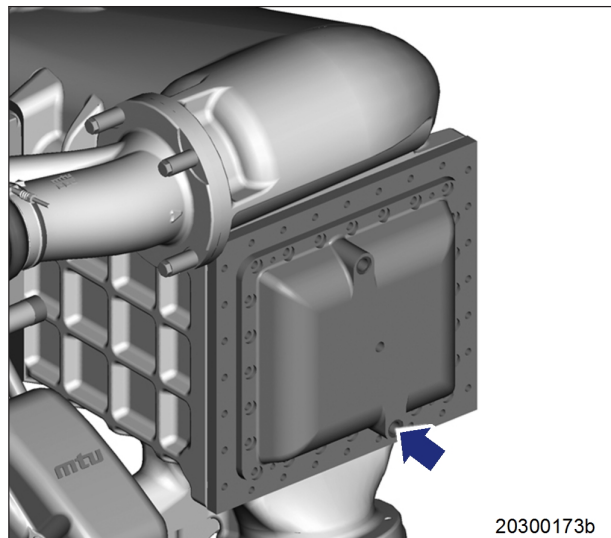
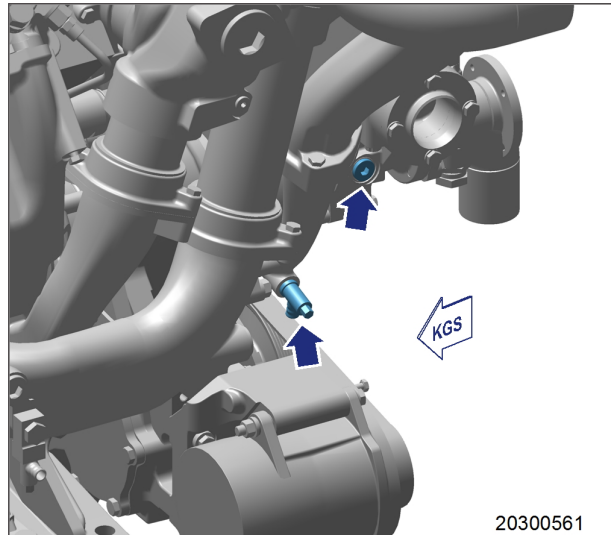
Coolant is hot and under pressure.

Risk of injury and scalding!

- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Draining charge-air coolant

1. Have a suitable container ready to catch the coolant.
2. Turn pressure cap on coolant expansion tank counterclockwise until the first stop and allow pressure to escape.
3. Continue to turn pressure cap counterclockwise and remove.
4. Draw off separated corrosion inhibitor fluid in expansion tank through the filler neck.
5. Open drain valves and/or drain plugs and drain coolant at the following points:
 - on the low-temperature coolant pump
 - on the low-temperature thermostat housing.
6. Drain off residual coolant:
 - on the intercooler
7. Close all drain valves and screw in drain plugs using new sealing rings.
8. Place pressure cap on filler neck and close.



TTM-ID: 0000007022 - 004

7.16.4 Charge-air coolant – Filling

Preconditions

- ☑ Engine shut down and starting disabled.
- ☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Charge-air 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.

CAUTION



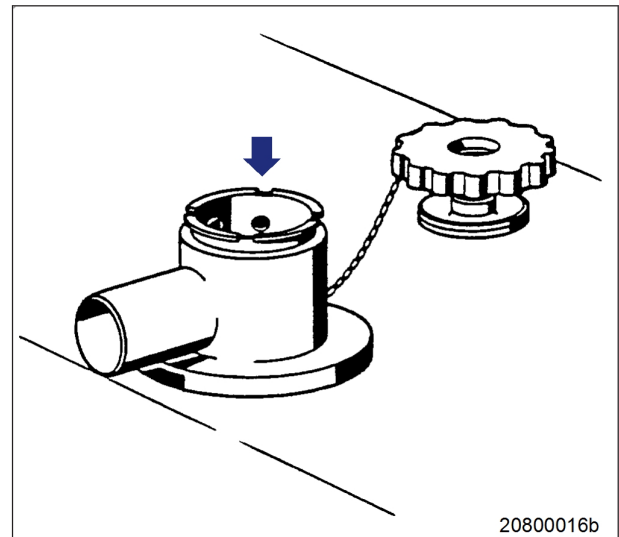
Cold coolant in hot engine can cause thermal stress.

Formation of cracks in components!

- Fill / top up coolant only into cold engine.

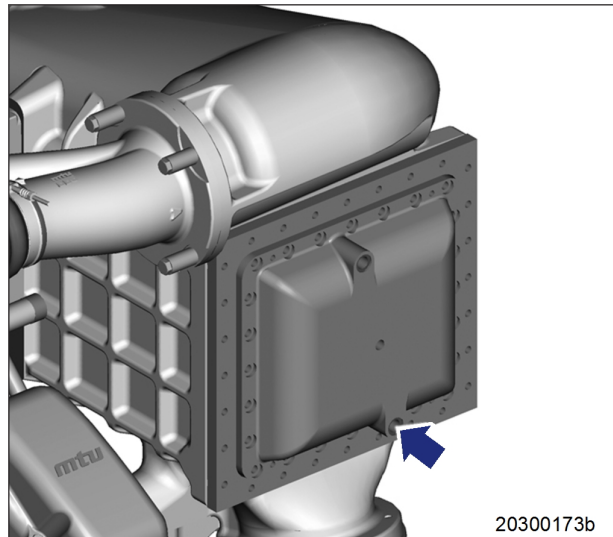
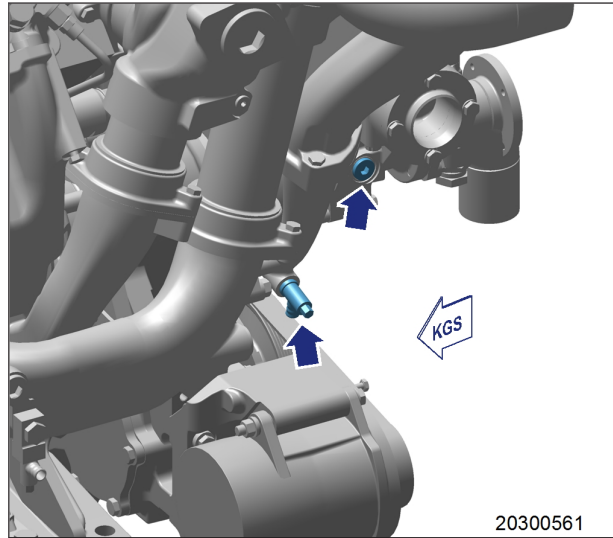
Preparatory steps

1. Turn breather valve of coolant expansion tank counterclockwise until the first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.



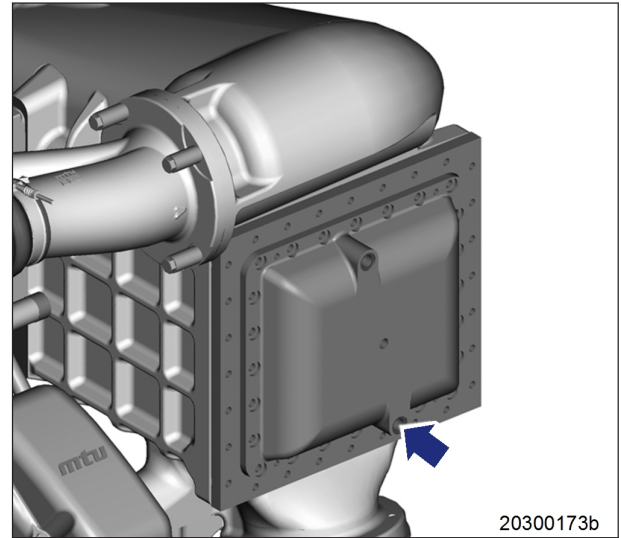
Filling with charge-air coolant using pump

1. Connect appropriate pump with hose to a drain valve (arrow) or at the lowest point between engine and cooler.
2. Open vent point on charge-air cooler (arrow).
3. Open drain valve and pump coolant into engine at 0.5 bar minimum.
4. When coolant emerges from the vent point, close vent point.
5. Fill expansion tank until overflow edge is reached.
6. Close drain valve.
7. Check proper condition of breather valve on coolant expansion tank, clean sealing faces if required.
8. Fit breather valve and close it.
9. Start engine (→ Page 51).
10. After 10 seconds of running the engine without load, shut down the engine (→ Page 52).
11. Turn breather valve of coolant expansion tank counterclockwise until the first stop and allow pressure to escape.
12. Continue to turn breather valve counterclockwise and remove.
13. Check coolant level (→ Page 132) and top up engine coolant as required:
 - a) Top up engine coolant via coolant expansion tank until coolant level remains constant in sight glass at max. mark.
 - b) Set breather valve onto coolant expansion tank and close it.
 - c) Repeat the steps from 'Start engine' (→ Step 9) until coolant no longer needs to be topped up.
 - d) Disconnect pump and hose.



Alternatively: Filling with coolant through filler neck

1. Open vent point on charge-air cooler (arrow).
2. Top up engine coolant via filler neck on coolant expansion tank until coolant level remains constant in sight glass at max. mark.
3. When coolant emerges from the vent point, close vent point.
4. Check proper condition of breather valve on coolant expansion tank, clean sealing faces if required.
5. Mount breather valve and turn until the first stop.
6. Start engine (→ Page 51).
7. After 10 seconds of running the engine without load, shut down the engine (→ Page 52).
8. Turn breather valve of coolant expansion tank counterclockwise until the first stop and allow pressure to escape.
9. Continue to turn breather valve counterclockwise and remove.
10. Check coolant level (→ Page 132) and top up engine coolant as required:
 - a) Top up engine coolant via coolant expansion tank until coolant level remains constant in sight glass at max. mark.
 - b) Set breather valve onto coolant expansion tank and close it.
 - c) Repeat the steps from 'Start engine' (→ Step 6) until coolant no longer needs to be topped up.



Final steps

1. Check proper condition of breather valve on coolant expansion tank, clean sealing faces if required.
2. Fit breather valve and close it.
3. Start the engine and run it without load for some minutes.
4. Check coolant level (→ Page 132) and top up engine coolant as required.

7.16.5 Charge-air coolant pump - Checking pressure relief port

DANGER



Unguarded rotating and moving engine components.

Risk of serious injury – danger to life!

- Take special care when working on a running engine.

WARNING



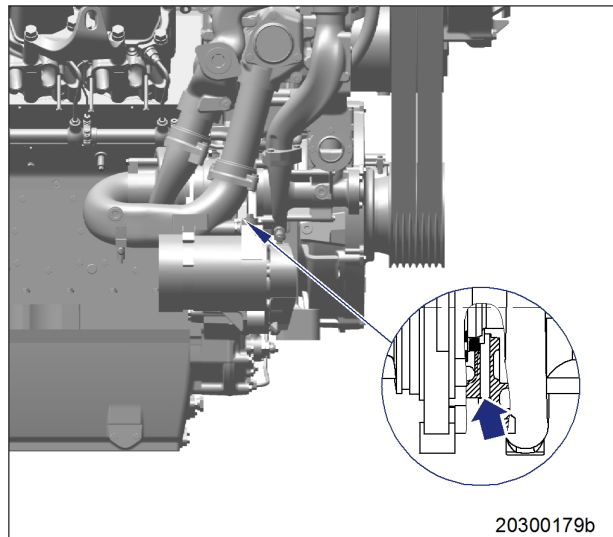
Engine noise above 85 dB (A).

Risk of damage to hearing!

- Wear ear protectors.

Charge-air coolant pump – Checking pressure relief port

1. Check pressure relief port for oil and coolant discharge.
2. Shut down engine (→ Page 52) and secure against being restarted, observe general “Maintenance and Repair” safety instructions.
3. Clean the pressure relief port with a wire if it is dirty.
 - Permissible 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.



20300179b

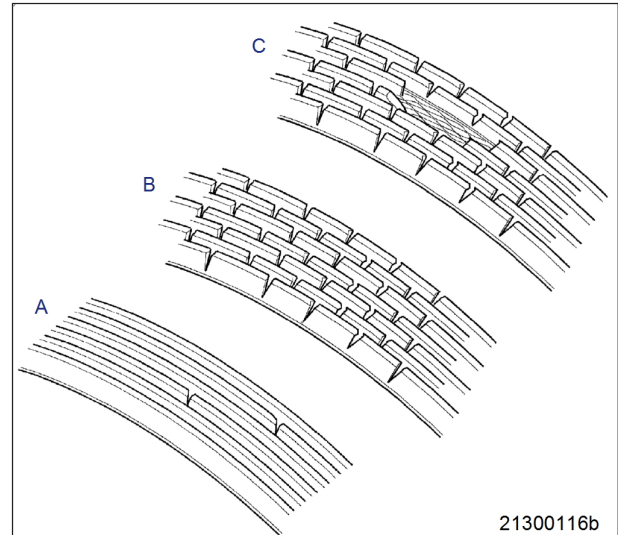
7.17 Belt Drive

7.17.1 Drive belt – Condition check

Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ Guard is removed.

Drive belt – Condition check



Item	Findings	Action
Drive belt A	Singular cracks	None
Drive belt	Belt is oily, shows signs of over-heating	Replace (→ Page 144)
Drive belt B	Cracks on entire circumference	
Drive belt C	Chunking	

7.18 Battery-Charging Generator

7.18.1 Alternator – Removing and refitting

Preconditions

- ☑ Engine shut down and secured against being restarted.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 20-100 Nm	F30026582	1
Ratchet adapter	F30027340	1

WARNING



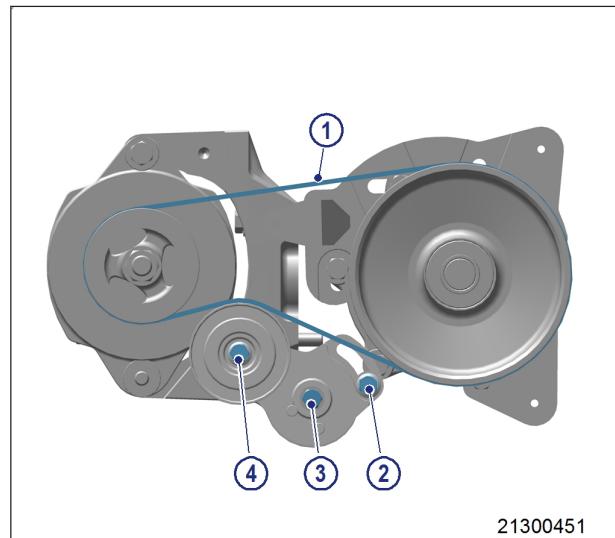
Heavy object.

Risk of crushing!

- Use appropriate lifting devices and appliances.

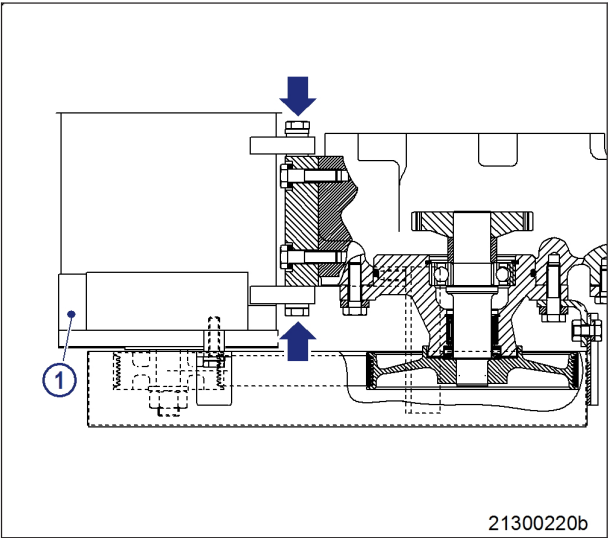
Removing alternator

1. Remove protective cover.
2. Mark electrical leads on alternator for identification and disconnect.
3. Protect all leads from damage.
4. Slacken bolts (2) and (3) by half a turn.
5. Fit socket or box wrench on bolt (4) and press belt tensioner in direction of arrow as far as the stop.
6. Tighten bolt (2).
7. Remove drive belt (1).



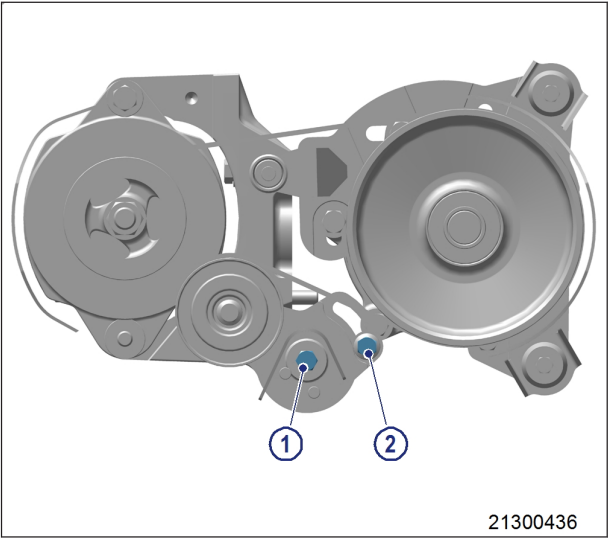
21300451

8. Unscrew bolts (arrowed).
9. Remove alternator (1).
10. Clean alternator (1) thoroughly (→ Page 142).
11. Refit alternator (1) in reverse order of removal.



Tensioning drive belt

1. Fit drive belt.
 2. Slacken bolt (2) by half a turn.
- Result: Belt tensioner moves against the drive belt and tensions it.



3. Tighten bolt (2) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw	M10	Tightening torque		60 Nm +5 Nm

4. Tighten bolt (1) to specified tightening torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw	M10	Tightening torque		60 Nm +5 Nm

5. Refit protective cover.
6. Readjust belt tension after 30 minutes and again after engine has been running for 8 hours (→ Page 143).

7.18.2 Battery-charging generator - Check

Preconditions

☑ Engine shut down and starting disabled.

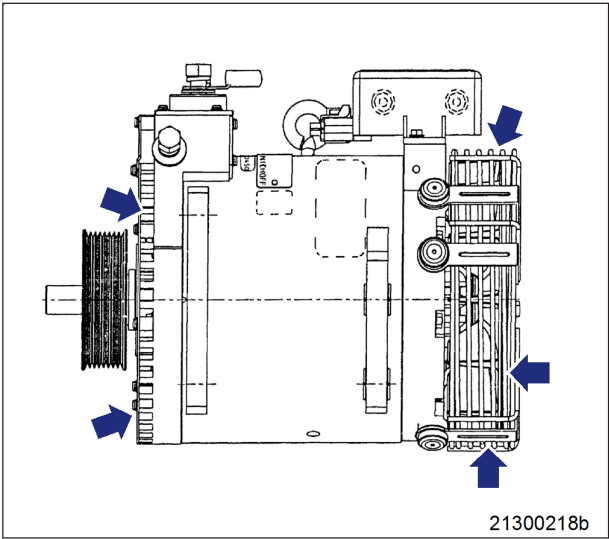
WARNING



Compressed air

Risk of injury!

- Do not direct compressed-air jet at persons.
- Wear protective goggles / safety mask and ear protectors.



Checking battery-charging generator

Item	Findings	Measure
Ventilation area (arrow)	Clean	None
Ventilation area (arrow)	Contaminated	Clean

Cleaning battery-charging generator

- Note: Dry-clean battery-charging generator only.
1. Remove coarse dirt from battery-charging generator.
 2. Blow out ventilation area (arrow) with compressed air until all dust is cleared.

7.18.3 Battery-charging generator drive – Drive belt tension adjustment

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 60-320 Nm	F30452768	1
Ratchet	F30027341	1
Torque wrench, 10-60 Nm	F30452769	1
Ratchet	F30027340	1

WARNING



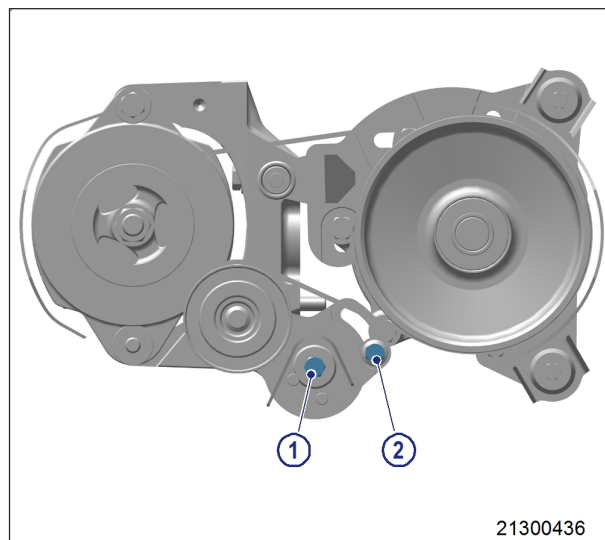
Spring/circlip/tensioning roller preload.

Risk of injury!

- Only use specified tool and equipment.

Adjusting belt tension

1. Remove protective cover.
 2. Slacken screws (1) and (2) by half a turn.
- Result: Belt tensioner moves against the drive belt and tensions it.



21300436

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

Name	Size	Type	Lubricant	Value/Standard
Screw	M10	Tightening torque		60 Nm +5 Nm

4. Tighten screw (1) with torque wrench to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw	M10	Tightening torque		42 Nm

5. Install protective cover.

TM-ID: 000000945 - 007

7.18.4 Battery-charging generator – Drive belt and belt tensioner replacement

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 20-100Nm	F30026582	1
Ratchet adapter	F30027340	1
Drive belt	(→ Spare Parts Catalog)	
Belt tensioner	(→ Spare Parts Catalog)	1

WARNING



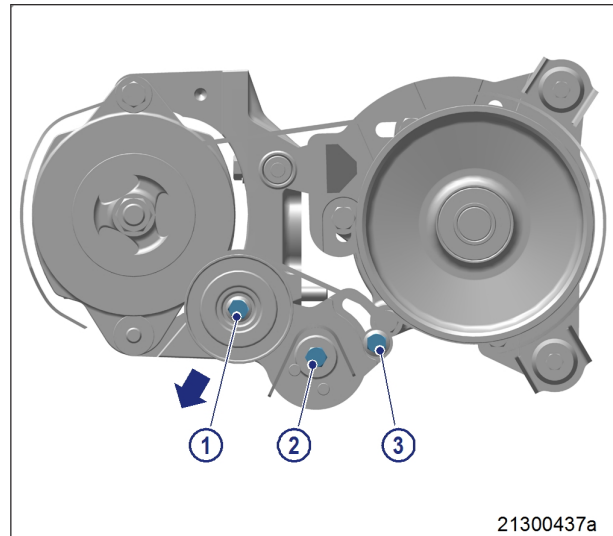
Heavy object.

Risk of crushing!

- Use appropriate lifting devices and appliances.

Replacing drive belt and belt tensioner

1. Remove protective cover.
2. Slacken screws (2) and (3) by half a turn.
3. Mount socket or box wrench on screw (1) and press belt tensioner in direction of arrow as far as the stop.
4. Tighten screw (3).
5. Remove drive belt.
6. Screw on screw (2) and replace belt tensioner.
7. Fit new drive belt.



Tensioning drive belt

1. Slacken screw (3) by half a turn.
Result: Belt tensioner moves against the drive belt and tensions it.
2. Tighten screw (3) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw	M10x1.5	Tightening torque		60Nm +5Nm

3. Tighten screw (2) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw	M10x1.5	Tightening torque		42Nm

TIM-ID: 000007421 - 007

4. Install protective cover.
5. Readjust belt tension after 30 minutes and again after 8 hours engine runtime (→ Page 143).

7.19 Fan Drive

7.19.1 Fan drive – Drive belt tension check / adjustment

Preconditions

- ✓ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

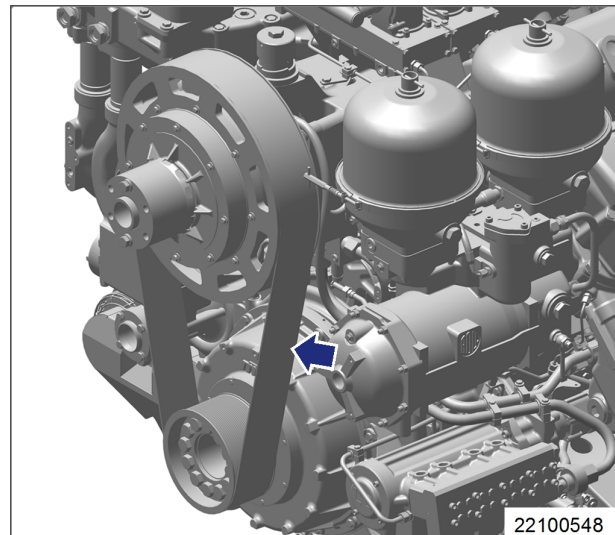
Designation / Use	Part No.	Qty.
Optibell 2 belt tension tester	Y4345711	1

Preparatory steps

1. Remove protective cover.
 2. Check belt condition visually (→ Page 139).
- Result: For drive belt replacement (→ Page 148).

Checking V-belt tension – Rockford S270 fan clutch

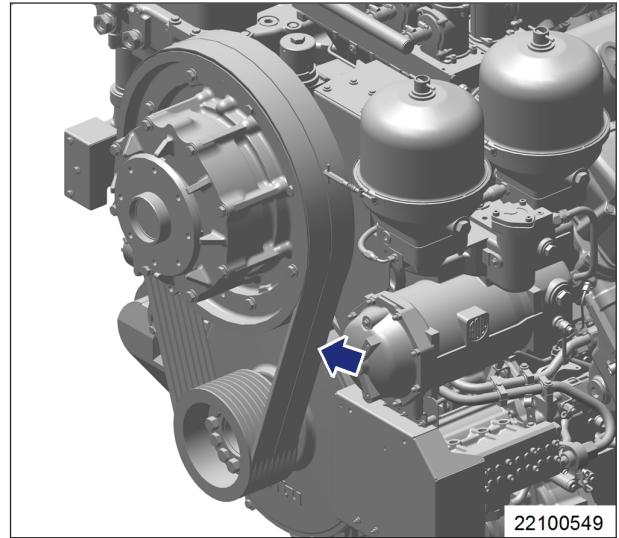
1. Switch on belt tension tester.
2. Hold measuring tip of belt tension tester over belt drive. Tap drive belt (arrow) with a suitable tool.
3. Hold belt tension tester over belt drive until the measured value is indicated.



Initial assembly at MTU	Initial operation with fan	Re-tensioning
None	60 Hz $\pm$ 1 Hz	52 Hz $\pm$ 1 Hz

Checking V-belt tension – Rockford S370 fan clutch

1. Switch on belt tension tester.
2. Hold measuring tip of belt tension tester over belt drive. Tap drive belt (arrow) with a suitable tool.

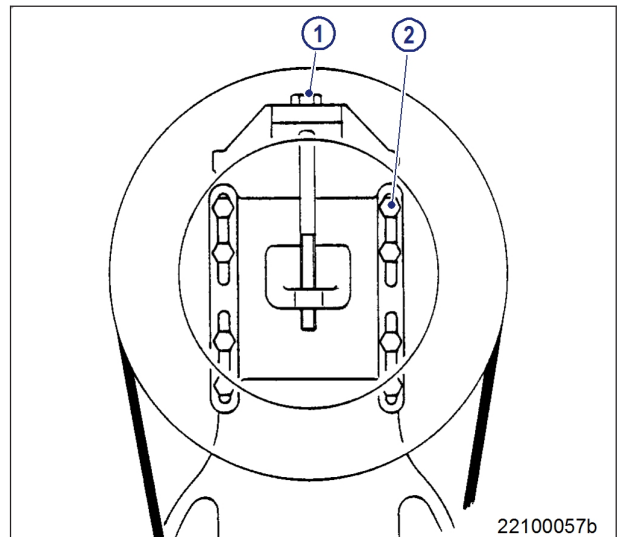


3. Hold belt tension tester over belt drive until the measured value is indicated.

Initial assembly at MTU	Initial operation with fan	Re-tensioning
36 Hz $\pm$ 5 Hz	49 Hz $\pm$ 2 Hz	44 Hz $\pm$ 2 Hz

Adjusting drive belt tension

1. Release screws (2) until fan clutch can be moved.
2. Tighten stud (1) until the required frequency is achieved.



3. For Rockford S270 fan clutch: Tighten screws (2) to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw	M12x60	Tightening torque		100 Nm + 10 Nm

4. For Rockford S370 fan clutch: Tighten screws (2) to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw	M16x80	Tightening torque		270 Nm + 10 Nm

7.19.2 Fan drive - Drive belt replacement

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

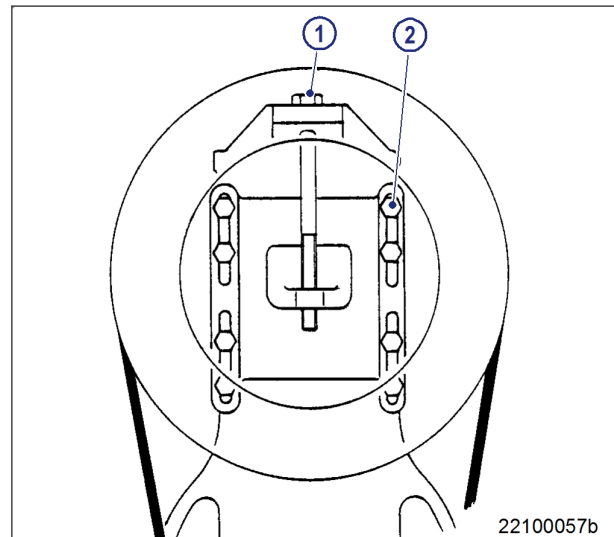
Designation / Use	Part No.	Qty.
Drive belt	(→ Spare Parts Catalog)	

Preparatory steps

1. Remove protective cover.
2. Remove fan.

Replacing drive belt

1. Release screws (2).
2. Slacken off stud (1) until drive belt can be removed.
3. Clean belt pulleys.
4. Fit new drive belt on belt pulleys, ensuring that it is not under tension.
5. Adjust belt tension (→ Page 146).



7.20 Wiring (General) for Engine/Gearbox/Unit

7.20.1 Engine wiring – Check

Preconditions

- ☒ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

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

Engine wiring – Check

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 ties are firm, tighten loose cable ties.
 4. Replace faulty cable ties.
 5. Visually inspect the following electrical line components for damage:
 - connector housings;
 - contacts;
 - sockets;
 - cables and terminals;
 - plug-in contacts.
 6. (→ Contact Service) if cable conductors are damaged.
- Note: Close male connectors that are not plugged in with the protective cap supplied.
7. Clean dirty connector housings, sockets and contacts with isopropyl alcohol.
 8. Ensure that all sensor connectors are securely engaged.

7.21 Accessories for (Electronic) Engine Governor / Control System

7.21.1 Engine governor and connectors – Cleaning

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

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

Note: Always use test connectors to enter the connectors. Never use test leads for this purpose. Otherwise the contacts could be bent.

Engine governor and connectors – Cleaning

1. Remove coarse dirt from housing surface with isopropyl alcohol.
2. Remove dirt from connector and cable surfaces with isopropyl alcohol.
3. Check legibility of cable labels. Clean or replace illegible labels.

Cleaning severely contaminated connectors on the engine governor

Note: Seal unused connectors with the supplied protective cap.

1. Release the latch and pull off connectors.
2. Clean connector housings, connector socket housings and all contacts with isopropyl alcohol.
3. When connectors, sockets and all contacts are dry: Fit connectors and lock them.

7.21.2 Engine governor plug connections – Check

Preconditions

- ☒ Engine is stopped and starting disabled.

Note: Always use test plugs to check the connections. Never use test leads. Otherwise, the contacts might be bent.

Engine governor plug connections – Check

1. Check all plug connections for secure seating.
2. Latch plugs if loose.

8 Appendix A

8.1 Abbreviations

Abbreviation	Meaning	Explanation
AC	Alternating Current	
AdBlue	-	Brand name given by the German automotive industry association (VDA) Urea solution with 32.5% urea content
ADEC	Advanced Diesel Engine Controller	Engine management system
EGR	Exhaust Gas Recirculation	
AL	Alarm	
ANSI	American National Standards Institute	Association of American standardization organizations
ATL	Abgasturbolader	Exhaust turbocharger
BDM	Backup Data Module	Data backup module
BR	Baureihe	Series
BV	Betriebsstoffvorschrift	Fluids and Lubricants Specifications, MTU Publication No. A01061/..
CAN	Controller Area Network	Data bus system, bus standard
CaPoS	Capacitor Power System	Starting system based on capacitors
CDC	Calibration Drift Compensation	Resets the drift correction with DiaSys® in engine governor to ensure optimum emission and consumption behavior
CRC	Cyclic Redundancy Control	Check sum procedure to detect data transmission faults
DC	Direct Current	
DEF	Diesel Exhaust Fluid	Urea solution with 32.5% urea content Term used in North America
DIFF	Difference	
DIN	Deutsches Institut für Normung e. V.	German National Standards Institute, at the same time identifier of German standards (DIN = "Deutsche Industrie-Norm")
DL	Default Lost	Alarm: CAN bus failure
DPF	Diesel particulate filter	
ECU	Engine Control Unit	Engine governor
ETK	Ersatzteilkatalog	Spare Parts Catalog
FO	Frequency output	
GND	Ground	
HP	High Pressure	
HI	High	Alarm: Measured value exceeds 1st maximum limit
HIHI	High High	Alarm: Measured value exceeds 2nd maximum limit
HT	High Temperature	
ID	Identification number	

T1M-ID: 0000009959 - 008

Abbreviation	Meaning	Explanation
IIE	Initial Injector Equalization	Input of the injector code with DiaSys® in engine governor to ensure optimum emission and consumption behavior
ISO	International Organization for Standardization	International umbrella organization for all national standardization institutes
ITS	Integrated Test System	
KGS	Kraftgegenseite	Engine free end in accordance with DIN ISO 1204
KS	Kraftseite	Engine driving end in accordance with DIN ISO 1204
LED	Light Emitting Diode	
LO	Low	Alarm: Measured value lower than 1st minimum limit
LOLO	Low Low	Alarm: Measured value lower than 2nd minimum limit
MTU	Motoren- und Turbinenunion	
MV	Magnetventil	Solenoid valve
OEM	Original Equipment Manufacturer	
OT	Oberer Totpunkt	Top Dead Center
PAU	Power Automation Unit	Module for monitoring, control and plant-related system integration of peripheral components
PDU	Process Data Unit	
POM	Power Output Module	Module to control starter and battery-charging generator
PU	Projektierungsumgebung	Project planning environment
P-xyz	Pressure-xyz	Pressure measuring point, xyz specifies the measuring point designation
SAE	Society of Automotive Engineers	U.S. standardization organization
SAM	Service and Automation Module	
SD	Sensor Defect	Alarm: Sensor failure
SS	Safety System	Safety system alarm
TBO	Time Between Overhaul	Time until major overhaul
T-xyz	Temperature-xyz	Temperature measuring point, xyz specifies the measuring point designation
U	Symbol for electric voltage	
UIC	Union Internationale des Chemins de Fer	International railway association
Ultra-Caps	UltraCaps modules	Capacitors for starting system
UT	Unterer Totpunkt	Bottom Dead Center
WZK	Werkzeugkatalog	Tool Catalog

TM-ID: 0000009939 - 008

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 at Headquarters: Service-support@mtu-online.com

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

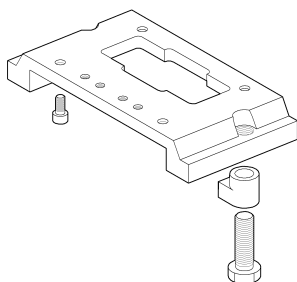
Phone: +49 7541 908555

Fax: +49 7541 908121

9 Appendix B

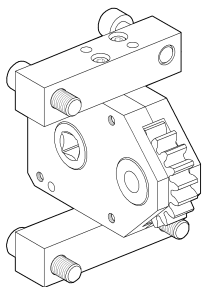
9.1 Special Tools

Adapter



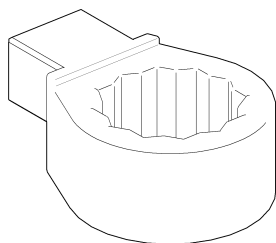
Part No.:	F6558528
Qty.:	1
Used in:	7.1.1 Cranking engine manually (→ Page 78)

Barring device



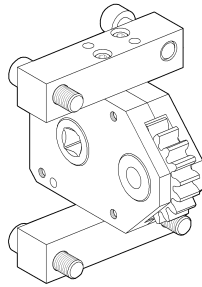
Part No.:	F6555766
Qty.:	1
Used in:	7.2.1 Cylinder liner – Endoscopic examination (→ Page 81)

Box wrench socket, 24 mm



Part No.:	F30039526
Qty.:	1
Used in:	7.5.2 Valve clearance – Check and adjustment (→ Page 91)

Cranking tool

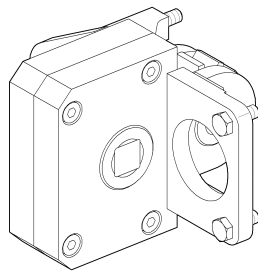


Part No.: F6555766

Qty.: 1

Used in: 7.1.1 Cranking engine manually (→ Page 78)

Cranking tool

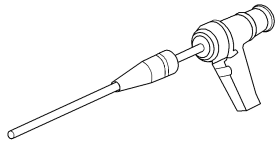


Part No.: F6783293

Qty.: 1

Used in: 7.1.1 Cranking engine manually (→ Page 78)

Endoscope

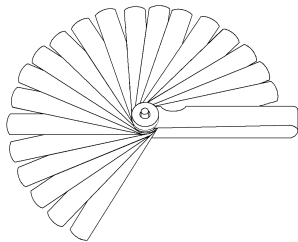


Part No.: Y20097353

Qty.: 1

Used in: 7.2.1 Cylinder liner – Endoscopic examination (→ Page 81)

Feeler gauge



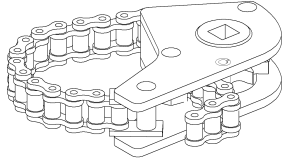
Part No.: Y20098771

Qty.: 1

Used in: 7.5.2 Valve clearance – Check and adjustment (→ Page 91)

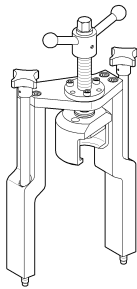
DCL-ID: 0000013811 - 005

Filter wrench



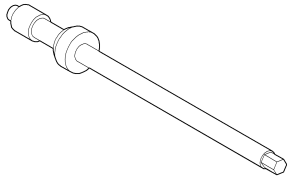
Part No.:	F30379104
Qty.:	1
Used in:	7.9.1 Fuel filter – Replacement (→ Page 104)
Qty.:	1
Used in:	7.15.6 Engine coolant filter – Replacement (→ Page 130)

Installation/removal tool



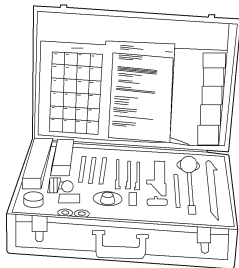
Part No.:	F6789889
Qty.:	1
Used in:	7.7.2 Injector – Removal and installation (→ Page 98)

Milling cutter



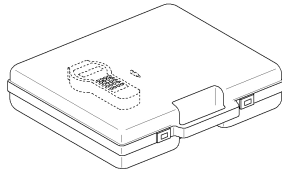
Part No.:	F30452739
Qty.:	1
Used in:	7.7.2 Injector – Removal and installation (→ Page 98)

MTU test kit



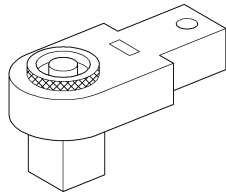
Part No.:	5605892099/00
Qty.:	1
Used in:	7.13.4 Engine oil – Sample extraction and analysis (→ Page 114)
Qty.:	1
Used in:	7.15.7 Engine coolant – Sample extraction and analysis (→ Page 131)

Optibell 2 belt tension tester



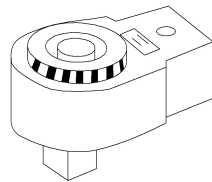
Part No.:	Y4345711
Qty.:	1
Used in:	7.19.1 Fan drive – Drive belt tension check / adjustment (→ Page 146)

Ratchet



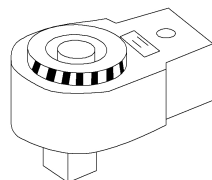
Part No.:	F30027340
Qty.:	1
Used in:	1.5 Crankshaft transportation lock – For transport with flange-mounted generator (→ Page 10)
Qty.:	1
Used in:	7.3.1 Crankcase breather – Oil separator element replacement, diaphragm check and replacement (→ Page 85)
Qty.:	1
Used in:	7.7.2 Injector – Removal and installation (→ Page 98)
Qty.:	1
Used in:	7.18.3 Battery-charging generator drive – Drive belt tension adjustment (→ Page 143)

Ratchet



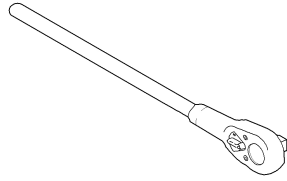
Part No.:	F30027341
Qty.:	1
Used in:	7.7.2 Injector – Removal and installation (→ Page 98)
Qty.:	1
Used in:	7.18.3 Battery-charging generator drive – Drive belt tension adjustment (→ Page 143)

Ratchet adapter



Part No.:	F30027341
Qty.:	1
Used in:	7.13.3 Engine oil – Change (→ Page 112)

Ratchet with extension



Part No.:	F30006212
Qty.:	1
Used in:	7.1.1 Cranking engine manually (→ Page 78)
Qty.:	1
Used in:	7.2.1 Cylinder liner – Endoscopic examination (→ Page 81)

Steam jet cleaner

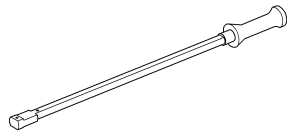
Part No.:	-
Qty.:	1
Used in:	4.6 Plant cleaning (→ Page 54)

Torque wrench, 0.5-5 Nm



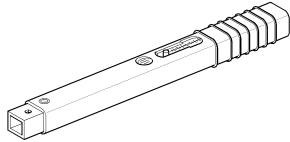
Part No.:	0015384230
Qty.:	1
Used in:	7.7.2 Injector – Removal and installation (→ Page 98)

Torque wrench, 10-60 Nm



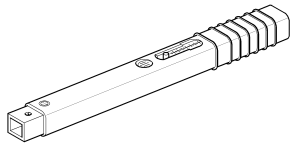
Part No.:	F30452769
Qty.:	1
Used in:	1.4 Crankshaft transport locking device (→ Page 8)
Qty.:	1
Used in:	1.5 Crankshaft transportation lock – For transport with flange-mounted generator (→ Page 10)
Qty.:	1
Used in:	7.7.2 Injector – Removal and installation (→ Page 98)
Qty.:	1
Used in:	7.18.3 Battery-charging generator drive – Drive belt tension adjustment (→ Page 143)

Torque wrench, 20-100Nm



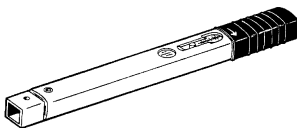
Part No.:	F30026582
Qty.:	1
Used in:	7.18.4 Battery-charging generator – Drive belt and belt tensioner replacement (→ Page 144)

Torque wrench, 20-100 Nm



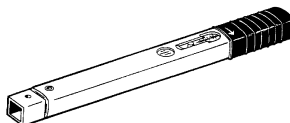
Part No.:	F30026582
Qty.:	1
Used in:	7.18.1 Alternator – Removing and refitting (→ Page 140)

Torque wrench, 40-200Nm



Part No.:	F30027337
Qty.:	1
Used in:	7.13.3 Engine oil – Change (→ Page 112)

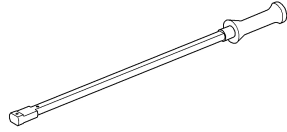
Torque wrench, 6-50 Nm



Part No.:	F30027336
Qty.:	1
Used in:	7.3.1 Crankcase breather – Oil separator element replacement, diaphragm check and replacement (→ Page 85)
Qty.:	1
Used in:	7.14.3 Centrifugal oil filter – Cleaning and filter-sleeve replacement (→ Page 120)

DCL-ID: 0000013811 - 005

Torque wrench, 60-320 Nm



Part No.:	F30452768
Qty.:	1
Used in:	1.4 Crankshaft transport locking device (→ Page 8)
Qty.:	1
Used in:	7.5.2 Valve clearance – Check and adjustment (→ Page 91)
Qty.:	1
Used in:	7.7.2 Injector – Removal and installation (→ Page 98)
Qty.:	1
Used in:	7.18.3 Battery-charging generator drive – Drive belt tension adjustment (→ Page 143)

9.2 Index

Numerics

- 12/16 V 4000 C13/13R/13L engine data: Application group 5A, optimized exhaust emissions (EPA Stage 2) 32
- 12/16 V 4000 C13/13R/13L engine data: Application group 5A, optimized fuel consumption 25
- 12/16 V 4000 C23/23R engine data: Application group 5B, optimized exhaust emissions (EPA Stage 2) 43
- 12/16 V 4000 C23/23R engine data: Application group 5B, optimized fuel consumption 39

A

- Abbreviations 152
- After shutting down the engine 53
- Alternator
 - Removing and refitting 140
- Automatic oil filter
 - Filter candles
 - Replacement 115

B

- Battery-charging generator
 - Check 142
 - Drive belt tension adjustment 143
- Battery-charging generator
 - Drive belt and belt tensioner replacement 144

C

- Centrifugal oil filter
 - Cleaning 120
- Charge-air coolant
 - Change 133
 - Draining 134
 - Filling 135
 - Level check 132
- Charge-air coolant level
 - Check 132
- Charge-air coolant pump
 - Checking pressure relief port 138
- Connectors
 - Cleaning 150
- Contact persons 154
- Coolant
 - Change 133
 - Pump - Checking pressure relief port 129, 138
- Coolant - charge air
 - Level check 132
- Crankcase breather
 - Diaphragm check 85
 - Oil separator element replacement 85
- Crankshaft transport locking device
 - Installation 8
 - Removal 8

- Crankshaft transportation lock
 - With flange-mounted generator
 - Installation 10
 - Removal 10

Cylinder

- Designation 19
- Cylinder head cover
 - Removal and installation 95
- Cylinder liner
 - Endoscopic examination 81

D

- Drive belt
 - Condition check 139

E

- Engine
 - Barring with starting system 80
 - Cranking manually 78
 - Start in manual mode 51
 - Stopping in manual mode 52
 - Wiring check 149
- Engine coolant
 - Change 123
 - Draining 124
 - Filling 126
 - Level check 122
 - Sample extraction and analysis 131
- Engine coolant filter
 - Replacement 130
- Engine coolant pump
 - Checking pressure relief port 129
- Engine governor
 - Cleaning 150
 - Plug connections
 - Check 151
- Engine layout 20
- Engine oil
 - Centrifugal oil filter
 - Cleaning 120
 - Filter sleeve
 - Replacement 120
 - Sample analysis 114
 - Sample extraction 114
- Engine oil
 - Change 112
- Engine oil level
 - Checking 110
 - Checking on oil sight glass 111
- Engine side
 - Designation 19
- Engine wiring
 - Check 149

F

Fan drive

- Drive belt replacement 148
- Drive belt tension check / adjustment 146

Fault messages of the engine governor ADEC (ECU 7) for series 4000 C&I engines 59

Filter

- Automatic oil filter
 - Replacing filter candles 115

Filter sleeve

- Replacement 120

Firing order 47

Fuel filter

- Replacing 104

Fuel prefilter

- Draining 105, 106

Fuel system

- Venting 103

G

Grounding device

- Carbon brush check 87

Grounding device

- Carbon brush replacement 89

H

Hotline 154

HP pump

- Filling with engine oil 96

I

Injector

- Removal and installation 98
- Replacement 97

Instructions and comments on endoscopic and visual examination of cylinder liners 83

Intercooler

- Checking condensate drain for coolant discharge 107
- Checking condensate drain for obstructions 107

M

Main engine dimensions 48

Maintenance schedule

- Maintenance task reference table [QL1] 55

MTU contact persons 154

O

Oil indicator filter

- Check 118
- Cleaning 118

P

Plant

- Cleaning 54

Putting the engine into operation

- Preparation after scheduled out-of-service-period 50

R

Recommissioning

- Preparations for after long out-of-service periods (>3 months) 49

S

Safety notices, standards 18

Safety regulations

- Auxiliary materials 16
- Environmental protection 16
- Fire prevention 16
- Fluids and lubricants 16
- Important provisions 5
- Maintenance work 13
- Operation 12
- Organizational requirements 6
- Personnel requirements 6
- Repair work 13
- Safety notices, standards 18
- Startup 12

Sensors and actuators - Overview 21

Service indicator

- Signal ring position check 108

Service partners 154

Spare parts service 154

Starter

- Condition check 109

T

Transport 7

Troubleshooting 56

V

Valve clearance

- Adjustment 91
- Check 91

Valve gear

- Lubrication 90

W

Wiring - engine

- Check 149