Operating Instructions

Diesel Engine
12V/16V4000C11
12V/16V4000C11R
12V/16V4000C21
16V4000C21L
12V/16V4000C21R
16V4000C31

MS150049/05E

Power. Passion. Partnership.

Engine model	Power rating	Application group
12V4000C11	107 kW/cyl.	5A Continuous operation, unrestricted
12V4000C11R	99 kW/cyl.	5A Continuous operation, unrestricted
12V4000C21	125 kW/cyl.	5B; Continuous operation, variable
12V4000C21R	117 kW/cyl.	5B; Continuous operation, variable
16V4000C11	107 kW/cyl.	5A Continuous operation, unrestricted
16V4000C11R	100 kW/cyl.	5A Continuous operation, unrestricted
16V4000C21	125 kW/cyl.	5B; Continuous operation, variable
16V4000C21L	125 kW/cyl.	5B; Continuous operation, variable
16V4000C21R	93 kW/cyl.	5B; Continuous operation, variable
16V4000C31	133 kW/cyl.	5B; Continuous operation, variable

Table 1: Applicability

WARNING: Breathing diesel engine exhaust exposes you to chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

- Always start and operate the engine in a well-ventilated area.
- If in an enclosed area, vent the exhaust to the outside.
- Do not modify or tamper with the exhaust system.
- Do not idle the engine except as necessary.

For more information, go to www.P65warnings.ca.gov/diesel

Table of Contents

1 Revision Overview

1.1 Revision - Overview

Revision overview – General

Chapter	S150049/04	S150049/05
–	Warning notices in general.	Warning notices updated.
–	Graphics in general.	Graphics updated.
4.1	–	Chapter "Tightening specifications for screws, nuts and bolts" added.
5.1	Chapter "Product data 12V4000C11, 12V4000C11R".	Chapter "Product data 12V4000C11, 12V4000C11R" updated.
5.3	Chapter "Product data 12V4000C21, 12V4000C21R".	Chapter "Product data 12V4000C21, 12V4000C21R" updated.
5.4	Chapter "Product data 16V4000C21, 16V4000C21R, 16V4000C21L".	Chapter "Product data 16V4000C21, 16V4000C21R, 16V4000C21L" updated.
6.3	–	Chapter "Re-starting the engine following an automatic safety shutdown" added new.

Revision overview – Maintenance schedule

Task No.	Status MS50095/05	Edition MS50095/06
W1003	Task "Check drive belt condition and tension, replace if necessary".	Task deleted.
W1463	Task "Check general condition of engine mounting (visual inspection)".	Task deleted.
W1241	–	Task "Inspect condition of drive belts and fit new ones if necessary. Adjust tension" new.
W1481	–	Task "Replace intermediate fuel filter of filter element of intermediate fuel filter" new.
W1605	–	Task "Visually check oil priming pump" new.
W1675	–	Task "Fit new fuel prefilter or new fuel prefilter insert" new.
W4172	–	Task "Check general condition of resilient mount (visual inspection)" new.

Revision overview – Task description

Chapter	M015675/06	M015675/07
9.3.1	Chapter "Crankcase breather – Filter element replacement".	Updated legends and text mismatch.
9.5.3	Chapter "Valve clearance – Check and adjustment".	Updated valve clearance of cold engine.
9.9.2	–	Chapter "Intermediate fuel filter – Replacement" added new.
9.9.3	–	Chapter "Fuel prefilter – Draining" added new.

Chapter	M015675/06	M015675/07
9.9.4	–	Chapter "Fuel prefilter – Filter element replacement" added new.
9.9.5	–	Chapter "Fuel prefilter with internal electrical priming pump – Draining" added new.
9.9.6	–	Chapter "Fuel prefilter with internal electrical priming pump – Filter element replacement" added new.
9.13.5	–	Chapter "Lube-oil priming pump – Overview" added new.

2 Safety

2.1 Important provisions for all products

General

This product may pose a risk of injury or damage in the following cases:
- Incorrect use
- Operation, maintenance and repair by unqualified personnel
- Changes or modifications which are neither made nor authorized by the manufacturer
- Noncompliance with the safety instructions and warning notices

Nameplates

The product is identified by nameplate, model designation or serial number. This data must match the specifications in these instructions.

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

All EU-certified engines delivered by MTU come with a second nameplate. This second nameplate is delivered "loosely" with the engine. If the nameplate secured to the engine after installation in the vehicle/system is not visible without the removal of components, the system integrator must install the second nameplate in a clearly visible area on the vehicle/system.

Emission specifications and emission label

Responsibility for compliance with emission regulations

Modification or removal of any mechanical/electronic components or the installation of additional components including the execution of calibration processes that might affect the emission characteristics of the product are prohibited by emission regulations. Emission-related components must only be serviced, exchanged or repaired if the components used for this purpose are approved by the manufacturer.

Noncompliance with these specifications will invalidate the design type approval or certification issued by the emissions regulation authorities. The manufacturer does not accept any liability for violations of the emission regulations.

The product must be operated over its entire life cycle according to the conditions defined as "Intended use" (→ Page 9).

Emission certification applicable to engines with EPA Nonroad Tier 4 emission certification in accordance with 40 CFR 1039 and with EPA Locomotive emission certification in accordance with 40 CFR 1033

Extract from the standard:

Failing to follow these instructions when installing a certified engine in a piece of nonroad equipment violates federal law (40 CFR 1068.105(b)), subject to fines or other penalties as described in the Clean Air Act.

Extract from the standard:

If you install the engine in a way that makes the engine's emission control information label hard to read during normal engine maintenance, you must place a duplicate label on the equipment, as described in 40 CFR 1068.105.

When fitting the second label, the requirements of 40 CFR 1068.105(c) must be followed and observed. This paragraph describes the process for requesting and fitting the label, the documentation obligations and storage obligations for the required documents.

Replacing components with emission labels

On all MTU engines fitted with emission labels, these labels must remain on the engine throughout its operational life.

Exception: Engines used exclusively in land-based, military applications other than by US government agencies.

Please note the following when replacing components with emission labels:
- The relevant emission labels must be affixed to the spare part.
- Emission labels shall not be transferred from the replaced part to the spare part.
- The emission labels must be removed from the replaced part and destroyed.

2.2 Correct use of all products

Correct use

The product is intended for use in accordance with its contractually-defined purpose as described in the relevant technical documents only.

Intended use entails operation:
- Within the permissible operating parameters in accordance with the (→ Technical data)
- With fluids and lubricants approved by the manufacturer in accordance with the (→ Fluids and Lubricants Specifications of the manufacturer)
- With preservation approved by the manufacturer in accordance with the (→ Preservation and Represervation Specifications of the manufacturer)
- With spare parts approved by the manufacturer in accordance with the (→ Spare Parts Catalog/MTU contact/Service partner)
- In the original as-delivered configuration or in a configuration approved by the manufacturer in writing (also applies to engine control/parameters)
- In compliance with all safety regulations and in adherence with all warning notices in this manual
- In compliance with the maintenance work and intervals specified in the (→ Maintenance Schedule) throughout the useful life of the product
- 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

The product must not be operated in explosive atmospheres unless the engine fulfills the conditions for such use and approval has been granted.

Any other use, particularly misuse, is considered as being contrary to the intended purpose. Such improper use increases the risk of injury and damage when working with the product. The manufacturer shall not be held liable for any damage resulting from improper, non-intended use.

The specifications of the manufacturer will be amended or supplemented as necessary. Prior to operation, make sure that the latest version is used. The latest version can be found on the websites:
- For drive systems: http://www.mtu-online.com
- For power generation: http://www.mtuonsiteenergy.com

Modifications or conversions

Unauthorized changes to the product represent a contravention of its intended use and compromise safety.

Changes or modifications shall only be considered to comply with the intended use when expressly authorized by the manufacturer. The manufacturer shall not be held liable for any damage resulting from unauthorized changes or modifications.

2.3 Personnel and organizational requirements

Organizational measures of the user/manufacturer

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

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

Personnel must receive instruction on product handling and repair based on this manual. In particular, personnel must have read and understood the safety requirements and warnings before starting work.

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

Personnel requirements

All work on the product must be carried out by trained, instructed and qualified personnel only:
- Training at the Training Center of the manufacturer
- Qualified personnel from the areas mechanical engineering, plant construction, and electrical engineering and also for work with live parts

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

Personnel shall not report for duty under the influence of alcohol, drugs or strong medication.

Clothing and personal protective equipment

Always wear appropriate personal protective equipment, e.g. safety shoes, hearing protection, protective gloves, goggles, breathing mask. Follow the instructions concerning personal protective equipment in the descriptions of the individual activities.

Safe handling of Substances of Very High Concern pursuant to the REACH regulation (Registration, Evaluation, Authorization and restriction of Chemicals): We recommend wearing protective gloves at all times in order to reduce risk when working.

2.4 Safety regulations for initial start-up and operation

Safety regulations for initial start-up

Install the product correctly and carry out acceptance in accordance with the manufacturer's specifications before putting the product into service. All necessary approvals must be granted by the relevant authorities and all requirements for initial startup must be fulfilled.

Whenever the product is subsequently taken into operation ensure that:
- All personnel is clear of the danger zone surrounding moving parts of the machine. Electrically-actuated linkages may be set in motion when the Engine Control Unit (governor) is switched on.
- All maintenance and repair work has been completed.
- All loose parts have been removed from rotating machine components.
- All safeguards are in place.
- All components must be properly grounded. Ground separately by means of a grounding stake as necessary.
- No persons wearing pacemakers or any other technical body aids are present.
- Adequate ventilation of the operating room must be ensured for any operating status.
- In the first few hours of operation, the product emits gases as a result of smoldering e.g. lacquers or oil. These gases may be hazardous to health. Always wear respiratory protection in the operating room during this period.
- The exhaust system is leak-tight and that the gases are vented to atmosphere.
- The product must be free of any damage, this applies in particular to lines and cabling.
- Protect battery terminals, generator terminals or cables against accidental contact.
- Check that all connections have been correctly allocated e.g. +/- polarity, fuel line/reduction agent line, supply/return.

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

Smoking is prohibited in the area of the product.

Safety regulations during 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

Practice emergency procedures, especially emergency stopping, at regular intervals.

Take the following steps if any system malfunctions are detected or signaled by the system:
- Inform supervisor(s) in charge.
- Analyze the message.
- Respond by taking any necessary emergency action, e.g. emergency stop.

After a safety shutdown, the engine must only be started after the cause of the shutdown has been eliminated.

Contact Service if the root cause of the malfunction cannot be clearly identified.

Operation

Do not remain in the operating room when the product is running unless absolutely necessary. Keep your stay as short as possible.

Keep a safe distance away from the product if possible. Do not touch the product unless expressly instructed to do so following a written procedure.

Do not inhale the exhaust gases of the product.

The following requirements must be fulfilled before the product is started:
- Wear ear protectors.
- Mop up any leaked or spilled fluids and lubricants immediately or soak up with a suitable binding agent.

Operation of electrical equipment

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

Follow the applicable operating and safety instructions when operating the devices and heed warnings at all times.

2.5 Safety regulations for assembly, maintenance, and repair work

Safety regulations for work prior to assembly, maintenance, and repair

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

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

Relieve pressure in fluid and lubricant systems and compressed-air lines which are to be opened. Use suitable containers of adequate capacity to catch fluids and lubricants.

Release residual pressure before removing or replacing a component in the supply line. To depressurize pressurized lines, shut off the lines first, then release the residual pressure.

Work must only be carried out on lines when they are free of fluids and lubricants.

Ensure adequate ventilation of the operating room when conducting an oil change, working on the gaseous/liquid fuel system or working with consumables (e.g. adhesive, cleaner).

Never carry out assembly, maintenance, or repair work with the product in operation, unless:
- It is expressly permitted to do so following a written procedure.

Lock-out the product to preclude undesired starting, e.g.
- Start interlock
- Key switch
- Close supply line for hydraulic starting.
- Close the main valve on the compressed-air system and vent the compressed-air line when air starters are fitted.

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

Disconnect the battery cables or actuate the battery isolating switch, if fitted. Lock circuit breakers.

Before starting work on CaPoS, if used:
- Switch off the charging system (DC/DC converter).
- Discharge the UltraCap modules using the appropriate discharger.
- Short-circuit the UltraCap modules with a suitable wire jumper.

Before working on the exhaust gas aftertreatment system, close the shutoff valve on the reducing agent tank. Note that the reducing agent pumps continue to run for a certain period when the engine is stopped.

Disconnect the control equipment from the product.

Use the recommended special tools or suitable equivalents when instructed to do so.

Safety regulations when performing assembly, maintenance, and repair work

Special tools and lifting equipment

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

Setting down, lifting and climbing

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

Use appropriate lifting equipment for all components. Use all specified attachment points and observe the center of gravity.

Never stand beneath a suspended load.

Never work on engines or components when they are held in place by lifting equipment.

Make sure components or assemblies are placed on stable surfaces and secured against tilting over or rolling away. Adopt suitable measures to prevent components/tools from falling down.

Assume a safe standing position when performing assembly work.

Never use the product as a climbing aid.

When working high on the equipment, always use suitable ladders and work platforms. Special instructions for outdoor areas: There must be no risk of slipping e.g. due to icing.

Removing, installing and cleanliness

Pay particular attention to cleanliness at all times.

Completely wipe up escaped fluids and lubricants due to the risk of slipping.

Take special care when removing ventilation or plug screws from the product.

Ensure that O-rings are not installed in a slanted/twisted condition.

Carry out appropriate cleaning procedures to clean and inspect components requiring special cleanness (e.g. components carrying oil, fuel, or air).

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

Ensure that all mounts and dampers are installed correctly.

Remove any accumulation of condensate after assembling chilled components. Coat the components with a suitable corrosion inhibitor as necessary.

Lines

Ensure that lines for all fluids and lubricants and their connections are clean.

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

Fit new seals when re-installing lines.

Never bend lines and avoid damaging lines, particularly the fuel lines.

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.

Miscellaneous

Sufficient ventilation must be guaranteed during the work.

Wear a breathing mask offering protection against soot, dust, and mineral fibers (filter class P3) when working on exhaust components. Clean the work area with a dust extraction machine of class H. Wear protective gloves and goggles for protection against acidic condensate.

Do not touch elastomeric seals (e.g. Viton sealing rings) with your bare hands if they have a carbonized or resinous appearance.

Elastomer components (e.g. engine mounts, damping elements, couplings and V-belts) must not be painted. Only install them after painting the engine or mask them prior to painting.

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

Safety regulations after performing assembly, maintenance, and repair work

Before barring the engine, make sure no one is in the danger zone of the engine.

Check that all access ports/apertures which have been opened to facilitate working are closed again.

All safety devices must be installed and all tools and loose parts must be removed (especially the barring tool).

Ensure that no unattached parts have been left in/on the product (e.g. including rags and cable straps).

Ensure that the grounding system is properly connected.

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 cables or actuate the battery isolating switch.
- Separate the electrical ground of electronic equipment from the ground of the unit.

No other assembly, maintenance, or repair work must be carried out in the vicinity of the product while welding is in progress. There is a risk of explosion or fire due to oil vapors or 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 can induce interfering voltages in the wiring harnesses which may damage the electrical system.

Remove components (e.g. exhaust pipe) from the product before performing necessary welding work.

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 which are under pressure.

Before starting work, pay attention to the following:
- Vent the installation/removal jig, the pumps and the pipework at the relevant designated points.
- For hydraulic installation, screw on the jig with the piston retracted.
- For hydraulic removal, screw on the jig with the piston extended.

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

During hydraulic installation and removal of components, 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 manufacturer when working on batteries.

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

Do not allow battery acids to come into contact with skin or clothing.

Wear protective clothing, goggles and protective gloves.

Do not place objects on the battery.

Before connecting the cable to the battery, check the battery polarity. The battery may explode and spray acid if the battery terminals are connected incorrectly.

Working on electrical and electronic assemblies

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

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

ESD (Electrostatic Discharge): Work on components which could be damaged by electrostatic discharge must always be carried out with appropriate equipment. Appropriate equipment is e.g. electrically conductive work surfaces or antistatic wristbands.

Do not damage wiring during removal work. When reconnecting, ensure that cabling cannot be damaged during operation by:
- Contact with sharp edges
- Chafing on components
- Contact with hot surfaces.

Do not secure cables on lines carrying fluids.

Do not use cable ties to secure lines.

Always use connector pliers to tighten union nuts on connectors.

Subject the device as well as the product to functional testing on completion of all repair work. The emergency stop function must be tested in particular. The functional check of the emergency stop, during which the voltage supply of the engine governor is switched off, must only be carried out when the product is cold.

Store spare parts properly prior to replacement, i.e. protect them against moisture in particular. Package faulty electronic components or assemblies properly before dispatching for repair:
- Moisture-proof
- Shock-proof
- Wrapped in antistatic foil (as necessary)

Working with laser equipment

Work with laser devices shall be carried out by trained and qualified personnel only. Follow the safety instructions in the manufacturer's user manual when working with laser equipment.

Wear special laser safety glasses when working with laser equipment (danger of concentrated radiation).

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

Measuring component dimensions

Workpieces, components and measuring equipment lie in the specified tolerance range at a reference temperature of 20 °C.

2.6 Fire and environmental protection, fluids and lubricants

Fire prevention and fire

Fire, exposed light bulbs and smoking are prohibited.

In case of a fire, stop the fuel supply if this is possible without endangering personnel.

The product has hot surfaces that can ignite combustible gases and other substances in the immediate area. The operating company must install and operate the product a safe distance away from danger sources and observe any relevant safety regulations or recommendations. Products that comply with the SOLAS Convention do not constitute such as danger.

After working with combustible fluids and lubricants (e.g. cleaning agents), ensure the area is well ventilated. The resultant vapor/air mixture must be sufficiently diluted to prevent a potentially explosive atmosphere.

Eliminate leaks of fluids and lubricants immediately. Fluids and lubricants on hot components can cause fires, so keep the product clean at all times. Do not leave rags saturated with fluids and lubricants on the product. Do not store combustible materials near the product.

Incorrect refueling of the reducing agent system with fuel can result in fire.

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

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 cable from the external power source to the ground cable of the engine or to the ground terminal of the starter.

Ensure that suitable extinguishing agents (fire extinguishers) are always available and that staff are familiar with their correct handling.

A fire can result in the creation of toxic substances. Always wear protective gloves when handling components and wear additional personal protective equipment is necessary.

Noise

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

Noise can lead to an increased risk of accidents if acoustic signals, warning shouts or sounds indicating danger are compromised.

Environmental protection and disposal

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

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

Fluids and lubricants/auxiliary materials (process materials)

Process materials can also be or contain hazardous or toxic substances. When using process materials and other chemical substances, observe the associated safety data sheet. The safety data sheet may be obtained from the relevant manufacturer or from MTU.

Only process materials approved by the manufacturer in accordance with the Fluids and Lubricants Specifications must be used. The most recent respective version must be requested from the manufacturer.

Contamination of process materials with reducing agent (e.g. AdBlue®, DEF): Store process materials in separate containers and their own drip trays. Even extremely small amounts of reducing agent contamination can result in malfunctions in sensors and other components.

Used oil contains combustion residues that are harmful to health.

When handling used oil, protective gloves must be used.

Wash relevant areas after contact with used oil.

Registration, evaluation, approval and restriction of chemicals (REACH ordinance)

Particularly hazardous substances used with our products are named in a list:
- For drive systems: www.mtu-online.com/mtu/technische-info → SVHC as per REACH in MTU products
- For power generation: www.mtuonsiteenergy.com/technische-infos → Tools and Downloads → SVHC ACC. REACH IN MTU PRODUCTS

Compressed air

- Unauthorized use of compressed air, e.g. forcing flammable liquids (hazard class AI, AII and B) out of containers, risks causing an explosion.
- Wear goggles when blowing dirt off workpieces or blowing away chips.
- Blowing compressed air into thin-walled containers (e.g. containers made of sheet metal, plastic or glass) for drying purposes or to check for leaks risks bursting them.
- Pay special attention to the pressure in the compressed air system or pressure vessel.
- Assemblies or products which are to be connected must be designed to withstand this pressure. Install pressure-reducing or safety valves set to the admissible pressure if this is not the case.
- Hose couplings and connections must be securely attached.
- Provide the snout of the air nozzle with a protective disk (e.g. rubber disk).
- Release residual pressure before removing a compressed air device from the supply line. To depressurize compressed-air lines, shut off the lines first, then release the residual pressure.
- Carry out a leak test in the specified manner.

Painting

- 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 adversely affected.
- Avoid open flames in the surrounding area.
- 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.
- Work with liquid nitrogen may be carried out only by qualified personnel.
- 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 safety goggles.
- Make sure that the working area is well ventilated.
- Avoid knocking or jolting the containers, valves and fittings or workpieces in any way.

Acids/alkalines/reducing agents (e.g. AdBlue®, DEF)

- Observe the relevant safety data sheet for all materials.
- When working with acids and alkaline solutions, wear goggles or face mask, gloves and protective clothing.
- Do not inhale vapors.
- If reducing agent is swallowed, rinse out mouth and drink plenty of water.
- Remove any wet clothing immediately.
- After skin contact, wash affected body areas with plenty of water.
- Rinse eyes immediately with eyedrops or clean mains water. Consult a doctor as soon as possible.
  Contamination of reducing agent with other process materials: Store reducing agent in separate containers and use separate drip trays. Even extremely slight contamination can lead to malfunctions in the exhaust aftertreatment system.
  Mistakenly filling the tank of the reducing agent system with fuel can cause leakage at the seals and in the hoses.

2.7 Standards for warning notices in the text and highlighted information

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.

Warning notices

1. This manual with all safety instructions and warning notices must be issued to all personnel involved in operation, maintenance, repair, assembly, installation, or transportation.
2. The highest level warning notice is used if several hazards apply at the same time. Warnings related to personal injury shall be considered to include a warning of potential damage.

Highlighted information

Important
This field contains product information which is important or useful for the user. This information must not refer to hazards related to personal injury or material damage.

3 Transport

3.1 Transportation

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Crossbeam	T80091826	1
Crossbeam	T80092210	1

DANGER

Suspended load
Danger to life
- Never stand under suspended loads!
- Wear appropriate personal protective equipment.

Transportation

1. Install the engine mount locking devices and the engine shipping lock prior to transportation (→ Page 22).
2. Use the lifting eyes provided to transport the engine/generator (→ Page 20).
3. Use suitable transport and lifting gear only.
4. Transport the system, engine/generator in their respective installation positions only: max. admissible diagonal pull 10° (→ Page 20).
5. Do not place unsecured parts on the system, engine/generator.
6. Raise and lower the system, engine/generator slowly. Do not allow hoist slings or chains to contact the system, engine/generator or any of their component parts. Readjust lifting tackle as necessary.
7. For special packaging with aluminum foil: Suspend the engine by the lifting eyes on the bearing pedestal or transport by means of handling equipment (forklift truck) capable of bearing the load.
8. Secure the system, engine/generator to prevent tipping during transportation. Secure such as to preclude slipping and tipping when driving up or down inclines and ramps.

Setting down after transportation

1. Set the system down on a firm, flat surface only.
2. Make sure that the consistency and load-bearing capacity of the ground or support surface is adequate.
3. Never set the engine down on its oil pan unless expressly authorized to do so by MTU.

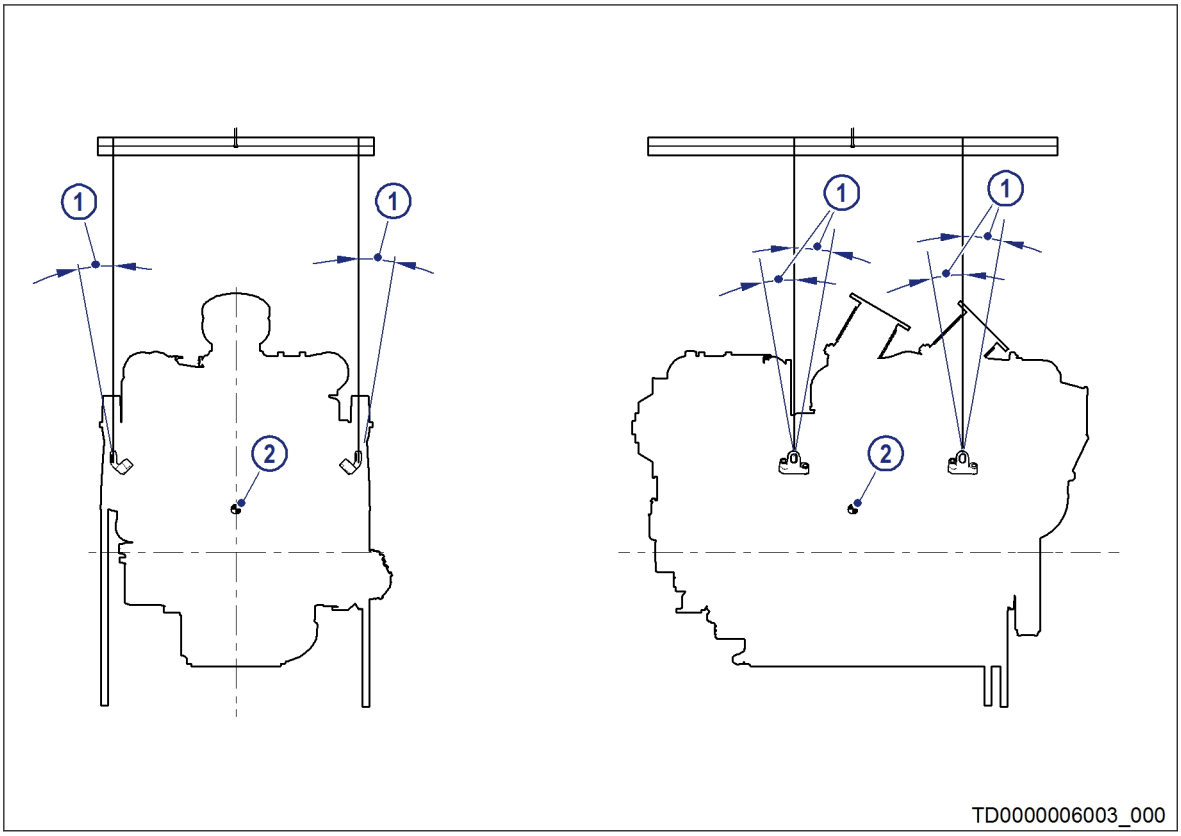
3.2 Lifting specifications

Lifting specifications

DANGER

Suspended load.
Danger to life!
- Use suitable equipment and lifting devices.
- Never stand beneath a suspended load and keep a safe distance.
- Wear personal protective equipment (e.g. protective helmet, safety shoes).

Applies also to 16V4000Cx0, 16V4000Cx1



1 Max. permissible diagonal pull: 10°
2 Center of gravity

Take note of the engine center of gravity

Refer to the installation/arrangement drawings for details of the center of gravity of the system or the center of gravity of the engine/generator.

3.3 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		

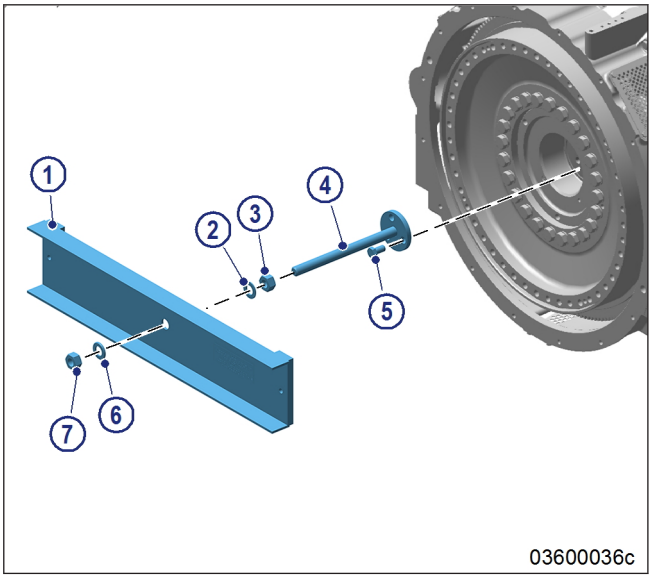
Note: The transport locking device on both sides protects the crankshaft bearings from shocks and possible vibration damage during engine transport.

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

1. The transport locking device on both sides must remain installed as long as possible during engine installation in order to avoid damage.
2. Prior to every engine transport (without generator) , the transport locking device on both sides must be installed 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 (→ Page 25).
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 this documentation to a highly visible area of the engine.

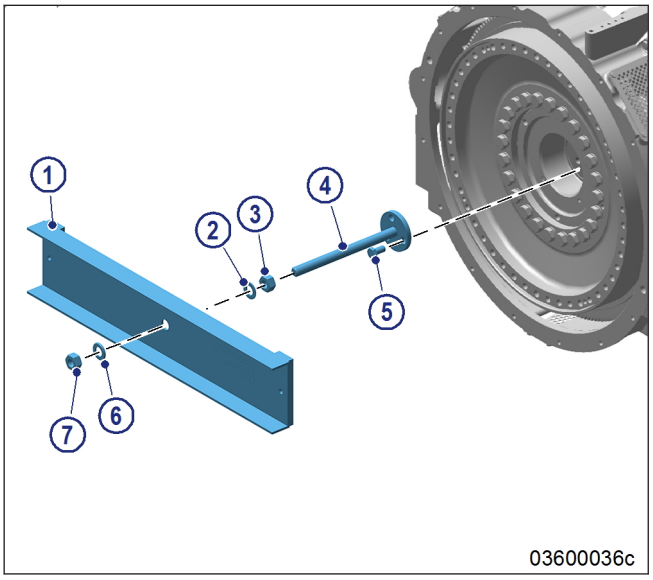
Removing the transport locking device from driving end (KS), version A

1. Remove parts (1) to (7) from engine.
2. Store the removed parts of the transport locking device carefully for possible reuse.



Installing the transport locking device on driving end (KS), version A

1. Screw holder (4) with screws (5) onto crankshaft.



2. Tighten screws (5) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw	M16	Tightening torque	(Engine oil)	180 Nm +18 Nm

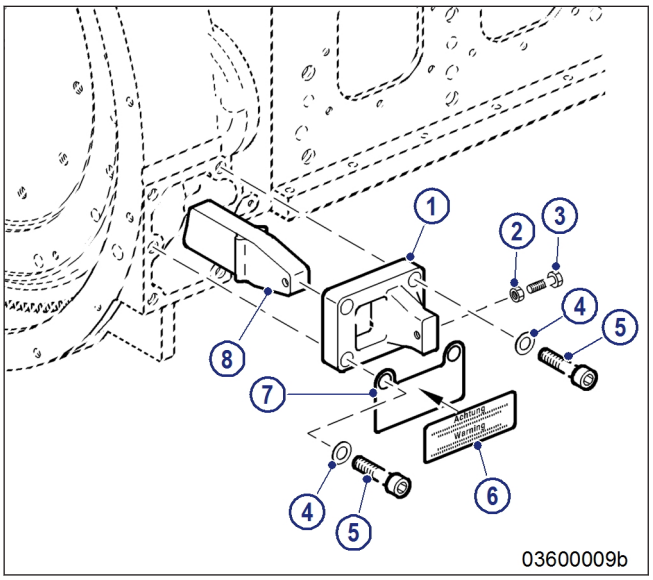
3. Screw nut (3) with washer (2) onto holder (4). Screw on carrier (1) with washer (6) and nut (7) and tighten nut (7) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Nut	M24	Tightening torque	(Engine oil)	100 Nm +10 Nm

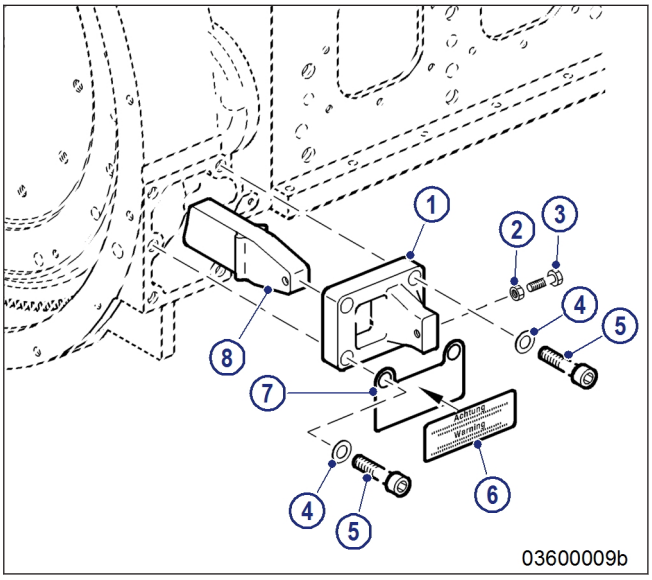
4. Secure with nut (3).
5. Mark the engine as “Fitted with transport locking device”.

Removing the transport locking device from driving end (KS), version B

1. Release the locknuts (2) on both sides of the flywheel housing, remove screw (3) and take off holder (8).
2. Unscrew screws (5) and remove with washers (4), cover plate (7) sign (6) and plates (1).
3. Store the removed parts of the transport locking device carefully for possible reuse together with this documentation.



Installing the transport locking device on driving end (KS), version B



1. Secure plate (1) with screws (5) and washers (4) together with cover plate (7) 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

2. Screw locknut (2) onto screws (3) up to the end of the thread.
3. Insert holder (8) through opening in plate (1) and secure with screw (3).
4. Tighten screws (3) alternately to specified torque using a torque wrench.

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

5. Place locknuts (2) of screw (3) in position on both sides of plate (1) and lock.
6. Fit sign (6) to mark the engine as “Fitted with transport locking device”.

TIM-ID: 0000040575 - 003

3.4 Crankshaft transport locking device - For transport with flanged-on generator

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		

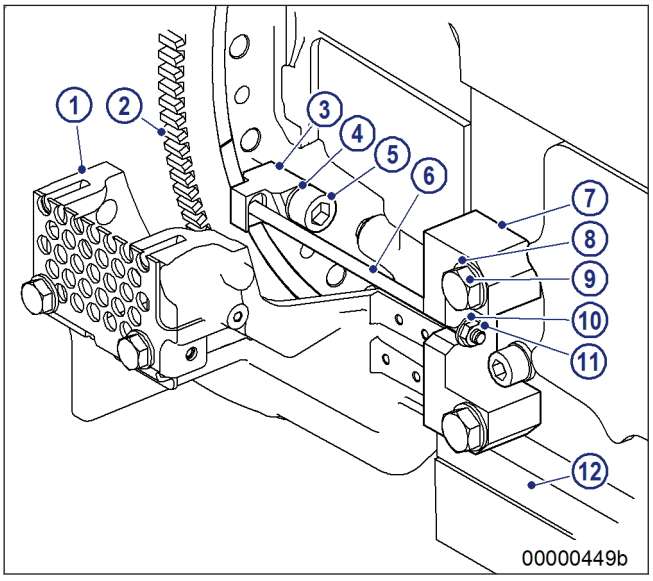
Note: The transport locking device on the engine protects the crankshaft bearings from shocks and vibration damage during genset transport.

The following must be taken into account when removing/installing the transport locking device:

1. The transport locking device must remain installed as long as possible during genset installation in order to avoid damage.
2. Prior to every genset transport, the transport locking device must be reinstalled on the engine and generator according to the instructions.
3. Always use the screws supplied with or installed in the transport locking device to secure it on the engine.
4. Starting or barring the engine is allowed only with the transport locking device removed from engine and generator.

Removing the transport locking device from driving end (KS)

1. Release nut (11) on both sides.
2. Remove screw (5), washer (4), holder (3) and screw (6) from flywheel (2).
3. Remove screw (9), washer (8) and holder (7) from crankcase (12).



4. Install the two screws with washers to secure the diaphragm coupling to the flywheel.

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

Installing the transport locking device on driving end (KS)

1. Remove the transport locking device installed by MTU (→ Page 22).
2. Remove protective cover from flywheel housing (1).

3. Install the holders (7) on both sides of the crankcase (12) with screw (9) and washer (8). Tighten screw (9).

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque	(Engine oil)	290Nm +20 Nm

4. To allow the holders (3) to be secured on each side of the flywheel (2), the corresponding screws and washers must be removed from the driving end.
5. Leave the unscrewed screws with washers on engine and screw back in when the transport locking device has been removed.
6. Place screw (6) in the recess of holder (3) and insert through the opening at the flywheel housing (1). Secure holder (3) with screw (5) and washer (4) to flywheel (2). Tighten screw (5).

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque	(Engine oil)	180Nm +18 Nm

7. Fit conical spring washer (10) on screw (6) and tighten nut (11).

Name	Size	Type	Lubricant	Value/Standard
Nut		Tightening torque	(Engine oil)	27Nm +3 Nm

4 General Information

4.1 Tightening specifications for screws, nuts and bolts

Tightening torques for setscrew and connections as per MTN 5008 standard

This standard applies to setscrews not subject to dynamic loads and the associated nuts according to:

- MMN 384
- ISO 4762 (DIN 912)
- ISO 4014 (DIN 931-1)
- ISO 4017 (DIN 933)
- DIN EN ISO 8765 (EN 28765; DIN 960)
- DIN EN ISO 8676 (EN 28676; DIN 961)
- DIN 6912

This standard applies to studs not subject to dynamic loads and the associated nuts according to:

- DIN 833
- DIN 835
- DIN EN ISO 5395 (DIN 836)
- DIN 938
- DIN 939

This standard applies to screws with hexalobular heads according to:

- DIN 34800
- DIN 34801

The standard does not apply to heat-resistant screws in the hot component zone.

Tightening torques M_A are specified for screws of strength class 8.8 (surface condition bare, phosphatized or galvanized) and 10.9 (surface condition bare or phosphatized).

The values in the table are based on a friction coefficient µtot = 0.125.

Threads and mating faces of screws and nuts must be coated with engine oil prior to assembly.

When hand-tightening (defined torque), an assembly tolerance of -5+15% of the figures in the table is permitted.

When machine-tightening, the permissible assembly tolerance is ±15%.

Tightening torques for setscrews

Thread	Hand-tightening		Machine-tightening	
	8.8 M_A (Nm)	10.9 M_A (Nm)	8.8 M_A (Nm)	10.9 M_A (Nm)
M6	9	12	8	11
M8	21	31	20	28
M8 x 1	23	32	21	30
M10	42	60	40	57
M10 x 1.25	45	63	42	60
M12	74	100	70	92
M12 x 1.25	80	110	75	105
M12 x 1.5	76	105	72	100
M14	115	160	110	150
M14 x 1.5	125	180	120	170
M16	180	250	170	235
M16 x 1.5	190	270	180	255

Thread	Hand-tightening		Machine-tightening	
	8.8 M_A (Nm)	10.9 M_A (Nm)	8.8 M_A (Nm)	10.9 M_A (Nm)
M18	250	350	240	330
M18 x 1.5	280	400	270	380
M20	350	500	330	475
M20 x 1.5	390	550	350	520
M22	480	680	450	650
M22 x 1.5	520	730	490	700
M24	600	850	570	810
M24 x 1.5	680	950	640	900
M24 x 2	660	900	620	850
M27	900	1250	850	1175
M27 x 2	960	1350	900	1275
M30	1200	1700	1100	1600
M30 x 2	1350	1900	1250	1800
M_A = tightening torques				

Tightening torques for studs

Thread	screwed into		
	Steel M_A (Nm)	Gray cast iron M_A (Nm)	Al alloy M_A (Nm)
M6	9	6	6
M8	11	9	10
M10	17	13	13
M12	27	23	18
M14	37	33	33
M16	55	45	–
M_A = tightening torques			

Tightening torques for setscrews and nuts made of stainless steel

The values in the table are based on a friction coefficient µtot = 0.12, lubricated with Molykote on the thread and under the screw head.

Basic size	Strength class		Material
	70 M_A (Nm)	80 M_A (Nm)	
M5	3.7	4.9	A2 / A4
M6	6.4	8.5	A2 / A4
M8	15.3	20.4	A2 / A4
M10	31	41	A2 / A4
M12	52	70	A2 / A4
M16	126	167	A2 / A4
M20	254	326	A2 / A4
M_A = tightening torques			

Tightening torque for self-locking hex nuts

Thread	M_A (Nm)	Lubricants
M6	7.5 +1	–
M8	17 +2	–
M10	35 +4	–
M12	59 +6	–
M14	100 +10	–
M16	140 +14	–
M20	290 +29	–
M_A = tightening torques		

Tightening torque for stress bolt connections as per MTN 5007 standard

This standard applies to stress pin bolts and stress bolts which are subjected to static and dynamic load of strength class 10.9 as well as to the associated nuts.

Shaft and transition dimensions as per MMN 209 standard and material and machining as per MMN 389 standard (bright surface or phosphatized).

The values in the table are based on a friction coefficient µtot = 0.125.

Threads and mating faces of screws and nuts must be coated with engine oil prior to assembly.

An assembly tolerance of +10% of the figures in the table is permitted due to unavoidable deviations during the tightening process.

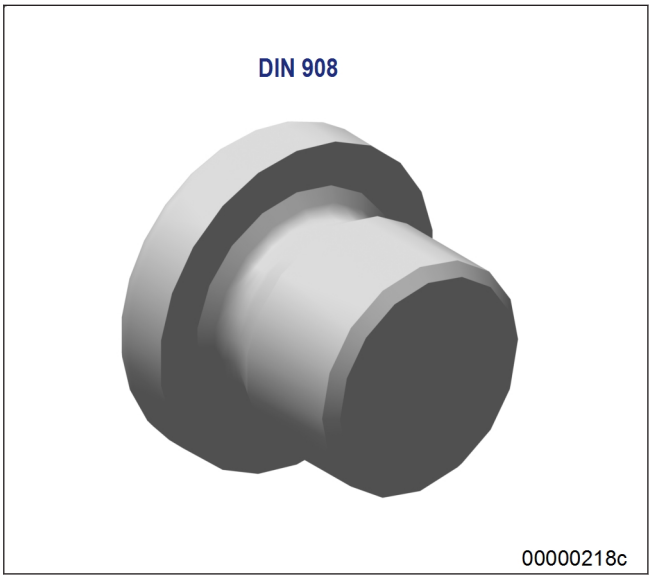
The values in the tables are for manual tightening using a torque wrench.

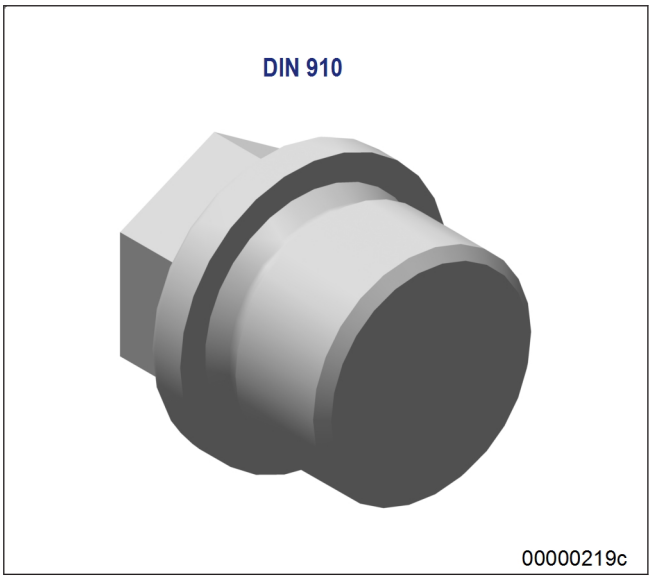
Thread	Not torsion-protected M_A(Nm)	Torsion-protected M_A (Nm)
M6	9	12
M8	21	28
M8 x 1	24	30
M10	42	55
M10 x 1.25	46	60
M12	75	93
M12 x 1.5	78	99
M14	120	150
M14 x 1.5	135	160
M16	180	225
M16 x 1.5	200	245
M18	250	315
M18 x 1.5	300	360
M20	350	450
M20 x 1.5	430	495
M22	500	620
M22 x 1.5	560	675
M24	640	790
M24 x 2	700	850
M27	900	1170
M27 x 2	1000	1230

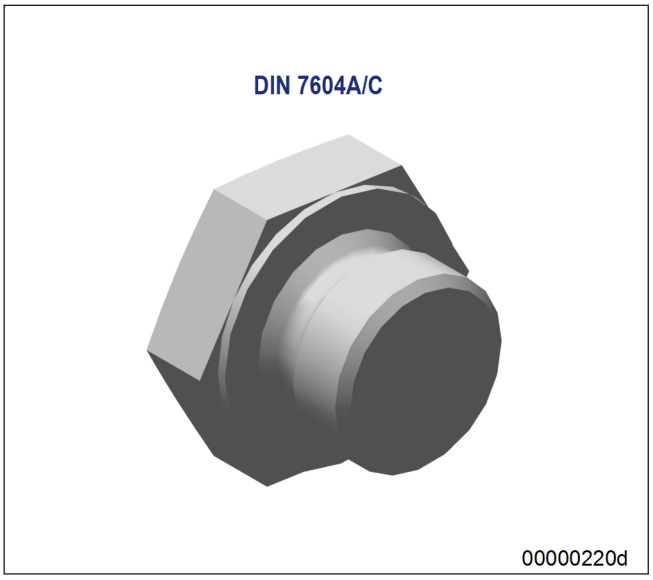
Thread	Not torsion-protected M_A(Nm)	Torsion-protected M_A (Nm)
M30	1250	1575
*Protect screw shaft from torsion when tightening.		
M_A= tightening torques.		

Tightening torques for plug screws as per MTN 5183-1 standard

This standard applies to plug screws to DIN 908, DIN 910 and DIN 7604 with threaded end to DIN 3852 Form A (sealed with sealing ring to DIN 7603-Cu).







Tightening torques M_A are given for screw plugs made of steel (St) with surface protected by a phosphate coating and oiled or galvanized.

Threads and mating faces beneath heads must be coated with engine oil prior to assembly.

An assembly tolerance of +10% of the figures in the table is permitted due to unavoidable deviations during the tightening process.

Tightening torques for plug screws to DIN 908, DIN 910 and DIN 7604A (with short threaded end).

Thread	screwed into	
	Steel/gray cast iron M_A (Nm)	AI alloy M_A (Nm)
M10 x 1	15	15
M12 x 1.5	25	25
M14 x 1.5	35	30
M16 x 1.5	40	35
M18 x 1.5	50	40
M20 x 1.5	60	50
M22 x 1.5	70	70
M24 x 1.5	85	80
M26 x 1.5	100	100
M27 x 2	100	100
M30 x 1.5	110	110
M30 x 2	120	120
M33 x 2	160	160
M36 x 1.5	190	180
M38 x 1.5	220	200
M42 x 1.5	260	240
M45 x 1.5	290	270
M48 x 1.5	310	300
M52 x 1.5	325	320
M56 x 2	380	360

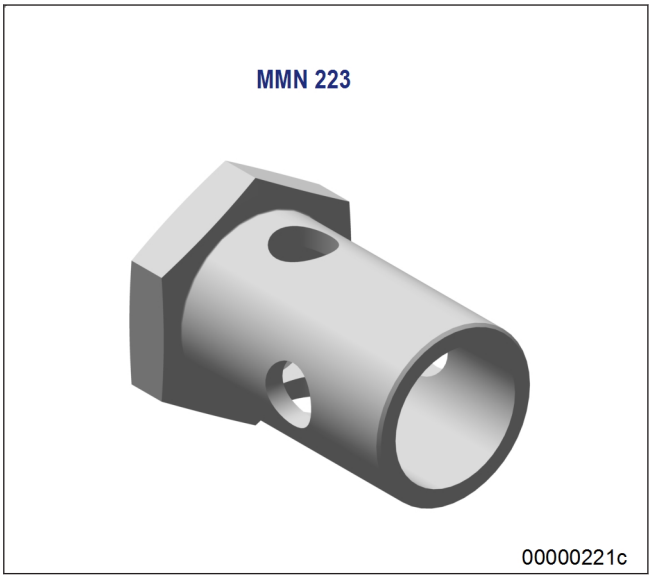
Thread	screwed into	
	Steel/gray cast iron M_A (Nm)	AI alloy M_A (Nm)
M64 x 2	400	400
M_A = tightening torques		

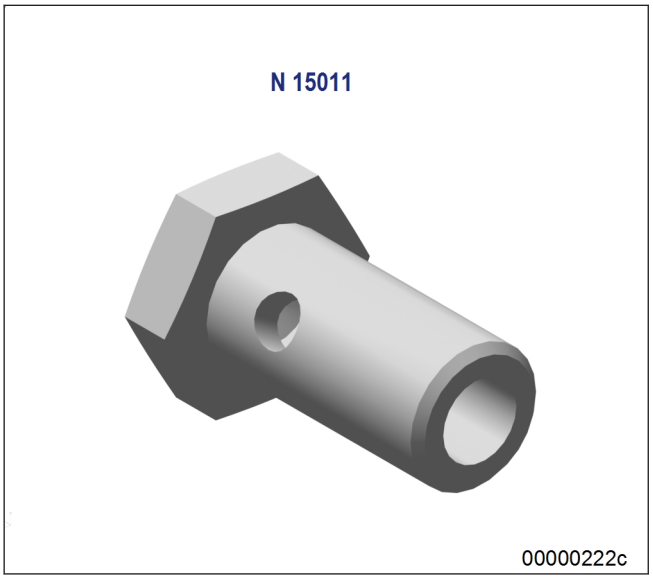
Tightening torque for plug screws DIN 7604C (with long screwed end)

Thread	screwed into	
	Steel/gray cast iron M_A (Nm)	AI alloy M_A (Nm)
M8 x 1	10	10
M22 x 1.5	80	65
M26 x 1.5	105	90
M30 x 1.5	130	130
M38 x 1.5	140	120
M45 x 1.5	160	140
M_A = tightening torques		

Tightening torque for banjo screws as per MTN 5183-2 standard

This standard applies to banjo screws to MMN 223 and N 15011 sealed with sealing ring to DIN 7603-Cu.





The stated tightening torques M_A apply to steel (St) banjo screws with a phosphatized surface and oiled or galvanized and for copper-aluminum alloy.

Threads and mating faces beneath heads must be coated with engine oil prior to assembly.

An assembly tolerance of +10% of the figures in the table is permitted due to unavoidable deviations during the tightening process.

Tightening torques for steel banjo screws

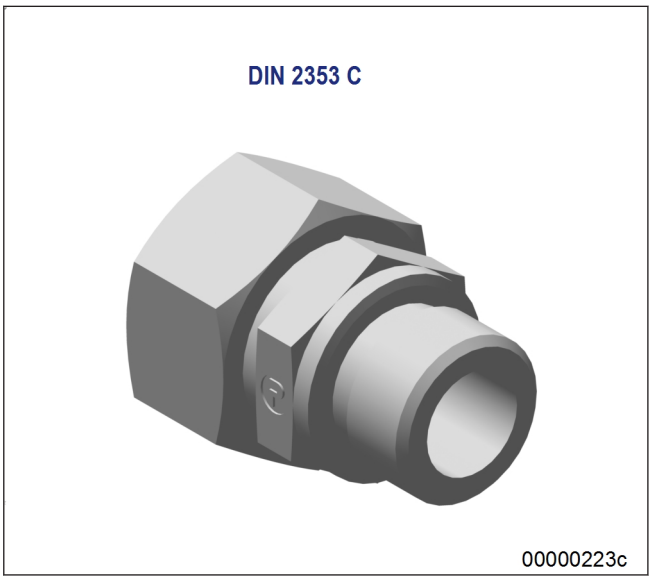
Thread	inserted in steel/gray cast iron/aluminum alloy M_A (Nm)
M8 x 1	10
M10 x 1	15
M12 x 1.5	20
M14 x 1.5	25
M16 x 1.5	25
M18 x 1.5	30
M22 x 1.5	60
M26 x 1.5	90
M30 x 1.5	130
M38 x 1.5	140
M45 x 1.5	160
M_A = tightening torques	

Tightening torques for copper-aluminum alloy banjo screws

Thread	inserted in steel/gray cast iron/aluminum alloy M_A (Nm)
M10 x 1	15
M16 x 1.5	30
M_A = tightening torques	

Tightening torques for male connectors as per MTN 5183-3 standard

This standard applies to male unions to DIN 2353 Series L with threaded end to DIN 3852 Form A (sealed by sealing ring to DIN 7603-Cu).



Tightening torques M_A are given for male unions made of steel (St) with phosphatized surface coating and oiled, or galvanized.

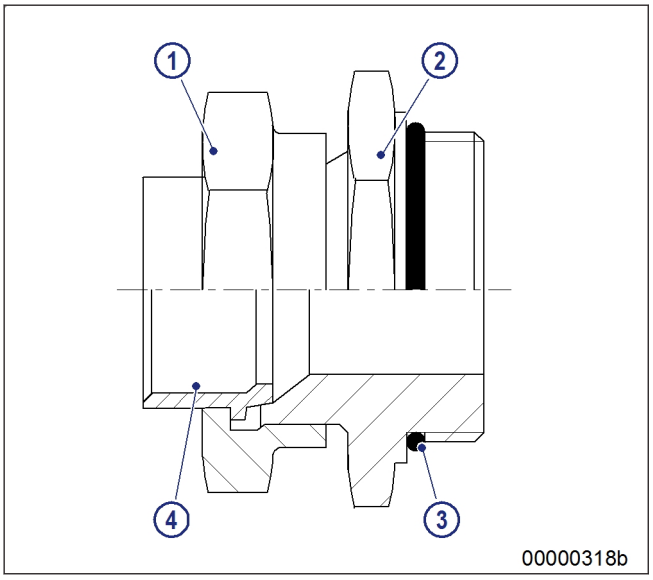
Threads and mating faces beneath heads must be coated with engine oil prior to assembly.

An assembly tolerance of +10% of the figures in the table is permitted due to unavoidable deviations during the tightening process.

Thread	inserted in steel/gray cast iron M_A (Nm)
M10 x 1	15
M12 x 1.5	20
M14 x 1.5	35
M16 x 1.5	50
M18 x 1.5	60
M22 x 1.5	70
M26 x 1.5	100
M32 x 2	160
M42 x 2	260
M48 x 2	320
M_A = tightening torques	

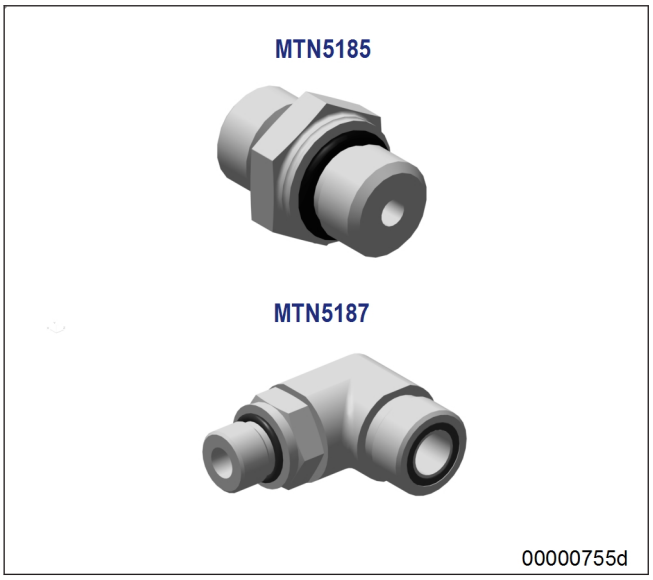
Tightening torques for union nuts as per DIN 3859-2

1 Union nut
2 Screw fixture
3 O-ring
4 Linear ball bearing



Union nut: On installing the ball-type union, after tightening the union nut firmly by hand (noticeable increase in force), it should be tightened another 1/4 turn (90°) past this point.

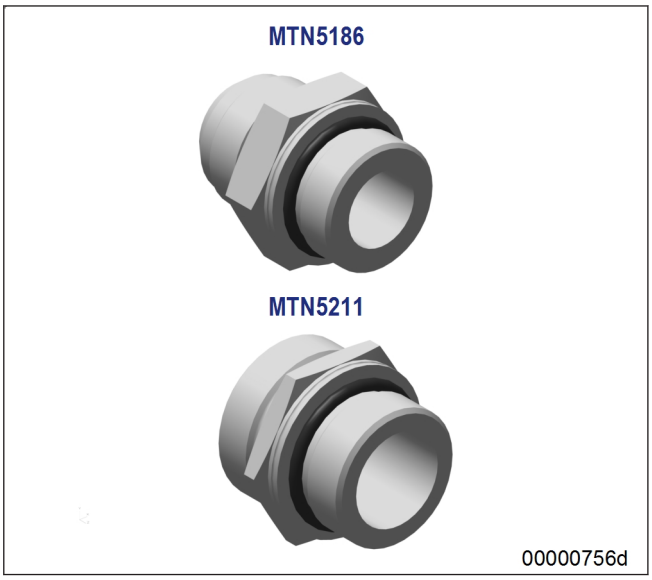
Tightening torques for spigot unions with O-ring to ISO 6149-2



Thread	Torque (Nm) +10%
M8 x 1	10
M10 x 1	20
M12 x 1.5	35
M14 x 1.5	45
M16 x 1.5	55
M18 x 1.5	70
M20 x 1.5[1)]	80
M22 x 1.5	100

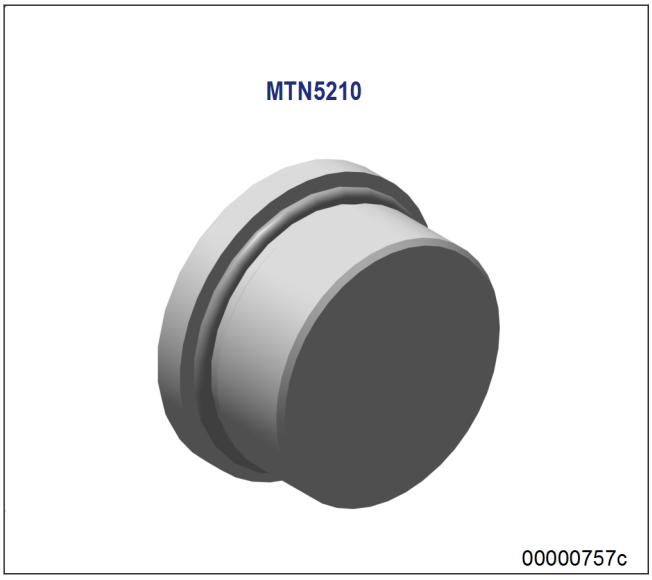
Thread	Torque (Nm) +10%
M27 x 2	170
M33 x 2	310
M42 x 2	330
M48 x 2	420
M60 x 2	500
[1)]Only for sealing off installation spaces for screw-in valves (see ISO 6149-47 and ISO 7789)	

Tightening torques for screwed plugs with O-ring as per ISO 6149-3



Thread	Torque (Nm) +10%
M8 x 1	8
M10 x 1	15
M12 x 1.5	25
M14 x 1.5	35
M16 x 1.5	40
M18 x 1.5	45
M22 x 1.5	60
M27 x 2	100
M33 x 2	160
M42 x 2	210
M48 x 2	260
M60 x 2	315

Tightening torques for plug screw joints as per MTN 5183-6



Thread	screwed into	
	Steel/gray cast iron M_A (Nm)	Al alloy M_A (Nm)
M10 x 1	20	10 +2
M12 x 1.5	35	14 +2
M14 x 1.5	45	15 +3
M16 x 1.5	55	18 +3
M18 x 1.5	70	23 +3
M22 x 1.5	100	33 +4
M27 x 2	170	57 +5
M33 x 2	310	103 +10
M42 x 2	330	110 +11
M48 x 2	420	140 +14
M60 x 2	–	200 +20
M_A = tightening torques		

Assembly instructions and tightening torque for hose fittings with union nuts

These instructions do not apply to ORFS fittings. In contrast to the instructions for pipe unions, hose fittings with sealing heads and the matching adapters must be fitted and connected as follows.

Hose fitting, metallic sealing with union nut: tighten union nut by hand then tighten a further max. 1/4 of a turn with a wrench.

Hose fitting with O-ring and union nut: tighten union nut by hand then tighten a further max. 1/2 of a turn with a wrench.

Hoses must be properly aligned before tightening the union nuts.

Sealing head/sealing cone with metric union nut		
Metric thread	Pipe outer dia.	Torque (Nm)
M12 x 1.5	6	20
M14 x 1.5	8	38

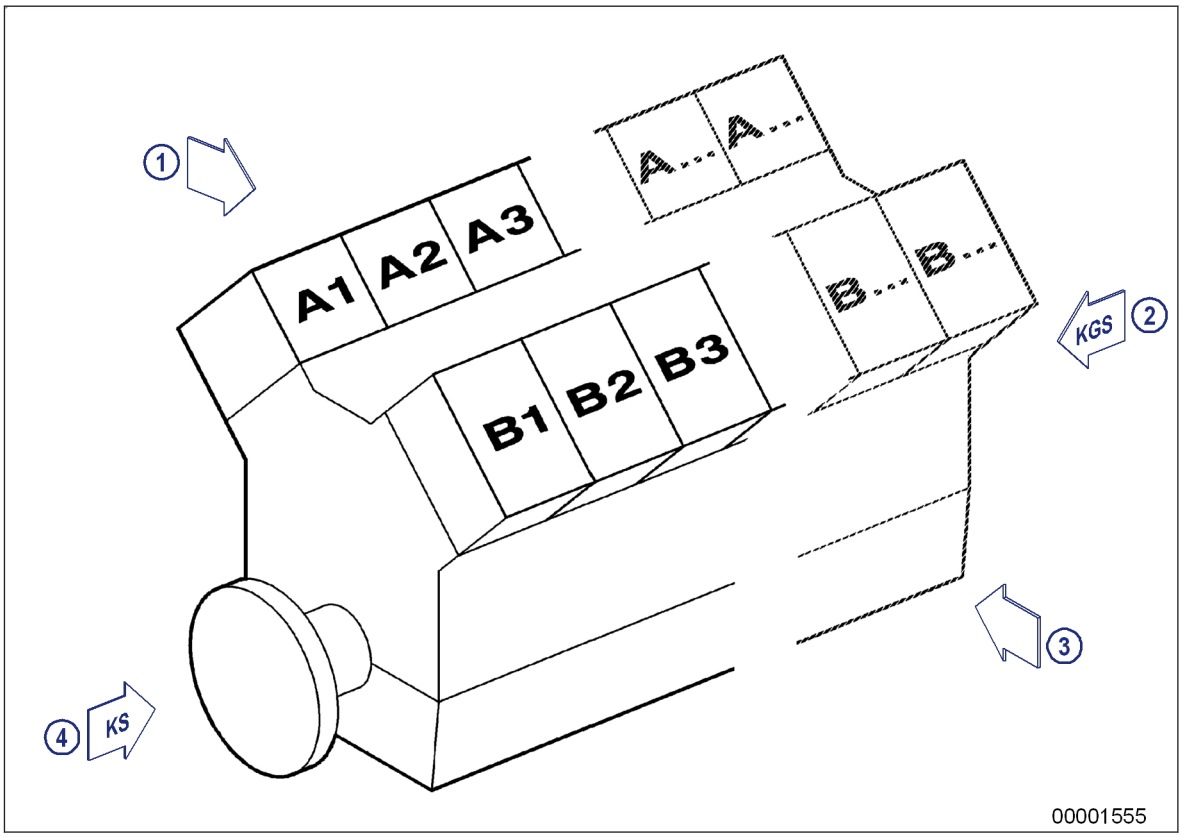
Sealing head/sealing cone with metric union nut		
Metric thread	Pipe outer dia.	Torque (Nm)
M16 x 1.5	8 10	45
M18 x 1.5	10 12	51
M20 x 1.5	12	58
M22 x 1.5	14 15	74
M24 x 1.5	16	74
M26 x 1.5	18	105
M30 x 2	20 22	135
M36 x 2	25 28	166
M42 x 2	30	240
M45 x 2	35	290
M52 x 2	38 42	330

Sealing head with BSP union nut	
BSPP thread	Torque (Nm)
G1/4	20
G3/8	34
G1/2	60
G5/8	69
G3/4	115
G1	140
G1.1/4	210
G1.1/2	290
G2	400

SAE sealing cone with union nut JIC 37°		
UNF thread	Size	Torque (Nm)
7/16-20	-4	15
1/2-20	-5	20
9/16-18	-6	30
3/4-16	-8	50
7/8-14	-10	69
1.1/16-12	-12	98
1.3/16-12	-14	118
1.5/16-12	-16	140
1.5/8-12	-20	210
1.7/8-12	-24	290
2.1/2-12	-32	450

ORFS – flat sealing with union nut		
UNF thread	Size	Torque (Nm)
9/16–18	–4	14 +2
11/16–16	–6	24 +3
13/16–16	–8	43 +4
1–14	–10	60 +8
1.3/16–12	–12	90 +5
1.3/16–12	–14	90 +5
1.7/16–12	–16	125 +10
1.11/16–12	–20	170 +20
2–12	–24	200 +25
2–1/2–20	–32	460 +30

4.2 Engine side and cylinder designations



1 Left engine side (A-side)
2 Engine free end in accordance with DIN ISO 1204 (KGS = Kupplungsgegenseite)
3 Right engine side (B-side)
4 Engine driving end in accordance with DIN ISO 1204 (KS = Kupplungsseite)

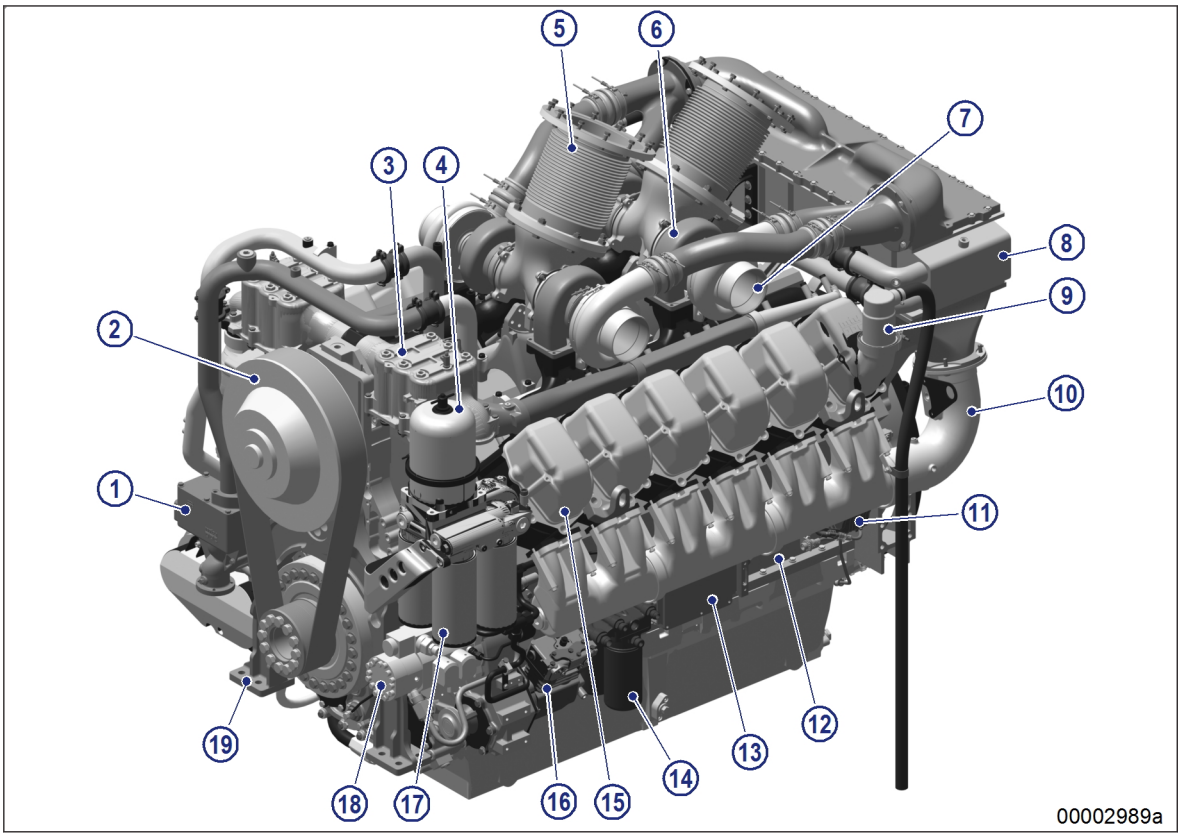
Engine sides are always designated (in accordance with DIN ISO 1204) as viewed from driving end (4).

For cylinder designation (in accordance with DIN ISO 1204), the letter "Ax" refers to the cylinders on the left-hand side of the engine (1) and letter "Bx" refers to the cylinders on the right-hand side (3). The cylinders of each bank are numbered consecutively, starting with x=1 at driving end (4).

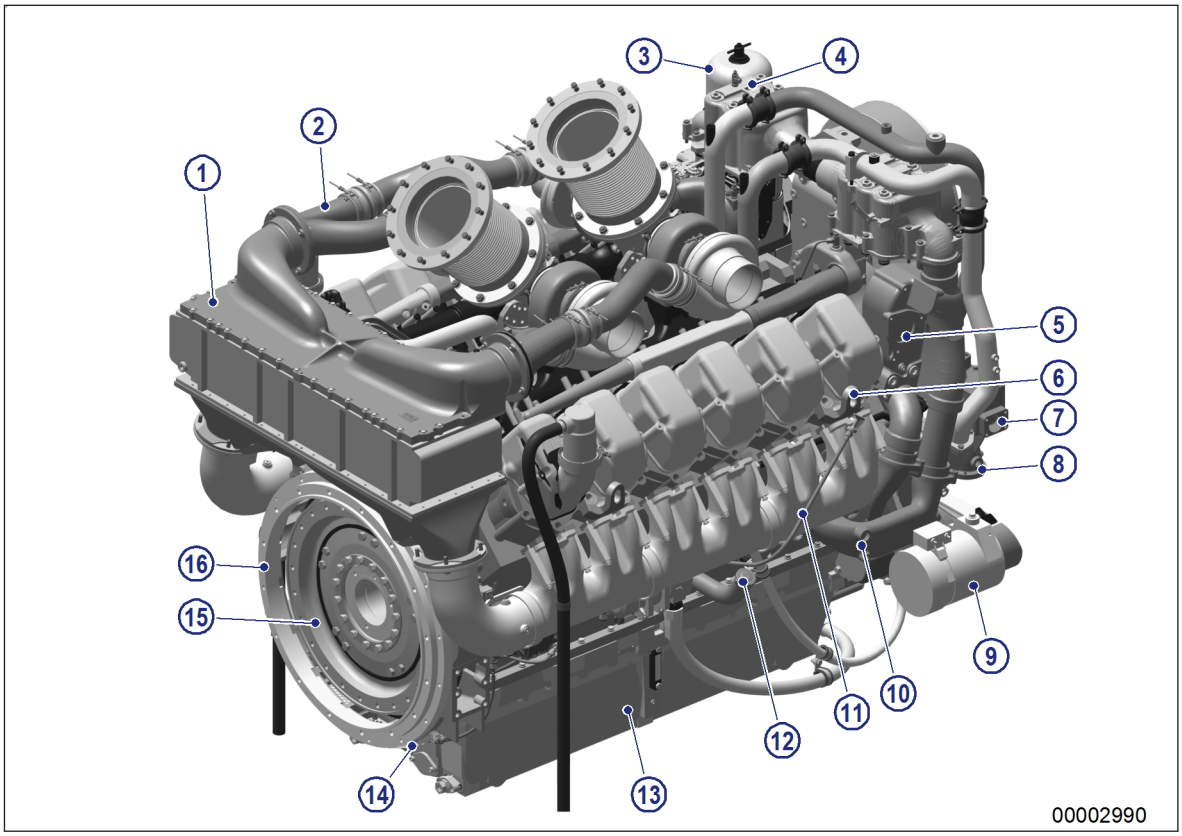
The numbering of other engine components also starts with 1 at driving end (4).

4.3 Engine - Overview

Image also applies to 16V4000Cxyz



1 Intercooler thermostat
2 Fan coupling
3 Engine oil heat exchanger
4 Centrifugal oil filter
5 Exhaust pipe bellows
6 Turbocharger
7 Combustion-air inlet
8 Intercooler
9 Crankcase breather
10 Charge-air line
11 Electric starter
12 Crankcase
13 Engine governor
14 Easy-change fuel filter
15 Cylinder head
16 Air conditioning compressor drive
17 Oil filter
18 HP fuel pump
19 Engine mounting

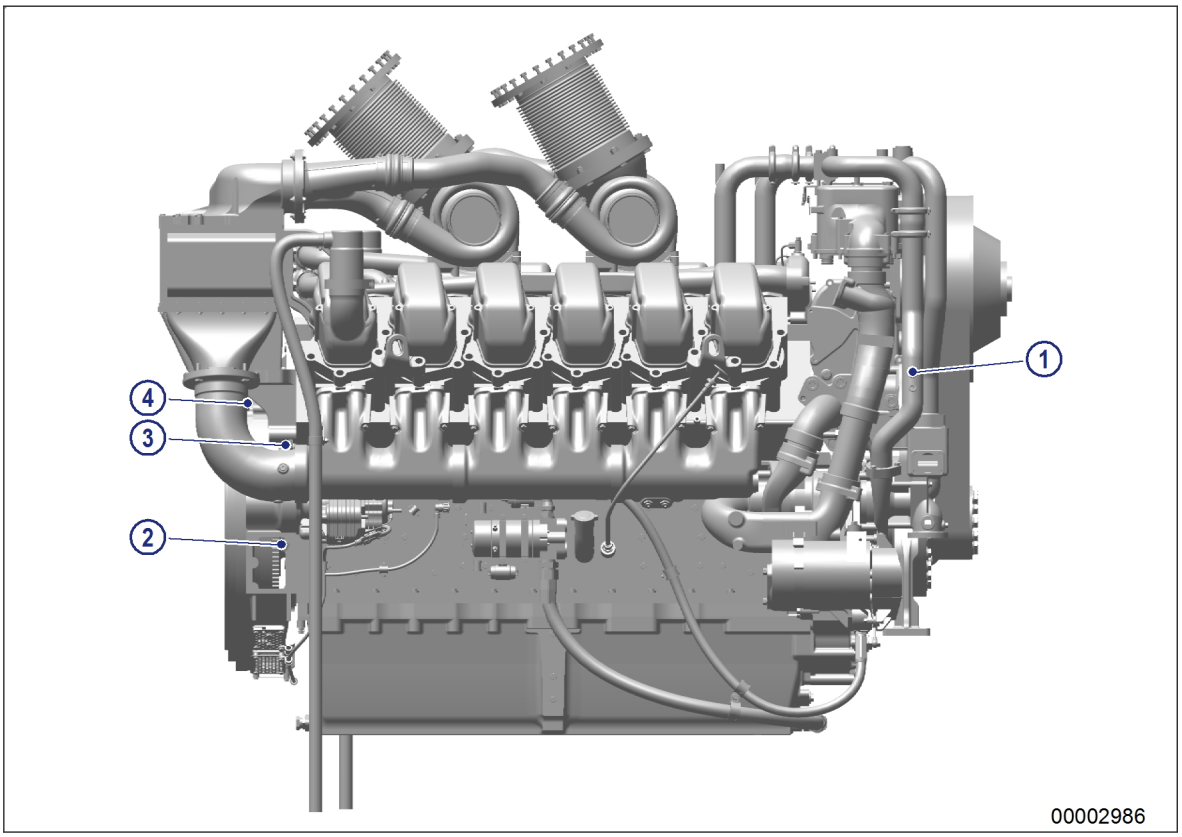


1 Intercooler
2 Charge-air line
3 Centrifugal oil filter
4 Oil cooler
5 Engine coolant inlet
6 Lifting eyes
7 Charge-air coolant outlet
8 Charge-air coolant inlet
9 Battery-charging generator
10 Engine coolant pump
11 Oil dipstick
12 Oil filler neck
13 Oil pan
14 Carbon brushes
15 Flywheel
16 Flywheel housing

Engine model designation

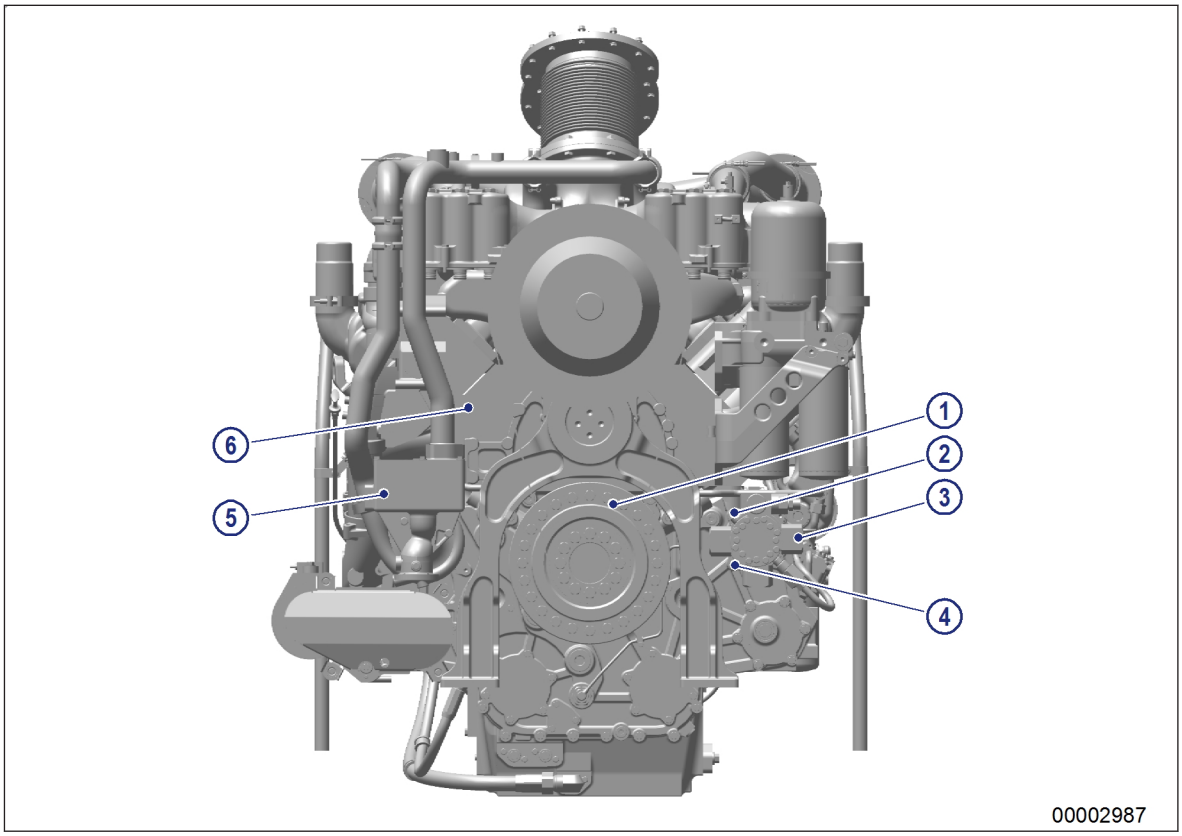
Explanation of engine model designation 12/16V4000Cxyz	
12/16	Number of cylinders
V	Cylinder arrangement (Vee engine)
4000	Series
C	Application (Construction and Industrial, mobile)
x	Application segment (1, 2, ...)
y	Design status (0, 1, 2,...)
z	Additional features

4.4 Sensors - Overview

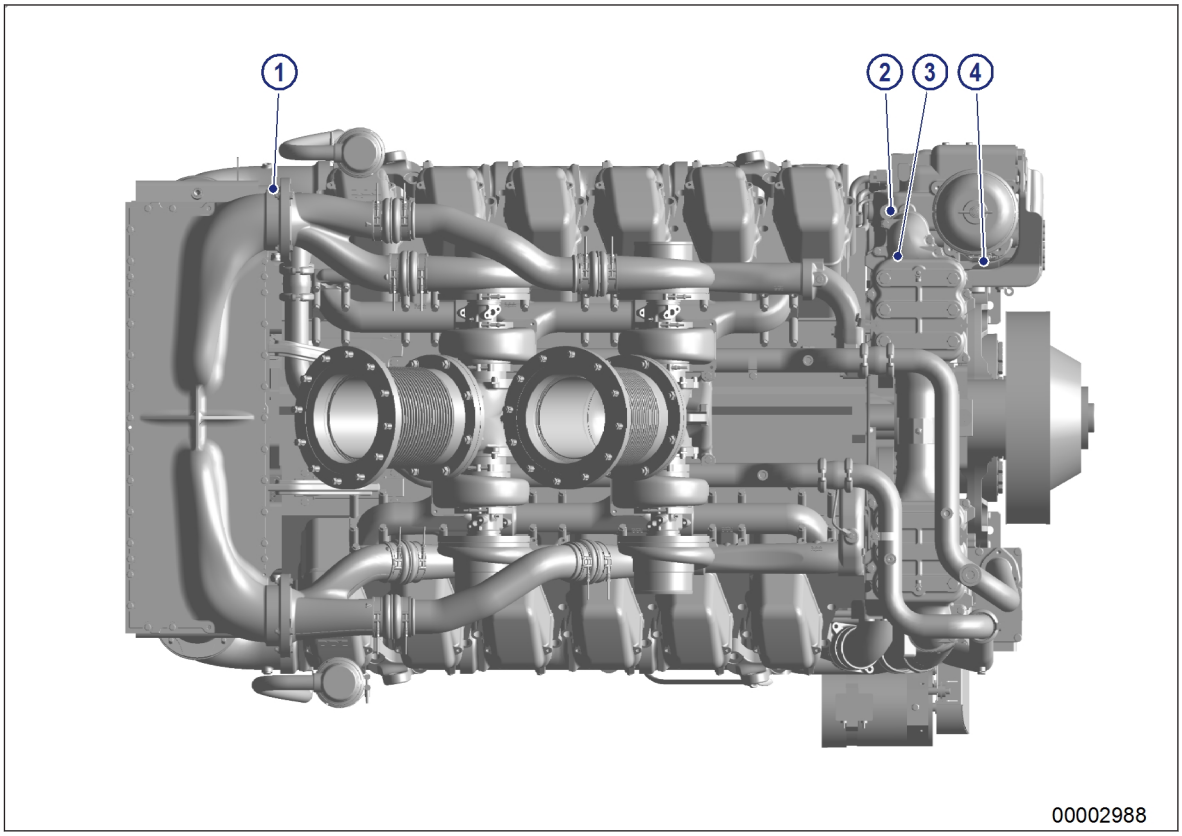


1 Engine coolant temperature
2 Crankshaft speed
3 Charge-air temperature
4 Charge-air pressure

The injectors are underneath the cylinder head covers of the cylinder. Injector replacement and necessary activities (→ Page 113).



1 Camshaft speed
2 Fuel pressure (LP)
3 Fuel temperature
4 HP fuel
5 Intercooler coolant pressure
6 Engine coolant pressure



1 Intercooler coolant temperature
2 Crankcase pressure
3 Lube oil temperature
4 Lube oil pressure

5 Technical Data

5.1 Product data 12V4000C11, 12V4000C11R

Legend

DL Ref. value continuous power (CP): Continuous power under standard conditions
BL Ref. value fuel stop power (FSP): Maximum engine power; not available for continuous operation in some applications (control reserve)
A Design value: Value required to design an external system (plant)
R Reference value: Typical average value for information, only partially suitable for design purposes
L Limit: Value which must not be violated (lower limit value, min. value / upper limit value, max. value), not suitable for design purposes
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** Value not adequately verified (tolerance +/- 5%)

ID	Product type	Application	Engine speed	List performance	
1	12V4000C11 (T1237K11-1102)	Industrial / vehicle main drive 5A continuous operation, unrestricted 5B continuous operation, variable	1900 rpm	1286 kW 1725 bhp	Optimized fuel consumption
2	12V4000C11R (T1237K11-1284)	Industrial / vehicle main drive 5A continuous operation, unrestricted 5B continuous operation, variable	1900 rpm	1193 kW 1600 bhp	Optimized fuel consumption
3	12V4000C11 (T1237K33-1328)	Industrial / vehicle main drive 5A continuous operation, unrestricted 5B continuous operation, variable	1900 rpm	1286 kW 1725 bhp	EPA Nonroad T1 (40CFR89)
4	12V4000C11R (T1237K33-1329)	Industrial / vehicle main drive 5A continuous operation, unrestricted 5B continuous operation, variable	1900 rpm	1193 kW 1600 bhp	EPA Nonroad T1 (40CFR89)

Reference conditions

ID			1	2	3	4
Intake air temperature		°C	25	25	25	25
Barometric pressure		mbar	1000	1000	1000	1000
Site altitude above sea level		m	100	100	100	100

Performance data

ID			1	2	3	4
Rated engine speed	A	rpm	1900	1900	1900	1900
Continuous power (w/o fan) (fuel stop power ISO 3046)	A	kW	1286	1193	1286	1193

General conditions (for max. power)

ID			1	2	3	4
Intake depression (new filter)	A	mbar	30	30	30	30
Intake depression, max.	L	mbar	50	50	50	50
Exhaust overpressure	A	mbar	37	37	37	37
Exhaust overpressure, max.	L	mbar	50	50	50	50

Model related data (basic design)

ID			1	2	3	4
Cylinder arrangement: V angle		Degrees	90	90	90	90
Bore		mm	165	165	165	165
Stroke		mm	190	190	190	190
Displacement of a cylinder		Liters	4.1	4.1	4.1	4.1
Total displacement		Liters	48.80	48.80	48.80	48.80
Number of inlet valves per cylinder			2	2	2	2
Number of exhaust valves per cylinder			2	2	2	2

Combustion air / exhaust gas

ID			1	2	3	4
Charge-air pressure before cylinder	R	bar	2.0	1.84	2.1	1.95
Exhaust gas temperature	R	°C	380	371	395	382

Coolant system (HT circuit)

ID			1	2	3	4
Coolant temperature (at engine connection: outlet to cooling equipment)	A	°C	95	95	95	95
Coolant pump: inlet pressure, max.	R	bar	1.5	1.5	1.5	1.5
Thermostat: Starts to open	R	°C	75	75	76	76
Thermostat: Fully open	R	°C	87	-	87	87

Lube oil system

ID			1	2	3	4
Lube oil operating pressure upstream of engine, from	R	bar	6.3	6.3	6.3	6.3

Fuel system

ID			1	2	3	4
Fuel temperature before pump, max.	L	°C	60	60	60	60

Capacities

ID			1	2	3	4
Engine coolant, engine side (without cooling equipment)	R	Liters	127	127	127	127
Charge-air coolant, engine side	R	Liters	33	33	33	33
Engine oil, max.	R	Liters	190	190	190	190

Weights

ID			1	2	3	4
Engine weight, dry (basic engine configuration acc. to scope of delivery specification)	R	kg	6044	6044	6044	6044

Sound

Number of cylinders			1	2	3	4
Unsilenced exhaust noise at 1 m distance	R	dB(A)	106	-	106	105

5.2 Product data 16V4000C11, 16V4000C11R

Legend

DL Ref. value continuous power (CP): Continuous power under standard conditions
BL Ref. value fuel stop power (FSP): Maximum engine power; not available for continuous operation in some applications (control reserve)
A Design value: Value required to design an external system (plant)
R Reference value: Typical average value for information, only partially suitable for design purposes
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** Value not adequately verified (tolerance +/- 5%)

ID	Product type	Application	Engine speed	List performance	
1	16V4000C11 (T1637K11-1103)	Industrial / vehicle main drive 5A continuous operation, unrestricted 5B continuous operation, variable	1900 rpm	1715 kW 2300 bhp	Optimized fuel consumption,
2	16V4000C11 (T1637K33-1477)	Industrial / vehicle main drive 5A continuous operation, unrestricted 5B continuous operation, variable	1900 rpm	1715 kW 2300 bhp	EPA Nonroad T1 (40CFR89)
3	16V4000C11R (T1637K33-1336)	Industrial / vehicle main drive 5A continuous operation, unrestricted 5B continuous operation, variable	1800 rpm	1600 kW 2146 bhp	EPA Nonroad T1 (40CFR89)

Reference conditions

ID			1	2	3
Intake air temperature		°C	25	25	25
Barometric pressure		mbar	1000	1000	1000
Site altitude above sea level		m	100	100	100

Performance data

ID			1	2	3
Rated engine speed	A	rpm	1900	1900	1800
Continuous power (without fan) (fuel stop power)	A	kW	1715	1715	1600

General conditions (for max. power)

ID			1	2	3
Intake depression (new filter)	A	mbar	30	30	30
Intake depression, max.	L	mbar	50	50	50
Exhaust overpressure	A	mbar	37	37	37
Exhaust overpressure, max.	L	mbar	50	50	50

Model related data (basic design)

ID			1	2	3
Cylinder arrangement: V angle		Degrees	90	90	90
Bore		mm	165	165	165
Stroke		mm	190	190	190
Displacement of a cylinder		Liters	4.1	4.1	4.1
Total displacement		Liters	65.0	65.0	65.0
Number of inlet valves per cylinder			2	2	2
Number of exhaust valves per cylinder			2	2	2

Combustion air / exhaust gas

ID			1	2	3
Charge-air pressure before cylinder	R	bar	2.0	2.1	1.95
Exhaust gas temperature	R	°C	377	377	376

Coolant system (HT circuit)

ID			1	2	3
Coolant temperature (at engine connection: outlet to cooling equipment)	A	°C	95	95	95
Coolant pump: inlet pressure, max.	R	bar	1.5	1.5	1.5
Thermostat: Starts to open	R	°C	76	76	76
Thermostat: Fully open	R	°C	87	87	87

Lube oil system

ID			1	2	3
Lube oil operating pressure upstream of engine, from	R	bar	6.1	6.1	6.0

Fuel system

ID			1	2	3
Fuel temperature before pump, max.	L	°C	60	60	60

Capacities

ID			1	2	3
Engine coolant, engine side (without cooling equipment)	R	Liters	164	164	164
Charge-air coolant, engine side	R	Liters	42	42	42
Engine oil, max.	R	Liters	230	230	230

Weights

ID			1	2	3
Engine weight, dry (basic engine configuration acc. to scope of delivery specification)	R	kg	7083	7083	7083

Sound

ID			1	2	3
Unsilenced exhaust noise at 1 m distance	R	dB(A)	108	108	108

5.3 Product data 12V4000C21, 12V4000C21R

Legend

DL Ref. value continuous power (CP): Continuous power under standard conditions
BL Ref. value fuel stop power (FSP): Maximum engine power; not available for continuous operation in some applications (control reserve)
A Design value: Value required to design an external system (plant)
R Reference value: Typical average value for information, only partially suitable for design purposes
L Limit: Value which must not be violated (lower limit value, min. value / upper limit value, max. value), not suitable for design purposes
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< Actual value must be less than the specified value.
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** Value not adequately verified (tolerance +/- 5%)

ID	Product type	Application	Engine speed	List performance	
1	12V4000C21 (T1237K11-1099)	Industrial / vehicle main drive 5A continuous operation, unrestricted 5B continuous operation, variable	1900 rpm	1510 kW 2025 bhp	Optimized fuel consumption,
2	12V4000C21R (T1237K11-1100)	Industrial / vehicle main drive 5A continuous operation, unrestricted 5B continuous operation, variable	1900 rpm	1398 kW 1875 bhp	Optimized fuel consumption,
3	12V4000C21 (T1237K33-1326)	Industrial / vehicle main drive 5A continuous operation, unrestricted 5B continuous operation, variable	1900 rpm	1510 kW 2025 bhp	EPA Nonroad T1 (40CFR89)
4	12V4000C21R (T1237K33-1327)	Industrial / vehicle main drive 5A continuous operation, unrestricted 5B continuous operation, variable	1900 rpm	1398 kW 1875 bhp	EPA Nonroad T1 (40CFR89)

Reference conditions

ID			1	2	3	4
Application group			5A, 5B	5A, 5B	5A, 5B	5A, 5B
Intake air temperature		°C	25	25	25	25
Barometric pressure		mbar	1000	1000	1000	1000
Site altitude above sea level		m	100	100	100	100

Performance data

ID			1	2	3	4
Rated engine speed	A	rpm	1900	1900	1900	1900
Continuous power (without fan) (fuel stop power)	A	kW	1510	1398	1510	1398

General conditions (for max. power)

ID			1	2	3	4
Intake depression (new filter)	A	mbar	30	30	30	30
Intake depression, max.	L	mbar	50	50	50	50
Exhaust overpressure	A	mbar	37	37	37	37
Exhaust overpressure, max.	L	mbar	50	50	50	50

Model related data (basic design)

ID			1	2	3	4
Cylinder arrangement: V angle		Degrees	90	90	90	90
Bore		mm	165	165	165	165
Stroke		mm	190	190	190	190
Displacement of a cylinder		Liters	4.1	4.1	4.1	4.1
Total displacement		Liters	48.80	48.80	48.80	48.80
Number of inlet valves per cylinder			2	2	2	2
Number of exhaust valves per cylinder			2	2	2	2

Combustion air / exhaust gas

ID			1	2	3	4
Charge-air pressure before cylinder	R	bar	2.5	-	2.4	2.2
Exhaust gas temperature	R	°C	415	390	431	413

Coolant system (HT circuit)

ID			1	2	3	4
Coolant temperature (at engine connection: outlet to cooling equipment)	A	°C	95	95	95	95
Coolant pump: inlet pressure, max.	R	bar	1.5	1.5	1.5	1.5
Thermostat: Starts to open	R	°C	76	75	76	76
Thermostat: Fully open	R	°C	87	87	87	87

Lube oil system

ID			1	2	3	4
Lube oil operating pressure upstream of engine, from	R	bar	6.3	6.3	6.3	6.3

Fuel system

ID			1	2	3	4
Fuel temperature before pump, max.	L	°C	60	60	60	60

Capacities

ID			1	2	3	4
Engine coolant, engine side (without cooling equipment)	R	Liters	127	127	127	127
Charge-air coolant, engine side	R	Liters	33	33	33	33
Engine oil, max.	R	Liters	198	190	198	198

Weights

ID			1	2	3	4
Engine weight, dry (basic engine configuration acc. to scope of delivery specification)	R	kg	6044	6044	6044	6044

Sound

ID			1	2	3	4
Unsilenced exhaust noise at 1 m distance	R	dB(A)	106	106	106	106

5.4 Product data 16V4000C21, 16V4000C21R, 16V4000C21L

Legend

DL Ref. value continuous power (CP): Continuous power under standard conditions
BL Ref. value fuel stop power (FSP): Maximum engine power; not available for continuous operation in some applications (control reserve)
A Design value: Value required to design an external system (plant)
R Reference value: Typical average value for information, only partially suitable for design purposes
L Limit: Value which must not be violated (lower limit value, min. value / upper limit value, max. value), not suitable for design purposes
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< Actual value must be less than the specified value.
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** Value not adequately verified (tolerance +/- 5%)

ID	Product type	Application	Engine speed	List performance	
1	16V4000C21 (T1637K11-1085)	Industrial / vehicle main drive 5A continuous operation, unrestricted 5B continuous operation, variable	1900 rpm	2013 kW 2700 bhp	Optimized fuel consumption,
2	16V4000C21L (T1637K11-1095)	Industrial / vehicle main drive 5A continuous operation, unrestricted 5B continuous operation, variable	1900 rpm	2013 kW 2700 bhp	Optimized fuel consumption,
3	16V4000C21 (T1637K33-1476)	Industrial / vehicle main drive 5A continuous operation, unrestricted 5B continuous operation, variable	1900 rpm	1864 kW 2500 bhp	EPA Nonroad T1 (40CFR89)
4	16V4000C21L (T1637K33-1475)	Industrial / vehicle main drive 5A continuous operation, unrestricted 5B continuous operation, variable	1900 rpm	2013 kW 2700 bhp	EPA Nonroad T1 (40CFR89)
5	16V4000C21R (T1637K33-1338)	Industrial / vehicle main drive 5B continuous operation, variable	1900 rpm	1491 kW 2001 bhp	EPA Nonroad T1 (40CFR89)

TIM-ID: 0000040213 - 003

Reference conditions

ID			1	2	3	4	5
Application group			5A, 5B	5A, 5B	5A, 5B	5A, 5B	5A, 5B
Intake air temperature		°C	25	25	25	25	25

ID			1	2	3	4	5
Barometric pressure		mbar	1000	1000	1000	1000	1000
Site altitude above sea level		m	100	100	100	100	100

Performance data

ID			1	2	3	4	5
Rated engine speed	A	rpm	1900	1900	1900	1900	1900
Continuous power (without fan) (fuel stop power)	A	kW	2013	2013	1864	2013	1491

General conditions (for max. power)

ID			1	2	3	4	5
Intake depression (new filter)	A	mbar	30	30	30	30	30
Intake depression, max.	L	mbar	50	50	50	50	50
Exhaust overpressure	A	mbar	37	37	37	37	37
Exhaust overpressure, max.	L	mbar	50	50	50	50	50

Model related data (basic design)

ID			1	2	3	4	5
Cylinder arrangement: V angle		Degrees	90	90	90	90	90
Bore		mm	165	165	165	165	165
Stroke		mm	190	190	190	190	190
Displacement of a cylinder		Liters	4.1	4.1	4.1	4.1	4.1
Total displacement		Liters	65.0	65.0	65.0	65.0	65.0
Number of inlet valves per cylinder			2	2	2	2	2
Number of exhaust valves per cylinder			2	2	2	2	2

Combustion air / exhaust gas

ID			1	2	3	4	5
Charge-air pressure before cylinder	R	bar	2.5	-	2.3	2.4	1.8
Exhaust gas temperature	R	°C	401	401	395	415	356

Coolant system (HT circuit)

ID			1	2	3	4	5
Coolant temperature (at engine connection: outlet to cooling equipment)	A	°C	95	95	95	95	95
Coolant pump: inlet pressure, max.	R	bar	1.5	1.5	1.5	1.5	1.5
Thermostat: Starts to open	R	°C	76	75	76	76	75
Thermostat: Fully open	R	°C	87	87	87	87	87

Lube oil system

ID			1	2	3	4	5
Lube oil operating pressure upstream of engine, from	R	bar	6.1	6.1	6.1	6.1	6.1

Fuel system

ID			1	2	3	4	5
Fuel temperature before pump, max.	L	°C	60	60	60	60	60

Capacities

ID			1	2	3	4	5
Engine coolant, engine side (without cooling equipment)	R	Liters	164	164	164	164	164
Charge-air coolant, engine side	R	Liters	42	42	42	42	42
Engine oil, max.	R	Liters	230	240	230	230	240

Weights

ID			1	2	3	4	5
Engine weight, dry (basic engine configuration acc. to scope of delivery specification)	R	kg	7083	7083	7083	7083	7083

Sound

ID			1	2	3	4	5
Unsilenced exhaust noise at 1 m distance	R	dB(A)	108	-	112	114	-

5.5 Product data 16V4000C31

Legend

DL Ref. value continuous power (CP): Continuous power under standard conditions
BL Ref. value fuel stop power (FSP): Maximum engine power; not available for continuous operation in some applications (control reserve)
A Design value: Value required to design an external system (plant)
R Reference value: Typical average value for information, only partially suitable for design purposes
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** Value not adequately verified (tolerance +/- 5%)

ID	Product type	Application	Engine speed	List performance	
1	16V4000C31	Industrial / vehicle main drive 5B continuous operation, variable	1900 rpm	2125 kW 2850 bhp	Optimized fuel consumption,

Reference conditions

ID			1
Intake air temperature		°C	25
Barometric pressure		mbar	1000
Site altitude above sea level		m	100

Performance data

ID			1
Rated engine speed	A	rpm	1900
Continuous power (without fan) (fuel stop power)	A	kW	2125

General conditions (for max. power)

ID			1
Intake depression (new filter)	A	mbar	25
Intake depression, max.	L	mbar	50
Exhaust overpressure	A	mbar	37
Exhaust overpressure, max.	L	mbar	50

Model related data (basic design)

ID			1
Cylinder arrangement: V angle		Degrees	90
Bore		mm	165
Stroke		mm	190

ID			1
Displacement of a cylinder		Liters	4.06
Total displacement		Liters	65.0
Number of inlet valves per cylinder			2
Number of exhaust valves per cylinder			2

Combustion air / exhaust gas

ID			1
Charge-air pressure before cylinder	R	bar	2.6
Exhaust gas temperature	R	°C	440

Coolant system (HT circuit)

ID			1
Coolant temperature (at engine connection: outlet to cooling equipment)	A	°C	95
Coolant pump: inlet pressure, max.	R	bar	-
Thermostat: Starts to open	R	°C	77
Thermostat: Fully open	R	°C	87

Lube oil system

ID			1
Lube oil operating pressure upstream of engine, from	R	bar	5.0

Fuel system

ID			1
Fuel temperature before pump, max.	R	°C	55

Capacities

ID			1
Engine coolant, engine side (without cooling equipment)	R	Liters	190
Charge-air coolant, engine side	R	Liters	-
Engine oil, max.	R	Liters	290

Weights

ID			1
Engine weight, dry (basic engine configuration acc. to scope of delivery specification)	R	kg	7083

Sound

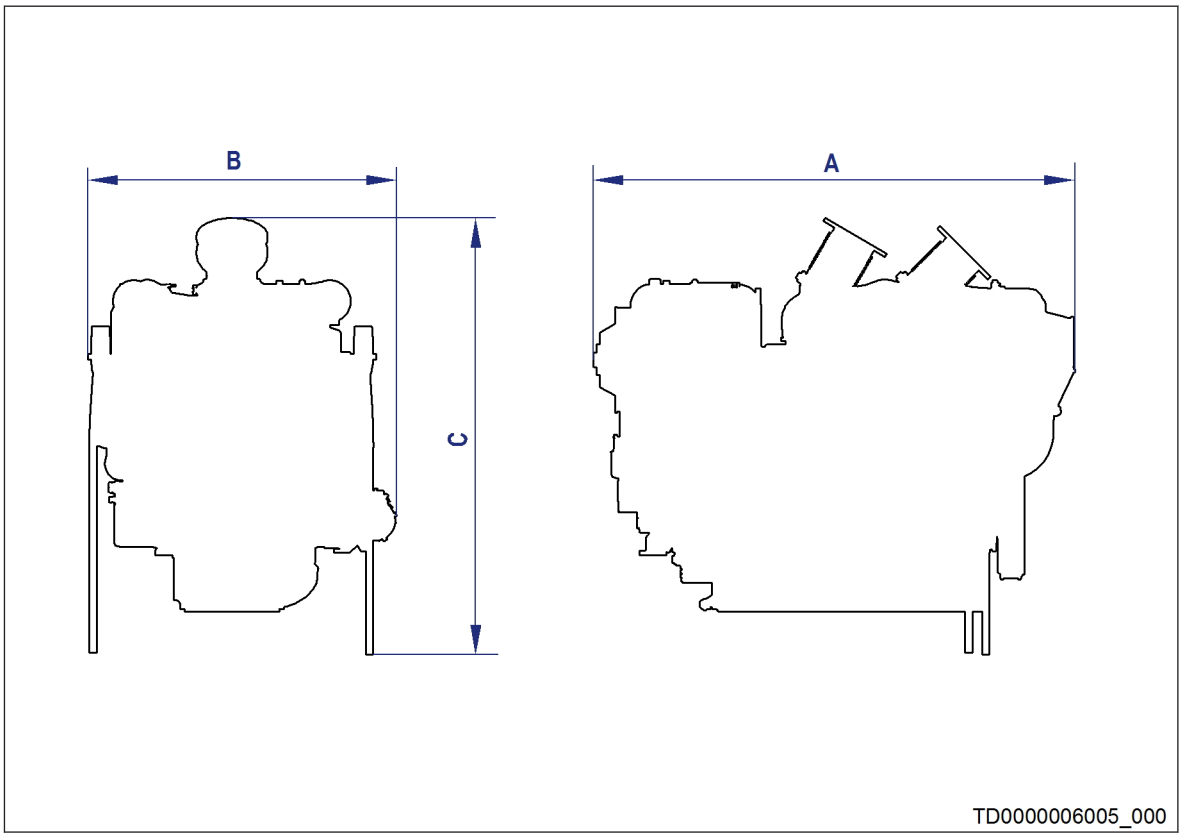
ID			1
Unsilenced exhaust noise at 1 m distance	R	dB(A)	-

5.6 Firing order

Firing order

Number of cylinders	Firing order
8V	A1-B4-A4-A2-B3-A3-B2-B1
12V	A1-B2-A5-B4-A3-B1-A6-B5-A2-B3-A4-B6
16V	A1-A7-B4-B6-A4-B8-A2-A8-B3-B5-A3-A5-B2-A6-B1-B7
20V	A1-B5-A8-B7-A5-B2-A7-B10-A2-B3-A10-B6-A3-B4-A6-B9-A4-B1-A9-B8

5.7 Engine - Main dimensions



Engine model	Length (A)	Width (B)	Height (C)
12V4000Cxyz	approx. 2540 mm	approx. 1630 mm	approx. 2050 mm
16V4000Cxyz	approx. 3010 mm	approx. 1630 mm	approx. 2050 mm

6 Operation

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

Preconditions

☑ Engine is stopped and starting disabled.

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

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

Item	Measure
Engine	Depreserve (→ MTU Preservation and Represervation Specifications A001070/..).
Valve drive	Lubricate valve gear every ≥ 6 months (→ Page 104).
Lube oil system	Check engine oil level (→ Page 134); Crank engine on starting system (→ Page 93).
Fuel system	Vent (→ Page 119).
Coolant circuit	If engine is out of service for more than one year, change engine coolant (→ Page 145). Change charge-air coolant (→ Page 155).
Coolant circuit	Check engine coolant level (→ Page 143); Check charge-air coolant level (→ Page 153).
Coolant circuit	Preheat coolant with preheating unit, if fitted.
DDEC	Check plug-in connections (→ Page 176).

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

Preconditions

☑ Engine is stopped and starting disabled.

WARNING

In case of out-of-service periods of more than one week: Possible corrosion of components carrying air or exhaust gas due to weather conditions, e.g. rain or snow.
Risk of injury by flying debris when putting the engine into operation!
- Check the components carrying air and exhaust for corrosion.
- Do not put the engine in operation if corrosion was detected.

Putting into operation

Item	Measure
Engine oil system	Check engine oil level (→ Page 134).
Coolant circuit	Check engine coolant level (→ Page 143); Check charge-air coolant level (→ Page 153).
Coolant circuit	Heat coolant with coolant preheater (if available; see manufacturer's documentation).
Engine control system	Put into operation (see manufacturer's documentation).

6.3 Re-starting the engine following an automatic safety shutdown

NOTICE

Re-starting the engine following an automatic safety shutdown.
Risk of severe engine damage!
- Before starting the engine, make sure the root cause of the safety shutdown was eliminated.
- If the root cause cannot be identified or eliminated, contact Service.

Note:
- If an engine has been shutdown by a fault (red alarm), the engine may only be re-started when the fault has been identified and eliminated.

Procedure following an automatic safety shutdown

1. Eliminate fault.
2. If the root cause cannot be identified or eliminated, contact Service.

Important

The function "Overdrive safety system" (if fitted), which is only used in emergency situations, is not affected.

6.4 Engine – Starting in manual mode

Preconditions

☑ Engine is not under load.

☑ External start interlock is not activated.

DANGER

Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Before cranking the engine with starter system, make sure that there are no persons in the engine's danger zone.

WARNING

A high level of noise is produced when the engine is running.
Risk of hearing loss!
- Wear suitable hearing protection.

NOTICE

Re-starting the engine following an automatic safety shutdown.
Risk of severe engine damage!
- Before starting the engine, make sure the root cause of the safety shutdown was eliminated.
- If the root cause cannot be identified or eliminated, contact Service.

Preparation

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

Starting the engine

Item	Action
Control cabinet, control panel etc. (depending on manufacturer).	1. If a coolant preheating unit is available, ensure that the coolant temperature is > 40 °C. 2. Press start button. • Automatic starting sequence is executed. • Engine speed instrument indicates increasing speed. • After the starting sequence is completed, engine runs at idle speed.

6.5 Operational checks

DANGER

Components are moving or rotating.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Operate the engine at low load only. Keep clear of the danger zone of the engine.

WARNING

A high level of noise is produced when the engine is running.
Risk of hearing loss!
- Wear suitable hearing protection.

Operational checks

Item	Measure
Control and display panels	Check readings of operational data (speed, temperature, pressures).
Engine oil	Check engine oil level (→ Page 134)
Engine operation	Visually inspect engine and attached components for condition and leaks; Check for abnormal running noise, exhaust discoloration and vibrations (→ Page 70).
Battery-charging generator	Check for contamination, clean if necessary (→ Page 165).
Fuel prefilter	Drain water and contaminants from fuel prefilter, if applicable.
HP pump	Check relief bore (→ Page 112).
HT coolant pump	Check relief bore (→ Page 149).
LT coolant pump	Check relief bore (→ Page 160).
Intercooler	Check intercooler drain (→ Page 130)

6.6 Engine – Stopping in manual mode

Preconditions

☑ Engine is not under load.

☑ Engine is running in manual mode.

NOTICE

Stopping the engine when it is running at full load subjects it to extreme thermal and mechanical stresses.

Overheating of and, therefore, damage to components is possible!

- Before shutting down the engine, allow it to idle until the engine temperatures decrease and constant levels are indicated.

Preparation

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

Stop engine

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

6.7 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 146), (→ Page 156), 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/..).

6.8 Plant – Cleaning

Preconditions

☑ Engine is stopped and starting disabled.

☑ No operating voltage applied.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
High-pressure cleaner	(→ Tools Catalog)	1
Cleaner (Hakupur 50/136)	X00056700	1

WARNING

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

WARNING

Water jet from high-pressure cleaning unit.
Risk of eye injury, risk of scalding!
- Do not direct water jet at persons.
- Wear protective clothing, protective gloves, and goggles/safety mask.

NOTICE

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

NOTICE

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

Cleaning the plant

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 high-pressure cleaning units carefully and observe the safety precautions.
3. The following requirements apply for cleaning the plant outside with a high-pressure cleaning unit:
   - 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 fan jet nozzle only.

Note: Never direct compressed air directly at electronic components.

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

7 Maintenance

7.1 Maintenance task reference table [QL1]

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

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

Task	Option	Maintenance tasks	
W0500		Check engine oil level.	(→ Page 134)
W0501		Carry out visual inspection of engine for general condition and leaks.	(→ Page 65)
W0502	X	Inspect intercooler drain system.	(→ Page 130)
W0504		Check the inspection bores of the HP fuel pump.	(→ Page 65)
W0505		Check relief bores of coolant pump(s).	(→ Page 149) (→ Page 65)
W0506		Check for abnormal running noises, exhaust gas color and vibration.	(→ Page 65) (→ Page 70)
W0507	X	Drain off water and contamination from fuel prefilter.	(→ Page 65)
W1001		Fit new fuel filter or new fuel filter insert.	(→ Page 120)
W1006		Replace fuel injectors.	(→ Page 113)
W1008		Fit new engine oil filters each time the engine oil is changed or, at the latest, on expiry of the time limit (given in years).	(→ Page 140)
W1009	X	Check thickness of oil residue layer. Clean. Fit new sleeve, at the latest, each time the engine oil is changed.	(→ Page 141)
W1011		Inspect cylinder chambers using endoscope.	(→ Page 94)
W1046		Fit new filters or filter inserts.	(→ Page 98)
W1207		Check valve clearance, adjust if required. ATTENTION! Initial adjustment after 1,000 operating hours and subsequently 1,000 operating hours after each cylinder-head overhaul.	(→ Page 107)
W1241	X	Inspect condition of drive belts and fit new ones if necessary. Adjust tension.	(→ Page 163)
W1296	X	Replace valve.	(→ Page 152)
W1481	X	Replace intermediate fuel filter of filter element of intermediate fuel filter.	(→ Page 121)
W1519		Check tightness of securing screws.	(→ Page 161)
W1605	X	Visually check oil priming pump.	(→ Page 139)
W1675	X	Fit new fuel prefilter or new fuel prefilter insert.	(→ Page 123) (→ Page 123)
W1689		Measure valve stem end to cylinder head top distance.	(→ Page 105)
W1697	X	Check carbon brushes on flywheel, replace as necessary.	(→ Page 101)
W1698	X	Replace carbon brushes on flywheel.	(→ Page 103)
W4172		Check general condition of resilient mount (visual inspection).	(→ Page 161)

Table 2: Maintenance task reference table [QL1]

8 Troubleshooting

8.1 Troubleshooting

Engine does not turn when starter is actuated

Cause	Corrective action
Battery low or faulty	▶ Charge or replace (→ manufacturer's documentation)
Battery: Cable connections faulty	▶ Check that cable connections are properly secured (→ manufacturer's documentation)
Starter: Engine cabling or starter faulty	▶ Check if cable connections are properly secured, contact Service.
Engine wiring faulty	▶ Check (→ Page 173)
Engine/generator control system: Assemblies or connectors possibly loose	▶ Perform visual inspection (→ manufacturer's documentation)
DDEC: Plug-in connections possibly loose	▶ Check plug-in connections (→ Page 176).
Running gear blocked (engine cannot be barred manually)	▶ Contact Service.

Engine turns but does not fire

Cause	Corrective action
Poor rotation by starter: Battery low or faulty	▶ Charge or replace battery (→ manufacturer's documentation)
Engine wiring faulty	▶ Check (→ Page 173)
Air in fuel system	▶ Vent fuel system (→ Page 119).
DDEC defective	▶ Contact Service.

Engine fires unevenly

Cause	Corrective action
Fuel injection: Injector defective	▶ Replace (→ Page 113).
Engine wiring faulty	▶ Check (→ Page 173)
Air in fuel system	▶ Vent fuel system (→ Page 119).
DDEC defective	▶ Contact Service.

Engine does not reach rated speed

Cause	Corrective action
Fuel prefilter clogged	▶ Clean or replace filter element.
Easy-change fuel filter clogged	▶ Replace (→ Page 120).
Air filter clogged	▶ Check signal ring position of contamination indicator (→ Page 133).
Injector defective	▶ Replace (→ Page 113).
Engine wiring faulty	▶ Check (→ Page 173)
Engine load too high	▶ Contact Service.

Engine speed not steady

Cause	Corrective action
Injector defective	▶ Replace (→ Page 113).
Speed transmitter defective	▶ Contact Service.
Air in fuel system	▶ Vent fuel system (→ Page 119).
DDEC defective	▶ Contact Service.

Charge-air temperature too high

Cause	Corrective action
Engine coolant treatment incorrect	▶ Check (→ MTU test kit)
Intercooler contaminated	▶ Contact Service.
Engine room: Air-intake temperature too high	▶ Check fans and intake/exhaust lines.

Charge-air pressure too low

Cause	Corrective action
Air filter clogged	▶ Check signal ring position of contamination indicator (→ Page 133).
Intercooler contaminated	▶ Contact Service.
Exhaust turbocharger defective	▶ Contact Service.

Coolant leaks at intercooler

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

Exhaust gas black

Cause	Corrective action
Air filter clogged	▶ Check signal ring position of contamination indicator (→ Page 133).
Injector defective	▶ Replace (→ Page 113).
Engine load too high	▶ Contact Service.

Exhaust gas blue

Cause	Corrective action
Too much engine oil in the engine	▶ Drain engine oil (→ Page 136).
Filter element in oil separator is clogged	▶ Replace (→ Page 98).
Exhaust turbocharger, cylinder head, piston rings, cylinder liner defective	▶ Contact Service.

Exhaust gas white

Cause	Corrective action
Engine is not at operating temperature	▶ Warm up
Fuel system: Water in fuel	▶ Drain fuel prefilter. Check fuel system.
Intercooler leaking	▶ Contact Service.

8.2 Fault messages from DDEC engine governor

The DDEC engine governor generates alarms which are indicated in different ways depending on the equipment configuration:
- Two-digit flashing code
- Fault code and text on a display or PC screen

To facilitate troubleshooting without additional auxiliary equipment, the two-digit flash codes can be read out from the DDEC by means of the vehicle-side alarm lamps CHECK ENGINE LIGHT (yellow) and STOP ENGINE LIGHT (red).

Two switches (DIAGNOSTIC REQUEST) must be provided in the plant in this case. The first switch is used for reading out the flash codes of the master DDEC unit, the second one to read out the receiver DDEC unit. The flash-code signals from master and receiver are transmitted to the same alarm lamps.

Active codes:	Inactive codes:
indicated by STOP ENGINE LIGHT (red)	indicated by CHECK ENGINE LIGHT (yellow)

Activation of “FLASH-CODES”:

1. Set “IGNITION” switch to ON.C.
2. Actuate “DIAGNOSTIC REQUEST” switch of Master or Receiver.
3. Read-off codes.
4. Identify fault on the basis of the DDC fault code list.

Example:			
Active code 23:		Inactive code 34:	
STOP ENGINE LIGHT lamp flashes:		CHECK ENGINE LIGHT lamp flashes:	
Flashing phase 1	Flashing phase 2	Flashing phase 1	Flashing phase 2
O O	O O O	O O O	O O O O
2 x flash	3 x flash	3 x flash	4 x flash

There is a pause lasting 0.5 seconds between flashing phases 1 and 2. There is a pause of approx. 3 seconds on changing between active and inactive code.

Switch off the “DIAGNOSTIC REQUEST” and “IGNITION” switches to cancel “FLASH-CODE” indication.

The “IGNITION” switch may only be switched back on after a 30 sec. delay.

Precise fault diagnosis is, however, not possible using this method as any one flashing code may be used to cover several different fault causes.

Detailed diagnosis is possible using the Diagnostic Data Reader (DDR) readout/programming unit.

The Diagnostic Data Reader (DDR) is used to:
- Read out DDEC electronics fault messages
- Change a limited scope of parameters

Active and inactive fault codes can be read out with the DDR via separate menus. Inactive fault codes stored in the governor can also be deleted.

Refer to the DDR device description for details of the range of features.

The DDR (part no. 5355383601/77) comprises:
- One Pro Link 9000 basic unit
- One cartridge to accommodate a PCMCIA plug-in circuit board (MPC cartridge)
- One PCMCIA plug-in circuit board
- One connecting cable
- An additional adapter cable is also required (part no. J 38500 60A)

Additional accessories:
- Printer (part no. J-38699) for direct connection to the DDR
- Spare paper (part no. J-38480-5) for the printer (5 rolls respectively)

The following information is available on reading out the fault codes with the DDR.

Example:

33	MID:128		Engine
TURBO	BOOST		SENSOR
INPUT	VOLTAGE		HIGH
▲ A1	PID:	102	FMI:3 ▼

Explanation:
- 33 → Flashing code
- MID: 128 →Information about the source of the fault message
- TURBO-BOOST-SENSOR-INPUT-VOLTAGE-HIGH → Fault text
- ▲▼ → more faults pending A= active, I= inactive

MID (Message Identification Character)
- Information about the source of the fault message:
  MID 128 → Master
  MID 175 → Receiver 1
  MID 183 → Receiver 2

PID (Parameter Identification Character).
- Information to identify transmitted data: (e.g. engine speed, coolant temperature etc.)
  PID 0-127 → 1 data byte
  PID 128-191 → 2 data bytes
  PID 192-253 → Variable

SID (Subsystem Identification Character)
- Information about the source of fault messages from subordinate systems which may be replaced as a unit (e.g. injectors).

FMI (Failure Mode Identifier)
- Information about the type of fault which has occurred.
  FMI 0 → Measured value above limit value (monitoring of TOO HIGH) example: Coolant temperature
  FMI 1 → Measured value below limit value (monitoring of TOO LOW) example: Lube oil pressure
  FMI 3 → Signal disrupted or signal above admissible measuring range (sensor failure)
  FMI 4 → Signal short-circuited to (-) supply of sensor or signal below admissible measuring range (sensor failure)

Flash-ing code	PID	SID	FMI	Description	Maintenance tasks
11	187		4	Position sensor of variable speed governor → voltage too low.	Contact Service.
11	187		7	Control system/ variable speed governor→ voltage too high.	Contact Service.
12	187		3	Position sensor of variable speed governor → voltage too high.	Contact Service.
13	111		4	Coolant level sensor, input voltage too low.	1. Check coolant condition (→ Page 150). 2. Check coolant level, top up if required (→ Page 143). 3. Check cabling. 4. Contact Service.

Flashing code	PID	SID	FMI	Description	Maintenance tasks
13	111		6	Sensor "Top up coolant", input voltage too low.	1. Check coolant condition (→ Page 150). 2. Check coolant level, top up if required (→ Page 143). 3. Check cabling. 4. Contact Service.
14	52		3	Temperature sensor/intercooler, input voltage too high.	1. Check cabling. 2. Contact Service.
14	110		3	Coolant temperature sensor, input voltage too high.	1. Check cabling. 2. Contact Service.
14	175		3	Oil temperature sensor, input voltage too high.	Contact Service.
15	52		4	Temperature sensor/intercooler, input voltage too low.	1. Check cabling. 2. Contact Service.
15	110		4	Coolant temperature sensor, input voltage too low.	1. Check cabling. 2. Contact Service.
15	175		4	Oil temperature sensor, input voltage too low.	Contact Service.
16	111		3	Coolant level sensor, input voltage too high.	1. Check coolant condition (→ Page 150). 2. Check coolant level, top up if required (→ Page 143). 3. Check cooler for dirt. 4. Check cabling. 5. Contact Service.
16	111		5	Sensor "Top up coolant", input voltage too high.	1. Check cabling. 2. Contact Service.
17	51		3	Throttle sensor, input voltage too high.	1. Check cabling. 2. Contact Service.
17	72		3	Blower bypass position, input voltage too high.	1. Check cabling. 2. Contact Service.
17	354		3	Humidity sensor, electric circuit defective / high (version 33.0 or later).	1. Check cabling. 2. Contact Service.
18	51		4	Throttle sensor, input voltage too low.	1. Check cabling. 2. Contact Service.
18	72		4	Blower bypass position, input voltage too low.	1. Check cabling. 2. Contact Service.
18	354		4	Humidity sensor, electric circuit defective / low (version 33.0 or later).	1. Check cabling. 2. Contact Service.
21	91		3	Throttle sensor, input voltage too high.	1. Check cabling. 2. Contact Service.
22	91		4	Throttle sensor, input voltage too low.	1. Check cabling. 2. Contact Service.
23	174		3	Fuel temperature sensor, input voltage too high.	1. Check cabling. 2. Contact Service.

Flashing code	PID	SID	FMI	Description	Maintenance tasks
23		65		Oxygen concentration circuit, input voltage too high.	1. Check cabling. 2. Contact Service.
24	174		4	Fuel temperature sensor, input voltage too high.	1. Check cabling. 2. Contact Service.
24		65	4	Oxygen concentration circuit, input voltage too low.	1. Check cabling. 2. Contact Service.
25				Reserved for “No Codes”.	No troubleshooting.
26		25	11	Aux. shutdown 1 active.	Contact Service.
26		61	11	Aux. shutdown 2 active.	Contact Service.
27	105		3	Inlet elbow temperature sensor, input voltage too high.	1. Check cabling. 2. Contact Service.
27	171		3	Outside temperature sensor, input voltage too high.	1. Check cabling. 2. Contact Service.
27	172		3	Air temperature sensor, input voltage too high.	1. Check cabling. 2. Contact Service.
28	105		4	Inlet elbow temperature sensor, input voltage too low.	1. Check cabling. 2. Contact Service.
28	171		4	Outside temperature sensor, input voltage too low.	1. Check cabling. 2. Contact Service.
28	172		4	Air temperature sensor, input voltage too low.	1. Check cabling. 2. Contact Service.
29	351		4	Circuit exhaust turbocharger inlet temperature defective / low (version 33.0 or later).	1. Check cabling. 2. Contact Service.
29	404		4	Temperature sensor/ exhaust turbocharger outlet, input voltage too low (version 32.0 or later).	1. Check cabling. 2. Contact Service.
31		51	3	Auxiliary output 3, open circuit (side "high") S3.	Contact Service.
31		51	4	Auxiliary output 3, ground short circuit (side "high") S3.	Contact Service.
31		51	7	Auxiliary output 3, fault in mechanical system S3.	Contact Service.
31		52	3	Auxiliary output 4, open circuit (side "high") S3.	Contact Service.
31		52	4	Auxiliary output 4, ground short circuit (side "high") T3.	Contact Service.
31		52	7	Auxiliary output 4, fault in mechanical system T3.	Contact Service.
32		238	3	SEL, short circuit on battery circuit (plus).	1. Check cabling. 2. Contact Service.
32		238	4	SEL, open circuit .	1. Check cabling. 2. Contact Service.
32		239	3	CEL, short circuit on battery circuit (plus).	1. Check cabling. 2. Contact Service.

Flashing code	PID	SID	FMI	Description	Maintenance tasks
32		239	4	CEL, open circuit .	1. Check cabling. 2. Contact Service.
33	102		3	Charge pressure sensor, input voltage too high.	1. Check cabling. 2. Contact Service.
34	102		4	Charge pressure sensor, input voltage too low.	1. Check cabling. 2. Contact Service.
35	19		3	Oil pressure sensor upper level, input voltage too high.	1. Check cabling. 2. Contact Service.
35	100		3	Oil pressure sensor, input voltage too low.	1. Check cabling. 2. Contact Service.
36	19		4	Oil pressure sensor upper level, input voltage too high.	1. Check cabling. 2. Contact Service.
36	100		4	Oil pressure sensor, input voltage too low.	1. Check cabling. 2. Contact Service.
37	18		3	Fuel pressure sensor upper level, input voltage too high.	1. Check cabling. 2. Contact Service.
37	94		3	Fuel pressure sensor, input voltage too high.	1. Check cabling. 2. Contact Service.
37	95		3	Fuel differential pressure sensor, input voltage too high.	1. Check cabling. 2. Contact Service.
38	18		4	Fuel pressure sensor upper level, input voltage too low.	1. Check cabling. 2. Contact Service.
38	94		4	Fuel pressure sensor, input voltage too low.	1. Check cabling. 2. Contact Service.
38	95		4	Fuel differential pressure sensor, input voltage too low.	1. Check cabling. 2. Contact Service.
39		146	2	EGR system leaking, charge-air pressure (version 33.0 or later).	Contact Service.
39		146	12	EGR system leaking, exhaust brake operation (version 33.0 or later).	Contact Service.
39		146	7	EGR valve does not respond (version 33.0 or later).	Contact Service.
39		147	2	VNT nozzles do not respond, charge-air pressure (version 33.0 or later).	Contact Service.
39		147	11	VNT nozzles at maximum, exhaust brake operation (version 33.0 or later).	Contact Service.
39		147	12	VNT nozzles do not respond, brake pressure (version 33.0 or later).	Contact Service.

Flashing code	PID	SID	FMI	Description	Maintenance tasks
39		147	14	Exhaust gas recirculation flow too low, VNT nozzles do not respond, charge-air pressure (version 33.0 or later).	Contact Service.
39		147	7	VNT vanes do not respond, EGR (version 33.0 or later).	Contact Service.
39		152	7	No signal from EGR valve (version 29.0 or later).	1. Check contamination indicator signal ring position (→ Page 133). 2. Contact Service.
39		153	7	VNT vanes do not respond, (version 29.0 or later).	1. Check contamination indicator signal ring position (→ Page 133). 2. Contact Service.
41		21	0	Too many SRS (TRS missing).	Contact Service.
42		21	1	Too few SRS (SRS missing).	Contact Service.
43	111		1	Coolant level too low.	1. Check coolant level, top up if required (→ Page 143). 2. Contact Service.
44	52		0	Intercooler coolant temperature too high.	1. Check coolant condition (→ Page 150). 2. Check coolant level, top up if required (→ Page 153). 3. Check intercooler for contamination. 4. Contact Service.
44	105		0	Inlet elbow temperature too high.	1. Check contamination indicator signal ring position (→ Page 133). 2. Contact Service.
44	110		0	Coolant temperature too high.	1. Check coolant condition (→ Page 150). 2. Check coolant level, top up if required (→ Page 143). 3. Check cooler for dirt. 4. Contact Service.
44	172		0	Air inlet temperature too high.	1. Check contamination indicator signal ring position (→ Page 133). 2. Contact Service.
44	175		0	Oil temperature too high.	1. Check engine oil level (→ Page 134). 2. Contact Service.
		105	14	Inlet elbow temperature: power reduction.	1. Check contamination indicator signal ring position (→ Page 133). 2. Contact Service.
		110	14	Coolant temperature: power reduction.	1. Check coolant condition (→ Page 150). 2. Check coolant level, top up if required (→ Page 143). 3. Check cooler for dirt. 4. Contact Service.

Flashing code	PID	SID	FMI	Description	Maintenance tasks
45	19		1	High range: Oil pressure too low.	1. Check engine oil level (→ Page 134). 2. Contact Service.
45	100		1	Oil pressure too low.	1. Check engine oil level (→ Page 134). 2. Contact Service.
46	168		1	ECM battery voltage too low.	Contact Service.
46		214	1	Real-time clock auxiliary battery, voltage too low (version 29.0 or later).	Contact Service.
46		232	1	Sensor supply voltage too low.	Contact Service.
47	18		0	High range: Fuel pressure too high.	Contact Service.
47	94		0	Fuel pressure too high.	Contact Service.
47	102		0	Charge pressure too high.	Contact Service.
47	106		0	Air inlet pressure too high.	Contact Service.
47	164		0	Injection control pressure too high.	Contact Service.
48	18		1	High range: Fuel pressure too low.	1. Check fuel prefilter. 2. Check fuel filter (→ Page 120). 3. Fill tank as necessary. 4. Contact Service.
48	94		1	Fuel pressure too low.	1. Check fuel prefilter. 2. Check fuel filter (→ Page 120). 3. Fill tank as necessary. 4. Contact Service.
48	106		1	Air inlet pressure too low.	Contact Service.
48	164		1	Injection control pressure too low.	Contact Service.
48	351		1	Exhaust turbocharger inlet temperature below range (version 33.0 or later).	Contact Service.
48	404		1	Exhaust turbocharger outlet temperature too low (version 33.0 or later).	Contact Service.
48	411		1	EGR OPD low (version 33.0 or later).	Contact Service.
48	412		1	EGR temperature too low (version 33.0 or later).	Contact Service.
48		154	1	EGR temperature too low.	Contact Service.
48		155	1	EGR differential pressure too low.	Contact Service.

Flashing code	PID	SID	FMI	Description	Maintenance tasks
49	351		0	Temperature at exhaust turbocharger inlet above range (version 33.0 or later).	1. Check contamination indicator signal ring position (→ Page 133). 2. Check exhaust system. 3. Contact Service.
49	404		0	Temperature at exhaust turbocharger outlet too high (version 32.0 or later).	1. Check contamination indicator signal ring position (→ Page 133). 2. Check exhaust system. 3. Contact Service.
	404		14	TCO temperature- power reduction.	Contact Service.
51	351		3	Temperature sensor on exhaust turbocharger inlet, circuit defective / high.	1. Check cabling. 2. Contact Service.
51	404		3	Temperature sensor on exhaust turbocharger outlet, input voltage too high (version 32.0 or later).	1. Check cabling. 2. Contact Service.
52		254	12	A/D conversion, fault.	Contact Service.
53		253	2	Nonvolatile check sum error.	Contact Service.
53		253	12	EEPROM write error.	Contact Service.
53		253	13	Out of calibrated range.	Contact Service.
54	84		12	Vehicle's speed sensor defect.	1. Check cabling. 2. Contact Service.
55		216	14	Fault in another control unit (version 27.0 or later). This fault is stored in conjunction with another fault in order to indicate missing information from another control unit .	Contact Service.
55		231	12	Data link J1939, fault.	Contact Service.
55		248	8	System-related data link, fault (Master).	Contact Service.
55		248	9	System-related data link (Receiver).	Contact Service.
56		250	12	Data link J1587, fault.	Contact Service.
57		249	12	Data link J1922, fault.	Contact Service.
58	92		0	Torque too high.	Contact Service.
61		xxx	0	Reaction time injection nozzle xxx too long.	Contact Service.
62		26	3	Auxiliary output 1, short circuit on battery circuit (plus) F3.	Contact Service.
62		26	4	Auxiliary output 1, open circuit F3.	Contact Service.

Flashing code	PID	SID	FMI	Description	Maintenance tasks
62		26	7	Auxiliary output 1, mechanical system does not respond correctly F3.	Contact Service.
62		40	3	Auxiliary output 2, short circuit on battery circuit (plus) A2.	Contact Service.
62		40	4	Auxiliary output 2, open circuit A2.	Contact Service.
62		40	7	Auxiliary output 2, mechanical system does not respond correctly A2.	Contact Service.
62		53	3	Auxiliary output 5, short circuit on battery circuit (plus) W3.	Contact Service.
62		53	4	Auxiliary output 5, open circuit W3.	Contact Service.
62		53	7	Auxiliary output 5, mechanical system does not respond correctly W3.	Contact Service.
62		54	3	Auxiliary output 6, short circuit on battery circuit (plus) X3.	Contact Service.
62		54	4	Auxiliary output 6, open circuit X3.	Contact Service.
62		54	7	Auxiliary output 6, mechanical system does not respond correctly X3.	Contact Service.
62		55	3	Auxiliary output 7, short circuit on battery circuit (plus) Y3.	Contact Service.
62		55	4	Auxiliary output 7, open circuit Y3.	Contact Service.
62		55	7	Auxiliary output 7, mechanical system does not respond correctly Y3.	Contact Service.
62		56	3	Auxiliary output 8, short circuit on battery circuit (plus) A1.	Contact Service.
62		56	4	Auxiliary output 8, open circuit A1.	Contact Service.
62		56	7	Auxiliary output 8, mechanical system does not respond correctly A1.	Contact Service.
63		57	0	PWM 1 above normal range.	Contact Service.
63		57	1	PWM 1 below normal range.	Contact Service.
63		57	3	PWM 1 short circuit on battery circuit (plus).	Contact Service.

Flashing code	PID	SID	FMI	Description	Maintenance tasks
63		57	4	PWM 1 open circuit.	Contact Service.
63		58	0	PWM 2 above normal range.	Contact Service.
63		58	1	PWM 2 below normal range.	Contact Service.
63		58	3	PWM 2 short circuit on battery circuit (plus).	Contact Service.
63		58	4	PWM 2 open circuit.	Contact Service.
63		59	0	PWM 3 above normal range.	Contact Service.
63		59	1	PWM 3 below normal range.	Contact Service.
63		59	3	PWM 3 short circuit on battery circuit (plus).	Contact Service.
63		59	4	PWM 3 open circuit.	Contact Service.
63		60	0	PWM 4 above normal range.	Contact Service.
63		60	1	PWM 4 below normal range.	Contact Service.
63		60	3	PWM 4 short circuit on battery circuit (plus).	Contact Service.
63		60	4	PWM 4 open circuit.	Contact Service.
64	103		0	Turbocharger speed too high.	Contact Service.
64	103		8	Exhaust turbocharger speed sensor, input signal faulty (irregular period).	Contact Service.
65	51		0	Throttle position above normal range.	Contact Service.
65	51		1	Throttle position below normal range.	Contact Service.
65	51		2	Throttle position not regular.	Contact Service.
65	51		7	Throttle does not respond.	Contact Service.
65	107		3	Air filter differential pressure sensor, voltage too high.	1. Check cabling. 2. Contact Service.
65	107		4	Air filter differential pressure sensor, voltage too low.	1. Check cabling. 2. Contact Service.
66	99		3	Oil filter differential pressure sensor, voltage too high.	1. Check cabling. 2. Contact Service.
66	99		4	Oil filter differential pressure sensor, voltage too low.	1. Check cabling. 2. Contact Service.
66		76	0	Engine knock level above normal range.	Contact Service.
66		76	3	Knock sensor, input voltage too high.	Contact Service.
66		76	4	Knock sensor, input voltage too low.	Contact Service.
66		76	7	Knock sensor does not respond.	Contact Service.

Flashing code	PID	SID	FMI	Description	Maintenance tasks
67	20		3	Coolant pressure sensor, high range (input voltage too high).	Contact Service.
67	20		4	Coolant pressure sensor, high range (input voltage too low).	Contact Service.
67	106		3	Air inlet pressure sensor, input voltage too high.	Contact Service.
67	106		4	Air inlet pressure sensor, input voltage too low.	Contact Service.
67	109		3	Coolant pressure sensor, input voltage too high.	Contact Service.
67	109		4	Coolant pressure sensor, input voltage too low.	Contact Service.
68		230	5	Idle detection pedal travel sensor (TPS), fault in circuit (circuit disrupted).	Contact Service.
68		230	6	Idle detection pedal travel sensor (TPS), fault in circuit (short-circuit to ground).	Contact Service.
71		xxx	1	Reaction time injection nozzle xxx too short.	Contact Service.
72	84		0	Vehicle's speed too high.	Contact Service.
72	84		11	Vehicle's speed too high (absolute).	Contact Service.
72		65	0	Oxygen concentration too high.	Contact Service.
72		65	1	Oxygen concentration too low.	Contact Service.
73	107		0	Air filter differential pressure too high.	1. Check contamination indicator signal ring position (→ Page 133). 2. Contact Service.
73		77	0	Gas valve position above normal range.	Contact Service.
73		77	1	Gas valve position below normal range.	Contact Service.
73		77	3	Gas valve position input voltage too high.	Contact Service.
73		77	4	Gas valve position input voltage too low.	Contact Service.
73		77	7	Gas dosing valve does not respond.	Contact Service.
73		151	14	ESS transmission, engaged gear step jamming.	Contact Service.

Flashing code	PID	SID	FMI	Description	Maintenance tasks
73		226	11	Transmission idling switch defective, (ESS transmission).	Contact Service.
73		227	2	Analog auxiliary input: data failing irregularly or defective (ESS transmission).	Contact Service.
73		227	3	Analog auxiliary input 1, voltage too high (ESS transmission).	Contact Service.
73		227	4	Analog auxiliary input 1, voltage too low (ESS transmission).	Contact Service.
74	70		4	Optimized idle security loop) ground short circuit.	Contact Service.
74	99		0	Oil filter badly clogged.	1. Replace oil filter (→ Page 140) 2. Contact Service.
75	168		0	ECM battery voltage too high.	Contact Service.
75		214	0	Real-time clock backup, battery voltage too high (version 29.0 or later).	Contact Service.
75		232	0	Sensor supply voltage too high.	Contact Service.
76	121		0	Engine overspeed with exhaust brake.	Contact Service.
77	3		0	Cylinder head temperature too high.	Contact Service.
77	19		0	High range: oil pressure too high.	Contact Service.
77	20		0	High range: coolant pressure too high.	Contact Service.
77	72		0	Blower bypass position too high.	Contact Service.
77	72		1	Blower bypass position too low.	Contact Service.
77	73		1	Fire pump pressure too low.	Contact Service.
77	81		0	Exhaust back pressure too high.	Contact Service.
77	81		1	Exhaust back pressure too low.	Contact Service.
77	81		3	Exhaust back pressure sensor voltage too high.	Contact Service.
77	81		4	Exhaust back pressure sensor voltage too low.	Contact Service.
77	81		12	Exhaust back pressure near limit for power reduction.	Contact Service.

Flashing code	PID	SID	FMI	Description	Maintenance tasks
77	95		1	Fuel filter differential pressure too low.	Contact Service.
77	99		1	Oil filter differential pressure too low.	Contact Service.
77	100		0	Engine oil pressure too high.	Contact Service.
77	102		1	Charge-air pressure too low.	Contact Service.
77	105		1	Inlet elbow temperature too low.	Contact Service.
77	107		1	Air filter differential pressure too low.	Contact Service.
77	108		0	Atmospheric pressure too high.	Contact Service.
77	108		1	Atmospheric pressure too low.	Contact Service.
77	109		0	Coolant pressure too high.	Contact Service.
77	110		1	Coolant temperature too low.	Contact Service.
77	111		0	Coolant level too high.	1. Check engine coolant level (→ Page 143). 2. Contact Service.
77	171		0	Outside temperature too high.	Contact Service.
77	171		1	Outside temperature too low.	Contact Service.
77	172		1	Intake air temperature too low.	Contact Service.
77	174		0	Fuel temperature too high.	Contact Service.
77	174		1	Fuel temperature too low.	Contact Service.
77	175		1	Engine oil temperature too low.	Contact Service.
77	222		14	Theft protection faulty.	Contact Service.
77	251		10	Clock module with irregular alteration speed.	Contact Service.
77	251		13	Clock module faulty.	Contact Service.
77	252		10	Clock module with irregular alteration speed.	Contact Service.
77	252		13	Clock module faulty.	Contact Service.
77	354		0	Relative air humidity above range (version 33.0 or later).	Contact Service.
77	354		1	Relative air humidity under range (version 33.0 or later).	Contact Service.
77	446		0	Cylinder head temperature above range (version 33.0 or later).	Contact Service.

Flashing code	PID	SID	FMI	Description	Maintenance tasks
77		151	11	Maintenance display lamp, faulty / service interval exceeded (version 32.0 or later).	Contact Service.
78	86		14	Self-adaptive speed control faulty (version 27.0 or later).	Contact Service.
81	98		3	Oil level sensor, input voltage too high.	Contact Service.
81	101		3	Crankcase pressure sensor, input voltage too high.	Contact Service.
81	153		3	Crankcase pressure, input voltage too high (version 27.0 or later).	Contact Service.
81	164		3	Injection control pressure sensor, input voltage too high.	Contact Service.
81	173		3	Exhaust temperature sensor, input voltage too high.	Contact Service.
81	411		3	EGR OPD, circuit defective / high (version 33.0 or later).	Contact Service.
81	412		3	EGR temperature too high (version 33.0 or later).	Contact Service.
81		129	3	Exhaust duct temperature 1, sensor voltage too high (version 32.0 or later).	Contact Service.
81		130	3	Exhaust duct temperature 2, sensor voltage too high (version 32.0 or later).	Contact Service.
81		131	3	Exhaust duct temperature 3, sensor voltage too high (version 32.0 or later).	Contact Service.
81		132	3	Exhaust duct temperature 4, sensor voltage too high (version 32.0 or later).	Contact Service.
81		133	3	Exhaust duct temperature 5, sensor voltage too high (version 32.0 or later).	Contact Service.
81		134	3	Exhaust duct temperature 6, sensor voltage too high (version 32.0 or later).	Contact Service.
81		135	3	Exhaust duct temperature 7, sensor voltage too high (version 32.0 or later).	Contact Service.
81		136	3	Exhaust duct temperature 8, sensor voltage too high (version 32.0 or later).	Contact Service.

Flashing code	PID	SID	FMI	Description	Maintenance tasks
81		137	3	Exhaust duct temperature 9, sensor voltage too high (version 32.0 or later).	Contact Service.
81		138	3	Exhaust duct temperature 10, sensor voltage too high (version 32.0 or later).	Contact Service.
81		139	3	Exhaust duct temperature 11, sensor voltage too high (version 32.0 or later).	Contact Service.
81		140	3	Exhaust duct temperature 12, sensor voltage too high (version 32.0 or later).	Contact Service.
81		141	3	Exhaust duct temperature 13, sensor voltage too high (version 32.0 or later).	Contact Service.
81		142	3	Exhaust duct temperature 14, sensor voltage too high (version 32.0 or later).	Contact Service.
81		143	3	Exhaust duct temperature 15, sensor voltage too high (version 32.0 or later).	Contact Service.
81		144	3	Exhaust duct temperature 16, sensor voltage too high (version 32.0 or later).	Contact Service.
81		154	3	EGR temperature, input voltage too high.	Contact Service.
81		155	3	EGR differential pressure, input voltage too high.	Contact Service.
81		277	9	EGR mass flow, intelligent sensor does not respond (version 33.0 or later).	Contact Service.
81		277	12	EGR mass flow, intelligent sensor failure (version 33.0 or later).	Contact Service.
82	98		4	Oil level sensor, input voltage too low.	Contact Service.
82	101		4	Crankcase pressure sensor, input voltage too low.	Contact Service.
82	153		4	Crankcase pressure sensor, input voltage (version 27.0 or later).	Contact Service.
82	164		4	Injection control pressure sensor, input voltage too low.	Contact Service.
82	173		4	Exhaust temperature sensor, input voltage too low.	Contact Service.

Flashing code	PID	SID	FMI	Description	Maintenance tasks
82	411		4	EGR OPD, sensor circuit defective / low (version 33.0 or later).	Contact Service.
82	412		4	EGR temperature too low (version 33.0 or later).	Contact Service.
82		129	4	Exhaust duct temperature 1, sensor voltage too low (version 32.0 or later).	Contact Service.
82		130	4	Exhaust duct temperature 2, sensor voltage too low (version 32.0 or later).	Contact Service.
82		131	4	Exhaust duct temperature 3, sensor voltage too low (version 32.0 or later).	Contact Service.
82		132	4	Exhaust duct temperature 4, sensor voltage too low (version 32.0 or later).	Contact Service.
82		133	4	Exhaust duct temperature 5, sensor voltage too low (version 32.0 or later).	Contact Service.
82		134	4	Exhaust duct temperature 6, sensor voltage too low (version 32.0 or later).	Contact Service.
82		135	4	Exhaust duct temperature 7, sensor voltage too low (version 32.0 or later).	Contact Service.
82		136	4	Exhaust duct temperature 8, sensor voltage too low (version 32.0 or later).	Contact Service.
82		137	4	Exhaust duct temperature 9, sensor voltage too low (version 32.0 or later).	Contact Service.
82		138	4	Exhaust duct temperature 10, sensor voltage too low (version 32.0 or later).	Contact Service.
82		139	4	Exhaust duct temperature 11, sensor voltage too low (version 32.0 or later).	Contact Service.
82		140	4	Exhaust duct temperature 12, sensor voltage too low (version 32.0 or later).	Contact Service.
82		141	4	Exhaust duct temperature 13, sensor voltage too low (version 32.0 or later).	Contact Service.
82		142	4	Exhaust duct temperature 14, sensor voltage too low (version 32.0 or later).	Contact Service.

Flashing code	PID	SID	FMI	Description	Maintenance tasks
82		143	4	Exhaust duct temperature 15, sensor voltage too low (version 32.0 or later).	Contact Service.
82		144	4	Exhaust duct temperature 16, sensor voltage too low (version 32.0 or later).	Contact Service.
82		154	4	EGR- temperature, input voltage too high.	Contact Service.
82		155	4	EGR differential pressure input voltage too low.	Contact Service.
82		412	9	EGR temperature, intelligent sensor does not respond (version 33.0 or later).	Contact Service.
82		412	12	EGR temperature, intelligent sensor failure (version 33.0 or later).	Contact Service.
83	73		0	Pump pressure too high.	Contact Service.
83	98		0	Oil level is too high.	1. Check engine oil level (→ Page 134). 2. Contact Service.
83	101		0	Crankcase pressure too high.	Contact Service.
83	153		0	Crankcase pressure too high (version 27.0 or later).	Contact Service.
83	173		0	Exhaust temperature too high.	Contact Service.
83	411		0	EGR OPD, high (version 33.0 or later).	Contact Service.
83	412		0	EGR temperature too high (version 33.0 or later).	Contact Service.
83		129	0	Exhaust duct temperature 1, sensor voltage too high (version 32.0 or later).	Contact Service.
83		130	0	Exhaust duct temperature 2, sensor voltage too high (version 32.0 or later).	Contact Service.
83		131	0	Exhaust duct temperature 3, sensor voltage too high (version 32.0 or later).	Contact Service.
83		132	0	Exhaust duct temperature 4, sensor voltage too high (version 32.0 or later).	Contact Service.
83		133	0	Exhaust duct temperature 5, sensor voltage too high (version 32.0 or later).	Contact Service.

Flashing code	PID	SID	FMI	Description	Maintenance tasks
83		134	0	Exhaust duct temperature 6, sensor voltage too high (version 32.0 or later).	Contact Service.
83		135	0	Exhaust duct temperature 7, sensor voltage too high (version 32.0 or later).	Contact Service.
83		136	0	Exhaust duct temperature 8, sensor voltage too high (version 32.0 or later).	Contact Service.
83		137	0	Exhaust duct temperature 9, sensor voltage too high (version 32.0 or later).	Contact Service.
83		138	0	Exhaust duct temperature 10, sensor voltage too high (version 32.0 or later).	Contact Service.
83		139	0	Exhaust duct temperature 11, sensor voltage too high (version 32.0 or later).	Contact Service.
83		140	0	Exhaust duct temperature 12, sensor voltage too high (version 32.0 or later).	Contact Service.
83		141	0	Exhaust duct temperature 13, sensor voltage too high (version 32.0 or later).	Contact Service.
83		142	0	Exhaust duct temperature 14, sensor voltage too high (version 32.0 or later).	Contact Service.
83		143	0	Exhaust duct temperature 15, sensor voltage too high (version 32.0 or later).	Contact Service.
83		144	0	Exhaust duct temperature 16, sensor voltage too high (version 32.0 or later).	Contact Service.
84	98		1	Oil level low.	1. Check engine oil level (→ Page 134). 2. Contact Service.
84	101		1	Crankcase pressure too low.	Contact Service.
84	153		1	Crankcase pressure too low (version 27.0 or later).	Contact Service.
85	190		0	Engine speed too high.	Contact Service.
85	190		14	Engine overspeed signal (version 28.0 or later).	Contact Service.
86	73		3	Pump pressure sensor, input voltage too high.	Contact Service.
86	108		3	Atmospheric pressure sensor, input voltage too high.	Contact Service.

Flashing code	PID	SID	FMI	Description	Maintenance tasks
87	73		4	Pump pressure sensor, input voltage too low.	Contact Service.
87	108		4	Atmospheric pressure sensor, input voltage too low.	Contact Service.
88	20		1	High range: coolant pressure too low.	Contact Service.
88	109		1	Coolant pressure too low.	Contact Service.
89	95		0	Fuel differential pressure too high.	Contact Service.
89	111		12	Coolant level, maintenance indication, fault.	1. Check engine coolant level (→ Page 143). 2. Contact Service.

9 Task Description

9.1 Engine

9.1.1 Engine - Barring manually

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

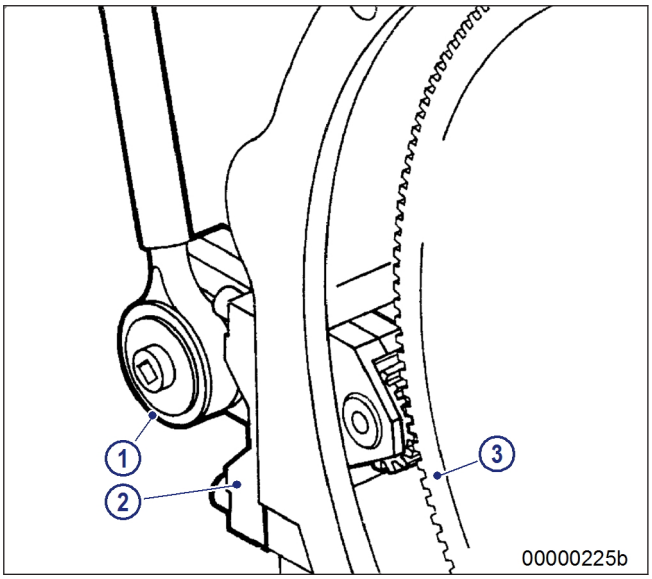
Designation / Use	Part No.	Qty.
Barring tool	F6555766	1
Adapter	F6558528	1
Ratchet with extension	F30006212	1

DANGER

Rotating/moving engine parts.
Risk of crushing, danger of body parts being caught up or drawn in!
- Ensure that all personnel is clear of the danger zone before cranking the engine on the starter.

Barring engine manually (lateral installation)

1. Remove guard plate.
2. Engage barring tool (2) in ring gear (3) and install on flywheel housing.
3. Set ratchet (1) onto barring tool (2).
4. Rotate crankshaft in engine direction of rotation. Apart from the normal compression resistance, there should be no resistance.
5. Remove barring tool in reverse order.



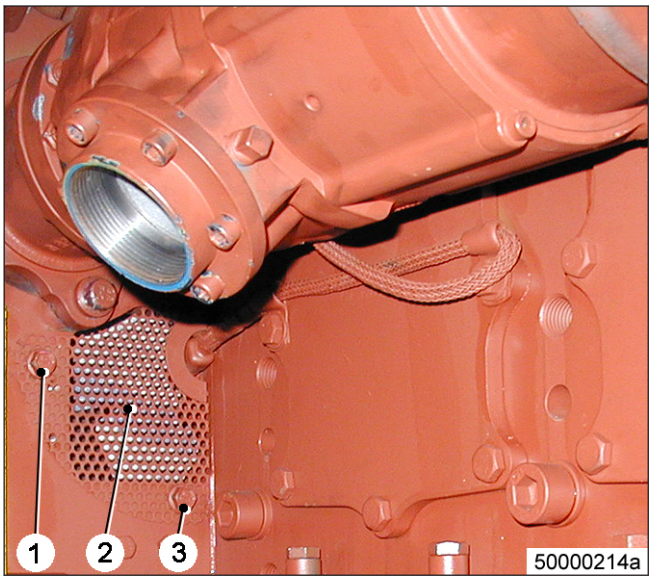
9.1.2 Engine - Cranking on starting system

DANGER

Rotating/moving engine parts.
Risk of crushing, danger of body parts being caught up or drawn in!
- Ensure that all personnel is clear of the danger zone before cranking the engine on the starter.

Cranking engine on starting system

1. Remove screws (1, 3) and take off perforated plate (2).



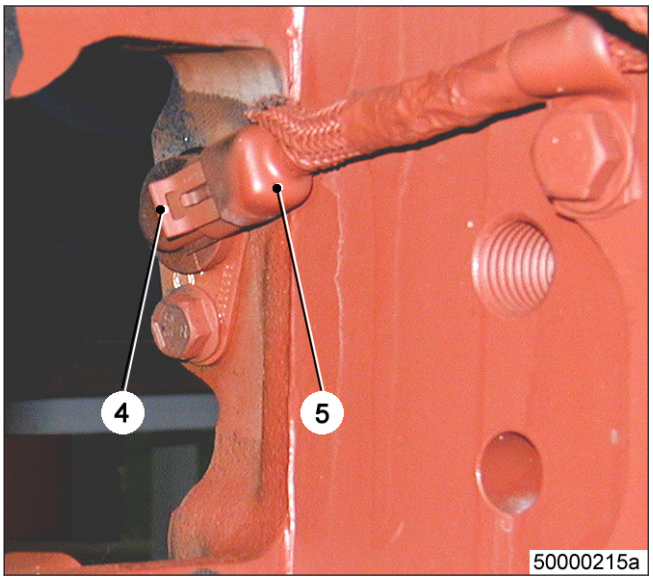
2. Disconnect connector (5) from crank angle sensor for injection timing of any cylinder (→ Page 43). For this purpose, unlock latch (4).
3. Crank engine in unloaded state: Press START pushbutton.

Note: Interrupt engine start after maximum ten seconds for thirty seconds to prevent starter from overheating.

4. Let the crankshaft rotate until oil pressure is indicated.

Note: Contact Service if no oil pressure is indicated after three start cycles.

5. Slide connector (5) until lock (4) latches into position.
6. Fit perforated plate (2) and secure with two screws (1, 3).



9.2 Cylinder Liner

9.2.1 Cylinder liner - Endoscopic examination

Preconditions

☑ Engine is stopped and starting disabled

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Barring tool	F6555766	1
Ratchet with extension	F30006212	1
Endoscope	Y20097353	1

Preparatory steps

1. Remove cylinder head cover (→ Page 111).
2. Remove injector (→ Page 114).

Positioning crankshaft at BDC

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

Endoscopic examination of cylinder liner

Findings	Measure
• Thin carbon coating around 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 actions 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 are faultless • Piston rings are faultless	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, contact Service.

1. Compile endoscopic report using the table.
2. Use technical terms to describe the liner surface (→ Page 96).
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 114).
2. Install cylinder head cover (→ Page 111).

9.2.2 Cylinder liner - Instructions and comments on endoscopic and visual examination

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
Minor dirt scores	Minor dirt scores can occur during the assembly of a new engine (honing products, particles, broken-off burrs). Removed cylinders clearly show such scoring on the running surface under endoscope magnification. Cannot be felt with the fingernail. Findings not critical
Single scores	Clearly visible scores caused by hard particles. They usually start in the TDC area and cross through the honing pattern in the direction of stroke. Findings not critical
Scored area	These areas consist of scores of different length and depth next to one another. In most cases, they are found at the 6-o'clock and 12-o'clock positions (inlet/ exhaust) along the transverse engine axis. Findings not critical
Polished area	Polished areas are on the running surface but almost the whole honing pattern is still visible. Polished areas appear brighter and more shiny than the surrounding running surface. Findings not critical
Bright area	Bright areas are on the running surface and show local removal of the honing pattern. Grooves from 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 moisture (condensate) 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 preliminary stage of burn marks. They are visible as a clear discoloration from TDC to BDC in the running surface and the start of localized damage to the honing pattern. Cylinder liners with a large number of black lines around the running surface have limited service life and should be replaced.

Findings	Measure
Burn mark	Burn marks are caused by a disturbance in the liner / ring tribo system. 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. Liners with heat discoloration starting in the TDC-ring 1 have to be replaced.
Seizure marks, scuffing	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 burn marks are similar. A thorough investigation and compliance with the above evaluation criteria allow an unambiguous evaluation. To avoid unnecessary disassembly work, it is recommended that another inspection be carried out after further operation of the engine.

9.3 Crankcase Breather

9.3.1 Crankcase breather - Filter element replacement

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 10–60 Nm	F30452769	1
Engine oil		
Filter element	(→ Spare Parts Catalog)	

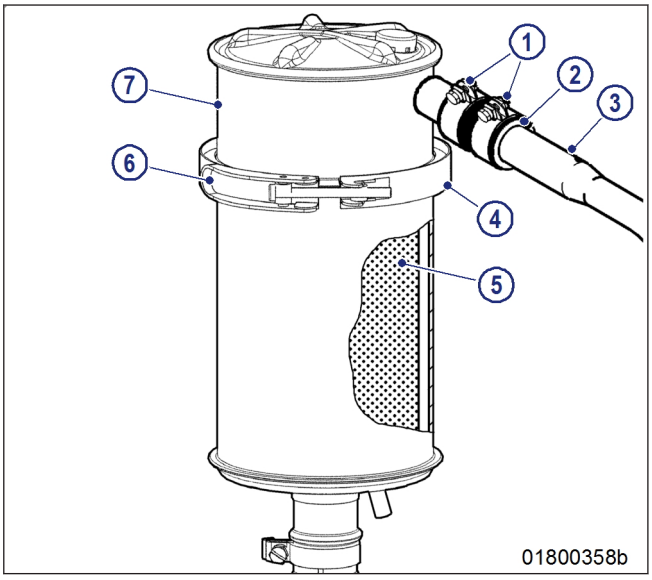
WARNING

Oil is hot.
Oil can contain residue/substances which are harmful to health.
Risk of injury and poisoning!

- Allow the product to cool to below 50 °C before beginning work.
- Wear protective clothing, protective gloves and goggles/safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

Crankcase breather (closed-circuit crankcase ventilation) – Filter element replacement

1. Loosen clamps (1), push rubber sleeves (2) over pipe (3).
2. Release band clamp (4) with lever (6).
3. Remove cover (7).
4. Replace filter element (5).
5. Install cover (7).
6. Operate lever (6) to tension clamping band (4).
7. Push back rubber sleeve (2) and tighten clamp (1).
8. Replace further filter elements in the same way.



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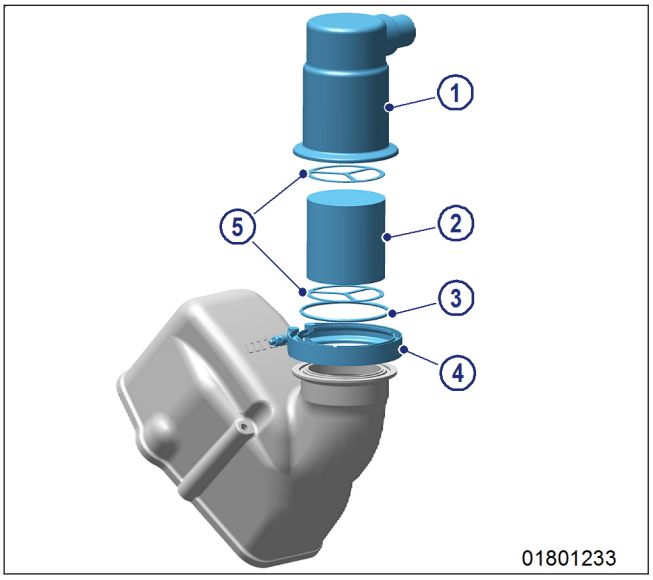
Crankcase breather (open-circuit crankcase ventilation) – Filter element cleaning or replacement



1. Clean filter externally.
2. Release vent hose on oil separator cover (1) and remove.
3. Remove oil separator cover (1).
4. Loosen clamp (5).
5. Clean or replace filter element (2) (→ Page 100).
6. Insert new sealing ring (3).
7. Install cleaned or new filter element (2) with filter holder (5).
8. Mount oil separator cover (1).
9. Use torque wrench to tighten nut of clamp (4) to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Nut		Tightening torque	(Engine oil)	9 Nm +1 Nm

10. Push vent hose onto oil separator cover (1) and bolt on.
11. Replace further filter elements (2) in the same way.

9.3.2 Crankcase breather (open-circuit crankcase ventilation) – Filter element cleaning

Preconditions

☑ Engine is stopped and starting disabled.

WARNING

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

NOTICE

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

Cleaning filter element

1. Remove filter element (→ Page 98).
2. Clean filter element with cleaning agent.
3. Remove cleaning agent.
4. Blow out filter element thoroughly with compressed air.
5. Install filter element (→ Page 98).

9.4 Running Gear

9.4.1 Grounding device - Carbon brush check

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

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

WARNING

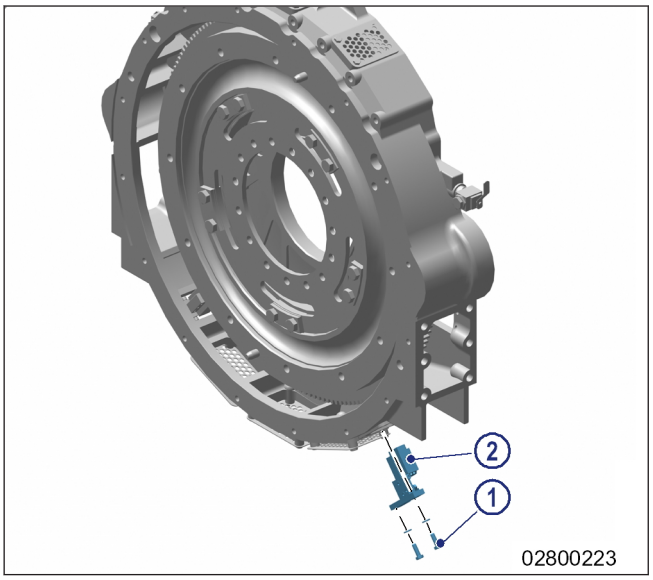
Compressed air gun ejects a jet of pressurized air.
Risk of injury to eyes and damage to hearing, risk of rupturing internal organs!
- Never direct air jet at people.
- Always wear safety goggles/face mask and hearing protection.

NOTICE

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

Removing grounding assembly

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



Checking grounding equipment

Item	Findings	Measure
Carbon brush	Damaged Wear limit 45 mm (new condition 60 mm)	Replace (→ Page 103) Replace (→ Page 103)
Press carbon brush against spring pressure Spring	 Broken, damaged	 Replace (→ Page 103)
Running surface on adapter	Dirty, 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. Remove dirt from flywheel housing installation surface.
2. Install grounding device (2) on flywheel housing and secure with screws (1) and washers.
3. Tighten screws (1) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw	M8	Tightening torque	(Engine oil)	21 Nm +2 Nm

9.4.2 Grounding device – Carbon brush replacement

Preconditions

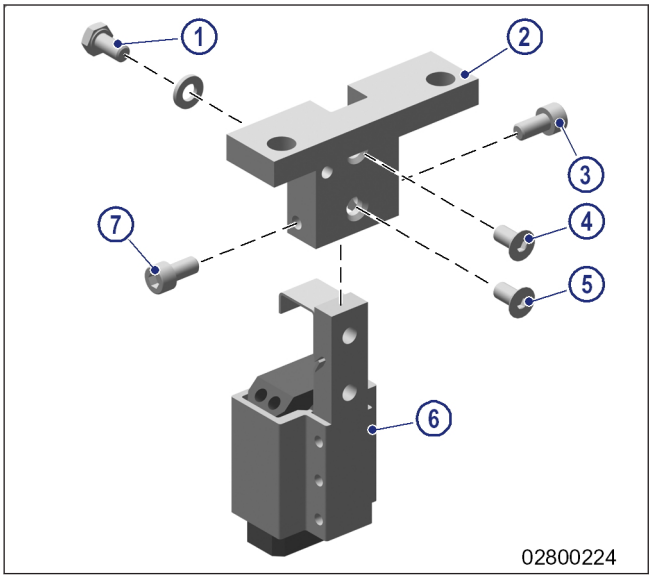
☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 4–20 Nm	F30044239	1
Screw locking compound (Loctite 270)	40083	1
Carbon brush	(→ Spare Parts Catalog)	

Replacing carbon brush

1. Undo screw (1) with washer.
2. Disconnect cable from screw (1).
3. Undo screws (4) and (5).
4. Remove screws (3) and (7).
5. Remove carbon brush (6) from adapter (2).
6. Fit new carbon brush (6) on adapter (2).
7. Tighten screws (4) and (5) finger-tight.
8. Turn screws (3) and (7) as far as the stop and tighten lightly.



9. Tighten screws (4) and (5) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw	1/4"-20	Tightening torque	(Screw locking compound (Loctite 270))	9 Nm +1 Nm

Note: Apply screw locking compound to thread only to prevent isolating effect.

10. Connect cable to screw (1) with washer.
11. Tighten screw (1) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw	M6	Tightening torque	(Screw locking compound (Loctite 270))	9 Nm +1 Nm

9.5 Valve Drive

9.5.1 Valve gear - Lubrication

Preconditions

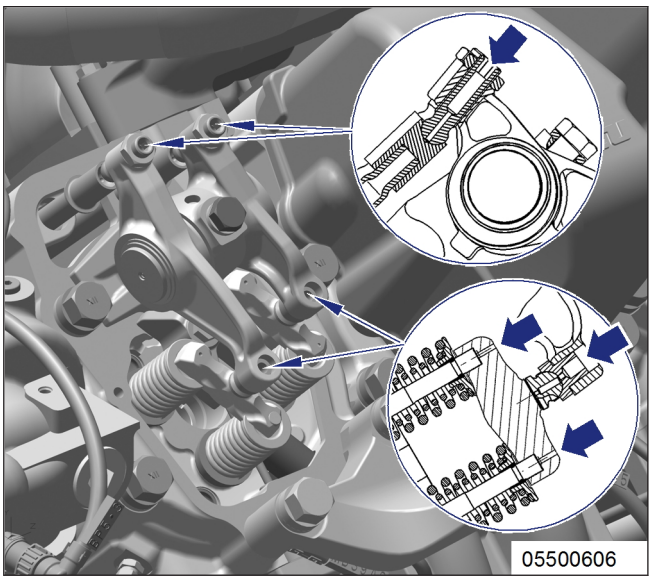
☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine oil		

Valve gear – Lubrication

1. Remove cylinder head covers (→ Page 111).
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 111).



9.5.2 Valve protrusion - Measurement

Preconditions

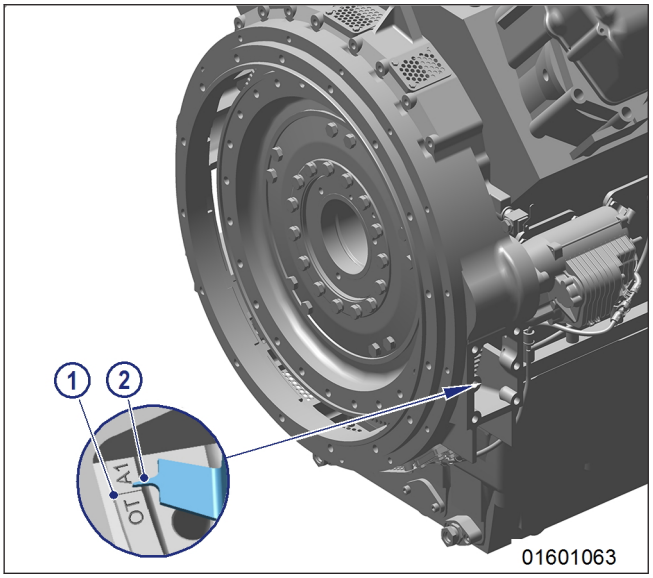
☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Depth gage, 200 mm	Y20000918	1

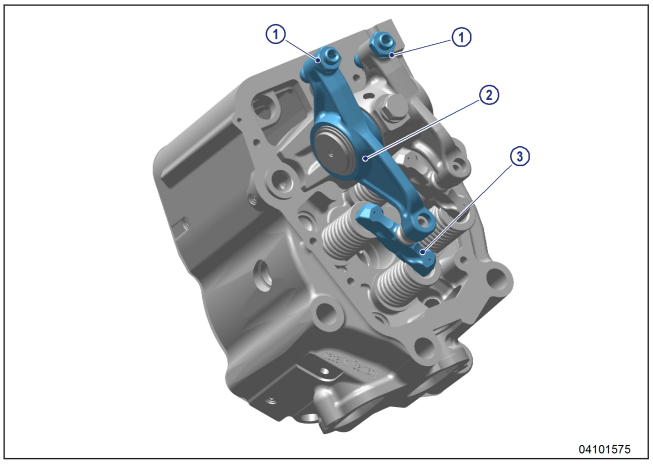
Preparatory steps

1. Remove cylinder-head cover upper section (→ Page 111).
2. Remove injector (→ Page 114).
3. Install barring tool (→ Page 92).
4. Turn crankshaft in direction of engine rotation using barring tool until OT marking (1) and pointer (2) are aligned.

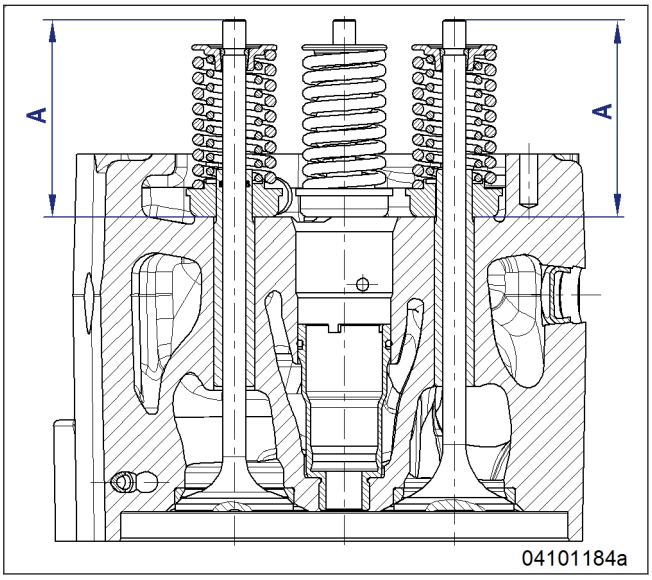


Measuring valve protrusion

1. Check TDC position of piston in cylinder A1:
   - If rocker arms on cylinder A1 are unloaded, the piston is in firing TDC.
   - If rocker arms on cylinder A1 are loaded, the piston is in overlap TDC.
2. Measure valve protrusion for each valve in two crankshaft positions (firing TDC and overlap TDC) according to the diagram. Diagram (→ Page 107).
3. Undo adjusting screw (1) and remove valve bridge (3). Do not remove rocker arm (2).



4. Measure distance between valve stem end and cylinder head top at the injector bore with depth gage (see figure).
   - Specified value for a new cylinder head: 93.8 mm.
   - Admissible wear: 2 mm.
   - If the measured value is > 95.8 mm, have the relevant cylinder head replaced by specialist personnel ahead of schedule.
5. Install valve bridge.
6. Adjusting valve clearance (→ Page 107)



Final steps

1. Remove barring tool (→ Page 92).
2. Install injector (→ Page 114).
3. Install cylinder-head cover upper section (→ Page 111).

9.5.3 Valve clearance – Check and adjustment

Preconditions

☑ Engine is stopped and starting disabled.

☑ Engine coolant temperature is max. 40 °C.

☑ Valves are closed.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Feeler gage	Y20098771	1
Torque wrench, 60–320 Nm	F30452768	1
Socket box wrench	F30039526	1
Engine oil		

Preparatory steps

1. Remove cylinder head cover (→ Page 111).
2. Install barring tool (→ Page 92).
3. Use barring tool to turn crankshaft in direction of rotation until marking OT-A1 (1) and pointer (2) are aligned.

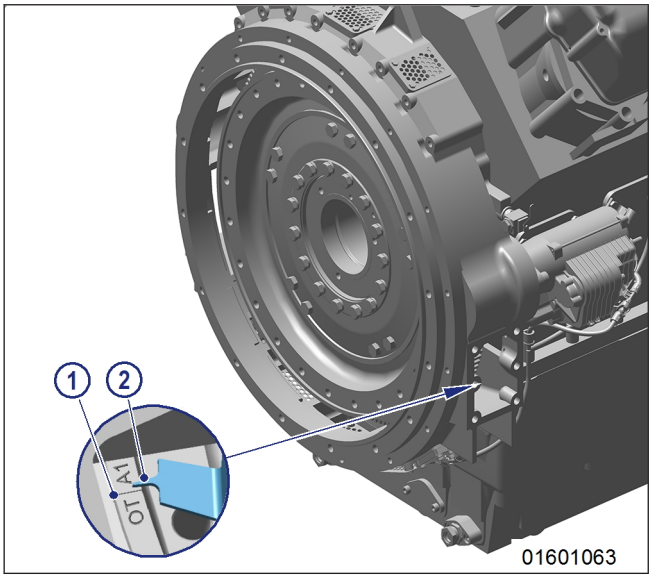


Diagram for 8V engines – two crankshaft positions

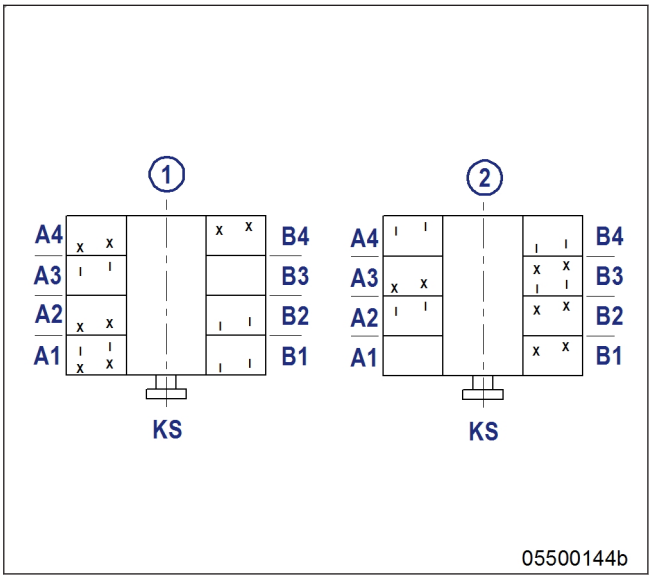


Diagram for 12V engines – two crankshaft positions

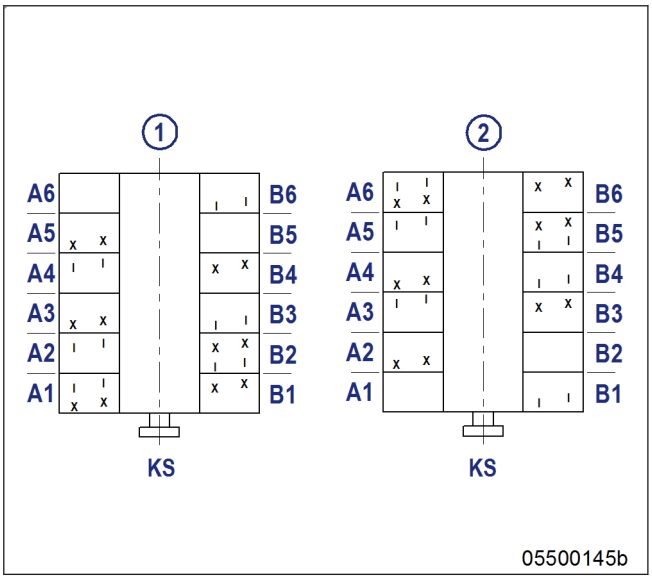


Diagram for 16V engines – two crankshaft positions

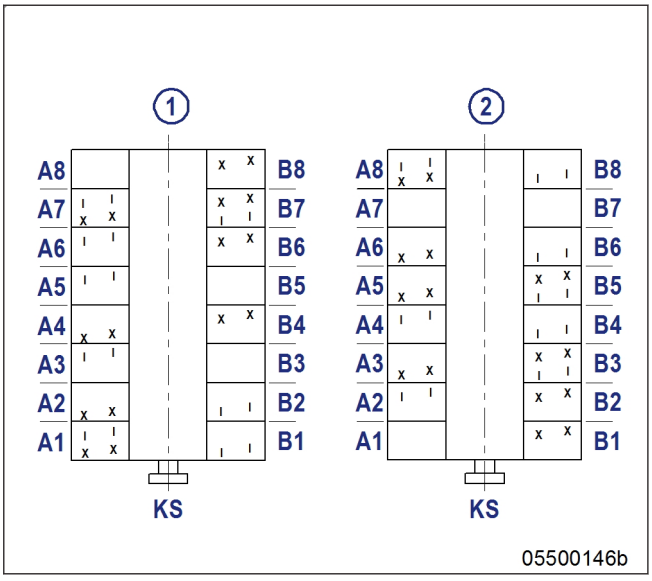


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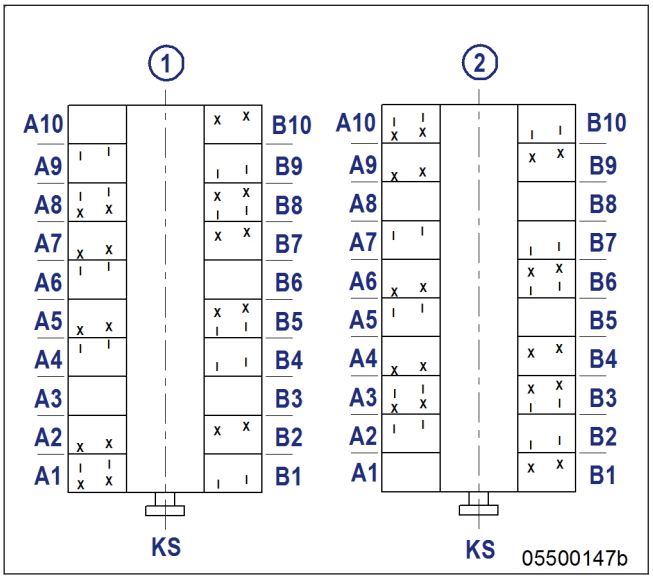
Diagram for 20V engines – two crankshaft positions

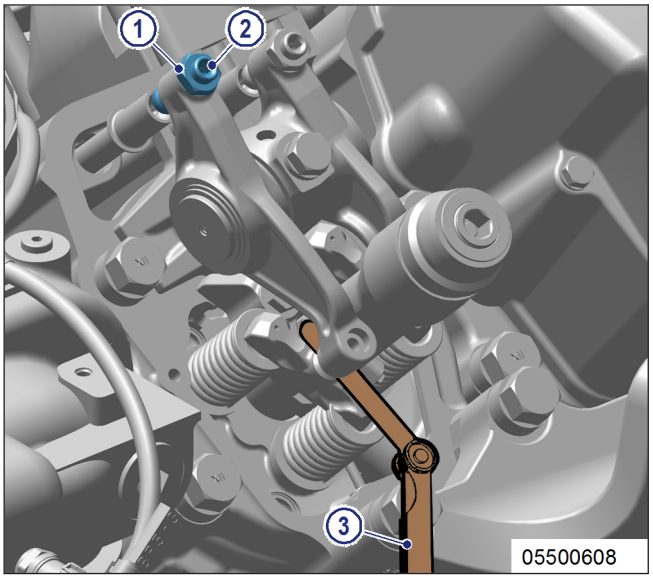


Checking valve clearance at two crankshaft positions

1. Check TDC position of piston in cylinder A1:
   - If rocker arms on cylinder A1 are unloaded, the piston is in firing TDC.
   - If rocker arms on cylinder A1 are loaded, the piston is in overlap TDC.
2. Check valve clearance with cold engine:
   - Inlet (long rocker arm) = 0.2 mm ±0.05 mm
   - Exhaust (short rocker arm) = 0.5 mm ±0.0 5mm
3. Check all valve clearances in two crankshaft positions (firing TDC and overlap TDC of cylinder A1) as per diagram:
   - 1 Cylinder A1 is in firing TDC
   - 2 Cylinder A1 is in overlap TDC
   - I Inlet valve
   - X Exhaust valve
4. Use feeler gage to determine the distance between valve bridge and rocker arm.
5. If the deviation from the specified value exceeds ±0.05 mm, adjust valve clearance.

Adjusting valve clearance

1. Release locknut (1).
2. Insert feeler gage (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 gage (3) must just pass through the gap.



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

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

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

Final steps

1. Remove barring tool (→ Page 92).
2. Install cylinder head cover (→ Page 111).

9.5.4 Cylinder head cover - Removal and installation

Preconditions

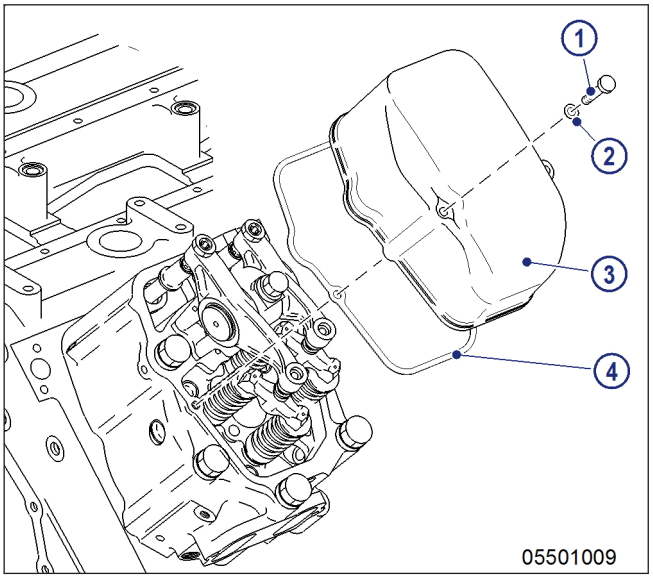
☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

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

Removing cylinder head cover

1. Clean very dirty cylinder head covers (3) prior to removal.
2. Undo screws (1) and remove with washers (2).
3. Remove cylinder head cover (3) with gasket (4) from cylinder head.
4. Remove other cylinder head covers in the same way.



Installing cylinder head cover

1. Clean mating faces.
2. Check gasket (4) for damage, replace if necessary.
3. Place gasket (4) and cylinder head cover (3) onto cylinder head.
4. Install cylinder head cover (3) with screws (1) and washers (2).
5. Install other cylinder head covers in the same way.

9.6 Injection Pump / HP Pump

9.6.1 HP fuel pump - Relief bore check

DANGER

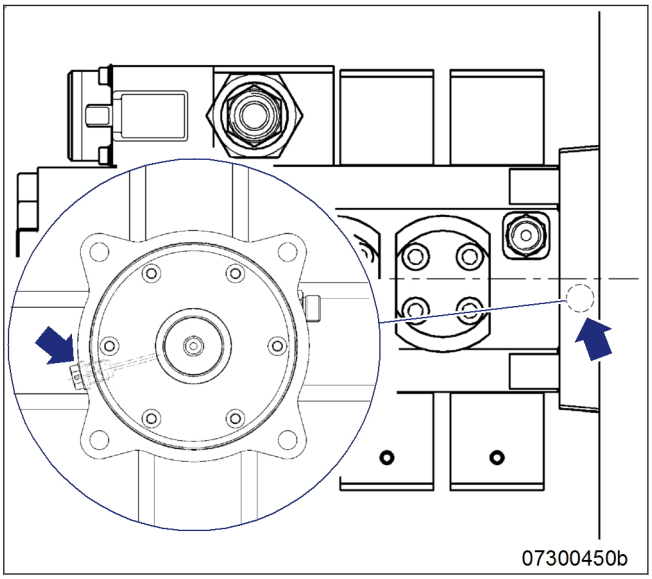
Components are moving or rotating.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Operate the engine at low load only. Keep clear of the danger zone of the engine.

WARNING

A high level of noise is produced when the engine is running.
Risk of hearing loss!
- Wear suitable hearing protection.

HP fuel pump – Relief bore check

1. Check relief bore for oil and fuel discharge by visual inspection.
2. If relief bore is found dirty, stop the engine, disable engine start, and clean relief bore.
3. Note the following in case of fluid discharge:
   - Heavy discharge means continuous discharge of fluids (leakage). Contact Service.
   - Minor discharge of fluids up to 10 drops per day is normal (moistening) and not considered a leakage.



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9.7 Injector

9.7.1 Injector - Replacement

Special tools, Material, Spare parts

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

Injector – Replacement

▶ Remove injector and install new one (→ Page 114).

9.7.2 Injector - Removal and installation

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Installation and removal jig	F6794703	1
Milling cutter	F30452739	1
Slotted screwdriver	F30452578	1
Torque screwdriver, 1–5 Nm	F30452774	1
Torque wrench, 10–60 Nm	F30452769	1
Torque wrench, 60–320 Nm	F30452768	1
Assembly compound (Optimoly Paste White T)	40477	1
Assembly compound (Kluthe Hakuform 30-15)	X00067260	1
Engine oil		

WARNING

Fuels are combustible and explosive.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.
- Wear protective clothing, protective gloves, and safety glasses / facial protection.

NOTICE

Cable damage during operation.
Fire hazard!
- Twist the cables when attaching.
- Ensure that the cables do not touch any components.

NOTICE

Removing all injectors.
Component damage possible!
- Ensure that the HP accumulator is secured on the engine through two HP lines.

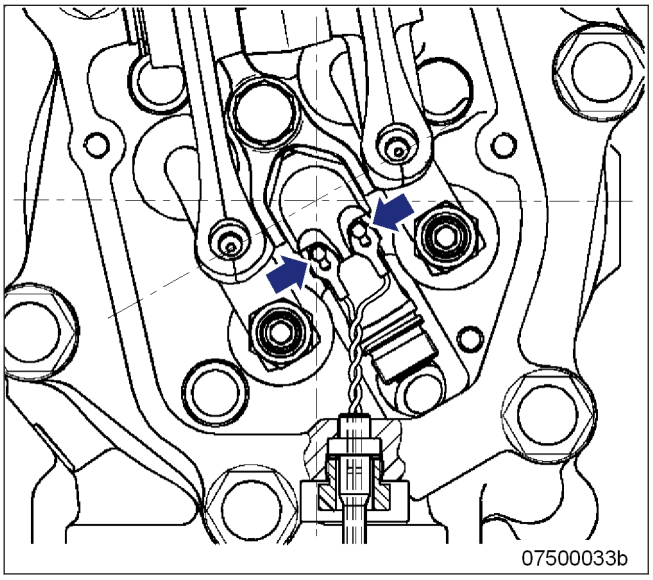
Preparatory steps

1. Close off fuel supply to engine.
2. Remove cylinder head cover (→ Page 111).

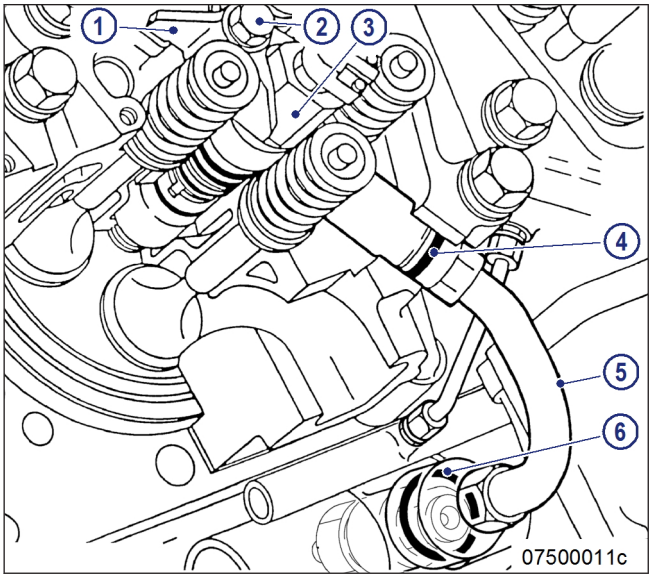
Removing injector

Note: Always replace the first and last injectors of one engine side first. Replace the inner injectors only after the installation of the outer injectors on this engine side is completed.

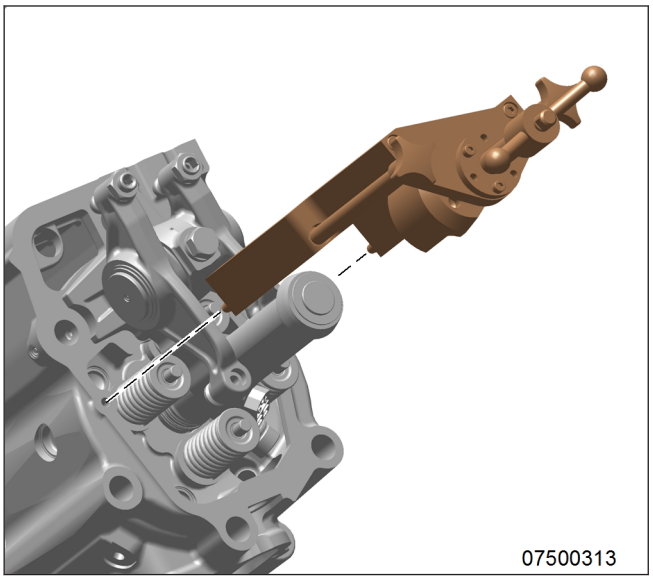
1. Release the cable terminal threaded connection (arrowed) on the injector and remove cable terminals.



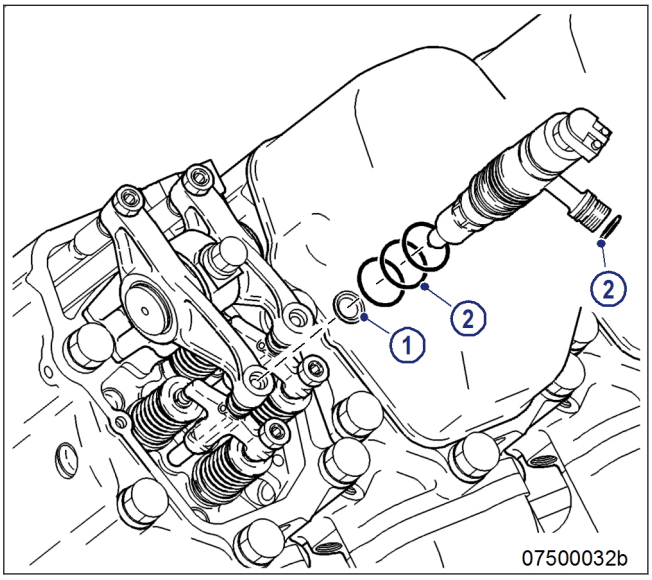
2. Remove screw (2) and take off hold-down clamp (1).
3. Remove HP fuel line (5).



4. Install installation/removal jig on the cylinder head.
5. Remove injector with installation/removal jig.
6. Remove the installation/removal jig.

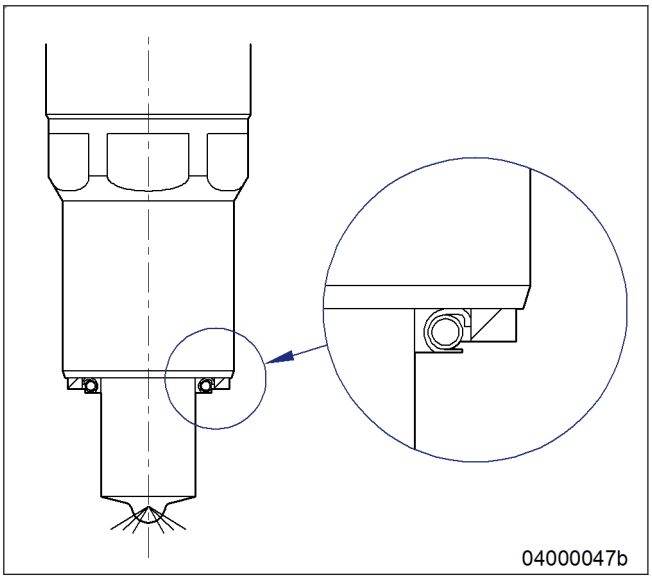


7. Remove sealing ring (1) from injector or use a self-made hook to take it out of the cylinder head.
8. Remove O-rings (2) from injector.
9. Cover all connections and bores, or seal with suitable plugs.

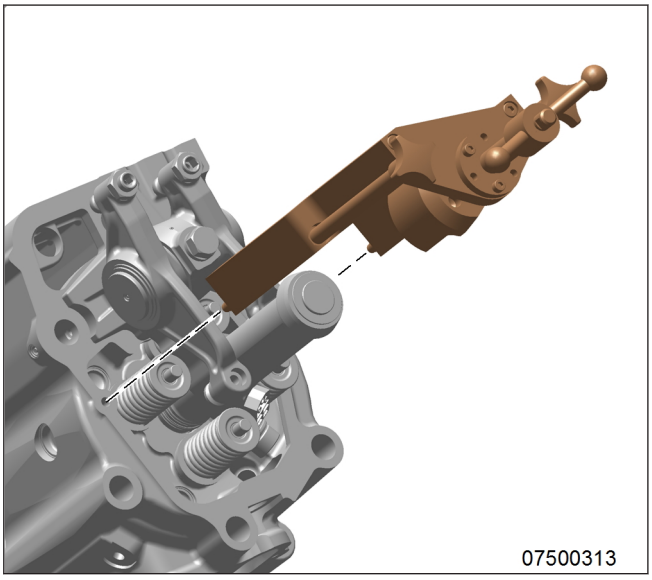


Installing injector

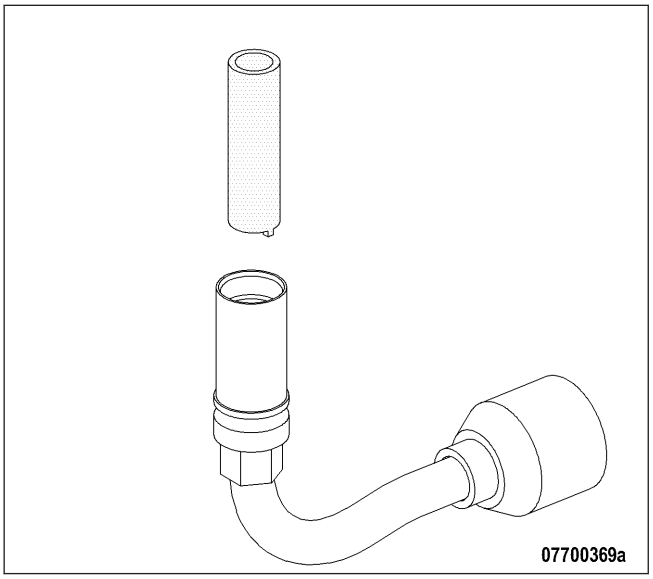
1. Prior to installation, remove all blanking plugs.
2. Coat injector with assembly paste in the area of the nozzle retaining nut.
3. Fit new O-rings on injector and apply assembly compound.
4. Fit new sealing ring with assembly compound on injector, pay attention to installation position of sealing ring.



5. Clean sealing face on cylinder head and protective sleeve with milling cutter.
6. Insert injector into cylinder head, making sure that the HP line connections are aligned correctly.
7. Press in injector with installation/removal jig.
8. Remove the installation/removal jig.



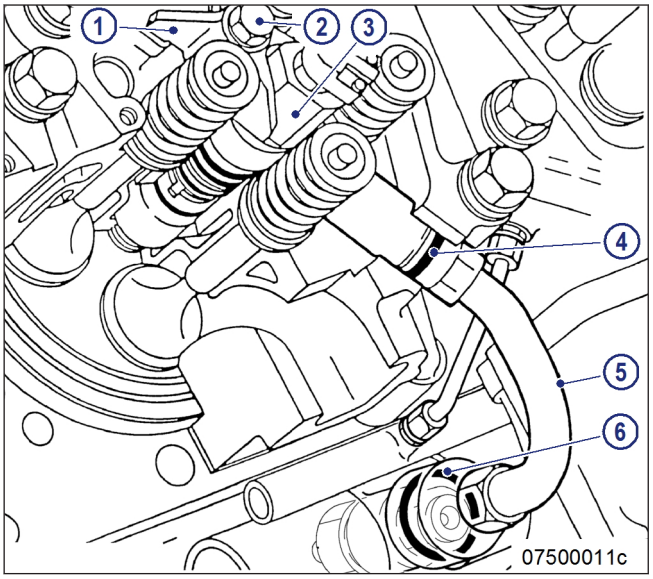
9. Use slotted screwdriver to check thrust ring at both line ends for secure seating.



10. Tighten loose thrust ring to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Thrust ring		Tightening torque		5 Nm to 10 Nm

11. Coat screw head mating face (2) and thread with engine oil.



12. Fit hold-down clamp (1) in correct position by hand. Tighten screw (2) to specified initial tightening torque using a torque wrench.

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

13. Fit O-rings (4) and (6) on HP fuel line (5) and coat with assembly compound.

14. Tighten HP fuel line (5) to specified initial tightening torque.

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

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

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

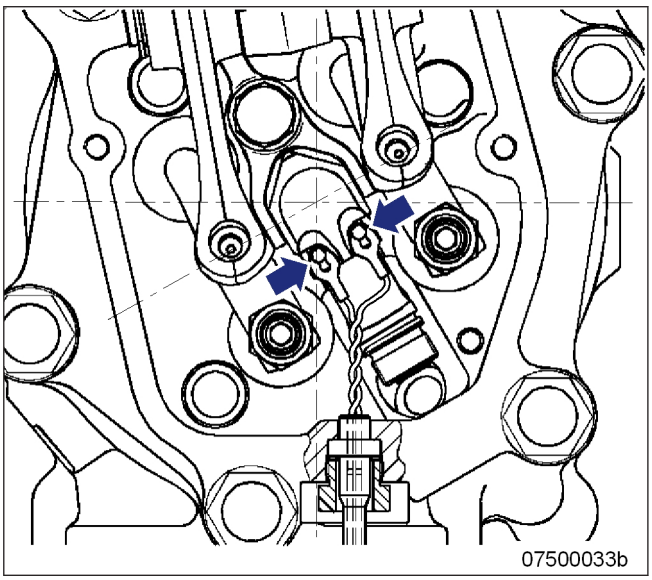
16. Tighten union nut of adapter (limiting valve) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Union nut		Tightening torque		140 Nm + 10 Nm

17. Tighten union nut of adapter (injector) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Union nut		Tightening torque		120 Nm +10 Nm

18. Twist cable several times.



19. Insert cable lugs (arrowed) underneath the screws on the injector and tighten screws to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque		1.5 Nm

Final steps

1. Install cylinder head cover (→ Page 111).
2. Open fuel supply to engine.

9.8 Fuel System

9.8.1 Fuel system - Venting

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

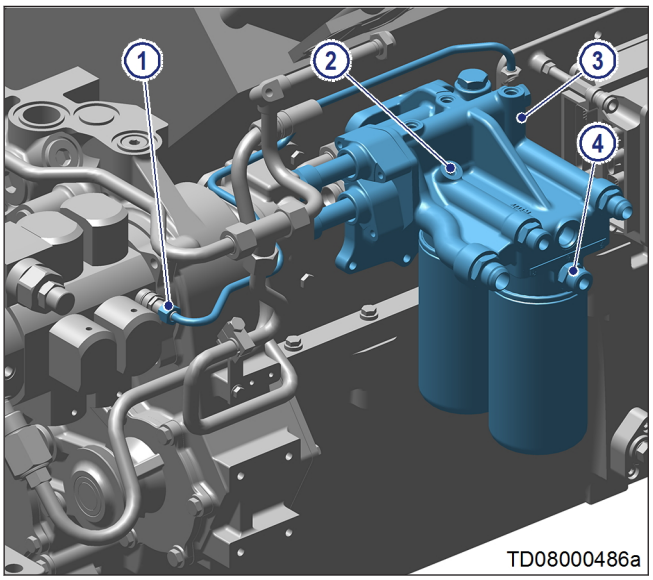
Designation / Use	Part No.	Qty.
Filling device	B80144852	1
Diesel fuel		

WARNING

Fuels are combustible and explosive.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.
- Wear protective clothing, protective gloves, and safety glasses / facial protection.

LP fuel system – Venting

1. Connect filling device to connection (4).
2. Disconnect return line at connection (1).
3. Use hand pump to fill fuel system, providing pressure of min. 0.5 bar / max. 2.0 bar, until fuel emerges without bubbles at connection (1).
4. Connect return line to connection (1).
5. Open vent plug (2) on filter housing (3).
6. Use hand pump to fill fuel system, providing pressure of min. 0.5 bar / max. 2.0 bar, until fuel emerges without bubbles at connection (2).
7. Close vent plug (2).
8. Remove filling device and seal connection (4).



9.9 Fuel Filter

9.9.1 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

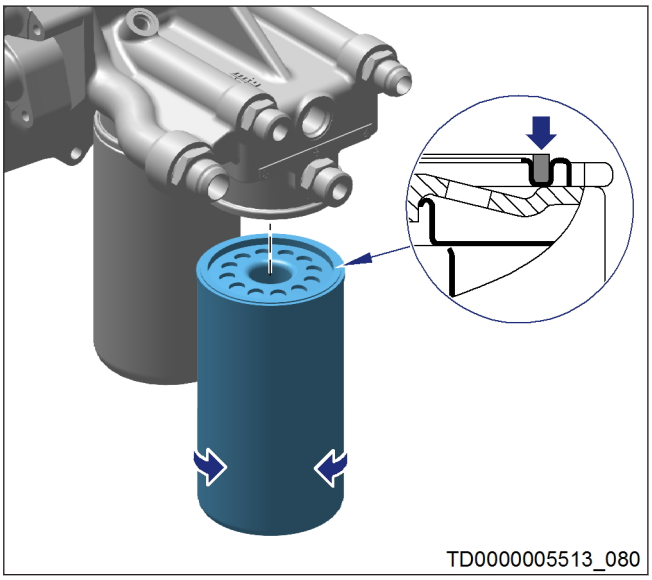
Fuels are combustible and explosive.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.
- Wear protective clothing, protective gloves, and safety glasses / facial protection.

WARNING

Liquid or gaseous media, e.g. fuel, are poisonous.
Escaping vapors of highly volatile media, e.g. fuel or ether.
Risk of fatal injury through swallowing; risk of poisoning through inhalation; irritation to eyes and skin!
- Seek medical attention immediately; do not induce vomiting.
- Do not inhale vapors or mist.
- Wear protective clothing, protective gloves, and safety glasses.
- If contact is made with skin, wash off with water and soap.

Fuel filter – Replacement

1. Use filter wrench to remove easy-change filter.
2. Clean sealing surface on filter head.
3. Coat seal on easy-change filter slightly with engine oil (arrow).
4. Screw on the easy-change filter by hand until the seal makes contact and tighten finger-tight.
5. Replace further easy-change filters in the same way.
6. Vent fuel system (→ Page 119).



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9.9.2 Intermediate fuel filter - Replacement

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

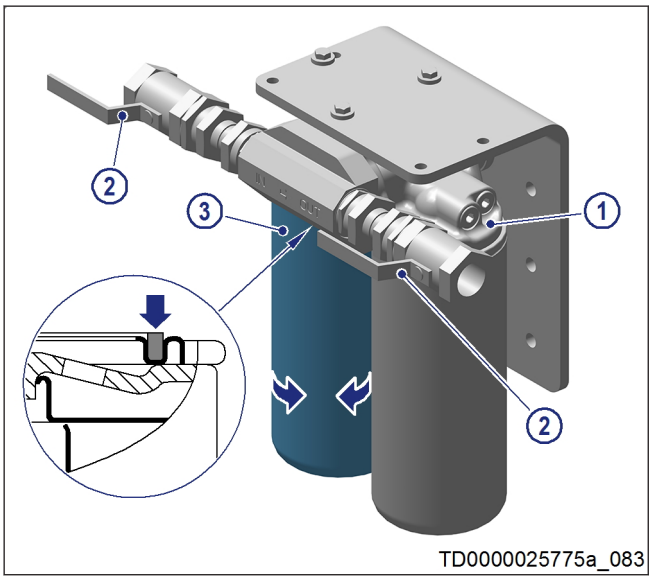
Designation / Use	Part No.	Qty.
Filter wrench	F30379104	1
Engine oil		
Easy-change filter	(→ Spare Parts Catalog)	2

WARNING

Fuels are combustible and explosive.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.
- Wear protective clothing, protective gloves, and safety glasses / facial protection.

Intermediate fuel filter – Replacement

1. Close the two shut-off valves (2) to stop the fuel supply to the filters.
2. Remove easy-change filter (3) with filter wrench.
3. Clean sealing surface on filter head (1).
4. Coat seal on easy-change filter (3) slightly with engine oil (arrow).
5. Screw on easy-change filter (3) by hand until the seal makes contact with the filter head and tighten manually.
6. Replace other easy-change filters in the same way.
7. Open shut-off valves (2).
8. Vent fuel system (→ Page 119).



9.9.3 Fuel prefilter - Draining

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

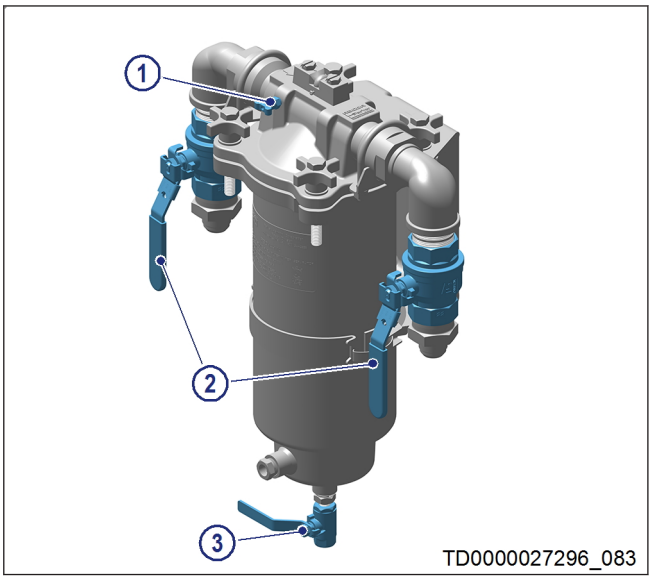
Designation / Use	Part No.	Qty.
Diesel fuel		

WARNING

Fuels are combustible and explosive.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.
- Wear protective clothing, protective gloves, and safety glasses / facial protection.

Fuel prefilter – Draining

1. Close shut-off valve (2) in fuel supply line.
2. Open threaded vent plug (1) of the filter.
3. Open drain valve (3) and drain water and contaminates until clear fuel escapes.
4. Close drain valve (3).
5. Tighten vent plug (1) by hand.
6. Open shut-off valve (2) in fuel supply line.



9.9.4 Fuel prefilter – Filter element replacement

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 4–20 Nm	F30044239	1
Diesel fuel		
Filter element	(→ Spare Parts Catalog)	
O-ring	(→ Spare Parts Catalog)	

WARNING

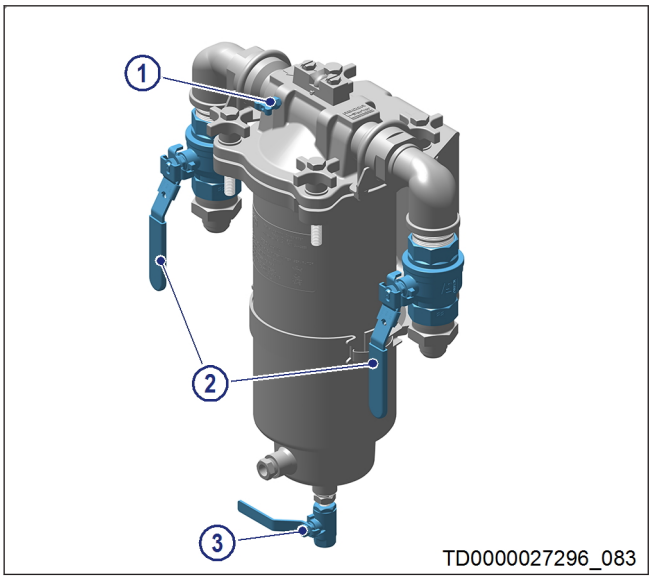
Fuels are combustible and explosive.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.
- Wear protective clothing, protective gloves, and safety glasses / facial protection.

WARNING

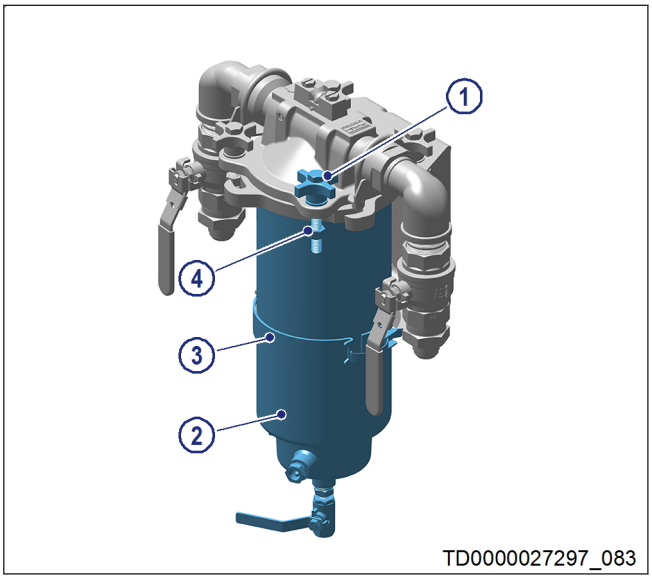
Liquid or gaseous media, e.g. fuel, are poisonous.
Escaping vapors of highly volatile media, e.g. fuel or ether.
Risk of fatal injury through swallowing; risk of poisoning through inhalation; irritation to eyes and skin!
- Seek medical attention immediately; do not induce vomiting.
- Do not inhale vapors or mist.
- Wear protective clothing, protective gloves, and safety glasses.
- If contact is made with skin, wash off with water and soap.

Replacing filter element

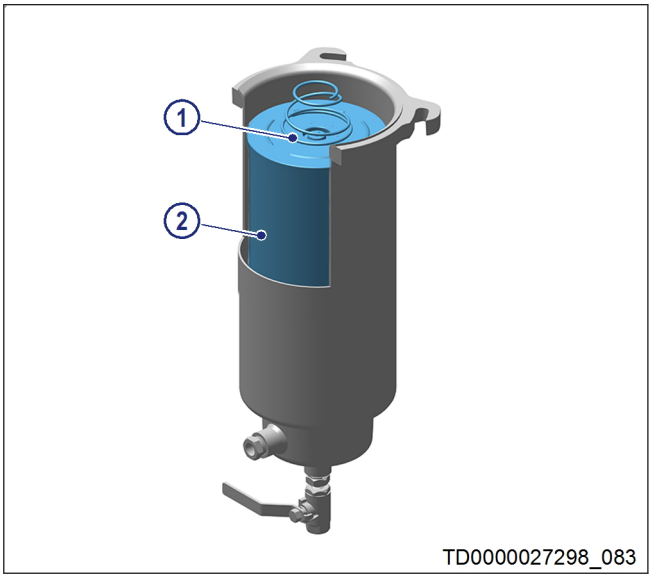
1. Close shut-off valve (2) in fuel supply line.
2. Open threaded vent plug (1) of the filter.
3. Open drain valve (3) and drain filter completely.
4. Close drain valve (3).



5. Remove clamp (3) from filter housing (2).
6. Loosen screws (1) and nuts (4) until it is possible to rotate the filter housing (2) out of the fixture.
7. Remove filter housing (2) from filter assembly.

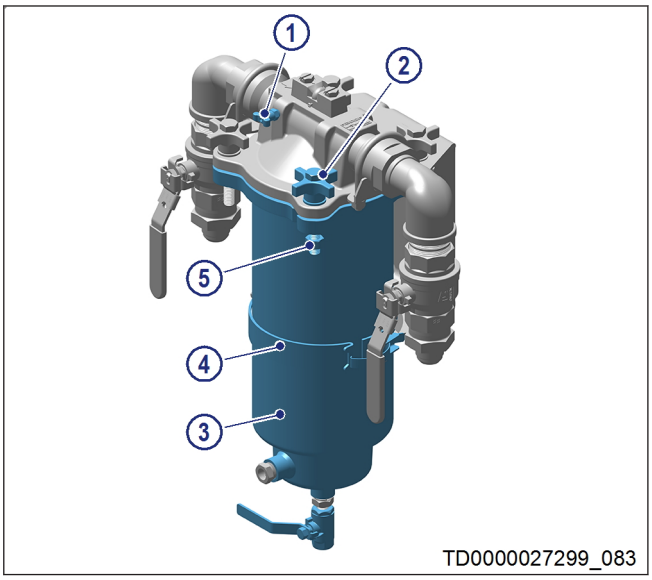


8. Remove O-ring from filter housing and discard it.
9. Remove filter element (2) with spring (1).
10. Install new O-ring in cover, lubricate it with fuel or oil.
11. Install new filter element (2) in filter housing.



Note: If the fuel pressure before the prefilter is negative (The fuel tank below prefilter and no pump before prefilter) continue with step 12. If the fuel pressure before the prefilter is positive (The fuel tank above prefilter or/and pump before prefilter) go to step 18.

12. Close threaded vent plug (1).
13. Fill filter housing (3) with clean fuel.
14. Install filter housing (3) with spring on filter assembly and secure filter housing with clamp (4).
15. Tighten screws (2) and nuts (5) by hand.



16. Use torque wrench to tighten screw (2) to the specified torque.

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

17. Open shut-off valve.

Note: If the fuel pressure before the prefilter is positive continue with step 18, if you followed the instructions from steps 12 to 17, proceed with step 23.

18. Install filter housing (3) with spring on filter assembly and secure filter housing with clamp (4).
19. Tighten all screws (2) and nuts (5) by hand.
20. Use torque wrench to tighten screws (2) to the specified torque.

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

21. Open shut-off valve, wait until clear fuel escapes at the threaded vent plug (1).
22. Close threaded vent plug (1).
23. If the main or/and intermediate filter have been replaced as well, vent fuel system. (→ Page 119).

9.9.5 Fuel prefilter with internal electrical priming pump - Draining

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

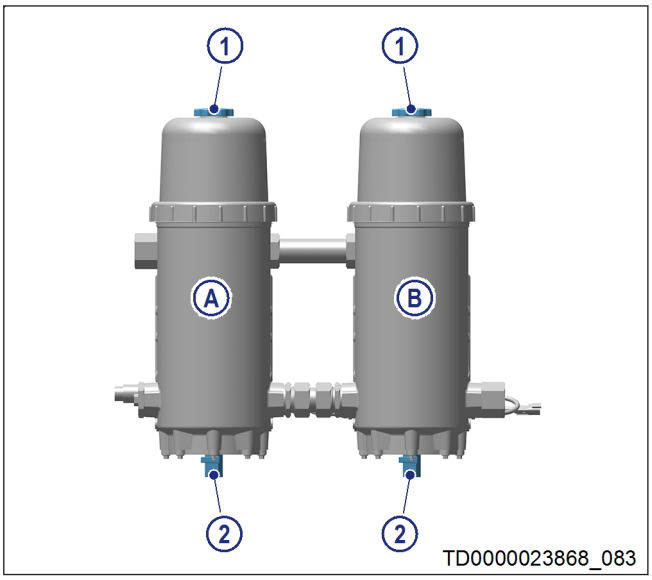
Designation / Use	Part No.	Qty.
Diesel fuel		

WARNING

Fuels are combustible and explosive.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.
- Wear protective clothing, protective gloves, and safety glasses / facial protection.

Fuel prefilter – Draining

1. Close shut-off valve in fuel supply line for filter A and B.
2. Open threaded vent plug (1) of the filter that should be drained.
3. Open drain valve (2) and drain water and contaminates until clear fuel emerges.
4. Close drain valve (2).
5. Fill filter housing with clean fuel through the vent plug opening.
6. Tighten vent plug (1) by hand until it clicks.
7. Open shut-off valve in fuel supply line for filter A and B.



9.9.6 Fuel prefilter with internal electrical priming pump – Filter element replacement

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Diesel fuel		
Filter element	(→ Spare Parts Catalog)	
O-ring	(→ Spare Parts Catalog)	
Collar wrench	(→ Scope of Supply)	

WARNING

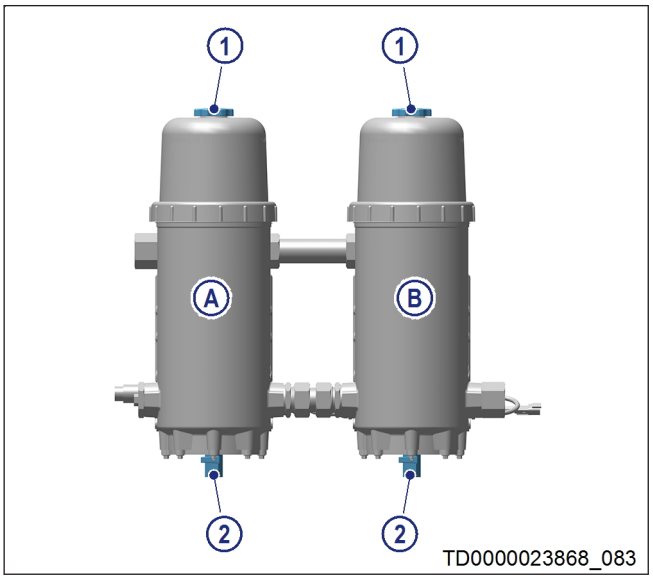
Fuels are combustible and explosive.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.
- Wear protective clothing, protective gloves, and safety glasses / facial protection.

WARNING

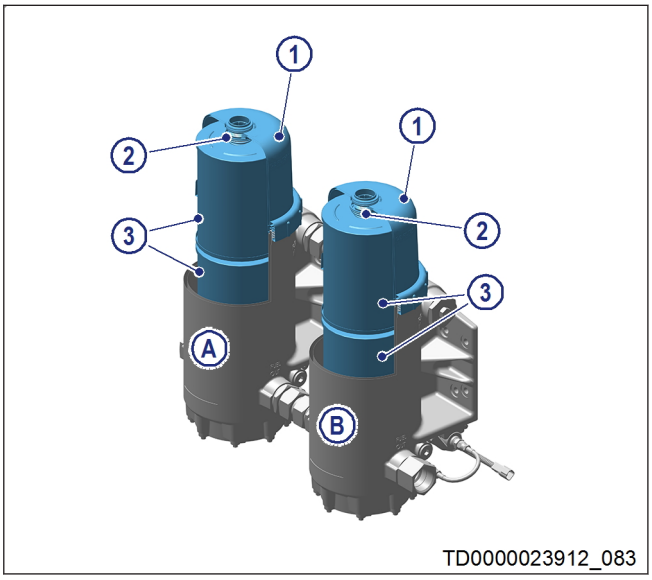
Liquid or gaseous media, e.g. fuel, are poisonous.
Escaping vapors of highly volatile media, e.g. fuel or ether.
Risk of fatal injury through swallowing; risk of poisoning through inhalation; irritation to eyes and skin!
- Seek medical attention immediately; do not induce vomiting.
- Do not inhale vapors or mist.
- Wear protective clothing, protective gloves, and safety glasses.
- If contact is made with skin, wash off with water and soap.

Replacing filter element

1. Close shut-off valve in fuel supply line for filter A and B.
2. Open threaded vent plug (1) of the filter to be replaced.
3. Open drain valve (2) and drain filter completely.
4. Close drain valve (2).



5. Use collar wrench to remove clear cover (1) with spring (2) and discard the O-ring from the cover.
6. Remove filter elements (3) by pulling them upwards.
7. Install new O-ring (supplied with new filter elements.) in cover.



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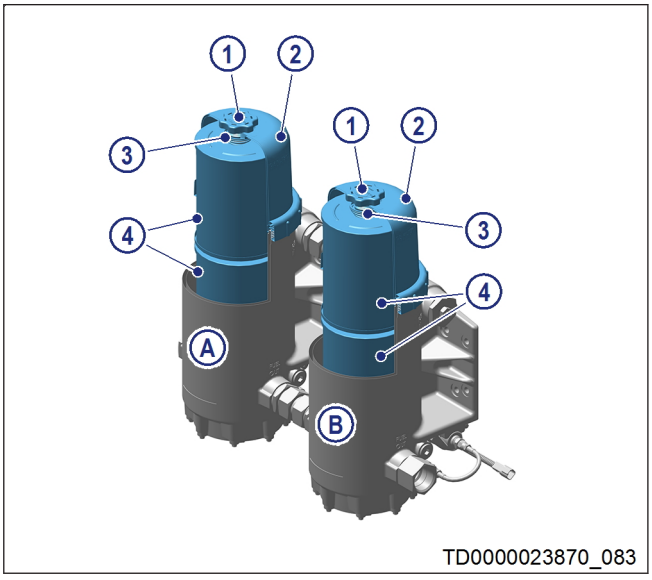
8. Insert new filter elements (4) in filter housing.
9. Use collar wrench to tighten clear cover (2) with spring (3).



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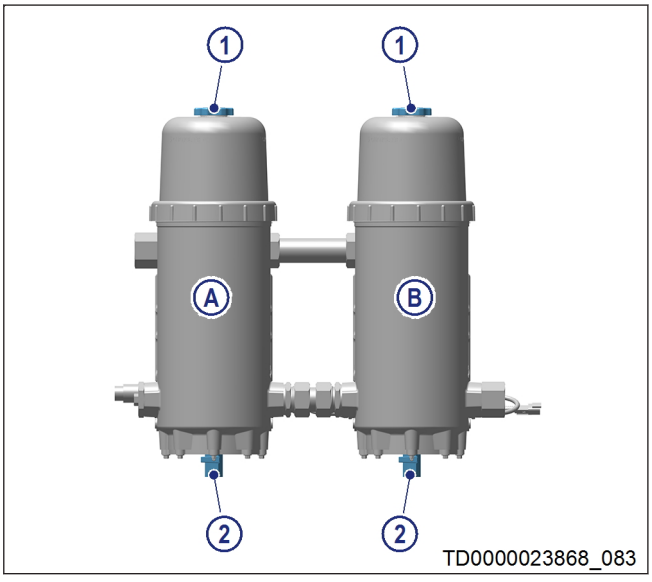
Venting when only the prefilter elements are replaced

1. Fill filter housing with clean fuel through the opening of the threaded vent plug (1).
2. Tighten the threaded vent plug (1) by hand until it clicks.
3. Open shut off valve in fuel supply line for filter A and B.



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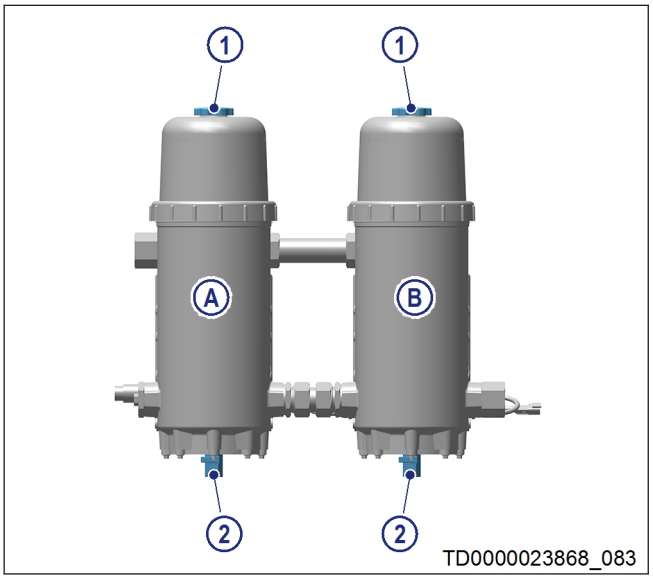
Venting when the whole filter chain is replaced (prefilter, primary filter, secondary filter)

Note: If only the primary and secondary filters are replaced, the pump of the prefilter can be used instead of the hand pump to vent the primary and secondary filters.

1. Tighten threaded vent plug (1) of prefilter by hand until it clicks.
2. Open shut off valve in fuel supply line for filter A and B.
3. Open threaded vent plug primary filter (→ Page 119) and connect a suitable hose to collect escaping fuel.
4. Run electrical priming pump of prefilter until bubble-free fuel escapes at the vent plug on the primary filter.
5. Close threaded vent plug on primary filter.



9.10 Charge-Air Cooling

9.10.1 Intercooler - Checking condensate drain for coolant leakage and obstruction

DANGER

Components are moving or rotating.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Operate the engine at low load only. Keep clear of the danger zone of the engine.

WARNING

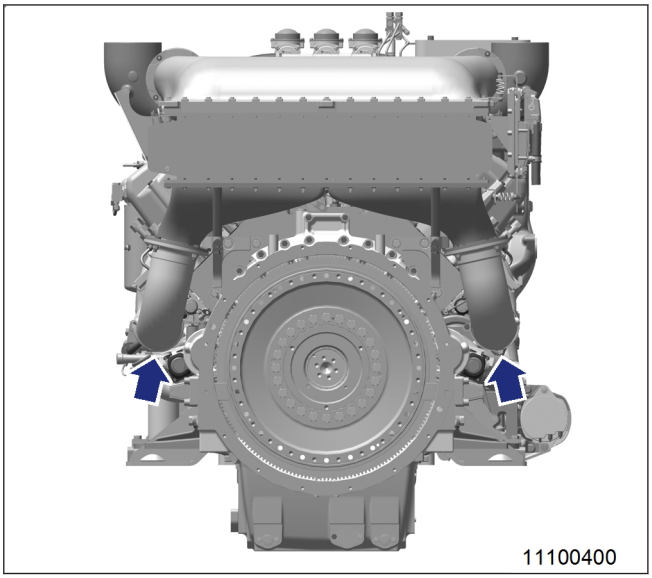
A high level of noise is produced when the engine is running.
Risk of hearing loss!
- Wear suitable hearing protection.

WARNING

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

Intercooler – Checking condensate drain for coolant leakage and obstruction

1. With the engine running, verify that air escapes from the condensate drain bore(s) at driving end, left and right engine side. If no air escapes:
   - Clean condensate drain bore(s)
   - Blow out with compressed air
2. If a large amount of coolant is continuously discharged, the intercooler is leaking. Contact Service.



Emergency measures prior to engine start with a leaking intercooler

1. Remove the injectors (→ Page 114).
2. Bar engine manually (→ Page 92).
3. Bar engine with starting system to blow out combustion chambers (→ Page 93).
4. Install the injectors (→ Page 114).

9.11 Starting Equipment

9.11.1 Starter – Condition check

Preconditions

☑ Engine is stopped and starting disabled.

Starter – Condition check

1. Check securing screws of starter and nut on cable connection for secure seating and tighten if required.
2. Check cabling (→ Page 173).

9.11.2 Cold start system with ether injection - Check

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

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

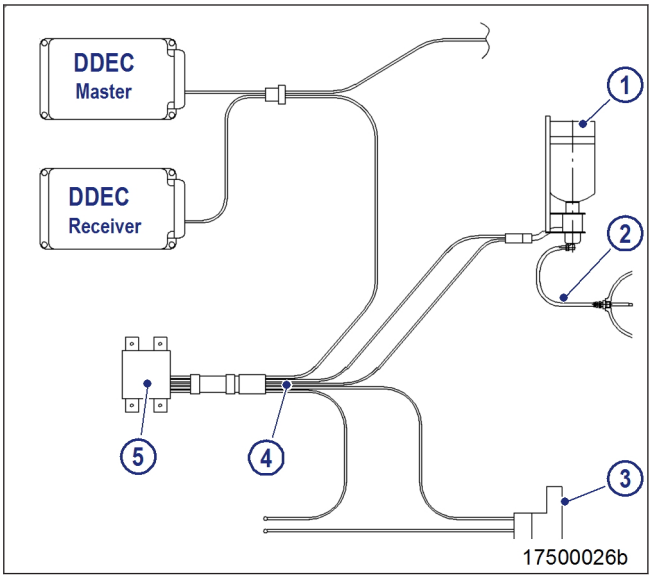
DANGER

Cleaner is an explosive and poisonous substance.
Danger to life, major material damage!
- Avoid open flames, electrical sparks and ignition sources.
- Wear goggles/facial protection.
- Only work in a well-ventilated room.
- Do not smoke.

Checking filling level and condition of system

Note: After two successive starting attempts with cold start system, try to start the engine again after 10 minutes only. If the next two staring trials fail, contact Service.

1. If the indicator lamp on the relay module (5) lights up, fit a new ether cartridge (1).
2. Check the condition of lines (2) and connections. If damage is found, contact Service.
3. Check the condition of electric lines (4) and connections. If damage is found, contact Service.
4. If the system fails, check fuses in fuse holder (3). If fuses are broken, contact Service.



9.12 Air Intake

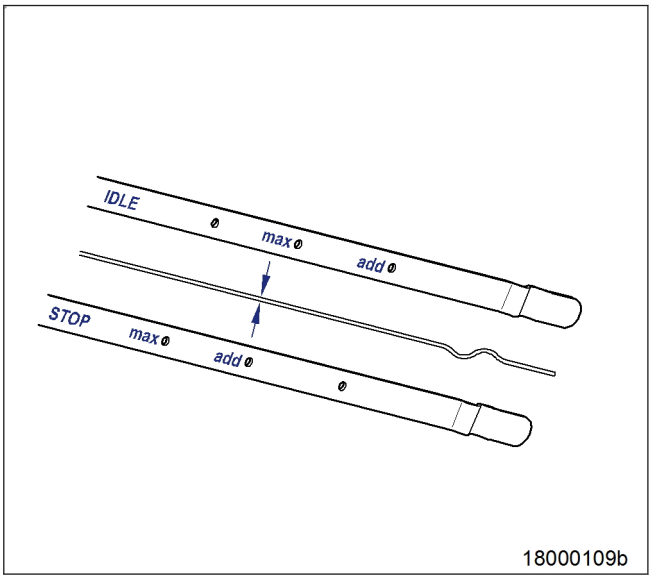
9.12.1 Service indicator – Check

See manufacturer's documentation.

9.13 Lube Oil System, Lube Oil Circuit

9.13.1 Engine oil - Level check

Checking oil level before starting engine



1. Remove oil dipstick from guide tube and wipe it clean.
2. Insert dipstick into guide tube up to the stop. Pull out after approx. 10 seconds and check oil level.
3. 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 (1). This might be caused by engine oil flowing from oil filter and heat exchanger back into the oil pan.

4. The oil level must reach the "max." mark or exceed it by up to 2 cm.
5. If necessary, top up to "max." mark (→ Page 136).
6. Insert dipstick into guide tube up to the stop.

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, remove oil dipstick from guide tube and wipe it.
2. Insert dipstick into guide tube up to the stop, pull out 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 136).

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 up to the stop, pull out 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 136).
5. Insert dipstick into guide tube up to the stop.

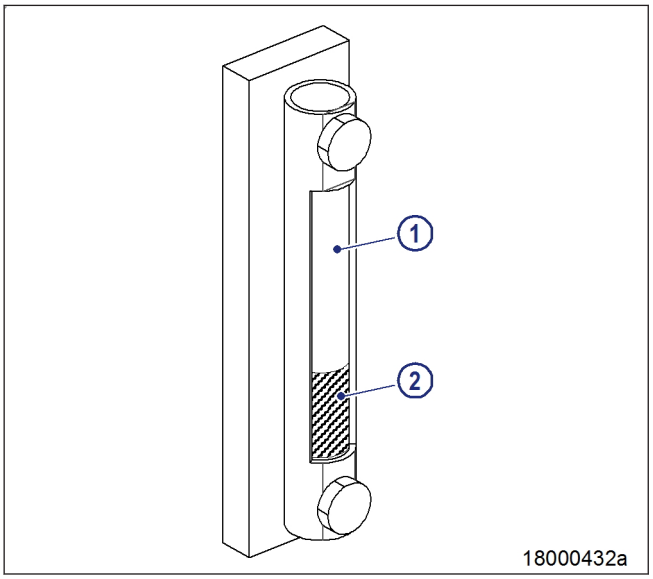
9.13.2 Checking engine oil level

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 134).



9.13.3 Engine oil - Change

Preconditions

☑ Engine is stopped and starting disabled.

☑ Engine is at operating temperature.

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

Special tools, Material, Spare parts

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

WARNING

Oil is hot.
Oil can contain residue/substances which are harmful to health.
Risk of injury and poisoning!
- Allow the product to cool to below 50 °C before beginning work.
- Wear protective clothing, protective 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.

Engine oil treatment

1. Check layer thickness of the oil residue, clean out and replace filter sleeve (→ Page 141).

Note: For engines with easy-change oil filters:

2. Replace engine oil filter (→ Page 140).

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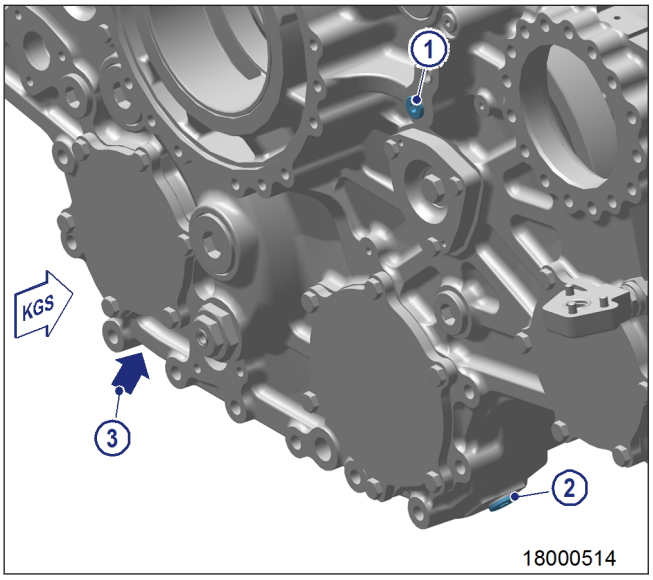
Draining residual oil from equipment carrier (only with unscheduled engine oil change)

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 plugs (2) and (3) and drain engine oil:
   - (2) approx. 12 liters
   - (3) approx. 5 liters
4. Install drain plug(s) with new sealing ring.

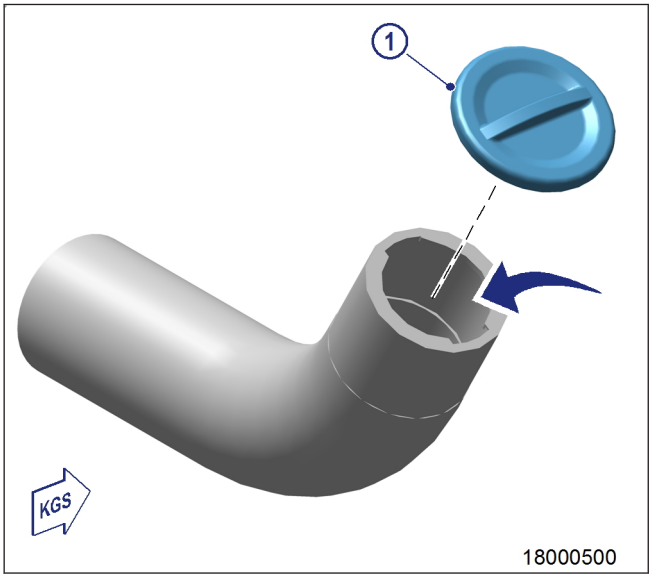


5. use torque wrench to tighten drain plugs (2) and (3) to specified tightening torque.

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

New engine oil – Filling

1. Open cover (1) on filler neck.
2. Fill engine oil through filler neck until “max.” mark on oil dipstick is reached.
3. Close cover (1) on filler neck.
4. Check engine oil level (→ Page 134).
5. Crank engine on starting system (→ Page 93).



9.13.4 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

Components are moving or rotating.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Operate the engine at low load only. Keep clear of the danger zone of the engine.

WARNING

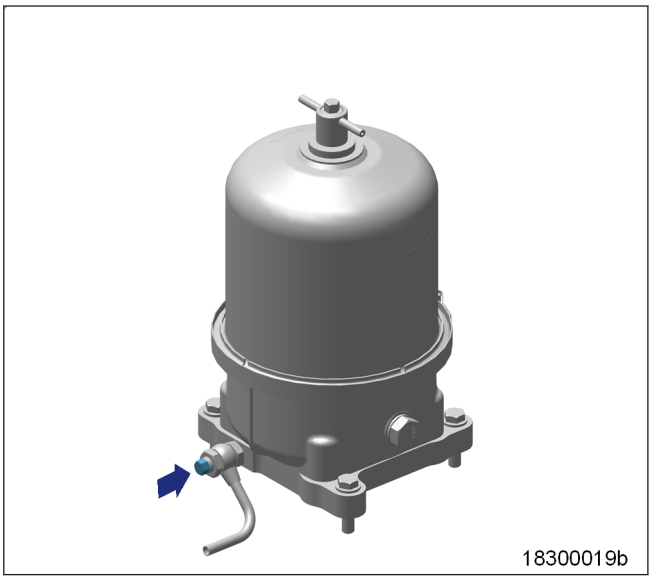
Oil is hot.
Oil can contain residue/substances which are harmful to health.
Risk of injury and poisoning!
- Allow the product to cool to below 50 °C before beginning work.
- Wear protective clothing, protective gloves and goggles/safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

WARNING

A high level of noise is produced when the engine is running.
Risk of hearing loss!
- Wear suitable hearing protection.

Engine oil – Sample extraction and analysis

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



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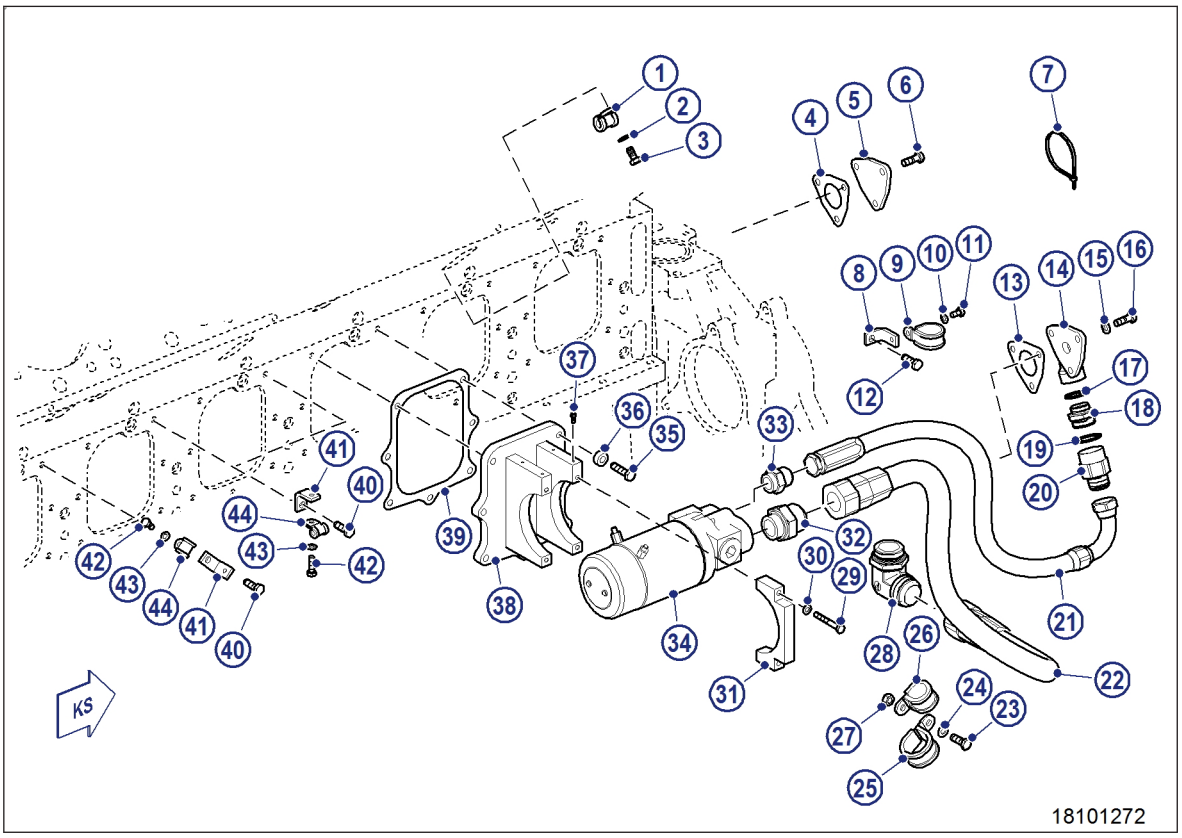
9.13.5 Lube-oil priming pump – Overview



1	Clamp	16	Screw	31	Pipe half-clamp
2	Washer	17	Sealing ring	32	Fitting
3	Screw	18	Union	33	Fitting
4	Gasket	19	Sealing ring	34	Lube-oil priming pump
5	Cover	20	Non-return valve	35	Screw
6	Screw	21	Hose line	36	Washer
7	Strap	22	Hose line	37	Screw
8	Retainer	23	Screw	38	Inspection port cover
9	Clamp	24	Washer	39	Gasket
10	Washer	25	Clamp	40	Screw
11	Screw	26	Clamp	41	Retainer
12	Screw	27	Nut	42	Screw
13	Gasket	28	Threaded connection	43	Washer
14	Connecting flange	29	Screw	44	Clamp
15	Washer	30	Washer		

9.14 Oil Filtration / Cooling

9.14.1 Engine oil filter - Replacement

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

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

WARNING

Oil is hot.
Oil can contain residue/substances which are harmful to health.
Risk of injury and poisoning!

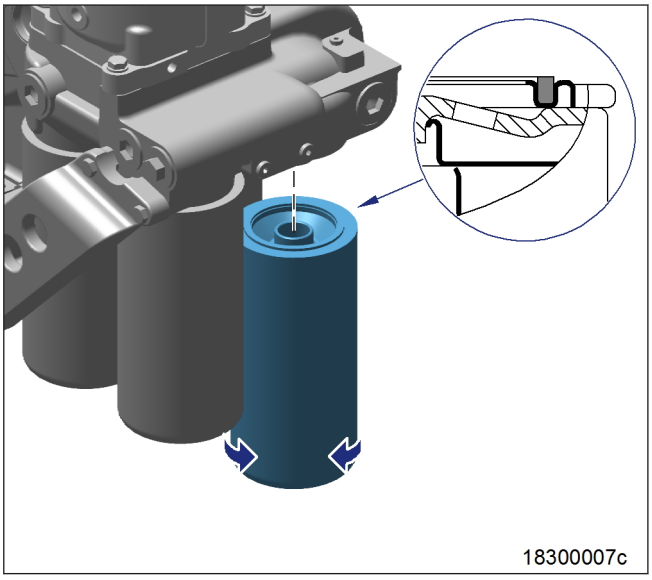
- Allow the product to cool to below 50 °C before beginning work.
- Wear protective clothing, protective gloves and goggles/safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

Engine oil filter – Replacement

1. Use filter wrench to remove engine oil filter.
2. Clean sealing surface on connecting piece.

Note: Use only oil filters with integrated safety valve.

3. Check condition of new oil filter sealing ring and coat it with engine oil.
4. Screw on and tighten new engine oil filter by hand.
5. Replace other engine oil filters in the same way.
6. Check engine oil level (→ Page 134).
7. After oil change and oil filter replacement, crank engine with starting system (→ Page 93).



9.14.2 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.
Filter wrench	F30379104	1
Torque wrench, 6–50 Nm	F30027336	1
Ratchet bit	F30027339	1
Solvent cleaner (Hakutex 60)	X00070585	1
Assembly compound (Kluthe Hakuform 30-11C/Emulgier)	X00059351	1
Filter sleeve	(→ Spare Parts Catalog)	
Sealing ring	(→ Spare Parts Catalog)	
Sealing ring	(→ Spare Parts Catalog)	

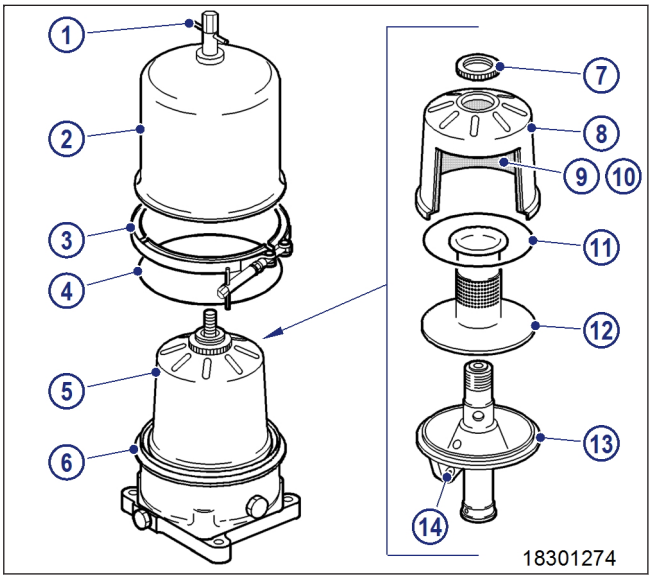
WARNING

Oil is hot.
Oil can contain residue/substances which are harmful to health.
Risk of injury and poisoning!
- Allow the product to cool to below 50 °C before beginning work.
- Wear protective clothing, protective gloves and goggles/safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

WARNING

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

Centrifugal oil filter – Cleaning and filter-sleeve replacement



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

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

22. Use torque wrench to ighten screw (1) to specified tightening torque.

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

9.15 Coolant Circuit, General, High-Temperature Circuit

9.15.1 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.

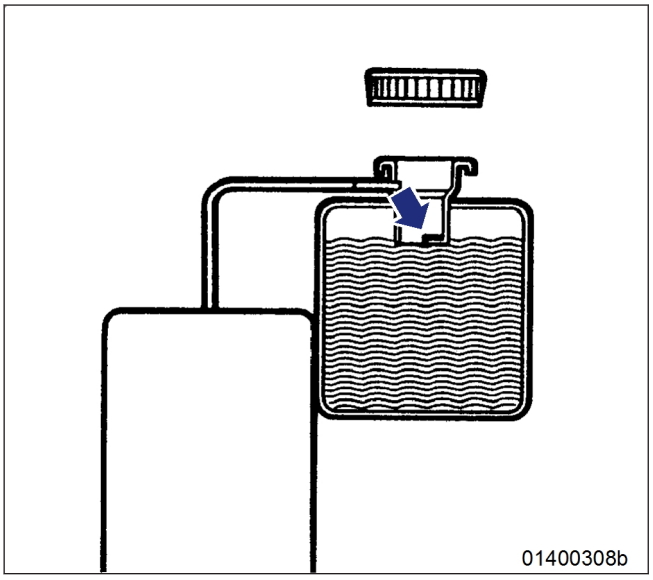
Checking coolant level at filler neck:

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

Checking coolant level at external cooler:

Note: Engine coolant must be visible at marker plate.

1. Check engine coolant level.
2. Top up engine coolant as necessary (→ Page 147).
3. Check and clean cap.
4. Place cap on filler neck and close.



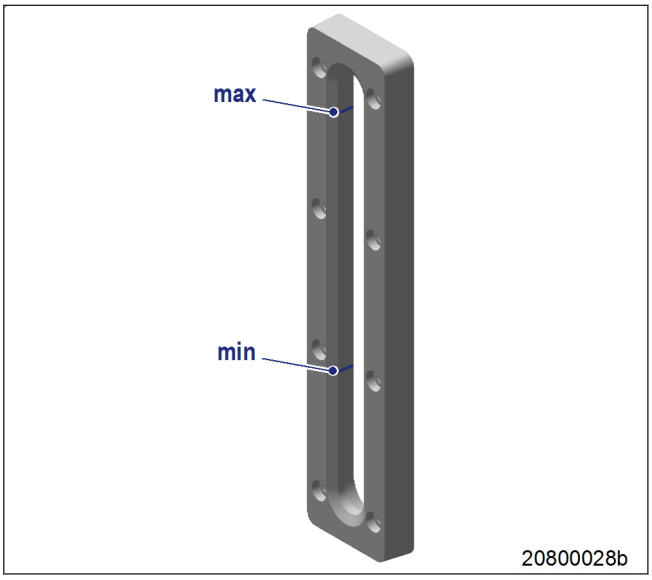
Checking coolant level with level sensor:

Note: Engine coolant level is automatically monitored by the engine control system.

1. Switch on engine control system and check readings on the display.
2. Top up engine coolant as necessary (→ Page 147).

Checking engine coolant level at sight glass

1. Check coolant level (coolant level must be between “min.” and “max.” mark).
2. Top up coolant if necessary (→ Page 147).



9.15.2 Engine coolant - Change

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Coolant		

Engine coolant change

1. Drain engine coolant (→ Page 146).
2. Fill with engine coolant (→ Page 147).

9.15.3 Engine coolant - Draining

Preconditions

☑ Engine is stopped and starting disabled.

WARNING

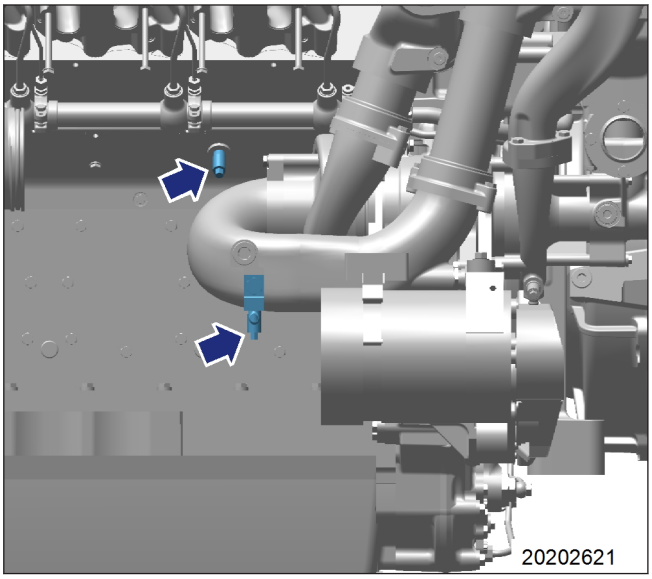
Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Preparatory steps

1. Provide a suitable container in which to collect the coolant.
2. Switch off preheating unit.

Engine coolant – Draining

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.
3. Draw off separated corrosion inhibitor oil in expansion tank through the filler neck.
4. Open drain valves and/or drain plugs and drain coolant at the following points:
   - Elbow of HT engine coolant pump
   - Crankcase, left and right sides.
   - Preheating unit



5. Use torque wrench to tighten shut-off cock on elbow of engine coolant pump to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Spindle	SW11	Tightening torque		12 Nm

6. Use torque wrench to tighten shut-off cocks on crankcase, left and right sides, to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Spindle	SW11	Tightening torque		12 Nm

7. Close all remaining open drain points.
8. Place breather valve on filler neck and close.

9.15.4 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

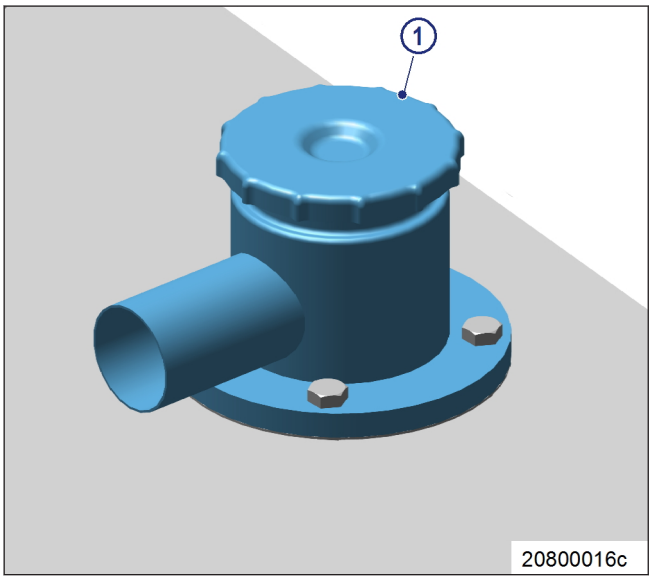
Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

NOTICE

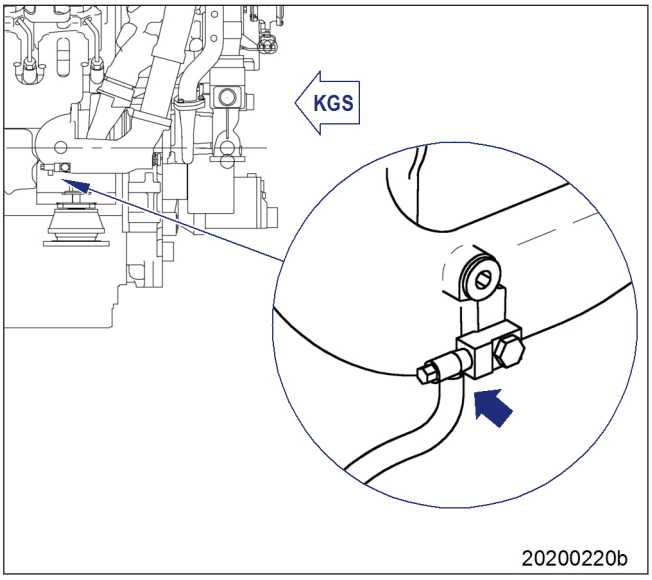
Cold coolant in hot engine can cause thermal stress.
Possible formation of cracks in the engine!
- Fill / top up coolant only into cold engine.

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.



Filling with coolant using a pump



1. Connect appropriate pump with hose to drain valve.
2. Open drain valve and pump coolant into engine at 0.5 bar minimum.
3. Fill expansion tank until overflow edge is reached.
4. Close drain valve.
5. Check proper condition of breather valve and clean sealing faces if required.
6. Place breather valve on filler neck and close.
7. Start engine (→ Page 64).
8. After 10 seconds of running the engine without load, shut down the engine (→ Page 66).
9. Turn breather valve of filler neck on coolant expansion tank counterclockwise to first stop and allow pressure to escape.
10. Continue to turn breather valve counterclockwise and remove.
11. Check coolant level (→ Page 143) and top up engine coolant as required:
    a) Fill in coolant in expansion tank until the coolant level at top edge of filler neck remains constant.
    b) Place breather valve on filler neck and close.
    c) Repeat the steps from “Start engine” (→ Step 7) until coolant is no longer needed to be topped up.
    d) Disconnect pump and hose.

Filling with coolant through filler neck

1. Alternatively: Fill in engine coolant via filler neck on expansion tank until engine coolant level remains constant at top edge of filler neck.
2. Check proper condition of breather valve and clean sealing faces if required.
3. Set breather valve onto filler neck and turn until the first stop.
4. Start engine (→ Page 64).
5. After 10 seconds of running the engine without load, shut down the engine (→ Page 66).
6. Turn valve cover counterclockwise and remove.
7. Check coolant level (→ Page 143) and top up engine coolant as required:
    a) Repeat the steps from “Start engine” (→ Step 4) until coolant is no longer needed 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 without load for some minutes.
2. Check coolant level (→ Page 143) and top up engine coolant as required.

9.15.5 Engine coolant pump - Relief bore check

DANGER

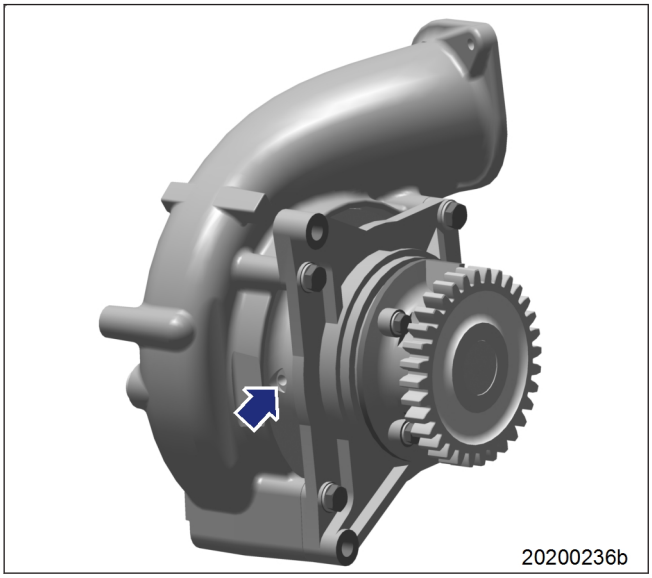
Components are moving or rotating.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Operate the engine at low load only. Keep clear of the danger zone of the engine.

WARNING

A high level of noise is produced when the engine is running.
Risk of hearing loss!
- Wear suitable hearing protection.

Engine coolant pump – Relief bore check

1. Check relief bore for oil and coolant discharge.
   - Permissible coolant discharge: up to 10 drops per hour
   - Permissible oil discharge: up to 5 drops per hour
   - If discharge exceeds the specified limits: Contact Service.
2. If the relief bore is dirty, stop the engine (→ Page 66) and disable engine start, observe general safety instructions for maintenance and repair.
3. Clean relief bore with a wire.



9.15.6 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	F6798833	1

DANGER

Components are moving or rotating.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Operate the engine at low load only. Keep clear of the danger zone of the 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

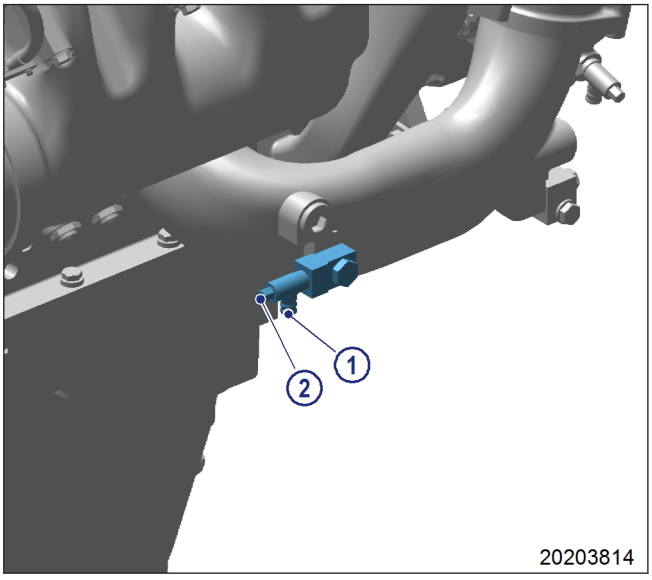
Coolant contains antifreeze and is toxic.
Risk of poisoning and slipping!
- Avoid contact with eyes and skin.
- Do not inhale vapors or mist, wear breathing protection.
- Do not eat, drink, smoke when working with antifreeze.
- Wear protective clothing, protective gloves and goggles/safety mask.
- Wipe up escaped/spilled coolant immediately.

WARNING

A high level of noise is produced when the engine is running.
Risk of hearing loss!
- Wear suitable hearing protection.

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.



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4. Tighten shut-off cock (2) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Spindle	A/F11	Tightening torque		12 Nm

5. Using the equipment and chemicals from the MTU test kit, examine coolant for:
   - antifreeze concentration
   - Amount of corrosion protection oil
   - pH value
6. For engine coolant change intervals, refer to (→ MTU Fluids and Lubricants Specifications (A001061/..)).

9.15.7 Coolant expansion tank valve cover - Replacement

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Valve cover	(→ Spare Parts Catalog)	1

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.

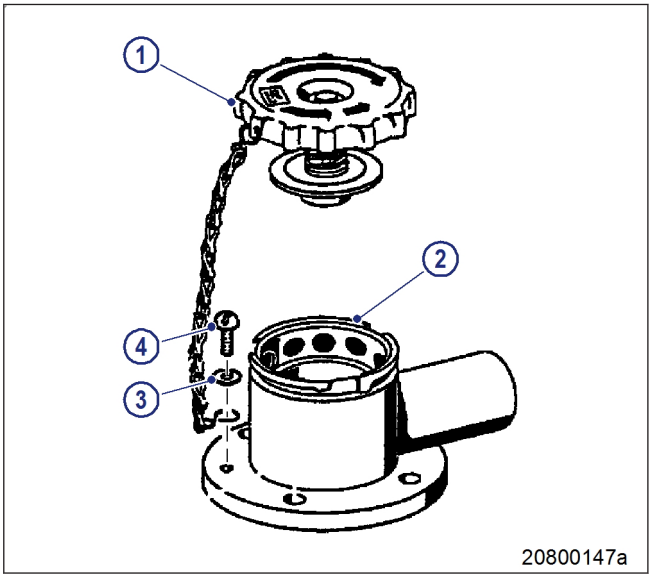
Preparatory steps

▶ Switch off preheater.

Replacing valve cover

Note: Schematic diagram. Design may deviate.

1. Turn valve cover (1) on coolant expansion tank counterclockwise until the first stop and release pressure.
2. Continue to turn valve cover counterclockwise and remove.
3. Remove chain with screw (4) and washer (3).
4. Draw off separated corrosion inhibitor oil in expansion tank via filler neck (2).
5. Fit new valve cover and close it.
6. Install chain.



9.16 Low-Temperature Circuit

9.16.1 Charge-air coolant level - Check

Preconditions

☑ Engine is stopped and starting disabled.

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

DANGER

Falling from great heights.
Risk of serious injury – danger to life!
- When working high on the equipment, always use suitable ladders or work platforms.
- Use personal protective equipment.

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

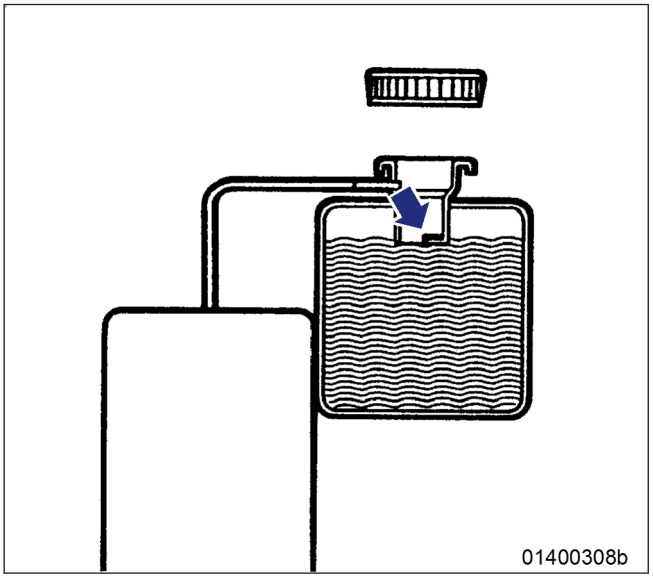
Coolant contains antifreeze and is toxic.
Risk of poisoning and slipping!
- Avoid contact with eyes and skin.
- Do not inhale vapors or mist, wear breathing protection.
- Do not eat, drink, smoke when working with antifreeze.
- Wear protective clothing, protective gloves and goggles/safety mask.
- Wipe up escaped/spilled coolant immediately.

Checking charge-air coolant level at filler neck

1. Turn cover on coolant expansion tank counterclockwise to the first stop and allow pressure to escape.
2. Continue to turn cover counterclockwise and remove.

Note: Charge-air coolant must be visible at marker plate.

3. Check charge-air coolant level.
4. Top up charge-air coolant as necessary (→ Page 157).
5. Check that cover is in serviceable condition.
6. Clean sealing surfaces as necessary.
7. Fit cover and close it.



Checking charge-air coolant level by means of level sensor

Note: The charge-air coolant level is monitored automatically by the engine control system.

1. Switch on engine control system and check readings on the display.
2. Top up with charge-air coolant as necessary (→ Page 157).

9.16.2 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 156).
2. Fill with charge-air coolant (→ Page 157).

9.16.3 Charge-air coolant – Draining

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

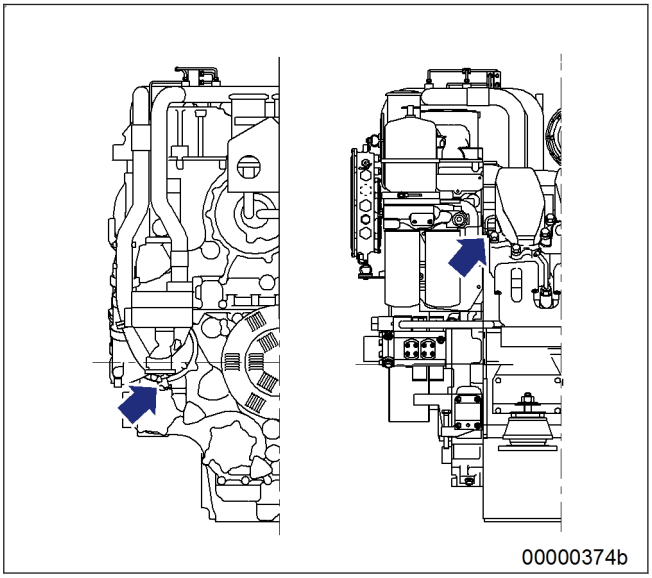
Designation / Use	Part No.	Qty.
Sealing ring	(→ Spare Parts Catalog)	

WARNING

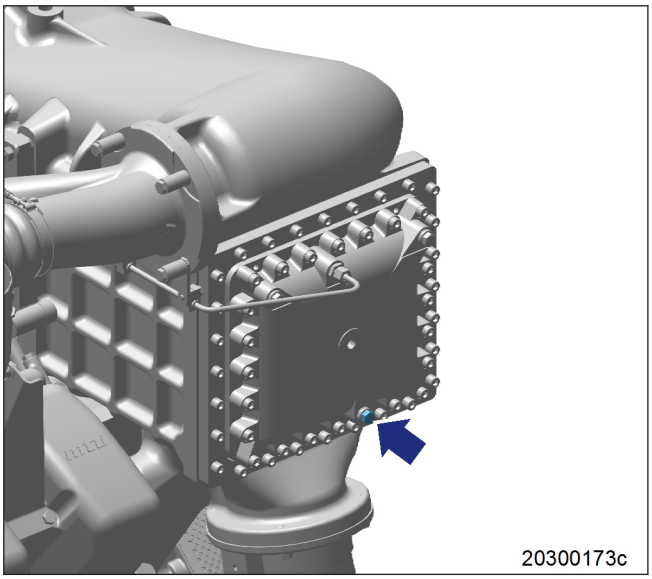
Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Draining charge-air coolant

1. Provide a suitable receptacle to catch the coolant.
2. Turn breather valve of coolant expansion tank counterclockwise until the first stop and allow pressure to escape.
3. Continue to turn breather valve counterclockwise and remove.
4. Draw off separated corrosion inhibitor oil in expansion tank through the filler neck.
5. Open drain valves and/or drain plugs and drain coolant at the following points:
   - at the LT coolant pump
   - at the coolant lines to and from the intercooler



6. Drain residual coolant:
   - at intercooler
7. Close all drain valves and screw in drain plugs with new sealing rings.
8. Place breather valve on filler neck and close.



9.16.4 Charge-air 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.
Coolant		
Sealing ring	(→ Spare Parts Catalog)	

WARNING

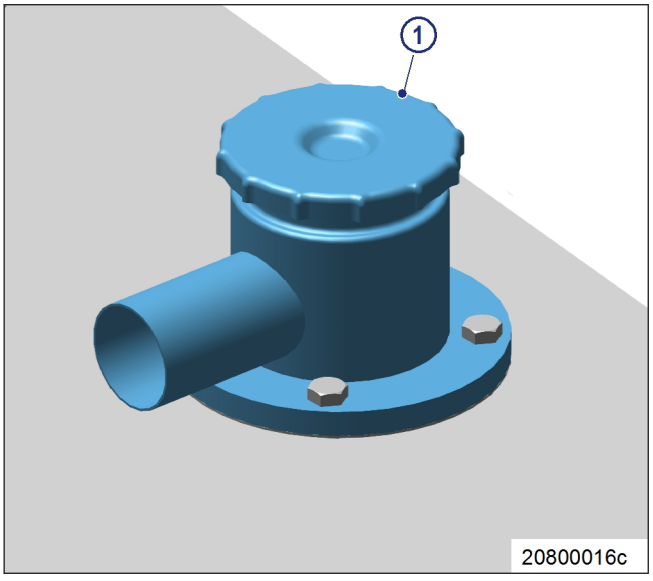
Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

NOTICE

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

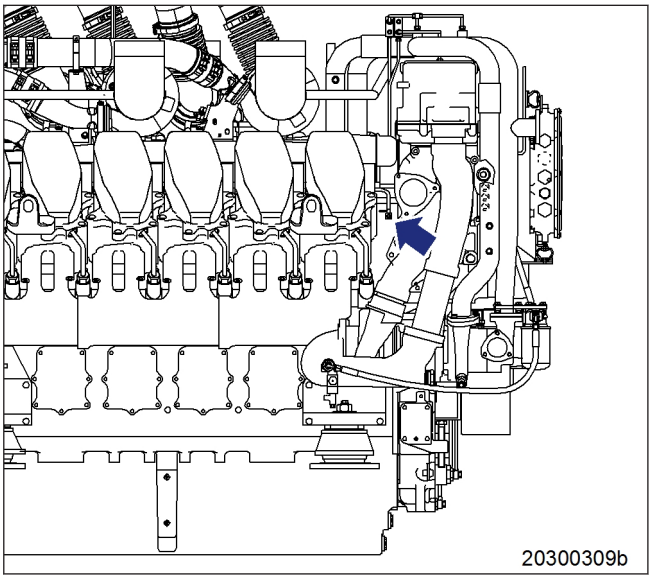
Preparatory steps

1. Turn valve cover (1) on expansion tank on the left to the first stop and release pressure.
2. Turn pressure cap (1) counterclockwise and remove.

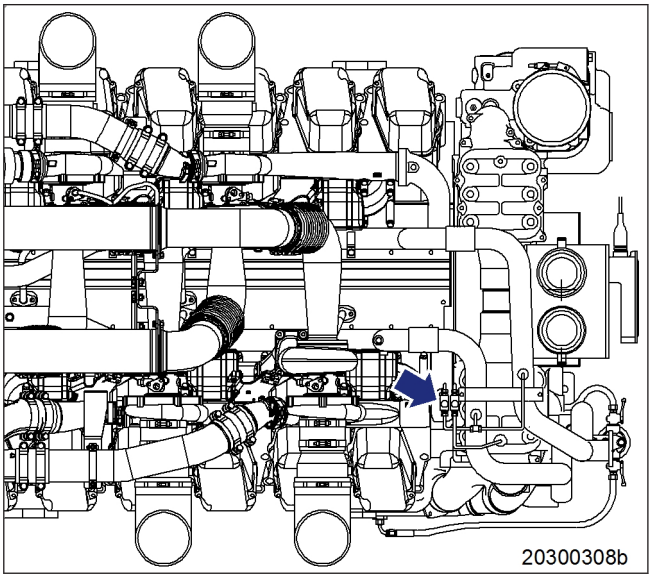


Filling with coolant using a pump

1. Connect a suitable pump with a hose to the drain valve (arrowed).

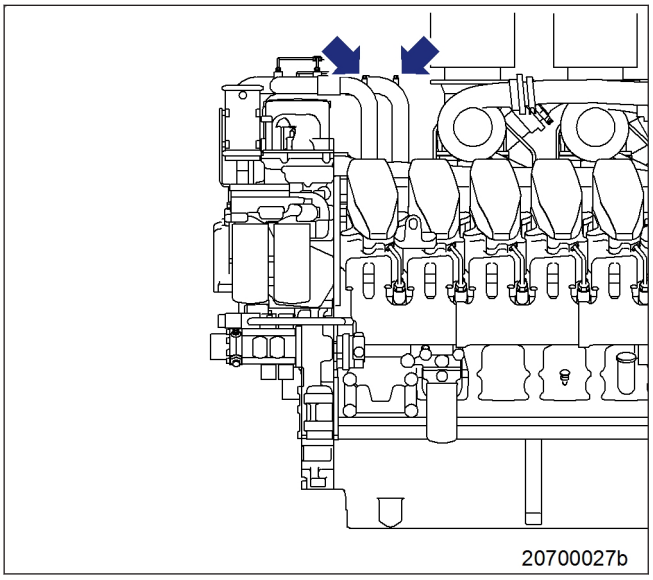


2. Open air bleed on intercooler (arrow).
3. Open drain valve and pump coolant into engine at 0.5 bar minimum.
4. When coolant emerges from the bleed valve, close the bleed valve.
5. Top expansion tank up to the overflow.
6. Close drain valve.
7. Check pressure cap is in perfect condition and clean sealing faces if necessary.
8. Position breather valve on filler neck and close.
9. Start engine (→ Page 64).
10. After 10 seconds of running the engine without load, shut down the engine (→ Page 66).
11. Turn pressure cap of coolant expansion tank counterclockwise until the first stop and allow pressure to escape.
12. Turn pressure cap counterclockwise and remove.
13. Check coolant level (→ Page 153) and top up coolant as required:
    a) Top up with coolant via expansion tank until the coolant level is constant at the overflow.
    b) Position breather valve on filler neck and close.
14. Repeat steps from start engine (→ Step 9) until coolant is no longer needed to be topped up.
15. Disconnect pump and hose.

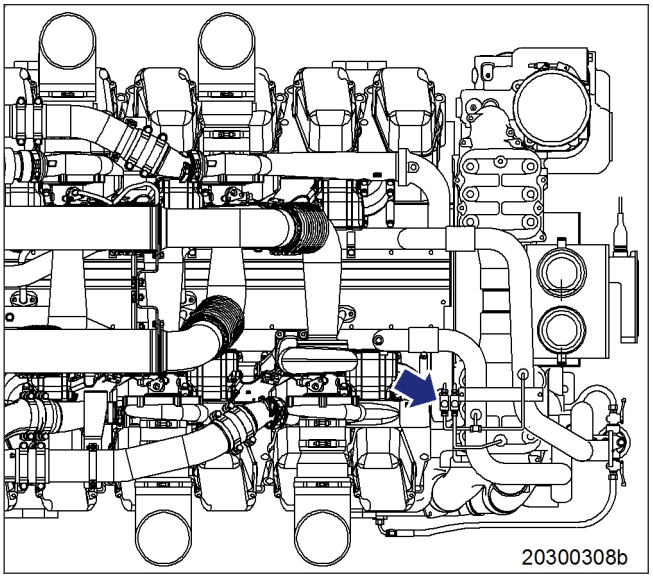


Alternatively: Filling with coolant through filler neck

1. Remove plug screws from filling points (arrows) on coolant lines from and to the intercooler.



2. Open air bleed on the intercooler (arrow).
3. Fill coolant via the filling points on the coolant lines to and from the intercooler and via the expansion tank up to the overflow.
4. When coolant emerges from the bleed valve, close the bleed valve.
5. Install plug screws of filling points with new sealing rings.
6. Check pressure cap is in perfect condition and clean sealing faces if necessary.
7. Position pressure cap on the filler neck and close to the first stop.
8. Start engine (→ Page 64).
9. After 10 seconds of running the engine without load, shut down the engine (→ Page 66).
10. Turn pressure cap counterclockwise and remove.
11. Check coolant level (→ Page 153) and top up coolant as required:
    a) Top up with coolant via expansion tank until the coolant level is constant at the overflow.
    b) Position breather valve on filler neck and close.
12. Repeat steps from start engine (→ Step 8) until coolant is no longer needed to be topped up.



Final steps

1. Start the engine and run it without load for some minutes.
2. Check coolant level (→ Page 153) and top up coolant as required.

9.16.5 Charge-air coolant pump – Relief bore check

DANGER

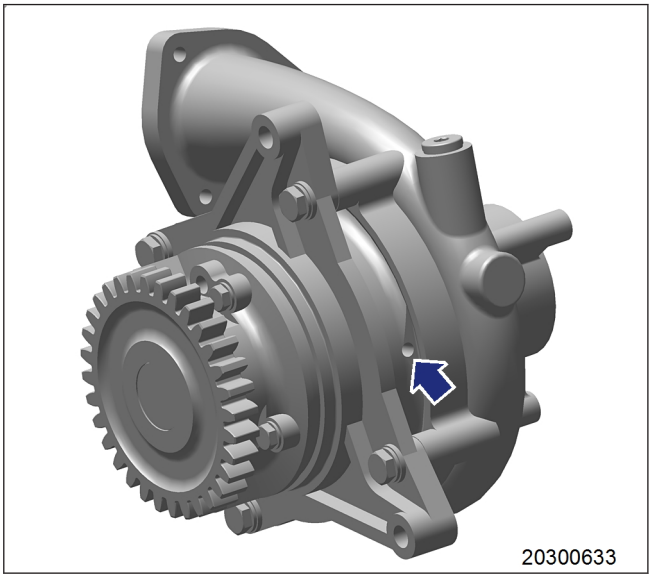
Components are moving or rotating.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Operate the engine at low load only. Keep clear of the danger zone of the engine.

WARNING

A high level of noise is produced when the engine is running.
Risk of hearing loss!
- Wear suitable hearing protection.

Charge-air coolant pump – Relief bore check

1. Check relief bore for oil and coolant discharge.
2. Stop engine (→ Page 66) and disable engine start, observe general safety instructions for maintenance and repair.
3. Clean the relief bore with a wire if it is contaminated.
   - 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.



9.17 Engine Mounting / Support

9.17.1 Engine mounting - Checking resilient element

NOTICE

Contamination of engine mounts made of natural rubber with fuel or oil.
Engine mounts swell. Risk of shorter service life or destruction of the mounts!
- Cover engine mounts when working with fuel or oil.
- Remove contaminations on the rubber mounts immediately with a dry cloth and degrease them.

Engine mounting – Check

Item	Findings	Action
Visually inspect resilient elements.	• Damage • Brittleness • Deformation • Crack formation • Swelling	Replace (contact Service).

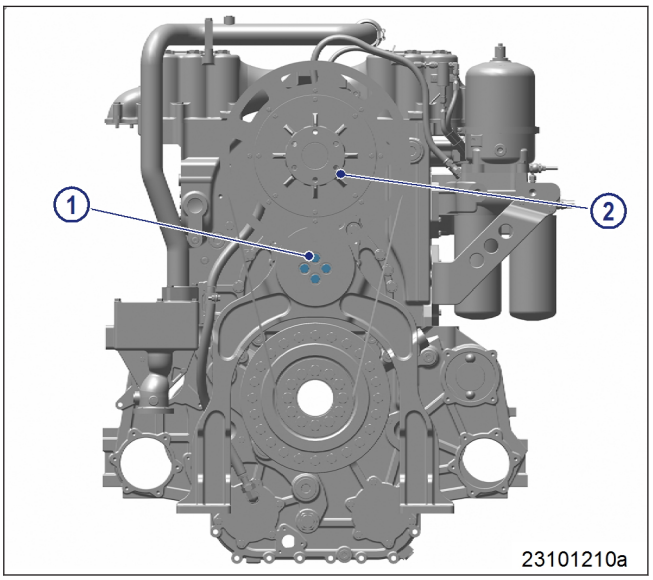
9.17.2 Securing screws – Check for firm seating

Preconditions

☑ Engine is stopped and starting disabled

Checking securing screws for firm seating

1. Check securing screws (1) on fan housing (2) for firm seating.
2. Tighten loose threaded connections using a torque wrench.



9.18 Belt Drive

9.18.1 Drive belt - Condition check

Preconditions

☑ Engine is stopped and starting disabled.

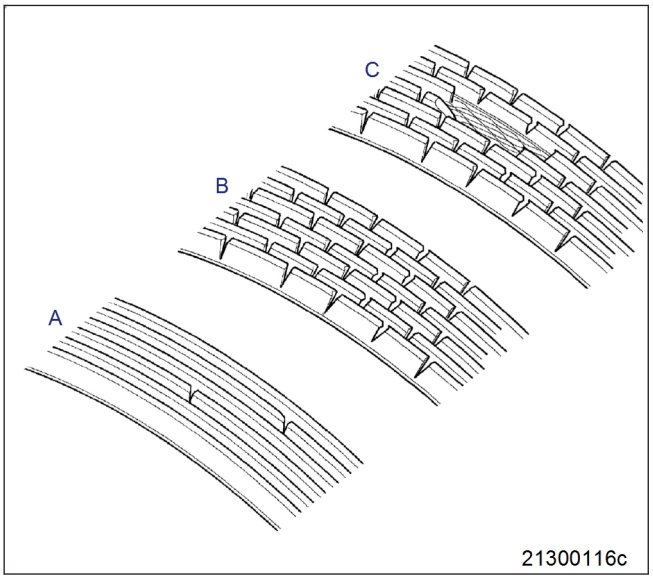
WARNING

Exposed rotating parts can eject drawn-in components or draw in body parts.
Risk of crushing, limbs or extremities may be pinched, trapped or entangled!
Risk of injury due to flying parts!

- Install rotating components at a suitable distance from other components.
- Never operate the engine without protective covers or safety guards which meet applicable accident prevention regulations.
- Ensure that the safety guards can prevent body parts from being drawn in by rotating components.

Drive belt – Condition check

1. Remove cover.



2. Checking drive belt condition:

Item	Findings	Action
Drive belt A	Singular cracks	None
Drive belt B	Cracks on entire circumference	Replace (→ Page 167)
Drive belt C	Chunking	
Drive belt	Belt is oily, shows signs of over-heating	

3. Install cover.

9.19 Battery-Charging Generator

9.19.1 Battery-charging generator – Condition check

Preconditions

☑ Engine shut down and starting disabled.

Battery-charging generator – Condition check

1. Check if securing screws of battery-charging generator fit firmly.
2. Tighten any loose threaded connections.
3. Check wiring (→ Page 173).

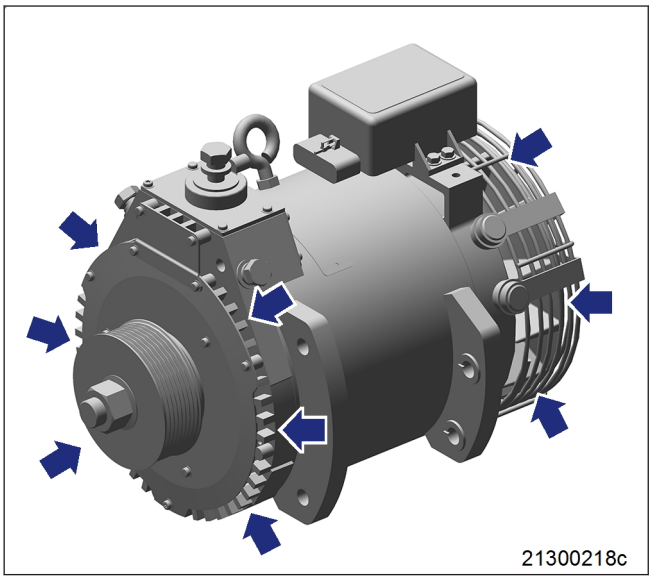
9.19.2 Battery-charging generator - Check

Preconditions

☑ Engine is stopped and starting disabled.

WARNING

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



Checking battery-charging generator

Item	Findings	Measure
Ventilation areas (arrows)	Clean	None
Ventilation areas (arrows)	Contaminated	Clean

Cleaning battery-charging generator

Note: Dry-clean battery-charging generator only. Do not insert sharp objects in the ventilation openings.

1. Remove coarse contamination from battery-charging generator.
2. Blow out ventilation areas (arrows) with compressed air until there is no more dust development.

9.19.3 Battery-charging generator – Removal and installation

Preconditions

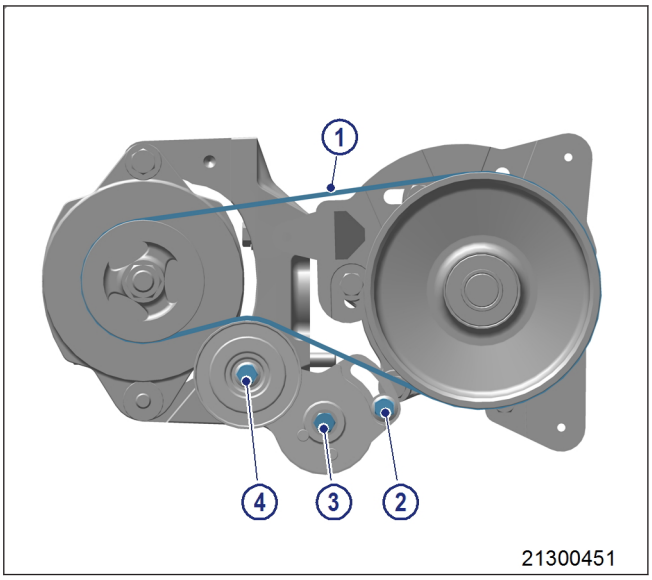
☑ Engine is stopped and starting disabled

WARNING

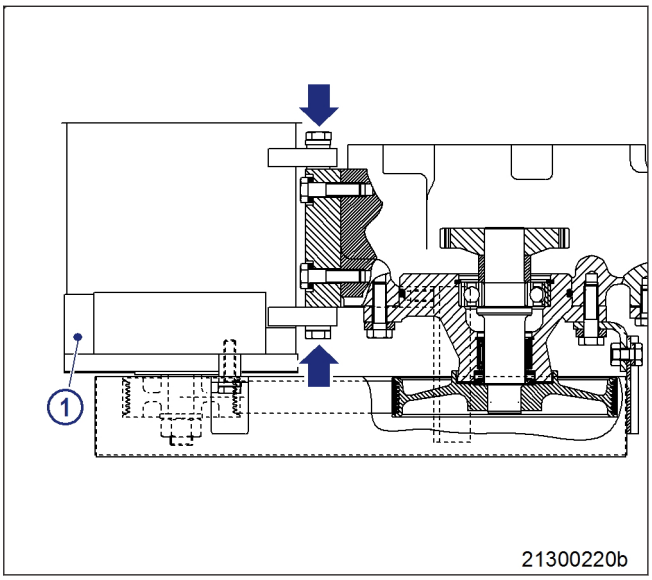
Heavy part, risk of falling or overturning due to lack of stability.
Risk of crushing body or limbs!
- Use appropriate lifting gear and appliances.
- Wear safety shoes.

Removing battery-charging generator

1. Remove protective cover.
2. Mark electric cables on battery-charging generator and remove.
3. Protect all cables from damage.
4. Slacken screws (2) and (3) by half a turn.
5. Mount socket or box wrench on screw (4) and press belt tensioner in direction of arrow as far as the stop.
6. Tighten screw (2).
7. Remove drive belt (1).



8. Release screws (arrow).
9. Remove battery-charging generator (1).
10. Clean battery-charging generator (1) thoroughly (→ Page 165).
11. Install battery-charging generator (1) following reverse sequence of working steps.
12. Adjust drive belt tension (→ Page 168).



9.19.4 Battery-charging generator - Drive belt and belt tensioner replacement

Preconditions

☑ Engine is stopped and starting disabled

Special tools, Material, Spare parts

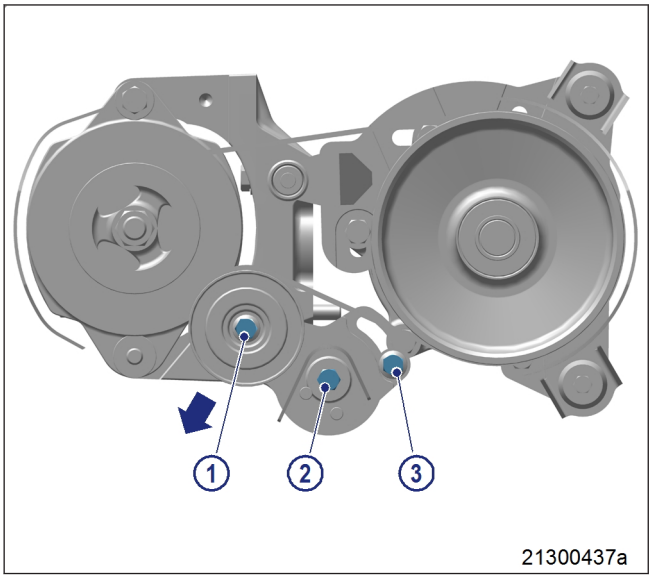
Designation / Use	Part No.	Qty.
Drive belt	(→ Spare Parts Catalog)	
Belt tensioner	(→ Spare Parts Catalog)	1

WARNING

Heavy part, risk of falling or overturning due to lack of stability.
Risk of crushing body or limbs!
- Use appropriate lifting gear and appliances.
- Wear safety shoes.

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.
8. Adjust drive belt tension (→ Page 168).



9.19.5 Battery-charging generator – Drive belt tension adjustment

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

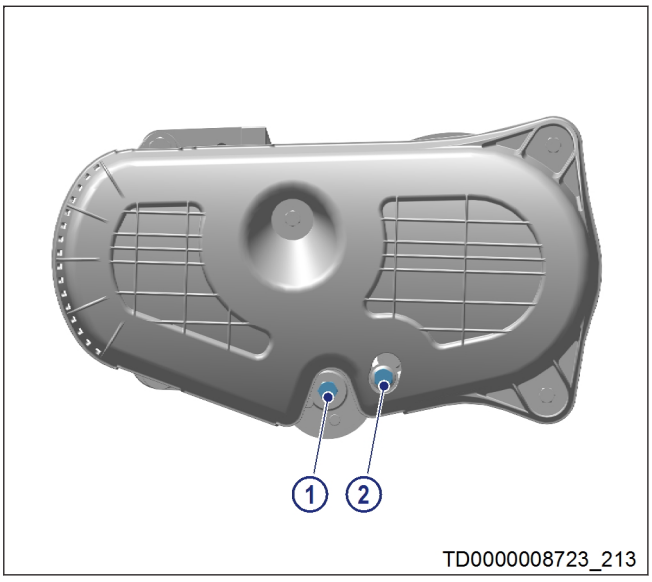
Designation / Use	Part No.	Qty.
Torque wrench, 60–320 Nm	F30452768	1
Ratchet bit	F30027341	1
Torque wrench, 10–60 Nm	F30452769	1
Ratchet bit	F30027340	1

WARNING

Belt tensioner spring is pretensioned.
Risk of hands being crushed!
- Lock belt tensioner in position.
- Only use specified tools and devices.

Adjusting belt tension

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



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

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

3. Tighten screw (1) with a torque wrench.

9.20 Fan Drive

9.20.1 Fan drive - Adjust and check drive belt tension

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Optibelt TT belt tension tester	Y4345711	1

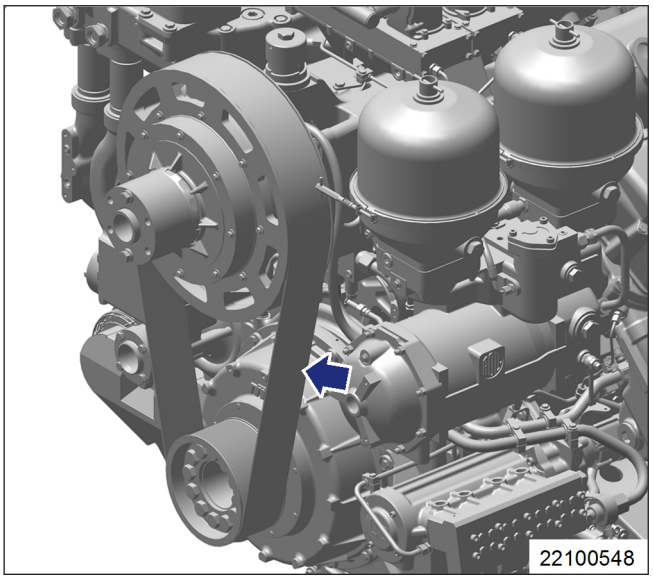
Preparatory steps

1. Remove protective cover.
2. Check belt condition visually (→ Page 163).

Result: Measure for drive replacement (→ Page 171).

Checking V-belt tension

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.



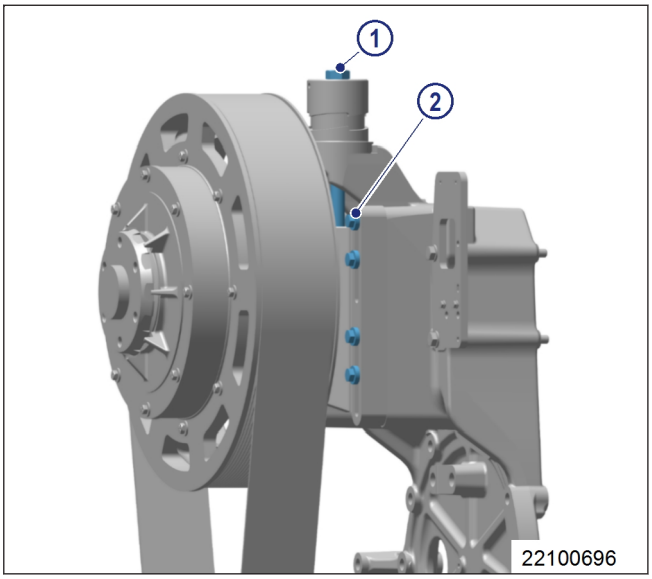
3. Hold belt tension tester over belt drive until the measured value is indicated.

Part numbers			Frequencies		
Belt pulleys	Fan drive	Belt	Initial assembly at MTU	Initial operation with fan	Belt tension adjustment
UPC.0K601A0515	UPC.06K01 2233	UPC.06K01B0324	47 Hz ±3 Hz	64 Hz ±1 Hz	56 Hz ±1 Hz
UPC.0K601A0515	UPC.06K01 2233	X00027176	46 Hz ±3 Hz	62 Hz ±1 Hz	55 Hz ±1 Hz
UPC.0K601A0515	UPC.06K01 2264	UPC.06K01B0325	43 Hz ±3 Hz	59 Hz ±1 Hz	52 Hz ±1 Hz
UPC.0K601A0515	UPC.06K01 2264	UPC.06K01B0326	39 Hz ±3 Hz	53 Hz ±1 Hz	46 Hz ±1 Hz
UPC.0K601A0516	UPC.06K01 2233	UPC.06K01B0324	46 Hz ±3 Hz	63 Hz ±1 Hz	57 Hz ±1 Hz
UPC.0K601A0516	UPC.06K01 2264	UPC.06K01B0325	43 Hz ±3 Hz	59 Hz ±1 Hz	53 Hz ±1 Hz
UPC.0K601A0516	UPC.06K01 2264	X00027176	45 Hz ±3 Hz	61 Hz ±1 Hz	55 Hz ±1 Hz
UPC.0K601A0517	UPC.06K01 2233	UPC.06K01B0325	46 Hz ±3 Hz	59 Hz ±1 Hz	51 Hz ±1 Hz
UPC.0K601A0517	UPC.06K01 2233	X00027176	48 Hz ±3 Hz	62 Hz ±1 Hz	55 Hz ±1 Hz
UPC.0K601A0517	UPC.06K01 2264	UPC.06K01B0326	40 Hz ±3 Hz	52 Hz ±1 Hz	45 Hz ±1 Hz
UPC.0K601A0518	UPC.06K01 2233	UPC.06K01B0324	48 Hz ±3 Hz	63 Hz ±1 Hz	55 Hz ±1 Hz

Part numbers			Frequencies		
Belt pulleys	Fan drive	Belt	Initial assembly at MTU	Initial operation with fan	Belt tension adjustment
UPC.0K601A0518	UPC.06K01 2233	X00027176	47 Hz ±3 Hz	62 Hz ±1 Hz	54 Hz ±1 Hz
UPC.0K601A0518	UPC.06K01 2264	UPC.06K01B0325	44 Hz ±3 Hz	58 Hz ±1 Hz	51 Hz ±1 Hz
UPC.0K601A0518	UPC.06K01 2264	UPC.06K01B0326	39 Hz ±3 Hz	52 Hz ±1 Hz	45 Hz ±1 Hz
UPC.0K601A0519	UPC.06K01 2264	UPC.06K01B0326	43 Hz ±3 Hz	53 Hz ±1 Hz	47 Hz ±1 Hz
UPC.0K601A0605	UPC.06K01 2233	UPC.06K01B0325	47 Hz ±3 Hz	59 Hz ±1 Hz	52 Hz ±1 Hz
UPC.0K601A0605	UPC.06K01 2264	UPC.06K01B0326	41 Hz ±3 Hz	52 Hz ±1 Hz	45 Hz ±1 Hz
XS526220.00004	UPC.06K01 2264	XS526220.00005	46 Hz ±3 Hz	60 Hz ±1 Hz	53 Hz ±1 Hz
XS527220.00004	UPC.06K01 2264	X00027176	45 Hz ±3 Hz	62 Hz ±1 Hz	55 Hz ±1 Hz

Adjusting drive belt tension

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



3. Tighten screws (2) to specified tightening torque.

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

9.20.2 Fan drive - Drive belt replacement

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

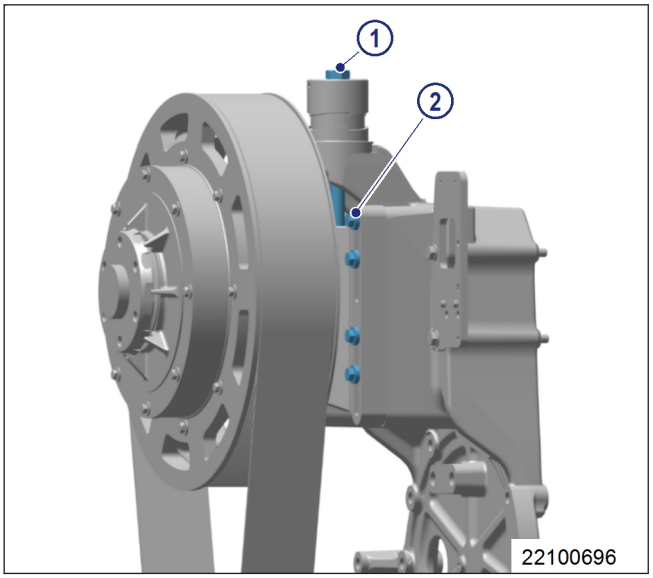
Designation / Use	Part No.	Qty.
Drive belt	(→ Spare Parts Catalog)	

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 169).



9.21 Auxiliary PTO

9.21.1 Compressor - Check

Preconditions

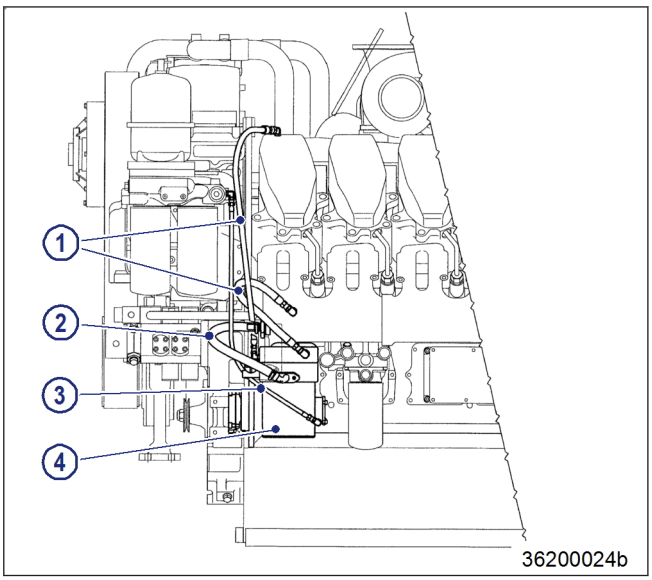
☑ Engine is stopped and starting disabled.

WARNING

Compressed-air pipes may still be under pressure, although the shut-off valve is closed.
Risk of injury!
- Before starting work, release pressure from pipework.

Checking compressor

1. Check oil supply line (3) and connections for condition and leaks.
2. Check coolant lines (1) and connections for condition and leaks.
3. Check air intake line (2) and connections for condition and leaks.
4. Check compressor (4) for leaks.
5. If damage or leaks are found, contact Service.



9.22 Wiring (General) for Engine/Gearbox/Unit

9.22.1 Engine cabling - Check

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Solvent (isopropyl alcohol)	X00058037	1

Engine cabling – Check

1. Check securing screws of cable clamps on engine and tighten loose screw connections.
2. Ensure that cables are securely seated in clamps and cannot move freely.
3. Check if all cable clips are closed and intact.
4. Replace faulty cable clips.
5. Check cable clamps for secure fit, tighten loose clamps.
6. Replace faulty cable clamps.
7. Visually inspect the following electrical components for damage:
   - Connector housings
   - Contacts
   - Plug connectors
   - Cables and terminals
   - Plug-in contacts

Result: If cable conductors are damaged, contact Service.

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

8. Use isopropyl alcohol to clean dirty connector housings, plug connectors and contacts.
9. Ensure that all connecting plugs of the sensors are correctly engaged.

9.23 Accessories for (Electronic) Engine Governor / Control System

9.23.1 DDEC and connectors - Cleaning

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

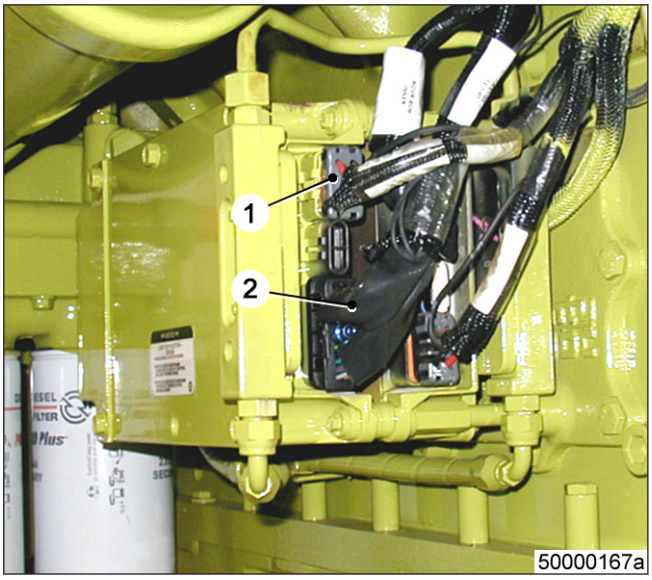
Designation / Use	Part No.	Qty.
Isopropyl alcohol		

DANGER

Cleaner is an explosive and poisonous substance.
Danger to life, major material damage!
- Avoid open flames, electrical sparks and ignition sources.
- Wear goggles/facial protection.
- Only work in a well-ventilated room.
- Do not smoke.

DDEC and connectors – Cleaning

1. Remove coarse dirt from housing surface using a cloth moistened with isopropyl alcohol.
2. Remove dirt from surface of connectors (1), connector sockets and shrink sleeves (2) using a cloth moistened with isopropyl alcohol.
3. Check legibility of cable labels.
   - Clean or replace illegible labels.



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Cleaning severely contaminated connectors on DDEC

1. Disconnect connectors on both sides of DDEC. For this purpose, withdraw connectors (1).
2. Unscrew connectors (3).
3. Remove covers (2).
4. Clean connector housings, connector socket housings and all contacts with isopropyl alcohol.
5. When connectors, sockets and all contacts are dry: Install connectors and check plug-in connection on DDEC (→ Page 176).

9.23.2 DDEC - Checking plug-in connections

Preconditions

☑ Engine is stopped and starting disabled.

Checking plug-in connections on DDEC

1. Check all plug-in connections on both sides of DDEC for secure seating.
2. Slide connectors (1) on until they latch into position.
3. Screw in connectors (3) securely.
4. Seal non-assigned connector bases with covering caps (2).
5. If plug-in connection is defective, contact Service.

10 Appendix A

10.1 Abbreviations

Abbreviation	Meaning	Explanation
A/D	Analog/Digital converter	Converter: converts sensor voltages into digital values
ADEC	Advanced Diesel Engine Controller	Engine management system
AFRS	Air Filter Restriction Sensor	
AL	alarm	
ANSI	American National Standards Institute	Association of American standardization organizations
ATS	Air Temperature Sensor	
BR	Series	
BV	Betriebsstoffvorschrift	Fluids and Lubricants Specifications, MTU Publication No. A001061/..
CAN	Controller Area Network	Data bus system, bus standard
CDC	Calibration Drift Compensation	Drift correction setting with DiaSys in engine governor
CEL	Check Engine Lamp	1st function: Warning lamp (rectify fault as soon as possible) 2nd function: Read out fault codes
CKT	Circuit	
CLS	Coolant level sensor	Monitors coolant level
CM	Current Measurement	Current measured value
CPS	Coolant pressure sensor	Monitors coolant pressure
CR	Common Rail	
CTS	Coolant temperature sensor	Monitors coolant temperature
DDEC	Detroit Diesel Electronic Controls	Engine control system made by Detroit Diesel
DDL	Diagnostic Data Link	Diagnostic lines
DDR	Diagnostic Data Reader	Diagnostic unit
DiaSys®	Electronic dialog system	
DIN	Deutsches Institut für Normung e. V.	At the same time identifier of German standards (DIN = “Deutsche Industrie-Norm”)
DL	Default Lost	Alarm: Default CAN bus failure
DMC	Data Matrix Code	
DOC	Diesel Oxidation Catalyst	Oxidation catalyst upstream of the diesel particulate filter
DPF	Diesel Particulate Filter	
DT	Diagnostic Tool	Diagnostic unit
ECM	Electronic Control Module	Electronic control unit of the DDEC system
ECU	Engine Control Unit	Engine governor
EDM	Engine Data Module	Memory module for engine data

Abbreviation	Meaning	Explanation
EEPROM	Electrically Erasable Programmable Read Only Memory	
EFPA	Electronic Foot Pedal Assembly	Electronic accelerator pedal
EGR	Exhaust Gas Recirculation	
EIL	Engine Ident Label	
EIM-ID	Emission Identification Number	
EMU	Engine Monitoring Unit	
ESCM	Extreme Site Condition Management	Power reduction for operation in extreme conditions
ESD	Einzelspeicherdruck	Injector accumulator pressure
ETC	Exhaust turbocharger/exhaust turbocharging	
EUI	Electronic Unit Injector	Electronic injection nozzle unit
FO	Frequency Output	
FPS	Fuel Pressure Sensor	Monitors fuel pressure
FRS	Fuel Restriction Sensor	Monitors differential fuel pressure
FTS	Fuel Temperature Sensor	Monitors fuel temperature
FWCP	Fire Water Control Panel	Control cabinet
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	
IDM	Interface Data Module	Memory module for interface data
IIG	Initial injector equalization	Initial input of injector code in Engine Control Unit with DiaSys
INJ	Injector	
ISO	International Organization for Standardization	International umbrella organization for all national standardization institutes
KGS	Kupplungsgegenseite	Engine free end in accordance with DIN ISO 1204
KS	Kupplungsseite	Engine driving end in accordance with DIN ISO 1204
L1	Limit 1	Limit value, limit 1
L2	Limit 2 Reference surface for heights above sea level	Limit value, limit 2
LED	Light Emitting Diode	Light emitting diode
LLK	Ladeluftkühlung	Charge-air cooling
LO	Low	Alarm: Measured value lower than 1st minimum limit value
LOLO	Low Low	Alarm: Measured value lower than 2nd minimum limit value
LP	Low Pressure	
LSG	Limit Speed Governor	Maximum-speed governor
LSU	Lambda Sonde Universal	Universal Lambda probe
LT	Low Temperature	

Abbre-viation	Meaning	Explanation
MCR	Maximum Continuous Rating	Torque limitation curve
N/A	Not Applicable	
NN	Normal Null	Reference surface for heights above sea level
OEM	Original Equipment Manufacturer	
OI	Optimized Idle	
OLS	Oil Level Sensor	Monitors oil level
OPS	Oil pressure sensor	Monitors oil pressure
OTS	Oil Temperature Sensor	Monitors oil temperature
OT	Oberer Totpunkt	Top Dead Center (TDC)
PAN	Panel	Control panel
PIM	Peripheral Interface Module	
PWM	Pulse Width Modulation	Modulated signal
P-xyz	Pressure-xyz	Pressure measuring point xyz
RL	Redundancy Lost	Alarm: Redundant CAN bus failure
rpm	Revolutions per minute	
SAE	Society of Automotive Engineers	U.S. standardization organization
SD	Sensor Defect	Alarm: Sensor failure
SEL	Stop Engine Lamp	1st function: Warning lamp (stop engine and rectify fault); 2nd function: Read out fault codes
SID	System Identifier	
SPC	Spare Parts Catalog	
SRS	Synchronous Reference Sensor	TDC cylinder 1
SS	Safety System / Security Shutdown	Safety system alarm
TBS	Turbocharger Boost Sensor	Monitors charge-air pressure
TC	Tool Catalog	
TCI	Turbo Compressor Inlet	
TCO	Turbo Compressor Outlet	
TD	Transmitter Deviation	Alarm: Sensor comparison fault
TPS	Throttle Position Sensor	
TRS	Timing Reference Sensor	
T-xyz	Temperature-xyz	Temperature measuring point xyz
U_PDU	Voltage Power Driver Unit	Distribution voltage for solenoid valve output stages
UDV	Überdruckventil	Pressure relief valve
UT	Unterer Totpunkt	Bottom Dead Center (BDC)
VNT	Variable nozzle turbine	
VSG	Variable-speed governor	
VSS	Vehicle Speed Sensor	
ZKP	Zuordnung - Kategorie - Parameter	A number allocated to a parameter describing its function and assignment

10.2 MTU Contact/Service Partners

The worldwide network of the sales organization with subsidiaries, sales offices, representatives and customer service centers ensure fast and direct support on site and ensure 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 high flexibility, we're your contact around the clock: during each operating phase, preventive maintenance and corrective operations in case of a malfunction, for information on changes in conditions of use and for supplying spare parts.

Your contact person in our Customer Assistance Center:

E-mail: info@mtu-online.com

Tel.: +49 7541 9077777

Fax.: +49 7541 9077778

Asia/Pacific: +65 6100 2688

North and Latin America: +1 248 560 8000

Spare Parts Service

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

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

Your contact at Headquarters:

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

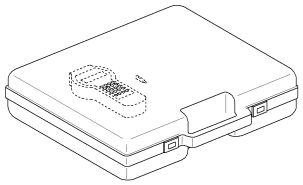
Tel.: +49 7541 9077777

Fax.: +49 7541 9077778

11 Appendix B

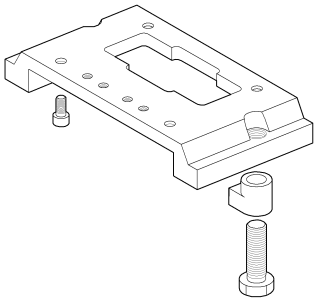
11.1 Special Tools

Optibelt TT belt tension tester



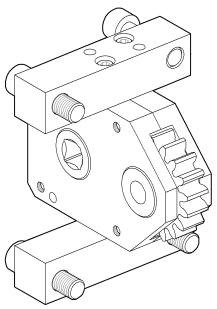
Part No.:	Y4345711
Qty.: Used in:	1 9.20.1 Fan drive – Adjust and check drive belt tension (→ Page 169)

Adapter



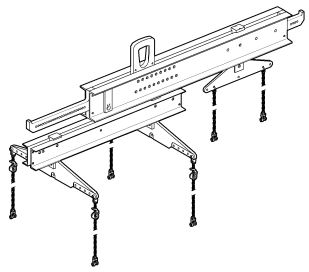
Part No.:	F6558528
Qty.: Used in:	1 9.1.1 Engine – Barring manually (→ Page 92)

Barring tool



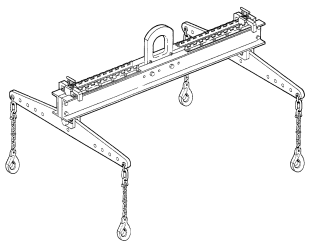
Part No.:	F6555766
Qty.: Used in:	1 9.1.1 Engine – Barring manually (→ Page 92)
Qty.: Used in:	1 9.2.1 Cylinder liner – Endoscopic examination (→ Page 94)

Crossbeam



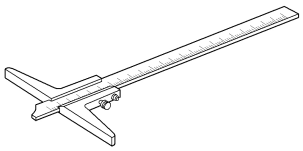
Part No.:	T80091826
Qty.:	1
Used in:	3.1 Transportation (→ Page 20)

Crossbeam



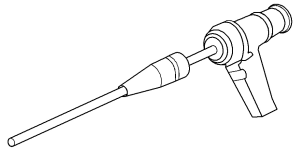
Part No.:	T80092210
Qty.:	1
Used in:	3.1 Transportation (→ Page 20)

Depth gage, 200 mm



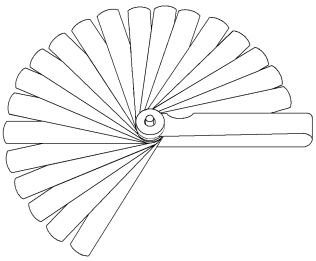
Part No.:	Y20000918
Qty.:	1
Used in:	9.5.2 Valve protrusion – Measurement (→ Page 105)

Endoscope



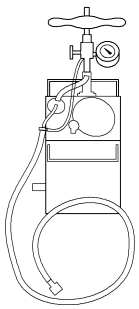
Part No.:	Y20097353
Qty.:	1
Used in:	9.2.1 Cylinder liner – Endoscopic examination (→ Page 94)

Feeler gage



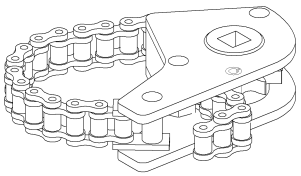
Part No.:	Y20098771
Qty.:	1
Used in:	9.5.3 Valve clearance – Check and adjustment (→ Page 107)

Filling device



Part No.:	B80144852
Qty.:	1
Used in:	9.8.1 Fuel system – Venting (→ Page 119)

Filter wrench

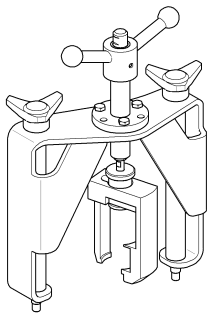


Part No.:	F30379104
Qty.:	1
Used in:	9.9.1 Fuel filter – Replacement (→ Page 120)
Qty.:	1
Used in:	9.9.2 Intermediate fuel filter – Replacement (→ Page 121)
Qty.:	1
Used in:	9.14.1 Engine oil filter – Replacement (→ Page 140)
Qty.:	1
Used in:	9.14.2 Centrifugal oil filter – Cleaning and filter-sleeve replacement (→ Page 141)

High-pressure cleaner

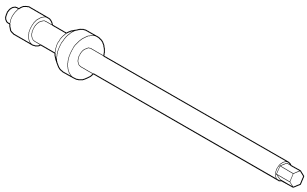
Part No.:	
Qty.:	1
Used in:	6.8 Plant – Cleaning (→ Page 68)

Installation and removal jig



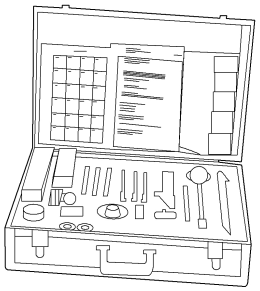
Part No.:	F6794703
Qty.:	1
Used in:	9.7.2 Injector – Removal and installation (→ Page 114)

Milling cutter



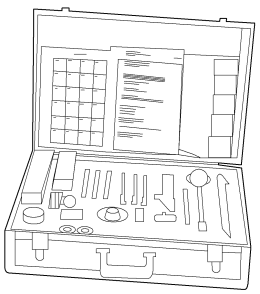
Part No.:	F30452739
Qty.:	1
Used in:	9.7.2 Injector – Removal and installation (→ Page 114)

MTU test kit



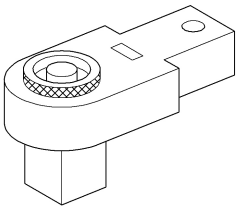
Part No.:	5605892099/00
Qty.:	1
Used in:	9.13.4 Engine oil – Sample extraction and analysis (→ Page 138)

MTU test kit



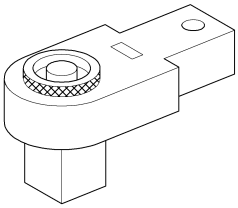
Part No.:	F6798833
Qty.:	1
Used in:	9.15.6 Engine coolant – Sample extraction and analysis (→ Page 150)

Ratchet bit



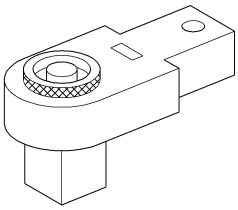
Part No.:	F30027341
Qty.: Used in:	1 9.13.3 Engine oil – Change (→ Page 136)
Qty.: Used in:	1 9.19.5 Battery-charging generator – Drive belt tension adjustment (→ Page 168)

Ratchet bit



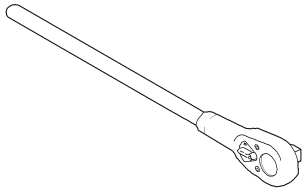
Part No.:	F30027339
Qty.: Used in:	1 9.14.2 Centrifugal oil filter – Cleaning and filter-sleeve replacement (→ Page 141)

Ratchet bit



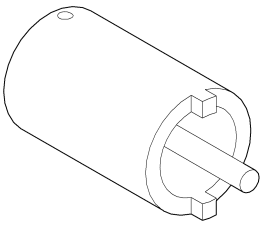
Part No.:	F30027340
Qty.: Used in:	1 9.19.5 Battery-charging generator – Drive belt tension adjustment (→ Page 168)

Ratchet with extension



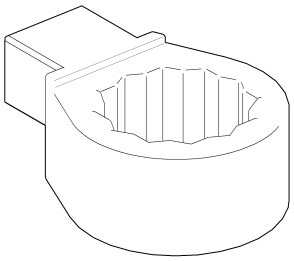
Part No.:	F30006212
Qty.: Used in:	1 9.1.1 Engine – Barring manually (→ Page 92)
Qty.: Used in:	1 9.2.1 Cylinder liner – Endoscopic examination (→ Page 94)

Slotted screwdriver



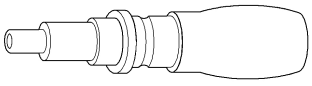
Part No.:	F30452578
Qty.: Used in:	1 9.7.2 Injector – Removal and installation (→ Page 114)

Socket box wrench



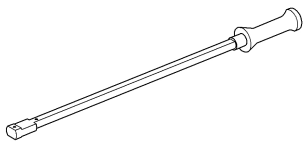
Part No.:	F30039526
Qty.: Used in:	1 9.5.3 Valve clearance – Check and adjustment (→ Page 107)

Torque screwdriver, 1–5 Nm



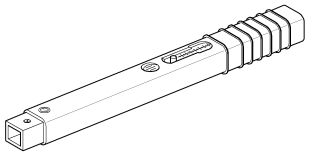
Part No.:	F30452774
Qty.: Used in:	1 9.7.2 Injector – Removal and installation (→ Page 114)

Torque wrench, 10–60 Nm



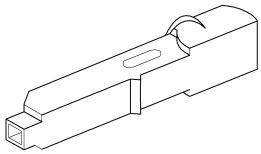
Part No.:	F30452769
Qty.: Used in:	1 3.3 Crankshaft transport locking device (→ Page 22)
Qty.: Used in:	1 3.4 Crankshaft transport locking device – For transport with flanged-on generator (→ Page 25)
Qty.: Used in:	1 9.3.1 Crankcase breather – Filter element replacement (→ Page 98)
Qty.: Used in:	1 9.7.2 Injector – Removal and installation (→ Page 114)
Qty.: Used in:	1 9.19.5 Battery-charging generator – Drive belt tension adjustment (→ Page 168)

Torque wrench, 40–200 Nm



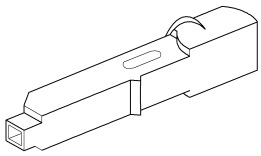
Part No.:	F30027337
Qty.: Used in:	1 9.13.3 Engine oil – Change (→ Page 136)

Torque wrench, 4–20 Nm



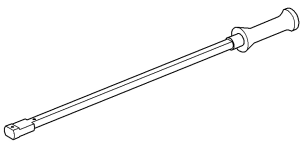
Part No.:	F30044239
Qty.: Used in:	1 9.9.4 Fuel prefilter – Filter element replacement (→ Page 123)

Torque wrench, 4–20 Nm



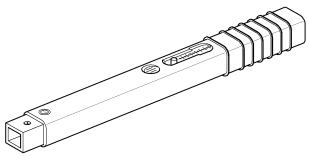
Part No.:	F30044239
Qty.: Used in:	1 9.4.2 Grounding device – Carbon brush replacement (→ Page 103)

Torque wrench, 60–320 Nm



Part No.:	F30452768
Qty.: Used in:	1 3.3 Crankshaft transport locking device (→ Page 22)
Qty.: Used in:	1 3.4 Crankshaft transport locking device – For transport with flanged-on generator (→ Page 25)
Qty.: Used in:	1 9.5.3 Valve clearance – Check and adjustment (→ Page 107)
Qty.: Used in:	1 9.7.2 Injector – Removal and installation (→ Page 114)
Qty.: Used in:	1 9.19.5 Battery-charging generator – Drive belt tension adjustment (→ Page 168)

Torque wrench, 6–50 Nm



Part No.:	F30027336
Qty.:	1
Used in:	9.14.2 Centrifugal oil filter – Cleaning and filter-sleeve replacement (→ Page 141)

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