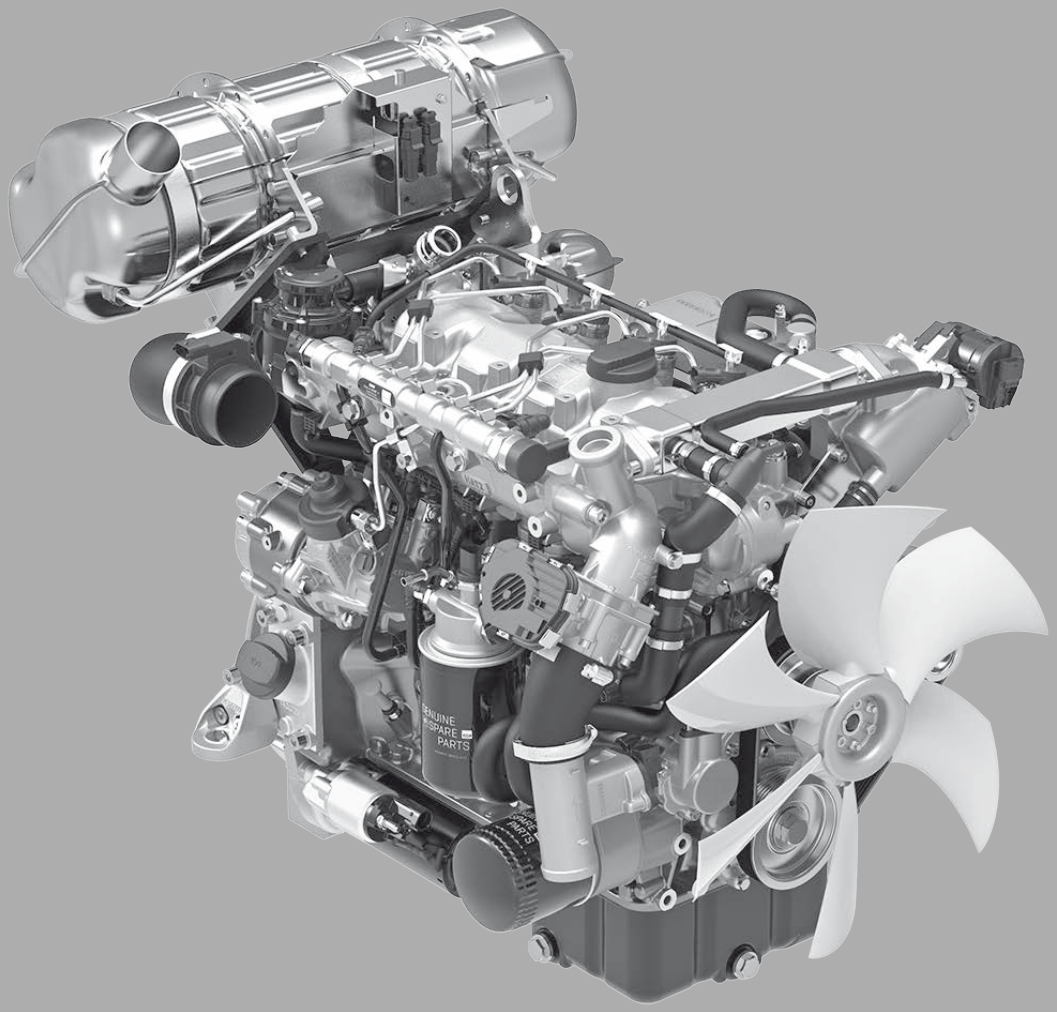
CREATING POWER SOLUTIONS.



3H50 | 4H50

ASSEMBLY INSTRUCTION
Diesel engine

Hatz Diesel

1 Legal notices

Contact data

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Original manual

This manual has been translated into multiple languages.

The German version is the **original manual**. All other language versions are **translations** of the **original manual**.

Revision

Version	Date	Name
Ver. 00	01/13/2023	GMV / bw
Ver. 01	01.03.2023	GMV / bw
Ver. 02	28.04.2023	GMV / bw
Ver. 03	19/07/2023	GMV / bw
Ver. 04	09/13/2023	GMV / bw
Ver. 05	12/12/2023	GMV / bw
Ver. 06	04/16/2024	GMV / bw
Ver. 07	05/23/2024	GMV / bw
Ver. 08	16.07.2024	GMV / bw
Ver. 09	09.10.2024	Techology / bw

2 General information

Information on the document

Our engines are state of the art and meet the basic safety and health requirements specified in the EC - Machinery Directive (2006/42/EC). These Assembly Instructions contain important instructions on how to safely assemble the engine. In addition, the rules and regulations for accident preventions applicable for the place of use must be heeded.

The engine provides a high degree of operational safety and a high quality standard which is ensured by a certified quality management system (EN ISO 9001). Proper functioning of all engines is checked prior to leaving the factory.

HATZ diesel engines are efficient, robust, and have a long service life. Therefore, they are usually installed in machines that are used for commercial purposes.

You must read the manual for diesel engine before starting the first time. It will help you avoid accidents, operate and maintain the engine correctly and, hence, ensure a long service life.

Give the manual for diesel engine to any further users or subsequent owner of the engine.

Machine

This manual describes the following machine.

Machine name	HATZ diesel engine
Type number	3H50T, 3H50TI, 3H50TIC, 3H50TICD, 4H50TI, 4H50TIC, 4H50TICD

Customer service

Have service work performed by qualified technicians only. We recommend that you work with one of the over 500 **HATZ service stations**. Trained specialists there will repair your machine with **Hatz original spare parts** and with **HATZ tools**. The global HATZ service network is at your disposal to advise you and supply you with spare parts. For the address of the **Hatz service station** nearest you, please see the enclosed spare parts list or visit us in the Internet at: **www.hatz-diesel.com**

Installation of unsuitable spare parts can lead to problems. We cannot accept liability for direct damage or secondary damage that results from this.

We therefore recommend the use of **genuine Hatz spare parts**. These parts are manufactured according to strict Hatz specifications and achieve maximum operational reliability through their perfect fit and functionality. The order number can be found in the Internet at: **www.hatz.com**

Exclusion of liability

The manufacturer cannot be held liable for personal injury, damage to property or damage to the machine itself caused by improper use, foreseeable misuse, or failure to follow or adequately follow the safety measures and procedures described in this manual. This also applies to changes made to the machine and the use of unsuitable spare parts.

Modifications, which serve the technical improvements, are reserved.

3 Safety

3.1 General information

Introduction

This chapter contains the information you need to work safely with this machine.

To prevent accidents and damage to the machine, it is imperative that these safety instructions be followed.

Read this chapter carefully before beginning work.

3.1.1 Intended use

Intended use

The machine described in this manual fulfills the following functions:

- Diesel engine intended for installation in a machine or for assembly with other machines to form a machine. See chapter *17 Declaration of incorporation, page 205*.

This engine is intended exclusively for the purpose specified and tested by the manufacturer of the machine in which the engine is installed.

Any other use is not intended and therefore not permitted. Violations compromise the safety of the personnel working with the machine. Motorenfabrik HATZ does not accept any liability for damage resulting from this.

The operational safety of the machine is only guaranteed if it is used as intended.

Use according to the intended purpose also includes observance of the instructions in this Operator's Manual and the Diesel Engine Manual

Foreseeable misuse

The following is considered to be foreseeable misuse:

- Any use that varies from or extends beyond the uses specified above.
- Failure to comply with the instructions given in this manual.
- Failure to comply with the safety instructions.
- Failure to immediately eliminate malfunctions that impact safety before continuing work with the machine (working with the machine when it is not in perfect condition, either functionally or in terms of safety).
- Failure to perform the necessary inspection and maintenance work.
- Any unauthorized modification of or removal of safety equipment.
- Use of spare parts and accessories that are unsuitable or have not been approved by HATZ.
- Fuel other than specified in the instructions.
- Operation in flammable or hazardous environments.
- Operation in closed-off or poorly ventilated rooms.
- Operation in an aggressive atmosphere (e.g., high salt content) without further measures for corrosion protection.
- Improper operation at variance with DIN ISO 3046 -1 and DIN ISO 8528 (climate, load, safety).

Residual risks

Residual risks result during daily use and in association with maintenance work.

These residual risks will be pointed out in chapter *3.2.2 Machine-specific safety instructions for operation, page 15* and in chapter *3.2.3 Machine-specific safety instructions for maintenance work, page 16* as well as in the further contents of the manual, directly in front of the descriptions or operating instructions concerned.

3.1.2 Machine user or machine manufacturer obligations

Machine manufacturer obligations

These assembly instructions contain important information on how to safely assemble the engine including the equipment delivered by HATZ.

It is prohibited to start the engine before it is fully installed!

It is prohibited to start up the machine before it has been ensured that the machine meets all safety-related measures and legal regulations.

Before placing the machine on the market, the device manufacturer is responsible for ensuring that all legal regulations and the locally applicable requirements for the machine have been fulfilled.

User obligations

The operator is obliged to only operate the machine when it is in perfect condition. The operator must check the condition of the machine before use and ensure that any defects are eliminated before it is taken into service. Running the machine while identified defects exist is not permitted. The operator must also ensure that all persons who work on the machine are familiar with the contents of this manual, and the Diesel Engine Manual.

Obligations of the operating and maintenance personnel

Personnel assigned with operating and maintaining the machine must have read and understood this manual or must possess the qualifications necessary for working with this equipment, acquired in training/instructional courses. No one may work with the machine without the necessary qualifications, even if for just a brief period.

The operating and maintenance personnel must not be under the influence of drugs, medication or alcohol.

All work performed on the machine must be in compliance with the information provided in this manual.

3.1.3 Representation of safety notes

Overview

This machine has been designed and built according to state-of-the-art technology and the recognized safety standards. Despite these precautions, risks exist when commissioning or operating the machine and during maintenance work. The risks are identified in this manual by means of safety notes. The safety notes precede the relevant description or operating step.

Structure of the safety notes

The safety notes consist of:

- Danger symbol
- Signal word
- Description of the danger
- Possible consequences
- Preventative measures

General danger symbol

The general danger symbol is used to identify the danger of personal injury.

Signal words

Signal words identify the magnitude of the risk and the seriousness of possible injury:

Danger symbol/ signal word	Meaning
DANGER	This signal word is used to indicate imminently dangerous situations which, if not avoided, will lead to serious injury or death.
WARNING	This signal word is used to indicate potentially dangerous situations which, if not avoided, may lead to serious injury or death.
CAUTION	This signal word is used to indicate potentially dangerous situations which, if not avoided, may lead to minor or moderate injury.
CAUTION	This signal word, without a danger symbol, is used to indicate the risk of property damage.
NOTICE	This signal word indicates additional useful information, such as operating tips and cross references.

3.1.4 Meaning of safety symbols

Explanation of symbols

The following table describes the meanings of the safety symbols used in this manual.

Symbol	Meaning
	Smoking, fire, and open flames are prohibited!
	Warning of personal injury!
	Warning of hot surfaces!
	Warning of hot surfaces! (Alternative)
	Warning of flammable substances!
	Warning of explosive substances!
	Warning of toxic engine exhaust!
	Warning of corrosive substances!
	Warning of heavy loads!
	Warning of environmental damage!
	Comply with this manual or additional documentation from other manufacturers or the operator.
	Additional information that is useful to the reader.

3.2 Safety notes

3.2.1 Operational safety

Introduction

This chapter contains all of the important safety instructions for personal protection and for safe and reliable operation. Additional, task-related safety instructions can be found at the beginning of each chapter.

DANGER

Danger to life, danger of injury or danger of property damage due to failure to comply with this manual and the safety instructions contained therein.

- As the operator of the machine, you must ensure that all people working on the machine are familiar with the content of this manual.
- Before working on the machine, read this manual carefully, paying special attention to the safety notes in Diesel Engine Manual..
- Fulfill all required safety conditions before working on the machine.
- Follow all general safety instructions as well as the specific task-related safety instructions contained in the individual chapters.

Using the machine

- Only operate the machine for the purposes described in chapter *3.1.1 Intended use, page 9*.

Compliance with other regulations

- The applicable regulations of the relevant professional associations must be observed.
- Comply with the regulations concerning the minimum safety and health requirements for the use of work equipment by workers at work.
- In addition, local safety, accident prevention and environmental regulations also apply when operating the machine.

Personal protective equipment

During operation and maintenance of the machine, personal protective equipment must be available and must be used if necessary. The use of personal protective equipment is specified in the description of the operating steps.

Personal protective equipment	Pictogram	Function
Safety shoes		Safety shoes offer protection against: ▪ Slipping ▪ Falling objects
Hearing protection		Hearing protection offers protection against ear injuries due to excessive and constant noise.
Safety gloves		Safety gloves protect the hands against injury, e.g., from battery acid.
Safety goggles (with side protection)		Safety goggles protect the eyes from flying objects (e.g., dust particles, spraying liquids, spraying acid).
Fine dust mask		A fine dust mask protects the wearer against particulate pollutants.
Working clothes		Wear close-fitting working clothes. It must not restrict the wearer's freedom of movement, however.

Warning labels and information signs on the machine

The warning labels and information signs on the machine must be followed (see chapter "Labels" *3.2.5 Labels, page 19*).

The warning labels and information signs must be kept legible and must be replaced if necessary. For this purpose, contact your nearest **HATZ service station**.

Maintenance work

Maintenance work that goes beyond the scope described in this manual must only be performed by qualified technicians (see chapter *2 General information, page 8*).

Independent maintenance work and constructional changes to the machine, especially to the safety equipment, are not permitted.

Safety equipment

Safety equipment must not be modified and must not be rendered ineffective during normal operation.

General safety instructions

DANGER

Danger to life and danger of injury due to failure to follow the warnings on the machine and in this manual.

- Heed the warnings on the machine and in this manual.

WARNING

Danger of injury and danger of incorrect operation due to inadequate personnel qualifications.

- The personnel must have read and understood this manual or must possess the qualifications necessary for working with this equipment, acquired in training/instructional courses.
- Only qualified personnel is permitted to operate and maintain this machine.
- Failure to comply will cause the warranty to become void.

WARNING

Danger of injury from failure to follow the Operating Instructions and from performing unauthorized tasks on the machine.

- Follow all instructions.
- Do not perform activities for which no qualification is available. Contact properly trained personnel if necessary.

CAUTION

Danger of injury from overloading the body.

Lifting the machine to transport it or to move it to another location can lead to injuries (of the back, for example).

- Only lift the machine with a hoist (see chapter *7.1 Transport, page 45*).

3.2.2 Machine-specific safety instructions for operation

Introduction

The machine can pose residual risks during operation. To eliminate these risks, all persons working on the machine must follow the general and machine-specific safety instructions.

If you have an engine that is not yet installed in a machine, it is imperative that you follow the **Assembly Instructions for HATZ Diesel Engines** before installing the engine.

These Assembly Instructions contain important information on safe installation.

If the engine is installed in a machine or assembled with other machines to form a machine, it is prohibited to start the engine before it has been determined that the newly created machine fulfills all safety-related requirements and applicable legal regulations.

Safe operation

- Before switching on the machine, ensure that no one can be injured when the machine is started up.
- During machine operation, ensure that unauthorized persons do not have access to the area in which the machine has an impact.
- Parts of the exhaust gas system and the surface of the engine become hot during operation. Risk of injury from touching hot parts! Let the engine cool before maintenance.
- Do not refuel during operation if this would result in a potential danger, e.g., if the engine would be operated close to the tank.

Faults

- Immediately eliminate faults that compromise safety.
- Switch off the machine and do not take into service again until all faults have been eliminated.

Safety instructions for operation

DANGER

Danger to life from inhaling exhaust gases.

Toxic engine exhaust gases can lead to loss of consciousness, and even death, in closed-off and poorly ventilated rooms.

- Never operate the machine in closed-off or poorly ventilated rooms.
- Do not breathe in the exhaust gases.

DANGER

Danger of fire from hot exhaust gas system.

If inflammable materials come into contact with the exhaust gas flow or the hot exhaust gas system, these materials can ignite.

- Keep inflammable materials away from the exhaust gas system.
- Do not operate the engine (exhaust flow or hot exhaust gas system) in the direct vicinity of combustible materials.

DANGER

Fire hazard from fuel.

Leaked or spilled fuel can ignite on hot engine parts and cause serious burn injuries.

- Only refuel when the engine is switched off and has cooled down.
- Never refuel in the vicinity of open flames or sparks that can cause ignition.
- Do not smoke.
- Do not spill fuel.

3.2.3 Machine-specific safety instructions for maintenance work

Introduction

The machine can pose residual risks during maintenance. To eliminate these risks, all persons working on the machine must follow the general and machine-specific safety instructions.

Maintenance intervals

- Strictly adhere to the maintenance intervals.
- Check the safety equipment regularly to ensure it is in good condition and functioning properly.
- Check connections, cables and fasteners regularly to ensure they are in good condition.

Maintenance work

Maintenance work that goes beyond the scope described in the manual for diesel engine must only be performed by qualified technicians. We recommend that you work with one of the over 500 **HATZ service stations**.

Replacing parts

- When replacing defective components, we recommend that you use **genuine Hatz spare parts** (see chapter *3.1.1 Intended use, page 9*).
- When disposing of parts that can no longer be used, do so in accordance with local environmental regulations or send them to a recycling center.

Measures following maintenance and troubleshooting

- Securely reconnect loose electrical connections; check that the electrical components and equipment are functioning properly.
- Check the entire machine for foreign bodies; remove any foreign bodies.

Safety instructions for maintenance work

DANGER

Danger of explosion from flammable cleaning agents.

Cleaning with benzene is an explosion hazard. It is highly flammable, can become electrostatically charged, and can generate an explosive gas/air mixture.

- Use halogen-free, cold cleaners with a high flash point for cleaning.
- Comply with manufacturer's instructions.

DANGER

Fire hazard from spontaneous combustion.

Cleaning materials soaked with cold cleaner may produce heat together with atmospheric oxygen and combust spontaneously.

- Collect cleaning materials soaked with cold cleaner only in fire-proof, tightly sealed containers.
- Do not dispose of cold cleaner residues and used cleaning materials with domestic waste, rather only in accordance with manufacturer instructions.
- Comply with the instructions for preventing fire on the safety data sheet for the cold cleaner.

WARNING

Danger of injury from compressed air and dust particles.

Eye injuries can occur when cleaning with compressed air.

- Wear safety goggles.

⚠ CAUTION

Danger of injury from ignoring the maintenance instructions.

- Only perform maintenance work when the engine is switched off.
- For engines with an electric starter:
  Disconnect the negative battery terminal.
  Protect the starting key from unauthorized access.

⚠ CAUTION

Danger of burns.

There is a danger of burns when working on a hot engine.

- Let the engine cool before maintenance.

3.2.4 Electrical equipment

Safety notes

DANGER

Danger to life, danger of injury or danger of property damage due to incorrect use of batteries.

- Do not place tools or other metal objects on the battery.
- Before performing work on the electrical equipment, always disconnect the negative battery terminal.
- Never swap the plus (+) and negative (–) battery terminals.
- When installing the battery, first connect the **plus cable** and then the **negative cable**.
- When removing the battery, first disconnect the **negative cable** and then the **plus cable**.
- It is imperative to prevent short circuits and mass contact of current carrying cables.
- If faults occur, check the cable connections for good contact.

DANGER

Danger of explosion from flammable substances.

There is a danger of explosion from flammable gases.

- Keep batteries away from open flames and incendiary sparks.
- Do not smoke when working with batteries.

CAUTION

Danger of chemical burns

Chemical burns can occur when using batteries for the electrical operation.

- Protect your eyes, skin, and clothing from corrosive battery acid.
- Immediately rinse areas affected by splashed acid with clear water and consult a physician if necessary.

- Promptly replace defective indicator lamps.
- Do not disconnect the battery while the machine is running. Resulting voltage peaks could destroy the electronic components.
- When performing welding work on the machine, disconnect the battery and place the ground clamp of the welding equipment as close as possible to the welding area. Disconnect the plug connectors to the engine control unit and to the voltage regulator of the three phase alternator.

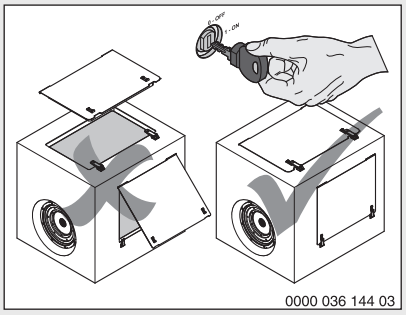
NOTICE

- We cannot be held liable for electrical equipment that is not designed according to HATZ wiring diagrams.

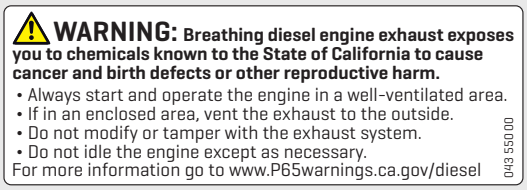
3.2.5 Labels

Warning labels and information signs on the engine

Engine specification **Silent Pack**

Label	Meaning
	CAUTION! Damage from noise and insufficient engine cooling. ▪ Only operate the engine when all covers are installed.
	Warning of hot surfaces!
	Cleaning with a high pressure cleaner is prohibited!

Engine specification **TIC/TICD**

sign	Meaning
	CALIFORNIA Proposition 65 Warning. For more information, see www.P65warnings.ca.gov/diesel (The warning label must be attached in a location where it is clearly visible on the machine. If necessary, Hatz can deliver the adhesive label unattached.)

Warning labels and information signs on the battery (option)

sign	Meaning
	1. Fire, sparks, open flames and smoking are prohibited: avoid causing sparks when working with cables and electrical machines. Avoid short-circuits. 2. Follow the instructions on the battery and in the battery user manual. 3. Keep children away from acid and batteries. 4. Danger of explosion: A highly explosive electrolytic gas is created when batteries are charged. 5. Wear safety goggles when filling. 6. Danger of chemical burns: Battery acid is highly corrosive. Therefore, wear safety gloves and eye protection. Do not tilt the battery; acid may spill out of the vent openings. 7. Do not dispose of the battery with the household trash. 8. Take the used battery to a collection center.

4 General information about the engine

4.1 Engine selection

Ideally, the engine is selected when the operating conditions have been analyzed and taken into account.

Not only are the operating conditions defined by the direct installation in the machine, but also by boundary conditions such as temperature, altitude, etc., and the planned starting method.

Generally speaking we recommend defining an engine according to the following flow chart:

Selection of:	Criteria for the selection process:
Speed	Speed level dependent on: ▪ Operating hours per year ▪ Noise ▪ Free mass forces/torques/vibrations ▪ Flexible/rigid attachment ▪ Geographic area of use of the driven machine
Power setting	Power calculation including: ▪ Temperature ▪ Height above sea level ▪ Efficiency of the driven machine (see section *4.4.1 Power consumption of the machine, page 25*) ▪ Safety margin (see section *4.4.5 Sicherheitsreserve, page 28*) ▪ Load profile, power classes of the standard
Engine variations	Selection of the engine, taking into account: ▪ Standard, power class ▪ exhaust gas standard ▪ Speed/Power ▪ Weight/Volume ▪ Starting method, starting temperature ▪ Power take off ▪ Permissible load on power take off points ▪ Flange capability ▪ Flexible/rigid attachment ▪ Dataset (e.g. speed parameter)
Additional equipment	▪ Adaptation to the machine and its environment
Fault replacement reaction	▪ Emergency off ▪ Emergency run

The most important points for the correction selection of the engine can be worked out using the **"Engine selection checklist"**. To do so, please contact the respective HATZ subsidiary. Based on this generally held view of the engine selection, the details can be found in the following sections.

4.2 Choice of speed

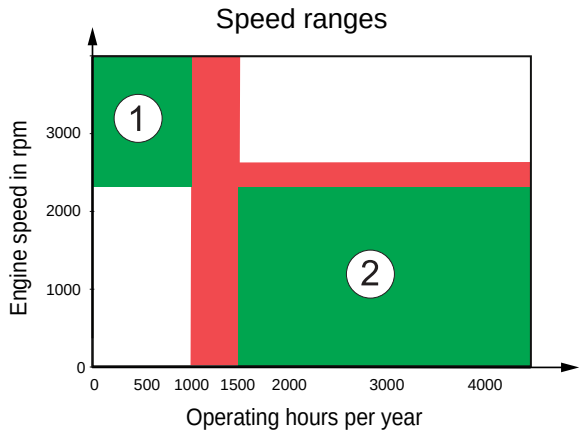
General information (noise, service life, …)

Specify the operating speed at the beginning of the equipment specification since this variable has significant influence on all the essential operating parameters of your machine. It is important to pay attention to a balanced compromise of efficiency for the following parameters:

- service life
- Fuel consumption
- Weight
- Noise
- Vibrations
- Power requirement
- Torque requirement
- Dimensions
- Exhaust gas quality

The right engine speed selection is important when selecting the engine since it significantly influences the behavior of the engine. When defining the right engine speed, the number of operating hours is decisive.

The number of operating hours is assigned to the so-called speed ranges:



4.2.1 Speed range 1

Speed range 1 begins at above 2,300 rpm and extends to the maximum speed of the engine.

For engines in speed range 1, the number of operating hours is normally less than 1,000 h/year, although this limit can certainly occasionally be at 1,200 h/year, for example.

Engines for construction machinery, and industrial or commercially operated engines, are generally situated in speed range 1.

Example:

In a year with 240 working day, a commercially used machine is operated on approx. 70% of days and is operated about 60% of the time in an 8-hour working day. This yields an annual number of operating hours of approx. 800 h.

Under these circumstances, the engine can normally easily be operated up to the maximum permissible speed range, although the speed of 3,600 rpm only appears reasonable in combination with 60 Hz generating sets and should not necessarily be used with other drives.

The engine speed has a significant influence on the following properties:

The noise behavior

The engine emits less noise at low speeds.

The vibration level of the engine

The vibration level is improved by a reduction in speed because the mass forces and mass torques are significantly less at lower speeds. A better vibration level means less structure-borne excitation, and hence a quieter machine.

Maintenance deficits

Generally, lower speed increases the service life. However, this only applies if the maintenance interval is adhered to consistently. If no other variables require a higher speed (e.g. building up torque), the lowest possible speed should be chosen.

4.2.2 Speed range 2

when the number of operating hours is greater than 1,500 h/year, a 5-year operating period of the machine accumulates an considerable total number of operating hours; this is true, for example, for irrigation pumps or generating sets, which reach a runtime of approx. 1,800 h/year by operating as little as 5 hours daily, or 9,000 hours in 5 years.

For these types of drives, speeds from speed range 2 must be selected, i.e. for more than 1,500 operating hours/year, the selected speed selection must be from 2,300 rpm to a maximum of 2,600 rpm. This speed selection also makes sense for third-world countries where service and maintenance options may not be reliable.

The noise behavior and vibration level of the engine also apply in speed range 2.

4.3 Power class selection

The lower setting of HATZ diesel engines is made in accordance with the power classes of the international standard of engines for work machinery ISO 3046-1:

The standard reference conditions for ISO 3046-1 are:

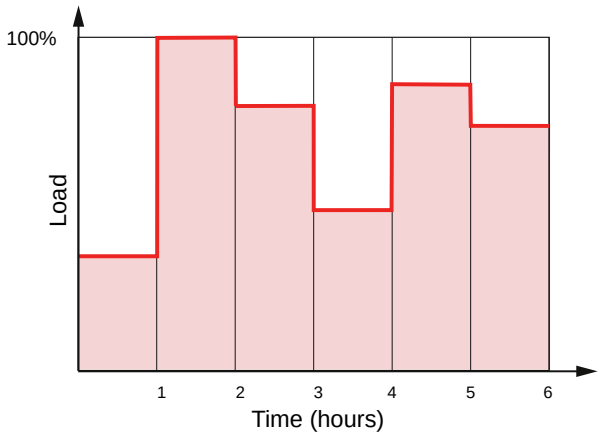
- Air pressure: 100 kPa (at approx. 100 m height above sea level),
- Intake air temperature: 298 K (25 °C)
- Relative humidity: 30%

Power class ISO 3046-1:		
1	Blocked power for intermittent operation = **blocked ISO effective power**	IFN
2	Blocked power for highly intermittent operation **= blocked ISO effective power**	IFNSI
3	Continuous power output, 10% overload capacity = **ISO standard power output, 10% overload capacity**	ICXN
4	Continuous power output, no overload capacity **= blocked ISO standard power output**	ICFN

4.3.1 Power class IFN

This power setting cannot be exceeded, and **corresponds to normal machinery use for alternating load at predominantly constant speed.**

The maximum value of the blocked ISO net power can be removed for a duration of up to one hour within 6 hours of alternating load.



Typical uses are with machines such as:

- Compressors,
- Trench cutting machines,
- Earth-moving equipment with hydrostatics such as caterpillars, loaders, etc.,
- Fire-fighting pumps,
- Vibratory plate compactors and vibratory rollers.

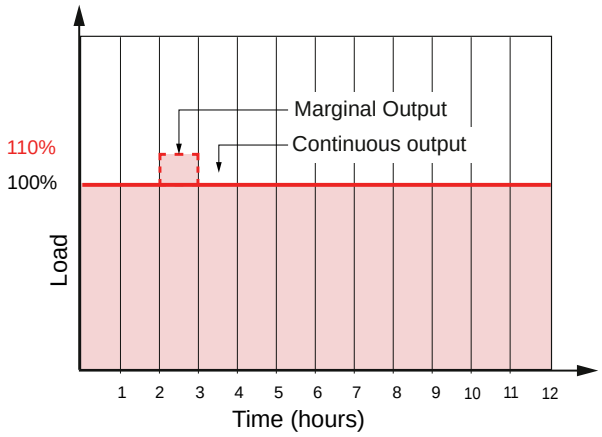
4.3.2 Power class IFNsi

Employed **when full power is only required briefly**, although the speed is largely constant, such as in refrigerators, welding machinery, forklift trucks, mobile cranes, etc.

Engine speed setting suitable for:	Engine speed setting not suitable for:
Welding equipment	Tractors
Forklift trucks	Generators
Mobile cranes	Water pumps
Excavators	
Wheel loaders	

4.3.3 Power class ICXN

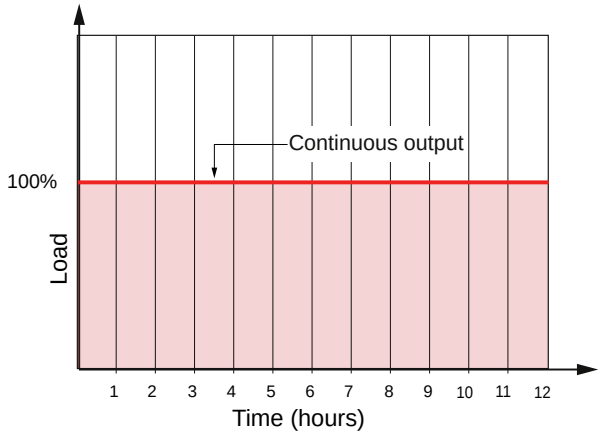
The **ICXN** is used for machines with **constant load consumption at a constant engine speed** such as power generation sets for a basic load or for ship drives. A one-hour overload operation is possible within a 12-hour period.



The engine setting takes this overpower capability into account. The magnitude of the overpower is selected depending on the purpose of the engine – normally it is set to an overpower of 10%.

4.3.4 Power class ICFN

The ICFN must not be exceeded. **It is the continuous effective power that the engine – interrupted only by maintenance work – is able to output continuously at a constant engine speed.**



This power setting is used, for example, for irrigation pumps and for machines that can be run on the torque rise curve for hours (e.g. joint cutters at maximum feed).

If there is no ICFN setting for Hatz diesel engines, please contact **Motorenfabrik Hatz Ruhstorf** beforehand.

4.4 Power calculation

After the power class is specified, the necessary engine power is determined:

An **undersized engine** (overload) leads to high wear and high probability of failure.

An **oversized engine** (permanent underload) leads to high specific fuel consumption, soot aggregation in the exhaust gas tract, deposits in the engine, etc.

For these reasons, a power calculation is essential!

In the power calculation the following are determined:	
1	The size of the net power requirement of the driven machine.
2	The size to set the safety reserves.
3	The load capacity of the engine due to the elevation at the place of use.

4.4.1 Power consumption of the machine

The net power consumption of the driven machine (PG) is obtained from the output of the machine, taking into account the efficiency of the machine and the force-transmitting elements.

Examples:	Efficiency
Gear drives	Approx. 95%
Belt drives	Approx. 85 – 95%
Hydrostatic systems (pump, lines, engine)	Approx. 60 – 70%
Generators	
→ 2 kW	Approx. 70%
→ 20 kW	Approx. 85%
Non-self-priming centrifugal pump	Approx. 60 – 65%
Self-priming, centrifugal pump	Approx. 45 – 50%

In the case of centrifugal pumps, it must still be taken into account that the pump input power is increased 33 % when the speed is only increased by 10 %. And conversely the pump input power also falls when the speed is reduced.

Formulae for calculating the net power requirement for:

- **Water pumps**

$$P(kW) = \frac{\mathrm{Q(m^3/h)} \times \mathrm{H(m)}}{367 \times \eta(\%/100)}$$

Example:

A non self-priming, centrifugal pump with η = 60 %, pumps 200 m³ of water per hour at a pressure of 4 bar (1 bar = 10.2 m water column at a water density of 1000 g/dm³). The net power requirement of the pump is:

$$P = \frac{200 \times (4 \times 10{,}2)}{367 \times 60/100} = 37{,}1kW$$

- **Hydraulic pumps**

$$P(kW) = \frac{Q(l/min) \times \mathrm{p(bar)}}{600 \times \eta(\%/100)}$$

Example:

A gear pump pumps 120 liters per minute at a pressure of 140 bar. The efficiency of the overall system is 70 %. The net power requirement is:

$$P = \frac{120 \times 160}{600 \times 70/100} = 45{,}7kW$$

- **Generating set**

$$P\ (kW) = \frac{kVA\ \times \cos\varphi}{\eta(\%/100)}$$

Example:

A generator with 36 kVA at full load has an efficiency of 82% and is

- connected to inductive consumers with a cos φ of 0.8. The net power requirement is:

$$P = \frac{36\ \times 0{,}8}{82/100} = 35{,}1kW$$

- connected to ohmic consumers with a cos φ of 1.0. The net power requirement is:

$$P = \frac{36 \times 1{,}0}{82/100} = 43{,}9kW$$

4.4.2 Power requirement of auxiliary take-off systems

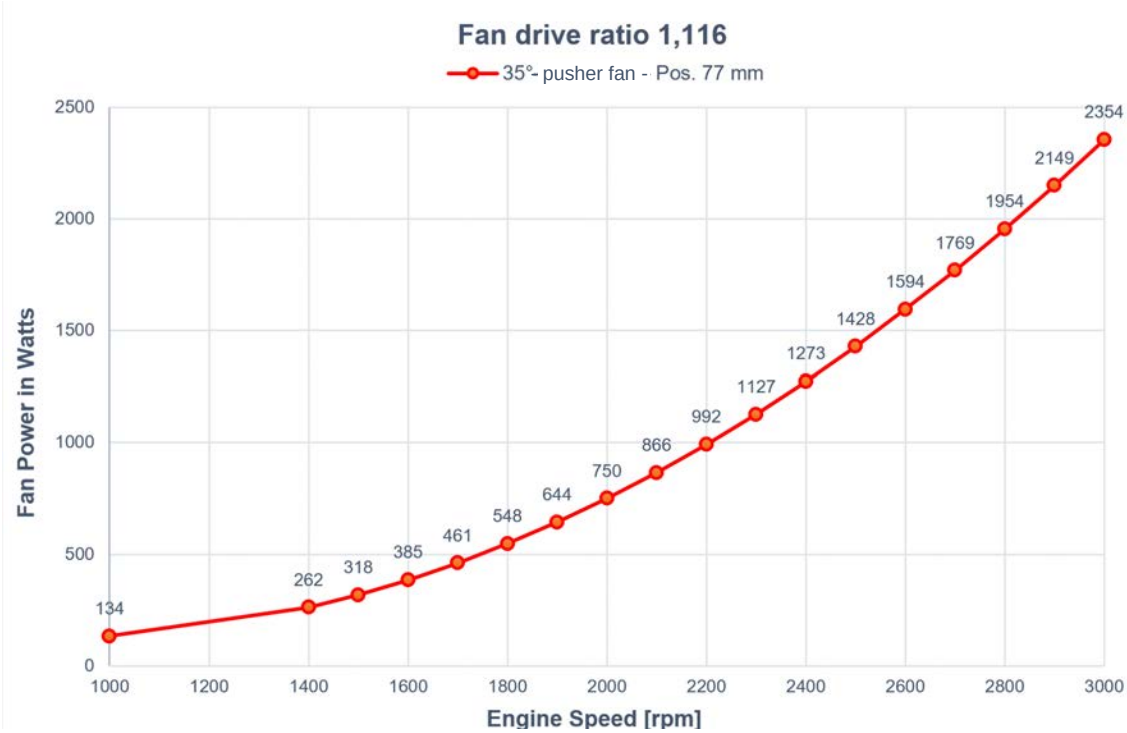
The power calculation must also take power-consuming auxiliary take off systems into account, such as auxiliary hydraulics.

Due to the common rail system, the electric power supply is necessary for operation with the H50, the power of the alternator has already been taken into account and does not need to be considered separately in the power calculation.

4.4.3 Power requirement for engine cooling - fan TI/TIC/TICD

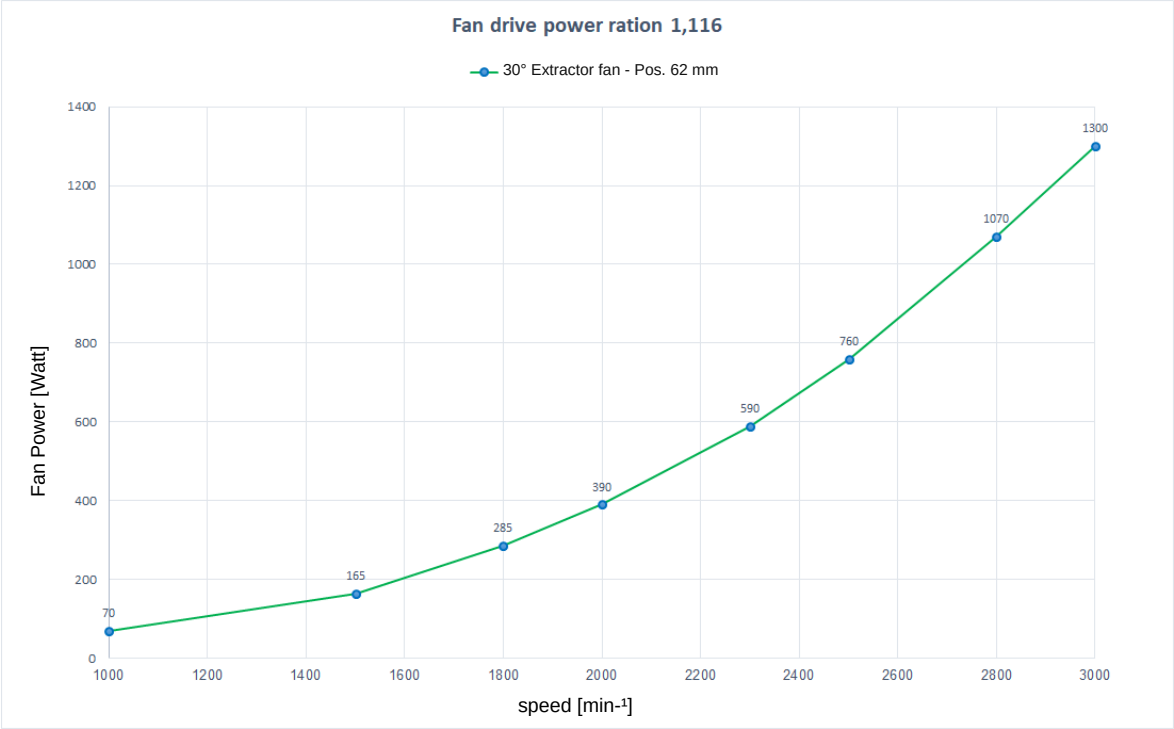
Extractor fan – 410 mm

Pressure fan – 410 mm



4.4.4 Power requirement for engine cooling - fan 3H50T/4H50N

Pressure fan and extractor fan fan – 350 mm



4.4.5 Margin of safety (factor fs)

The vast majority of assumptions to determine the power requirements are theoretical in nature, and therefore a margin of safety is necessary.

In addition, the power requirement of the machine can change during operation and increase, e.g. due to wear. For both reasons, a margin of safety is necessary.

It is generally recommended that a safety margin between 5 and 10% is assumed for uncertainties in the calculation. This results in the safety factor fs:

Safety			
%	5	10	15
fs	1.05	1.1	1.15

4.4.6 Required engine power

With the aid of the number specified earlier for the

- power consumption of the machine (PG)
- the power of the auxiliary take offs (PN)
- power consumption of the fan (PL)
- the power margin for safety (factor fs)

the power requirement on the engine can now be specified:

$$P\ (kW) = (PG + PN + PL)\ x\ fs$$

As an example for the determination of the engine power size, the aforementioned 36 kVA generating set with ohmic load is used for which the following data apply:

Power requirement of the generator	PG	43.9 kW
Power requirement for auxiliary take-off systems	PN	0 kW
Power requirement of fan	PL	2.3* kW
Margin of safety 5%	fs	1.05

*Example for 410 mm / 35°

$$\mathrm{P} = (43{,}9 + 0 + 2{,}3)\ x\ 1{,}05 = 48{,}5kW$$

For the corresponding technical data, see section *4.4.3 Power requirement for engine cooling - fan TI/TIC/TICD, page 27* and section *4.4.4 Power requirement for engine cooling - fan 3H50T/4H50N, page 28*.

5 Technical data

5.1 Engine information and filling quantities

Type		3H50	4H50
Type		Liquid-cooled four stroke diesel engine	
Combustion system		Direct injection	
Number of cylinders		3	4
Bore/Stroke	mm	84 / 88	84 / 88
Displacement	Liter	1.463	1.951
Engine oil consumption (after running-in period)	Max.	0.5 % of fuel consumption, pertaining to full load	
Engine oil pressure		2.5 bar to 4.5 bar	
Sense of rotation		Left (view toward flywheel)	
Tappet clearance		Automatic hydraulic valve adjustment (maintenance-free)	
Max. perm. continuous tilt position [1]		HATZ cooler with **integrated expansion tank** cooler low: 20°, other parts: 30°	
		HATZ cooler with **external expansion tank**	
		30°	30°
		40° [2]	35° [2]
Battery capacity	Max.	12 V – 110 Ah / 760 A (EN) / 800 A (SAE)	
		24 V – 66 Ah / 510 A (EN) / 540 A (SAE)	

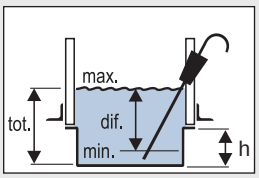
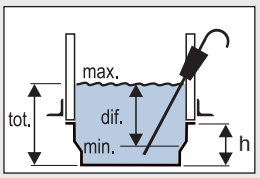
[1] Exceeding these limit values causes engine damage!

[2] Permissible tilt position for a maximum of 7 hours. After this period, return the engine from the tilt position to the horizontal position and switch it off for at least 5 minutes. Merely a reduction in the tilt position is not sufficient.

Engine specifications

Model	Description
T	With turbocharger.
TI	with turbocharger and charge air cooling.
TIC	With turbocharger, charge air cooling, cooled exhaust gas recirculation (EGR) and diesel oxidation catalyst (DOC)
TICD	With turbocharger, charge air cooling, cooled exhaust gas recirculation (EGR), diesel oxidation catalyst (DOC) and diesel particulate filter (DPF).
OPU	Open Power Unit. Complete system with all components required for engine cooling.
Silent Pack	Open Power Unit with noise and weather protection capsule.

Engine oil capacities

	Oil sump *					
						
Type	**h (mm)**	**tot. ltr.**[1)]	**dif. ltr.**[2)]	**h (mm)**	**tot. ltr.**[1)]	**dif. ltr.**[2)]
3H50	118	5.0	0.8	149	5.9	1.0
4H50	118	7.0	1.0	149	7.3	1.0
	148	9.0	1.0			

* To determine the engine oil capacity, note dimension (h) and the oil sump contour.

[1)] **tot. ltr.**: Engine oil capacity (in liters) for oil change with filter change.

[2)] **dif. ltr.**: Oil refill quantity (in liters) between the "min" and "max" marking on the dipstick.

These values are approximations only. The max. mark on the dipstick is decisive in any case.

Coolant filling quantities (engines with Hatz cooler)

	Hatz cooler	
	With external expansion tank	**With integrated expansion tank**
Type	**Filling quantity in liters ***	
3H50 T	–	7.9
3H50 TI	12,6	13,6
3H50 TIC	12,6	13,6
3H50 TICD	12,6	13,6
4H50 Ti	13.7	14.7
4H50 TIC	13.7	14.7
4H50 TICD	13.7	14.7

* These values are approximations only. The **MAX** marking on the dipstick applies in all cases.

Weights (without operating fluids)

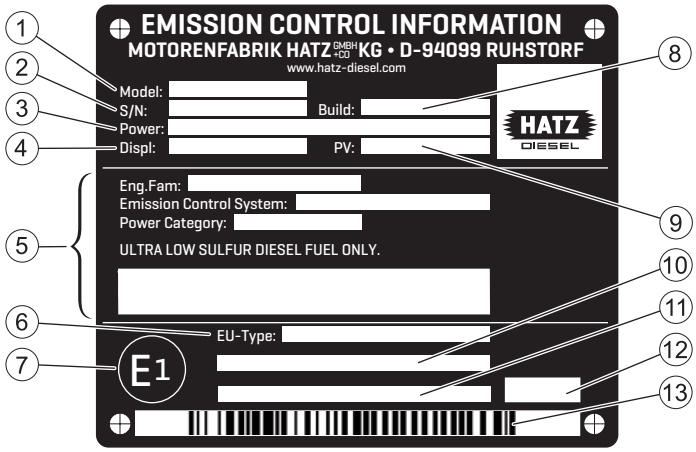
	Model		
	Standard	**OPU**	**Silent Pack**
Type	**Weight in kg**		
3H50 T	132 *	188	–
3H50 TI	133 *	215	312
3H50 TIC	154 *	236	333
3H50 TICD	161 *	243	345
4H50 Ti	152 *	234	333
4H50 TIC	173 *	255	354
4H50 TICD	180 *	262	366

* Without cooler.

Screw tightening torque

Designation	Nm
Oil drain screw	58
Drain screw on engine cooler	50
Drain screw on charge air cooler	50
Connection and fixing screws (**M10**) for protective guard (engine specification **TI**, **TIC**, **TICD**)	30
Connection and fixing screws (**M8**) for protective guard (engine specification **T**)	23
Screws for the breather cap of the crankcase ventilation	4

5.2 Engine type plate



The engine type plate is affixed to the crankcase and includes the following engine information:

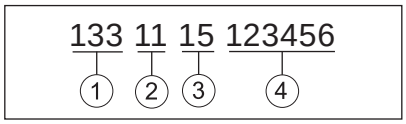
1	Model designation of the engine
2	Engine serial number
3	Engine power (kW) at rated speed (rpm)
4	Displacement (liters)
5	Information for US emission certification (EPA/CARB)
6	EU type approval number
7	EU country of origin (Germany)
8	Model year (month/year)
9	Test specification for special settings
10	Engine family designation or exemption code (EM) or transition code (TM) according to regulation (EU) 2016/1628
11	Additional specifications according to Regulation 2017/656 (exceptions) or "Separate shipment information"
12	Code for type plate variant
13	Barcode (engine serial number)

The following data must always be specified in case of queries and for spare parts orders:

1	Model designation
2	Engine serial number

5.2.1 Engine serial number

Breakdown of the engine serial number



1	Engine type number
2	Engine serial number
3	Model year
4	Fabrication number (consecutive)

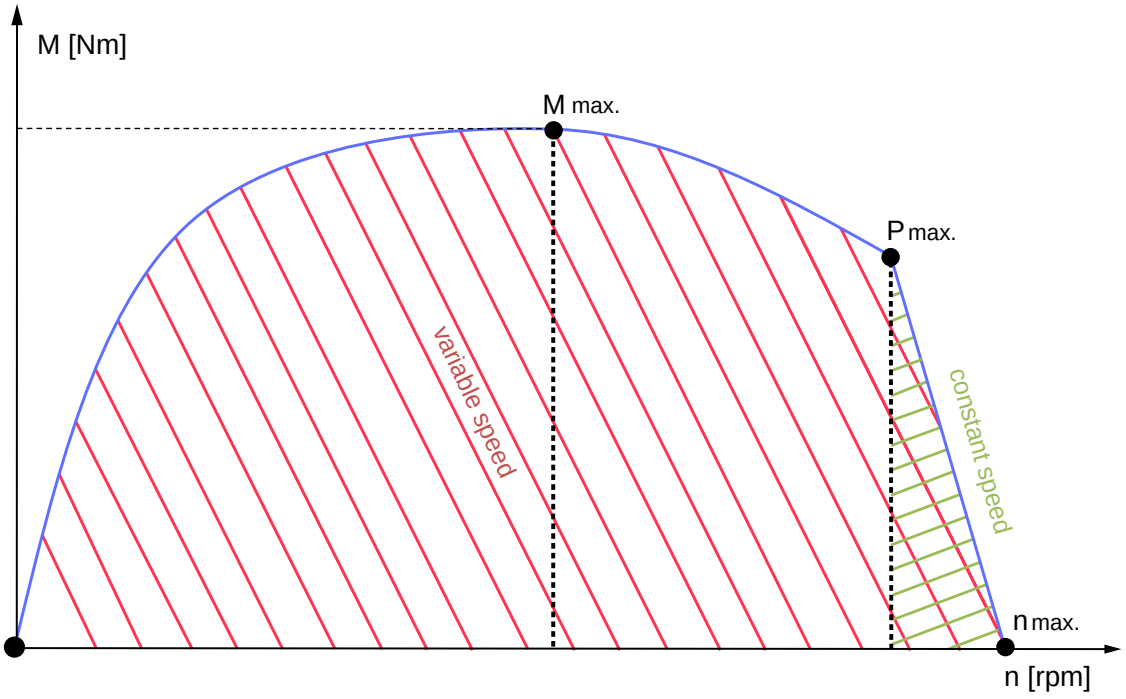
Engine type number

The engine type number makes it possible to see if the engine is equipped with a diesel oxidation catalyst (DOC). Engines with DOC have more stringent requirements on engine oil and fuel quality. The following table shows which engine types are equipped with DOC.

Engine type number	Type number	DOC
135	3H50TIC	X
136	4H50TIC	X
161	4H50TI	
163	3H50TI	
164	3H50TICD	X
165	4H50TICD	X
178	3H50T	

5.3 Power data H50

Speed application - constant speed/variable speed (P-degree 0%, 5%)



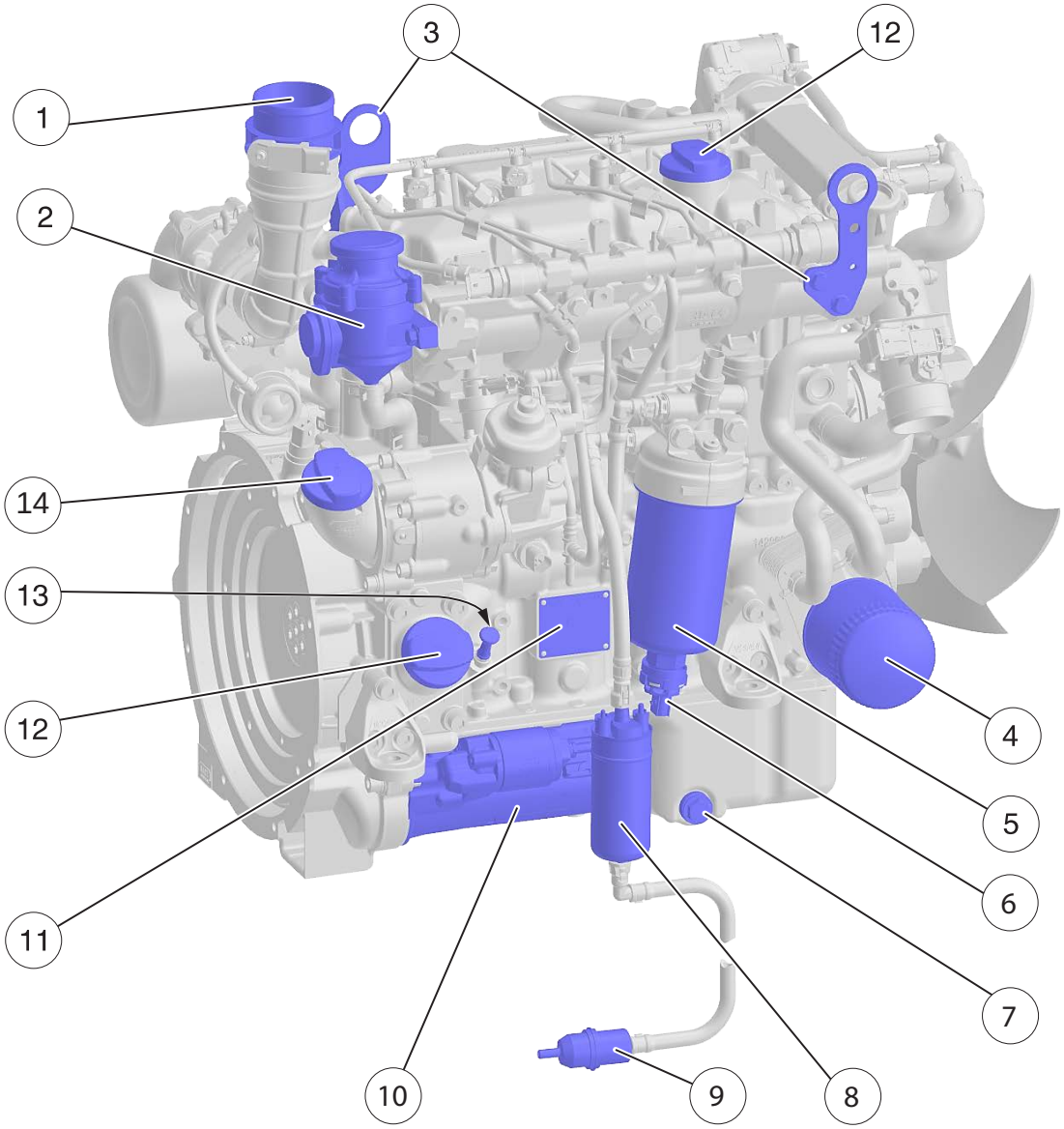
Definition of constant speed/variable speed

Constant speed applications are machines where the operating speed is between the nominal speed and the upper idle speed. In contrast, variable speed applications are used in the entire speed range (e.g. on the full load curve).

6 Engine overview

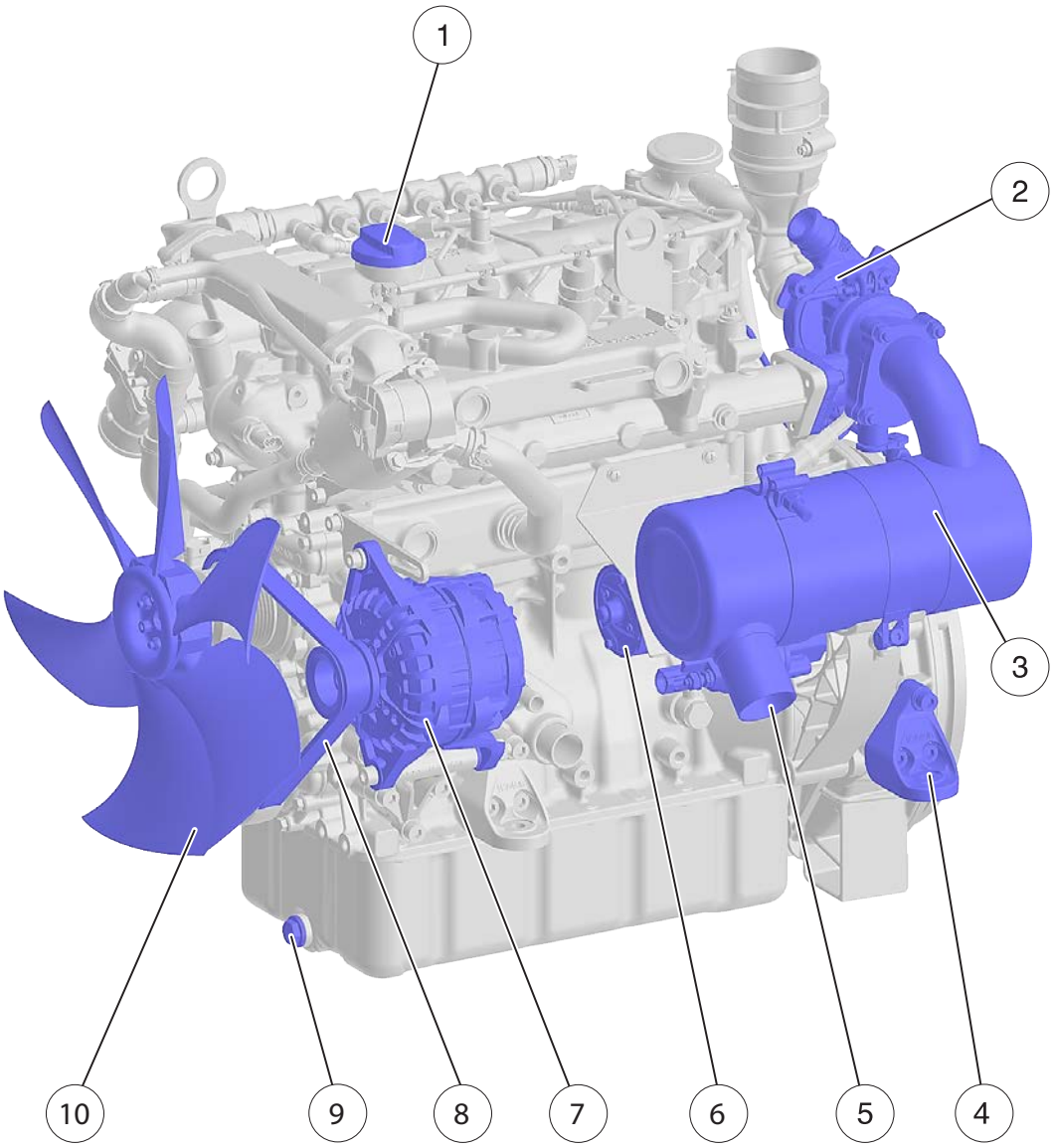
6.1 Designation of components

Intake side – Fan2Flywheel (F2F) TIC



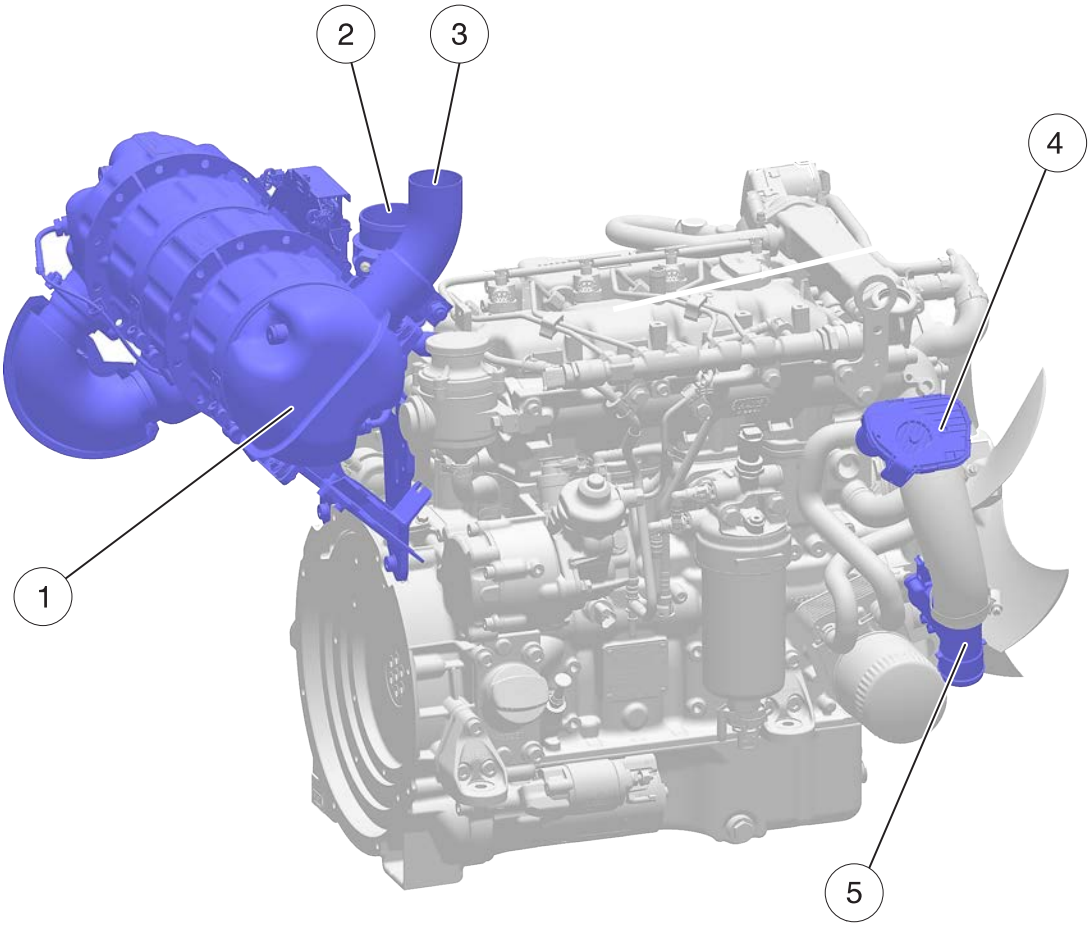
1	Intake opening for combustion air	8	Electric fuel pump
2	crankcase ventilation	9	Fuel prefilter
3	Lifting eyes	10	Starter
4	Oil filter	11	Type plate
5	Main fuel filter	12	Oil filler plug bottom, top (option)
6	Drain screw with integrated water in fuel sensor	13	Dipstick
7	Side oil drain screw	14	Oil filler plug, middle (option)

Exhaust side – Fan2Flywheel (F2F) TIC



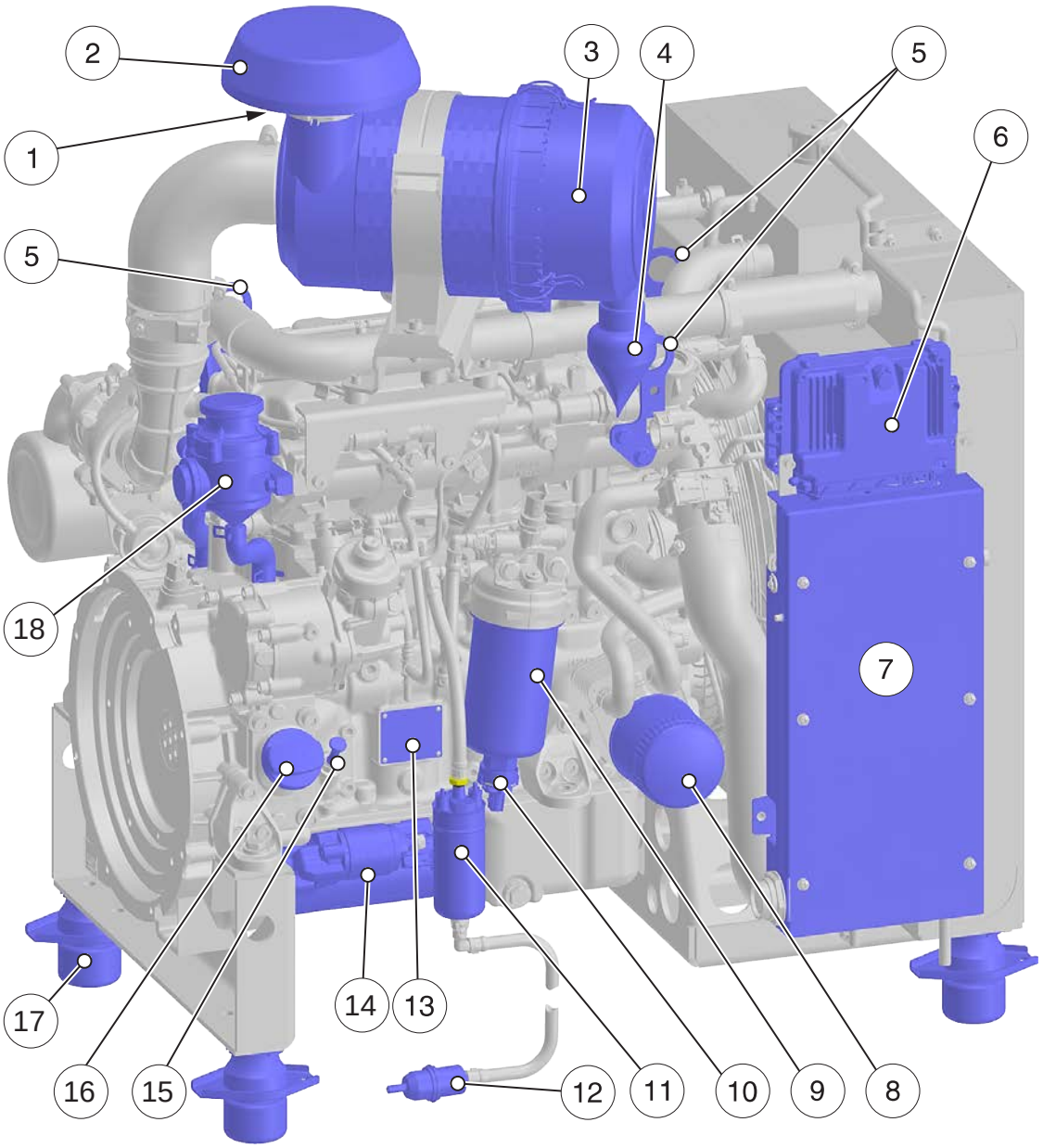
1	Oil filler plug, top (option)	6	Starter (option: mounting position at top)
2	Turbocharger	7	Three phase alternator
3	Diesel oxidation catalytic converter (DOC)	8	Poly v belt
4	Engine bracket	9	Oil drain screw, front
5	Exhaust outlet	10	Fan

Intake side – Fan2Flywheel (F2F) TICD



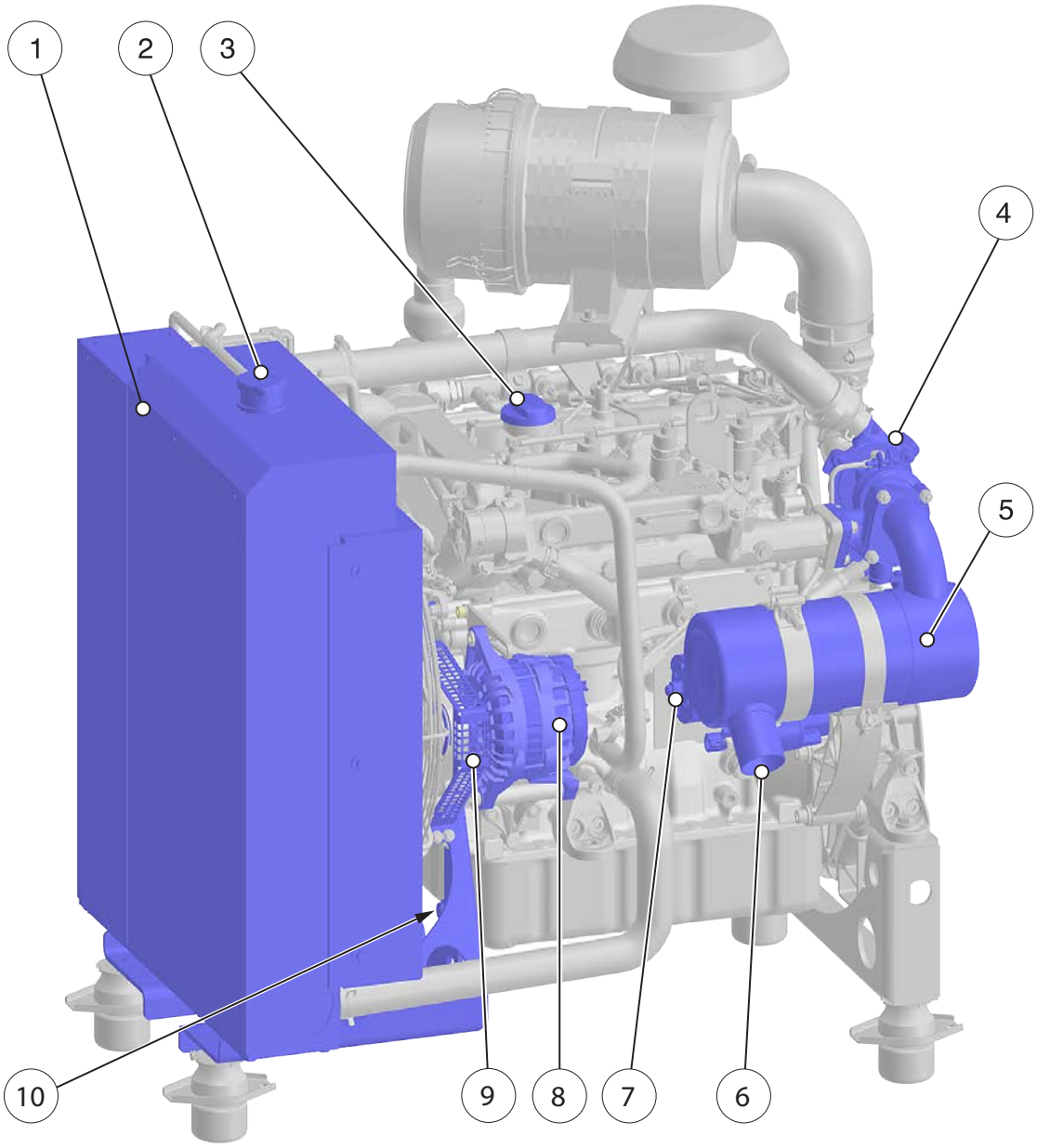
1	Diesel particulate filter (DPF)
2	Intake opening for combustion air
3	Exhaust outlet
4	Intake throttle
5	Air mass meter

Intake side – Open Power Unit (OPU) TIC



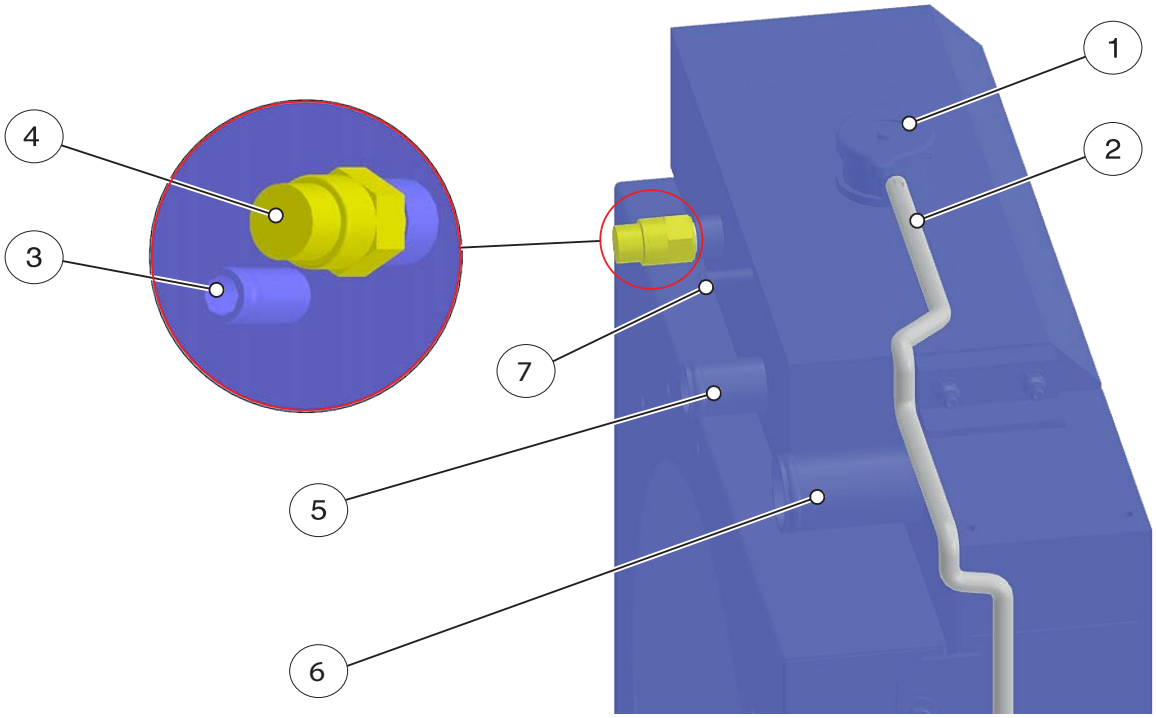
1	Intake opening for combustion air	10	Drain screw with integrated water in fuel sensor
2	Rain cap	11	Electric fuel pump
3	Air filter (optional)	12	Fuel prefilter
4	Dust discharge valve	13	Engine type plate
5	Lifting eyes (3 pieces)	14	Starter (low mounting position)
6	Engine control unit (ECU)	15	Dipstick
7	Plug holder with integrated relays, glow control unit and fuse holder	16	Oil filler plug, bottom
8	Oil filter	17	Vibration damper
9	Main fuel filter	18	Crankcase ventilation

Exhaust side – Open Power Unit (OPU) TIC



1	Cooler with integrated expansion tank
2	Sealing cap for coolant
3	Oil filler plug, top (option)
4	Turbocharger
5	Diesel oxidation catalytic converter
6	Exhaust outlet
7	Starter (installation position at top)
8	Three phase alternator
9	Belt guard (option)
10	Oil drain screw, front

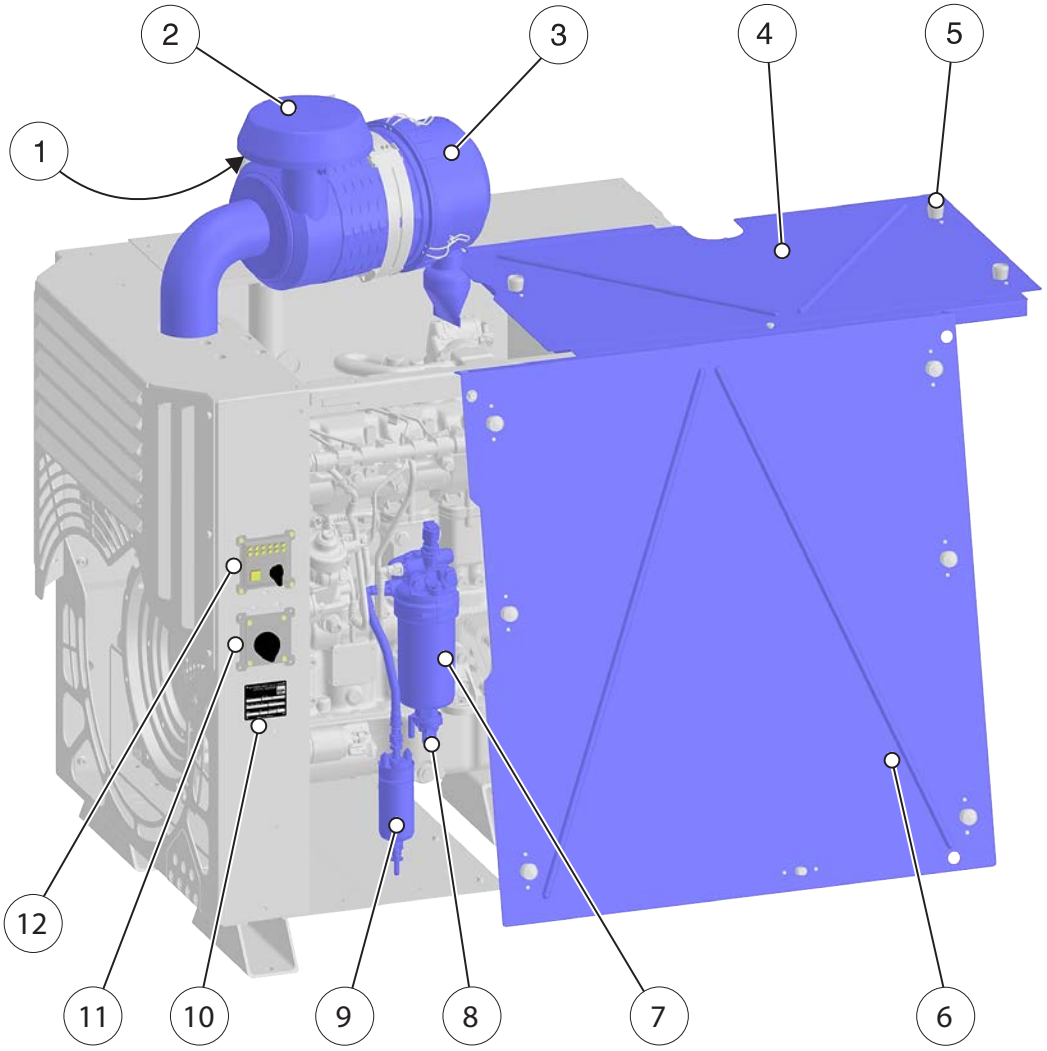
Combination cooler with integrated expansion tank - OPU



1	Sealing cap for coolant
2	Coolant overflow
3	From the integrated expansion tank to the water pump
4	Coolant level sensor (integrated expansion tank)
5	Thermostat infeed
6	Charge air cooler inlet
7	EGR cooler relief

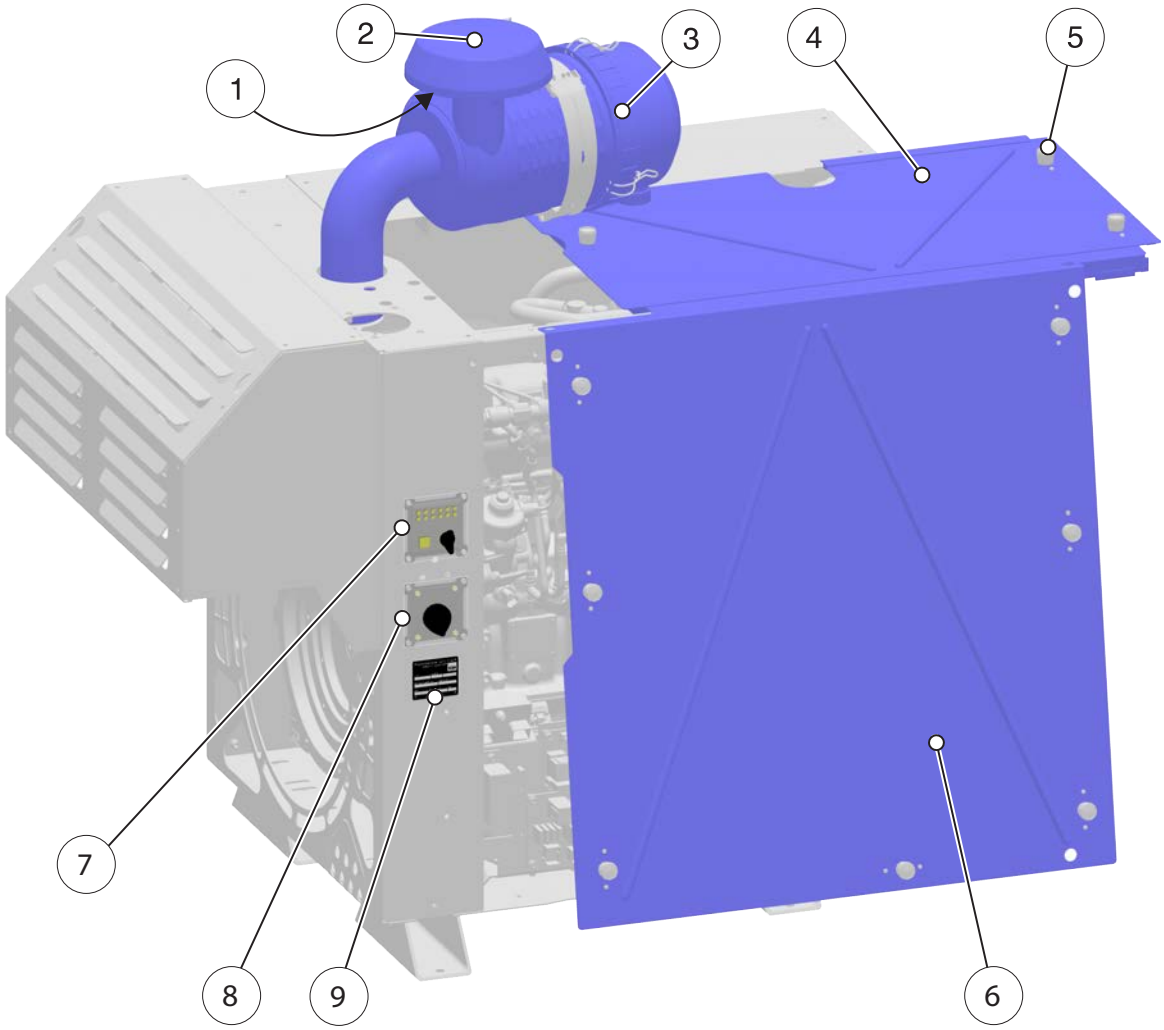
For more information on the coolant filling quantity for integrated expansion tank, see chapter *5.1 Engine information and filling quantities, page 30*, table "Coolant filling quantities (engines with Hatz cooler)".

Intake side – Silent Pack TI/TIC



1	Intake opening for combustion air
2	rain cap
3	Air filter (optional)
4	Top maintenance cover
5	Quick-release coupling
6	Side maintenance cover
7	Main fuel filter
8	Drain screw with integrated water in fuel sensor
9	Electric fuel pump
10	Engine type plate
11	Speed control
12	HATZ instrument box

Intake side – Silent Pack TICD



1	Intake side for combustion air
2	rain cap
3	Air filter (optional)
4	Top maintenance cover
5	Quick-release coupling
6	Side maintenance cover
7	HATZ instrument box
8	Speed control
9	Engine type plate
	Drain screw with integrated water-in-fuel sensor (see Silent Pack TI/TIC)
	Main fuel filter (see Silent Pack TI/TIC)
	Electric fuel pump (see Silent Pack TI/TIC)

NOTICE	
	The Silent Pack is an Open Power Unit (OPU) that is surrounded by a noise and weather protection capsule. The maintenance covers (4) and (6) can be removed for daily maintenance work. The individual maintenance positions are shown on the figures of the OPU.

	NOTICE
	For operation in corrosive atmospheres, addition rust prevention measures are needed since the powder coating of the Silent Pack capsule parts can corrode rapidly in salty air or external operating conditions. This is an optical flaw and not a functional deficiency. A corroded capsule therefore is not covered by the warranty. If a capsule is to be exposed to these types of environmental influences, we ask that you contact Motorenfabrik Hatz Ruhstorf (Sales) beforehand.

7 Transport and packaging

7.1 Transport

Safety notes

⚠ WARNING

Danger of injury from improper lifting and transport.

Danger of crushing from the engine falling or tipping.

- Only use the lifting eye already mounted on the machine for lifting.
- Before lifting the engine, check the lifting eye for damage. Lifting with a damaged lifting eye is not permitted. Replace a damaged lifting eye before using it for lifting.
- Only use a suitable hoist with a sufficient carrying capacity.
- Do not remain under suspended loads.

⚠ CAUTION

Only use the lifting eye for transporting the engine.

Do not use for lifting the entire machine.

⚠ CAUTION

Danger of injury from overloading the body.

Lifting the machine to transport it or to move it to another location can lead to injuries (of the back, for example).

- Only lift the machine with a hoist.

NOTICE

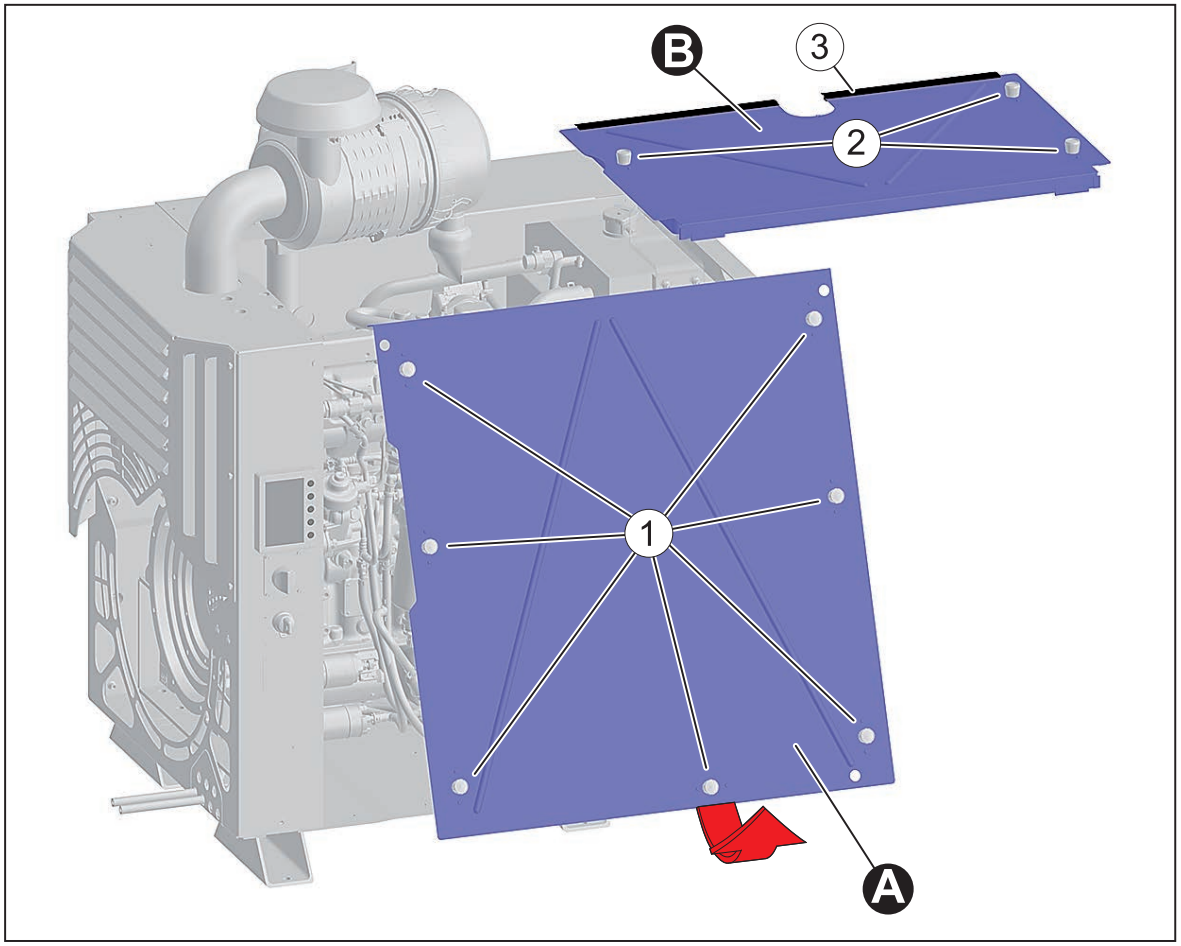
Danger of environmental damage from leaking fluid.

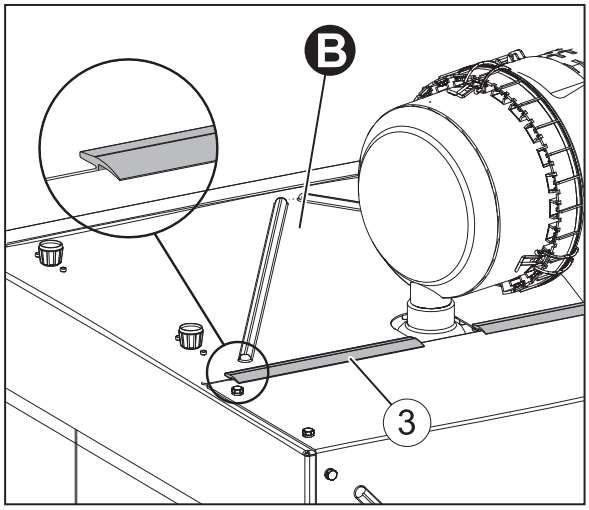
If the machine is tilted, engine oil and fuel can run out.

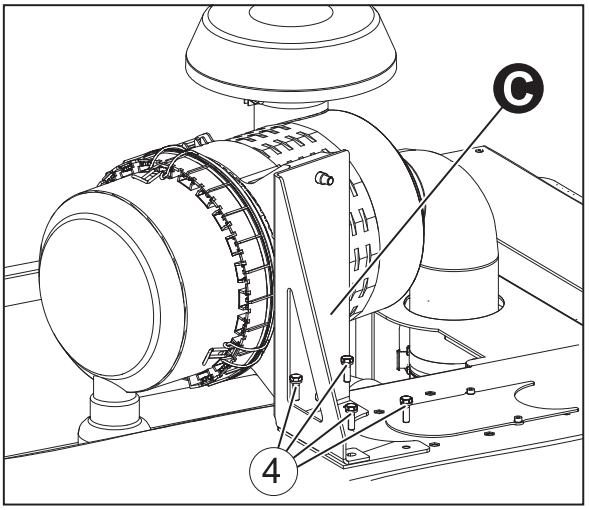
- Only transport the machine in an upright position.

Access to the lifting eyes with the Silent Pack

Overview





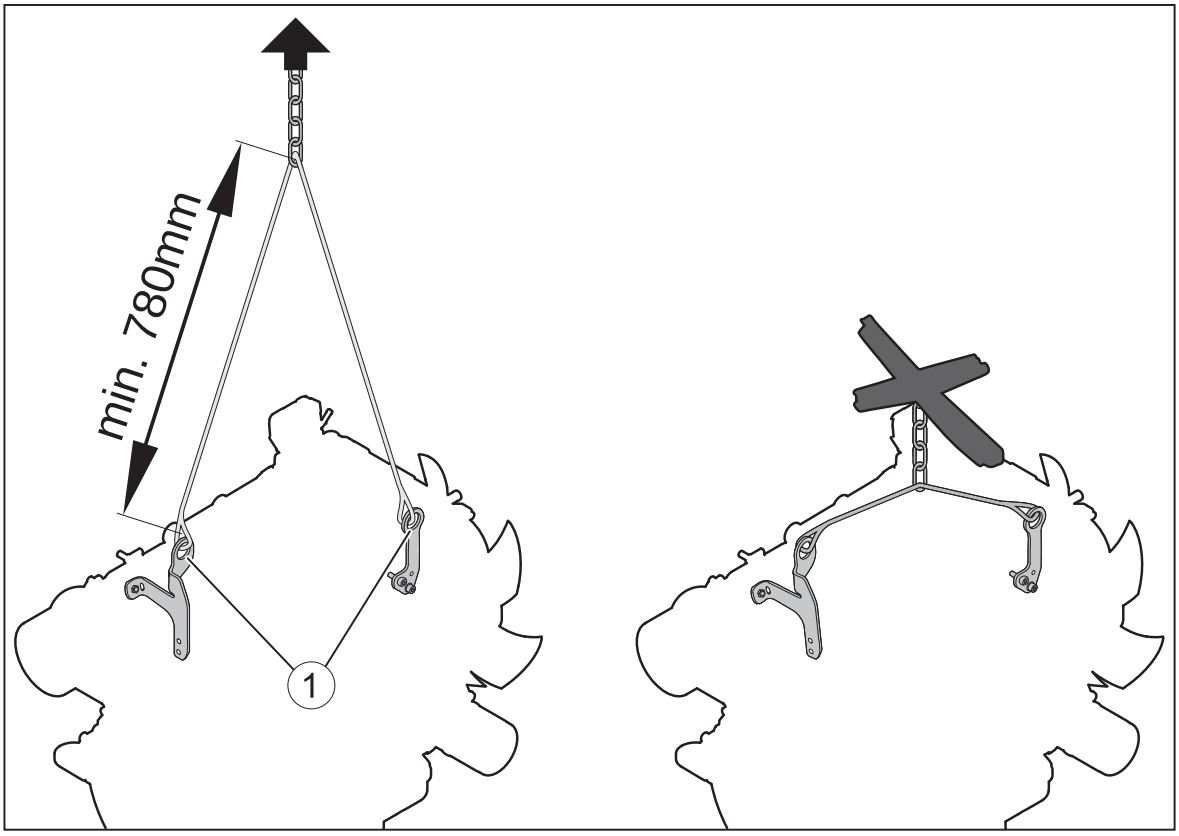


A	Control side maintenance lid
B	Top maintenance cover
C	Bracket for the air filter
1	Clamp-type fasteners for control side maintenance cover
2	Clamp-type fasteners for top maintenance cover
3	Sealing lip
4	Fixing screws for bracket for the air filter (4 pieces)

Procedure

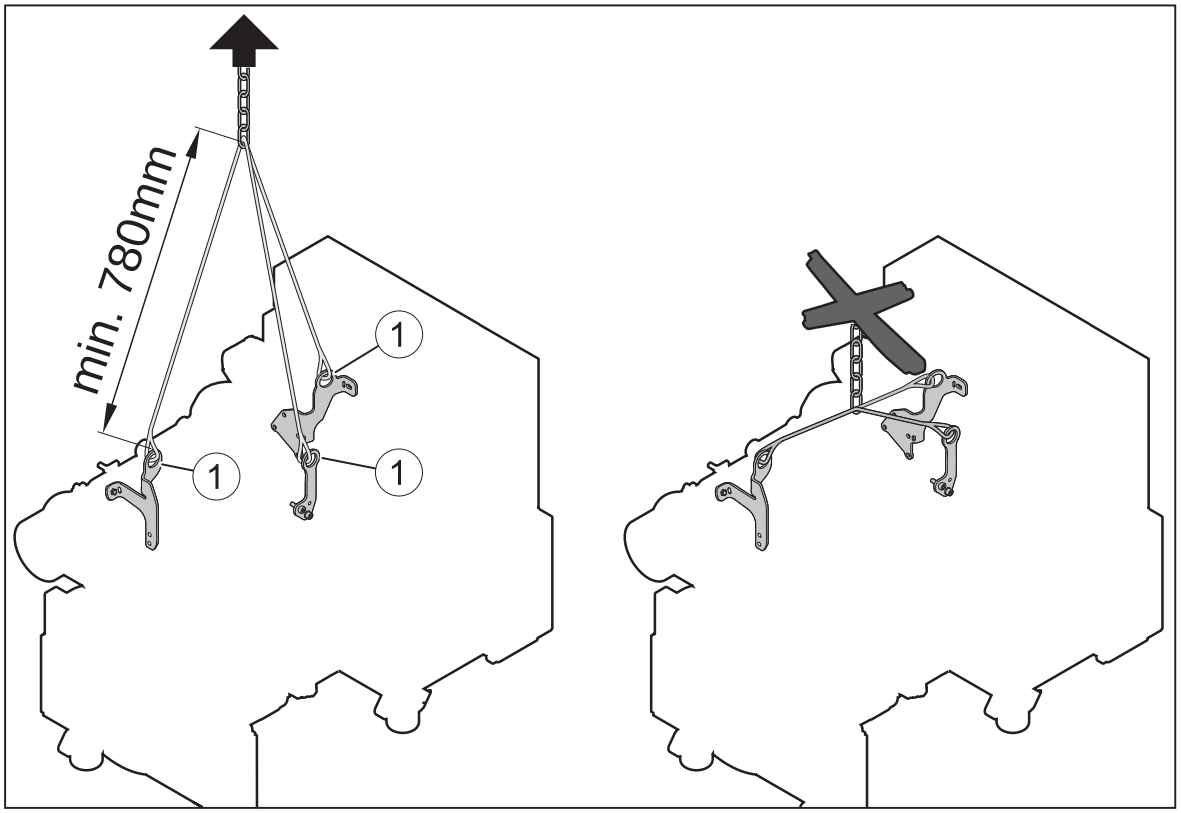
Step	Activity
1	Turn clamp-type fasteners (1) to the left up to the stop. Tip maintenance cover on the bottom to the outside and lift away upwards.
2	Turn clamp-type fasteners (2) to the left up to the stop and then remove the maintenance cover.
3	Unscrew the fixing screws (4).
4	Position of the lifting eyes, see section *lifting points (engines with 3 lifting eyes)* in this chapter.
5	Mount all parts again after completing the transport activities. Make sure that the seal lip (3) of the maintenance cover (B) is not trapped!

Lifting points (engines with 2 lifting eyes)



1	Lifting points

Lifting points (engines with 3 lifting eyes)



1	Lifting points

Transport conditions

- When transporting the machine, follow the safety instructions.
- When transporting, follow the applicable safety and accident prevention regulations.
- After delivery, check the machine for completeness and transport damage.
- Only transport the machine when it is switched off and has cooled down.
- If you have questions on transporting the machine, please contact your nearest **HATZ service station**. For contact data, see chapter *1 Legal notices, page 7* or **www.hatz-diesel.com**.

Transport damage

- Inspect the product for transport damage.
- Document any transport damage in the shipping documents, have them countersigned by the shipping agent and immediately inform the manufacturer.

Transport safety

- Select means of transport according to the weight and packaging of the engine (see shipping documents).
- Secure the load properly and transport carefully.
- For transporting the engine by crane, use lifting eyes (see Diesel Engine Manual).

7.2 Temporary stoppage

Take the following measures if you intend to take the machine out of service for a lengthy period (3–12 months):

Step	Activity
1	Drain the fuel tank until it is nearly empty and fill with FAME*-free fuel. Operate the engine for a few minutes so that only FAME*-free fuel is still in the fuel system.
3	Change the fuel filter.
4	Let the machine cool down.
5	Remove the battery (if present) in accordance with the Operator's Manual for the machine and store at ambient temperature. Comply with the local regulations as well as the regulations of the battery manufacturer for the storage of batteries.
6	Close and seal all engine openings (air intake openings, air outlet openings and the exhaust gas opening) so that no foreign bodies can enter, but a small amount of air can still be exchanged. This avoids condensation.
7	After the machine has cooled down, cover it to protect it against contamination, and store it in a dry and clean place.

*FAME = Fatty Acid Methyl Ester

Ambient conditions during storage

- Max. permissible storage temperature: -25 °C to +60 °C
- Max. permissible humidity: 70%
- Protect the engine from direct sunlight

Step	Activity
1	Remove all covers.
2	Check the cables, hoses and lines for cracks and leak tightness.
3	Check the engine oil level.
4	Check the coolant level.
5	Install the battery in accordance with the Operator's Manual for the machine.

The brand new engine can normally be stored for up to 12 months. The protection lasts up to approx. 6 months at very high humidity and in sea air.

For storage periods of more than 12 months, please contact the nearest **HATZ Service**.

7.3 Packaging

Dispose of packaging materials (cardboard, wood, PET strip etc.) according to local environmental regulations.

8 Installation instructions

8.1 Installation notes – general information

HATZ diesel engines are efficient, robust, and have a long service life. Therefore, they are usually installed in machines that are used for commercial purposes. The machine manufacturer must follow the applicable regulations regarding machine safety.

The engine is a part of a machine – depending on the use and installation of the engine, it may be necessary for the machine manufacturer and machine user to install safety equipment to prevent inappropriate use. Note the following:

- Parts of the exhaust gas system and the engine surface become hot during operation and may not be touched until they cool down after the engine is switched off.
- Incorrect cable connections and incorrect operation of the electrical equipment can lead to sparking and must be avoided.
- After the engine is installed in the machine, rotating parts must be protected against contact. Protective devices from HATZ (e.g., belt protection) are available for this.
- Comply with all notices and warning labels on the engine and keep them in a legible condition. If an adhesive label should become detached or become difficult to read, it must be replaced promptly.
- Any improper modification of the engine will result in a loss of liability coverage for resulting damage.
- If the engine is speed limited via the CAN bus, care must be taken that the maximum machine speed is not exceeded.

The Assembly Instructions contain important information on how to safely assemble the engine.

8.1.1 Torques and screw classification

	NOTICE
	To ensure proper screw connections, the specifications in the list **Torques + classification**056758xx must be adhered to for every installation. For a **category A screw connection,** there are additional requirements that need to be adhered to. The current list can be downloaded at the following link: **www.hatz.com/docu**.

8.2 Engine support/installation

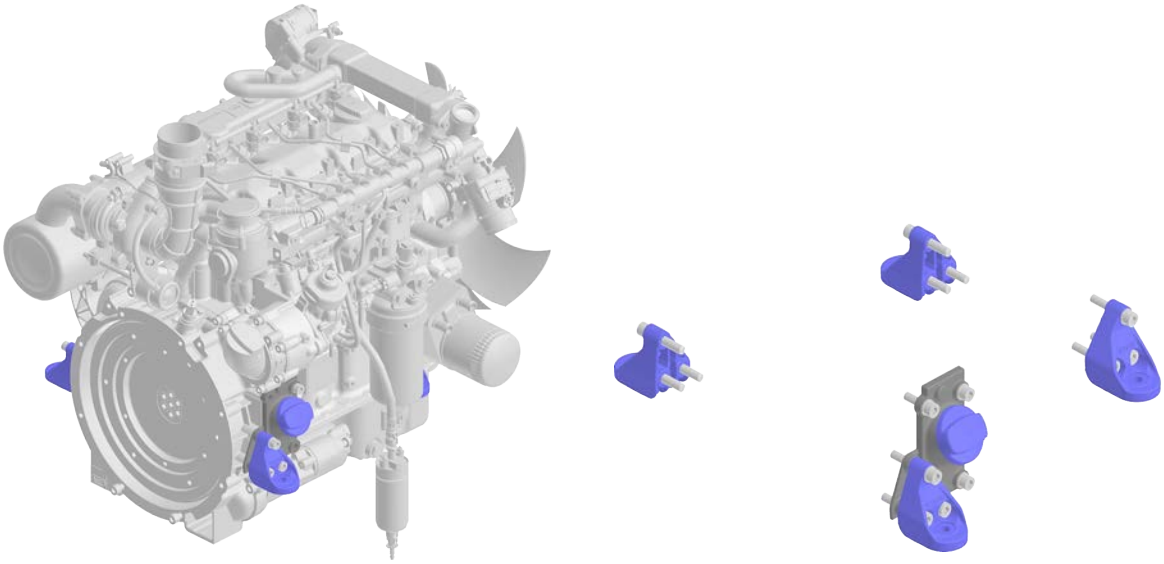
Good operating performance of the machine can be realized neither by the engine nor by the machine to be driven alone, rather the two components must be appropriately and properly matched to each other.

Generally, flexible mounting of the engine should be aimed at. In addition, the engine should be uniformly loaded; see *8.2.6 Uniform bearing load, page 59*.

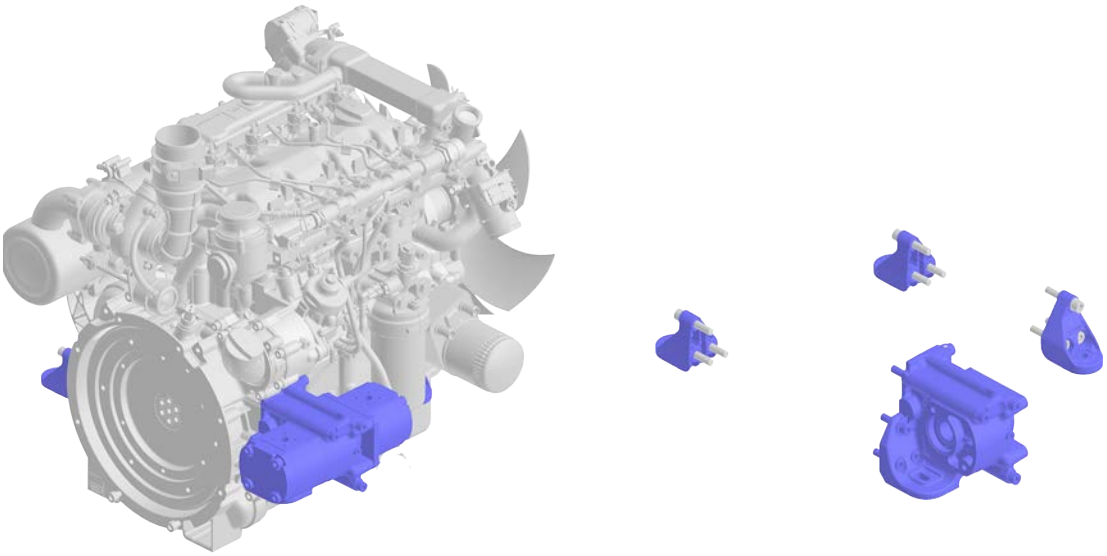
If there is any doubt, please contact your nearest **Hatz service station**.

8.2.1 engine brackets

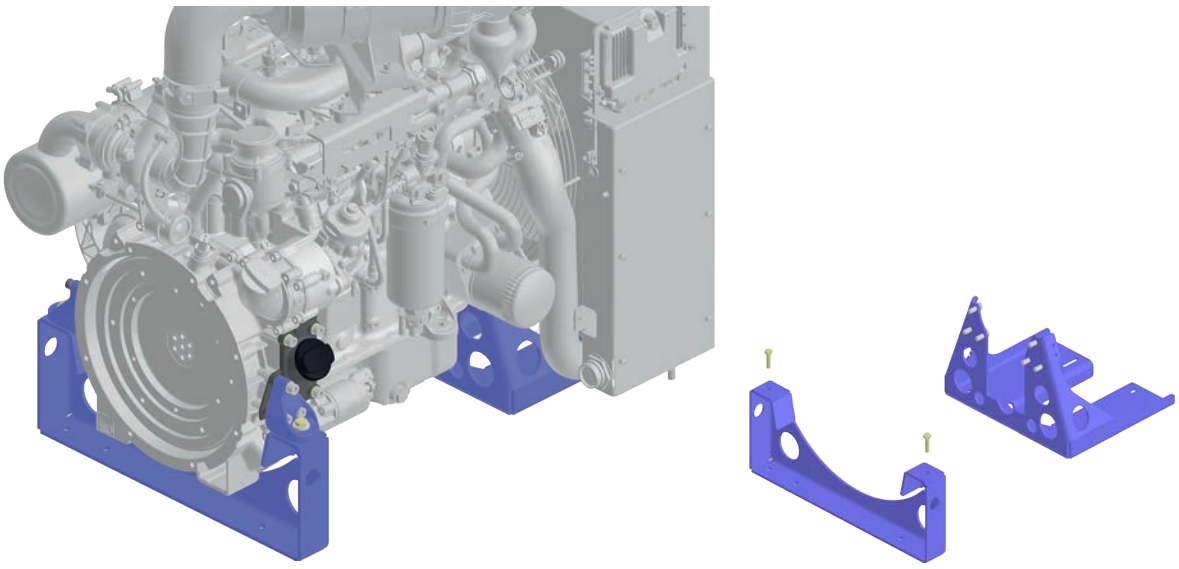
Standard



For hydraulic power take off

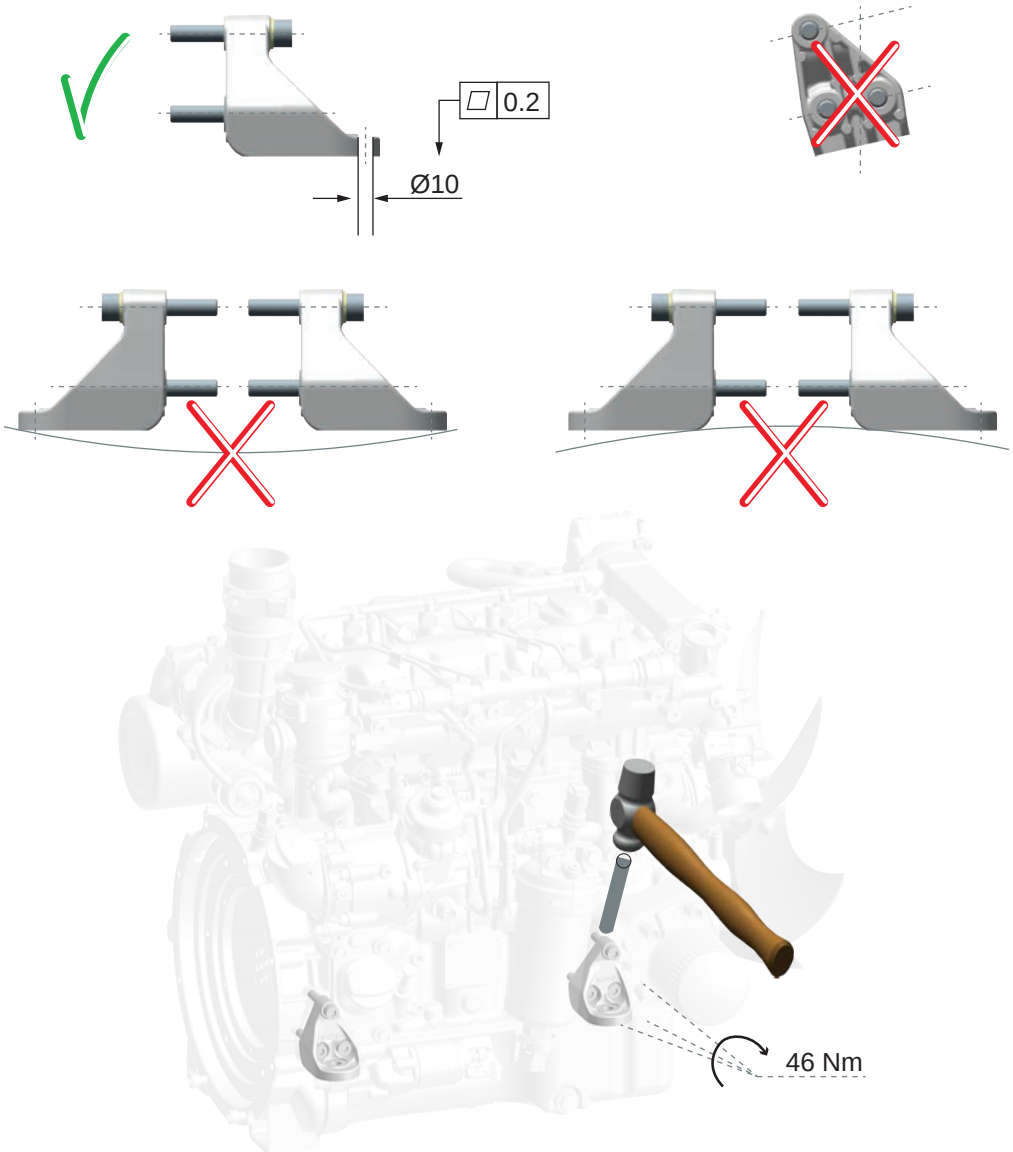


Open Power Unit



8.2.2 Rigid engine suspension

CAUTION
Danger of injury and danger of engine damage if the engine is not mounted without stress ▪ If the engine fastening is rigid, the engine brackets with the baseplate must be set up in a stress-free manner (flatness tolerance of the contact surface must be 0.2 mm). ▪ The engine is not permitted to be mounted on painted surfaces. ▪ Non-observance can lead to a risk of injury, breaking of the engine brackets/baseplate, and thus engine damage.



Tightening torque of engine bracket **M10** with **46 Nm**. In order for the engine to also be installed absolutely free of stress, one of the 4 identical engine brackets must be adjusted/aligned to the contact surface.

Rigid mounting can only be allowed up to an engine speed of approx. 1,800 rpm. In addition, the free mass forces are typically so large that a flexible support now makes sense.

The **most important prerequisite for any engine mounting** is that the frame or the mount is rigid and of sufficient size in terms of strength. Parts of the frame that are not rigid act like springs and must be stiffened by braces.

If the **engine speed in a rigid setup should be> 1800 rpm**, Hatz must be consulted to determine if the application can be approved.

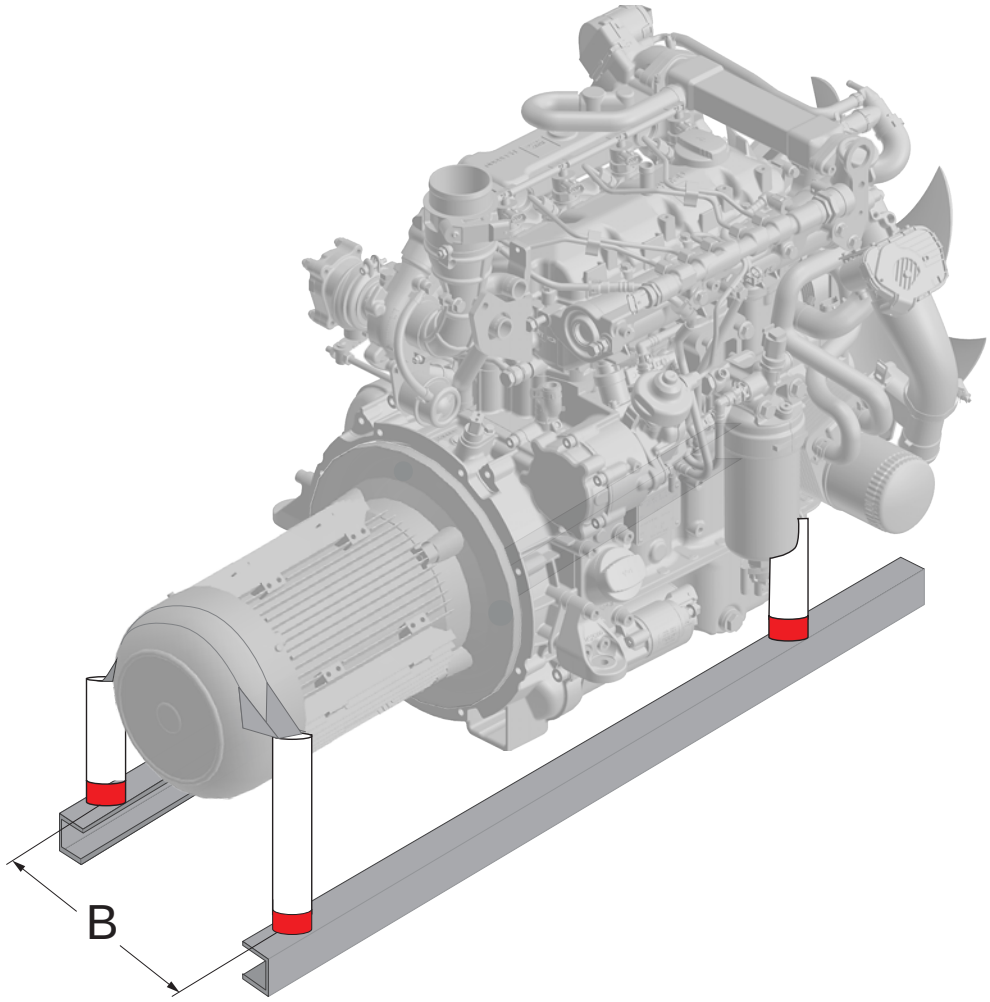
8.2.3 Flexible engine mounting

A flexible engine mount is preferable to a rigid engine mount.

For noise reasons too, flexible mounting can be advantageous because when rubber is used as a bearing element, no structure borne noise is passed on.

The connections for fuel, exhaust gas and exhaust air for flexibly mounted engines must be designed so that the relative movements that occur can be absorbed, i.e. they must be flexible.

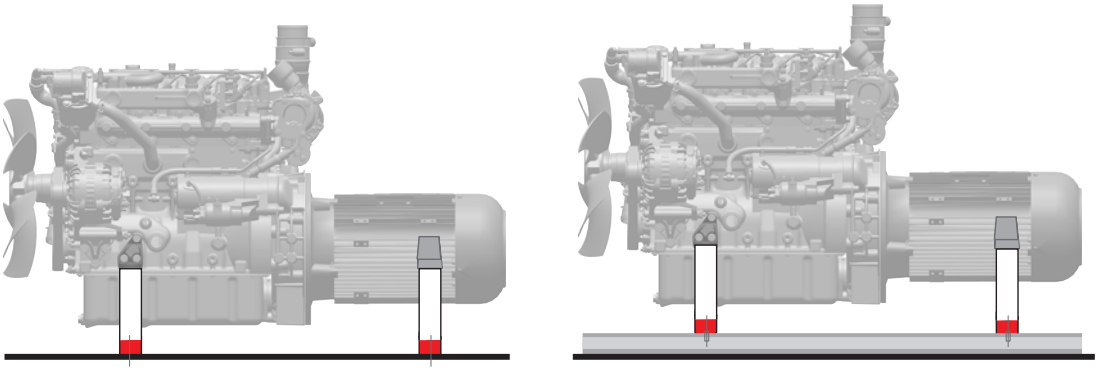
For a flexible mounting, the **base B** must be as wide as possible. This lowers vibration peaks and the forces.



Depending on the type of machine, the flexible mounts are differentiated as follows:

a) Flexible mounting with flange-mounted force sensor

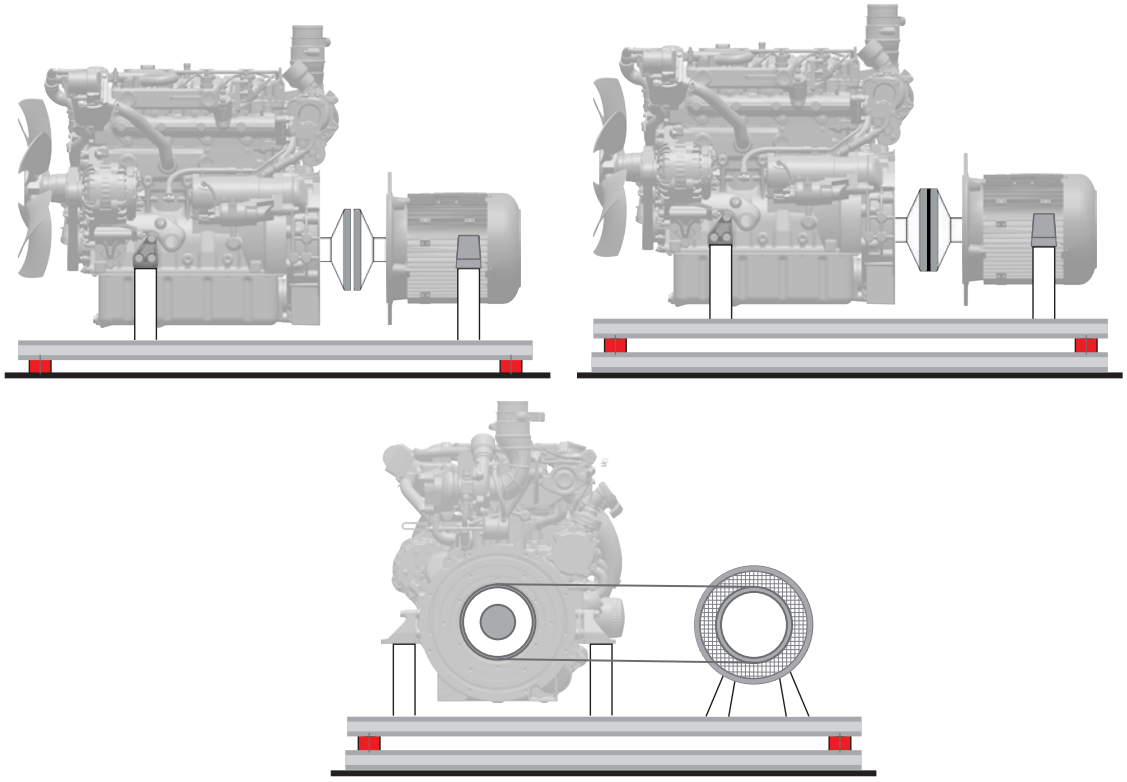
The engine is flange-mounted on the driven force sensors and constitutes a common vibration system. If a corresponding base is available, a frame can be dispensed with because the engine and force sensor already make up a rigid frame.



b) Flexible mounting with non-flange-mounted force sensors

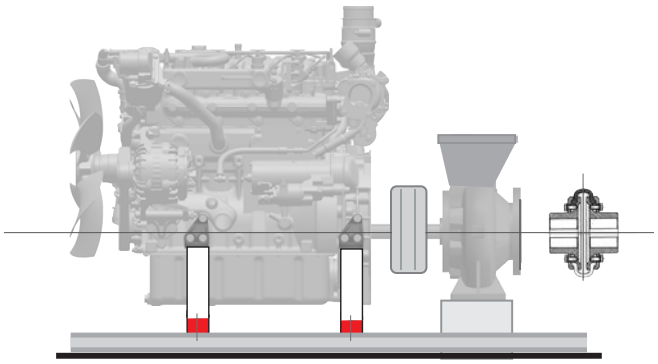
In place of the housing connection to flange-mounted force sensors, there is now a frame onto which the engine and the machine to be driven are rigidly screwed.

Either **flexible couplings or belts** serve as power transmission elements. The frame with rigidly mounted engine and rigidly mounted machine to be driven is now placed on rubber elements or springs, thus constituting a vibration system.

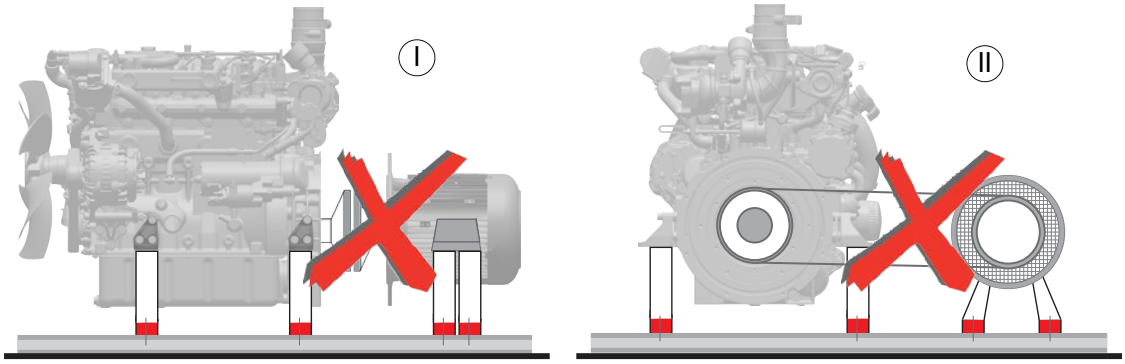


Special case:

Due to the open, non-flange-mounted construction, a **highly elastic coupling** must be used as the shaft connection between the flexibly mounted engine and rigidly mounted pump.



In contrast, variants I and II are not permitted because the engine and machine form separate vibration systems which work against each other and damage the flexible coupling or belt.



8.2.4 vibration damper

The support surface for the fixing of the engine must comply with a flatness tolerance of max. 1 mm. The engine is not permitted to be mounted on painted surfaces.

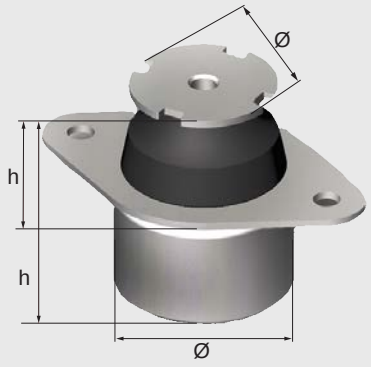
NOTICE

Depending on the application, the device manufacturer must define and set up the installation of the engine together with the appropriate vibration dampers.

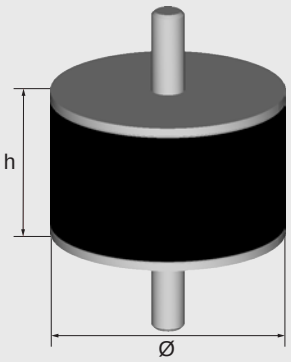
For engine installations on mobile machines (such as vehicles, trailers etc.), the engine must be secured against transverse forces. For this, either vibration dampers with a breakaway or separate mechanical safety elements should be used (e.g., arrestor cables). For this purpose, contact your nearest Hatz service.

No.	Material no.	vibration damper	Ø [mm]	h [mm]	Hardness [Shore A]
1	503 236 xx	Hydro mount V600 (M10)	64/88	32/91	45
2	402 173 xx	Hydro mount V1500 (M12)	64/89	44/103	55
3	502 602 xx	Cylindrical rubber buffer (M10)	70	45	55
4	502 603 xx	Cylindrical rubber buffer (M10)	70	45	65
5	506 617 xx	Cylindrical rubber buffer (M10)	70	45	55
6	506 618 xx	Cylindrical rubber buffer (M10)	70	45	70
7	506 679 xx	Mounting foot with breakaway (M10)	58.5/77	30	40
8	506 678 xx	Mounting foot with breakaway (M10)	58.5/77	30	60
9	506 947 xx	Mounting foot with breakaway (M10)	58.5/78	31	High damping

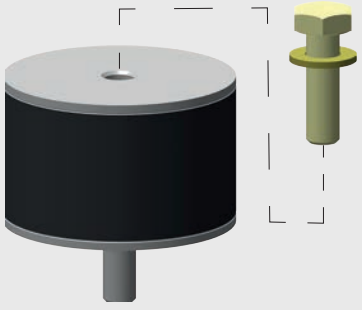
Hydro mount (1, 2)



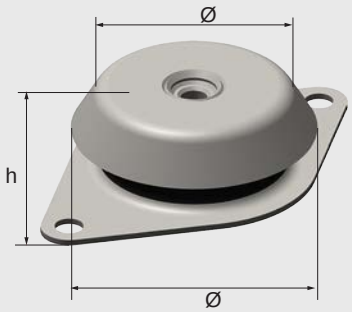
Cylindrical rubber buffer (3, 4)



Cylindrical rubber buffer (5, 6)



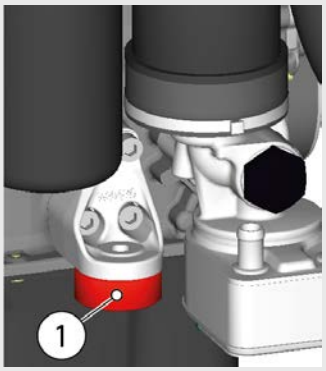
Mounting foot with breakaway (7, 8, 9)

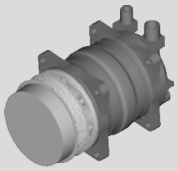
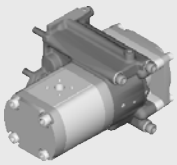


8.2.5 Vibration damper fastener kits

For the mounting options of a horizontal/vertical oil filter, A/C compressor or hydraulic pump, the clamping position must be corrected using spacers (1) or else there will be a component collision.

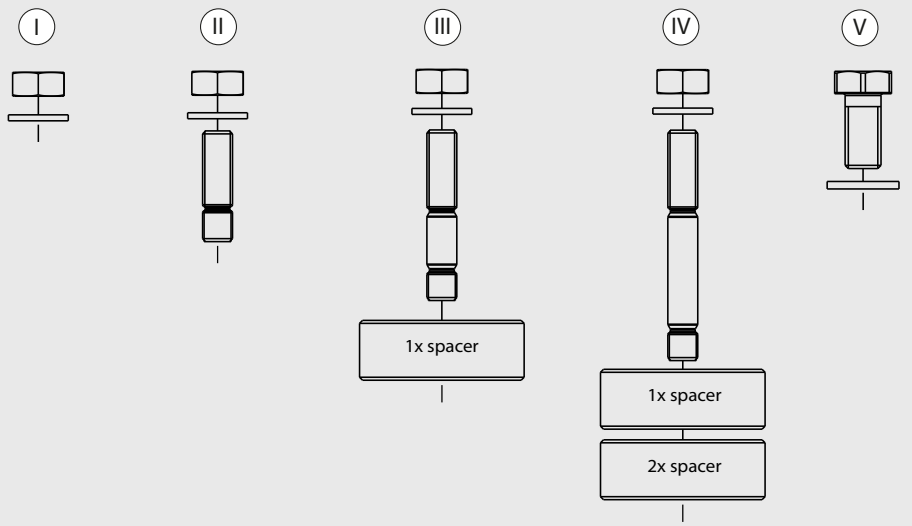
The fastener kit overview shows how many spacers are needed.



Mounting options								
Basis		F2F	F2F	F2F	F2F	F2F	F2F	OPU
		Hori-zontal	Hori-zontal	Horizon-tal	Vertical	Vertical	Vertical	/
		–	Yes	Yes	–	Yes	Yes	/
		–	–	Yes	–	–	Yes	/
F2F = Fan2Flywheel								

	Selection of fastener kit (I – V)							
No.	vibration damper	F2F	F2F	F2F	F2F	F2F	F2F	OPU
1	Hydro mount V600	✓+ III	✓ + III	✓ + III	✓ + IV	✓ + IV	✓ + IV	–
2	Hydro mount V1500	–	–	–	–	–	–	✓+ V
3/4	Cyl. rubber buffer	✓+ I	–	–	–	–	–	✓+ I
5/6	Cyl. rubber buffer	–	✓ + II	✓ + II	✓ + III	✓ + III	✓ + III	✓+ II
7/8/9	Mounting foot with breakaway	✓ + II	✓ + II	✓ + II	✓ + IV	✓ + IV	✓ + IV	✓+ II

Fastener kit overview

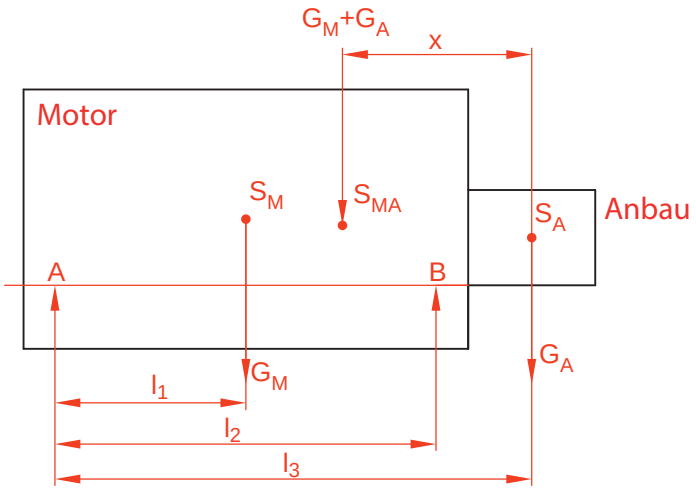


Tightening torques of nuts, screws and set screws
M10: 40 Nm
M12: 70 Nm

8.2.6 Uniform bearing load

When using bearing elements, ensure the bearing load is uniform. No more than 60% of the total weight should rest on A or B; if in doubt, contact your nearest **Hatz service center**.

Determination of bearing forces (if centers of gravity of the engine, attachments such as hydraulic pump, generator, and their intrinsic weights are known)



$$A = \frac{G_M \, x \, (l_2 - l_1) - G_A x \, (l_3 - l_2)}{l_2} \; [N]$$

$$B = \frac{(G_M \, x \, l_1) + (G_A \, x \, l_3)}{l_2} \; [N]$$

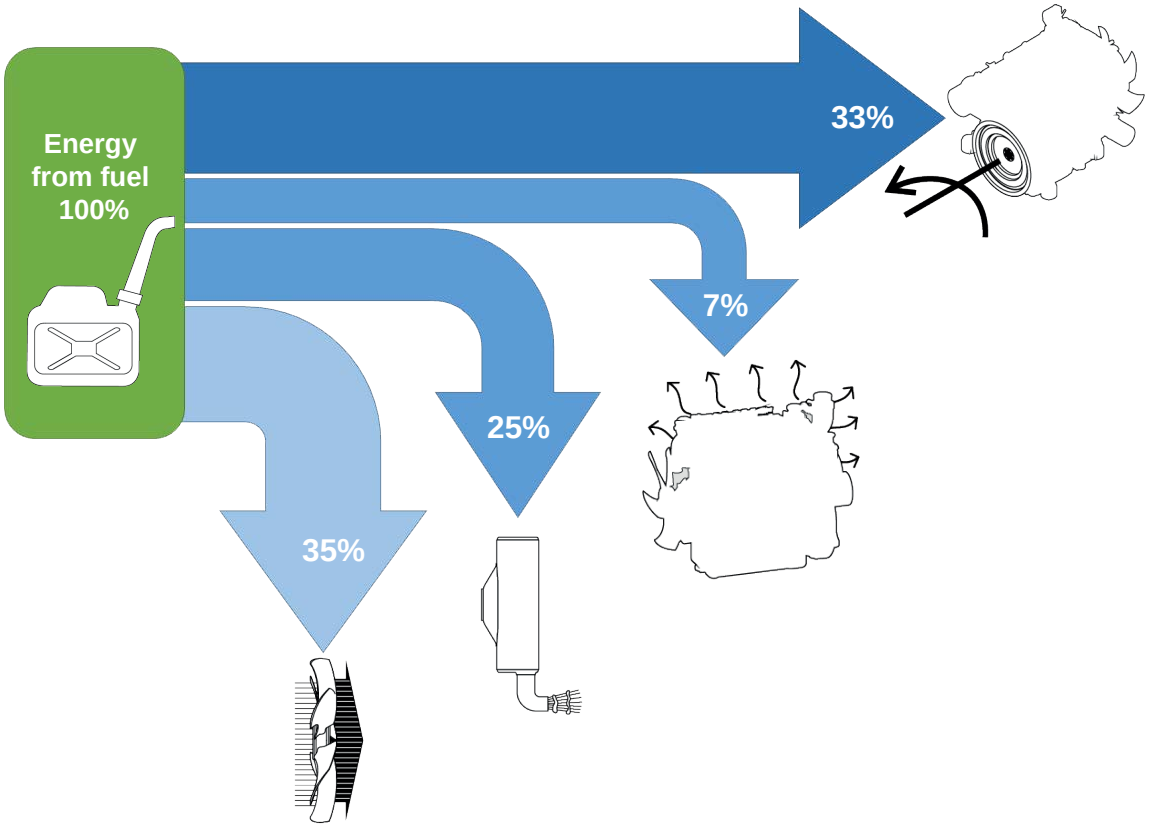
Abbreviation	Meaning
S_M	Center of gravity of engine
S_A	Center of gravity of attachment (e.g., hydraulic pump, generator,…)
S_{MA}	Overall center of gravity (engine + attachment)
G_M	Engine weight force[N]
G_A	Attachment weight force [N] (e.g., hydraulic pump, generator etc.)
A	Bearing load A
B	Bearing load B
$L_{1,2,3}$	Distances [m]

For the position of the overall center of gravity (engine with attachment):

$$x = \frac{l_3 - l_1}{1 + \frac{(G_A)}{(G_M)}} \; [m]$$

8.3 Energy balance

The energy balance looks something like this:
Approx. 33% of the engine power available for effective work
Approx. 25% contained in the exhaust gas
Approx. 35% contained in the cooling air or cooling water
The remainder (approx. 7 %) is radiated from the engine surface



8.3.1 Installation of engines under a cover

To successfully enclose a system, it is necessary to dissipate the radiated heat of the engine, the exhaust pipe and the applied machines from the engine compartment again. In most cases, the natural circulation of air through the fan is sufficient.

However, if the cooler is mounted away from the engine, forced ventilation is often necessary. It is important here that the air flowing through the fan can escape unhindered and that no heat buildup occurs in the engine interior.

An exhaust pipe lying in the air flow has proven to be effective here.

A maximum temperature of +80 °C should not be exceeded in the engine interior because certain sensitive (electronic) components can be functionally impaired or even damaged.

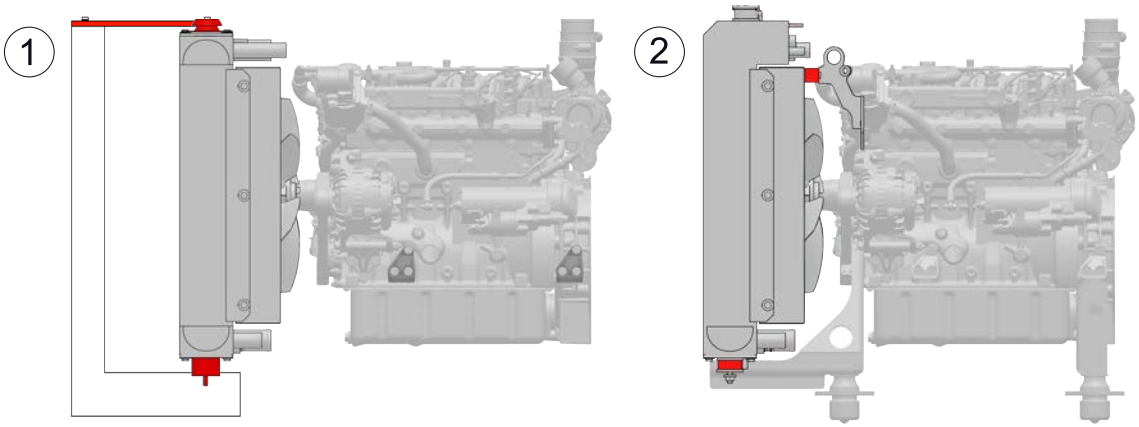
8.4 Engine cooling

The cooler and the coolant reservoir, hoses, gaskets, etc., **must not** contain **non-ferrous mFetals**, i.e. neither copper or zinc compounds.

8.4.1 General - Attachment of the engine cooler

The engine radiator must be decoupled from the engine vibrations.
The cooler (from HATZ) is permitted to be subjected to maximum vibration values of 5 g only.
With the Open Power Unit (OPU), the cooler is vibration-decoupled with rubber buffers ex-works.

If using third party coolers, please consult and come to agreement with the cooler manufacturer.

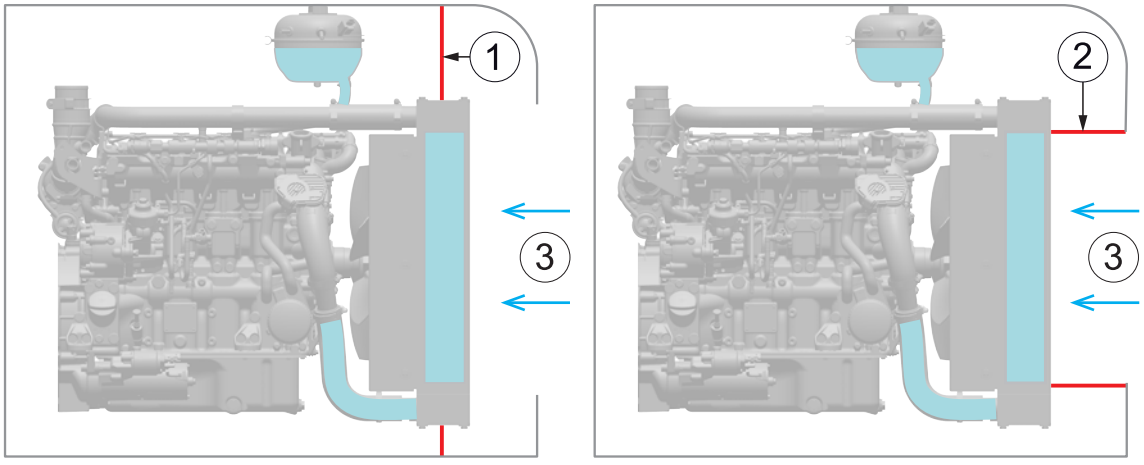


1	Fan2Flywheel (F2F)
2	Open Power Unit (OPU)

The engine cooler should be protected against external contamination. In addition, during installation ensure that accessibility for maintenance work is not restricted.

8.4.2 Installation of the cooler under a cover

Example: extractor fan



1	Separation
2	Cooling air duct
3	Air flow

The connections of the separating plates to the cooler must be flexible in design (e.g. rubber sealing lip). The separating plates must not have an air gap to the cooler and must have a flexible range of min. 20 mm.

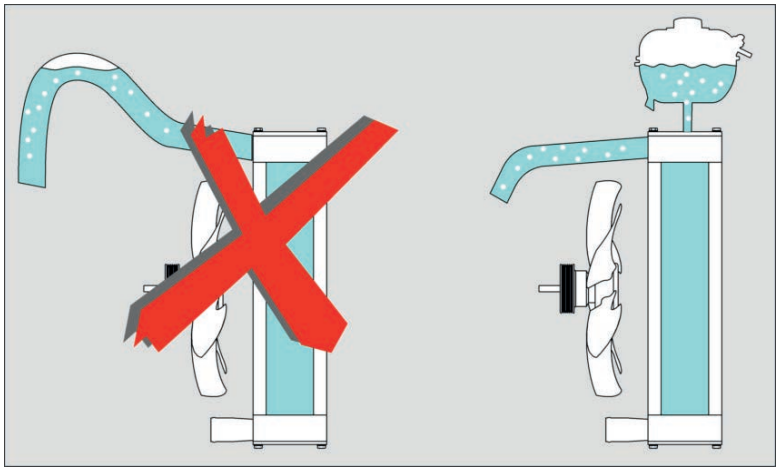
8.4.3 Cooling water hoses

Cooling water hoses in accordance with DIN 73411 / EPDM must be used.

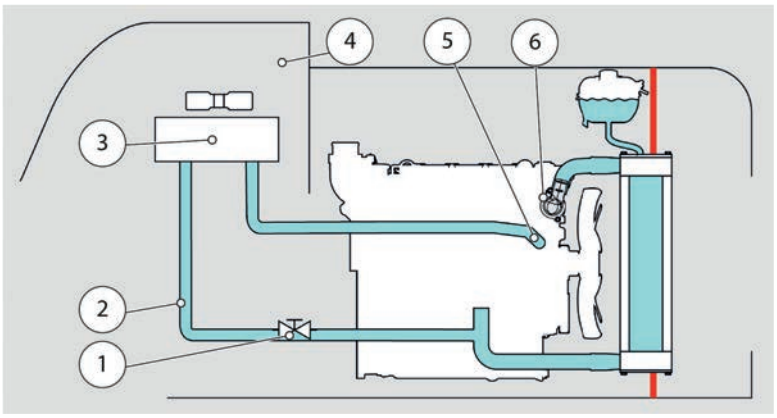
Min. wall thickness of 4 mm, pressure resistance of 2 bar, temperature resistance of -40 °C to +120 °C.

The use of nonferrous heavy metals is not permitted.

Avoid air pockets when laying the hoses.

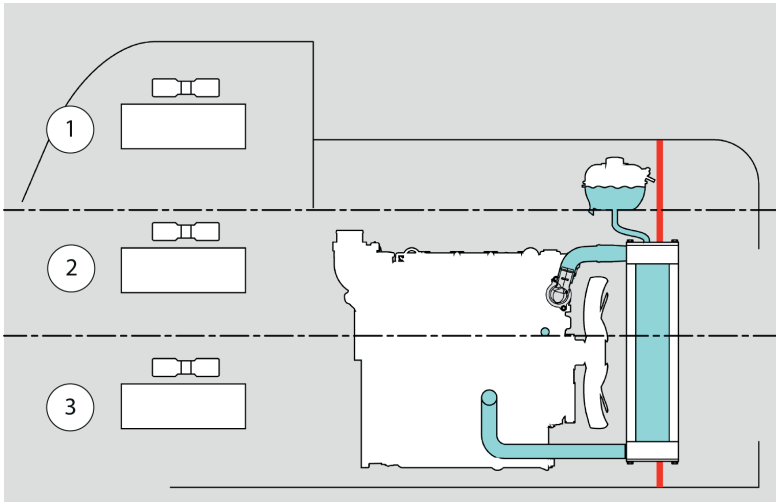


8.4.4 Installation in combination with a cab heater



1	Closing valve
2	Cab heater return
3	Cab heater
4	Cab
5	Cab heater supply
6	Thermostat

Cab heater variants

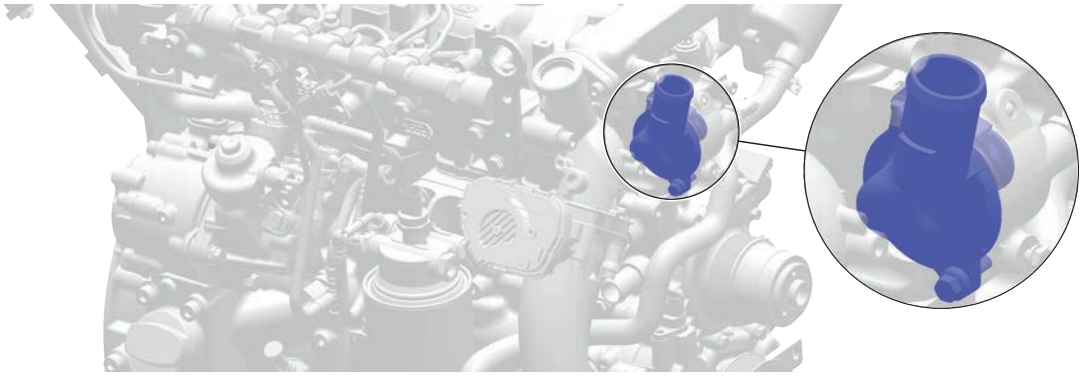


Variant	Additional measures when filling
1	No additional measures required when filling
2	Attach vent screw or vacuum filling necessary
3	Vacuum filling necessary

Consultation with HATZ required for variants 2 and 3.

8.4.5 Thermostat

The wax element of the thermostat opens the coolant flow to the cooler at 80 °C and is fully open at 95 °C. The engine is thus kept in the optimum temperature range.



The Hatz thermostat supplied with the engine must always be used.

8.4.6 Engine cooler

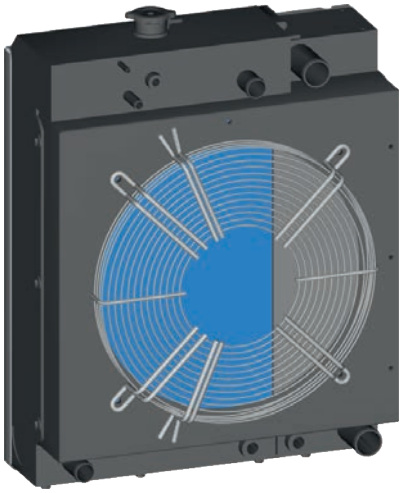
WARNING

Danger of injury from rotating parts.

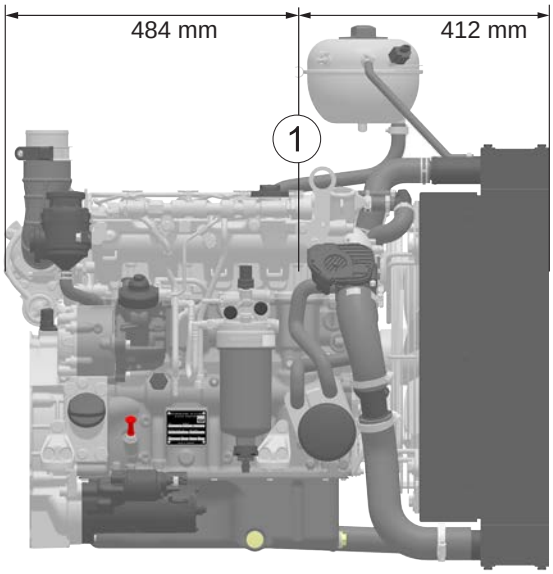
Touching the fans or poly v belts can lead to serious injury when the engine is running.

- Only operate the engine when all covers are installed.

Contact guard for fan (optional)



Maximum coolant temperature T_{max} is 105 °C. The (standard) engine cooler from HATZ is a heavy-duty version and usually does not require a coarse dirt mesh. This is not to be confused with the contact guard for the fan. The contact guard can be provided by HATZ.



- Ambient temperature theoretically up to 50 °C at 56 kW, depending on the application
- Expansion tank Hatz 2.4 L, Ø approx. 200 mm
- Heavy duty version, contact guard for fan wheel optionally available

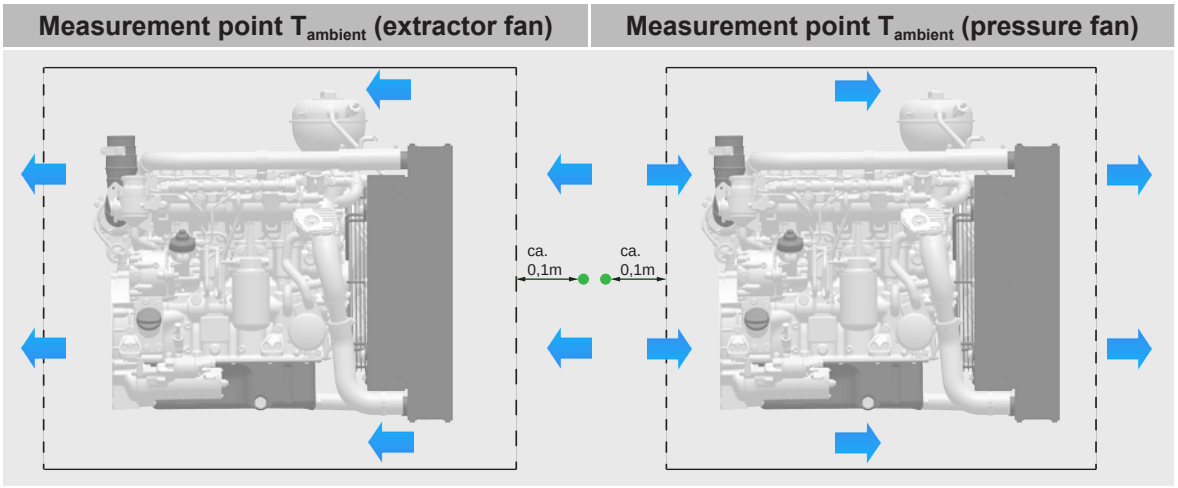
Pos. 1, middle of first cylinder

8.4.7 Design / Dimensioning

Determination of thermal energy to be dissipated

See chapter Amount of heat to be dissipated at the full load curve (100 % engine load).

Determining the maximum ambient temperature



The temperatures are determined with the machine operating at full load, where the coolant liquid thermostat must be bridged (widened thermostat with full opening). With the exhaust fan, the air temperature is determined at the cooling air inlet in the engine compartment.

The formula can be used to calculate the maximum ambient temperature up to which the installed cooling system can be used.

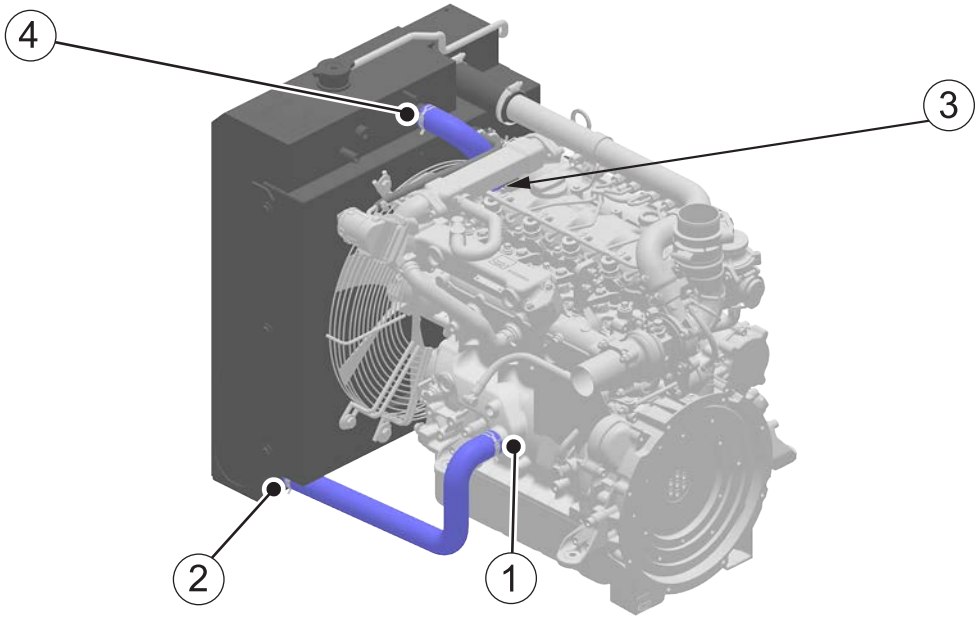
Example:

$T_{ambient}$ = 7 °C $T_{coolant}$ = 60 °C T_{max} = 105 °C	$T_{ambient\_max} = T_{ambient} + (T_{max} - T_{coolant})$ $T_{ambient\_max} = 7°C + (105°C - 60°C)$ $T_{ambient\_max} = 52°C$

$T_{ambient}$	Ambient temperature (see measurement point)
T_{max}	The **maximum temperature** is 110 °C, calculated design on the warning threshold 105 °C
$t_{coolant}$	Coolant temperature in full load test
$T_{Ambient\_max}$	Maximum ambient temperature

The cooling system can be used up to an ambient temperature of 52 °C.

8.4.8 Water circuit piping



	Transfer point	Diameter Ø
1	crankcase	32 $^{-1.5}$
2	cooler	32 $^{-1.5}$
3	Thermostat	32 $^{-1.5}$
4	cooler	32 $^{-1.5}$

8.4.9 expansion tank

The capacity of the expansion tank must be 2.4 ± 0.2 liters, approx. 20% of the total cooling water quantity. See also *5.1 Engine information and filling quantities, page 30*, table "Coolant filling quantities".

For the size of the expansion tank, it must be ensured that there is an overpressure of 0.3 bar upstream of the water pump when the thermostat is open (> 80 °C cooling water outlet temperature at the engine).

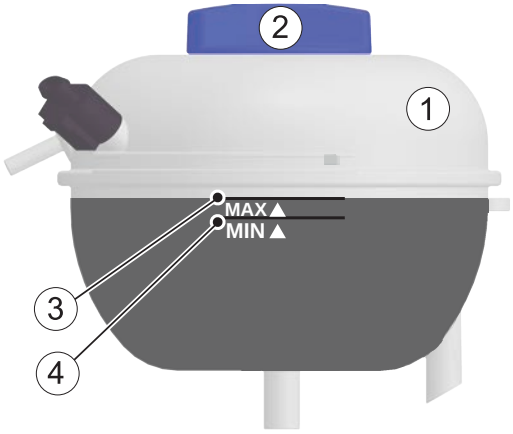
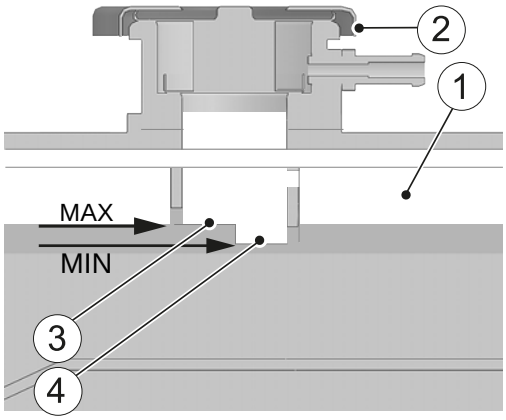
When using third party tanks, a **container tank** with a **coolant level switch** must be used.

The return line from the EGR cooler and the coolant cooler must be inserted separately into the expansion tank.

Good accessibility must be ensured for maintenance work such as inspection or filling.

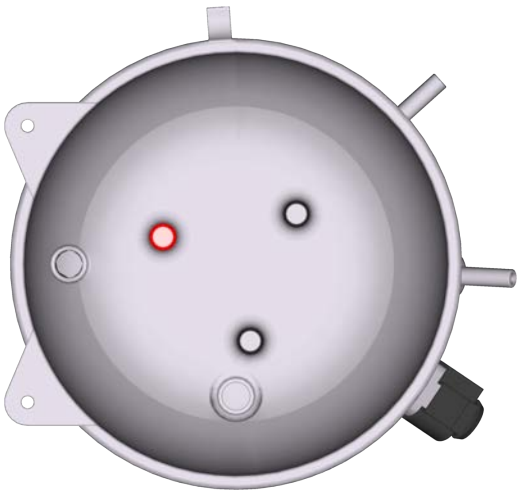
	NOTICE
	The overpressure valve in the coolant circuit must be designed for an opening pressure of 1.3–1.5 bar.

Overview of expansion tanks

External	Internal
	

1	Expansion tank for coolant
2	Sealing cap
Check the coolant level:	
3	**MAX** - Maximum coolant level
4	**MIN** - Minimum coolant level

Positioning of the expansion tank



Theoretically, it is sufficient if the **MIN** marking of the expansion tank is located above the highest component coming into contact with water (TIC or TICD: EGR cooler, T, TI or N: cylinder head).

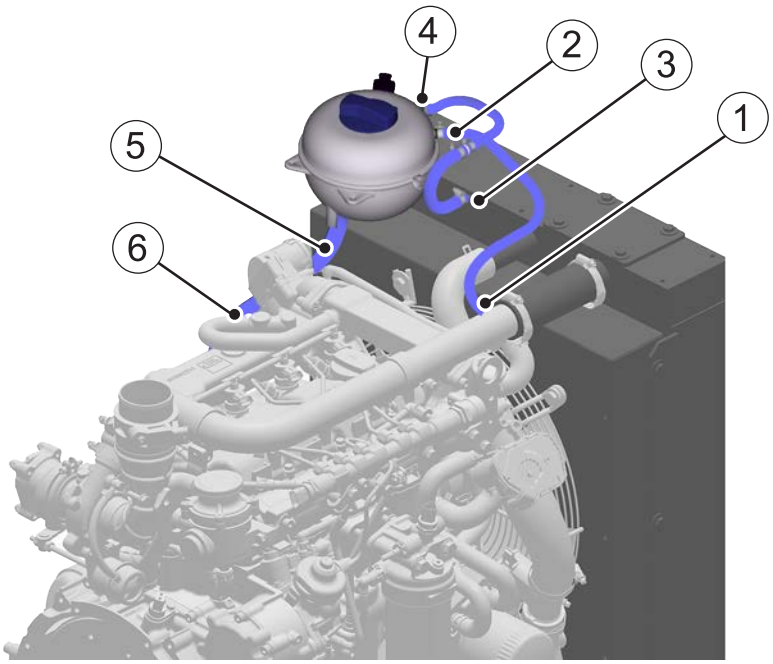
In order to gain a little safety, however, the MIN marking should be located "significantly" above this point.

If the expansion tank is mounted above the cooler, this is quite sufficient.

Higher installation situations of the expansion tanks are preferable.

The expansion tank must be accessible at the overflow opening (external HATZ expansion tank marked in red underneath).

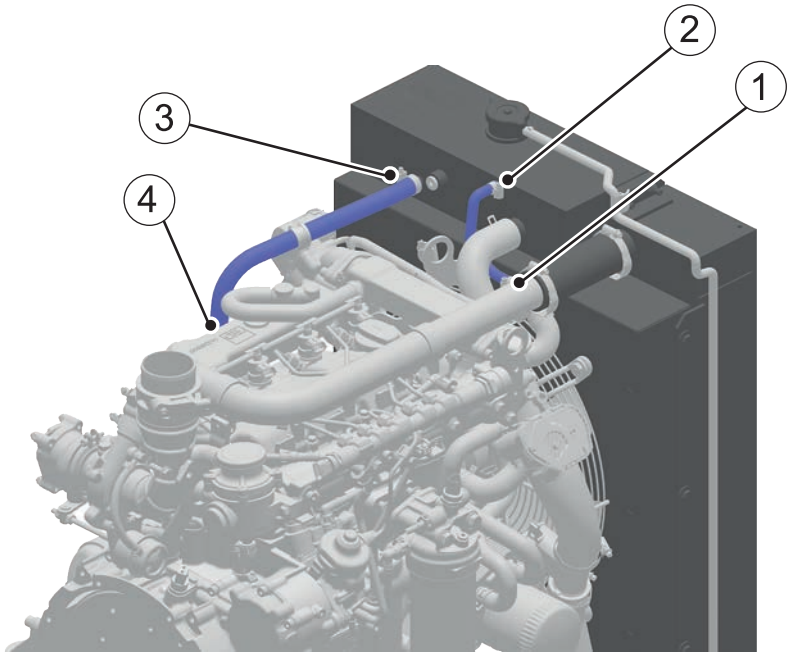
8.4.10 Tubing of external expansion tank



	Description	Transfer point	Diameter at transfer point
1	EGR cooler relief line	AGR cooler >	Ø 8 $^{-1.5}$
2		expansion tank	Ø 8 $^{-1.5}$
3	Cooler relief line	cooler >	Ø 10 $^{-1.5}$
4		expansion tank	Ø 8 $^{-1.5}$
5	Return	expansion tank >	Ø 16 $^{-1.5}$
6		crankcase	Ø 16 $^{-1.5}$

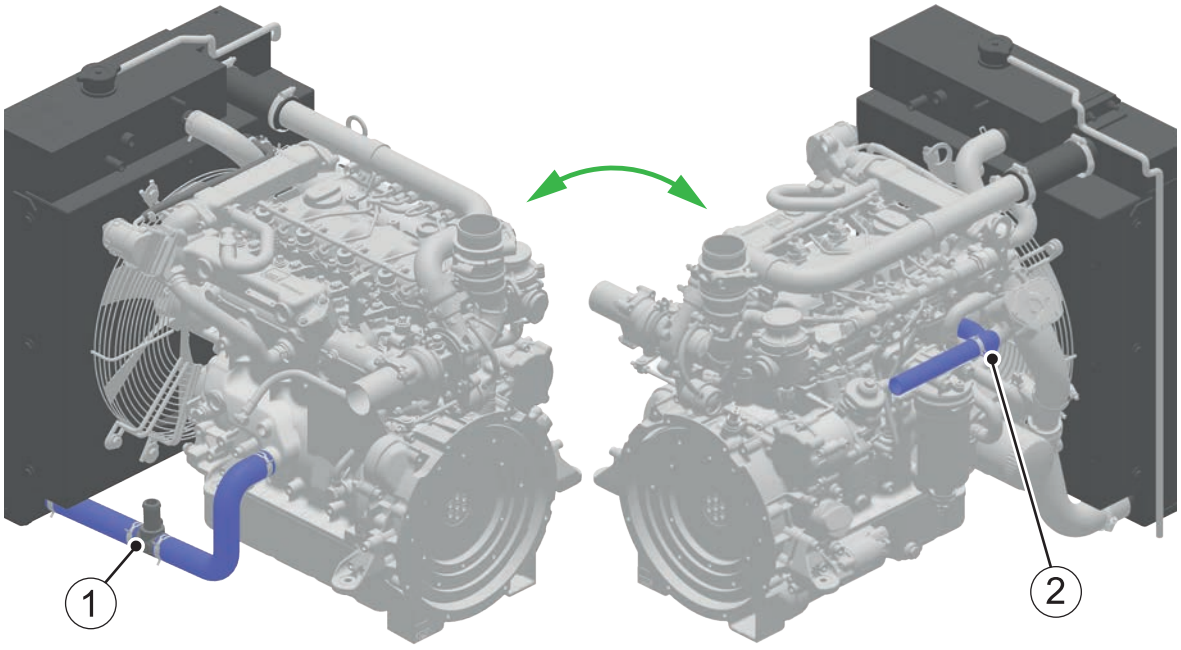
	NOTICE
	The piping to the expansion tank must be laid in a steadily rising manner. A drain (valve) must be provided for the coolant drain at the lowest point of the cooling system. If the piping to the expansion tank **CANNOT** be laid in a **steadily rising** manner, vacuum filling is required.

8.4.11 Hoses of internal expansion tank



	Description	Transfer point	Diameter at transfer point
1	relief line cooler	AGR cooler >	Ø 8 - 1.5
2		expansion tank	Ø 8 - 1.5
3		expansion tank >	Ø 16 - 1.5
4		crankcase	Ø 16 - 1.5

8.4.12 Piping of the cab heater



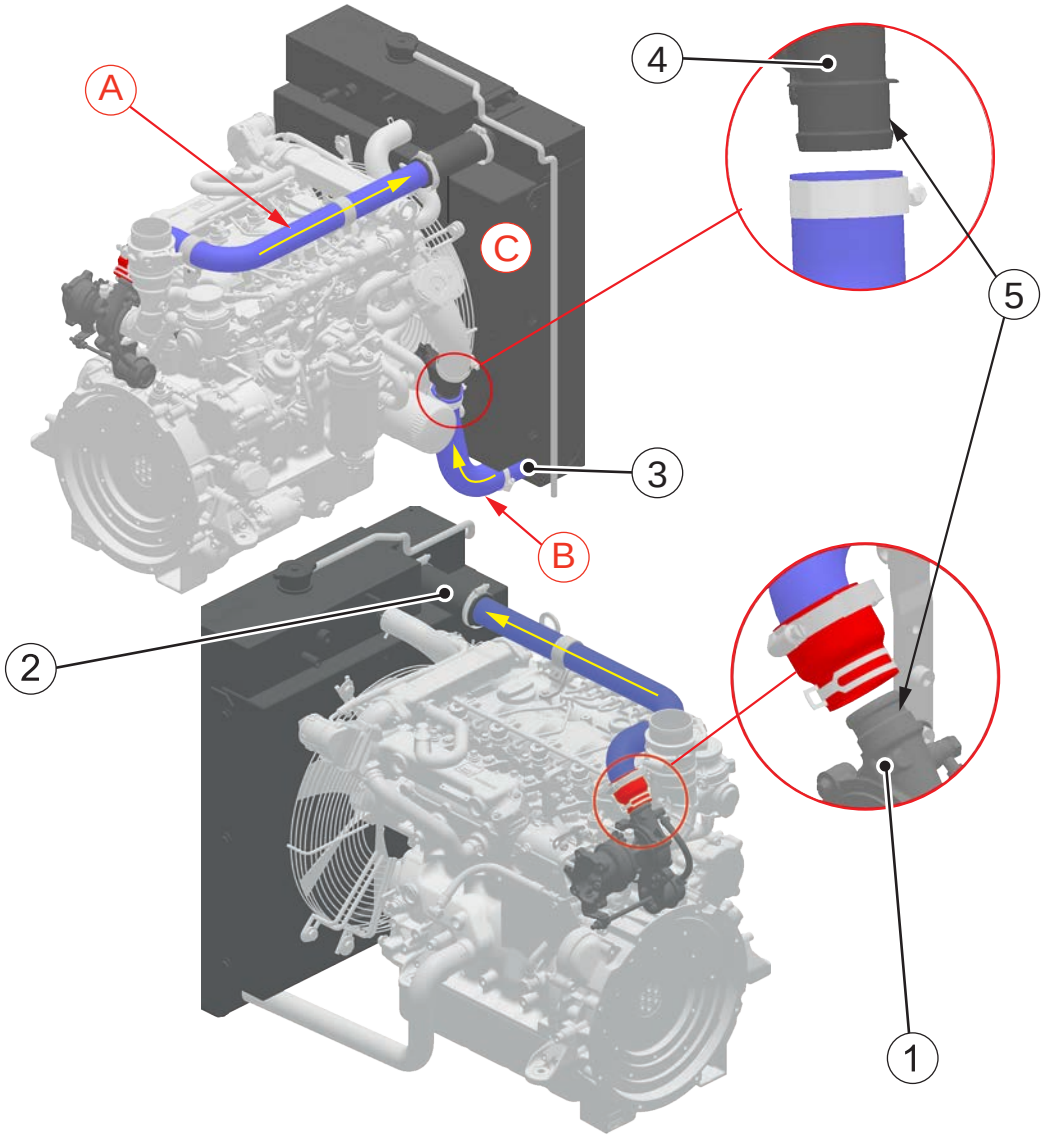
1	Cab heater return, insertion with T-piece	Ø 32 $^{-1.5}$
2	Supply for cab heater	Ø 22 $^{-1.5}$

Control of the cab heater using closing valves is preferable (here no bypass when not used, no restriction on the temperature range).

If the cab heater is circulated constantly, a **flow rate of maximum 10 l/min must not be exceeded or undercut at a pressure difference of at least 100 mbar**.

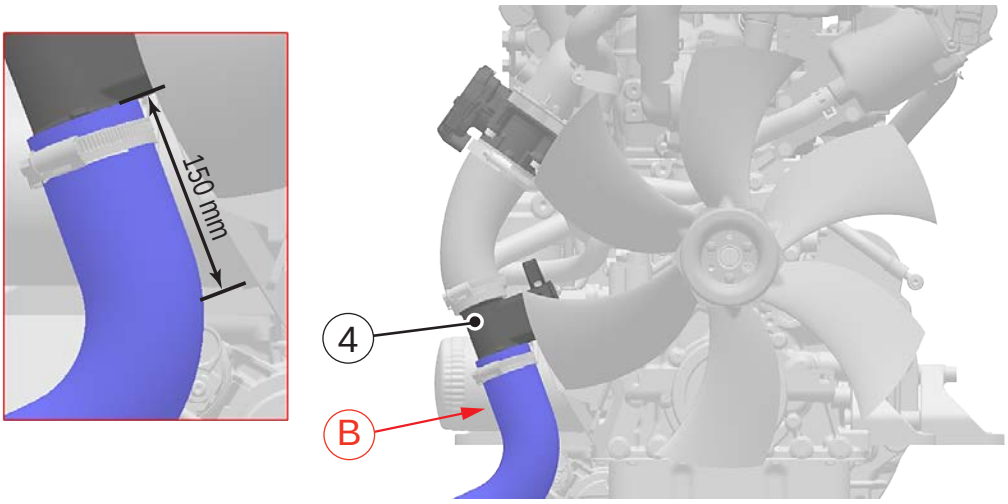
This also reduces the maximum permissible ambient temperature by about 3 °C.

8.4.13 Charge air piping



	Transfer point	Description
1	Exhaust gas turbocharger Ø35 $^{-1.5}$ >	**Charge air pipe** (widening of the diameter as close as possible to the exhaust gas turbocharger to reduce flow losses. Note the ring groove (5) on the exhaust gas turbocharger)
2	Charge air cooler (CAC) Ø45 $^{-1.5}$ (input)	
3	Charge air cooler Ø45 $^{-1.5}$ > (output)	**Compressed air hose** (note ring groove (5) on air mass meter)
4	Air mass meter Ø45 $^{-1.5}$	
A	Charge air pipe	
B	Compressed air hose	
C	Charge air cooler	

NOTICE	
	To ensure the tube connector is securely attached to the turbocharger (1) or the air mass meter (4), position the hose clamp over the ring groove (5).



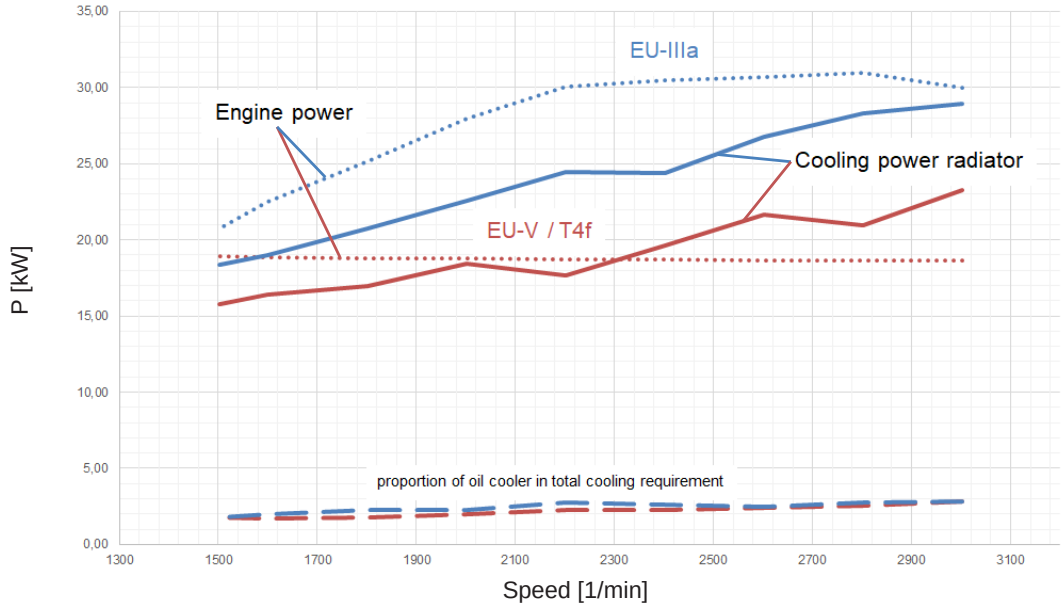
	NOTICE
	On the charge air path between the charge air cooler (C) and the air mass meter (4), a straight hose length of at least 150 mm before entry into the air mass meter must be provided for to prevent air turbulence. The air mass meter thus delivers precise air mass measurements to the engine control unit (ECU).

8.4.14 Amount of heat to be dissipated at the full load curve (100 % engine load)

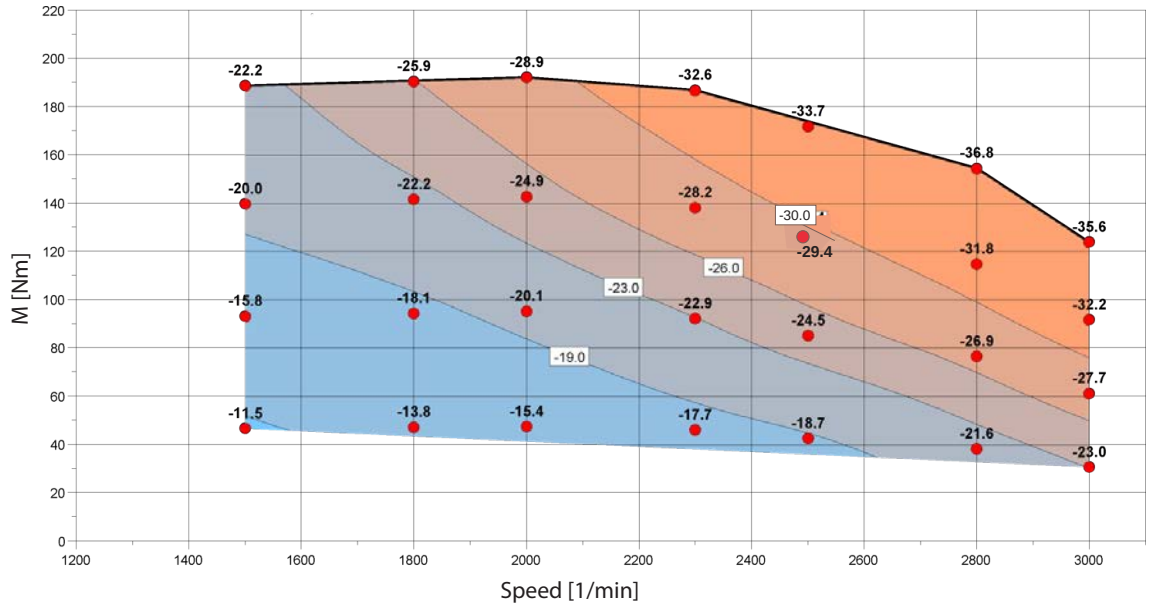
NOTICE

In the design of the cooler, a reserve for efficiency losses amounting to 10–15 % should be taken into account due to soiled coolers.

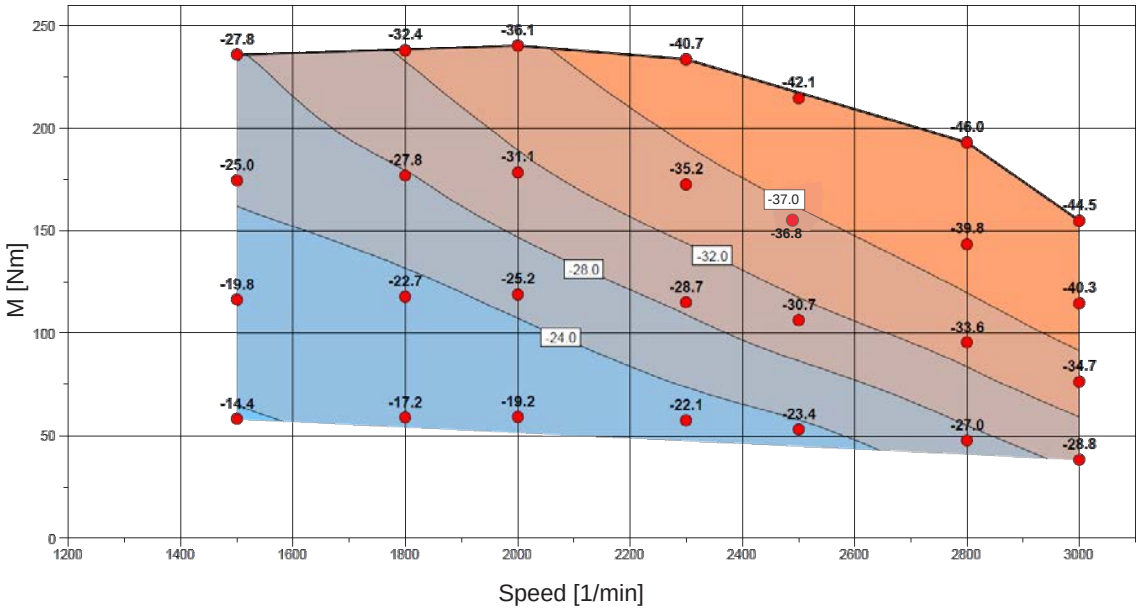
Cooling capacity of the coolant cooler 3H50T [kW]



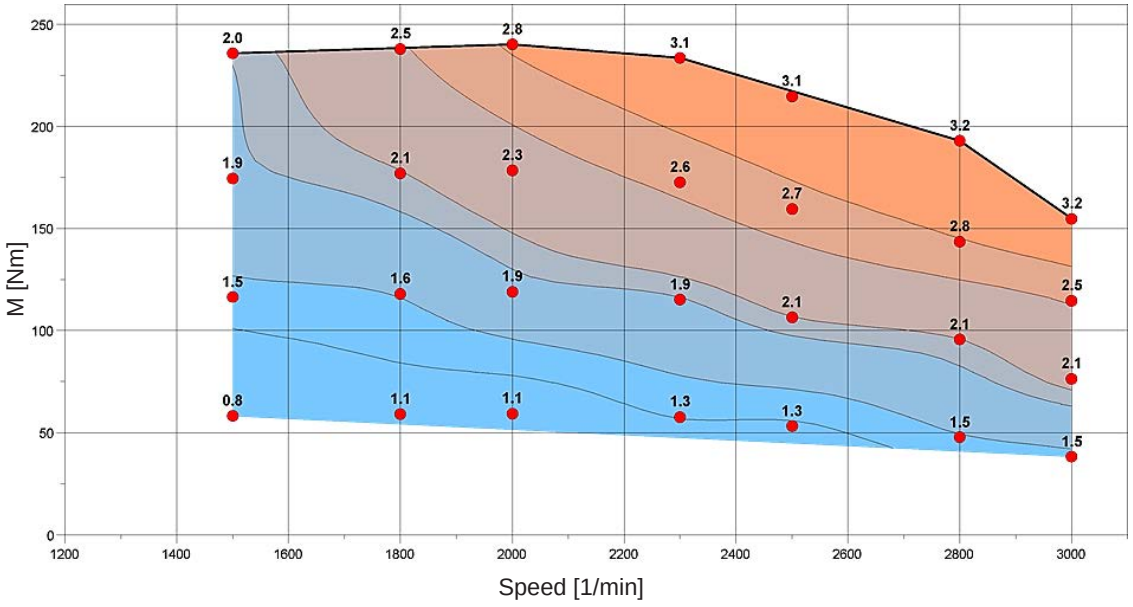
Cooling capacity of the coolant cooler 3H50TIC/TICD [kW]



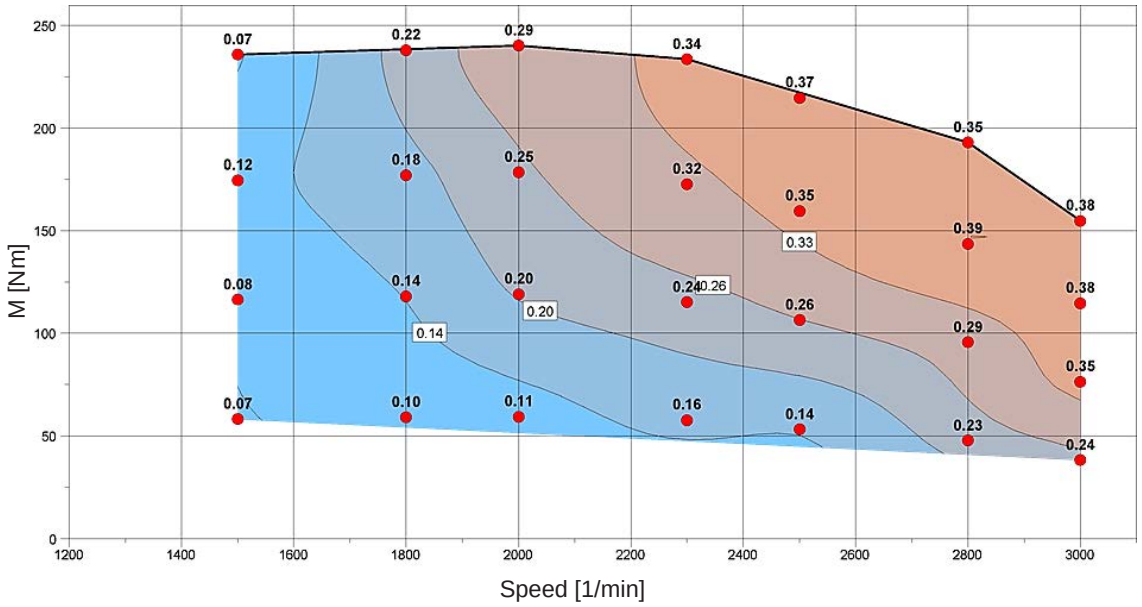
Cooling capacity of the coolant cooler 4H50TIC/TICD [kW]



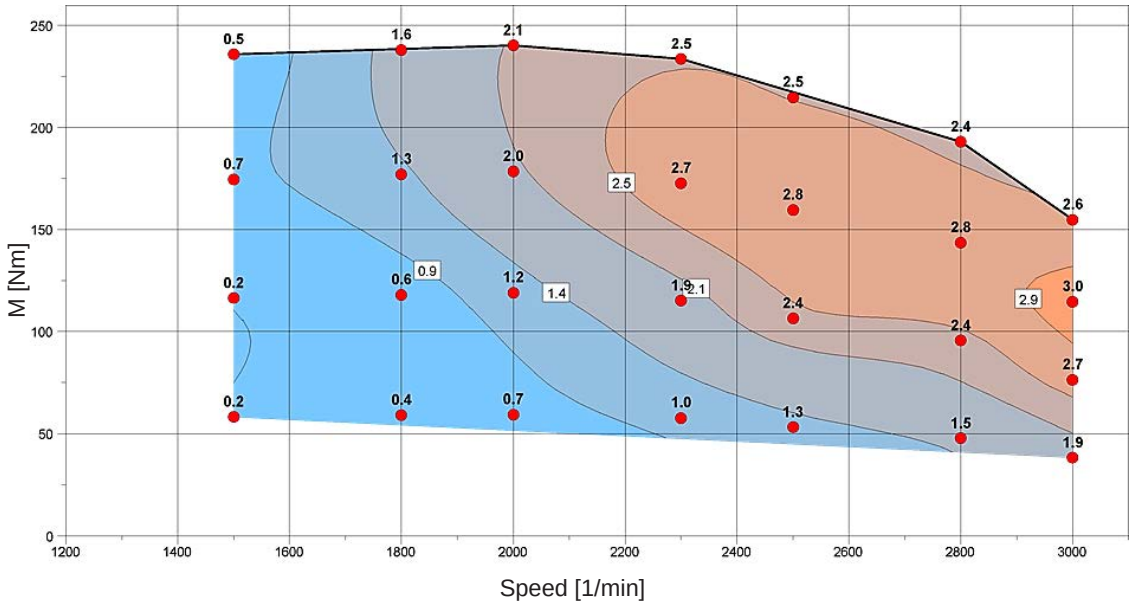
Cooling capacity of the EGR precooler 4H50TIC/TICD [kW]



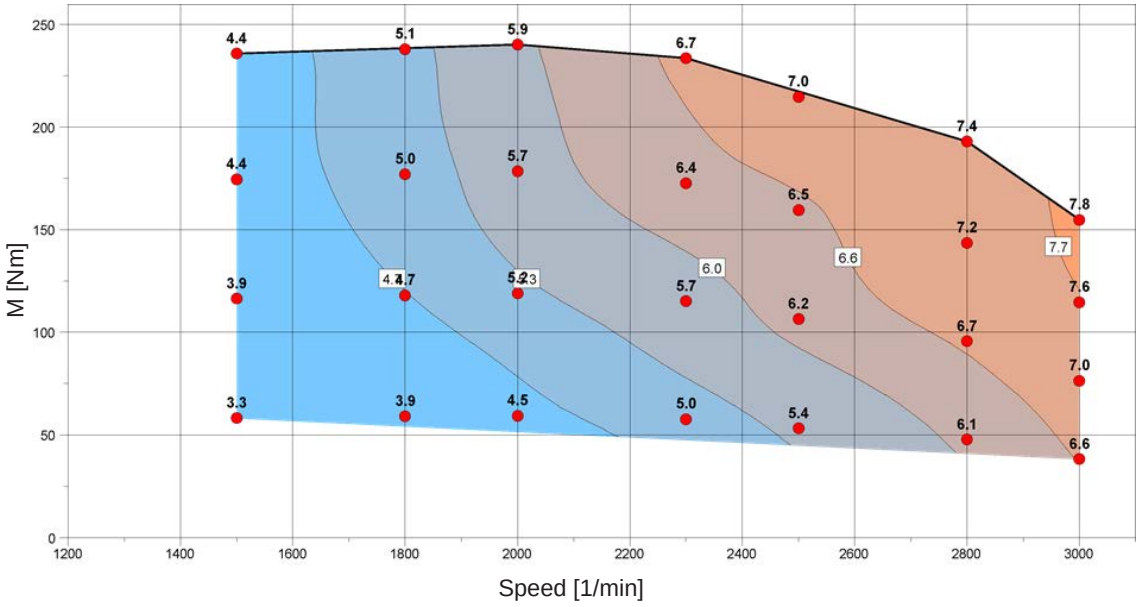
Cooling capacity of the EGR valve 4H50TIC/TICD [kW]



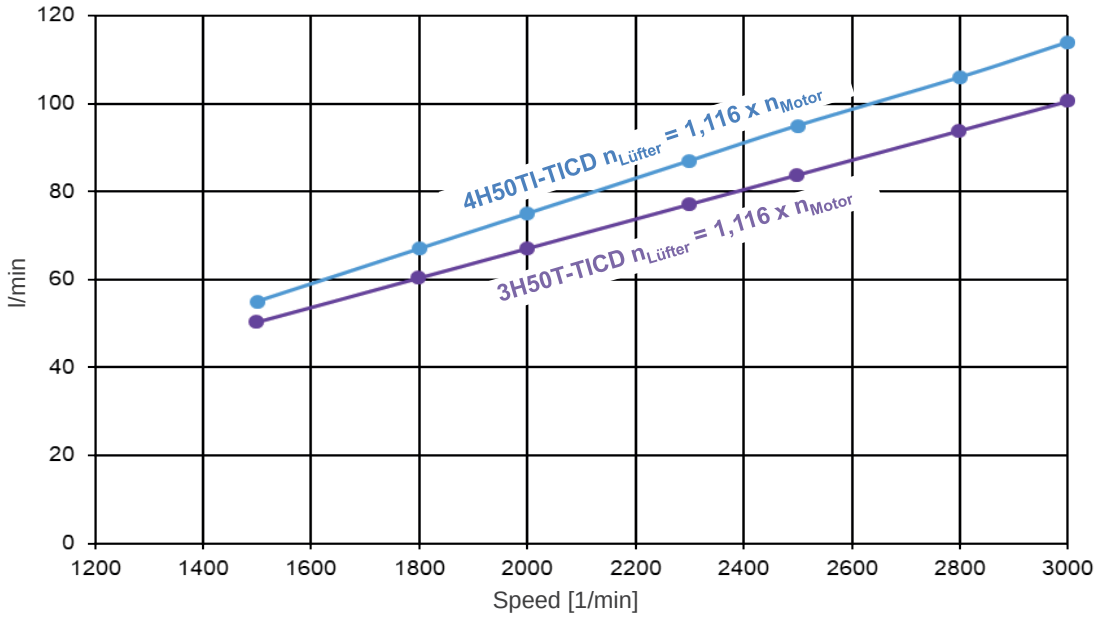
Cooling capacity of the EGR main cooler 4H50TIC/TICD [kW]



Cooling capacity of the oil cooler 4H50TIC/TICD [kW]



Coolant flow of the coolant cooler 3/4H50TIC/TICD [l/min]



Charge air cooler – 3H50TIC(D)

	Alternator application			Variable speed					
Speed n [1/min]	3000	1800	1500	2800	2700	2600	2500	2400	2300
Power P [kW]	-	28	22	42	40.4	38.9	36.4	36.4	-
Delta T CAC outlet - T ambient [°C]	-	8	7	13	12	11	11	10	-
Delta T CAC inlet-outlet [°C]	-	85	68	125	123	121	120	120	-
Delta p CAC inlet-outlet [mbar]	-	25	15	70	67	65	67	62	-
Combustion air throughput [kg/h]	-	130	100	260	250	235	250	220	-
Cooling air throughput (35° extractor fan) [kg/h]	7122	4273	3561	6648	6410	6172	6648	5935	5460
CAC cooling capacity (dry) [kW]	9.8	3.1	1.9	9.1	8.6	7.9	8.4	7.4	6.3

Delta T: T ambient to T intake maximal 8°C.

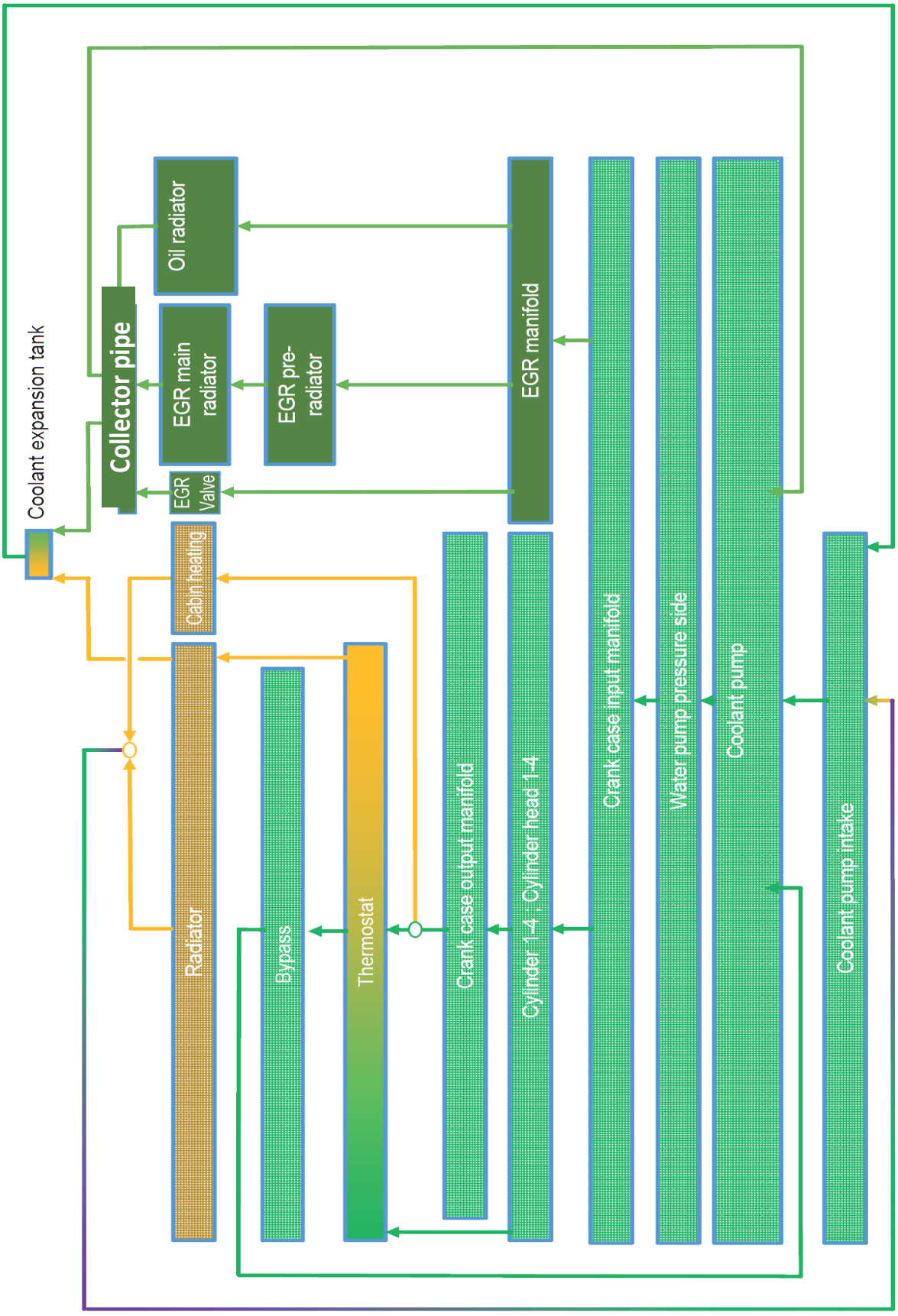
Charge air cooler 4H50TIC(D)

	Alternator application			Variable speed					
Speed n [1/min]	3000	1800	1500	2800	2700	2600	2500	2400	2,300
Power P [kW]	50	38	28.7	55	53.2	51.3	49.5	47.7	45.9
delta T LLK outlet - T ambient [°C]	16	9	8	16	15	15	14	13	13
delta T LLK inlet-outlet [°C]	139	94	58	137	133	129	126	124	119
delta p LLK inlet-outlet [mbar]	75	30	20	55	50	45	43	40	37
Combustion air throughput [kg/h]	336	177	123	319	304	290	272	263	253
Cooling air throughput (35° extractor fan] [kg/h]	7122	4273	3561	6648	6410	6172	5935	5698	5460
LLK cooling capacity (dry) [kW]	13.1	4.5	2	12.2	11.3	10.5	9.6	9	8.4

Customer cooler

For the design of your own coolers, contact your **Hatz subsidiary**.

8.4.15 Cooling circuit diagram



8.4.16 Coolant

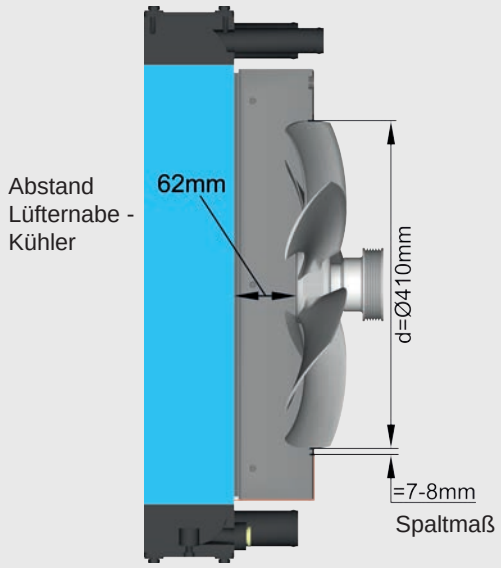
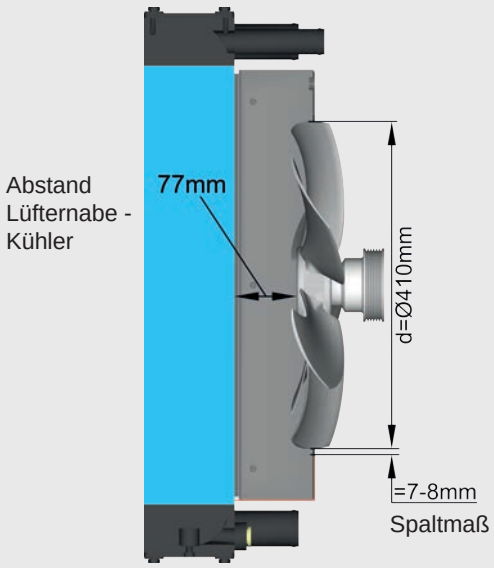
Recommended coolants, see **Manual for Diesel Engine**, *chapter "Coolant"*.

8.4.17 Extractor fan / pressure fan

The use of an extractor or exhaust fan depends on the application. If an pressure fan is used, the temperature in the engine interior is lower than with an extractor fan. However, here the air is heated by the engine, exhaust pipe and the driven machine so there is a higher temperature at the cooler.

With identical coolers, the maximum permissible ambient temperature for the pressure fan is reduced by at least 10% (depending on the application).

Installation information for extractor fan/pressure fan/engine cooler (F2F)

Extractor fan	Pressure fan
	

Standard ratio $\mathbf{n}_{fan}$ = 1.116 * $\mathbf{n}_{engine}$ [1/min]

Ratios of 1.00 and 1.33 are also available.

- With the 1.33 ratio, the maximum engine speed is limited to 2,500 rpm (due to the max. circulation speed of the fan).
- For the attachment variant with the fan raised and air conditioning compressor, only the 1.116 ratio is currently available.
- Other ratios on request.

Installation instructions

It must be ensured that the fan only draws the fresh air from the environment. The fan must not draw the warm air or exhaust gas from the engine. This would lead to a temperature short circuit, causing the engine to overheat.

The opening for the cooling air inlet should be designed so it is protected from the weather (e.g. protection against water ingress). Provide a water drain if necessary.

HATZ coolers are heavy-duty coolers and so robust that usually no additional protection of the cooler is necessary. If a light-duty cooler is used by the customer, it must be protected accordingly against damage.

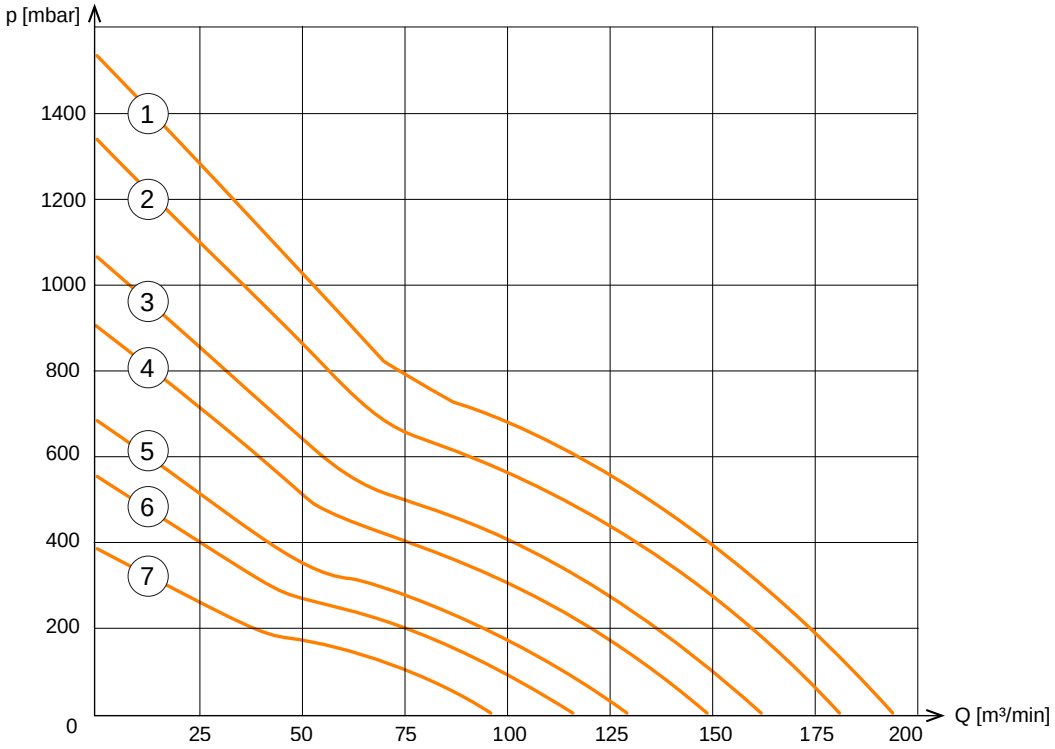
The pressure fan has the following disadvantages:

a) As the air flows through the engine, it is already preheated so it blows onto the cooler at a higher temperature, thus reducing the maximum permissible ambient temperature.

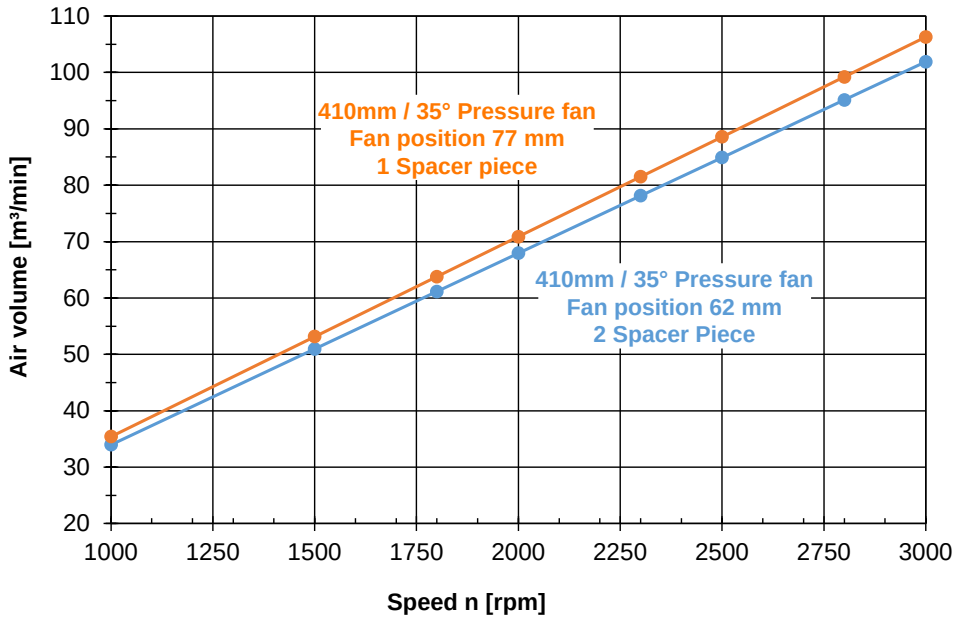
b) The cooling air is ejected at an angle of approx. 45°. This is ideal for the extractor fan because the air is diverted around the engine. With the pressure fan, however, the cooler is unevenly exposed to cooling air, thus tending to impair the cooling performance.

The fan characteristics for 410 mm/35° extractor/pressure fan at a ratio of n_{fan} = 1.116

*** n_{engine}**



	$n_{engine[min^{-1}]}$	$n_{fan\ [min^{-1}]}$
1	3000	3348
2	2800	3125
3	2500	2790
4	2300	2567
5	2,000	2232
6	1800	2009
7	1500	1674



8.4.18 Fan mounting positions

Device-specific safety instructions

WARNING

Danger of injury from rotating parts.

Touching the fans or poly v belts can lead to serious injury when the engine is running.

- Only operate the engine when all covers are installed.

WARNING

Danger of injury from loose screws.

Failure to use the specified thread locker when installing the fan can lead to serious injury from loose screws during fan operation.

- Only operate the engine if all screws of the fan have been sufficiently locked.

CAUTION

Danger of engine damage from overheating.

Before initial commissioning, check that a fan is installed in the engine. Starting the engine without a fan can lead to overheating during prolonged operation due to the lack of a cooling function and consequently cause considerable damage to the engine.

CAUTION

Danger of engine damage due to untested fans.

The use of fans that do not comply with the specifications tested by Hatz GmbH can lead to engine damage.

- Use of fans with deviating specification only after prior approval by Motorenfabrik HATZ (parent plant).

NOTICE

The Open Power Unit (OPU) is a complete system which, in addition to the engine, also includes all of the components required for cooling.

In the OPU version with **standard water pump**, only fans from Hatz must be used. Larger fans must not be used.

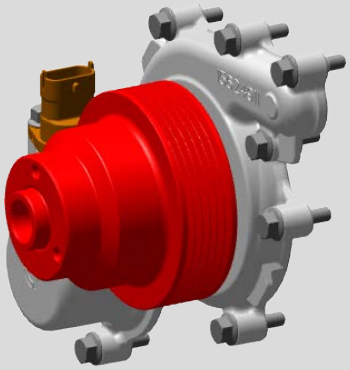
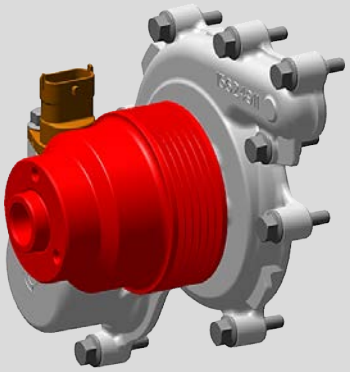
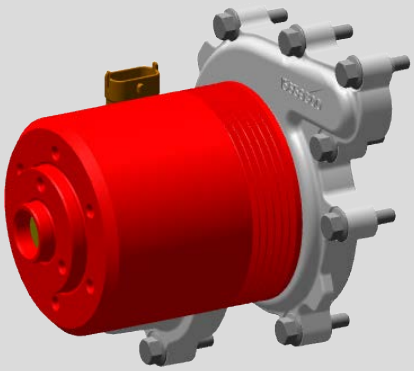
NOTICE

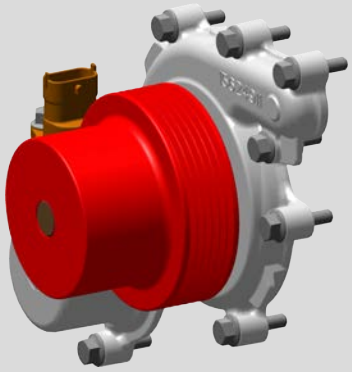
The Open Power Unit (OPU) with **boosted water pump,** for **more powerful and larger fans,** is delivered from the factory **without** fans.

Permissible drive power

Permissible drive power belt with boosted water pump		
pulley	Fan mounting position	Torque M
Lima 110A	Normal	20 Nm
Lima 150A		15 Nm
A/C compressor		Not possible with boosted water pump due to greater belt overload.
Lima 110A	Raised	20 Nm
Lima 150A		20 Nm

Water pump versions

Model	Description
1	**Standard water pump 1.116** for Hatz fan in ▪ standard mounting position and ▪ mounting position raised (not valid for standard gear ratio 1.33) For details, see *8.4.18.4 With standard water pump, page 84*.
	
2	**Standard water pump 1.33** for Hatz fan in ▪ standard mounting position ▪ Limitation of speed to 2500 [1/min] (due to maximum circumferential speed with Hatz fan) For details, see *8.4.18.4 With standard water pump, page 84*.
	
3	**Boosted water pump** for more powerful and heavy fans, e.g, for spiral fans (customer supplied) in ▪ standard mounting position. For details, see *8.4.18.6 With boosted water pump, page 87*.
	

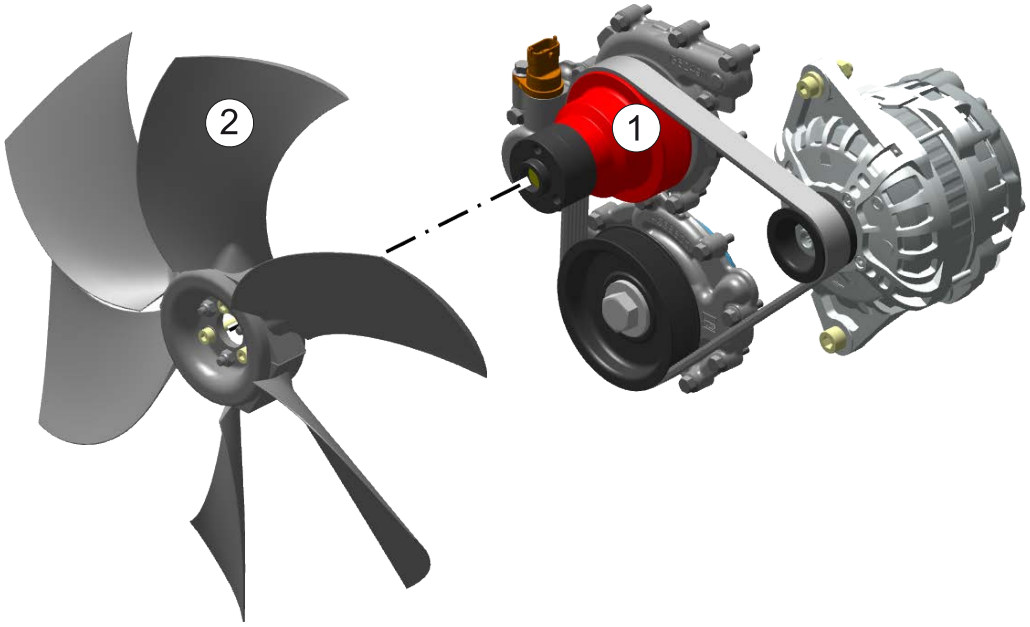
Model	Description
4	**Standard water pump 1,116** without fan attachment ▪ standard mounting position For details, see *8.4.18.4 With standard water pump, page 84*.
	

With standard water pump

Fan mounting positions with **standard water pump** (1) are exclusively **equipped with** pre-mounted Hatz fan (2).

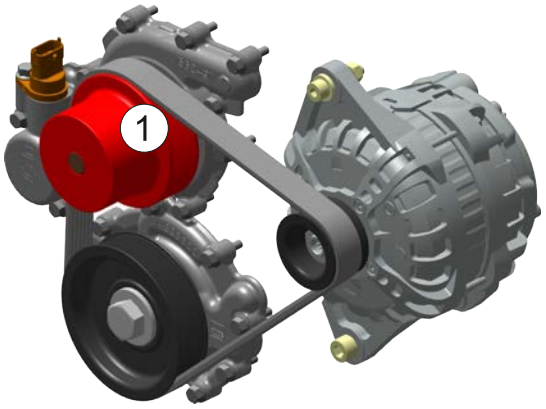
The following variants (**with** fan) are available:

- **Normal** fan mounting position

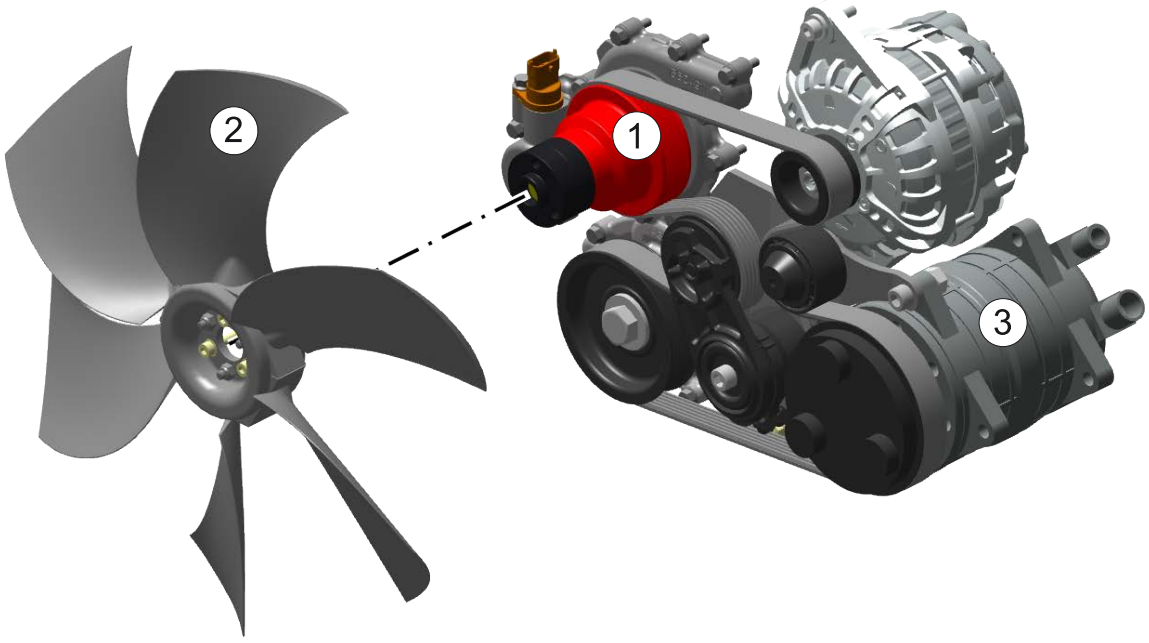


The following variants (**without** fan) are available:

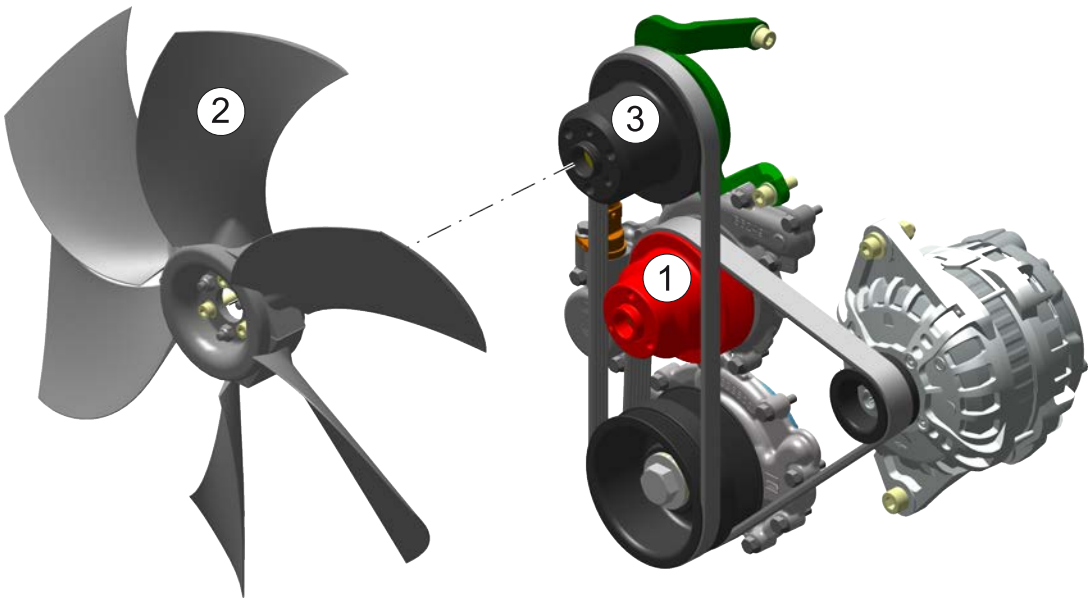
- **Normal** fan mounting position



- **Normal** fan mounting position, with air conditioning compressor (3) The values for the fan in the following diagram must not be exceeded.



- The **raised (3)*** fan mounting position is equipped with reinforced bearings like the version with boosted water pump: The mounting weight of max. 5 kg tested and approved by Hatz, with unbalance class G2, also applies here.



***Raised** mounting position not valid for standard gear ratio 1.33.

Fan power consumption

The following values for the fan must not be exceeded when using the standard water pump.

Extractor fan – 410 mm

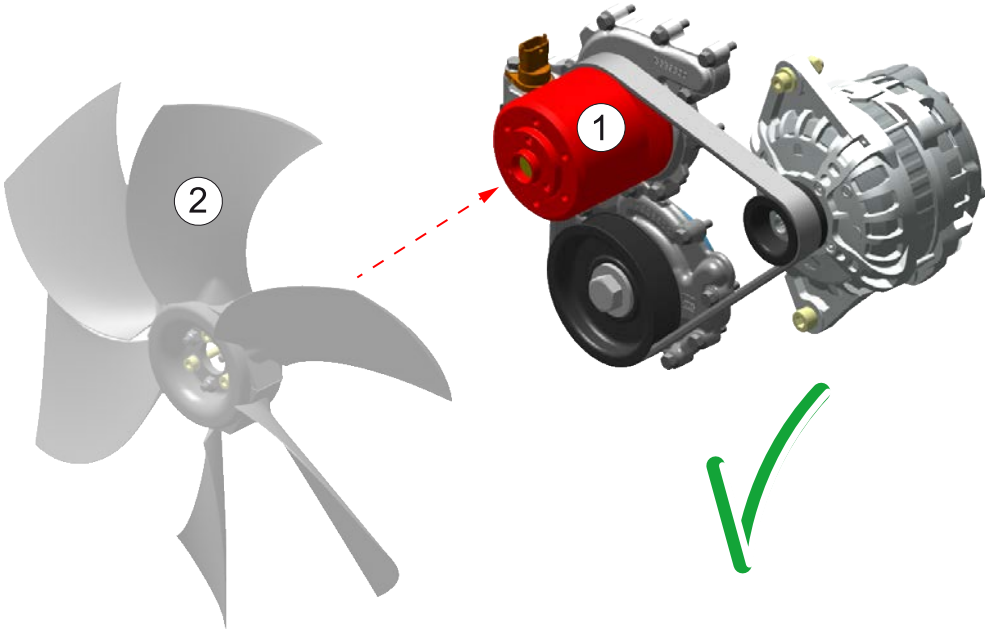
With boosted water pump

If more powerful fans (2) are used by the customer, e.g., reversible fans, a **boosted water pump** (1) (i.e. a pump with reinforced bearings) is installed in the fan mounting position.

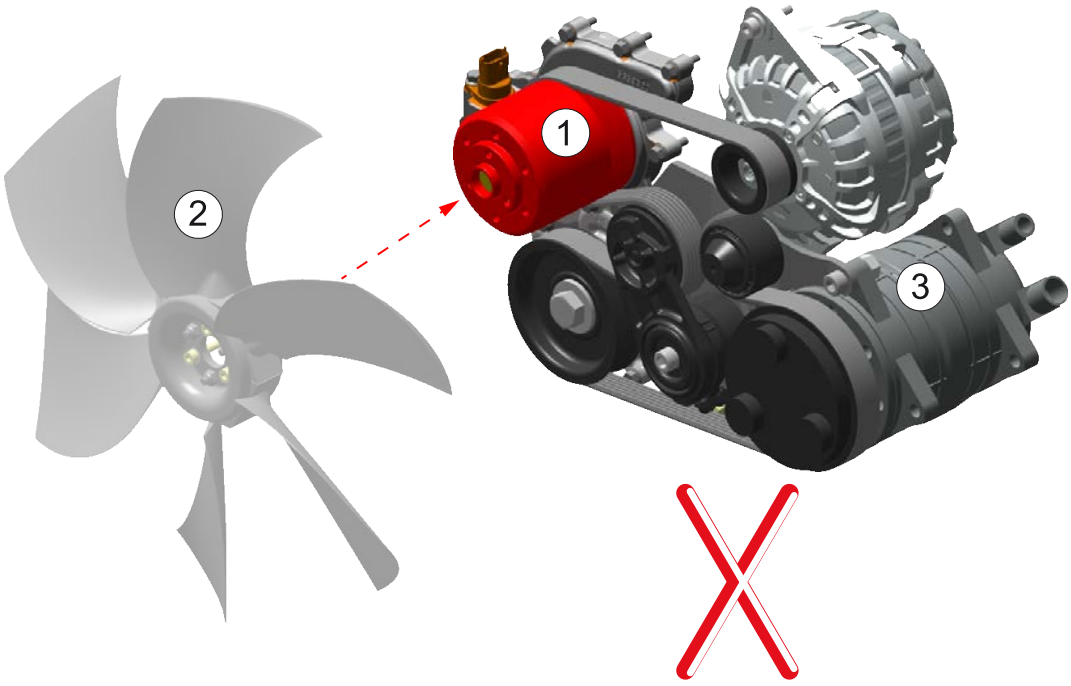
The attachment weight for forced cooling fans tested and approved by Hatz here is max. 5 kg, with unbalance class G2.

The following variants (**without** fan) (2), are available:

- **Normal** fan mounting position



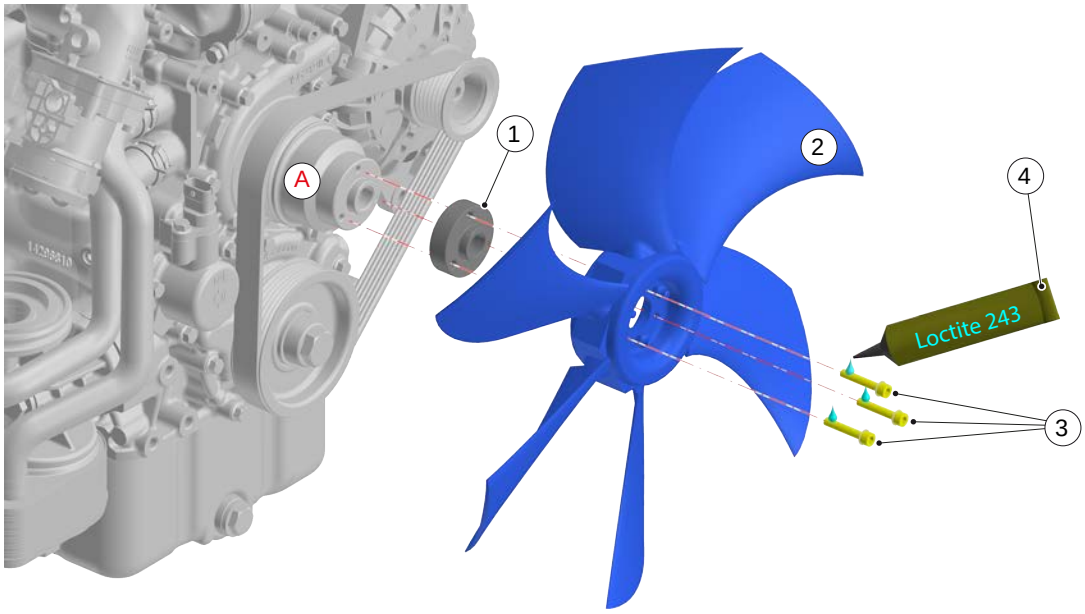
- Fan mounting position **on boosted water pump** with air conditioning compressor (3) **is not** permissible! This configuration overloads the belt drive and belt tensioner.



Fan thread locker

When the fan is delivered unattached to the engine, the following procedure must be adhered to when installing the equipment.

Overview — Preparatory activities



Delivery of loose parts in model with extractor and pressure fan 15 mm

Pos	Designation	Piece
1	Spacer 15 mm belt pulley	1
2	Fan 15 mm 410/6-6/35°/(1HL = extractor fan) or (1HR = pressure fan)	1
3	Cylinder head screw M6 x 35 **and** spring washers A6	3 / 3
4	LOCTITE 243 (not included in the scope of delivery but available under material number 70018918 from Hatz).	-

Delivery of loose parts in model with extractor and pressure fan 30 mm

Pos	Designation	Piece
1	Spacer 15 mm belt pulley	2
2	Fan 30 mm 410/6-6/35°/(1HL = extractor fan) or (1HR = pressure fan)	1
3	Cylinder head screw M6 x 50 **and** spring washers A6	3 / 3
4	LOCTITE 243 (not included in the scope of delivery but available under material number 70018918 from Hatz).	-

Procedure

Step	Designation
1	**To lock all threads of the cylinder head screws, use LOCTITE 243!** Moisten the cylinder head screws, pos. 3, with LOCTITE 243.
2	Mount pos. 1 to 3 on the water pump, pos. A. Tightening torque of cylinder head screws **9.5 Nm.**

8.5 fuel system

8.5.1 Fuel

DANGER

Fire hazard from fuel.

Leaked or spilled fuel can ignite on hot engine parts and cause serious burn injuries.

- Only refuel when the engine is switched off and has cooled down.
- Never refuel in the vicinity of open flames or sparks that can cause ignition.
- Do not smoke.
- Do not spill fuel.

CAUTION

Danger of engine damage from low quality fuel.

The use of fuel that does not meet the specifications can lead to engine damage.

- Only use fuel that is very low in sulfur or that contains no sulfur at all.
- The use of fuels that do not meet specifications require approval by Motorenfabrik HATZ (main plant).

NOTICE

Max. permitted fuel temperature is +80 °C. If exceeded, the engine switches to the engine emergency run program. Therefore, place the tank in a cool area of the machine.

Even trace amounts of zinc, lead and copper can lead to deposits in the injection nozzles, which is why elements containing zinc, copper or lead are not permitted to be used in the fuel system.

Zinc flake coating and hot-dip galvanizing produces a bare zinc surface and must be avoided.

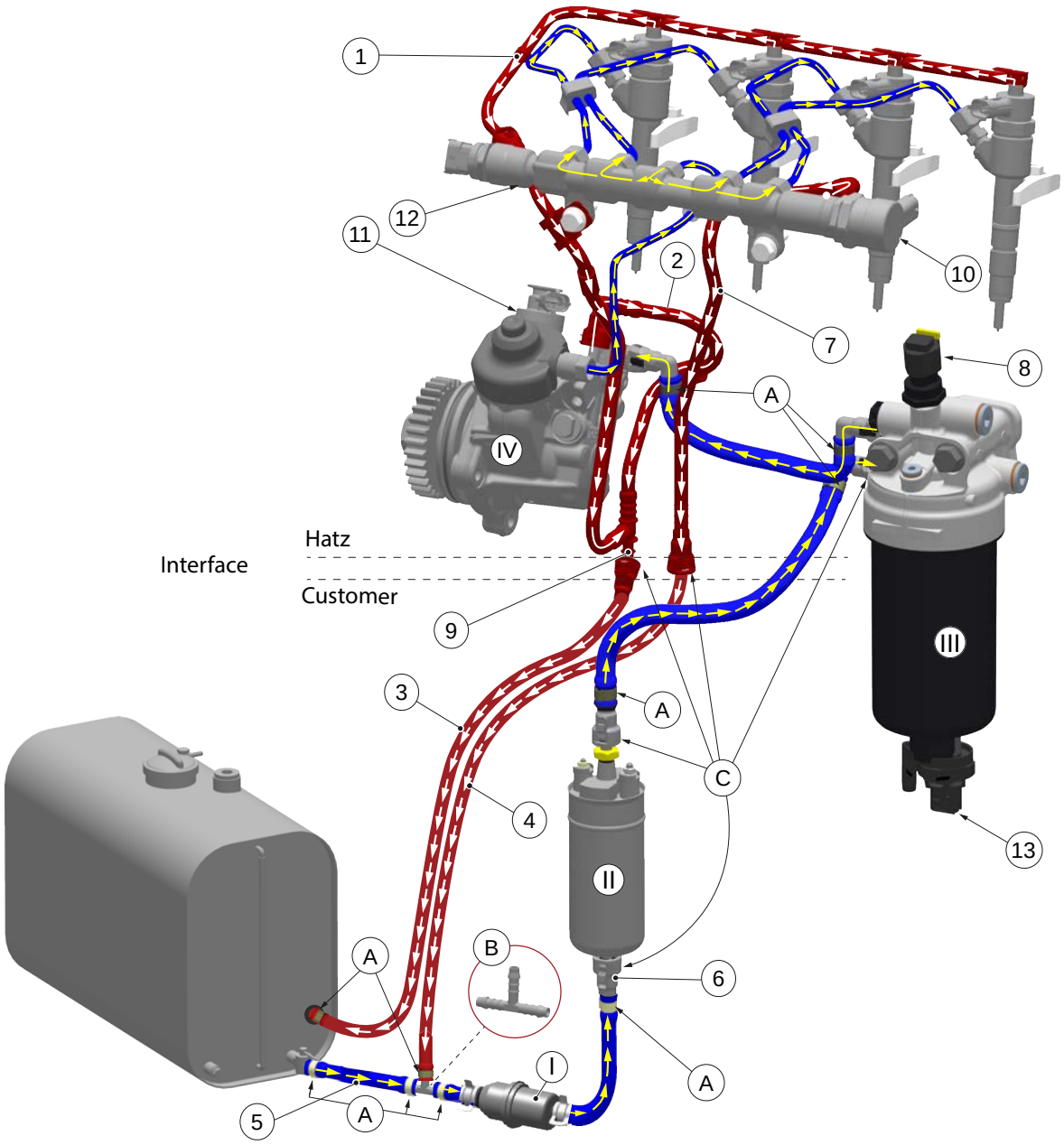
- Zinc ions lead to accelerated clogging of the injection holes in the injectors.
- Copper acts as a catalytic converter and massively lowers the fuel oxidation stability in combination with the FAME (**F**atty **A**cid **M**ethyl **E**ster) content in modern fuels of up to 7 %. This also causes injection nozzles to clog more rapidly with combustion residue.

Galvanized (passivated) components may be used.

8.5.2 Fuel specification

See the **Diesel Engine Manual**.

8.5.3 fuel circuit diagram



1	Injector return
2	High-pressure pump return
3	Return to tank
4	Return to prefilter
5	Supply from tank
6	Measuring point for fuel feed pump supply
7	Rail return
8	Low fuel pressure and temperature sensor
9	Measuring point for return to tank
10	Pressure control valve
11	Metering unit (→volume control valve)
12	Common rail
13	Water separator (with water in fuel sensor)
I	Fuel prefilter

Installing fuel lines

The connection points of the fuel lines must be fixed at the T-connector (B) – supply from the tank (5), return from the rail to the pre-filter (4) and the connecting line to the fuel prefilter – with suitable hose clamps (A).

It must be ensured that all other connections of the fuel lines, which are also mounted by the customer, are secured using suitable hose clamps (A), with the exception in the following **note** and **figure**.

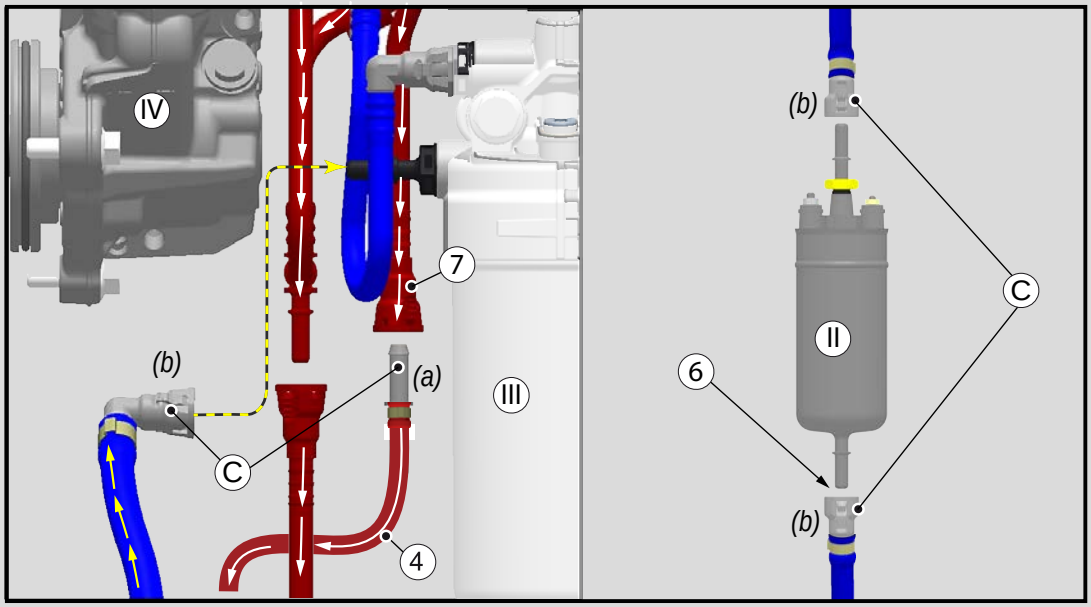
Spring band clamps are recommended on the fuel prefilter (I) due to easier maintenance.

After installation, a leak tightness test must be performed on all lines.

II	Electrical fuel feed pump
III	Main fuel filter
IV	High-pressure pump
A	Hose clamps
B	T connection piece
C	Adapter (a) / QuickConnector (b) - (optional)

Note: If the customer does not use the following adapter (C) from Hatz, the customer is responsible for ensuring that a fitting adapter (a) / QuickConnector (b) is used for the fuel hoses (customer side).

Any other connection of the fuel supply line to the main filter (III) and the connection of the return rail (7) with the return to the prefilter (4) is not permissible!



Fuel line specification: DIN 73379-8x3-A6, DIN 73379-8x3-B1 or better.

8.5.4 Rail pressure control

Position fuel prefilter (I) and fuel feed pump (II) as close as possible to the tank.. Since the engine has a special cold-running control, no fuel filter heating is necessary.

- **Rail pressure control as fuel heating**

During a cold start, the high-pressure pump (IV) delivers the maximum possible flow rate into the rail (12), thus heating the fuel. Excess fuel is drained through the pressure control valve (10) and returned to the fuel supply (5) via the return rail (7) and return to the prefilter (4). This control works like a filter heater.

Once the fuel is heated sufficiently, the delivery amount is regulated back to the actually required amount via the metering unit (11).

This control is deactivated when the fuel temperature exceeds 15 °C and is reactivated when the fuel temperature during operation drops below 10 °C.

- **Rail pressure control during normal operation**

During normal operation, the fuel supply to the high-pressure pump (IV) is controlled by the metering unit (11). Consequently, only the necessary amount of fuel is delivered to the rail (12) and the pressure control valve (10) can remain closed. This avoids excess heating of the fuel and power loss.

8.5.5 Fuel filtration

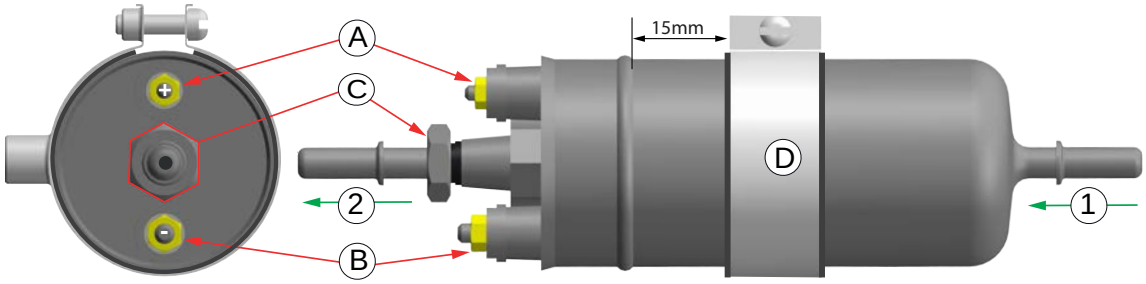
During initial start-up, the ignition key must be turned to the "ignition on" position so that the fuel feed pump (II) fills the fuel main filter (III) with fuel and forces the air out of the system. This is important because air bubbles in the fuel system damage the high-pressure pump (IV). See chapter **"Starting the engine for the first time/after a filter change" in the Diesel Engine Manual"**.

8.5.6 Electric fuel pump

Technical data

Rated and test voltage	12 V
*Supply/return length with Ø 8 mm	Max. 5 m
Permitted negative pressure at delivery pump	0.3 bar (tank level and flow resistance of line/loaded pre-filter) pos. 6
Feed pressure	4.5 bar (can be read via diagnostics) pos. 8
Engine stop	≤ 1.5 bar
Required return flow rate	At least 80 l/h (measuring point pos. 9)
Pmax	7 bar
Max. pressure in return	0.3 bar (measurement point for return pressure) pos. 9

**The specified pressures and volumes are important in all cases.*



Pos	Tightening torque connections for electrical fuel pump 12 V
A	(M4) 1.2 Nm
B	(M5) 1.6 Nm
Tightening torque of screw-in fitting	
C	(M8) 20 – 24 Nm
1	Intake side
2	Pressure side

The electric fuel feed pump is mounted with a rubberized fastening clamp (D). The clamp must be fastened at distance of at least 15 mm from the bead.

Mounting of the fuel pump directly on the engine is not permitted due to engine vibrations!

NOTICE
For engines with 24-V equipment, a **DC/DC converter** is used to regulate the voltage for the engine control unit C81 and the fuel feed pump down to 12 V. If a **customer-supplied fuel pump** is used, make sure that the pump is rated for 12 V.

**Current consumption of DC/DC converter in standby mode < 2 mA.*

8.5.7 Fuel main filter

NOTICE

The fuel line between the high-pressure pump and the main fuel filter must never be detached.

WARNING

Danger of injury due to fuel splashes.

Fuel can exit under pressure when the main fuel filter is removed.

- Carefully remove the main fuel filter.
- Wear safety goggles.

Due to the different ways of storing fuel in the various fields of application, the fuel cleanliness cannot always be guaranteed. Condensation and deposits can occur in the fuel. For this reason, a fuel main filter (III) with a water separator (and water in the fuel sensor) pos. 13 is required.

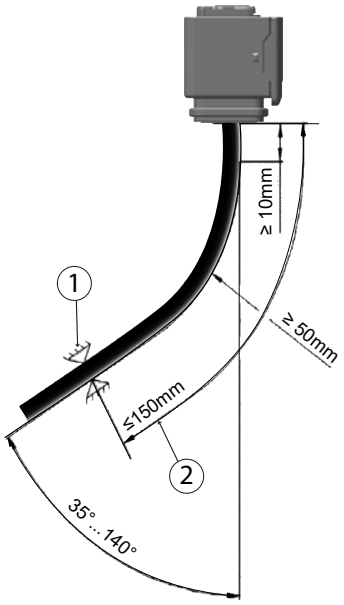
The engine may only be operated with HATZ main fuel filters! Use of products from other manufacturers is not permitted! The water in fuel sensor contained inside is integrated in the engine control unit (ECU). See chapter *8.5.3 fuel circuit diagram, page 90*.

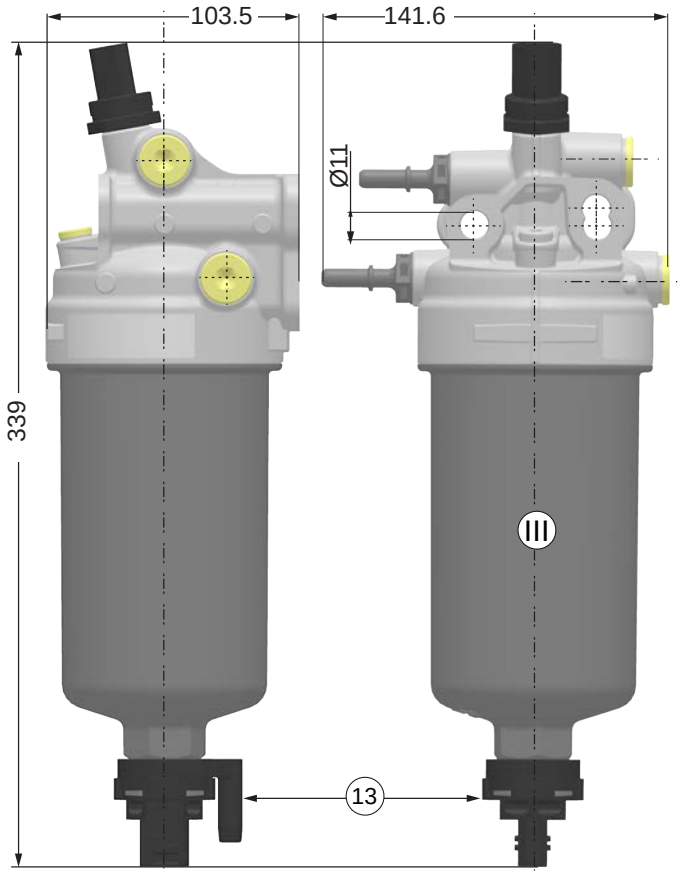
Fuel line installation instructions:

No non-ferrous metals, copper, lead nor zinc compounds are permissible in the tank, lines, gaskets and delivery pumps.

Exception:

Galvanized components with a passivated surface may be used.





Separated volume until signal:

135 cm³ to min. 0° tilt position,

60 cm³ to max. 30° tilt position

1	Support point on the unit support
2	Length up to support point

8.5.8 fuel tank

DANGER

Fire hazard from fuel.

Leaked or spilled fuel can ignite on hot engine parts and cause serious burn injuries.

- Only refuel when the engine is switched off and has cooled down.
- Never refuel in the vicinity of open flames or sparks that can cause ignition.
- Do not smoke.
- Do not spill fuel.

CAUTION

Danger of environmental damage from spilled fuel.

Do not overfill the fuel tank and do not spill fuel.

- Collect any leaking fuel and dispose of it according to local environmental regulations.

When a fuel tank is installed, make sure that it does not have any processing residues, impurities, water, etc.

A discharge port must be provided at the lowest point on the fuel tank to drain water and dirt when needed. The reason for this is deposits and fuels with FAME content.

Due to the penetration of water (hygroscopic action of FAME) in the fuel tank, biocultures (fungi) can occur in the transition layer between the fuel and water.

This can cause damage to the injection system, which can lead to failure of the system. It is therefore imperative to keep the fuel tank clean.

This also applies to the fuel main filter, for which (despite the water in fuel sensor) the maintenance intervals must be carried out in accordance with the **Diesel Engine Manual**. This is especially the case before extended storage periods (e.g., winter breaks).

NOTICE

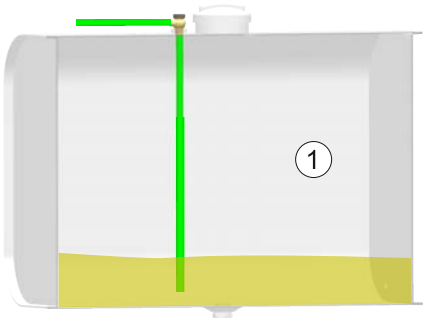
If possible, never run the fuel tank empty, otherwise air can enter the fuel system and the engine switches to the emergency program.

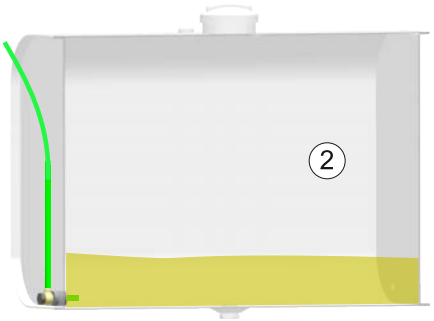
Furthermore, there is a risk of damage being caused in the fuel high-pressure area. A fuel level sensor should be implemented (possibly several warning levels) in order to exclude possible damage in advance.

Tank variants

The **fuel return line to the tank must be introduced under the fuel level** to prevent the lines from emptying. If this is not possible, a check valve must be installed. The permissible pressures must be observed; see section *8.5.6 Electric fuel pump, page 93*.

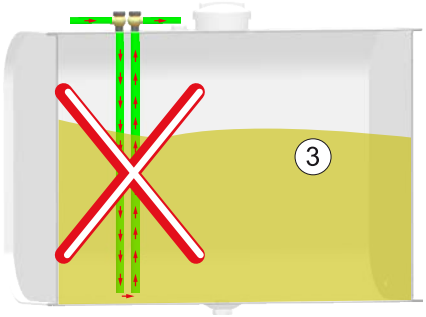
A check valve in the fuel supply before the electric fuel pump (EFP) is not permitted.

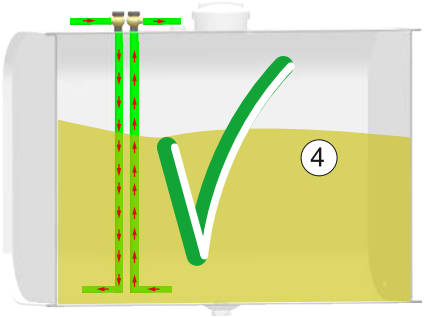


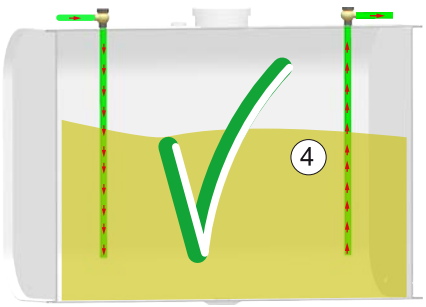


1	Return at the top (with standpipe)
2	Return below the fuel level

The **distance between the supply and return lines** should be as large as possible. It absolutely must be avoided that the warm fuel of the return line can enter into the supply line (thermal short circuit).







3	Supply and return flow – wrong!
4	Supply and return flow – right!

8.6 Exhaust system

CAUTION

Danger of burns from hot exhaust gas systems.

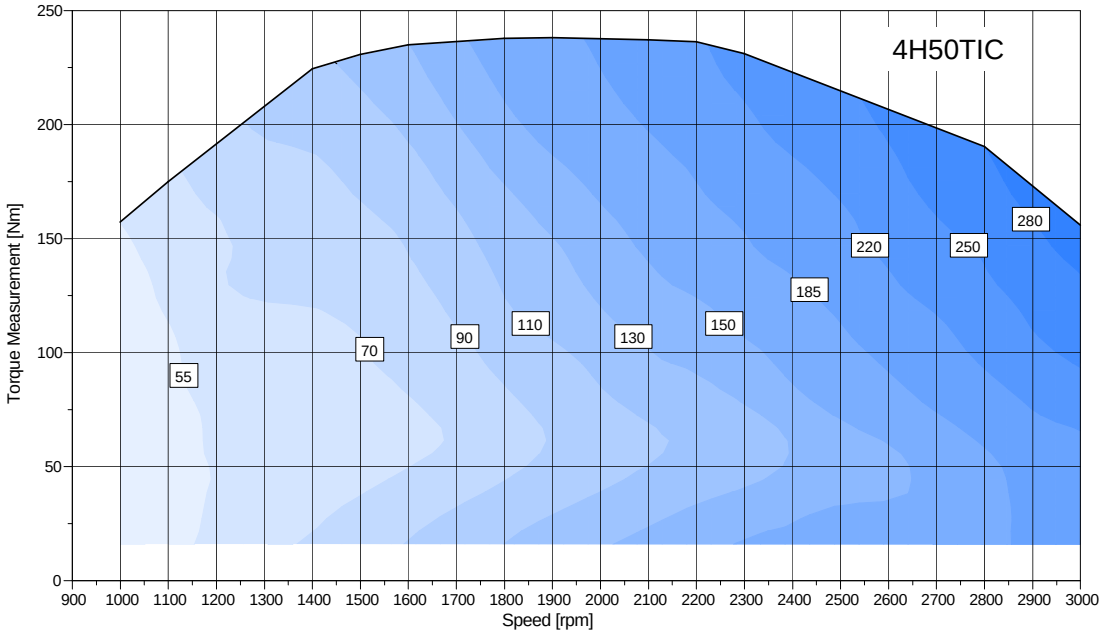
Hot surfaces on the entire exhaust system! Keep explosives and flammable materials away from the engine.

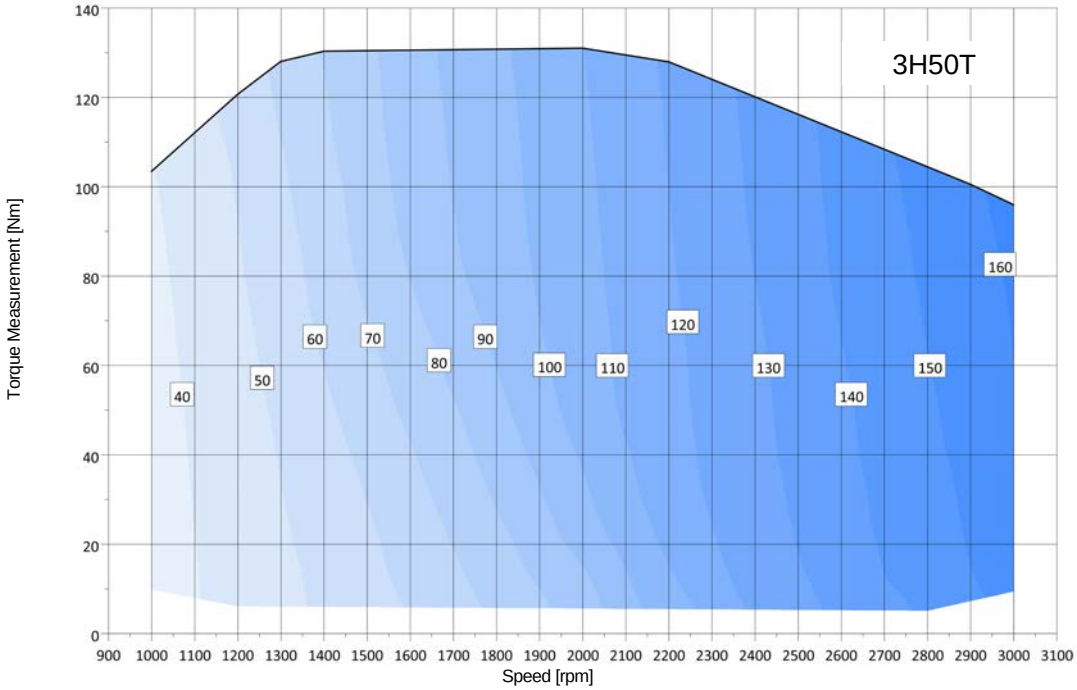
- Attach the protective device.
- Wear safety gloves.

NOTICE

The machine manufacturer is obligated to ensure that all safety precautions have been taken in the complete machine so that injuries from hot surfaces can be ruled out. Hatz can deliver a variety of safety devices. See chapter Contact protection for machine safety.

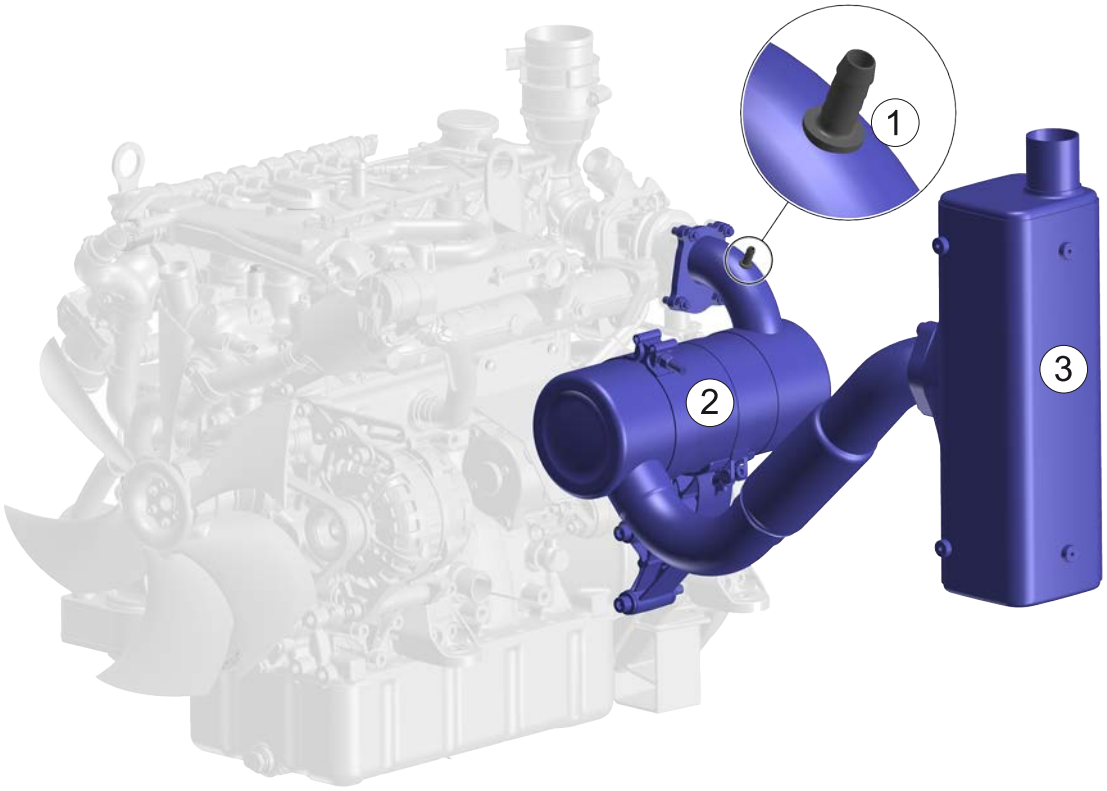
8.6.1 Exhaust gas volume flow





8.6.2 Permissible exhaust gas back pressure

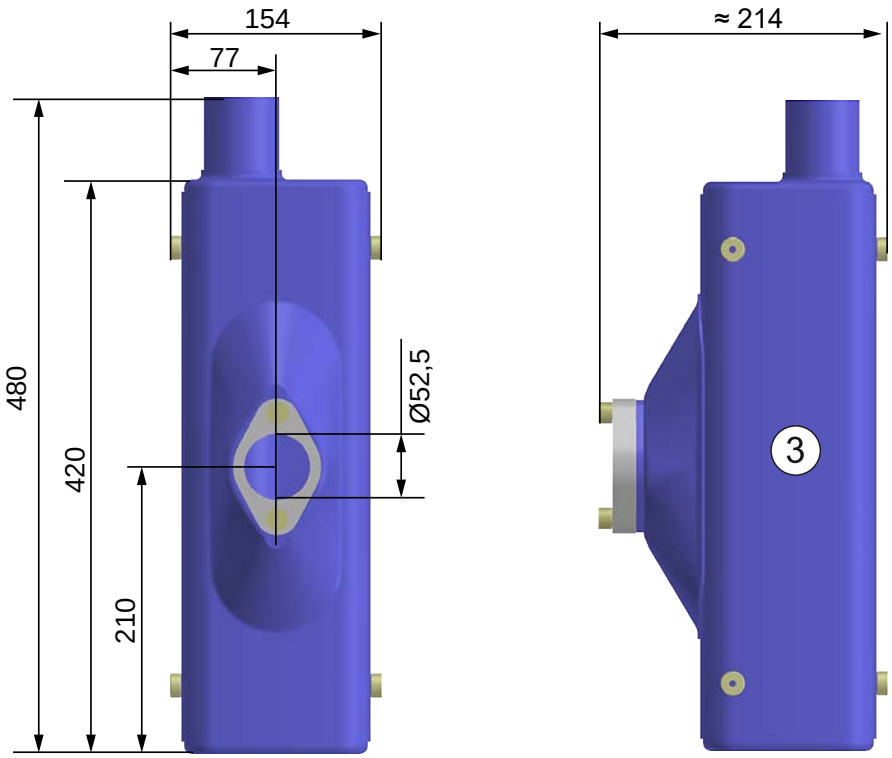
If additional silencers are used, but also if the exhaust gas is transferred from the engine compartment through pipe elbows or flexible lines, pay attention to the permissible exhaust back pressure. The measuring point (1) of the exhaust back pressure is located immediately downstream of the exhaust gas turbocharger.



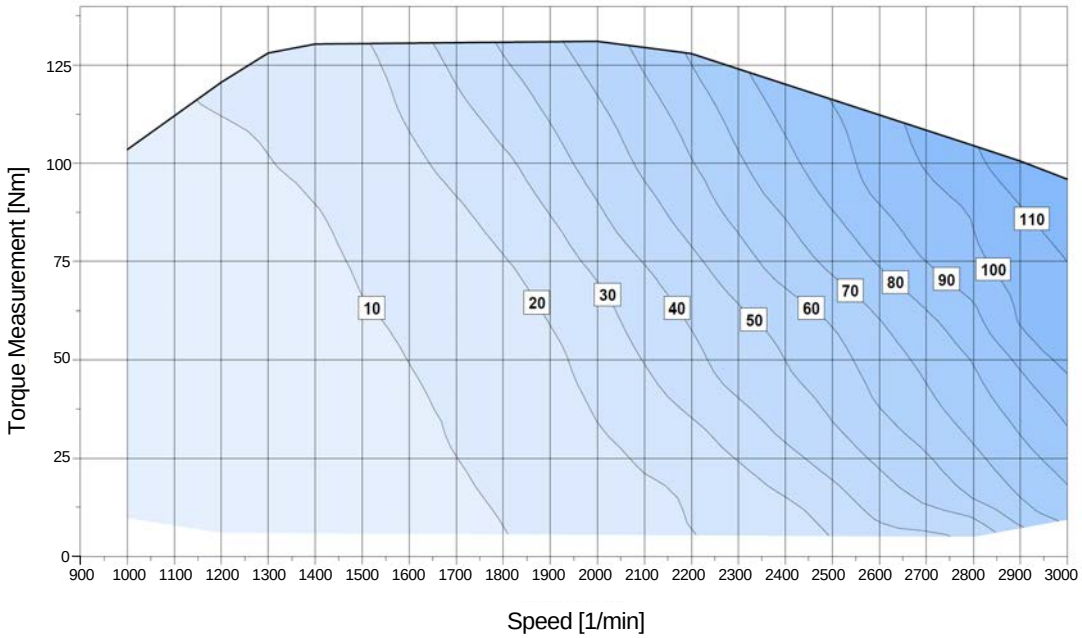
**Exhaust back pressures apply to the DOC (2) and rear silencer (3) at the measuring point (1).*

Exhaust gas back pressures are target values, not maximum values; tolerance ± 15%, in constant speed applications (1500 rpm, 1800 rpm) ± 5 mbar

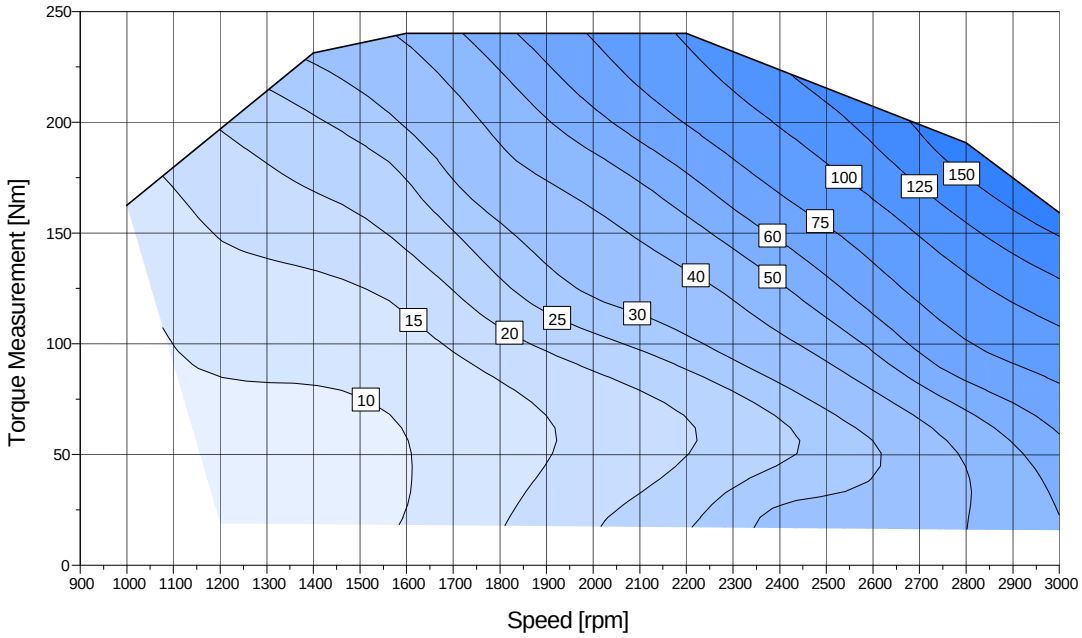
Exhaust gas back pressure of DOC at 2800 rpm/full load 100 mbar



Permissible exhaust gas back pressure 3H50T [mbar]



Permissible exhaust gas back pressure TI/TIC [mbar]



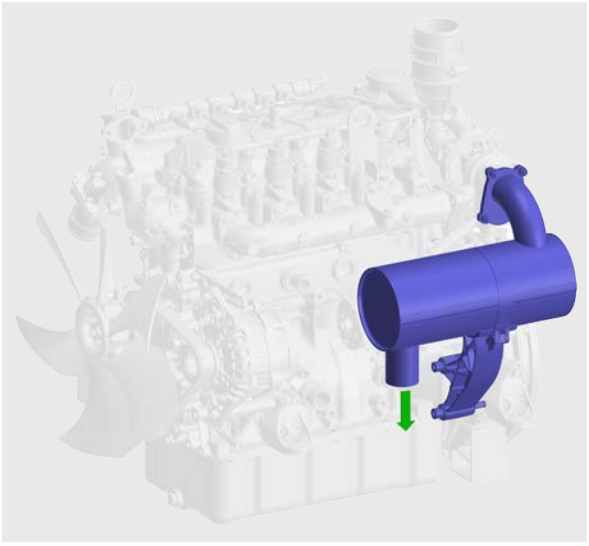
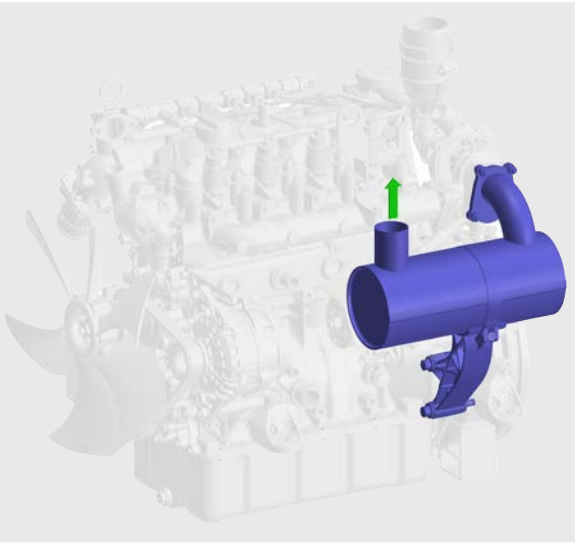
8.6.3 Recommended dimensioning of the exhaust gas system

The design of the exhaust gas system is based on the exhaust gas back pressure specified in chapter *8.6.2 Permissible exhaust gas back pressure, page 98*.

The recommended pipe diameters for the continuation of the exhaust pipe corresponds to the outside diameter of the DOC (Ø 52 mm).

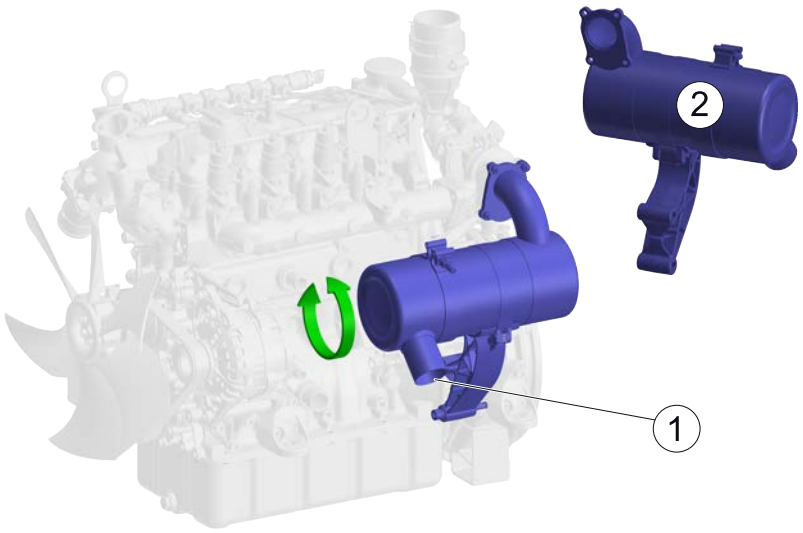
It should be noted that pipe elbows from 45° significantly affect the exhaust gas back pressure.

8.6.4 Silencer T/TI

Exhaust gas outlet, bottom (4H50 only)	Exhaust gas outlet, top
	

The silencer on engine specification TI cannot be rotated.

8.6.5 Engine-side diesel oxidation catalytic converter (DOC)

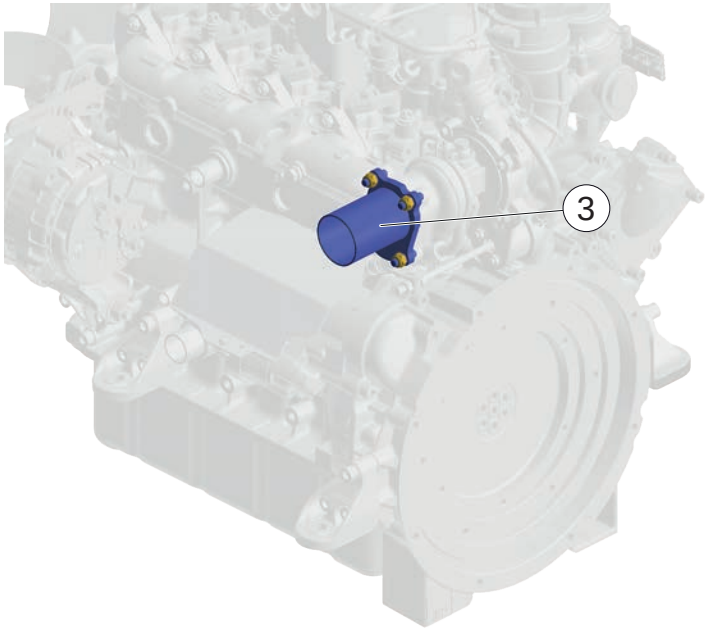


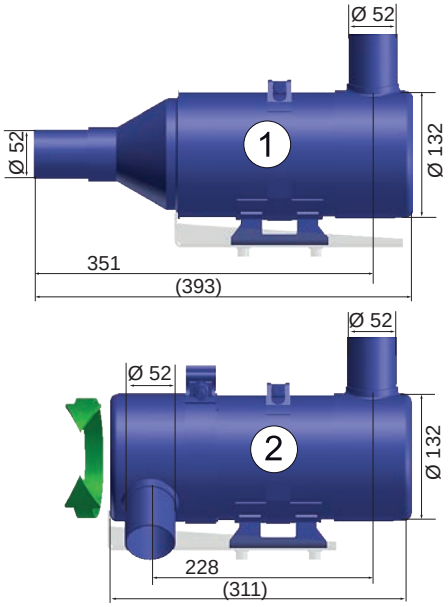
1	Outlet port can be freely rotated
2	View of DOC, rear

8.6.6 DOC separated

For a separated DOC, this retaining plate is available for chassis mounting.

There are two variants (1) and (2) for the separated oxidation catalytic converter:





Pos.	Input	Dimensions	Output	Dimensions
1	Radial	Outside Ø 52 x 1.5 mm	Axial	Outside Ø 52 x 1.5 mm
2	Radial	Outside Ø 52 x 1.5 mm	Radial	Outside Ø 52 x 1.5 mm
	Outlet port can be freely rotated			
3	Flange for turbocharger (tightening torque M8 (4x) 23 Nm)			Outside Ø 55 x 85 x 1.5 mm

Distance of turbocharger outlet flange – DOC ≤ 300 mm, with insulation ≤ 500 mm

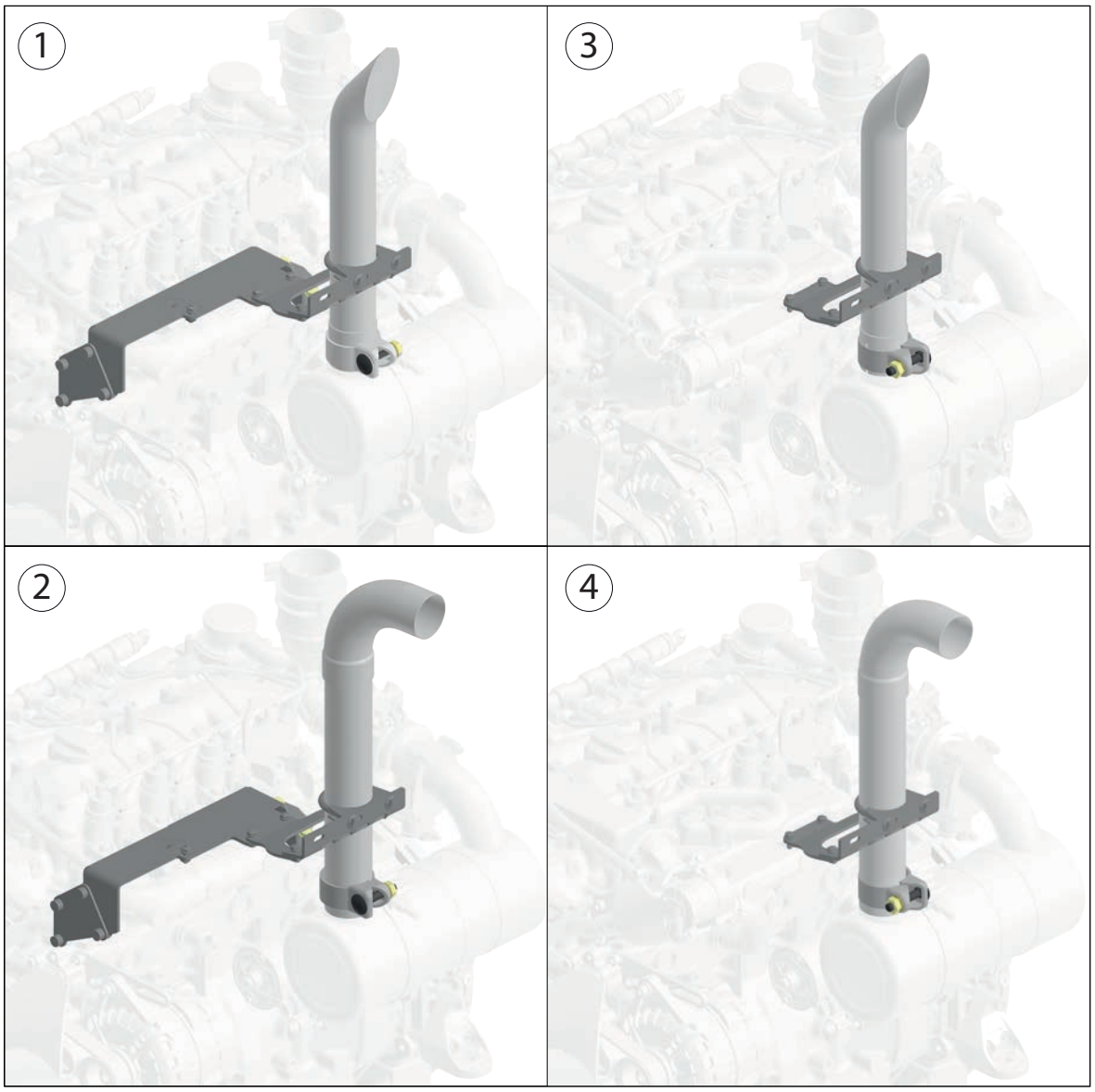
The main influencing factor is the cooling by cooling air flowing past. For this reason, thermal insulation may be necessary for greater distances and/or stronger circulation.

8.6.7 Exhaust gas pipes downstream from exhaust gas aftertreatment

	CAUTION
	Damage due to failure to comply with the assembly instructions. A compensator absolutely must be used directly after the exhaust gas aftertreament as the components will otherwise be damaged. An exception is the use of an exhaust gas support on the engine.

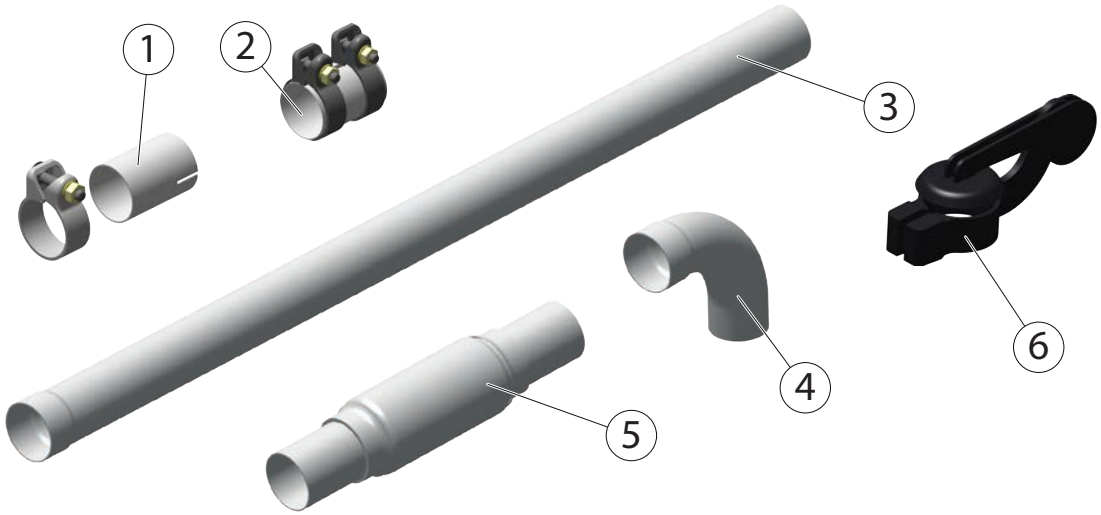
The following points must be noted when laying the pipes. See also the chapter *8.6.14 Exhaust gas pipes for exhaust gas aftertreatment, page 119*.

Exhaust piping without compensator downstream from the exhaust gas aftertreatment, approved by Hatz



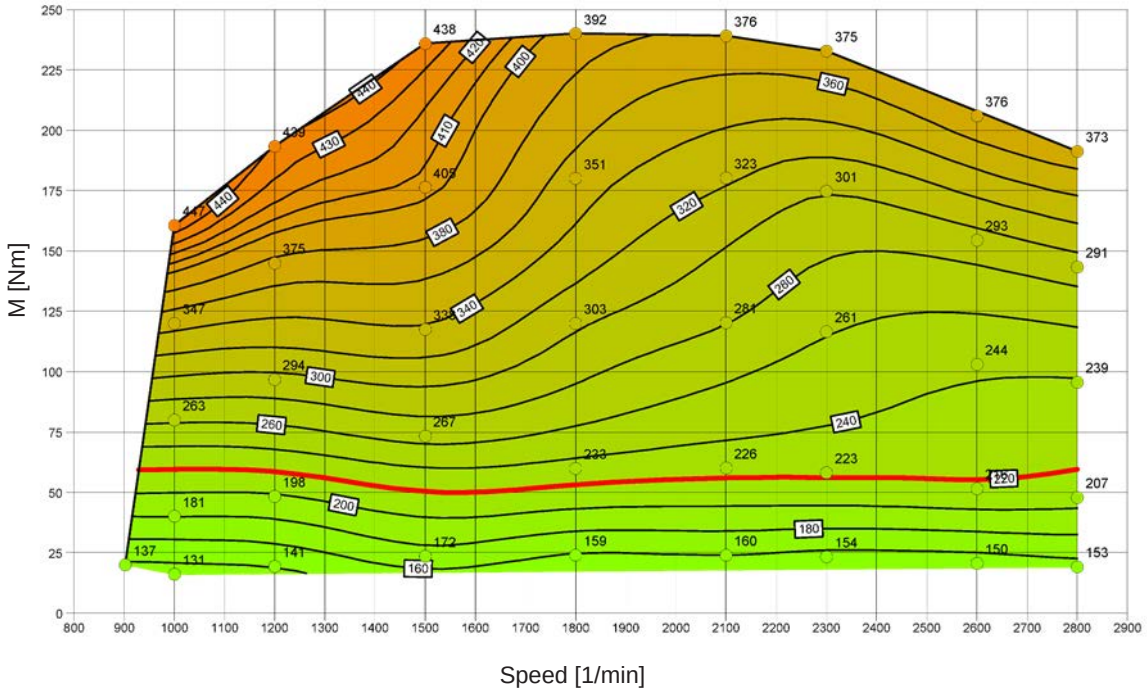
1	Exhaust pipe support on engine (TI) + Hatz exhaust pipe
2	Exhaust pipe support on engine (TI) + 300 mm pipe + pipe elbow
3	Exhaust pipe support on engine (TIC) + Hatz exhaust pipe
4	Exhaust pipe support on engine (TIC) + 300 mm pipe + pipe elbow

The following parts for the piping are available from Hatz:

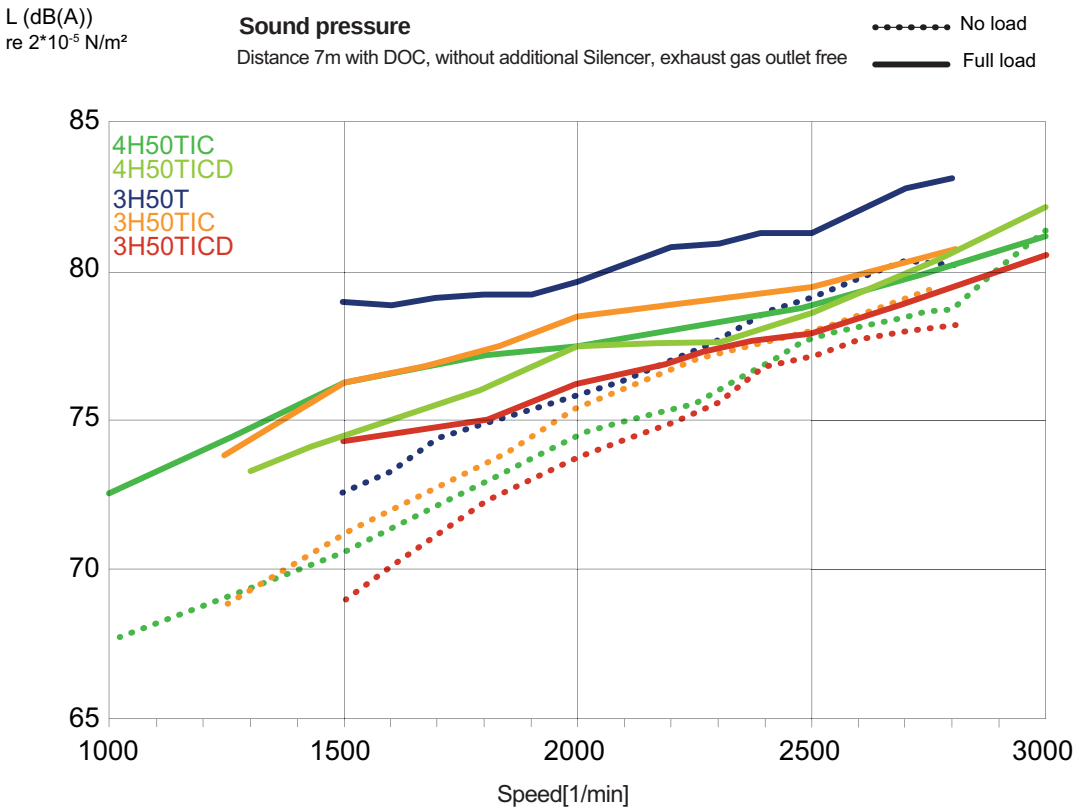


1	Pipe adapter, slit on one side with suitable pipe clamp	Inside Ø 52 x 80 x 1.5 mm
2	Pipe connector	Inside Ø variant 1: 55 x 90 mm Inside Ø variant 2: 58 x 90 mm
3	Exhaust pipe, straight	Inside Ø 52 x 980 x 1.5 mm Inside Ø 55.7 (widening)
4	Exhaust pipe, bent	Inside Ø 52 x 220 x 1.5 mm Inside Ø 55.7 (widening)
5	exhaust gas compensator	Inside Ø 55 x 340 x 1.5 mm
6	Weather cap	Inside Ø 55 mm

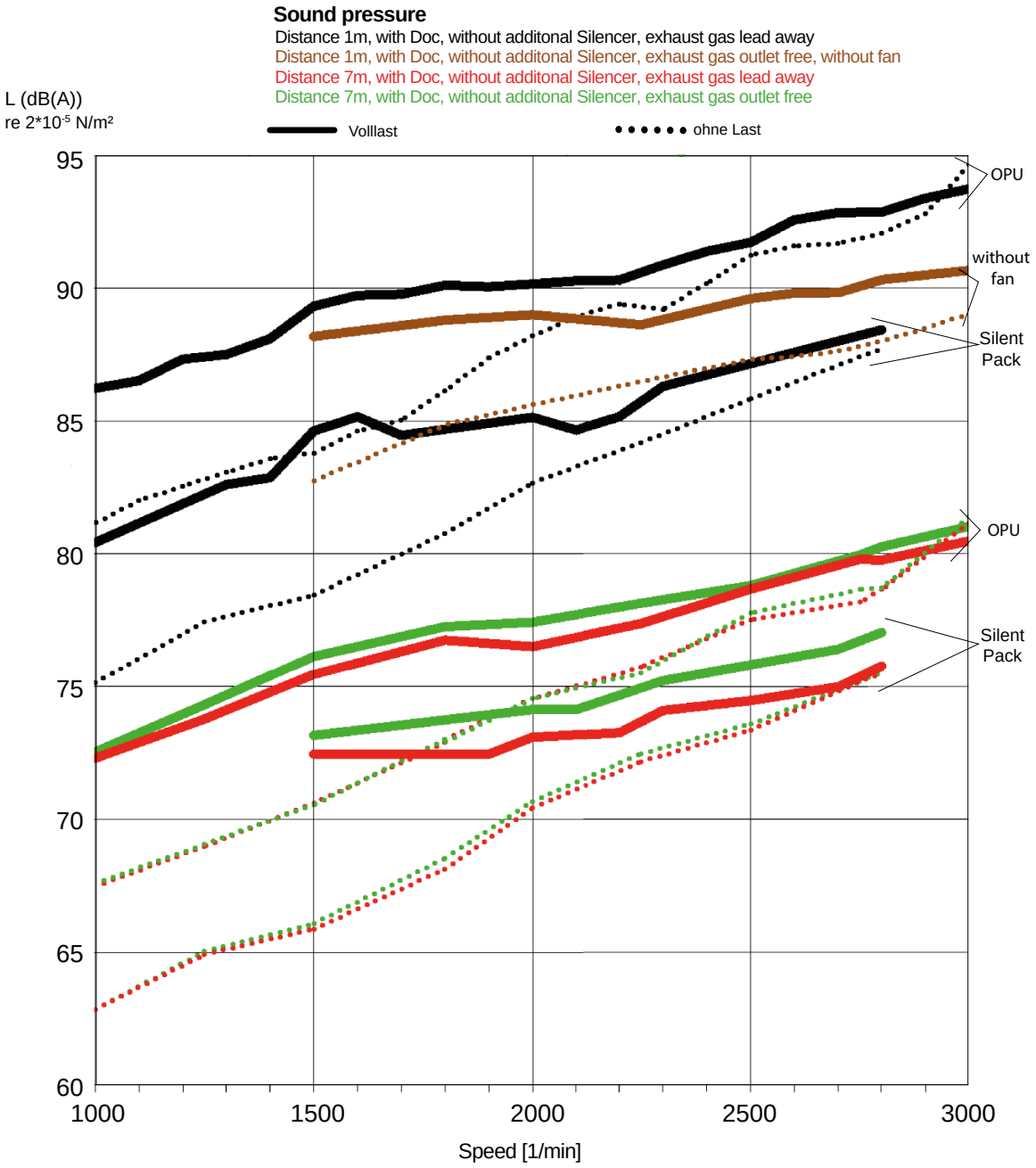
Diesel oxidation catalytic converter characteristic map



8.6.8 Sound pressure values OPU



8.6.9 Sound pressure values - 4H50TIC OPU & SilentPack



8.6.10 Diesel particulate filter (DPF) TICD

CAUTION

Danger of cutting!

Sharp edges on the diesel particulate filter.

- Wear personal protective equipment (gloves).

CAUTION

Danger of burns.

During the regeneration process, the diesel particulate filter and the exhaust system become very hot, approx. 650 C. There is a danger of burns when working on a hot exhaust system.

- Ensure that nobody is endangered by the hot exhaust gases or the hot exhaust gas system.
- Let the diesel particulate filter and exhaust system cool down.
- Wear safety gloves.

DANGER

Danger of fire from hot exhaust gas system.

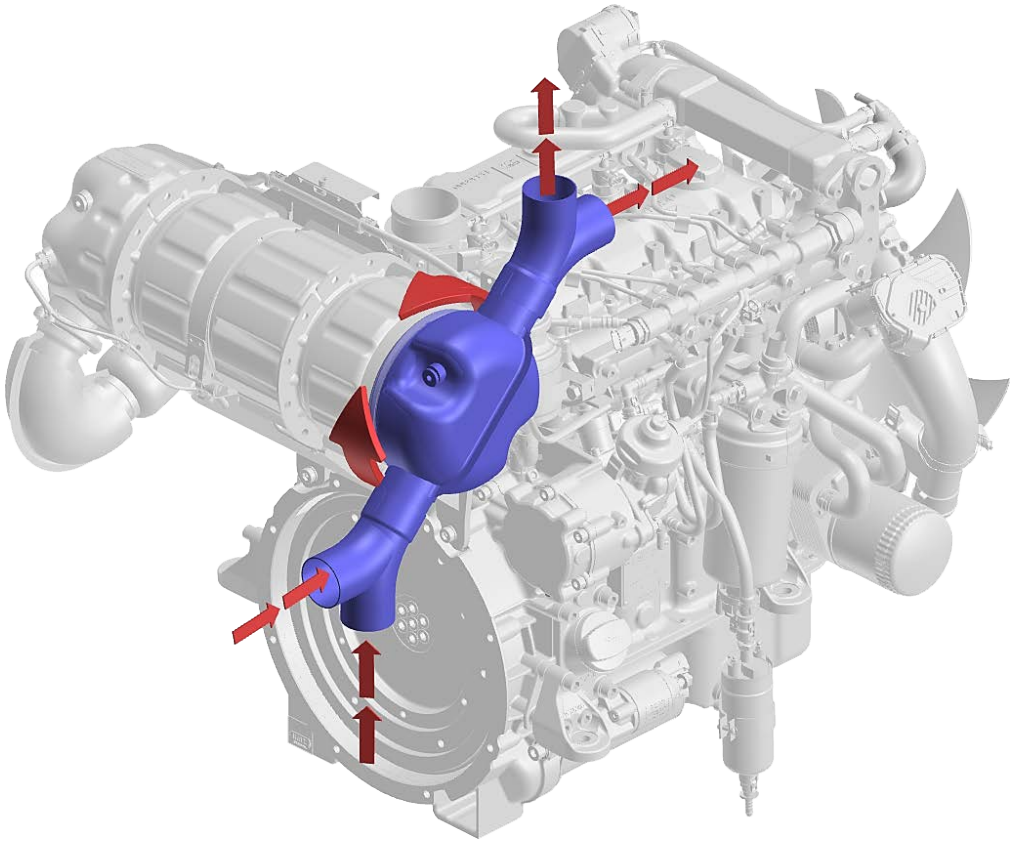
If inflammable materials come into contact with the exhaust gas flow or the hot exhaust gas system, these materials can ignite.

- Keep inflammable materials away from the exhaust gas system.
- Do not operate the engine (exhaust flow or hot exhaust gas system) in the direct vicinity of combustible materials.

8.6.11 Engine-mounted DPF

Engine-mounted diesel particulate filter with possible exhaust gas outlet positions.

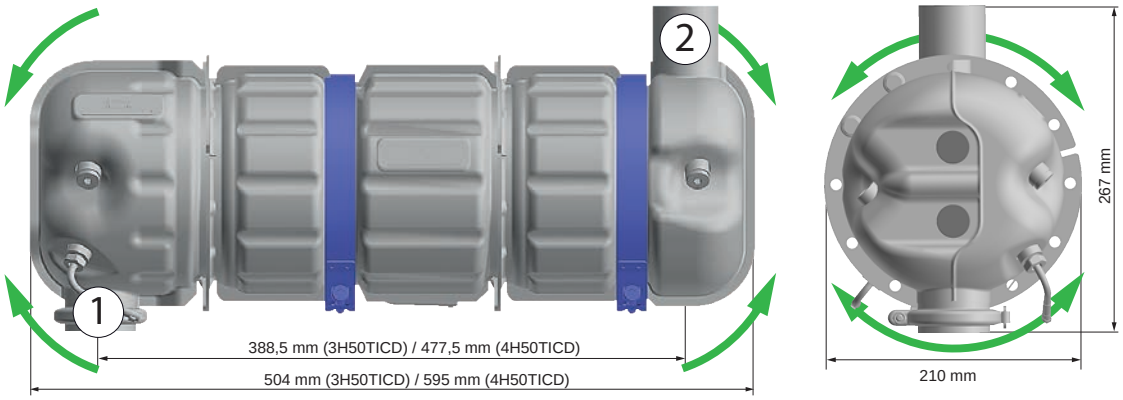
Inlet/outlet position correction: The exhaust gas outlet can be rotated by 180°.



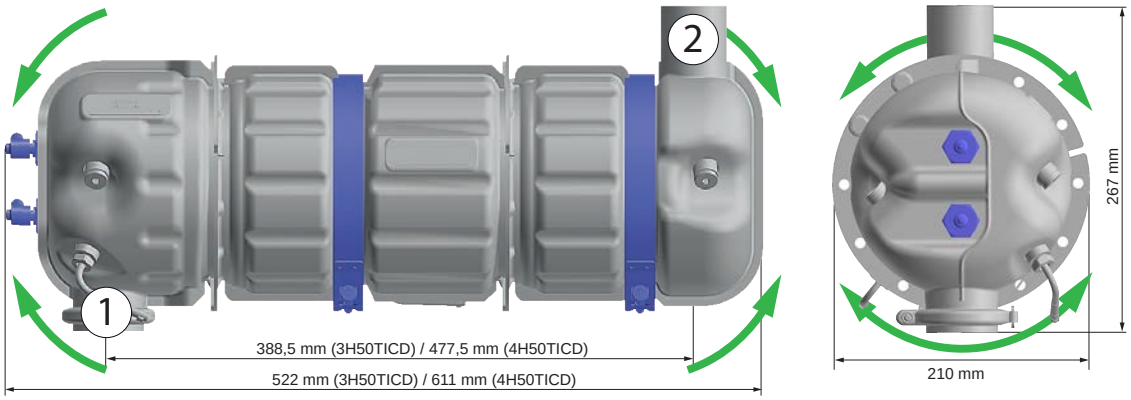
8.6.12 Separated DPF

Overview of dimensions of diesel particulate filter removed (chassis)

Active



Active Premium



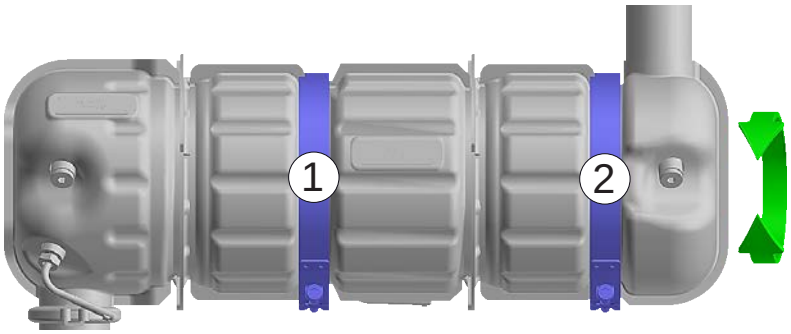
		Dimensions
1	Exhaust inlet	Inside Ø 55.60 mm
2	Exhaust outlet	Outside Ø 55 mm

Inlet/outlet position correction

The outlet of the chassis-mounted DPF can be rotated to any position.

Procedure

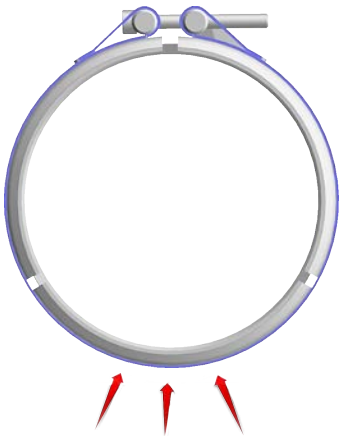
Pos.	V-band clamp	Description
1	Inlet	Because the leak tightness of the system is no longer ensured after the position of the inlet is corrected, it is prohibited to perform a position correction here.
2	Outlet for the position correction	If further standards and regulations apply to the overall machine (e.g. permissible exhaust gas volume loss in the engine compartment), the machinery manufacturer is responsible for a leak tightness test where necessary.



After the position is corrected, the following steps must be performed:

Procedure

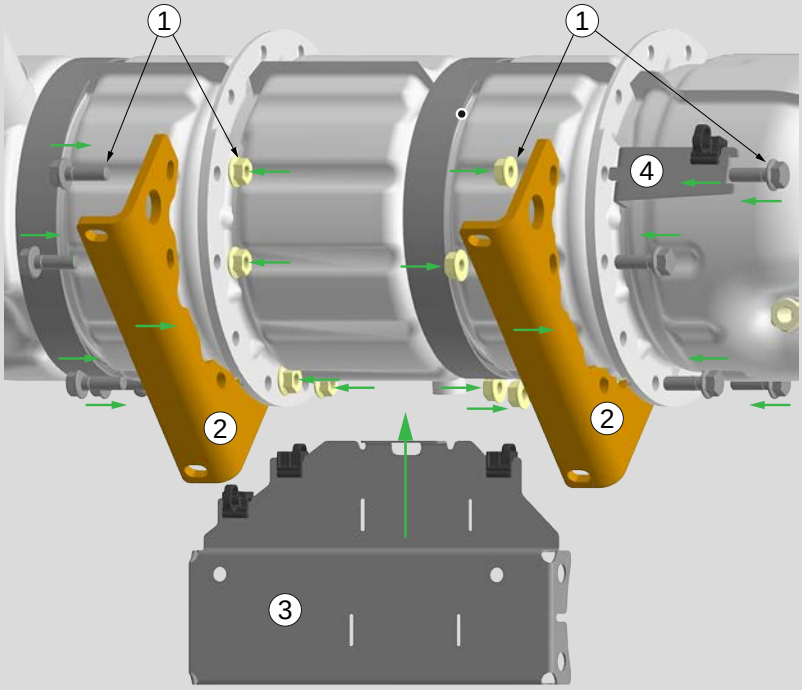
Step	Description
1	Tighten the V-band clamp with **12 Nm**. Max. screw speed **350 rpm** (when using a power screwdriver). No lubricant on screws and bolts.
2	Strike the V-band clamp at the indicated location using a blow-back-proof soft-head hammer.
3	Tighten the V-band clamp again with **12 Nm**.



8.6.13 Installing the DPF, chassis-mounted 12 V/24 V

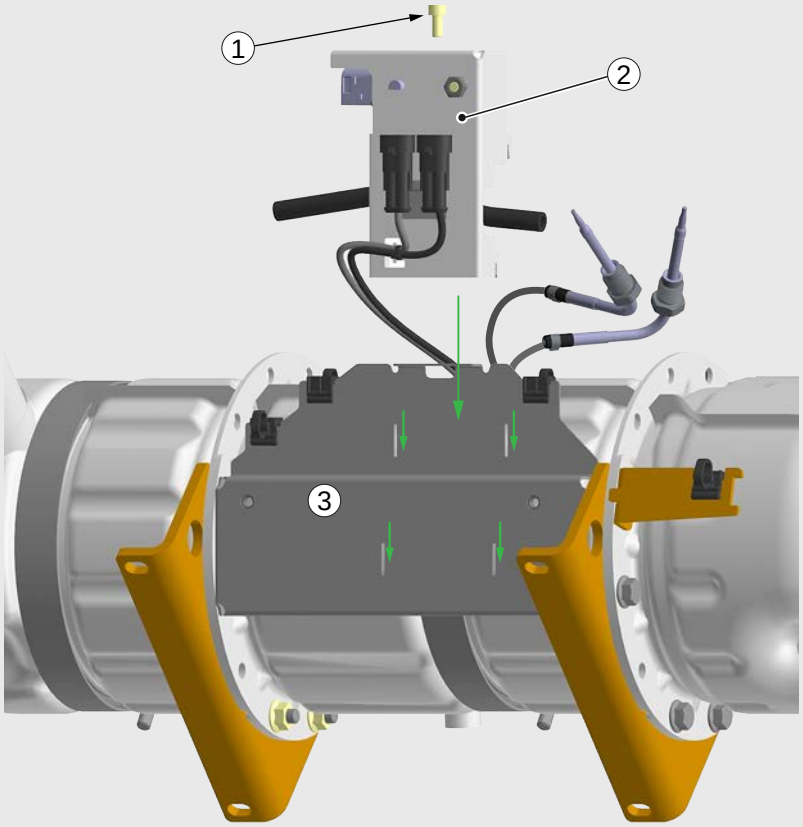
Procedure

Install the diesel particulate filter in the reverse order used to remove it!

Step	Description
1	**Install the retaining plate, angle brackets of the DPF and the cable retaining plate:** Install the DPF angle brackets (2), retaining plate (3) and *cable retaining plate (4) on the DPF using the 8 hexagon head screws M8x30 and flange nuts M8 (1). **Tightening torque 23 Nm.**  *Cable retaining plate, pos. 4, only exists in the Activ Premium model.*

2 **Install the holder with the complete sensor system:**

Install the holder with the complete sensor system (2) onto the retaining plate in the direction of the arrow and fasten it onto the retaining plate (3) using the cylinder head screw M6 (1).



3

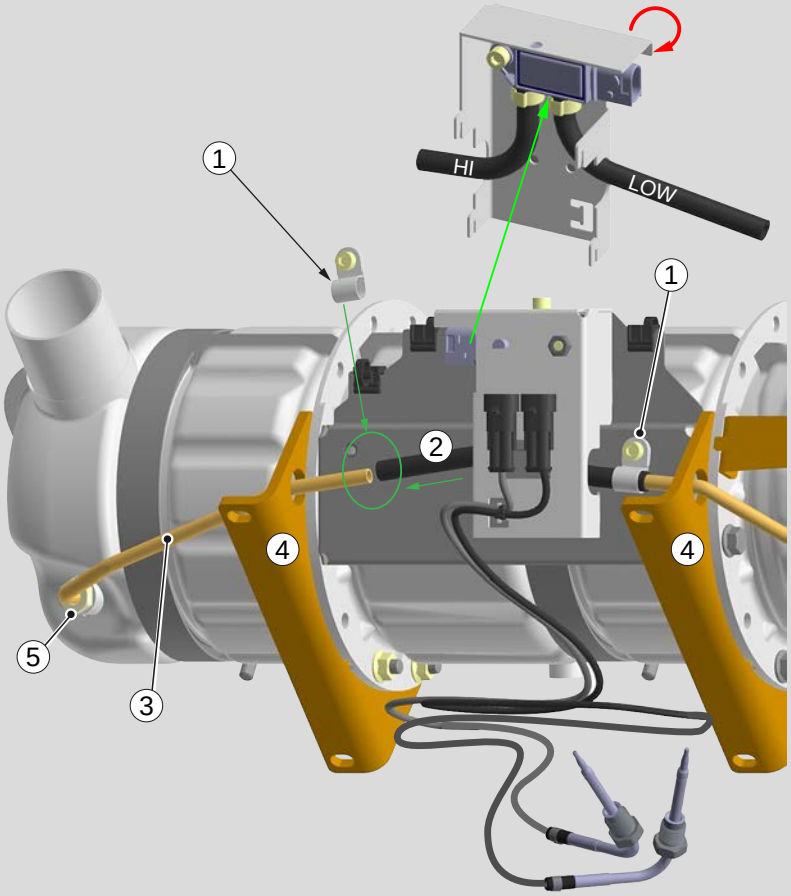
Install the pressure pipes:

Clean the threads of the pressure pipes (3) using a brass brush and coat with high temperature paste (Castrol Optimol TA or Castrol Molub Alloy Paste).

Pass the pressure pipes through the opening of the DPF angle brackets (4), insert them in the thread openings on the DPF and hand-tighten the connecting nuts (5).

Then connect the pressure pipes (3) with the hoses (2) and secure with pipe clamps (1).

Close the two remaining threads on the opposite side of the DPF with sealing ring A14 x 18 and screw plug M14 x 1.5. **Tightening torque: 45 Nm.**



Ensure that the **high pressure (HI)** side is connected to the pressure pipe at the DPF inlet and the **low pressure (LOW)** side is connected to the pressure pipe on the DPF outlet.

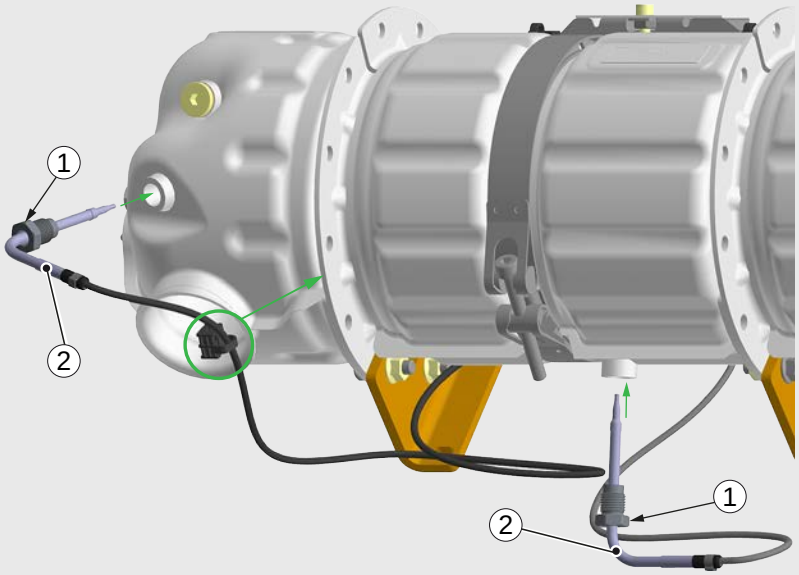
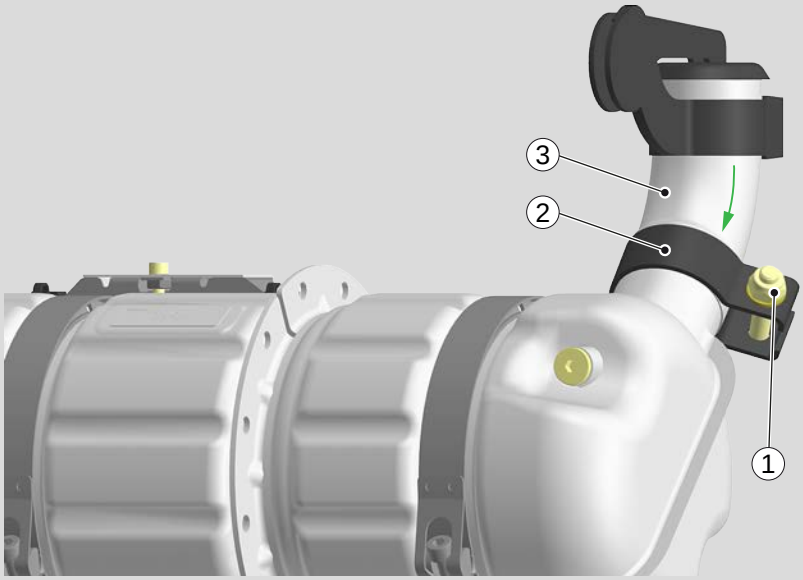
The **pressure lines must be installed in such a way that they rise continuously toward the pressure** sensor (the pressure sensor is the highest point). Then tighten the connecting nuts with a **tightening torque of 45 Nm.**

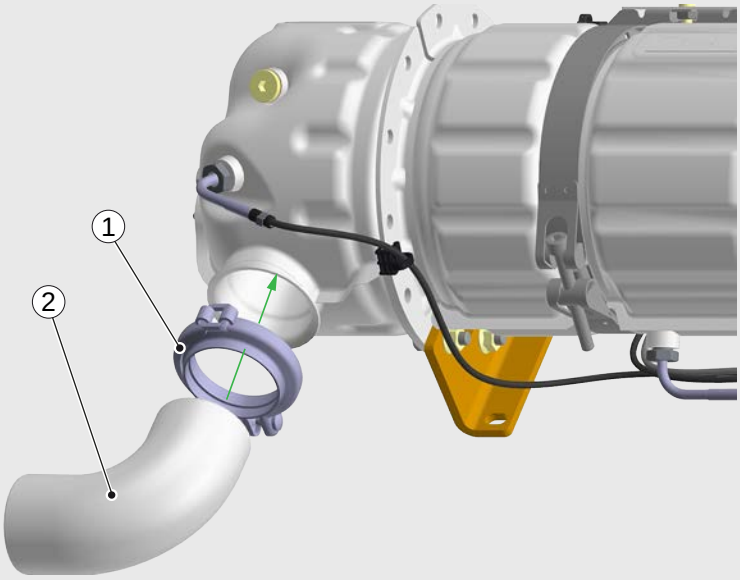
Note: Connect the pressure sensor and the two pressure pipes with the 1000-mm hose and the 4 hose clips. The hose must be divided at the desired length.

Total length (pressure pipe + hose):

- Minimum 300 mm (200 mm pipe + 100 mm hose)
- Maximum 900 mm

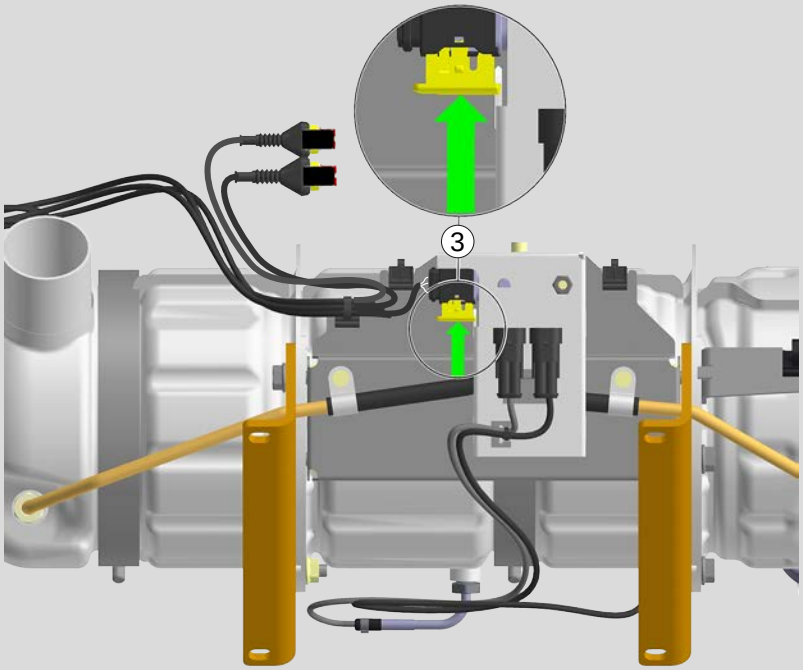
Flushing of the engine compartment must be designed so that the maximum permissible temperature (275 °C) of the hose is not exceeded, even under extreme ambient conditions.

4	**Install the temperature sensors:** Before installing the temperature sensors (2), clean the threads with a brass brush and coat with a high temperature paste. Then insert in the threaded holes in the right order and tighten the connecting nuts with a **tightening torque of 45 Nm. F**asten the cable on the DPF using the cable holder. 
5	**Install the exhaust pipe on the exhaust outlet of the DPF:** Mount the exhaust pipe (3) on the DPF exhaust outlet and secure with the fastening clamp (2) by tightening the hexagon nut (1). 

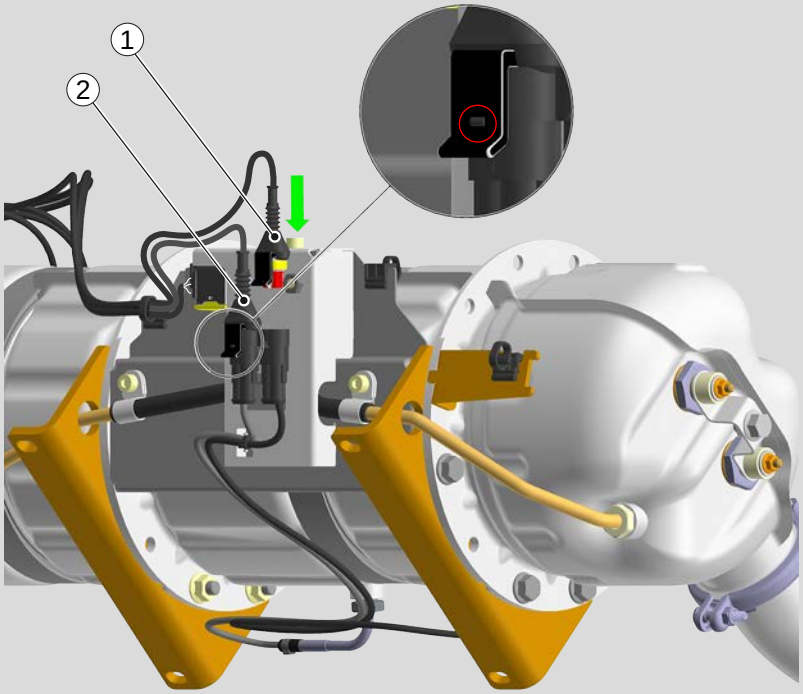
6	**Install the exhaust pipe on the exhaust inlet of the DPF:** Install the exhaust pipe (2) on the DPF exhaust inlet and fasten with the *V-clamp (1). **Tightening torque of V-clamp: 9 Nm.**  **Replace the V-clamp with new HATZ original V-clamps when reinstalling.*

7 **Install the temperature sensor connectors and the differential pressure sensor connector:**

Install the differential pressure sensor connector (3) on the sensor and push the yellow lock in the direction of the arrow by hand until it engages.



Push on the temperature sensor connectors DPF T1 (1) and DPF T2 (2) until they engage.

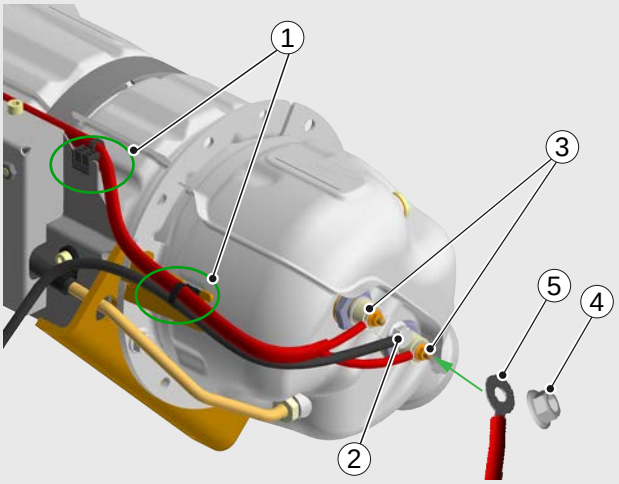


8 **Install the electrical connections - only for Activ Premium model:**

Note the differences between the 12-V and 24-V models!

Install the cable lugs (5) of the positive lines (3) on the glow plugs and secure using the flange nut M5 (4). **Tightening torque of flange nut: 4 Nm**. Screw the ground line (2) (Ø10 mm²) onto the ground connection plate.

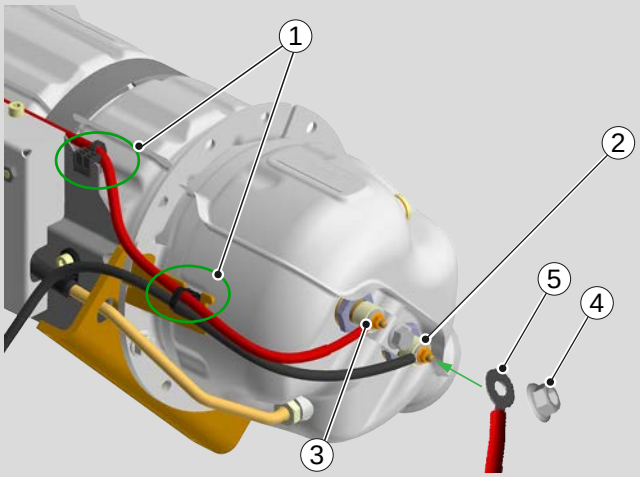
12-V model



In the 12-V model, two glow plugs are connected in parallel.

Screw the cable lug (5) of the positive line (3) and the ground line (2) onto the glow plugs and secure with the flange nut M5 (4). T**ightening torque of flange nut: 4 Nm**.

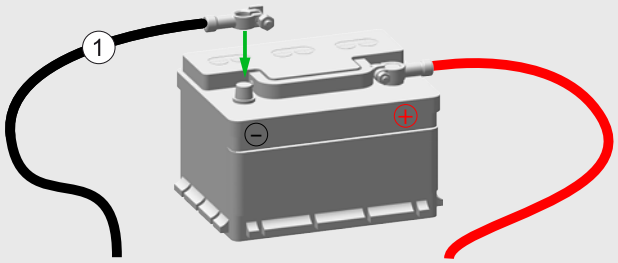
24-V model



In the 24-V model, the two glow plugs are connected in series.

Connect the electric lines (12/24 V) of the auxiliary heating to the cable retaining plate (1) using cable ties. The lines must be mechanically fastened after no more than 250 mm to protect them against pulling, pushing and vibration forces (strain relief).

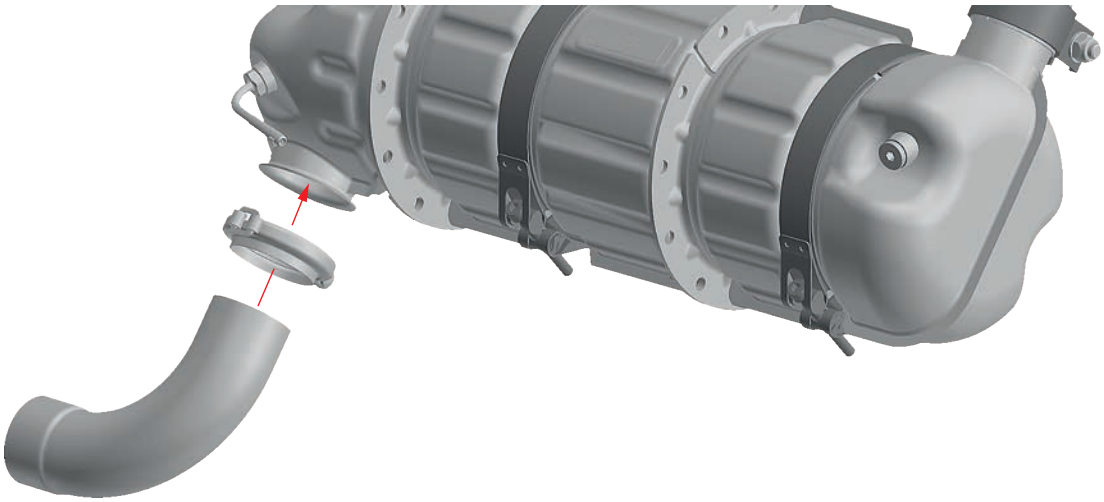
*** In the Activ model, the electrical connections shown are not installed. In this case, continue with step 9.**

9	Finally, reconnect the negative line (1) to the battery. 

8.6.14 Exhaust gas pipes for exhaust gas aftertreatment

Exhaust gas pipes downstream from exhaust gas turbocharger and upstream of DPF exhaust inlet

- The exhaust gas pipes between the exhaust gas turbocharger and the DPF exhaust gas inlet must not exceed 1.5 m and contain no more than 3 pipe elbows. The pipe cross-section must not become narrower.
- Downstream from the exhaust gas turbocharger, only an elbow with a maximum angle of 90° may be used, and it must be followed by a long compensator (at least 200 mm elastic length). The compensator must be attached close to the pivot point of the elastic bearing. A fixed point is required after the compensator.
- The exhaust gas pipe at the DPF exhaust inlet must have a Ø of 55 mm and must be attached using the supplied V-band clamp with a tightening torque of **9 Nm** (see figure).



- The pipes must be fully insulated, for which an insulating tape is available from Hatz. This insulating tape must be wrapped so it overlaps in two layers. If an insulating tape from a different source is used, it must have the following properties:
  - Stable at continuous temperature up to 450 °C, short-term 550 °C
  - U-value 20 W/m²k at 300 °C

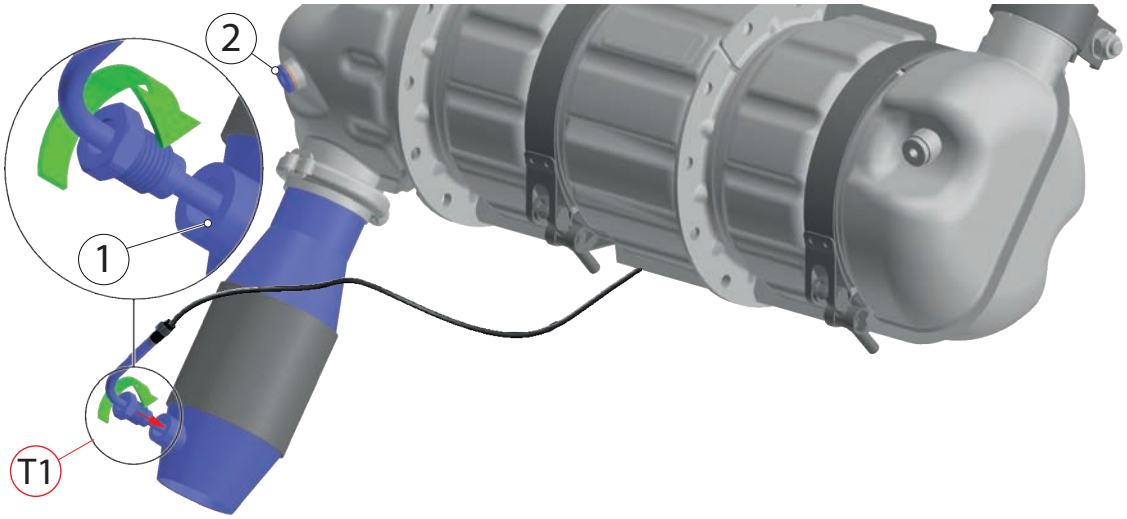
	CAUTION
	The exhaust pipe between the engine and the diesel oxidation catalyst must be gas tight. Max. 5 l/min are permitted to escape between the exhaust turbocharger and the diesel oxidation catalyst.

	NOTICE
	The exhaust gas piping for TIC and TICD must be made of stainless steel upstream of the exhaust gas inlet and upstream of the exhaust gas aftertreatment.

Pre-catalytic converter

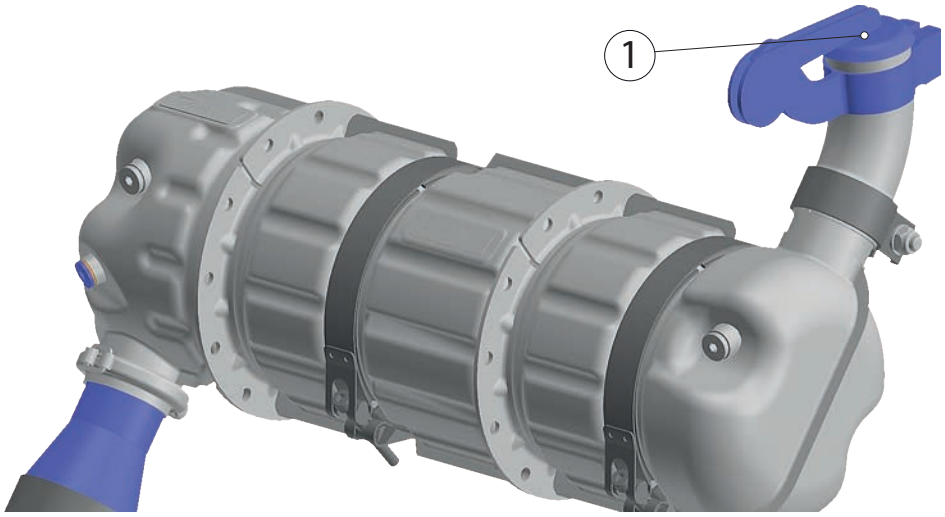
To prevent the DOC from clogging, a pre-catalytic converter is recommended for low load/weak load applications. For chassis-mounted DPFs, the pre-catalytic converter is available as an option from Hatz and must be mounted as close as possible to the exhaust inlet of the DOC/DPF in the exhaust pipe.

When using the pre-catalytic converter, temperature sensor T1 must be screwed into the thread (1) of the pre-catalytic converter. Coat the thread of the temperature sensor with Castrol Optimol TA. Lock the remaining thread (2) with the sealing ring A14 x 18 and screw plug M14 x 1.5 with a tightening torque of **45 Nm**.



Exhaust pipe downstream from the exhaust gas outlet

Without a compensator, the following may be installed downstream from the DPF: an elbow with a maximum angle of 45°, a 100 mm exhaust pipe and a weather cap (1). This also prevents water from entering the exhaust pipe.



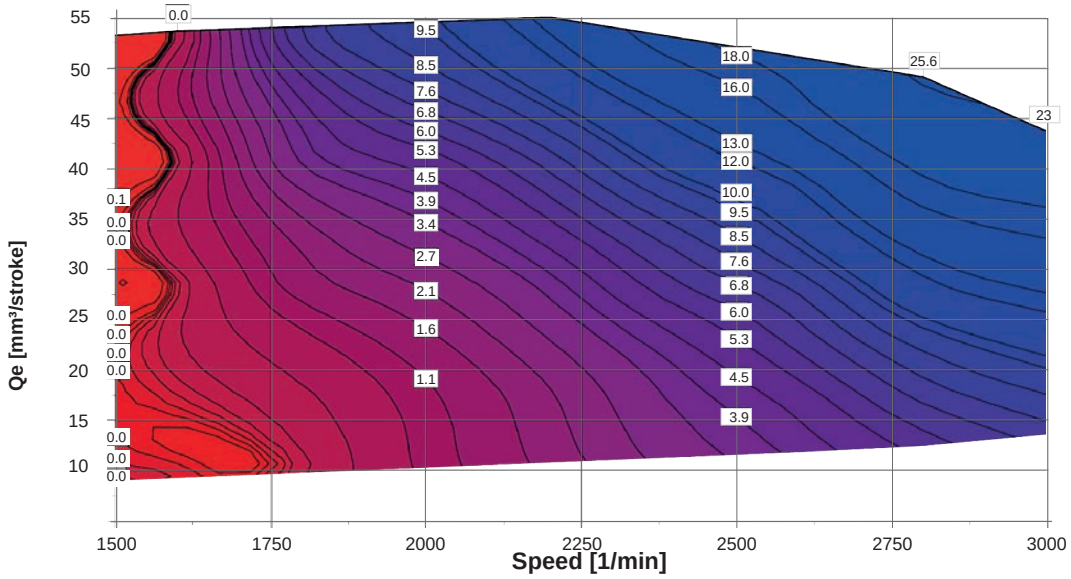
If a longer exhaust gas pipe is required or must be routed, the following points must be noted:

- Do not under any circumstances constrict the line cross-section after the exhaust gas aftertreatment exit.
- When installing an exhaust pipe, an elastic intermediate part (compensator) must be installed along the exhaust pipe to absorb the engine movement. The compensator must be attached close to the pivot point of the elastic bearing. A fixed point is required after the compensator.
- A compensator is also required for a rigidly mounted engine.

- In long exhaust pipes and in engines at low load, the exhaust gas condenses. Such exhaust pipes must have a condensate drain. The condensate drain must be located at the lowest point in the exhaust system. This enables the condensate to flow out by the force of gravity.
- Keep the exhaust gas backpressure within the permissible tolerance window in relation to the possible pipe lengths and number of pipe elbows (angles). See the following exhaust gas pressure characteristic field.

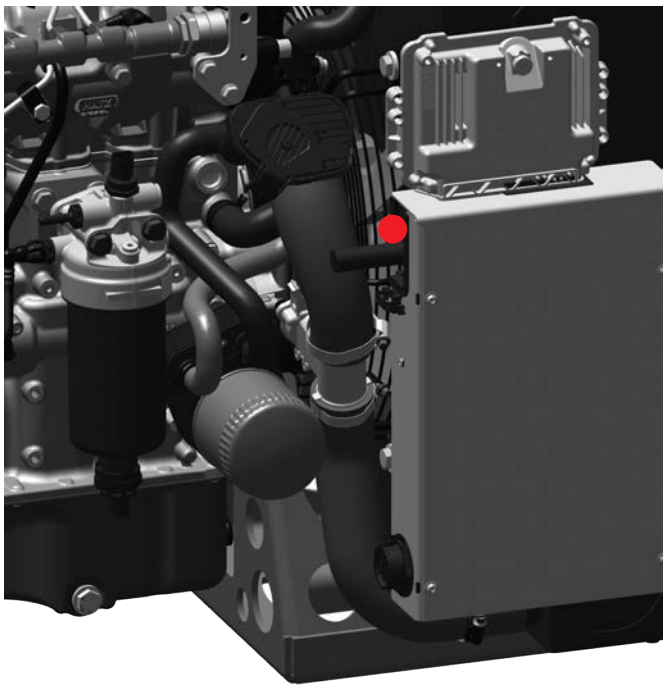
Maximum permissible exhaust gas pressure downstream from DPF system

Exhaust gas pressure characteristic field H50 TICD [mbar]

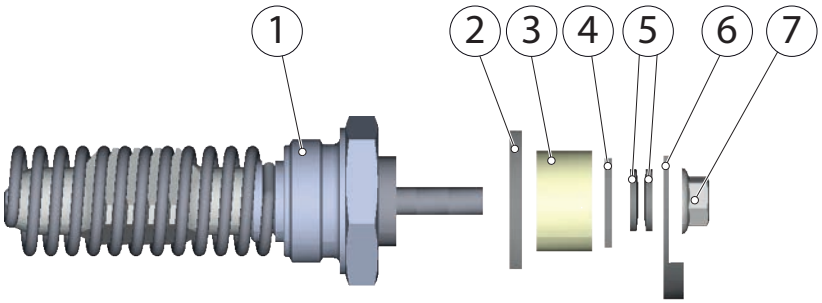


DPF wiring harness transfer point

The transfer point for the chassis-mounted DPF cable is at the plug retaining plate (see the following figure). From this point onward, a cable has a length of approx. 1.2 m. In addition, a 2.0 m extension wiring harness is available from Hatz.



Glow plug for exhaust gas heater DPF Active Premium 12 V/24 V

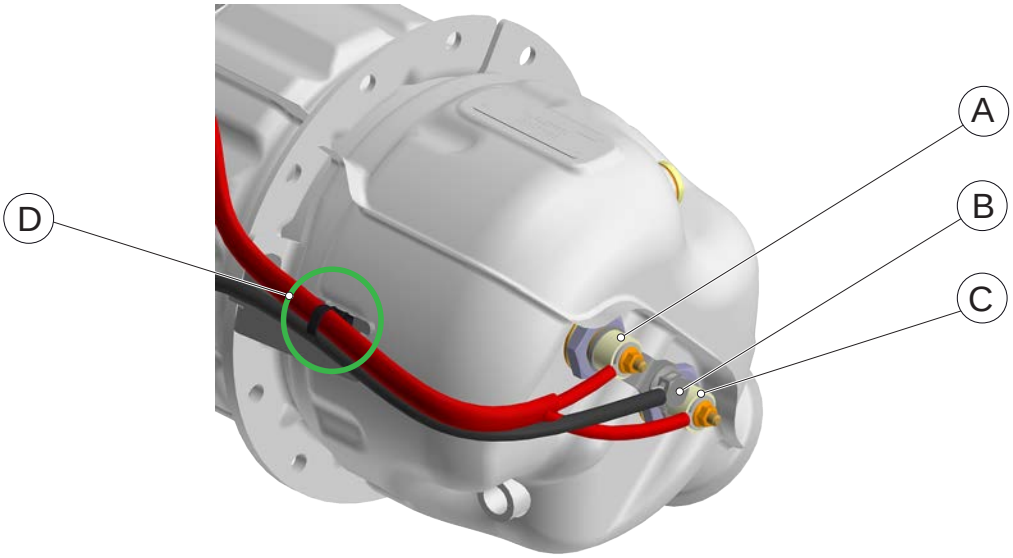


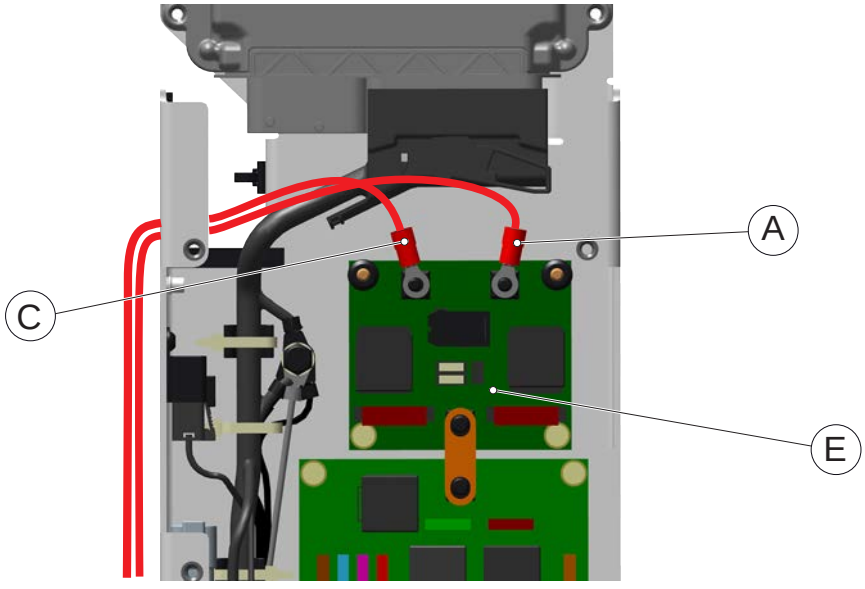
Pos.	Designation
1	Glow plugs GK1 and GK2 (2 pieces)
12 V	Glow plugs are switched in parallel. 2 x plus lines – EXH+/GK1 and EXH+/GK2, red (Ø 6 mm²) and 1x ground line EXH/GND, black (Ø 10 mm²)
24 V	Glow plugs are switched in series. 1 x plus line, red (Ø 6 mm²) and 1x ground line EXH/GND, black (Ø 6 mm²)
2	Ground connection plate (covered with insulating tube for 24 V version)
3	Ceramic sleeve
4	Washer M5
5	2 x curved washer M5 per glow plug
6	Cable lug Attention: please only use heat resistant original Hatz parts.
7	Flange nut (tightening torque 4 Nm)

Cabling for exhaust gas heating DPF Active Premium 12 V

Procedure

Step	Description
1	Screw the plus lines (Ø6 mm²) for the exhaust gas heaters onto the glow plugs GK1 (A) and GK2 (C). Connect the ground line (Ø10 mm²) (B). Tightening torque **M5 4 Nm.** Attention: When cabling the system, only use heat resistant original Hatz parts.
2	The lines of the exhaust gas heating must be mechanically fastened to the cable holder (D) with a cable tie after no more than 250 mm to protect these against pulling, pushing and vibration forces (strain relief).
3	Connect the lines of the exhaust gas heating GK1 (A) and GK2 (C) to the board of the power module (E) of the particulate filter.

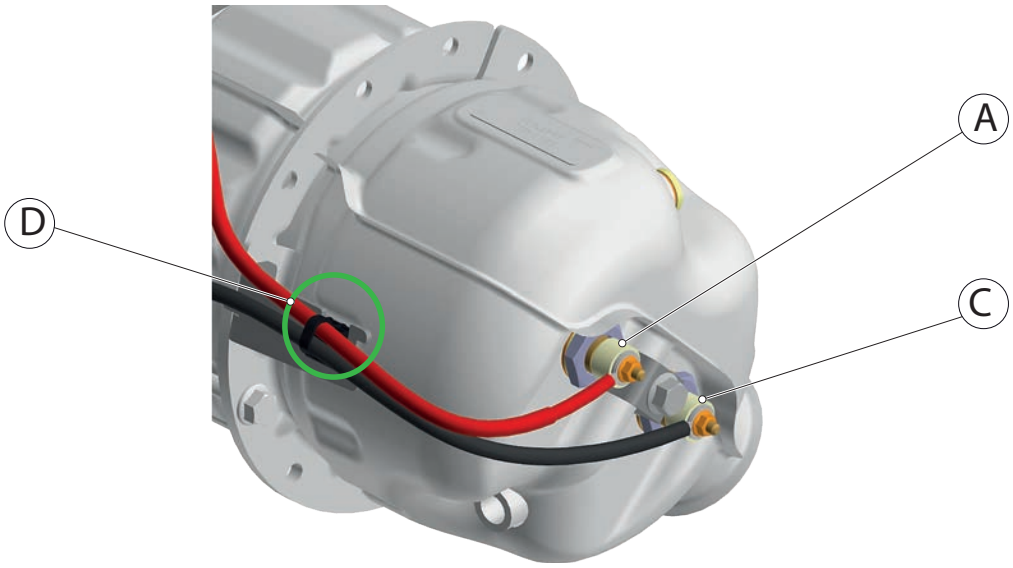


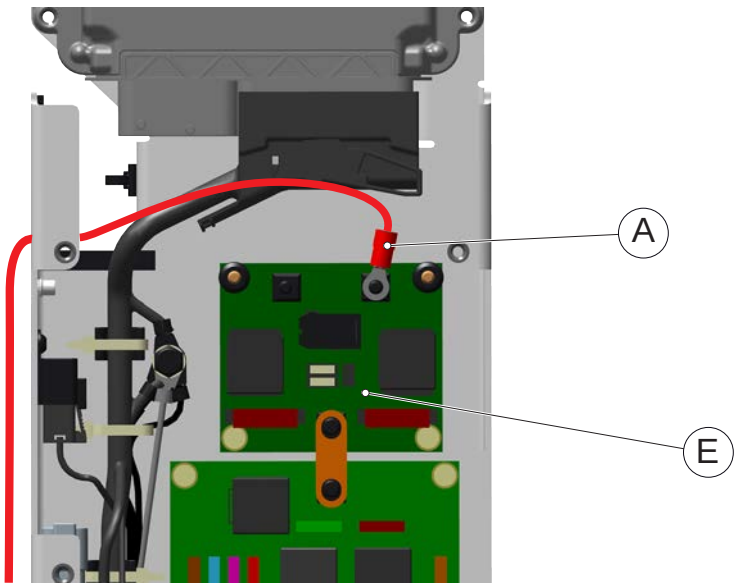


Cabling for exhaust gas heating DPF Active Premium 24 V

Procedure

Step	Description
1	In the **24-V version,** only one plus line is used since the two glow plugs are switched in series. The plus line (Ø6 mm²) of the exhaust gas heater is mounted on the glow plugs GK1 (A) and the ground line (Ø6 mm²) is mounted on GK2 (C). Tightening torque **M5 4 Nm.** Attention: When cabling the system, only use heat resistant original Hatz parts.
2	The lines of the exhaust gas heating must be mechanically fastened to the cable holder (D) with a cable tie after no more than 250 mm to protect these against pulling, pushing and vibration forces (strain relief).
3	Connect the line of the exhaust gas heater GK1 (A) to the board of the power module (E) of the particulate filter.



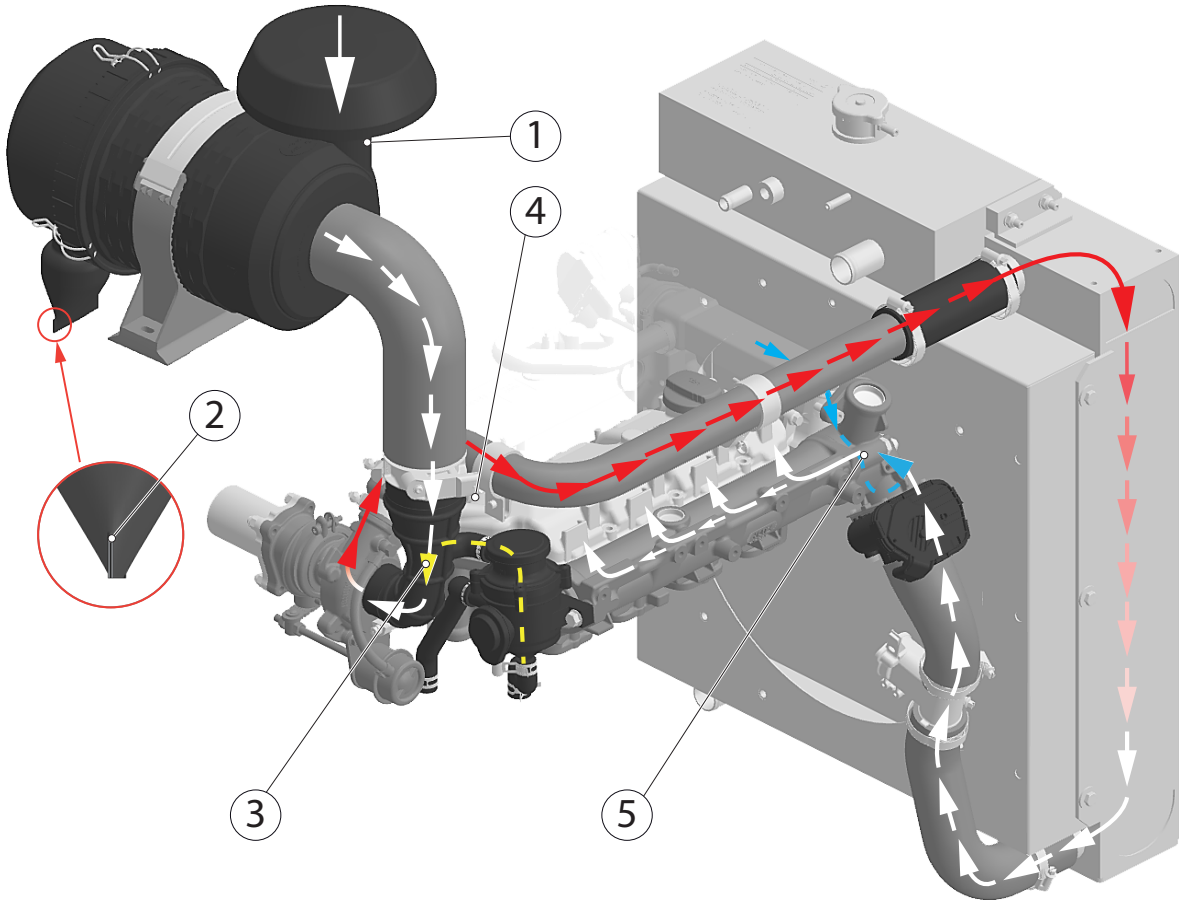


8.6.15 Engine load required for active regeneration

	3H50TICD - Dynamic				4H50TICD - Dynamic			
	optiHEAT Active		optiHEAT ActivePremium		optiHEAT Active		optiHEAT ActivePremium	
	<1700min-1	>1700min-1	<1700min-1	>1700min-1	<1700min-1	>1700min-1	<1700min-1	>1700min-1
≥0°C	≥35Nm	≥60Nm	≥35Nm	≥60Nm	≥50Nm	≥80Nm	≥50Nm	≥80Nm
-10°C	≥40Nm	≥70Nm	≥35Nm	≥60Nm	≥55Nm	≥90Nm	≥50Nm	≥80Nm
-20°C	≥45Nm	≥80Nm	≥35Nm	≥60Nm	≥60Nm	≥100Nm	≥50Nm	≥80Nm
-30°C	≥50Nm	≥90Nm	≥40Nm	≥70Nm	≥65Nm	≥100Nm	≥55Nm	≥90Nm
-40°C	≥55Nm	≥100Nm	≥45Nm	≥80Nm	≥70Nm	≥110Nm	≥60Nm	≥100Nm

	3H50TICD - Standby		4H50TICD - Standby	
≥0°C	≥20Nm / >2300min^{-1}	≥0Nm / >1400min^{-1}	≥0Nm / >2300min^{-1}	≥0Nm / >1400min^{-1}
-10°C	≥30Nm / >2300min^{-1}	≥0Nm / >1400min^{-1}	≥10Nm / >2300min^{-1}	≥0Nm / >1400min^{-1}
-20°C	Not possible	≥10Nm / >1400min^{-1}	≥20Nm / >2300min^{-1}	≥10Nm / >1400min^{-1}
-30°C	Not possible	≥20Nm / >1400min^{-1}	≥30Nm / >2300min^{-1}	≥20Nm / >1400min^{-1}
-40°C	Not possible	≥30Nm / >1400min^{-1}	Not possible	≥30Nm / >1400min^{-1}

8.7 Intake and combustion air system

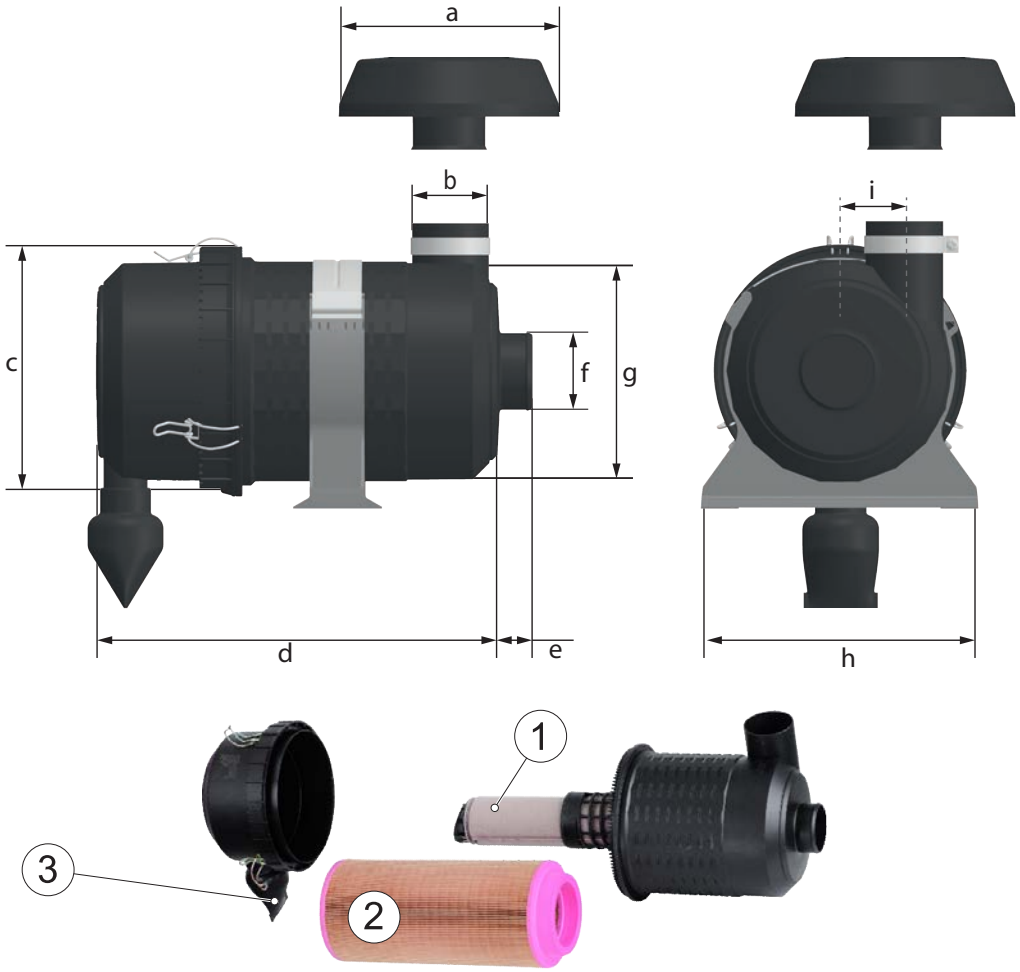


Pos.	Designation
1	Pre-separation through tangential inlet
2	**Dust discharge valve** ▪ Approx. 82% of the dust is pre-separated through the tangential air inlet, the dust is ejected through the large dust discharge valve by pulsation. ▪ The valve must be regularly cleaned of adhesions due to dirt, etc., by pressing the rubber lips together. ▪ The spacing between the sealing lips should be max. 2 mm. ▪ The valve must not be in contact with other elements.
3	Crankcase ventilation insertion
4	Measurement point for negative intake pressure
5	Exhaust gas recirculation insertion

8.7.1 Air filter selection, dimensioning and intake section

The most important dimensions of the HATZ air filter system including fasteners and rain cap.

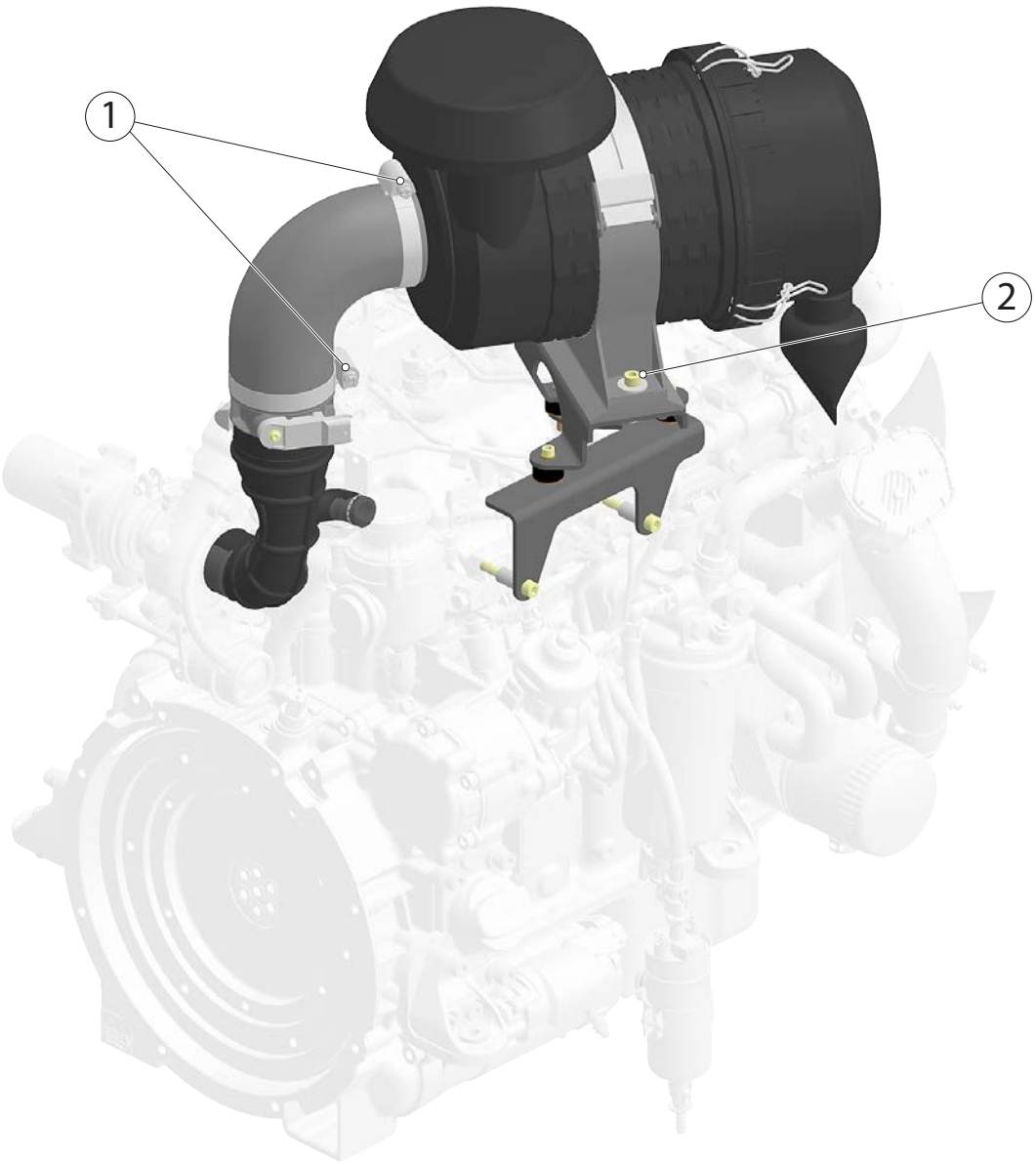
8.7.2 Air filter - Europiclon



	Europiclon 200* [mm]	Europiclon 300 [mm]
Engine type	All 3H50 and 4H50N	All H50 variants
a	150	200
b	62	70
c	200	228
d	327	367
e	27	30
f	62	70
g	173	203
h	190 ± 7.75	220 ± 7.75
i	48	59
Accessories Europiclon 300		
1	Secondary filter	
2	Primary filter	
3	Dust discharge valve (Europiclon 200 and 300)	

*The air filter Europiclon 200 can be used for applications with low dust accumulation. However, it is not part of the Hatz sales program and must be procured by the customer.

8.7.3 Air filter installation above the engine for Europiclon 300

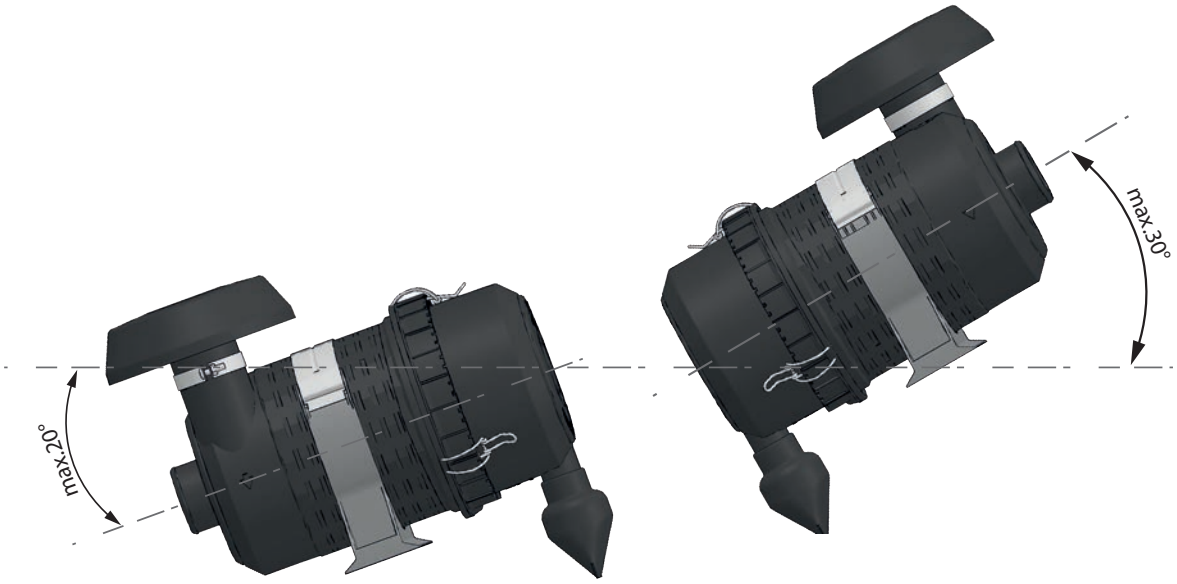


1	Tightening torque 5 Nm
2	Tightening torque 23 Nm

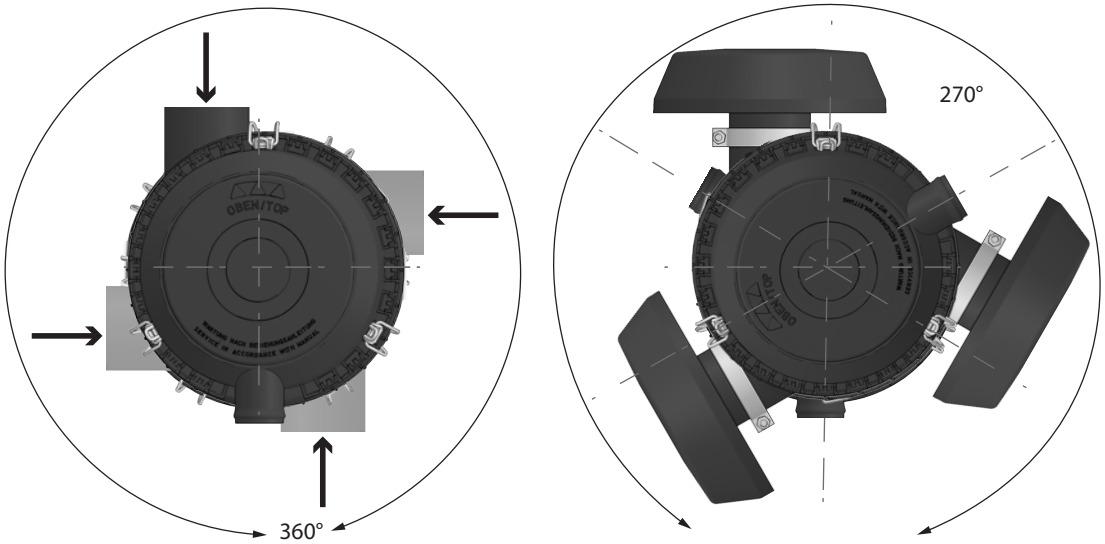
	NOTICE
	Air filters from the Hatz product range are matched to Hatz diesel engines. If the customer uses its own air filter, it must be ensured that it has **two stages and is designed according to industry standards.**.

8.7.4 Air filter - tilt positions

Permissible tilt positions of the air filter



Permissible tilt positions for air intake with and without a rain cap



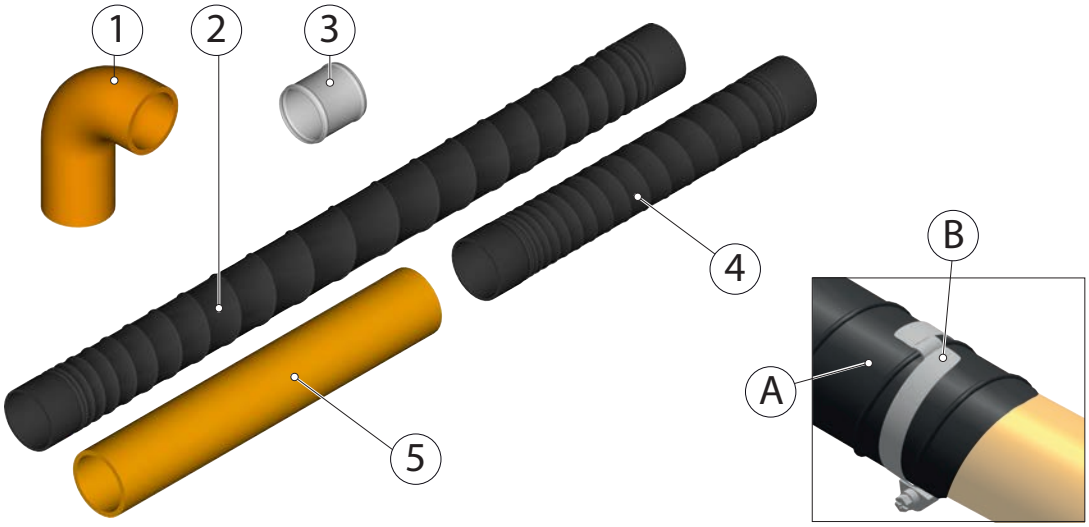
Permissible tilt positions of dust discharge valve

8.7.5 Intake section

	CAUTION
	Note the following regarding hoses with spiral wire inserts: ▪ In very dusty and dirty environments, the hose needs to be checked regularly for leaks. ▪ The hose is very thin between the spirals (1.5 – 2 mm). Do not touch with sharp or pointed objects. ▪ Because the hose has low strength, no pressure is permitted to be applied to the hose. ▪ Minimum bending radius = 105 mm ▪ The hose has good resistance to oil, but is not approved for permanent contact with oil.

Leaks on the clean air side must be avoided. The intake line must be resistant to the pulsation in the intake air and to the engine vibrations. For example, a hose with a spiral wire insert would therefore be suitable as the line material.

The following hoses can be used upstream of the air filter as well as between the air filter and turbocharger.



1	Hose elbow 90°	Ø 70 mm
2	Flexible hose piece, cannot be shortened	Ø 70 x 1000 mm
3	Connecting sleeve	Ø 70 mm
4	Flexible hose piece, cannot be shortened	Ø 70 x 500 mm
5	Rigid hose piece, can be shortened	Ø 70 x 500 mm

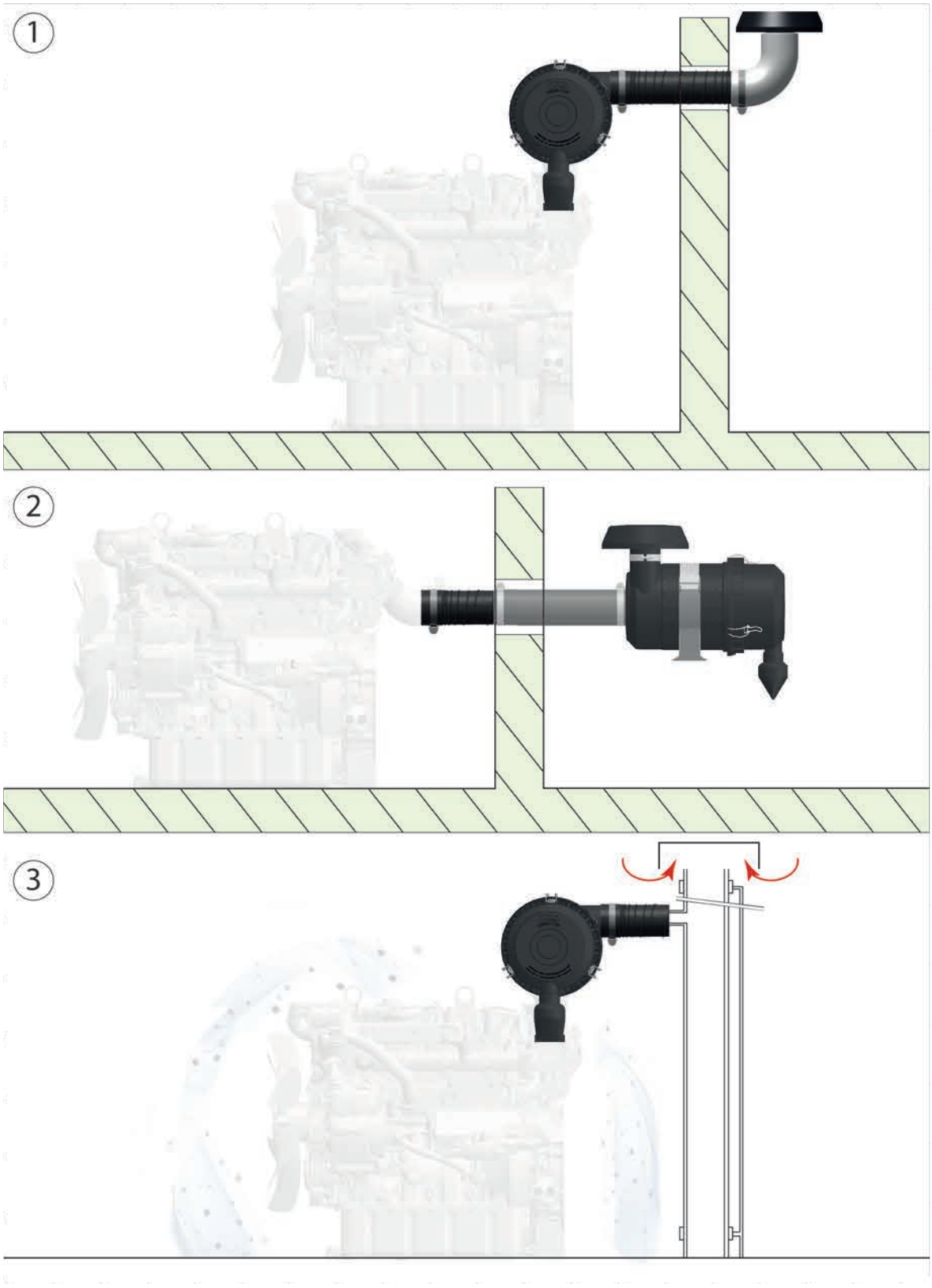
For radii greater than 45°, make sure the radius is as large as possible to prevent the boot from chafing the pipe. If a large radius cannot be realized, it is also possible to use an intermediate piece (90° pipe elbow).

If necessary, the air supply line must be supported, depending on the length, with suitable fasteners in order to avoid damage to the intake system.

	CAUTION
	The intake system line **must be gas-tight**.

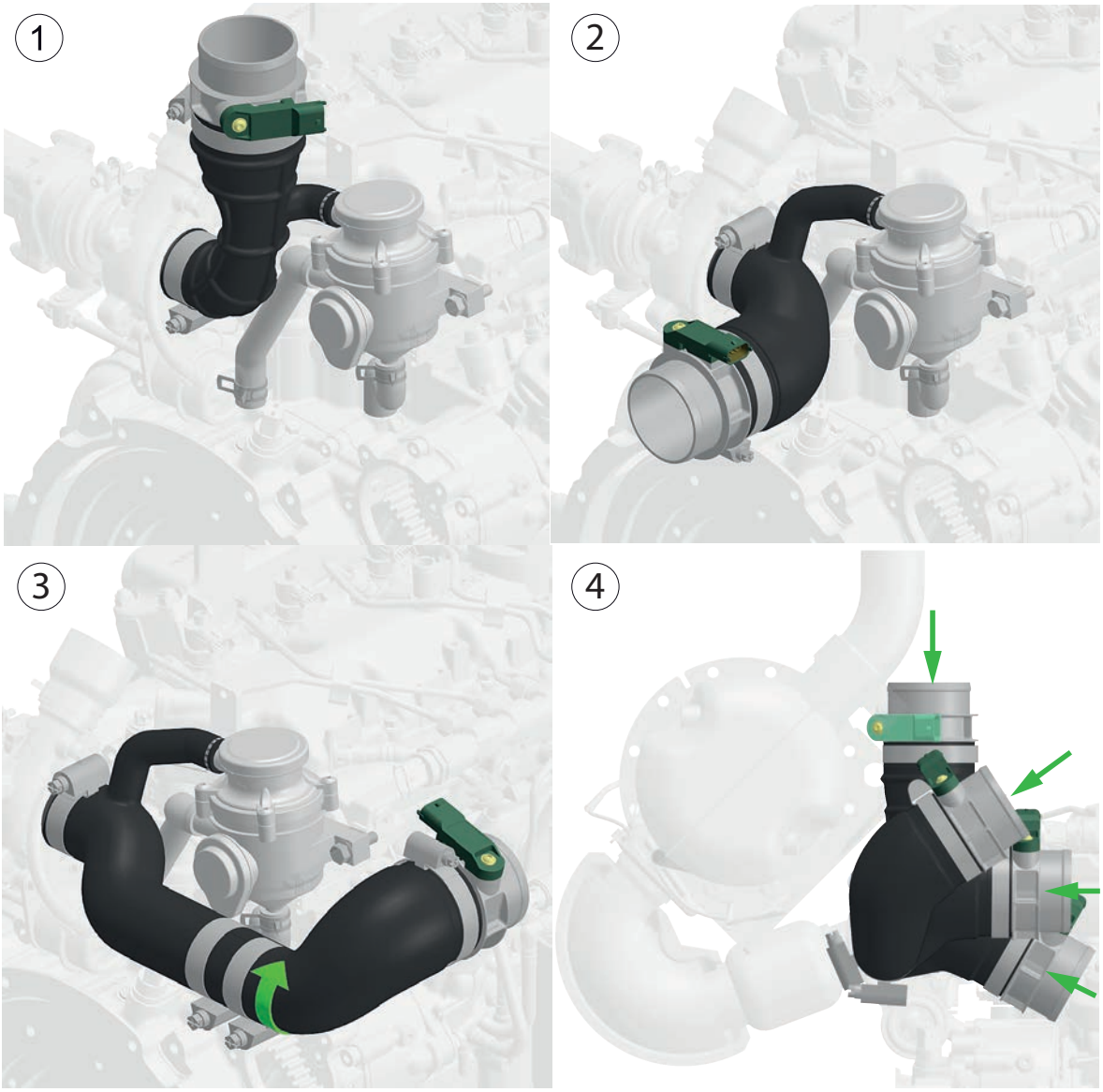
	NOTICE
	If the spiral insert of the hose (A) goes all the way through, a simple hose clamp cannot be used to create a gas-tight connection. For this reason, such hoses can only be used in combination with a spiral hose clamp (B).

Intake section – possible variants



1	Recommended variant
2	Alternative variant
3	To increase the service life of the filter, the opening for the intake air must always be located in the zone with the least dust. Also, the intake opening must be protected against splash water and rain by a rain cap.

8.7.6 Intake hose connection options



1	Vertical intake hose
2	Intake hose, horizontal
3	Lateral intake hose – 360° rotatable
4	Lateral intake hose on engine-mounted DPF

NOTICE	
	The intake hose on the engine-mounted DPF is restricted in its rotational range.

8.7.7 Combustion air/intake vacuum specifications

4H50											
		constant speed			Variable speed						
		3000	1800	1500	2800	2700	2600	2500	2400	2300	2200
TICD	q [mg/hub]	47,5	49	50,5	48,1	48,1	47,4	46,3	45.9	45,3	44.7
	WT [mbar]	66	27	17	61	57	52	49	45	42	39
	FT [mbar]	76	31	20	71	66	60	57	53	49	45
TIC	q [mg/hub]		47,6	47,4	47,6	47,4	46.5	45.6	45,2	44,4	
	WT [mbar]		26	16	61	57	52	49	45	42	
	FT [mbar]		30	19	71	66	60	57	53	49	
TI	q [mg/hub]	48,1	46,3	42,1	48,9	48,7	48,5	48,3	47,8	47.7	40,2
	WT [mbar]	57	26	16	55	52	50	47	45	42	37
	FT [mbar]	71	32	20	69	66	62	59	56	52	46
N	q [mg/hub]	On request									
	WT [mbar]										
	FT [mbar]										

3H50											
		Constant speed			Variable speed						
		3000	1800	1500	2800	2700	2600	2500	2400	2300	2200
TIDC	q [mg/hub]	51	50,5	50,5	52	50.8	49,6	48,6	47,1	47	46,4
	WT [mbar]	44	21	14	44	41	39	37	34	32	30
	FT [mbar]	55	26	18	55	52	49	46	43	40	37
TIC	q [mg/hub]		46	44	50,5	50	49				
	WT [mbar]		20	14	44	42	39				
	FT [mbar]		25	18	55	52	49				
TI	q [mg/hub]	49,6	53	51,1	49,6	52	51,2	48.4			
	WT [mbar]	57	26	17	55	53	50	47			
	FT [mbar]	71	33	21	69	66	63	59			
T	q [mg/hub]		33,5	39,5	26	26,5	27	27	27.5	28.5	29
	WT [mbar]		19	14	38	36	34	32	30	28	26
	FT [mbar]		24	17	48	46	43	40	37	35	33

q = q from setup

WT = warning threshold

FT = fault threshold

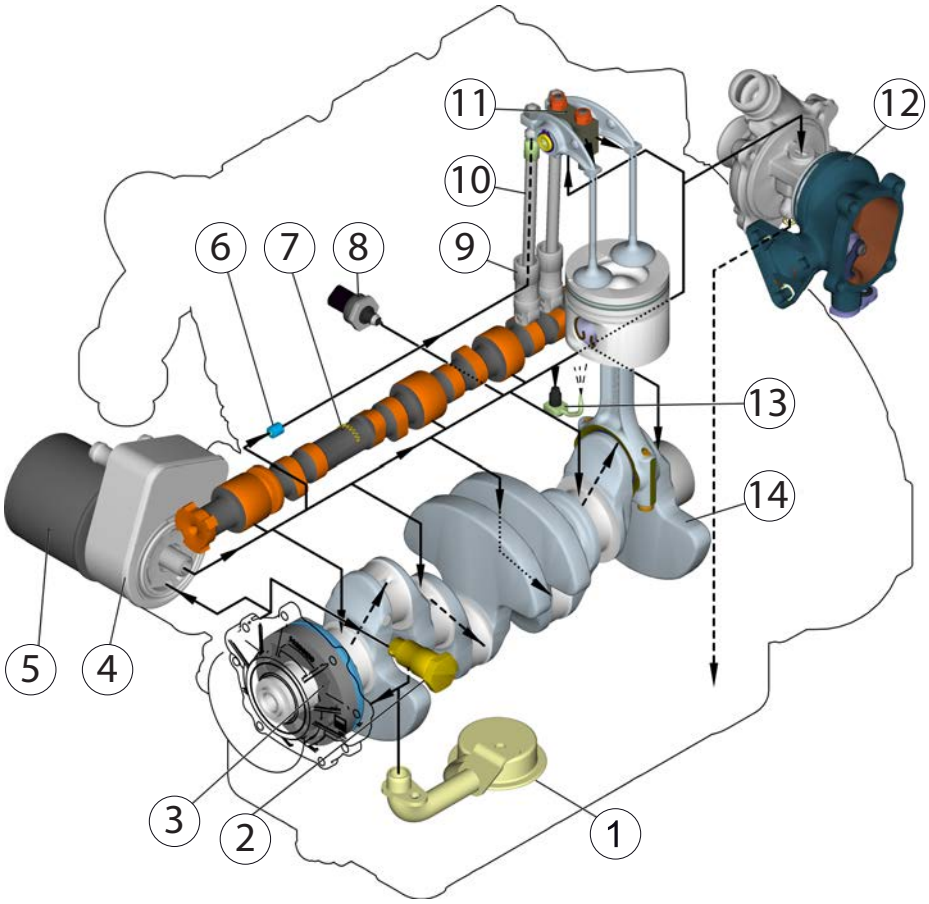
8.8 Engine oil

For operating the engine, it is important that the dipstick, oil filler, oil drain and oil filter are all easily accessible. If necessary, extensions are required for the oil filler and oil drain.

A tip: On the sample machine, try checking the oil level, filling in oil, draining the oil and changing the oil filter yourself. Only if you are convinced of the ease of carrying out this work will the series machine be maintained later in accordance with the Diesel Engine Manual.

For information on oil specification and oil viscosity, see the **"Technical data - Engine oil" chapter of the Diesel Engine Manual.**For information on the **oil filling quantity,** see chapter *5.1 Engine information and filling quantities, page 30*.

8.8.1 Lubricating oil system

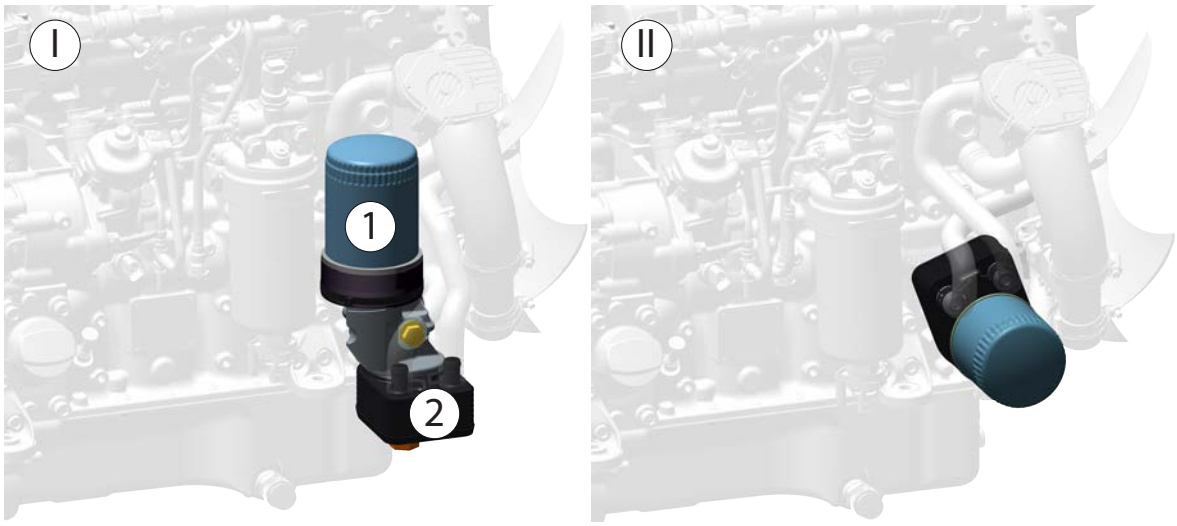


Pos.	Designation	Pos.	Designation
1	Oil suction pipe	**8**	Oil pressure sensor
2	oil overpressure valve	**9**	Roller tappet with hydraulic valve adjustment
3	oil pump	**10**	push rod
4	oil cooler	**11**	Bell crank support with spray nozzles
5	Oil filter	**12**	Exhaust gas turbocharger
6	Oil check valve	**13**	Piston cooling
7	camshaft	**14**	crankshaft

8.8.2 Engine oil service points

Information on the **service points for engine oil** is contained in chapter *13.1 Accessibility of service points, page 192*.

8.8.3 Oil filter mounting options



I	Vertical mounting position (with the vertical oil cooler, the mounting position must be lowered, see chapter *8.2.5 Vibration damper fastener kits, page 57*).
II	Horizontal mounting position (standard)
1	Oil filter cartridge
2	Oil cooler

8.8.4 Continuous skewed positions

Max. tilt position 3H50 *F2F	Max. tilt position 4H50 *F2F	Max. operating time in tilt position	Equipment	Remark
≤ 10°	≤ 10°	Max. permissible tilt when installed	Standard	In tilted installations, a modified dipstick is required by the customer
≤ 30°	≤ 30°	Without time limitations	Standard	
≤ 40°	≤ 35°	< 7 hours	Standard	
* ≤ 55°	* ≤ 50°	< 30 minutes	Optional tilt package	Optional tilt position package is required

**Exceeding the max. tilt positions in the table leads to engine damage.*

When using the **standard equipment**:

After a tilt position of 30° is exceeded, the engine must be switched off after **7 hours at the latest** with a tilt position of **less than 10°** for at least 5 minutes. A reduction of the tilt position to less than 30° is insufficient.

When using the **optional tilt position package:**

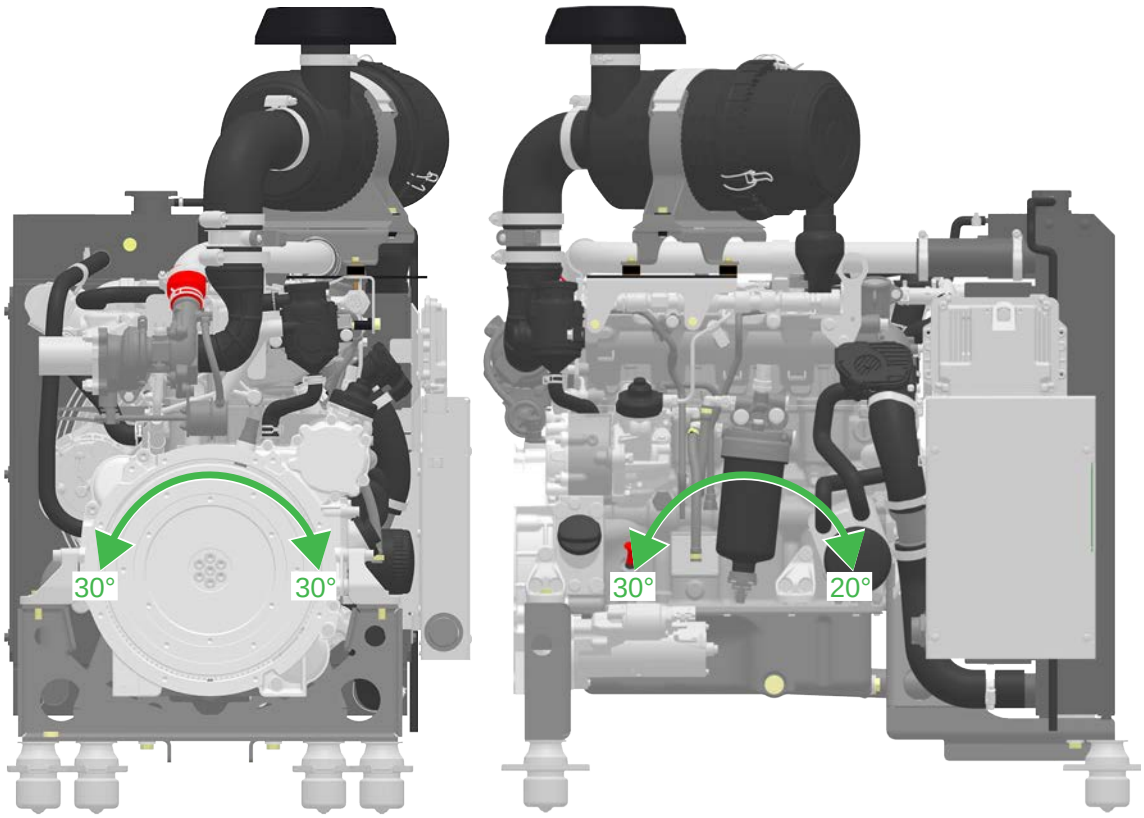
After a tilt position of 30° is exceeded, the tilt position side must be changed after **30 minutes** at the latest or the tilt position must be reduced to **less than 30°**. It is not necessary to switch off the engine in the horizontal position.

Tilt positions with our vehicle cooler

When using our vehicle cooler and a suitable expansion tank (e.g. our spherical expansion tank), the above-mentioned tilt positions permitted for the Fan2Flywheel version apply.

Tilt-position OpenPowerUnit (OPU)

Since the expansion tank is the limiting element in this cooler, there are **no changes** to the existing releases.

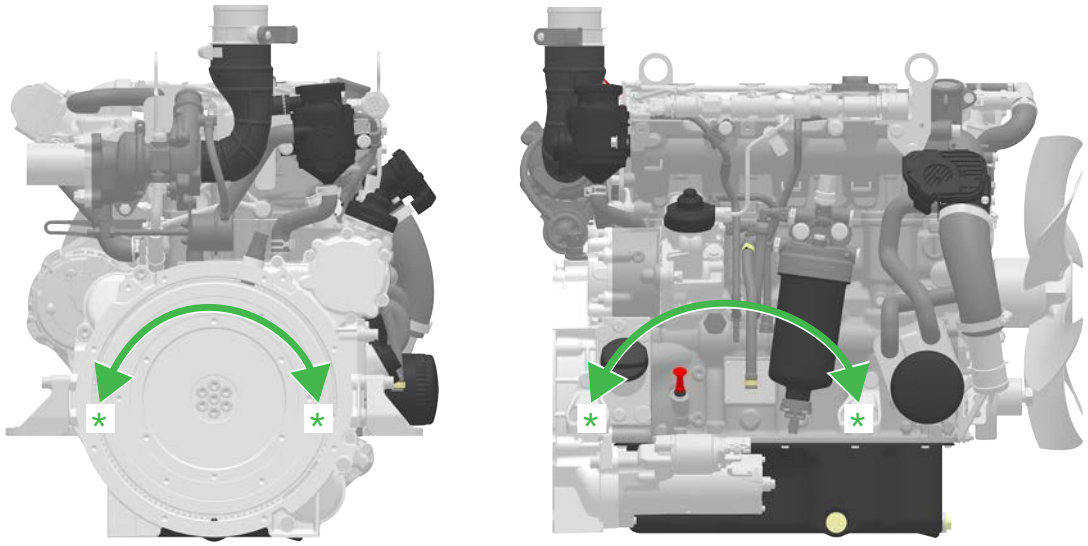


8.8.5 Extreme tilt positions

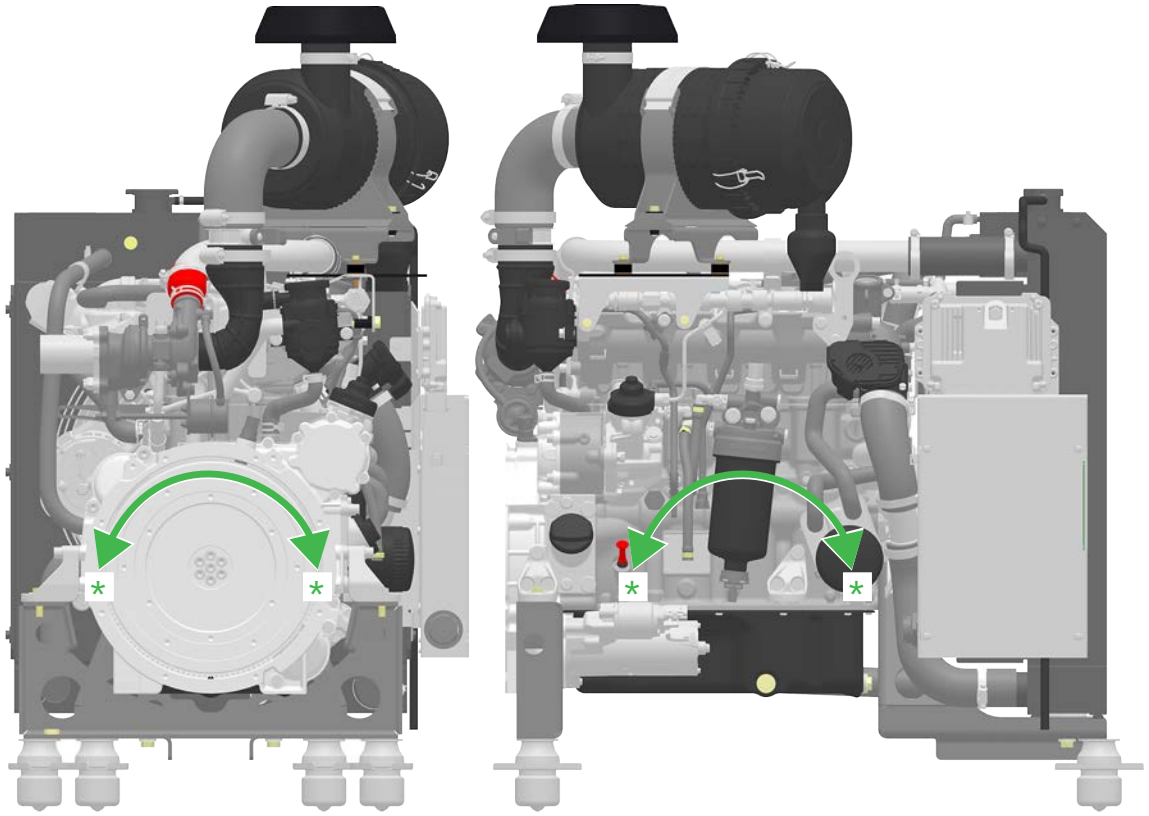
During transport (F2F/OPU):

If the max. tilt position of *≤ 35° or *≤ 40° is only exceeded **during transport (engine at a stand-still)**, the **standard oil sump** can be used..

F2F



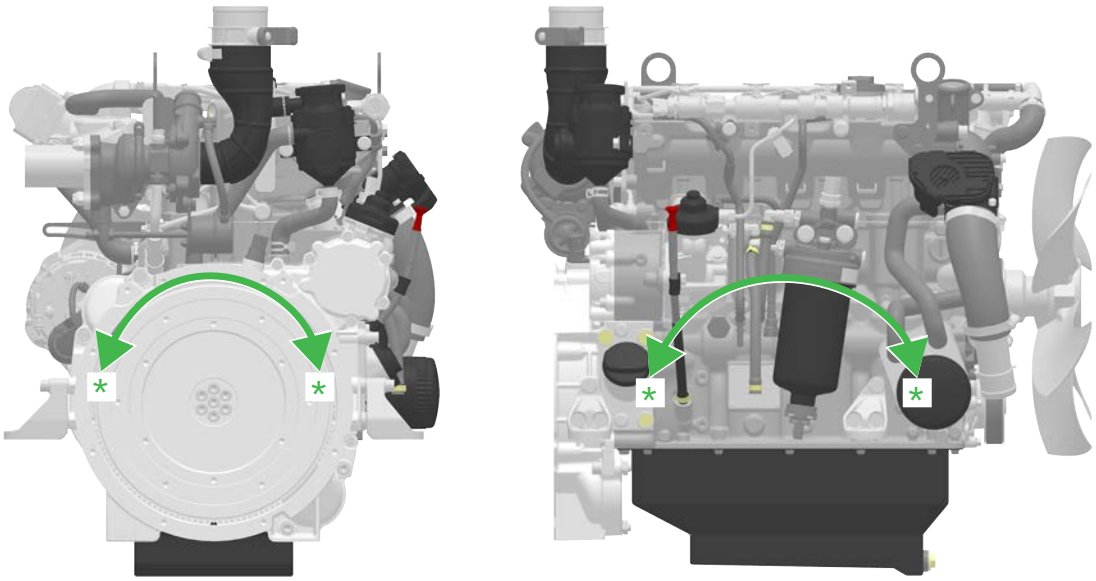
OPU



During transport and operation (F2F only):

If the max. tilt position of ≤ 35° or ≤ 40° is exceeded during transport (engine at a standstill) and during operation, the **tilt-position oil sump** is required.

F2F

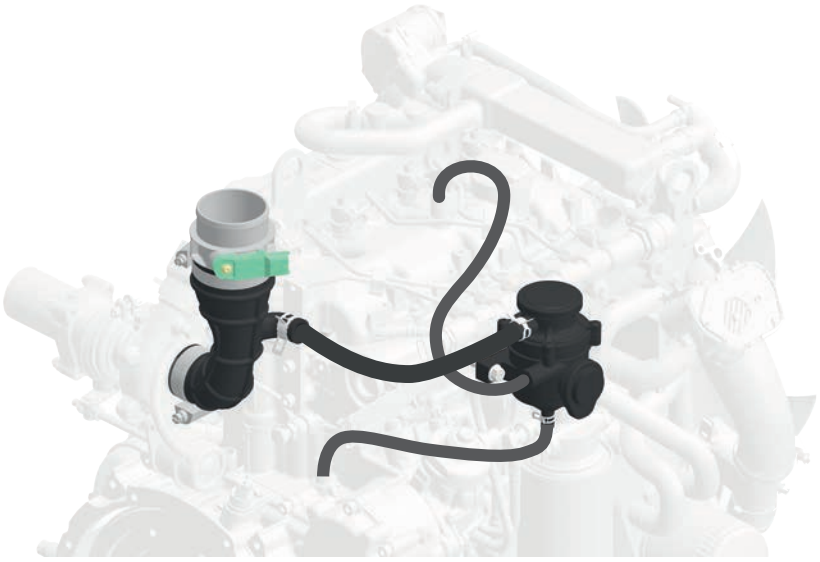


	Filling quantity (liters)	Delta min-max (liters)
3H50	5.85	approx. 1
4H50	7.30	Approx. 1.3

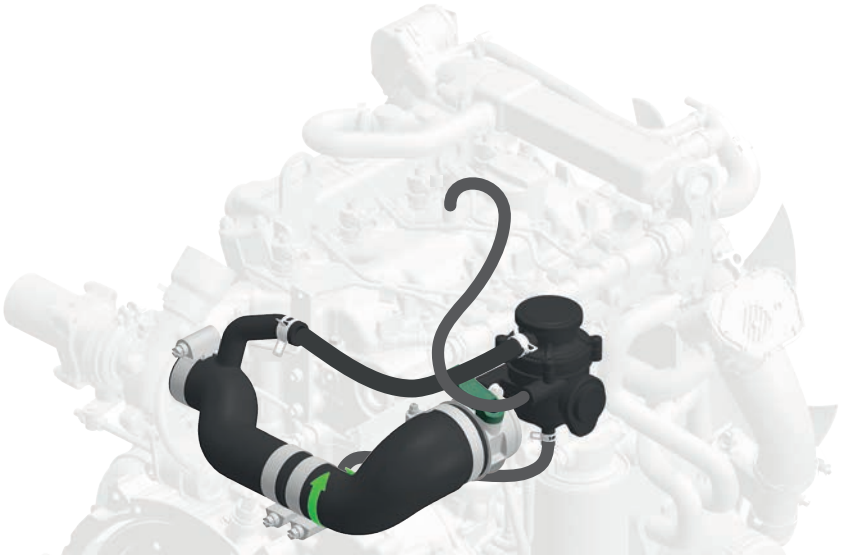
8.8.6 Crankcase ventilation (ProVent) tilt-position package

Delivery status

Air intake, vertical



Air intake, lateral

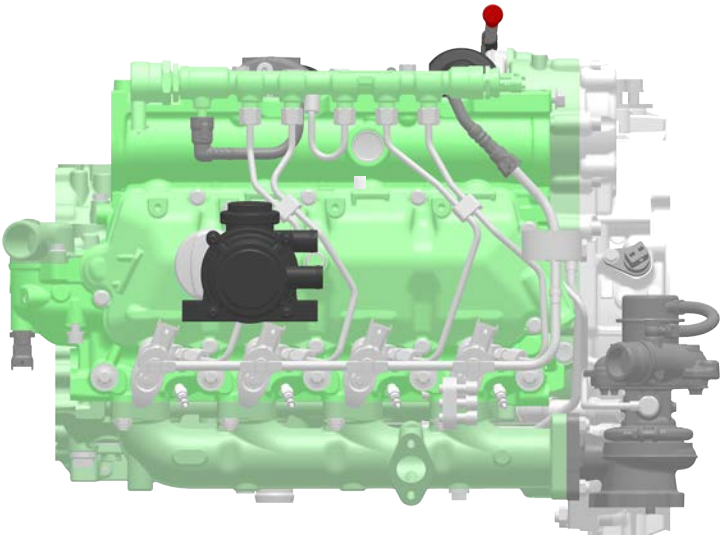


	NOTICE
	The crankcase tubing must always be routed in a descending direction.

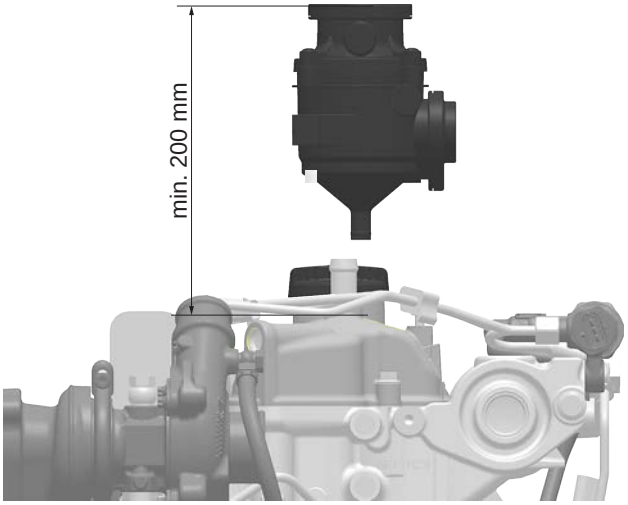
	NOTICE
	After the crankcase ventilation is installed, the tubing must be checked for possible chafing and kinks and, if present, these must be eliminated.

Minimum height of crankcase ventilation – position above engine without connection housing (green area)

Top view

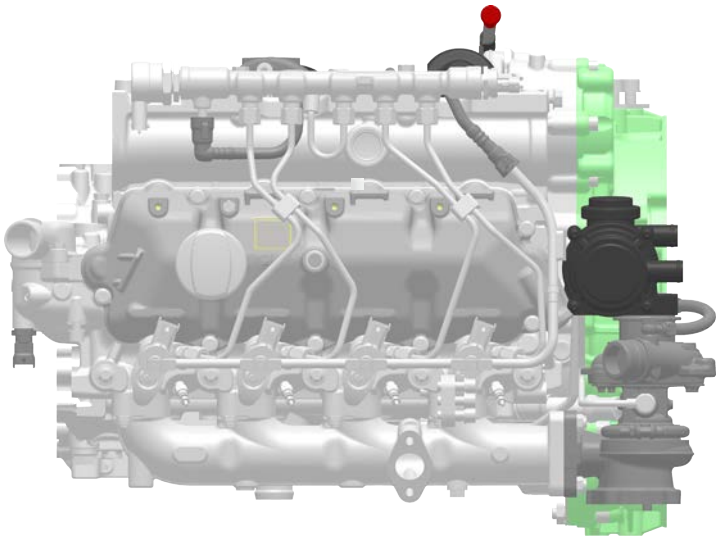


Front view

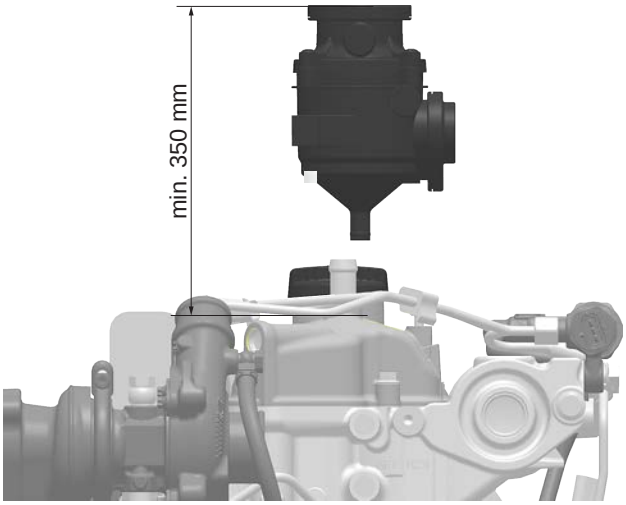


Minimum height of crankcase ventilation – position above connection housing (green area)

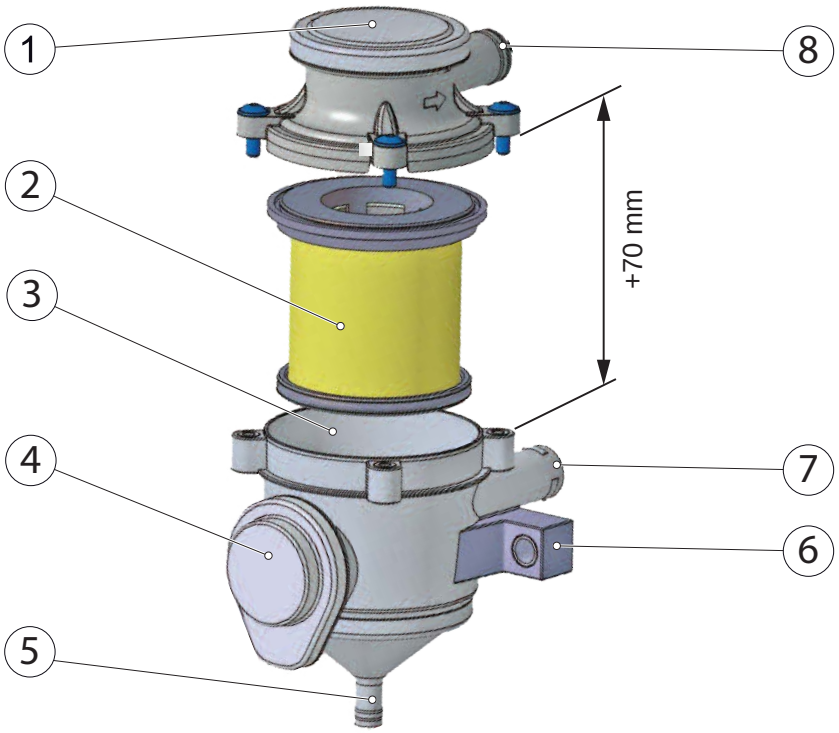
Top view



Front view



The expansion dimension of 70 mm must also be taken into consideration when installing in the machine.



1	Cover with integrated pressure control valve	5	Oil return
2	Oil separation element with cover seal	6	bracket
3	Housing	7	Inlet
4	overpressure valve	8	outlet

NOTICE

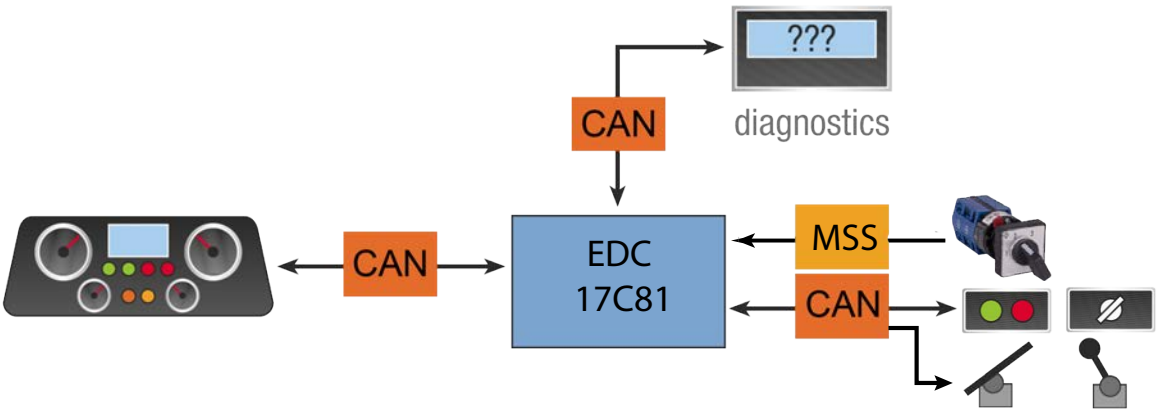
When operating the engine below -5 °C for a short period, the filter element can become clogged due to the formation of condensate. After switching off, the condense water at the filter element freezes, which increases the crankcase pressure dramatically. This can cause leakages at the shaft sealing rings and to oil exiting at the overpressure valve of the ProVent.

Remedy: Engine operation up to an oil temperature of approx. 80 °C, then the condense water and the oil emulsion formation in the ProVent should be eliminated.

9 electrical system

9.1 engine control

Control unit optionally with analog/digital control and CAN display **or** full CAN bus control



Completely optional CAN control panel	Machine basic control
▪ Torque check	▪ Throttle pedal
▪ Torque limiting	▪ Brake pedal
▪ Speed check	▪ Hand throttle
▪ Speed limiting	▪ Engine start/stop
▪ P-degree check	
▪ Vehicle speed check	
▪ Engine start/stop via CAN	

NOTICE

When using multiple CAN devices, the resistance between CAN-high and CAN-low must be between 60 and 120 ohms.

9.1.1 Start variants

The following engine start variants are selectable and configurable.

Variant	Start per ignition switch (IS = ignition switch)
IS no safe	Without safety conditions during start and standstill regeneration
IS driving analog S1&2/3	For the start and standstill regeneration, the neutral gear, manual brake and redundant brake switch are needed (hard-wired, see circuit diagram)
IS safe analog S1&2	For the start and standstill regeneration, the neutral gear and manual brake are needed (hard-wired, see circuit diagram)
IS driving CAN S1&2/3	For the start and standstill regeneration, the neutral gear, manual brake and redundant brake switch are needed (CAN message)
IS safe CAN S1&2	For the start and standstill regeneration, the neutral gear and manual brake are required (CAN message)

Variant	Start by remote start (RS = remote start)
RS CAN no safe	Start message via CAN, without safety conditions during start and standstill regeneration
RS switch no safe	Start via switch (see circuit diagram), without safety conditions during start and standstill regeneration
RS CAN safe analog S1&2	Start message via CAN; the neutral gear and manual brake are needed for the start and standstill regeneration.(hard-wire, see circuit diagram)
RS CAN safe CAN S1&2	Start message via CAN; the neutral gear and manual brake are needed for the start and standstill regeneration (CAN message)
RS Switch safe analog S1&2	Start via switch; the neutral gear and manual brake are needed for the start and standstill regeneration (hard-wired, see circuit diagram)
RS switch safe CAN S1&2	Start via switch (see circuit diagram); the neutral gear and manual brake are needed for the start and standstill regeneration (CAN message)

9.1.2 Start mode

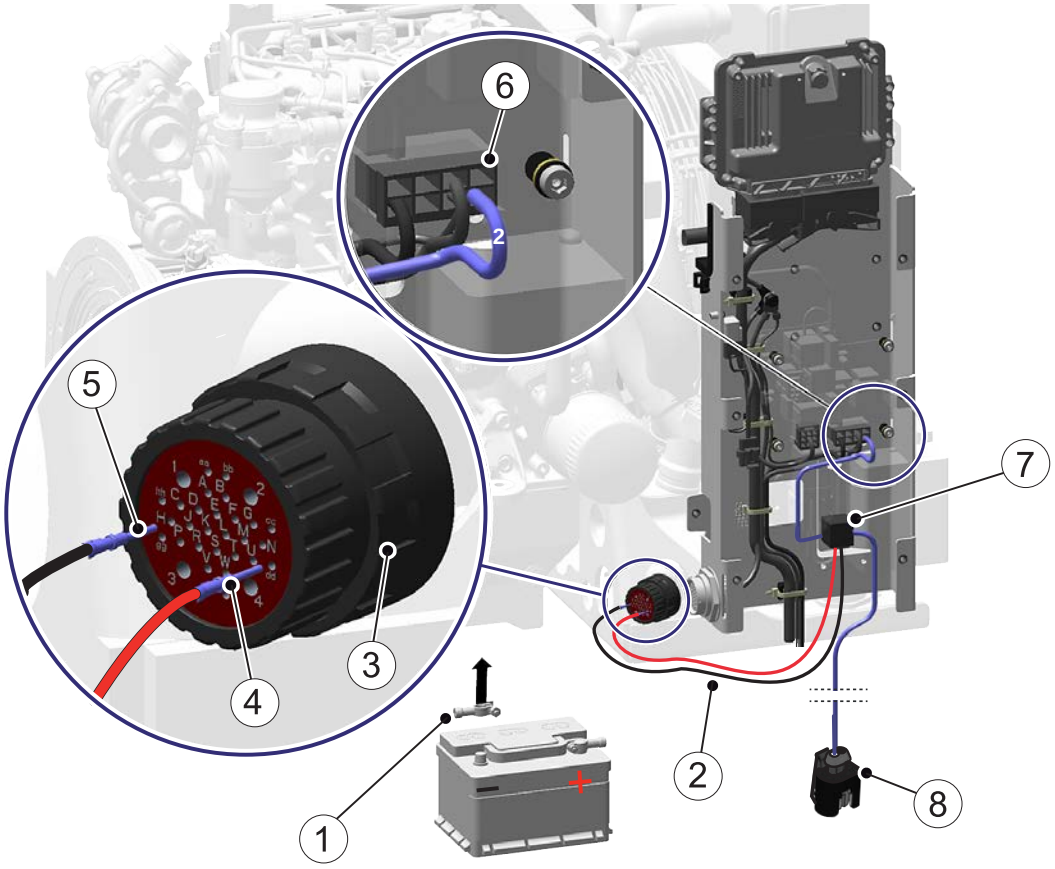
Depending on the Hatz applications, Hatz offers the "Hard Start" and "Easy Start" options for the engine start, both either with or without the lower idle (ULL).

Variant	Description
Hard Start **with** ULL	The alternator already charges at idle speed and the starter decouples at 650 rpm; this setting is recommended as the **standard setting**.
Hard Start **without** ULL	Without ULL, the "Engine Running Lamp“ (ERL) and charge control are only activated at approx. 1300 rpm. This means that the engine can be easily started with a higher basic load and the alternator does not additionally strain the ramp-up of the engine. This variant must be wired by the customer.
Easy Start **with** ULL	Starter decouples at 450 rpm; suitable for all applications without large power consumption during ramp-up, e.g. generating sets.
Easy Start **without** ULL	Starter also decouples at 450 rpm; but here, too, the charge control is only activated at approx. 1300 rpm.

Customer wiring (hard start without lower idle)

To ease the starting procedure of devices with a high basic load, we recommend delaying the generator excitation and integrating a relay with a diode in the power supply of the alternator D+, line no. 2. This has the effect that the power consumption of the alternator only begins at an engine speed of approx. 1300 rpm[1/min], (standard at 900 rpm[1/min]).

Overview — Preparatory activities

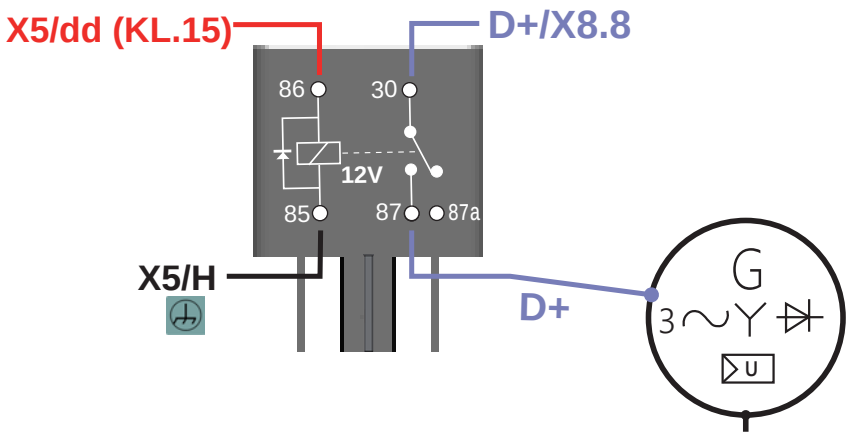


Pos.	Designation
1	Terminal clamp (negative terminal)
2	Control line **relay** (connection 85, 86)
3	Connector **X5** for customer signals
4	Control line for **relay connection 86** (T.15) (slot **dd)**
5	Control line for **relay connection 85** (slot **H,** ERL)
6	Connector **X8** central electrical system
7	Relay with diode
8	Alternator connector with connection line D+

Procedure

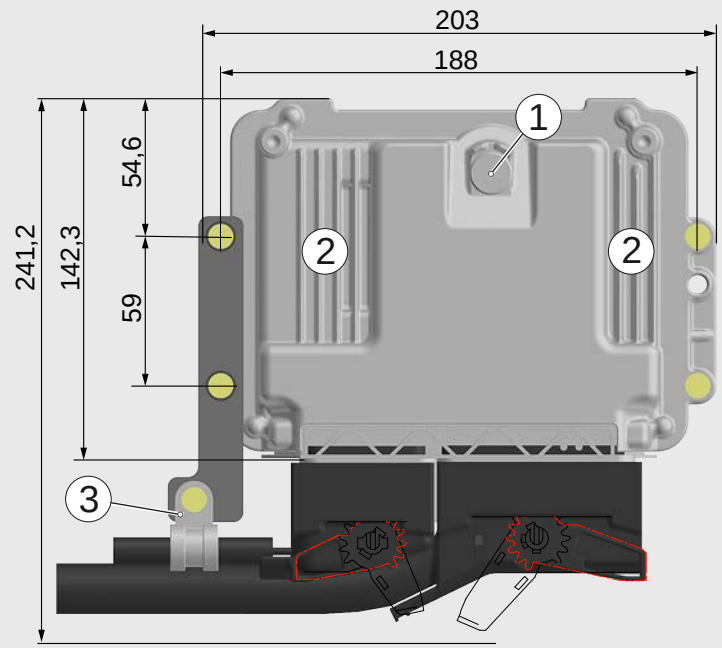
Step	Activity
1	Switch off the engine. Turn the starting key to position "0".
2	Release the terminal clamp at the negative terminal (pos. 1) and detach it safely from the battery.
3	Detach the alternator connector with connection line D+ (pos. 8) from the alternator.
4	Plug the pins (pos. 4 and 5) into the provided plug-in positions; see figure. Pierce the seal and insert the respective pin fully into the connector until it engages.
5	Connect the control line (pos. 4) to relay (pos. 7) connection 86. Connect the control line (pos. 5) to relay connection 85.
6	Separate the alternator D+ line from the connector X8 (X8.8) and connect one end to relay connection 30. Connect the second end to relay connection 87.
7	Plug the generator connector with connection line D+ onto the alternator connection D+ again to the point where you can hear it engage.
8	Connect the terminal clamp to the negative battery terminal (1).

Relay connection plan



Relay connection	Designation	Slot X5
85	Relay ground	H
86	Control line + relay (T.15)	dd
87	Connection line (D+) relay to alternator	
30	Connection line (D+) excitation resistance to relay	

9.1.3 Control unit setup



**Wiring harness connector plugged in (red dashed line)/not plugged in (black dashed line)*

1	Area of the ambient pressure sensor
2	Temperature measurement points (to max. +105 °C)
3	Bracket for securing the cable

9.1.4 Installation conditions for control unit

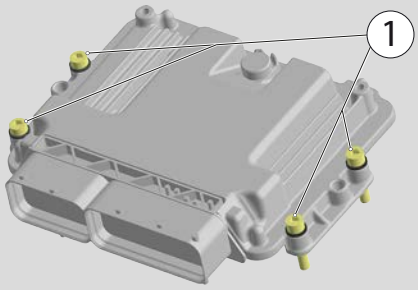
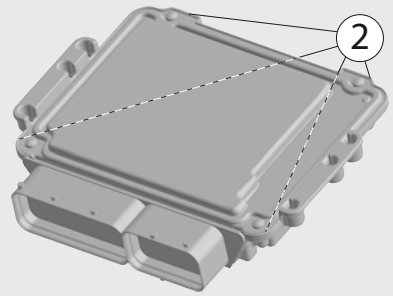
Bosch control unit EDC17C81

The control unit is mounted on the four (1) available locations (**4 x M6 x 30, max. tightening torque 10 Nm**).

The installation in a vehicle must be executed in such a way that the control unit cannot collide with other vehicle parts due to additional fasteners.

After the control unit is installed, it must be ensured that:

- No water can enter into the control unit along the wiring loom.
- No standing or permanently running water is located in the area of the ambient pressure sensor.
- No standing or permanently running water is located in the area of the groove area (2).
- Adequate ventilation is provided since the maximum ambient temperature of 80 °C must not be exceeded.
- The two wiring harnesses must be mechanically fastened after no more than 100 mm to protect the plug-in connections against pulling, pushing and vibration forces (strain relief).
- Vibration decoupled from engine separated

Technical properties of control unit:	
▪ Ambient temperature -32° to 80° ▪ Spray water protected ▪ Dust tight ▪ Tropicalized ▪ Heavy duty ▪ Nominal voltage: 12 V ▪ Permissible voltage range 8-16 V ▪ Current consumption with ignition off: 0.1 mA	 

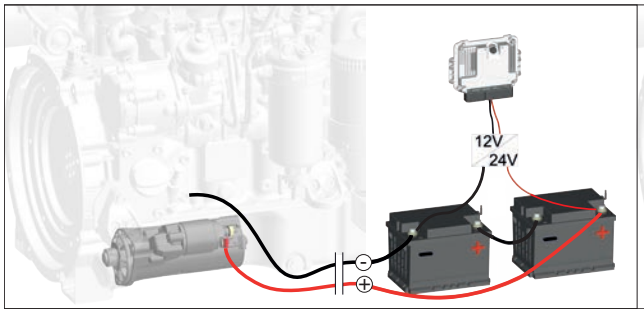
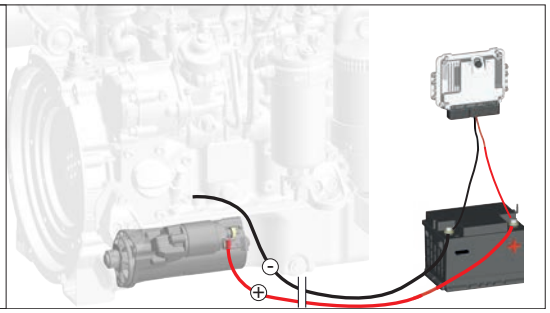
9.1.5 Control unit - connections

EDC 17C81
Inputs/outputs:
CAN bus SAE J1939
ANALOG
▪ **M**ulti-**s**tate **s**witch **MSS**
DIGITAL
▪ Remote starting/stopping ▪ Diagnosis lamp

9.1.6 Control unit - power supply

NOTICE
The control unit must be separated from the engine and vibration-decoupled. Installation on the cooler is permissible. (see also OPU)

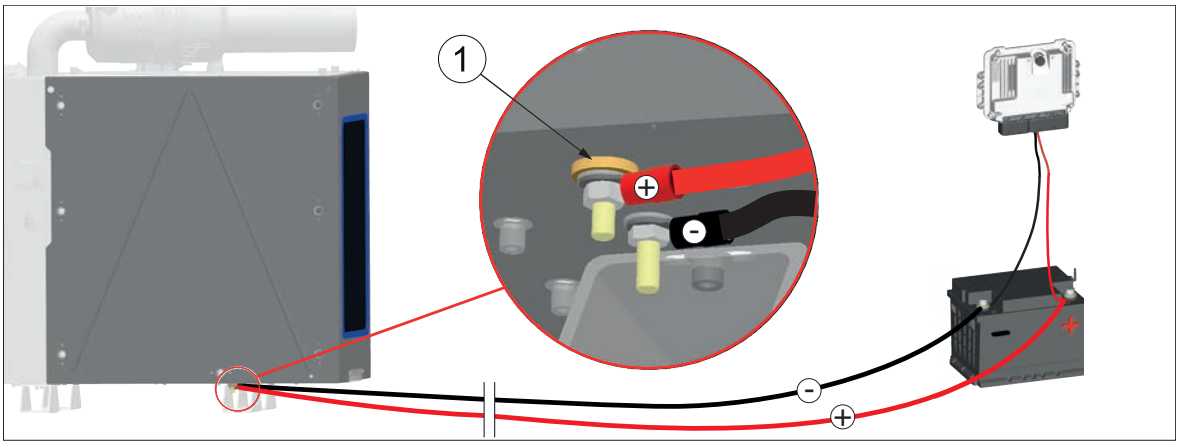
NOTICE
The power supply of the control unit must be connected directly to the battery; see the following figure. If the voltage supply is implemented via the starter cable, a voltage undersupply or a fault in the control unit during the starting procedure is probable.

EDC17C81 24V	ECD17C81 12V
	

NOTICE
If using a battery master switch, the power supply of the control unit must be tapped downstream of the main switch. This ensures the full de-energization of all components. Before actuating the battery main switch, wait at least 30 seconds after "ignition off (ignition start switch)" to complete internal processes in the control unit. If the 30 seconds are not adhered to several times, an error is output by the motor control unit.

9.1.7 Control unit - SilentPack power supply

In the encapsulated engine version, the connections of the battery main lines are located below the capsule in the area of the engine bracket. **Tightening torque: battery main line 10 Nm**



DANGER

Danger of injury or danger of property damage due to incorrect use of batteries.

- Never swap the positive (+) and negative (–) battery terminals of the battery connection lines.
- When connecting the machine to the battery, first connect the **positive cable** and then the **negative cable**. The connection of the positive cable can be identified by the insulating washer pos. 1.
- It is imperative to prevent short circuits and mass contact of current carrying cables.
- If faults occur, check the cable connections for good contact.

NOTICE

For the positive cable + at the connection of the capsule, a suitable protective rubber sleeve is recommended as protection against short circuits (caused, for example, by electrically conductive foreign bodies or moisture). Short circuits can cause cable fires and damage to electric and electronic components.

9.1.8 Diagnosis tool HDS²

The **HDS²** diagnostics tool (Hatz Diagnostic Software) is available for troubleshooting and analyzing the engine parameters. The **HDS²lite** is available in addition to the desktop-based diagnostic system. It is connected via a Bluetooth adapter, app and smartphone or tablet. If necessary, please contact **Hatz service** or go directly to www.hatz-diesel.com/hds2-lizenz.

9.1.9 Diagnostic interface HDS²

An additional diagnostic interface must be provided on the wiring harness to connect the HDS diagnostic tool. The correct pin assignment on the engine control unit (ECU) for mounting a diagnostic interface can be found on the ECU wiring plan.

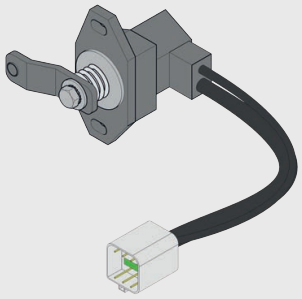
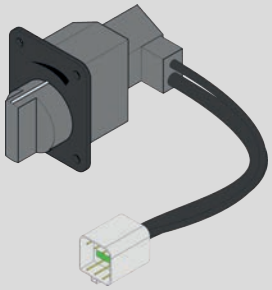
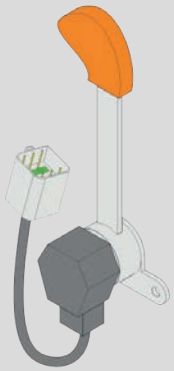
9.1.10 CAN lists and wiring plans

The CAN lists and the ECU wiring plan can be viewed under the link: www.hatz.com/docu (to access these, you will require your engine serial number).

9.2 Engine monitoring

9.2.1 Overview of speed control

Between the control unit interface and the operating module (instrument box), the max. cable length is 10 m with a cable cross section of 1 mm².

Speed control		IP degree of protection
bowden cable (CAN)		IP66
Rotary knob (CAN)		IP66
Pedal (CAN)		IP69K
Manual lever (CAN)		IP66
Multi-state switch (MSS) (optional 2, 3 or 4 steps)		IP65

NOTICE
Speed limiting for CAN-enabled speed control possible. As a safety precaution against overspeed, the unprogrammed CAN speed controls are set to 900-1500 rpm.

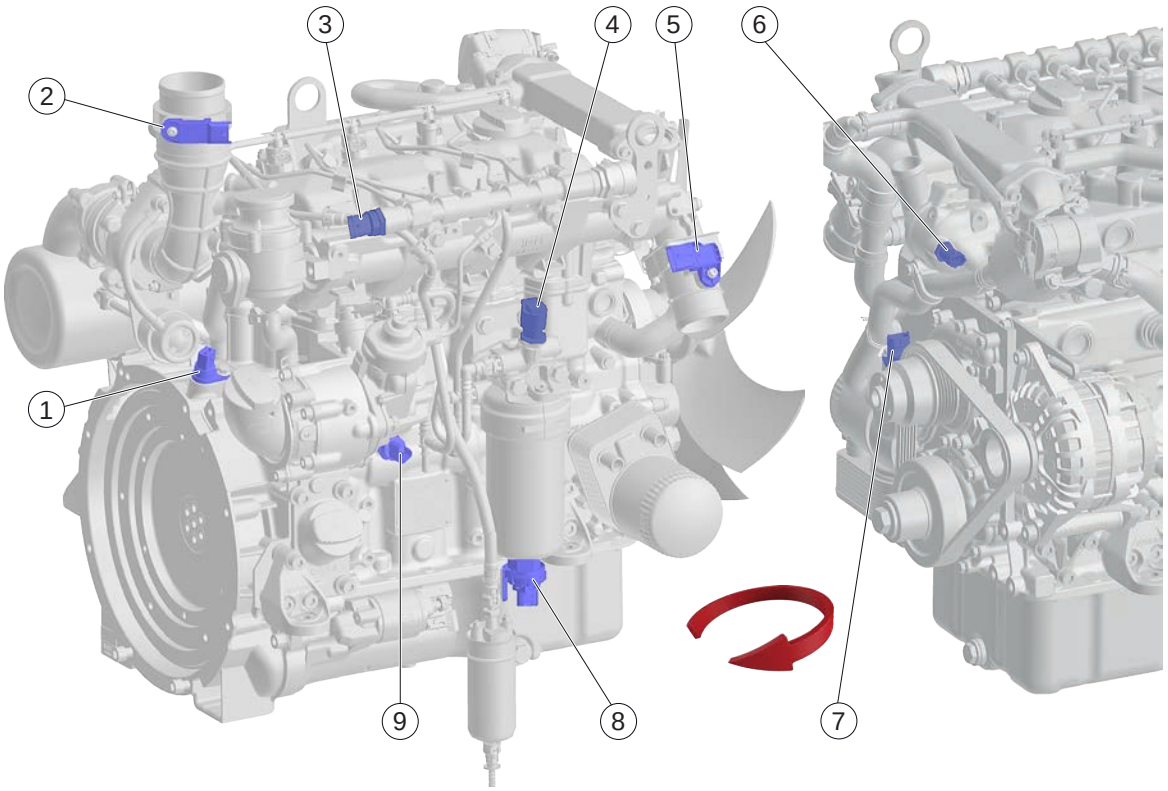
9.2.2 Overview of instrument box

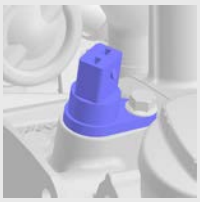
HATZ instrument box		IP protection class	Use
HSP CAN display		IP65	For all variants

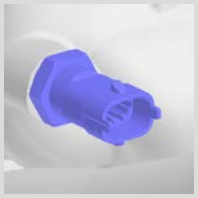
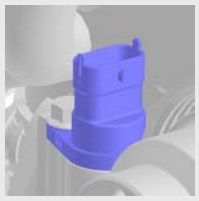
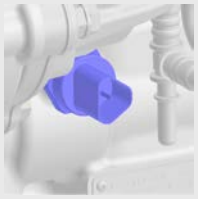
Connection of customer wiring harness to CAN display HSP, see *9.6 Cabling, page 166*Customer control unit wiring harness.

9.2.3 Sensor overview

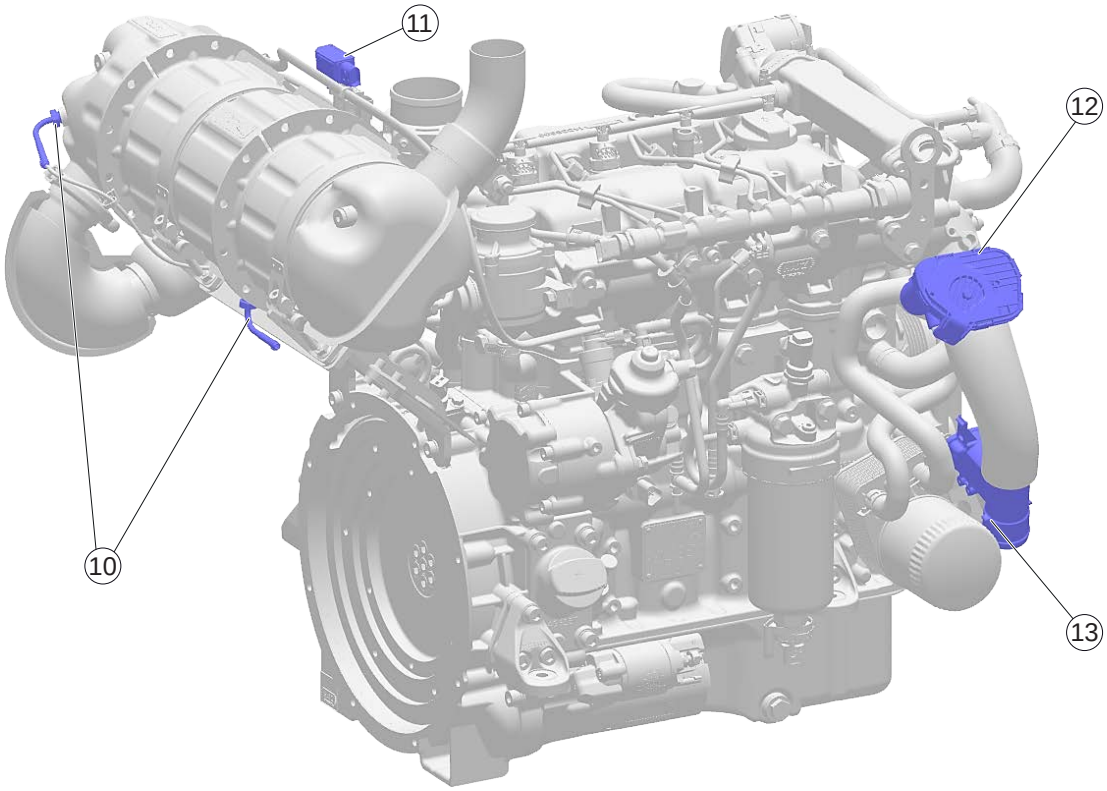
Installation position

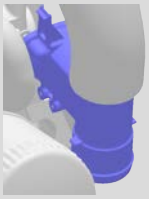


Pos.	Designation	Sensor
1	Crankshaft speed sensor	
2	Air filter differential pressure sensor	
3	Rail pressure sensor	
4	Fuel low pressure and fuel temperature sensor	

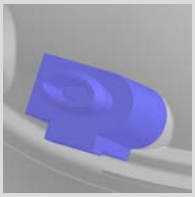
Pos.	Designation	Sensor
5	Charge air pressure and charge-air temperature sensor (T/TI/TIC)	
6	Coolant temperature sensor	
7	Camshaft sensor	
8	Water in fuel sensor	
9	Oil pressure and oil temperature sensor	

Installation position



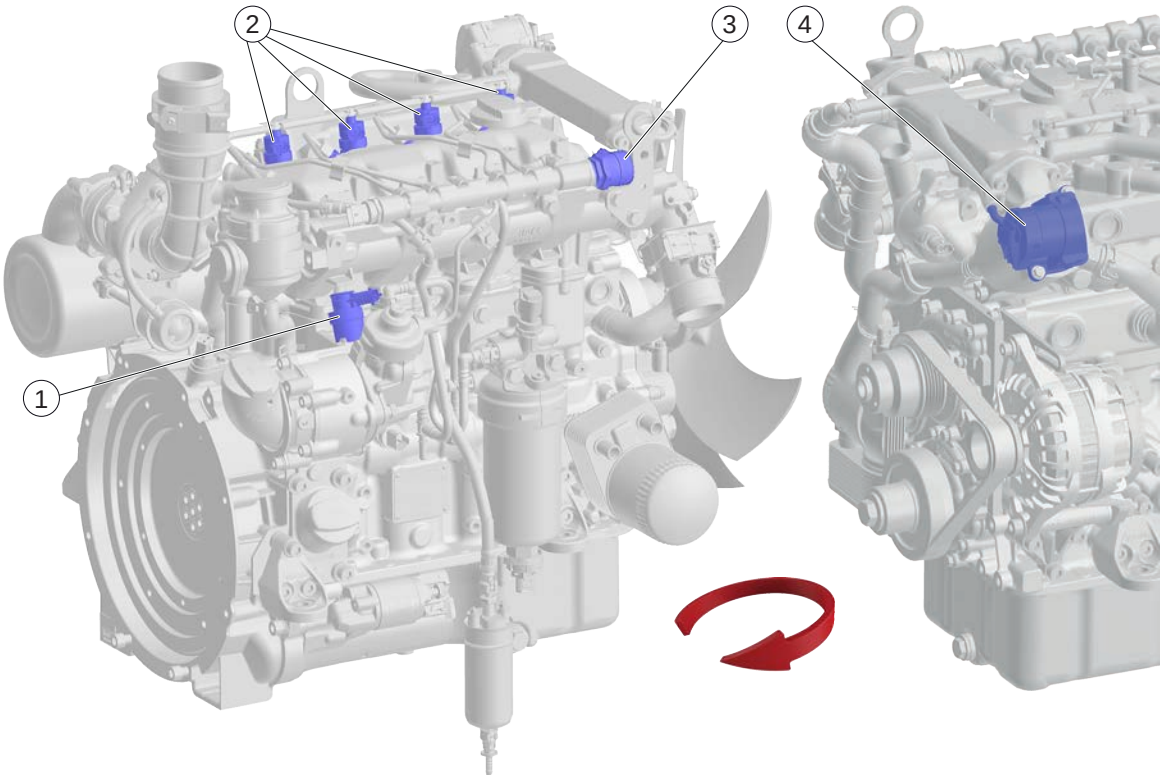
Pos.	Designation	Sensor
10	Exhaust temperature sensors (TICD)	
11	Differential pressure sensor (TICD)	
12	Intake throttle (TICD)	
13	Air mass meter (TICD)	

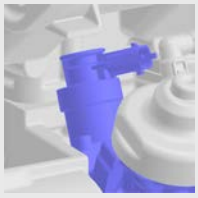
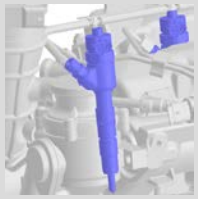
Installation position: chassis-side

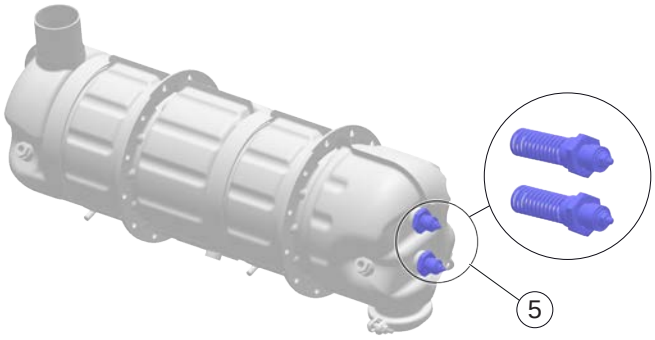
Pos.	Designation	Sensor
14	Ambient pressure sensor (integrated in the engine control unit)	
15	Coolant level sensor (with external expansion tank)	
16	Coolant level sensor (OPU cooler)	

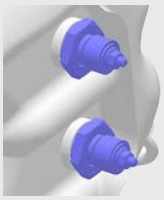
9.2.4 Actuator overview

Installation position



Pos.	Designation	Actuator
1	Metering unit on the high-pressure pump	
2	Injectors	
3	Rail pressure control valve	
4	EGR valve	



Pos.	Designation	Actuator
5	Heating element (version – TICD ActivePremium)	

9.3 Battery

DANGER

Danger to life, danger of injury or danger of property damage due to incorrect use of batteries.

- Do not place tools or other metal objects on the battery.
- Before performing work on the electrical equipment, always disconnect the negative battery terminal.
- Never swap the plus (+) and negative (–) battery terminals.
- When installing the battery, first connect the **plus cable** and then the **negative cable**.
- When removing the battery, first disconnect the **negative cable** and then the **plus cable**.
- It is imperative to prevent short circuits and mass contact of current carrying cables.
- If faults occur, check the cable connections for good contact.

DANGER

Danger of explosion from flammable substances.

There is a danger of explosion from flammable gases.

- Keep batteries away from open flames and incendiary sparks.
- Do not smoke when working with batteries.

CAUTION

Danger of chemical burns

Chemical burns can occur when using batteries for the electrical operation.

- Protect your eyes, skin, and clothing from corrosive battery acid.
- Immediately rinse areas affected by splashed acid with clear water and consult a physician if necessary.

Temperature limits of normal batteries:

- From approx. +60 °C, the self-discharge increases significantly and the service life decreases significantly.
- From approx. -22 °C, half-charged batteries can freeze. A frozen battery must be thawed prior to charging.
- Fully charged batteries have a freezing threshold of approx. -60 °C.

Conclusions concerning the charge state of a battery are possible from measuring the voltage when loaded (min. 1 A). A discharged battery has the rated voltage at the terminals when unloaded!

9.3.1 Battery recommendation

Besides the battery capacity, the low-temperature test current (see the following table) is decisive for the cold start behavior. If a battery is used with a larger cold test current than recommended, the starter can be mechanically and thermally overloaded and damaged.

If a battery with a low-temperature test current that is too small is used, the cold start behavior deteriorates.

Recommended max. battery capacity of a 12-V lead battery during starting.	Power, 12-V starter [kW]	Max. permissible capacity [Ah]	Low-temperature test current [A]			
Engine type			EN[1]	SAE[2]	DIN[3]	IEC[4]
3H50/4H50	2.2	110	760	800	450	510

Recommended max. battery capacity of a 24-V lead battery (2x12V) during starting.	Power, 24-V starter [kW]	Max. permissible capacity [Ah]	Low-temperature test current [A]			
Engine type			EN[1]	SAE[2]	DIN[3]	IEC[4]
3H50/4H50	3.0	66	510	520	300	335

[1] European Standard 60095-1

[2] Society of Automotive Engineers, United States standard

[3] German Institute for Standardization (DIN) 43 539 Part 2

[4] International Electrotechnical Commission) 95-1

NOTICE

The required battery capacity may deviate, depending on the installation case (e.g., resistances in the hydraulic system).

NOTICE

In the case of lead batteries, a self-discharge of approx. 5% of the total capacity per month must be taken into account.

9.3.2 Battery compartment

The positioning of the battery installation in the engine space must be verified by temperature measurements.

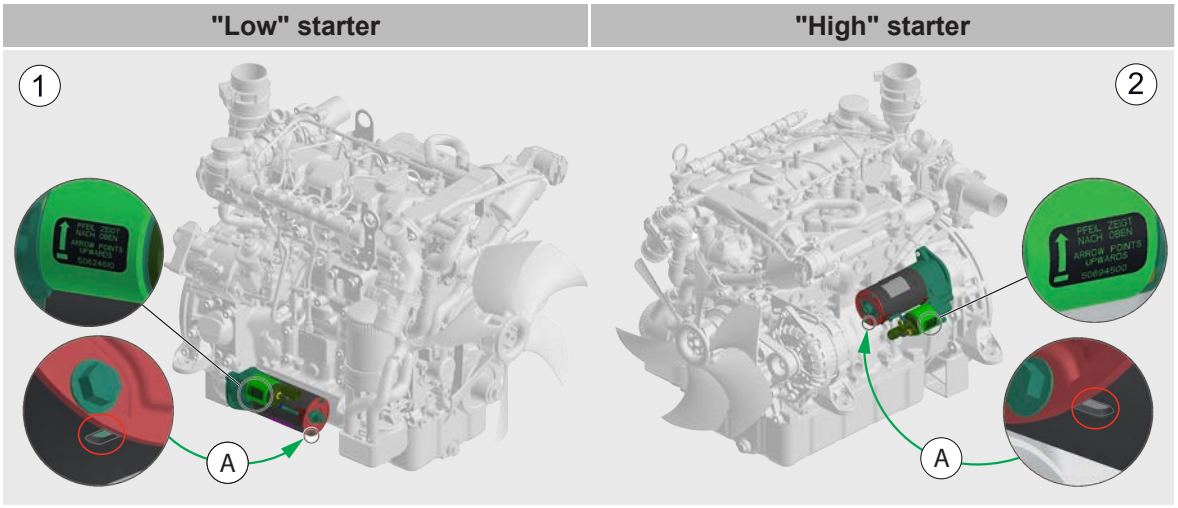
NOTICE

- The max. ambient temperature of the batteries is +60 °C
- Installation of the battery easily accessible for maintenance work
- Secure the battery mount against inherent movement
- Ventilation of the battery installation compartment
- Mounting of electrical switches in the vicinity of the battery is not permitted due to sparking and the potential explosion hazard.

9.4 Starter

Mounting positions

Depending on the installation situation of the engine, a suitable "low" starter (1) or "high" starter (2) needs to be selected. The water drain opening (A) of the starter must be positioned vertically downward in each case.



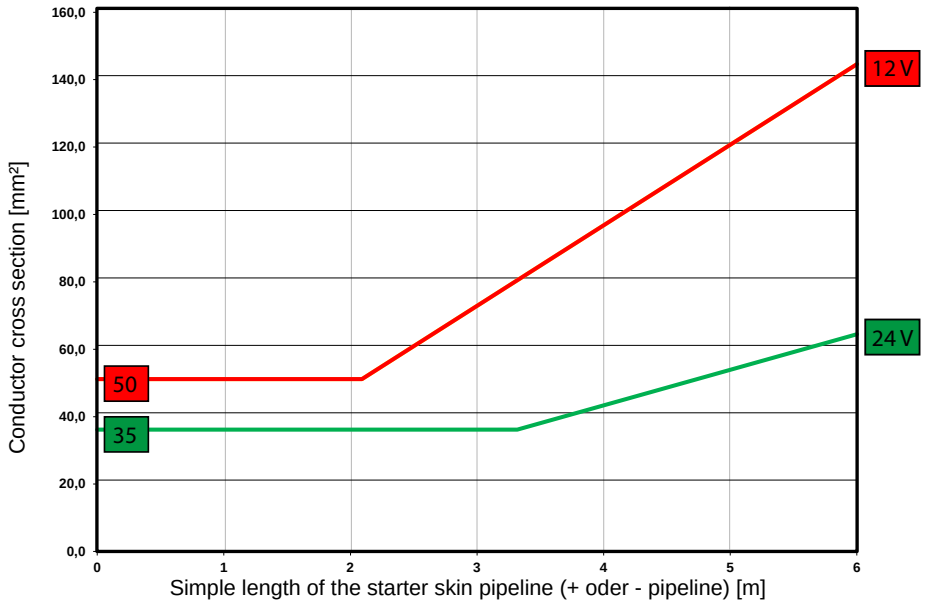
With the ignition switch, the pull-in winding and holding winding of the starter solenoid (terminal 50) (1) are switched on via the starter relay (short-term max. **56 A** in the pull-in winding and **10 A** in the holding winding).

At the end of the pull-in path (starter pinion engaged in the sprocket), the main starter current is switched on (depending on the starter and condition, approx. **450 to 500 A**). The starter motor is now connected directly to the battery by terminal 30 (2) and the main starter line.

NOTICE
The hexagon nut M8 for fastening the main power line T.30 to the starter must be tightened with max. 22 Nm.

NOTICE
It is recommended to protect the starter terminal 30 (B+ connection) against short circuits (e.g., caused by electrically conductive foreign bodies) with a suitable cover (e.g., rubber protective cover). Short circuits can cause cable fires and damage to other electronic components.

Sizing of the starter main line between the starter and battery:



The conductor cross section of the starter control line (T.50), between the relay and the starter, is 6 mm².

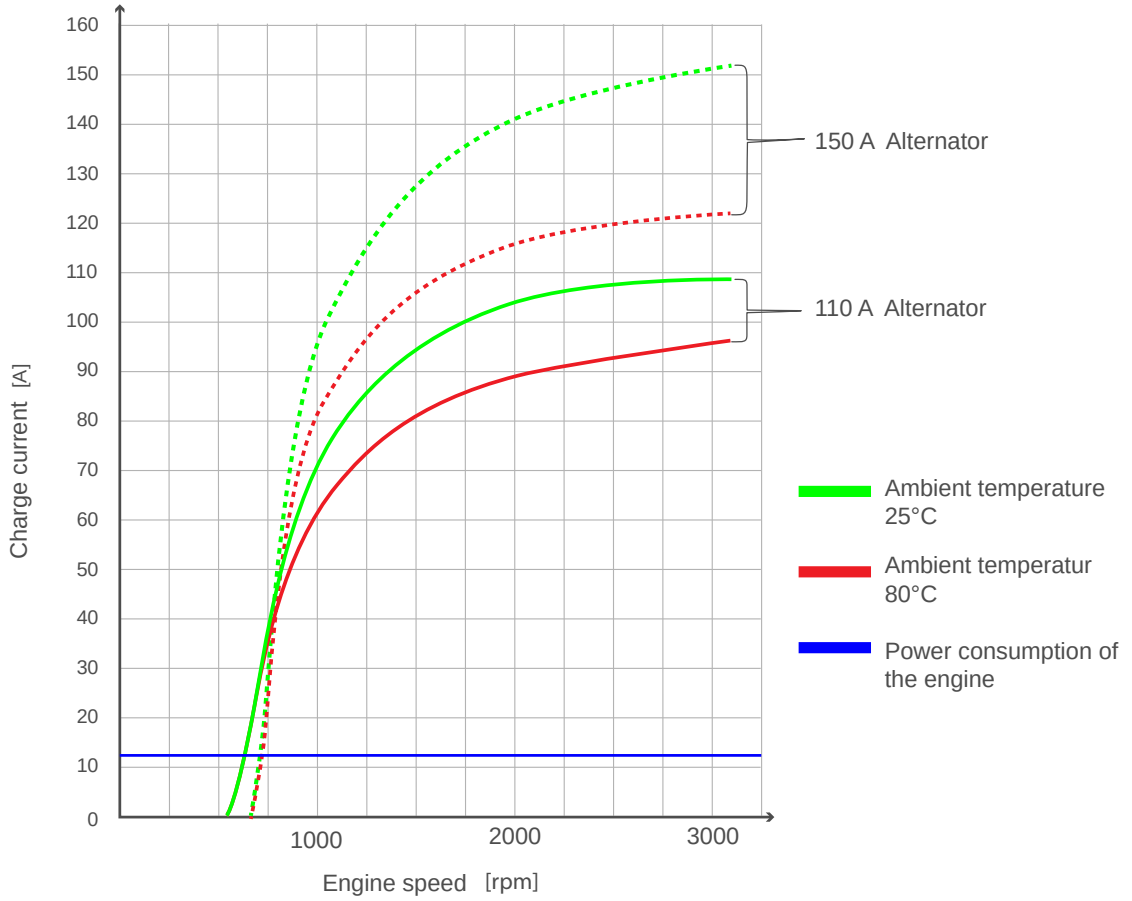
	NOTICE
	Select the battery capacity according to HATZ plant specifications. If it is necessary to have a larger battery capacity, the line cross section and/or the length of the main starter line must be adapted accordingly. This will prevent overloading the starter and damaging it. To determine the right line cross section, please contact HATZ service.

9.5 Alternator

Type	Air cooled compact alternator with internal fan
Belt drive	Poly v belt profile 6PK 768 (6 grooves, Ø49 mm)
Ratio with crankshaft pulley Ø103 mm	$n_{alternator}$ = 2.08 * n_{engine} [min-1]

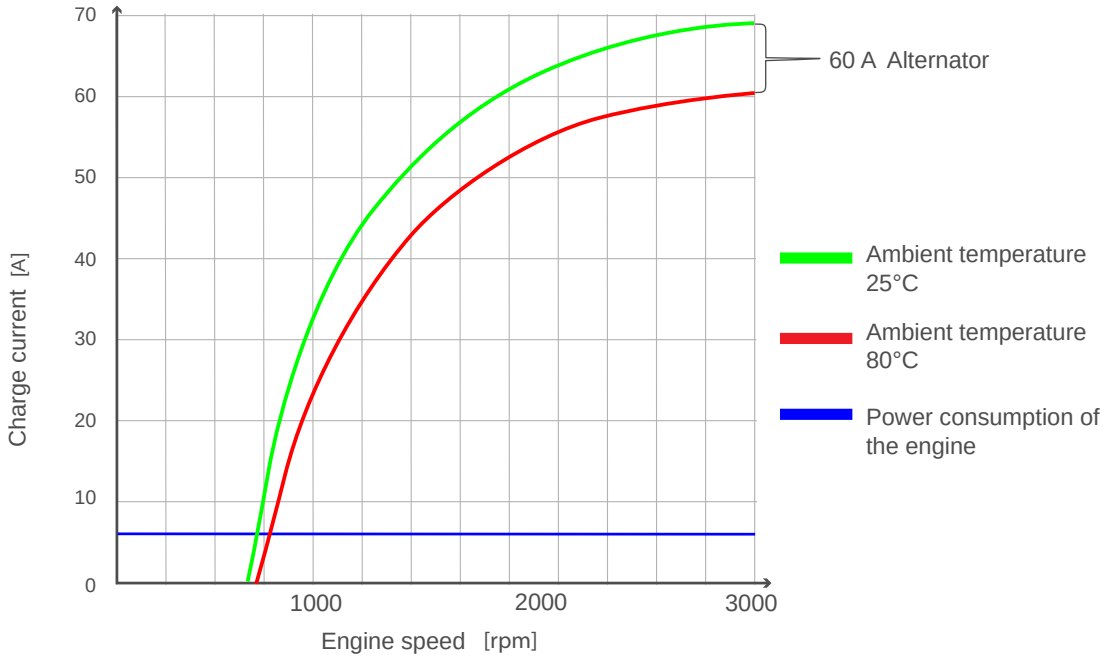
Type	12 V (standard)	12 V (option)	24 V (option)
Max. current at engine speed 2880 rpm	110 A	150 A	60 A
Max. current at engine speed 860 rpm	55 A	Approx. 70 A	18 A
Control voltage 20 °C	14.25 – 14.75 V	14.25 – 14.75 V	28.10 – 28.70 V

9.5.1 Charge curve 12 V



The power consumption of the engine is an approximate value that depends on multiple conditions (such as temperature, voltage, etc.). The starting procedure consumes approx. 2 Ah.

9.5.2 Charge curve 24 V



The power consumption of the engine is an approximate value that depends on multiple conditions (such as temperature, voltage, etc.). The starting procedure consumes approx. 1 Ah.

9.6 Cabling

NOTICE

All wiring harnesses and lines behind stationary plug connections must be feature a tension relief mechanism after a maximum distance of 100 mm.

NOTICE

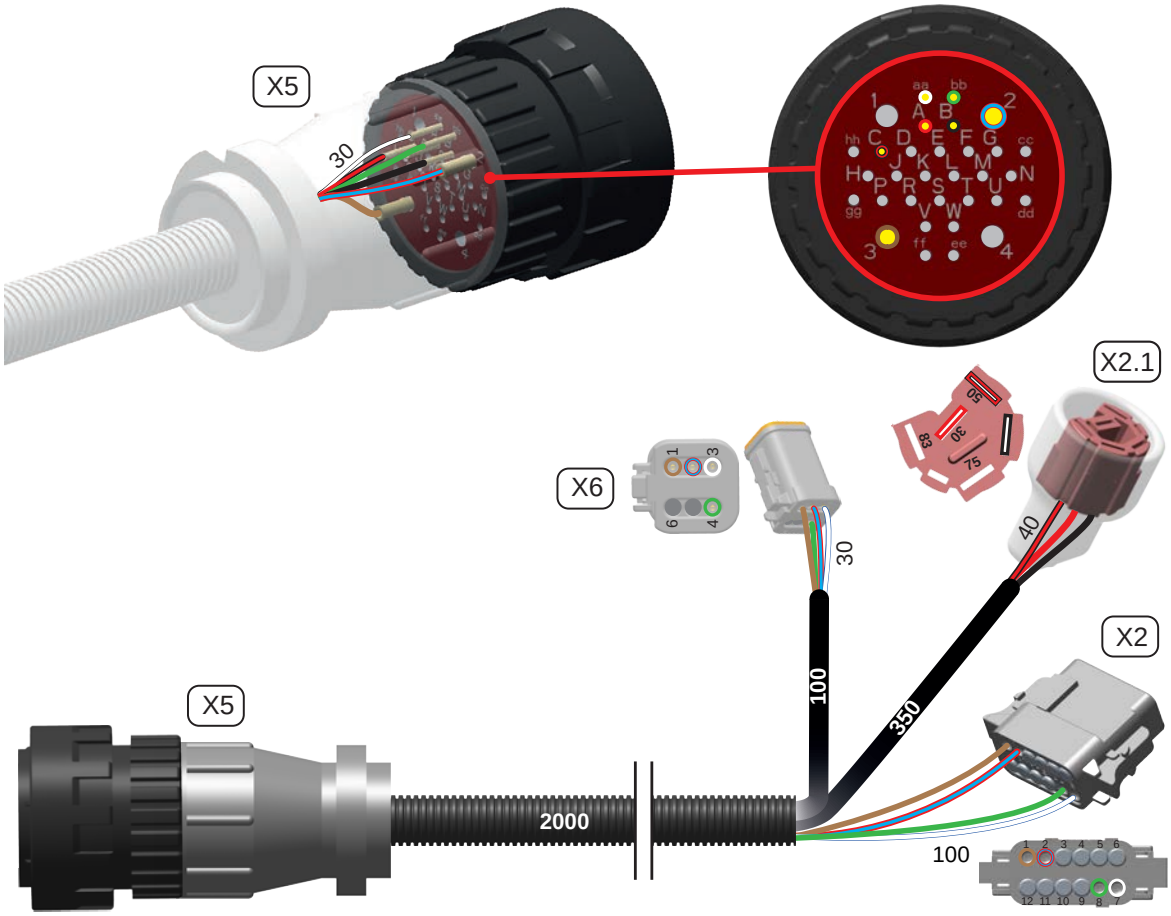
All wiring harnesses must be laid in such a way that their properties are not endangered. Note the following criteria here:

- Protection against external influences, e.g., high temperatures, chemical substances, (spray) water etc.
- Protection against motor vibrations, shocks, direct pressure on cables, sharp edges and thus against mechanical damage to the cables.
- Compliance with permissible bending radii and tensile forces.

NOTICE

Line ends that are not connected to a connector (open wire) must be insulated against short circuits.

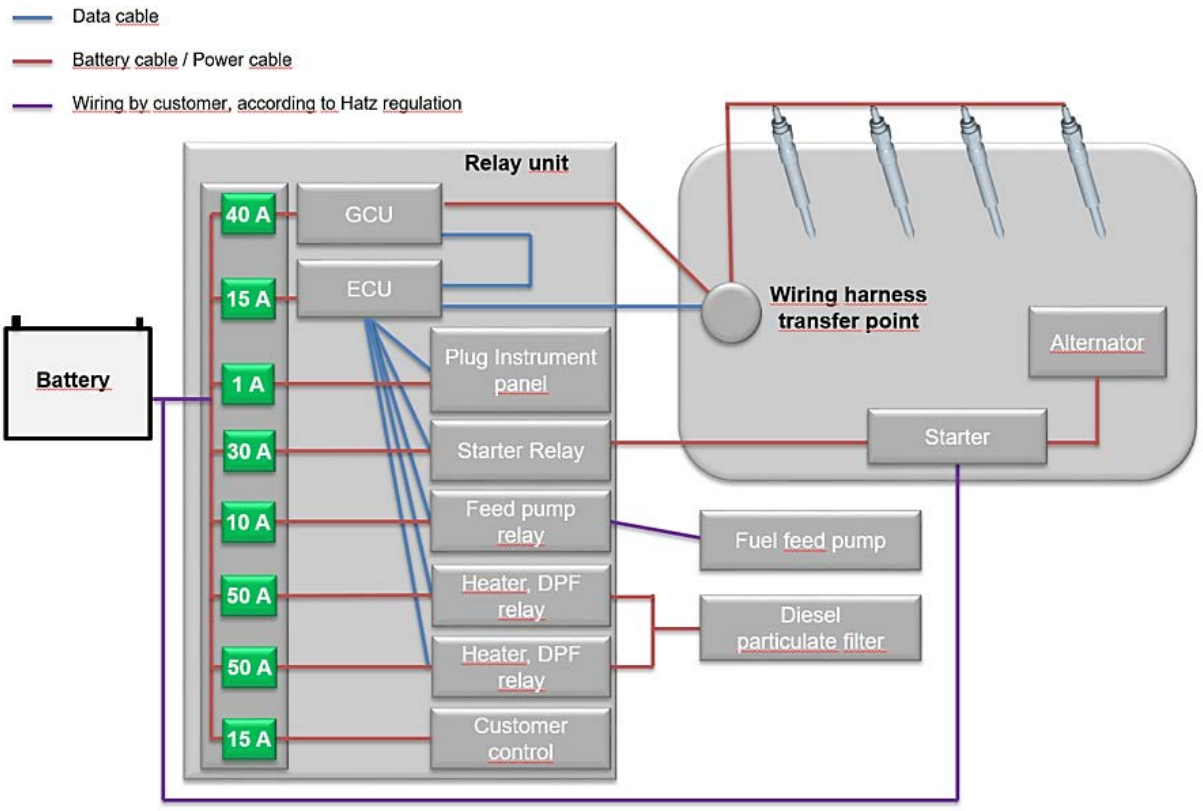
Customer control unit wiring harness



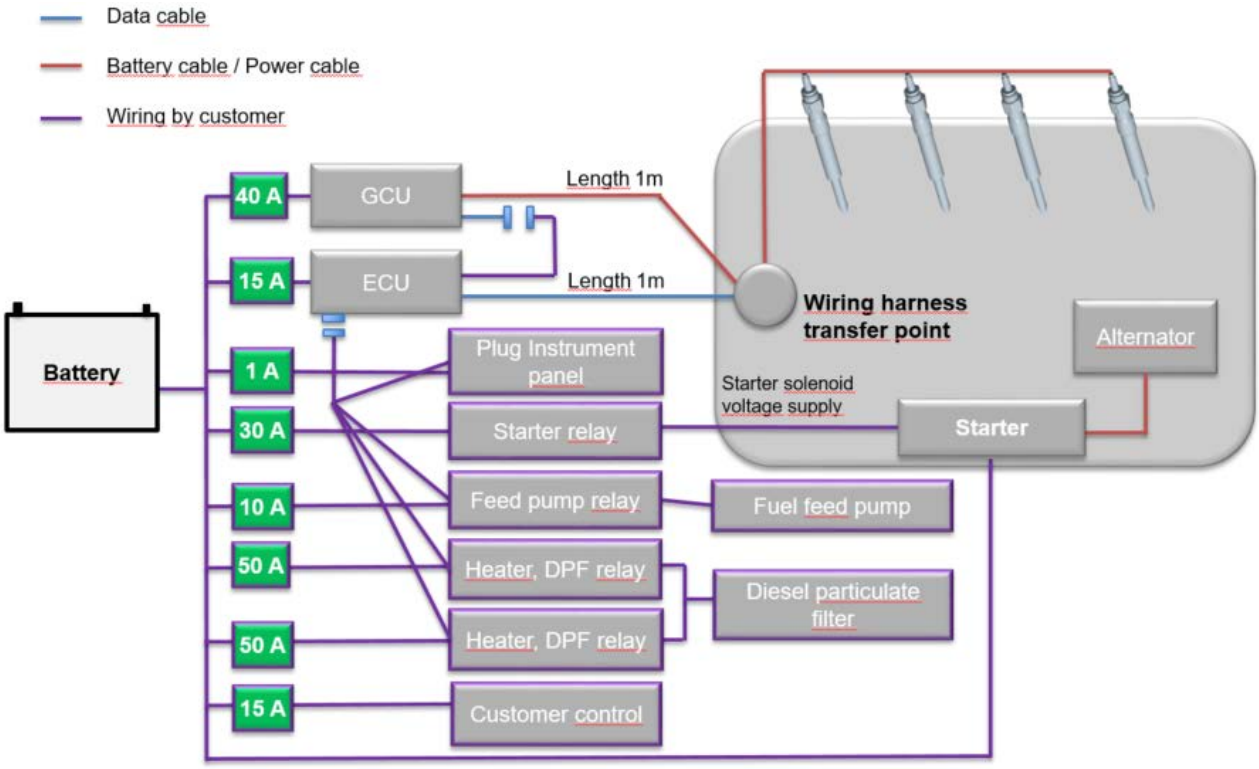
Connector pin assignment					
X5* **Pin no., connector designation (ITT Cannon, Plug 4/28 192900-0549)**		**Color coding**	**X6 Diagnostics interface**	**X2 CAN display (HSP)**	**X2.1 Ignition switch**
2	Ignition on T.15 with post-running	Red/blue	2	2	
3	B- T.31	Brown	1	1	
A	B+ / 5A power supply T15/50	Red			30
B	Ignition on T.15	black			15
C	Start signal T.50	Red/black			50
aa	CAN 0 high (customer CAN)	White	3	8	
bb	CAN 0 low (customer CAN)	Green	4	7	

***X5** *consists of two parts: the circular connector sleeve housing (actual pinning) and the circular connector housing.*

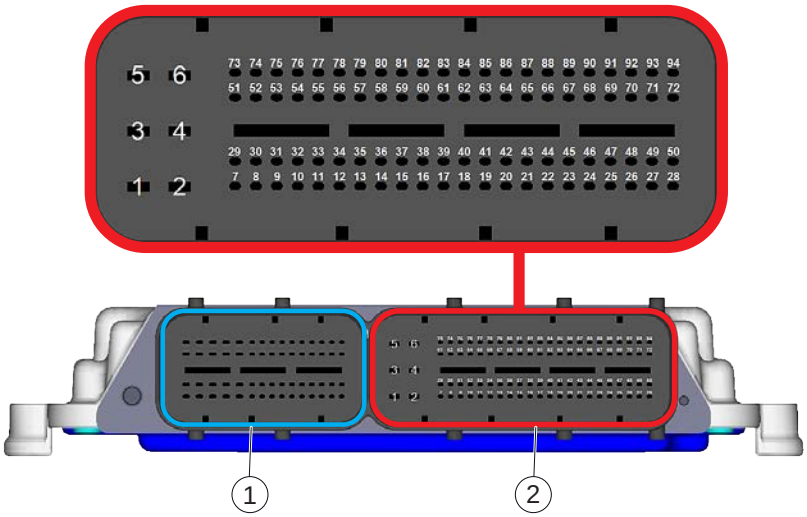
9.6.1 Open Power Unit (OPU) C81



9.6.2 Fan2Flywheel (F2F) C81



9.6.3 Pin assignment



Pos.	Control unit (ECU) connector
1	Engine side (X2) A plug
2	Customer-side/chassis-side (X1) K plug

Pin	Connector designation (X1) K plug	Bosch designation
K01	Battery B- 1 of 3	V_V_BAT1R
K03	Battery B- 2 of 3	V_V_BAT2R
K05	Battery B- 3 of 3	V_V_BAT3R
K02	Battery B+ 1 of 3	G_G_BAT1
K04	Battery B+ 2 of 3	G_G_BAT2
K06	Battery B+ 3 of 3	G_G_BAT3
K46	Ignition "On" T.15	I_S_T15
K74	Starter signal T.50	I_S_T50
K93	Engine running lamp (ERL)	O_S_ERL
K68	Diesel particulate filter lamp [1)]	O_S_FHRLY
K92	Diagnostic lamp (DIA)	O_S_DIA
K18	Multi-state switch (ground)	G_R_MSSRPM
K09	Speed selector switch	I_A_MSSRPM
K50	Engine start/stop switch	I_S_ENGSA
K66	CAN 0 High	B_D_CANL0
K87	CAN 0 Low	B_D_CANH0
K86	CAN 1 DIA High	B_D_CANH1
K64	CAN 1 DIA Low	B_D_CANL1
K86	CAN 1 DIA High	B_D_CANH1
K64	CAN 1 DIA Low	B_D_CANL1
K37	Alternator D+ (alternator monitoring)	I_S_AM
K47	Main relay signal	O_S_MRLY
K72	Control, electrical fuel pump relay	O_S_PSPRLY1
K57	Glow time control unit DI control	O_T_GCU

Pin	Connector designation (X1) K plug	Bosch designation
K42	Glow time control unit ST control	O_T_GCU
K77	Water in fuel sensor	I_S_WFS
K14	Coolant level sensor	I_S_CLS
K17	Coolant level sensor (ground)	G_R_CLS
K85	Air filter differential pressure sensor (ground)	G_R_AFDPS
K82	Air filter differential pressure sensor (signal)	I_A_AFDPS
K23	Air filter differential pressure sensor (5 V)	O_V_5VAFDPS
K32	Parking brake switch	I_S_BRKPS
K89	Neutral gear switch	I_S_GNSW
K38	Brake pedal switch (normally open contact)	I_S_BRKMN
K78	Brake pedal switch (normally closed contact)	I_S_BRKRED
K24	DPF differential pressure sensor (5 V) [1)]	O_V_5VPFDP
K65	DPF differential pressure sensor (signal PFDP) [1)]	I_A_PFDP
K80	DPF differential pressure sensor (ground) [1)]	G_R_PFDP
K36	DPF exhaust gas temperature sensor T1 [1)]	I_A_EXTS1
K63	DPF exhaust gas temperature (ground) [1)]	G_R_EXTS
K11	DPF exhaust gas temperature sensor T2 [1)]	I_A_EXTS2
K27	Air mass flow meter (5 V) [1)]	O_V_5VSENT
K12	Air mass flow meter (signal 1) [1)]	I_D_SENT1
K21	Air mass flow meter (signal 2) [1)]	I_D_SENT2
K73	Air mass flow meter (ground) [1)]	G_R_SENT
K56	DPF auxiliary heating 1 [1)]	I_S_EXHD1
K54	DPF auxiliary heating 2 [1)]	I_S_EXHD2
K45	External exhaust heating [1)]	O_S_HH

[1)]Only for TICD version

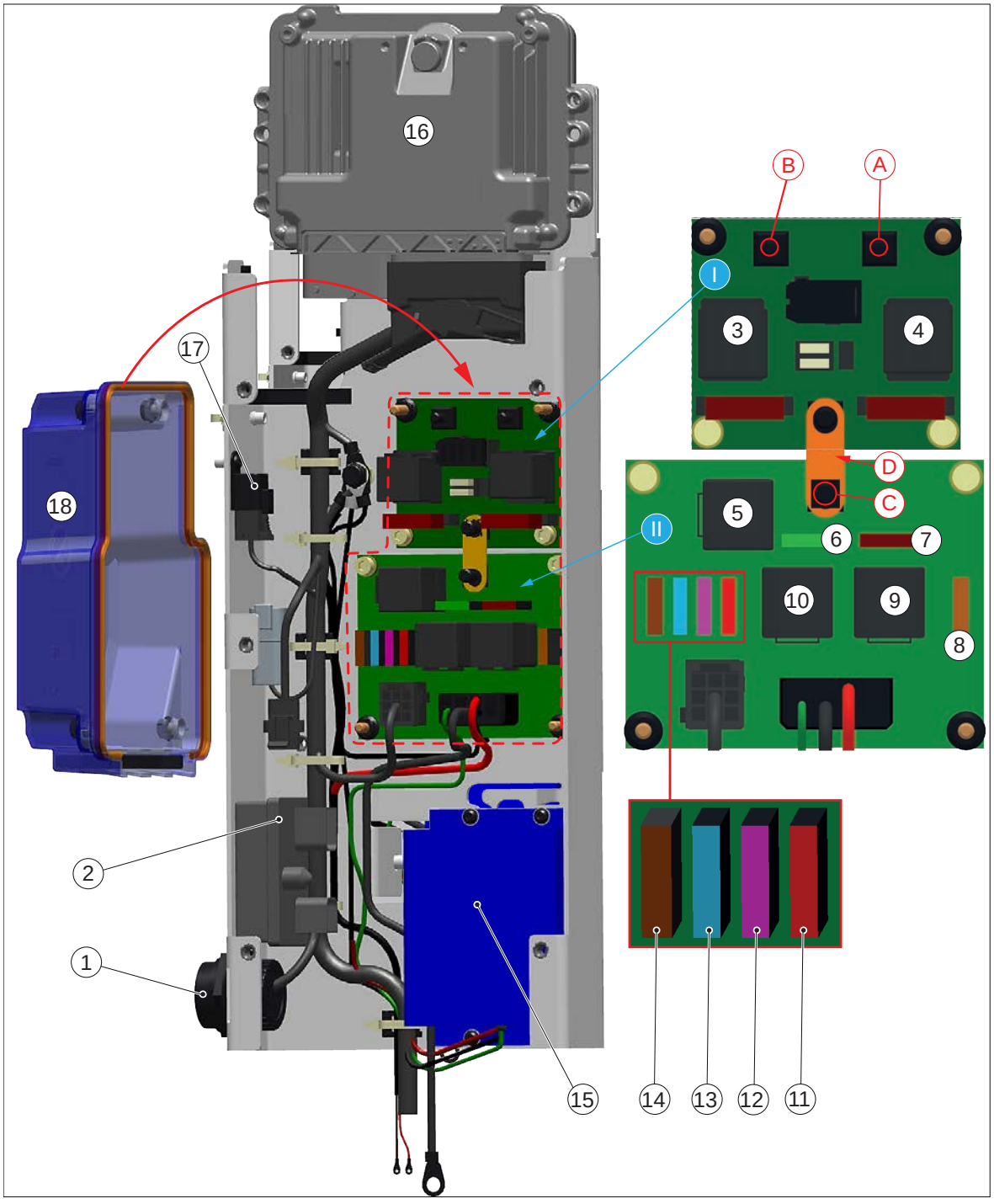
ECU-PIN nomenclature:

I_A_XXXX	Analog input
I_S_XXXX	Digital input
I_F_XXXX	Frequency input
O_F_XXXX	Frequency output
O_S_XXXX	Low side (ON/OFF)
O_T_XXXX	Power modul (PWM) output
O_P_SVHXY	Injector output high side
O_P_SVLXY	Injector output low side
O_V_XXXX	Switched battery output (high side)
B_D_XXXX	Bi-directional line
V_V_XXXX	Sensor supply voltage
G_R_XXXX	Sensor ground
G_G_XXXX	Ground

9.7 Plug retaining plate

NOTICE

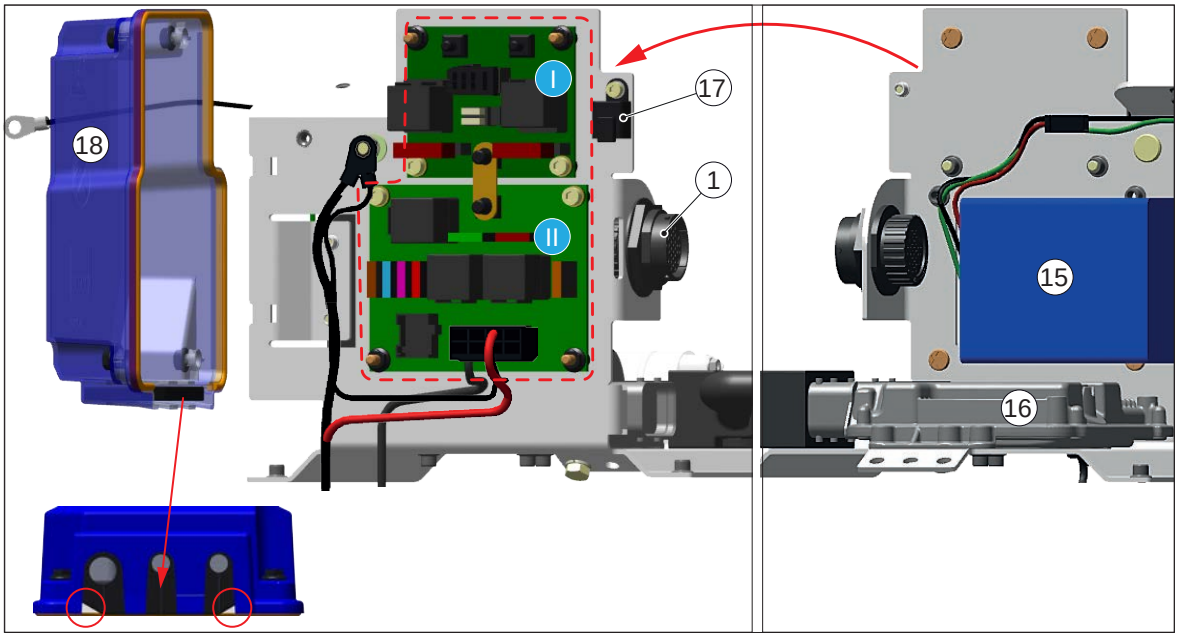
For leak-tight plug connections, it must be ensured that the lines extend straight out of the connector for approx. 50 mm. For the single wire seals, the diameter must fit or else the plug connection will not be tight.



	Pos.	Use	Circuit diagram designation	Fuse
	1	Instrument panel/customer control: ITT Cannon, Plug 28+4 192900-0549 Connection or customer control unit wiring harness (circular connector X5)		
	2	Glow time control unit 24 V (or 12 V)	GPCU (GCU)	

	Pos.	Use	Circuit diagram designation	Fuse
I	Power module DPF additional heating (TICD)			
	3	Relay exhaust heater 1 + fuse (Active Premium)	2K7 / 2F7	50A
	4	Relay exhaust heater 2 + fuse (Active Premium)	2K8 / 2F8	50A
	A	GK1 Plus line exhaust heater (Active Premium)		
	B	GK2 Plus line exhaust heater (only for Active Premium 12-V version)		
II	Central electrics C81			
	C	B+ power supply for central electrics (tightening torque 9 Nm)		
	D	B+ jumper to power module (I)		
	5	Control unit main relay on	1K6	
	6	Fuse, starter 50	1F6	30 A
	7	Fuel pump fuse	1F2	10 A
	8	Glow plug fuse	1F3	40 A
	9	Fuel feed pump relay	1K5	
	10	Starter relay	1K4	
	11	Ignition on fuse, terminal 15	1F5	10 A
	12	Ignition on fuse, terminal 15 customer	1F7	4 A
	13	Control unit B+ fuse	1F4	15 A
	14	T15/T50 fuse	1F1	5 A
	15	DC/DC converter, only with 24-V version (option)		
	16	Engine control unit EDC 17C81 - 12 V		
	17	Diagnosis connector		
	18	**Central electrics cover** Note: Assemble the seal strip for the cable connections with the 45° edges facing down (see figure below).		

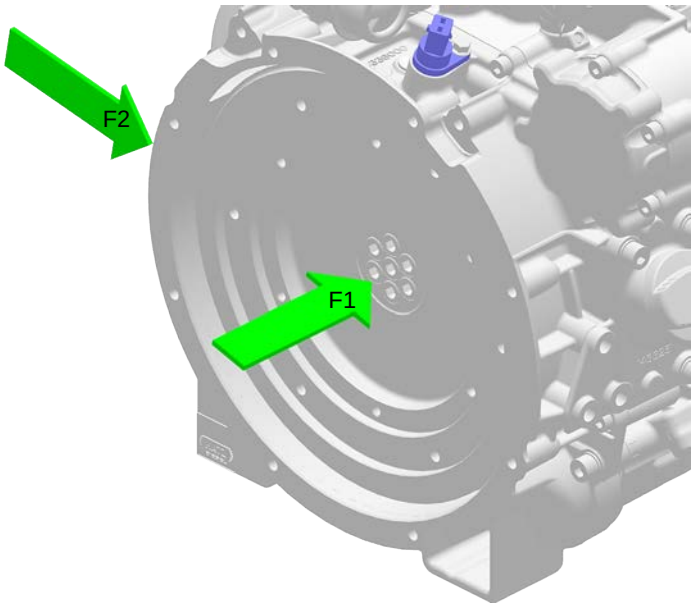
SilentPack connector retention plate



10 Power take off

10.1 Main take off – flywheel side

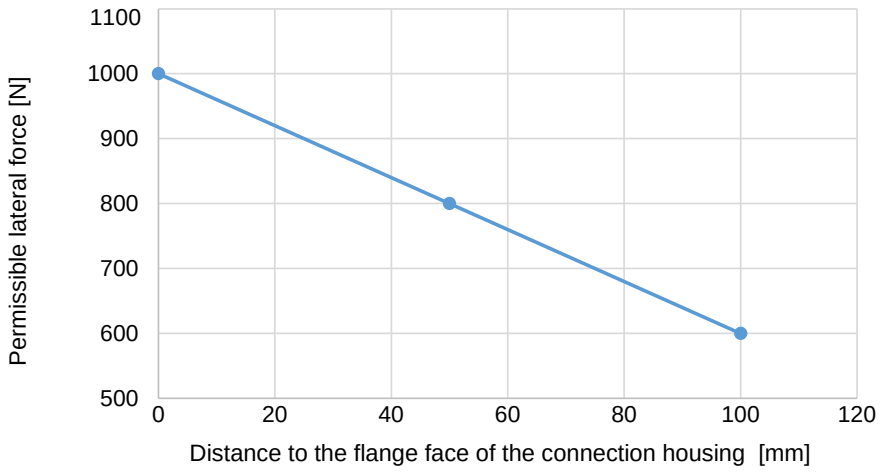
NOTICE
Before installing further add-on parts, the preservation wax must be removed from the screw-on surfaces and the surfaces must be cleaned.



Axial (F1)	3000 N, direction dependent
Radial (F2)	See diagram
Max. perm. mass moment of inertia	0.2 kg/m^2
$J_{flywheel+engine}$ 4H50	0.234 kg/m^2
$J_{flywheel+engine}$ 3H50	0.217 kg/m^2
Fixed mass on flywheel	Up to 10 kg at 80 mm centroidal distance to flywheel flange

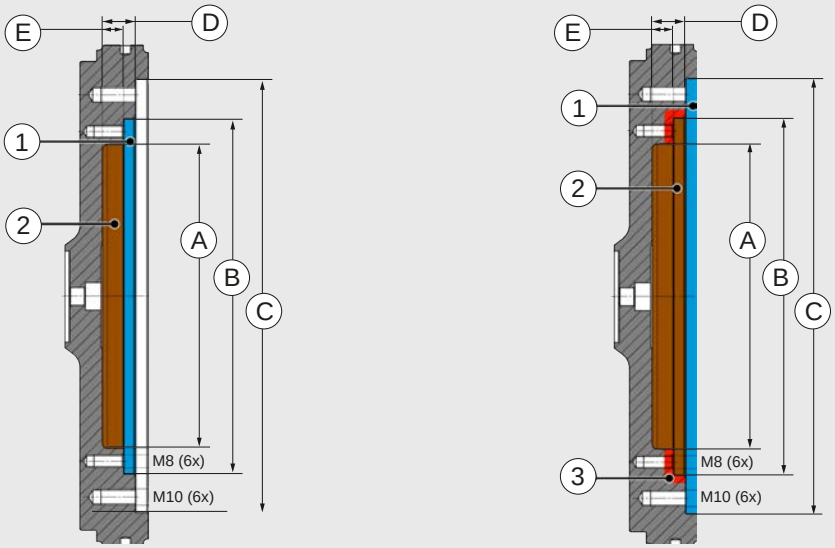
SAE 5 (standard), SAE 4 or SAE 3 connection housing and the 6.5"/8" or 10" flywheels will be available for the main take off.

Lateral force on flywheel without additional mount



10.2 Combined flywheel 6.5"/8" with connection housing/10" flywheel

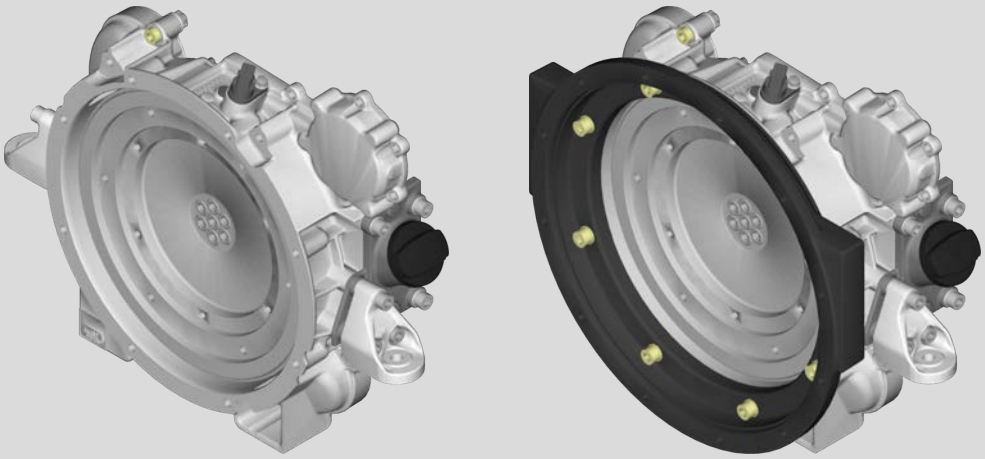
6.5 inch	8 inch



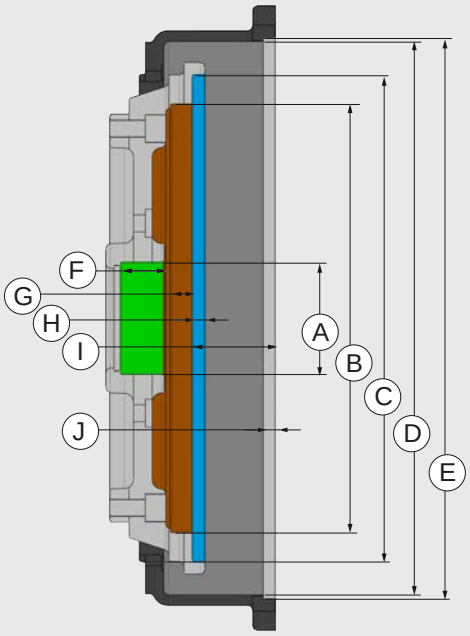
1	Coupling diameter
2	Indentation
3	For the manufacture of a combined flywheel required deviation from the SAE standard

A		B		C		D		E	
mm	inch	mm	inch	mm	inch	mm	inch	mm	inch
184.2	7 ¼	215.90	8 ½	263.52	10 ⅜	12.9		20.1	

connection housing	flywheel	connection housing	flywheel
SAE 5	**Combined flywheel 6.5" and 8"**	**SAE 4**	**Combined flywheel 6.5" and 8"**



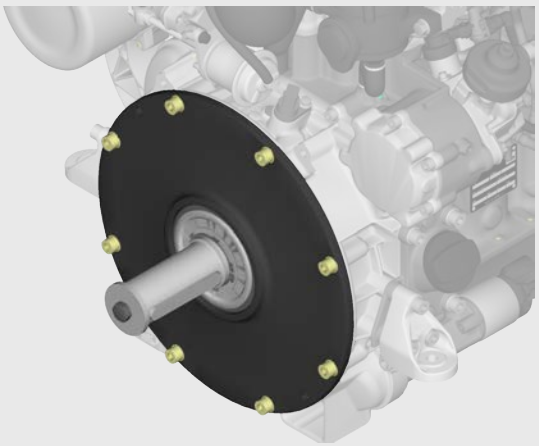
Connection housing SAE 4 with 10" flywheel



A	72 mm	**F**	28.4 mm
B	276.4 mm	**G**	14.3 mm
C	314.32 mm	**H**	8.3 mm
D	357 mm	**I**	53.8 mm
E	361.95 mm	**J**	8 mm

10.3 Connection housing with outside bearing

Permissible transverse forces on outside bearing



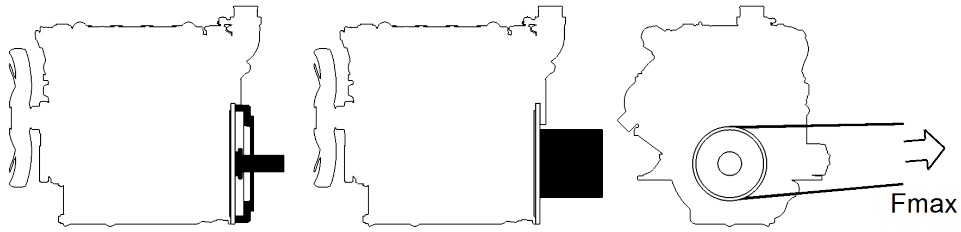
Distance to flange level [mm]	Permissible tensile force [N]
0	9,000
45	9,000
90	4,500
135	3000
180	2,250
225	1800
270	1500

stub shaft	Ø48 h7 x 110, mass inertia 0.023 kg/m²
stub shaft	Ø50 h7 x 110
feather key	100 x 14 P9

10.4 Power take off

10.4.1 Not separable

The offered drive elements may only be used according to the instructions in the dimensional drawings. The permissible radial load capacity of the stub shafts or the permissible axial offset of elastic couplings must not be exceeded.



The calculation of the load capacity of the power take off on the engine can be found at *10.1 Main take off – flywheel side, page 172*.

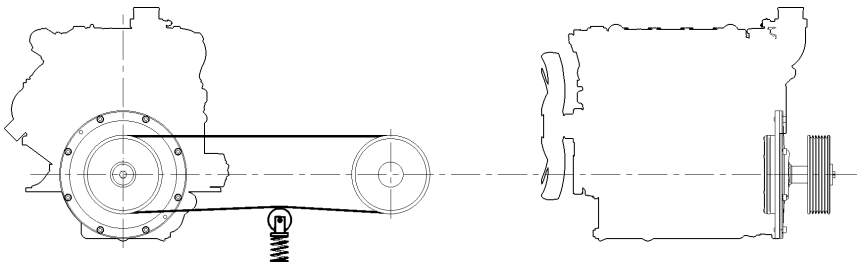
The overload of power take offs, particularly by uncontrollable belt tensioning devices, can cause damage to the bearings and shaft fractures.

If the permissible limits cannot be adhered to, please contact your responsible **HATZ subsidiary**. They will show you possible solutions.

10.4.2 Belt drives

Since the type of belt tension can have a greater impact on the size of the bearing load than the size of the torque to be transmitted, the following applies:

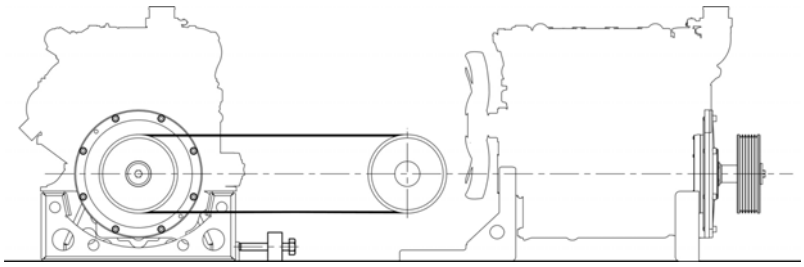
- **Controllable belt tensioners guarantee** that bearings and shafts are not overloaded and do not break. The belt tension is controllable by a spring-loaded idler pulley or hydraulic belt tensioner, for example.



The **actual force effect** in case of **flexible** belt tension can be calculated as follows:

$$\mathrm{Fges} = (33\ x\ \mathrm{P}max)/(\mathrm{n}/1000\ x\ \mathrm{d}w)$$

- **Uncontrollable belt tensioners** have the risk of overloading the bearings due to excessive tension forces. These tensioners include tensioning screws, prestressing via flexible belts etc.



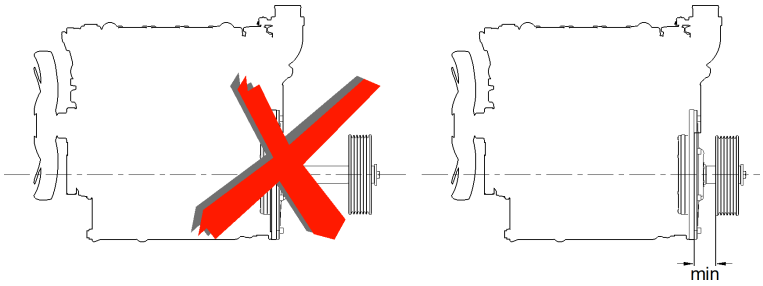
The **actual force effect** in case of rigid belt tension can be calculated as follows:

$$Fges = (47.8 \; x \; Pmax)/(n/1000 \; x \; dw)$$

Ftot	Actual force effect [N]
Pmax	Engine output [kW]
n	Speed [min^{-1}]
dw	Diameter of engine pulley [m]

Two further recommendations for belt drives:

- Mount the pulley as close as possible to the bearing to keep the bearing load low; see chapter *10.3 Connection housing with outside bearing, page 174*.
- The pulley on the engine must be as large as possible in order to keep the belt tension low.



10.4.3 Hydraulic pump on main take off

⚠ CAUTION
Risk of injury or danger of engine or hydraulic pump damage caused by failure to comply with the installation instructions/Operator's Manual of your hydraulic pump. As the operator of the machine, you must ensure that all people working on the machine are familiar with the content of this manual. Read the instructions and especially the safety conditions before working on the machine.

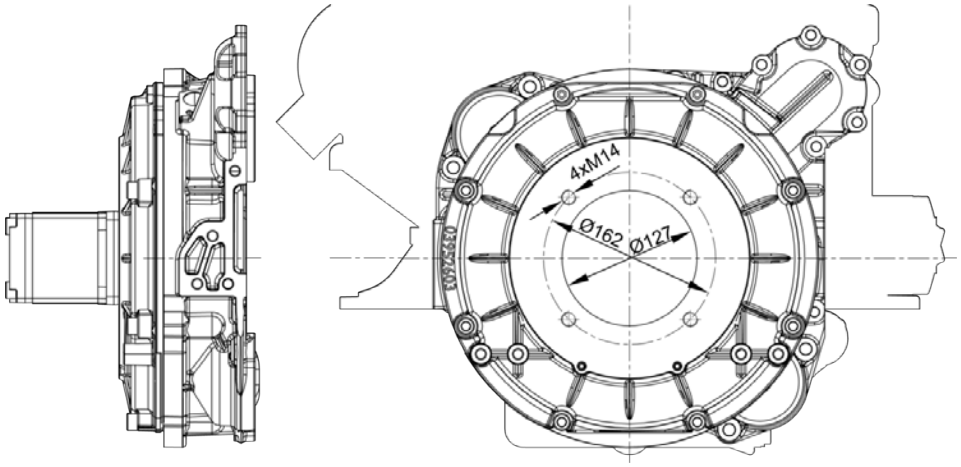
$$F_{zul} = \frac{1{,}7 * 10^6 [Nmm]}{(l + 53{,}1)[mm]}$$

F perm	Maximum permissible alternating load
l	Distance of attack point to the flange connection on the connection housing

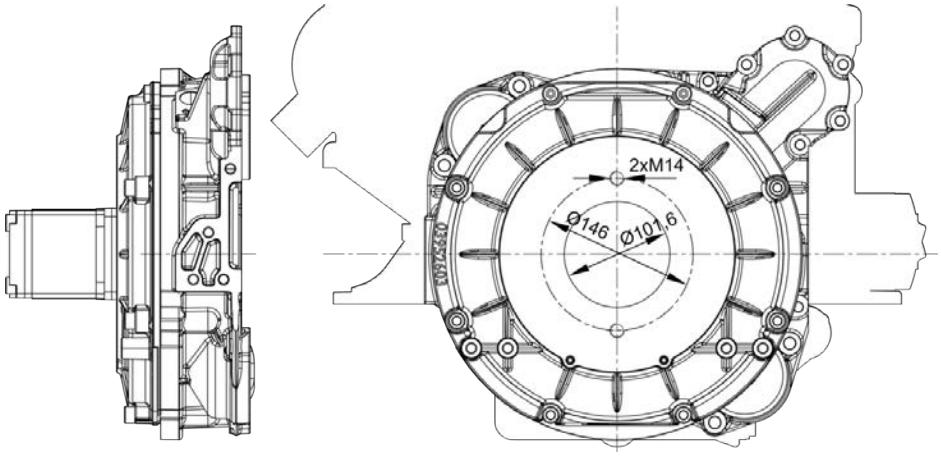
To install your hydraulic pump, only use the screw dimensions and qualities recommended by the hydraulic pump manufacturer. For mounting on the engine, heed the most recent installation instructions for your hydraulic pump.

If you have any other questions, please contact the hydraulic pump manufacturer.

SAE 4



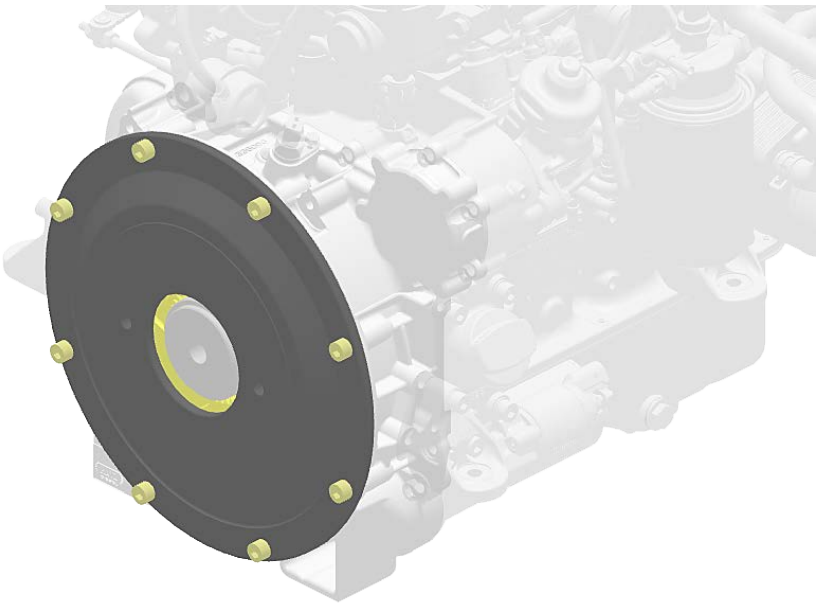
SAE 5

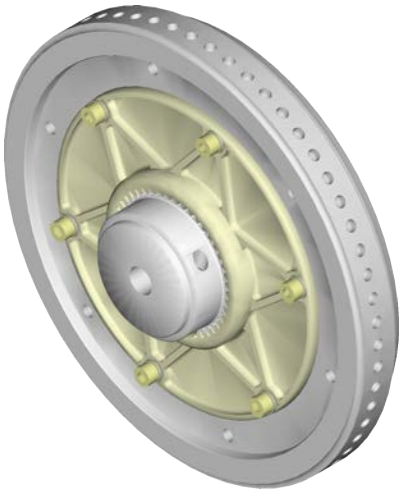
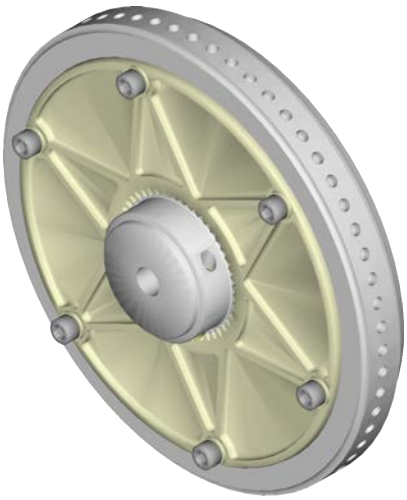
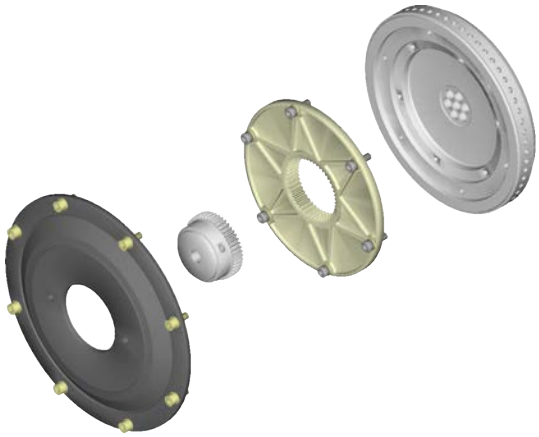


For details on the flange and shaft dimensions of the planned hydraulic pump, please contact your **HATZ Service Station**. Apart from hydraulic pumps of various sizes, Hatz also has additional add-on parts for hydraulic pumps available on request. Please contact your **Hatz subsidiary**.

10.5 Couplings

Couplings are available in 6.5 and 8 inches. Both are combinable with SAE5 and with SAE4 connection.



6.5 inch coupling	8 inch coupling
	
SAE 5 inch connection	**SAE 4 inch connection**
	
Drilled hole Ø 101.6 / M14 – 2-hole flange Pitch circle Ø 146	Drilled hole Ø 101.6 / M14 – 4-hole flange Pitch circle Ø 162

Coupling hubs

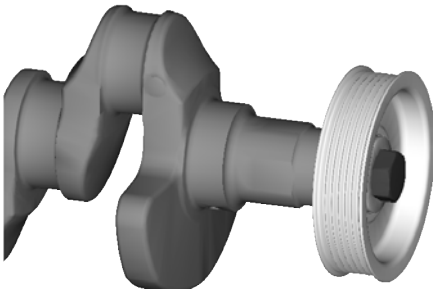
Hubs are available in the following sizes:

- Pre-drilled Ø 18.9 mm
- 7/8 inch, 13 teeth as per ANSI B92.1a/1976
- 1 inch, 15 teeth as per ANSI B92.1

Further hubs on request.

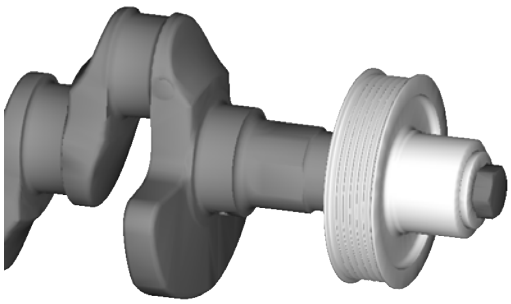
10.6 Main drive - timing cover side (crankshaft/fan)

Standard crankshaft

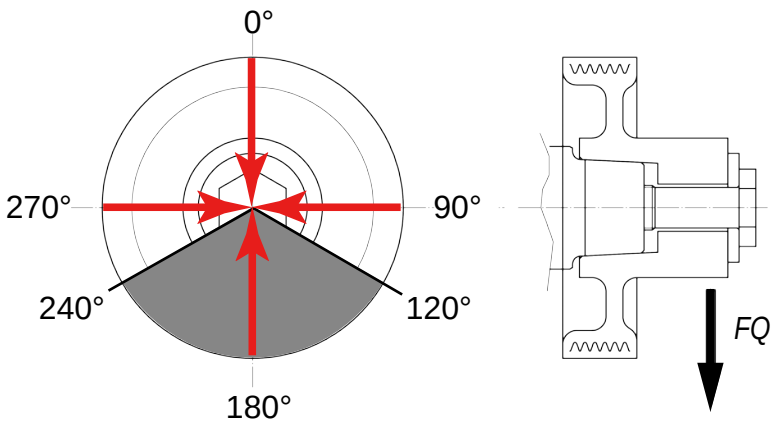


Without lateral force	42 Nm
With air conditioning compressor	12.5 Nm

Tapered crankshaft



Without lateral force	200 Nm
With lateral force, see the following diagram ▪ The maximum lateral force FQ 2 kN may be tapped at 120° to 240°.	50 Nm



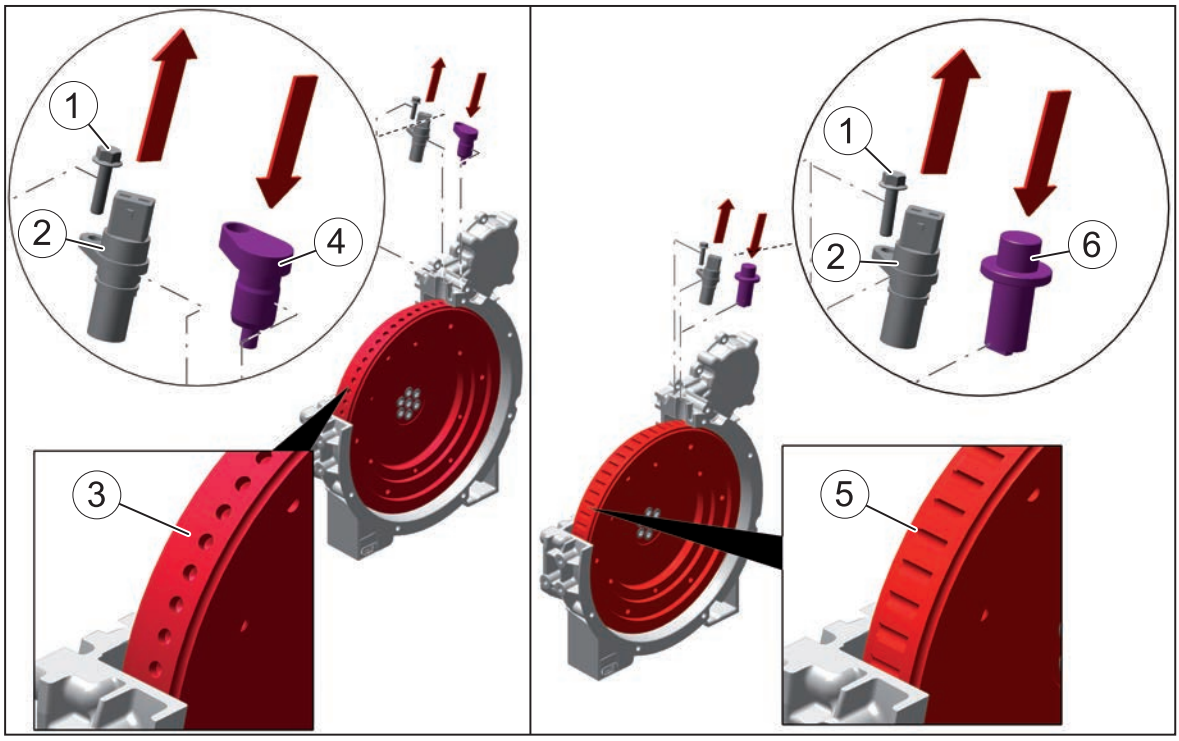
FQ = transverse force

10.7 Blocking the crankshaft

Introduction

To fix and tighten add-on parts to the flywheel, it is often helpful to block the flywheel against rotation. For this purpose, Hatz offers two blocking tools - depending on the flywheel version.

Overview of the different flywheel versions



1	Fixing screw
2	Crankshaft speed sensor
3	Markings on the flywheel (example: version with round markings)*
4	Blocking tool for flywheel with round markings (order number 841 797 10)
5	Markings on flywheel (version with slotted markings)*
6	Blocking tool for flywheel with slotted markings (order number 657 842 00)

* The markings serve as pulse generators for the crankshaft speed sensor.

Procedure

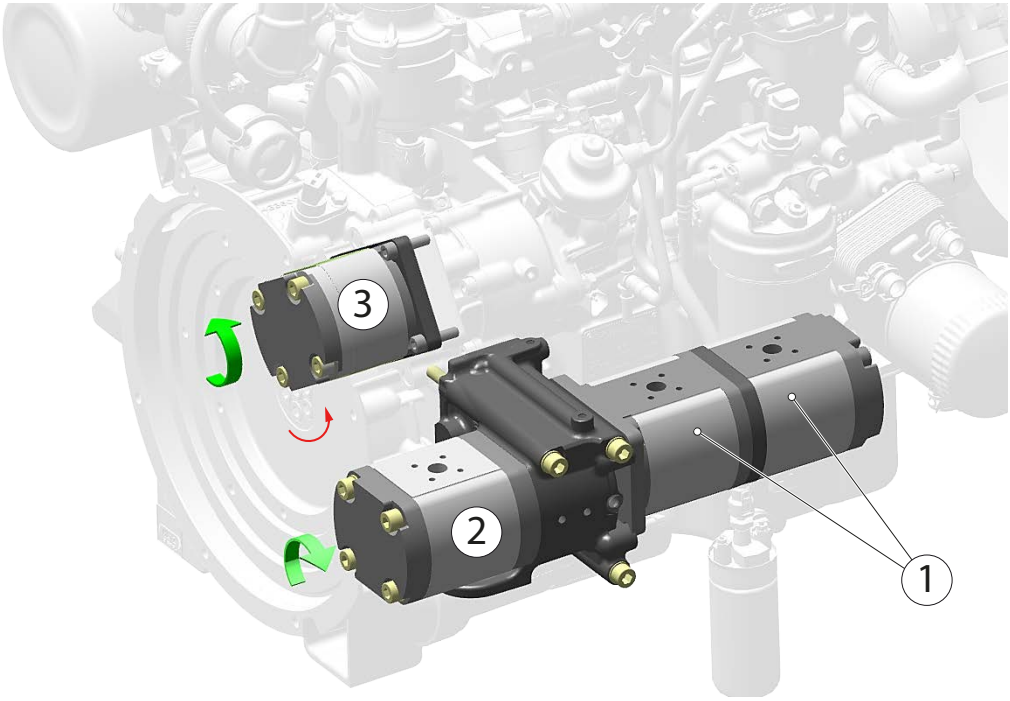
Step	Activity
1	Unscrew the fastening screw (1).
2	Carefully remove the crankshaft speed sensor (2).
3	Insert blocking tool (4) or (6) - depending on the type of flywheel markings - into the hole for the speed sensor. Turn the flywheel slowly until the tool engages.
4	Fix the blocking tool with the fastening screw (1).

NOTICE

The blocking tool can absorb torques of 250 Nm at the crankshaft center. Off-center bolted connections are to be calculated with the maximum displacement of the lever force.

10.8 Power take off - hydraulic pump

A maximum of four hydraulic pumps must be flangeable on the two power take-offs.



1/2	M_{max} = 100 Nm / $n_{hydr.}$ = 1.1 x n_{engine} [min^{-1}]
3	M_{max} = 80 Nm / $n_{hydr.}$ = 1.0 x n_{engine}[min^{-1}]

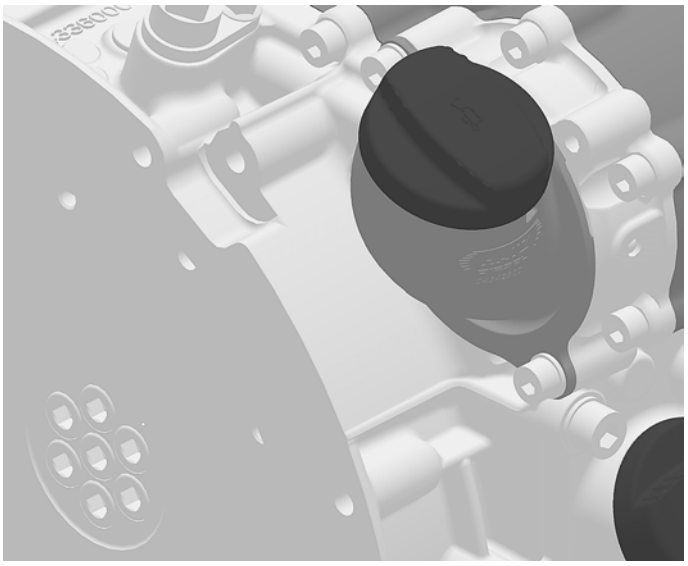
Standard available hydraulic pumps:				
Pos	**Hydraulic pump**	**Description**	**Sense of rotation**	**Available [cm³]**
1	4-hole HP Ø 80	4-hole flange, 4.6 to 31 cm³/rev. splined shaft DIN 5482 B17x14 - 9 teeth	Clockwise hydraulic pump	4.65, 6.45, 8.25, 12, 13.8, 15.52
1	SAE-A HP Ø 82.55	2-hole flange, 4.6 to 31 cm³/U splined shaft SAE J744 16-4 9T – 9 teeth	Clockwise hydraulic pump	None
2	2-hole HP Ø 50	Without flange, 4.6 to 31 cm³/rev. splined shaft DIN 5482 B17x14 - 9 teeth	Counterclockwise hydraulic pump	12, 22.87, 31.2
3	4-hole HP Ø 80	4-hole flange, 4.6 to 31 cm³/rev. splined shaft DIN 5482 B17x14 - 9 teeth	Clockwise hydraulic pump	4.65, 6.45, 8.25, 12, 13.8, 15.52

NOTICE

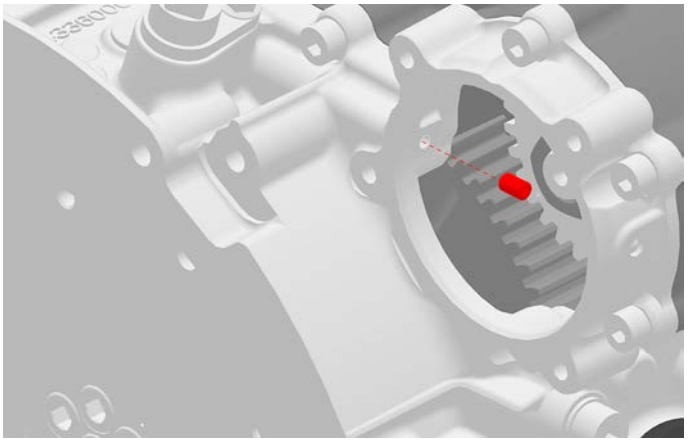
The sum of the torques of all power take-offs must not exceed 100 Nm.

Top power take-off with pressure oil hole

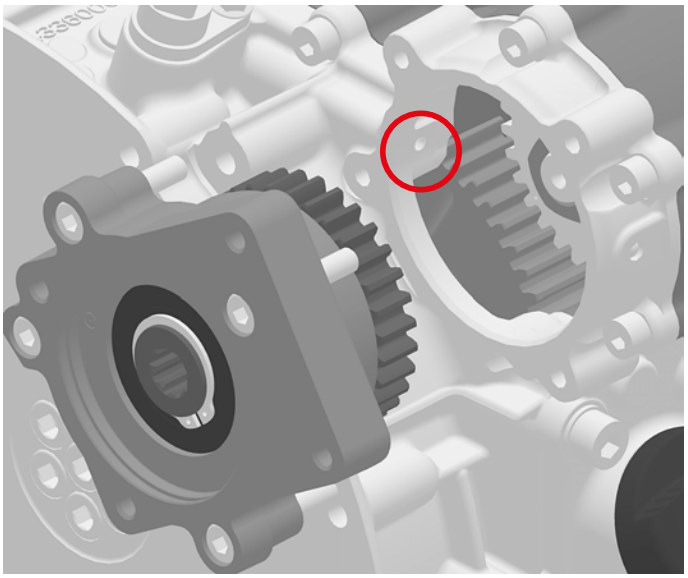
Engine with oil filler on top power take-off (PTO); see *10.8 Power take off - hydraulic pump, page 181*, position 3.



To enable the top PTO to be supplied with pressure oil, the set screw M6x10 must be removed. Failure to do so can lead to **serious engine damage**!



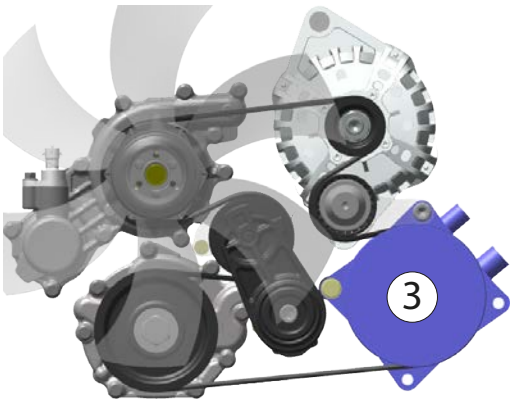
The PTO may only be mounted on CP4 after the pressure oil hole is open.

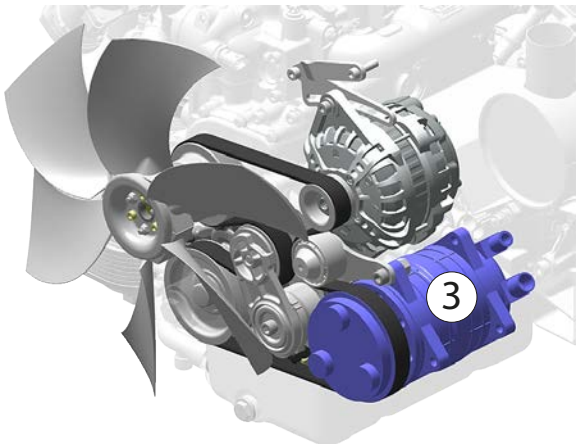


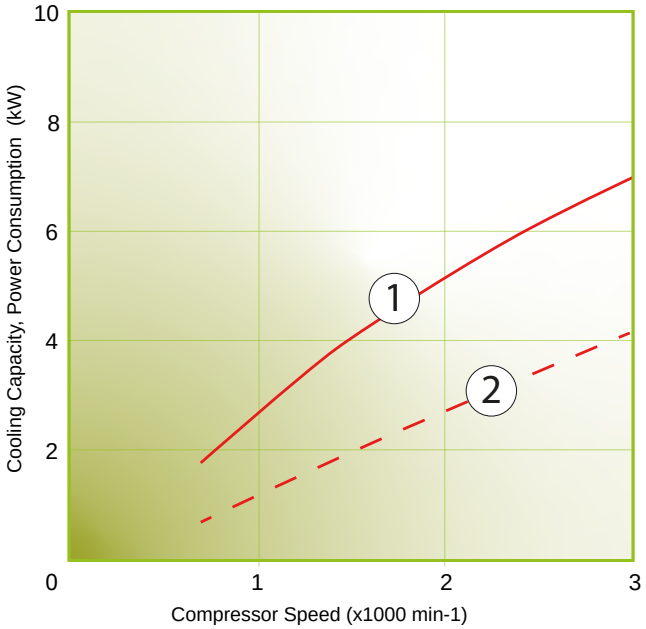
10.9 Power take off - air conditioning compressor

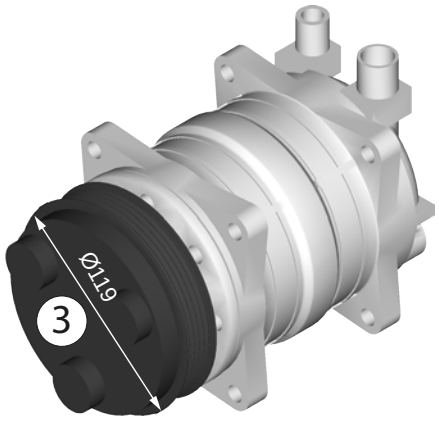
NOTICE

Air conditioning compressor add-on only possible with 12 V and 1.116 ratio.









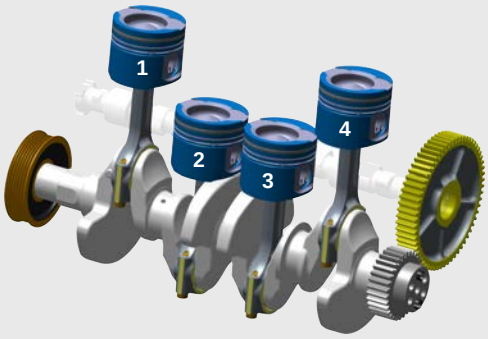
Pos.	Air conditioning compressor TM15: $n_{air\ conditioning\ compressor} = 0.86 \times n_{engine}$ [min-1]
1	Cooling capacity
2	Energy consumption
3	**TM15 air conditioning compressor:** Length 218 mm Depth 125 mm Height 142.5 mm
	Permissible coolant: HFC-R134a, HFO-R1234yf

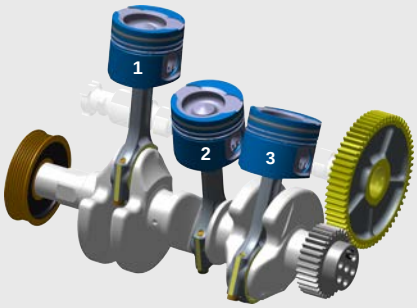
NOTICE

The a/c compressor has an oil filling which enables the engine to be operated even if an air conditioner is not yet connected. If the air-tight caps are removed from the compressor or damaged, the air conditioner must be filled to prevent the compressor from being damaged.

10.10 Drive data

Drilled hole [mm]	84
Stroke [mm]	88
Conrod length [mm]	141.5
Oscillating mass [g] (Mosc)	988





3H50						
	Pulley	1	2	3		**Gear drive**
J [kgmm²]	1323	9017	2926	8707		2855
Pos [°]		0	480	240		
4H50						
	Pulley	1	2	3	4	**Gear drive**
J [kgmm²]	1323	6511	6511	6586	6664	2893
Pos [°]		0	540	180	360	

3H50					
	A	B	C	D	E
N [Nm/mrad]	263.473833	511.11184	511.11184	827.921236	
4H50					
	A	B	C	D	E
N [Nm/mrad]	263.473833	511.11184	511.11184	511.11184	827.921236

Remark:

- Belt and system are not taken into account.
- Gear drive including parts not shown reduced to crankshaft speed.
- Rotating conrod part is taken into account in the crank.
- Flywheel inertia 6.5/8" 0.19 kgm², adapter SAE10 0.15 kgm²

11 General limits of use

11.1 Cold start capability

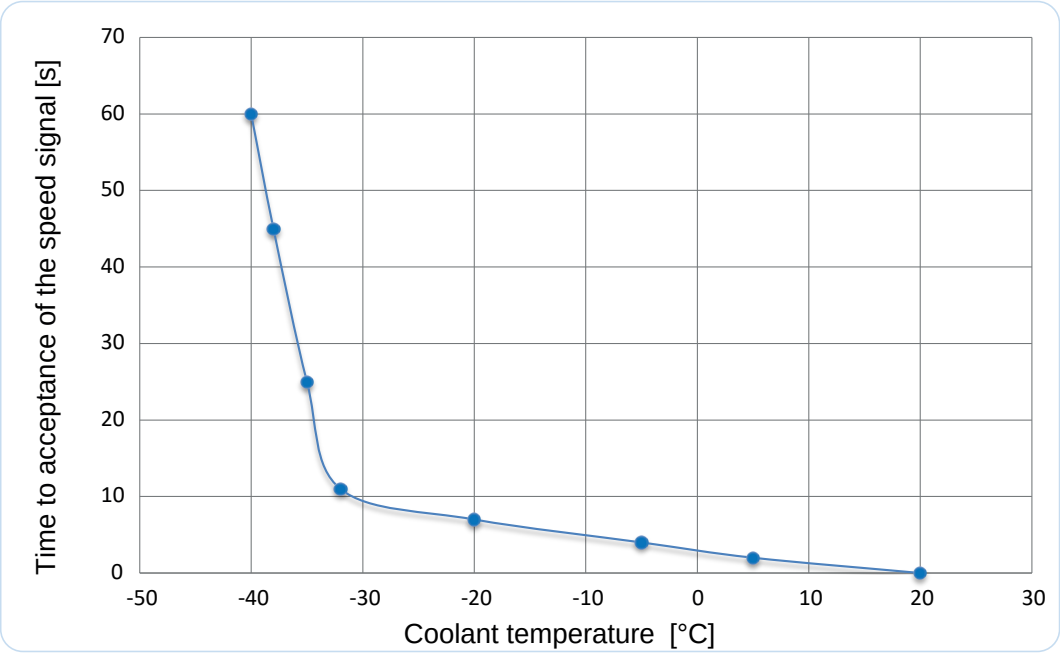
The following specifications are valid up to an altitude of approx. 1460 m above sea level. At higher altitudes, the cold-start capability deteriorates compared to these values.

Cold start with 12-V equipment	-25 °C
Cold start with 24-V equipment	-32 °C
Cold start with 24-V equipment	-40 °C (with special release)

The driven machines should now draw a load during the starting process. If this cannot be guaranteed, e.g., in hydraulic systems, an increase in the minimum cold starting temperature can be expected. This cold start limit temperature must always be determined experimentally, depending on the application and use case.

Engine protection function: delayed speed acceptance after cold start

Because the establishment of the oil pressure is delayed at cold temperatures due to the high oil viscosity, the engine does not accept the engine speed until after the time indicated in the diagram.



11.2 Extreme conditions

The engine is mostly not used at the standard reference point of the **performance standard ISO 3046-1**, (+ 25 °C, 100 m above sea level, 30 % rel. humidity), but in places with **higher altitude and higher/lower temperatures, usually also with higher relative humidity**.

Also **temperature increases** caused by sunlight under a cowling must be considered.

Due to climatic conditions that differ from the standard reference location (altitude, temperature, humidity, contamination), the capacity of the engine leads to power reductions or system adjustments for extreme operating conditions.

It is necessary therefore to consult the **HATZ main plant** in order to best match the system to the application.

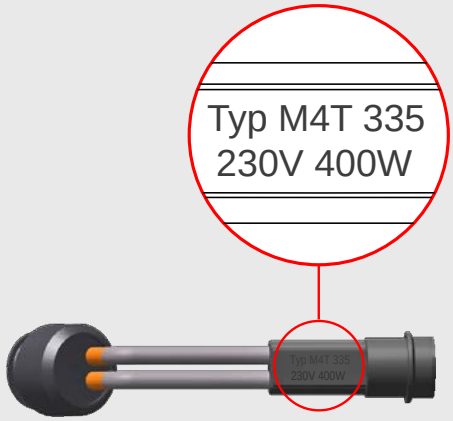
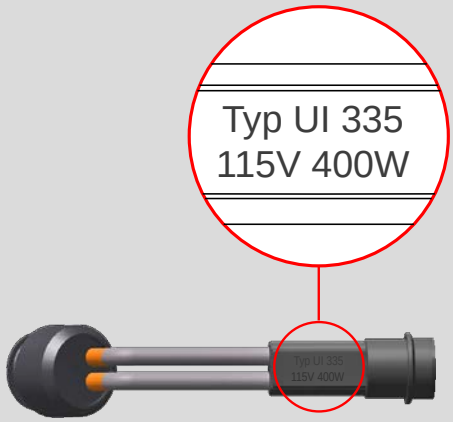
11.3 Permissible speed in coasting overrun

NOTICE	
	Maximum speed in coasting overrun → 3300 rpm

11.4 Electrical coolant prewarming

There are two variants of electrical coolant prewarming units (block heaters). To avoid mix-ups, note the following type label, showing the **voltage V,** on the upper wide area of the heating element before installation (see the following figures).

Variations in the information stamped on the label:

Variant 1: Type: M4T 335 **230V** 400W ID number: 506642xx Packaging code: RE 335	
Variant 2: Type: UI 335 **115V** 400W ID number: 506936xx Packaging code: UI 335	

DANGER

Danger of injury from voltage.

Serious injury can occur during work on electrical equipment.

- Work on electrical equipment with a rated voltage of more than 50 V may only be performed by certified electricians as per IEC 60050.[IEV 195-4-1]

CAUTION

Damage to the heating element if the cooling circuit is not sufficiently filled

Damage to the heating element can happen if the cooling circuit is insufficiently filled or not filled at all.

- Before commissioning, ensure that the line voltage is correct for the variant in use: 115 V or 230 V.

NOTICE

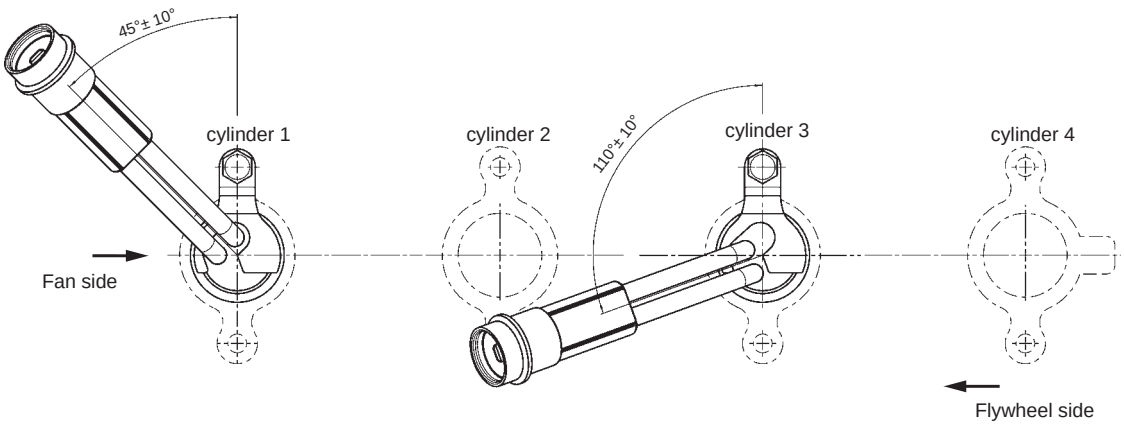
The cable is installed as per the European standard EN 50110-1:2008-09-01 section 3.2.3 Electrician, by a person with suitable technical training, knowledge and experience – to ensure that this person is able to detect and avoid hazards caused by electricity.

In the IEC 60050, it is contained in [IEV 195-4-1]. In the German DGUV Specification 3, Terms No. 6, the electrician is defined in a similar manner.

11.4.1 Installation situation

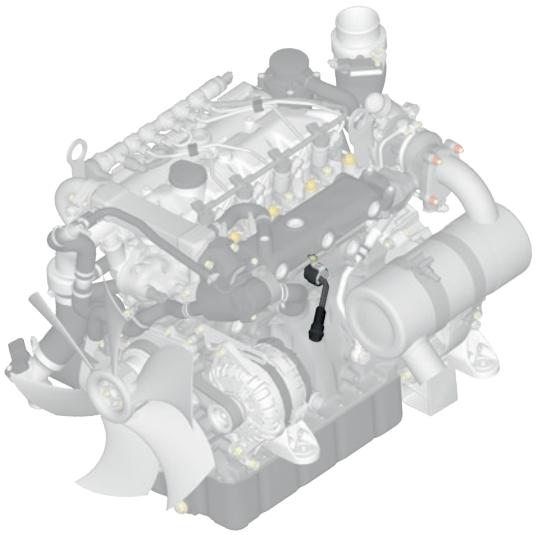
Electrical coolant prewarming

The following different installation positions must be taken into account in the 3H50 and 4H50.



Installation Position 3H50

Installation Position 4H50



Recommended switched-on period					
°C	-20 °C	-10 °C	-5 °C	0 °C	+10 °C
Hours	3	2	1.5	1	1

U = 115V/230V, P = 400W

12 Contact protection - machine safety

12.1 Contact protection for machine safety

It is the responsibility of the manufacturer to heed and comply with the safety rules that apply to an engine in a finished machine.

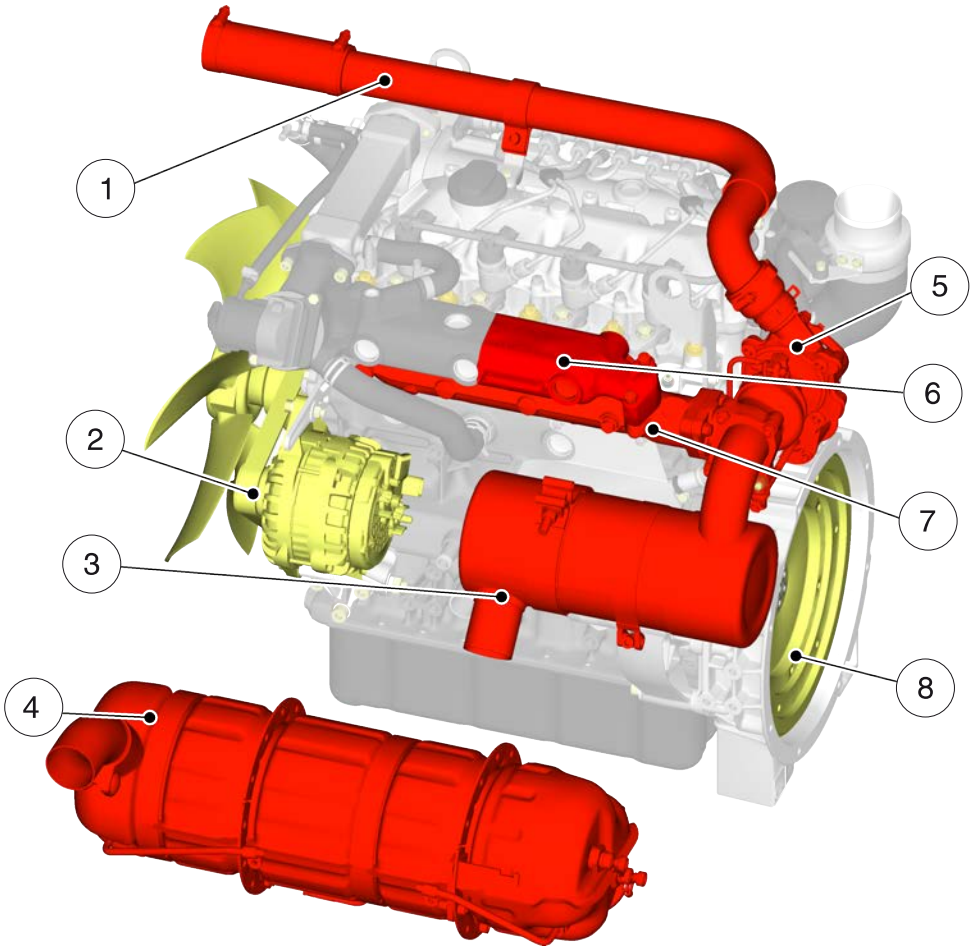
The following chapter shows which contact protective devices are available from HATZ.

An overview that shows the hot surfaces (diesel oxidation catalytic converter, exhaust gas turbocharger (ETC), etc.) and rotating parts (flywheel, fan, poly v belt, etc.) appears below. There is an increased risk of injury here.

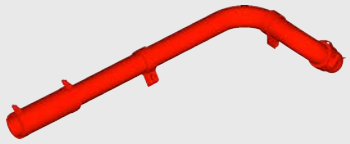
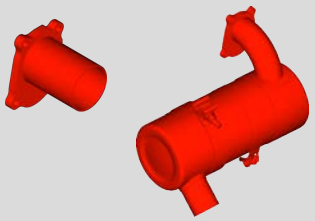
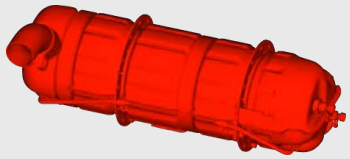
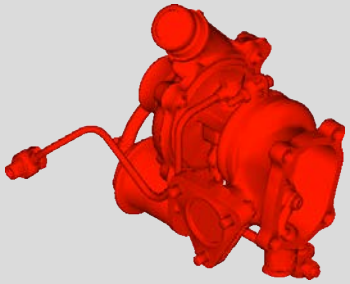
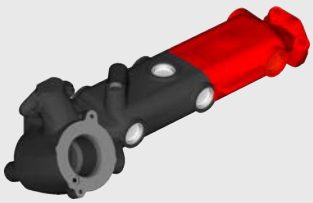
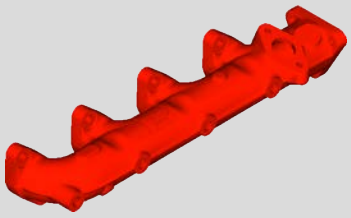
It is the duty of the machine manufacturer to ensure that all safety precautions (e.g. contact protection for the diesel oxidation catalytic converter) are taken for the whole machine so that any injury from hot surfaces and rotating parts can be ruled out.

The protective devices are available from HATZ.

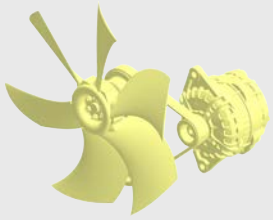
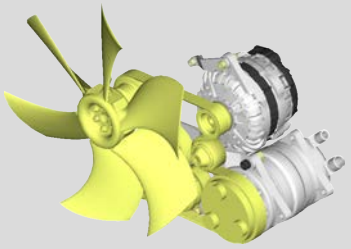
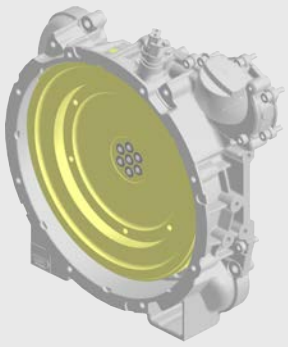
12.1.1 Hot surfaces and rotating parts



Hot surfaces:

Pos	Designation	Function
1	Charge air pipe	
3	Diesel oxidation catalytic converter (DOC)/flange for turbocharger	
4	Diesel particulate filter (DPF)	
5	Exhaust gas turbocharger	
6	EGR precooler	
7	exhaust manifold	

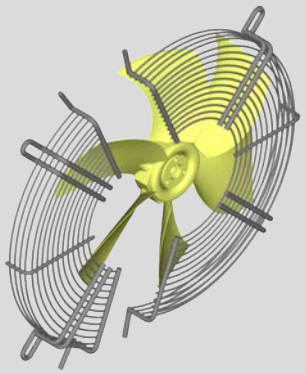
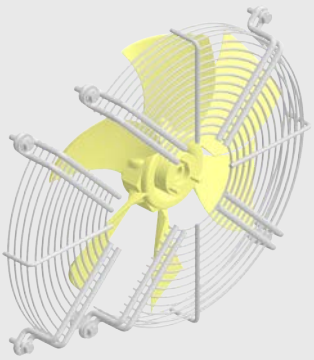
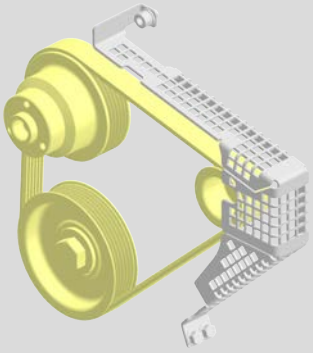
Rotating parts:

Pos	Designation	Function
2	V belt drive (fan, poly v belt, alternator)	
	A/C compressor	
8	flywheel	

12.1.2 Contact guard

Diesel oxidation catalytic converter/exhaust gas turbocharger

- The outlet from the DOC can also be rotated with the contact protection in all directions.

Contact guard for fan (optional) 3H50 TI / TIC / TICD 4H50 TI / TIC / TICD	
Contact guard for fan (optional) 3H50 T	
Contact guard for poly v belt (optional)	

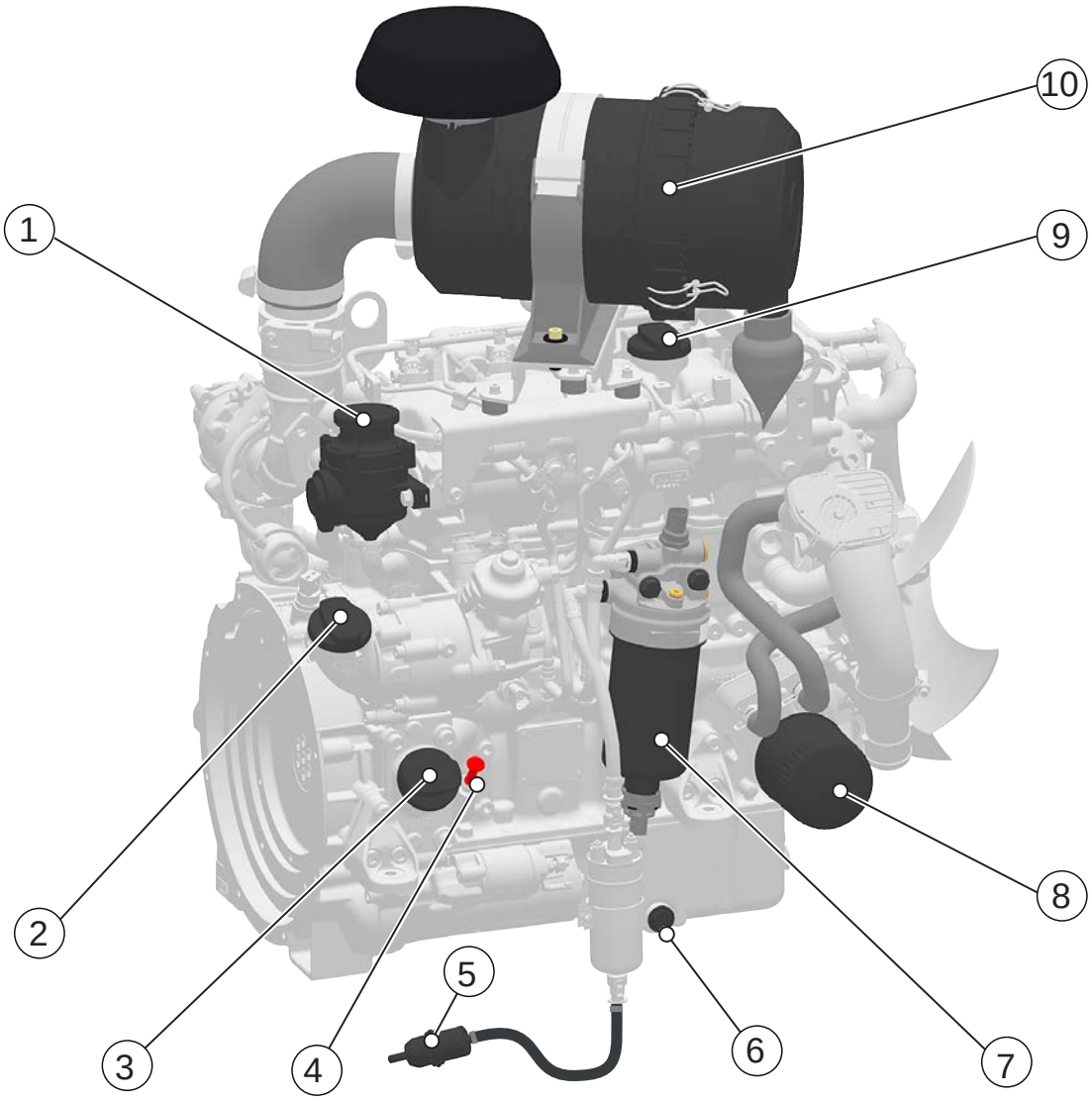
13 maintenance

13.1 Accessibility of service points

When installing the engine, it must be ensured that all service points are easily accessible.

If there is no easy access, there is a risk that the necessary maintenance work will not be carried out at all or will not be carried out at the right time. This can lead to increased wear and premature failure of the engine.

Service points – operating side

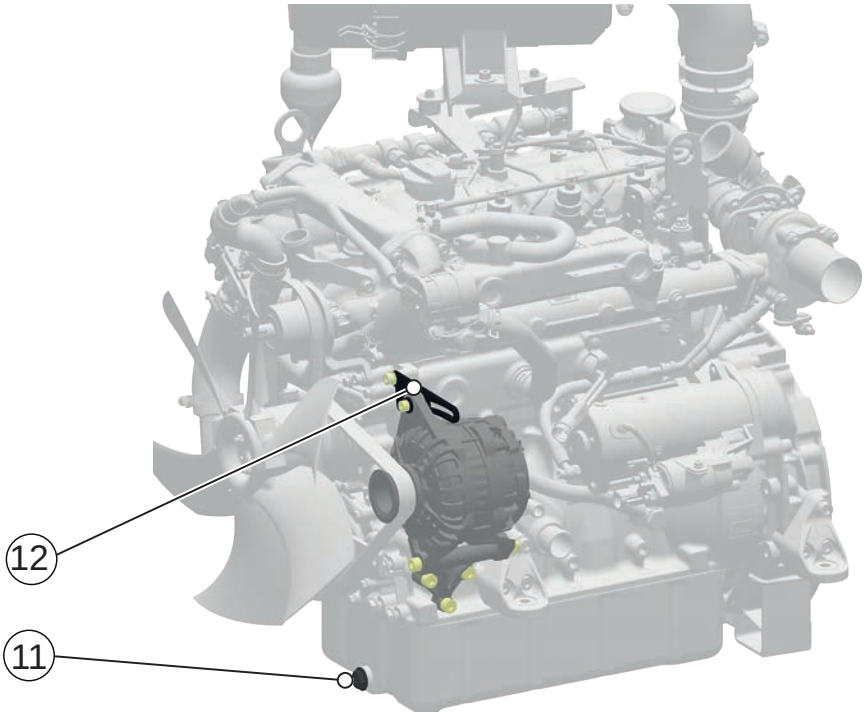


1	Crankcase ventilation	6	Side oil drain screw
2	Oil filler plug, middle (option)	7	Main fuel filter
3	Oil filler plug, bottom (option: oil drain screw)	8	Oil filter
4	Dipstick	9	Oil filler plug, top (option)
5	fuel prefilter	10	Air filter (optional)

NOTICE

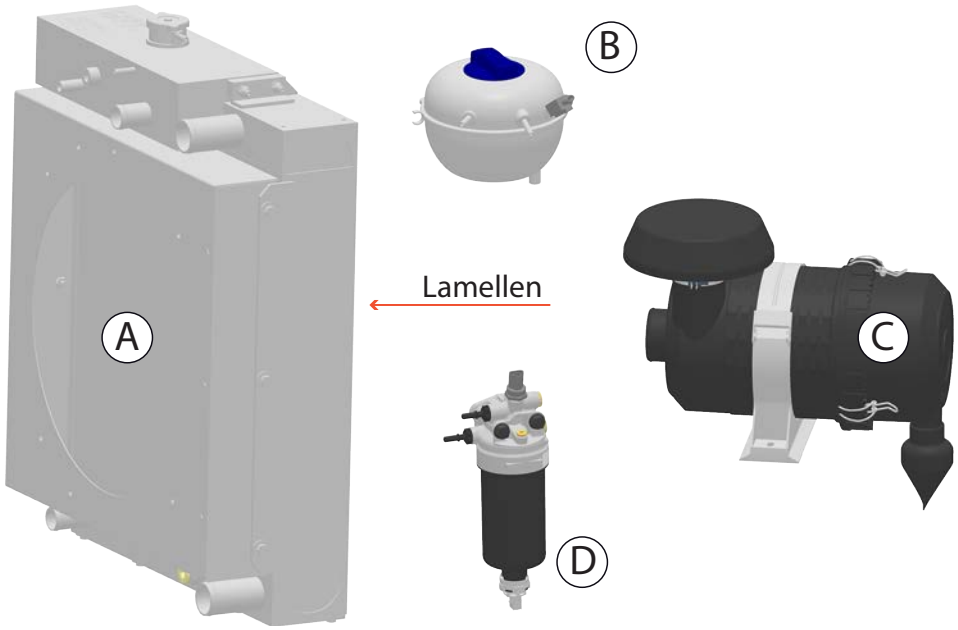
The corresponding tightening torques are provided in the "Screw tightening torques" table in section *5.1 Engine information and filling quantities, page 32*.

Service points – exhaust gas side



11	Oil drain valve, front (option: oil drain screw)
12	Tensioning arm for external alternator

Service points – chassis side



A	Cooler with integrated expansion tank	C	Air filter
B	External coolant compensation tank	D	Main fuel filter with water drain plug and integrated water-in-fuel sensor.

13.2 Maintenance intervals

Detailed information on maintenance intervals and carrying out maintenance work can be found in the **Diesel Engine Manual**.

14 Engine preservation

	NOTICE
	If an extended storage period,> 12 months, is planned, preservation procedures as per the Hatz Preservation Instructions 043 450XX must be followed.

15 Test of the engine installation (checklist)

The engine can only function so well as its installation situation dictates. Engine damage caused by an unfavorable engine installation, a neglected power calculation or a non-matching speed selection are **not considered as warranty cases**.

Please use the previous guidelines as a checklist during the final test on the engine installation.

We recommend proceeding as follows:

15.1 installation note

HATZ diesel engines are efficient, robust, and have a long service life. Therefore, they are usually installed in machines that are used for commercial purposes. The machine manufacturer must follow the applicable regulations regarding machine safety – the engine is a part of a machine.

Depending on the use and installation of the engine, it may be necessary for the machine manufacturer and machine user to install safety equipment to prevent inappropriate use. Note the following:

- Parts of the exhaust gas system and the engine surface become hot during operation and may not be touched until they cool down after the engine is switched off.
- Incorrect cable connections and operation of the electrical equipment can lead to sparking and must be avoided.
- After the engine is installed in the machine, rotating parts must be protected against contact. HATZ safety equipment is available for the belt drive of the cooling fan and alternator.
- Comply with all notices and warning labels on the engine and keep them in a legible condition. If an adhesive label should become detached or difficult to read, it must be replaced promptly. For this purpose, contact your nearest Hatz service.
- Any improper modification of the engine will result in a loss of liability coverage for resulting damage.

Only regular maintenance, as specified in manual for diesel engine, will maintain the operating readiness of the engine.

The Assembly Instructions contain important information on how to safely assemble the engine. They are available from any Hatz service.

If you have any questions, please contact your nearest **HATZ** Service Station prior to commissioning the engine.

15.2 Initial startup

Before initial startup, check the delivered parts for completeness, damage, and other noticeable issues.

DANGER

Danger to life from inhaling exhaust gases.

Toxic engine exhaust gases can lead to loss of consciousness, and even death, in closed-off and poorly ventilated rooms.

- Never operate the machine in closed-off or poorly ventilated rooms.
- Do not breathe in the exhaust gases.

CAUTION

Health hazard due to inhalation of flue gas.

To protect exposed metal parts against corrosion, the parts concerned are coated with a protective wax. When the engine is started for the first time, this protective wax evaporates on hot components. This can lead to the generation of smoke for a brief period.

- Do not inhale flue gas.
- Ensure sufficient ventilation.

CAUTION

Danger of engine damage from the use of starting fluid.

- Engine damage from the use of starting fluid can lead to uncontrolled ignition.
- Engine damage from uncontrolled ignition.
- Never use starting fluid.

NOTICE

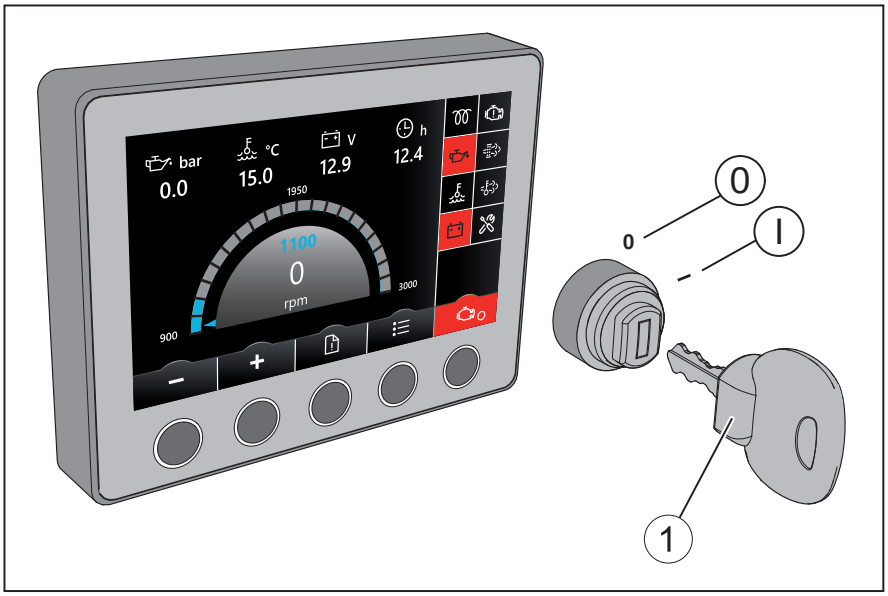
Before installing further add-on parts, the preservation wax must be removed from the screw-on surfaces and the surfaces must be cleaned.

Before starting

Before starting the engine, several tests need to be performed to ensure the machine is working properly.

Step	Test
1	The machine is standing securely and on a level surface.
2	The installation location is adequately ventilated.
3	Sufficient amount of fuel in the fuel tank.
4	Sufficient amount of engine oil in the engine housing.
5	Sufficient amount of coolant in the expansion tank.
6	The cooler and cooler hoses are leak-free.
7	No persons are located in the danger zone of the engine or machine.
8	All safety equipment is in place.

Overview – HATZ fixtures box



1	Starting key
Ignition lock	
0	Off
I	Operation (ignition on)

Switch on

Step	Activity
1	Insert the starting key all the way and turn to position "I". The image appears on the display after a few seconds.

Switch off

Step	Activity
1	Turn the starting key to position "0". The display switches off after approx. 20 seconds.

NOTICE

For further details on the instrument box, see chapter *9.2.2 Overview of instrument box, page 152*.

NOTICE

- In case of irregularities, switch off the engine immediately.
- Identify the fault and eliminate it.
- For details on troubleshooting measures, see the Operator's Manual for the machine.

15.3 Starting the engine

NOTICE

For details, see the Diesel Engine Manual.

15.4 Checking of engine choice and engine environment

- Is the speed correctly chosen, properly adjusted and matches the operating hours per year?
- Is the load on the engine in order?
- Has the climate at the place of use been taken into account?
- When installing the engine under a cover or in a room, has the climate change been taken into account in the power calculation?
- As small a temperature difference as possible between the ambient temperature and the temperature immediately in front of the Exhaust gas turbocharger is decisive for as long a service life as possible.
- Is the machine **vibration free/oscillation decoupled** as far as possible?
- Have our recommendations for **engine attachment** been taken into account?

15.5 Testing of engine equipment

- Was the engine mount designed correctly?
- Are the fuel lines laid in a flexible and ventable manner?
- Is the (fuel) tank content large enough for the intended operating time?
- Is the engine adequately protected against environmental influences?
  - Dust formation
  - Driving rain
  - Corrosive substances in the air
  - Rock fall
- Where present, are the supply and return air lines flexible, laid with the correct dimension, and in the right place?
- Were the lines and hoses laid without chafing and are they free of collision?
- Was the correct fault compensation response option chosen?
- Has the exhaust pipe (if present) been selected so the exhaust gas back pressure is within the tolerance band and was the exhaust pipe laid in a flexible manner?
- Are the load limits adhered to at the power take off points?
- Do the following parameters of the engine installation correspond to the requirements of the machine?
  - Vibrations
  - Speed stability
  - Start-up time
- Is the max. oil capacity sufficiently large for the intended operating period?
- Is the max. possible machine tilt ≤ the max. engine tilt?
- Does the machine correspond to
  - the **noise regulations** in the specified fields of use?
  - the **exhaust gas regulations**?
  - the **safety regulations**?
  - all relevant **statutory regulations** (e.g., noise emission, exhaust gas emission, low voltage, electromagnetic compatibility, functional safety …)?

15.6 Checking the accessibility of the operating and service points

It must be possible to carry out operating and maintenance work easily. The more accessible the service points, the more reliable the engine is maintained and the better it will work.

Poorly accessible service points are not recognized by service personnel as service points, which affects the service life of the engine.

Please ensure that there is good accessibility to the operating and service points by carrying out the necessary manual actions personally.

Operating points:

See type sheet and Diesel Engine Manual

Service points:

See the installation drawings and the Diesel Engine Manual, as well as section *13.1 Accessibility of service points, page 192* in the installation instructions.

- Dipstick
- Oil filler
- Oil drain
- Oil filter
- Cooling water filling
- Coolant drain
- Cooler (fins)
- Air filter
- Crankcase ventilation filter (ProVent)
- Belts (fan, alternator)
- Cooling air passages
- Battery
- Fuel main filter with water separator
- fuel prefilter
- Diagnostics interface
- Fuse holder
- The engine can be easily removed for repair work

15.7 Installation log

Hatz Ruhstorf reserves the right to perform the installation check and the installation log for the engine in series machines. For this, please contact the respective subsidiary. The installation check is carried out by **Hatz Ruhstorf** or the relevant **Hatz representative/subsidiary**. The warranty commitment for the engine in series machines is linked to the installation log.

15.7.1 Prerequisite for carrying out the installation check

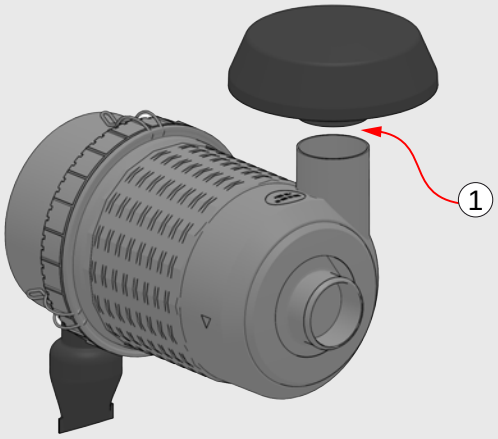
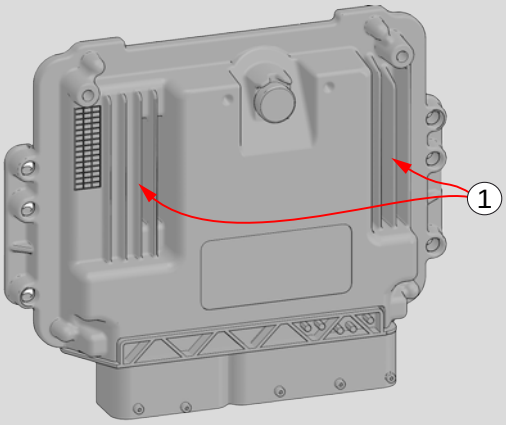
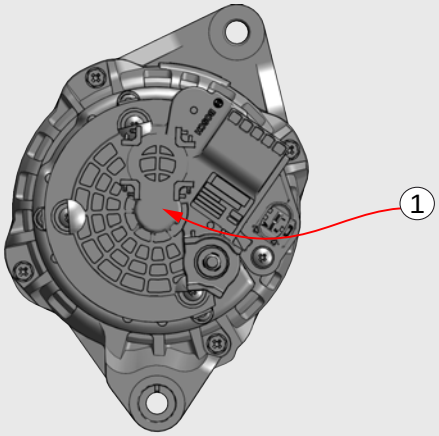
Before an installation check with cooling capacity measurement is carried out, the following prerequisites must be fulfilled by the machine manufacturer:

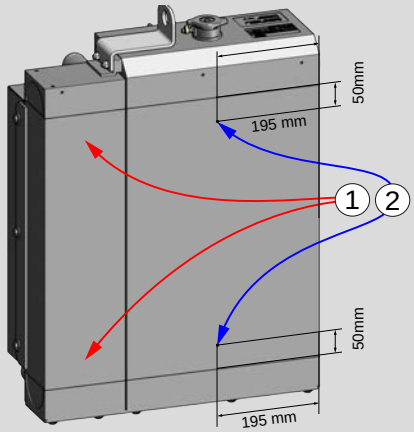
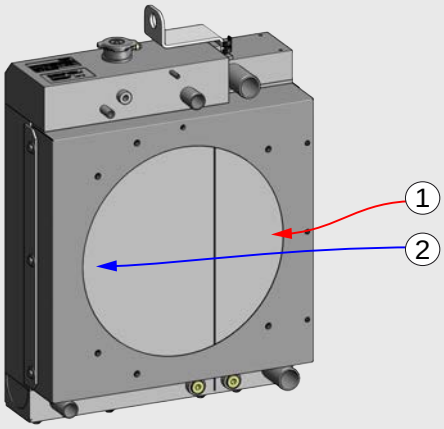
- The application should correspond as close as possible to the series condition
- The application must be operational for the measurements
- Any covers (e.g. for sound optimization) on the machine must be fitted for measurements and correspond to the series status
- Cables, hoses etc. must be laid and connected
- The complete machine electronic system must be installed and fully operational
- Display and warning elements must function properly
- All power take offs must be operational and tight
- The duration and carrying out of the installation check can vary due to the complexity of the application

15.7.2 Measuring point overview

Note: For temperature measurement, a permanently opened thermostat must/should be installed in the engine!

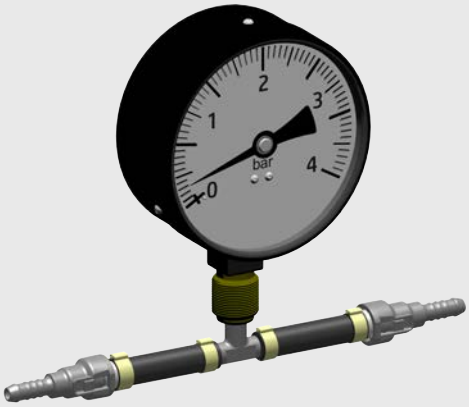
Analog measuring points

Ambient temperature	
	Measuring position (1) at the air filter intake, intake temperature The temperature should rise as little as possible compared to the ambient temperature.
	Measuring positions (1) on control unit ED-C17C81 Temperature min. – 40 °C, max. + 85 °C
	Measuring position (1) on the alternator Temperature min. – 40 °C, max. + 105 °C

Ambient temperature	
	Measuring positions on the cooler on the front of the extractor fan In front of the charge air cooler (1) at the top and bottom centered 15 mm in front of the radiator network In front of the water cooler (2) at the top and bottom centered 15 mm in front of the radiator network The temperature should rise as little as possible compared to the ambient temperature. Note the cooler sealing!
	Measuring positions on cooler, engine side, pressure fan Side of water cooler (2) centered on the radiator frame/safety guard Side of charge air cooler (1) centered on the radiator frame/safety guard

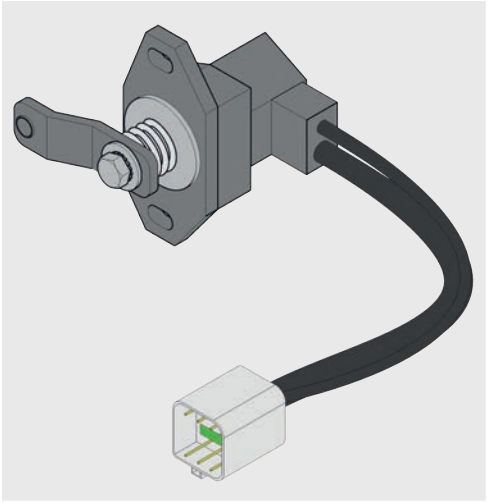
Further measuring points as required

HDS recording values	
Data set/software/error memory from screen	
	Limit values (error substitute reaction)
Operating hours (optional)	
Engine speed (mandatory)	
Torque (mandatory)	
Injection quantity (optional)	
Fuel consumption (optional)	
Battery voltage (optional)	
Coolant temperature (mandatory)	
Oil temperature (mandatory)	120 °C warning, 140 °C error substitute reaction
Oil pressure (optional)	
Fuel temperature (mandatory)	80 °C
Fuel pressure, low circuit (mandatory)	
Rail pressure (optional)	
Air mass flow (TICD mandatory)	
Suction vacuum (mandatory)	
Ambient pressure (optional)	
Charge pressure, actual value (optional)	
Charge air temperature (mandatory)	Max. 15 °C above ambient temperature
Exhaust gas temperature before DOC (TICD mandatory)	
Exhaust gas temperature before DPF (TICD mandatory)	
Gas pedal 1 position (optional)	

Pressures in the fuel lines	
	Connect pressure gage between return on engine and return line. See also *8.5.3 fuel circuit diagram, page 90* pos. 9. ▪ The max. permissible pressure in the return line is 0.3 bar. Connect the pressure gage between the fuel prefilter and the fuel pump. See also *8.5.3 fuel circuit diagram, page 90* pos. 6. ▪ The max. permissible vacuum is also 0.3 bar but before the fuel pump.

16 Functional safety

16.1 Speed control



All continuously adjustable rotational speed setpoint adjusters (gas pedal, manual lever, etc.) are CAN speed controls.

If the speed is specified via a speed selection switch (multi-state switch), no redundant setpoint is given.

Even with the speed setting via CAN bus, no redundant setpoint is given.

16.2 Fault replacement reaction

There are 3 different engine settings for the fault compensation response. Depending on the engine specification, the engine controller reacts as follows in case of a malfunction.

Emergency running

The engine switches over to emergency operation. In this situation, the engine power is reduced or the maximum speed is limited. The engine fault indicator lights up.

- Oil pressure error
- Temperature error (oil or cylinder head, cabling)
- Battery voltage too high
- Fuel pump output error

Failure	Fault replacement reaction
Engine speed setting, analog	If possible, emergency operation, otherwise lower neutral gear
Speed setpoint CAN	Lower idling speed
Speed setpoint MSS*	
With master data set 450E, the engine switches off upon absence of oil pressure.	

** Multistage switch*

Stop engine (standard with constant speed)

The "Stop engine" option has the same fault compensation responses as emergency running, except for engine switch-off in the event of the following errors:

- Oil pressure min./max. or sensor failure
- Max. oil temperature
- Coolant level below min.
- Water in fuel or sensor failure
- Max. coolant temperature
- Max. intake negative pressure reached (air filter clogged) or sensor failure
- Max. charge air temperature or sensor failure
- Min. fuel low pressure or sensor failure

Failure speed setting, analog	Emergency running
Speed setpoint failure	Lower idling speed

Display for engine control

If engine malfunctions occur, the engine malfunction indicator lamp lights up without a fault compensation response.

- Oil pressure error
- Temperature error (oil or cylinder head, cabling)
- Charge control
- Speed error (speed too high, speed signal malfunction, wiring)
- Battery voltage too high/low
- Sensor voltage too high/low
- Ambient pressure too high/low
- Fuel pump output error, glow plug, injection pump, wiring

Failure	Fault replacement reaction
Engine speed setting, analog	No fault compensation response
Speed setpoint CAN	Engine running with last known speed specification
Speed setpoint MSS*	

No.	Sensor	Min.			ERR	Recommendation
1	Coolant temperature	-44	°C	105	110	Cut off the engine
2	Oil temperature	-44	°C	120	140	
3	Oil pressure *1	0,8	bar	7,2		
4	Fuel temperature	-44	°C	80		
5	Fuel pressure *1	1,5	bar	10		
6	Rail pressure	bar		1950	1990	
7	Intake vacuum *2 (Air filter)	-14/-71 *2	-13/-57 *2	mbar		
8	Ambient pressure (ECU)	450	mbar	1100		
9	Boost pressure (ECU)	0,5	mbar	2,75		
10	Charge air temperature	-44	°C	85		
11	EGR valve position sensor	0	%	100		
12	Crankshaft sensor	-				
13	Camshaft sensor	-				
14	Glow plug *3	No error in glow device		Error in glow device		
15	Injectors	-				
16	Coolant level sensor	Coolant level below min.				
*1 Characteristic / *2 Characteristic diagramm						
*3 Glow plug only warning, no error replacement reaction						
WARNING		error replacement reaction(ERR)				

NOTICE

Only in exceptional cases for engines that are not emissions-compliant

17 Declaration of incorporation

Extended Declaration of Incorporation
EC Machinery Directive 2006/42/EC

The manufacturer: **Motorenfabrik Hatz GmbH & Co.KG**
Ernst-Hatz-Straße 16
D-94099 Ruhstorf a. d. Rott, Germany

herewith declares that the incomplete machine: product designation: **Hatz diesel engine**
type designation and beginning with consecutive serial no.:
3H50T = 17811; 3H50TI = 16321; 3H50TIC = 13521; 3H50TICD = 16411;
4H50TI = 16122; 4H50TIC = 13622; 4H50TICD = 16512;
4H50N = 14712; 4H50N = 19310; 4H50NO = 19210

is in compliance with the following basic safety and health protection requirements as per Annex I of the Machinery Directive named above.

- General principles no. 1
- No. 1.1.2., 1.1.3., 1.1.5., 1.2.1., 1.2.2., 1.2.3., 1.2.4.1., 1.2.4.2., 1.3.1., 1.3.2., 1.3.3., 1.3.4., 1.3.7., 1.4.1., 1.5.1., 1.5.2., 1.5.3., 1.5.8., 1.5.9., 1.5.10., 1.5.11., 1.6.1., 1.6.2., 1.6.4., 1.7.1, 1.7.2

All relevant basic safety and health protection requirements up to the interfaces described in the following documents:
☒ Diesel Engine Manual
☒ Attached data sheets
☒ Attached technical documentation
have been met.

The following standards (or parts thereof) were applied:
- EN 1679-1: 092011 - EN ISO 12100: 032011 - EN ISO 13857: 042020
- EN 60204-1:062019

The Diesel Engine Manual is included with the incomplete machine and the Installation Instructions were made available to the customer electronically with the order confirmation.

The special technical documentation was created as per Annex VII B of Machinery Directive 2006/42/EC.
I will forward the special technical documentation specified above to the appropriate authority if necessary.

The special technical documentation specified above can be requested from:
Wolfgang Krautloher; contact the manufacturer for the address

Commissioning of the equipment is prohibited until it has been established, if possible, that the machine into which the above machine is to be installed meets the specifications of the Machinery Directive.

Date		
18/06/2024	Friedrich Peter Head of Type Series, Water-Cooled Engines	Dr.-Ing. Simon Thierfelder Chief Executive Officer - CEO

18 Compliance with emission regulations

The certificates on the engine type plate are decisive for the necessity of a Delegated Assembly and/or a Separate Shipment Contract.

18.1 Delegated Assembly

If **EPA/CARB** emission-relevant components are not installed on the engine as part of the scope of delivery, a **Delegated Assembly Contract** must be concluded between the supplier (Hatz) and the customer.

See chapter *8.6 Exhaust system, page 97*.

18.2 Separate Shipment

If **EU emission-relevant components** are not installed on the engine as part of the scope of delivery and are also delivered separately from each other, a **Separate Shipment Contract** must be concluded between the supplier (Hatz) and the customer.

See chapter *8.6 Exhaust system, page 97*.

18.3 Delegated Assembly & Separate Shipment

If **EPA/CARB & EU emission-relevant** components are not installed on the engine as part of the scope of delivery, a **Delegated Assembly Contract** and additionally a **Separate Shipment Contract** must be concluded between the supplier (Hatz) and the customer.

See chapter *8.6 Exhaust system, page 97*.

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