KALMAR

Product Division name

Reachstackers 40-45 tonnes

Additional row 1
Additional row 2
Additional row 3
Additional row 4

Publ. no VDRF03.02GB

Workshop Manual in original

WORKSHOP MANUAL

DRF 400-450

KALMAR

Workshop manual

Table of Contents A Foreword

Foreword

About the Workshop Manual

General

Thank you for choosing Cargotec as your machine supplier. We hope that we will meet your expectations.

Conditions

The instructions are based on the use of generally available standard tools. All lifting devices, such as slings, straps and ratchet blocks, must meet governing national standards and regulations for lifting devices.

Cargotec will not accept any responsibility for modifications performed without permission from Cargotec, or in the event of the use of lifting devices, tools or work methods other than those described in this manual.

Storage

NOTE

The workshop manual should be accessible to service personnel.

About the machine version

The information in this publication corresponds to the machine's design and appearance at the time of delivery from Cargotec. Due to customisations, there may be variations and/or deviations.

Cargotec reserves the right to modify specifications and equipment without prior notice. All information and data in this manual are valid at the time of publication.

DANGER

External equipment must only be used if it is approved by Cargotec.

Danger to life and property!

Only use equipment approved by Cargotec.

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Reading instructions

Warning information

Warnings inform on potential dangers which can, if the warnings are not heeded, result in personal injury or product damage.

DANGER

Situation that may result in serious personal injury, possible death, if the instruction is not followed.

WARNING

Situation that may result in serious personal injury if the instruction is not followed.

CAUTION

Situation that may result in damage to the product if the instruction is not followed.

Important information

Important information marked with NOTE facilitates the work process, operation/handling or increases understanding of the information.

NOTE

Information that is important without being safety related.

Read the Operator's Manual

000262

Read the Operator's Manual

The symbol to the left is used in certain cases on the machine and refers to important information in the operator's manual.

Read the Maintenance Manual

001128

Read the Maintenance Manual

The symbol to the left is sometimes found on the machine. It refers to important information in the Maintenance Manual.

Workshop manual contents

The Workshop Manual contains information to facilitate maintenance (part replacement) and is a supplement to the Maintenance Manual. Accompanying the Workshop Manual is supplier documentation for engine, transmission and drive axle. If possible, the Workshop Manual provides reference to supplier documentation instead of printing the same information twice. Methods for preventive maintenance and certain checks are found in the Maintenance Manual, no references are given. Use the function groups to locate the information in the Maintenance Manual.

The workshop manual is divided into the following sections.

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<tr><td>C</td><td>Preventive maintenance</td><td>Reference to maintenance manual: Preventive maintenance.</td></tr>
<tr><td>0</td><td>Complete machine</td><td rowspan="13">Technical description, comprehensive function descriptions and a description of the function of components included in the machine, divided into function groups.
The components used for each function are described under each subfunction. Consequently, common components are described in several places, but in general under the first function to use the component.
Together with the general description is a detailed description of what is unique about the specific subfunction. The next subfunction to use the same component only has a description what is unique for the new function.
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<tr><td>F</td><td>Technical data</td><td>Technical data, conversion tables, information for conversion of units.</td></tr>
<tr><td>G</td><td>Terminology and index</td><td>General terminology and abbreviations, explanation of terms and abbreviations that can appear in the sections, index for headings in the manual.</td></tr>
</table>

Function group structure

The information in the manual is divided into a structure of functions at different levels based on machine structure and usage. The categories are known as function groups.

The highest level (called main group) indicates area, such as group 7 Load handling. The second level (called two-position) indicates function, such as 7.2 Lifting/lowering. The third and fourth levels are used to break down functions into smaller parts (components).

The main group and two-position group level structure for the function groups is used for all Cargotec machines, e.g. 4.3 Power-assisted brake system. Machine-specific function group adaptations are done at the third and fourth group level, e.g. 4.3.9 Wheel brake and 4.3.9.1 Disc assembly. Function groups (headings) are only included in the documentation of a machine if the machine has that function or component. Thus, there may be gaps in function group numbering, e.g. the three-position heading level 4.8.7 Oil cooler is included for some machines but not for others.

The function groups are intended as a search term to be able to find various types of information between different sections and manuals. The information of a function group is divided into smaller segments based on type of content, such as description or replacement.

The Maintenance Manual and Workshop Manual contain different information. The Maintenance Manual only contains information required for preventive maintenance and minor troubleshooting. The Workshop Manual contains more in-depth information and repair instructions.

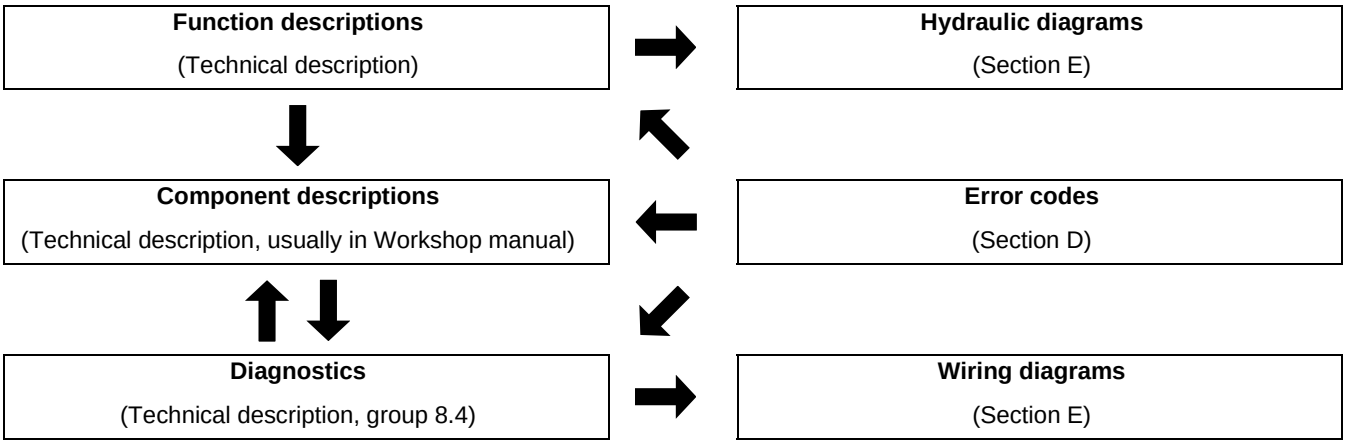
References between sections in the same manual are indicated using section and group number, e.g., "see section *4 Brakes* , group *4.3.9 Wheel brake* ". Reference within a section are indicated with page number, e.g., "see *Sensor fuel level, description page 24* ".

There are no references between the Maintenance Manual and Workshop Manual. If more information on a function group is required, search under the same function group in the other manual. For more in-depth information on where different types of information are located and what references are made, see *References between different information types page 7*.

References between different information types

The maintenance manual and workshop manual are mainly divided into function groups, see *Workshop manual contents page 5*. Certain parts are broken out as separate parts to increase usability, e.g., "Technical data".

The basic rule of searching for information is to use function groups to find different types of information regarding the function or component in question. As a complement to this, there are references according to the below.



- From Function description to Component description, to enable fast finding of more information about the different components that create a function.
- From Function description to Hydraulic diagram, to enable fast finding of the right hydraulic diagram for the function in question.
- From Component description or Function description to Diagnostics, to enable fast finding of the right diagnostic menu that can be used to check the component (only applies to electrical components).
- From Diagnostics to Wiring diagrams. to enable fast finding of the right circuit diagram for further troubleshooting.
- From Diagnostics to Component description or Function description. To enable fast finding of more information about the component's appearance and position when troubleshooting.
- From Error codes to Diagnostics, to enable fast finding of the right diagnostic menu to troubleshoot component or function in question.
- From Error codes to Function description or Component description, to enable fast finding of more information about components or function.

Product alternatives and optional equipment

The information in the manual is divided into modules. If a product alternative or optional equipment is fitted, handling may differ from that indicated in the modules depending on what is being described. See below.

Special equipment is not described in the manual. If uncertain as to what equipment is fitted to the machine, use the machine card to determine which information is relevant. See *Machine card page 8*.

Product alternative

Product alternative describes options that are fitted instead of a specific piece of standard equipment (e.g. engine alternative).

Equivalent information for different product alternatives are described consecutively in separate segments within the same function group. To indicate that there are different alternatives, "Product alternative" is added to the heading together with a simple description of the alternative, e.g. "(Product alternative Climate control system ECC)". In addition, the alternative that is an option is marked with the symbol for optional equipment.

Symbol for optional equipment

000264

Optional equipment

Optional equipment refers to options that can be added to standard equipment for more or improved functions.

Information on auxiliary equipment is described in separate segments together with the standard equipment. The optional equipment description covers how the equipment affects standard function and what components are added.

Machine card

NOTE

If the machine has been modified after delivery, information on the machine card may be incomplete or incorrect.

The machine card indicates of which drawings the machine consists, in many cases these can be associated options and product alternatives. For more information about handling of product alternatives and optional equipment, see *Product alternatives and optional equipment page 8*. The machine card is delivered with the parts catalogue.

The machine card is divided into the same function groups as the spare parts catalogue, maintenance manual and workshop manual. For reasons of practicality, the machine card only uses the first and second level of the function group register. The function groups are written in groups of four characters, e.g. group 0107 refers to group 1.7 Cooling system in the manual.

For more information on how the machine card is used to order spare parts, see the foreword of the spare parts catalogue.

If the information on the card machine does not help, contact Cargotec.

NOTE

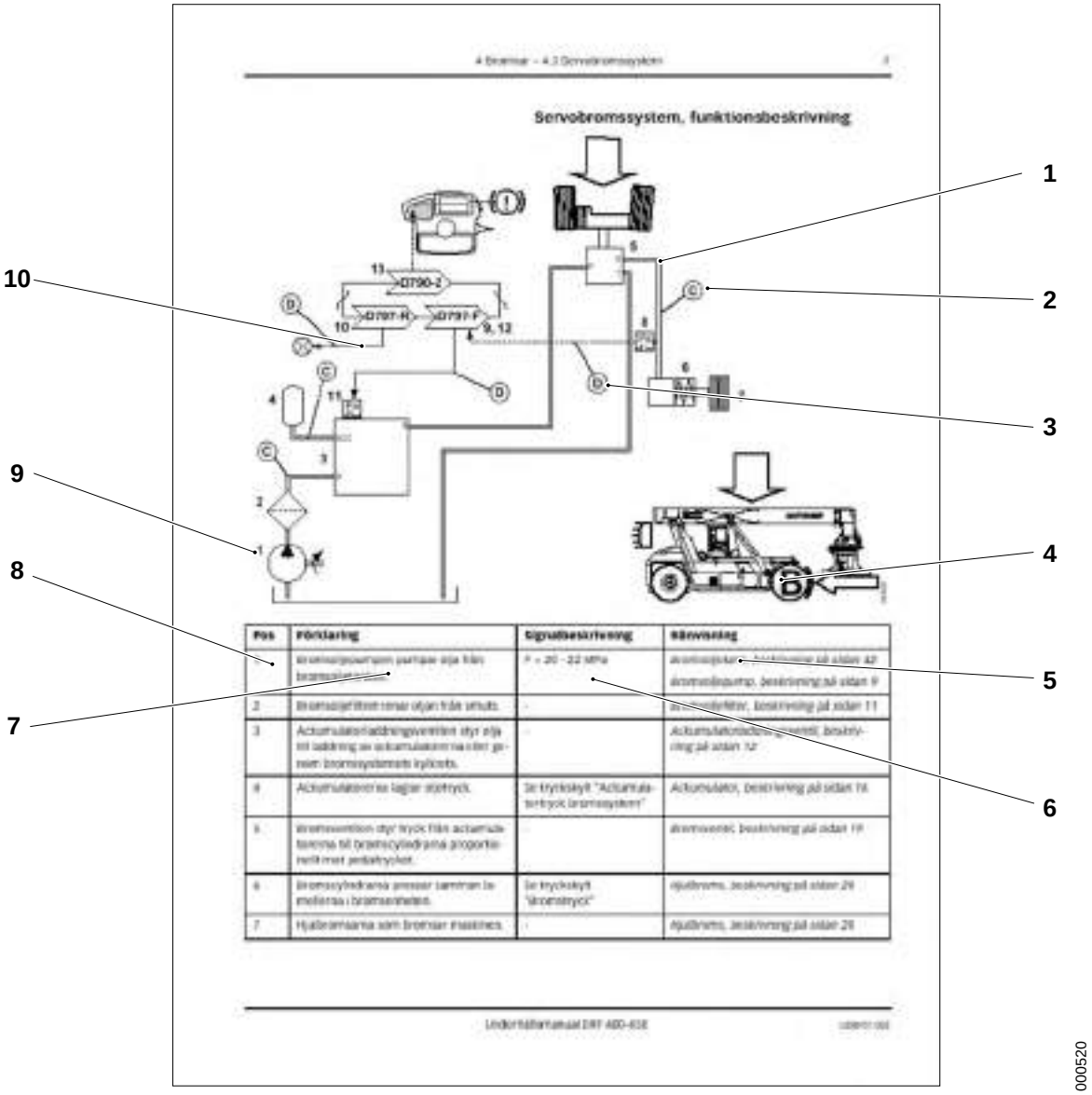
All documents that accompany the machine are non-registered documents. No notification is made regarding changes.

Function descriptions

Function descriptions are schematic overviews that describe how a function works as well as which components and signals work together.

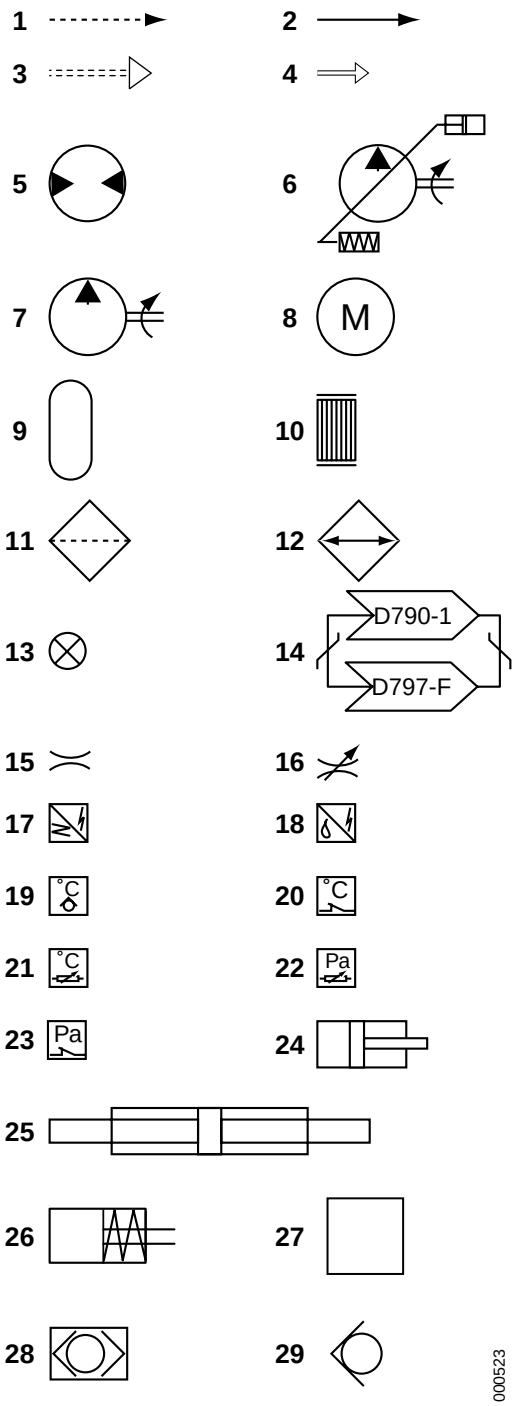
Function descriptions describe the function in a logical flow from input signal to desired output signal. Most functions require that preset conditions are fulfilled for the function to be activated. In these cases, the conditions are listed above the illustration.

Function descriptions use symbols to illustrate components such as valves, sensors, etc.



Example of function description

1. Hydraulic force (solid double line)
2. Flag pressure check connection (Check point), indicates that there is pressure check connection for checking pressure signal
3. Flag diagnostic test, indicates that the signal can be checked with diagnostic test, see section *8 Control system,* group *8.4 Diagnostics*
4. Illustration of function, (apply brake)
5. Reference to description of component
6. Signal description, reference value for signal out from component
7. Description of component's function
8. Position number, reference to position in illustration
9. Position number in illustration, reference to row in table
10. Electric power (solid single line)



Symbol explanation function descriptions

The following symbols are used in function descriptions, the symbols are based on standard symbols used in wiring and hydraulic diagrams.

1. Electric control signal
2. Electric force
3. Hydraulic control signal
4. Hydraulic force
5. Hydraulic motor
6. Hydraulic oil pump with variable displacement
7. Hydraulic oil pump with fixed displacement
8. Electric motor
9. Accumulator
10. Disc brake
11. Filter
12. Radiator
13. Bulb
14. Control system, two control units with CAN-bus
15. Restriction
16. Adjustable restriction
17. Inductive position sensor
18. Electrically controlled servo valve
19. Thermal bypass valve
20. Temperature-controlled switch
21. Temperature sensor
22. Pressure sensor
23. Pressure-controlled switch
24. Hydraulic cylinder
25. Double-acting hydraulic cylinder
26. Spring brake cylinder
27. Valve block
28. Shuttle valve
29. Non-return valve

About the documentation

Documentation sections

The documentation to the machine comprises the following sections:

Operator’s manual

The operator’s manual is supplied with the machine in the cab.

Documentation kit

Maintenance manual and spare parts catalogue with machine card are supplied with the machine as a separate documentation kit.

Supplementary documentation

Supplementary documentation can be ordered for the machine.

- Workshop manual.
- Supplier documentation for engine, transmission and drive axle.

Ordering of documentation

Documentation is ordered from your Cargotec dealer.

Always specify the publication number when ordering.

See the machine card for publication number.

Feedback

Form for copying

Cargotec's ambition is that you who work with maintenance of a Kalmar machine shall have access to correct information.

Your feedback is important to be able to improve the information.

Copy this form, write down your views and send it to us. Thank you for your participation!

To:	**Cargotec Sweden AB** **Technical Documentation** **Torggatan 3** **SE-340 10 Lidhult** **SWEDEN** **Fax: +46 372 263 93**
From:	Company / Sender: ..... Telephone: ..... E-mail: ..... Date: ..... - ..... - .....
Manual information	Name / Publication number: ..... Section / page number: .....
Suggestions, views, remarks, etc.	....

Table of Contents B Safety

Safety

General safety information

Safety concerns everyone!

The safety information concerns everyone who works with the machine! Persons who do not follow the safety instructions given in this manual must make absolutely sure that the work is performed without risks of personal injury and without risk of damage to machine or machine property!

Remember to:

- follow the instructions in this manual
- be trained for the work in question
- follow local laws, safety rules and regulations
- use the correct equipment and tools for the job
- wear the correct clothes
- use common sense and work carefully. Do not take any risks!

Cargotec has in this publication documented and warned for situations and risks that may occur in connection with using as well as service or repairs of the machine during normal circumstances.

That is why it is important that all who work with the machine, or repair or service the machine, read and follow the information in the Workshop Manual and Operator's Manual.

A near accident is a warning!

A near-accident is an unexpected event where neither persons, machine or property are injured or damaged. However, a near-accident indicates that there is an injury risk and actions must be taken to avoid the risk of injuries.

Safety instructions

General

Read, consider and follow the safety instructions below before starting to work in the machine:

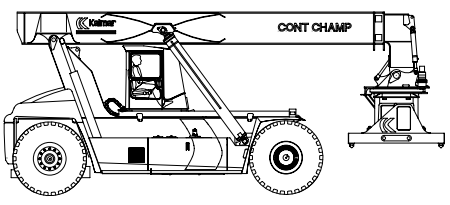
Service position

General

Service position is used for service, maintenance and other situations when the machine needs to be secured.

Service position means:

- Machine parked, that is, parking brake applied.
- Boom fully retracted and lowered to horizontal position.
- Engine off.
- Main electric power off (with battery disconnector).



003603

Machine with a fully retracted and lowered boom

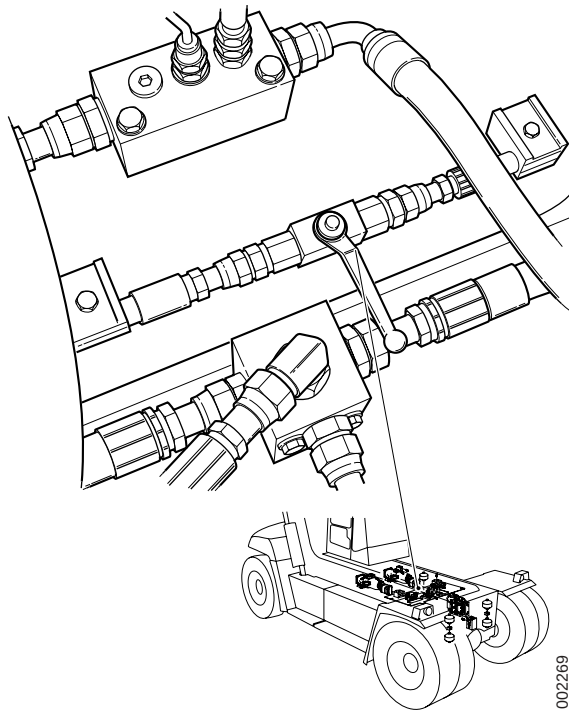
Hydraulic and brake systems, depressurising

1 Machine in service position.

2 Depressurise the hydraulic system.

Turn the start key to position I and activate extension out, a strong hissing sound is heard if there is pressure in the hydraulic system. Activate lift, extension and side shift several times.

3 Turn the start key to position 0 and turn off the main electric power.



The illustration above shows closed valve.

4 Depressurise the attachment.

Open the relief valve for top lift.

CAUTION

Hydraulic oil may be directed the wrong way.

Risk of damage to the fine filter for hydraulic oil.

Check that the relief valve top lift is closed before the engine is started after the completion of work.

5 Depressurise the brake system by opening the drain valve on the accumulator charging valve.

NOTE

Keep the drain valve open as long as work is in progress.

NOTE

After work is finished, close drain valve and tighten the lock ring.

Oils

The following safety instructions shall be followed for work when handling oils.

⚠ WARNING

Warm and pressurised oil.

Always depressurise hydraulic and brake systems completely before starting to work in the systems. Hydraulic and brake systems are pressurised and the oil may cause personal injuries.

Avoid skin contact with the oil, use protective gloves. Warm oil can cause burn injuries, rashes and irritation! The oil may also be corrosive to mucous membranes in, e.g., the eyes, skin and throat.

IMPORTANT

Always clean the area around components and connections before they are loosened. Dirt in oil systems causes increased wear, resulting in subsequent material damages.

Always take action to avoid spills. In places where drain containers cannot be used, use a pump or hose for safe handling.

Always check that plugs seal tight before collection containers are moved.

Handle all oil as environmentally hazardous waste. Oils freely released cause damage to the environment and may also cause fires. Waste oils/fluids shall always be handled by an authorised company.

Fuel system

The following safety instructions shall be followed for work when handling fuel.

DANGER

Pay attention to the risk of fire when working on the fuel system.

Work on the fuel system shall be avoided when the engine is warm since fuel can spill on hot surfaces and may ignite.

Ensure that naked flames, sparks or glowing objects have been removed before work begins on or near the fuel system.

Do not smoke in the vicinity of the machine when working on the fuel system.

WARNING

Use protective gloves and protective goggles. If a component is to be disconnected, hold a rag over the connection as protection and to collect fuel. The engine's fuel system operates at very high pressure. The pressure is so high that the jet can injure the skin, resulting in severe injuries. Risk of personal injuries.

Avoid skin contact with fuel, use protective gloves. Fuel is corrosive to mucous membranes in, e.g., eyes, skin and throat.

CAUTION

Always clean the area around components and connections before they are loosened. Dirt in the fuel may cause malfunctions and engine stop in undesirable situations as well as increase wear, resulting in subsequent material damages.

IMPORTANT

Always take action to avoid spills. In places where drain containers cannot be used, use a pump or hose for safe handling.

Always check that plugs and connections seal tight before moving collection containers.

Handle the fuel as environmentally hazardous waste. Fuel freely released causes damage to the environment and may also cause fires. Fuel shall always be handled by an authorised company.

Clothing, etc.

Clothes should be in good condition. Remove loosely hanging clothing (tie, scarf, etc.). Do not wear clothes with wide sleeves, wide trouser legs, etc.

Remove jewellery as it may conduct electricity and get caught in moving parts.

Long hair should be adequately gathered since it can easily get caught in moving parts. Be careful when working with welding or an open flame since hair easily catches on fire.

Several mechanics on the same machine

WARNING

If several mechanics are working on the same vehicle, take extra care so that unintentional movements do not injury another person. Communicate so that everyone knows where all are and what they are doing.

Risks

Work with wheels or axle suspension, mountings, etc. may result in components on the other side moving and causing damage/injury.

Movements performed from the operator's station, e.g., movement of lifting equipment, may cause severe personal injuries.

Safety precautions

- Make sure that the machine's lifting equipment is completely lowered or secured in another way.
- Move battery disconnector to position zero, remove the key.
- Be aware of the risks when several persons work around the vehicle.
- Make your co-workers aware of what you're working with.
- Do not work with drive wheels on the machine's both sides at the same time.

Working under machine

Working under cab

On machines with liftable cab, the cab must be secured in the raised position with the locks designed for this purpose.

Working under the frame

A raised vehicle may not, for any reason, be supported or lifted in parts that belong to the wheel suspension or steering. Always support under the frame or wheel axle.

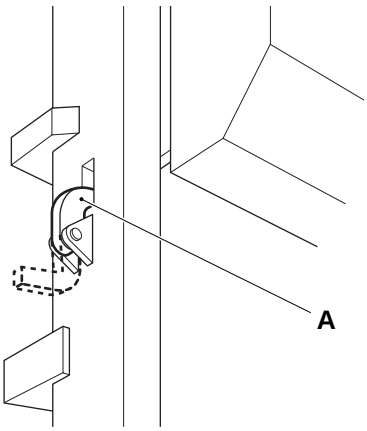
Risks

Mechanical or hydraulic tools and lifting devices can fall over or accidentally be lowered due to malfunctions or incorrect use.

Safety precautions

Use axle stands and supports that stand securely.

Lifting tools should be inspected and type approved for use.



Locks on lift mast for securing the liftable cab in the raised position.

Lifting heavy components

WARNING

Careless handling of heavy components can lead to serious personal injury and material damage.

Use type approved lifting tools or other devices to move heavy components. Make sure that the device is stable and intact.

Risks

Unsuitable lift slings, straps, etc. may break or slip.

The centre of gravity (balance point) of the component can change during the course of the work, and the component may then make unexpected movements which may cause severe personal injuries and material damage.

A component lifted with lifting equipment can start to turn if the equilibrium is upset.

A component lifted using an overhead crane may start to swing back and forth, which can cause severe crushing injuries or material damage.

Safety precautions

Lifting with lifting device. Use lifting tools or other tools, especially when there are such adapted for certain work. See workshop manual for methods.

If lifting must be performed without lifting device:

- Lift near the body.
- Keep your back vertical. Raise and lower with legs and arms, do not bend your back. Do not rotate your body while lifting. Ask for assistance in advance.
- Wear gloves. They're good protection against minor crushing injuries and cuts to fingers.
- Always use protective shoes.

Vibrations

In case of long-term use of vibrating tools, for example, impact nut runners or grinders, injuries may be sustained as vibrations can be transmitted from tools to hands. Especially when fingers are cold.

Safety precautions

Use heavy gloves to protect against cold and somewhat against vibrations.

Switch between work duties to give the body time to rest.

Vary work position and grip so that the body is not stressed in only one position by the vibrations.

Noise

Noise louder than 85 dB (A) that lasts for longer than 8 hours is considered harmful to hearing. (Limit values may vary between different countries.) High tones (high frequencies) are more damaging than low tones at the same sound level. Impact noise can also be hazardous, e.g. hammer blows.

Risks

At noise levels higher than the limits hearing damage can occur. In more severe cases, hearing damage can become permanent.

Safety precautions

Use hearing protection. Make sure that it is tested and protects against the noise level in question.

Limit noise with noise-absorbing dividers, for example, noise-absorbing materials in roof and on walls.

Solvents

Fluids that (as opposed to water) dissolve grease, paint, lacquer, wax, oil, adhesive, rubber, etc. are called organic solvents. Examples: White (petroleum) spirits, gasoline, thinner, alcohols, diesel, xylene, trichloroethylene, toluene. Many solvents are flammable and constitute a fire hazard.

Risks

Products containing solvents produce vapours that can cause dizziness, headaches and nausea. They may also irritate mucous membranes in the throat and respiratory tracts.

If the solvent ends up directly on the skin it may dry out and crack. Risk of skin allergies increases. Solvents may also cause injury if they penetrate through the skin and are absorbed by the blood.

If the body is continuously exposed to solvents, the nervous system may be damaged. Symptoms include sleep disorders, depressions, nervousness, poor memory or general tiredness and fatigue. Continuous inhalation of gasoline and diesel fumes is suspected to cause cancer.

Safety precautions

Avoid inhaling solvent fumes by providing good ventilation, or wearing a fresh-air mask or respiratory device with a suitable filter for the toxic gases.

Never leave a solvent container without tight-sealing lid.

Use solvents with a low content of aromatic substances. It reduces the risk of injury.

Avoid skin contact.

Use protective gloves.

Make sure that work clothes are solvent-resistant.

Fire and explosion risks

Examples of flammable and explosive substances are oils, gasoline, diesel fuel oil, organic solvents (lacquer, plastics, cleaning agents), rustproofing agents, welding gas, gas for heating (acetylene), high concentration of dust particles consisting of combustible materials. Rubber tyres are flammable and cause explosive fires.

Risks

Examples of cause of ignition is welding, cutting, smoking, sparks when working with grinders, contact between hot machine parts and flammable materials, heat development in rag drenched with oil or paint (linseed oil) and oxygen. Oxygen cylinders, lines and valves shall be kept free from oil and grease.

Fumes from, e.g., gasoline are heavier than air and may "run" down into a sloping plane, or down in a grease pit, where welding flames, grinding sparks or cigarette embers may cause an explosion. Evaporated gasoline explodes very forcefully.

Special cases

Diesel fuel oil with added gasoline has a lower ignition point. Risk of explosion already at room temperature. The explosion risk for warmed diesel fuel oil is higher than for gasoline.

When changing oil in the engine, hydraulic system and transmission, keep in mind that the oil may be hot and can cause burn injuries.

Welding on or near machine. If diesel and or other oils have leaked out and been absorbed by rags, absorbent agents, paper or other porous material, hot welding sparks can cause ignition and explosive fires.

When a battery is charged, the battery fluid is divided into oxygen and hydrogen gas. This mixture is very explosive. The risk of explosion is especially high when using a booster battery or quick-charger, as this increases the risk of sparks.

Today’s machines contain a lot of electronic equipment. When welding, the control units must be disconnected and the electric power must be turned off with the battery disconnector. Powerful welding currents may otherwise short-circuit the electronics, destroy expensive equipment or cause an explosion or fire.

Never weld on painted surfaces (remove paint, by blasting at least 10 cm around the welding or cutting point). Use gloves, breathing protection and protective glasses. Also, welding work may not be done near plastic or rubber materials without first protecting them from the heat. Paints, plastics, and rubber develop a number of substances that may be hazardous to health when heated. Be careful with machines that have been exposed to intense heat or fire.

Safety precautions

Store hazardous substance in approved and sealed container.

Make sure that there is no ignition source near flammable or explosive substances.

Make sure that ventilation is adequate or there is an air extraction unit when handling flammable substances.

Fluid or gas under pressure

High-pressure lines can be damaged during work, and fluid or gas can stream out.

There may be high pressure in a line even if the pump has stopped. Therefore, gas or fluid can leak out when the connection to the hose is loosened.

A gas cylinder subjected to careless handling can explode, for example, if it falls onto a hard surface. Gas can stream out through damaged valves.

Risks

Risk of damage/injuries in connection with work on:

- Hydraulic systems (e.g., working hydraulics and brake system).
- Fuel system.
- Tyre repairs.
- Air conditioning.

Safety precautions

- Use safety glasses and protective gloves.
- Never work on a pressurised system.
- Never adjust a pressure limiting valve to a higher pressure than recommended by the manufacturer.
- A hydraulic hose that swells, for example, at a connection, is about to rupture. Replace it as soon as possible! Check connections thoroughly.
- Use fluid when checking for leaks.
- Never blow clothes clean with compressed air.
- Discarded pressure accumulator shall first be depressurised and then punctured before it is discarded (to avoid risk of explosion). Carefully, drill a hole with 3 mm diameter after depressurising.
- Never use your hands directly to detect a leak. A fine high-pressure stream from a hydraulic hose can easily penetrate a hand and causes very severe injuries.

Coolant

The coolant in the machine's cooling system consists of water, anti-corrosion compound and (when needed) anti-freeze fluid, for example, ethylene glycol.

Coolant must not be drained into the sewer system or directly onto the ground.

Risks

The cooling system operates at high pressure when the engine is warm. Hot coolant can jet out and cause scalding in case of a leak or when the expansion tank cap (filler cap) is opened.

Ingesting ethylene glycol and anti-corrosion compound is dangerous and hazardous to health.

Safety precautions

- Use protective gloves and safety glasses if there is a risk of splashing or spraying.
- Open the filler cap first, to release the excess pressure. Open carefully. Hot steam and coolant can stream out.
- If possible, avoid working on the cooling system when the coolant is hot.

Refrigerant

Refrigerant is used in the machine's air conditioning system.

Work on the air conditioning system must be performed by accredited/ authorised and trained personnel according to national legislation and local regulations.

Risks

The air conditioning operates at high pressure. Escaping refrigerant can cause frostbite.

Refrigerant that is heated (e.g., when repairing leaking climate/AC system), generates gases that are very dangerous to inhale.

Safety precautions

- Use special instructions and equipment for refrigerant according to the manual when working on the air conditioning system. Special certification and authorisation is often required of the person who may do the work. (Note national legislation and local regulations!)
- Use protective gloves and safety glasses if there's a risk of leaks.
- Make sure that heat-producing sources or objects are not close by (cigarette glow, welding flame).

Air pollution

Air pollution is the impurities in the air around us and which are regarded as hazardous to health. Certain pollution is more prominent in certain environments.

The following health-hazardous air pollution is especially prominent in workshops:

- **Carbon monoxide (fumes)** is present in exhaust fumes. Odourless and therefore especially dangerous.
- **Nitrogen oxides (nitrous gases)** are present in exhaust fumes.
- **Welding smoke** especially hazardous to health when welding on oily surfaces, galvanised or lacquered materials.
- **Oil mist** for example, when applying anti-corrosion agent.
- **Grinding dust and gases** generated when grinding and heating plastics, lacquer, anti-corrosion agents, lubricants, paint, etc.
- **Isocyanates** are present in certain paints, fillers, adhesives and foam plastics used on machines.

Risks

Sulphuric acid mist is corrosive and injures the respiratory tracts. (Generated when heating certain plastics and paints.)

Isocyanates can be released in the form of steam, dust (or may be present in aerosols) when cutting, grinding or welding. Can irritate mucous membranes producing symptoms similar to asthma and impairing lung function. Even brief exposure to high concentrations can give problems with persistent high sensitivity.

Safety precautions

- Make sure of adequate ventilation with fresh air when welding, battery charging and other work when hazardous gases are generated.
- Use suitable protective gloves and breathing protection when there is a risk of oil mist. Make sure that the protection is oil-proof.
- Apply oil-resistant protective lotion to unprotected skin.
- Make sure that an eye-wash station is in the immediate vicinity when working with corrosive substances.
- Avoid unnecessary operation of the machine inside the workshop. Connect an air extractor to the exhaust pipe so that the exhaust fumes are removed from the workshop.

Tensioned springs

Examples of tensioned springs:

1. Torque springs in pedals for example
2. Return spring (cup springs) in parking brake cylinder.
3. Lock rings
4. Gas springs

Risks

If a tensioned spring releases, it is shot out by the spring force and can also take adjoining parts with it.

Small springs can cause eye injuries.

Parking brake springs are tensioned with high force and can cause very severe accidents if they are accidentally released in an uncontrolled manner.

Gas springs and gas-charged shock absorbers are tensioned with high force and can cause very severe accidents if they are accidentally released in an uncontrolled manner.

Safety precautions

- Use safety glasses.
- Lock rings should be of a suitable type and in good condition.
- Follow the instructions in this and other manual when performing maintenance and changing parts and components.
- Always use recommended tools.

Electric motors

Safety precautions

Always turn off the battery disconnector when working on electric motors.

Always block the machine’s wheels and make sure that the parking brake is activated and that the gear selector is in neutral position before starting any work on the machine.

Rotating components and tools

Examples of rotating components and tools:

- Cooling fan
- Drive belts
- Propeller shafts
- Drills
- Grinders

Risks

Rotating components, for example, fans or shafts, can cause severe injuries if touched.

Drills, lathes, grinders or other machines with rotating parts can cause severe accidents if clothes or hair get caught and are wound up in the machine.

Safety precautions

- Do not use gloves when working with a drill.
- Remove loose, hanging clothing, scarf or tie.
- Never use clothing with wide sleeves or trouser legs.
- Make sure that clothing is intact and in good condition.
- Long hair should be gathered up in a hair-net or similar.
- Remove large or loose hanging jewellery from hands, arms and neck.

Tyres and rims

DANGER

Tires shall be regarded as pressure reservoirs. If handled incorrectly, they constitute a fatal danger

Parts can be thrown with explosive force and may cause severe injuries.

Never repair damaged tyres, rims or lock rings. Tyre changes shall be performed by authorised personnel.

Risks

Dismantling wheels: Tyres, rims or lock rings can be thrown.

Inflating of wheels: Tires, rims or lock rings may be ejected.

Safety precautions

- Always deflate the tyre before starting to work on the wheel.
- Check that tyres, rims and lock rings aren't damaged. Never repair damaged rims or lock rings.
- Wheels shall be inflated on the machine or in a protective device, designed and dimensioned so that it can handle or dissipate a shock wave from a tyre explosion as well as catch the ejected parts.
- Use protective screen and safety glasses.

Lifting equipment

When working on the machine in general, and with the machine's lifting equipment in particular, the greatest caution must be exercised with respect to securing the boom and attachment.

For this reason, always be in the habit of having the boom fully lowered and fully retracted during work on the machine.

Risks

Risk of crushing if the machine's lifting equipment is not lowered or secured.

Risk of crushing is extra high when depressurising the hydraulic system, see *Hydraulic and brake systems, depressurising page 5*.

Safety precautions

- Do not start work until the boom is lowered and fully retracted if possible.

Spare parts

WARNING

The following parts must, for safety reasons, only be replaced with original spare parts:

- **Brake valve**
- **Drive axle**
- **Valve for mini-wheel/lever steering**
- **Steering valve (Orbitrol)**
- **Steering valve incl. priority valve**
- **Steering axle**
- **Steering cylinder**
- **Rims**
- **Lift boom**
- **Boom nose extension**
- **Lift cylinder**
- **Valve block lift**
- **Extension cylinder**
- **Valve block extension**
- **Rotation motor unit**
- **Tilt cylinder**
- **Twistlocks, lifting shoe**
- **Safety switch (for hydraulic function)**
- **Emergency switch**
- **Frame**
- **Accumulator**
- **Main valve load handling**
- **Accumulator charging valve**
- **All control units**

Non-ionised radiation

WARNING

Extra equipment such as communication radio, RMI, phone, etc. can emit non-ionised radiation.

Danger of disruption to active or inactive medical products.

Use communication radio, RMI, phone, etc. when there are no people with active or inactive medical products in the vicinity.

NOTE

When there are no people with active or inactive products in the vicinity the phone and communication radio in the cab may be used.

Equipment should not be used during operation or load handling as your concentration as operator is reduced.

Cargotec accepts no responsibility for equipment not installed by Cargotec or with Cargotec approved installation.

Environment

General

Ever-increasing industrialisation of our world is having a significant impact on our global environment. Nature, animals and man are subjected daily to risks in connection with various forms of chemical handling.

There are still no environmentally safe chemicals, such as oils and coolants, available on the market. Therefore, all who handle, perform service on or repair machines must use the tools, assisting devices and methods necessary to protect the environment in an environmentally sound manner.

By following the simple rules below, you will contribute to protecting our environment.

Recycling

Well-thought out recycling of the machine is the cornerstone of ending its life cycle and being able to re-use materials in new products. According to calculations by Cargotec, the machine can be recycled to more than 90% by weight.

Environmentally hazardous waste

Components such as batteries, plastics, and other materials that may be considered as environmentally hazardous waste must be handled in an environmentally correct manner.

Discarded batteries contain substances hazardous to personal health and the environment. Therefore, handle batteries in an environmentally safe manner and according to national regulations.

Oils and fluids

Oils freely discharged cause environmental damage and can also be a fire hazard. Therefore, when emptying and draining oils or fuel, take appropriate action to prevent unnecessary spills.

Waste oils and fluids must always be taken care of by an authorised disposal company.

Pay close attention to oil leaks and other fluid leaks! Take immediate action to seal the leaks.

Air conditioning unit

The refrigerant in the air conditioning unit for the cab contributes to the greenhouse effect and may not be intentionally released into the open air. Special training is required for all service work on the air conditioning unit. Many countries demand certification by a governing authority for such work.

Working in a contaminated area

The machine shall be equipped for work within a contaminated area (environmental contamination or health-hazardous area) before work is started. Also, special local regulations apply to such handling and to service work on such a machine.

Declarations

The machine does not contain asbestos.

The machines contains lead in batteries and in electric cabling. In certain models, there are lead castings as counterweight.

If the machine is equipped with air conditioning, then refrigerant of the type R134a is used, in an amount between 1-3 kg.

C Preventive maintenance

The information is found in the Maintenance Manual

The information is found in the Maintenance Manual.

For information on how to order the Maintenance Manual, see the section *A Foreword*.

Table of Contents 0 Complete machine

Complete machine

Complete machine, description

The Kalmar DRF 400–450 is a "Reachstacker" for container handling. The machine a lifting capacity of 40–45 tonnes depending on version.

The drive source is a six-cylinder, four-stroke diesel engine with direct injection.

The transmission is hydromechanical, with constant mesh gears. It has four speeds forwards and four speeds in reverse. Engine power is transmitted by a torque converter.

The driveline/axle comprises a propeller shaft and a rigid drive axle with hub reduction. Drive is via the front wheels.

The service brake is of wet disc type, built together with drive wheel hubs. The parking brake is a disc brake and acts on the drive axle input shaft.

Steering is via the rear wheels and a double acting hydraulic cylinder. The steering axle is pendulum-suspended in the frame.

The wheels are mounted on the hubs with clamps. Twin wheels are mounted on the drive axle, while the steering axle has single wheels.

Load handling comprises components and functions for managing loads. Loads are lifted with and attachment that is fitted on a liftable telescopic boom. Load handling is divided into lifting/lowering, extension, side shift, spreading, rotation, tilt, levelling and load carrier functions.

- Lifting/lowering is the function used to raise and lower the boom.
- Extension is the function to extend the boom in and out.
- Side shift is used to move the lift attachment laterally in relation to the machine.
- Spreading is used to adjust the width between the attachment’s lifting points.
- Rotation is rotating the load in relation to the machine.
- Tilt is angling the load in the longitudinal direction of the truck.
- Levelling is angling the load in the lateral direction of the truck.
- The load carriers are designed to hold a fixed load.

The control system is functions for warning the operator of dangerous situations and machine faults. The control system has diagnostic resources that simplify troubleshooting.

The frame supports the machine. Mounted in the frame are the engine, transmission, drive axle and steering. The side of the frame houses tanks for fuel, hydraulic oil and oil for the brake system. The cab is centrally located and can be tilted longitudinally. As an option the cab is available in a side-mounted version that can be raised and lowered.

Troubleshooting, general work instructions

When troubleshooting, it is important that the work is structured and logical. The point of the troubleshooting described in the maintenance manual is to exclude components as error source so that the real error source can be pin-pointed. A suggested structured work method is described below.

When troubleshooting, it is important to understand how the machine functions. Certain malfunctions can be pin-pointed directly using function descriptions. Sections *0–12* contain descriptions of the various functions of the machine.

Troubleshooting procedure

1 Check that there is battery voltage available.
   - Battery disconnector, must be in position 1.
   - Battery voltage, should be 22–30 V.
   - Fuses, check that they are intact.

2 Check that all oil and fluid levels are normal.
   - Fuel
   - Engine oil
   - Transmission oil
   - Brake system fluid
   - Hydraulic oil
   - Coolant
   - Washer fluid

3 Check if there are error codes.

4 If there are error codes, use the error code lists as a guide. See *Troubleshooting with error code, example page 5*.

   In the error code lists there are recommended actions for every error code. Error code lists are found in section *D Error codes*.

5 If there is no error code or the problem persists, use the function description for the function in question in section *0–12*.

   The function description contains information on which components are involved in the function and how these components work together. In some cases, there is information on what conditions are required in order for it to be possible to activate the function. Measurement points are marked with flags (C for measuring outlet, D for diagnostic menu).

Troubleshooting without an error code, example

1 Choose suitable section *0–12* to find the function and sub-function that have caused the symptom.

2 Read the function description for the function in question to get an overall understanding of which components are affected and how these interact.

3 Use the function description and check the signals for the function in question to find where in the function chain that signal or reaction is incorrect.

4 The fault is probably between the two units where the signal is failing. Start by checking the component that should send the signal.

5 If the component that is to send the signal seems to be correct, check transmission of the signal (electric wiring or hydraulic hoses).

For electric cabling, see *Troubleshooting cable harness page 7*.

For hydraulic hoses,
see *Troubleshooting hydraulic hoses page 8*.

6 If the leads or hoses between the components seem in order, then check the component that receives the signal.

Troubleshooting with error code, example

Error codes are strong indicators of malfunctions detected by the control system. Many error codes are connected to electrical malfunctions but there are also error codes that interpret associations between one or several signals that indicate a non-electrical malfunction. It’s important to not draw conclusions too fast based on an error code.

1 Read out error codes from the display, e.g., error code 34.

2 Use the error code lists and search information about the error code, see "Example of error code information in error code list" below.

Error code lists are found in section *D Error codes*.

For detailed instruction on reading out error code, see section *D Error codes*.

3 Follow the instructions in the field “Action”.

4 Use diagnostic menus and circuit diagrams to determine if the input signal to the control unit is correct; see section *8 Control system* , group *8.4 Diagnostics* as well as section *E Schematics*.

5 Use the function group to find more information if needed.

In section *0–12* there is function description, the function's included components and their position as well as, in certain cases, work instructions for how components are checked, cleaned or adjusted.

6 If possible, eliminate component fault by testing the component individually.

Electric components can sometimes be checked with resistance measurements using a multimeter.

Hydraulic components are often checked by measuring pressure (then described in the function group and indicated in the section *C Preventive maintenance*). Sometimes valves can be activated mechanically to determine if the malfunction is electric or hydraulic.

7 If the component's measurement values are correct, continue by troubleshooting electric cables and hydraulic hoses.

For electric cabling, see *Troubleshooting cable harness page 7*.

For hydraulic hoses, see *Troubleshooting hydraulic hoses page 8*.

8 If the cable is not defective, then connect the lead to the control unit.

NOTE

The main electric power shall be turned off with the battery disconnector!

9 Disconnect the cable from the component in question.

10 Turn on the main electric power with the battery disconnector.

11 Turn the ignition key to the operating position.

12 Check that voltage reaches the component.

Table 1. Example of error code information in error code list

Code	Description	Limitation	Action	Connections and components	Diagnostic menu	Function group
34	Signal error from parking brake switch, indicates released and applied at same time or nothing at all.	Parking brake cannot be released.	Check cabling between the control unit and the component with diagnostic menu. Check component.	D791-1/K8:5 - S107, K8:13 - S107	HYD, menu 5	4.1.2 Parking brake control

Troubleshooting cable harness

NOTE

Perform troubleshooting for all cables in the same way to avoid damage to control units, components or measuring equipment.

1 Study the circuit diagram in question, check where the suspected cable is connected and if, and if so where, it is spliced.

2 Turn off the main electric power with the battery disconnector.

3 Unplug the connector at the control unit or component in question.

⚠ CAUTION

Wipe and re-grease the connectors.

Risk of corrosion on contact surfaces.

Clean all connectors loosened during troubleshooting using electronic cleaner 923836.0826 and re-grease them with connector grease 923836.0552.

4 Check if there is open circuit.

NOTE

Some components cannot be checked without power supply to the component. In such an event, proceed to point 5.

a. Measure resistance between connections for the component in the connector at the control unit or component.

b. The resistance must correspond with the component. Otherwise there may be an open circuit or short circuit in cable harness and/or component.

5 Check if there is short circuit to frame:

a. Unplug the connector at both the control unit and the component in question.

b. Measure the resistance of one lead at a time. Measure between the lead and a frame-connected part of the machine.

c. The multimeter should show endless resistance.

Troubleshooting hydraulic hoses

WARNING

Oil under high pressure!

Personal injury!

Always depressurise hydraulic and brake systems before starting to work on the systems.

1 Depressurise the hydraulic and brake systems; see section *B Safety*.

2 Study the relevant hydraulic diagram, check between whichever components the suspect hose is connected and correspondingly where it is spliced.

3 Locate the hose on the machine.

Start at one component and follow the hose to the next component.

4 Inspect the entire hose and splicing points with respect to chafing damage, pinching damage and leaks.

Change damaged hoses. When removing a hydraulic hose, change of O-ring is always recommended on the hoses that have these (ORFS).

Table of Contents1 Engine

1 Engine

Engine, general

Engine alternative

The machine can be equipped with one of the following engine alternatives:

- Volvo TWD1240VE stage II as per Directive 97/68/EC
- Volvo TAD1250VE (stage III as per Directive 97/68/EC)
- Cummins QSM11 (stage III as per Directive 97/68/EC)

If there are differences between engine alternatives, this is written in brackets after headings or under figures to clarify that which is shown.

Volvo engines have many similarities. Descriptions and instructions that are the same for both engine alternatives are denominated "(engine alternative Volvo)". If a description or set of instructions only applies to one engine alternative then the whole engine designation is written out, for instance "(engine alternative Volvo TAD1250VE).

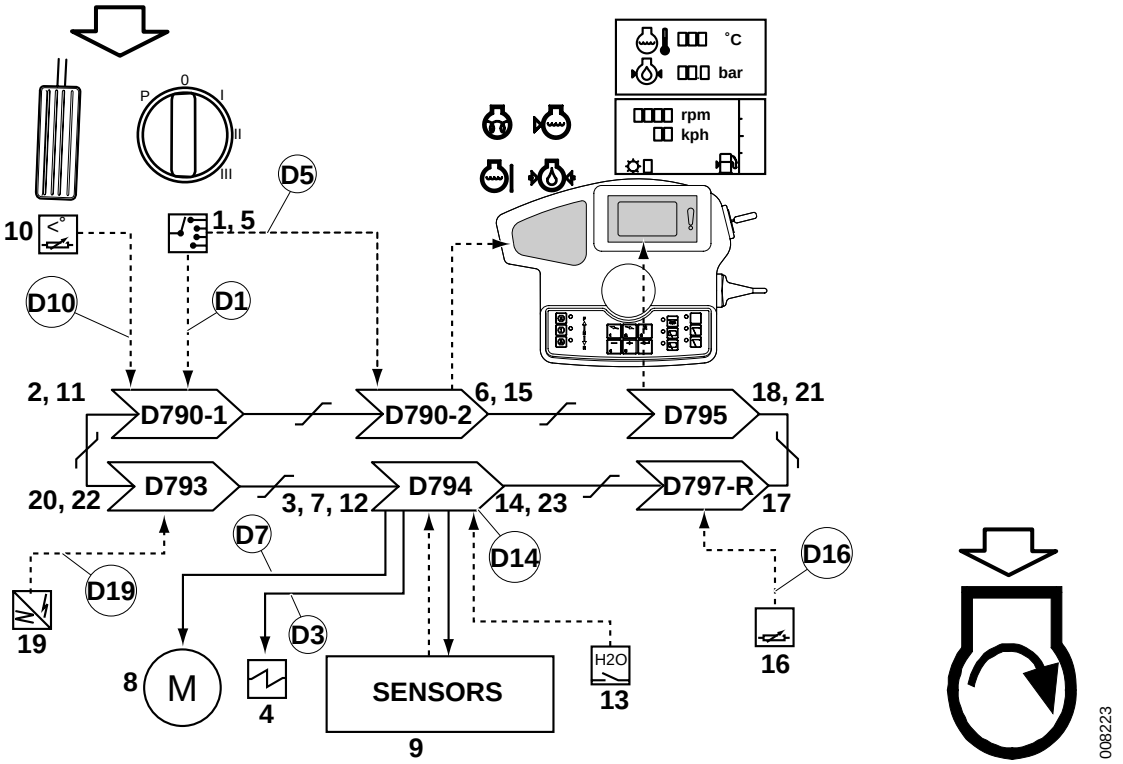
Component supplier documentation

The Workshop manual only describes components and work descriptions that concern installation in the machine. For descriptions and instructions for the engine’s components and systems, refer to supplier documentation.

References to component supplier documentation are only provided in exceptional cases. If information about a component is not found, the component supplier documentation should be used.

Engine alternative Volvo, function description

Condition	Reference value	Reference
Engine heater ⊕	Disconnected (when cable is in start lock-out is activated)	*Engine heater, description page 35*



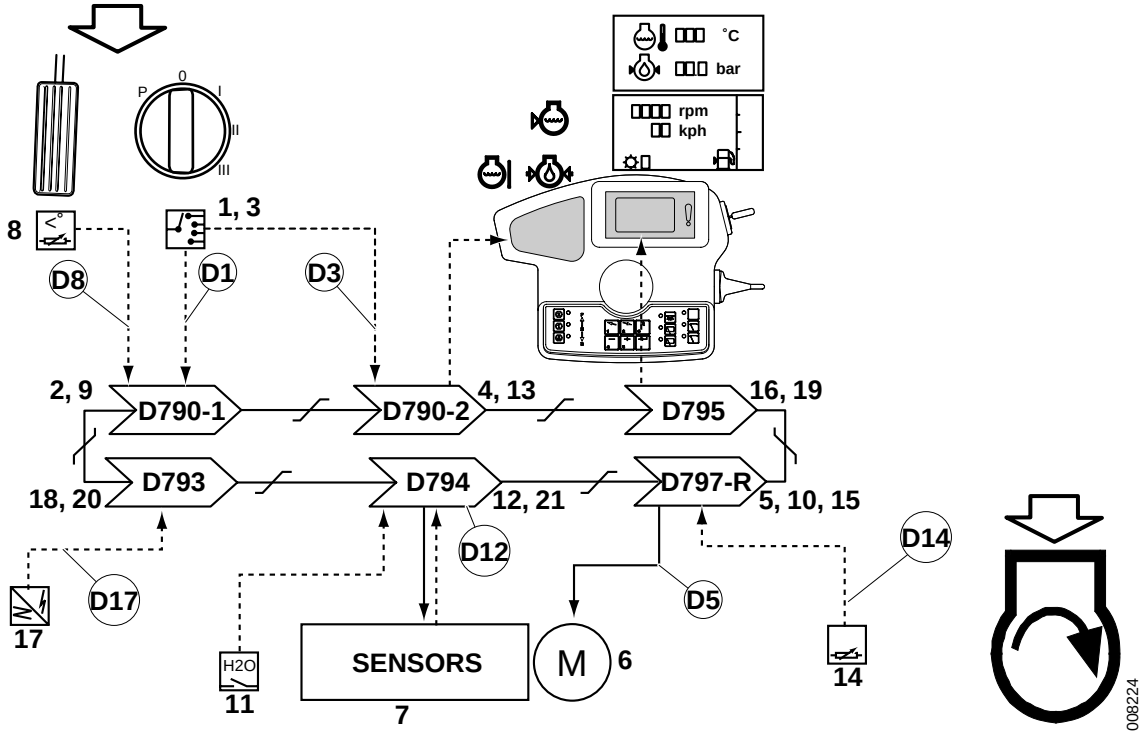
Pos	Explanation	Signal description	Reference
1	The ignition key lock sends a voltage signal to the cab control unit (D790-1) when the start key is turned to position 1 or the preheating position.	U = 24 V	*Ignition switch, description page 23* D1: Diagnostic menu, see section *8 Control system* , group *8.4.1.4 CAN/POWER, menu 4* and *8.4.6.4 ENGINE, menu 4*
2	Cab control unit (D790-1) sends ignition on via the CAN bus. If the key is turned to the preheating position, then preheating is also sent on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.1 Cab control unit*
3	If preheating is activated with the start key then Control unit, engine (D794) supplies power to the preheating element.	U = 24 V	D3: Diagnostic menu, see section *8 Control system* , group *8.4.6.5 ENGINE, menu 5*
4	The preheating coil warms the engine intake air.	-	D3: Diagnostic menu, see section *8 Control system* , group *8.4.6.5 ENGINE, menu 5*

Pos	Explanation	Signal description	Reference
5	The ignition key lock sends a voltage signal to the Control unit KIT (D790-2) when the start key is turned to the start position.	U = 24 V	*Ignition switch, description page 23* D5: Diagnostic menu, see section *8 Control system* , group *8.4.6.4 ENGINE, menu 4*
6	Control unit KIT (D790-2) transmits a start signal on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.11 Control unit KIT*
7	The engine control unit (D794) supplies power to the starter motor.	U = 24 V	*Starter motor, description (engine alternative Volvo) page 37* D7: Diagnostic menu, see section *8 Control system* , group *8.4.6.5 ENGINE, menu 5*
8	The starter motor cranks the engine.	-	*Starter motor, description (engine alternative Volvo) page 37* D7: Diagnostic menu, see section *8 Control system* , group *8.4.6.5 ENGINE, menu 5*
9	The engine's sensors send signals to the engine control unit (D794), which regulates the injectors so that the engine starts.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.10 Engine control unit*
10	The accelerator pedal sends the cab control unit (D790-1) a voltage signal proportional to the downward press of the pedal.	U = 0.5–4.5 V Lower voltage than 0.5 V and higher voltage than 4.5 V used to detect malfunction in cable harnesses and controls.	Section *9 Frame, body, cab and accessories,* group *9.1 Controls and instruments* D10: Diagnostic menu, see section *8 Control system* , group *8.4.6.1 ENGINE, menu 1*
11	The cab control unit (D790-1) transmits a message with the rpm request on the CAN bus	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.1 Cab control unit*
12	The engine control unit (D794) increases engine speed.	-	Section *11 Common electrics,* group *11.5.3.10 Engine control unit*
13	The NO switch for coolant level sends a voltage signal to Control unit, engine (D794) if the coolant level in the expansion tank is low.	U = 24 V	*Cooling system, description page 28*
14	The engine control unit (D794) transmits engine data and warning messages on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.10 Engine control unit* D14: Diagnostic menu, see section *8 Control system* , group *8.4.6.6 ENGINE, menu 6 and 8.4.6.7 ENGINE, menu 7*
15	The KID control unit (D795) shows engine data via display figures.	-	Section *11 Common electrics,* group *11.5.3.12 KID control unit*

Pos	Explanation	Signal description	Reference
16	The fuel level sensor (B757) sends a voltage signal to Control unit, frame rear (D797-R) proportional to the fuel level in the tank.	U = 0.5–4.5 V Lower voltage than 0.5 V and higher voltage than 4.5 V used to detect malfunction in cable harnesses and controls.	*Sensor, fuel level, description page 25* D16: Diagnostic menu, see section *8 Control system* , group *8.4.3.7 CAB, menu 7*
17	Control unit, frame rear (D797-R) transmits fuel level on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.3 Control unit, frame rear*
18	The KID control unit (D795) displays the fuel level in the operating menu for engine.	-	Section *11 Common electrics,* group *11.5.3.12 KID control unit*
19	The output shaft sensor (B758) sends the transmission control unit (D793) pulses with frequency proportional to output shaft rpm.	-	D19: Diagnostic menu, see section *8 Control system* , group *8.4.7.6 TRANSM, menu 6*
20	The transmission control unit (D793) transmits speed on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.9 Control unit, transmission*
21	The KID control unit (D795) shows the machine's speed.	-	Section *11 Common electrics,* group *11.5.3.12 KID control unit*
22	If output shaft rpm is so high that it reaches the limit for the machine's speed limitation, the cab control unit (D790-1) transmits a reduce engine rpm request on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.1 Cab control unit*
23	Control unit engine (D794) restricts engine rpm.	-	Section *11 Common electrics,* group *11.5.3.10 Engine control unit*

Engine alternative Cummins QSM11, function description (model year-2008)

Condition	Reference value	Reference
Engine heater ⊕	Disconnected (when cable is in start lock-out is activated)	*Engine heater, description page 35*



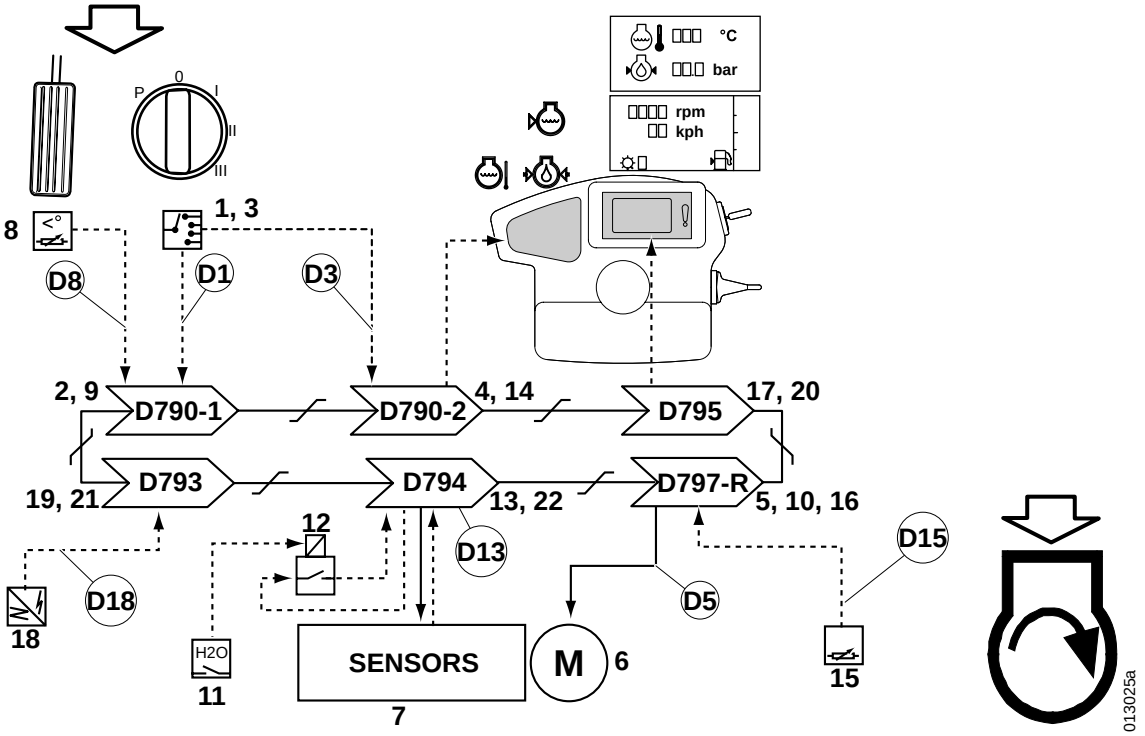
Pos	Explanation	Signal description	Reference
1	The ignition switch sends a voltage signal to the cab control unit (D790-1) when the ignition key is turned to position 1.	U = 24 V	*Ignition switch, description page 23* D1: Diagnostic menu, see section *8 Control system* , group *8.4.1.4 CAN/POWER, menu 4* and *8.4.6.4 ENGINE, menu 4*
2	The cab control unit (D790-1) transmits Ignition on as a start message on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.1 Cab control unit*
3	The ignition switch sends a voltage signal to Control unit KIT (D790-2) when the start key is turned to the start position.	U = 24 V	*Ignition switch, description page 23* D2: Diagnostic menu, see section *8 Control system* , group *8.4.6.4 ENGINE, menu 4*
4	The KIT control unit (D790-2) transmits a start signal on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.11 Control unit KIT*

Pos	Explanation	Signal description	Reference
5	Control unit, frame rear (D797-R) supplies power to the starter motor.	U = 24 V	*Starter motor, description (engine alternative Cummins) page 37* D5: Diagnostic menu, see section *8 Control system* , group *8.4.6.5 ENGINE, menu 5*
6	The starter motor cranks the engine.	-	*Starter motor, description (engine alternative Cummins) page 37*
7	The engine's sensors send signals to the engine control unit (D794), which regulates the injectors so that the engine starts.	-	Section *11 Common electrics,* group *11.5.3.10 Engine control unit*
8	The accelerator pedal sends the cab control unit (D790-1) a voltage signal proportional to the downward press of the pedal.	U = 0.5–4.5 V Lower voltage than 0.5 V and higher voltage than 4.5 V used to detect malfunction in cable harnesses and controls.	Section *9 Frame, body, cab and accessories,* group *9.1 Controls and instruments* D8: Diagnostic menu, see section *8 Control system* , group *8.4.6.1 ENGINE, menu 1*
9	The cab control unit (D790-1) transmits a message with the rpm request on the CAN bus	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.1 Cab control unit*
10	The engine control unit (D794) controls engine speed.	-	Section *11 Common electrics,* group *11.5.3.10 Engine control unit*
11	The NO switch for coolant level sends a voltage signal to Control unit, engine (D794) if the coolant level in the expansion tank is low.	U = 24 V	*Cooling system, description page 28*
12	The engine control unit (D794) transmits engine data and warning messages on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.10 Engine control unit* D12: Diagnostic menu, see section *8 Control system* , group *8.4.6.6 ENGINE, menu 6 and 8.4.6.7 ENGINE, menu 7*
13	The KID control unit (D795) shows engine data via display figures.	-	Section *11 Common electrics,* group *11.5.3.12 KID control unit*
14	The fuel level sensor (B757) sends a voltage signal to Control unit, frame rear (D797-R) proportional to the fuel level in the tank.	U = 0.5–4.5 V Lower voltage than 0.5 V and higher voltage than 4.5 V used to detect malfunction in cable harnesses and controls.	*Sensor, fuel level, description page 25* D14: Diagnostic menu, see section *8 Control system* , group *8.4.3.7 CAB, menu 7*
15	Control unit, frame rear (D797-R) transmits fuel level on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.3 Control unit, frame rear*
16	The KID control unit (D795) displays the fuel level in the operating menu for engine.	-	Section *11 Common electrics,* group *11.5.3.12 KID control unit*

Pos	Explanation	Signal description	Reference
17	The output shaft sensor (B758) sends the transmission control unit (D793) pulses with frequency proportional to output shaft rpm.	-	D17: Diagnostic menu, see section *8 Control system* , group *8.4.7.6 TRANSM, menu 6*
18	The transmission control unit (D793) transmits speed information on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.9 Control unit, transmission*
19	The KID control unit (D795) shows the machine's speed.	-	Section *11 Common electrics,* group *11.5.3.12 KID control unit*
20	If the speed is at the machine's speed limitation limit, the cab control unit (D790-1) transmits an engine speed reduction request on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.1 Cab control unit*
21	Control unit engine (D794) restricts engine rpm.	-	Section *11 Common electrics,* group *11.5.3.10 Engine control unit*

Engine alternative Cummins QSM11, function description (model year 2009-)

Condition	Reference value	Reference
Engine heater ⊕	Disconnected (when cable is in start lock-out is activated)	*Engine heater, description page 35*

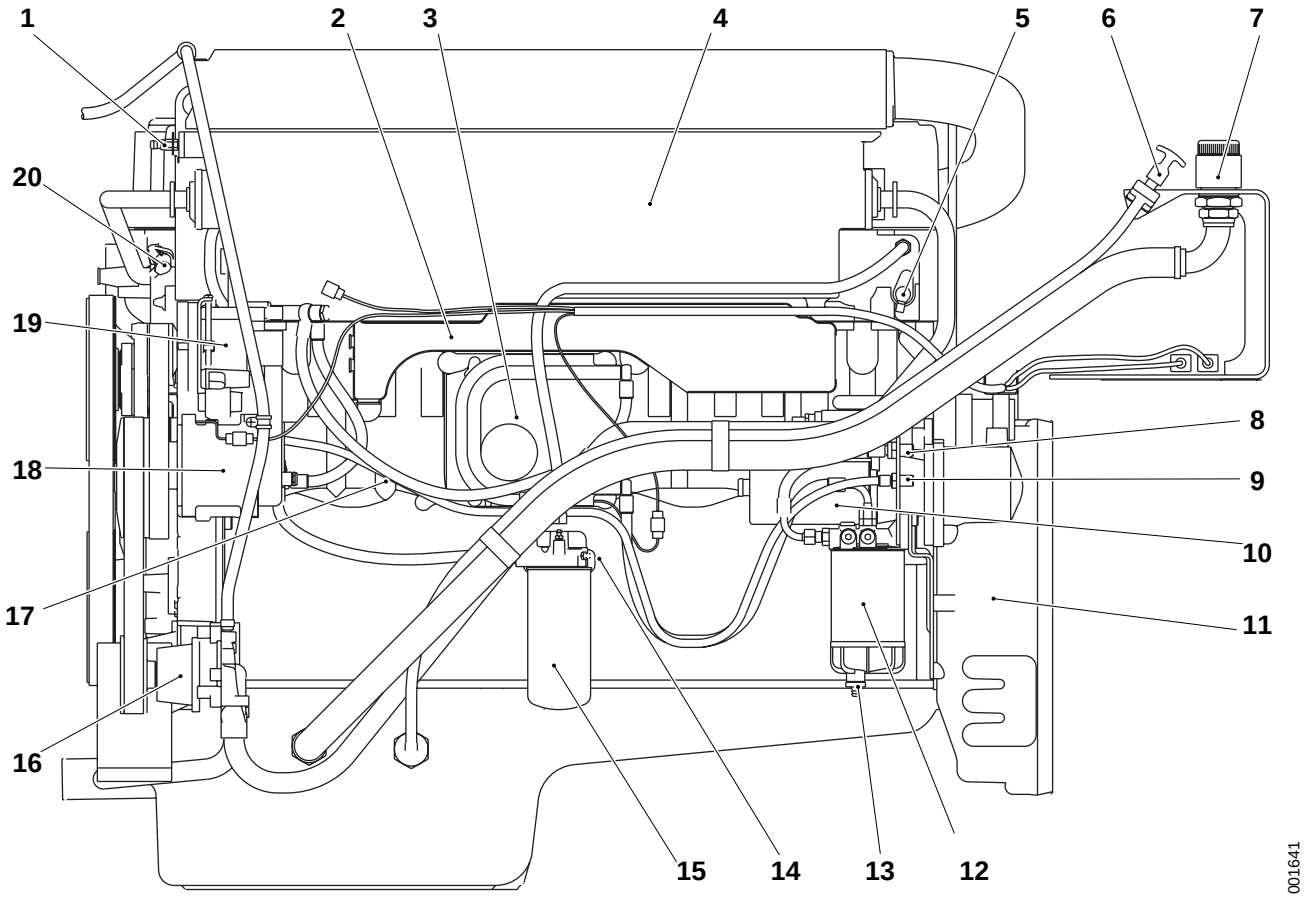


Pos	Explanation	Signal description	Reference
1	The ignition switch sends a voltage signal to the cab control unit (D790-1) when the ignition key is turned to position 1.	U = 24 V	*Ignition switch, description page 23* D1: Diagnostic menu, see section *8 Control system*, group *8.4.1.4 CAN/POWER, menu 4* and *8.4.6.4 ENGINE, menu 4*
2	The cab control unit (D790-1) transmits Ignition on as a start message on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.1 Cab control unit*
3	The ignition switch sends a voltage signal to Control unit KIT (D790-2) when the start key is turned to the start position.	U = 24 V	*Ignition switch, description page 23* D2: Diagnostic menu, see section *8 Control system* , group *8.4.6.4 ENGINE, menu 4*
4	The KIT control unit (D790-2) transmits a start signal on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.11 Control unit KIT*

Pos	Explanation	Signal description	Reference
5	Control unit, frame rear (D797-R) supplies power to the starter motor.	U = 24 V	*Starter motor, description (engine alternative Cummins) page 37* D5: Diagnostic menu, see section *8 Control system* , group *8.4.6.5 ENGINE, menu 5*
6	The starter motor cranks the engine.	-	*Starter motor, description (engine alternative Cummins) page 37*
7	The engine's sensors send signals to the engine control unit (D794), which regulates the injectors so that the engine starts.	-	Section *11 Common electrics,* group *11.5.3.10 Engine control unit*
8	The accelerator pedal sends the cab control unit (D790-1) a voltage signal proportional to the downward press of the pedal.	U = 0.5–4.5 V Lower voltage than 0.5 V and higher voltage than 4.5 V used to detect malfunction in cable harnesses and controls.	Section *9 Frame, body, cab and accessories,* group *9.1 Controls and instruments* D8: Diagnostic menu, see section *8 Control system* , group *8.4.6.1 ENGINE, menu 1*
9	The cab control unit (D790-1) transmits a message with the rpm request on the CAN bus	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.1 Cab control unit*
10	The engine control unit (D794) controls engine speed.	-	Section *11 Common electrics,* group *11.5.3.10 Engine control unit*
11	The NO switch for coolant level grounds the control terminal of the coolant level relay (K322) if the coolant level is low in the expansion tank.	Low coolant level: $U_{K322:85}$ = 0 V	*Cooling system, description page 28*
12	Coolant level relay (K322) breaks the circuit to Control unit, engine (D794) if the coolant level is low in the expansion tank.	-	*Cooling system, description page 28*
13	The engine control unit (D794) transmits engine data and warning messages on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.10 Engine control unit* D13: Diagnostic menu, see section *8 Control system* , group *8.4.6.6 ENGINE, menu 6 and 8.4.6.7 ENGINE, menu 7*
14	The KID control unit (D795) shows engine data via display figures.	-	Section *11 Common electrics,* group *11.5.3.12 KID control unit*
15	The fuel level sensor (B757) sends a voltage signal to Control unit, frame rear (D797-R) proportional to the fuel level in the tank.	U = 0.5–4.5 V Lower voltage than 0.5 V and higher voltage than 4.5 V used to detect malfunction in cable harnesses and controls.	*Sensor, fuel level, description page 25* D15: Diagnostic menu, see section *8 Control system* , group *8.4.3.7 CAB, menu 7*

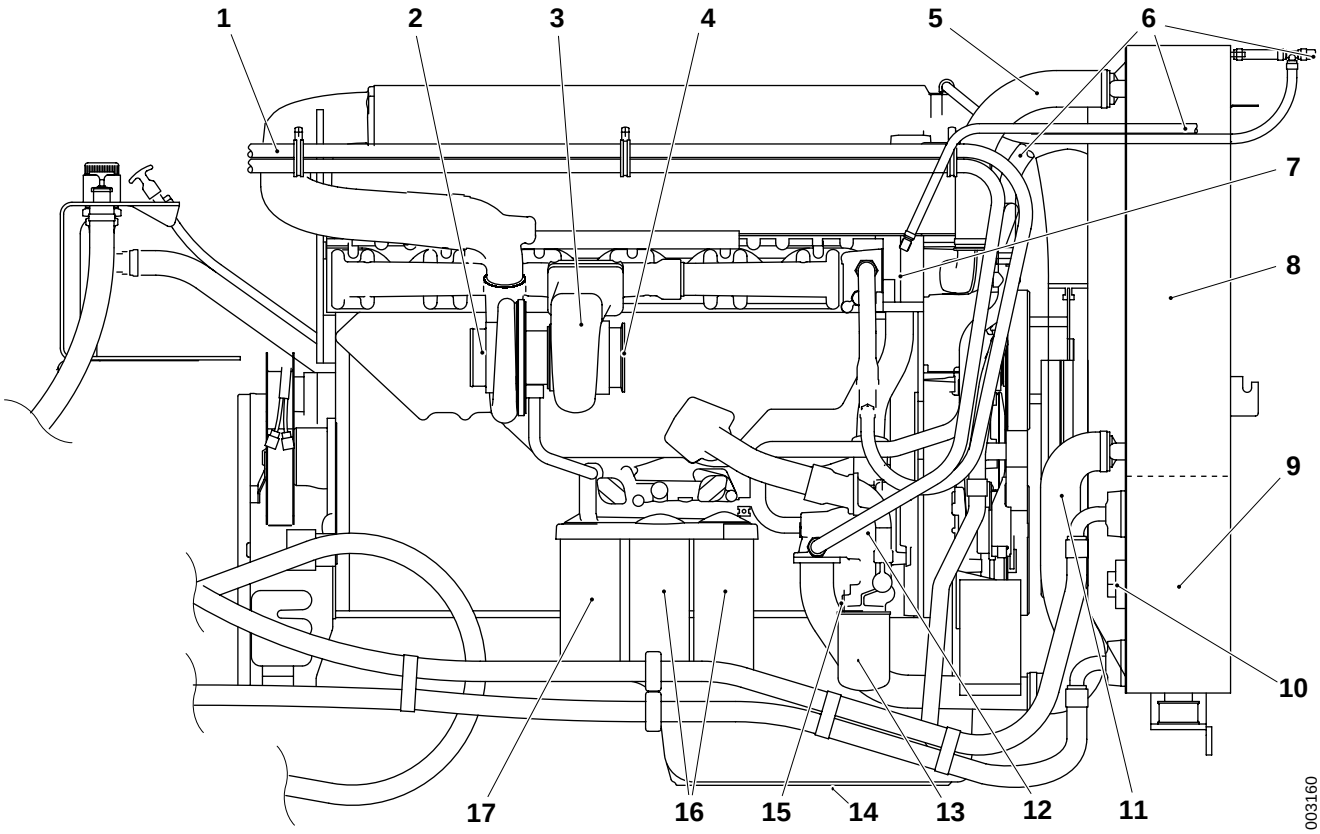
Pos	Explanation	Signal description	Reference
16	Control unit, frame rear (D797-R) transmits fuel level on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.3 Control unit, frame rear*
17	The KID control unit (D795) displays the fuel level in the operating menu for engine.	-	Section *11 Common electrics,* group *11.5.3.12 KID control unit*
18	The output shaft sensor (B758) sends the transmission control unit (D793) pulses with frequency proportional to output shaft rpm.	-	D18: Diagnostic menu, see section *8 Control system* , group *8.4.7.6 TRANSM, menu 6*
19	The transmission control unit (D793) transmits speed information on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.9 Control unit, transmission*
20	The KID control unit (D795) shows the machine's speed.	-	Section *11 Common electrics,* group *11.5.3.12 KID control unit*
21	If the speed is at the machine's speed limitation limit, the cab control unit (D790-1) transmits an engine speed reduction request on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.1 Cab control unit*
22	Control unit engine (D794) restricts engine rpm.	-	Section *11 Common electrics,* group *11.5.3.10 Engine control unit*

Engine alternative Volvo TWD1240VE, component location



Engine alternative, Volvo TWD1240VE, right side (in machine's direction of travel)

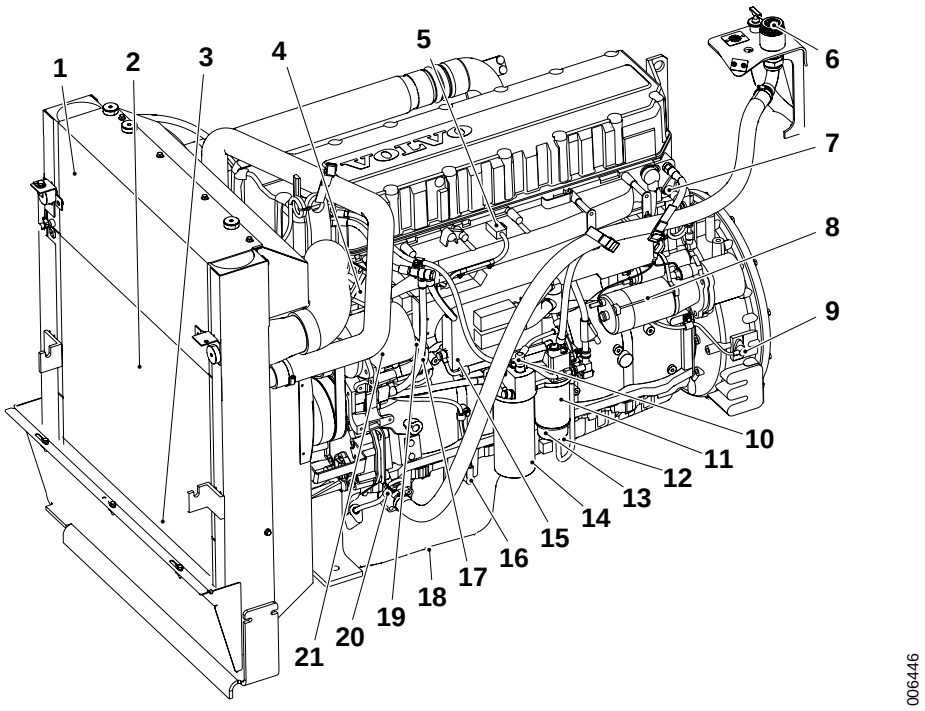
1. Air nipple, cooling system
2. Charge air pressure and charge air temperature sensor
3. Engine control unit (D794)
4. Intercooler
5. Coolant temperature sensor
6. Dipstick
7. Engine oil filling point
8. Fuel connection (intake)
9. Fuel connection (return)
10. Starter motor
11. Sensor, engine speed
12. Fuel pre-filter
13. Draining of condensation from fuel filter and water-in-fuel sensor
14. NO switch, fuel pressure
15. Fuel filter
16. Extra coolant pump
17. Oil pressure and oil temperature sensor
18. Compressor, air conditioning
19. Alternator
20. Sensor camshaft rpm



Engine alternative, Volvo TWD1240VE, left side (in machine's direction of travel)

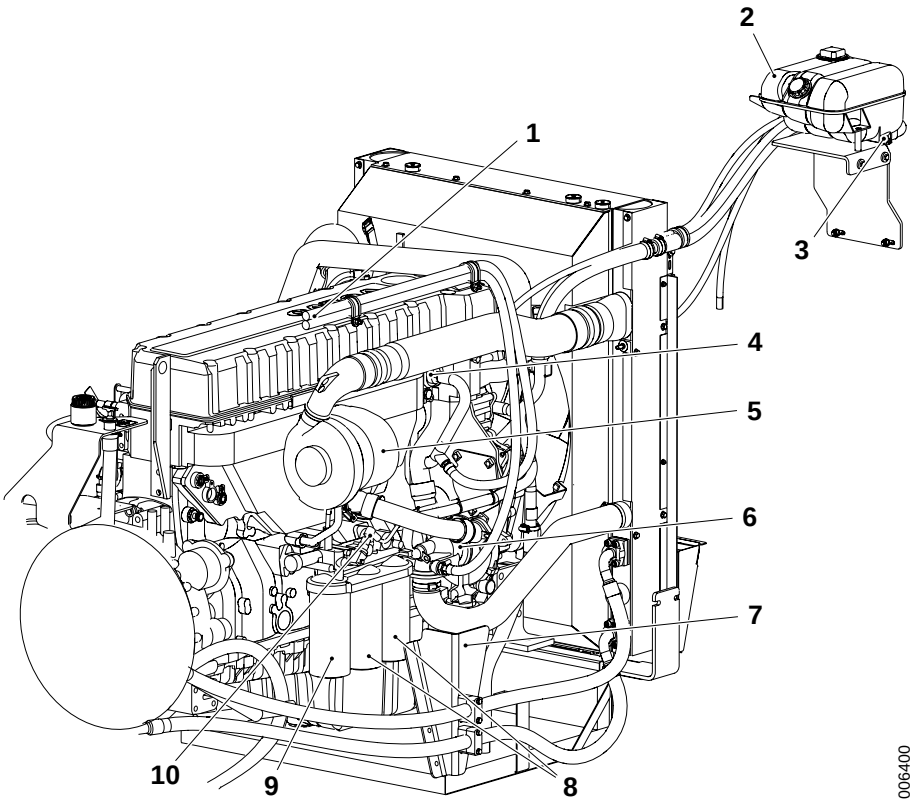
1. Connection cab heat
2. Air cleaner connection
3. Turbocharger
4. Exhaust system connection
5. Radiator connection outlet
6. Expansion tank connection
7. Thermostat
8. Water cooler
9. Transmission oil cooler
10. Thermostat, transmission oil cooler
11. Radiator connection intake
12. Coolant pump
13. Coolant filter
14. Engine oil drain plug
15. Coolant shut-off cock
16. Oil filter (full flow)
17. Oil filter (bypass)

Engine alternative Volvo TAD1250VE, component location



Volvo TAD1250VE engine right side (in machine's direction of travel)

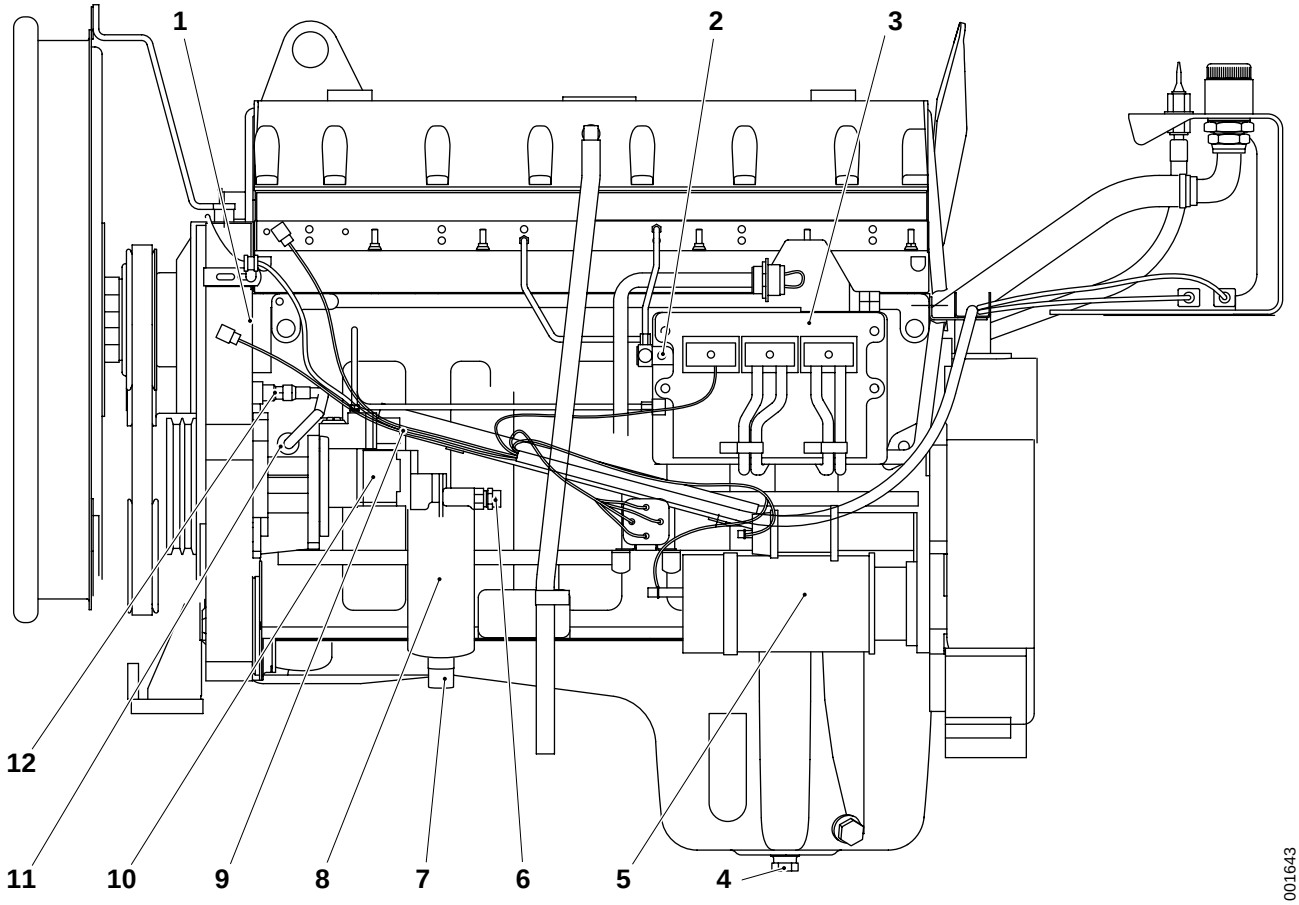
1. Intercooler
2. Water cooler
3. Transmission oil cooler
4. Preheating element
5. Charge air pressure and charge air temperature sensor
6. Engine oil filling point
7. Coolant temperature sensor
8. Starter motor
9. Sensor, engine speed
10. NO switch, fuel pressure
11. Fuel pre-filter
12. Water separator
13. Sensor, water-in-fuel
14. Fuel filter
15. Engine control unit (D794)
16. Oil level sensor
17. Crankcase pressure sensor
18. Engine oil drain plug
19. Oil pressure and temperature sensor
20. Dipstick
21. Alternator



Volvo TAD1250VE engine, left side (in machine's direction of travel)

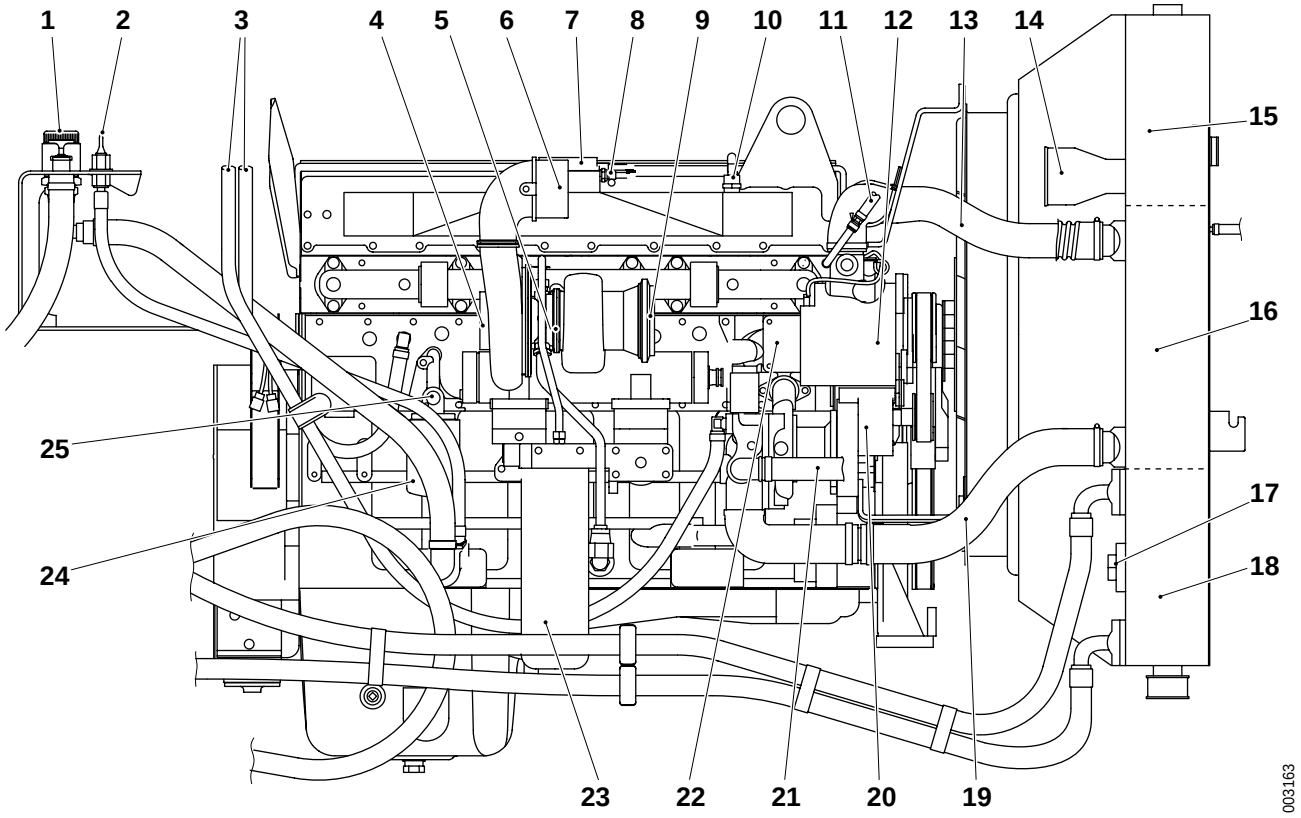
1. Connection cab heat
2. Expansion tank
3. Sensor, coolant level
4. Thermostat
5. Turbocharger
6. Coolant pump
7. Coolant filter (behind console)
8. Oil filter (full flow)
9. Oil filter (bypass)
10. Oil pressure sensor, piston cooling

Engine alternative Cummins QSM11, component location



Engine alternative, Cummins, right side (in machine's direction of travel)

1. Location for air conditioning compressor
2. Fuel connection (outlet)
3. Engine control unit (D794)
4. Engine oil drain plug
5. Starter motor
6. Fuel connection (intake)
7. Draining of condensation from fuel filter and water-in-fuel sensor
8. Fuel filter
9. Sensor fuel pressure
10. Fuel pump
11. Oil pressure and oil temperature sensor
12. Crankshaft position sensor



Engine alternative, Cummins, left side (in machine's direction of travel)

1. Engine oil filling point
2. Dipstick
3. Connection cab heat
4. Air cleaner connection
5. Turbocharger
6. Intercooler connection (outlet)
7. Intercooler connection (intake)
8. Intake temperature sensor
9. Exhaust system connection
10. Boost pressure sensor
11. Expansion tank connection
12. Alternator (coolant temperature sensor behind alternator)
13. Radiator connection (outlet)
14. Intake, intercooler
15. Intercooler
16. Water cooler
17. Thermostat
18. Transmission oil cooler
19. Radiator connection (intake)
20. Coolant pump
21. Expansion tank connection
22. Thermostat housing
23. Oil filter
24. Coolant filter
25. Coolant shut-off cock

Engine and transmission, separation (engine alternative Volvo)

Separation

1 Machine in service position, see section *B Safety*.

2 Disconnect the requisite hoses and cables before separating engine and transmission.

NOTE

Drain and collect liquids before detaching hoses.

3 Attach hoisting equipment to the engine.

4 Use a jack to secure the transmission.

5 Remove the plugs in front of the flywheel.

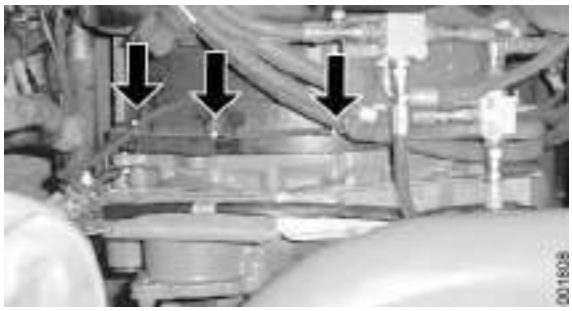
Use the outer hole to turn the engine round.

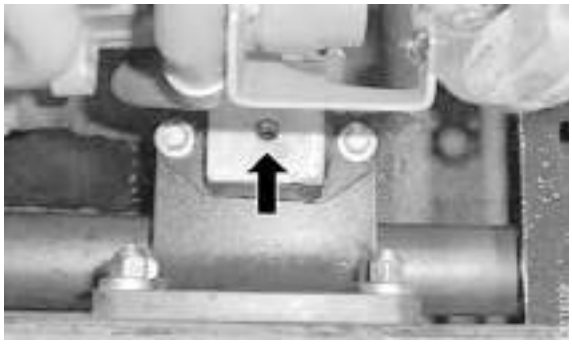
6 Remove the flex plate’s attaching bolt. Turn the engine until flex plate’s attaching bolts are visible in the inner hole. The flex plate has eight attachment points to be loosened.

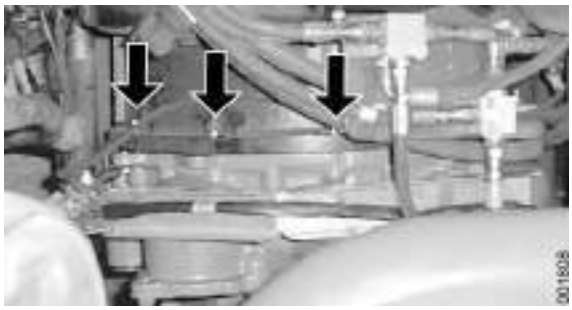
7 Take up the slack in the hoisting equipment.

NOTE

Do not lift the engine or transmission.







8 Remove the bolts between the engine and the transmission.

9 Loosen the engine or transmission attachment brackets and separate the engine and transmission.

Assembly

10 Check that the holes for the flex plate's mounting in the flywheel are just in front of the flex plate's retaining nuts.

The flex plate has eight attachment points to be connected with the flywheel on the engine.

11 Fit the engine or transmission brackets.

Tighten to a torque of **168 Nm**.

12 Connect the engine to the transmission.

13 Fit the bolts between the engine and transmission. Tighten to a torque of **40 Nm**.

14 Fit the flex plate's attaching bolts. Tighten to a torque of **40 Nm**.

NOTE

The engine must be loosened from the engine mounts and separated from the transmission to remove a dropped bolt. Secure the bolt in the socket when installing.

15 Fit the plugs in front of the flywheel.

16 Remove the hoisting equipment from the engine.

17 Remove the jack from underneath the transmission.

18 Connect the requisite hoses and cables for the engine and transmission. Check and fill fluids as needed.

19 Bleed air from the engine's fuel system before start.

Engine and transmission, separation (engine alternative Cummins QSM11)

Separation

1 Machine in service position, see section *B Safety*.

2 Attach hoisting equipment to the engine.

3 Disconnect the requisite hoses and cables before separating engine and transmission.

NOTE

Drain and collect liquids before detaching hoses.

4 Use a jack to secure the transmission.

5 Remove the cover washer.

6 Rotate the engine for each bolt in the flex plate that has to be removed.

7 Remove the screws of the flex plate through the hole under the cover washer.

8 Take up the slack in the hoisting equipment.

NOTE

Do not lift the engine.

9 Remove the bolts between engine and transmission.

10 Loosen the engine and transmission brackets.

11 Withdraw the engine rearwards to separate it from the transmission.

Assembly

12 Rotate the engine so that the holes in the flywheel are just in front of the attachment points on the flex plate.

The flex plate has eight attachment points to be connected with the flywheel on the engine.

13 Fit the bolts to the engine and transmission brackets. Tighten to a torque of **168 Nm**.

14 Connect the engine to the transmission.

15 Fit the bolts between engine and transmission. Tighten to a torque of **52 Nm**.

16 Fit the flex plate's attaching bolts. Tighten to a torque of **40 Nm**.

NOTE

The engine must be loosened from the engine mounts and separated from the transmission to remove a dropped bolt. Secure the bolt in the socket when installing.

17 Fit the plug in front of the flywheel.

18 Remove the hoisting equipment from the engine.

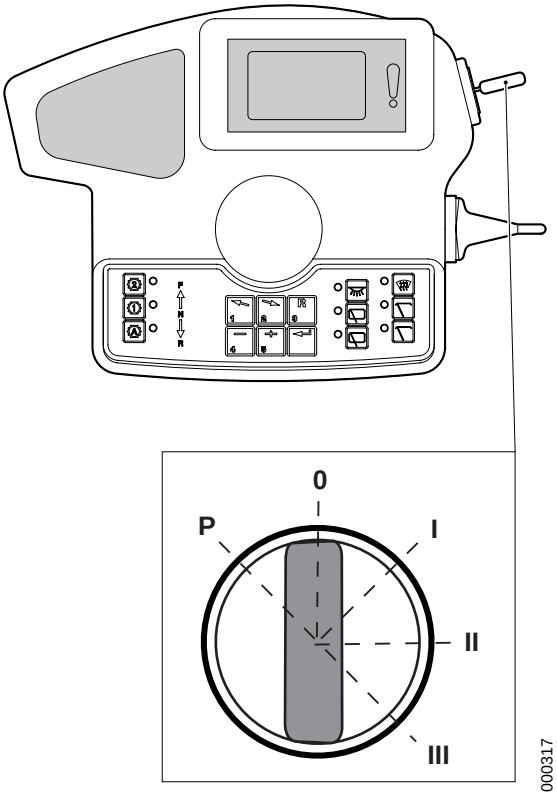
19 Remove the jack from underneath the transmission.

20 Connect the requisite hoses and cables for the engine and transmission. Check and fill fluids as needed.

1.1 Controls and instruments

1.1.1 Ignition switch

Ignition switch, description



P No function.

0 Stop position. Everything switched off; key can be removed.

I Operating position.

Voltage to all electrical functions. Engine and transmission control units are now ready for start.

The signal can be checked from the diagnostic menu, see section *8 Control system* , group *8.4.1.4 CAN/POWER, menu 4*.

II Preheating position.

In the preheating position the engine's intake air is heated by the electric heater to a suitable temperature. The preheating lamp illuminates during preheating.

The signal can be checked from the diagnostic menu, see section *8 Control system* , group *8.4.6.4 ENGINE, menu 4*.

III Start position.

Engagement of starter motor for engine start.

NOTE

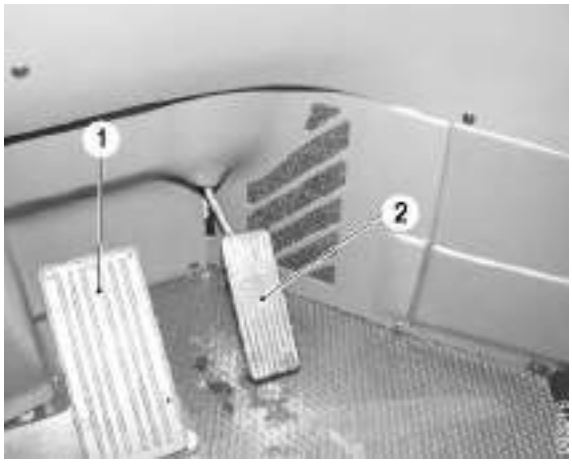
The machine is equipped with an electric restart interlock, which prevents engagement of the starter motor when the engine is rotating.

Conditions for starter motor engagement are that transmission is in neutral position and the engine is not already running.

The signal can be checked from the diagnostic menu, see section *8 Control system* , group *8.4.6.4 ENGINE, menu 4*.

1.1.2 Accelerator pedal

Accelerator pedal, replacement



1. Brake pedal
2. Accelerator pedal

1 Machine in service position, see section *B Safety*.

2 Pull one edge of the cover away to facilitate access to the accelerator pedal.

3 Unplug the cable from the connector.

4 Unscrew the connector from the accelerator pedal.

5 Replace the accelerator pedal.

6 Fit in the reverse order.

7 Calibrate the gas pedal, see the section *8 Control system,* group *8.5.2.3 Calibrate DRIVE-TRAIN*.

Accelerator pedal, calibration

See section *8 Control system,* group *8.5.2.3 Calibrate DRIVE-TRAIN*.

1.2 Fuel system

Fuel system, description

The fuel system distributes fuel between the cylinders and thereby controls the engine output power and rpm.

When the engine is started, the fuel pump sucks fuel from the tank through the fuel filter and forces it to the unit injections. The unit injectors spray in the fuel and atomises the fuel to the engine's combustion chamber.

1.2.1 Fuel tank

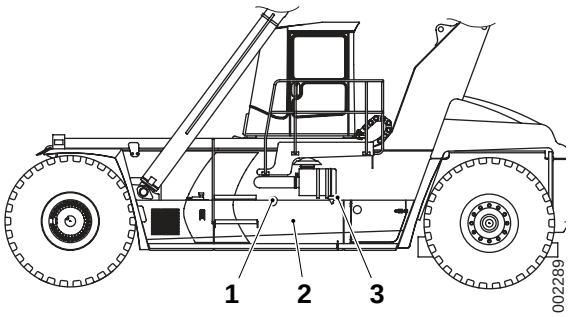
Fuel tank, description

The fuel tank is located on the left-hand side of the machine behind the brake fluid reservoir.

1.2.2 Sensor, fuel level

Sensor, fuel level, description

The signal can be checked from the diagnostic menu, see section *8 Control system* , group *8.4.3.7 CAB, menu 7*.



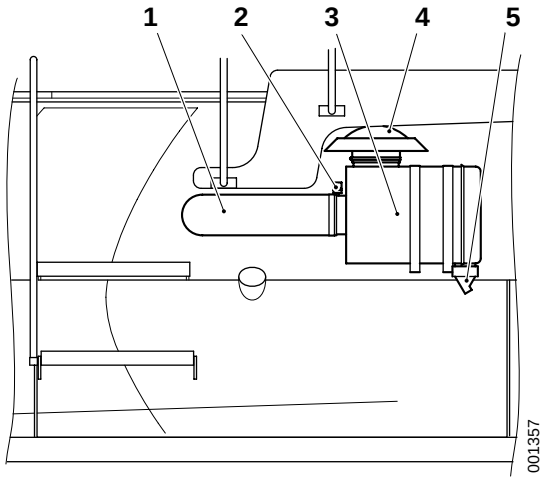
1. Fuel filler orifice
2. Fuel tank
3. Sensor, fuel level (behind air filter)

1.6 Air intake and exhaust outlet

1.6.1 Air cleaning system

Air cleaning system, description

Combustion in the engine requires air. Free unobstructed flow for fresh air and exhausts is essential for effective engine operation.

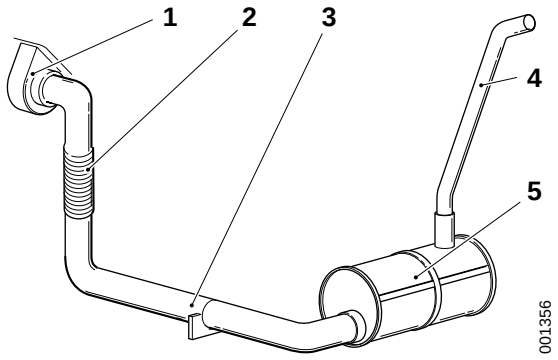


Air cleaning system, overview
1. Intake hose
2. Filter indicator
3. Air cleaner
4. Intake
5. Dust reservoir

1.6.3 Exhaust system

Exhaust system, description

The exhaust system is installed in the chassis. A heat shield is installed between the engine and the exhaust system to protect wiring, etc. A flex-pipe between the turbo and silencer absorbs the engine's movements. On the outside of the machine, there is a heat shield fitted over the exhaust system.



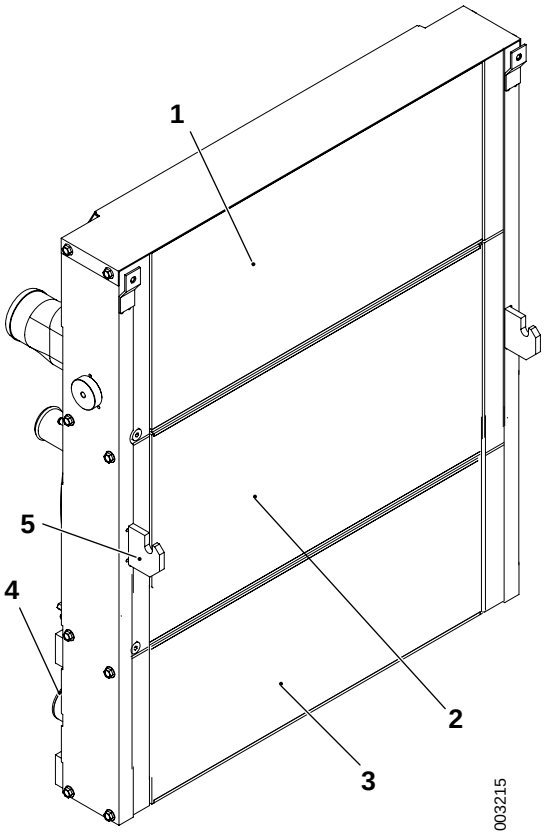
Exhaust system overview
1. Turbocharger
2. Flex pipe
3. Exhaust pipe
4. Tail pipe
5. Silencer

WARNING

Hot exhaust system!

Risk of burn injuries!

Never touch the turbo or muffler when the machine is running or just after it has been turned off!



Cooling unit, engine alternative Volvo TAD1250VE and Cummins QSM11
1. Intercooler
2. Engine cooler
3. Transmission oil cooler
4. Transmission oil thermostat
5. Condenser mounting (to AC)

1.6.4 Intercooler

Intercooler, description

Engine alternative Volvo TAD1250VE and Cummins QSM11

The charge air is cooled by an air-air intercooler in the upper part of the cooling unit.

Engine alternative Volvo TWD1240VE

The charge air is cooled by a water-air intercooler on the engine, see engine supplier documentation.

Also refer to *Cooling system, description page 28*.

1.7 Cooling system

Cooling system, description

The engine is water-cooled and has passages through which the coolant from the radiator flows round a closed system.

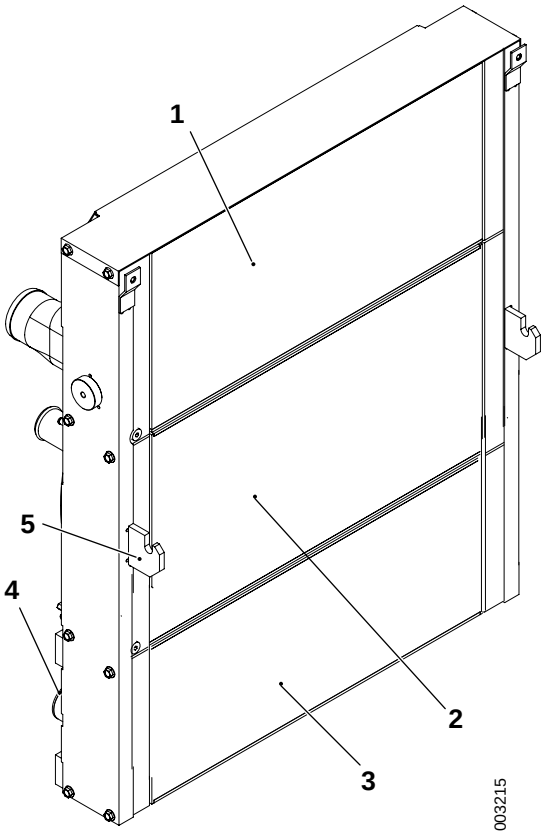
Main parts of the cooling system:

- Coolant pump
- Expansion tank
- Thermostat
- Cooling fan
- Radiator
- Engine oil cooler
- Intercooler
- Coolant filter

How the engine cooling system works:

1. The coolant pump pumps coolant through the cylinder head, engine block and oil cooler. On the engine alternative Volvo TWD1240VE a separate coolant pump pumps coolant through the intercooler.
2. The thermostat directs the heated coolant back to the coolant pump or through the radiator.
3. When the coolant is colder than the thermostat opening temperature it is pumped back to the engine.

   When the coolant is warmer than the thermostat opening temperature it is pumped through the radiator and then back to the coolant pump.
4. The expansion tank allows the coolant to expand without escaping from the engine.



Cooling unit, engine alternative Volvo TAD1250VE and Cummins QSM11

1. Intercooler
2. Engine cooler
3. Transmission oil cooler
4. Transmission oil thermostat
5. Condenser mounting (to AC)

1.7.4 Radiator and expansion tank

Radiator and expansion tank, description

Radiator for the engine is located in the cooling unit which is fitted behind the engine.

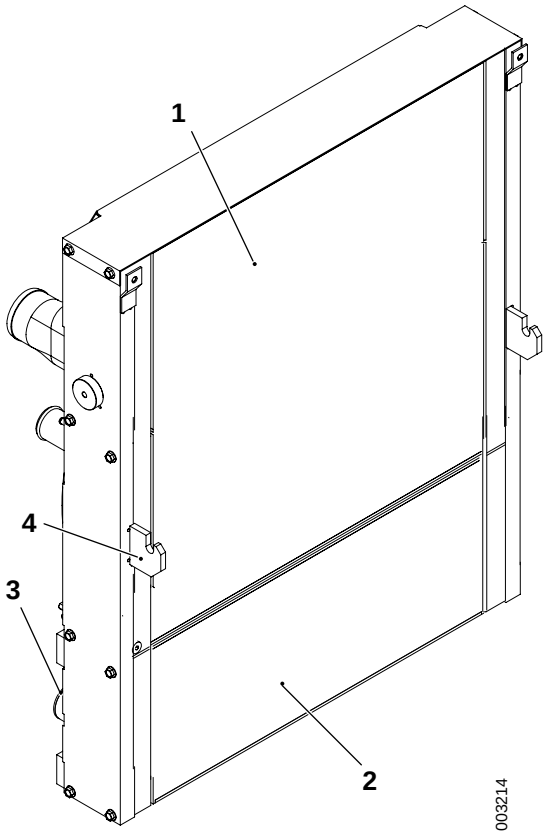
The purpose of the cooler assembly is to cool:

- Engine coolant
- Transmission oil (cooled in the lower part of the cooling unit), see also section *2 Transmission,* group *2.6.3 Oil cooler*.
- The charge air (engine alternative Volvo TAD1250VE and Cummins QSM11) is cooled in the upper cooling unit), see also *Intercooler, description page 27*.

  Engine alternative Volvo TWD1240VE has water-air intercooler mounted directly on the engine.

Also refer to *Cooling system, description page 28*.

For more information, see *supplier documentation, engine*.



Cooling unit, engine alternative Volvo TWD1240VE

1. Engine cooler
2. Transmission oil cooler
3. Transmission oil thermostat
4. Condenser mounting (to AC)

1.7.5 Cooling fan

Fan belt, replacement (engine alternative Volvo)

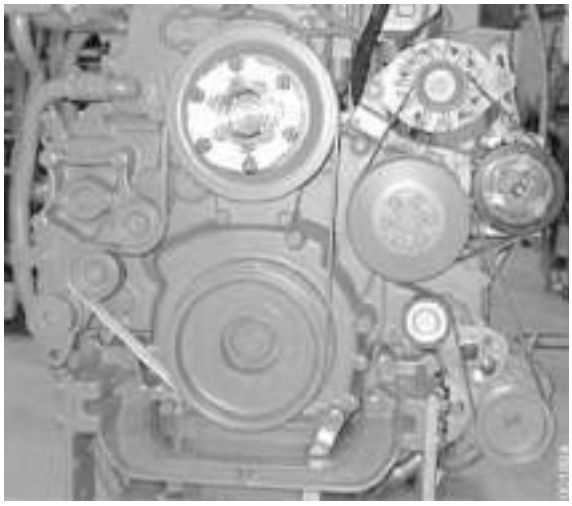
1 Position the cab in the front position.

2 Machine in service position, see section *B Safety*.

3 Remove the cover plates over the engine and radiator.

4 Release the tension on the fan belt and release the fan belt from belt pulley on the belt tensioner.

5 Remove the fan belt.



The figure shows engine without cooling fan.

6 Fit the new fan belt as illustrated.

Drive belt, extra water pump, replacement (engine alternative Volvo TWD1240VE)

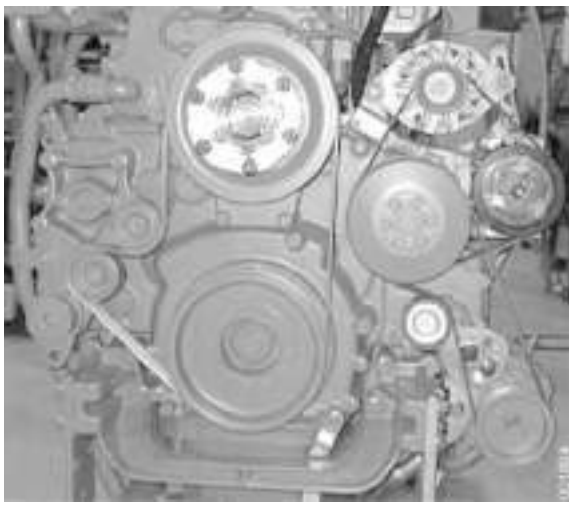
1 Position the cab in the front position.

2 Machine in service position, see section *B Safety*.

3 Remove the cover plates over the engine and radiator.

4 Release the tension on the fan belt.

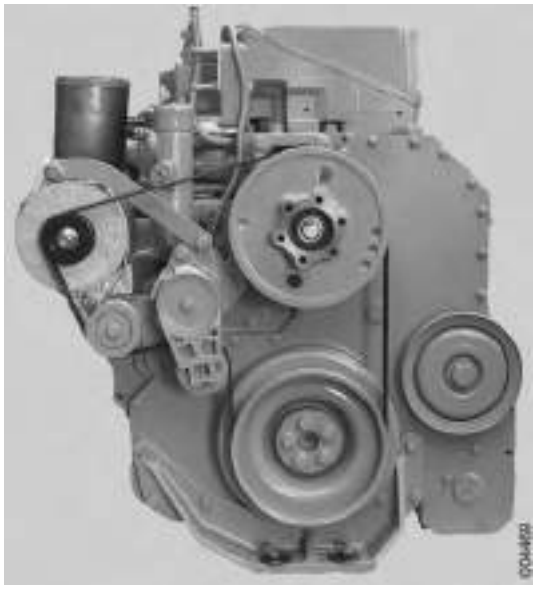
5 Remove the drive belt.



The figure shows engine without cooling fan.

6 Fit the new drive belt as illustrated.

Fan belt, replacement (engine alternative Cummins)



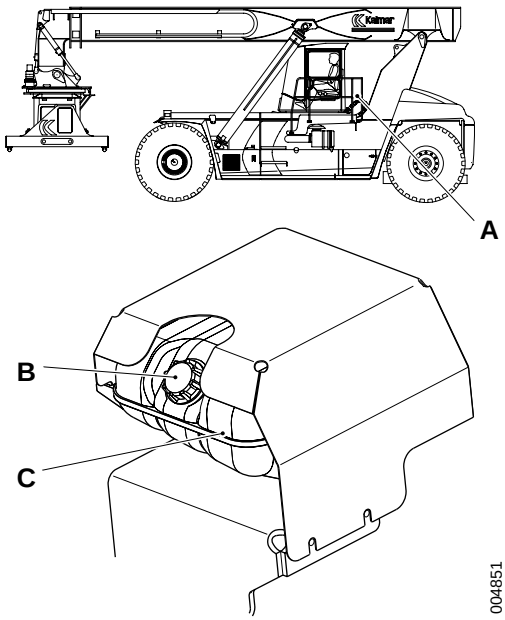
1 Position the cab in the front position.
2 Machine in service position, see section *B Safety*.
3 Remove the cover plates over the engine and radiator.
4 Loosen the belt tensioner.
5 Remove the fan belt.
6 Fit a new fan belt.
7 Tension the fan belt with the belt tensioner.

1.7.7 Coolant

Coolant, changing (engine alternative Volvo)

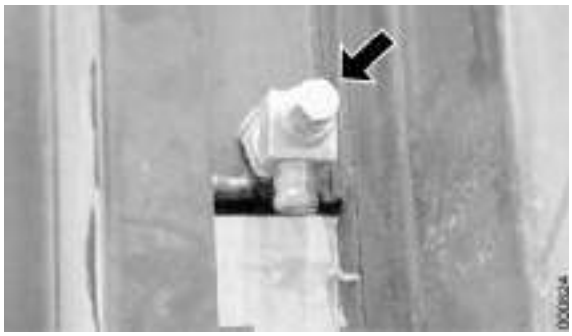
NOTE

Read the safety instructions for coolant before starting work, see section B Safety.



A. Location, expansion tank
B. Filling point
C. Level marking

1 Machine in service position, see section *B Safety*.
2 Remove the cap on the expansion tank.
3 Place a receptacle under the radiator and engine. (The cooling system holds about 40 l.)



4 Drain the cooling system.

Open the drain cock on the bottom of the radiator. Collect the coolant in the receptacle.

5 Open the drain cock on the engine.

6 Once all the coolant has drained out, close drain cocks.

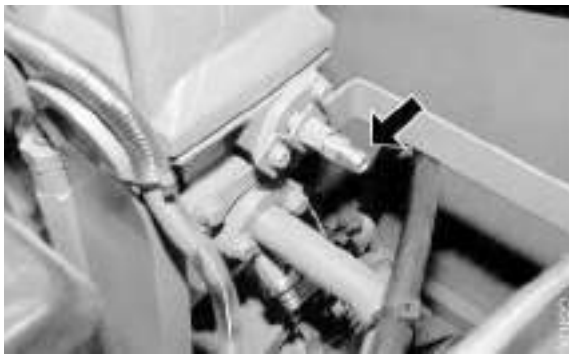
7 Fill the new premixed coolant of the correct type in the expansion tank. For volume and quality, see section *F Technical data*.

CAUTION

Different types of coolant cannot be mixed.

Risk of engine damage and damage to the cooling system if different coolant types are mixed.

When changing and refilling the coolant the coolant must be of the same type as was previously used.



8 Open the bleed nipple to release the air and speed up the filling. Close the bleed nipple when clean coolant without air bubbles is flowing out.

9 Turn on the main electric power and start the engine.

10 Turn on max. heat in the cab.

11 Run the engine to operating temperature so the thermostat opens and coolant is pumped around the whole system.

12 Check the level in the expansion tank, fill if required.

13 Check the coolant level again after 10 operating hours.

Coolant, changing (engine alternative Cummins QSM11)

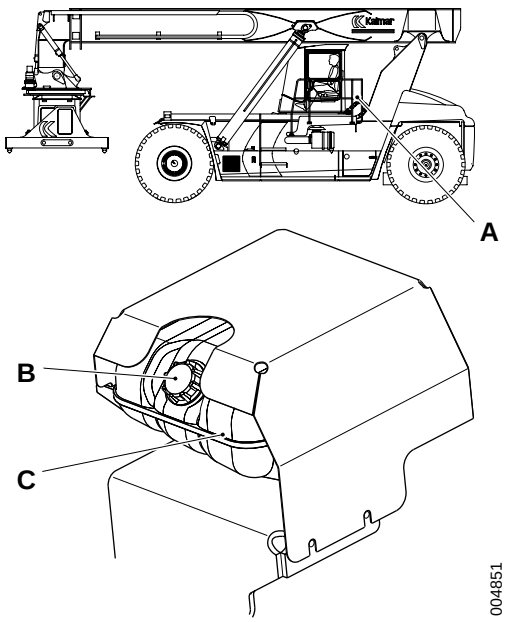
NOTE

Read the safety instructions for coolant before starting work, see section B Safety

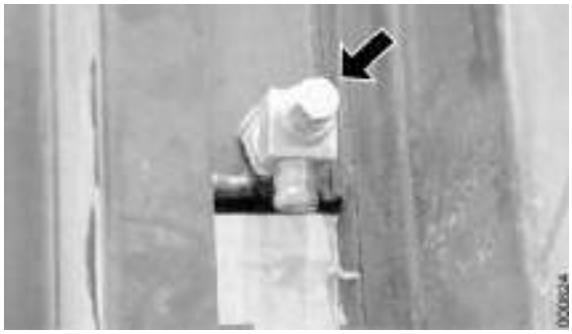
1 Machine in service position, see section *B Safety*.

2 Remove the cap on the expansion tank.

3 Place a receptacle under the radiator and engine. (The cooling system holds about 40 l.)

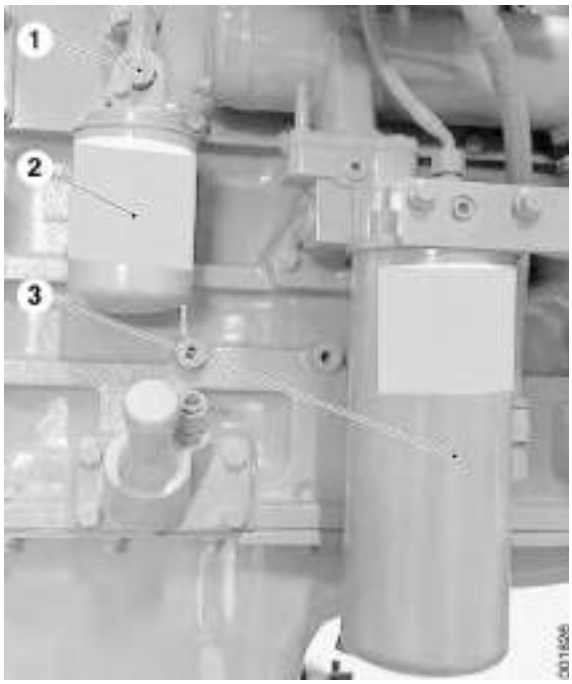


A. Location, expansion tank
B. Filling point
C. Level marking



4 Drain the cooling system.

Open the drain cock on the bottom of the radiator. Collect the coolant in the receptacle.



1. Coolant shut-off cock
2. Coolant filter
3. Oil filter

5 Open the drain cock on the engine.

6 Once all the coolant has drained out, close drain cocks.

7 Fill the new premixed coolant of the correct type in the expansion tank. For volume and quality, see section *F Technical data*.

CAUTION

Different types of coolant cannot be mixed.

Risk of engine damage and damage to the cooling system if different coolant types are mixed.

When changing and refilling the coolant the coolant must be of the same type as was previously used.

8 Turn on the main electric power and start the engine.

9 Turn on max. heat in the cab.

10 Run the engine to operating temperature so the thermostat opens and coolant is pumped around the whole system.

11 Check the level in the expansion tank, fill if required.

12 Check the coolant level again after 10 operating hours.

1.7.10 Engine heater

Engine heater, description

See *supplier documentation, engine*.

A start-inhibitor function is available as an option coupled with the engine heater. The function is activated when the heater is running.

1.9 Engine control system

1.9.1 Control unit, engine

Engine control unit, general

See section *11 Common electrics,* group *11.5.3.10 Engine control unit* and *supplier documentation, engine*.

1.11 Start/stop

1.11.1 Starter motor

Starter motor, description (engine alternative Volvo)

The starter motor cranks the engine until fuel combustion begins and the engine starts.

The starter motor is supplied with voltage directly from the start batteries. A relay on the starter motor (solenoid) is activated by the engine control unit (D794).

For more information, see *supplier documentation, engine*.

Starter motor, description (engine alternative Cummins)

The starter motor cranks the engine until fuel combustion begins and the engine starts.

The starter motor is supplied with voltage directly from the start batteries. A relay on the starter motor (solenoid) is activated by Control unit, frame rear (D797-R).

The signal can be checked from the diagnostic menu, see section *8 Control system* , group *8.4.6.5 ENGINE, menu 5*.

For more information, see *supplier documentation, engine*.

1.11.2 Stopping device

Stopping device, description

The engines have electrically regulated injectors that stop delivering fuel when the voltage is cut off, which means that the engine stops.

The engine can only be stopped by turning off the ignition via the ignition switch.

NOTE

The battery disconnect switch must not be used for emergency stop!

For more information, see *supplier documentation, engine*.

(+) Automatic engine shutdown is available as an option. This means that the engine shuts off automatically after 3-30 minutes (depending on customer setting) if the machine is stationary and idling.

Table of Contents 2 Transmission

2 Transmission

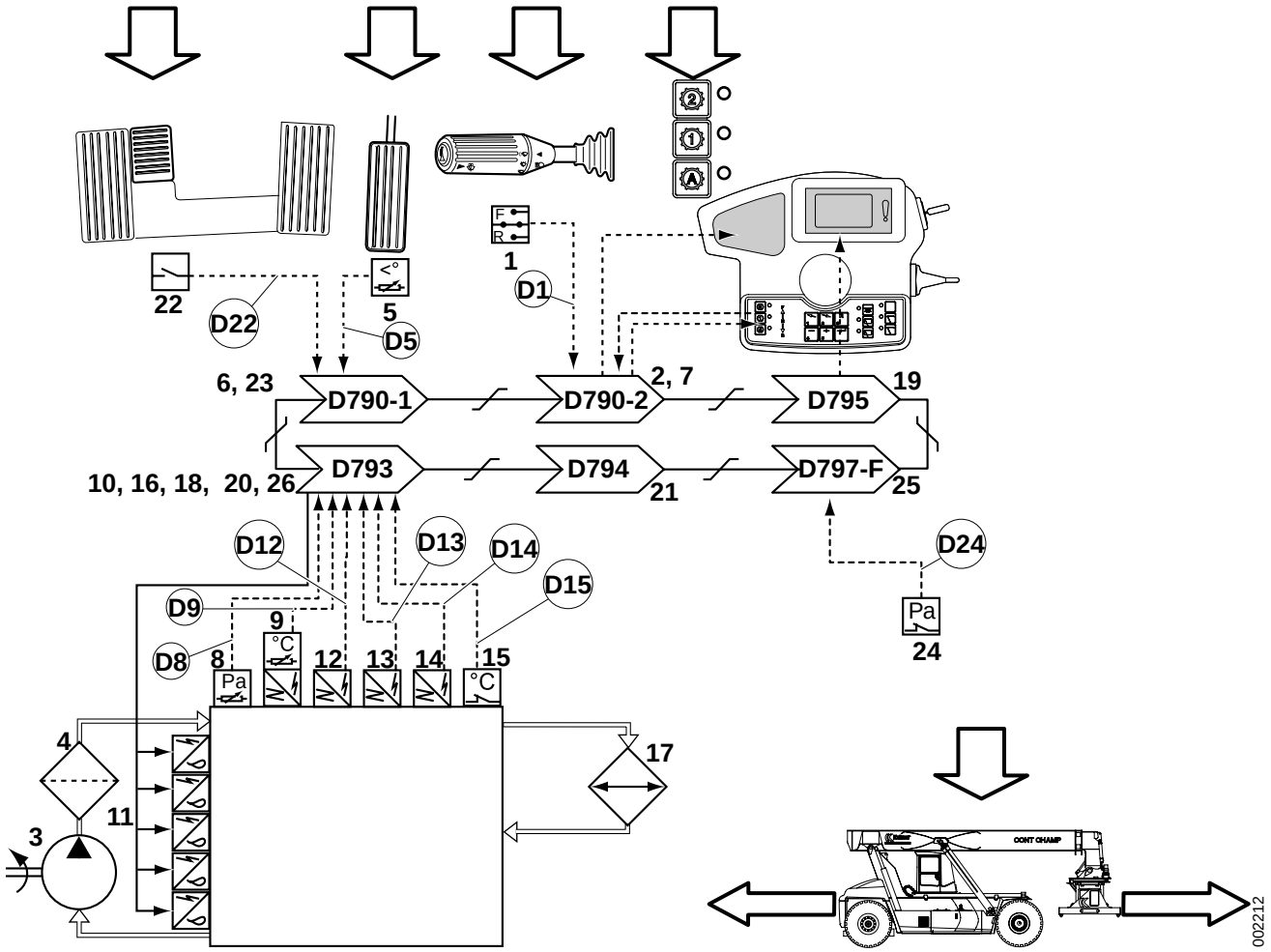
Transmission, general

Component supplier documentation

The workshop manual only describes components and work descriptions that concern installation in the machine. For descriptions of and instructions for the transmission's components and systems, refer to the supplier documentation.

References to component supplier documentation are only provided in exceptional cases. If information about a component is not found, the component supplier documentation should be used.

Transmission, function description (transmission alternative Dana)

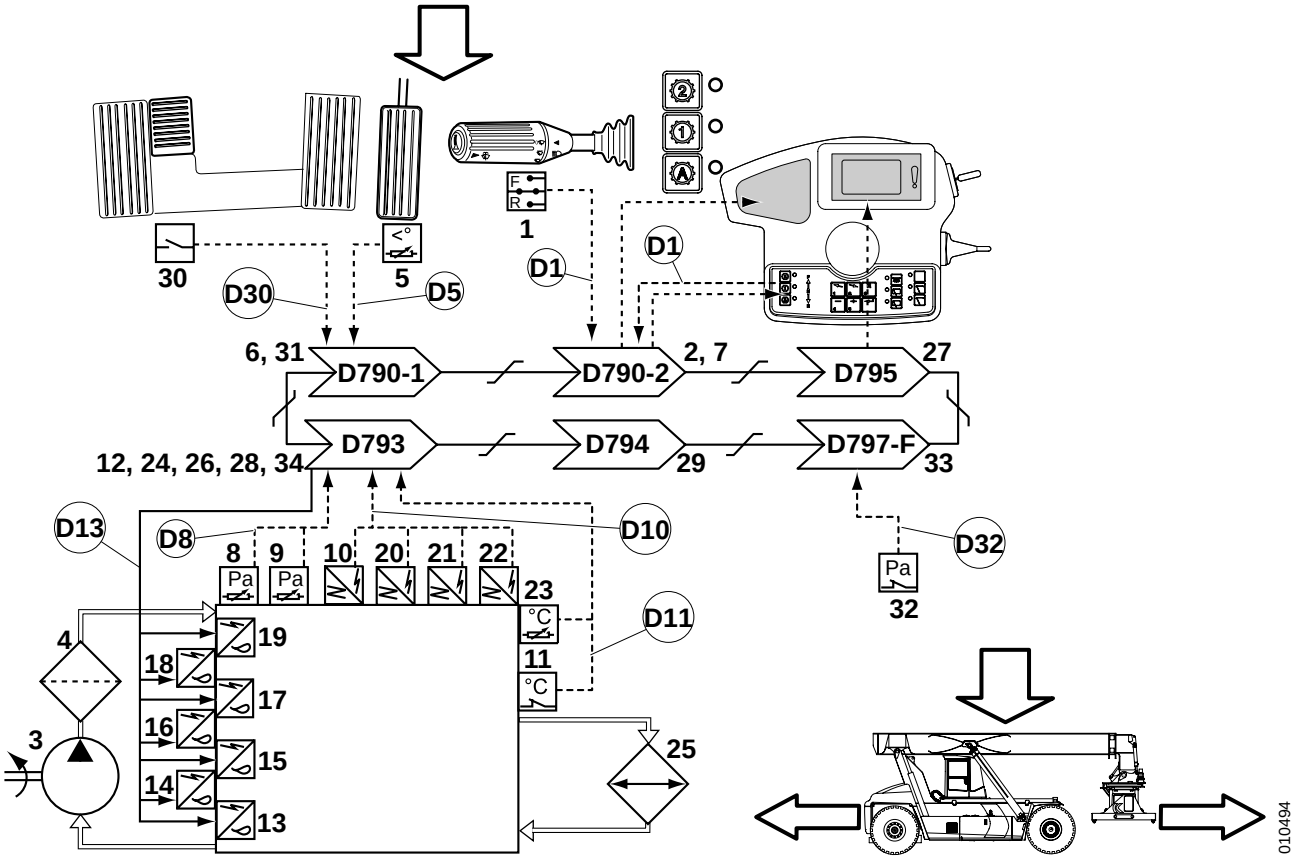


Pos	Explanation	Signal description	Reference
1	The gear selector sends a voltage signal to the KIT control unit (D790-2).	Forward, Conn. F: U = 24 V Reverse, Conn. R: U = 24 V	Section *9 Frame, body, cab and accessories,* group *9.1 Controls and instruments* D1: Diagnostic menu, see section *8 Control system* , group *8.4.7.2 TRANSM, menu 2*
2	The KIT control unit (D790-2) transmits the selected direction of travel (forward or reverse) on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.11 KIT control unit*
3	The transmission's oil pump pumps oil when the engine is running.	-	-
4	The transmission's oil filter cleans the oil from impurities.	-	-
5	The accelerator pedal transmits a signal to the cab control unit (D790-1).	U = 0.5-4.5 V	Section *1 Engine,* group *1.1.2 Accelerator pedal* D5: Diagnostic menu, see section *8 Control system* , group *8.4.6.1 ENGINE, menu 1*

Pos	Explanation	Signal description	Reference
6	The cab control unit (D790-1) transmits the desired throttle application on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.1 Cab control unit*
7	The KIT control unit (D790-2) transmits the selected shifting program on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.11 KIT control unit*
8	The oil pressure sensor sends the transmission control unit (D793) a voltage signal proportional to oil pressure.	Checked by Control unit transmission, error shown with error code.	D8: Diagnostic menu, see section *8 Control system* , group *8.4.7.10 TRANSM, menu 10*
9	The engine speed and oil temperature sensor (B758/766) sends the transmission control unit (D793) a pulse signal with frequency proportional to engine speed and a voltage signal proportional to the transmission oil temperature.	Checked by Control unit transmission, error shown with error code.	D9: Diagnostic menu, See Section *8 Control system* , group *8.4.7.6 TRANSM, menu 6* and *8.4.7.10 TRANSM, menu 10*
10	The transmission control unit (D793) supplies voltage to valve block transmission control to obtain desired function.	Checked by Control unit transmission, error shown with error code.	Section *11 Common electrics,* group *11.5.3.9 Transmission control unit*
11	Solenoid valves for travel direction and gear position in valve block transmission control activate gears in the transmission and the engine's power is transmitted to the transmission's output shaft.	Checked by Control unit transmission, error shown with error code.	-
12	The turbine speed sensor (B751) sends the transmission control unit (D793) a pulse signal with frequency proportional to turbine speed.	Checked by Control unit transmission, error shown with error code.	D12: Diagnostic menu, see section *8 Control system* , group *8.4.7.6 TRANS, menu 6*
13	The drum sensor (B752) sends the transmission control unit (D793) a pulse signal with frequency proportional to drum speed.	Checked by Control unit transmission, error shown with error code.	D13: Diagnostic menu, see section *8 Control system* , group *8.4.7.6 TRANSM, menu 6*
14	The output shaft speed sensor (B758) sends the transmission control unit (D793) a pulse signal with frequency proportional to output shaft speed.	Checked by Control unit transmission, error shown with error code.	D14: Diagnostic menu, see section *8 Control system* , group *8.4.7.6 TRANSM, menu 6*
15	The torque converter temperature switch (S221) sends the transmission control unit (D793) a voltage signal if oil temperature in the torque converter becomes too high.	Checked by Control unit transmission, error shown with error code.	D15: Diagnostic menu, see section *8 Control system* , group *8.4.7.10 TRANSM, menu 10*

Pos	Explanation	Signal description	Reference
16	The transmission control unit (D793) controls gear shifting according to selected shifting program.	Checked by Control unit transmission, error shown with error code.	Section *11 Common electrics,* group *11.5.3.9 Transmission control unit*
17	The oil cooler cools the transmission oil. A thermostat senses the oil's temperature and directs the oil back to the transmission if the oil is cold.	-	*Oil cooler, description page 31*
18	The transmission control unit (D793) transmits temperature and speed data on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.9 Transmission control unit*
19	The KID control unit (D795) shows transmission information in operating menus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.12 KID control unit*
20	If the signal from the output shaft speed sensor (B758) indicates that machine speed exceeds the speed limitation, the transmission control unit (D793) transmits a engine speed reduction request on the CAN bus.	-	D15: Diagnostic menu, see section *8 Control system* , group *8.4.7.6 TRANSM, menu 6*
21	The engine control unit (D794) reduces engine speed.	-	Section *11 Common electrics,* group *11.5.3.10 Engine control unit*
22	If the clutch pedal (S220-1) is depressed, it sends a voltage signal to the cab control unit (D790-1).	U = 24 V	Section *9 Frame, body, cab and accessories,* group *9.1 Controls and instruments* D22: Diagnostic menu, see section *8 Control system* , group *8.4.7.1 TRANSM, menu 1*
23	The cab control unit (D790-1) transmits disengage drive on CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.1 Cab control unit*
24	Normally closed (NC) switch, disengagement (S220-2) sends the Control unit, frame front (D797-F) a voltage signal if brake pressure is high enough to allow drive disengagement.	Brake pressure above 0.2 MPa: Conn 1, U = 24 V Conn 2, U = 24 V Brake pressure below 0.2 MPa: Conn 1, U = 24 V Conn 2, U = 0 V	*Normally closed (NC) switch, disengagement, description page 32* D24: Diagnostic menu, see section *8 Control system* , group *8.4.7.1 TRANSM, menu 1*
25	Control unit, frame front (D797-F) transmits disengagement approved on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.2 Control unit, frame front*
26	The transmission control unit (D793) supplies voltage to valve block transmission control so that drive is disengaged.	Checked by Control unit transmission, error shown with error code.	Section *11 Common electrics,* group *11.5.3.9 Transmission control unit*

Transmission, function description (transmission alternative Dana full flow)



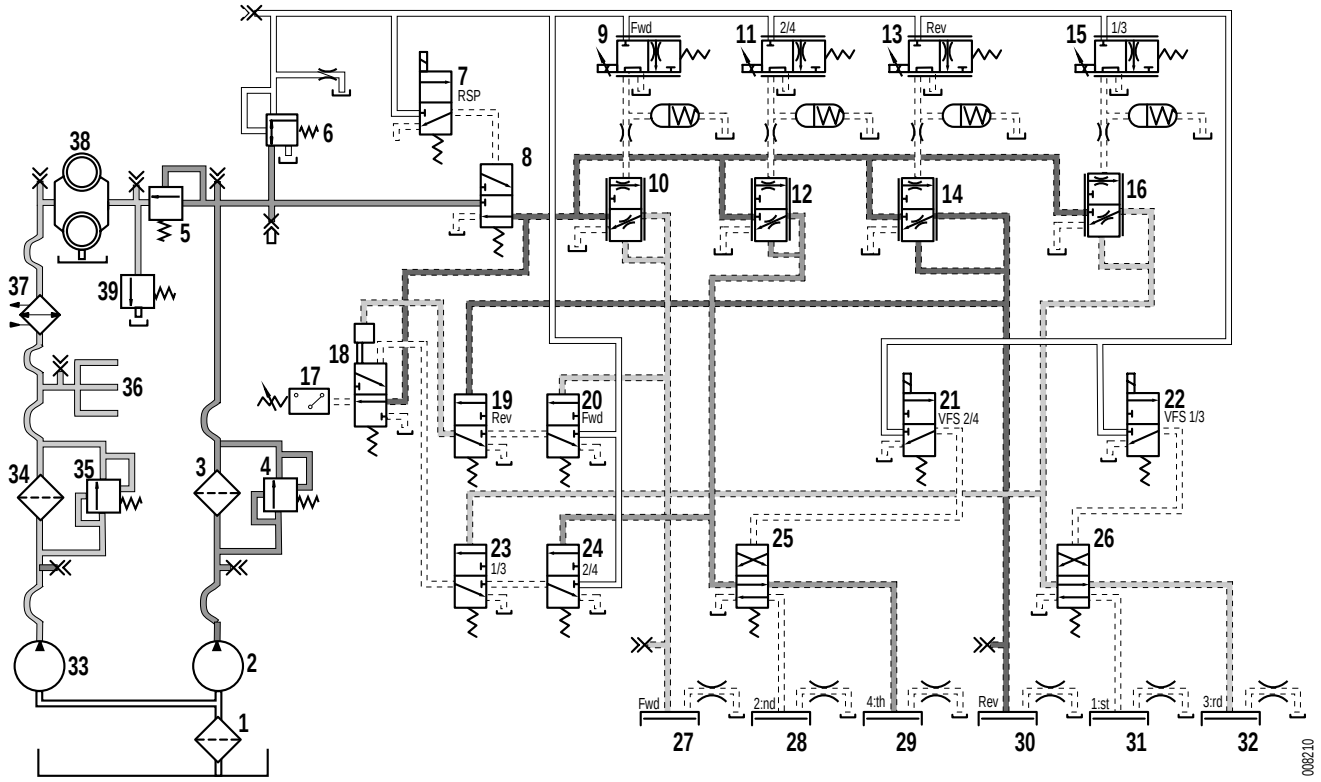
Pos	Explanation	Signal description	Reference
1	The gear selector sends a voltage signal to the KIT control unit (D790-2).	Forward, Conn. F: U = 24 V Reverse, Conn. R: U = 24 V	Section *9 Frame, body, cab and accessories,* group *9.1 Controls and instruments* D1: Diagnostic menu, see section *8 Control system* , group *8.4.7.2 TRANSM, menu 2*
2	The KIT control unit (D790-2) transmits the selected direction of travel (forward or reverse) on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.11 KIT control unit* D1: Diagnostic menu, see section *8 Control system* , group *8.4.7.2 TRANSM, menu 2*
3	The transmission's oil pump pumps oil when the engine is running.	-	-
4	The transmission's oil filter cleans the oil from impurities.	-	-
5	The accelerator pedal transmits a signal to the cab control unit (D790-1).	U = 0.5-4.5 V	Section *1 Engine,* group *1.1.2 Accelerator pedal* D5: Diagnostic menu, see section *8 Control system* , group *8.4.6.1 ENGINE, menu 1*

Pos	Explanation	Signal description	Reference
6	The cab control unit (D790-1) transmits the desired throttle application on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.1 Cab control unit*
7	The KIT control unit (D790-2) transmits the selected shifting program on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.11 KIT control unit*
8	Pressure sensor gear 1/3 (B6067) sends the transmission control unit (D793) a voltage signal proportional to oil pressure.	Checked by Control unit transmission, error shown with error code.	D8: Diagnostic menu, see section *8 Control system* , group *8.4.7.10 TRANSM, menu 10*
9	Pressure sensor gear 2/4 (B6069) sends the transmission control unit (D793) a voltage signal proportional to oil pressure.	Checked by Control unit transmission, error shown with error code.	D8: Diagnostic menu, see section *8 Control system* , group *8.4.7.10 TRANSM, menu 10*
10	Sensor, engine speed (B7530) sends a pulse signal with frequency proportional to the engine speed to Control unit, transmission (D793).	Checked by Control unit transmission, error shown with error code.	D10: Diagnostic menu, see section *8 Control system* , group *8.4.7.6 TRANSM, menu 6*
11	The oil temperature sensor (B7660) sends the transmission control unit (D793) a voltage signal proportional to transmission oil temperature.	Checked by Control unit transmission, error shown with error code.	D11: Diagnostic menu, see section *8 Control system* , group *8.4.7.10 TRANSM, menu 10*
12	The transmission control unit (D793) supplies voltage to the solenoid and servo valves to obtain the desired function.	Checked by Control unit transmission, error shown with error code.	Section *11 Common electrics,* group *11.5.3.9 Transmission control unit*
13 14 15 16 17 18 19	Solenoid valve drive forward (Y6066F) or Solenoid valve drive reverse (Y6066R) and Servo valve gear forward/reverse (Y6300) are activated to select the direction of travel. Solenoid valve gear selection 1/3 (Y6075) and Servo valve gear 1/3 (Y6067) or Solenoid valve gear selection 2/4 (Y6074) and Servo valve gear 2/4 (Y6069) are activated to select gear position. The engine's power is transferred to the transmission's output shaft.	Checked by Control unit transmission, error shown with error code.	D13: Diagnostic menu, See Section *8 Control system* , group *8.4.7.7 TRANSM, menu 7* , *8.4.7.8 TRANSM, menu 8* and *8.4.7.9 TRANSM, menu 9*
20	The turbine speed sensor (B7510) sends the transmission control unit (D793) a pulse signal with frequency proportional to turbine speed.	Checked by Control unit transmission, error shown with error code.	D10: Diagnostic menu, see section *8 Control system* , group *8.4.7.6 TRANS, menu 6*

Pos	Explanation	Signal description	Reference
21	The drum sensor (B7520) sends the transmission control unit (D793) a pulse signal with frequency proportional to drum speed.	Checked by Control unit transmission, error shown with error code.	D10: Diagnostic menu, see section *8 Control system* , group *8.4.7.6 TRANSM, menu 6*
22	The output shaft speed sensor (B7580) sends the transmission control unit (D793) a pulse signal with frequency proportional to output shaft speed.	Checked by Control unit transmission, error shown with error code.	D10: Diagnostic menu, see section *8 Control system* , group *8.4.7.6 TRANSM, menu 6*
23	The torque converter temperature switch (S2210) sends the transmission control unit (D793) a voltage signal if oil temperature in the torque converter becomes too high.	Checked by Control unit transmission, error shown with error code.	D11: Diagnostic menu, see section *8 Control system* , group *8.4.7.10 TRANSM, menu 10*
24	The transmission control unit (D793) controls gear shifting according to selected shifting program.	Checked by Control unit transmission, error shown with error code.	Section *11 Common electrics,* group *11.5.3.9 Transmission control unit*
25	The oil cooler cools the transmission oil. A thermostat senses the oil's temperature and directs the oil back to the transmission if the oil is cold.	-	*Oil cooler, description page 31*
26	The transmission control unit (D793) transmits temperature and speed data on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.9 Transmission control unit*
27	The KID control unit (D795) shows transmission information in operating menus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.12 KID control unit*
28	If the signal from the output shaft speed sensor (B7580) indicates that machine speed exceeds the speed limitation, the transmission control unit (D793) transmits a engine speed reduction request on the CAN bus.	-	D10: Diagnostic menu, see section *8 Control system* , group *8.4.7.6 TRANSM, menu 6*
29	The engine control unit (D794) reduces engine speed.	-	Section *11 Common electrics,* group *11.5.3.10 Engine control unit*
30	If the clutch pedal (S220-1) is depressed, it sends a voltage signal to the cab control unit (D790-1).	U = 24 V	Section *9 Frame, body, cab and accessories,* group *9.1 Controls and instruments* D30: Diagnostic menu, see section *8 Control system* , group *8.4.7.1 TRANSM, menu 1*
31	The cab control unit (D790-1) transmits disengage drive on CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.1 Cab control unit*

Pos	Explanation	Signal description	Reference
32	Normally closed (NC) switch, disengagement (S220-2) sends the Control unit, frame front (D797-F) a voltage signal if brake pressure is high enough to allow drive disengagement.	Brake pressure above 0.2 MPa: Conn 1, U = 24 V Conn 2, U = 24 V Brake pressure below 0.2 MPa: Conn 1, U = 24 V Conn 2, U = 0 V	*Normally closed (NC) switch, disengagement, description page 32* D32: Diagnostic menu, see section *8 Control system* , group *8.4.7.1 TRANSM, menu 1*
33	Control unit, frame front (D797-F) transmits disengagement approved on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics,* group *11.5.3.2 Control unit, frame front*
34	The transmission control unit (D793) supplies voltage to valve block transmission control so that drive is disengaged.	Checked by Control unit transmission, error shown with error code.	Section *11 Common electrics,* group *11.5.3.9 Transmission control unit*

Transmission shifting, function description (transmission alternative Dana)



Pos	Explanation	Signal description	Reference
1.	Bottom strainer oil sump, separates particles from the oil before the pumps.	-	-
2.	The transmission's oil pump 1 feeds the transmission with control pressure for control of the transmission.	100.5 l/min at 1973 rpm	-
3.	The oil filter cleans the oil.	-	-
4.	The bypass valve in the filter bracket leads the oil past the filter if the resistance through the filter becomes too high.	Opening pressure: 410-450 kPa	-
5.	The pressure governor releases pressure to the torque converter if the pressure becomes too high.	Opening pressure: 2200 kPa	-
6.	The pressure reducer reduces the feed pressure to servo pressure.	1200 kPa	-
7.	Solenoid valve neutral position (RSP) (Y6066) controls Valve spool neutral position.	-	Diagnostic menu, see section *8 Control system* , group *8.4.7.7 TRANSM, menu 7*

Pos	Explanation	Signal description	Reference
8.	Valve spool neutral position opens or closes to allow control pressure to the transmission.	-	-
9.	Solenoid valve drive forward (Y630) controls Pressure booster drive forward.	0-600 kPa	Diagnostic menu, see section *8 Control system* , group *8.4.7.8 TRANSM, menu 8* and *8.4.7.9 TRANSM, menu 9*
10.	Pressure booster forward increases the pressure and pressurises Drive clutch forward.	0-2000 kPa	-
11.	Solenoid valve gear 2/4 (Y6069) controls Pressure booster gear 2/4.	0-600 kPa	Diagnostic menu, see section *8 Control system* , group *8.4.7.8 TRANSM, menu 8* and *8.4.7.9 TRANSM, menu 9*
12.	Pressure booster gear 2/4 increases the pressure and feeds Valve slide gear selection 2/4 as well as Valve slide gear 2/4 control.	0-2000 kPa	-
13.	Solenoid valve drive reverse controls Pressure booster drive reverse.	0-600 kPa	Diagnostic menu, see section *8 Control system* , group *8.4.7.8 TRANSM, menu 8* and *8.4.7.9 TRANSM, menu 9*
14.	Pressure booster reverse increases the pressure and pressurises Drive clutch reverse.	0-2000 kPa	-
15.	Solenoid valve 1/3 (Y6067) controls Pressure booster gear 1/3.	0-600 kPa	Diagnostic menu, see section *8 Control system* , group *8.4.7.8 TRANSM, menu 8* and *8.4.7.9 TRANSM, menu 9*
16.	Pressure booster gear 1/3 increases the pressure and feeds Valve slide gear selection 1/3 as well as Valve slide gear 1/3 control.	0-2000 kPa	-
17.	Contact drive sends signal to the control unit to verify that drive clutches for travel direction and gear selection are activated when solenoid valve neutral position (RSP) (Y6066) is activated.	-	
18.	The drive control valve compares pressure signals from drive clutches for direction of travel and gear selection and sends the pressure signal on to the drive contact.	-	-
19.	The valve spool for reverse drive control opens when the reverse drive clutch is pressurised and leads a pressure signal to the drive control valve.	0-2000 kPa	
20.	The valve spool for forward drive control opens when the forward drive clutch is pressurised and leads a pressure signal to the drive control valve.	0-2000 kPa	-
21.	Solenoid valve VFS 2/4 (Y6074) controls servo pressure to Valve slide gear selection 2/4.	1200 kPa	Diagnostic menu, see section *8 Control system* , group *8.4.7.7 TRANSM, menu 7*