Workshop manual

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A Foreword

About the Workshop Manual

General

Thank you for choosing Kalmar Industries as your machine supplier. We hope that we'll meet your expectations.

Workshop manual contents

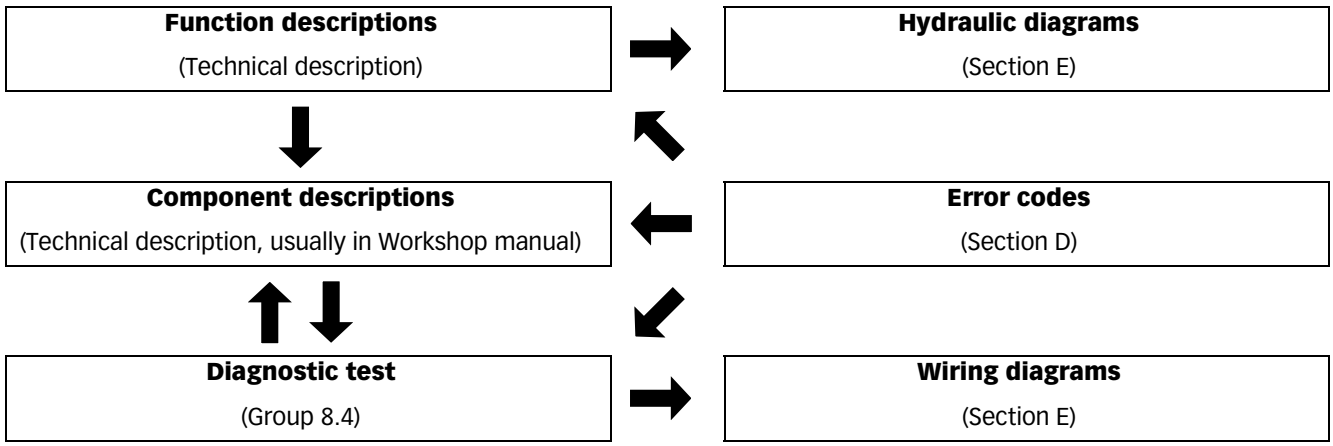
The workshop manual contains information for corrective maintenance (replacement of components) and complements the maintenance manual. Accompanying the workshop manual is supplier documentation for engine, transmission and drive axle. Where practicable, please refer from the workshop manual to the maintenance manual and supplier documentation to avoid duplicated information. The workshop manual is divided into the following sections.

A	Foreword	General information about the workshop manual's purpose, contents and reading instructions as well as survey for feedback of views and any inaccuracies.
B	Safety	Keep in mind for your safety.
C	Preventive maintenance	Reference to maintenance manual: Preventive maintenance.
0	Complete machine	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. Work instructions for corrective maintenance (replacement of components).
1	Engine	
2	Transmission	
3	Driveline/axle	
4	Brakes	
5	Steering	
6	Suspension	
7	Load handling	
8	Control system	
9	Frame, body, cab and accessories	
10	Common hydraulics	
11	Common electrics	
12	Common pneumatics	
D	Error codes	Reference to maintenance manual: Error code information and instructions for reading error code information.
E	Schematics	Reference to maintenance manual: Wiring and hydraulic diagrams
F	Technical data	Technical data, conversion tables, information for conversion of units.
G	Terminology and index	General terminology and abbreviations, explanation of terms and abbreviations that can appear in the sections, index for headings in the sections.

References between different information types

The maintenance manual and workshop manual are mainly divided into function groups, see *Workshop manual contents page 3*. 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 Diagnostic test, to enable fast finding of the right diagnostic menu that can be used to check the component (only applies to electrical components).
- From Diagnostic test to Wiring diagrams. to enable fast finding of the right circuit diagram for further troubleshooting.
- From Diagnostic test 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 Diagnostic test, 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.

Function group breakdown

Breakdown into function groups is common for all machines from Kalmar Industries, down to two-digit heading level (e.g., 4.3 Power-assisted brake system). Machine-unique adaptations of function groups are done at the third and fourth group levels (e.g., 4.3.9 Wheel brake resp. 4.3.9.1 Disc pack).

This results in certain headings (function groups) being omitted in the documentation for certain machines since the machine lacks that particular function. This means that there may be gaps in the function groups' numbering (e.g., the three-digit heading level 4.8.7 Oil cooler may be included for certain machines, but may be missing for other machines).

References between manual types (of the type "see Workshop manual DFR 400–450") are used since the different manual types have different purposes and thus different information content.

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

Conditions

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

Kalmar Industries will not accept any responsibility for modifications performed without permission from Kalmar Industries or if other lifting devices, tools or work methods are used other than those described in this manual.

Storage

NOTE

The Maintenance Manual should be accessible to the 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 Kalmar Industries. Due to customizations, there may be variations and/or deviations.

Kalmar Industries 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.

Copyright

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.

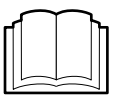
Important information

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/maintenance manual



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Read the operator's manual/maintenance manual

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

Optional equipment

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Indicates optional equipment

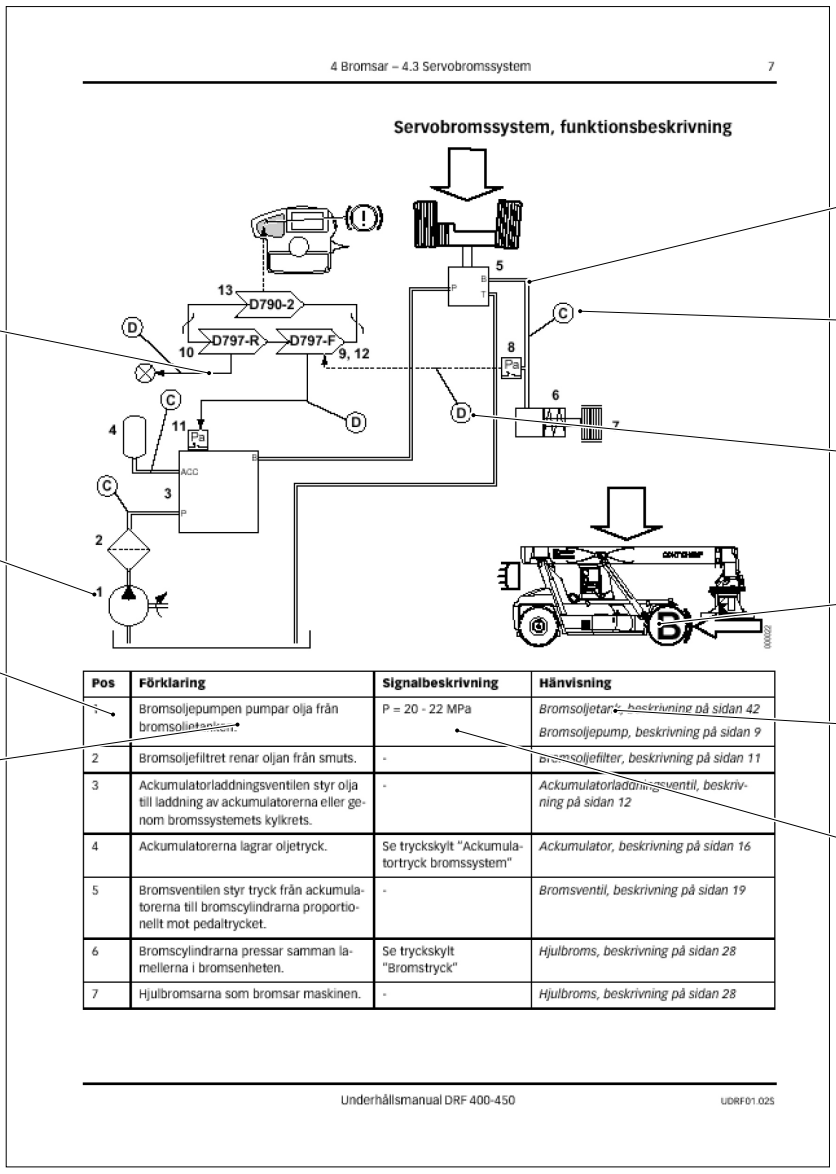
The symbol to the left is used in the manual to indicate that a function or component is optional equipment. Detailed information on how the machine is equipped is presented by the machine card enclosed with the spare parts catalogue.

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.

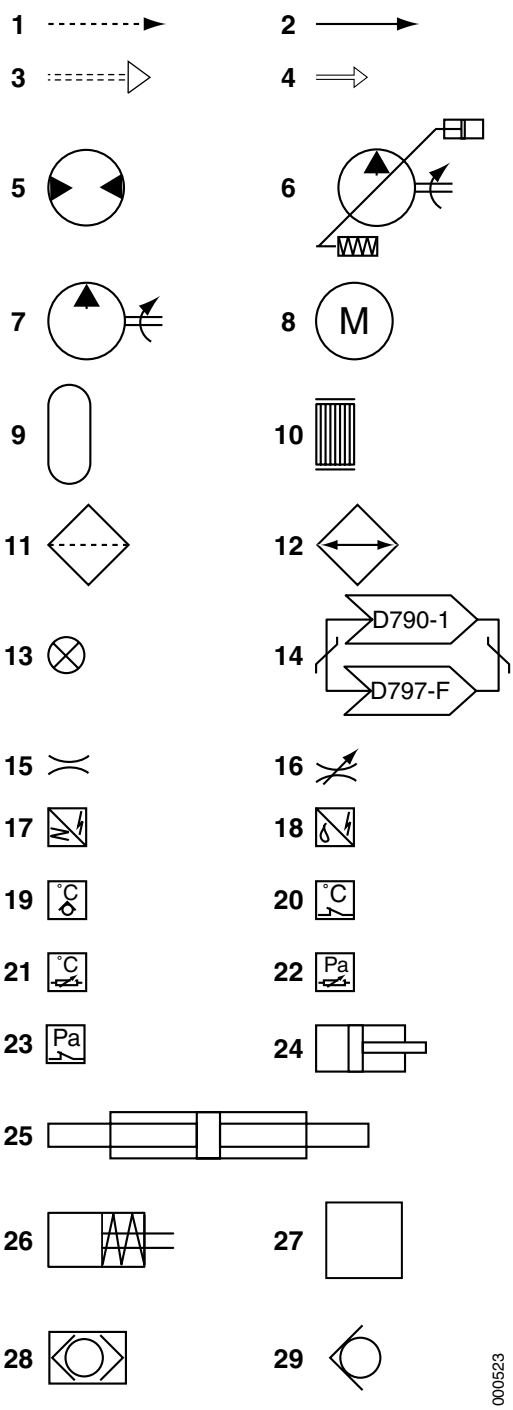
Function descriptions use symbols to illustrate components such as valves, sensors, etc.



Pos	Förklaring	Signalbeskrivning	Hänvisning
1	Bromsoljepumpen pumpar olja från bromsoljetanken.	P = 20 - 22 MPa	*Bromsoljetank, beskrivning på sidan 42* *Bromsoljepump, beskrivning på sidan 9*
2	Bromsoljefiltret renar oljan från smuts.	-	*Bromsoljefilter, beskrivning på sidan 11*
3	Ackumulatorladdningsventilen styr olja till laddning av ackumulatorerna eller genom bromssystemets kylkrets.	-	*Ackumulatorladdningsventil, beskrivning på sidan 12*
4	Ackumulatorerna lagrar oljetryck.	Se tryckskylt "Ackumulatortryck bromssystem"	*Ackumulator, beskrivning på sidan 16*
5	Bromsventilen styr tryck från ackumulatorerna till bromscylindrarna proportionellt mot pedaltrycket.	-	*Bromsventil, beskrivning på sidan 19*
6	Bromscylindrarna pressar samman lamellerna i bromsenheten.	Se tryckskylt "Bromstryck"	*Hjulbroms, beskrivning på sidan 28*
7	Hjulbromsarna som bromsar maskinen.	-	*Hjulbroms, beskrivning på sidan 28*

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 signal can be checked with diagnostic test, see *group "8.4 Diagnostic test"*
4. Illustration of function, (applied 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 by-pass 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

There are Supplementary documentation that can be ordered for the machine in the form of a Workshop manual. The Workshop manual includes supplier documentation for engine, transmission and drive axle.

Ordering of documentation

Extra copies and supplementary documentation is ordered from Kalmar Industries.

Kalmar Industries AB

SE-341 81 Ljungby, Sweden.

NOTE

If possible, always indicate publication number when ordering.

Feedback

Form for copying

Kalmar Industries' ambition is that you who work with maintenance of Kalmar machines 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:	**Kalmar Industries AB** **Product Support** **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

B 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 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!

In this publication, Kalmar Industries has documented and warned for situations and risks that may occur/exist in connection with operation as well as service/repairs of the truck under normal conditions.

Therefore, its very important that all who work with the truck, or carry out repairs/service work, acquaint themselves with and act according to the information in the maintenance manual and operators manual.

A near-accident is a warning signal!

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:

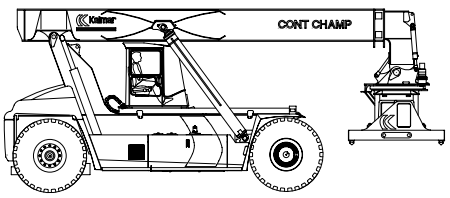
Service position

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).



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Machine with fully retracted and lowered boom

Hydraulic and brake systems, depressurizing

1 Machine in service position, see *Service position page 4*.

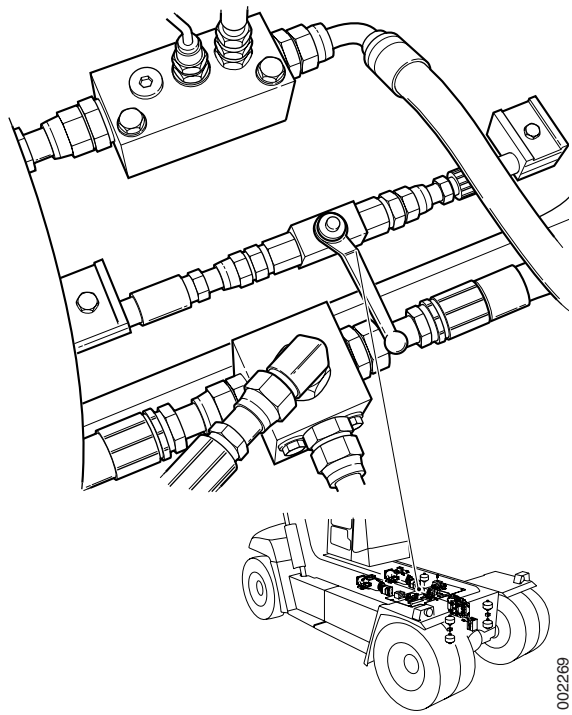
2 Depressurize the hydraulic system.

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

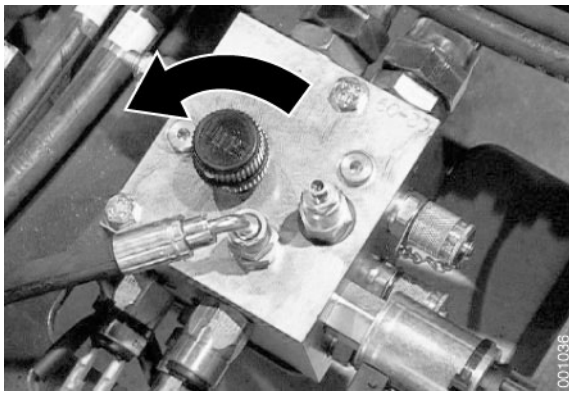
3 Turn the start key to position 0 and turn off the main electric power.

4 Depressurize the attachment.

Open the relief valve top lift.



The above illustration shows closed valve.



5 Depressurize 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.

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

Long hair must be tied up securely, otherwise it may easily get caught in moving parts. Be careful when performing welding work or work requiring open flames since hair catches fire easily.

Several mechanics on the same machine

⚠ WARNING

Be extra careful if several mechanics work on the same vehicle, so that unintentional movements do not injury another person. Communicate so that everyone knows where all are and what they are doing.

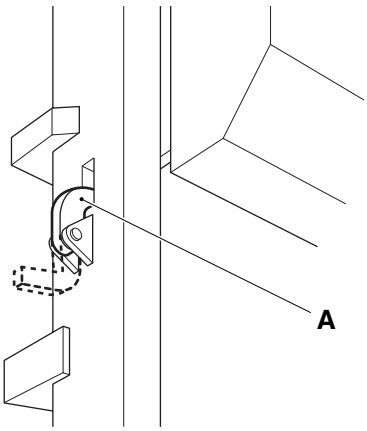
Risks

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 actions

- 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.



Lock on lift frame for securing cab in raised position.

Working under machine

Working under cab

On machines with cab lift the machine shall be secured in raised position with the intended locks.

Working under chassis

A lifted/raised vehicle may under no circumstances 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 actions

Use axle stands and supports that stand securely.

Lifting tools should be inspected and type approved for use.

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

Lift using a lifting device. Use lifting tools or equipment, especially when such equipment is available for specific work operations. See the 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 actions

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 vapors that can cause dizziness, headaches and nausea.They may also irritate mucous membranes in the throat and respiratory tracts.

If the solvent comes into direct contact with the skin, this may cause drying and cracking.Risk for 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 low content of aromatic substances. This reduces the risk of injuries.

Avoid skin contact.

Use protective gloves.

Make sure that work clothes are solvent-resistant.

Fire and explosion risks

Examples of explosion-prone substances are oils, petrol, diesel fuel, organic solvents (lacquer, plastic, cleaning agents), rust proofing agents, welding gas, gas for heating (acetylene), high concentration of dust particles of combustible materials. Rubber tyres are highly flammable and cause fires that spread explosively.

Risks

Examples of causes of ignition include welding, cutting, smoking, sparks produced by grinding, inflammable materials coming into contact with hot machine parts, the generation of heat in rags saturated with oil or paint (linseed oil) and oxygen.Oxygen cylinders, lines and valves must be kept free from oil and grease.

Fumes from gasoline, for example, are heavier than air and can thus “run down” a sloping grade, or down into a grease pit, where welding flames, grinding sparks or a burning cigarette can cause an explosion. Evaporated gasoline has a very powerful explosive force.

Special cases

Diesel fuel oil with an additive of petrol has a reduced flash point. Explosion risk even at room temperature. The explosion risk due to warmed diesel fuel oil is greater 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 the machine. If diesel or other oils have leaked out and have been absorbed by rags, absorbing agent, paper or other porous material, glowing welding sparks can cause ignition and an explosive spread of fire.

When a battery is being charged, the battery electrolyte water is divided into oxygen and hydrogen gas. This mixture is very explosive. The risk of explosion is especially high when a booster battery or a rapid-charge unit is used, as these increase the risk of sparks.

The machines nowadays contain a lot of electronic equipment. During welding work, the control units must be disconnected and current turned off using the battery disconnect switch. Otherwise, strong welding currents can short-circuit the electronics, destroy expensive equipment, and may also cause an explosion or fire.

Welding work must never be carried out on painted surfaces (remove paint by blasting at least 10 cm around the welding or cutting point.) Use gloves, breathing protection and protective safety glasses. Also, welding work must never take place near plastic or rubber materials without first protecting them from the heat. Paints, plastics and rubber generate various substances when heated that may be hazardous to health. Be careful with machines that have been exposed to intense heat or a 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

There are injury risks in connection with work on:

- Hydraulic system (for example, working hydraulics and brake system).
- Fuel system.
- Tyre repairs.
- Air conditioning.

Safety precautions

- Use safety glasses and protective gloves.
- Never work in on a pressurized 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 accumulators must first be punctured before they are deposited as waste (to avoid risk of explosion). Carefully drill a hole with 3 mm diameter after depressurizing.
- 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 machines air conditioning.

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

Risks

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

Heated refrigerant (e.g. during the repair of leaks in the A/C system), produces gases that are very toxic if inhaled.

Safety precautions

- Use special instructions and equipment for refrigerant according to the workshop manual when working on the air conditioning system. Special certification and authorization must be held by personnel permitted to do the work. (Follow 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. Odorless and therefore especially dangerous.
- **Nitrogen oxides (nitrous gases)** are present in exhaust fumes.
- **Welding smoke** especially hazardous to health when welding on oily surfaces, galvanized 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 gloves and breathing protection when there's a risk of oil mist. Make sure that protective gear is oil-resistant.
- 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 actions

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

Always block the machine's wheels, 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
- Drive 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.

Tyre system

DANGER

Tyres should be regarded as pressurized containers. They constitute fatal danger if handled incorrectly.

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

Never repair damaged tyres, rims or lock rings. Tyre repairs should only be performed by authorized personnel.

Risks

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

Inflating tyres: Tyres, rims and lock rings can be thrown.

Safety actions

- 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.
- Use protective screen and safety glasses.

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

Deposit discarded materials for recycling or destruction.

Environmentally hazardous waste

Components such as batteries, plastics and other items that may constitute environmentally hazardous waste must be handled and taken care of in an environmentally safe and sound 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 system

The refrigerant in the air conditioning system for the cab adds to the greenhouse effect and may never be intentionally released into open air. Special training is required for all service work on the air conditioning system. Many countries require special certification by an authority for such work.

Working in a contaminated area

Used cab and engine air filters from machines operating in conditions with asbestos dust, or other hazardous dust, must be sealed in air-tight plastic bags before being deposited in the designated area. The machine must be equipped for work in a contaminated area (environmentally contaminated or hazardous to personal health) before work is started. In addition, special local regulations apply when handling and servicing such a machine.

C Preventive maintenance

Preventive maintenance

See *Maintenance manual DRF 400–450*, section *C Preventive maintenance*.

0 Complete machine

Complete machine, description

Kalmar DRF 400–450 is a “Reachstacker” for container handling. The machine has a lift capacity of 40–45 tons depending on version.

The engine is a six cylinder four-stroke direct-injected diesel engine.

The transmission is hydromechanical with gears in constant mesh. It has four forward gears and four reverse gears. The engine power is transmitted with a torque converter.

The driveline/axle consists of a drive shaft and a rigid drive axle with hub reduction. Drive takes place on the front wheels.

The service brake is of the type disc brake in oil which is built together with the drive wheels' wheel hubs. The parking brake is of the type disc brake and acts on the drive axle's input shaft.

Steering takes place on the rear wheels with a double-acting hydraulic cylinder. The steering axle is oscillation-mounted in the frame.

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

Load handling is components and functions for handling loads. Loads are lifted with an attachment that is mounted on a liftable telescopic boom. Load handling is divided into the functions lift and lower, extension, sideshift, spreading, rotation, tilt, levelling and load carrying. Lift and lower is the function to lift and lower the boom. Extension is the function to push out and retract the boom. Sideshift is to move the attachment sideways in relation to the machine. Spreading is to adjust the width between the attachment's lifting points. Rotation is to rotate the load in relation to the machine. Tilt is to angle the load in the machine's longitudinal direction. Levelling is to angle the load in the machine's lateral direction (sideways). Load carrying is to grab the load.

The control system are functions for warning the operator of dangerous situations and malfunctions. The control system has diagnostic possibilities that facilitate troubleshooting.

The frame supports the machine. The engine, transmission, drive axle and steering axle are mounted in the frame. On the frame's sides there are tanks for fuel, hydraulic oil and oil for the brake system. The cab is located in the centre and can be moved fore-aft. As an option the cab is available in a side-mounted version that can be raised and lowered.

Troubleshooting instructions, general

For instructions, see *Maintenance manual DRF 400–450*. There are following instructions:

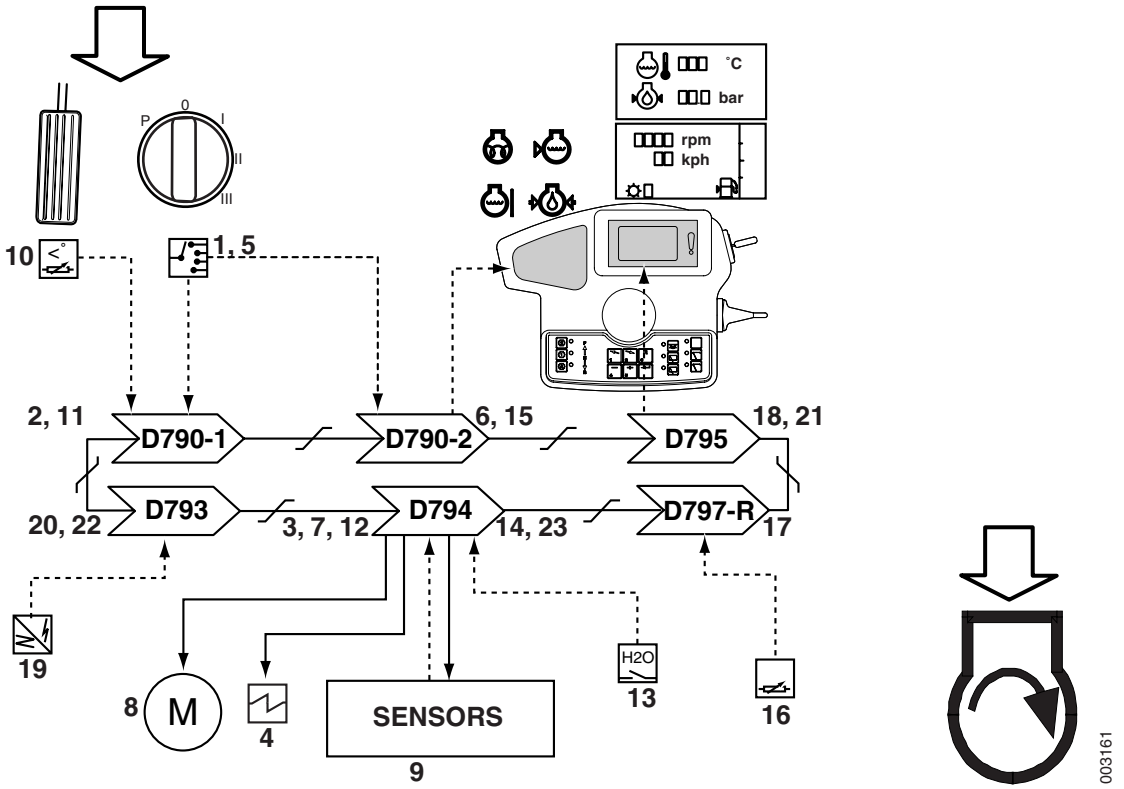
- Troubleshooting, general work instructions
- Troubleshooting without error code, example
- Troubleshooting with error code, example
- Troubleshooting cable harnesses
- Troubleshooting hydraulic hoses

Table of Contents 1 Engine

1 Engine

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 30*



Pos	Explanation	Signal description	Reference
1	The ignition sends voltage signal to Control unit cab (D790-1) when the start key is turned to position 1 or preheating position.	U = 24 V	*Ignition, description page 13* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.1.4 CAN/POWER, menu 4* and *8.4.6.4 ENGINE, menu 4*
2	Control unit cab (D790-1) sends ignition on via CAN-bus. If the key is turned to 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 *11.6 Communication*
3	If preheating has been activated with start key, then control unit engine (D794) feeds voltage to the preheating coil.	U = 24 V	*Preheating coil, description page 33* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.6.5 ENGINE, menu 5*

Pos	Explanation	Signal description	Reference
4	The preheating coil warms the inlet air for the engine.	-	*Preheating coil, description page 33* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.6.5 ENGINE, menu 5*
5	The ignition sends voltage signal to Control unit KIT (D790-2) when the start key is turned to start position.	U = 24 V	*Ignition, description page 13* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.1.4 CAN/POWER, menu 4* and *8.4.6.4 ENGINE, menu 4*
6	Control unit KIT (D790-2) sends start signal on the CAN-bus.		Section *11 Common electrics*, group *11.6 Communication*
7	Control unit engine (D794) feeds voltage to starter motor.	U = 24 V	*Starter motor, description (Volvo engine) page 34* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.6.5 ENGINE, menu 5*
8	Starter motor rotates engine.	-	*Starter motor, description (Volvo engine) page 34* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.6.5 ENGINE, menu 5*
9	The engine's sensors send signals to Control unit engine (D794) which controls the injectors so that the engine starts.	-	Section *11 Common electrics*, group *11.5.3.10 Control unit engine*
10	Throttle pedal sends voltage signal proportional to downward pressing to Control unit cab (D790-1).	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.	*Accelerator pedal, description page 14* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.6.1 ENGINE, menu 1*
11	Control unit cab sends message with rpm request on CAN-bus.	Checked by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
12	Control unit engine increases engine rpm.	-	Section *11 Common electrics*, group *11.5.3.10 Control unit engine*
13	Make-contact coolant level sends voltage signal to Control unit engine (D794) if coolant level is low in expansion tank.	U = 24 V	*Cooling system, description page 23*

Pos	Explanation	Signal description	Reference
14	Control unit engine sends engine data and warning messages on CAN-bus.	Checked by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.6.6 ENGINE, menu 6 and 8.4.6.7 ENGINE, menu 7*
15	Control unit KID (D795) shows engine data via display figures.	-	*Operating menu engine and transmission, description page 16Operating menu engine, description page 16*
16	Sensor fuel level (B757) sends voltage signal proportional to fuel level in tank to Control unit frame rear (D797-R).	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 17* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.3.7 CAB, menu 7*
17	Control unit frame rear (D797-R) sends fuel level on CAN-bus.	Checked by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
18	Control unit KID (D795) shows fuel level in operating menu for engine.	-	*Operating menu engine, description page 16*
19	Sensor output shaft (B758) sends pulses with frequency proportional to rpm on output shaft to control unit transmission (D793).	-	Section *2 Transmission*, group *2.3.8 Sensor output shaft* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.7.6 TRANSM, menu 6*
20	Control unit transmission (D793) sends speed on CAN-bus.	Checked by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
21	Control unit KID (D795) shows the machine's speed.		Section *11 Common electrics*, group *11.5.3.12 Control unit KID*
22	If the rpm on the output shaft is so high that it matches the limit for the machine's speed limitation, then Control unit transmission (D793) sends reduce engine rpm on the CAN-bus.		Section *11 Common electrics*, group *11.6 Communication*
23	Control unit engine (D794) restricts engine rpm.	-	Section *11 Common electrics*, group *11.5.3.10 Control unit engine*

Engine and gearbox, separation (Volvo engine)

Separation

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

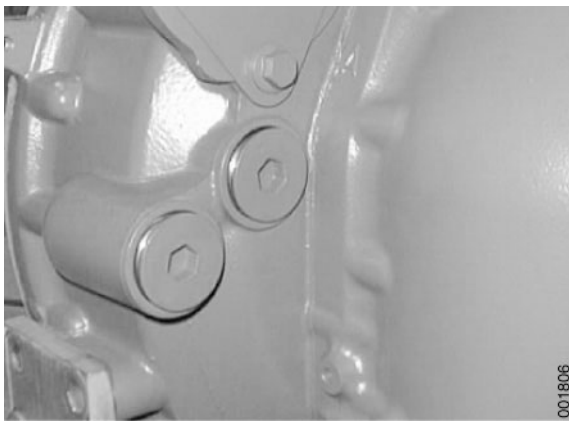
2 Detach relevant hoses and cables before separating engine and gearbox.

NOTE

Drain and collect liquids before detaching hoses.

3 Attach hoisting equipment to the engine.

4 Use a jack to secure the gearbox.



5 Remove the plugs ahead of the flywheel.

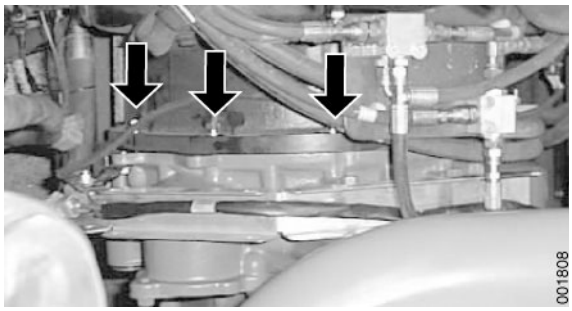
The outer hole is used for turning the engine over.

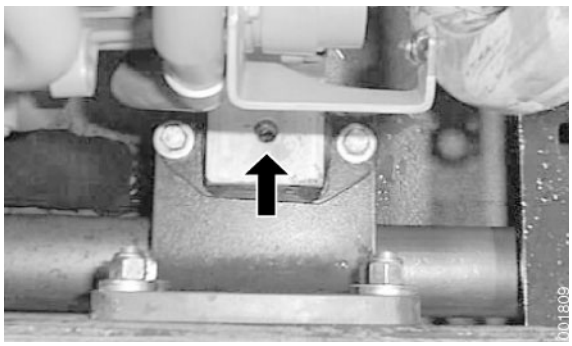
6 Remove the flexible plate retaining screws. Turn the engine over until the flexible plate screws are visible through the inner hole. The flexible plate has eight attachment points that must be undone.

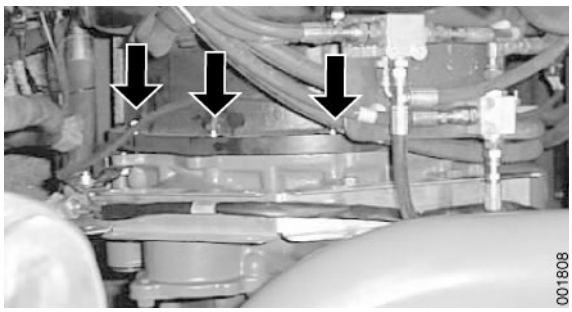
7 Take up the slack in the hoisting equipment.

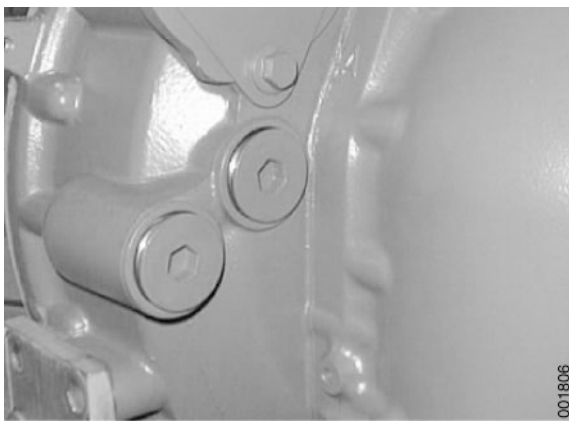
NOTE

Do not raise the engine or gearbox.









8 Remove the screws between engine and gearbox.

9 Remove the engine or gearbox brackets and separate engine and gearbox.

Assembly

10 Check that the holes for securing the flexible plate to the flywheel are in line with the plate retaining nuts.

The flexible plate has eight attachment points that must be connected to the flywheel on the engine.

11 Fit the engine or gearbox brackets.

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

12 Connect the engine to the gearbox.

13 Insert the screws between engine and gearbox. Tighten to a torque of **40 Nm**.

14 Fit the flexible plate retaining screws. Tighten to a torque of **40 Nm**.

NOTE

To remove a dropped screw the engine must be detached from the engine brackets and separated from the gearbox. Secure the screw in the sleeve on assembly.

15 Fit the plugs ahead of the flywheel.

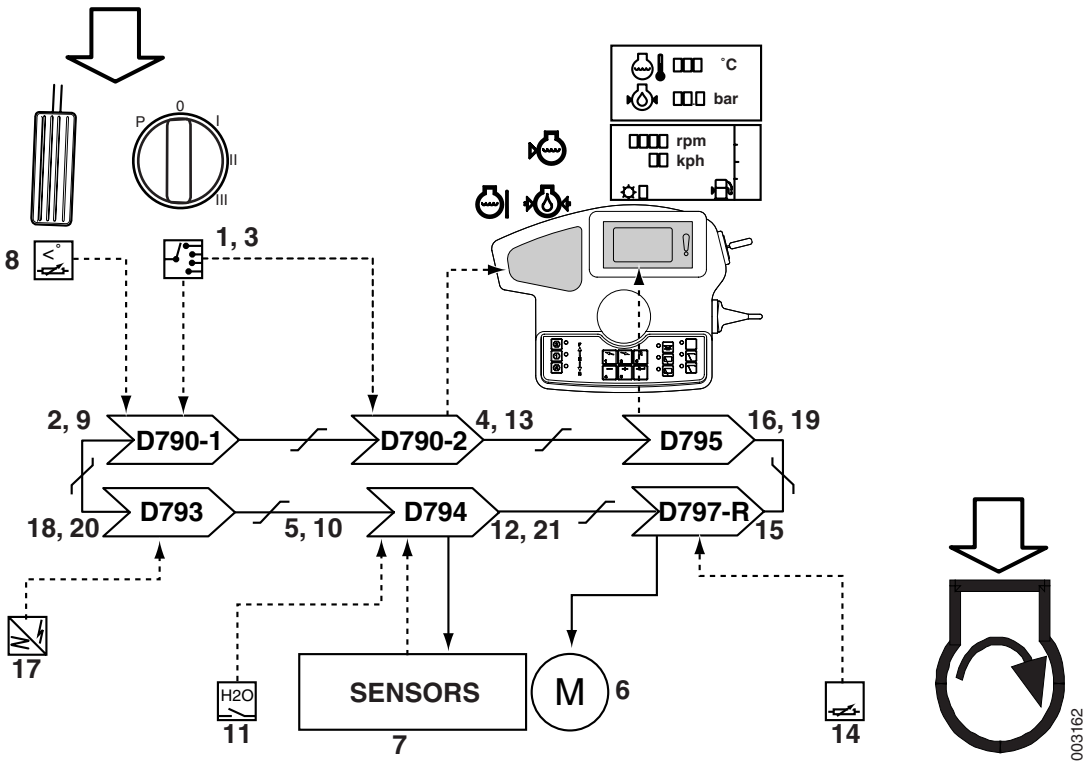
16 Remove the hoisting equipment from the engine.

17 Remove the jack from underneath the gearbox.

18 Attach relevant hoses and cables to engine and gearbox. Check fluid levels and top up as necessary.

Engine alternative Cummins, function description

Condition	Reference value	Reference
Engine heater ⊕	Disconnected (when cable is in start lock-out is activated)	*Engine heater, description page 30*



Pos	Explanation	Signal description	Reference
1	The ignition sends voltage signal to Control unit cab (D790-1) when the start key is turned to position 1.	U = 24 V	*Ignition, description page 13* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.1.4 CAN/POWER, menu 4* and *8.4.6.4 ENGINE, menu 4*
2	Control unit cab (D790-1) sends ignition on start message on CAN-bus.	Checked by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
3	The ignition sends voltage signal to Control unit KIT (D790-2), when the start key is turned to start position.	U = 24 V	*Ignition, description page 13* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.1.4 CAN/POWER, menu 4* and *8.4.6.4 ENGINE, menu 4*
4	Control unit KIT (D790-2) sends start signal on the CAN-bus.	Checked by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*

Pos	Explanation	Signal description	Reference
5	Control unit frame rear (D797-R) feeds voltage to starter motor.	U = 24 V	*Starter motor, description (Cummins engine) page 34* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.6.5 ENGINE, menu 5*
6	Starter motor rotates engine	-	*Starter motor, description (Cummins engine) page 34* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.6.5 ENGINE, menu 5*
7	The engine's sensors send signals to Control unit engine (D794) which controls the injectors so that the engine starts.	-	Section *11 Common electrics,* group *11.5.3.10 Control unit engine*
8	Throttle pedal sends voltage signal proportional to downward pressing to Control unit cab (D790-1).	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.	*Accelerator pedal, description page 14* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.6.1 ENGINE, menu 1*
9	Control unit cab sends message with rpm request on CAN-bus.	Checked by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
10	Control unit engine increases engine rpm.	-	Section *11 Common electrics*, group *11.5.3.10 Control unit engine*
11	Make-contact coolant level sends voltage signal to Control unit engine (D794) if coolant level is low in expansion tank.	U = 24 V	*Cooling system, description page 23*
12	Control unit engine (D794) sends engine data and warning messages on CAN-bus.	Checked by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.6.6 ENGINE, menu 6 and 8.4.6.7 ENGINE, menu 7*
13	Control unit KID (D795) shows engine data via display figures.	-	*Operating menu engine and transmission, description page 16Operating menu engine, description page 16*
14	Sensor fuel level (B757) sends voltage signal proportional to fuel level in tank to Control unit frame rear (D797-R).	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 17* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.3.7 CAB, menu 7*

Pos	Explanation	Signal description	Reference
15	Control unit frame rear (D797-R) sends fuel level on CAN-bus.	Checked by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
16	Control unit KID (D795) shows fuel level in operating menu for engine.	-	*Operating menu engine, description page 16*
17	Sensor output shaft (B758) sends pulses with frequency proportional to rpm on output shaft to control unit transmission (D793).	-	Section *2 Transmission*, group *2.3.9 Sensor output shaft* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.7.6 TRANSM, menu 6*
18	Control unit transmission (D793) sends “reduce engine rpm” on CAN-bus.	Checked by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
19	Control unit KID (D795) shows the machine's speed.	-	Section *11 Common electrics*, group *11.5.3.12 Control unit KID*
20	If the rpm on the output shaft is so high that it matches the limit for the machine's speed limitation, then Control unit transmission (D793) sends reduce engine rpm on the CAN-bus.	Checked by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
21	Control unit engine (D794) restricts engine rpm.	-	Section *11 Common electrics*, group *11.5.3.10 Control unit engine*

Engine and gearbox, separation (Cummins engine)

Separation

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

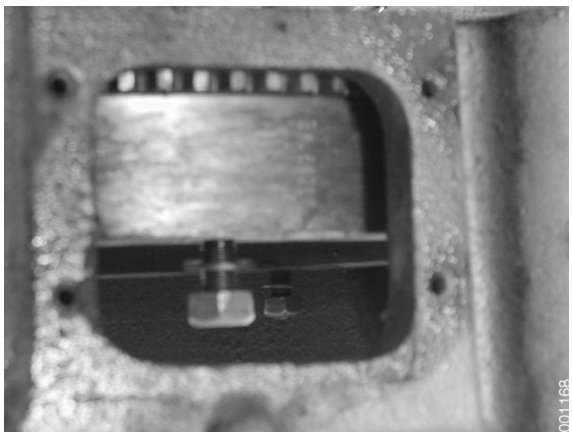
2 Attach hoisting equipment to the engine.

3 Detach relevant hoses and cables before separating engine and gearbox.

NOTE

Drain and collect liquids before detaching hoses.

4 Use a jack to secure the gearbox.



5 Remove the cover plate in front of the flywheel.

6 Remove the flexible plate retaining screws. Turn engine over until one of the flexible plate screws is visible through the hole.

7 Take up the slack in the hoisting equipment.

NOTE

Do not raise the engine.

8 Remove the screws between engine and gearbox.

9 Remove the engine or gearbox brackets.

10 Withdraw the engine rearwards to separate it from the gearbox.

Assembly

11 Rotate the engine until the holes in the flywheel are in line with the flexible plate attachment points.

The flexible plate has eight attachment points that must be connected to the flywheel on the engine.

12 Fit the screws in the engine bracket.

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

13 Connect the engine to the gearbox.

14 Fit the screws between engine and gearbox. Tighten to a torque of **52 Nm**.

15 Fit the flexible plate retaining screws. Tighten to a torque of **40 Nm**.

NOTE

To remove a dropped screw the engine must be detached from the engine brackets and separated from the gearbox. Secure the screw in the sleeve on assembly.

16 Fit the plug in front of the flywheel.

17 Remove the hoisting equipment from the engine.

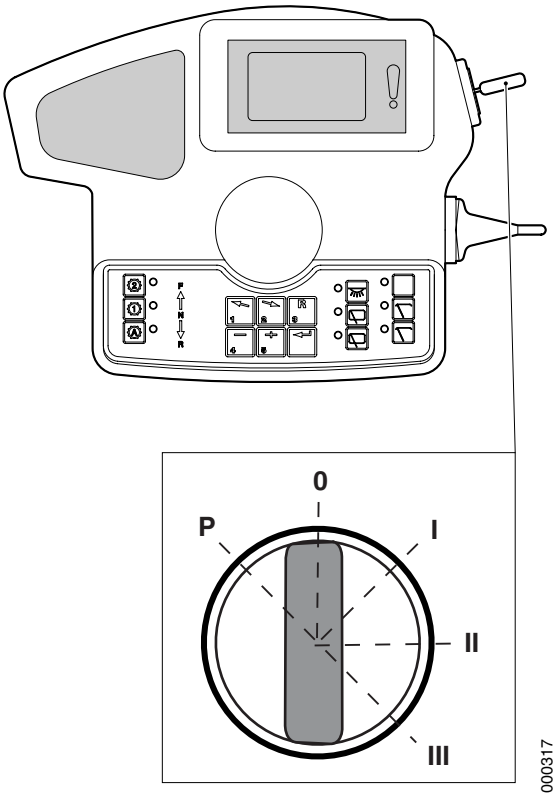
18 Remove the jack from underneath the gearbox.

19 Attach relevant hoses and cables to engine and gearbox. Check fluid levels and top up as necessary.

1.1 Controls and instrumentation

1.1.1 Ignition

Ignition, description



P No function.

0 Stop position. Everything is off, key can be removed.

I Operating position.

Voltage to all electrical functions. Control units for engine and transmission are now ready for start.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.1.4 CAN/POWER, menu 4*.

II Preheating position.

In preheating position, the engine's inlet air is preheated with a preheating coil to a suitable temperature. Indicator light for preheating is activated during preheating.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.6.4 ENGINE, menu 4*.

III Start position.

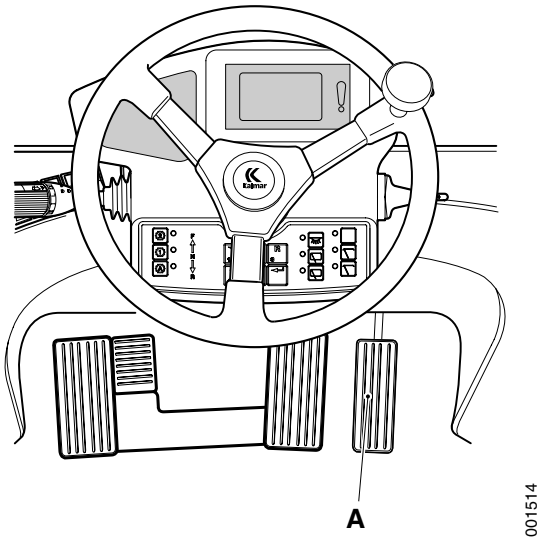
Engagement of starter motor for engine start.

NOTE

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

Condition for starter motor to engage is that transmission is in neutral position and that the engine isn't already running.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.6.4 ENGINE, menu 4*.



A. Accelerator pedal

1.1.2 Accelerator

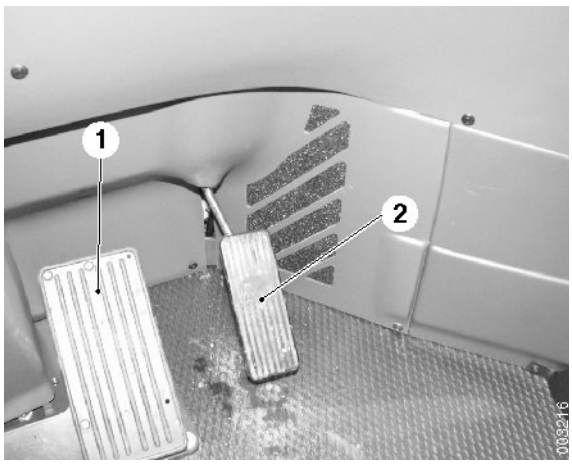
Accelerator pedal, description

The accelerator pedal controls the engine's torque and rpm.

The accelerator pedal acts on a rotary potentiometer which gives a signal to Control unit cab (D790-1). The accelerator pedal's positions are factory calibrated but may need to be recalibrated if the pedal is replaced.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.6.1 ENGINE, menu 1*.

Accelerator pedal, change



1. Brake pedal
2. Throttle 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 Change the accelerator pedal.

6 Fit in the reverse order.

7 Calibrate the accelerator pedal, see 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*.

1.1.3 Warning light low oil pressure in engine

Warning light low oil pressure in engine, description

000303

The warning light is activated when the engine's oil pressure is so low that there is a risk of damage. The warning light is supplied with voltage by Control unit KIT (D790-2) and is located in the light panel.

Volvo engine: If the oil pressure is low, the engine rpm is reduced for three seconds, then the engine is turned off. The engine can be re-started and run for intervals of 30 seconds.

NOTE

Restart may result in engine breakdown.

Low engine oil pressure warning lamp, change

The lamp is part of the Kalmar Information Terminal, KIT. Not changed separately. See section *8 Control system,* group *8.1.1 Information terminal*.

1.1.4 Indicator light preheating

Indicator light preheating, description

Only applies to Volvo engines.

000304

The preheating indicator light is on during the engine's preheating period. The indicator light is supplied with voltage by Control unit KIT (D790-2) and is located in the light panel.

Preheating indicator lamp, change

The lamp is part of the Kalmar Information Terminal, KIT. Not changed separately. See section *8 Control system,* group *8.1.1 Information terminal*.

1.1.5 Warning light low coolant level

Warning light, low engine coolant level, description

000305

The warning light is activated if the coolant level is too low. The indicator light is supplied with voltage by Control unit KIT (D790-2) and is located in the light panel.

Volvo engine: If the coolant level is low, the engine rpm is reduced for three seconds, then the engine is turned off. The engine can be restarted and run for intervals of 30 seconds.

NOTE

Restart may result in engine breakdown.

Low engine coolant level warning lamp, change

The lamp is part of the Kalmar Information Terminal, KIT. Not changed separately. See section *8 Control system,* group *8.1.1 Information terminal*.


000302

1.1.6 Warning light high coolant temperature

Warning light high coolant temperature, description

The warning light is activated if the engine's coolant temperature should become too high. The warning light is supplied with voltage by Control unit KIT (D790-2) and is located in the light panel.

Volvo engine: If coolant temperature exceeds 100 °C, engine rpm is restricted to approx. 1000 rpm.

High coolant temperature warning lamp, change

The lamp is part of the Kalmar Information Terminal, KIT. Not changed separately. See section *8 Control system,* group *8.1.1 Information terminal*.

1.1.7 Warning light low fuel level

Warning light low fuel level, description


000307

The warning light is activated when approx. 17% of the fuel remains, which corresponds to approx. 5 hours operating time. The warning light is supplied with voltage by Control unit KIT (D790-2) and is located in the light panel.

Low fuel level warning lamp, change

The lamp is part of the Kalmar Information Terminal, KIT. Not changed separately. See section *8 Control system,* group *8.1.1 Information terminal*.

1.1.8 Operating menu engine and transmission

Operating menu engine and transmission, description

000353

a. Shows current engine rpm.

b. Shows current speed in km/h (in display kilometer per hour, kph).

c. Shows current gear.

   Travel direction and shifting program are shown on steering wheel panel.

d. Shows current fuel level.

1.1.9 Operating menu engine

Operating menu engine, description

000355

a. Shows coolant temperature in °C.

   Volvo engine: If coolant temperature exceeds 100 °C, engine rpm is restricted to approx. 1000 rpm.

b. Shows engine oil pressure in bar.

1.2 Fuel system

Fuel system, description

The fuel system distributes fuel to the cylinders and so controls engine output power and rpm.

When the engine starts, the fuel pump sucks fuel from the tank through the fuel filter and feeds it to the unit injectors under pressure. The unit injectors inject the atomized fuel into the engine combustion chambers.

1.2.1 Fuel tank

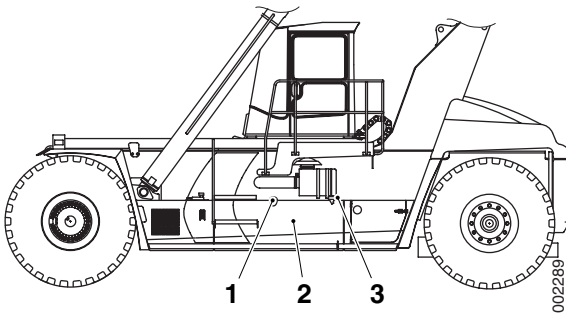
Fuel tank, description

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 *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.3.7 CAB, menu 7*.



1. Filling point, fuel
2. Fuel tank
3. Sensor, fuel level (behind air filter)

1.2.3 Fuel pre-filter

Fuel prefilter, general

See *Maintenance manual DRF 400–450* and *supplier documentation engine* (Volvo engine)

1.2.4 Fuel filter

Fuel filter, general

See *Maintenance manual DRF 400–450* and *supplier documentation engine*.

1.2.5 Sensor water in fuel

Sensor water in fuel, description

See *supplier documentation engine* (Cummins engine).

1.2.6 Fuel pump

Fuel pump, description

See *supplier documentation engine*.

1.2.7 Sensor fuel pressure

Sensor fuel pressure, description

See *supplier documentation engine* (Cummins engine).

1.2.8 Injectors

Injectors, description

See *supplier documentation engine*.

1.2.9 Breaking contact fuel pressure

Breaking contact fuel pressure, description

See *supplier documentation engine* (Volvo engine).

1.2.10 Making contact water in fuel

Make-contact water in fuel, description

See *Subcontractor documentation, engine* (Volvo engine).

1.5 Mechanical parts

Engine's mechanical parts, general

See *supplier documentation engine*.

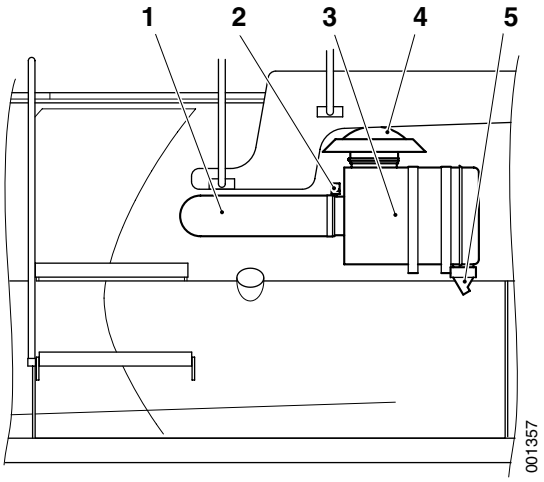
1.6 Air intake and exhaust outlet

1.6.1 Air cleaning system

Air cleaning system, description

Air is required for combustion in the engine. Free and unobstructed passages for fresh air and exhaust gases are essential for efficient engine operation.

For location of components, also see *Maintenance manual DRF 400–450,* section *1 Engine*.



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

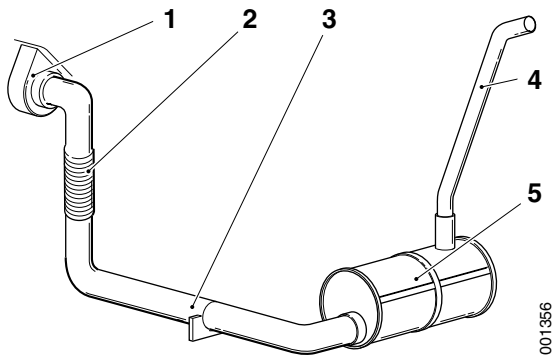
Air filter, changing

See *Maintenance manual DRF 400–450*.

1.6.2 Turbo

Turbo, description

See *supplier documentation engine*.



Exhaust system, overview
1. Turbocharger
2. Flex hose
3. Exhaust pipe
4. End pipe
5. Muffler

1.6.3 Exhaust system

Exhaust system, description

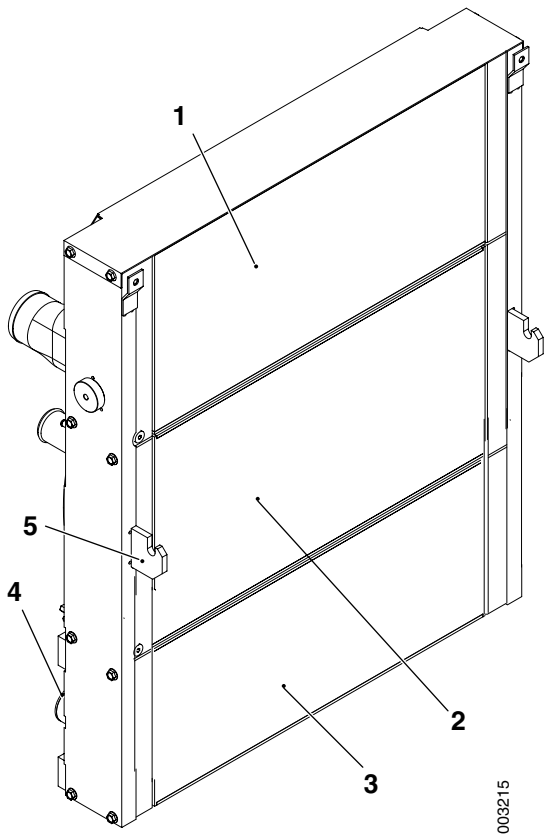
The exhaust system is mounted to the chassis. A heat shield is mounted between the engine and the exhaust system to protect cable harnesses, etc. A flex hose between the turbo and muffler absorbs engine movements. On the outside of the machine, there is a heat shield located over the exhaust system.

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!



Radiator assembly, Cummins engine
1. Intercooler
2. Radiator, engine
3. Cooler, transmission oil
4. Thermostat, transmission oil
5. Mounting, condenser (for AC)

1.6.4 Intercooler

Intercooler, description

The charge air is cooled in the upper part of the radiator assembly (only Cummins engine)

For the Volvo engine, see *supplier documentation engine*.

See also *Cooling system, description page 23*.

1.6.5 Sensor boost pressure

Sensor, intercooler, description

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.6.6 ENGINE, menu 6*.

For more information, see *supplier documentation engine*.

1.6.6 Sensor charge-air temperature

Sensor charge-air temperature, description

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.6.7 ENGINE, menu 7*.

For more information, see *supplier documentation engine*.

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. Coolant is circulated through the cylinder head, engine block and oil cooler by the coolant pump. Coolant is pumped through the intercooler on the Volvo engine by a separate coolant pump.
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.

1.7.1 Coolant pump

Coolant pump, description

See *supplier documentation engine*.

1.7.2 Coolant filter

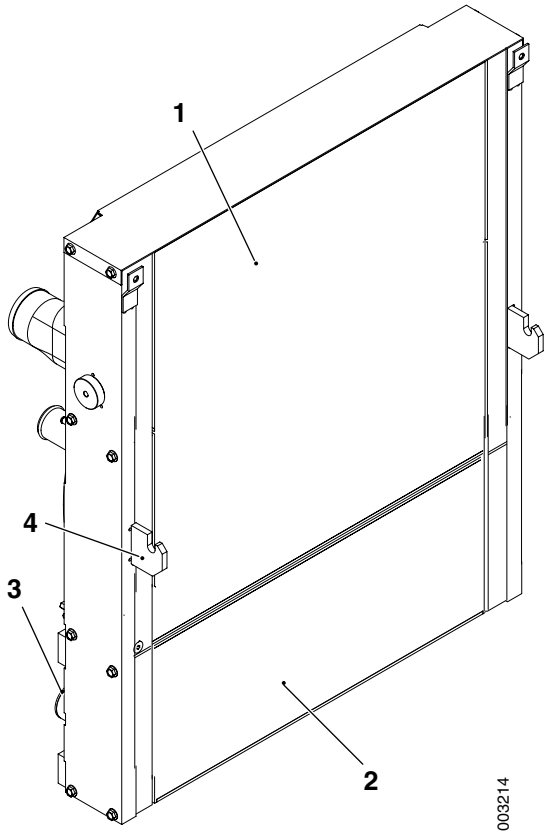
Coolant filter, general

See *Maintenance manual DRF 400–450* and *supplier documentation engine*.

1.7.3 Coolant thermostat

Thermostat coolant, description

See *supplier documentation engine*.



Radiator assembly, Volvo engine
1. Radiator, engine
2. Cooler, transmission oil
3. Thermostat, transmission oil
4. Mounting, condenser (for AC)

1.7.4 Radiator and expansion tank

Radiator and expansion tank, description

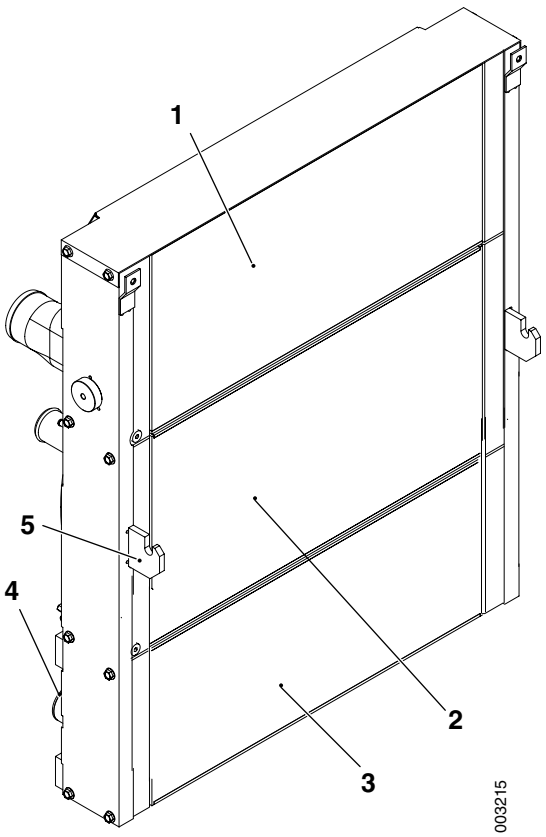
The radiator for the engine coolant is mounted in the radiator assembly (made of aluminium) located on one side of the engine.

The purpose of the cooler assembly is to cool:

- Engine coolant
- Gearbox oil (cooled in the lower part of the radiator assembly), see also section *2 Transmission*, group *2.6.3 Oil cooler*.
- The charge air (only Cummins engine) is cooled in the upper part of the radiator assembly, see also *Intercooler, description page 22*.

See also *Cooling system, description page 23*.

For more information, see *supplier documentation engine*.



Radiator assembly, Cummins engine

1. Intercooler
2. Radiator, engine
3. Cooler, transmission oil
4. Thermostat, transmission oil
5. Mounting, condenser (for AC)

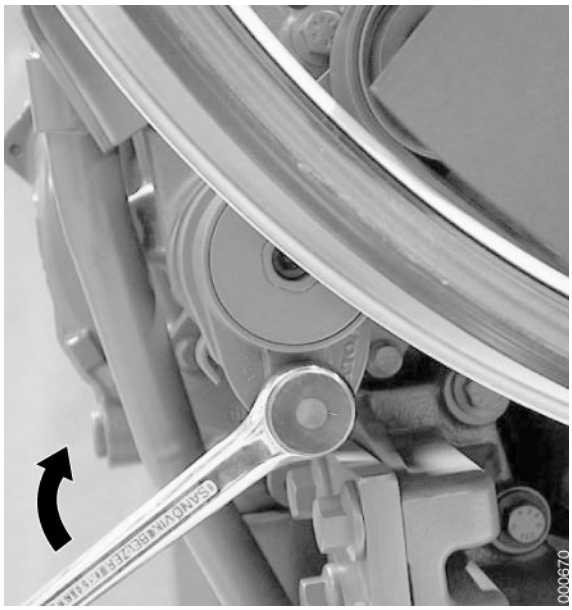
1.7.5 Cooling fan

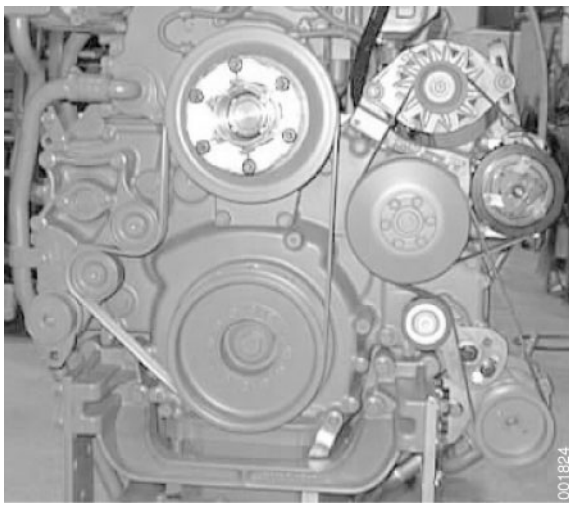
Cooling fan, description

See *supplier documentation engine*.

Fan belt, change (Volvo engine)

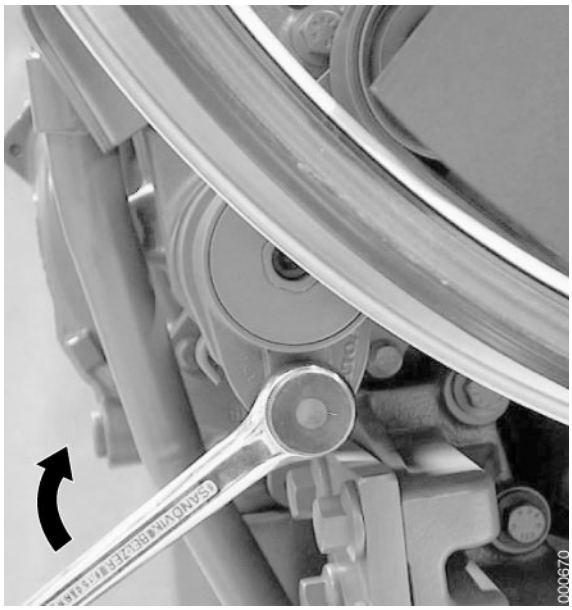
1 Move the cab into its foremost position.
2 Machine in service position, see section *B Safety*.
3 Remove the cover plates over the engine and radiator.
4 Release the belt catch using the ratchet handle and remove the fan belt from the belt pulley on the belt tensioner.
5 Remove the fan belt.





The illustration shows the engine without radiator fan.

6 Fit a new fan belt on the fan wheel and crankshaft belt pulley.



7 Release the belt catch using the ratchet handle and fit the fan belt on the belt tensioner pulley.

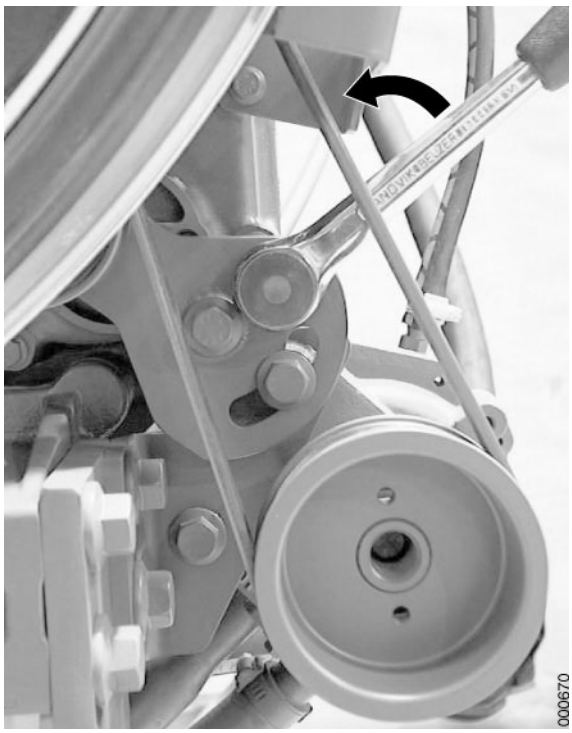
Extra water pump drive belt, change (Volvo engine)

1 Move the cab into its foremost position.

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

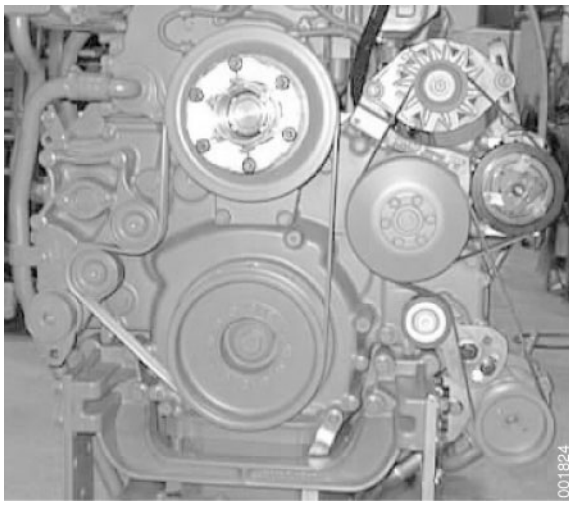
3 Remove the cover plates over the engine and radiator.

4 Wash the engine bay.



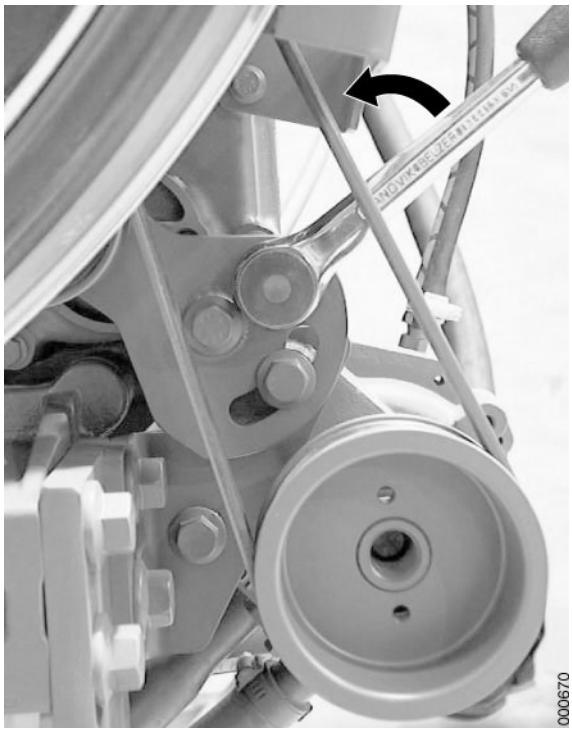
5 Release the belt catch using the ratchet handle and remove the drive belt from the belt pulley on the belt tensioner.

6 Remove the drive belt.



The illustration shows the engine without radiator fan.

7 Fit a new drive belt round the water pump and fuel pump pulleys.



8 Release the belt catch using the ratchet handle and fit the fan belt on the belt tensioner pulley.

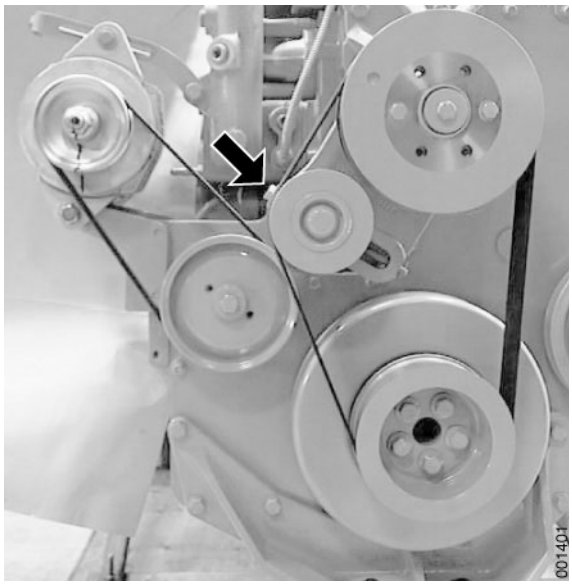
Fan belt, change (Cummins engine)

1 Move the cab into its foremost position.

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

3 Remove the cover plates over the engine and radiator.

4 Wash the engine bay.



5 Remove the belt tensioner.
6 Remove the fan belt.
7 Fit a new fan belt.
8 Use the belt tensioner to tension the fan belt.

1.7.6 Oil cooler

Oil cooler, description

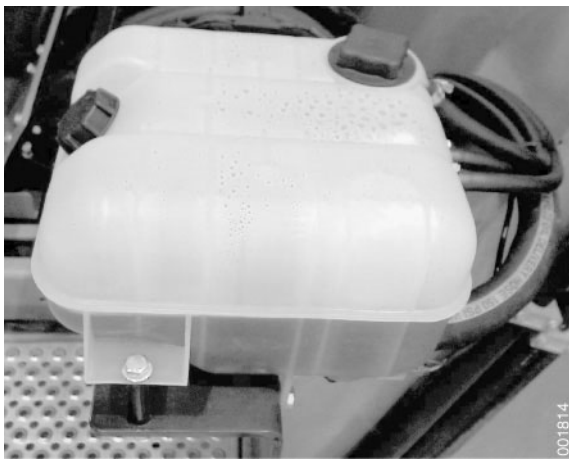
See *supplier documentation engine*.

1.7.7 Coolant

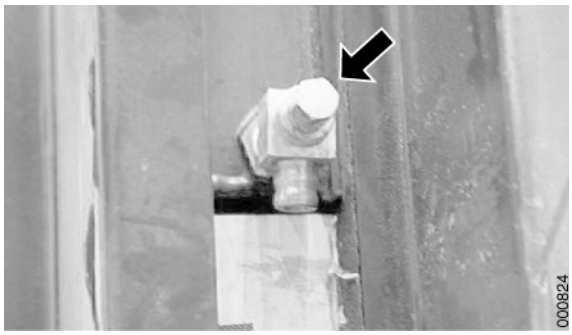
Coolant, description

See *supplier documentation engine*.

Coolant, changing

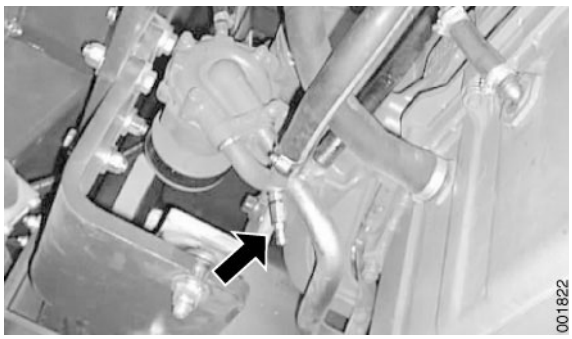


1 Machine in service position, see section *B Safety*.
2 Remove the cap on the expansion tank.
3 Place a receptacle under the radiator and engine. (Cooling system capacity is 40 litres.)



4 Drain the cooling system.

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

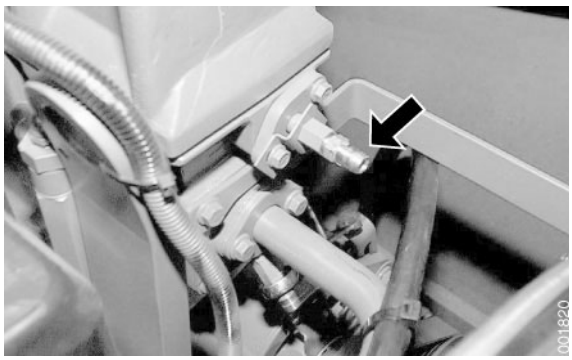


The Volvo engine is shown in the illustration.

5 Open the drain cock on the engine.

6 When all the coolant has run out, close the drain cocks.

7 Fill new coolant through the expansion tank.



The Volvo engine is shown in the illustration.

8 Open the bleed nipple to release air and to accelerate filling. Close the bleed nipple when clean coolant without air bubbles runs out.

9 Switch on the main circuit and start the engine.

10 Turn heating to max. in the cab.

11 Warm up the engine until the thermostat opens and coolant is pumped round the whole system.

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

13 Check the coolant level again after 10 working hours.

1.7.8 Making contact coolant level

Make-contact coolant level, description

See *supplier documentation engine*.

1.7.9 Sensor coolant temperature

Sensor coolant temperature, description

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.6.7 ENGINE, menu 7*.

For more information, see *supplier documentation engine*.

1.7.10 Plug-in heater

Engine heater, description

See *supplier documentation engine*.

Available as an option in conjunction with the engine heater is a start-inhibiting function. It is activated when the heater is in operation.

1.8 Lubrication

Lubrication system, description

See *supplier documentation engine*.

Engine oil, change

See *Maintenance manual DRF 400–450*.

1.8.1 Oil sump

Oil sump, description

See *supplier documentation engine*.

1.8.2 Oil pump

Oil pump, description

See *supplier documentation engine*.

1.8.3 Sensor oil pressure

Sensor oil pressure, description

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.6.6 ENGINE, menu 6*.

For more information, see *supplier documentation engine*.

1.8.4 Full flow filter

Full-flow filter, general

See *Maintenance manual DRF 400–450,* section *1 Engine,* group *1.8.4 Full flow filter* and *supplier documentation engine*.

1.8.5 By-pass filter

By-pass filter, general

See *Maintenance manual DRF 400–450,* section *1 Engine,* group *1.8.4 Full flow filter* and *supplier documentation engine (Volvo)*.

1.8.6 Oil cooler

Oil cooler, description

See *supplier documentation engine*.

1.8.7 Sensor oil temperature

Sensor oil temperature, description

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.6.7 ENGINE, menu 7*.

For more information, see *supplier documentation engine*.

1.9 Control system engine

Control system engine, description

See *Maintenance manual DRF 400–450* and *supplier documentation engine*.

1.9.1 Control unit engine

Control unit, general

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

1.10 Ignition/heating

1.10.1 Preheating

Preheating coil, description

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.6.5 ENGINE, menu 5*.

For more information, see *supplier documentation engine*.

1.11 Start/stop

1.11.1 Start motor

Starter motor, description (Volvo engine)

The starter motor rotates 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 engine (D794).

For more information, see *supplier documentation engine*.

Starter motor, description (Cummins engine)

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

The starter motor is supplied with current directly from the starter 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, *Maintenance manual DRF 400–450,* see section *8 Control system*, group *8.4.6.5 ENGINE, menu 5*.

For more information, see *supplier documentation engine*.

1.11.2 Stop device

Stop device, description

The engines have unit 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.

NOTE

The battery disconnector may not be used for emergency stop!

For more information, see *supplier documentation engine*.

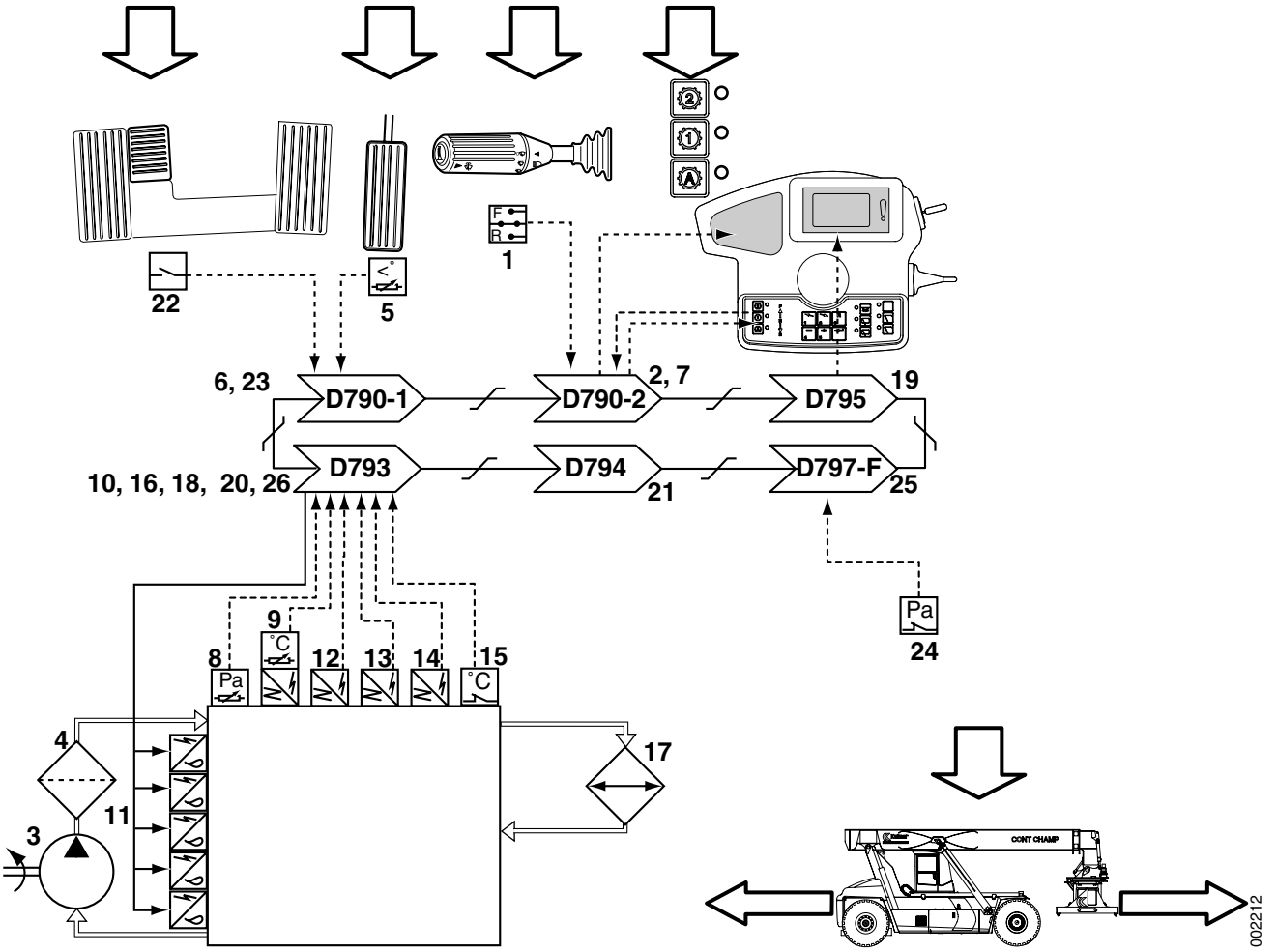
⊞

Automatic motor shutoff after a certain adjustable time is available as an option.

Table of Contents 2 Transmission

2 Transmission

Transmission, function description



Pos	Explanation	Signal description	Reference
1	The gear selector sends voltage signal to Control unit KIT (D790-2).	Forward, Conn. F: U = 24 V Reverse, Conn. R: U = 24 V	*Gear and multi-function lever, description page 7* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.7.2, TRANSM, menu 2*
2	Control unit KIT (D790-2) sends selected travel direction (forward or reverse) on CAN-bus.	Checked by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
3	The transmission's oil pump pumps oil when the engine is running.		*Oil pump, description page 15*
4	The transmission's oil filter cleans the oil from impurities.	-	*Oil filter, general page 16*

Pos	Explanation	Signal description	Reference
5	The throttle pedal sends signal to Control unit cab (D790-1).	U = 0.5-4.5 V	Section *1 Engine*, group *1.1.1 Accelerator pedal* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.6.1 ENGINE, menu 1*
6	Control unit cab (D790-1) sends desired throttle application on CAN-bus.	Checked by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
7	Control unit KIT (D790-2) sends selected shifting program on CAN-bus.	Checked by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
8	Sensor oil pressure sends voltage signal proportional to oil pressure in Control unit transmission TCU (D793).	Checked by Control unit transmission, error shown with error code.	*Sensor oil pressure, description page 15* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.7.10, TRANSM, menu 10*
9	Sensor oil pressure and oil temperature sends pulse signal with frequency proportional to engine rpm and voltage signal proportional to transmission oil temperature to Control unit transmission TCU (D793).	Checked by Control unit transmission, error shown with error code.	*Sensor engine rpm and oil temperature transmission, description page 12* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.7.6, TRANSM, menu 6*
10	Control unit transmission TCU (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 *11.5.4.11 Control unit, transmission*
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.	*Valve block transmission control, description page 13*
12	Sensor rpm turbine sends pulse signal with frequency proportional to turbine's rpm to Control unit transmission TCU (D793).	Checked by Control unit transmission, error shown with error code.	*Sensor rpm turbine, description page 13* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.7.6, TRANS, menu 6*
13	Sensor rpm drum sends pulse signal with frequency proportional to drum's rpm to Control unit transmission TCU (D793).	Checked by Control unit transmission, error shown with error code.	*Sensor rpm drum, description page 13* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.7.6, TRANSM, menu 6*
14	Sensor rpm output shaft sends pulse signal with frequency proportional to output shaft's rpm to Control unit transmission TCU (D793).	Checked by Control unit transmission, error shown with error code.	*Sensor output shaft, description page 14* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.7.6, TRANSM, menu 6*

Pos	Explanation	Signal description	Reference
15	Temperature monitor torque converter sends voltage signal to Control unit transmission TCU (D793) if oil temperature in torque converter becomes too high.	Checked by Control unit transmission, error shown with error code.	*Sensor engine rpm and oil temperature transmission, description page 12* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.7.6, TRANSM, menu 6*
16	Control unit transmission controls gearshifting according to selected shifting program.	Checked by Control unit transmission, error shown with error code.	Section *11 Common electrics*, group *11.5.4 Control units*
17	The oil cooler cools the transmission oil. A thermostat senses the oil temperature and directs the oil back to the transmission if the oil is cold.	-	*Oil cooler, description page 17*
18	Control unit transmission TCU (D793) sends temperature and rpm information on CAN-bus.	Checked by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
19	Control unit KID (D795) shows transmission information in operating menus.	Checked by control system, error shown with error code.	*Operating menu engine and transmission, description page 9Operating menu oil temperature, description page 9*
20	If signal from Sensor output shaft indicates that the machine's speed exceeds the speed limitation, then Control unit transmission TCU (D793) sends signal for reduced engine rpm on CAN-bus.	-	*Sensor output shaft, description page 14* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.7.6, TRANSM, menu 6*
21	Control unit engine (D794) reduces engine rpm.	-	Section *11 Common electrics*, group *11.5.3.10 Control unit, engine*
22	If the clutch pedal is pressed down it sends a voltage signal to Control unit cab (D790-1).	U = 24 V	*Clutch pedal, description page 7* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.7.1, TRANSM, menu 1*
23	Control unit cab (D790-1) sends disengage drive on CAN-bus.	Checked by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
24	Make-contact disengage sends voltage signal to Control unit frame front (D797-F) if brake pressure is high enough to allow disengagement of drive.	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	*Breaking contact disengagement (declutch), description page 18* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.7.1, TRANSM, menu 1*

Pos	Explanation	Signal description	Reference
25	Control unit frame front (D797-F) sends disengagement approved on CAN-bus.	Checked by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
26	Control unit transmission (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 Control unit, transmission*

Engine and gearbox, separation

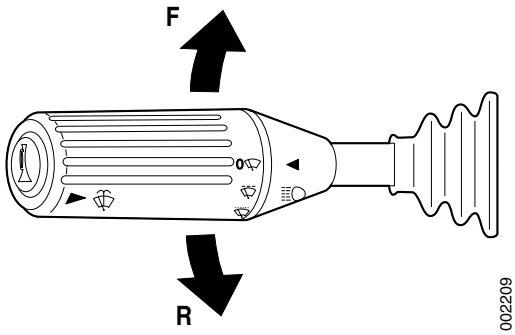
Engine alternative Volvo: see section *1 Engine*, group *1 Engine and gearbox, separation (engine alternative Volvo)*.

Engine alternative Cummins: see section *1 Engine*, group *1 Engine and gearbox, separation (engine alternative Cummins)*.

2.1 Controls and instrumentation

2.1.1 Gear and multi-function lever

Gear and multi-function lever, description



002209

Travel direction is selected with the gear and multi-function lever.

Selection of travel direction:

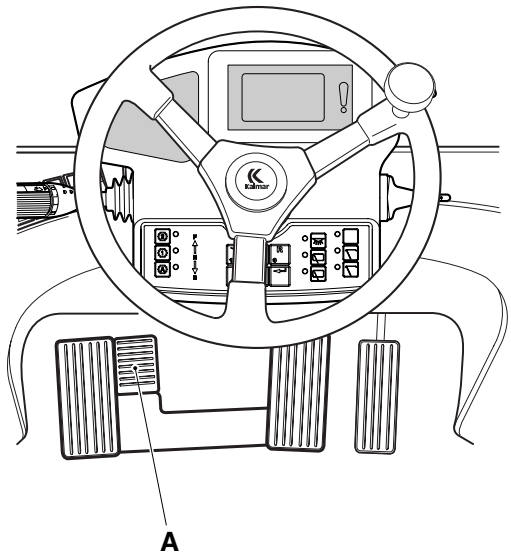
- F – Forward
- N – Neutral
- R – Reverse

The switch is supplied with voltage by and sends signals to Control unit KIT (D790-2).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.7.2 TRANSM, menu 2*.

2.1.2 Clutch pedal

Clutch pedal, description



001515

A. Clutch pedal

The switch is supplied with voltage by and sends signals toControl unit cab (D790-1).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.7.1 TRANSM, menu 1*.

2.1.3 Switch shifting program A

Switch shifting program A, description


000413

The switch activates shifting program A, which means automatic selection of gear position.

The switch is supplied with voltage by and sends signals to Control unit KIT (D790-2).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.7.2 TRANSM, menu 2*.

2.1.4 Switch shifting program 1

Switch shifting program 1, description

The switch activates shifting program 1, which means that gear position is locked to 1st gear.

000414

The switch is supplied with voltage by and sends signals to Control unit KIT (D790-2).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.7.2 TRANSM, menu 2*.

2.1.5 Switch shifting program 2

Switch shifting program 2, description

The switch activates shifting program 2, which means that gear position is locked to 2nd gear.

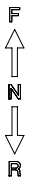
000415

The switch is supplied with voltage by and sends signals to Control unit KIT (D790-2).

The sensor can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.7.2 TRANSM, menu 2*.

2.1.6 Travel direction indicator forward, neutral, reverse

Travel direction indicator forward, neutral and reverse, description



Indicates selected travel direction with gear and multi-function lever. The letters F (Forward), N (Neutral) or R (Reverse) are lit for each respective travel direction.

000403

2.1.7 Warning light high oil temperature in transmission

Warning light high oil temperature in transmission, description

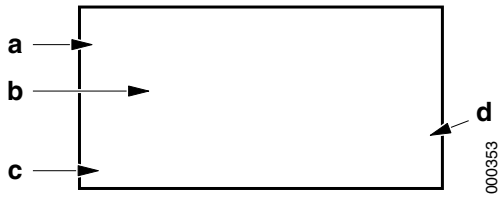
The warning light is activated if the transmission's oil temperature is too high. Stop the machine and let the engine run at idle speed.

000306

2.1.8 Operating menu engine and transmission

Operating menu engine and transmission, description

Field c shows current gear.



a. Engine rpm
b. Speed
c. Current gear
d. Fuel level

2.1.9 Operating menu oil temperature

Operating menu oil temperature, description

Field a shows transmission oil temperature.

a. Transmission oil temperature
b. Hydraulic oil temperature

2.2 Torque converter/clutch system

Torque converter, description

See *supplier documentation transmission*.

2.2.1 Flex plates

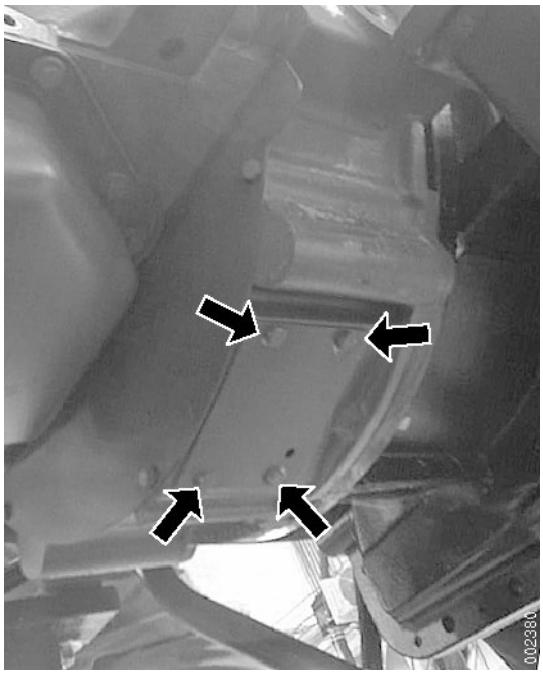
Flex plates, description

See *supplier documentation transmission*.

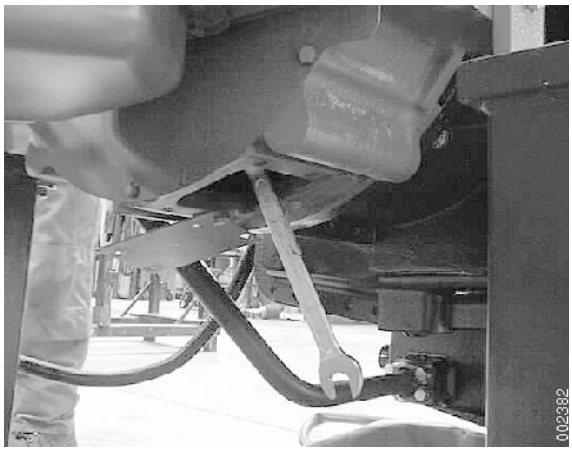
Flex plates, changing

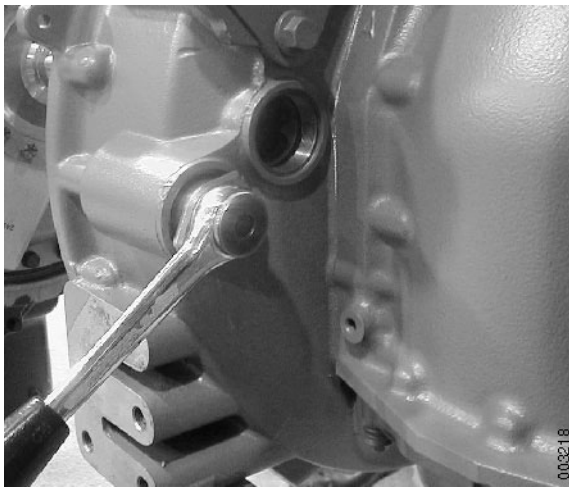
1 Machine in service position, see section *B safety*.

2 Remove the flywheel cover plate.



3 Remove the nuts from the flex plate.

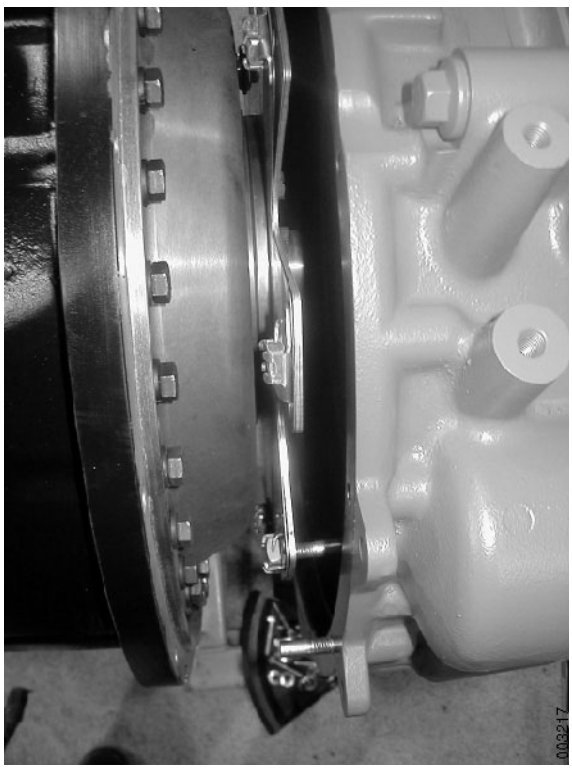




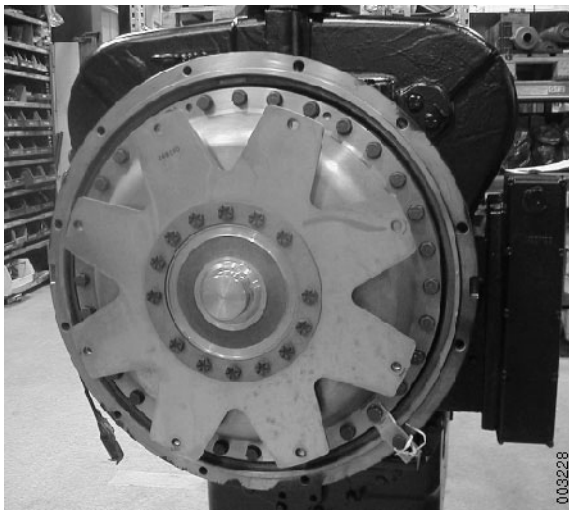
4 Turn the engine for each nut to be removed from the flex plate.

5 Attach the transmission to an overhead crane.

6 Remove the bolts holding together the transmission and engine.



7 Carefully separate the transmission and engine.



Attachment of flex plate.

8 Remove the bolts holding the flex plate to the transmission.
9 Change the flex plate.
10 Fit in the reverse order. Fit the attaching bolts with **40 Nm**.

2.2.2 Pump rotor

Pump rotor, description

See *supplier documentation transmission*.

2.2.3 Stator

Stator, description

See *supplier documentation transmission*.

2.2.4 Turbin rotor

Turbine rotor, description

See *supplier documentation transmission*.

2.2.5 Sensor engine speed and oil temperature in transmission

Sensor engine rpm and oil temperature transmission, description

The sensor can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.7.6 TRANSM, menu 6*.

For more detailed information, see *supplier documentation transmission*.

2.3 Mechanical transmission

Mechanical transmission, description

See *Maintenance manual DRF 400–450* and *supplier documentation transmission*.

2.3.1 Gear pack

Gear pack, description

See *supplier documentation transmission*.

2.3.2 Power take-off

Power take-off, description

See *supplier documentation transmission*.

2.3.3 Input shaft

Input shaft, description

See *supplier documentation transmission*.

2.3.4 Valve block transmission control

Valve block transmission control, description

See *supplier documentation transmission*.

2.3.5 Sensor turbine speed

Sensor rpm turbine, description

The sensor can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.7.6 TRANSM, menu 6*.

For more detailed information, see *supplier documentation transmission*.

2.3.6 Sensor shaft speed

Sensor rpm drum, description

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.7.6 TRANSM, menu 6*.

For more detailed information, see *supplier documentation transmission*.

2.3.7 Output shaft

Output shaft, description

See *supplier documentation transmission*.

2.3.8 Sensor output shaft speed

Sensor output shaft, description

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.7.6 TRANSM, menu 6*.

For more detailed information, see *supplier documentation transmission*.

2.6 Lubrication

Lubrication system, description

The transmission lubricating system has the following function:

- Lubricate gear wheel and bearings
- Apply the clutches in the gearbox
- Cool down the torque converter and gearbox
- Clean the oil of any impurities with two oil filters.

During operation of the engine, the oil pump draws oil from the gearbox oil pan through a strainer, and it then pumps it through two oil filters to a control valve.

The control valve provides oil at the correct pressure to the gearbox valve housing to activate the clutch plates for FORWARD or REVERSE and gear 1, 2, 3, or 4. The clutch plates require just a small amount of the oil flow supplied by the pump. The remainder of the oil is pumped through the torque converter circuit to the oil cooler and returns to the gearbox for lubrication.

See also *Maintenance manual DRF 400–450* and *supplier documentation transmission*.

Transmission oil, changing

See *Maintenance manual DRF 400–450*.

2.6.1 Oil pump

Oil pump, description

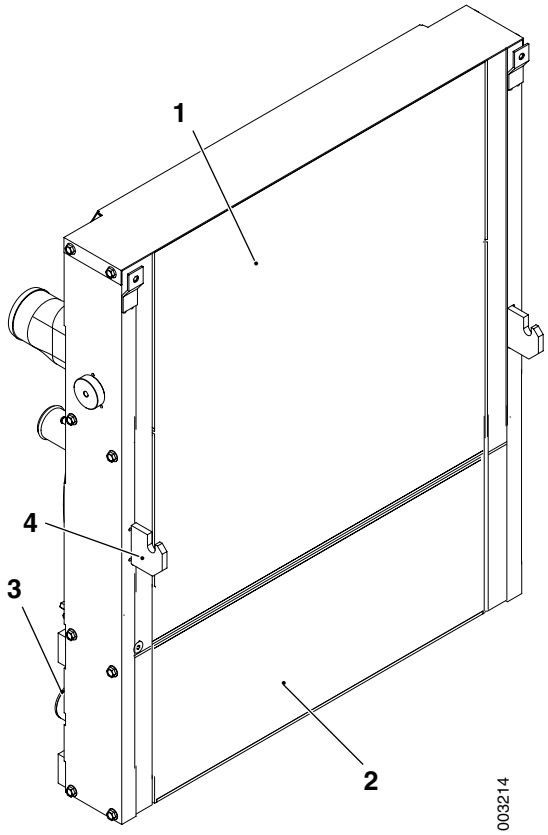
See *supplier documentation transmission*.

2.6.2 Sensor oil pressure

Sensor oil pressure, description

The sensor can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.7.10 TRANSM, menu 10*.

For more detailed information see *supplier documentation transmission*.



Radiator core, engine alternative Volvo
1. Radiator, engine
2. Cooler, transmission oil
3. Thermostat, transmission oil
4. Mounting, condenser (to AC)

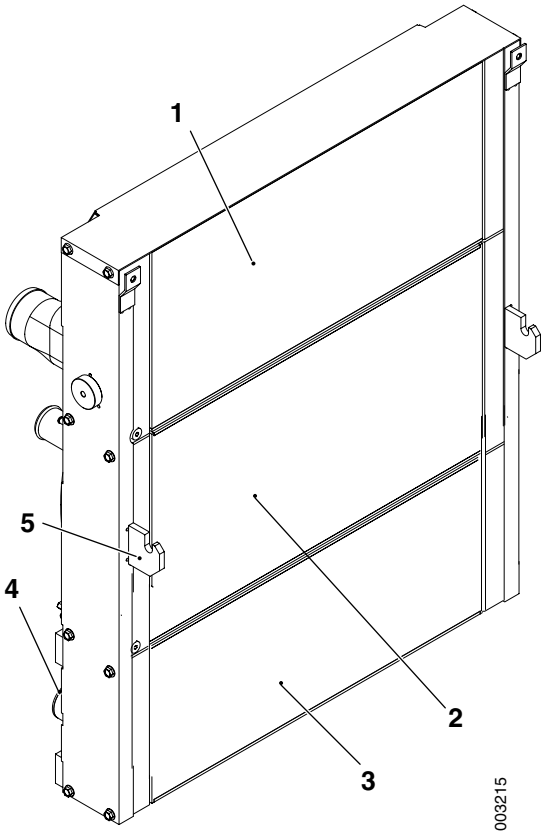
2.6.3 Oil cooler

Oil cooler, description

The transmission oil is cooled in the lower section of the cooler assembly.

A temperature controlled bypass valve, which only acts on the cooling circuit for transmission oil, is located in a pipe at the lower edge of the radiator (on engine side). The valve closes when oil starts to reach operating temperature. In this way the oil reaches operating temperature more quickly.

For more detailed information see *supplier documentation transmission*.



Radiator core, engine alternative, Cummins

1. Charge air cooler
2. Radiator, engine
3. Cooler, transmission oil
4. Thermostat, transmission oil
5. Mounting, condenser (to AC)

2.6.4 Oil filter

Oil filter, general

See *Maintenance manual DRF 400–450* and *supplier documentation transmission*.

2.7 Cooling

Cooling system, description

See *supplier documentation transmission*.

2.7.1 Cooling oil pump

Oil pump, description

See *supplier documentation transmission*.

2.7.2 Sensor oil temperature

Sensor oil temperature, description

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.7.10 TRANSM, menu 10*.

For more detailed information see *supplier documentation transmission*.

2.7.3 Oil cooler

Oil cooler, description

See *Oil cooler, description page 16*.

2.8 Control system transmission

Control system, transmission, general

See *Maintenance manual DRF 400–450* and *supplier documentation transmission*.

Transmission, calibration

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

2.8.1 Control unit transmission

Control unit, transmission, general

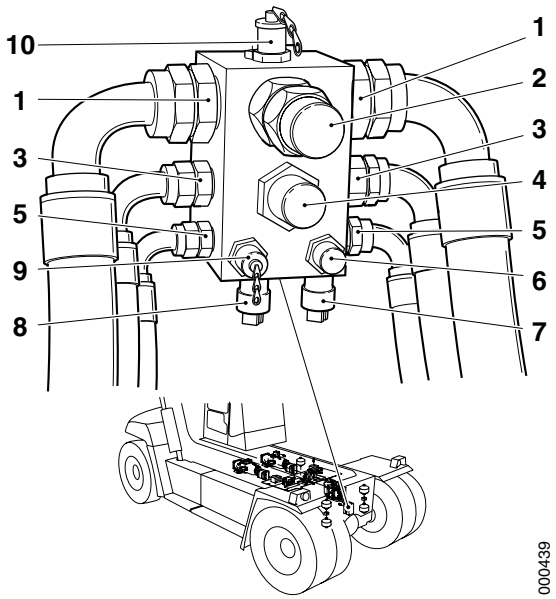
See section *11 Common electrics*, group *11.5.3.9 Control unit, transmission* and *supplier documentation transmission*.

2.8.2 Breaking contact declutch

Breaking contact disengagement (declutch), description

The break contact for disengagement senses if the wheel brakes are pressurised. The break contact is located on the distribution block for the brake system, above the drive axle's differential.

The sensor can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.7.1 TRANSM, menu 1*.



1. Connection brake cooling, return from wheel brake
2. Connection brake cooling, return to radiator and tank
3. Connection brake cooling, to wheel brake
4. Connection brake cooling, from accumulator charging valve
5. Connection brake cylinder, to wheel brake
6. Connection brake pressure, from brake valve
7. Make-contact, declutch (S220)
8. Make-contact, wheel brake (S216)
9. Test outlet, brake pressure
10. Test outlet, back-pressure brake cooling

2.8.3 Cable harness transmission

Cable harness transmission, description

See section *E Diagrams*.

Table of Contents 3 Driveline/axle

3 Driveline/axle

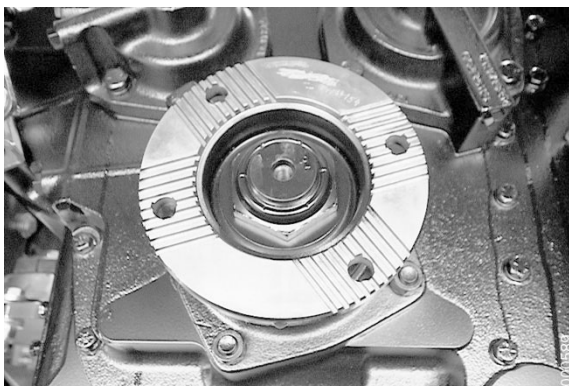
3.2 Drive shaft

Universal drive shaft, description

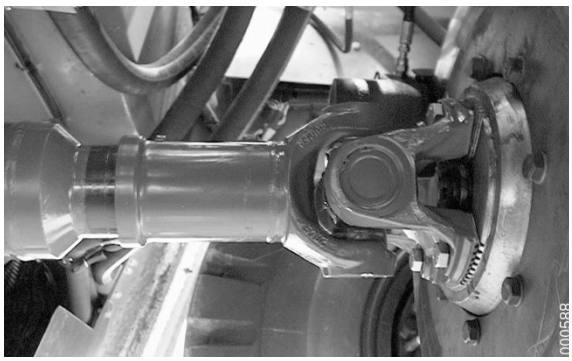
The universal drive shaft transfers the engine power from the transmission to the drive axle. The universal drive shaft has two joints which mean that the engine and drive axle can move in relation to each other.

Universal drive shaft, replacement

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



2 Clean the contact surfaces (cross-toothed) on the drive axle and gearbox.



3 Fit the universal drive shaft in position with the coupling upward.

4 Fit the universal drive shaft attaching bolts.

Tightening torque **200 Nm**. Retighten the attaching bolts after 50 hours operating time.

3.3 Drive axle

Drive axle, general

See *Maintenance manual DRF 400–450* and *supplier documentation drive axle*.

3.3.1 Differential

Differential, description

See *supplier documentation drive axle*.

3.3.2 Drive shaft

Drive shaft, description

See *supplier documentation drive axle*.

3.3.3 Hub reduction

Hub reduction, description

See *supplier documentation drive axle*.

Table of Contents 4 Brakes

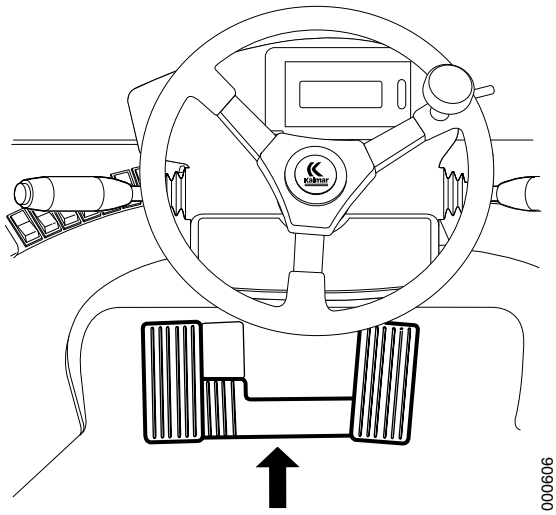
4 Brakes

4.1 Controls and instrumentation

4.1.1 Brake pedal

Brake pedal, description

The brake pedal affects the brake valve via a lever. A spring automatically returns the pedal to resting position.



Brake pedal, checking and adjustment

See *Maintenance manual DRF 400–450*.

Brake pedal, replacement

WARNING

Hot, pressurised oil.

Personal injury, burn injury, rash or irritation

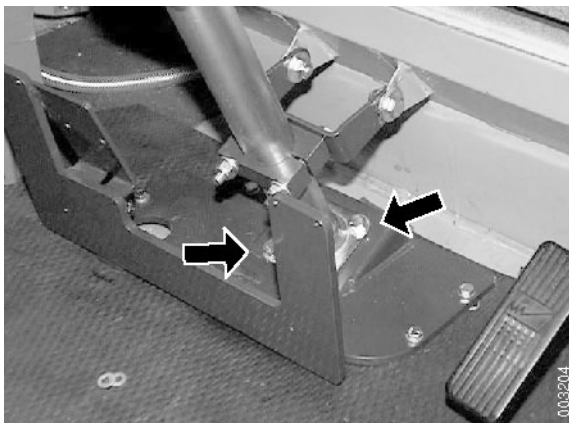
Depressurise the hydraulic and brake systems before starting to work on the brake system. Avoid skin contact with the oil, use protective gloves.

1 Turn off the engine and the main electrical power.

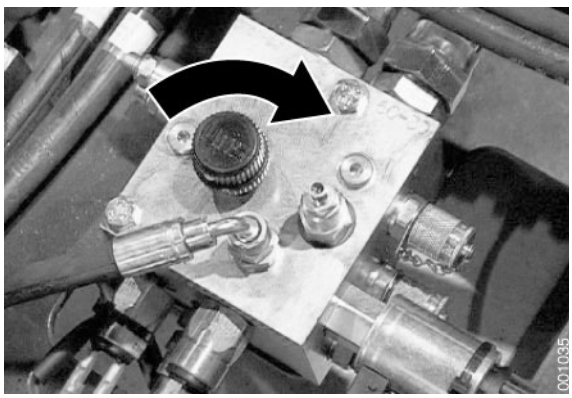
2 Depressurise the brake and hydraulic systems, see section *B Safety*, *Hydraulic and brake systems, depressurising*.

3 Detach the brake valve from the brake pedal

Secure the brake valve on the cab's underside and remove the brake valve attaching bolt.



Mounting of steering wheel shaft and steering valve in pedal bracket.



4 Remove the panel around the steering wheel shaft.

NOTE

There is a variant available with adjustable steering wheel shaft.

5 Detach the steering valve from the pedal bracket.

Secure the steering valve on the underside of the cab. Remove the steering valve's attaching bolts. Pull the valve down slightly so that the steering shaft releases from the steering valve.

6 Detach the steering wheel shaft from the brake pedal.

Undo the bolts and pull the steering wheel shaft up slightly so that the brake pedal can be removed.

7 Detach the clutch pedal from the brake pedal.

8 Remove the brake pedal

Remove the brake pedal's attaching bolts and lift away the brake pedal.

9 Transfer the pedal rubber to the new pedal.

10 Fit the new brake pedal

Fit the pedal and fit the pedal's attaching bolts.

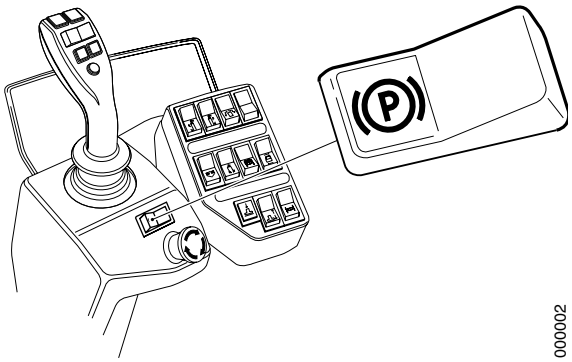
11 Connect the steering valve to the brake pedal.

12 Connect the brake valve to the brake pedal.

13 Fit the clutch pedal to the brake pedal.

14 Close the drain valve on the accumulator charging valve.

15 Grease and adjust the brake pedal, see *Maintenance manual DRF 400–450,* section *4 Brakes,* group *4.1.1 Brake pedal*.


000002

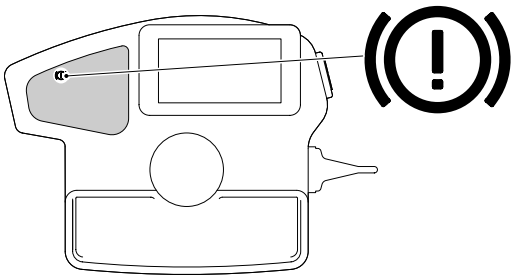
4.1.2 Switch parking brake

Switch parking brake, description

The parking brake is activated with Switch parking brake (S107).

The switch sends voltage signals to Control unit, cab (D790-1). The switch sends signals for both off and on position.

The signals can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.5 HYD, menu 5*.

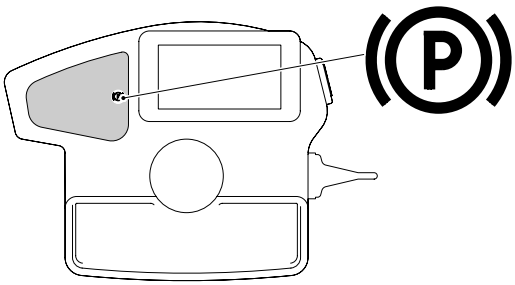

000003

4.1.3 Warning light low brake pressure

Warning light low brake pressure, description

Warning light low brake pressure is activated in case of pressure loss in the brake system's supply circuit, that is, when the pressure is below 11.5 MPa.

The warning light is supplied with voltage by Control unit KIT (D790-2).


000004

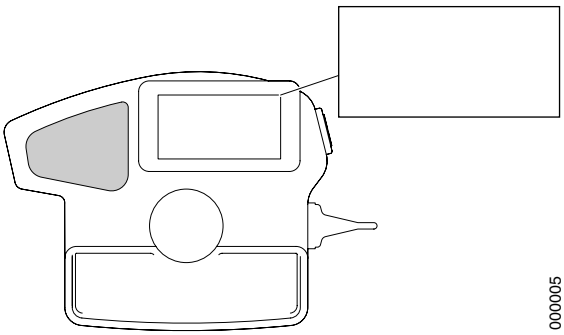
4.1.4 Indicator light parking brake

Indicator light parking brake, description

Indicator light parking brake is activated when the parking brake is applied.

If the operator leaves the seat without applying the parking brake, the parking brake is activated automatically by the control system. The indicator light flashes to indicate that the parking brake is applied despite the switch parking brake is not being on.

The warning light is supplied with voltage by Control unit KIT (D790-2).



4.1.5 Event menu high oil temperature

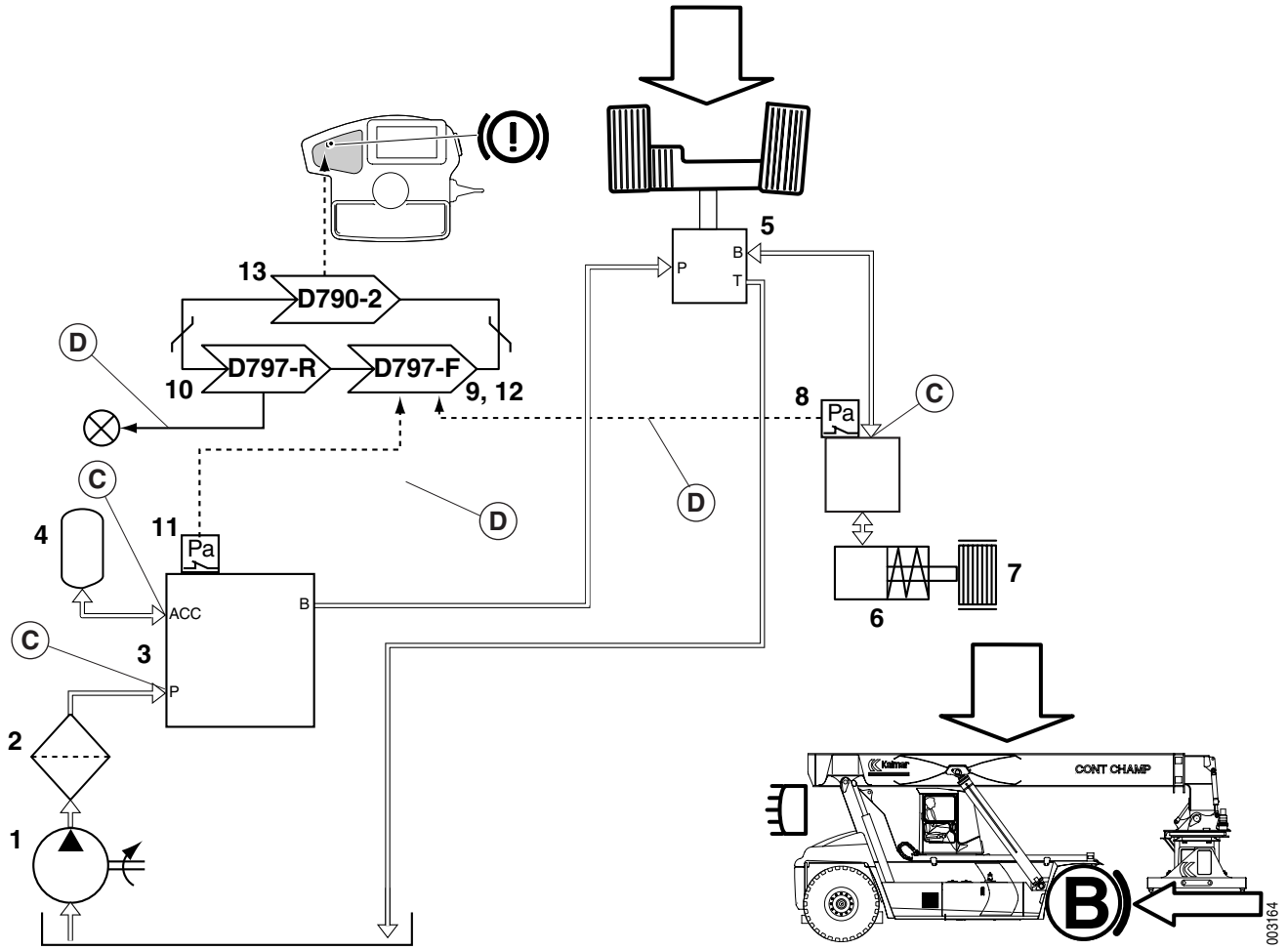
Event menu high oil temperature, description

Warning high oil temperature is shown on the display when the oil temperature is too high in the brake oil tank.

Warning is activated by Control unit KID (D795).

4.3 Service brake system

Power-assisted brake system, function description



Pos	Explanation	Signal description	Reference
1	The brake oil pump pumps oil from the brake tank.	P = 19±0.5 MPa	*Brake oil tank, description page 39* *Brake oil pump, description page 9*
2	The brake oil filter cleans the oil.	-	*Brake oil filter, description page 44*
3	The accumulator charging valve directs oil to charging of accumulators or through the brake system's cooling circuit.	-	*Accumulator charging valve, description page 12*
4	The accumulators store oil pressure.	See pressure plate "Accumulator pressure brake system", on left frame member.	*Accumulator, description page 16*

Pos	Explanation	Signal description	Reference
5	The brake valve directs pressure from the accumulators to the brake cylinders proportional to pressing of the pedal.	-	*Brake valve, description page 19*
6	The brake cylinders compress the discs in the brake unit.	See pressure plate "Brake pressure", on left frame member.	*Wheel brake, description page 27*
7	The wheel brakes brake the machine.	-	*Wheel brake, description page 27*
8	Make-contact brake lights (S216) close the circuit when the brake cylinders are pressurized.	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	*Make-contact brake lights, description page 25* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.4 HYD, menu 4*
9	Control unit frame front (D797-F) sends brake light request on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
10	Brake lights are activated by Control unit frame rear (D797-R).	U = 24 V	Section *9 Frame, body, cab and accessories*, group *9.6.5 Brake lights* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.11 LIGHTS, menu 11*
11	Breaking contact brake oil pressure (S204) opens the circuit if the pressure in the accumulators is low.	Brake pressure above 11.5 MPa: Conn 1, U = 24 V Conn 2, U = 24 V Brake pressure below 11.5 MPa: Conn 1, U = 24 V Conn 2, U = 0 V	*Make-contact brake pressure, description page 24* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.4 HYD, menu 4*
12	Control unit frame front (D797-F) sends warning about low brake pressure on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
13	Control unit KIT (D790-2) activates Warning light brake pressure.	Controlled by control system, error shown with error code.	*Warning light low brake pressure, description page 5*

Hydraulic diagram A40740.0100

Servo brake, checking

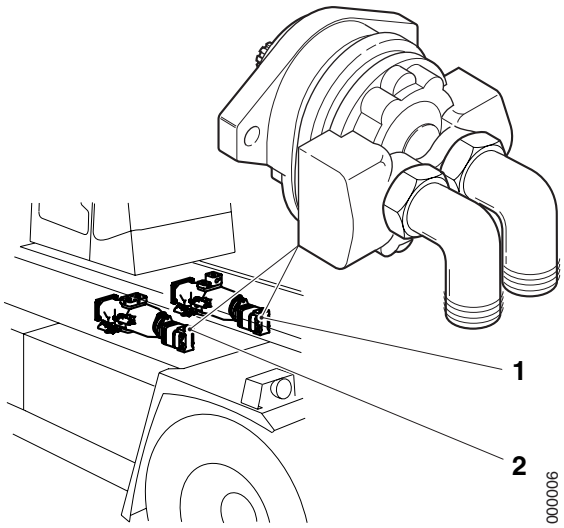
See *Maintenance manual DRF 400–450*.

4.3.1 Brake oil pump

Brake oil pump, description

The brake system has one gear pump with fixed displacement. The brake oil pump is located furthest forward on the left-hand main pump. The pump generates hydraulic force which is stored in an accumulator for braking force to servo brake and parking brake and also oil flow used for cleaning and cooling. Reconnection between power generation and flow is handled by the accumulator charging valve, see *Accumulator charging valve, description page 12*.

The brake oil pump is driven by the main pump shaft from the gearbox power take-off. The speed of the brake pump is directly dependent on engine speed. Pump flow increases with engine speed. The brake oil pump flow varies with the speed of the input shaft.



1. Brake oil pump
2. Pump cooling and filtering, working hydraulics

NOTE

It is very important that the clearance between gear wheels and housing is correct. Insufficient clearance causes wear damage. Too much clearance reduces the output of the pump.

Brake oil pump, replacement

⚠ WARNING

Hot, pressurised oil.

Personal injury, burn injury, rash or irritation

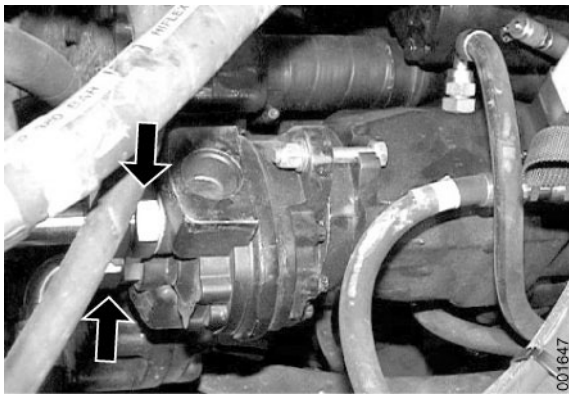
Always depressurise the hydraulic systems before starting work on them. Avoid skin contact with the oil, use protective gloves.

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

2 Clean the pump and its surrounding area.

3 Depressurise the brake and hydraulic systems, see section *B Safety*.

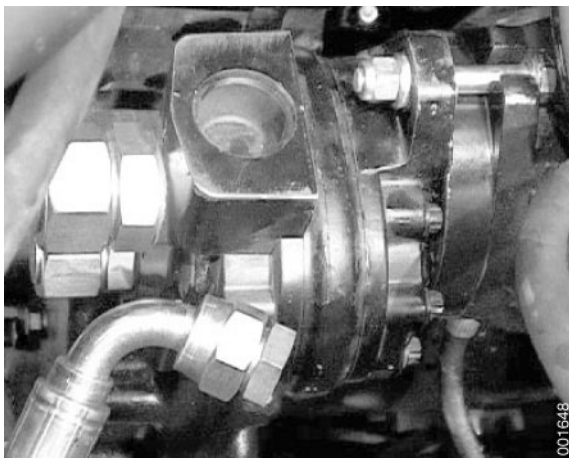
4 Position a collection container under the gearbox to collect any spilled oil.



5 Mark up and detach the hydraulic hoses from the pump.

NOTE

Plug all connections immediately to protect the brake system from impurities.



6 Remove the pump.

Remove the attaching bolts, pull the pump out backwards and lift it away.

7 Transfer the connection adapters to the new pump.

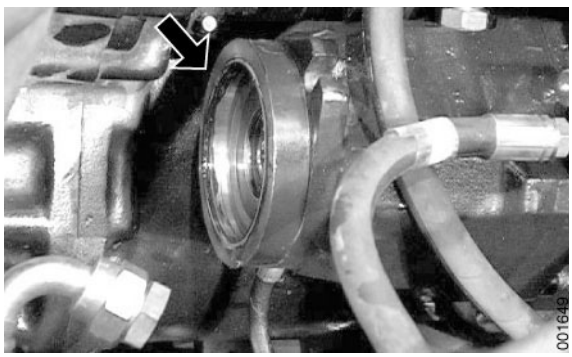
8 Remove the spacer ring from the brake pump or the hydraulic oil pump.

Clean the O-ring contact surfaces on the spacer ring.

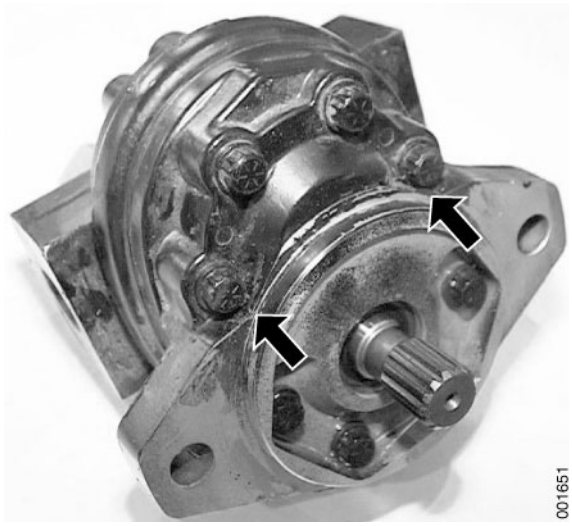
9 Check the O-rings, replace if necessary. Fit the O-rings on the spacer ring. Grease the sealing surface to the brake pump with silicone sealant, see section *F Technical data*.

NOTE

Use silicone only on one side, on the side which faces the brake pump.



10 Fit the spacer ring to the main pump.

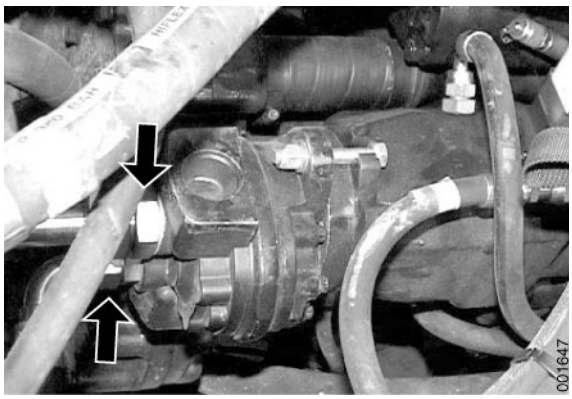


11 Grease the sealing surface to the spacer ring with silicone sealant, see section *F Technical data*.

12 Fit the brake pump to the main pump.

Fit the pump and check that the gear wheel engages in the shaft and that the spacer ring is straight against the brake pump.

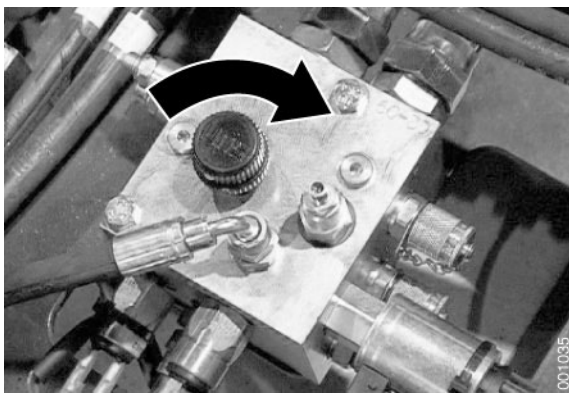
Fit the pump's attaching bolts.



13 Connect the hydraulic hoses to the brake pump.

NOTE

Check that the O-rings are intact and are fitted correctly.



14 Close the drain valve on the accumulator charging valve.

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

16 Check that the hose connections and the seal between hydraulic oil pump and brake pump are sealed tightly.

Check the feed pressure from the brake pump, see *Maintenance manual DRF 400–450,* section *4 Brakes,* group *4.3.1 Brake oil pump*.

17 Remove the collection container, treat the waste oil as environmentally hazardous waste.

18 Check the oil level in the brake system, fill as necessary.

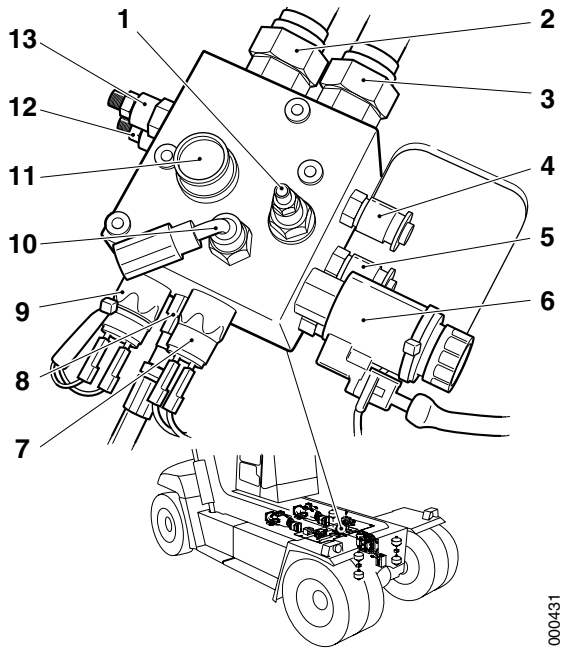
NOTE

If the pump is replaced due to breakdown then change the oil and filter in the brake system as well.

4.3.2 Brake oil filter

Brake oil filter, general

See *Brake oil filter, description page 44* and *Maintenance manual DRF 400–450, section 4 Brakes, group 4.8.12 Brake oil filter*.



1. Safety valve (22 MPa)
2. Connection from pump (P)
3. Connection wheel brake (T)
4. Measuring outlet, pump pressure (P)
5. Measuring outlet, accumulator pressure (M)
6. Solenoid valve, parking brake (Y642)
7. Make-contact, parking brake (GHB) (S260)
8. Connection accumulators (ACC)
9. Make-contact, brake oil pressure (LB) (S204)
10. Connection parking brake caliper (HB)
11. Drain valve
12. Main valve charging
13. Pressure limiting valve

4.3.3 Accumulator charging valve

Accumulator charging valve, description

The accumulator charging valve distributes oil from the brake oil pump between pressure storage and cooling of the wheel brakes. The accumulator charging valve is located on the beam in front of the transmission in the engine compartment.

The accumulator charging valve stores pressure by means of controlling the oil to the accumulators. The wheel brakes are cooled by means of oil directed to the drive axle cooling circuit and then on to the brake system cooler.

The accumulator charging valve prioritises charging of the accumulators above cooling. A restriction of the charging means that a small quantity of oil also flows to cooling during accumulator charging. At idling speed the flow from the pump is so small that all oil flows to pressure storage.

The drain valve (position 11) is used to drain the pressure in the accumulators to the tank. The valve opens a connection between the accumulators and the wheel brake's cooling circuit. The oil is drained through the wheel brake to the tank.

There is a measuring outlet for measuring accumulator pressure (position 5) and pump pressure (position 4) on the accumulator charging valve. The pressures are individual to each machine and are on the pressure plate on the left-hand frame beam, see section *10 Common hydraulics*. On the accumulator charging valve, there is also a solenoid valve, parking brake (position 6), make-contact brake oil pressure (position 9) and make-contact parking brake (position 7).

- *Solenoid valve parking brake, description page 33*
- *Make-contact brake lights, description page 25*
- *Make-contact parking brake, description page 37*

Accumulator charging, checking and adjustment

⚠ WARNING

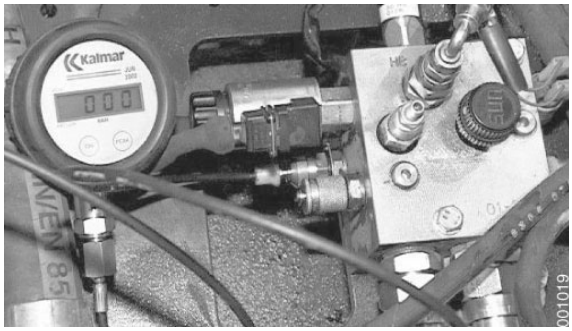
Hot, pressurised oil.

Personal injury, burn injury, rash or irritation

Always depressurise the hydraulic systems before starting work on them. Avoid skin contact with the oil, use protective gloves.

1 Operate and warm up the machine so that the brake oil reaches operating temperature, at least 50 °C.

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

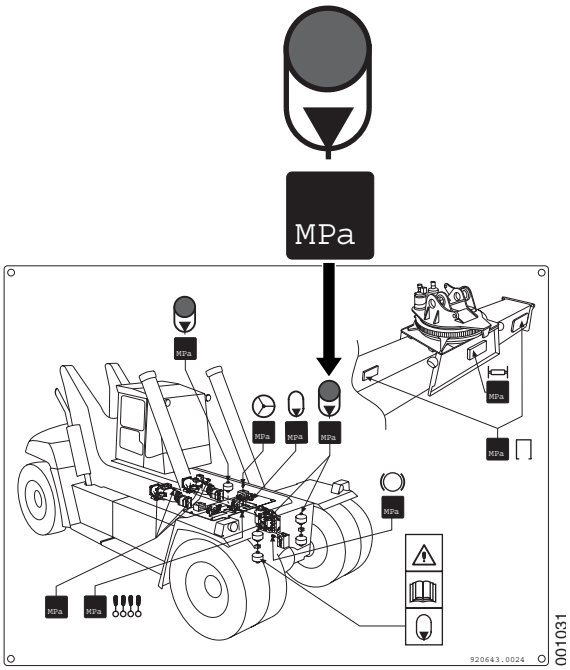


3 Depressurise the brake and hydraulic systems, see section *B Safety*.

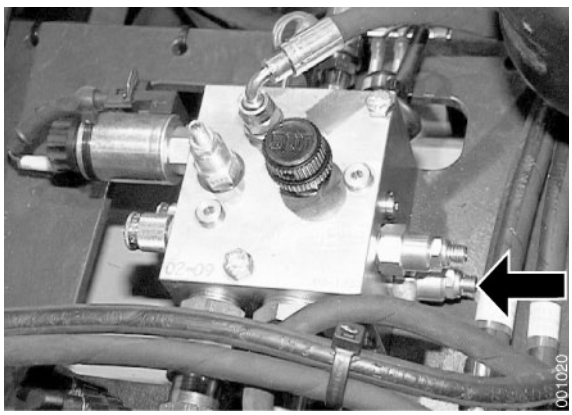
4 Connect a pressure gauge (0-25 MPa) to the measuring outlet for accumulator pressure on the accumulator charging valve.

5 Start the engine and run it at idling speed.

6 Close the drain valve on the accumulator charging valve.



7 Check that the maximum pressure corresponds with the accumulator pressure on the pressure plate on the left-hand frame beam.



8 If necessary, adjust the accumulator charging pressure on the pressure limiting slide.

Undo the lock nut and adjust the pressure by turning the adjusting screw.

Anticlockwise: reduce pressure.

Clockwise: increase pressure.

9 Open the drain valve on the accumulator charging valve so that the accumulators are drained and the valve changes to charging. Close the valve and check the maximum pressure again.

10 Repeat steps 8 - 10 until the accumulator pressure corresponds with the information on the pressure plate.

11 Depressurise the brake and hydraulic systems, see section *B Safety*.

12 Remove the pressure gauge and fit the protective cap on the measuring outlet.

13 Close the drain valve on the accumulator charging valve.

14 Fit the cover plates over the engine bay.

Accumulator charging valve, replacement

WARNING

Hot, pressurised oil.

Personal injury, burn injury, rash or irritation

Always depressurise the hydraulic systems before starting work on them. Avoid skin contact with the oil, use protective gloves.

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

2 Depressurise the brake and hydraulic systems, see section *B Safety*.

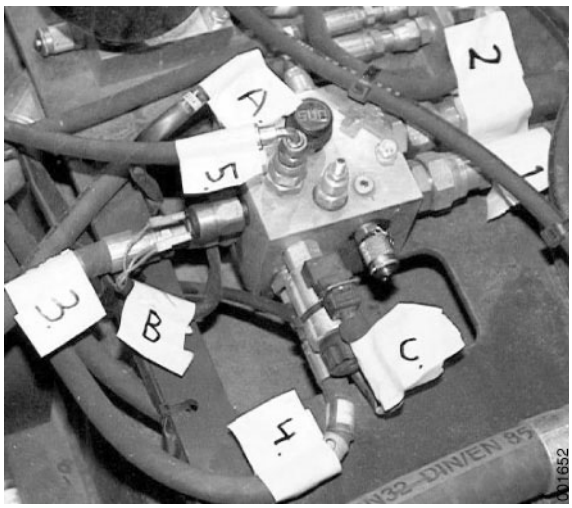
3 Position a collection container under the lift beam to collect any spilled oil.

4 Mark up hydraulic hoses and electric cables.

5 Detach the wiring from the accumulator charging valve.

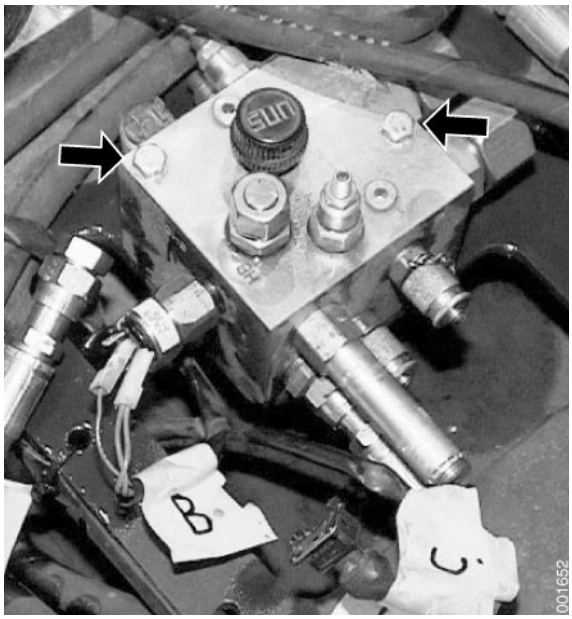
6 Detach and plug all hydraulic hoses from the accumulator charging valve.

Remove the parking brake valve (C) for easier access.



NOTE

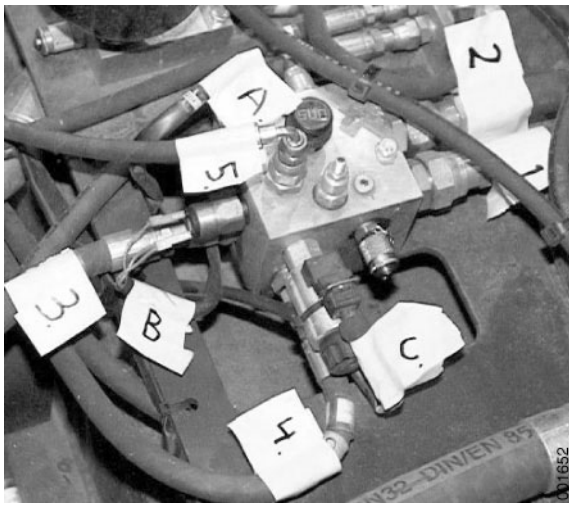
Plug all connections immediately to protect the brake system from impurities.



7 Remove the accumulator charging valve.

8 Transfer the connection adapters and sensors to the new accumulator charging valve.

9 Fit the new valve.



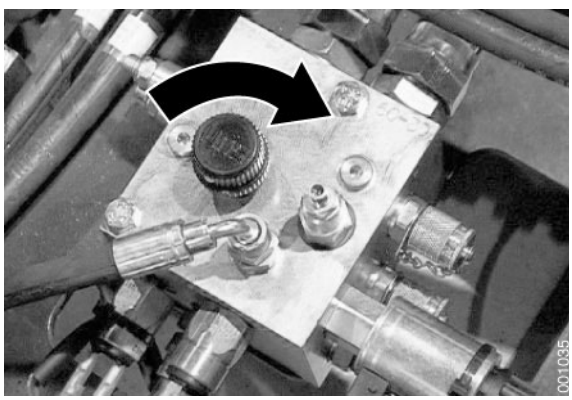
10 Connect the hoses to the accumulator charging valve in accordance with the marking.

NOTE

Check that the O-rings are intact and are fitted correctly.

11 Fit the parking brake valve and make-contact parking brake.

12 Connect the wiring to the accumulator charging valve.



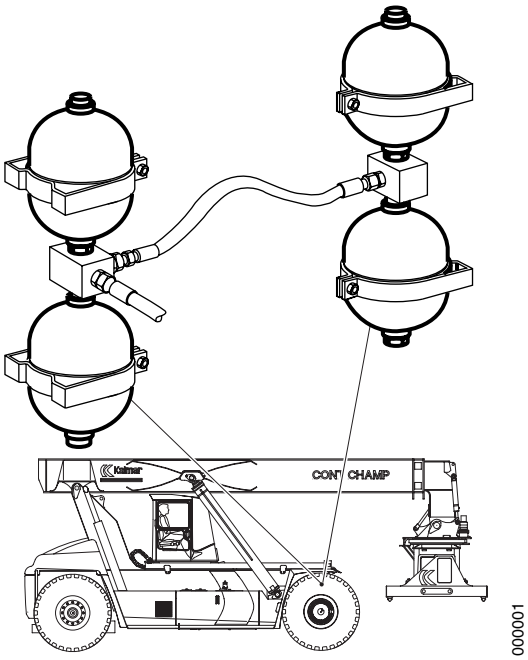
13 Close the drain valve on the accumulator charging valve.

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

Check that the hydraulic connections are sealed tightly.

15 Check the charging and changing function, see *Accumulator charging, checking and adjustment page 12*.

16 Remove the collection container, treat the waste oil as environmentally hazardous waste.



4.3.4 Accumulator

Accumulator, description

The accumulators store pressure so that there is a pressure reserve in the event of the engine stopping or faults in the brake system. The brake system has four accumulators connected in parallel which are located furthest forward in the engine bay, above the drive axle.

The accumulators are the diaphragm type. Each accumulator is divided into two spaces by a membrane. One side of the diaphragm is pressurised with nitrogen gas. The other side is pressurised by hydraulic oil which compacts the nitrogen gas.

The accumulator has a test outlet for checking gas pressure on the side opposite to the pressure connection.

Accumulator, checking

⚠ WARNING

Hot, pressurised oil.

Personal injury, burn injury, rash or irritation

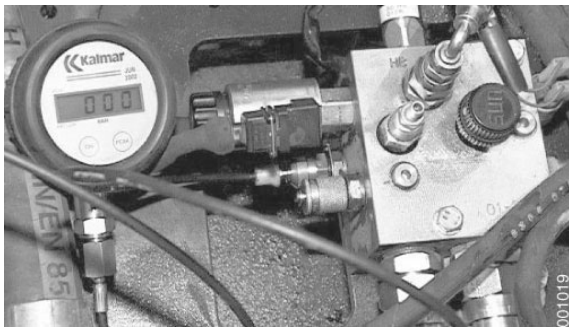
Always depressurise the hydraulic systems before starting work on them. Avoid skin contact with the oil, use protective gloves.

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

2 Depressurise the brake and hydraulic systems, see section *B Safety*.

3 Position a collection container under the accumulators to collect any spilled oil.

4 Detach three of the accumulators from the distribution block. Plug the connections on the distribution block with plugs which tolerate high pressures. Plug the connections on the accumulators to protect from impurities.



5 Connect a pressure gauge (0–25 MPa) to the measuring outlet for accumulator pressure on the accumulator charging valve.

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

7 Close the drain valve on the accumulator charging valve and charge the accumulator until the accumulator charging valve changes to cooling.

8 Check that the plugs remain sealed.

9 Turn off the engine.

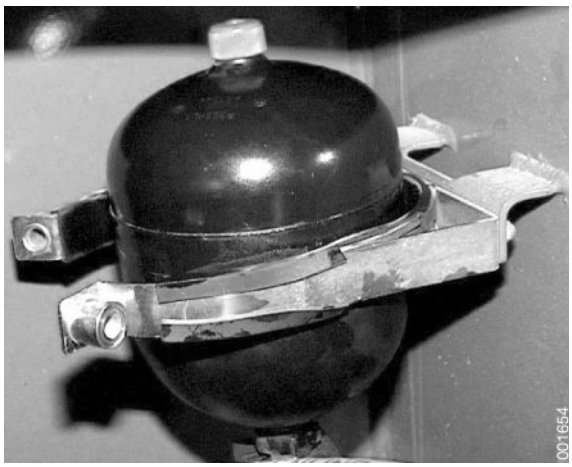
10 Lower the pressure by means of braking carefully several times while checking the pressure on the pressure gauge.

When the pressure reaches **approx. 10 MPa** the pressure must decrease immediately to 0 MPa.

If the pressure decreases immediately the engine is turned off then the accumulator has no precharge pressure. This indicates inner leakage and the accumulator must be replaced.

If the pressure can be reduced slowly to a pressure below **10 MPa** then the precharge pressure is too low and the accumulator must be replaced or given to authorised personnel for maintenance.

11 Depressurise the brake and hydraulic systems, see section *B Safety*.



12 Mark up and detach the tested accumulator. Plug the connections. Connect one of the other accumulators to the distribution block.

13 Repeat steps 10 - 17 until all accumulators have been checked.

14 Depressurise the brake and hydraulic systems, see section *B Safety*.

15 Connect all accumulators to the distribution blocks. If necessary, replace or fill faulty accumulators.

NOTE

Check that the seals are intact and are fitted correctly.

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

17 Close the drain valve on the accumulator charging valve so that the accumulators are charged.

18 Check that the accumulators' connections are sealed tightly.

19 When the accumulators are fully charged. Turn off the engine and turn the start key to position I.

20 Check that at least **8** brake applications (pedal depressions) can be performed before the pressure drops to **10 MPa**.

At **11.5 MPa** the warning lamp for low brake pressure must come on.

21 Remove the collection container, treat the waste oil as environmentally hazardous waste.

Accumulator, replacement

WARNING

Hot, pressurised oil.

Personal injury, burn injury, rash or irritation

Always depressurise the hydraulic systems before starting work on them. Avoid skin contact with the oil, use protective gloves.

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

2 Clean the accumulators and their surrounding area.

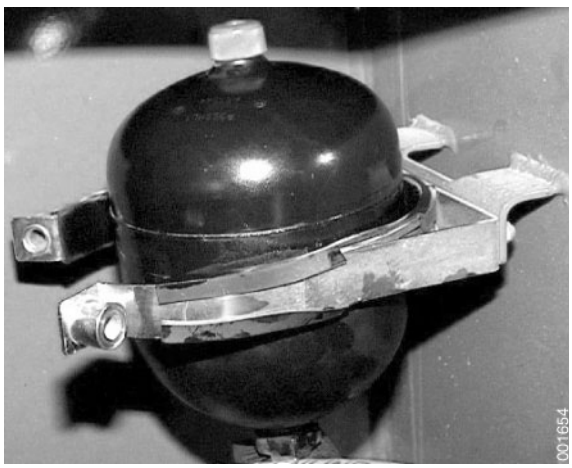
3 Turn off the engine and the main electrical power.

4 Depressurise the brake and hydraulic systems, see section *B Safety*.

5 Position a collection container under the accumulators to collect any spilled oil.

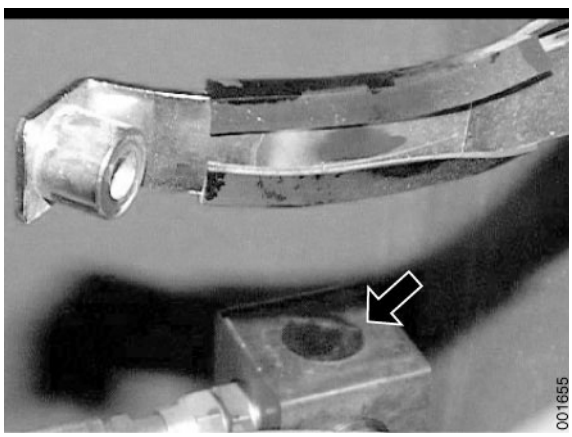
6 Detach the accumulator's clamp and remove the bolt.

7 Detach the accumulator from the distribution block.

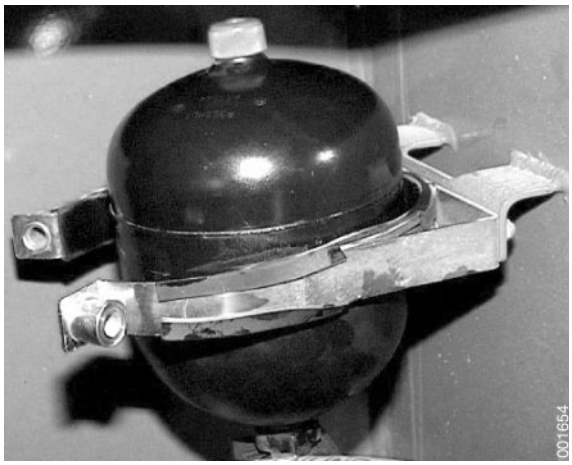


NOTE

Hold the block firmly so that the other accumulator does not work loose.



8 Bend the clamp away and remove the accumulator.

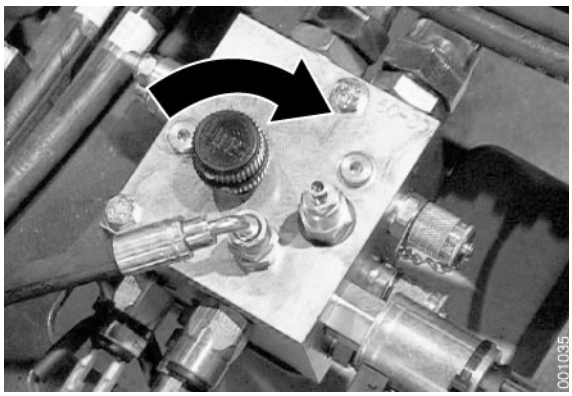


9 Fit the new accumulator.

NOTE

Check that the seal is intact and is fitted correctly.

10 Secure the accumulator's clamp and tighten the bolt.



11 Close the drain valve on the accumulator charging valve.

12 Turn on the main electric power and start the engine

13 Check that the accumulator's connection is sealed tightly.

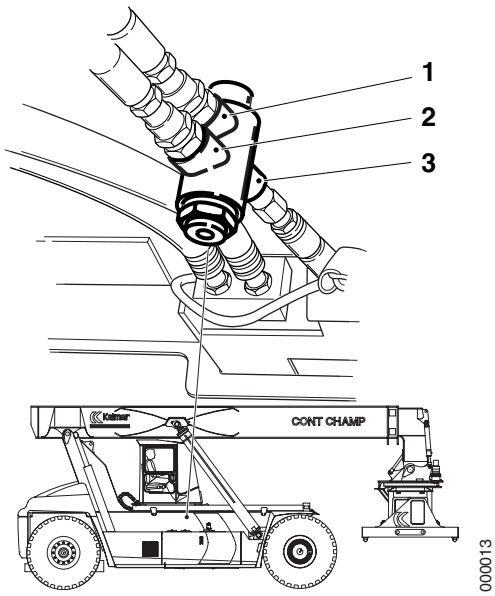
14 Remove the collection container, treat the waste oil as environmentally hazardous waste.

4.3.5 Brake valve

Brake valve, description

The brake valve, which is located on the underside of the cab underneath the brake pedal, controls the hydraulic pressure to the brakes. A lever transfers the force from the pedal to the valve.

The brake valve is a mechanically activated proportional valve, this means that the pressure in the brake valve increases proportionally to the brake pressure. This provides optimum pedal responsiveness and increased safety as the operator senses if no brake pressure is being built up (no resistance in the pedal).



1. Inlet from accumulators [P]
2. Return connection [T]
3. Outlet to brake cylinders [B]

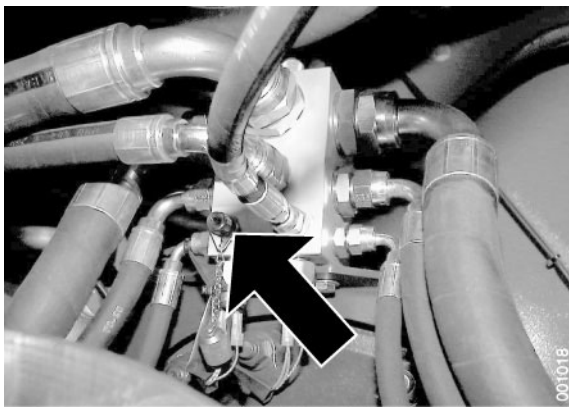
Brake valve, checking

WARNING

Hot, pressurised oil.

Personal injury, burn injury, rash or irritation

Always depressurise the hydraulic systems before starting work on them. Avoid skin contact with the oil, use protective gloves.



1 Operate and warm up the machine so that the brake oil reaches operating temperature, at least 50 °C.

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

3 Depressurise the brake and hydraulic systems, see section *B Safety*.

4 Connect a pressure gauge (0-25 MPa) to the measuring outlet for brake pressure on the distribution block on the front axle.

5 Close the drain valve on the accumulator charging valve.

6 Start the machine and run it at idling speed until the accumulators are charged and the accumulator charging valve changes to cooling.

7 Press the pedal to the bottom and read off the pressure. Compare it with the pressure plate on the left-hand frame beam.

8 Turn off the engine.

9 Depress the pedal fully and keep it pressed down, check the pressure.

The brake pressure must correspond with the value specified on the pressure plate and must not decrease from this value for 15 seconds.

10 Release the pedal, the brake pressure must decrease to 0 MPa immediately. Otherwise the brake valve is not sealed and can cause the brakes to remain applied and then overheat during operation.

Replace the brake valve if it is not sealed.

11 Depressurise the brake and hydraulic systems, see section *B Safety*.

12 Remove the pressure gauge and fit the protective cap on the measuring outlet.

13 Close the drain valve on the accumulator charging valve.

Brake valve, replacement

⚠ WARNING

Hot, pressurised oil.

Personal injury, burn injury, rash or irritation.

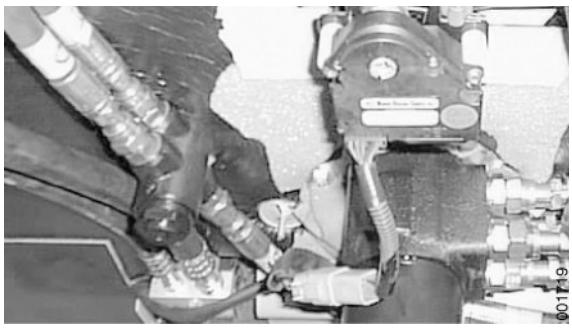
Always depressurise the hydraulic systems before starting work on them. Avoid skin contact with the oil, use protective gloves.

1 Slide the cab forward slightly so that the brake valve is accessible underneath the cab.

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

3 Depressurise the brake and hydraulic systems, see section *B Safety*.

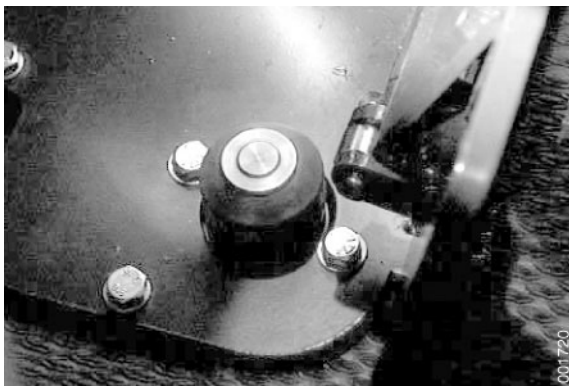
4 Mark up and detach the hydraulic hoses from the brake valve.



NOTE

Plug the connections immediately to protect the brake system from impurities.

5 Secure the brake valve under the cab.



6 Remove the brake valve attaching bolt.

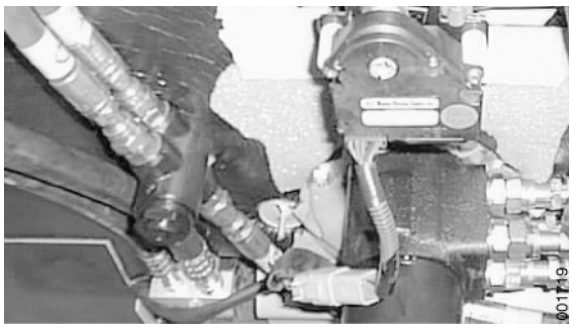
7 Remove the brake valve.

8 Transfer the connection adapters to the new brake valve.

9 Fit the new brake valve.

NOTE

Remember the spacer ring.

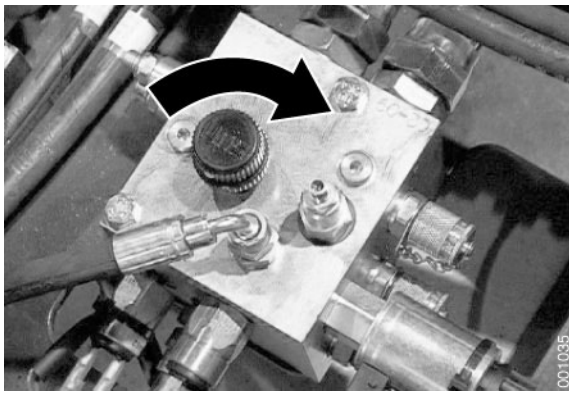


10 Connect the hydraulic hoses to the brake valve in accordance with the marking.

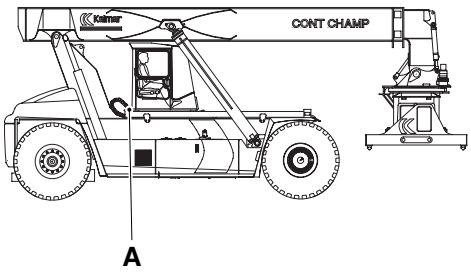
NOTE

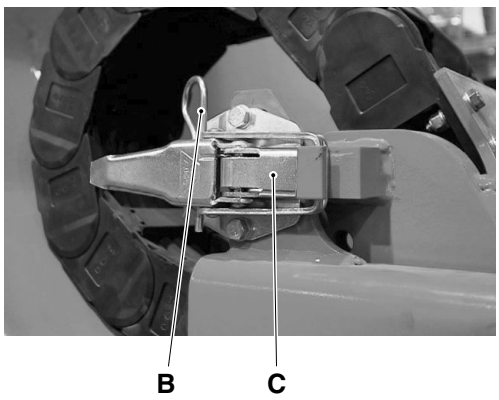
Check that the O-rings are intact and are fitted correctly.

11 Grease and adjust the brake pedal, see *Maintenance manual DRF 400–450,* section *4 Brakes,* group *4.1.1 Brake pedal*.



12 Close the drain valve on the accumulator charging valve.





A. Lock handle location
B. Lock pin
C. Lock handle for securing cab

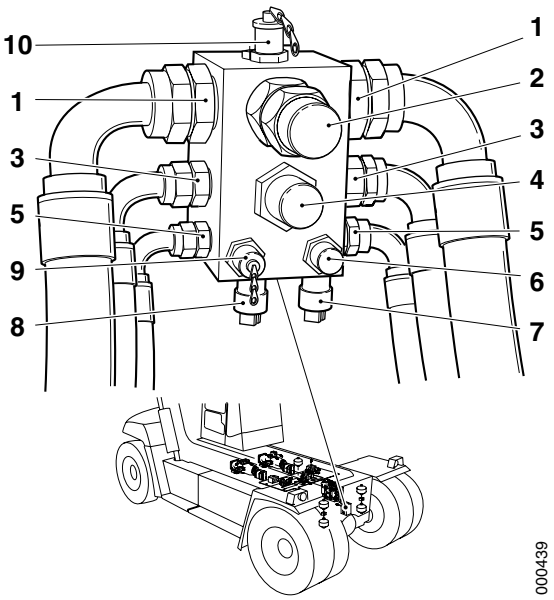
13 On machines with manual sliding cab. Secure the cab in its rear-most position with the cab locks.

14 Turn on the main electric power and start the engine. Run the engine at idling speed.

15 Test the brakes a couple of times.

16 Check that the brake valve's connections are sealed tightly.

17 Bleed the wheel brakes' brake cylinders, see *Wheel brakes, bleeding page 28*.



1. Connection brake cooling, return from wheel brake
2. Connection brake cooling, return to cooler
3. Connection brake cooling, to wheel brake
4. Connection brake cooling, from accumulator charging valve
5. Connection brake cylinder, to wheel brake
6. Connection brake pressure, from brake valve
7. Make-contact, declutch (S220)
8. Make-contact, brake lights (S216)
9. Measuring outlet, brake pressure
10. Measuring outlet, back pressure brake cooling

4.3.6 Drive axle block

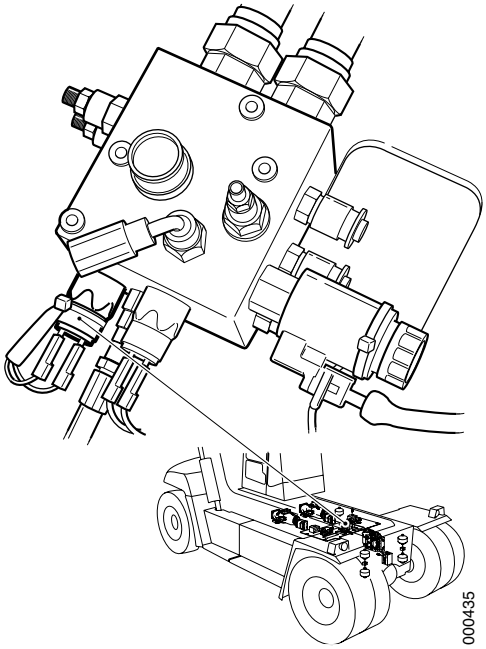
Drive axle block, description

The drive axle block distributes the oil flow and brake pressure to the right and left-hand wheel brakes. The drive axle block is located on a bracket above the drive axle differential.

The drive axle block has a measuring outlet for brake pressure and for measuring back pressure in the disc brake's cooling circuit.

The drive axle block has a bypass valve which guides oil directly from the cooling circuit's input to the cooling circuit's return if the resistance in the axle becomes too great. This protects the wheel brake seals, e.g. when the oil is cold.

There are two contacts in the drive axle block, make-contact brake lights (216), see *Make-contact brake lights, description page 25* and make-contact declutch, see section *2 Transmission,* group *2.8.2 Breaking contact declutch*.



4.3.7 Making contact brake pressure

Make-contact brake pressure, description

Make-contact brake pressure (S204) senses the pressure in the accumulators. The make-contact is located on the accumulator charging valve on the lift beam in front of the gearbox in the engine bay.

When the pressure in the feed circuit is high enough to ensure braking of the machine then the sensor closes an electric circuit. This is used to warn of pressure drops in the brake system. The sensor's final pressure is selected so that there is pressure for a further 8 brake applications without feed from the pump after the lamp comes on.

Make-contact brake pressure (S204) is supplied with voltage by Control unit frame front (D797-F). When the pressure increases above the final pressure, a voltage signal is sent to Control unit frame front (D797-F).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.4 HYD, menu 4*.

Make-contact brake pressure, adjustment

WARNING

Hot, pressurised oil.

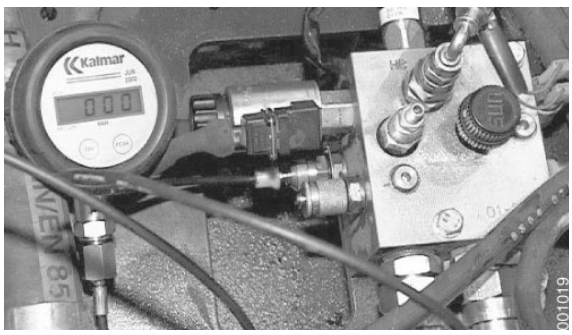
Personal injury, burn injury, rash or irritation.

Always depressurise the hydraulic systems before starting work on them. Avoid skin contact with the oil, use protective gloves.

1 Operate and warm up the machine until the oil reaches operating temperature, at least 50 °C.

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

3 Depressurise the brake and hydraulic systems, see section *B Safety*.



4 Connect a pressure gauge (0-25 MPa) to the measuring outlet for accumulator pressure on the accumulator charging valve.

5 Close the drain valve on the accumulator charging valve.

6 Start the engine and fully charge the accumulators (the accumulator charging valve changes to cooling).

7 Turn off the engine and turn the start key to position I.

8 Brake several times, stop when the warning lamp for low brake pressure comes on.

9 Read off the accumulator pressure. The pressure must be **approx. 11.5 MPa**.

10 If necessary, adjust the warning level by turning the adjusting screw in the rear edge of the sensor, between the contact pins.

NOTE

The setting is very sensitive, turn max. 1/4 turn at a time.

11 Repeat steps 6-10 until the warning lamp comes on at 11.5 MPa.

12 Seal the adjusting screw with locking fluid.

13 Depressurise the brake and hydraulic systems, see section *B Safety*.

14 Remove the pressure gauge and fit the protective cap on the measuring outlet.

15 Close the drain valve on the accumulator charging valve.

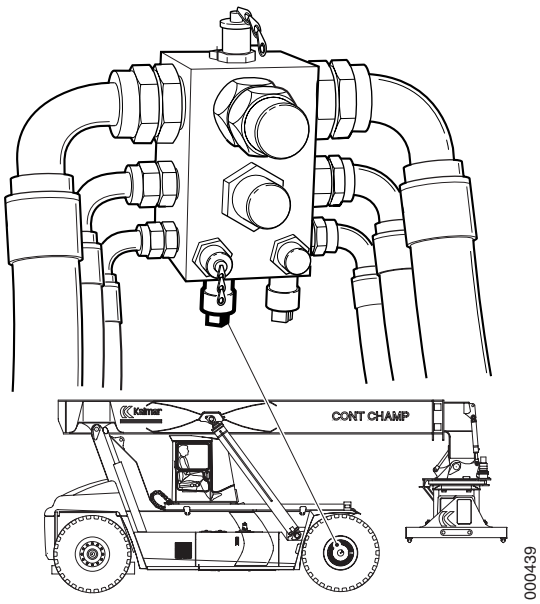
4.3.8 Making contact brake light

Make-contact brake lights, description

Make-contact brake lights controls brake light activation when the machine brakes. The contact is located on the drive axle block which is located on a bracket above the drive axle differential.

Make-contact brake lights (S216) is supplied with and sends a voltage signal to Control unit frame front (D797-F). When the pressure increases above the final pressure, a voltage signal is sent to Control unit frame front (D797-F).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.4 HYD, menu 4*.



Make-contact, brake lights, checking

WARNING

Hot, pressurised oil.

Personal injury, burn injury, rash or irritation

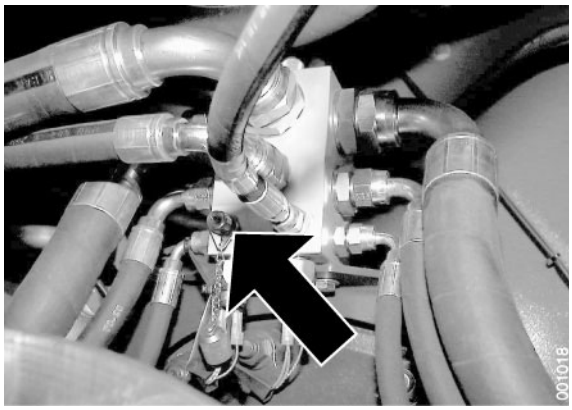
Always depressurise the hydraulic systems before starting work on them. Avoid skin contact with the oil, use protective gloves.

1 Operate and warm up the machine until the brake oil reaches operating temperature, at least 50 °C.

2 Turn off the engine and turn the start key to position I.

3 Brake and check that the brake light comes on.

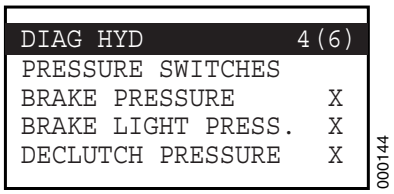
4 Depressurise the brake and hydraulic systems, see section *B Safety*.



5 Connect a pressure gauge (0-25 MPa) to the measuring outlet for brake pressure on the distribution block.

6 Close the drain valve on the accumulator charging valve.

7 Start the engine.



8 Use the display, go to the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.4 HYD, menu 4*.

BRAKE LIGHT PRESS. indicates status for the brake light contact. 1 = Activated contact (brakes applied).

9 Press the brake pedal slowly until the brake light comes on or the input signal status is changed. Keep the pedal in this position and check the pressure on the pressure gauge.

The status can be changed and the brake light should come on when the pressure is **approx. 0.2 MPa**.

10 Turn off the engine.

11 Depressurise the brake and hydraulic systems, see section *B Safety*.

12 Remove the pressure gauge and fit the protective cap on the measuring outlet.

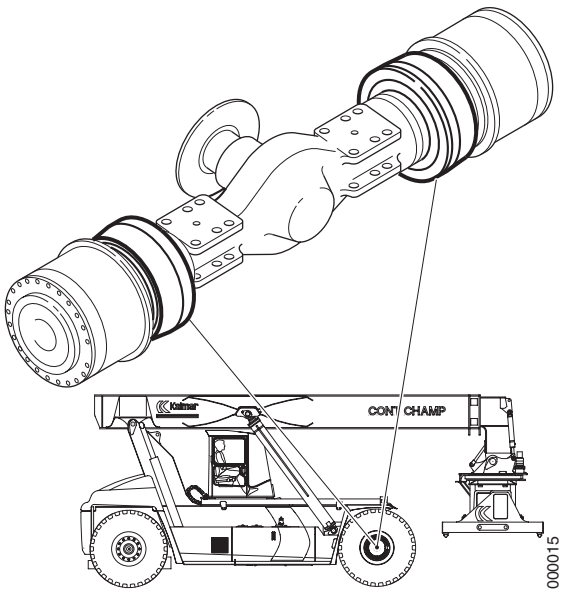
13 Close the drain valve on the accumulator charging valve.

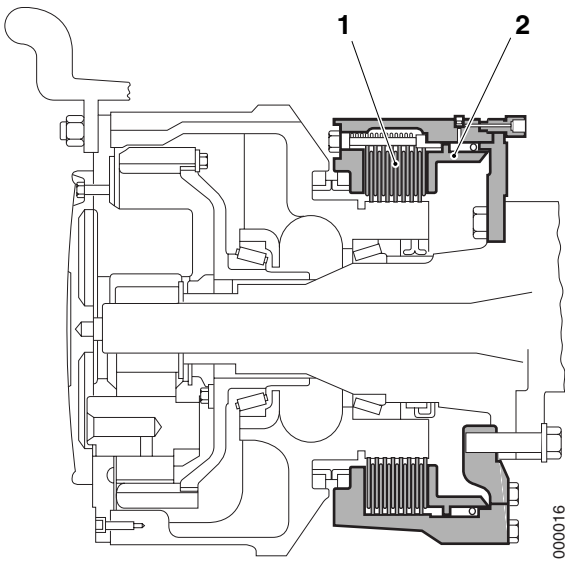
4.3.9 Wheel brakes

Wheel brake, description

The wheel brakes brake the machine during operation and are located on the drive axle between the drive axle housing and hub reduction.

The wheel brake uses so-called wet disc brakes WDB (Wet Disc Brakes). Wet disc brakes require minimal maintenance and have long life due to effective cooling. Maintenance requirements are minimised since oil circulates in the brake system and prevents corrosion.





Wheel hub and brake, cross section
1. Disc package
2. Brake cylinder

The wheel brakes have two main sections, disc package and brake cylinder. The disc package performs the braking. The brake cylinder presses the discs in the disc package together at braking.

Wheel brakes, bleeding

WARNING

Warm oil.

Burns, rashes and irritation!

Avoid skin contact with brake oil, use protective gloves.

IMPORTANT

Both brake cylinder and disc brake must be bled after work where the brake system is opened or after work on the wheel brake.

Brake cylinder

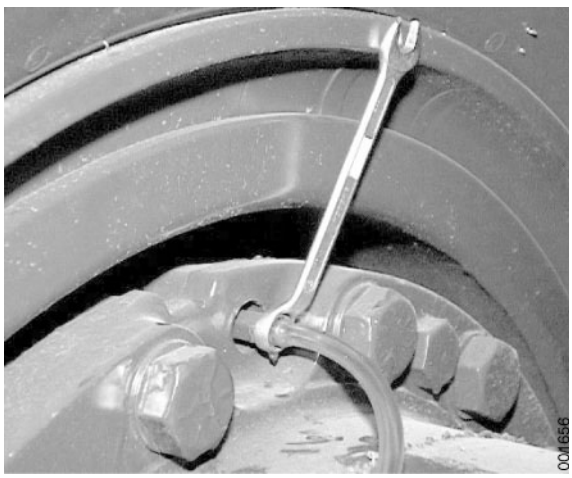
1 Machine in service position, see section *B Safety*.

2 Place a ring spanner on the bleed nipple and connect a transparent hose to the bleed nipple.

Direct the other end of the hose down into a collection container.

3 Start the machine and press down on the brake pedal, keep the pedal pressed down.

4 Open the bleed nipple and allow oil to run out of it until the oil is free of air bubbles.



Bleed nipple, brake cylinder, on top of the drive axle at the wheel hub's inner short side (left-hand side).

NOTE

The hydraulic hose between the brake pedal and brake is approx. 7 metres long. So allow at least two litres of oil to pass through the bleed nipple when bleeding to ensure that no air pockets remain in the system.

5 Close the bleed nipple.

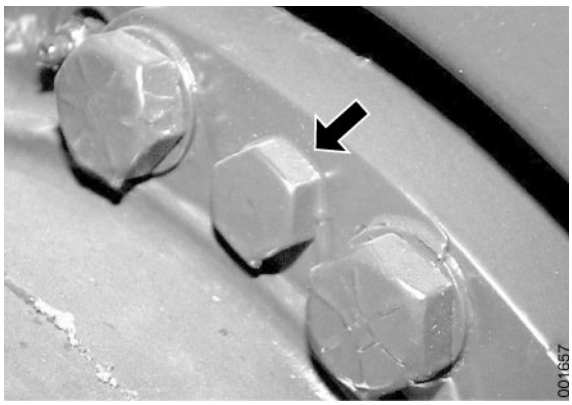
6 Move the spanner and hose and repeat steps 1–4 on the other side.

Disc brake

NOTE

Bleeding the disc brake is vital for correct cooling of the discs.

1 Position a collection container under the drive axle on the inside of the wheel. Position a plate or similar at the bleed nipple to direct the oil down into the collection container.



Bleed nipple, disc brake, on top of the drive axle at the wheel hub's inner short side (left-hand side).

2 Start the engine and run the engine at idling speed. Wait until the brake accumulators are fully charged and the accumulator charging valve has changed to brake cooling.

3 Remove the bleeder screw for the disc brake and allow oil to flow out from the hole until the oil is free of air bubbles. Fit the bleeder screw.

4 Move the container and plate over to the other wheel. Repeat steps 1-3 on the other wheel.

5 Remove the plate and the container, treat the waste oil as environmentally hazardous waste.

Wheel brake, replacement

See *supplier documentation drive axle*.

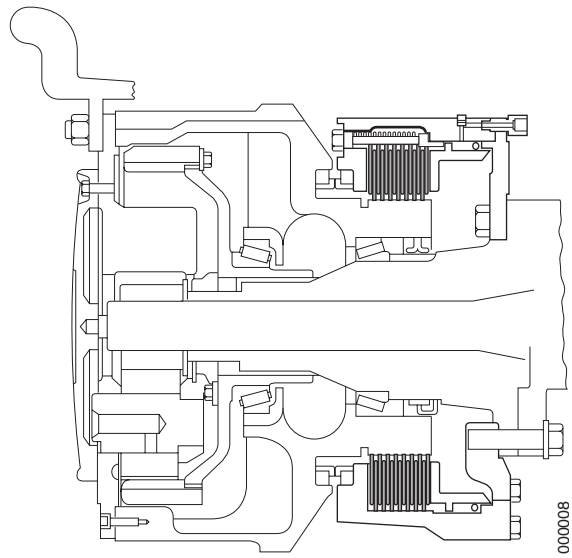
4.3.9.1 Disc pack

Disc pack, description

The disc package consists of several thin coated metal discs, alternately secured to the wheel brake housing and alternately to the hub reduction housing. The discs are fitted on splines which means that they can move laterally.

Oil circulates between the discs cooling them, thus the name wet disc brake. The oil is the same as in other parts of the brake system.

Braking is effected by the brake cylinder pressing together the discs. This creates friction between the discs that are fixed to the axle and those fixed to the hub reduction.



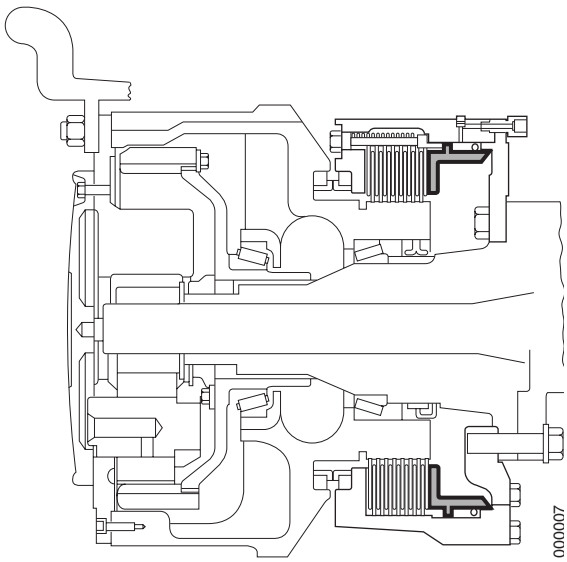
Disc package

4.3.9.2 Brake cylinder

Brake cylinder, description

The brake cylinder is integrated into the wheel brake and consists of a metal ring (cylinder) with two seal rings. The seal rings are supported laterally by a bevel on the cylinder and a bevel on the wheel brake housing.

The space between the seal rings is pressurised by means of a duct in the wheel brake housing. The pressure makes the metal ring move laterally and forces the disc package together.



Brake cylinder

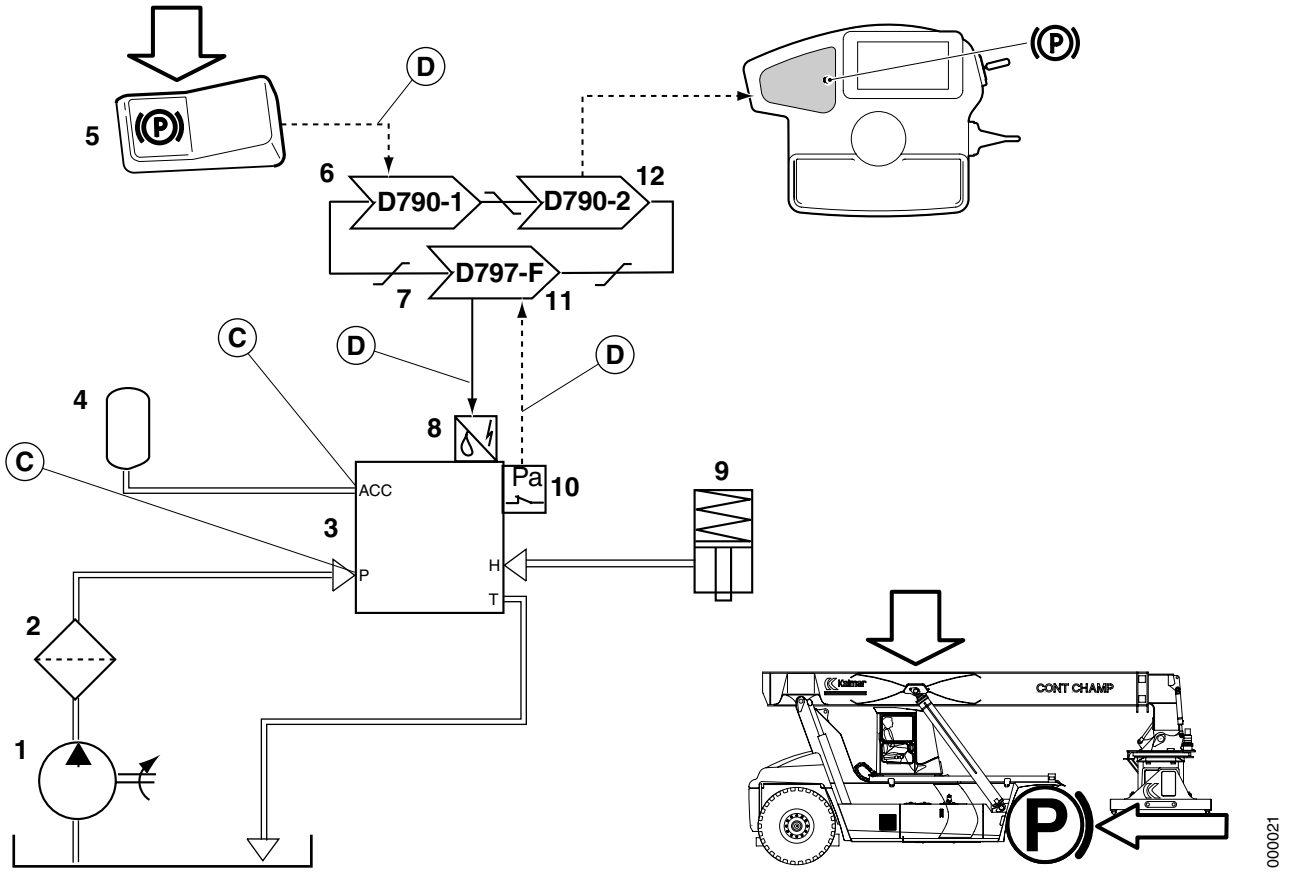
4.3.10 Pipes and hoses

Pipes and hoses, description

See section *10 Common hydraulics*, group *10.5.1 Pipes and hoses*.

4.5 Parking brake system

Parking brake system, function description



Pos	Explanation	Signal description	Reference
1	The brake oil pump pumps oil from the brake tank.	P = 19±0.5 MPa	*Brake oil tank, description page 39* *Brake oil pump, description page 9*
2	The brake oil filter cleans the oil from dirt.	-	*Brake oil filter, description page 44*
3	The accumulator charging valve directs oil to charging of accumulators or through the brake system's cooling circuit.		*Accumulator charging valve, description page 12*
4	The accumulators store oil pressure.	See pressure plate on left frame beam.	*Accumulator, description page 16*

Pos	Explanation	Signal description	Reference
5	Switch parking brake (S107) activates parking brake. The switch uses two signals one for applied and one for released parking brake. Both signals must be correct to enable release of the parking brake.	Switch activated: Conn 1, U = 22–28 V Conn 7, U = 0 V Switch in resting position: Conn 1, U = 0 V Conn 7, U = 22–28 V	*Switch parking brake, description page 5* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.5 HYD, menu 5*
6	Control unit, cab (D790-1) sends release or apply parking brake on the CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
7	Control unit, frame front (D797-F) activates solenoid valve parking brake (Y642).	U = 24 V	*Solenoid valve parking brake, description page 33* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.5 HYD, menu 5*
8	Solenoid valve parking brake (Y642) affects the valve spool which drains pressure in the parking brake caliper to tank.	Pump pressure.	*Solenoid valve parking brake, description page 33* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.5 HYD, menu 5*
9	The brake caliper is drained of pressure and the spring applies the parking brake.	0 MPa	*Parking brake unit, description page 34*
10	Breaking contact parking brake (S200) closes the circuit when the pressure drops.	Applied parking brake: Conn 1: U = 24 V Conn 2: U = 0 V Released parking brake: Conn 1: U = 24 V Conn 2: U = 24 V	*Make-contact parking brake, description page 37* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.5 HYD, menu 5*
11	Control unit, frame front (D797-F) sends Parking brake applied on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
12	Control unit KIT (D790-2) activates indicator light parking brake (508).	Controlled by control system, error shown with error code.	*Indicator light parking brake, description page 5*

Hydraulic diagram A40740.0100

4.5.1 Brake oil pump

Brake oil pump, general

See group *4.3.1 Brake oil pump*.

4.5.2 Brake oil filter

Brake oil filter, general

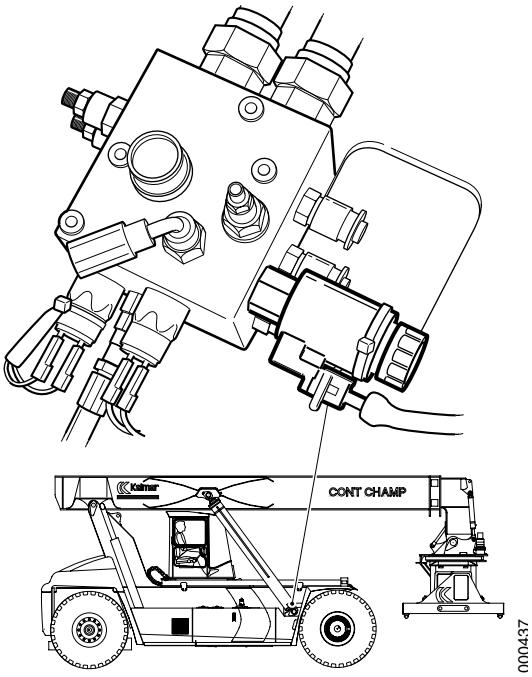
See *Brake oil filter, description page 44* and *Maintenance manual DRF 400–450, section 4 Brakes, group 4.8.12 Brake oil filter*.

Brake oil filter, replacement

See *Maintenance manual DRF 400–450*.

4.5.3 Solenoid valve parking brake

Solenoid valve parking brake, description



Solenoid valve, parking brake (Y642) activates the parking brake. The solenoid valve is located on the accumulator charging valve which is fitted on the lift beam in front of the gearbox in the engine bay, see *Accumulator charging valve, description page 12*.

The solenoid valve opens a connection between the accumulators and the parking brake caliper at activation. This means that the parking brake caliper is pressurised and the parking brake is disengaged. When the voltage feed to the solenoid valve is cut the connection between accumulators and parking brake caliper is terminated. Instead, a connection between the parking brake caliper and tank is opened and the parking brake applied. This means that the parking brake is applied if the machine loses electrical power or if the brake system becomes depressurised.

The solenoid valve is supplied with voltage by Control frame front (D797-F) at activation.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.5 HYD, menu 5*.

Solenoid valve parking brake, checking

⚠ DANGER

The machine may start to roll.

Risk of crushing.

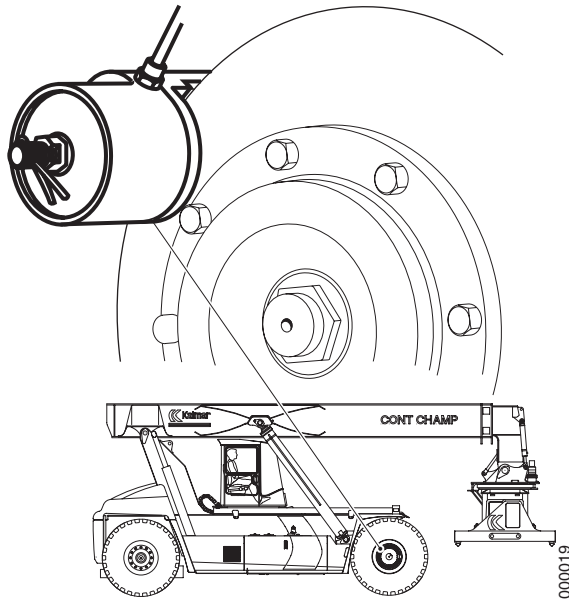
Block the wheels so that the machine cannot start to roll when the parking brake is released.

1 Start the engine and run the engine at idling speed until the warning lamp for brake pressure goes out and the accumulator charging valve changes to cooling.
2 Turn off the engine and turn the start key to position I.
3 Release the parking brake with the parking brake switch and check that the parking brake's brake caliper is released. The brake caliper should be able to move.

4 Activate the parking brake with the parking brake switch and check that the parking brake's brake caliper is applied.

4.5.4 Parking brake unit

Parking brake unit, description



The parking brake unit keeps the machine stationary when parking. The parking brake unit is located on the drive axle input shaft between the universal drive shaft and drive axle.

The parking brake acts on the universal drive shaft via a disc mounted on the drive axle input shaft and a brake caliper with dry brake pads mounted in a bracket on the drive axle.

NOTE

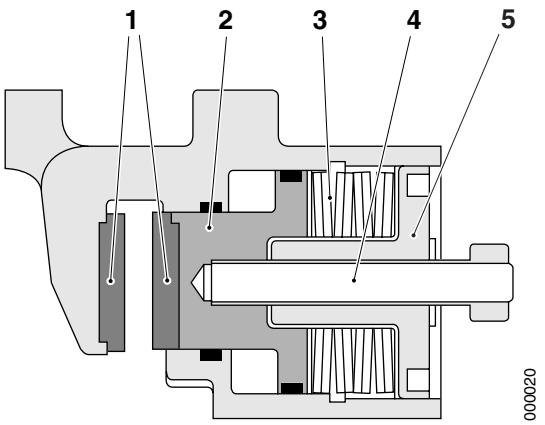
If the hydraulic pressure in the supply circuit drops, a warning is activated before the pressure drops so low that the parking brake is applied. If the parking brake is applied while the machine is on the move, the brake disc and brake pads must be changed.

Parking brake unit, checking and adjustment

See *Maintenance manual DRF 400–450*.

4.5.4.1 Parking brake calliper

Brake caliper, description



1. Brake pads
2. Release cylinder
3. Application spring
4. Release screw
5. Adjusting washer

The brake caliper has a spring section and a hydraulic section. The spring section applies the brake, the hydraulic section is used to release the brake. This means that the parking brake is applied if the brake system loses pressure. Which in turn means that the machine is braked if a serious fault arises.

4.5.4.2 Parking brake pads

Brake pads, description

The brake pad consists of a metal disc with friction material (coating).

Brake pads, replacement

> **DANGER**
>
> **The machine may start to roll.**
>
> **Risk of crushing.**
>
> **Block the wheels so that the machine cannot start to roll when the parking brake is released.**

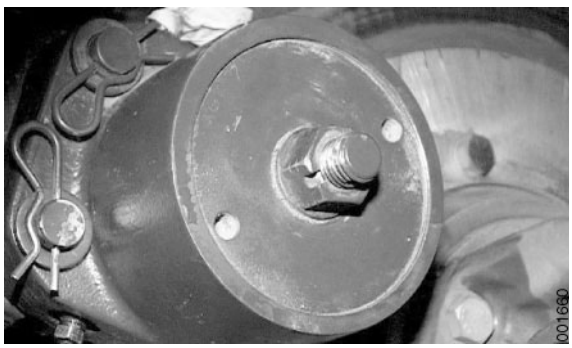
> **WARNING**
>
> **Hot, pressurised oil.**
>
> **Personal injury, burn injury, rash or irritation**
>
> **Always depressurise the hydraulic systems before starting work on them. Avoid skin contact with the oil, use protective gloves.**

1 Start the engine and run up hydraulic pressure until the accumulators are fully charged and the accumulator charging valve switches to cooling.

2 Turn off the engine and turn the start key to position I.

3 Release the parking brake.

4 Remove the pin and screw in the release nut on the parking brake caliper.



NOTE

The nut has counter-clockwise (left) threads.

5 Apply the parking brake and turn the start key to position 0.

6 Depressurise the brake and hydraulic systems, see section *B Safety*.

7 Remove the brake caliper from the bracket.

Pull out the pins. Remove the washer and O-ring. Remove the pins and lift away the parking brake caliper.

NOTE

Note down the order of washers and O-rings.

8 Suspend the brake caliper so that the hose is not damaged

9 Remove the old brake pads from the brake caliper.

10 Clean the brake pads' contact surfaces in the parking brake caliper.

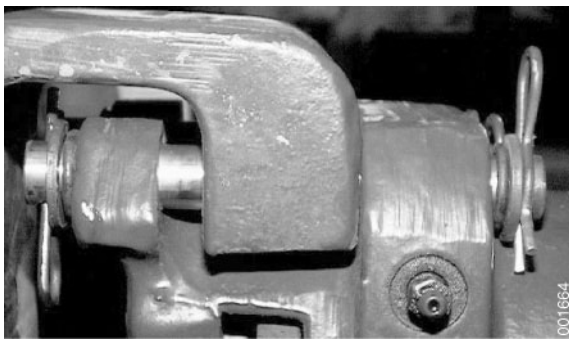
11 Fit the new pads in the parking brake caliper.

NOTE

Check that the pads' guide pins enter the recesses on the parking brake caliper.

12 Clean the brake disc with methylated spirit.

13 Grease the parking brake caliper shafts with universal grease "EP2"



14 Fit the brake caliper onto the bracket.

Fit shafts, O-rings, washers and pins.

NOTE

The O-rings must be positioned inside the washers.

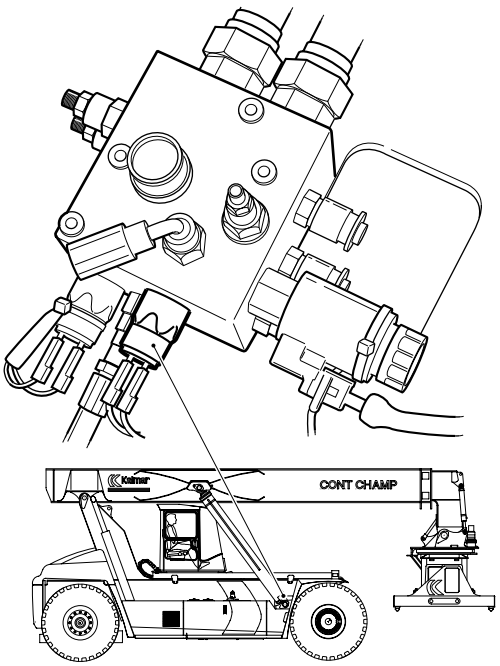
15 Close the drain valve on the accumulator charging valve.

16 Adjust the parking brake, see *Maintenance manual DRF 400–450,* section *4 Brakes,* group *4.5.4 Parking brake unit*.

4.5.4.3 Parking brake disc

Brake disc, description

The brake disc is fitted on the drive axle input shaft. The drive axle ratio reinforces braking force.



4.5.5 Making contact parking brake

Make-contact parking brake, description

Make-contact parking brake (S200) senses if the parking brake is applied or released. The make-contact is located on the accumulator charging valve which is fitted on the lift beam in front of the gearbox in the engine bay, see *Accumulator charging valve, description page 12*.

Make-contact parking brake (S200) senses the pressure in the parking brake circuit. When the pressure is so high that the parking brake is released the sensor closes an electric circuit. This is used to indicate that the parking brake is released.

Make-contact parking brake (S200) is supplied with voltage by and sends a voltage signal to Control unit frame front (D797-F). When the pressure increases above the opening pressure, voltage signal is sent to Control unit frame front (D797-F).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.5 HYD, menu 5*.

NOTE

Gears cannot be engaged when the parking brake is applied.

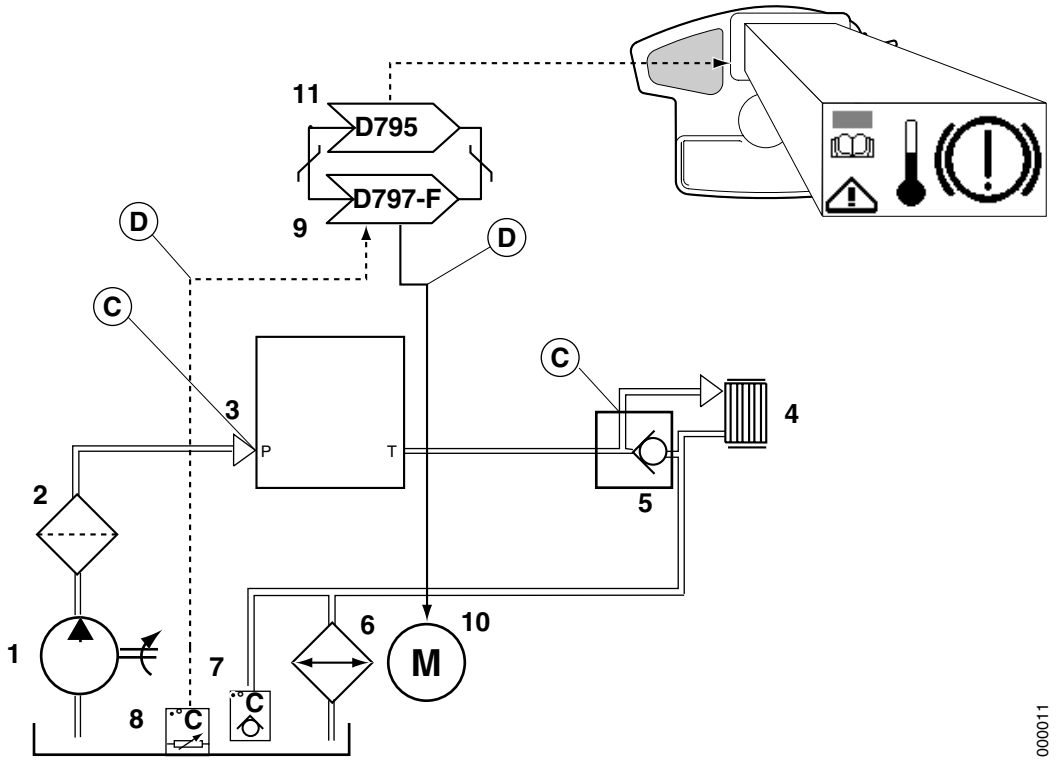
4.5.6 Pipes and hoses

Pipes and hoses, description

See section *10 Common hydraulics*, group *10.5.1 Pipes and hoses*.

4.8 Temperature control, filtration and brake fluid

Temperature control, cleaning and brake oil, function description



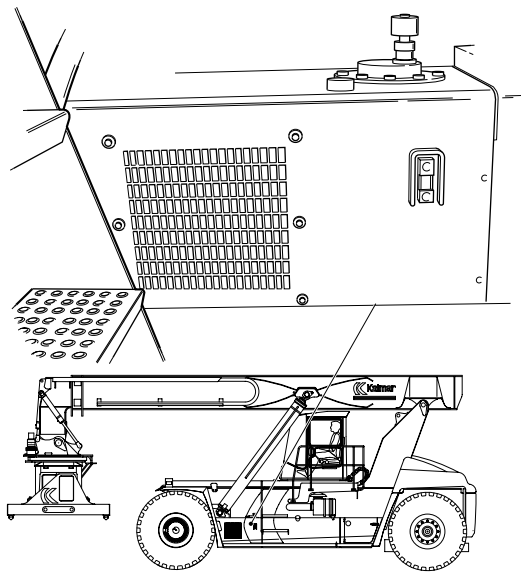
Pos	Explanation	Signal description	Reference
1	The brake oil pump pumps oil from the brake oil tank.	P = 19±0.5 MPa	*Brake oil pump, description page 9* *Brake oil tank, description page 39*
2	The brake oil filter cleans the oil.	-	*Brake oil filter, description page 44*
3	The accumulator charging valve directs oil to charging of accumulators or through the brake system's cooling circuit.	Max. 0.1 MPa	*Accumulator charging valve, description page 12*
4	The oil cools the wheel brake.	-	*Wheel brake, description page 27*
5	The by-pass valve in the distribution block leads oil past the drive axle if the back-pressure through the wheel brake is too high.	-	*Drive axle block, description page 23*
6	The cooler cools the oil.	-	*Oil cooler, description page 41*
7	The thermal by-pass valve leads oil past the cooler if the temperature is too low.	approx. 50 °C	*Thermal by-pass valve, description page 42*

Pos	Explanation	Signal description	Reference
8	The temperature sensor(B762), senses the oil temperature and sends voltage signal proportional to oil temperature to Control unit frame front (D797-F).	R = 25 kΩ at 20 °C	*Sensor brake oil temperature, description page 43* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.2 HYD, menu 2*
9	Control unit, frame front (D797-F) sends oil temperature information on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
10	When the oil is warm, Control unit frame front (D797-F) activates the cooling fan (M674) and increases the air flow through the cooler.	U = 24 V at activated fan Starts at 65 °C Stops at 55 °C	*Cooling fan, description page 41* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.2 HYD, menu 2*
11	If the temperature is high, Control unit KID (D795) activates warning for high brake oil temperature on the display.	Controlled by control system, error shown with error code.	*Event menu high oil temperature, description page 6*

Hydraulic diagram A40740.0100

4.8.1 Brake oil tank

Brake oil tank, description



The brake oil unit stores the oil in the brake system and is located on the left-hand side of the machine in front of the fuel tank.

The brake system is separated from other hydraulics and has its own tank and oil filter. This means that the oil in the brake system can be selected so that additives are avoided.

Filling hydraulic oil takes place directly to the tank. In the bottom of the tank is a drain plug. Hatches on the top of the tank facilitate internal cleaning.

The tank has a filtered bleed which allows volume change in the tank due to temperature variations and usage. See *Breather filter, description page 43*.

There is a level glass on the tank for checking the oil level.

4.8.2 Tank heater

Tank heater, safety

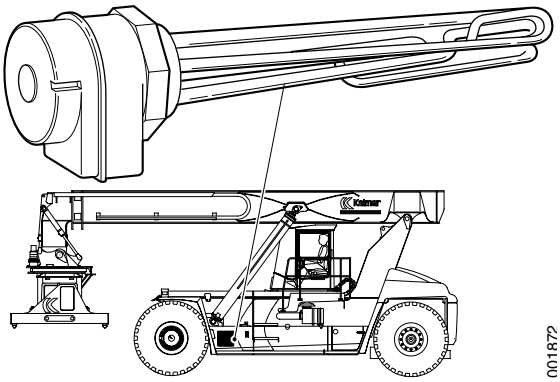
CAUTION

High voltage.

The tank heater is connected to high voltage (110 - 400 V).

Installation and reconnection of the tank heater must only be performed by personnel with high voltage authorisation.

Tank heater, description



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The brake oil tank can be equipped with tank heater. The tank heater heats the oil in the brake oil tank and is located in a flange on the tank's front short side. The tank heater is designed for use in cold climates.

The tank heater is driven by high voltage. The output of the heater is adapted by means of different connections and adaptations to different supply voltages, 110, 230 or 400 V AC. Higher voltage provides higher heat output.

The tank heater can be equipped with a programmable thermostat which maintains the temperature at an even level. The thermostat is fitted directly onto the heating element and can be adjusted with a knob on the junction box. Recommended temperature setting is 50–70 °C.

4.8.3 Brake oil pump

Brake oil pump, general

See group *4.3.1 Brake oil pump*.

4.8.4 Accumulator charging valve

Accumulator charging valve, general

See *4.3.3 Accumulator charging valve*.

4.8.5 Drive axle block

Drive axle block, description

See *Drive axle block, description page 23*.

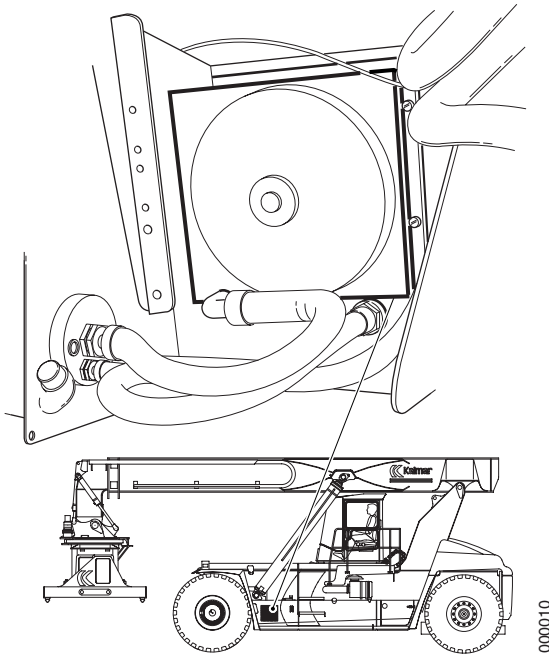
4.8.6 Wheel brake

Wheel brake, general

See *4.3.9 Wheel brake* and *supplier documentation drive axle*.

4.8.7 Oil cooler

Oil cooler, description



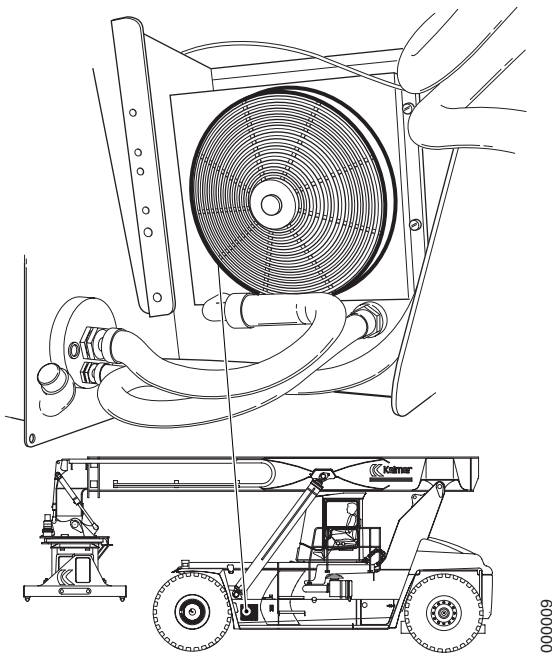
The oil cooler cools the oil in the brake system in order to maintain the performance of the brakes. The oil cooler is located inside the side cover on the left-hand side behind the front wing.

The brake system uses a through-flow type cooler with electrical cooling fan. The brake system oil is cooled when it passes the cooler. Openings in the frame cover allow air passage through the cooler.

A cooling fan is bolted directly onto the cooler, see *Cooling fan, description page 41*.

4.8.8 Cooling fan

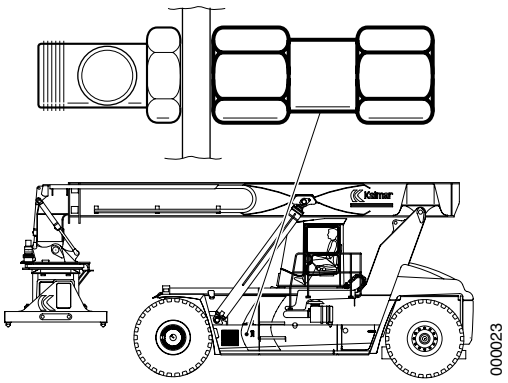
Cooling fan, description



The cooling fan (M674) is a suction-type electric fan. The fan draws air from the outside of the machine through the cooler and increases the air flow through the oil cooler as necessary. The cooling fan is fitted on the inside of the cooler inside the side cover behind the left-hand drive wheel.

The cooling fan (M674) is supplied with voltage by Control unit, frame front (D797-F). The cooling fan is activated when the oil temperature is 65 °C in the brake oil tank, the fan is switched off when the oil temperature is 55 °C.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.2 HYD, menu 2*.



4.8.9 Thermal by-pass valve

Thermal by-pass valve, description

When the oil is cold the thermo-bypass valve directs the oil past the cooler directly to the tank. The thermo-bypass valve is located on the brake oil tank by the hose connections to and from the cooler.

The thermo-bypass valve is a temperature controlled bi-metal valve. The valve is open at low temperatures and fully closed at 50 °C.

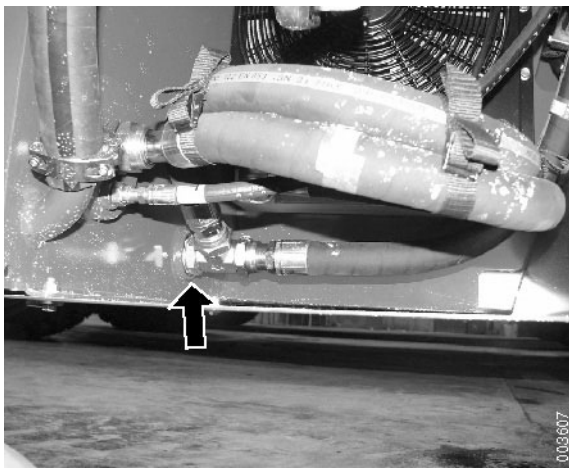
Thermo-bypass valve, replacement

WARNING

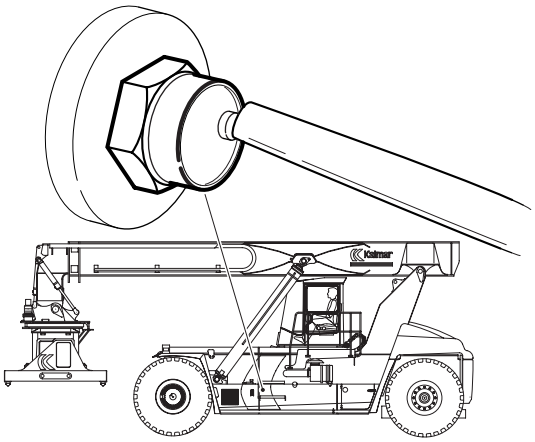
Hot, pressurised oil.

Personal injury, burn injury, rash or irritation

Always depressurise the hydraulic systems before starting work on them. Avoid skin contact with the oil, use protective gloves.



1 Machine in service position, see section *B Safety*.
2 Depressurise the brake and hydraulic systems, see section *B Safety*.
3 Drain the machine of hydraulic oil for the brake system. Use a pumping device.
4 Remove the thermo-bypass valve which is located inside the hydraulic oil tank.



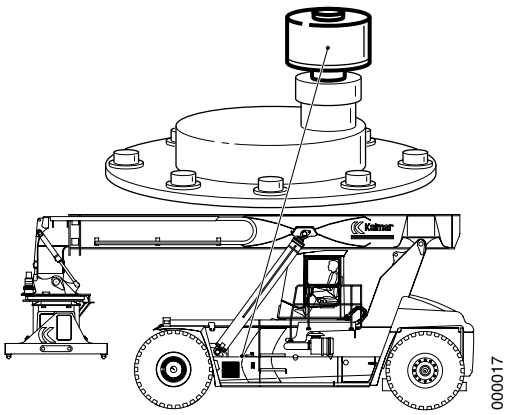
4.8.10 Sensor brake oil temperature

Sensor brake oil temperature, description

Sensor, brake oil temperature (B762), senses the temperature of the oil in the brake system. The sensor is fitted on the brake oil tank rear short side and therefore takes account of the accumulated heat in the oil in the brake system.

Sensor brake oil temperature (B762) is supplied with voltage by and sends a voltage signal proportional to the temperature to Control unit, frame front (D797-F).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.2 HYD, menu 2*.



4.8.11 Breather filter

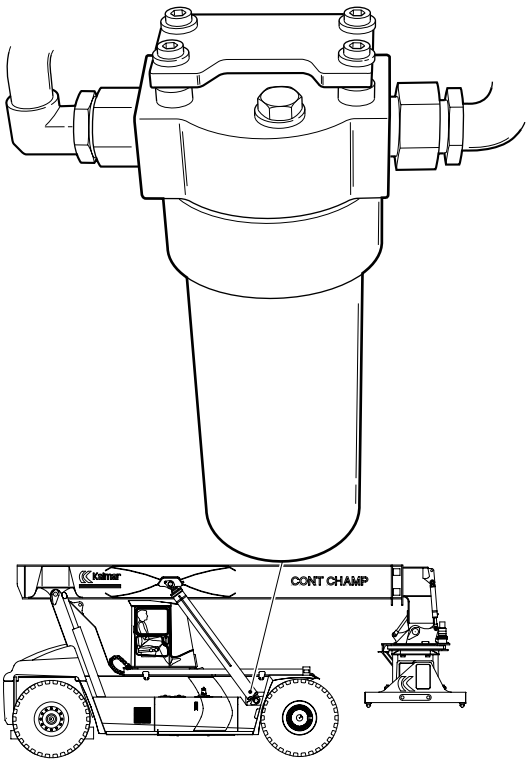
Breather filter, description

The breather filter cleans the air which passes the tank's bleed at volume changes which arise with use and temperature changes. The breather filter is fitted in a holder on the top of the brake oil tank.

The breather filter is a paper cartridge filter. The filter cleans the air which passes through the tank's bleed of moisture and dust.

Breather filter, replacement

See *Maintenance manual DRF 400–450*.



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4.8.12 Brake oil filter

Brake oil filter, description

The brake oil filter cleans the oil in the brake system from impurities. The filter is fitted in a bracket in front of the gearbox under the lift beam.

The brake system oil filter is a high pressure filter with detachable filter cartridge, located between pump and accumulator charging valve. The oil is cleaned when it is forced through the filter cartridge filter material which is made of fibreglass before it reaches the accumulator charging valve.

Between the inlet and outlet is a bypass valve which protects the cartridge. If the resistance through the filter surface is too great then the bypass valve opens a passage past the cartridge. The bypass function opens if the oil is viscous (cold or low/high viscosity) or if the filter cartridge is clogged by dirt.

NOTE

When the filter is clogged the oil flows past the filter without cleaning, which is why it is of utmost importance that the filter is changed in accordance with the specified interval.

Brake oil filter, replacement

See *Maintenance manual DRF 400–450*.

4.8.13 Pipes and hoses

Pipes and hoses, description

See section *10 Common hydraulics*, group *10.5.1 Pipes and hoses*.

4.8.14 Oil brake system

Oil, brake system, general

See section *F Technical data* and *Maintenance manual DRF 400–450*.

Table of Contents 5 Steering

5 Steering

5.1 Controls and instrumentation

5.1.1 Steering wheel and steering column

Steering wheel and mounting, description

The steering wheel steers the machine and is mounted on a steering wheel column. The steering wheel column has an instrument panel (steering wheel panel).

The steering wheel's (and steering wheel panel's) angle and height can be adjusted to desired position.

1. Steering wheel's height.

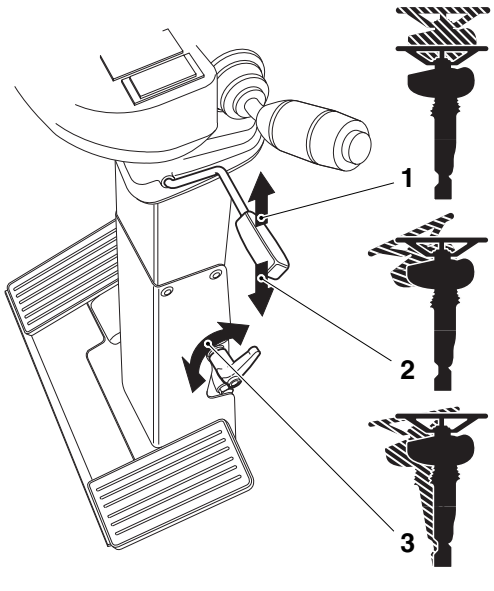
   To adjust: Move upper lever upward.

2. Steering wheel panel's angle.

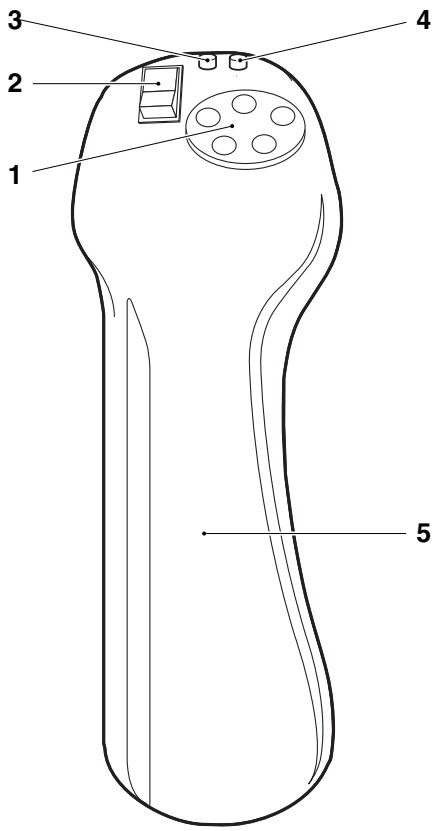
   To adjust: Move upper lever downward.

3. Steering column's angle. ⊕

   To adjust: Loosen the lower handle and adjust to desired position. Tighten the handle securely after adjusting.



Steering wheel adjustment possibilities



1. Mini-wheel
2. Travel direction selector (F / N / R)
3. Switch, activation of mini-wheel
4. Audible signal
5. Armrest

5.1.2 Mini-wheel

Mini-wheel, description

On machines with mini-wheel, the machine's steering is electronically controlled. A directional valve pressurises the steering cylinder.

The mini-wheel's control is built into the left armrest. The control consists of two rotary potentiometers and three switches to activate the mini-wheel, select travel direction and activate the horn.

NOTE

If the operator steers with the standard steering wheel, the mini-wheel is disengaged.

Mini-wheel or joystick control can only be activated at speeds below 3 km/h.

Mini-wheel

The rotary potentiometers give a signal of 0-5 V during a turn. The potentiometers are phase displaced to be able to determine the direction of the turn. The rotary potentiometers are supplied with voltage and send voltage signals proportional to the turn to Control unit cab (D790-1) to indicate steering angle.

There are 31 possible settings for the relationship between the mini-wheel's and the wheels' angle, from linear to very progressive. It's also possible to adjust how much the steering angle should be adapted to the machine's speed. This is done from the diagnostic menus, see section *8 Control system*, group *8.5.1 Initiation*.

The signals can be read from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.4 EL-STEERING*, menu 1.

Switch activation mini-wheel

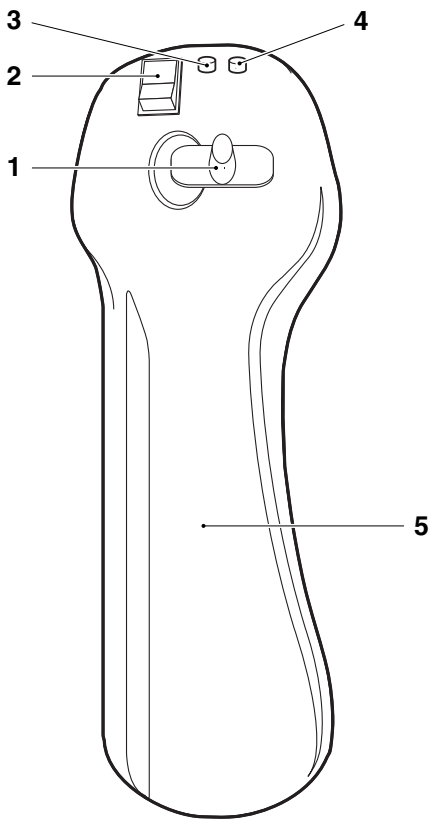
Switch mini-wheel (position 3) activates steering with the mini-wheel. The switch is supplied with voltage from and sends a voltage signal to Control unit, cab (D790-1).

The signals can be read from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.4 EL-STEERING*, menu 2.

Travel direction selector

The travel direction selector is used to select travel direction (forward or reverse) when the mini-wheel is activated. The switch is supplied with voltage from and sends a voltage signal to Control unit, cab (D790-1).

The signals can be read from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.4 EL-STEERING*, menu 2.



1. Lever steering
2. Travel direction selector (F / N / R)
3. Switch, activation of lever steering
4. Audible signal
5. Armrest

Audible signal

Audible signal is used to activate the horn when the mini-wheel is activated. The switch is supplied with voltage from and sends a voltage signal to Control unit, cab (D790-1).

The signals can be read from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.4 EL-STEERING*, menu 2.

5.1.3 Steering lever

Lever steering, description

⊕

On machines with lever steering, the machine's steering is electronically controlled. A directional valve acts on the steering cylinder.

The lever is built into the left armrest. The control consists of a slide potentiometer and three switches to activate joystick control, select travel direction or activate audible signal.

NOTE

If the operator steers with the standard steering wheel, the joystick control is disengaged.

Mini-wheel or joystick control can only be activated at speeds below 3 km/h.

Lever steering

The slide potentiometer is supplied with voltage by and sends voltage signals proportional to movement to Control unit cab (D790-1) to indicate steering angle.

The signals can be read from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.4 EL-STEERING*, menu 1 and 2.

There are 31 possible settings for the relationship between the lever's and the wheels' angle, from linear to very progressive. It's also possible to adjust how much the steering angle should be adapted to the machine's speed. This is done from the diagnostic menus, see section *8 Control system*, group *8.5.1 Initiation*.

The lever's positions (left, middle, right) can be calibrated from the diagnostic menus, see section *8 Control system*, group *8.5.2.2 Calibrate steering*.

Switch activation of lever steering

Switch activation of lever steering (position 3) activates lever steering. The switch is supplied with voltage from and sends voltage signals to Control unit, cab (D790-1).

The signals can be read from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.4 EL-STEERING*, menu 2.

Travel direction selector

The travel direction selector is use to select the direction of travel (forward or reverse) when joystick control is activated. The switch is supplied with voltage from and sends voltages signal to Control unit, cab (D790-1).

The signals can be read from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.4 EL-STEERING*, menu 2.

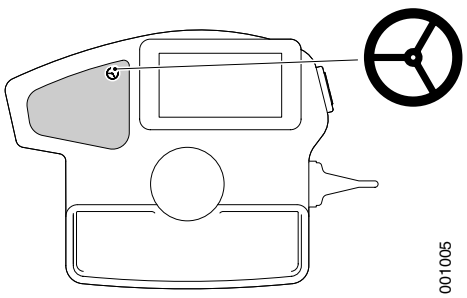
Audible signal

The audible signal is used to activate the horn when joystick control is activated. The switch is supplied with voltage from and sends voltage signals to Control unit, cab (D790-1).

The signals can be read from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.4 EL-STEERING*, menu 2.

5.1.4 Indicator light mini-wheel/steering lever

Indicator light mini-wheel or lever steering, description

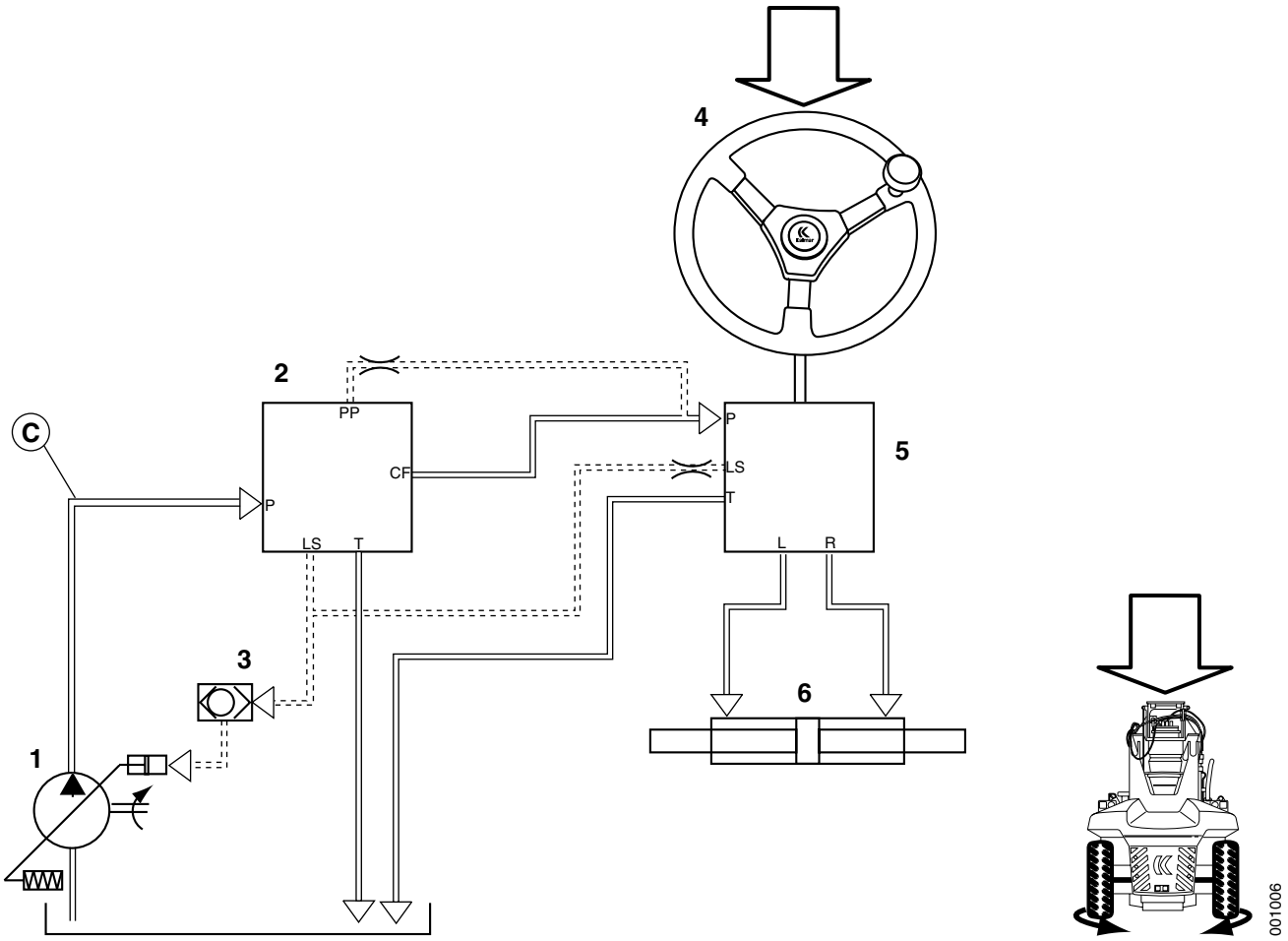


Indicator light mini-wheel or lever steering is lit up when lever steering or mini-wheel is activated.

The indicator light for mini-wheel or lever steering is supplied with voltage by Control unit, KIT (D790-2).

5.2 Power-assisted system

Power-assisted steering system, function description



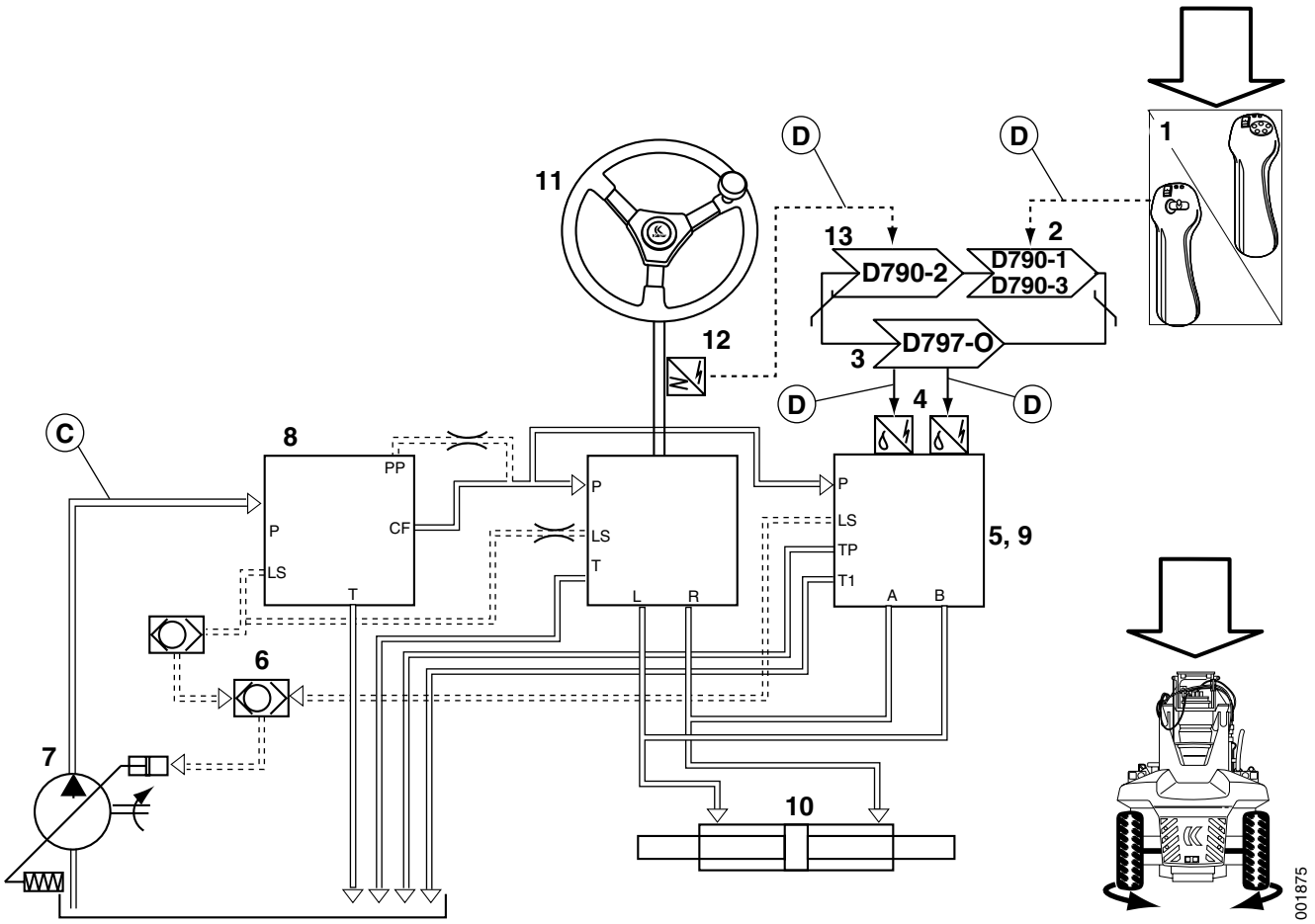
Pos	Explanation	Signal description	Reference
1	The hydraulic oil pumps pump oil to the priority valve.	See pressure plate on left frame beam.	Section *10 Common* hydraulics, group *10.4 Pumps*
2	The priority valve gives priority to pressure supply to the steering valve before the working hydraulics. In addition, the priority valve sends control signal to hydraulic oil pump 3 and 4.	Controlled by control system, error shown with error code.	*Priority valve, description page 11*
3	The shuttle valve selects the strongest load signal to the main pumps if hydraulic functions are activated at the same time as the steering wheel is turned.	Controlled by control system, error shown with error code.	Section *10 Common hydraulics,* group *10.5.3 Shuttle valve*
4	The steering wheel is turned and acts on the steering valve's input shaft.	-	*Steering wheel and mounting, description page 3*

Pos	Explanation	Signal description	Reference
5	The steering valve pumps pressurized oil to the steering cylinder and sends load signal to the main pumps.	-	*Steering valve, description page 14*
6	The steering cylinder turns the wheels.	-	*Steering cylinder, description page 16*

Hydraulic diagram A40740.0100

Joystick steering/mini-wheel, function description

Condition	Reference value	Reference
Joystick steering activated	Voltage signal from switch mini-wheel/joystick steering.	*Mini-wheel, description page 4* *Lever steering, description page 5* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.4 EL-STEERING, menu 2*
Steering wheel stationary	No signal from sensor steering angle.	*Sensor steering angle, description page 20*
Speed	Below 3 km/h (at engagement)	Section *2 Transmission*, group *2.3.8 Sensor output shaft*
Emergency stop	Not activated	Section *11 Common electrics*, group *11.5.1.4 Emergency stop voltage (15E)*



Pos	Explanation	Signal description	Reference
1	Switch joystick *or Switch mini-wheel* sends voltage signal to Control unit cab (D790-1). On machines with Combi attachment, the signal is sent to Control unit, cab optional (D790-3)	Signal 1, U = 0.5 - 4.5 V Signal 2, U = 0.5 - 4.5 V (only mini-wheel)	*Mini-wheel, description page 4* *Lever steering, description page 5* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.4 EL-STEERING, menu 1*
2	Control unit cab (D790-1) sends steering angle on CAN-bus.	Checked by control system, error indicated with error code.	Section *11 Common electrics*, group *11.6 Communication*
3	Control unit frame option (D797-O) supplies voltage to Solenoid valve steering right (Y636R) *or Solenoid valve steering left (Y636L)*.	I = 350–550 mA	*Control valve joystick control or mini-wheel, description page 18* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.4 EL-STEERING, menu 4 and 5*
4	Solenoid valve steering right (Y636R) *or Solenoid valve steering left (Y636L)* pressurizes steering spool in Control valve joystick steering or mini-wheel.	-	*Control valve joystick control or mini-wheel, description page 18* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.4 EL-STEERING, menu 4 and 5*
5	Control valve joystick steering or mini-wheel sends load signal to shuttle valve steering.	-	*Control valve joystick control or mini-wheel, description page 18*
6	The shuttle valve selects the strongest load signal to Hydraulic oil pump 3 and 4 if hydraulic functions are activated at the same time as the steering wheel is turned.	-	*Shuttle valve mini-wheel or lever steering, description page 19*
7	Hydraulic oil pump 3 and 4 pump oil from the hydraulic oil tank.	See pressure plate on left frame beam.	Section *10 Common* hydraulics, group *10.4 Pumps*
8	The priority valve gives priority to pressure supply to the steering valve before the working hydraulics. In addition, the priority valve sends control signal to hydraulic oil pump 3 and 4.	See pressure plate on left frame beam.	*Priority valve, description page 11*
9	The steering spool changes position and pressurizes the steering cylinder.	-	*Control valve joystick control or mini-wheel, description page 18*
10	The steering cylinder turns the wheels.	-	*Steering cylinder, description page 16*
11	The steering wheel is turned and acts on the steering valve's input shaft.	-	*Steering wheel and mounting, description page 3*
12	Sensor steering wheel shaft sends voltage signal to Control unit cab (D790-1).	U = 24 V	*Sensor steering angle, description page 20* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.4 EL-STEERING, menu 3*

Pos	Explanation	Signal description	Reference
13	Control unit cab (D790-1) sends abort steering on CAN-bus.	Checked by control system, error indicated with error code.	Section *11 Common electrics*, group *11.6 Communication*

Hydraulic diagram A43276.0100

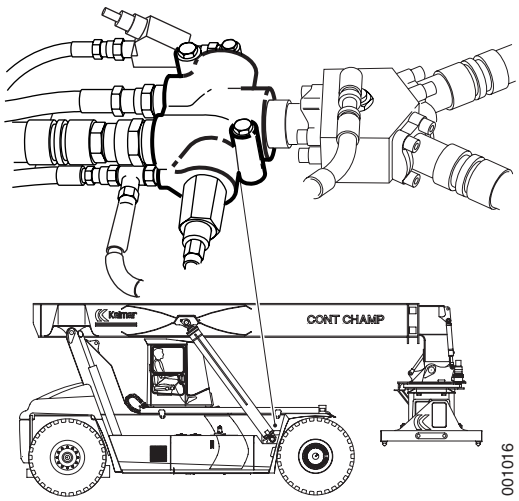
5.2.1 Hydraulic oil pump

Hydraulic oil pump, general

Steering is supplied with oil from hydraulic oil pump 3 and 4, see section *10 Common hydraulics*, group *10.4 Pumps*.

5.2.2 Priority valve

Priority valve, description



The priority valve separates the oil flow from main pump 3 and 4 so that there is always oil to the steering valve. The remainder flows to the working hydraulics or servo circuit.

The priority valve is load sensing and pilot pressure compensating. Load sensing means that the valve adapts the steering signal to steering valve consumption. Pilot pressure compensating means that the priority valve compensates for the pressure drop between the priority valve and the steering valve via a separate line.

The priority valve has an integral pressure limiter on the load signal. The pressure limiter maximises the load signal pressure.

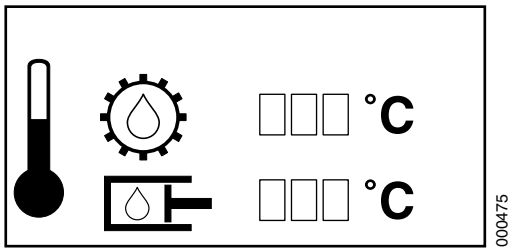
Control pressure, checking and adjustment

⚠ WARNING

Hot and pressurised oil.

Personal injury, burns, rash and irritation.

Always depressurise the hydraulic systems before starting work on them. Avoid skin contact with the oil, use protective gloves.



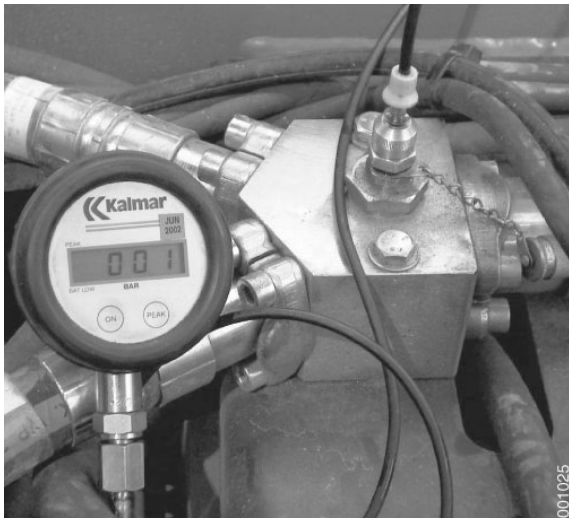
Operating menu, hydraulic oil temperature

1 Operate and warm up the machine so that the hydraulic oil reaches operating temperature, at least 50 °C.

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

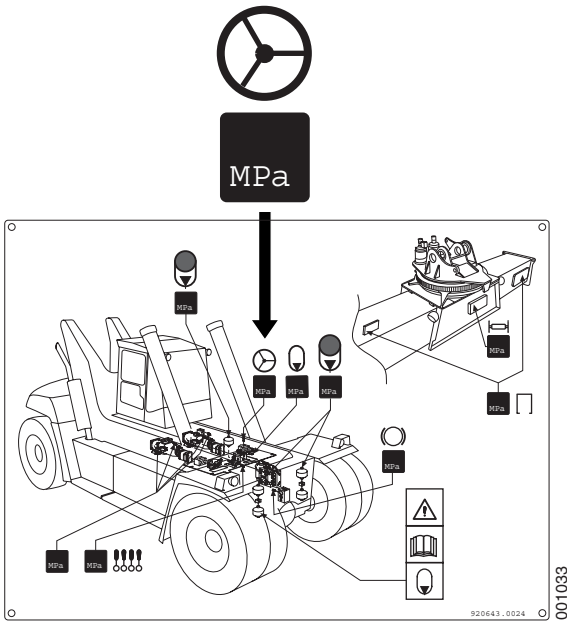
3 Depressurise the hydraulic and brake systems, see section *B Safety*.

4 Clean the area around the measuring outlet for pump pressure.

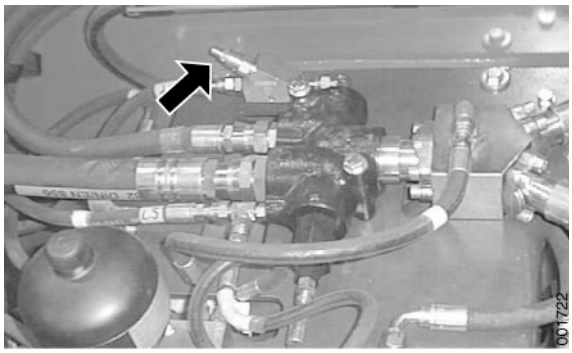


5 Connect the pressure gauge to the measuring outlet for pump pressure on the collection block between hydraulic oil pumps and control valve for lift and extension.

6 Start the engine and increase engine speed to approx. 1200 rpm.



7 Turn the steering wheel to full steering angle and read off the pump pressure during the steering movement. The maximum pressure must correspond with the control pressure on the hydraulic plate.



8 If necessary, adjust the pressure on the adjusting screw.

Undo the lock nut and turn the adjusting screw to change the pressure.

Clockwise: Increase the pressure

Anticlockwise: Decrease the pressure

9 Lock the adjusting screw by tightening the lock nut.

10 Turn off the engine and turn the start key to position I.

11 Depressurise the hydraulic and brake systems, see section *B Safety*, *Hydraulic and brake systems, depressurising*.

12 Turn the start key to position 0 and turn off the main electrical power.

13 Remove the pressure gauge and fit the protective cover on the measuring outlet.

Priority valve, replacement

⚠ WARNING

Hot and pressurised oil.

Personal injury, burns, rash and irritation.

Always depressurise the hydraulic systems before starting work on them. Avoid skin contact with the oil, use protective gloves.

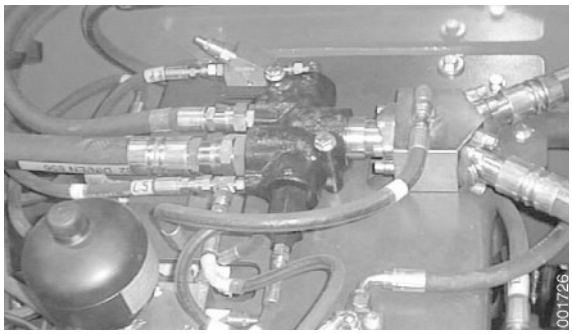
1 Machine in service position, see section *B Safety*

2 Depressurise the hydraulic and brake systems, see section *B Safety*.

3 Clean the priority valve and its surrounding area.

4 Turn the start key to position 0 and turn off the main electrical power.

5 Mark up and detach the hydraulic hoses from the priority valve.



NOTE

Plug all connections immediately to protect the brake system from impurities.

6 Remove the priority valve attaching bolts.

7 Detach the priority valve from the collection block.

8 Remove the priority valve.

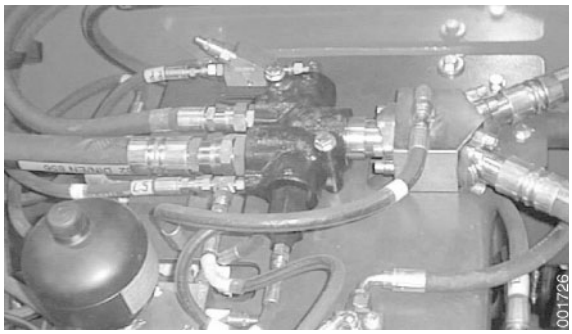
9 Transfer the connection adapters to the new priority valve.

NOTE

Transfer one connection at a time so that the marking is not mixed up.

10 Connect the new priority valve to the collection block.

> **CAUTION**
>
> **Voltages in the priority valve.**
>
> **Incorrect function.**
>
> **Do not tighten the hydraulic connection between priority valve and collection block before all other connections and attaching bolts are fitted.**



11 Fit the priority valve attaching bolts.

12 Connect the hydraulic hoses to the priority valve.

13 Check that the collection block is not pressing against the priority valve.

14 Tighten the hydraulic connection between priority valve and collection block.

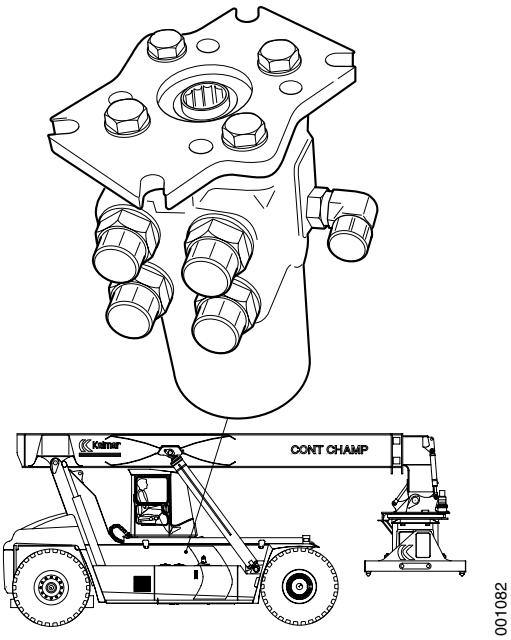
15 Start the engine and check that the hydraulic connections at the priority valve are sealed.

16 Check the control pressure, see *Control pressure, checking and adjustment page 11*.

17 Remove the collection container, treat the waste oil as environmentally hazardous waste.

5.2.3 Steering valve

Steering valve, description



Steering valve is a “progressive, closed centre, non-reaction” type with load signal connection to the priority valve.

The load signal provides loading dependent control of the oil flow from the priority valve to the steering valve. “Closed centre” means that the steering valve is closed in neutral position. It is essential that signal pressure can be connected to the steering valve.

The steering valve consists of a gear pump and a distribution valve. When the steering wheel is turned oil flows from the main pump over the gear pump to the distribution valve which controls oil to the steering cylinder. The gear pump ensures that the oil flow fed to the cylinder is proportional to the steering wheel turning angle.

There are double shock and anti-cavitation valves in the steering valve. The shock valves protect the hydraulics against pressure spikes which can arise from impacts on the steering wheels. The anti-cavitation valves (non-return valves) protect against vacuum on the piston's rear side, which can lead to cavitation.

Steering valve, replacement

⚠ WARNING

Hot and pressurised oil.

Personal injury, burns, rash and irritation

Always depressurise the hydraulic systems before starting work on them. Avoid skin contact with the oil, use protective gloves.

1 Remove the cover plates over the engine bay.

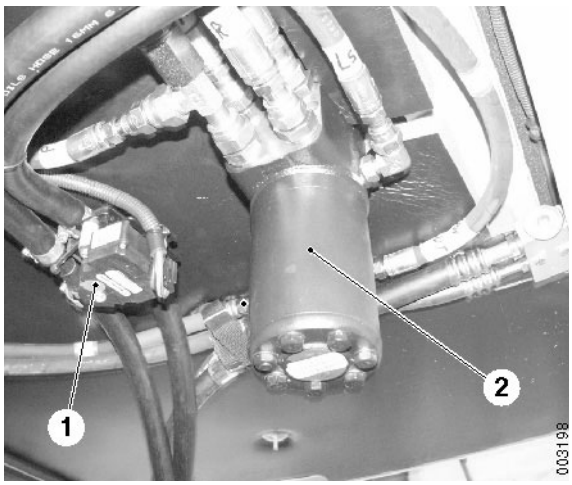
2 Move the cab forward so that the steering valve is easily accessible from below.

3 Turn off the engine and turn the start key to position I.

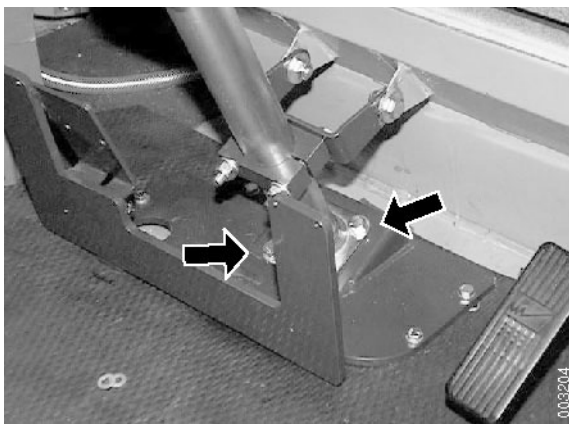
4 Depressurise the hydraulic and brake systems, see section *B Safety*.

5 Turn the start key to position 0 and turn off the main electrical power.

6 Position a collection container under the steering valve to collect spilled oil.



1. Water valve
2. Steering valve



7 Detach the steering valve from the brake pedal.

Remove the steering valve attaching bolts and lower the steering valve.

8 Mark up and detach the hydraulic hoses from the steering valve.

NOTE

Plug all connections immediately to protect the brake system from impurities.

9 Remove the steering valve.

10 Transfer the connection adapters to the new steering valve.

NOTE

Transfer one at a time so that the marking is not mixed up.

11 Connect the hydraulic hoses to the steering valve in accordance with the marking.

NOTE

Check that the O-rings are intact and are fitted correctly.

12 Connect the new steering valve to the brake pedal.

Fit the steering valve and check that the steering wheel shaft splines align straight into the steering valve recesses. Fit the attaching bolts.

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

14 Check that the connections on the steering valve are sealed.

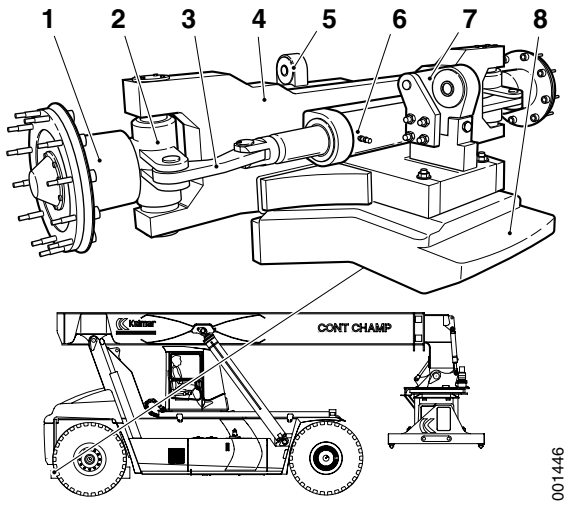
15 Steer very carefully a couple of times right - left. To bleed the steering valve and steering cylinder.

16 Remove the collection container and treat the waste oil as environmentally hazardous waste.

5.2.4 Steering cylinder

Steering cylinder, description

The steering cylinder acts on the wheels via the link arms. The steering cylinder is a double-acting hydraulic cylinder.



1. Wheel hub
2. Wheel spindle
3. Link arm
4. Steering axle
5. Mounting
6. Steering cylinder
7. Rear mounting
8. Counterweight

Hydraulic cylinders, repairing

See section *10 Common hydraulics,* group *10.7.1 Hydraulic cylinders*.

5.2.5 Steering axle cradle

Steering axle cradle, general

See section *6 Suspension*, group *6.2.1 Steering axle cradle*.

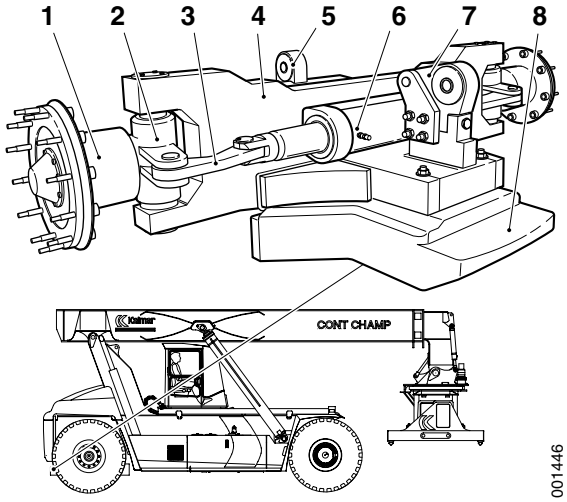
5.2.6 Link arm

Link arm, description

The link arm transfers the lateral movement of the steering cylinder to turning the wheel spindles.

The setting of the steering wheels cannot be adjusted. If the link arms are deformed so that the setting of the steering wheels is changed then they must be replaced.

The link arms must be turned to the right direction, otherwise they can be damaged by the rims with large wheel angles.



1. Wheel hub
2. Wheel spindle
3. Link arm
4. Steering axle
5. Mounting
6. Steering cylinder
7. Rear mounting
8. Counterweight

5.2.7 Wheel spindle

Wheel spindle, general

See section *6 Suspension*, group *6.2.2 Wheel spindle*.

5.2.8 Wheel hub

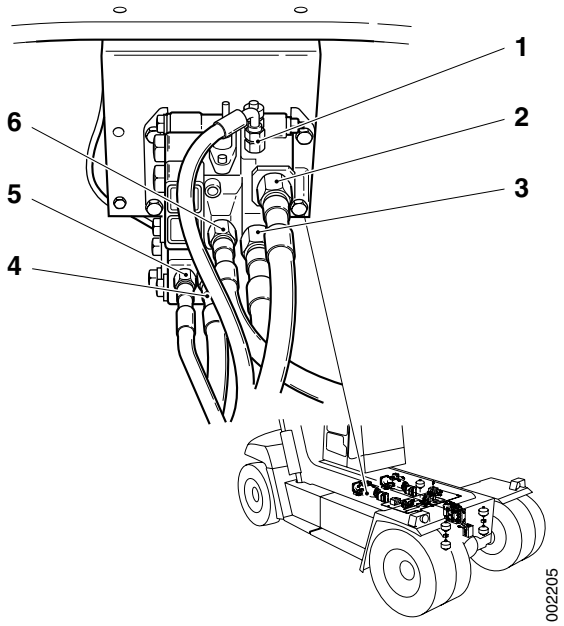
Wheel hub, general

See section *6 Suspension*, group *6.2.3 Wheel hub*.

5.2.9 Shuttle valve

Shuttle valve, description

See section *10 Common hydraulics*, group *10.5.3 Shuttle valve*.



1. Load signal (LS)
2. Pressure supply (P)
3. Tank return (T)
4. Connection, steering cylinder (B)
5. Tank return (TP)
6. Connection, steering cylinder (A)

5.2.10 Manoeuvre valve mini-wheel/lever steering

Control valve joystick control or mini-wheel, description

On machines with joystick control or mini-wheel, the steering cylinder's angle is controlled by control valve for joystick control or mini-wheel. The control valve is located on the inside of the right frame member in front of the engine. The control valve is controlled by control unit for frame option (D797-O).

The control valve is an electro-hydraulically controlled proportional and pressure compensated direction valve. Electrically controlled pressure reducing valves convert electrical current to servo pressure. The servo pressure controls the spring centred valve slides which control pressure and flow for the function in question. The valve slide has a flow limit in order that several functions can be activated simultaneously.

Valve slide, steering

The valve slide controls the direction and steering angle by controlling the hydraulic pressure to the steering cylinder.

The valve slide is controlled by servo valve right and servo valve left.

Servo valve right

Servo valve right controls servo pressure to valve slide, steering, so that it controls oil pressure for steering right.

The right servo valve is controlled electrically with Solenoid valve steering right (Y636R) which is activated by the control unit for frame option (D797-O).

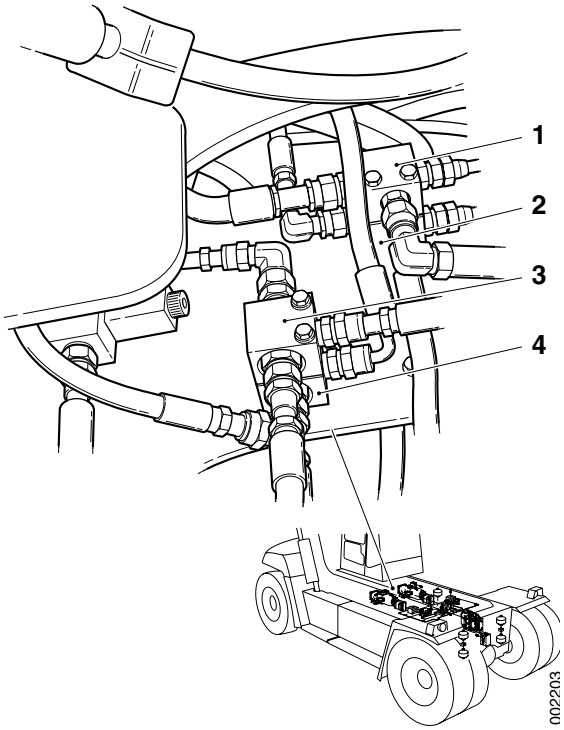
The signals can be read from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.4 EL-STEERING, menu 5*.

Servo valve left

Servo valve left controls servo pressure to valve slide, steering, so that it controls oil pressure for steering left.

The left servo valve is controlled electrically with Solenoid valve steering left (Y636L) which is activated by the control unit for frame option (D797-O).

The signals can be read from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.4 EL-STEERING, menu 4*.



Shuttle valves on attaching plate between engine and transmission

1. Shuttle valve, frame option ⊕
2. Shuttle valve, lift / steering
3. Shuttle valve, lever steering/mini-wheel ⊕
4. Shuttle valve , lift / attachment

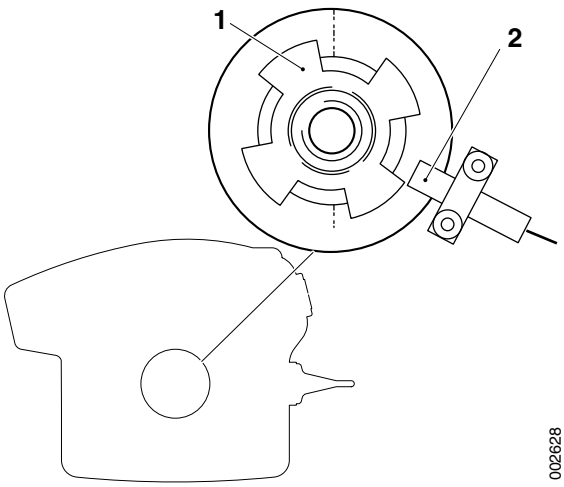
5.2.11 Shuttle valve mini-wheel/lever steering

Shuttle valve mini-wheel or lever steering, description

⊕

On machines with lever steering or mini-wheel, there is an extra shuttle valve for the hydraulic oil pumps' control signal lines. The shuttle valves are located on the bracket for the oil filling point and oil dipsticks between the engine and transmission.

The shuttle valve relays the control signal from the control valve to the main pumps.



1. Indicator ring
2. Sensor, steering angle (B770)

5.2.12 Sensor steering wheel angle

Sensor steering angle, description

Sensor steering angle (B770) senses if the steering wheel is turned and sends a signal to Control unit KIT (D790-2). This is used to disengage joystick control or the mini-wheel. The sensor is located by the steering wheel shaft inside the panels. The sensor is activated by an indicator ring on the steering wheel shaft with four lobes. The location of the sensor and lobes' spacing means that small steering wheel movements can be detected.

The signals can be read from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.4 EL-STEERING, menu 3*.

Position sensor, checking and adjustment

See section *7 Load handling*.

5.2.13 Pipes and hoses

Pipes and hoses, description

See section *10 Common hydraulics*, group *10.5.1 Pipes and hoses*.

Table of Contents 6 Suspension

6 Suspension

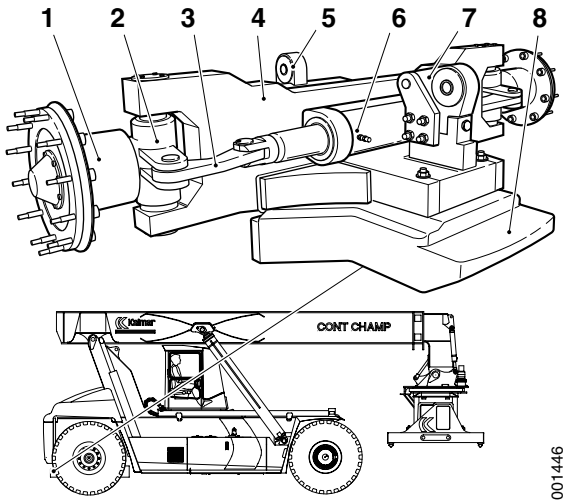
6.2 Suspension

6.2.1 Steering axle cradle

Steering axle cradle, description

The steering axle is pendulum suspended with a double-acting steering cylinder. The construction comprises a minimum of moving parts to minimise service points and simplify maintenance.

The chassis suspension comprises maintenance free parts. The rear suspension is designed with a leading knee which is used to indicate inadequate load on the steering axle, so-called "mechanical overload protection", see section *8 Control system*, group *8.2.1 Overload protection*.



1. Wheel hub
2. Wheel spindle
3 Link arm
4. Steering axle
5. Front mounting
6. Steering cylinder
7. Rear mounting
8. Counterweight

Steering axle cradle, changing

DANGER

Steering axle and machine are very heavy.

Risk of crushing!

Moving under a machine raised by jacks or similar is prohibited. For machine weight see section *F Technical data*.

1 Clean the steering axle and its surrounding area.

2 Switch off the engine and turn the start key to position I.

3 Depressurise the brake and hydraulic systems, see section *B Safety*.

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

5 Remove the counterweights on the rear of the machine.

NOTE

Mark up the positions of the counterweights so that they can be refitted in the same way, this is important for the machine's stability.

6 Connect the lifting equipment to the rear section of the machine.

7 Tension the lifting equipment, do not lift so high that the wheels start to hang.

8 Support the machine's rear section.

9 Detach the cable from overload sensor (applies only to machines with mechanical overload protection).

10 Detach the hydraulic hoses from the steering cylinder

NOTE

Plug all connections immediately to protect the hydraulic system from impurities.

11 Remove the pins holding the steering axle.

12 Raise the machine so that the frame eases off the axle.

13 Lift out the steering axle.

⚠ CAUTION

The steering axle may start to roll.

Crushing injury!

Make sure that the steering axle does not start uncontrolled movement.

14 Adjust the support so that the machine is secured in the new position.

15 Lift the steering axle into place underneath the frame.

16 Remove the support under the frame.

17 Lower the rear section of the machine.

18 Fit the pins at the steering axle mountings.

19 Connect the hydraulic hoses to the steering cylinder.

NOTE

Check that the O-rings are intact and that they are fitted correctly.

20 Connect the wiring to the overload sensor (applies only to machines with mechanical overload protection).

21 Remove the lifting equipment from the machine.

22 Fit the counterweights.

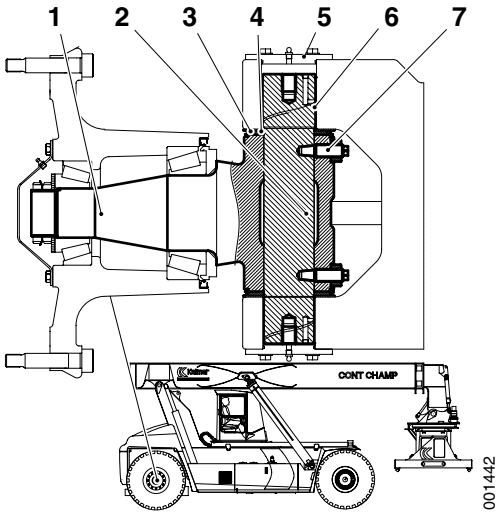
NOTE

Make sure that all counterweights are refitted and that they are located exactly as before. The machine's stability can be affected if the counterweights are changed.

6.2.2 Wheel spindle

Wheel spindle, description

The wheel spindle is the link between steering axle and wheel hubs which means that the wheels can be turned.



1. Wheel spindle
2. King pin
3. Seal
4. Slide bearing washer
5. Cover
6. King pin bearing
7. Lock bolt

King pin bearing, replacement

CAUTION

Poisonous grease!

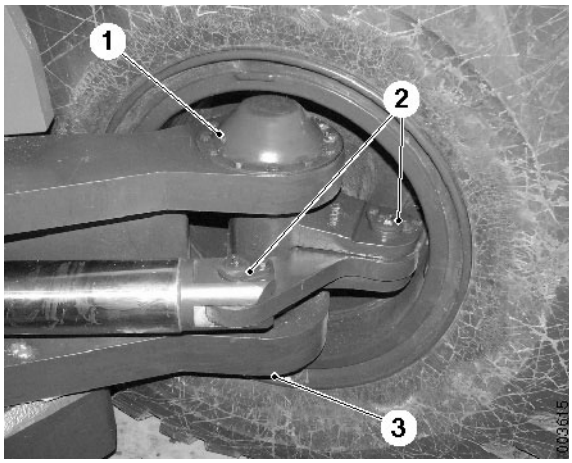
Rash and irritation.

The wheel spindle is lubricated with a poisonous special grease (SK 12). Use protective gloves.

1 Clean the wheel spindle and its surrounding area.

2 Lift the machine under the steering axle at the wheel in question. Support the steering axle in a suitable way.

3 Remove the current steering wheel, see *Maintenance manual DRF 400–450,* section *6 Suspension,* group *6.3 Tyre and rim system*.



1. Cover (upper)
2. Pin, link arm
3. Cover (lower)

4 Detach the link arm from the wheel spindle.

Remove the lock bolt and remove the pin. Turn aside the link arm.

5 Fit a lifting strap inside the hub so that the spindle is secured.

6 Remove the covers at the king pin upper and lower bearing.

7 Remove the grease between cover and king pin.

8 Remove the king pin upper and lower lock bolt.

Unscrew the nut and remove the lock bolt.

9 Adjust the lifting equipment so that the wheel spindle is unloaded.

10 Remove the king spin.

Pull the king pin up, use a slide hammer or similar which is connected to the threaded hole in the centre of the king pin.

11 Remove the wheel spindle.

Place the wheel spindle on a soft surface.

12 Remove the wear washers from the steering axle.

13 Replace the bearing races in the steering axle.

Press out the old bearing races with a drift.

14 Clean the surfaces in the steering axle.

15 Press in the new bearing races with the drift.

Smear the bearing races thoroughly with slide bearing grease, "SK12".

16 Fit the new wear bearings on the steering axle. Note down the position of the wear bearing so that the steering fits into the recess in the bearing.

Smear the bearing races thoroughly with slide bearing grease, "SK12".

17 Fit new O-rings on the wheel spindle.

Pull the O-ring to the hub.

18 Fit new wear bearings on the wheel spindle.

Smear both sides of the wear bearings with slide bearing grease "SK12" and fit the bearing in the wheel spindle. Note down the position of the wear bearing so that the guide pin fits into the recess in the bearing.

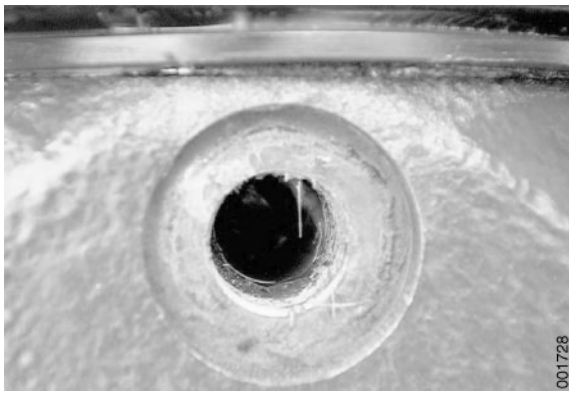
19 Lift the wheel spindle into place in the steering axle.

20 Fit the king pin.

Smear the king pin with slide bearing grease, "SK12" and press it into place.

NOTE

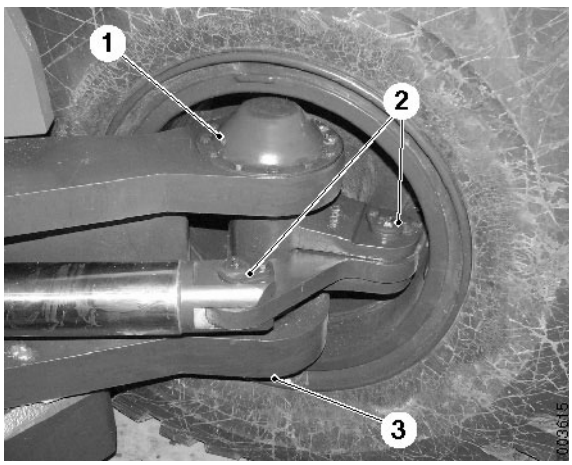
Check that the king pin is turned so that the holes for the guide pins are central to the holes in the wheel spindle.



21 Fit the lock bolts and lock with the lock nut.

22 Smear the area between wheel spindle and steering axle with slide bearing grease "SK12".

23 Pull the O-rings into place.



1. Cover (upper)
2. Pin, link arm
3. Cover (lower)

24 Fit the upper cover and the lower cover.

25 Grease the king pin upper and lower bearing with slide bearing grease "SK12".

26 Check that the wheel spindle can turn and that the resistance is even.

27 Connect the link arm to the wheel spindle.

Grease the link arm bearings with universal grease "EP2".

28 Fit the wheel, see *Maintenance manual DRF 400–450,* section *6 Suspension,* group *6.3 Tyre and rim system*.

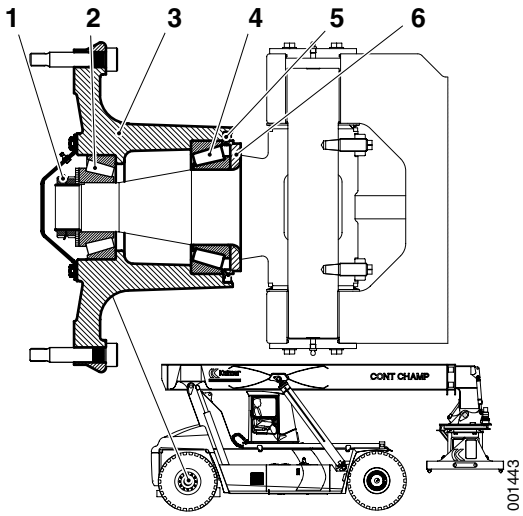
29 Remove the support and lower the steering wheel.

30 Test run the machine and test the steering. Also check that the machine feels stable during operation moving straight forward.

6.2.3 Wheel hub

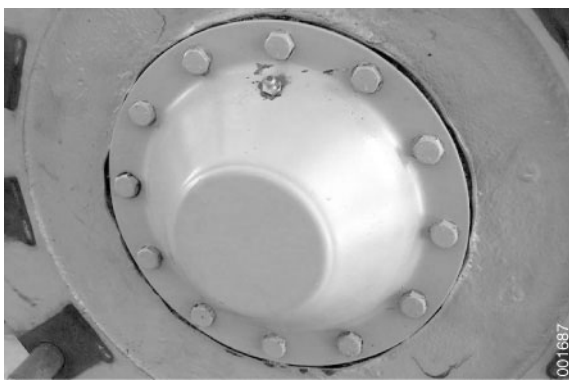
Wheel hub, description

The wheel hub holds the wheel in place and means that the wheel can rotate.



1. Hub nut with lock washer
2. Outer wheel bearing
3. Hub
4. Inner wheel bearing
5. Seal
6. Support ring

Wheel bearing, replacement



1 Lift the machine under the steering axle at the wheel in question. Support under the steering axle in a secure manner.

2 Remove the current steering wheel, see *Maintenance manual DRF 400–450,* section *6 Suspension,* group *6.3 Tyre and rim system*.

3 Clean the hub cover and its surrounding area.

4 Remove the hub cover.

5 Wipe grease off the hub cover and the hub nut. Treat as environmentally hazardous waste.

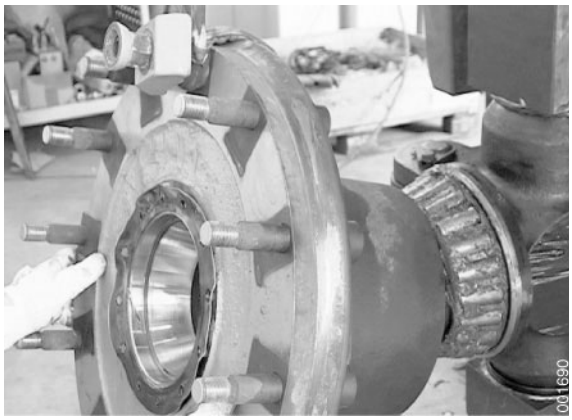
6 Secure the hub with a lifting strap.

Thread the lifting strap over the hub and around a wheel bolt. Fit a clamp and nut to secure the lifting strap. Use a hand truck, pallet jack or similar to lift the hub.

7 Bend up the lock washer's tabs, remove the lock nut and the lock washer.

8 Tension the lifting equipment so that the hub is unloaded.

9 Remove the hub nut.



10 Lift out the hub from the spindle.

Remove the outer bearing inner race and pull the hub from the axle.

11 Remove the inner bearing from the wheel spindle.

12 Remove the seal from the hub.

13 Remove the bearings' outer races from the hub.

Use a drift and press out the bearing races.

14 Clean the hub and smear the inside with universal grease "EP2".

15 Fit new bearing races in the hub.

Use a drift and press in the bearing races. Never use directly on the bearings.

NOTE

Fit the outer bearings with the larger diameter outward.

16 Fit a new seal on the inside with the seal lip turned out.

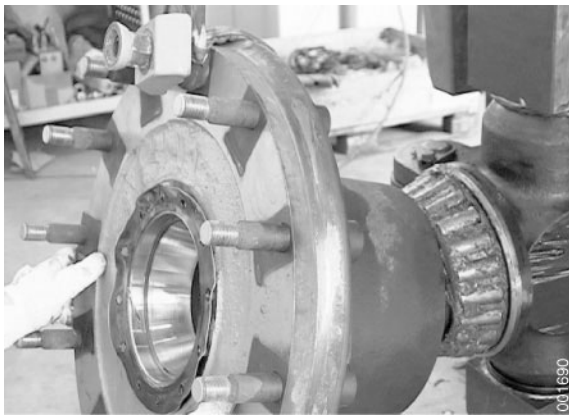
Press a new seal into the hub. Use a suitable round plate, the seal ring does not tolerate hammer blows.

NOTE

Turn the seal correctly.

17 Fit the inner bearing inner race and rollers on the wheel spindle. Pack in the bearing with universal grease "EP2".

18 Fill the empty space in the hub with universal grease "EP2".



19 Fit the hub on the wheel spindle.

20 Fit the outer bearing and protection washer and bearing nut.

Pack in the bearing with grease and fit the bearing.

Fit the washer and hub nut with the smooth surface in towards the hub.

21 Remove the lifting equipment.

22 Torque the bearing nut as follows.

A. Grease the thread on the side of the nut turned to the bearing with oil (SAE 80W7140).

B. Tighten the nut to 250 Nm.

C. Rotate the hub 10 revolutions.

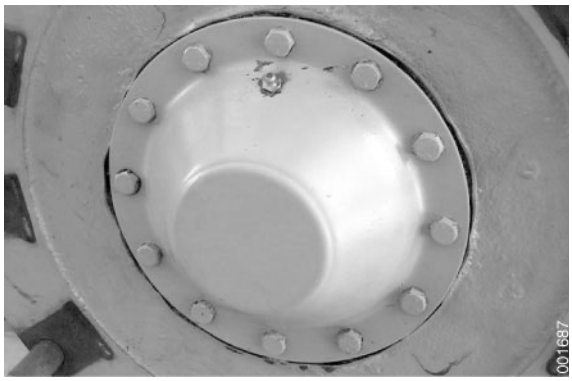
D. Angle torque the nut 45°.

E. Rotate the hub 10 revolutions.

F. Angle torque the nut 45°.

23 Grease the lock washer and fit it.

24 Fit the lock nut and tighten with a minimum torque of **250 Nm** or as hard as necessary to be able to turn the lock washer in the nearest groove. Lock the bearing nut and lock nut with the lock washer.



25 Fill the bearing casing with grease and fit it.

26 Grease the wheel bearing with grease through the grease nipple.

Lift the seal ring's lip with a small screwdriver to enable air to escape. Grease until grease comes out by the seal.

27 Fit the wheel, see *Maintenance manual DRF 400–450,* section *6 Suspension,* group *6.3 Tyre and rim system*.

28 Remove the support and lower the steering wheel.

6.3 Tyre and rim system

Tyre and rim system, safety

DANGER

Always block wheel on the side of the axle which is not going to be worked on before positioning the jack. Always fixate the jack to prevent it from sliding out of position.

Deflate tyres before removal. Otherwise the conical ring and locking clips can loosen and shoot out when the pressure is changed.

Do not release air via the valve if the tyre or rim is damaged. Drill a hole in the tread to release the air. Damaged tyres can explode.

Never stand directly in front of the wheel when deflating or inflating. The conical ring and locking clips can loosen and shoot out when the pressure is changed.

Never install damaged tyres or rims.

It's prohibited to repair rims with welding.

It's prohibited to operate the machine if one of the tyres is flat.

⚠ CAUTION

When removing wheels the wheel nuts shall be left in place after they have been loosened. If the wheel nuts are removed immediately, the wheel can fall from the hub.

When removing drive wheels, make sure that the wheels are fixated when the spacer rings are removed. If the wheels move they may displace the spacer rings, with crushing injuries as a result.

When installing drive wheels, ensure that the clamps clamp straight on the spacer ring.

Wheel nuts should be check-tightened after 4-5 operating hours.

Always follow the tyre manufacturer's or other approved instructions when changing tyres.

Never use a steel hammer to install or remove rim components. Instead, use a lead, brass or plastic mallet.

Keep the tyre pressures at prescribed level. Insufficiently inflated tyres reduce stability and reduce the machine's capacity.

Remove penetrating objects such as crushed glass, pieces of wood, metal filings, etc.

Check if tyre wear is abnormal, this may be indications of mechanical defects, e.g., unevenly acting brakes. Remedy defects immediately.

Tyre and rim system, removing and fitting

See *Maintenance manual DRF 400–450*.

6.3.1 Tyres

Tyres, description

Front wheels

The tyres are the point of contact between the machine and the ground. These absorb unevennesses and provide suspension.

The drive axle is subject to major forces during operation and if each tyre's rolling circumference differs then the stresses on the drive axle increase. For this reason it is important that the tyres on the drive axle have equal wear and correct air pressure.

Spare and exchange tyres shall be of a make approved by Kalmar Industries.

Rear wheels

Tyres, inflating

See *Maintenance manual DRF 400–450*.

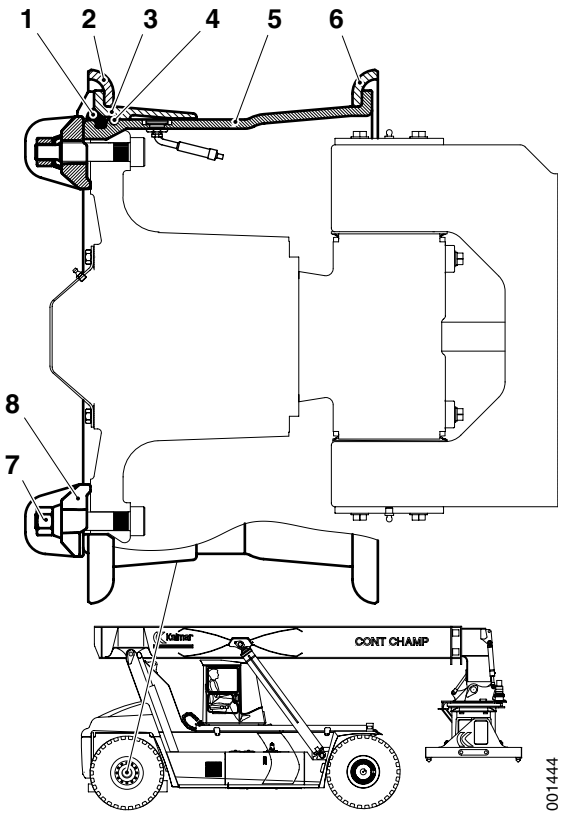
Tyres, changing

DANGER

Changing tyres is complicated and dangerous work.

FATAL DANGER!

Leave tyre work to authorized personnel/ tyre company.



1. Lock ring
2. Rim flange
3. Rim bead seat taper
4. O-ring
5. Rim
6. Rim flange
7. Wheel nut
8. Wheel clamp

6.3.2 Rims

Rims, description

The rim is split to enable installation of tyres. The rim consists of the following parts.

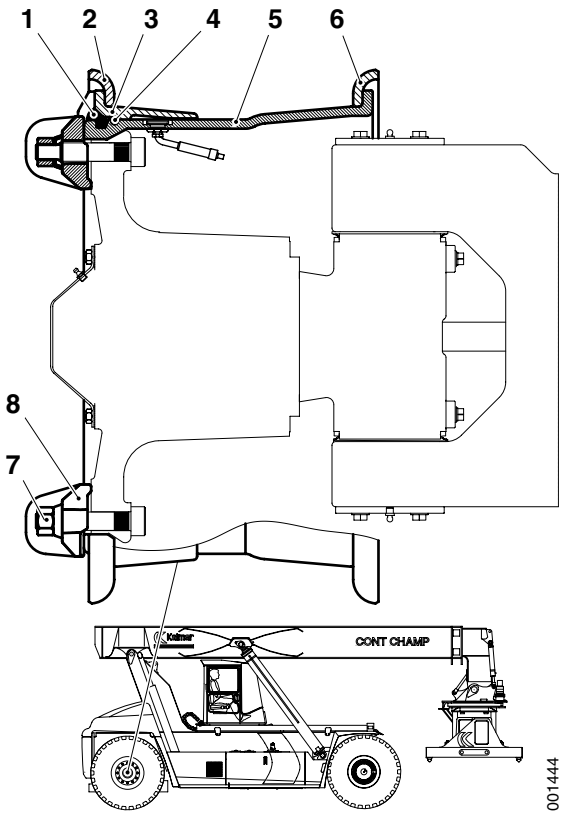
- Rim
- Rim bead seat
- Rim flange
- Lock ring
- Lock lugs
- Hub plate

6.3.3 Nut, washer and clamp (wedge)

Nut, washer and clamp, description

The rim is attached to the wheel hub with nuts and clamps.

The number of nuts and number of clamps vary depending on which type of drive axle and steering axle is used.

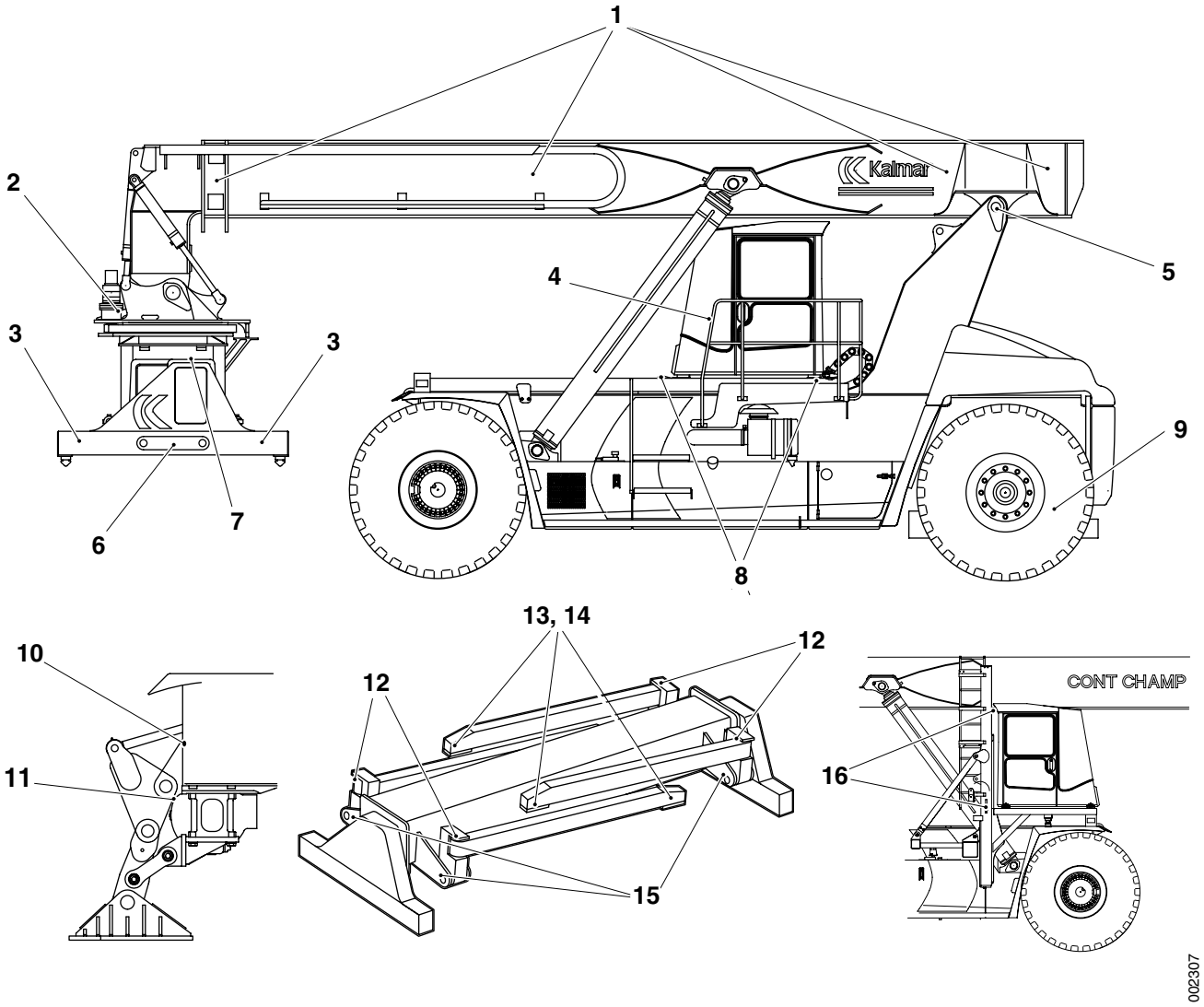


1. Lock ring
2. Rim flange
3. Rim bead seat taper
4. O-ring
5. Rim
6. Rim flange
7. Wheel nut
8. Wheel clamp

Table of Contents 7 Load handling

7 Load handling

Position sensor, checking and adjustment



1. Sensor, boom length
2. Sensor, rotation stop
3. Sensor, alignment
4. Sensor, steering angle
5. Sensor, boom angle
6. Sensor, twistlocks
7. Sensor, positioning
8. Sensor, damping end position
9. Sensor, steering axle
10. Sensor, support jacks up
11. Sensor, support jacks down
12. Sensor, lift leg
13. Sensor, alignment
14. Sensor, clamping position
15. Sensor, knee
16. Sensor, lowered cab

1 Machine in service position, see section *B Safety*.
2 Check that the sensor in question is free of damage and dirt.
3 Check that the distance between sensor and indicator is 5 ±1 mm.
4 Adjust if necessary.

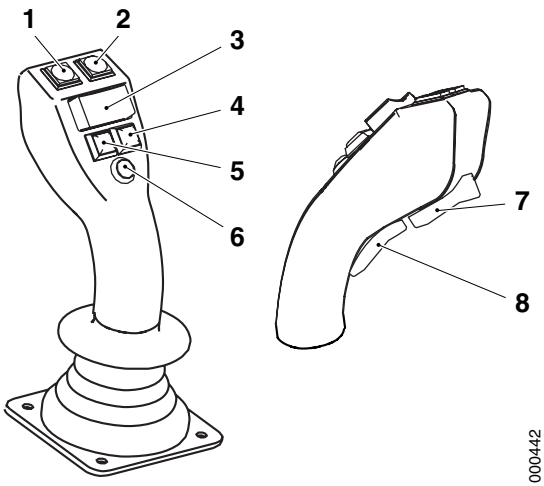
7.1 Controls and instrumentation

7.1.1 Control lever

Control lever, description

The control lever (S815) is used to control the boom and attachment. The lever sends voltage signals to Control unit cab (D790-1).

The control lever has three or four potentiometer-controlled functions and six on/off functions.



1. Tilt lock (S815-T3.1) ⊕
2. Levelling lock (S815-T3.2) ⊕
3. Rotation (S815-P3)
4. Sideshift right (S815-T1.2)
5. Sideshift left (S815-T1.1)
6. Opening of twistlocks (S815-T2) at full alignment
7. Tilt (S815-P4) ⊕
8. Pistol trigger (S815-T4): Activates weighing ⊕, changes function of sideshift to spreader out (S815-T1.2) and spreader in (S815-T1.1) as well as lift to synchronised lift ⊕

Lift and lower

Lift and lower is controlled by moving the control lever forward (lower boom) or back (lift boom). See *Lift and lower, function description page 20*.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.8.1 BOOM, menu 1*.

Protruding

Protruding is controlled by moving the control lever right (boom out) or left (boom in). See *Protruding, function description page 36*.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.8.1 BOOM, menu 1*.

Sideshift or Positioning

When switch (position 4) is pressed down sideshift right is activated, and when switch (position 5) is pressed down sideshift left is activated.

If the pistol trigger (position 8) is pressed in at the same time as sideshift right (position 4) then positioning out is activated. If the pistol trigger (position 8) is pressed in at the same time as sideshift left (position 5) then positioning in is activated. See *Sideshift, function description page 43* and *Positioning, function description page 55*.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.2 ATTACH, menu 2*.

Rotation

When the potentiometer (position 3) is pressed down on the left-hand side then rotation clockwise is activated, and when the right-hand side is pressed in then rotation anticlockwise is activated. See *Rotation, function description page 73*.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.1 ATTACH, menu 1*.

Opening of twistlocks

When the switch (position 6) is activated then the twistlocks open, if conditions for this are fulfilled. See *Twistlocks, function description page 105*.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.3 ATTACH, menu 3*.

Tilt

When the potentiometer (position 7) is pressed down at the top then tilt out is activated, and when the switch is pressed down at the bottom then tilt in is activated. See *Tilt control, function description page 90*.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.1 ATTACH, menu 1*.

Tilt lock

When the switch (position 1) is pressed down then tilt lock is activated. When tilt lock is activated the light on the switch comes on. See *Tilt lock, function description page 88*.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.4 ATTACH, menu 4*.

Levelling

When the rotation potentiometer (position 3) is pressed down on the left-hand side at the same time as the pistol trigger (position 8) is pressed in then levelling right is activated. When the right side is pressed down at the same time as the pistol trigger is pressed in, levelling left is activated. See *Hydraulic levelling, function description page 97*.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.1 ATTACH, menu 1*.

Levelling lock

When the switch (position 2) is pressed down then levelling lock is activated. When levelling lock is activated the indicator lamp on the switch comes on. See *Levelling lock, function description page 99*.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.4 ATTACH, menu 4*.

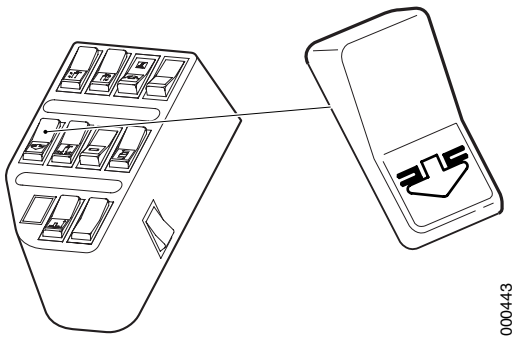
Pistol trigger

The pistol trigger (position 8) activates weighing if the machine is equipped with a weight indicator. The pistol trigger also changes the function of other buttons on the control lever. If sideshift is activated at the same time as the pistol trigger is pressed in, positioning is activated. If lift is activated at the same time as the pistol trigger is pressed in then synchronised lift is activated if the machine is fitted with this option.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.4 ATTACH, menu 4*.

7.1.2 Switch lock twistlocks

Switch lock twistlocks, description



Switch lock twistlocks (S1001) controls locking of twistlocks. The switch has three positions: two fixed and one rocker with the following functions.

1. Automatic locking of the twistlocks at full alignment and released parking brake.
2. Twistlocks open (off).
3. Manual locking of the twistlocks at full alignment and released parking brake (sprung).

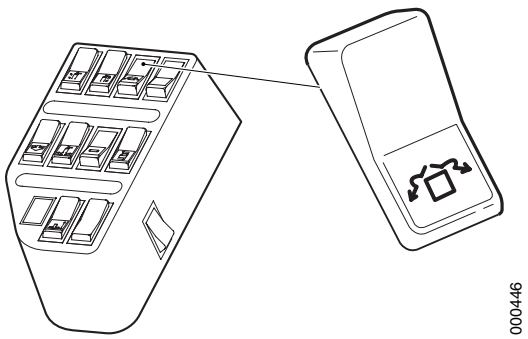
Twistlocks are opened with a switch on the control lever, see *Control lever, description page 7*.

The switch is supplied with voltage from and sends a voltage signal to Control unit cab (D790-1).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.3 ATTACH, menu 3*.

7.1.4 Switch rotation stop

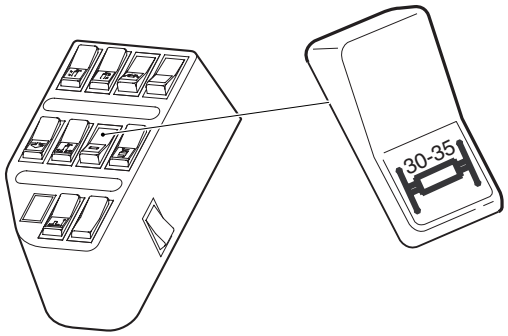
Switch rotation stop, description



Switch rotation stop (1014) activates the by-passing of rotation stop. When the switch is not activated, the attachment's rotation is limited to ±25°.

The switch is supplied with voltage from and sends a voltage signal to Control unit cab (D790-1) when the switch is activated.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.21 ATTACH, menu 21*.



000447

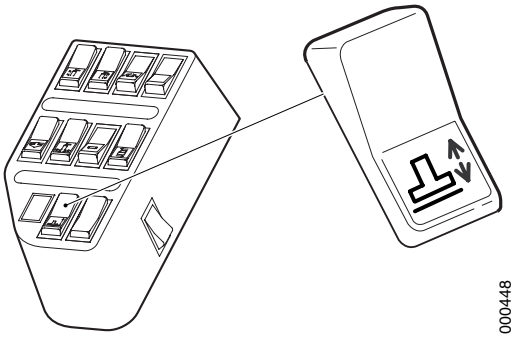
7.1.5 Switch stop at 30' or 35'

Switch stop at 30’ or 35’, description

Switch stop at 30’ or 35’ (S1004) activates 30 and 35 foot stop. When the switch is pressed down the positioning function changes from 20’–40’ to stop at 30’.

The switch is supplied with voltage from and sends a voltage signal to Control unit cab (D790-1).

The signal can be checked with from the menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.2 ATTACH, menu 2*.


000448

7.1.6 Switch support jacks

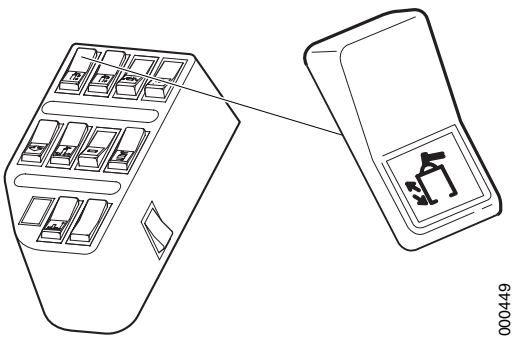
Switch support jacks, description

Switch support jacks (S1013) controls the support jacks. The switch has three positions: a neutral position and two rocker positions.

- Support jacks up
- Resting position
- Support jacks down

The switch is supplied with voltage from and sends two voltage signals to Control unit cab (D790-1).

The signals can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.3 SUPPORT-JACKS, menu 1*.


000449

7.1.7 Switch to lower front legs

Switch lowering front legs, description

Switch lowering front legs (S1006) controls lowering of the front lift legs on attachment with lift legs, see *Raising/lowering of front lift legs, function description page 114*. The switch has three positions: one neutral position and two rocker.

- Front legs up
- Resting position
- Front legs down

Legs are lowered according to a set sequence. The switch must be held down during the entire sequence. The sequence is reversed when the legs are raised.

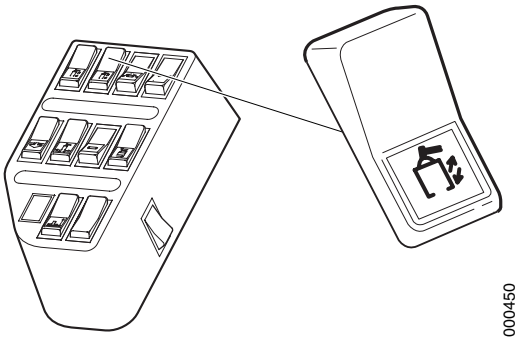
1. Left knee
2. Left leg
3. Right knee
4. Right leg

The switch is supplied with voltage from and sends a voltage signal to Control unit cab (D790-1).

The signals can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 1*.

7.1.8 Switch to lower rear legs

Switch lowering rear legs, description



Switch lowering rear legs (S1007) controls lowering of the rear lift legs on attachment with lift legs, see *Raising/lowering of rear lift legs, function description page 118*. The switch has three positions: one neutral position and two rocker.

- Rear legs up
- Resting position
- Rear legs down

Legs are lowered according to a set sequence. The switch must be held down during the entire sequence. The sequence is reversed when the legs are raised.

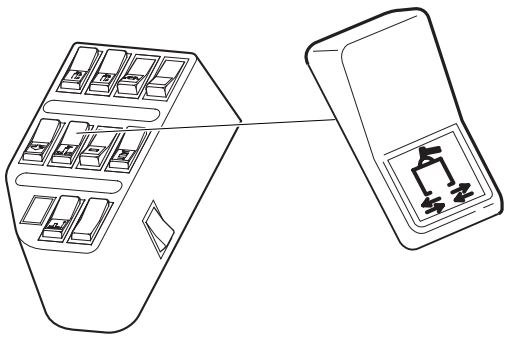
1. Left knee
2. Left leg
3. Right knee
4. Right leg

The switch is supplied with voltage from and sends a voltage signal to Control unit cab (D790-1) when the switch is activated.

The signals can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 1*.

7.1.9 Switch clamp/loose leg

Switch clamping/releasing legs, description

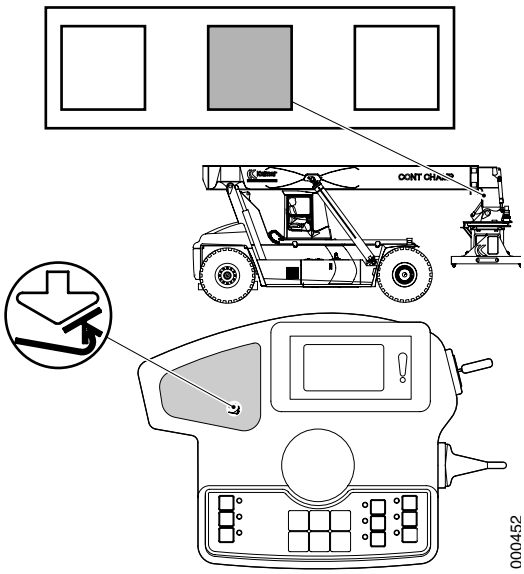


Switch clamping/releasing legs (S1008) controls clamping and releasing with lift legs on attachment with lift legs, see *Clamp with left legs, function description page 123*. The switch has three positions, resting position and two rocker.

1. Release
2. Resting position
3. Clamp

The switch is supplied with voltage from and sends a voltage signal to Control unit cab (D790-1) when the switch is activated.

The signals can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 1*.



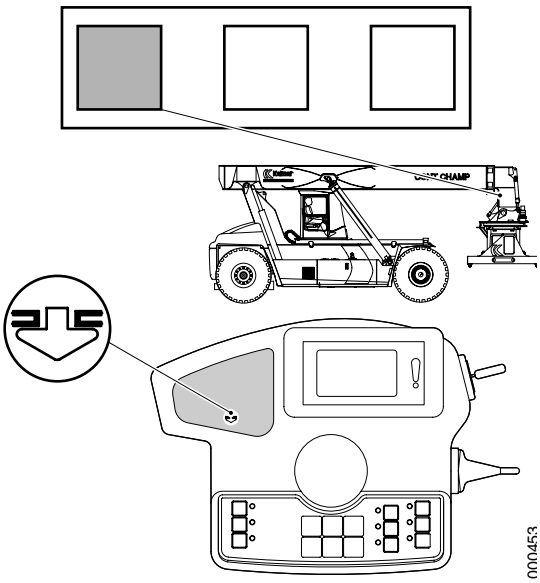
7.1.10 Indicator light alignment

Indicator light alignment, description

Alignment is indicated by two indicator lights, one on the light panel in the cab and one on the light panel on the boom nose. The indicator lights are activated when the attachment has contact with the container. This indicates when twistlocks can be activated.

The alignment indicator light in cab is supplied with voltage by Control unit KIT (D790-2).

Indicator light alignment (H564) on boom nose (orange) is supplied with voltage by Control unit attachment (D791). The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.10 ATTACH, menu 10*.



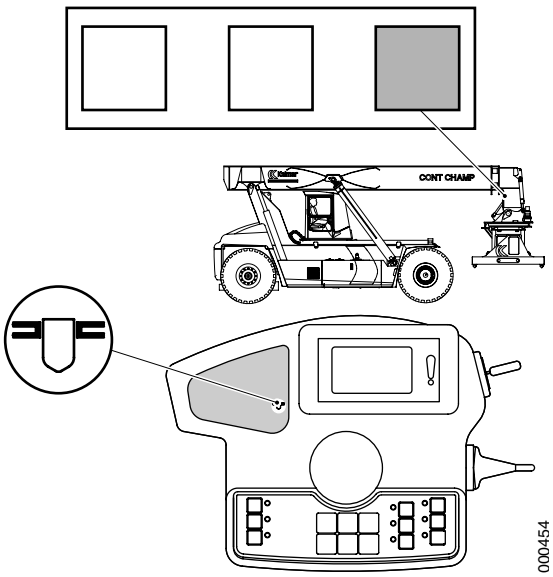
7.1.11 Indicator light locked twistlocks

Indicator light locked twistlocks, description

Locked twistlocks are indicated by two indicator lights, one on the light panel in the cab and one on the light panel on the boom nose. The indicator lights are activated when the twistlocks are locked.

The light in the cab is supplied with voltage by Control unit KIT (D790-2).

Indicator light for locked twistlocks (H563) on boom nose (green) is supplied with voltage by Control unit attachment (D791). The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.10 ATTACH, menu 10*.



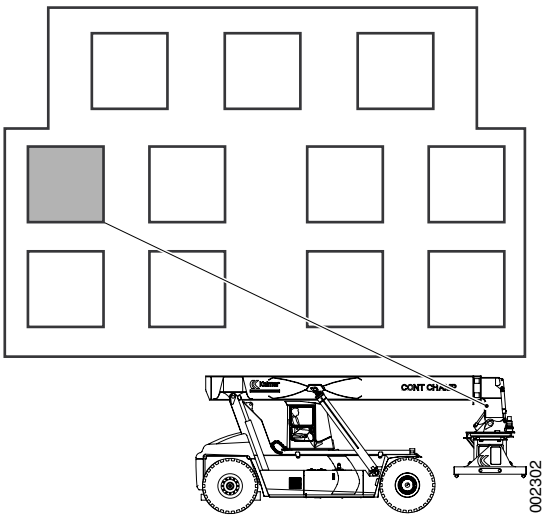
7.1.12 Indicator light unlocked twistlocks

Indicator light unlocked twistlocks, description

Unlocked twistlocks are indicated with two indicator lights, one on the light panel in the cab and one on the light panel on the boom nose. The indicator lights are activated when the twistlocks are unlocked.

Light in the cab is supplied with voltage by Control unit KIT (D790-2).

Indicator light for unlocked twistlocks (H565) on boom nose (red) is supplied with voltage by Control unit attachment (D791). The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.10 ATTACH, menu 10*.



7.1.13 Indicator light alignment left front leg

Indicator light alignment left front leg, description

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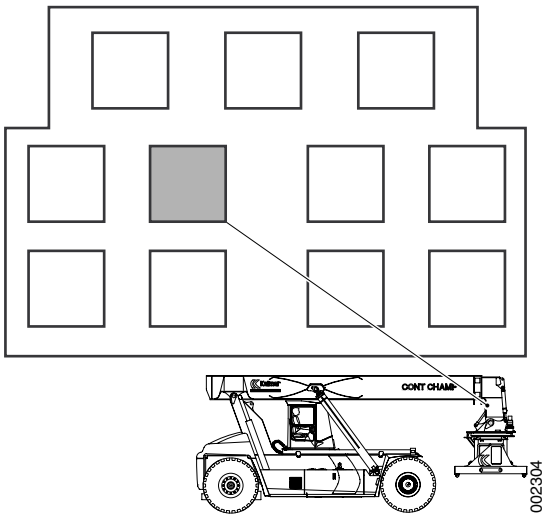
The indicator light is activated when left front leg has alignment with load.

Indicator light alignment left front leg (H566L) is supplied with voltage at activation by Control unit attachment left legs (D791-3).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI*, menu 7.

7.1.14 Indicator light alignment right front leg

Indicator light alignment right front leg, description



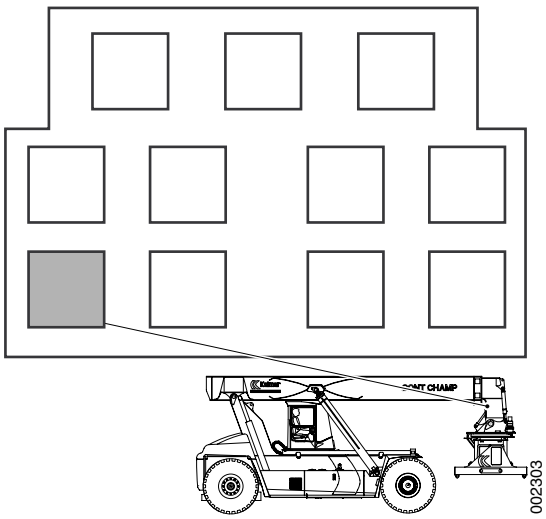
The indicator light is activated when right front leg has alignment with load.

Indicator light alignment right front leg (H566R) is supplied with voltage at activation by Control unit attachment left legs (D791-3).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI*, menu 7.

7.1.15 Indicator light alignment left rear leg

Indicator light alignment left rear leg, description



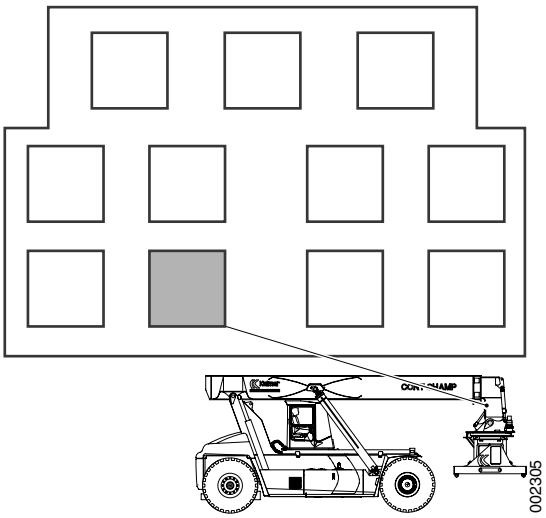
The indicator light is activated when left rear leg has alignment with load.

Indicator light alignment left rear leg (H567L) is supplied with voltage at activation by Control unit attachment left legs (D791-3).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI*, menu 7.

7.1.16 Indicator light alignment right rear leg

Indicator light alignment right rear leg, description



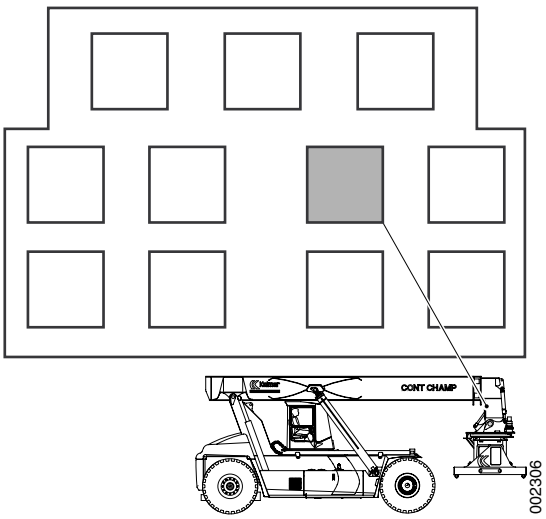
The indicator light is activated when right rear leg has alignment with load.

Indicator light alignment rear right leg (H567R) is supplied with voltage at activation by Control unit attachment left legs (D791-3).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI*, menu 7.

7.1.17 Indicator light clamping position front legs

Indicator light clamping position front legs, description



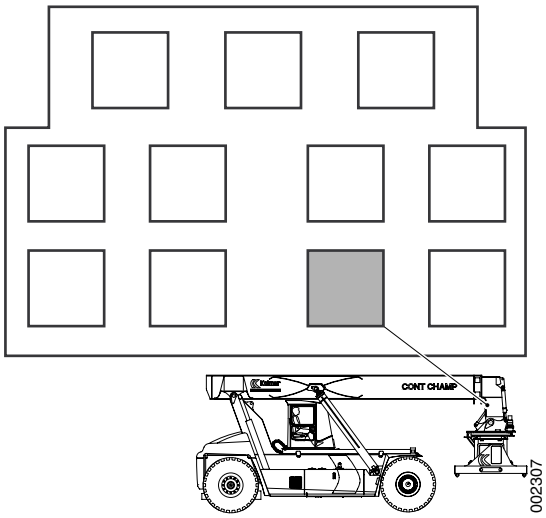
The indicator light is activated when the front leg pair clamps against load.

Indicator light clamping position front legs (H578) is supplied with voltage at activation by Control unit attachment right leg pair (D791-4).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI*, menu 8.

7.1.18 Indicator light clamping position rear legs

Indicator light clamping position rear legs, description



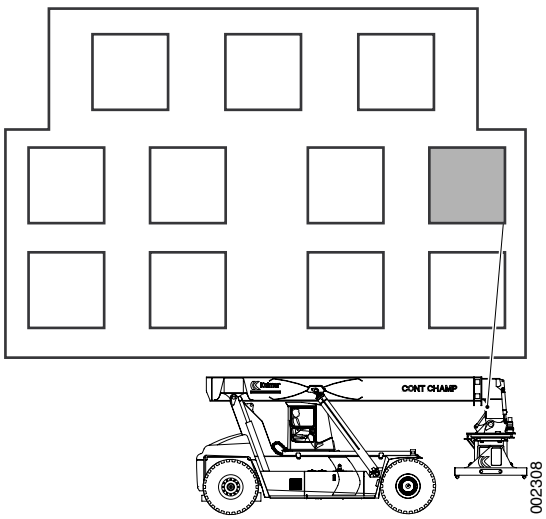
The indicator light is activated when the rear leg pair clamps against load.

Indicator light clamping position rear legs (H579) is supplied with voltage at activation by Control unit attachment right leg pair (D791-4).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI*, menu 8.

7.1.19 Indicator light front legs raised

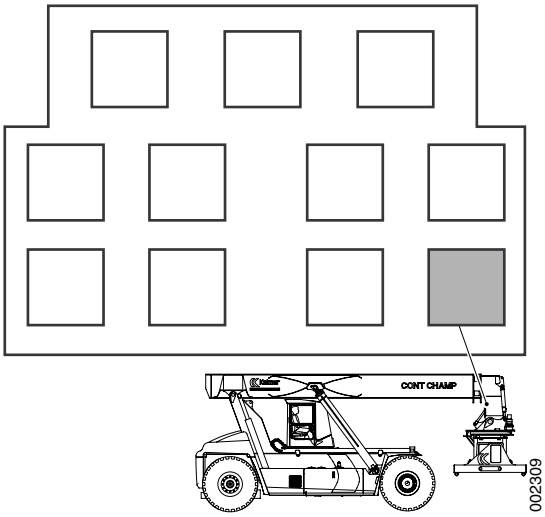
Indicator light front legs raised, description



The indicator light is activated when the front leg pair is up.

Indicator light front legs raised (H580) is supplied with voltage at activation by Control unit attachment right leg pair (D791-4).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI*, menu 9.



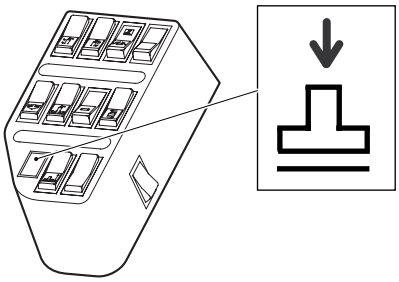
7.1.20 Indicator light front legs lowered

Indicator light front legs lowered, description

The indicator light is activated when the front leg pair is down.

Indicator light front legs lowered (H581) is supplied with voltage at activation by Control unit attachment right leg pair (D791-4).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI*, menu 9.



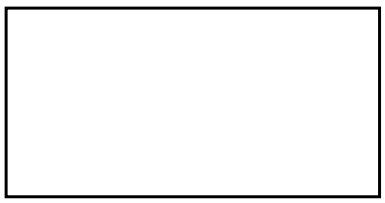
7.1.21 Indicator light support jacks down

Indicator light support jacks down, description

Indicator light support jacks down (H574) is activated when the support jacks are completely down. The event menu is shown when the support jacks are moving.

Light is supplied with voltage by Control unit cab (D790-1).

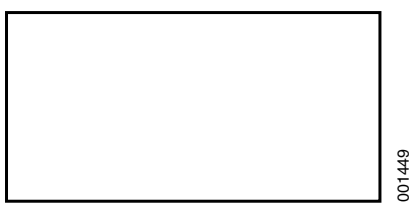
The signals can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.3 SUPPORT-JACKS, menu 4*.



7.1.22 Event menu support jacks

Event menu support jacks, description

This display is shown when the support jacks are moving. See *Support jacks, function description page 139*.



7.1.23 Event menu rotation stop

Event menu rotation stop, description

This display figure is shown when rotation stop is activated. See *Rotation stop, function description page 75*.

7.1.24 Event menu alignment

Event menu alignment, description

This display figure is shown when sensor alignment is activated and shows which twistlocks have alignment. Filled ring indicates alignment. See *Twistlocks, function description page 105*.

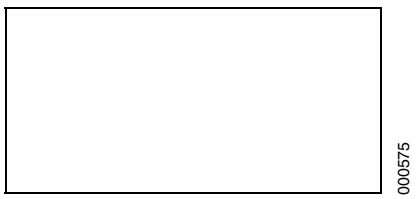
7.1.25 Event menu lift legs

Event menu alignment lift legs, description

This display figure is shown when lift leg sensor for alignment or for clamping position is activated. Filled ring means alignment, filled arrow means clamping position. The display figure is shown automatically when the first sensor is activated and goes off when all sensors are activated. See *Clamp with left legs, function description page 123*.

7.1.26 Operating menu fixed scale

Operating menu fixed scale, description



This display figure shows weight when the scale is activated with the control lever. See *Weight indicator, function description (product alternative fixed scale) page 146*.

7.1.27 Operating menu dynamic scale

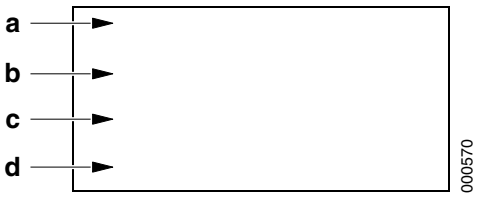
Operating menu dynamic scale, description

a. load weight in tonnes
b. load centre in relation to the centre of the drive axle in metres
c. utilised load capacity for current load centre in %

Machines with dynamic scale show this display figure menu of the load's weight, location and utilisation of the machine's capacity.

The bar c shows how large a part of the machine's load capacity is being utilised for the current boom position, e.g. if the load is constant and if the boom is extended then the utilised capacity (the full bar) will increase. Consequently the bar shows how big a margin there is until the overload protection cuts in. 100% means that the overload limit is reached.

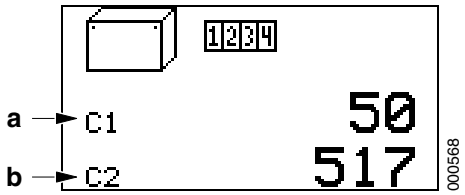
See *Weight indicator, function description (product alternative dynamic scale) page 147*.



7.1.28 Operating menu control of dynamic scale

Operating menu checking dynamic scale, description

This display shows the load's weight in tonnes (a), boom protruding in meters (b), load centre's distance to the drive axle centre (c) and boom angle (d). See *Weight indicator, function description (product alternative dynamic scale) page 147*.



7.1.29 Operating menu container counter

Operating menu container counter

The display shows the current value for the container counter. C1 and C2 are separate counters that can be reset individually. See *Container counter, function description (product alternative top lift) page 149* and *Container counter, function description (product alternative bottom lift) page 151*.

7.1.30 Event menu twistlocks

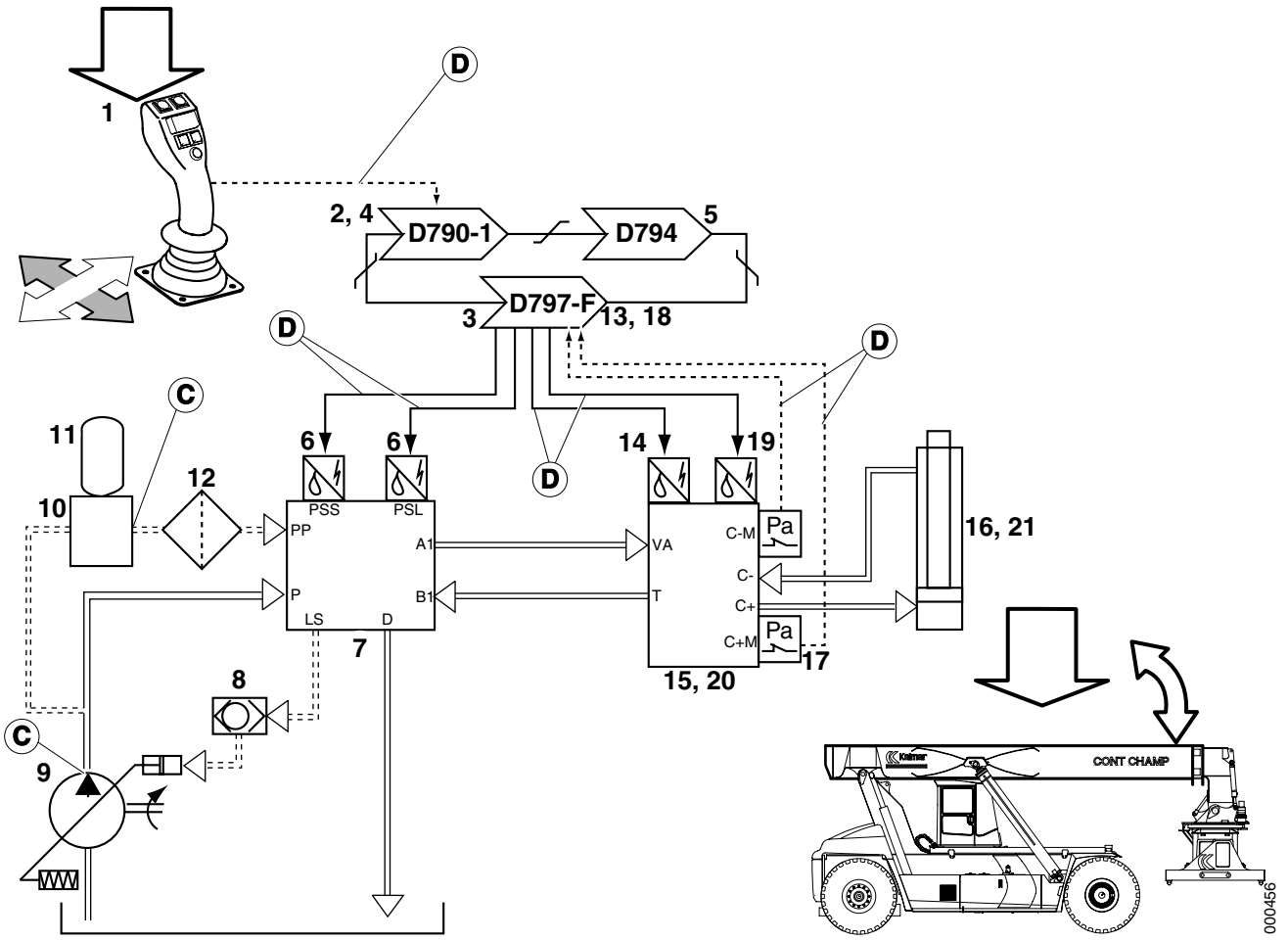
Event menu twistlocks, description

This display is shown if lift is started and twistlocks are not in locked or unlocked positions. See *Twistlocks, function description page 105*.

7.2 Lifting/lowering

Lift and lower, function description

Condition	Reference value	Reference
Emergency stop	Disengaged	Section *11 Common electrics*, group *11.5.1.4 Emergency stop voltage (15E)*
Twistlocks	Locked or unlocked, not intermediate position	*Twistlocks, description page 110*
Overload protection	Boom up: passive Boom down: passive or by-pass activated	Section *8 Control system*, group *8.2.1 Overload protection*.
Alignment	Boom down: no alignment	*Maintenance manual DRF 400–450,* section *7 Load handling,* group *7.9.1 Twistlocks*



Pos	Explanation	Signal description	Reference
1	Control lever (S815-P1) sends voltage signal proportional to lever movement to Control unit cab (D790-1).	Lower: $U_{S815\text{-}P1}$ = 0.5–2.0 V Zero position: $U_{S815\text{-}P1}$ = 2.0–3.0 V Lift: $U_{S815\text{-}P1}$ = 3.0–4.5 V 0.5 V is the highest lowering speed and 4.5 V is the highest lifting speed Lower voltage than 0.5 V and higher voltage than 4.5 V is used to detect defects in cable harnesses and controls.	*Control lever, description page 7* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.8.1 BOOM, menu 1*
2	Control unit cab (D790-1) sends request for Boom up *or Boom down* with speed information on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
3	Control unit frame front (D797-F) activates Servo valve, lift (Y6005) *or Servo valve, lower (Y6004)*.	I = 380–650 mA	*Control valve lift lower and protruding, description page 26* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.8.4 BOOM, menu 4 and 8.4.8.5 BOOM, menu 5*
4	Control unit cab (D790-1) sends request for increased engine rpm on CAN-bus	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
5	Control unit engine (D794) increases engine rpm.	Controlled by control system, error shown with error code.	-
6	Servo valve, lift (Y6004) *or Servo valve, lower (Y6005)* pressurizes control valve's lift spool with servo pressure.	-	*Control valve lift lower and protruding, description page 26* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.8.4 BOOM, menu 4 and 8.4.8.5 BOOM, menu 5*
7	The control valve's lift spool changes position and pressurizes valve block lift cylinder and sends load signal to the hydraulic oil pumps.	-	*Control valve lift lower and protruding, description page 26*
8	The shuttle valve sends the strongest load signal if several functions are activated simultaneously.	-	Section *10 Common hydraulics,* group *10.5.3 Shuttle valve*
9	The hydraulic oil pumps pump oil from the hydraulic oil tank.	See pressure plate on left frame beam.	Section *10 Common hydraulics*, group *10.4 Pumps*
10	The pressure reducer reduces the oil pressure from the hydraulic oil pumps to servo pressure for the control valve.	See pressure plate on left frame beam.	*Pressure reducer, description page 24*

Pos	Explanation	Signal description	Reference
11	The accumulator stores servo pressure. The non-return valve in the pressure reducer enables the pressure to be stored when the engine is turned off.	See pressure plate on left frame beam.	*Accumulator servo circuit, description page 24*
12	The servo filter cleans the servo oil before the control valve.	-	*Servo filter, description page 23*
13	At boom down Control unit frame front (D797-F) activates Servo valve, blocking right (Y6001) and Servo valve, blocking left (Y6002).	U = 24 V	*Valve block lift cylinder, description page 27* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.8.2 BOOM, menu 2*
14	For boom down, Servo valve, blocking right (Y6001) and Servo valve, blocking left (Y6002) affect the blocking valves in the valve blocks for left and right lift cylinder, respectively.	-	*Valve block lift cylinder, description page 27* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.8.2 BOOM, menu 2*
15	For boom up, the blocking valves are opened in the valve blocks for left and right lift cylinder, respectively, by the hydraulic pressure from the control valve. For boom down, the blocking valve opens and releases pressure from the lift cylinder.	-	*Valve block lift cylinder, description page 27*
16	The lift cylinders' piston side are pressurized and the boom lifts.	-	*Lift cylinder, description page 31*
17	**Regeneration** Sensor hydraulic pressure lift cylinder piston side left (B768-12) sends voltage signal proportional to oil pressure to Control unit frame front (D797-F). **NOTE** *Regeneration is not possible near end-position or at overload protection.*	Conn. 1: U = 5 V Conn. 2: U = 0 V Conn. 3: U = 0.5–4.5 V Regeneration is activated when the pressure in the lift cylinders is 85 bar, regeneration is interrupted if the pressure reaches 185 bar.	*Sensor hydraulic pressure lift cylinder, description page 32* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.10.3 OP, menu 3*
18	Control unit frame front (D797-F) activates Solenoid valve regeneration right (Y6051) and Solenoid valve regeneration left (Y6052) if the pressure is sufficiently low for regeneration.	U = 24 V	*Valve block lift cylinder, description page 27* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.8.3 BOOM, menu 3*

Pos	Explanation	Signal description	Reference
19	Servo valve, regeneration pressurizes the regeneration valve.	-	*Valve block lift cylinder, description page 27*
20	The regeneration valve changes position and leads oil from the lift cylinder's rod side to the piston side.	-	*Valve block lift cylinder, description page 27*
21	Lift speed increases.	-	-
22	When the boom nears an end-position, damping is activated.	-	Mechanical overload protection, function description Section *8 Control system,* group *8.2.1.2 Mechanical overload protection with analogue sensors* Section *8 Control system,* group *8.2.1.3 Electrical overload protection*

Hydraulic diagram A40740.0100

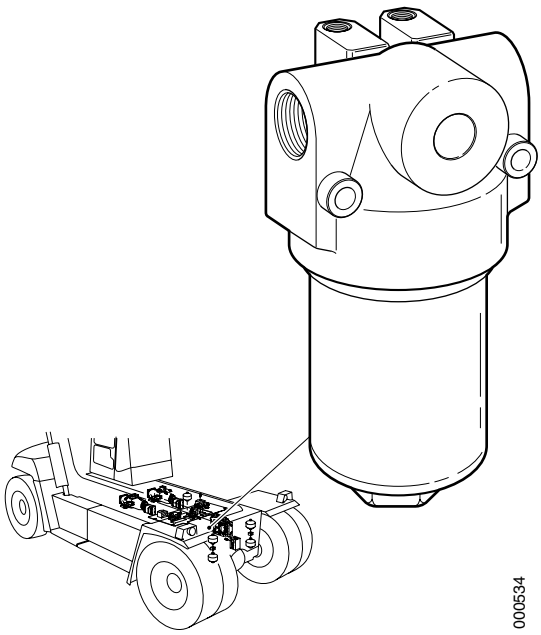
7.2.1 Hydraulic oil pump

Hydraulic oil pump, general

See section *10 Common hydraulics*, group *10.4.2 Axial piston pump with variable displacement*.

7.2.2 Servo filter

Servo filter, description



The servo filter protects the control valve's servo circuits against impurities. The servo filter is located in the front edge of the lift beam on the right-hand side in the engine bay, between the pressure reducer and control valve lift, lower and protruding.

The servo filter is a low pressure filter with detachable filter cartridge. The oil is cleaned when it passes through the filter cartridge filter material.

The filter cartridge is pressed against the upper section of the filter housing by a spring. Rubber gaskets seal between cartridge and filter housing. If the back pressure through the filter is too great the cartridge is pressed down so that the oil passes through the cartridge. This occurs if the oil is viscous (cold or incorrect viscosity) or if the filter cartridge is clogged.

Servo filter, replacement

See *Maintenance manual DRF 400–450*.

7.2.3 Pressure reducer

Pressure reducer, description

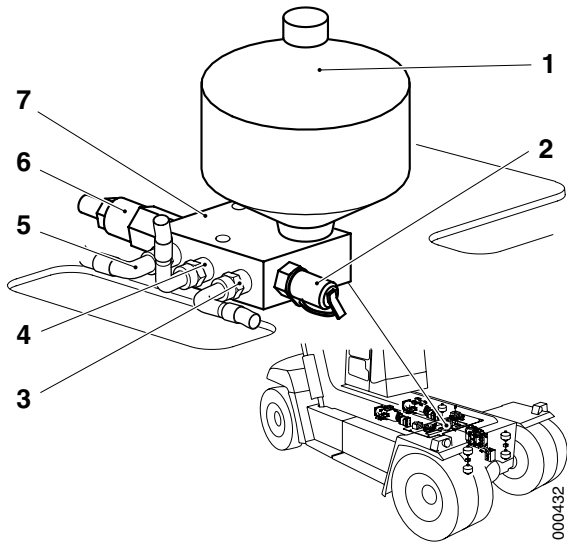
The pressure reducing valve reduces the pressure from the hydraulic oil pumps to servo pressure for the control valve. The pressure reducer is located to the right of the lift beam in the engine bay assembled with the accumulator for servo pressure.

Servo pressure is stored in an accumulator. An integral non-return valve prevents pressure leaks from the accumulator when the machine is not being used.

The pressure reducer is located in the lift beam assembled with the accumulator for servo pressure.

The pressure reducer reduces the pressure from the main pumps to servo pressure for the control valve. Servo pressure is stored in an accumulator for faster starting.

An integral non-return valve prevents pressure leaks from the accumulator when the machine is not being used.



1. Accumulator servo pressure
2. Test outlet, servo pressure
3. Pressure supply from servo filter
4. Return to tank
5. Servo pressure to control valve
6. Adjusting screw, servo pressure.

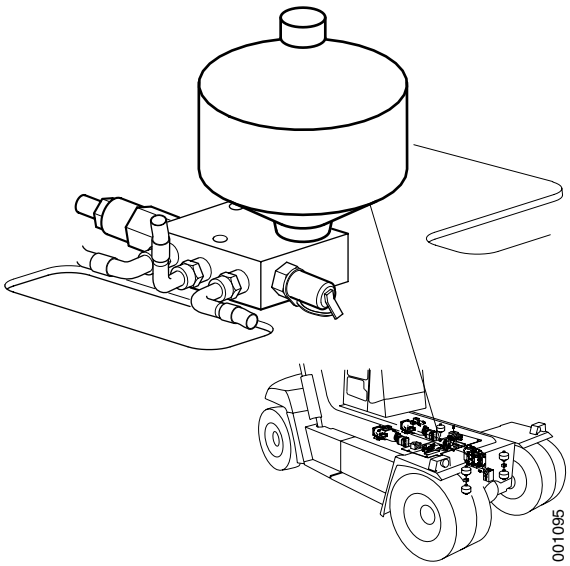
7.2.4 Accumulator servo circuit

Accumulator servo circuit, description

The accumulator stores pressurised oil and ensures that there is servo pressure for activating the control valve's functions. The accumulator is located on the pressure reducer to the right of the lift beam in the engine bay.

The accumulator is a diaphragm type and is divided into two spaces by a diaphragm. One side of the diaphragm is pressurised with nitrogen gas. The other side is pressurised by hydraulic oil which compacts the nitrogen gas.

Furthest up on the accumulator is a test outlet for checking gas pressure and filling gas.



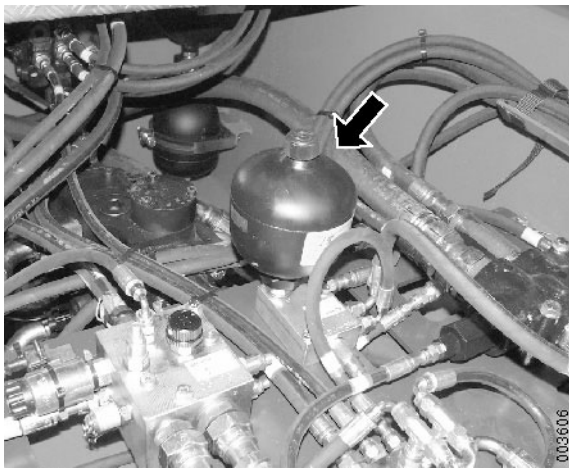
Accumulator servo circuit, replacement

WARNING

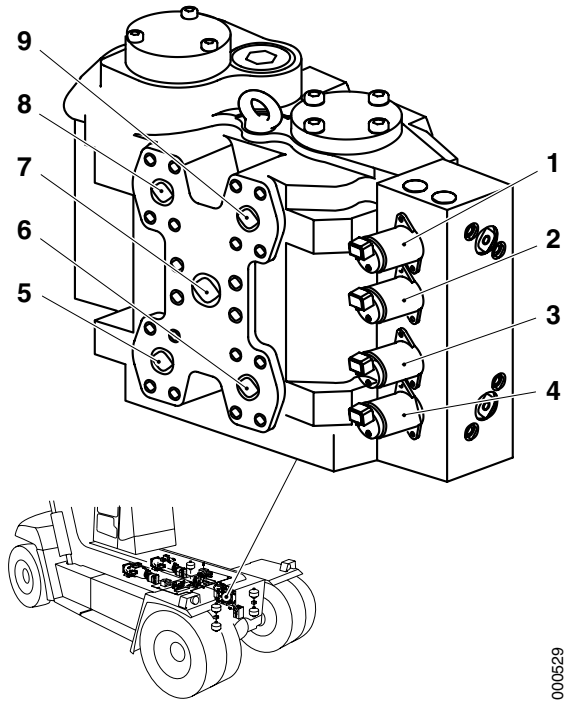
Hot, pressurised oil.

Personal injury, burn injury, rash or irritation

Always depressurise the hydraulic systems before starting to work on the hydraulic systems. Avoid skin contact with the oil, use protective gloves.



1 Depressurise the brake and hydraulic systems, see section *B Safety*.
2 Machine in service position, see section *B Safety*.
3 Detach the accumulator from its mounting.
4 Replace the accumulator.
5 Fit in the reverse order.
6 Check the oil level and fill with hydraulic oil as necessary.



1. Servo valve boom out (Y6006)
2. Servo valve boom in (Y6007)
3. Servo valve lower (Y6004)
4. Servo valve lift (Y6005)
5. Connection, rod side, right lift cylinder (B2)
6. Connection, piston side, right lift cylinder (A1)
7. Connection, feed from hydraulic oil pumps (P)
8. Connection, rod side, protrude cylinder (B1)
9. Connection, piston side, protrude cylinder (A1)

7.2.5 Manoeuvre valve lift, lower, protrude

Control valve lift lower and protruding, description

The control valve controls the speed and direction of lift and protruding. The control valve is located on a bracket in the space between the lift beam and front axle.

The valve has two sections: one for the lift function and one for boom protruding. The sections have great similarities but are described separately for each function. For protruding, see *Control valve lift, lower and protrude, description page 40*. Electric servo valves control the flow from the valve.

The control valve is a proportion valve controlled by servo valves. This means that both size and direction of flow from the valve can be adjusted and that the valve also sends a control signal to the variable pumps.

Electrically controlled pressure reducing valves (servo valves) convert electrical current to a small hydraulic pressure proportional to the current, so-called "servo pressure". The servo pressure acts on spring centred control slides in the control valve for the function in question and this way control the main flow.

The speed of the function is controlled by means of the flow being regulated in proportion to the lever movement.

Lift slide

The lift slide controls direction and flow of oil to the lift cylinder.

Servo valve lift

Servo valve lift controls servo pressure to the lift slide so that this controls oil pressure for lift. The valve is controlled electrically with Solenoid valve lift (Y6005) which is activated by Control unit frame front (D797-F).

The signals can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.8.4 BOOM, menu 4*.

Servo valve lower

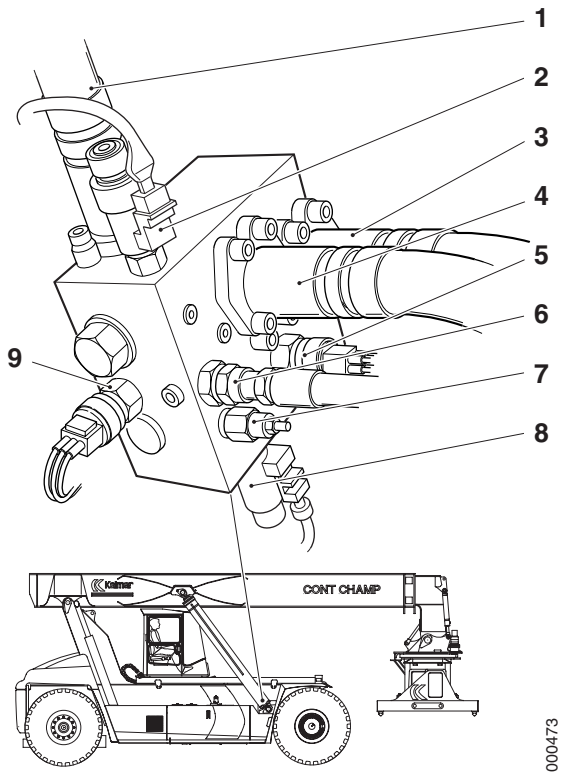
Servo valve lower controls servo pressure to the lift slide so that it controls oil pressure for lowering. The valve is controlled electrically with Solenoid valve lower (Y6004) which is activated by Control unit frame front (D797-F).

The signals can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.8.5 BOOM, menu 5*.

7.2.6 Shuttle valve

Shuttle valve, description

See section *10 Common hydraulics*, group *10.5.3 Shuttle valve*.



1. Connection, rod side, lift cylinder (C-)
2. Servo valve, regeneration (Y6051 or Y6052)
3. Connection, pressure supply (VA)
4. Connection tank (T)
5. Pressure sensor, piston side (C+M)
6. Drain servo valves (D)
7. Shock valve
8. Servo valve, blocking (Y6001 or Y6002)
9. Pressure sensor, rod side (C-M)

7.2.7 Valve block lift cylinder

Valve block lift cylinder, description

Valve block lift cylinder directs the oil to the lift cylinder and is bolted directly on the lower part of the lift cylinder. The valve block contains a blocking valve, regeneration valve, non-return valve and shock valve.

Blocking valve

The blocking valve prevents unwanted lowering and angling of the lift cylinders. The blocking valve holds the load by ensuring that the connection to the lift cylinder's piston side is closed. (The pressure passes through a restriction as blocking pressure and holds the valve slide closed.)

Servo valve blocking affects the blocking valve. The servo valve is controlled electrically with Solenoid valve, blocking left (Y6002) and Solenoid valve, blocking right (Y6001), which are activated by Control unit frame front (D797-F).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.8.2 BOOM, menu 2*.

Regeneration valve

The regeneration valve directs oil from the cylinder's rod side back to the piston side. This makes it possible to re-use the oil for lifting. For more information on regeneration, see *Maintenance manual DRF 400–450,* section *7 Load handling*. The regeneration valve is controlled by servo valve regeneration.

Servo valve for regeneration actuates the regeneration valve. The servo valve is controlled electrically with Solenoid valve, regeneration right (Y6051) and Solenoid valve, regeneration left (Y6052), which are activated by Control unit frame front (D797-F).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.8.3 BOOM, menu 3*.

Shock valve

The shock valve protects the hydraulic system against surges which can occur when operating with a load. The shock valve opens a connection between the lift cylinder piston side and tank if the pressure becomes too high.

Non-return valve

The non-return valve prevents oil from flowing the wrong way during regeneration.

Valve block lift cylinder, replacement

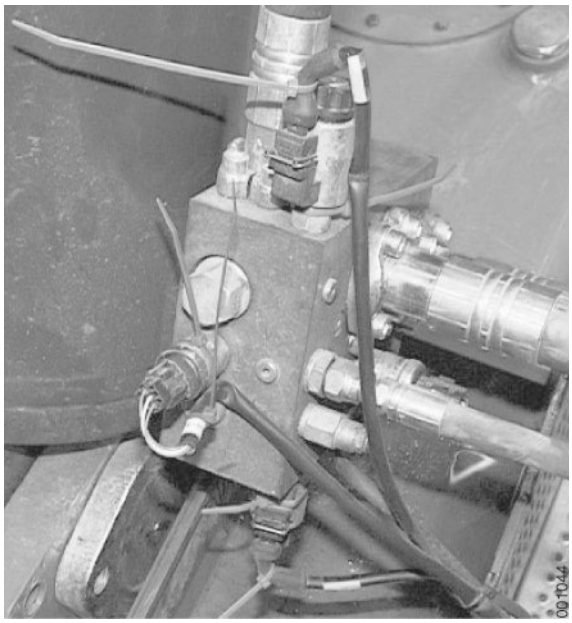
WARNING

Hot, pressurised oil.

Personal injury, burn injury, rash or irritation

Always depressurise the hydraulic systems before starting to work on the hydraulic systems. Avoid skin contact with the oil, use protective gloves.

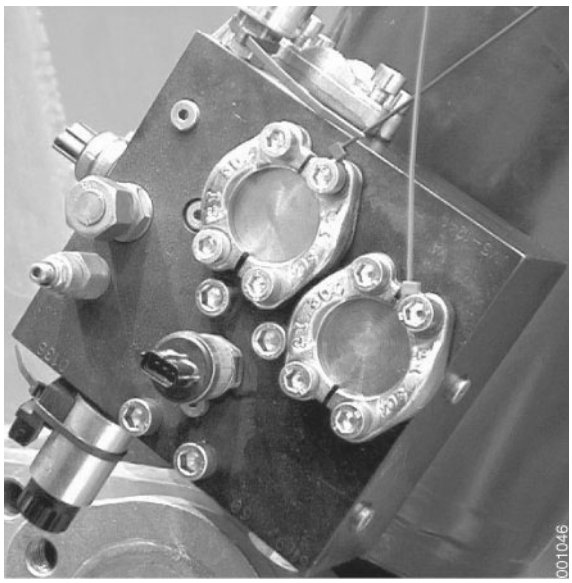
1 Clean the valve block and its surrounding area.
2 Park the machine with the boom lowered and fully retracted.
3 Turn off the engine and turn the start key to position I.
4 Depressurise the brake and hydraulic systems, see section *B Safety*, *Hydraulic and brake systems, depressurising*.
5 Turn the start key to position 0 and turn off the main electric power.
6 Position a collection container under the valve block to collect any spilled oil.
7 Mark up and detach the wiring from the valve block.
8 Remove the wiring clamping at the valve block.



9 Mark up and detach the hydraulic hoses from the valve block.

NOTE

Plug all connections immediately to protect the hydraulic system from impurities.



10 Remove the valve block from the lift cylinder.

Remove the attaching bolts and lift away the valve block.

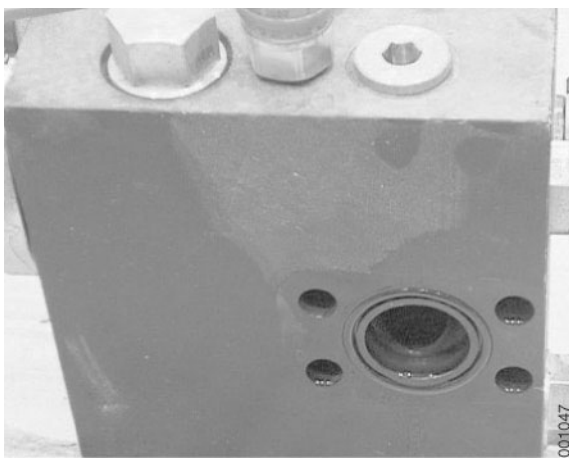
11 Transfer the connection adapters, sensors and servo valves to the new valve block.

NOTE

Check that the O-rings are intact and correctly fitted.

NOTE

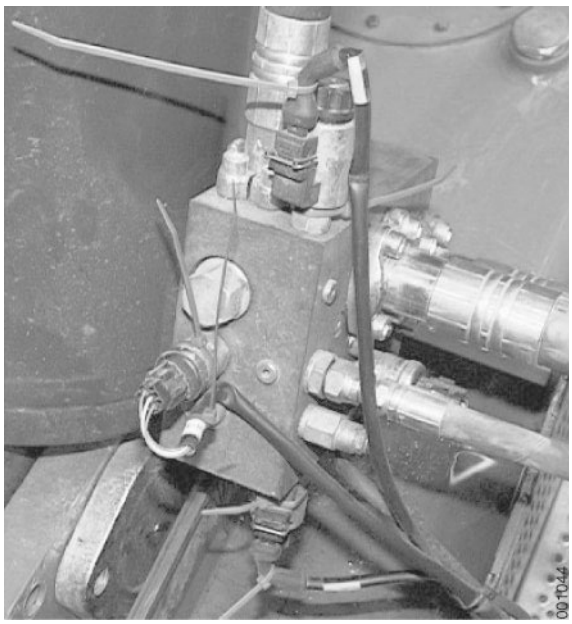
Transfer one part at a time so that the marking is not mixed up.



12 Fit a new valve on the lift cylinder.

NOTE

Check that the O-rings are intact and correctly fitted.



13 Connect the hydraulic hoses to the valve block in accordance with the marking.

NOTE

Check that the O-rings are intact and correctly fitted.

14 Connect the wiring to the valve block in accordance with the marking.

15 Clamp the cable harness as before.

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

17 Activate lift carefully.

⚠ CAUTION

Air in the hydraulic system can cavitate.

Product damage.

Activate the functions carefully and operate at the lowest possible speed a couple of times to avoid cavitation.

18 Check that the valve block's hydraulic connections are sealed and that lift and lower function correctly.

19 Remove the collection container, treat the oil as environmentally hazardous waste.

20 Clean the area surrounding the valve block.

21 Check the hydraulic oil level with the lift cylinders completely down and the protrude cylinder completely in. The oil level should be at the top of the level glass. Top up if needed.

⚠ CAUTION

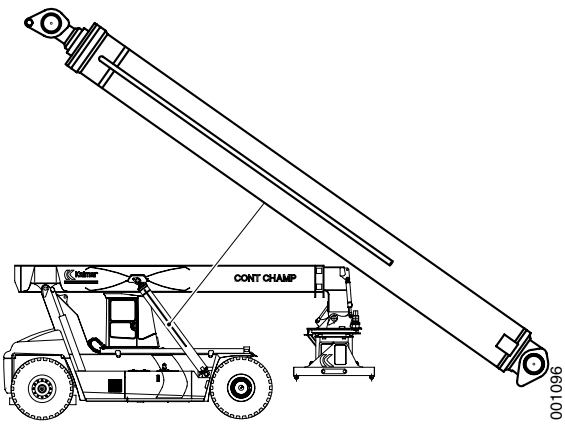
Overfilling of oil.

Leakage and environmental damage.

The hydraulic oil level is checked with the boom completely lowered and retracted.

7.2.8 Lift cylinder

Lift cylinder, description



The lift cylinders lift and lower (angle) the lift boom. The lift cylinders are located between boom and frame in the front edge of the machine, one on the right and one on the left-hand side.

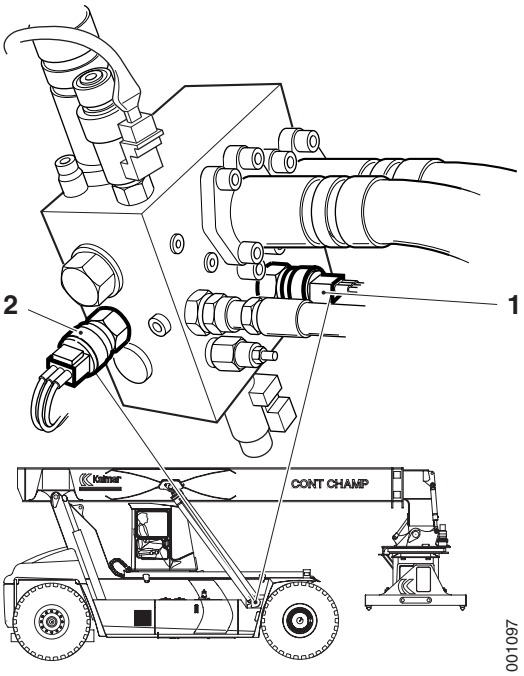
On each lift cylinder is a valve block which controls pressurising and regeneration of the lift cylinder.

The lift cylinder is equipped with pivot bearings both in the cylinder and the piston rod bracket. The piston rod bracket is threaded in the piston rod and locked with a lock nut.

The lift cylinders are connected in parallel and fed from control valve lift, lower and protruding, see *Control valve lift lower and protruding, description page 26*.

Hydraulic cylinders, repairing

See section *10 Common hydraulics,* group *10.7.1 Hydraulic cylinders*.



1. Sensor hydraulic pressure lift cylinder piston side left (B768-12)
   Sensor hydraulic pressure lift cylinder piston side right (B768-10) ⊞
2. Sensor hydraulic pressure lift cylinder rod side left (B768-11) ⊞
   Sensor hydraulic pressure lift cylinder rod side right (B768-13) ⊞

7.2.9 Sensor hydraulic pressure lift cylinder

Sensor hydraulic pressure lift cylinder, description

Sensor hydraulic pressure lift cylinder measures the pressure in the lift cylinders and is located on valve block lift cylinder.

The pressure is measured to decide if regeneration can be engaged. A sensor measures the pressure on the piston side on the left-hand lift cylinder.

⊞

If the machine is equipped with the option fixed scale an extra pressure sensor is used, on the piston side for the right lift cylinder.

⊞

If the machine is equipped with the option electrical dynamic scale a total of four pressure sensors are used for rod side and piston side on right and left-hand lift cylinder, respectively.

The sensors are supplied with voltage from and send a voltage signal proportional to hydraulic oil pressure to Control unit frame front (D797-F).

The signals can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.10.3 OP, menu 3*.

Sensor, hydraulic pressure, lift cylinder, replace

⚠ WARNING

Hot, pressurised oil.

Personal injury, burn injury, rash or irritation

Always depressurise the hydraulic systems before starting to work on the hydraulic systems. Avoid skin contact with the oil, use protective gloves.

1 Clean the sensor and its surrounding area.

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

3 Depressurise the brake and hydraulic systems, see section *B Safety*.

4 Position a collection container under the valve block to collect spilled oil.

5 Detach the wiring from the lift cylinder hydraulic pressure sensor.

6 Remove the lift cylinder hydraulic pressure sensor.

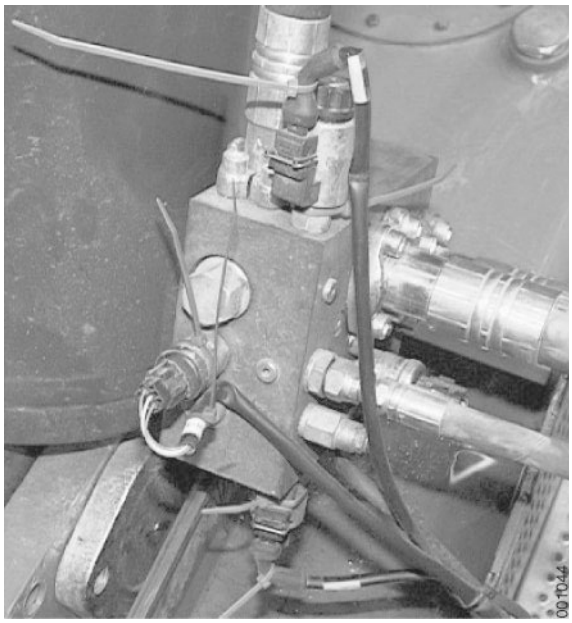
NOTE

Plug all connections immediately to protect the hydraulic system from impurities.

7 Fit a new sensor.

NOTE

Check that the O-rings are intact and correctly fitted.



8 Connect the wiring to the hydraulic pressure sensor.

9 Clamp the cable harness as before.

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

11 Activate lift carefully.

⚠ CAUTION

Air in the hydraulic system can cavitate.

Product damage.

Activate the functions carefully and operate at the lowest possible speed a couple of times to avoid cavitation.

12 Check that the valve block's hydraulic connections are sealed and that lift and lower function correctly.

13 Remove the collection container, treat the oil as environmentally hazardous waste.

14 Check the hydraulic oil level with the lift cylinders completely down and the protrude cylinder completely in. The oil level should be at the top of the level glass. Top up if needed.

⚠ CAUTION

Overfilling of oil.

Leakage and environmental damage.

The hydraulic oil level is checked with the boom completely lowered and retracted.

7.2.10 Lift boom

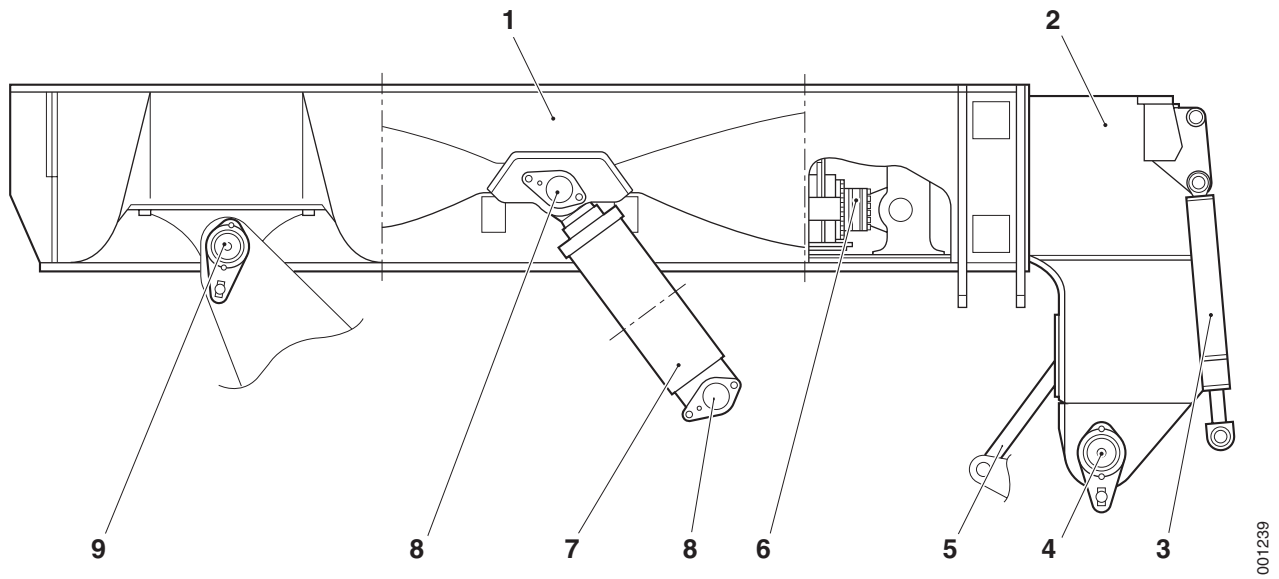
Lift boom, description

The lift boom lifts the load. The rear section of the boom is secured into the frame with two bearing-mounted shafts. In the front edge is a lift attachment and in the centre on each side of the boom are lift cylinders which are secured with bearing-mounted shafts. The lift cylinders angle the boom and raise the front section of the boom in this way. The lift boom is available in several versions depending on reach and load capacity.

The boom consists of outer boom and inner boom manufactured in high-strength steel with a minimum number of welds to provide maximum strength.

The inner boom runs in the outer boom and can be extended longitudinally with the protrude cylinder. There are slide plates between inner boom and outer boom which reduce the friction between them. The slide plates are located in the front edge of the outer boom and the rear edge of the inner boom.

Running along the left-hand side is a cable chain for hydraulic hoses and cables between outer and inner boom.



1. Outer boom
2. Inner boom
3. Tilt cylinder, right side
4. Mounting attachment
5. Tilt cylinder, left side
6. Protrude cylinder
7. Lift cylinder
8. Mounting, lift cylinder
9. Rear boom mounting

Slide plates, lift boom, general

See *Maintenance manual DRF 400–450*, section *7 Load handling*, group *7.3.10 Lift boom*.

7.2.11 Sensor boom angle

Sensor boom angle, general

See section *8 Control system*, group *8.2.1.2 Sensor boom angle*.

7.2.12 Pipes and hoses

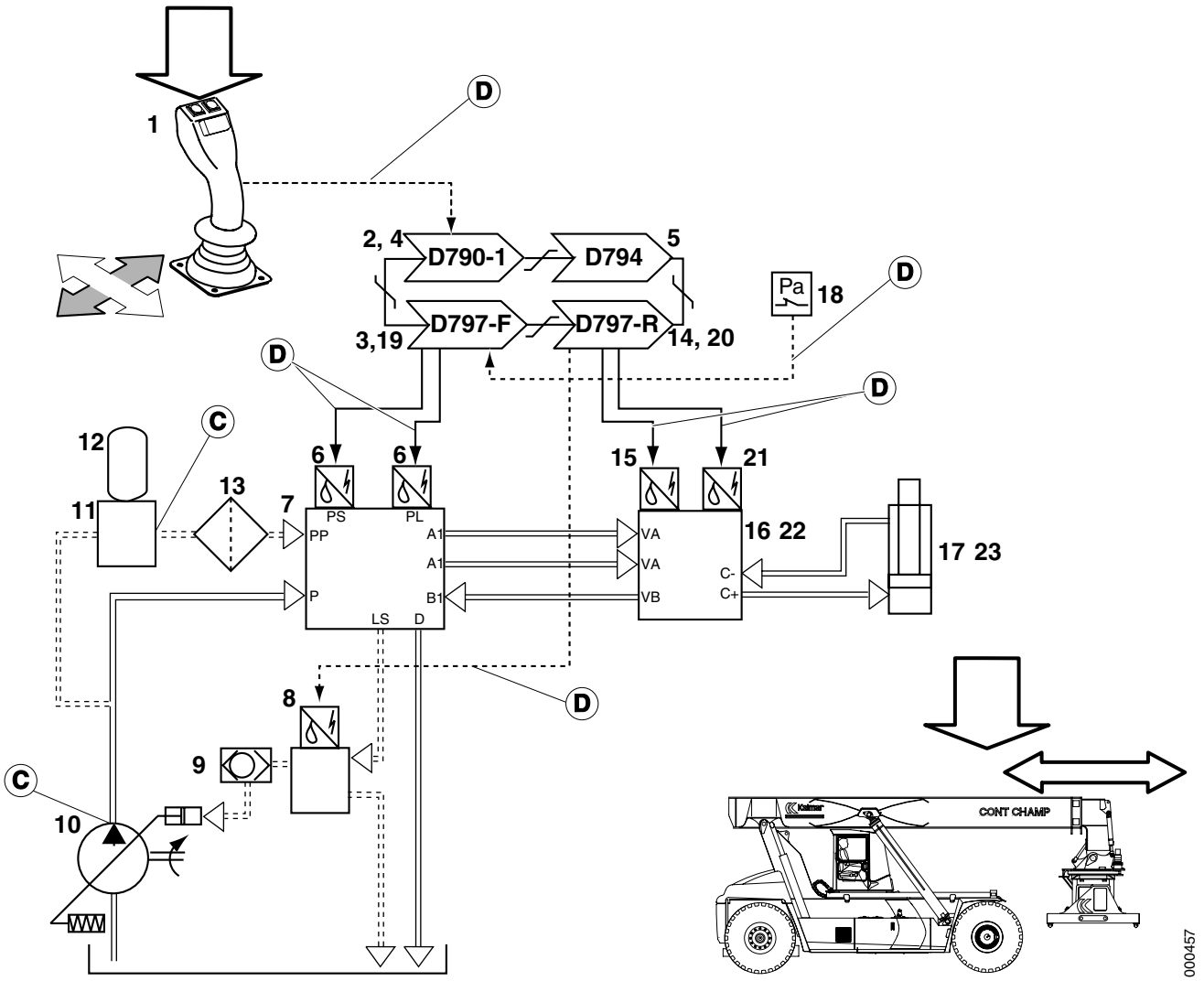
Pipes and hoses, description

See section *10 Common hydraulics*, group *10.5.1 Pipes and hoses*.

7.3 Protruding

Protruding, function description

Condition	Reference value	Reference
Emergency stop	Disengaged	Section *11 Common electrics*, group *11.5.1.4 Emergency stop voltage (15E)*
Overload protection.	Boom out: passive	Section *8 Control system*, group *8.2.1 Overload protection*.



Pos	Explanation	Signal description	Reference
1	Control lever (S815-P2) sends voltage signal proportional to lever movement to Control unit cab (D790-1)	Boom in: $U_{S815-P2}$ = 0.5–2.0 V Zero position: $U_{S815-P2}$ = 2.0–3.0 V Boom out: $U_{S815-P2}$ = 3.0–4.5 V 0.5 V is the highest retraction speed and 4.5 V is the highest protruding speed. Lower voltage than 0.5 V and higher voltage than 4.5 V is used to detect defects in cable harnesses and controls.	*Control lever, description page 7* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.8.1 BOOM, menu 1*
2	Control unit cab (D790-1) sends request for Boom out *or Boom in* with speed information on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
3	Control unit frame front (D797-F) activates Servo valve boom out (Y6006) *or Servo valve boom in (Y6007)*. At retraction of the boom Control unit frame rear (D797-R) activates Solenoid valve pump unloading (Y6062).	I = 380-650 mA	*Control valve lift, lower and protrude, description page 40* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.8.6 BOOM, menu 6*, *8.4.8.7 BOOM, menu 7 and 8.4.8.2 BOOM, menu 2*
4	Control unit cab (D790-1) sends request for increased engine rpm on CAN-bus	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
5	Control unit engine (D794) increases engine rpm.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
6	Servo valve boom out (Y6006) *or Servo valve boom in (Y6007)* pressurizes the control valve's protrude spool with servo pressure.	-	*Control valve lift, lower and protrude, description page 40* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.8.6 BOOM, menu 6 and 8.4.8.7 BOOM, menu 7*
7	The control valve's protrude spool changes position and pressurizes valve block protrude cylinder and sends load signal to the hydraulic oil pumps.	-	*Control valve lift, lower and protrude, description page 40*
8	At boom retraction, valve block pump unloading drains the load signal to two of the hydraulic oil pumps to tank so that only two pumps generate pressure.	-	*Valve block pump unloading, description page 42*

Pos	Explanation	Signal description	Reference
9	The shuttle valve sends the strongest load signal if several functions are activated simultaneously.	-	Section *10 Common hydraulics,* group *10.5.3 Shuttle valve*
10	The hydraulic oil pumps pump oil from the hydraulic oil tank.	See pressure plate on left frame beam.	Section *10 Common hydraulics*, group *10.4 Pumps*
11	The pressure reducer reduces the pressure from the hydraulic oil pumps to servo pressure.	See pressure plate on left frame beam.	*Pressure reducer, description page 24*
12	Servo pressure is stored in the accumulator. The non-return valve in the pressure reducer enables the pressure to be stored when the engine is turned off.	See pressure plate on left frame beam.	*Accumulator servo circuit, description page 24*
13	The servo filter filters the oil before the control valve.	-	*Servo filter, description page 23*
14	At boom in Control unit frame rear (D797-R) activates Servo valve, blocking protruding (Y6050).	U = 24 V	*Valve block protrude cylinder, description page 41* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.8.2 BOOM, menu 2*
15	At boom in Servo valve, blocking protruding (Y6050) acts on the blocking spool in valve block protrude cylinder.	-	*Valve block protrude cylinder, description page 41*
16	At boom out the blocking spool in valve block protrude cylinder is opened by hydraulic pressure from the control valve. At boom in the blocking valve opens and releases the pressure from the protrude cylinder.	-	*Valve block protrude cylinder, description page 41*
17	Protrude cylinder extends or retracts the boom.	-	*Protrude cylinder, description page 41*
18	**Regeneration** Sensor hydraulic pressure lift cylinder piston side left (B768-12) sends voltage signal proportional to cylinder pressure in lift cylinders to Control unit frame front (D797-F).	Conn. 1: U = 5 V Conn. 2: U = 0 V Conn. 3: U = 0.5–4.5 V	*Sensor hydraulic pressure lift cylinder, description page 32* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.10.3 OP, menu 3*
19	Control unit frame front (D797-F) sends information about pressure in lift cylinders.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*

Pos	Explanation	Signal description	Reference
20	Control unit frame rear (D797-R) activates Servo valve, regeneration (Y6046), if the pressure is sufficiently low for regeneration.	U = 24 V	*Valve block protrude cylinder, description page 41* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.8.3 BOOM, menu 3*
21	Servo valve, regeneration (Y6046) pressurizes the regeneration valve.	-	*Valve block protrude cylinder, description page 41*
22	The regeneration valve changes position and leads oil from the lift cylinder's rod side to the piston side.	-	*Valve block protrude cylinder, description page 41*
23	Protruding speed increases.	-	*Valve block protrude cylinder, description page 41*
24	When the protruding nears the end-position, damping is activated.	-	Section *8 Control system,* group *8.2.1.1 Mechanical overload protection* Section *8 Control system,* group *8.2.1.2 Mechanical overload protection with analogue sensors* Section *8 Control system,* group *8.2.1.3 Electrical overload protection*

Hydraulic diagram A40740.0100

7.3.1 Hydraulic oil pump

Hydraulic oil pump, general

See section *10 Common hydraulics*, group *10.4.2 Axial piston pump with variable displacement*.

7.3.2 Servo filter

Servo filter, description

See *Servo filter, description page 23*.

7.3.3 Pressure reducer

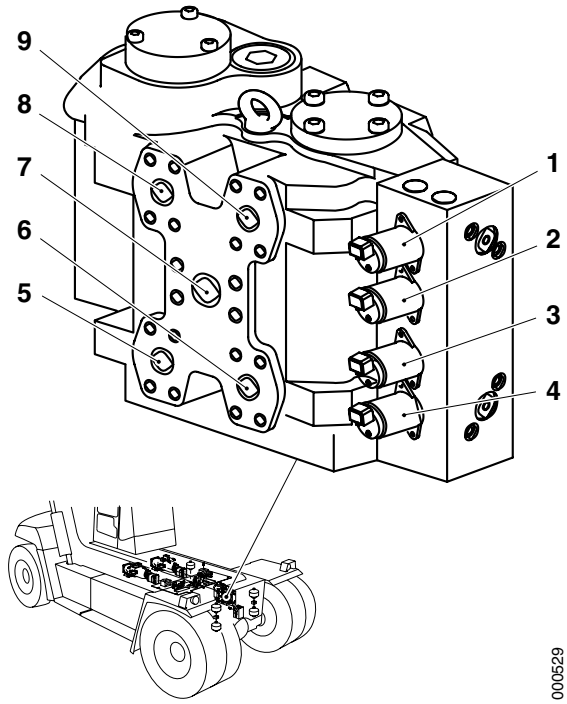
Pressure reducer, description

See *Pressure reducer, description page 24*.

7.3.4 Accumulator servo circuit

Accumulator servo circuit, description

See *Accumulator servo circuit, description page 24*.



1. Servo valve boom out (Y6006)
2. Servo valve boom in (Y6007)
3. Servo valve lower (Y6004)
4. Servo valve lift (Y6005)
5. Connection, rod side, right lift cylinder (B2)
6. Connection, piston side, right lift cylinder (A1)
7. Connection, feed from hydraulic oil pumps (P)
8. Connection, rod side, protrude cylinder (B1)
9. Connection, piston side, protrude cylinder (A1)

7.3.5 Manoeuvre valve lift, lower, protrude

Control valve lift, lower and protrude, description

The control valve has two sections: one for the lift function and one for boom protruding. The sections have great similarities but are described separately for each function.

For general information on the control valve, see *Control valve lift lower and protruding, description page 26*.

Protrude slide

The protrude slide controls direction (in or out) and oil flow to valve block protrude cylinder.

Servo valve boom out

Servo valve boom out, controls servo pressure to the protrude slide so that it controls oil pressure for protruding.

Servo valve boom out is controlled electrically with Solenoid valve boom out (Y6006) which is activated by Control unit frame front (D797-F).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.8.7 BOOM, menu 7*.

Servo valve boom in

Servo valve boom in, controls servo pressure to the protrude slide so that it controls oil pressure for boom retraction.

Servo valve boom in is controlled electrically with Solenoid valve boom in (Y6007) which is activated by Control unit frame front (D797-F).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.8.6 BOOM, menu 6*.

Shock valve, protruding

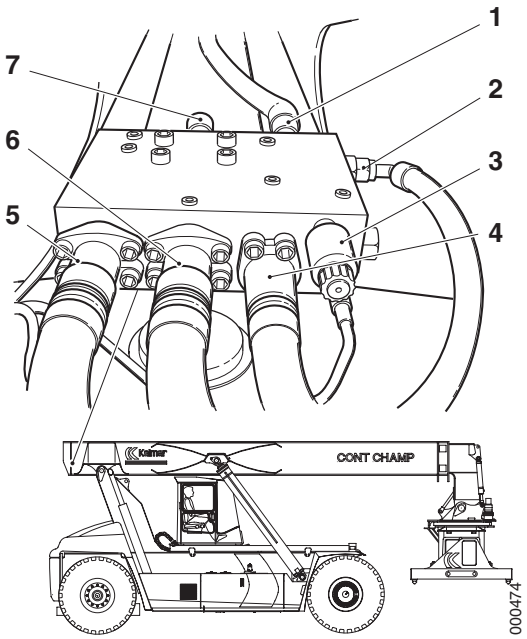
Two shock valves protect the hydraulic system against surges which can occur when operating on uneven ground or when stopping.

The shock valve opens a connection between the protrude cylinder piston side and tank if the pressure becomes too high.

7.3.6 Shuttle valve

Shuttle valve, description

See section *10 Common hydraulics*, group *10.5.3 Shuttle valve*.



1. Connection, rod side (C-)
2. Draining (D)
3. Servo valve regeneration (Y6046)
4. Connection, control valve (VB)
5. Connection, control valve (VA)
6. Connection, control valve (VA)
7. Servo valve blocking (Y6050)

7.3.7 Valve block protrude cylinder

Valve block protrude cylinder, description

Valve block protrude cylinder directs pressure to the protrude cylinder. The valve block is located at the trailing edge of the protrude cylinder in the lift boom and contains a blocking valve, regeneration valve, and non-return valve.

Blocking valve

The blocking valve prevents unwanted lowering. The valve holds the load by keeping the connection to the protrude cylinder's piston side closed. The pressure passes through a restriction providing a blocking pressure and holds the valve slide closed.

Solenoid valve blocking (Y6050) acts on the blocking valve. Solenoid valve, blocking protruding (Y6050) which is activated by Control unit frame rear (D797-R).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.8.2 BOOM, menu 2*.

Regeneration valve

The regeneration valve directs oil from the rod side back to the piston side. This makes it possible to re-use the oil for protruding. For more information on regeneration, see *Maintenance manual DRF 400–450,* section *7 Load handling*. The regeneration valve is controlled by servo valve regeneration.

Solenoid valve, protruding (Y6046) pressurises the regeneration valve. Solenoid valve, protruding (Y6046) is activated by Control unit frame rear (D797-R).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.8.3 BOOM, menu 3*.

Non-return valve

The non-return valve prevents oil from flowing the wrong way at regeneration.

7.3.8 Protrude cylinder

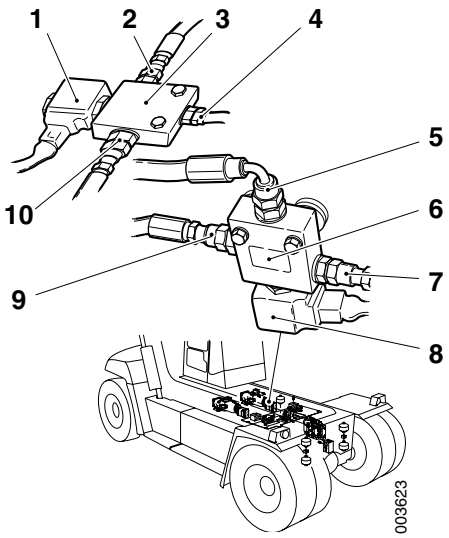
Protrude cylinder, description

The protrude cylinder forces out and pulls in the inner boom. The protrude cylinder is located in the lift boom. The rear section is secured in the outer boom, the front section is secured in the inner boom. On the protrude cylinder is a valve block which controls pressurising of the cylinder and regeneration for boom out.

The protrude cylinder piston rod end is designed as a lug with a flange which is secured on the piston rod with hexagonal bolts.

Hydraulic cylinders, repairing

See section *10 Common hydraulics,* group *10.7.1 Hydraulic cylinders*.



1. Solenoid valve engagement hydraulic pressure (Y6003)
2. Pressure signal to hydraulic oil pump 2
3. Valve block top lift hydraulics
4. Tank drain
5. Pressure signal in, from shuttle valve
6. Valve block pump unloading
7. Pressure signal to hydraulic oil pump 2
8. Solenoid valve pump unloading (Y6062)
9. Tank drain
10. Pressure signal in, from shuttle valve 1

7.3.9 Valve block pump unloading

Valve block pump unloading, description

For boom in, only a small oil flow is required. Solenoid valve pump unloading (Y6062) drains the control signal to hydraulic oil pump 2, to the tank. This results in only one pump unit building up pressure, which reduces the use of engine power and thus fuel consumption. If other functions are activated at the same time then the pressure signal will pass through the shuttle valve, see section *10 Common hydraulics,* group *10.5.3 Shuttle valve*. The load signal travels to the pumps required. The valve block is located standing on the bracket for the oil filling point between the engine and transmission.

Solenoid valve pump unloading (Y6062) is supplied with voltage by Control unit frame rear (D797-R) on activation.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.8.2 BOOM, menu 2*.

7.3.10 Lift boom

Lift boom, general

See *Lift boom, description page 34* and *Maintenance manual DRF 400–450*, section *7 Load handling*, group *7.3.10 Lift boom*.

7.3.11 Sensor boom length

Sensor boom length, general

See section *8 Control system*, group *8.2.1.3 Sensor boom length*.

7.3.12 Pipes and hoses

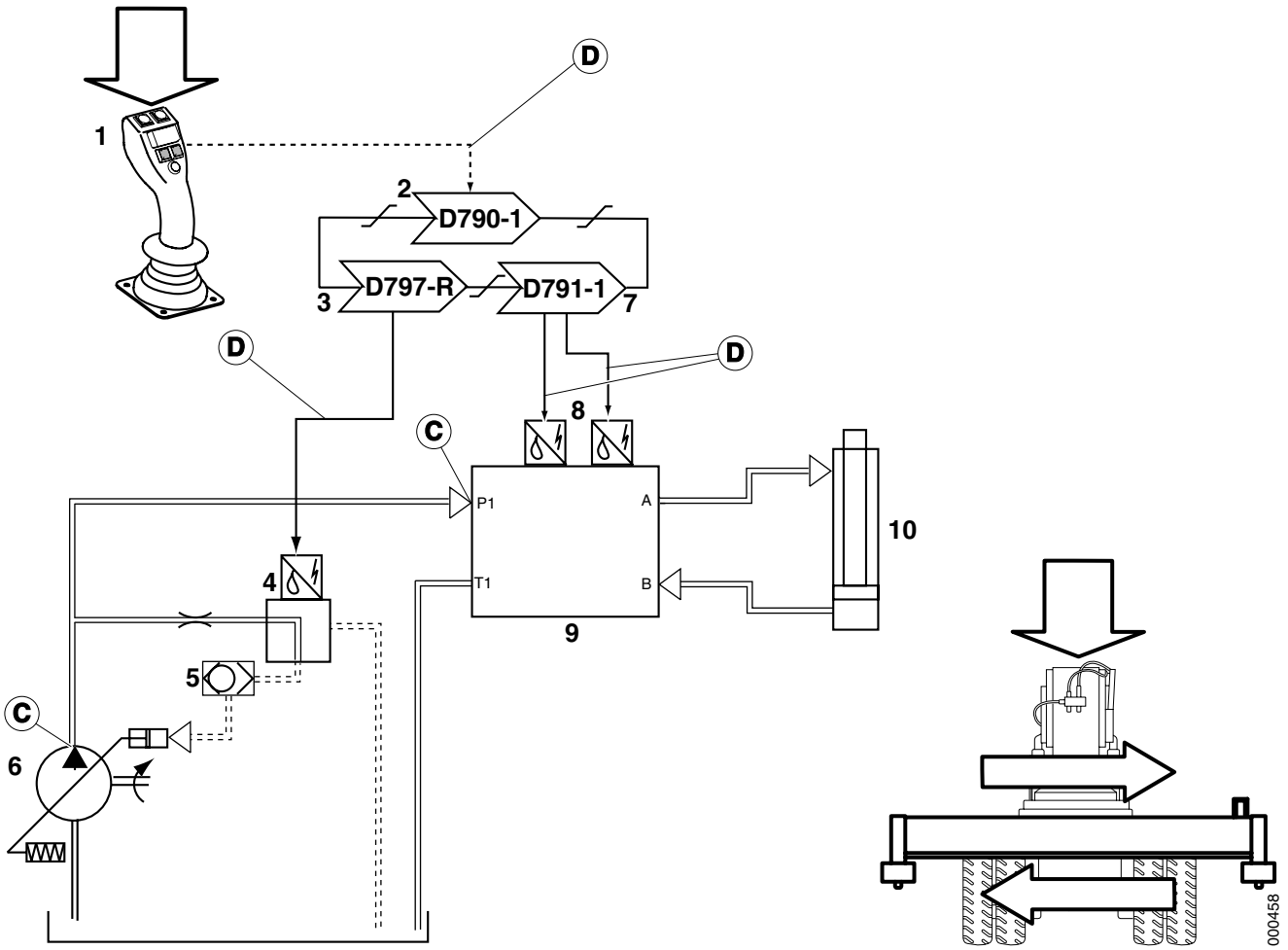
Pipes and hoses, description

See section *10 Common hydraulics*, group *10.5.1 Pipes and hoses*.

7.4 Side-shift

Sideshift, function description

Condition	Reference value	Reference
Emergency stop	Disengaged	Section *11 Common electrics*, group *11.5.1.4 Emergency stop voltage (15E)*



Pos	Explanation	Signal description	Reference
1	Control lever (S815-T1.1) sends voltage signal to Control unit cab (D790-1).	Left: $U_{S815\text{-}T1.1}$ = 24 V Right: $U_{S815\text{-}T1.2}$ = 24V	*Control lever, description page 7* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.2 ATTACH, menu 2*
2	Control unit cab (D790-1) sends sideshift left or right on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*

Pos	Explanation	Signal description	Reference
3	Control unit frame rear (D797-R) activates Solenoid valve, engagement of hydraulics for top lift (Y6003).	U = 24 V	*Valve block top lift hydraulics, description page 45* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.6 HYD, menu 6*
4	Solenoid valve, engagement of hydraulics for top lift (Y6003) opens and pressurizes valve block lift cylinder and sends load signal to hydraulic oil pump 2.	-	*Valve block top lift hydraulics, description page 45* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.6 HYD, menu 6*
5	The shuttle valve sends the strongest load signal to the hydraulic oil pumps if several functions are activated simultaneously.	-	Section *10 Common hydraulics,* group *10.5.3 Shuttle valve*
6	Hydraulic oil pump 2 pumps oil from the hydraulic oil tank.	See pressure plate on left frame beam.	Section *10 Common hydraulics*, group *10.4 Pumps*
7	Control unit attachment (D791-1) activates Servo valve, sideshift left (Y6020) *or Servo valve, sideshift right (Y6021)*.	U = 24 V	*Control valve attachment, description page 46* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.8 ATTACH, menu 8*
8	Servo valve, sideshift left (Y6020) *or Servo valve, sideshift right (Y6021)* pressurizes the sideshift spool in control valve attachment.	-	*Control valve attachment, description page 46* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.8 ATTACH, menu 8*
9	The control valve's sideshift spool changes position and pressurizes sideshift cylinders.	-	*Control valve attachment, description page 46*
10	The sideshift cylinders push in the main beam sideways in relation to the sideshift frame.	-	*Sideshift cylinder, description page 50*

Hydraulic diagram A43123.0100

Hydraulic diagram A41791.0100

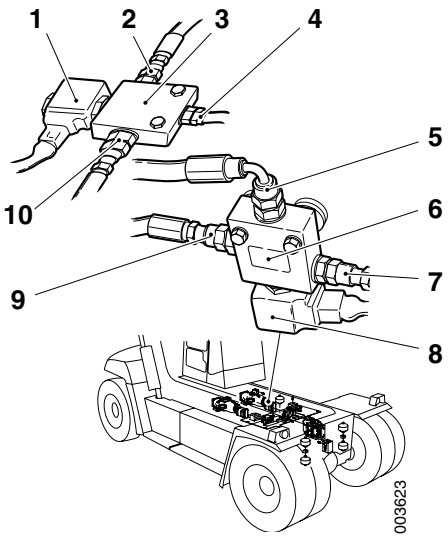
Hydraulic diagram A40853.0100

Hydraulic diagram A40853.0200

7.4.1 Hydraulic oil pump

Hydraulic oil pump, general

See section *10 Common hydraulics*, group *10.4.2 Axial piston pump with variable displacement*.



1. Solenoid valve engagement hydraulic pressure (Y6003)
2. Pressure signal to hydraulic oil pump 2
3. Valve block top lift hydraulics
4. Tank drain
5. Pressure signal in, from shuttle valve
6. Valve block pump unloading
7. Pressure signal to hydraulic oil pump 2
8. Solenoid valve pump unloading (Y6062)
9. Tank drain
10. Pressure signal in, from shuttle valve 1

7.4.2 Valve block top lift hydraulics

Valve block top lift hydraulics, description

The valve block for top lift hydraulics is an electrically controlled valve. It leads a reduced constant pressure as the load signal to the hydraulic oil pumps when attachment functions are activated. The valve block is located lying down on the bracket for the oil filling point between the engine and transmission.

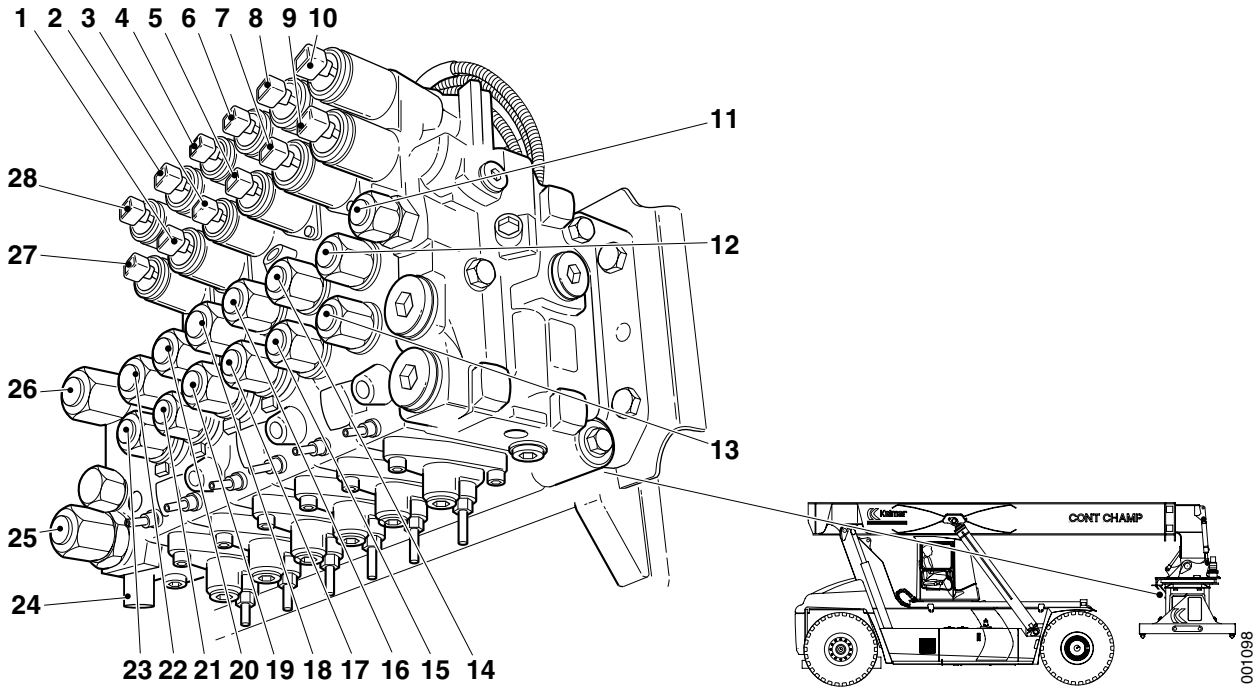
When the solenoid valve is activated, pressure is directed from the top lift hydraulics' supply through a shuttle valve to the hydraulic oil pumps' control. A restriction before the valve block ensures that the pressure to the hydraulic oil pumps' control does not become too high. When the solenoid valve is not activated, the load signal is drained to tank and the inlet from the top hydraulics' supply is closed.

The valve is controlled electrically with Solenoid valve, engagement hydraulic pressure (Y6003) which is activated by Control unit frame rear (D797-R).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.6 HYD, menu 6*.

7.4.3 Manoeuver valve attachment

Control valve attachment, description



1. Solenoid valve, tilt out (Y6010) ⊕
2. Solenoid valve tilt in (Y6011) ⊕
3. Solenoid valve, rotation clockwise (Y6008)
4. Solenoid valve, rotation counter-clockwise (Y6009)
5. Solenoid valve, sideshift right (Y6021)
6. Solenoid valve, sideshift left (Y6020)
7. Solenoid valve, positioning out (Y6018)
8. Solenoid valve, positioning in (Y6019)
9. Solenoid valve, lock twistlocks (Y6040)
10. Solenoid valve, open twistlocks (Y6039)
11. Drain to tank
12. Connection to lock cylinder
13. Connection to lock cylinder
14. Connection to positioning motor
15. Connection to positioning motor
16. Connection to sideshift cylinder
17. Connection to sideshift cylinder
18. Connection to rotation motor
19. Connection to rotation motor
20. Connection to tilt cylinder ⊕
21. Connection to tilt cylinder ⊕
22. Connection to levelling cylinder ⊕
23. Connection to levelling cylinder ⊕
24. Test outlet feed pressure to control valve
25. Feed from hydraulic oil pump 2
26. Return to tank (through tank filter)
27. Solenoid valve levelling right (Y6035) ⊕
28. Solenoid valve levelling left (Y6036) ⊕

Sideshift is controlled by a separate section in the control valve attachment.

The attachment control valve controls hydraulic functions on the attachment. The control valve is located in the middle of the back of the attachment. Electric servo valves control the flow from the valve.

The control valve is an electro-hydraulically controlled, proportional and pressure compensated direction valve. Electrically controlled servo valves convert current to servo pressure. The servo pressure controls the spring centred valve slides which control pressure and flow for the function in question. The valve slides have a flow limit in order that several functions can be activated simultaneously, and this way control the main flow.

The control valve has an integral pilot pressure supply. This means that the valve has an integral pressure reducer which converts feed pressure to servo pressure for the different functions. The pilot pressure supply is common for all functions. This reduces pressure variations due to long hoses and reduces the number of hoses to the valve.

The control valve has the following sections:

- Sideshift
- Positioning
- Rotation
- Twistlocks
- Controllable tilt ⊕
- Hydraulic levelling ⊕

Sideshift slide

The valve slide controls sideshift direction and speed.

The valve slide is controlled by servo valve sideshift right and servo valve sideshift left.

Servo valve sideshift left

Servo valve sideshift left controls pressure to the sideshift slide so that the sideshift slide opens and pressurises the sideshift cylinders.

Servo valve sideshift left is controlled electrically with Solenoid valve, sideshift left (Y6020) which is activated by Control unit attachment (D791-1). The servo valve directs servo pressure to the sideshift slide proportional to the control current to the solenoid valve.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.8 ATTACH, menu 8*.

Servo valve sideshift right

Servo valve sideshift right controls pressure to the sideshift slide so that the sideshift slide opens and pressurises the sideshift cylinders.

Servo valve sideshift is controlled electrically with Solenoid valve, sideshift right (Y6021) which is activated by Control unit attachment (D791-1). The servo valve directs servo pressure to the sideshift slide proportional to the control current to the solenoid valve.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.8 ATTACH, menu 8*.

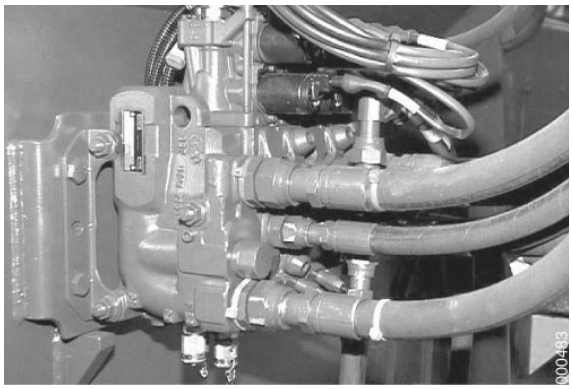
Control valve attachment, replacement

WARNING

Hot, pressurised oil.

Personal injury, burn injury, rash or irritation

Always depressurise the hydraulic systems before starting to work on the hydraulic systems. Avoid skin contact with the oil, use protective gloves.



1 Clean the control valve and its surrounding area.

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

3 Depressurise the brake and hydraulic systems, see section *B Safety*.

4 Position a collection container under the control valve to collect any spilled oil.

5 Mark up and detach the hydraulic hoses from the control valve.

NOTE

Plug all connections immediately to protect the hydraulic system from impurities.

6 Mark up and detach the wiring from the control valve.

7 Remove the control valve.

Remove the attaching bolts and lift away the valve. Place the valve on a clean and protected surface.

NOTE

The valve weighs approx. 30 kg.

8 Transfer the connection adapters to the new control valve.

NOTE

Check that the O-rings are intact and correctly fitted.

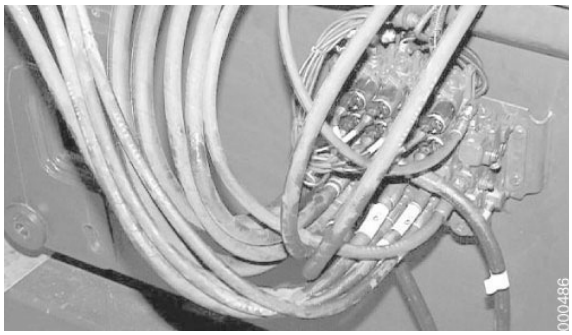
NOTE

Transfer one adapter at a time so that the marking is not mixed up.

9 Mark up the servo valves on the new control valve.

10 Fit the valve.

Lift the valve into place and fit the attaching bolts.



11 Connect the wiring to the control valve in accordance with the marking.

12 Connect the hydraulic hoses to the control valve in accordance with the marking.

NOTE

Check that the O-rings are intact and correctly fitted.

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

14 Check that the valve's hydraulic connections are sealed.

15 Remove the collection container, treat spills as environmentally hazardous waste.

16 Check that the attachment is working.

⚠ CAUTION

Air in the hydraulic system can cavitate.

Product damage.

Activate the functions carefully and operate at the lowest possible speed a couple of times to avoid cavitation.

17 Clean the attachment.

18 Check the hydraulic oil level with the lift cylinders completely down and the protrude cylinder completely in. The oil level should be at the top of the level glass. Top up if needed.

⚠ CAUTION

Overfilling of oil.

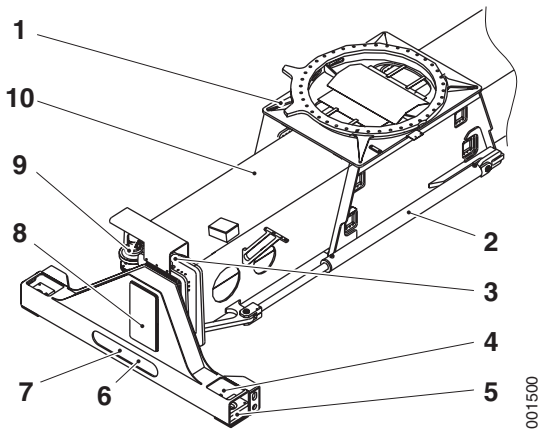
Leakage and environmental damage.

The hydraulic oil level is checked with the boom completely lowered and retracted.

7.4.4 Shuttle valve

Shuttle valve, description

See section *10 Common hydraulics*, group *10.5.3 Shuttle valve*.



1. Sideshift frame
2. Sideshift cylinder
3. Position sensor positioning
4. Sensor alignment
5. Twistlock
6. Sensor twistlocks
7. Lock cylinder twistlocks
8. Spreader boom
9. Spreader motor
10. Main beam attachment

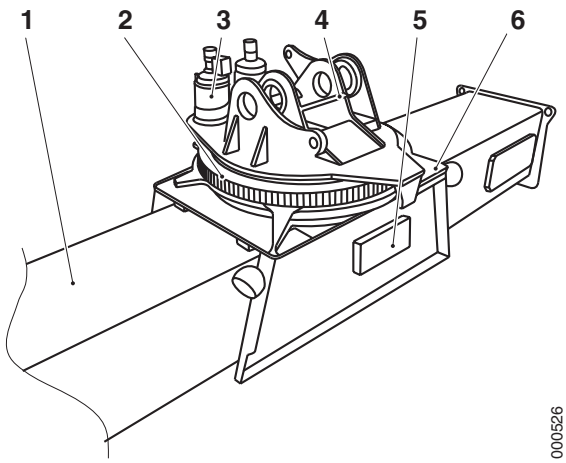
7.4.5 Sideshift cylinder

Sideshift cylinder, description

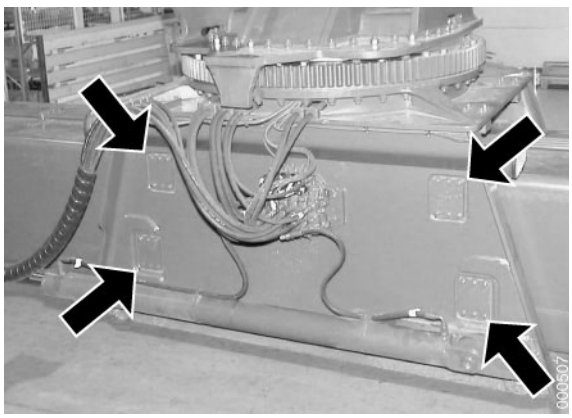
The sideshift cylinders are two cross connected hydraulic cylinders which extend the attachment's main beam laterally in relation to the sideshift frame. The sideshift cylinders are located along the front and rear of the attachment.

Hydraulic cylinders, repairing

See section *10 Common hydraulics,* group *10.7.1 Hydraulic cylinders*.



1. Main beam
2. Ring gear
3. Rotation motor unit
4. Rotation yoke
5. Control valve attachment
6. Sideshift frame



7.4.6 Sideshift frame

Sideshift frame, description

The attachment is secured in the boom with the rotation yoke. The sideshift frame is located under the rotation yoke. The attachment's main beam is located in the sideshift frame. The main beam can be extended laterally in relation to the sideshift frame with two hydraulic cylinders. Inside the main beam are two spreader beams which can be extended in and out with a hydraulic motor.

The position of the attachment can be adjusted laterally by moving the main beam in relation to the sideshift frame. The main beam runs on slide pates in the sides and in the bottom. The sideshift cylinders secure the side position.

The sideshift frame is available in two versions:

- Standard top lift. The sideshift frame allows the main beam to be levelled 5°. Sideshift 800 mm.
- Pile-slope top lift ⊕

  The sideshift frame is located in the rotation yoke with four hydraulic cylinders which mean that the levelling can be controlled for adaptation to angled containers. Sideshift 800 mm. See *Sideshift frame, description page 104*.

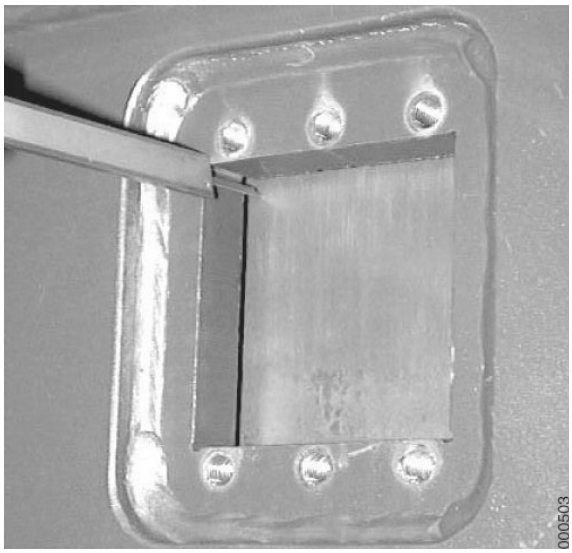
Slide plates, sideshift frame, replacement

1 Undo the cover plate's attaching bolt.

2 Remove the upper bolts and remove the cover plate

3 Remove the spacer plate and slide plate.

4 Repeat steps 1 - 3 on the other slide plates.



5 Measure the distance between the edge of the cover plate and the attachment's main beam slide surface on all slide plates.

6 Centre the boom so that the distance between the attachment's main beam and edge is the same on all slide plates.

Use a prybar to move the attachment's main beam.

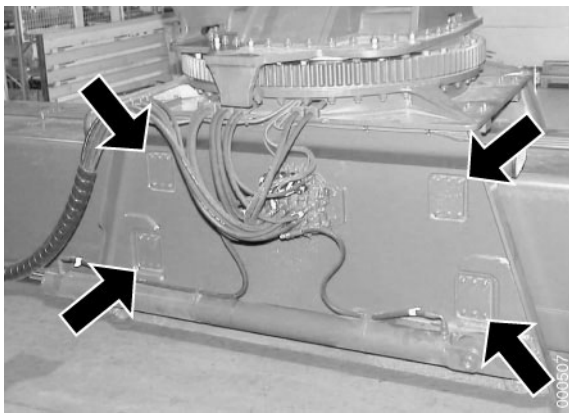
NOTE

Exercise caution so that the attachment's main beam layer of paint is not damaged. This is very important for the function of the slide plates.

7 Fit new a slide plate.

8 Check the slide plate clearance by measuring the distance between the slide plate and the edge of the cover plate. The clearance between the attachment's main beam and slide plates must be **1 mm**.

9 Fit spacer plates until the distance is correct.



10 Fit the cover plate.

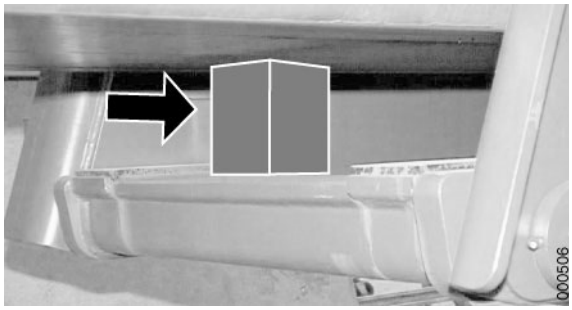
11 Repeat steps 7 - 10 on the other slide plates.

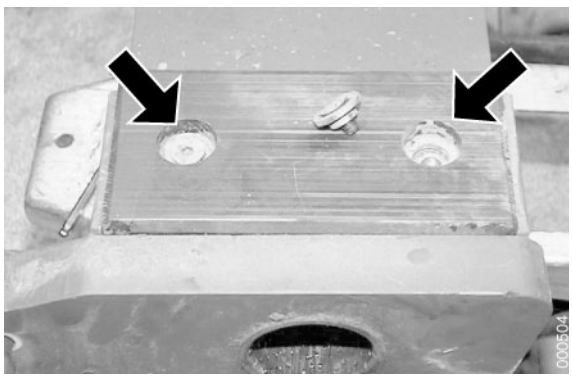
Lower slide plates, sideshift frame, replacement

1 Position axle stands or similar under the attachment's spreader booms and lower the attachment stands so that the sideshift frame's lower slide plates are released.

2 Turn off the engine and the main electrical power.

3 Fit spacers between cross member and attachment main boom on both cross members.





The illustration shows a detached cross member

4 Remove the attaching bolts and remove the slide plates.

5 Fit new slide plates.

6 Remove the spacer.

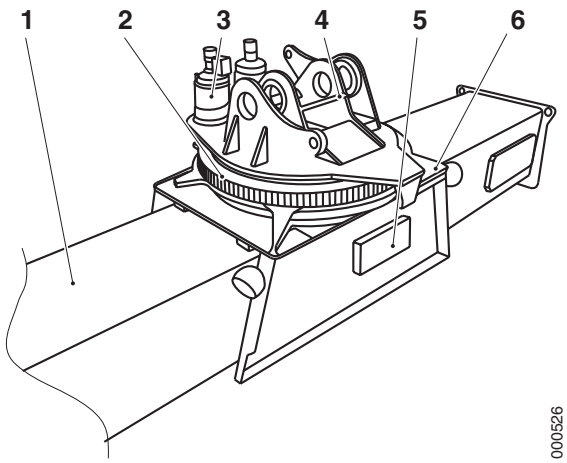
7 Turn on the main current and start the engine

8 Lift the attachment and remove the stands.

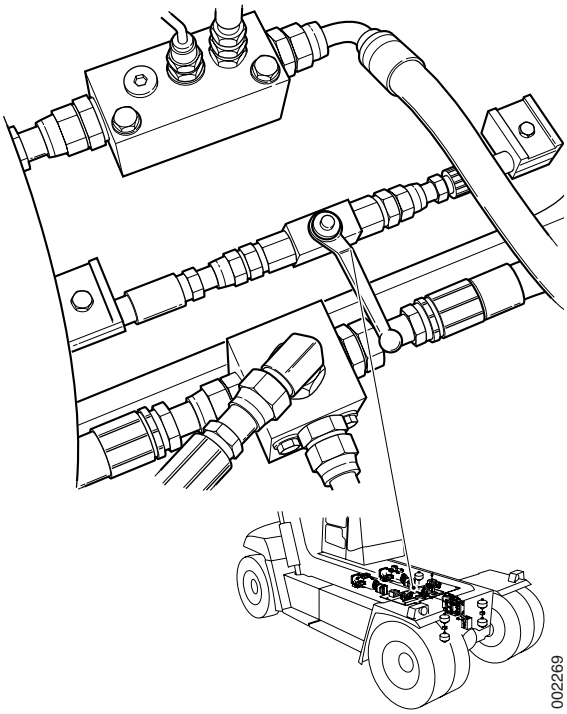
7.4.7 Main beam attachment

Main beam attachment, description

Main beam attachment is located in the sideshift frame. Main beam contains equipment for positioning (spreader beams, hydraulic motor, chains, slide plates and sensors). On the attachment's main beam are also the control valves to the attachment's hydraulic functions.



1. Main beam
2. Ring gear
3. Rotation motor unit
4. Rotation yoke
5. Control valve attachment
6. Sideshift frame



7.4.8 Unloading valve attachment

Relief valve attachment, description

The attachment relief valve opens a connection between the attachment's pressure feed and tank. This is used to drain the pressure in the hoses for the attachment before working on the hydraulic system. The relief valve is located at the trailing edge of the lift beam in front of the transmission.

7.4.9 Pipes and hoses

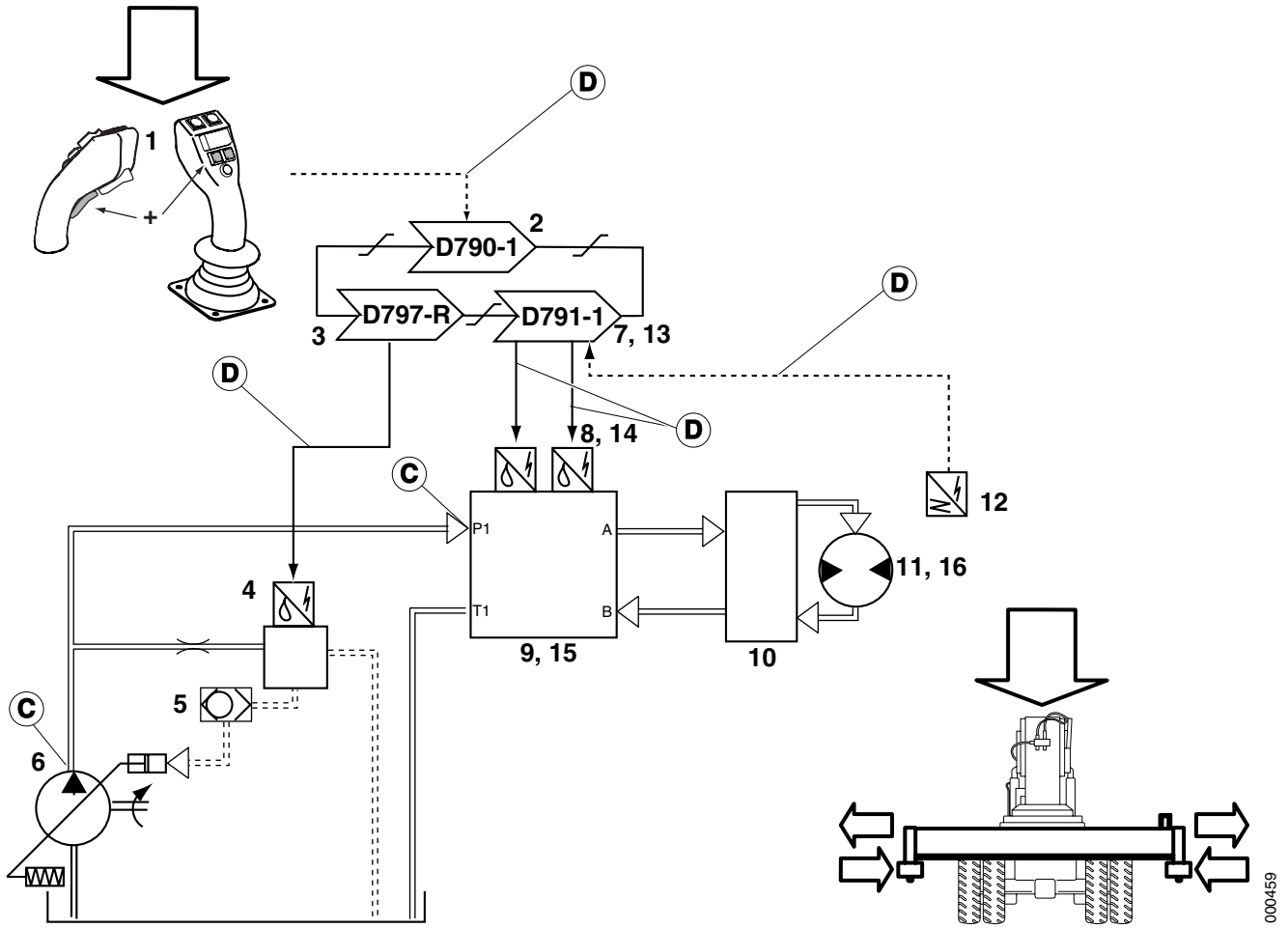
Pipes and hoses, description

See section *10 Common hydraulics*, group *10.5.1 Pipes and hoses*.

7.5 Positioning

Positioning, function description

Condition	Reference value	Reference
Emergency stop	Disengaged	Section *11 Common electrics*, group *11.5.1.4 Emergency stop voltage (15E)*
Twistlocks	Unlocked or by-pass activated	*Twistlocks, description page 110* Section *8 Control system*, group *8.2.2 By-passing*
Overload protection	Passive	Section *8 Control system*, group *8.2.1 Overload protection*



Pos	Explanation	Signal description	Reference
1	Control lever (S815-T1.x and S815-T4) sends voltage signal to Control unit cab (D790-1).	Positioning: $U_{S815\text{-}T4}$ = 24 V Out: $U_{S815\text{-}T1.2}$ = 24 V In: $U_{S815\text{-}T1.1}$ = 24V	*Control lever, description page 7* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.2 ATTACH, menu 2*

Pos	Explanation	Signal description	Reference
2	Control unit cab (D790-1) sends signal on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
3	Control unit frame rear (D797-R) activates Solenoid valve, engagement of hydraulics for top lift (Y6003).	U = 24 V	*Valve block top lift hydraulics, description page 45* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.6 HYD, menu 6*
4	Solenoid valve, engagement of hydraulics for top lift (Y6003) opens and sends load signal to hydraulic oil pumps.	-	*Valve block top lift hydraulics, description page 45* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.6 HYD, menu 6*
5	The shuttle valve sends the strongest load signal to the hydraulic oil pumps if several functions are activated simultaneously.	-	Section *10 Common hydraulics,* group *10.5.3 Shuttle valve*
6	Hydraulic oil pump 2 pumps oil from the hydraulic oil tank.	See pressure plate on left frame beam.	Section *10 Common hydraulics*, group *10.4 Pumps*
7	Control unit attachment (D791-1) activates Servo valve positioning out (Y6018) *or Servo valve positioning in (Y6019)*.	I = 350–600 mA	*Control valve attachment, description page 46* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.13 ATTACH, menu 13 and 8.4.9.14 ATTACH, menu 14*
8	Servo valve positioning out (Y6018)*or Servo valve positioning in (Y6019)* pressurizes the spreader spool in the attachment's control valve.	-	*Control valve attachment, description page 46* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.13 ATTACH, menu 13 and 8.4.9.14 ATTACH, menu 14*
9	The control valve's spreader spool changes position and directs pressure to the spreader motor.	-	*Control valve attachment, description page 46*
10	The motor valve block directs the pressure to the motor and prevents the motor from pumping (rotates faster than supplied pressure).	-	*Valve block spreader motor, description page 61*
11	The motor drives the chains that pull the spreader beams out *or in*.	-	*Spreader motor, description page 61*

Pos	Explanation	Signal description	Reference
12	Sensor, end-position 20'-40' (B769) sends voltage signal to Control unit attachment (D791-1).	Sensor directly opposite indicator plate: U > 24 V	*Position sensor positioning, description page 72* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.5 ATTACH, menu 5*
13	Control unit attachment (D791-1) reduces control current to Servo valve positioning out (Y6018)*or Servo valve positioning in (Y6019)*.	-	*Control valve attachment, description page 60* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.13 ATTACH, menu 13 and 8.4.9.14 ATTACH, menu 14*
14	Servo valve positioning out (Y6018)*or Servo valve positioning in (Y6019)* reduces the pressure to the spreader spool in the attachment's control valve.	-	*Control valve attachment, description page 60* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.13 ATTACH, menu 13 and 8.4.9.14 ATTACH, menu 14*
15	The control valve's spreader spool changes position and reduces pressure to the spreader motor.	-	*Control valve attachment, description page 60*
16	Spreader motor speed decreases.	-	*Spreader motor, description page 61*

Hydraulic diagram A43123.0100

Hydraulic diagram A41791.0100

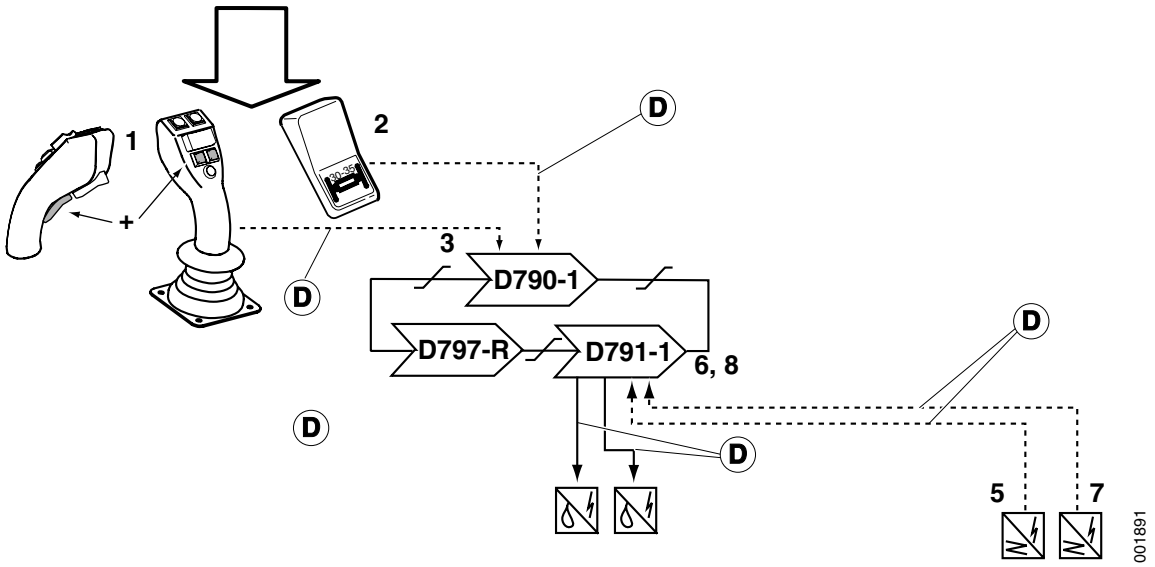
Hydraulic diagram A40853.0100

Hydraulic diagram A40853.0200

Positioning 30' stop, function description

Positioning is controlled with Control lever (S815), 30-foot stop is activated with Switch stop at 30’ or 35’, see *Switch stop at 30’ or 35’, description page 10*. When 30-foot stop is activated, positioning stops at 30 foot. Two inductive position sensors indicate the spreader beams' position and activate damping. At 30-foot stop two sensors are used to control the stops.

Condition	Reference value	Reference
Emergency stop	Disengaged	Section *11 Common electrics*, group *11.5.1.4 Emergency stop voltage (15E)*
Twistlocks	Unlocked or by-pass activated	*Twistlocks, description page 110* Section *8 Control system*, group *8.2.2 By-passing*
Overload protection	Passive	Section *8 Control system*, group *8.2.1 Overload protection*



Pos	Explanation	Signal description	Reference
1	Switch stop at 30’-35’ (S1004) sends voltage signal to Control unit cab (D790-1)).	Switch in on position: Conn. 1: U = 0 V Conn 5: U = 24 V Switch in off position: Conn 1: U = 24 V Conn 5: U = 24 V	*Switch stop at 30’ or 35’, description page 10* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.2 ATTACH, menu 2*
2	Control lever (S815-T1.2 and S815-T4) sends voltage signal to Control unit cab (D790-1).	Positioning: $U_{S815\text{-}T4}$ = 24 V Out: $U_{S815\text{-}T1.2}$ = 24 V In: $U_{S815\text{-}T1.1}$ = 24V	*Control lever, description page 7* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.2 ATTACH, menu 2*

Pos	Explanation	Signal description	Reference
3	Control unit cab (D790-1) sends positioning 30’ on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
4	Positioning is activated in the same way as the normal positioning steps 3–11.	-	*Maintenance manual DRF 400–450,* section *7 Load handling,* group *7.5 Positioning*
5	When positioning nears 30’-position Sensor, end-position 30’ (B777-3) sends voltage signal to Control unit attachment (D791-1).	Sensor directly opposite indicator plate: U = 24 V	*Position sensor positioning, description page 72* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.5 ATTACH, menu 5*
6	Control unit attachment (D791-1) dampens the speed in the same way as the normal positioning steps 13–16.	-	*Maintenance manual DRF 400–450,* section *7 Load handling,* group *7.5 Positioning*
7	When positioning is in 30' position, Sensor end-position 20'-40' (Y769) sends voltage signal.	Sensor directly opposite indicator plate: U = 24 V	*Position sensor positioning, description page 72* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.5 ATTACH, menu 5*
8	Positioning is stopped by Control unit attachment (D791-1) cutting off the current to servo valve positioning out (Y6018) *or servo valve positioning in (Y6019).*	U = 0 V	*Control valve attachment, description page 60* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.13 ATTACH, menu 13 and 8.4.9.14 ATTACH, menu 14*

Hydraulic diagram A43123.0100

Hydraulic diagram A41791.0100

Hydraulic diagram A40853.0100

Hydraulic diagram A40853.0200

7.5.1 Hydraulic oil pump

Hydraulic oil pump, general

See section *10 Common hydraulics*, group *10.4.2 Axial piston pump with variable displacement*.

7.5.2 Valve block top lift hydraulics

Valve block top lift hydraulics, description

See *Valve block top lift hydraulics, description page 45*.

7.5.3 Manoeuver valve attachment

Control valve attachment, description

Positioning is controlled by a separate section in the attachment's control valve. For a more detailed general description of the valve and component location, see *Control valve attachment, description page 46*.

Positioning slide

The valve slide controls positioning direction and speed. The valve slide is controlled by servo valve positioning out and servo valve positioning in.

Servo valve positioning out

Servo valve positioning out controls pressure to the positioning slide so that it opens and pressurises the spreader motor.

The servo valve is controlled electrically with Solenoid valve, spreader out (Y6018) which is activated by Control unit attachment (D791-1). The servo valve directs servo pressure to the positioning slide proportional to the control current to the solenoid valve.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.13 ATTACH, menu 13*.

Servo valve positioning in

Servo valve positioning in controls pressure to the positioning slide so that it opens and pressurises the spreader motor.

The servo valve is controlled electrically with Solenoid valve spreader in (Y6019) which is activated by Control unit, attachment (D791-1). The servo valve directs servo pressure to the positioning slide proportional to the control current to the solenoid valve.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.14 ATTACH, menu 14*.

Control valve attachment, replacement

See *Control valve attachment, replacement page 48*.

7.5.4 Shuttle valve

Shuttle valve, description

See section *10 Common hydraulics*, group *10.5.3 Shuttle valve*.

7.5.5 Valve block positioning motor

Valve block spreader motor, description

Valve block spreader motor controls the direction of the oil to the spreader motor. The valve block is located on the spreader motor furthest out to the left on the front of the attachment's main beam.

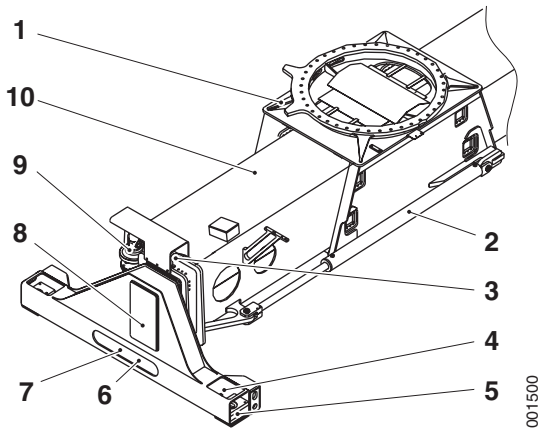
The valve block maintains balance between feed and positioning speed. Balance means that the valve block prevents the motor from pumping oil i.e. rotating faster than the feed of oil permits. Valve block positioning contains over-centre valves which block the outlet if the pressure on the outlet side is higher than the pressure on the inlet side.

7.5.6 Positioning motor

Spreader motor, description

The spreader motor pulls the spreader beams in and out in the attachment's main beam with two chains. The spreader motor is located furthest out to the left on the front of the attachment's main beam.

The hydraulic motor is built together with a planetary gear which reduces speed and reinforces the power of the motor. On the motor's hydraulic connections is a valve block with two over-centre valves which prevent the motor form being turned faster than the hydraulic pressure supplied.



1. Sideshift frame
2. Sideshift cylinder
3. Position sensor positioning
4. Sensor alignment
5. Twistlock
6. Sensor twistlocks
7. Lock cylinder twistlocks
8. Spreader boom
9. Spreader motor
10. Main beam attachment

Oil spreader motor, replacement

See *Maintenance manual DRF 400–450*.

Spreader motor, replacement

WARNING

Hot, pressurised oil.

Personal injury, burn injury, rash or irritation

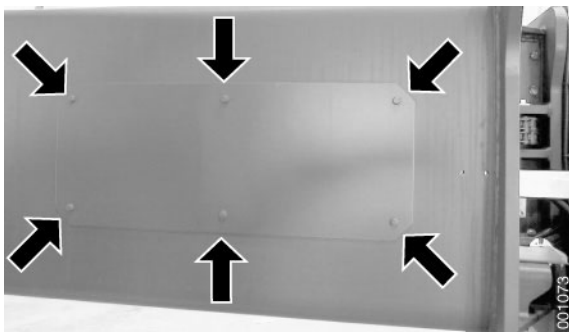
Always depressurise the hydraulic systems before starting to work on the hydraulic systems. Avoid skin contact with the oil, use protective gloves.

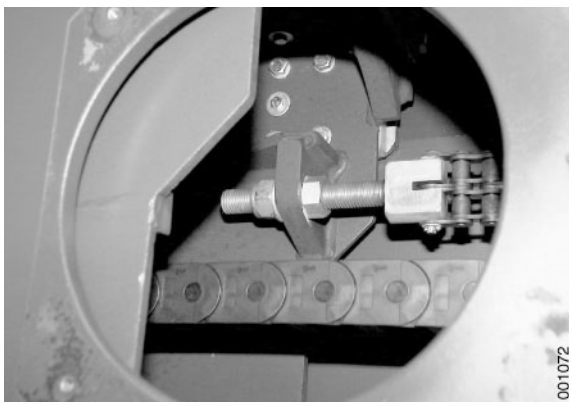
1 Clean the attachment.

2 Park the machine with the attachment as far down as possible.

3 Position a collection container under the attachment at the hydraulic motor to collect any spilled oil.

4 Remove the cover plate on the left-hand side of the attachment's main beam.





5 Start the engine and run out the positioning until the chain tensioners become visible in the inspection holes.

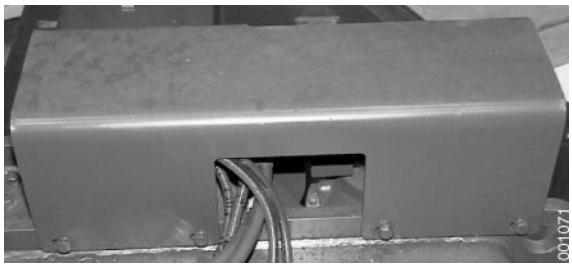
6 Turn off the engine and turn the start key to position I.

7 Depressurise the brake and hydraulic systems, see section section *B Safety*.

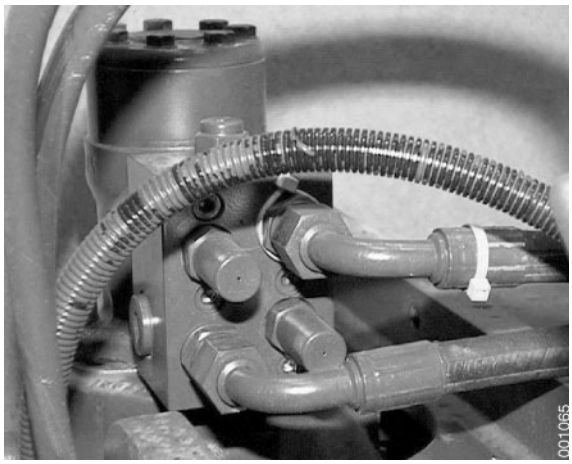
8 Turn the start key to position 0 and turn off the main electric power.

9 Measure and note down the chain tensioner's position to regain the correct tension on the chain when installing.

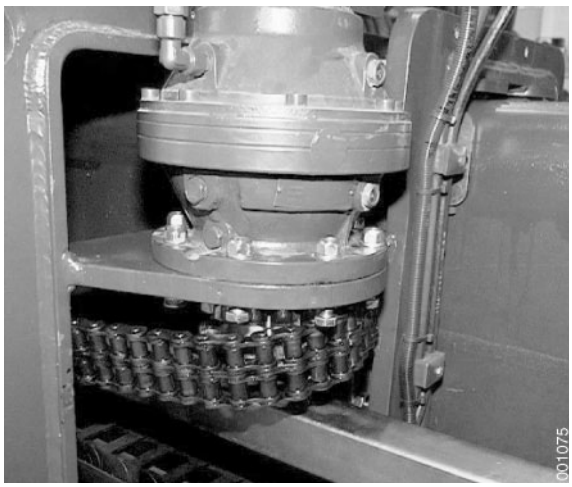
10 Detach the chain tensioner on the motor side and release the chain from the tensioner.



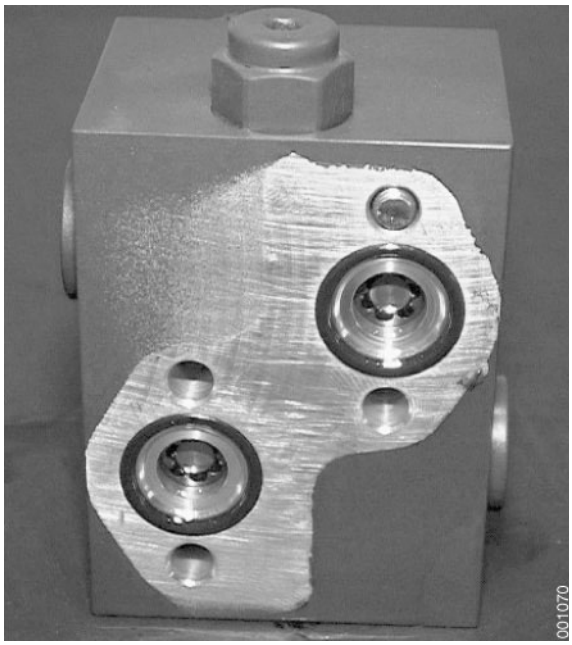
11 Remove the protective plate over the spreader motor.



12 Mark up and detach the hydraulic hoses from the valve block from the spreader motor.



13 Remove the spreader motor unit.



14 Transfer the valve block to the new motor unit.

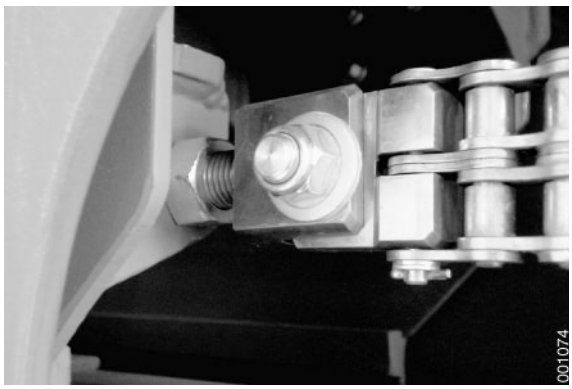
NOTE

Check that the O-rings are intact and correctly fitted.

15 Clean the contact surfaces between the planetary gear and the attachment's main beam.

16 Fit the motor unit. Tighten the bolts crosswise with torque, **117 Nm**.

17 Connect the hydraulic hoses to the valve block on the motor.



18 Connect the spreader chain to the chain tensioner. Check that the chain runs straight into the chain wheel on the hydraulic motor.

19 Tension the spreader chain to the same degree as before.

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

21 Check that the hydraulic connections seal tightly.

22 Remove the collection container, treat the waste oil as environmentally hazardous waste.

23 Check that positioning works.

24 Fit the protective plate over the motor.

25 Grease the spreader chain with universal grease "EP2".

26 Fit the cover plates to the attachment's main beam.

27 Check the hydraulic oil level with the lift cylinders completely down and the protrude cylinder completely in. The oil level should be at the top of the level glass. Top up if needed.

⚠ CAUTION

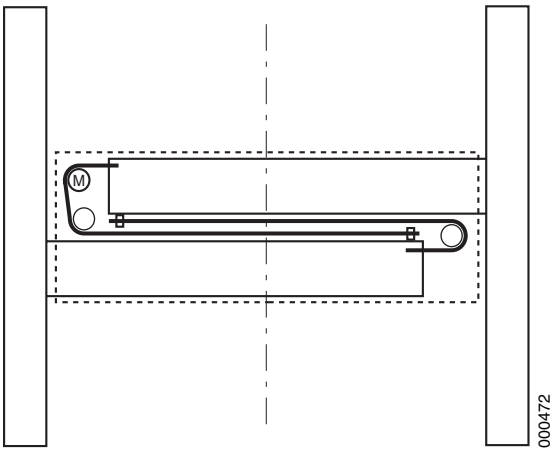
Overfilling of oil.

Leakage and environmental damage.

The hydraulic oil level is checked with the boom completely lowered and retracted.

7.5.7 Positioning chains

Spreader chains, description



Principle diagram spreader chains

The spreader chains pull the spreader beams in and out from the attachment's main beam. The output from the spreader motor is transferred to the spreader beams by two chains. The chains run inside the attachment between the spreader beams. Gear wheel realigns the chains' route. The chains are tensioned by adjusting the mounting.

The chains are secured crosswise with one end in the bottom of one spreader beam and the other end along the side of the other spreader beam.

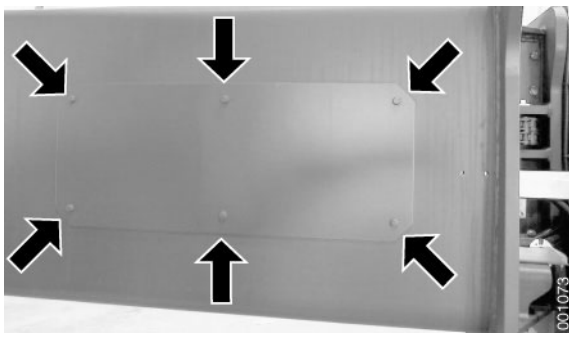
Openings in the sides of the spreader beams and the attachment's main beam make it possible to access the chains for maintenance.

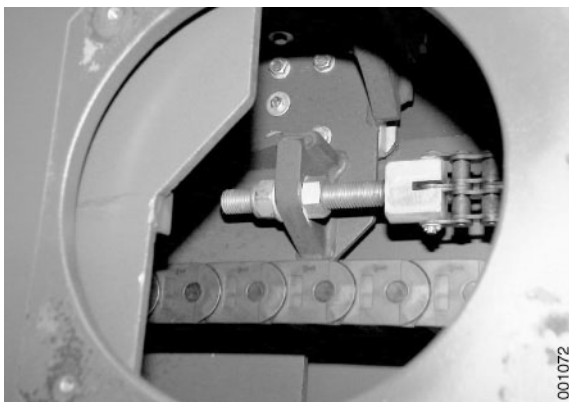
Spreader chain, replacement

1 Clean the attachment.

2 Park the machine with the attachment as far down as possible.

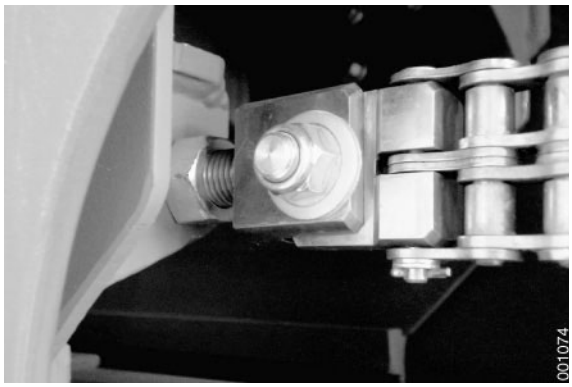
3 Remove the cover plates on the attachment's main beam.





4 Start the engine and run out the positioning until the chain tensioners become visible in the inspection holes.

5 Turn off the engine and the main electrical power.



6 Detach the defective chain's chain tensioner and release the chain from the tensioner.

NOTE

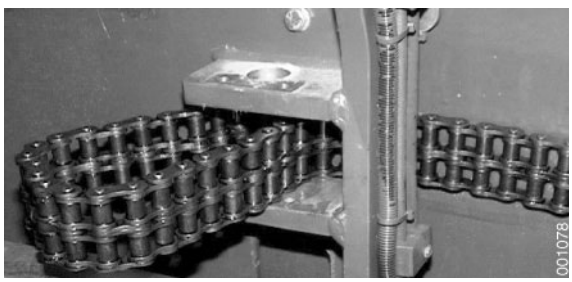
Measure and note down the chain tensioner's position to regain the correct tension on the chain when installing.

7 Remove the defective chain's chain wheel.

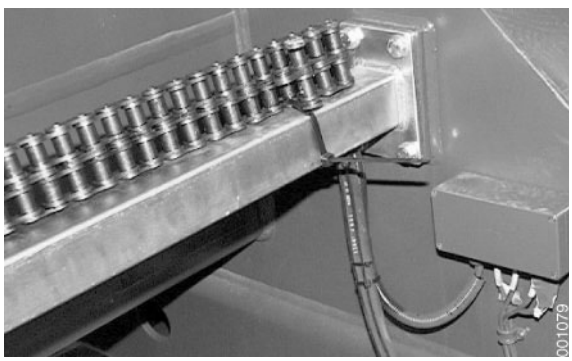
NOTE

Note down the position of the spacer ring.

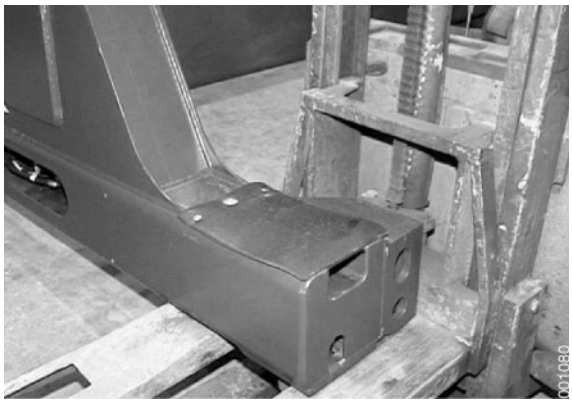
If the chain wheel on the motor side shall be removed then the spreader motor must first be removed, see *Spreader motor, replacement page 62*.



8 Pull the chain out through the hole for the chain wheel so that the chain runs along the spreader beam.



9 Secure the chain temporarily along the cable rack to prevent the chain from jamming.



10 Pull out the spreader beam.

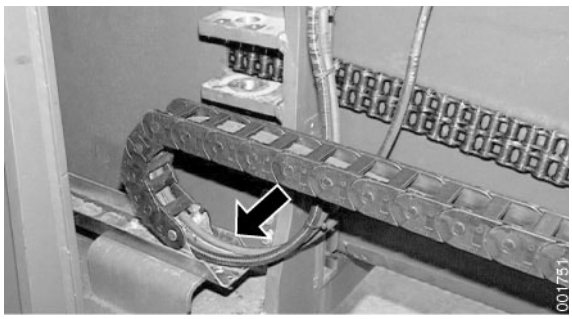
Use a machine or similar to pull the spreader beam from the attachment's main beam. Stop when the spreader beam is near the 40 foot stop.

NOTE

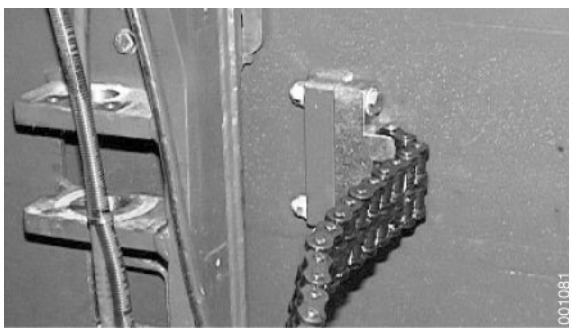
Support the spreader beam so that disruptions are minimised. If necessary remove the upper slide plates to minimise resistance.

11 Remove the boom stop from the attachment's main beam.

12 Remove the hydraulic hoses' clamping on the attachment's main beam.



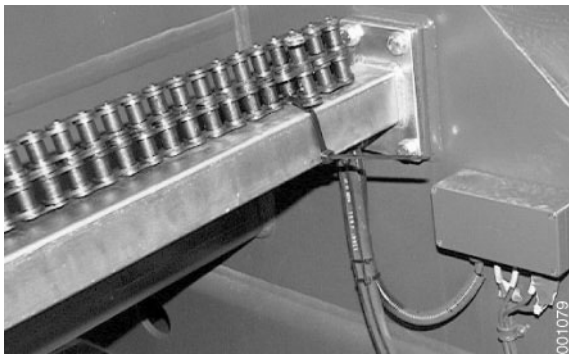
13 Detach the cable rack from the attachment's main beam. Support the cable rack so that it is not damaged.



14 Pull out the spreader beam until the chain's mounting is accessible.

15 Release the chain from the spreader beam and cable rack.

16 Connect the new chain to the spreader beam.



17 Secure the chain along the cable rack so that the chain runs straight in along the spreader beam.

18 Grease the chain with universal grease "EP2".

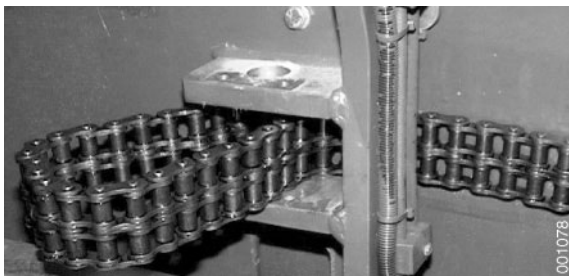
19 Retract the spreader beam so that the protruding stop can be fitted.

20 Fit the protruding stop.

21 Connect the cable rack to the attachment's main beam.

22 Fit the hydraulic hoses' clamping on the attachment's main beam.

23 Retract the spreader beam until it is retracted as far as the other one. This is important for facilitating the fitting of the chains.



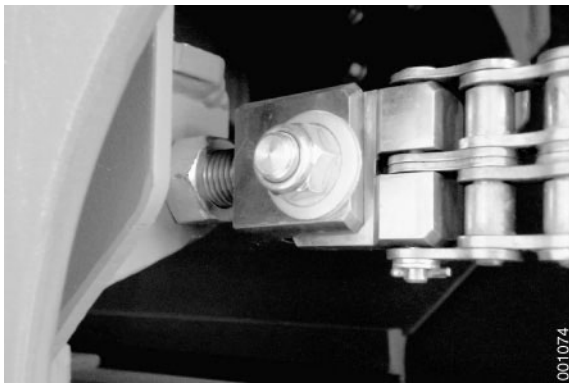
24 Release the chain from the cable rack and thread it through the chain wheel hole.

25 Fit the chain wheel. The spacer ring must fit on the underside of the chain wheel.

If the rotation motor was removed, fit it, see *Spreader motor, replacement page 62*.

NOTE

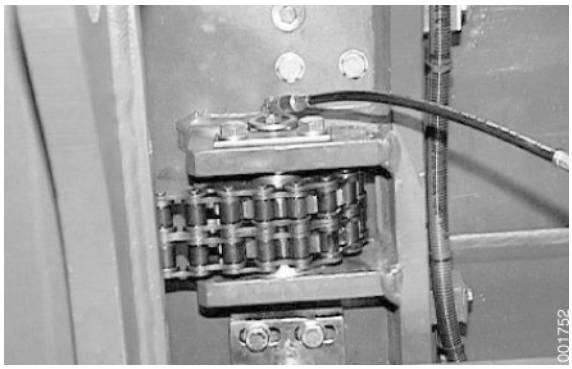
Check that the chain runs straight into the chain wheels.



26 Connect the chain to the chain tensioner.

NOTE

Use a new split pin.



27 Grease the chain wheel bearing with universal grease "EP2"

28 Tension the spreader chain to the same degree as before. Tighten the lock nut.

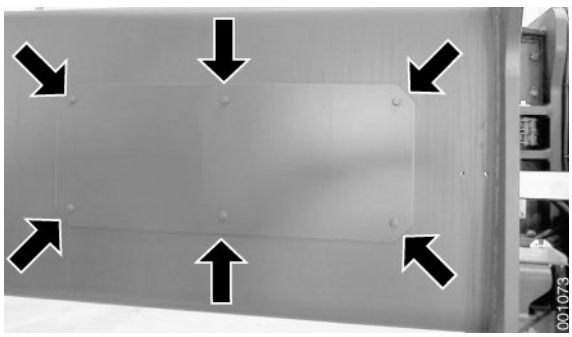
29 If the slide plates were removed, fit them.

30 Turn on the main current and start the engine

31 Check that the positioning is working correctly.

32 Turn off the engine.

33 Check the tension of the chains, see *Maintenance manual DRF 400–450,* section *7 Load handling,* group *7.5.7 Positioning chains*.



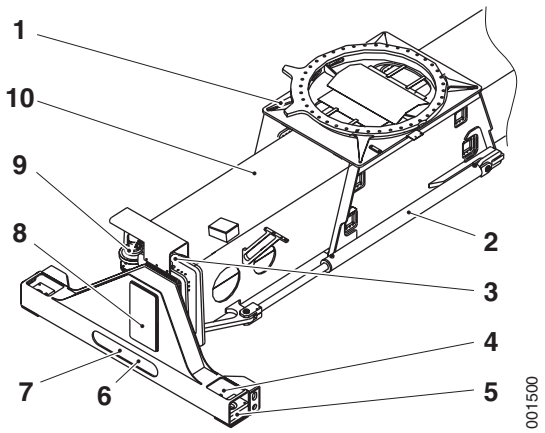
34 Fit the cover plates to the attachment's main beam.

7.5.8 Positioning beam

Spreader beam, description

The spreader beams are a part of the attachment which grips in the container. Two spreader beams run in the main beam. The spreader beams are retracted and extended with the spreader motor and the spreader chains.

There are twistlocks located in the spreader beam, see *Twistlocks, description page 110*.



1. Sideshift frame
2. Sideshift cylinder
3. Position sensor positioning
4. Sensor alignment
5. Twistlock
6. Sensor twistlocks
7. Lock cylinder twistlocks
8. Spreader boom
9. Spreader motor
10. Main beam attachment

Slide plates, spreader boom, replacement

1 Clean the attachment.

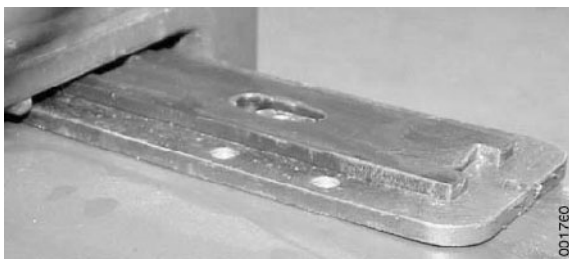
2 Turn off the engine and the main electrical power.

3 Take the strain off the slide plate in question.

Take the strain off the slide plates by lifting the spreader beam at the outside edge or by using wedges to change the spreader beam's position in the attachment's main beam.

The illustration shows the inner slide plates in the attachment's main beam.

The illustration shows the inner slide plates in the attachment's main beam.



4 Remove the attaching bolts for the slide plate's bracket.

5 Remove the guide plate's guide pin.

6 Pull out the slide plate with spacer plate and bracket.

7 Fit the new slide plate in the correct position.

Check the clearance between spreader beam and slide plate. Clearance should be less than 1 mm with all slide plates mounted.

Use a spacer plate to adjust the clearance.

8 Fit the slide plate's bracket and guide pin.

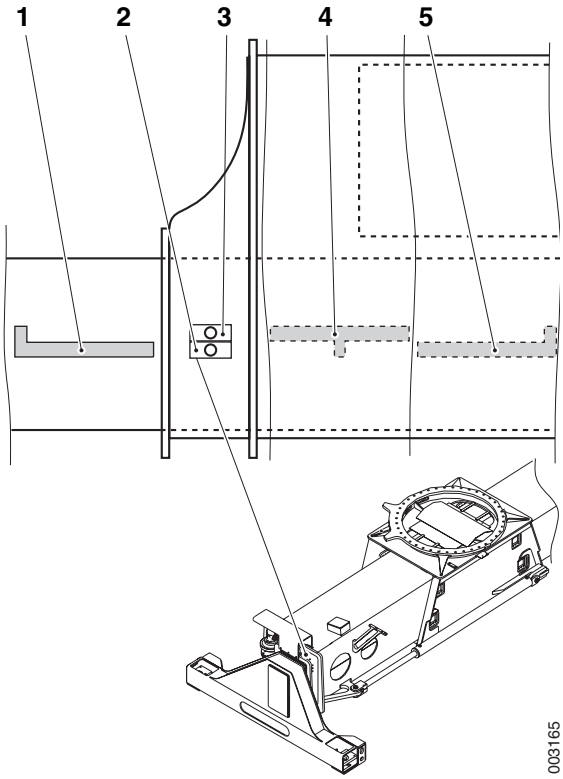
9 Grease the slide surface on the spreader beam.

10 Start the machine and check the positioning function. Try lifting a container and check the spreader beams' clearance in the attachment's main beam.

7.5.9 Main beam attachment

Main beam attachment, description

See *Main beam attachment, description page 53*.



1. Indicator plate 20'
2. Sensor damping 20' and 40', Stop 30'
3. Sensor damping 30' ⊞
4. Indicator plate 30' or 35' ⊞
5. Indicator plate 40'

7.5.10 Position sensor positioning

Position sensor positioning, description

Position sensor positioning indicates the position of the spreader beams. The position sensors are used to control positioning so that twistlocks fit on the container. The position sensors are located under the protective plate on the top side of the attachment's main beam on the left side.

Sensor end-position (B769) indicates end-position for 20 and 40 foot containers. The sensor senses the end-positions of the spreader beams with two indicator plates on the top side of the spreader beam. The sensor is used to activate damping.

⊞

For the optional 30 foot stop an extra sensor is installed, Sensor position (B779), and two indicator plates. The sensor is used to activate 30 foot stop.

The sensors are supplied with voltage and send a 24 V signal to Control unit attachment (D791-1) when the raised parts of the indicator plates pass the sensor. On the spreader units there are indicator plates mounted so that the sensors give a signal when the spreader unit passes the sensor. The indicator plates' and sensors' positions are adapted so that the distance between the spreaders becomes 20', (30') and 40'.

The signals can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.5 ATTACH, menu 5*.

Position sensor, checking and adjustment

See *Position sensor, checking and adjustment page 5*.

7.5.11 Unloading valve attachment

Relief valve attachment, description

See *Relief valve attachment, description page 54*.

7.5.12 Pipes and hoses

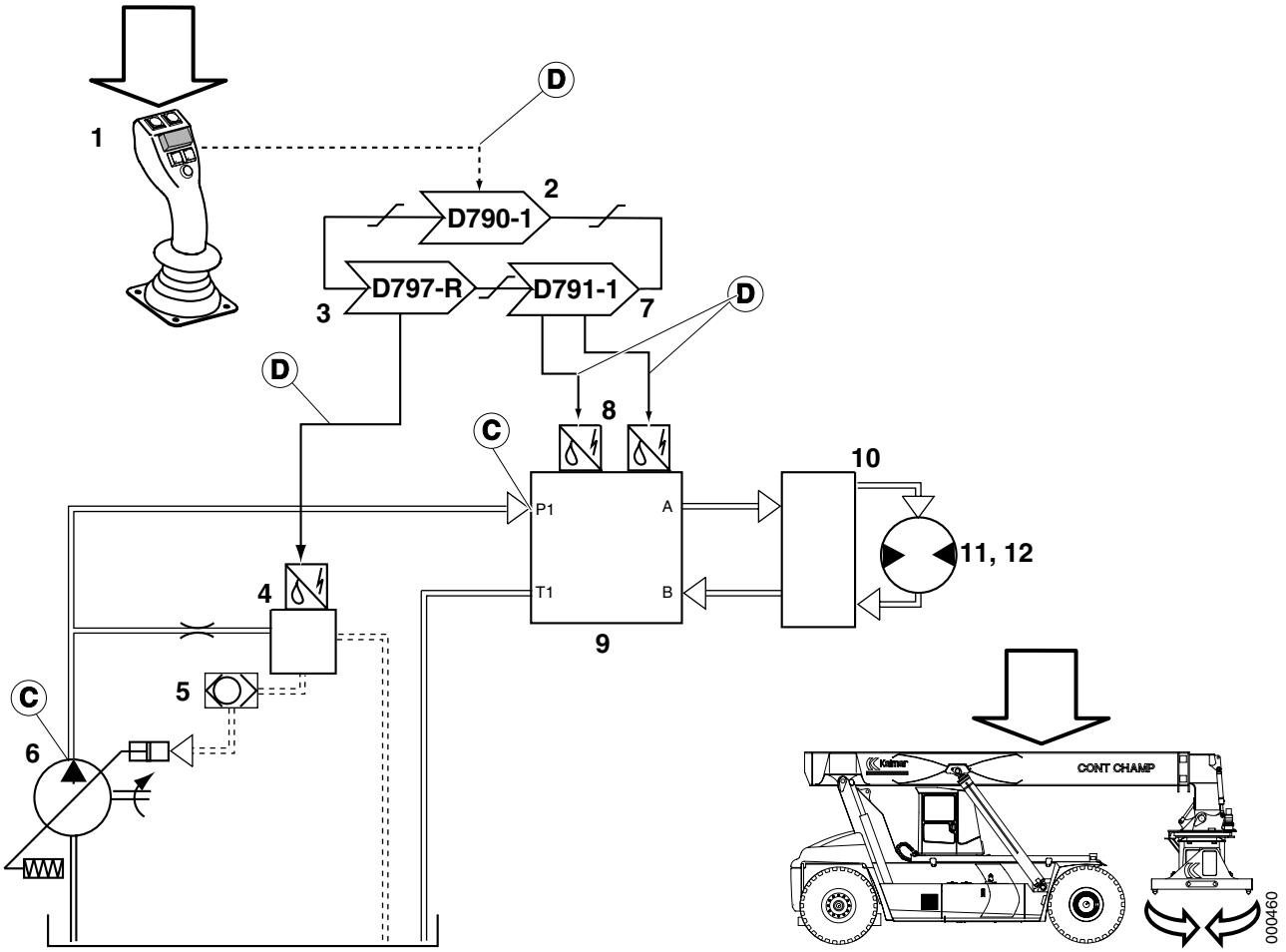
Pipes and hoses, description

See section *10 Common hydraulics*, group *10.5.1 Pipes and hoses*.

7.6 Rotation

Rotation, function description

Condition	Reference value	Reference
Emergency stop	Disengaged	Section *11 Common electrics*, group *11.5.1.4 Emergency stop voltage (15E)*
Overload protection	Passive	Section *8 Control system*, group *8.2.1 Overload protection*



Pos	Explanation	Signal description	Reference
1	Control lever (S815-P3) sends voltage signal proportional to lever movement to Control unit cab (D790-1).	Counter-clockwise: U = 0.5–2.0 V Zero position: U = 2.0–3.0 V Clockwise: U = 3.0–4.5 V 0.5 V is the highest rotation speed and 4,5 V is the highest rotation speed. Lower voltage than 0.5 V and higher voltage than 4.5 V is used to detect defects in cable harnesses and controls.	*Control lever, description page 7* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.1 ATTACH, menu 1*

Pos	Explanation	Signal description	Reference
2	Control unit cab (D790-1) sends rotation clockwise *or rotation counter-clockwise* on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
3	Control unit cab (D790-1) sends rotation clockwise to stop *or rotation counter-clockwise to stop* on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
4	Control unit frame rear (D797-R) activates Solenoid valve, engagement of hydraulics for top lift (Y6003).	U = 24 V	*Valve block top lift hydraulics, description page 45* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.6 HYD, menu 6*
5	Solenoid valve, engagement of hydraulics for top lift (Y6003) opens and pressurizes valve block lift cylinder and sends load signal to hydraulic oil pumps.	-	*Valve block top lift hydraulics, description page 45* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.6 HYD, menu 6*
6	The shuttle valve sends the strongest load signal to hydraulic oil pump 2 if several functions are activated simultaneously.	-	Section *10 Common hydraulics,* group *10.5.3 Shuttle valve*
7	Hydraulic oil pump 2 pumps oil from the hydraulic oil tank.	See pressure plate on left frame beam.	Section *10 Common hydraulics*, group *10.4 Pumps*
8	Control unit attachment (D791-1) activates Servo valve, rotation clockwise *or Servo valve, rotation counter-clockwise*.	I = 435–650 mA	*Control valve attachment, description page 77* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.11 ATTACH, menu 11 and 8.4.9.12 ATTACH, menu 12*
9	Servo valve rotation clockwise (Y6008) *or Servo valve rotation counter-clockwise (Y6009)* pressurizes rotation spool in control valve attachment.	-	*Control valve attachment, description page 77* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.11 ATTACH, menu 11 and 8.4.9.12 ATTACH, menu 12*
10	The rotation spool in control valve attachment changes position and directs pressure to Valve block hydraulic motor.	-	*Control valve attachment, description page 77*
11	Valve block hydraulic motor directs pressure to both motors.	-	*Valve block rotation motor, description page 78*

Pos	Explanation	Signal description	Reference
12	Hydraulic motors' disc brakes are released.	-	*Rotation motor unit, description page 79*
13	Hydraulic motors rotate the attachment.	-	*Rotation motor unit, description page 79*

Hydraulic diagram A43123.0100

Hydraulic diagram A41791.0100

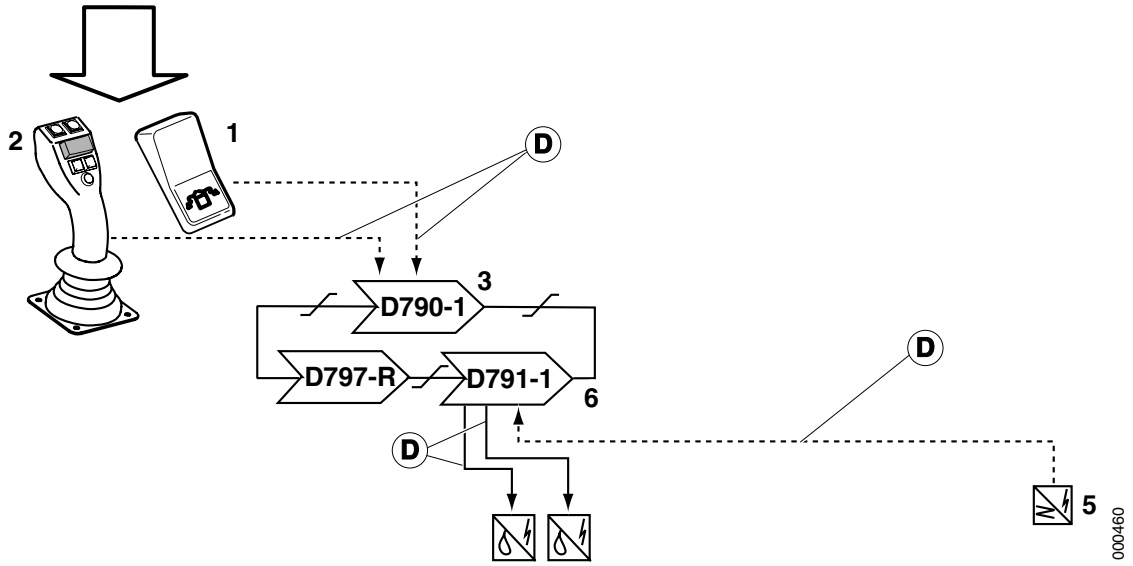
Hydraulic diagram A40853.0100

Hydraulic diagram A40853.0200

Rotation stop, function description

⊕

Condition	Reference value	Reference
Emergency stop	Disengaged	Section *11 Common electrics*, group *11.5.1.4 Emergency stop voltage (15E)*
Overload protection	Passive	Section *8 Control system*, group *8.2.1 Overload protection*



Pos	Explanation	Signal description	Reference
1	Switch rotation stop (S1014) sends voltage signal to Control unit cab (D790-1).	Switch in on position: Conn. 1: U = 0 V Conn 5: U = 24 V Switch in off position: Conn 1: U = 24 V Conn 5: U = 24 V	*Switch rotation stop, description page 9* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group 8.4.9.21 ATTACH, menu 21

Pos	Explanation	Signal description	Reference
2	Control lever (S815-P3) sends voltage signal proportional to lever movement to Control unit cab (D790-1).	Counter-clockwise: 0.5–2.0 V Zero position: 2.0–3.0 V Clockwise: 3.0–4.5 V 0.5 V is the highest rotation speed and 4,5 V is the highest rotation speed. Lower voltage than 0.5 V and higher voltage than 4.5 V is used to detect defects in cable harnesses and controls.	*Control lever, description page 7* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group 8.4.9.1 ATTACH, menu 1
3	Control unit cab (D790-1) sends rotation clockwise to stop *or rotation counter-clockwise to stop* on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
4	Rotation is activated in the same way as the normal rotation steps 3–12.	-	*Maintenance manual DRF 400–450,* section *7 Load handling,* group *7.6 Rotation*
5	Sensor rotation stop (B7225) sends voltage signal to Control unit attachment (D791-1).	Sensor directly opposite indicator plate: U = 24 V	*Sensor rotation stop, description page 86* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group 8.4.9.21 ATTACH, menu 21
6	Rotation is stopped by Control unit attachment (D791-1) cutting off the current to servo valve rotation clockwise (Y6008) *or servo valve rotation counter-clockwise (Y6009)*.	-	*Control valve attachment, description page 77*

Hydraulic diagram A43123.0100

Hydraulic diagram A41791.0100

Hydraulic diagram A40853.0100

Hydraulic diagram A40853.0200

7.6.1 Hydraulic oil pump

Hydraulic oil pump, general

See section *10 Common hydraulics*, group *10.4.2 Axial piston pump with variable displacement*.

7.6.2 Valve block top lift hydraulics

Valve block top lift hydraulics, description

See *Valve block top lift hydraulics, description page 45*.

7.6.3 Manoeuver valve attachment

Control valve attachment, description

Rotation is controlled by a separate section in the attachment's control valve. For a general description of the valve and component location, see *Control valve attachment, description page 46*.

Rotation slide

The valve slide controls rotation direction and speed. The valve slide is controlled by servo valve rotation clockwise and servo valve rotation anticlockwise.

Servo valve rotation clockwise

Servo valve rotation clockwise controls pressure to the rotation slide so that the rotation slide opens and pressurises the rotation motors.

Servo valve rotation clockwise is controlled electrically with Solenoid valve, rotation clockwise (Y6008) which is activated by Control unit attachment (D791-1). The servo valve directs servo pressure to the rotation slide proportional to the control current to the solenoid valve.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.11 ATTACH, menu 11*.

Servo valve positioning counter-clockwise

Servo valve rotation anticlockwise controls pressure to the rotation slide so that the rotation slide opens and pressurises the rotation motors.

Servo valve rotation anticlockwise is controlled electrically with Solenoid valve, rotation anticlockwise (Y6009) which is activated by Control unit attachment (D791-1). The servo valve directs servo pressure to the rotation slide proportional to the control current to the solenoid valve.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.12 ATTACH, menu 12*.

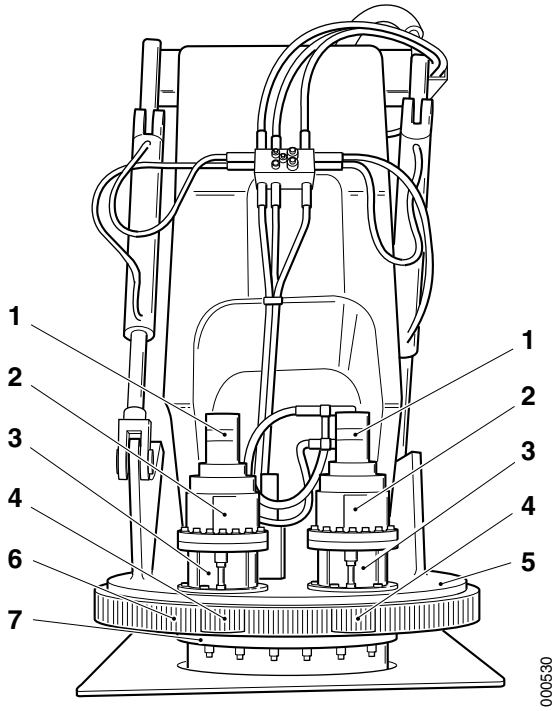
Control valve attachment, replacement

See *Control valve attachment, replacement page 48*.

7.6.4 Shuttle valve

Shuttle valve, description

See section *10 Common hydraulics*, group *10.5.3 Shuttle valve*.



1. Hydraulic motor, rotation
2. Disc brake
3. Planetary gear
4. Gear wheel
5. Rotation yoke
6. Ring gear
7. Sideshift frame

7.6.5 Valve block rotation motor

Valve block rotation motor, description

Valve block rotation motor controls pressure to the rotation motors. The valve block is located on one of the rotation motors.

The valve block provides a controlled rotation by preventing the load from pulling away and provides faster rotation than the hydraulic motor. The valve block contains a shuttle valve and over-centre valves.

7.6.6 Rotation motor unit

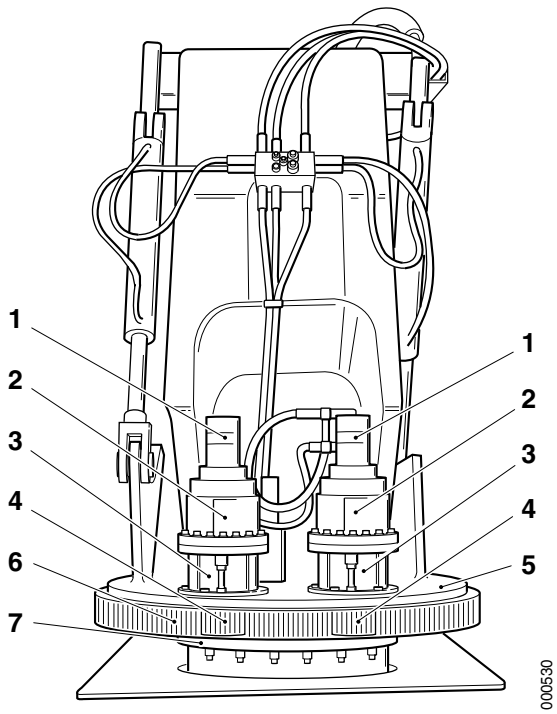
Rotation motor unit, description

The rotation motors rotate the attachment in relation to the boom. The motors are located along the attachment's rotation yoke. The motors work against the ring gear between the rotation yoke and the sideshift frame. The rotation motor unit consists of hydraulic motor, disc brake and planetary gear which is built together to one unit.

The hydraulic motor is located on the disc brake housing. Between the motor and the discs is a gear wheel.

The disc brake prevents accidental rotation. The disc brake is applied with springs and is disengaged when the hydraulic pressure is built up to rotate the yoke.

The planetary gear reinforces the output in the motor and disc brake. The planetary gear changes the motor speed down so that the motor power is greater.



1. Hydraulic motor, rotation
2. Disc brake
3. Planetary gear
4. Gear wheel
5. Rotation yoke
6. Ring gear
7. Sideshift frame

Oil rotation motor unit, replacement

See *Maintenance manual DRF 400–450*.

Rotation motor unit, replacement

WARNING

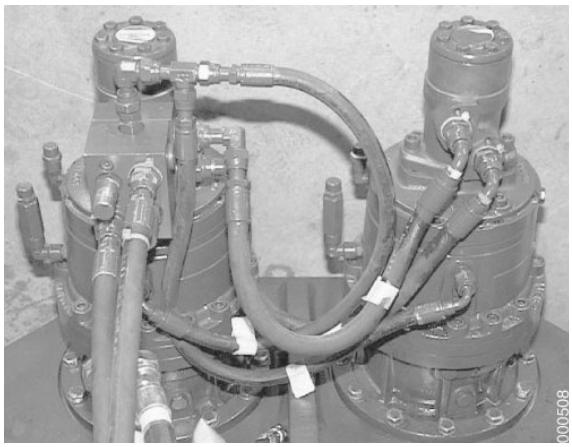
Hot, pressurised oil.

Personal injury, burn injury, rash or irritation

Always depressurise the hydraulic systems before starting to work on the hydraulic systems. Avoid skin contact with the oil, use protective gloves.

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

2 Depressurise the brake and hydraulic systems, see section *B Safety*.



3 Clean the rotation motor unit and its surrounding area.

4 Position a collection container under the attachment at the hydraulic motor to collect any spilled oil.

5 Mark up and detach the hydraulic hoses from the motor.

NOTE

Plug all connections immediately to protect the hydraulic system from impurities.

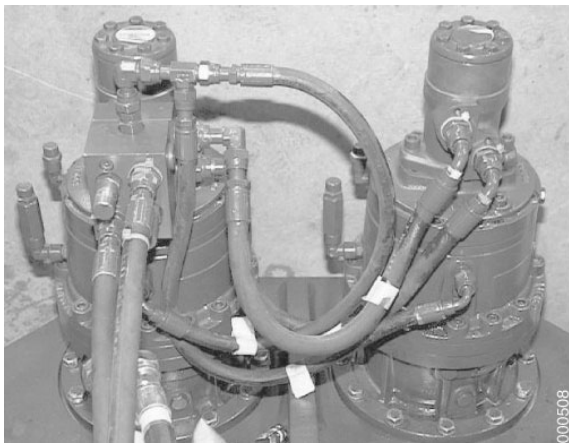
6 Remove the hydraulic motor's attaching bolts.

7 Lift away the rotation motor unit. Position the motor unit so that the pinion and planetary gear are not damaged.

8 Clean the contact surfaces on the motor unit and rotation yoke.

9 Lift the new motor unit into place.

10 Fit the motor unit. Tighten the bolts crosswise with torque **117 Nm**.



11 Connect the hydraulic hoses to the motor and brake in accordance with the marking.

NOTE

Check that the O-rings are intact and correctly fitted.

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

13 Check that the hydraulic connections seal tightly.

14 Remove the collection container, treat the spillage as environmentally hazardous waste.

15 Check that the rotation is working.

16 Check the hydraulic oil level with the lift cylinders completely down and the protrude cylinder completely in. The oil level should be at the top of the level glass. Top up if needed.

⚠ CAUTION

Overfilling of oil.

Leakage and environmental damage.

The hydraulic oil level is checked with the boom completely lowered and retracted.

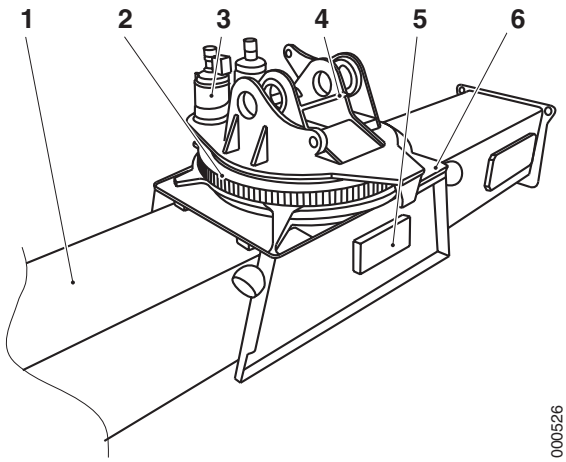
7.6.7 Rotation yoke

Rotation yoke, description

The rotation yoke is a part of the attachment which connects the attachment to the boom. The rotation yoke is secured on the inner boom with two shafts which run in bearing equipped attaching lugs. In the bottom of the rotation yoke is the ring gear with lead-through bolts.

Using the rotation motors which act on the ring gear the remaining parts of the attachment can be rotated in relation to the lift boom.

The rotation yoke's mounting in the lift boom facilitates longitudinal motion (so-called "tilt"). The oscillating motion is dampened by two hydraulic cylinders which are secured between the upper yoke and the upper edge on the inner boom.



1. Main beam
2. Ring gear
3. Rotation motor unit
4. Rotation yoke
5. Control valve attachment
6. Sideshift frame

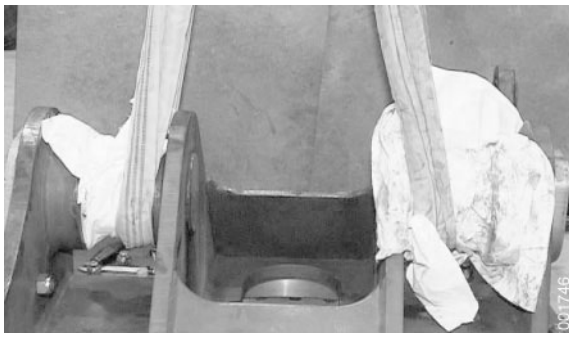
Rotation yoke, replacement

1 Clean the attachment and boom nose

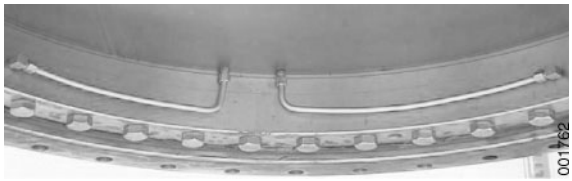
2 Release the attachment from the boom.

3 Remove the rotation motors from the rotation yoke. See *Rotation motor unit, replacement page 79*.

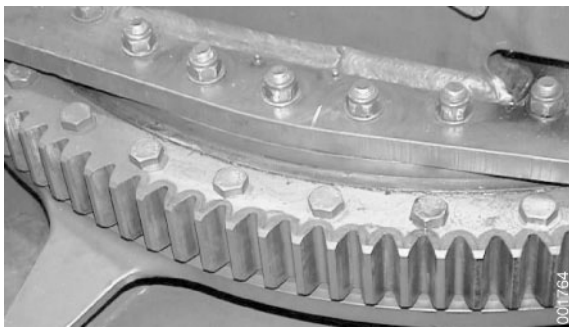
4 Fit the lifting equipment on the rotation yoke.



5 Remove the pipes for ring gear lubrication.



The illustration shows removed rotation yoke and ring gear.



6 Remove the rotation yoke attaching bolts.

7 Lift away the rotation yoke.

8 Clean the contact surfaces on the ring gear.

9 Remove the plastic plugs and clean the threads and holes on the new rotation yoke, clean the contact surface against the ring gear.

10 Transfer parts to the new rotation yoke.

- Grease cups
- Mounting pins

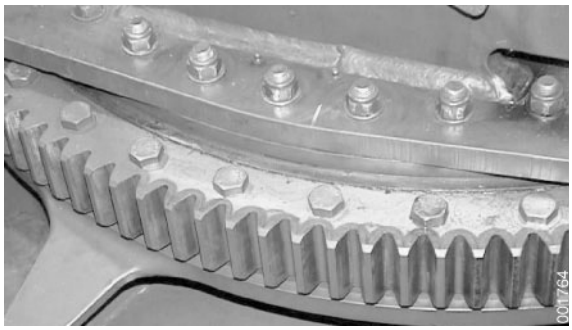
11 Transfer the lifting equipment to the new rotation yoke.

12 Lift the new rotation yoke into place.

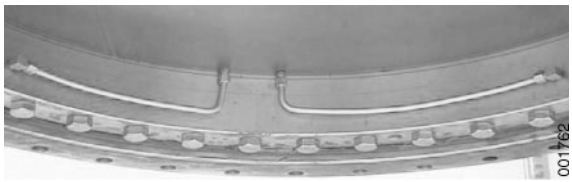
NOTE

Align the position against that of the ring gear so that the lubrication lines can be fitted.

13 Grease the rotation yoke's mounting pins with universal grease "EP2", and fit them in the rotation yoke.



14 Tighten the rotation yoke's attaching bolts with torque, **331 Nm**.



15 Fit the pipes for the ring gear lubrication lines.

16 Grease the ring gear with universal grease "EP2".

Rotate the yoke while greasing it so that the grease is distributed evenly.

17 Rotate the yoke so that it is straight.

18 Fit the rotation motors. See *Rotation yoke, description page 81*.

NOTE

If necessary, rotate the rotation yoke so that the rotation motor's gear wheel fits against the ring gear.

19 Connect the attachment to the boom.

20 Start the motor and check that the rotation is working.

21 Clean the attachment.

22 Check the hydraulic oil level with the lift cylinders completely down and the protrude cylinder completely in. The oil level should be at the top of the level glass. Top up if needed.

⚠ CAUTION

Overfilling of oil.

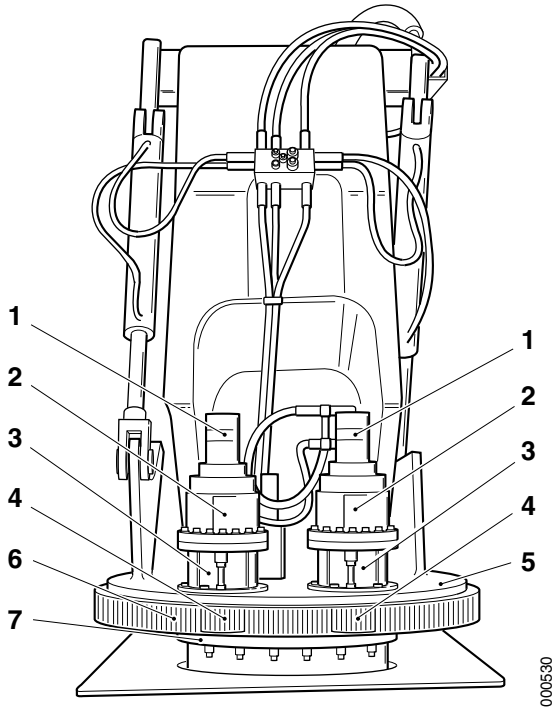
Leakage and environmental damage.

The hydraulic oil level is checked with the boom completely lowered and retracted.

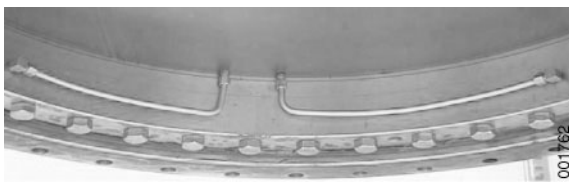
7.6.8 Ring gear

Ring gear, description

The ring gear is the joint between the rotation yoke and the sideshift frame. The ring gear consists of gear wheel, bearings and mounting parts. The unit is bolted into the rotation yoke and sideshift frame.



1. Hydraulic motor, rotation
2. Disc brake
3. Planetary gear
4. Gear wheel
5. Rotation yoke
6. Ring gear
7. Sideshift frame



The illustration shows removed rotation yoke and ring gear.

Ring gear, replacement

1 Remove the rotation yoke, see *Rotation yoke, replacement page 82*.

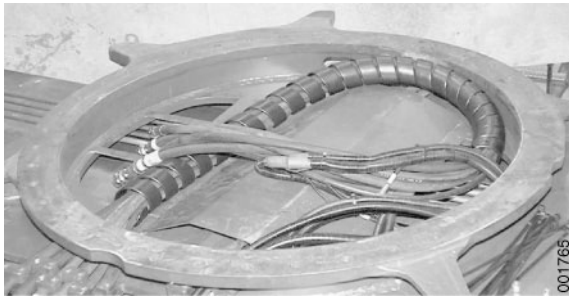
2 Remove the lubricating pipes from the ring gear.

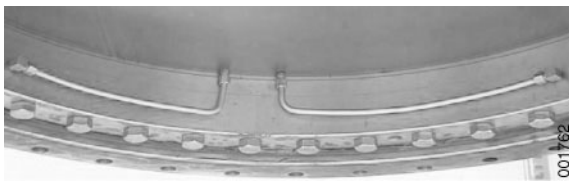
NOTE

Note down the locations of the lubricating pipes to facilitate fitting.

3 Remove the attaching bolts between the ring gear and the sideshift frame.

4 Lift away the ring gear.





The illustration shows removed rotation yoke and ring gear.

5 Clean the contact surfaces on the sideshift frame and ring gear. The surfaces must be totally clean.

6 Lift the new ring gear into place.

NOTE

Rotate it so that the connections for the lubricating pipes are in the same positions as before.

7 Grease the inner attaching bolts with universal grease "EP2" and fit them. Tighten the bolts crosswise with torque, **331 Nm**.

8 Fit the rotation yoke, see *Rotation yoke, replacement page 82*.

9 Fit the lubricating pipes to the ring gear.

10 Grease the ring gear with universal grease "EP2".

11 Start the motor and check the function of the rotation.

12 Check the hydraulic oil level with the lift cylinders completely down and the protrude cylinder completely in. The oil level should be at the top of the level glass. Top up if needed.

⚠ CAUTION

Overfilling of oil.

Leakage and environmental damage.

The hydraulic oil level is checked with the boom completely lowered and retracted.

7.6.9 Sideshift frame

Sideshift frame, description

See *Sideshift frame, description page 51*.

7.6.10 Sensor rotation stop

Sensor rotation stop, description

Sensor rotation stop (B7225) indicates when rotation is 25° from the middle position and is used to activate rotation stop. The sensor is located on a bracket on the left side of the rotation yoke and senses 25° towards the rotation yoke's mechanical stop.

The sensors are supplied with voltage and send 24 V signal to Control unit attachment (D791-1) when the raised parts pass the sensor.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.21 ATTACH, menu 21*.

Position sensor, checking and adjustment

See *Position sensor, checking and adjustment page 5*.

7.6.11 Unloading valve attachment

Relief valve attachment, description

See *Relief valve attachment, description page 54*.

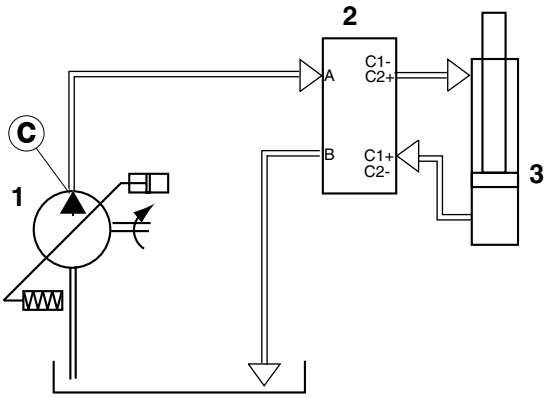
7.6.12 Pipes and hoses

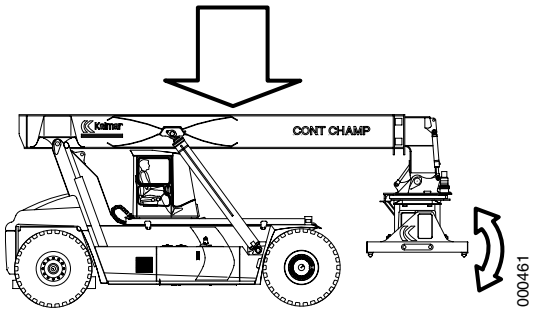
Pipes and hoses, description

See section *10 Common hydraulics*, group *10.5.1 Pipes and hoses*.

7.7 Tilt

Tilt damping, function description





Pos	Explanation	Signal description	Reference
1	Hydraulic oil pump 2 pumps oil.	See pressure plate on left frame beam.	Section *10 Common hydraulics*, group *10.4 Pumps*
2	Damping block tilt distributes oil to the tilt cylinders.	-	*Damping block tilt, description page 92*
3	The tilt cylinders dampen the attachment's movements.	-	*Tilt cylinder, description page 96*

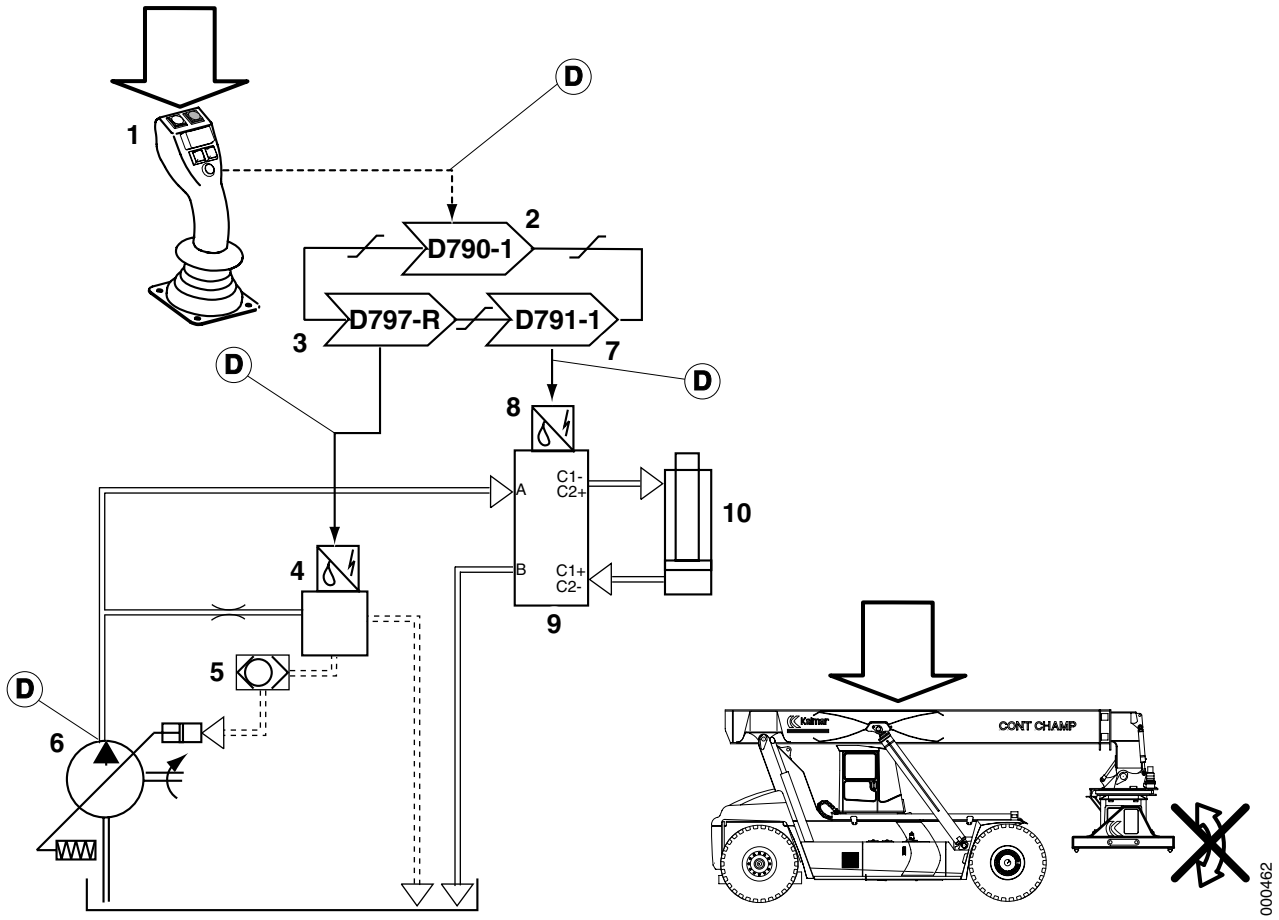
Hydraulic diagram A43123.0100

Hydraulic diagram A41791.0100

Hydraulic diagram A40853.0100

Hydraulic diagram A40853.0200

Tilt lock, function description



Pos	Explanation	Signal description	Reference
1	Control lever (S815-T3.1) sends voltage signal proportional to lever movement to Control unit cab (D790-1).	$U_{S815\text{-}T3.1}$ = 24 V	*Control lever, description page 7* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.4 ATTACH, menu 4*
2	Control unit cab (D790-1) sends tilt locking on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
3	Control unit frame rear (D797-R) activates Solenoid valve, engagement of hydraulics for top lift (Y6003).	U = 24 V	*Valve block top lift hydraulics, description page 45* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.6 HYD, menu 6*

Pos	Explanation	Signal description	Reference
4	Solenoid valve, engagement of hydraulics for top lift (Y6003) opens and pressurizes valve block lift cylinder and sends load signal to hydraulic oil pumps.	-	*Valve block top lift hydraulics, description page 45* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.6 HYD, menu 6*
5	The shuttle valve sends the strongest load signal to the hydraulic oil pumps if several functions are activated simultaneously.	-	Section *10 Common hydraulics,* group *10.5.3 Shuttle valve*
6	Hydraulic oil pump 2 pumps oil from the hydraulic oil tank.	See pressure plate on left frame beam.	Section *10 Common hydraulics*, group *10.4 Pumps*
7	Control unit attachment (D791-1) activates Servo valve, tilt lock (Y6012).	Float mode: U = 24 V Lock mode: U = 0 V	*Lock valve tilt, description page 94* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.15 ATTACH, menu 15*
8	Servo valve tilt lock (Y6012) pressurizes the lock valve in the attachment's control valve.	-	*Lock valve tilt, description page 94* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.15 ATTACH, menu 15*
9	The lock valve changes position and blocks the connections to the tilt cylinders.	-	*Lock valve tilt, description page 94*
10	The tilt cylinders lock the attachment's angle.	-	*Tilt cylinder, description page 96*

Hydraulic diagram A43123.0100

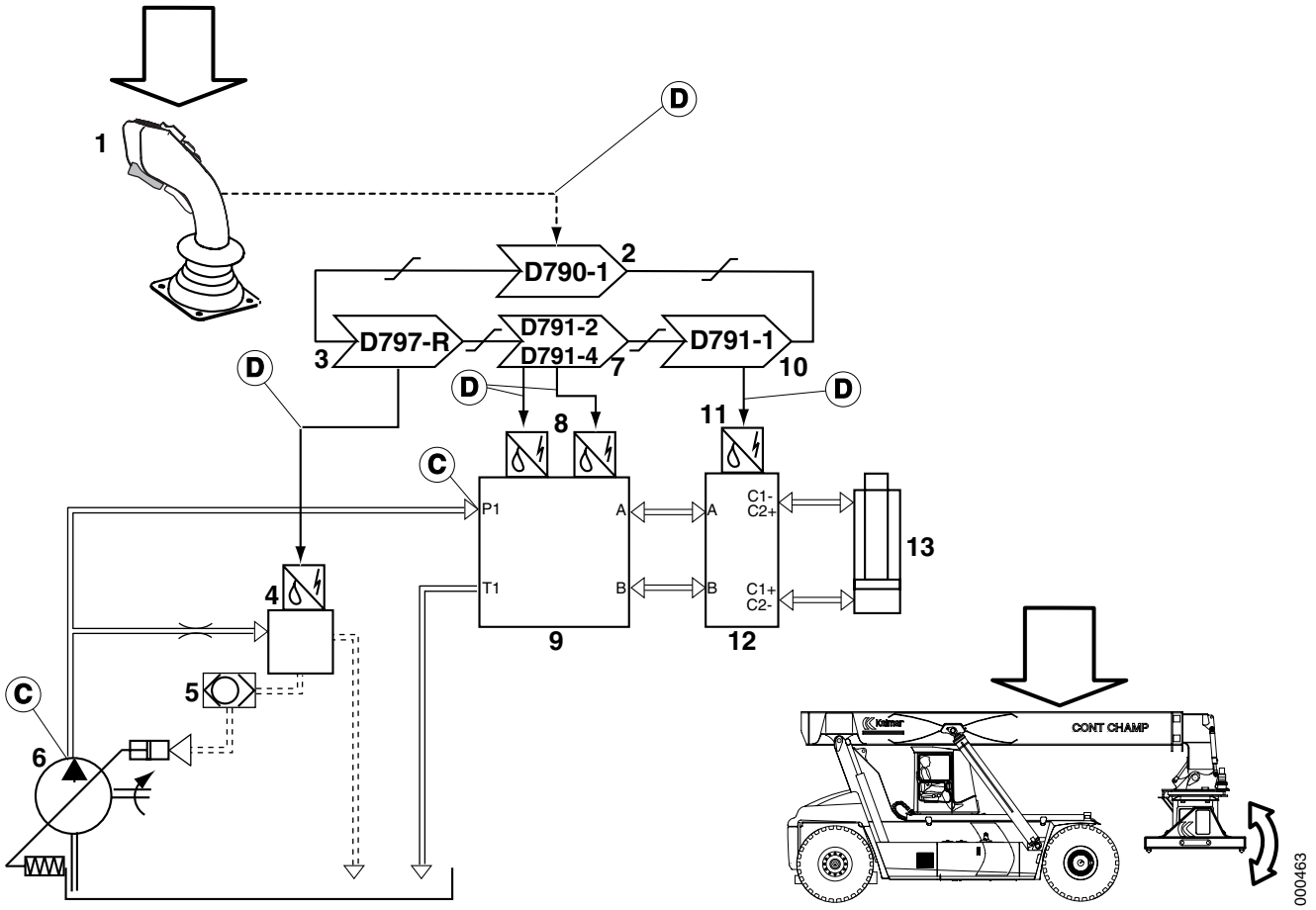
Hydraulic diagram A41791.0100

Hydraulic diagram A40853.0100

Hydraulic diagram A40853.0200

Tilt control, function description

Condition	Reference value	Reference
Emergency stop	Disengaged	Section *11 Common electrics*, group *11.5.1.4 Emergency stop voltage (15E)*
Overload protection	Passive	Section *8 Control system*, group *8.2.1 Overload protection*



Pos	Explanation	Signal description	Reference
1	Control lever (S815-P4) sends voltage signal proportional to lever movement to Control unit cab (D790-1).	Tilt out: $U_{S815\text{-}P4}$ = 0.5–2.0 V Zero position: $U_{S815\text{-}P4}$ = 2.0–3.0 V Tilt in: $U_{S815\text{-}P4}$ = 3.0–4.5 V	*Control lever, description page 7* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.1 ATTACH, menu 1*
2	Control unit attachment option (D791-2) sends tilt in *or tilt out* on CAN-bus.	Controlled by control system, error shown with error code.	*Section 11 Common electrics, group 11.6 Communication*

Pos	Explanation	Signal description	Reference
3	Control unit frame rear (D797-R) activates Solenoid valve, engagement of hydraulics for top lift (Y6003).	U = 24 V	*Valve block top lift hydraulics, description page 45* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.6 HYD, menu 6*
4	Solenoid valve, engagement of hydraulics for top lift (Y6003) opens and pressurizes valve block lift cylinder and sends load signal to hydraulic oil pumps.	-	*Valve block top lift hydraulics, description page 45* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.6 HYD, menu 6*
5	The shuttle valve sends the strongest load signal to the hydraulic oil pumps if several functions are activated simultaneously.	-	Section *10 Common hydraulics,* group *10.5.3 Shuttle valve*
6	Hydraulic oil pump 2 pumps oil from the hydraulic oil tank.	See pressure plate on left frame beam.	Section *10 Common hydraulics*, group *10.4 Pumps*
7	Control unit attachment option (D791-2) or Control unit attachment right leg pair (D791-4) activates Servo valve, tilt out (6010) *or Servo valve, tilt in (Y6011)*.	I = 400–650 mA	*Control valve attachment, description page 94* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.16 ATTACH, menu 16 and 8.4.9.17 ATTACH, menu 17*
8	Servo valve, tilt out *(Y6010) or Servo valve, tilt in (Y6011)* pressurizes the tilt spool in the attachment's control valve.	-	*Control valve attachment, description page 94* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.16 ATTACH, menu 16 and 8.4.9.17 ATTACH, menu 17*
9	The control valve's tilt spool changes position and pressurizes the damping block.	-	*Control valve attachment, description page 94*
10	Control unit attachment (D791-1) activates Servo valve, tilt lock (Y6012).	Float mode: U = 24 V Lock mode: U = 0 V	*Lock valve tilt, description page 94* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.15 ATTACH, menu 15*
11	Servo valve tilt lock (Y6012) pressurizes the lock valve in the attachment's control valve.	-	*Lock valve tilt, description page 94* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.15 ATTACH, menu 15*
12	The lock valve changes position and leads oil crosswise to the tilt cylinders.	-	*Damping block tilt, description page 92*
13	The tilt cylinders change the attachment's angle.	-	*Tilt cylinder, description page 96*

Hydraulic diagram A43123.0100

Hydraulic diagram A41791.0100

Hydraulic diagram A40853.0100

Hydraulic diagram A40853.0200

7.7.1 Hydraulic oil pump

Hydraulic oil pump, general

See section *10 Common hydraulics*, group *10.4.2 Axial piston pump with variable displacement*.

7.7.2 Valve block top lift hydraulics

Valve block top lift hydraulics, description

See *Valve block top lift hydraulics, description page 45*.

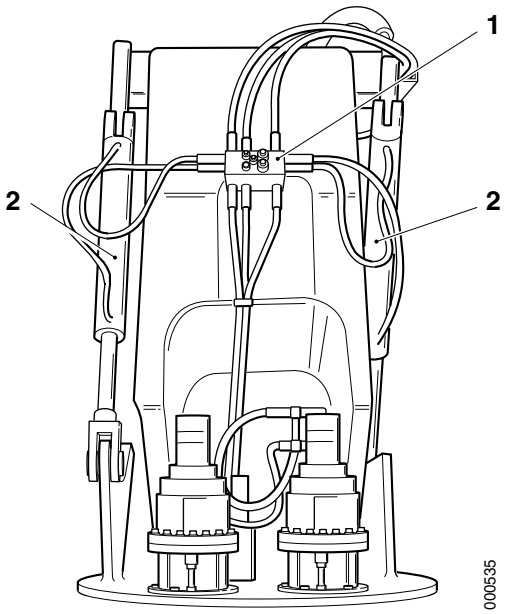
7.7.3 Damping block tilt

Damping block tilt, description

The damping block contains restrictions which create resistance to the tilt cylinder's movements which in turn dampen the attachment's oscillations. The damping block is located in the centre of the boom nose.

The damping block is supplied with oil via the return from the attachment's control valve. The feed means that the cylinders are always filled with oil. Tuned restrictions mean that the feed does not affect the tilting. The constant feed means that the tilt cylinders do not need bleeding after work on tilting.

The damping block contains two shock valves which protect the valve against surges.



1. Damping block
2. Tilt cylinder

Damping block tilt, replacement

⚠ WARNING

Hot, pressurised oil.

Personal injury, burn injury, rash or irritation

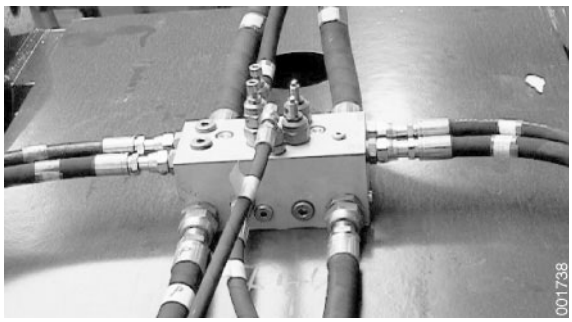
Always depressurise the hydraulic systems before starting to work on the hydraulic systems. Avoid skin contact with the oil, use protective gloves.

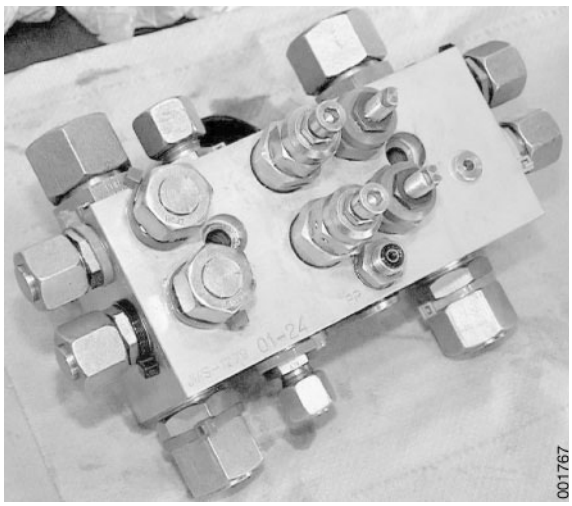
1 Machine in service position, see section *B Safety*.

2 Depressurise the brake and hydraulic systems, see section *B Safety*.

3 Clean the damping block and its surrounding area.

4 Mark up and detach the hydraulic hoses from the valve block.





The illustration shows the damping block with controllable tilt.

NOTE

Plug all connections immediately to protect the hydraulic system from impurities.

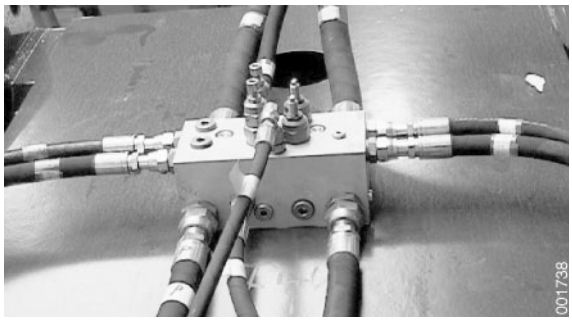
5 Remove the valve block from the boom.

6 Transfer the connection adapters to the new valve. Transfer one adapter at a time so that the marking is not mixed up.

NOTE

Check that the O-rings are intact and correctly fitted.

7 Fit a new valve block to the boom nose.



8 Connect the hydraulic hoses to the damping block in accordance with the marking.

NOTE

Check that the O-rings are intact and correctly fitted.

9 Start the machine and check seal integrity and function.

Check both tilt and attachment functions.

10 Check the hydraulic oil level with the lift cylinders completely down and the protrude cylinder completely in. The oil level should be at the top of the level glass. Top up if needed.

⚠ CAUTION

Overfilling of oil.

Leakage and environmental damage.

The hydraulic oil level is checked with the boom completely lowered and retracted.

7.7.4 Lock valve tilt

Lock valve tilt, description

On machines with tilt lock, there are two solenoid valves on the damping block's return lines. When the solenoid valves are activated the connection between the cylinders is blocked and locks the tilt position. The lock valves are located on the damping block.

Solenoid valve tilt (Y6012) is supplied with voltage by Control unit attachment option (D791-2) when tilt lock is not activated.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.15 ATTACH, menu 15*.

7.7.5 Manoeuver valve attachment

Control valve attachment, description

Controllable tilt is controlled by a separate section in the attachment's control valve. For a general description of the valve and component location, see *Control valve attachment, description page 46*.

Tilt slide

The valve slide controls direction and speed of attachment tilting.

The valve slide is controlled by servo valve tilt in and servo valve tilt out.

Servo valve tilt out

Servo valve tilt out controls pressure to the tilt slide so that the tilt slide opens and pressurises the tilt cylinders.

Servo valve tilt out is controlled electrically with Solenoid valve, tilt out (Y6010) which is activated by Control unit attachment option (D791-2). The servo valve directs servo pressure to the tilt slide proportional to the control current to the solenoid valve.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.16 ATTACH, menu 16*.

Servo valve tilt in

Servo valve tilt in controls pressure to the tilt slide so that the tilt slide opens and pressurises the tilt cylinders.

Servo valve tilt in is controlled electrically with Solenoid valve, tilt in (Y6011) which is activated by Control unit attachment option (D791-2). The servo valve directs servo pressure to the tilt slide proportional to the control current to the solenoid valve.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.17 ATTACH, menu 17*.

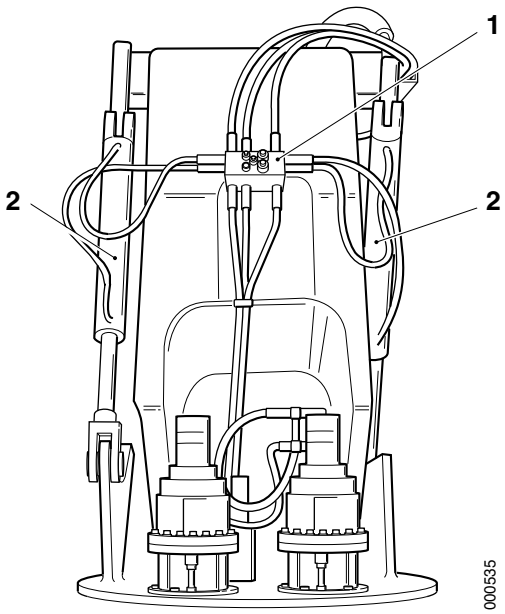
Control valve attachment, replacement

See *Control valve attachment, replacement page 48*.

7.7.6 Shuttle valve

Shuttle valve, description

See section *10 Common hydraulics*, group *10.5.3 Shuttle valve*.



1. Damping block
2. Tilt cylinder

7.7.7 Tilt cylinder

Tilt cylinder, description

The tilt cylinders are located between the inner boom's front edge and the rotation yoke's upper section. The two cylinders are positioned diagonally and can therefore effectively dampen or control tilt motion.

The piston rod bracket is welded to the piston rod, which is threaded in the piston head and locked with a lock bolt. The cylinder head is threaded in the cylinder pipe.

Hydraulic cylinders, repairing

See section *10 Common hydraulics,* group *10.7.1 Hydraulic cylinders*.

7.7.8 Lift boom

Lift boom, general

See *Lift boom, description page 34* and *Maintenance manual DRF 400–450*, section *7 Load handling*, group *7.3.10 Lift boom*.

7.7.9 Rotation yoke

Rotation yoke, general

See group *7.6.7 Rotation yoke*.

7.7.10 Unloading valve attachment

Relief valve attachment, description

See *Relief valve attachment, description page 54*.

7.7.11 Pipes and hoses

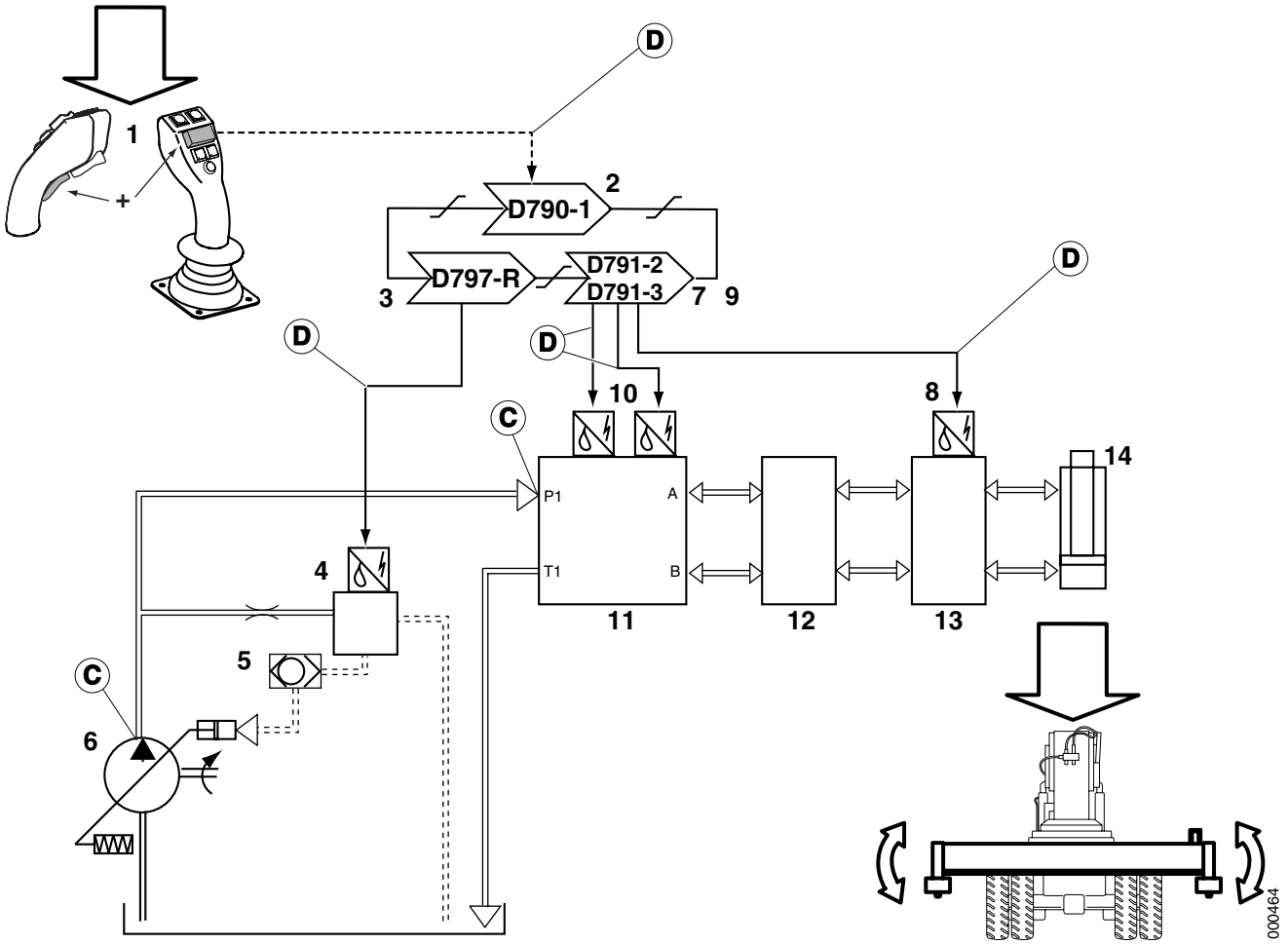
Pipes and hoses, description

See section *10 Common hydraulics*, group *10.5.1 Pipes and hoses*.

7.8 Levelling

Hydraulic levelling, function description

Condition	Reference value	Reference
Emergency stop	Disengaged	Section *11 Common electrics*, group *11.5.1.4 Emergency stop voltage (15E)*
Overload protection	Passive	Section *8 Control system*, group *8.2.1 Overload protection*



Pos	Explanation	Signal description	Reference
1	Control lever (S815-P3) sends voltage signal proportional to lever movement, at the same time as Control lever (S815-T4) sends voltage to Control unit cab (D790-1).	Levelling right: $U_{S815\text{-}P3}$ = 0.5–2.0 V Zero position: $U_{S815\text{-}P3}$ = 2.0–3.0 V Levelling left: $U_{S815\text{-}P3}$ = 3.0–4.5 V $U_{S815\text{-}T4}$ = 24 V	*Control lever, description page 7* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.1 ATTACH, menu 1*

Pos	Explanation	Signal description	Reference
2	Control unit cab (D790-1) sends levelling left or levelling right on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
3	Control unit frame rear (D797-R) activates Solenoid valve, engagement of hydraulics for top lift (Y6003).	U = 24 V	*Valve block top lift hydraulics, description page 45* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.6 HYD, menu 6*
4	Solenoid valve, engagement of hydraulics for top lift (Y6003) opens connection between the pumps and the attachment's control valve.	-	*Valve block top lift hydraulics, description page 45* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.6 HYD, menu 6*
5	The shuttle valve sends the strongest load signal to the hydraulic oil pumps if several functions are activated simultaneously.	-	Section *10 Common hydraulics,* group *10.5.3 Shuttle valve*
6	Hydraulic oil pump 2 pumps oil from the hydraulic oil tank.	See pressure plate on left frame beam.	Section *10 Common hydraulics*, group *10.4 Pumps*
7	Control unit attachment option (D791-2) or Control unit attachment left legs (D791-3) activates Solenoid valve levelling (Y6034).	U = 24 V	*Valve block levelling cylinders, description page 103* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.18 ATTACH, menu 18*
8	Solenoid valve levelling opens connection to levelling cylinders in Valve block levelling cylinders.	-	*Valve block levelling cylinders, description page 103*
9	Control unit attachment option (D791-2) or Control unit attachment left legs (D791-3) activates Servo valve levelling right (Y6035) *or Servo valve levelling left (Y6036)*.	I = 400–650 mA	*Control valve attachment, description page 101* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.19 ATTACH, menu 19 and 8.4.9.20 ATTACH, menu 20*
10	Servo valve levelling right (Y6035) *or Servo valve levelling left (Y6036)* act on the levelling spool in control valve attachment.	-	*Control valve attachment, description page 101* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.19 ATTACH, menu 19 and 8.4.9.20 ATTACH, menu 20*
11	The control valve's levelling spool changes position and pressurizes the over-centre valve levelling.	-	*Control valve attachment, description page 101*
12	The over-centre valve opens and leads the pressure to valve block levelling cylinders.	-	*Over-centre valve levelling, description page 102*

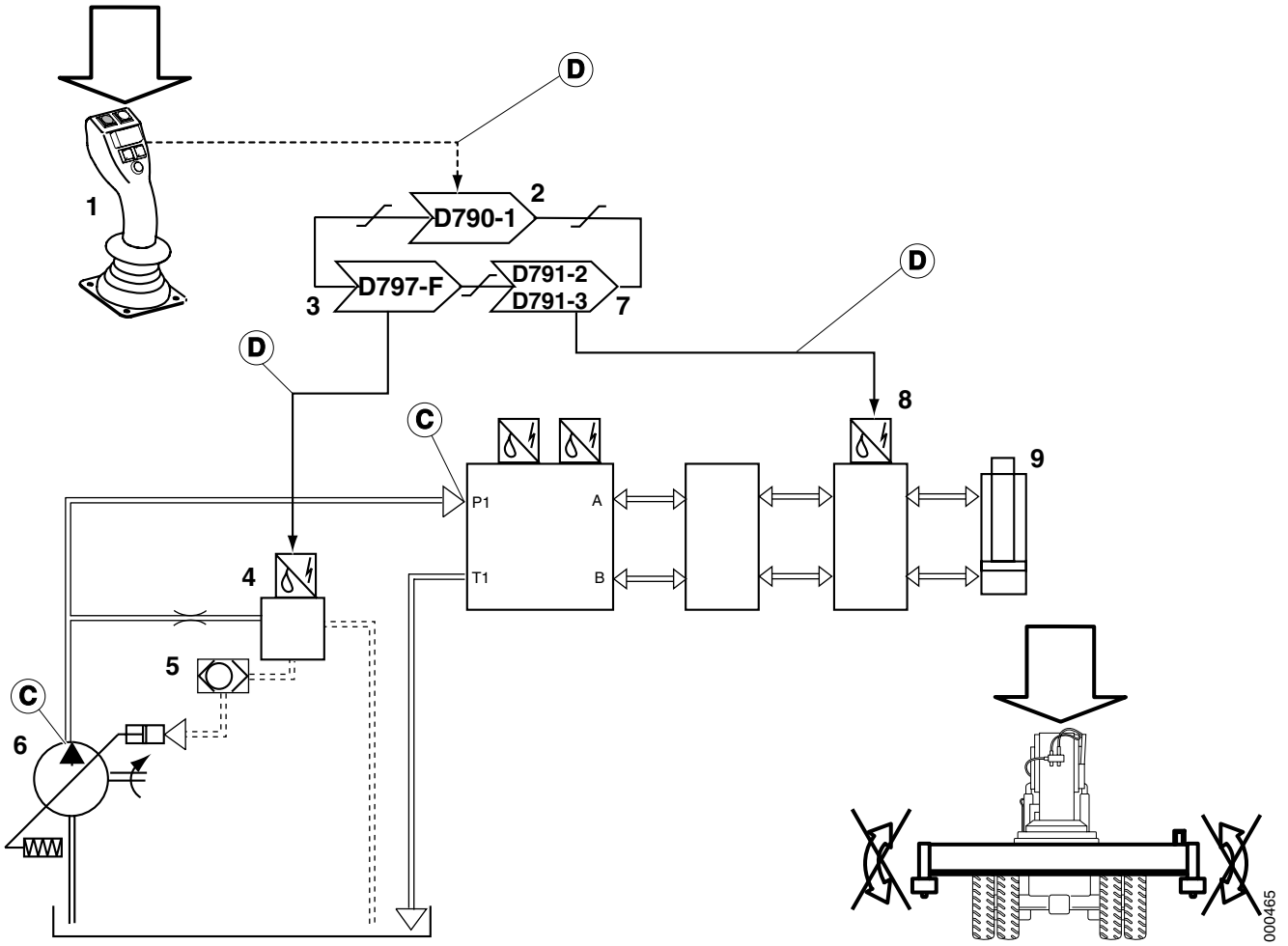
Pos	Explanation	Signal description	Reference
13	Valve block levelling cylinders leads the pressure on to levelling cylinders.	-	*Valve block levelling cylinders, description page 103*
14	The levelling cylinders lock the attachment's angle.	-	*Levelling cylinders, description page 103*

Hydraulic diagram A43123.0100

Hydraulic diagram A41791.0100

Levelling lock, function description

Condition	Reference value	Reference
Emergency stop	Disengaged	Section *11 Common electrics*, group *11.5.1.4 Emergency stop voltage (15E)*



Pos	Explanation	Signal description	Reference
1	Control lever (S815-T3.1) sends voltage signal to Control unit cab (D790-1).	$U_{S815\text{-}T3.1}$ = 24 V	*Control lever, description page 7* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.4 ATTACH, menu 4*
2	Control unit cab (D790-1) sends levelling lock on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
3	Control unit frame rear (D797-R) activates Solenoid valve, engagement of hydraulics for top lift (Y6003).	U = 24 V	*Valve block top lift hydraulics, description page 45* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.6 HYD, menu 6*
4	Solenoid valve, engagement of hydraulics for top lift (Y6003) opens connection between the pumps and the attachment's control valve.	-	*Valve block top lift hydraulics, description page 45* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.6 HYD, menu 6*
5	The shuttle valve sends the strongest load signal to the hydraulic oil pumps if several functions are activated simultaneously.	-	Section *10 Common hydraulics,* group *10.5.3 Shuttle valve*
6	The hydraulic oil pumps pump oil from the hydraulic oil tank.	See pressure plate on left frame beam.	Section *10 Common hydraulics*, group *10.4 Pumps*
7	Control unit attachment option (D791-2) or Control unit attachment left legs (D791-3) cuts off activation Solenoid valve levelling (Y6034).	U = 0 V	*Valve block levelling cylinders, description page 103* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.18 ATTACH, menu 18*
8	Solenoid valve levelling (Y6034) blocks connections to levelling cylinders in valve block levelling cylinders.	-	*Valve block levelling cylinders, description page 103*
9	The levelling cylinders change the attachment's angle.	-	*Levelling cylinders, description page 103*

Hydraulic diagram A43123.0100

Hydraulic diagram A41791.0100

7.8.1 Hydraulic oil pump

Hydraulic oil pump, general

See section *10 Common hydraulics*, group *10.4.2 Axial piston pump with variable displacement*.

7.8.2 Valve block top lift hydraulics

Valve block top lift hydraulics, description

See *Valve block top lift hydraulics, description page 45*.

7.8.3 Manoeuver valve attachment

Control valve attachment, description

Hydraulic levelling is controlled by a separate section in the control valve attachment. For a general description of the valve and component location, see *Control valve attachment, description page 46*.

Levelling slide

The valve slide controls direction and speed of attachment levelling.

The valve slide is controlled by servo valve levelling right (Y6035) and servo valve levelling left (Y6034).

Servo valve levelling right

Servo levelling right controls pressure to the levelling slide so that it opens and pressurises the levelling cylinders.

Servo valve levelling right is controlled electrically with Solenoid valve, levelling right (Y6035) which is activated by Control unit attachment option (D791-2). The servo valve directs servo pressure to the tilt slide proportional to the control current to the solenoid valve.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.19 ATTACH, menu 19*.

Servo valve levelling left

Servo levelling left controls pressure to the levelling slide so that it opens and pressurises the levelling cylinders.

Servo valve levelling left is controlled electrically with Solenoid valve levelling left (Y6036) which is activated by Control unit, attachment (D791-2). The servo valve directs servo pressure to the tilt slide proportional to the control current to the solenoid valve.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.20 ATTACH, menu 20*.

Passive levelling

The servo valves open a connection to the tank, in addition, hydraulic oil can flow between right and left-hand side levelling cylinders, from piston sides to rod sides, in accordance with inclination.

Active levelling

Levelling is monitored by the sequence valves in valve block levelling cylinder, which close when the feed pressure is high enough to set all cylinders in bottom position. Following which, hydraulic oil is fed to the rod sides on one side's cylinders and the side lifts. When levelling, the other side will thus always be in its lowest position. This always gives maximal levelling travel.

Control valve attachment, replacement

See *Control valve attachment, replacement page 48*.

7.8.4 Shuttle valve

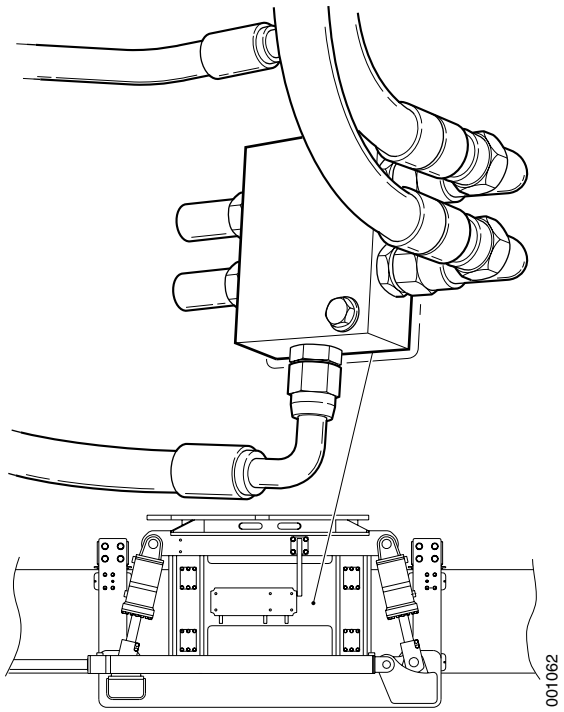
Shuttle valve, description

See section *10 Common hydraulics*, group *10.5.3 Shuttle valve*.

7.8.5 Over-centre valve levelling

Over-centre valve levelling, description

The over-centre valve makes sure that the levelling cylinders are run out completely. The valve is located to the right of the attachment control valve on the sideshift frame's trailing edge under Valve block levelling cylinders.

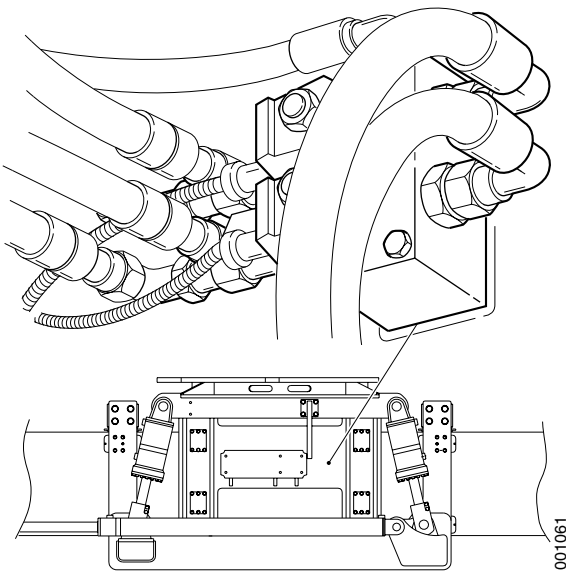


Passive levelling

The over-centre valves allow flow of hydraulic oil between right and left levelling cylinders, from piston sides to rod sides, all according to angle.

Active levelling

The over-centre valves close when the feed pressure is high enough to put all levelling cylinders in bottom position. Then, hydraulic oil is supplied through the levelling cylinder valve block to the rod sides on one side's (right or left) cylinders and the side lifts. When levelling, the other side will thus always be in its lowest position. This always gives maximal levelling travel.



7.8.6 Valve block levelling cylinders

Valve block levelling cylinders, description

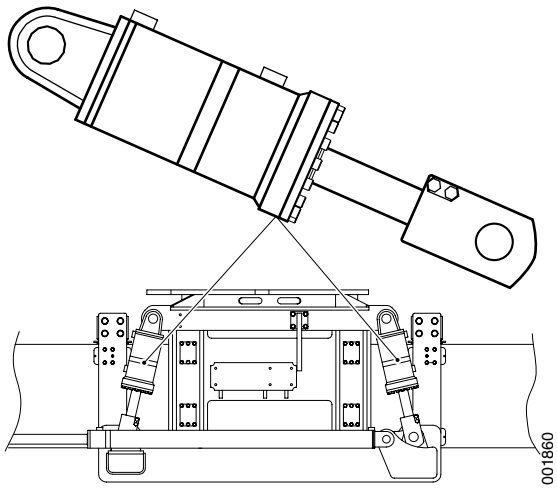
The valve block for levelling cylinders leads pressure from the attachment control valve to the levelling cylinders. The valve block contains lock valves that block levelling when levelling lock is activated or if the machine loses electrical power. The valve is located to the right of the attachment control valve on the sideshift frame's trailing edge above the over-centre valve levelling.

Lock valve

The lock valve is opened by Solenoid valve levelling (Y6034). When the lock valve is closed the oil is blocked to and from the levelling cylinders, and levelling is blocked. Solenoid valve levelling (Y6034) is supplied with voltage by Control unit attachment option (D791-2) or-Control unit attachment right leg pair (D791-4).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.18 ATTACH, menu 18*.

7.8.7 Levelling cylinders

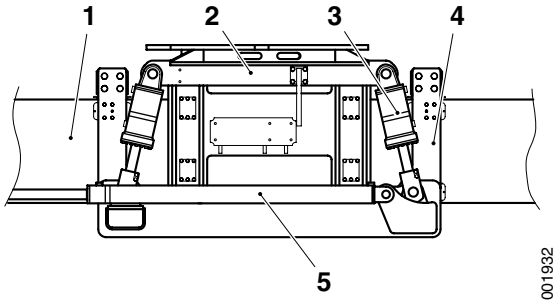


Levelling cylinders, description

On machines with hydraulic levelling there are four hydraulic cylinders between the sideshift frame's parts, see *Sideshift frame, description page 104*.

Hydraulic cylinders, repairing

See section *10 Common hydraulics,* group *10.7.1 Hydraulic cylinders*.



1. Main beam attachment
2. Sideshift frame upper section
3. Levelling cylinder
4. Sideshift frame lower section
5. Sideshift cylinder

7.8.8 Sideshift frame

Sideshift frame, description

The sideshift frame is available in two different versions, see *Sideshift frame, description page 51*.

Mechanical levelling

The sideshift frame is larger than the attachment's main beam. The main beam can move freely between the slide plates. This allows approx. 5 ° levelling.

Hydraulic levelling

The sideshift frame is split in two. There are four levelling cylinders between the two sections, see *Levelling cylinders, description page 103*. The outer section is secured in the rotation yoke via the ring gear. The inner part holds the attachment's main beam. The main beam slides on slide plates. The hydraulic cylinders' stroke makes levelling of the main beam possible, approx. 5°. With hydraulically controlled levelling, the angle of the main beam attachment can be controlled with the control lever.

7.8.9 Unloading valve attachment

Relief valve attachment, description

See *Relief valve attachment, description page 54*.

7.8.10 Pipes and hoses

Pipes and hoses, description

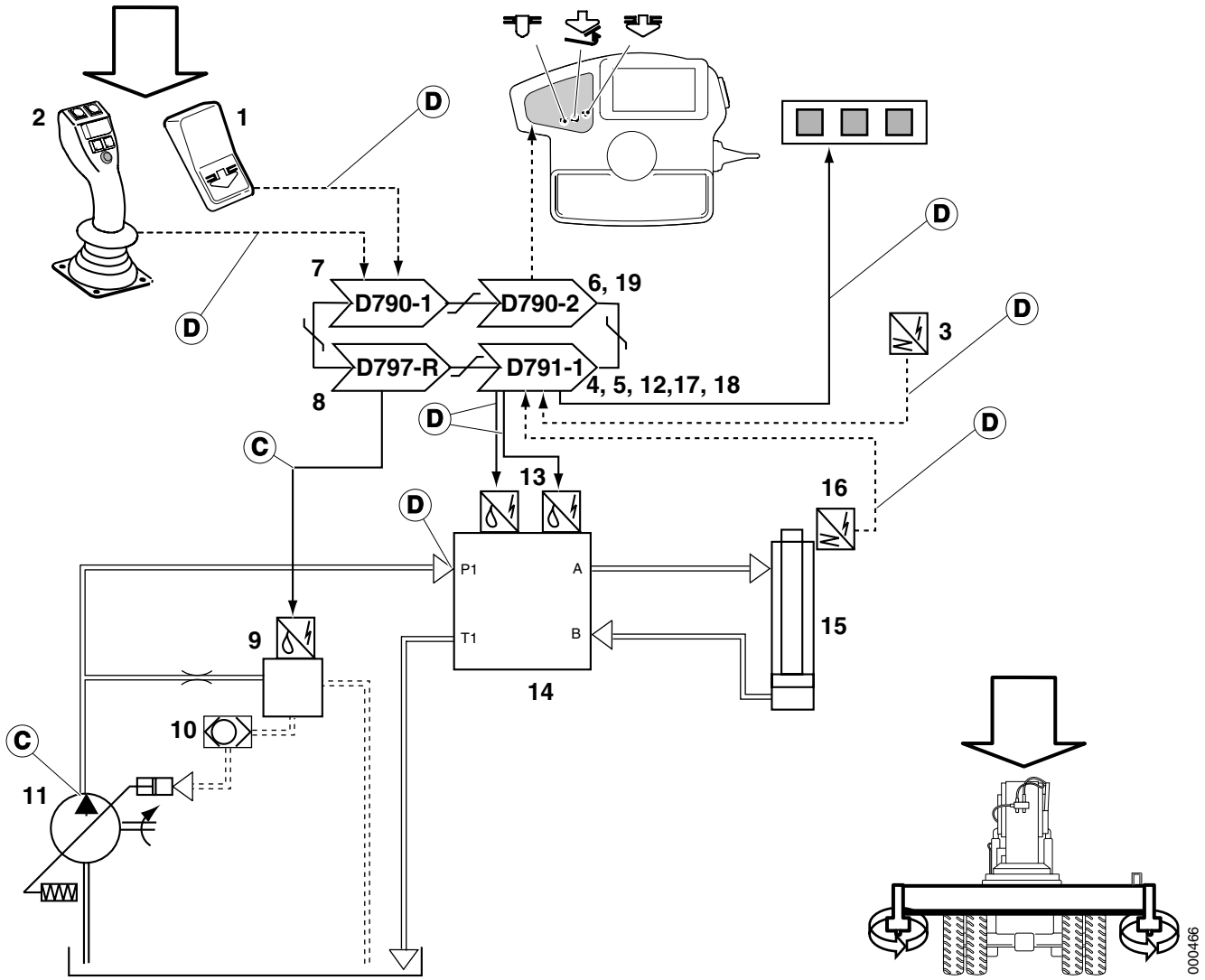
See section *10 Common hydraulics*, group *10.5.1 Pipes and hoses*.

7.9 Load carrying

7.9.1 Twistlocks

Twistlocks, function description

Condition	Reference value	Reference
Emergency stop	Disengaged	Section *11 Common electrics*, group *11.5.1.4 Emergency stop voltage (15E)*
Alignment	Full alignment or by-pass activated	*Twistlocks, description page 110* Section *8 Control system*, group *8.2.2 By-passing*
Overload protection	Passive	Section *8 Control system*, group *8.2.1 Overload protection*



Pos	Explanation	Signal description	Reference
1	Switch lock twistlocks (S1003) (automatic position) sends voltage signal to Control unit cab (D790-1).	U = 24 V	*Switch lock twistlocks, description page 9* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.3 ATTACH, menu 3*
2	Control lever (S815-T2) sends voltage signal to Control unit cab (D790-1) to open twistlocks. If Switch, lock twistlocks (S1003) is in manual position no signal is needed from control lever to open twistlock.	$U_{S815-T2}$ = 24 V	*Control lever, description page 7* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.3 ATTACH, menu 3*
3	Sensor alignment left front (7202L), Sensor alignment right front (7202R), Sensor alignment left rear (Y7203L) and Sensor alignment right rear (Y7203R) send voltage signals to Control unit attachment Control unit attachment (D791).	Sensor directly opposite indicator plate: U = 24 V	*Sensor alignment, description page 111* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.6 ATTACH, menu 6*
4	Control unit attachment (D791) sends alignment on the CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
5	Control unit attachment (D791) activates the indicator light for alignment on the boom's light panel.	U = 24 V	*Indicator light alignment, description page 12* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.10 ATTACH, menu 10*
6	Control unit KIT (D790-2) activates the indicator light for alignment on the cab's light panel.	-	*Indicator light alignment, description page 12*
7	Control unit cab (D790-1) sends open twistlocks *or lock twistlocks* on the CAN bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
8	Control unit frame rear (D797-R) activates Solenoid valve, engagement of hydraulics for top lift (Y6003)	U = 24 V	*Valve block top lift hydraulics, description page 45* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.6 HYD, menu 6*
9	Solenoid valve, engagement of hydraulics for top lift (Y6003) opens and pressurizes valve block lift cylinder and sends load signal to hydraulic oil pump 2.	-	*Valve block top lift hydraulics, description page 45*

Pos	Explanation	Signal description	Reference
10	The shuttle valve sends the strongest load signal to the hydraulic oil pumps if several functions are activated simultaneously.	-	Section *10 Common hydraulics,* group *10.5.3 Shuttle valve*
11	Hydraulic oil pump 2 pumps oil from the hydraulic oil tank.	See pressure plate on left frame beam.	Section *10 Common hydraulics*, group *10.4 Pumps*
12	Control unit attachment (D791) activates Servo valve open twistlocks (Y6039) *or Servo valve lock twistlocks (Y6040)*.	U = 24 V	*Control valve attachment, description page 108* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.9 ATTACH, menu 9*
13	Servo valve open twistlocks (Y6039) *or Servo valve lock twistlocks (Y6040)* pressurizes the twistlock spool with servo pressure.	-	*Control valve attachment, description page 108* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.9 ATTACH, menu 9*
14	The control valve's twistlock spool changes position and pressurizes the lock cylinders.	-	*Control valve attachment, description page 108*
15	The lock cylinders rotate the twistlocks.	-	*Lock cylinder, description page 109*
16	Sensor unlocked twistlocks (B7204) *or Sensor locked twistlocks (B7205)* sends signal to Control unit attachment (D791).	Sensor directly opposite indicator plate: U = 24 V	*Sensor twistlocks, description page 112* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.7 ATTACH, menu 7*
17	Control unit attachment (D791) supplies voltage to Indicator light unlocked twistlocks (H562) *or Indicator light locked twistlocks (H563)* on the boom's light panel.	U = 24 V	*Indicator light locked twistlocks, description page 12* *Indicator light unlocked twistlocks, description page 13* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.10 ATTACH, menu 10*
18	Control unit attachment (D791) sends information about twistlocks unlocked *or twistlocks locked* on the CAN bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
19	Control unit KIT (D790-2) supplies voltage to Indicator light unlocked twistlocks *or Indicator light locked twistlocks* on the cab's light panel.	-	*Indicator light unlocked twistlocks, description page 13* *Indicator light locked twistlocks, description page 12*

Hydraulic diagram A43123.0100

Hydraulic diagram A41791.0100

Hydraulic diagram A40853.0100

Hydraulic diagram A40853.0200

7.9.1.1 Hydraulic oil pump

Hydraulic oil pump, general

See section *10 Common hydraulics*, group *10.4.2 Axial piston pump with variable displacement*.

7.9.1.2 Valve block top lift hydraulics

Valve block top lift hydraulics, description

See *Valve block top lift hydraulics, description page 45*.

7.9.1.3 Manoeuver valve attachment

Control valve attachment, description

Twistlocks are controlled by a separate section in the attachment's control valve. For a general description of the valve and component location, see *Control valve attachment, description page 46*.

Twistlocks slide, description

The valve slide controls direction and the lock cylinder.

The valve slide is controlled by two servo valves, lock twistlocks and open twistlocks.

Servo valve lock twistlocks, description

Servo valve lock twistlocks controls pressure to the twistlocks slide so that the twistlocks slide opens and pressurises the lock cylinders.

Servo valve lock twistlocks is controlled electrically with Solenoid valve lock twistlocks (Y6040) which is activated by Control unit, attachment (D791-1). The servo valve directs servo pressure to the twistlocks slide proportional to the control current to the solenoid valve.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.9 ATTACH, menu 9*.

Servo valve open twistlocks, description

Servo valve open twistlocks controls pressure to the twistlocks slide so that the twistlocks slide opens and pressurises the lock cylinders.

Servo valve open twistlocks is controlled electrically with Solenoid valve open twistlocks (Y6041) which is activated by Control unit, attachment (D791-1). The servo valve directs servo pressure to the twistlocks slide proportional to the control current to the solenoid valve.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.9 ATTACH, menu 9*.

Control valve attachment, replacement

See *Control valve attachment, replacement page 48*.

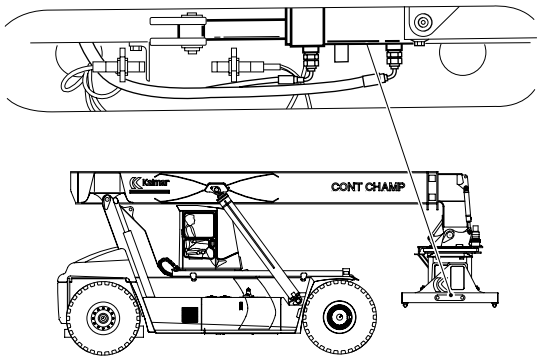
7.9.1.4 Shuttle valve

Shuttle valve, description

See section *10 Common hydraulics*, group *10.5.3 Shuttle valve*.

7.9.1.5 Lock cylinder

Lock cylinder, description



000539

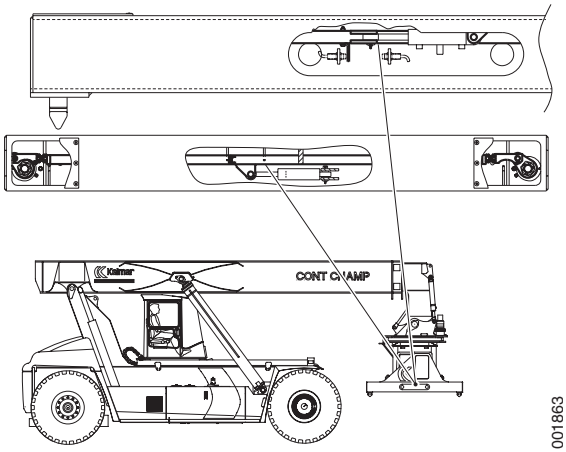
The lock cylinder turns the lock mechanism to rotate twistlocks. Two lock cylinders, one in the right-hand and one in the left-hand spreader beam turn the lock mechanism. The lock cylinders are located in the centre of the spreader beam's longitudinal section.

Hydraulic cylinders, repairing

See section *10 Common hydraulics,* group *10.7.1 Hydraulic cylinders*.

7.9.1.6 Lock mechanism

Lock mechanism, description



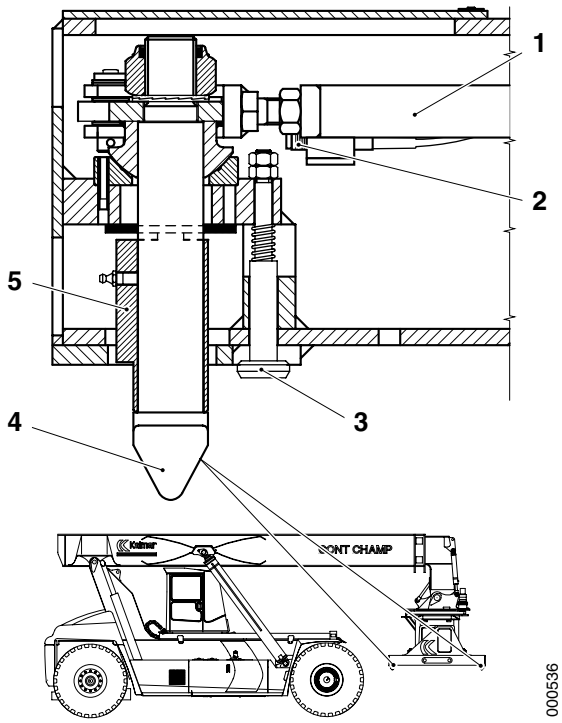
001863

The lock mechanism transfers the lock cylinders' output to the twistlocks. Two lock mechanisms, one in the right-hand and one in the left-hand spreader beam act on the twistlocks. The lock mechanism runs in the spreader beam's longitudinal section between the twistlocks.

The lock mechanism consists of a rod with linkages in the end. The rod is secured in the levers which turn the twistlocks. There is an attaching lug for the lock cylinder in the centre of the rod.

7.9.1.7 Twistlocks

Twistlocks, description



1. Lock mechanism
2. Sensor alignment
3. Alignment pin
4. Lift pin
5. Lock guide

WARNING

Dropped load.

Fatal danger!

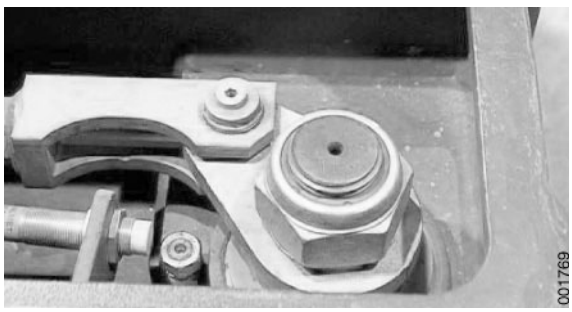
Twistlocks hold the load during load handling and therefore it is very important that twistlocks are checked according to instructions and are replaced at the slightest sign of damage or wear.

Twistlocks secure the load and are located in the corners of the spreader beam's longitudinal part.

Twistlocks are manufactured according to international standards for high-strength steel. The lift pins are marked with serial numbers.

Twistlocks are connected in pairs via a link system to a hydraulic cylinder which in turn is controlled via a section in the attachment's control valve. Inductive sensors send signals when twistlocks are locked and unlocked, respectively.

Twistlock, replacement



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

2 Depressurise the brake and hydraulic systems, see section *B Safety*.

3 Clean the twistlocks and the surrounding area.

4 Undo the centre nut for the twistlocks.

5 Tap the nut so that the lift pin releases from the wedge.

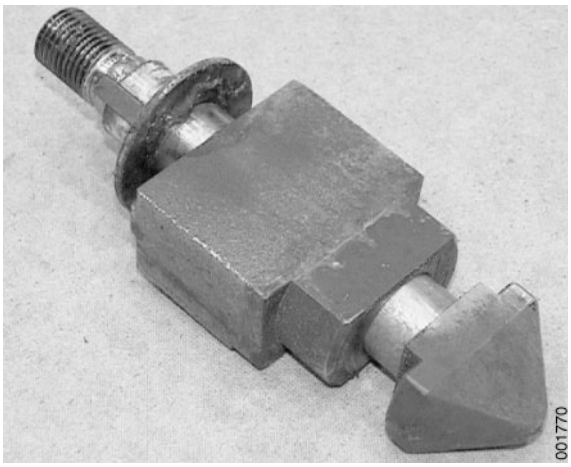
6 Hold the lift pin while the centre nut is removed.

WARNING

Dropped component.

Risk of crushing, product damage

Twistlock weight approx. 30 kg.



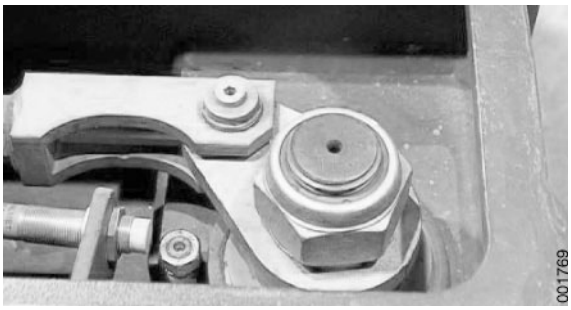
7 Remove the centre nut and lift away the twistlock.

8 Fit a new lift pin in the guide pin. Grease the lift pin with universal grease "EP2"

9 Fit the lift pin in the guide pin in the spreader beam. Fit the guide pin so that the grease cup is accessible through the holes in the spreader beam.

NOTE

Do not forget the washer between the spreader beam and the guide pin.



10 Fit the wedge, bearings, lever, **new lock washers** and **new lock nuts** on the lock pin.

Grease the parts with universal grease "EP2" before fitting.

11 Check the positions of the parts and that the twistlock can move.

12 Tighten the lock nuts with torque, **300 Nm**.

13 Grease the guide pin, lever and bearing with universal grease "EP2".

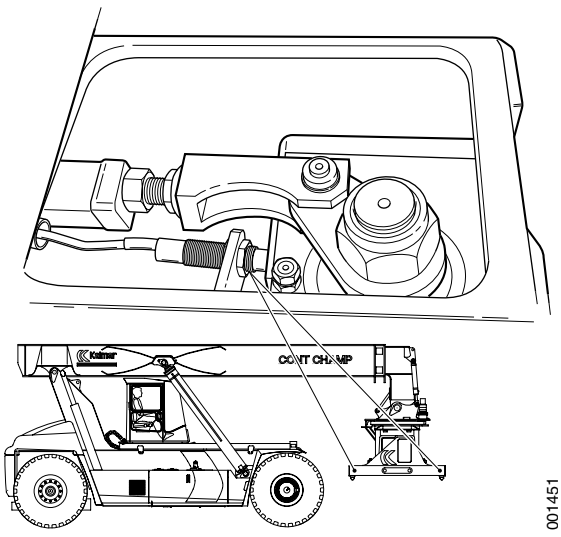
14 Check that the twistlocks mechanism can move.

15 Turn on the main electric power and start the machine.

16 Check that the twistlock is working.

7.9.1.8 Sensor alignment

Sensor alignment, description

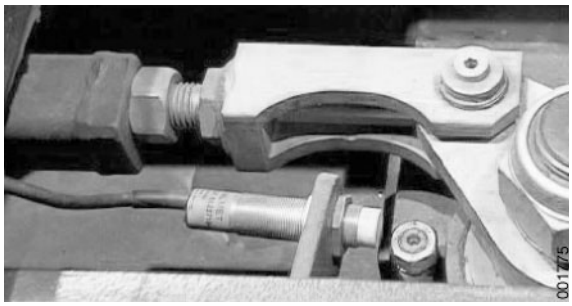


The sensor for alignment senses when the attachment has contact with the container. Four inductive position sensors, one at each twistlock located in the corners of the spreader beam's longitudinal section, are used to indicate alignment.

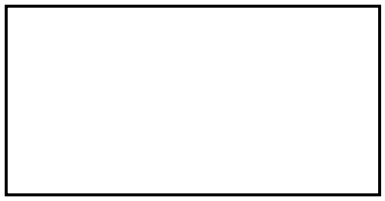
The sensor senses the position of a spring pin which is pressed in when the attachment has contact up against the container. The sensor is located over the pin. The position of the sensor can be adjusted so that it gives a signal when the pin is pressed in and the head is level with the spreader beam's lower edge. The clearance between the attachment and the container's corner boxes results in the sensors stop sending signals when the attachment is lifted.

The sensors are supplied with voltage and send a 24 V signal to Control unit attachment (D791) when the indicator pin is pressed in.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.6 ATTACH, menu 6*.



The illustration shows older versions of sensor mounting.



Event menu alignment

Sensor alignment, checking

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

2 Check that the indicator pins in the corner boxes can move up and down freely. The indictor pins must spring down when they are not loaded.

3 Check that the sensor is free of damage and dirt.

4 Start the machine.

5 Lower the attachment onto a container and check that all twistlocks indicate alignment, filled circles in event menu alignment, and that the indicator lamp alignment comes on.

6 Lift the attachment slightly so that the alignment just disappears (unfilled circles in event menu alignment or indicator lamp alignment goes out).

7 Check how large a movement on the indicator pins is required to detect alignment. The movement must be 3–4 mm.

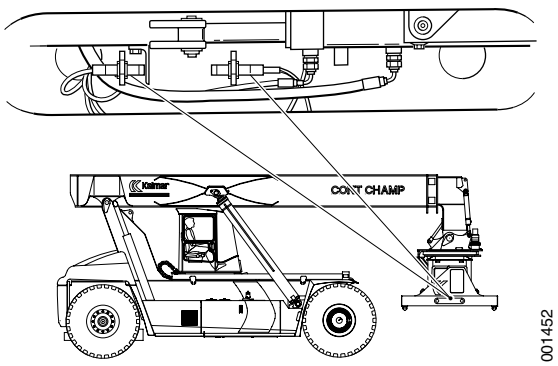
8 If necessary, adjust the position of the sensor, see *Position sensor, checking and adjustment page 5*.

Position sensor, checking and adjustment

See *Position sensor, checking and adjustment page 5*.

7.9.1.9 Sensor twistlocks

Sensor twistlocks, description



The twistlocks sensors sense when twistlocks are locked and unlocked, respectively. Four inductive position sensors, two in each spreader beam, sense the position of the lock mechanism. The sensors are located by the lock cylinder in the middle of the spreader beam's longitudinal section.

Both sides function in the same way independent of each other. On the lock mechanism by the lock cylinder there is an indicator plate. When the lock mechanism is in position for the twistlocks to be locked one of the sensors sends a signal to Control unit, attachment Control unit attachment (D791). When the lock mechanism is in position for the twistlocks to be unlocked the other sensor sends a signal to Control unit, attachment Control unit attachment (D791). If the lock mechanism remains in intermediate position then no signals are sent.

The sensors are supplied with voltage and send a 24 V signal to Control unit attachment (D791) when the indicator plate is in front of the sensor.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.7 ATTACH, menu 7*.

Position sensor, checking and adjustment

See *Position sensor, checking and adjustment page 5*.

7.9.1.10 Unloading valve attachment

Relief valve attachment, description

See *Relief valve attachment, description page 54*.

7.9.1.11 Pipes and hoses

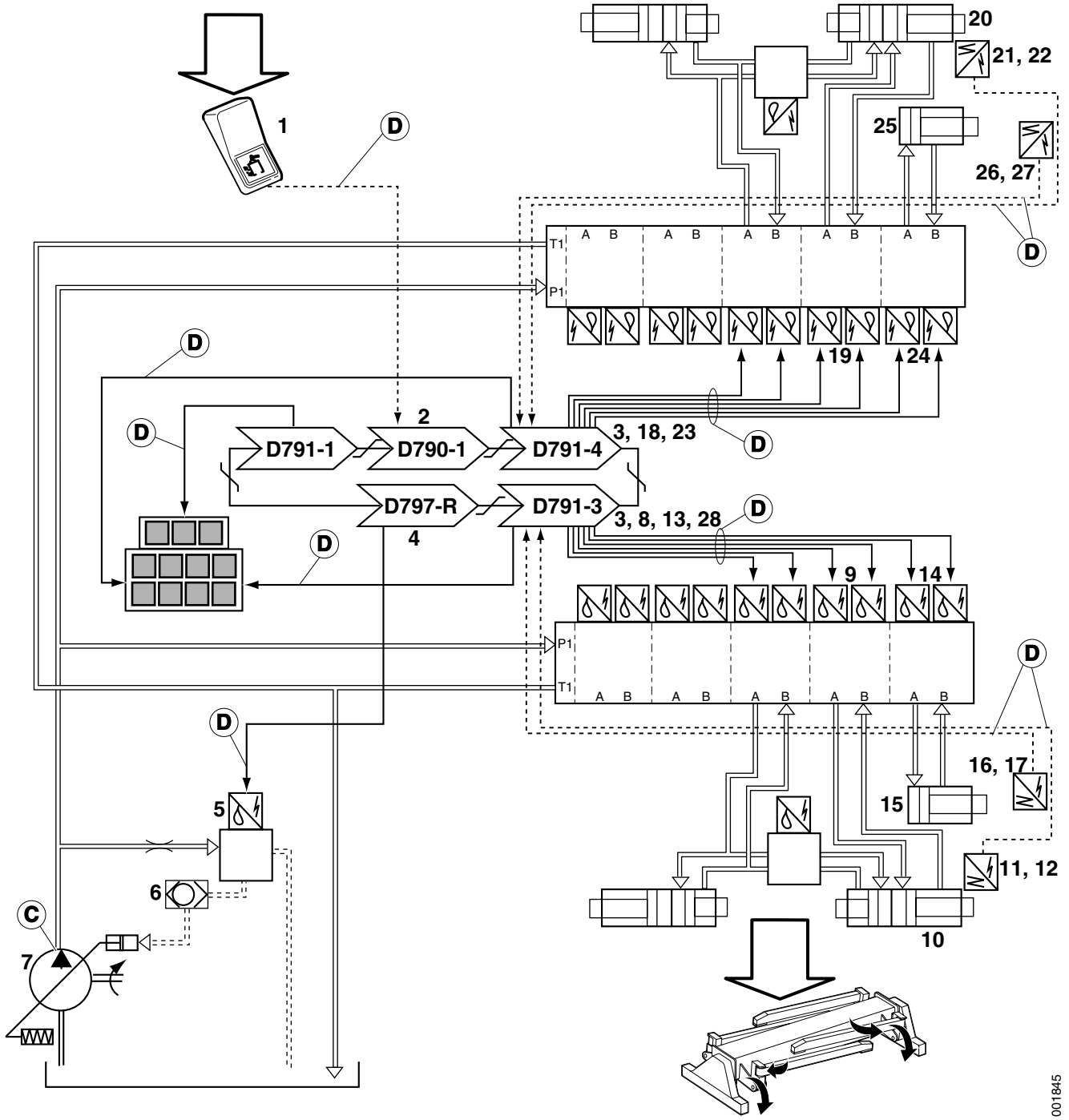
Pipes and hoses, description

See section *10 Common hydraulics*, group *10.5.1 Pipes and hoses*.

7.9.2 Lift legs

Raising/lowering of front lift legs, function description

Condition	Reference value	Reference
Emergency stop	Disengaged	Section *11 Common electrics*, group *11.5.1.4 Emergency stop voltage (15E)*



Pos	Explanation	Signal description	Reference
1	Switch lowering front legs (S1006) sends a voltage signal to Control unit cab (D790-1).	U = 24 V	*Switch lowering front legs, description page 10* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 1*
2	Control unit cab (D790-1) sends front lift legs down or up on the CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
3	Control unit attachment left legs (D791-3) and Control unit attachment right leg pair (D791-4) sends activate top hydraulics on the CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
4	Control unit frame rear (D797-R) activates Solenoid valve, engagement of hydraulics for top lift (Y6003).	U = 24 V	*Valve block top lift hydraulics, description page 45* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.6 HYD, menu 6*
5	Solenoid valve, engagement of hydraulics for top lift (Y6003) opens and pressurizes valve block lift cylinder and sends load signal to hydraulic oil pump 2.	-	*Valve block top lift hydraulics, description page 45* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.6 HYD, menu 6*
6	The shuttle valve sends the strongest load signal to the hydraulic oil pumps if several functions are activated simultaneously.	-	Section *10 Common hydraulics,* group *10.5.3 Shuttle valve*
7	Hydraulic oil pump 2 pumps oil from the hydraulic oil tank.	See pressure plate on left frame beam.	Section *10 Common hydraulics*, group *10.4 Pumps*
8	Control unit attachment left legs (D791-3) activates Solenoid valve front knee out left (Y6056L).	U = 24 V	*Control valve lift legs, description page 127* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 10*
9	Solenoid valve front knee out left (Y6056L) pressurizes Hydraulic cylinder knee left front.	-	*Control valve lift legs, description page 127* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 10*
10	Hydraulic cylinder knee left front lowers Knee left front.	-	*Hydraulic cylinder knee/clamp, description page 132*
11	Sensor front knee left (B7217L) sends voltage signal to Control unit attachment left legs (D791-3) when the knee is actuated.	U = 24 V	*Sensor knee, description page 133* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 4*

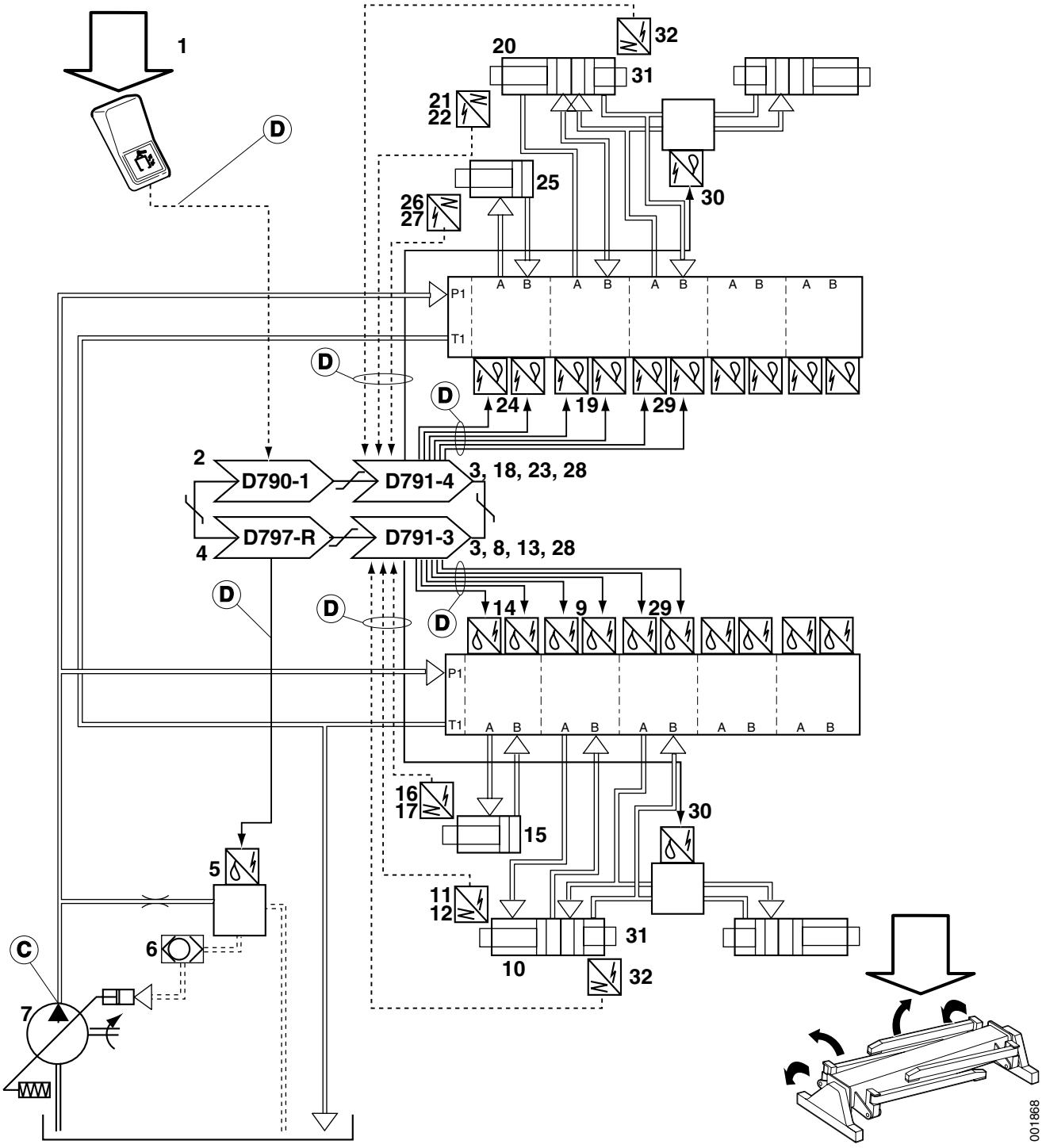
Pos	Explanation	Signal description	Reference
12	Sensor front knee left (B7217L) stops sending signal to Control unit attachment left legs (D791-3).	U = 0 V	*Sensor knee, description page 133* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 4*
13	Control unit attachment left legs (D791-3) activates Solenoid valve front leg down left (Y6013L) when Sensor front knee left (B7217L) stops sending signal.	U = 24 V	*Control valve lift legs, description page 127* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 10*
14	Solenoid valve front leg down left (Y6013L) pressurizes Hydraulic cylinder leg left front.	-	*Control valve lift legs, description page 127* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 10*
15	Hydraulic cylinder leg left front lowers leg left front.	-	*Hydraulic cylinder leg, description page 135*
16	Sensor front leg left (B7219L) sends a signal to Control unit attachment left legs (D791-3) when the leg is actuated.	U = 24 V	*Sensor lift leg, description page 135* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 4*
17	Sensor front leg left (B7219L) stops sending a signal to Control unit attachment left legs (D791-3).	U = 0 V	*Sensor lift leg, description page 135* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 4*
18	Control unit attachment right leg pair (D791-4) activates Solenoid valve front knee out right (Y6056R) when Sensor front leg left (B7219L) stops sending signal.	U = 24 V	*Control valve lift legs, description page 127* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 10*
19	Solenoid valve front knee out right (Y6056R) pressurizes Hydraulic cylinder knee right front.	-	*Control valve lift legs, description page 127* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 10*
20	Hydraulic cylinder knee right front lowers Knee right front.	-	*Hydraulic cylinder knee/clamp, description page 132*
21	Sensor front knee right (B7217R) sends voltage signal to Control unit attachment right leg pair (D791-4) when the knee is actuated.	U = 24 V	*Sensor knee, description page 133* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 4*
22	Sensor front knee right (B7217L) stops sending signal to Control unit attachment right leg pair (D791-4).	U = 0 V	*Sensor knee, description page 133* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 4*

Pos	Explanation	Signal description	Reference
23	Control unit attachment right leg pair (D791-4) activates Solenoid valve front leg down right (Y6013R) when Sensor front knee right (B7217R) stops sending signal.	U = 24 V	*Control valve lift legs, description page 127* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 10*
24	Solenoid valve front leg down right (Y6013R) pressurizes Hydraulic cylinder leg right front.	-	*Control valve lift legs, description page 127*
25	Hydraulic cylinder leg right front lowers leg right front.	-	*Hydraulic cylinder leg, description page 135*
26	Sensor front leg right (B7219R) sends voltage signal to Control unit attachment right leg pair (D791-4) when the leg is lowered.	U = 24 V	*Sensor lift leg, description page 135* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 4*
27	Sensor front leg right (B7219R) stops sending a voltage signal to Control unit attachment right leg pair (D791-4) when the leg reaches its end position.	U = 0 V	*Sensor lift leg, description page 135* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 4*
28	Control unit attachment right leg pair (D791-4) activates Indicator light front leg down (H580).	U = 24 V	*Indicator light front legs lowered, description page 17* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 9*
29	When the switch is released, activation of all solenoid valves is interrupted.		

Hydraulic diagram A41791.0100

Raising/lowering of rear lift legs, function description

Condition	Reference value	Reference
Emergency stop	Disengaged	Section *11 Common electrics*, group *11.5.1.4 Emergency stop voltage (15E)*



Pos	Explanation	Signal description	Reference
1	Switch rear legs (S1007) sends voltage signal to Control unit cab (D790-1).	U = 24 V	*Switch lowering rear legs, description page 11* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 1*
2	Control unit cab (D790-1) sends rear lift legs down or up on the CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
3	Control unit attachment left legs (D791-3) and Control unit attachment right leg pair (D791-4) sends activate top hydraulics on the CAN bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
4	Control unit frame rear (D797-R) activates Solenoid valve, engagement of hydraulics for top lift (Y6003)	U = 24 V	*Valve block top lift hydraulics, description page 45* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.6 HYD, menu 6*
5	Solenoid valve, engagement of hydraulics for top lift (Y6003) opens and pressurizes valve block lift cylinder and sends load signal to hydraulic oil pump 2.	-	*Valve block top lift hydraulics, description page 45* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.6 HYD, menu 6*
6	The shuttle valve sends the strongest load signal to the hydraulic oil pumps if several functions are activated simultaneously.	-	Section *10 Common hydraulics,* group *10.5.3 Shuttle valve*
7	Hydraulic oil pump 2 pumps oil from the hydraulic oil tank.	See pressure plate on left frame beam.	Section *10 Common hydraulics*, group *10.4 Pumps*
8	Control unit attachment left legs (D791-3) activates Solenoid valve rear knee out left (Y6058L).	U = 24 V	*Control valve lift legs, description page 127* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 12*
9	Solenoid valve rear knee out left (Y6058L) pressurizes Hydraulic cylinder knee left rear.	-	*Control valve lift legs, description page 127* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 12*
10	Hydraulic cylinder knee left rear lowers knee left rear.	-	*Hydraulic cylinder knee/clamp, description page 132*
11	Sensor rear knee left (B7218L) sends voltage signal to Control unit attachment left legs (D791-3) when the knee is actuated.	U = 24 V	*Sensor knee, description page 133* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 5*

Pos	Explanation	Signal description	Reference
12	Sensor rear knee left (B7218L) stops sending a signal to Control unit attachment left legs (D791-3).	U = 0 V	*Sensor knee, description page 133* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 5*
13	Control unit attachment left legs (D791-3) activates Solenoid valve rear leg down left (Y6014L) Sensor rear knee left (B7218L) stops sending signal.	U = 24 V	*Control valve lift legs, description page 127* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 12*
14	Solenoid valve rear leg down left (Y6014L) pressurizes Hydraulic cylinder leg left rear.	-	*Control valve lift legs, description page 127* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 12*
15	Hydraulic cylinder leg left rear lowers leg left rear.	-	*Hydraulic cylinder leg, description page 135*
16	Sensor rear leg left (B7220L) sends voltage signal to Control unit attachment left legs (D791-3) when the leg is actuated.	U = 24 V	*Sensor lift leg, description page 135* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 5*
17	Sensor rear leg left (B7220L) stops sending signal to Control unit attachment left legs (D791-3) when Sensor rear leg left (B7220L) stops sending signal.	U = 0 V	*Sensor lift leg, description page 135* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 5*
18	Control unit attachment right leg pair (D791-4) activates Solenoid valve rear knee out right (Y6058R).	U = 24 V	*Control valve lift legs, description page 127* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 12*
19	Solenoid valve rear knee out right (Y6058R) pressurizes Hydraulic cylinder knee right rear.	-	*Control valve lift legs, description page 127* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 12*
20	Hydraulic cylinder knee/ right rear lowers Knee right rear.	-	*Hydraulic cylinder knee/clamp, description page 132*
21	Sensor rear knee right (B7218R) sends voltage signal to Control unit attachment right leg pair (D791-4) when the knee is actuated.	U = 24 V	*Sensor knee, description page 133* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 5*
22	Sensor rear knee right (B7218R) stops sending a signal to Control unit attachment right leg pair (D791-4) when the knee reaches its end position.	U = 0 V	*Sensor knee, description page 133* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 5*

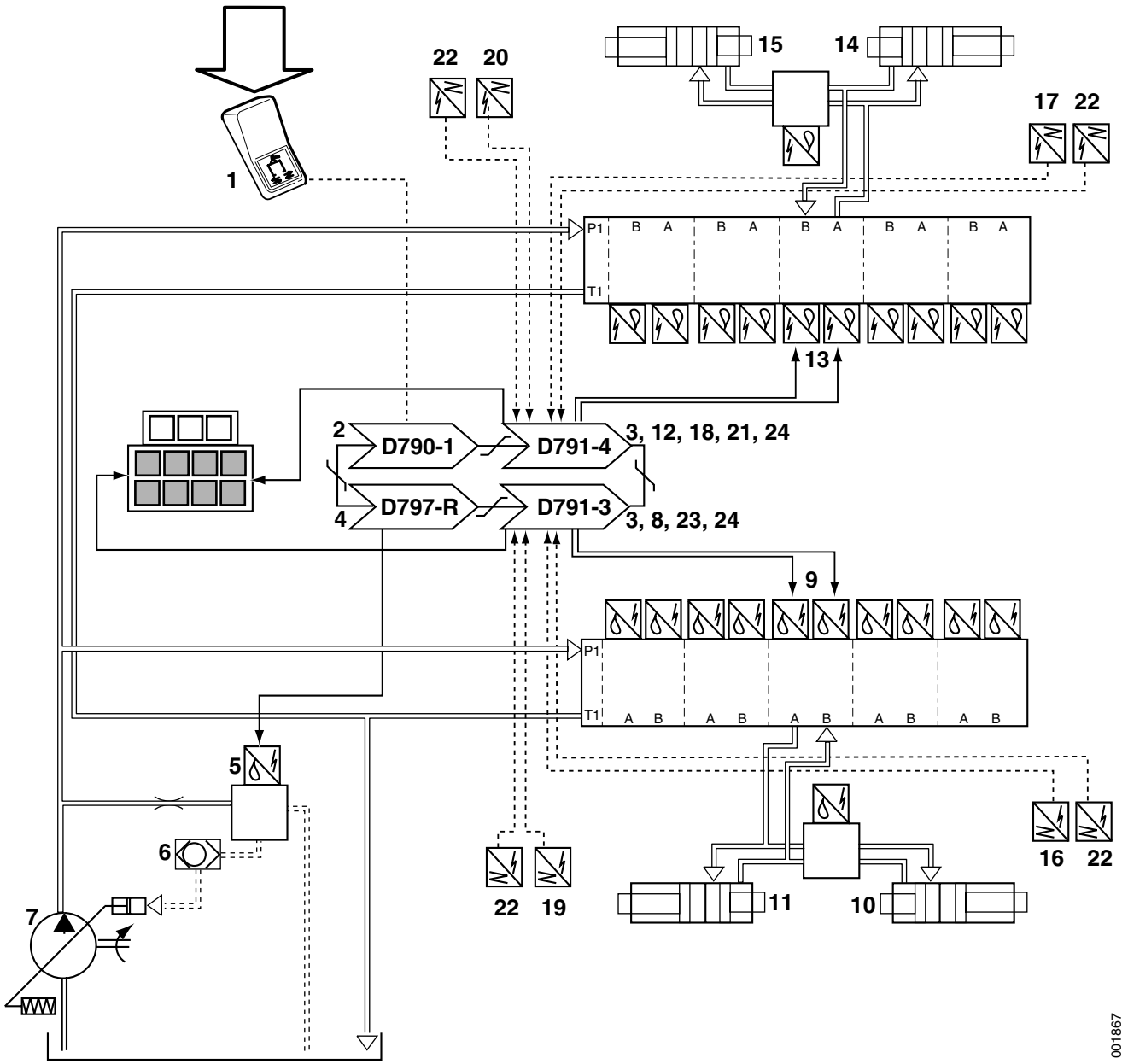
Pos	Explanation	Signal description	Reference
23	Control unit attachment right leg pair (D791-4) activates Solenoid valve rear leg out right (Y6014R) when Sensor rear knee right (B7218R) stops sending signal.	U = 24 V	*Control valve lift legs, description page 127* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 12*
24	Solenoid valve rear leg down right (Y6014R) pressurizes Hydraulic cylinder leg right rear.	-	*Control valve lift legs, description page 127* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 12*
25	Hydraulic cylinder leg right rear lowers leg right rear.	-	*Hydraulic cylinder leg, description page 135*
26	Sensor rear leg right (B7220R) sends voltage signal to Control unit attachment right leg pair (D791-4) when the leg is actuated.	U = 24 V	*Sensor lift leg, description page 135* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 5*
27	Sensor rear leg right (B7220R) stops sending a signal to Control unit attachment right leg pair (D791-4).	U = 0 V	*Sensor lift leg, description page 135* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 5*
28	When both rear lift legs are completely lowered Control unit attachment left legs (D791-3) activates Solenoid valve operating position left (Y6053L) and Solenoid valve clamping shut left (Y6054L). At the same time Control unit attachment right leg pair (D791-4) activates Solenoid valve operating position right (Y6053R) and Solenoid valve clamping right (Y6054R).	U = 24 V	*Control valve lift legs, description page 127* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 15 and 8.4.11.1 COMBI, menu 16*
29	Solenoid valve operating position left (Y6053L) closes the connection between control valve and hydraulic cylinder clamping left front. Solenoid valve operating position right (Y6053R) closes the connection between control valve and hydraulic cylinder clamping right front.	-	*Control valve lift legs, description page 127* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 15 and 8.4.11.1 COMBI, menu 16*
30	Solenoid valve clamping left (Y6054L) pressurizes hydraulic cylinder clamp left rear. Solenoid valve clamping right (Y6054R) pressurizes hydraulic cylinder clamp right rear.	-	*Control valve lift legs, description page 127* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 15*

Pos	Explanation	Signal description	Reference
31	Hydraulic cylinder clamp presses knee down and thus presses the rear lift legs forward.	-	*Hydraulic cylinder knee/clamp, description page 132*
32	When the switch is released, activation of all solenoid valves is interrupted.		

Hydraulic diagram A41791.0100

Clamp with left legs, function description

Condition	Reference value	Reference
Emergency stop	Disengaged	Section *11 Common electrics*, group *11.5.1.4 Emergency stop voltage (15E)*
Lift legs	Lowered	*Raising/lowering of front lift legs, function description page 114* ***Raising/lowering of rear lift legs, function description page 118***



Pos	Explanation	Signal description	Reference
1	Switch clamp/release leg (S1008) sends voltage signal to Control unit, cab (D790-1).	U = 24 V	*Switch clamping/releasing legs, description page 11* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 1*
2	Control unit cab (D790-1) sends clamp or release leg on the CAN bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
3	Control unit attachment left legs (D791-3) and Control unit attachment right leg pair (D791-4) send activate top hydraulics on the CAN bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
4	Control unit frame rear (D797-R) activates Solenoid valve, engagement of hydraulics for top lift (Y6003).	U = 24 V	*Valve block top lift hydraulics, description page 45* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.6 HYD, menu 6*
5	Solenoid valve, engagement of hydraulics for top lift (Y6003) opens and pressurizes valve block lift cylinder and sends load signal to hydraulic oil pump 2.	-	*Valve block top lift hydraulics, description page 45* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.6 HYD, menu 6*
6	The shuttle valve sends the strongest load signal to the hydraulic oil pumps if several functions are activated simultaneously.	-	Section *10 Common hydraulics,* group *10.5.3 Shuttle valve*
7	Hydraulic oil pump 2 pumps oil from the hydraulic oil tank.	See pressure plate on left frame beam.	Section *10 Common hydraulics*, group *10.4 Pumps*
8	Control unit attachment left legs (D791-3) activates Solenoid valve clamping left (Y6054L) *or Solenoid valve clamping release left (Y6055L)*.	U = 24 V	*Control valve lift legs, description page 127* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.11.1 COMBI, menu 15*
9	Solenoid valve clamping left (Y6054L) *or Solenoid valve clamping release left (Y6055L)* pressurizes Hydraulic cylinder clamping left front and Hydraulic cylinder clamping left rear.	-	*Control valve lift legs, description page 127* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 15*
10	Hydraulic cylinder knee and clamp left front act on knee left front so that left lift legs clamp shut or release.	-	*Hydraulic cylinder knee/clamp, description page 132*
11	Hydraulic cylinder knee and clamp left rear act on knee left rear so that left lift legs clamp shut or release.	-	*Hydraulic cylinder knee/clamp, description page 132*

Pos	Explanation	Signal description	Reference
12	Control unit attachment right leg pair (D791-4) activates Solenoid valve clamping right (Y6054R) *or Solenoid valve clamping release right (Y6055R)*.	U = 24 V	*Control valve lift legs, description page 127* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 15*
13	Solenoid valve clamping left (Y6054L) *or Solenoid valve clamping release left (Y6055L)* pressurizes Hydraulic cylinder clamping left front and Hydraulic cylinder clamping left rear.	-	*Control valve lift legs, description page 127* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 15*
14	Hydraulic cylinder knee and clamp right front act on knee left front so that left lift legs clamp shut or release.	-	*Hydraulic cylinder knee/clamp, description page 132*
15	Hydraulic cylinder knee and clamp right rear act on knee left rear so that left lift legs clamp shut or release.	-	*Hydraulic cylinder knee/clamp, description page 132*
16	Sensor clamping position front leg left (B7215L) sends voltage signal to Control unit attachment left legs (D791-3).	U = 24 V	*Sensor clamping position, description page 138* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 2*
17	Sensor clamping position front leg right (B7215R) sends voltage signal to Control unit attachment right leg pair (D791-4).	U = 24 V	*Sensor clamping position, description page 138* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 2*
18	Control unit attachment right leg pair (D791-4) activate Indicator light clamping position front legs (H578).	U = 24 V	*Indicator light clamping position front legs, description page 15* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 8*
19	Sensor clamping position rear leg left (B7216L) sends voltage signal to Control unit attachment left legs (D791-3).	U = 24 V	*Sensor clamping position, description page 138* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 2*
20	Sensor clamping position rear leg right (B7216R) sends voltage signal to Control unit attachment right leg pair (D791-4)	U = 24 V	*Sensor clamping position, description page 138* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 2*

Pos	Explanation	Signal description	Reference
21	Control unit attachment right leg pair (D791-4) activates Indicator light clamping position rear legs (H579).	U = 24 V	*Indicator light clamping position rear legs, description page 16* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.11.1 COMBI, menu 8*
22	When lift is started Sensor alignment sends front leg left (B7213L) and Sensor alignment rear leg left (B7214L) signal to Control unit attachment left legs (D791-3). Sensor alignment front leg right (B7213R) and Sensor alignment rear leg right (B7214R) signal to Control unit attachment right leg pair (D791-4). If it takes longer than 4 seconds between the first sensor's signal until all sensors send signals, the lift function is blocked.	U = 24 V	*Sensor alignment, description page 111* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.11.1 COMBI, menu 3*
23	Control unit attachment left legs (D791-3) activates the indicator light for alignment for the lift leg in question.	U = 24 V	*Indicator light alignment left front leg, description page 13* *Indicator light alignment right front leg, description page 14* *Indicator light alignment left rear leg, description page 14* *Indicator light alignment right rear leg, description page 15* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.11.1 COMBI, menu 7*
24	When more than two sensors indicate alignment or clamping position, speed limitation is activated.	Checked by control system, error shown with error code.	Section *2 Transmission*

Hydraulic diagram A41791.0100

7.9.2.1 Hydraulic oil pump

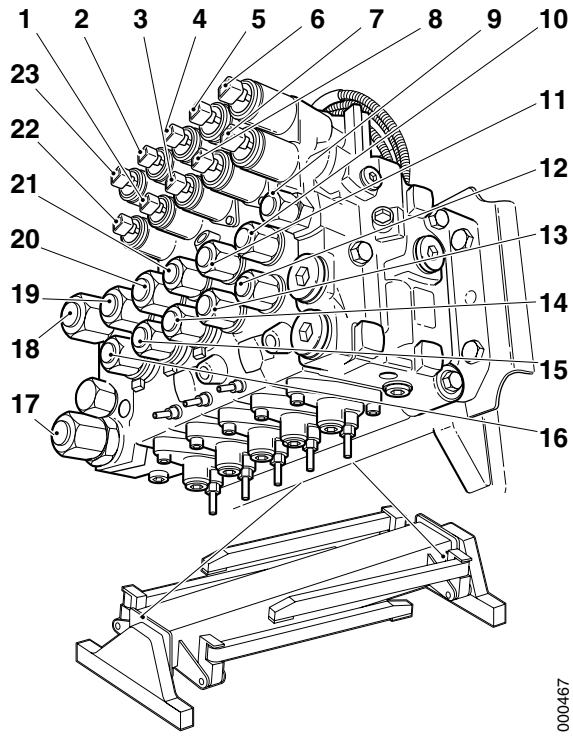
Hydraulic oil pump, general

See section *10 Common hydraulics*, group *10.4.2 Axial piston pump with variable displacement*.

7.9.2.2 Valve block top lift hydraulics

Valve block top lift hydraulics, description

See *Valve block top lift hydraulics, description page 45*.



1. Solenoid valve, rear knee out (Y6058)
2. Solenoid valve, rear knee in (Y6059)
3. Solenoid valve, clamping (Y6054)
4. Solenoid valve, clamping release (Y6055)
5. Solenoid valve, front knee in (Y6057)
6. Solenoid valve, front leg up (Y6060)
7. Solenoid valve, front leg down (Y6013)
8. Solenoid valve, front knee out (Y6056)
9. Drain to tank
10. Connection, hydraulic cylinder for front leg
11. Connection, hydraulic cylinder for front knee
12. Connection, hydraulic cylinder for front leg
13. Connection, hydraulic cylinder for front knee
14. Connection, hydraulic cylinder for clamping
15. Connection, hydraulic cylinder for rear knee
16. Connection, hydraulic cylinder for rear leg
17. Feed from hydraulic oil pumps
18. Tank return (through filter)
19. Connection, hydraulic cylinder for rear leg
20. Connection, hydraulic cylinder for rear knee
21. Connection, hydraulic cylinder for clamping
22. Solenoid valve, rear leg down (Y6014)
23. Solenoid valve, rear leg up (Y6061)

7.9.2.3 Manoeuver valve lift legs

Control valve lift legs, description

The lift legs are controlled by two control valves: one for left pair of legs and one for right pair of legs. The control valves are controlled by separate control units, Control unit attachment left legs (D791-3) and Control unit attachment right leg pair (D791-4). The control valves are located crosswise (left front and right rear, respectively) on the bracket for the knee on the attachment's main beam.

The control valves are identical and have five sections each:

- Raising/lowering of front knee
- Raising/lowering of front leg
- Raising/lowering of rear knee
- Raising/lowering of rear leg
- Clamping position

The control valve is an electro-hydraulically controlled, proportional and pressure compensated direction valve. Electrically controlled pressure reducing valves convert electrical current to servo pressure. The servo pressure controls the spring centred valve slides which control pressure and flow for the function in question. The valve slide has a flow limit in order that several functions can be activated simultaneously.

Valve slide front knee

The valve slide controls the direction and speed of front knee lowering by controlling the hydraulic pressure to hydraulic cylinder knee and clamp.

The valve slide is controlled by servo valve front knee out and servo valve front knee in.

Servo valve front knee out

Servo valve front knee out, controls servo pressure to valve slide front knee so that it controls oil pressure for front knee out.

Servo valve front knee is controlled electrically with Solenoid valve front knee out (Y6056) which is activated by Control unit attachment left legs (D791-3) or Control unit attachment right leg pair (D791-4), depending on if it is the right or left leg.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 10*.

Servo valve front knee out

Servo valve front knee in, controls servo pressure to valve slide front knee so that it controls oil pressure for front knee in.

Servo valve front knee is controlled electrically with Solenoid valve front knee in (Y6057) which is activated by Control unit attachment left legs (D791-3) or Control unit attachment right leg pair (D791-4), depending on if it is the right or left leg.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 11*.

Valve slide front leg

The valve slide controls the direction and speed of front leg lowering by controlling the hydraulic pressure to hydraulic cylinder leg.

The valve slide is controlled by servo valve front leg down and servo valve front leg out.

Servo valve front leg down

Servo valve front leg down, controls servo pressure to valve slide front leg so that it controls oil pressure leg lowering.

Servo valve front leg is controlled electrically with Solenoid valve front leg down (Y6013) which is activated by Control unit attachment left legs (D791-3) or Control unit attachment right leg pair (D791-4), depending on if it is the right or left leg.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 10*.

Servo valve front leg up

Servo valve front leg up, controls servo pressure to valve slide front leg so that it controls oil pressure for leg raising.

Servo valve front leg is controlled electrically with Solenoid valve front leg up (Y6060) which is activated by Control unit attachment left legs (D791-3) or Control unit attachment right leg pair (D791-4), depending on if it is the right or left leg.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 11*.

Valve slide clamping

Valve slide clamping controls the direction and speed of clamping with the leg pair by controlling the hydraulic pressure to hydraulic cylinder knee and clamp.

The valve slide is controlled by servo valve clamping and servo valve clamping release.

Servo valve clamping

Servo valve clamping, controls servo pressure to valve slide clamping so that it controls oil pressure for clamping.

Servo valve clamping is controlled electrically with Solenoid valve clamping (Y6054) which is activated by Control unit attachment left legs (D791-3) or Control unit attachment right leg pair (D791-4), depending on if it is the right or left pair of legs.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 15*.

Servo valve clamping release

Servo valve clamping release, controls servo pressure to valve slide clamping position so that it controls oil pressure for clamping release.

Servo valve clamping release is controlled electrically with Solenoid valve clamping release (Y6055) which is activated by Control unit attachment left legs (D791-3) or Control unit attachment right leg pair (D791-4), depending on if it is the right or left pair of legs.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 15*.

Valve slide rear knee

The valve slide controls the direction and speed of rear knee lowering by controlling the hydraulic pressure to hydraulic cylinder knee and clamp.

The valve slide is controlled by servo valve rear knee out and servo valve rear knee in.

Servo valve rear knee out

Servo valve rear knee out, controls servo pressure to valve slide rear knee so that it controls oil pressure for knee out.

Servo valve rear knee out is controlled electrically with Solenoid valve rear knee out (Y6058) which is activated by Control unit attachment left legs (D791-3) or Control unit attachment right leg pair (D791-4), depending on if it is the right or left knee.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 12*.

Servo valve rear knee in

Servo valve rear knee in, controls servo pressure to valve slide knee so that it controls oil pressure for knee in.

Servo valve rear knee in is controlled electrically with Solenoid valve rear knee in (Y6059) which is activated by Control unit attachment left legs (D791-3) or Control unit attachment right leg pair (D791-4), depending on if it is the right or left knee.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 13*.

Valve slide rear leg

The valve slide controls the direction and speed of rear leg lowering by controlling the hydraulic pressure to hydraulic cylinder leg.

The valve slide is controlled by servo valve rear leg down and servo valve rear leg out.

Servo valve rear leg down

Servo valve rear leg down, controls servo pressure to valve slide front leg so that it controls oil pressure leg lowering.

Servo valve rear leg down is controlled electrically with Solenoid valve rear leg down (Y6014) which is activated by Control unit attachment left legs (D791-3) or Control unit attachment right leg pair (D791-4), depending on if it is the right or left leg.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 12*.

Servo valve rear leg up

Servo valve rear leg up, controls servo pressure to valve slide rear leg so that it controls oil pressure for leg raising.

Servo valve rear leg up is controlled electrically with Solenoid valve rear leg up (Y6061) which is activated by Control unit attachment left legs (D791-3) or Control unit attachment right leg pair (D791-4), depending on if it is the right or left leg.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 13*.

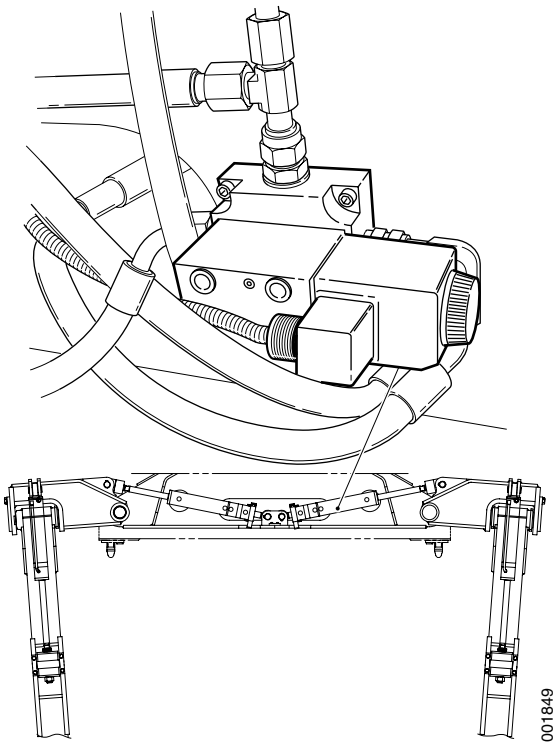
Control valve attachment, replacement

See *Control valve attachment, replacement page 48*.

7.9.2.4 Shuttle valve

Shuttle valve, description

See section *10 Common hydraulics*, group *10.5.3 Shuttle valve*.



7.9.2.5 Valve drive position

Valve operating position, description

The valve for operating position cuts off the pressure to the front clamping hydraulic cylinder. The valve is located on the attachment's main beam by the hydraulic cylinder knee and clamp.

When the valve is activated, it cuts the hydraulic connection between Control valve attachment lift legs and hydraulic cylinder knee and clamp front. This results in only the rear lift leg being angled forward.

Solenoid valve operating position (Y6053L/R) is activated by Control unit attachment left legs (D791-3) or Control unit attachment right leg pair (D791-4) depending on whether it is the right or left leg.

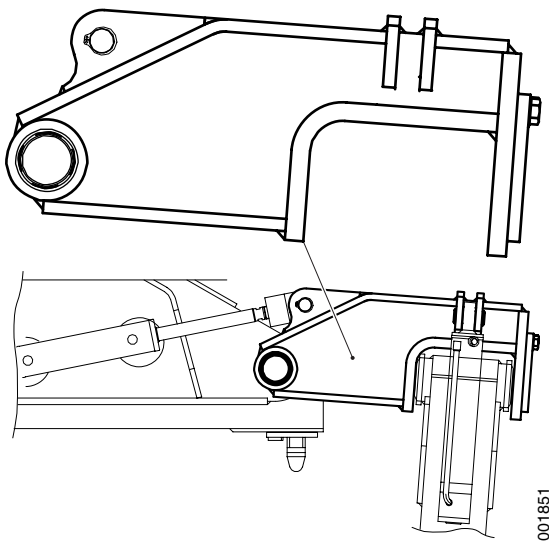
The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 16*.

7.9.2.6 Main beam attachment

Main beam attachment, description

The brackets for knee and hydraulic cylinder knee and clamp are located on the attachment's main beam.

7.9.2.7 Knee



Knee, description

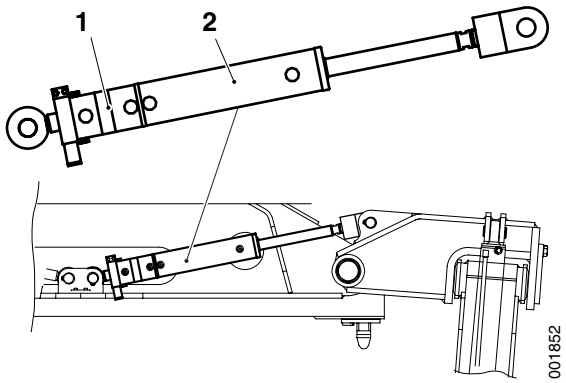
The knee is located between the attachment's main beam and lift leg. There are four knees, one at each lift leg. The knee enables folding in and clamping with the legs. The knee is controlled by hydraulic cylinder knee and clamp.

Located on the knee joint is an indicator ring which is turned with the lift leg. The indicator ring is used together with Sensor, knee, to determine whether the leg is raised, in intermediate position or lowered.

7.9.2.8 Hydraulic cylinder knee and bracket

Hydraulic cylinder knee/clamp, description

Hydraulic cylinder knee and clamp has two pistons in separate cylinders. There are four hydraulic cylinders, one at each lift leg. The hydraulic cylinder is located between attachment and knee. One of the hydraulic cylinder's pistons folds the knee joint out. The other piston clamps with the lift legs by angling the knee joint further.



1. Hydraulic cylinder, clamp
2. Hydraulic cylinder, knee

Hydraulic cylinders, repairing

See section *10 Common hydraulics,* group *10.7.1 Hydraulic cylinders*.

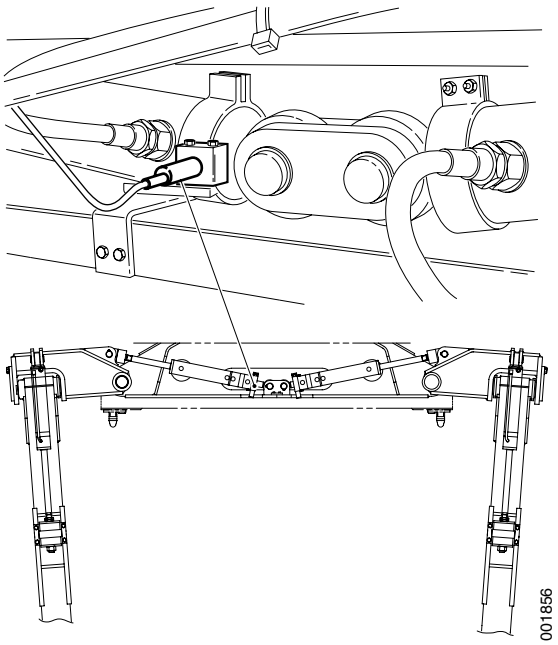
7.9.2.9 Sensor drive position

Sensor operating position, description

The sensor for operating position senses the position of the rear lift legs' hydraulic cylinder for knee and clamp. This is used to indicate operating position for the rear lift legs. There are two sensors, one on each side (right and left).

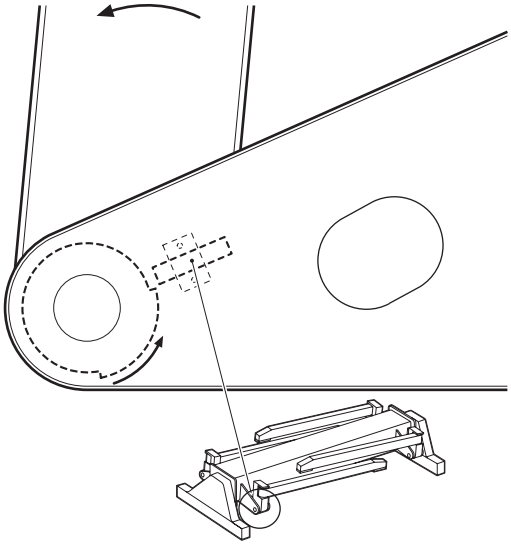
Sensor, operating position left (B7212L/R) provides a voltage signal when the rear hydraulic cylinder lowering knee/clamp is in its inner end position. The signal is used to stop activation of the solenoid valve for operating position when the rear lift leg is lowered.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 6*.



Position sensor, checking and adjustment

See *Position sensor, checking and adjustment page 5*.



7.9.2.10 Sensor knee

Sensor knee, description

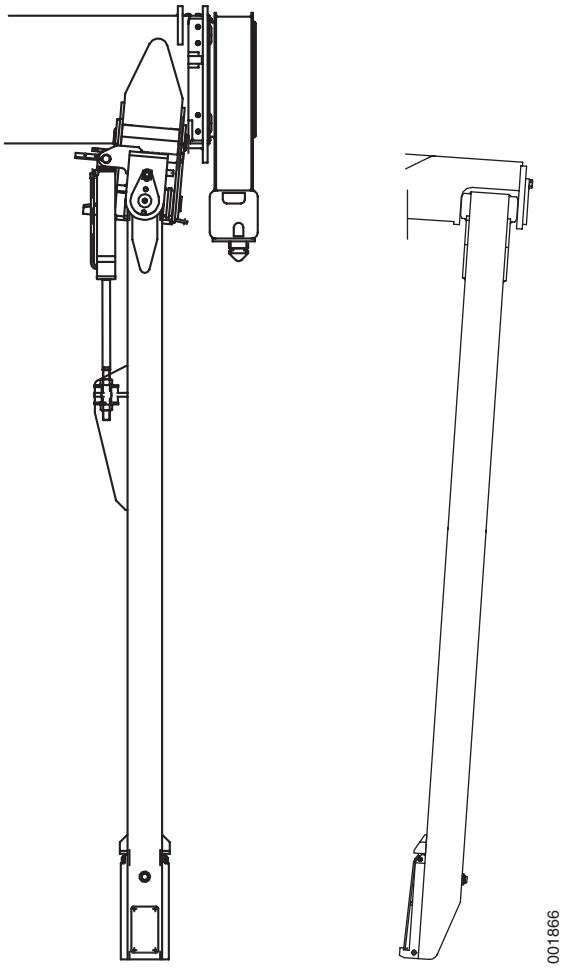
Sensor knee senses the position of the knee joint, this is used to control lowering of the legs. There are four sensors, one by each knee.

Sensor front knee (B7217) and Sensor rear knee (B7218) give voltage signals when the knee is between either end-position. The signal goes to 0 V when end-position is reached. This applies both when retracting and extending. The signal is used to activate the next step in the sequence. If the signal does not go to 0 V, the leg is not lowered.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI*, menu 4–5.

Position sensor, checking and adjustment

See *Position sensor, checking and adjustment page 5*.

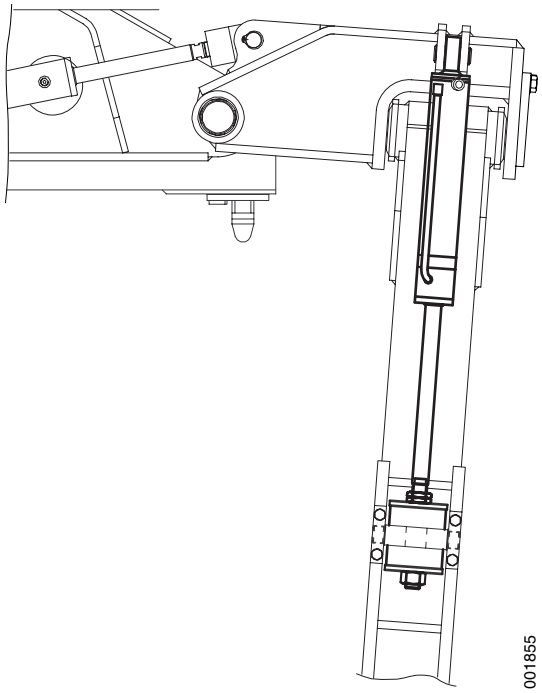


7.9.2.11 Lift legs

Lift legs description

The lift legs grip underneath around the load. On the lower ends of the legs are lift shoes. The lift legs are raised and lowered with the hydraulic cylinder lift leg.

Located on the lift leg joint is an indicator ring which is turned with the lift leg. The indicator ring is used together with Sensor, leg, to determine whether the leg is raised, in intermediate position or lowered.



7.9.2.12 Hydraulic cylinder legs

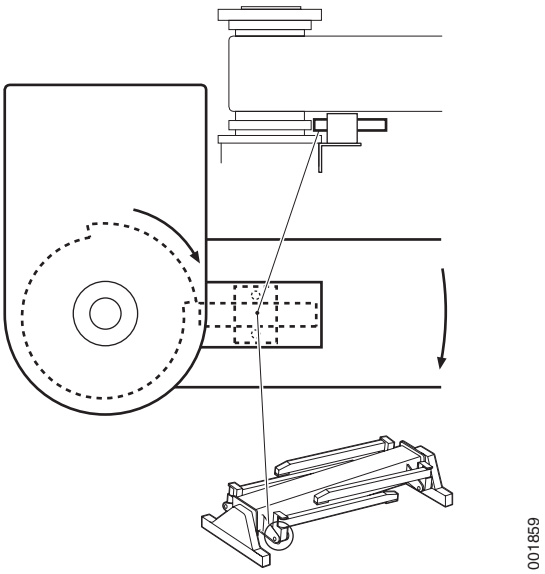
Hydraulic cylinder leg, description

Hydraulic cylinder lift leg is located between knee and lift leg. The hydraulic cylinder raises and lowers the lift legs.

Hydraulic cylinders, repairing

See section *10 Common hydraulics,* group *10.7.1 Hydraulic cylinders*.

7.9.2.13 Sensor lift legs



Sensor lift leg, description

Sensor lift leg senses the position of the lift leg. This is used to control lowering of the legs. There are four sensors, one by each lift leg.

Sensor front leg (B7219) and Sensor rear lift leg (B7220) give voltage signals when the lift legs are between either end-position. The signal goes down to 0 V when end-position is reached. This applies both when raising and lowering. The signal is used to activate the next step in the sequence. If the signal doesn't go to 0 V, the knees are not actuated.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI*, menu 4–5.

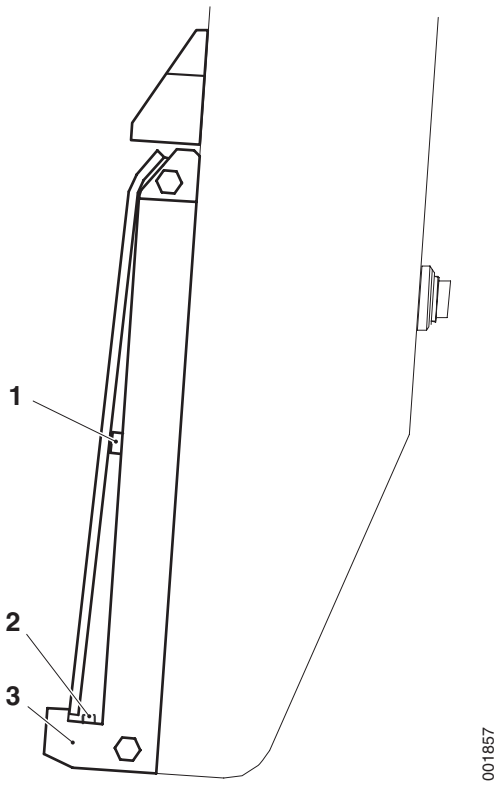
Position sensor, checking and adjustment

See *Position sensor, checking and adjustment page 5*.

7.9.2.14 Lifting shoe

Lift shoe, description

The lift shoe is located at the lower end of the lift legs. The lift shoe grips under the load. At each lift shoes there are two sensors. Sensor alignment senses when the lift shoe has contact with the load from above, see *Sensor alignment, description page 137*. Sensor clamping position senses when the lift shoe has horizontal contact with the load, see *Sensor clamping position, description page 138*.



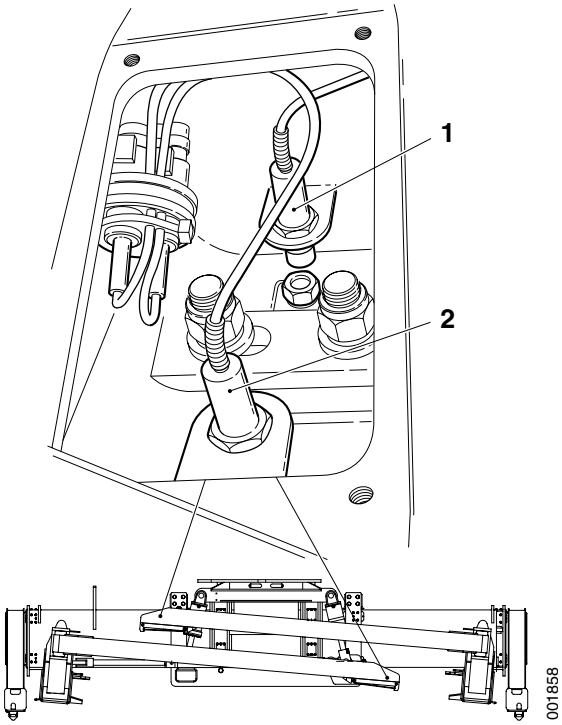
1. Indicator pin, clamping position sensor
2. Indicator pin, alignment sensor
3. Lift shoe

7.9.2.15 Sensor alignment

Sensor alignment, description

The sensor for alignment (B7213L/R or B7214L/R) senses when the lift shoe has contact with the load from above. The sensor is located behind the lift shoe and senses the position on a linkage. The linkage is affected by a pin in the middle of the lift shoe which is pressed down when the load is positioned correctly in the lift shoe.

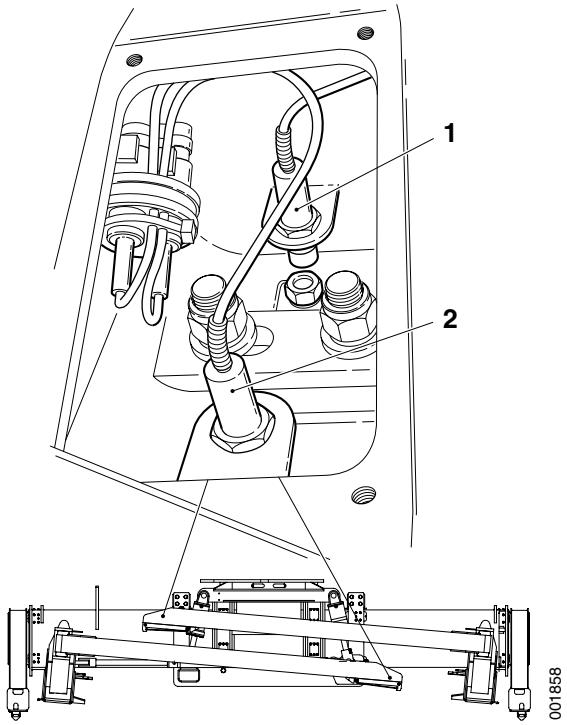
The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 3*.



1. Sensor, clamping position (B7215L/R or B7216L/R)
2. Sensor, alignment (B7213L/R or B7214L/R)

Position sensor, checking and adjustment

See *Position sensor, checking and adjustment page 5*.



1. Sensor, clamping position (B7215L/R or B7216L/R)
2. Sensor, alignment (B7213L/R or B7214L/R)

7.9.2.16 Sensor clamping position

Sensor clamping position, description

The sensor for clamping position (B7215L/R or B7216L/R) senses when the lift shoe has horizontal contact with the load. The sensor is located behind the lift shoe and is activated by a bolt mounted on a spring-loaded plate on the lift shoe.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 2*.

Position sensor, checking and adjustment

See *Position sensor, checking and adjustment page 5*.

7.9.2.17 Unloading valve attachment

Relief valve attachment, description

See *Relief valve attachment, description page 54*.

7.9.2.18 Pipes and hoses

Pipes and hoses, description

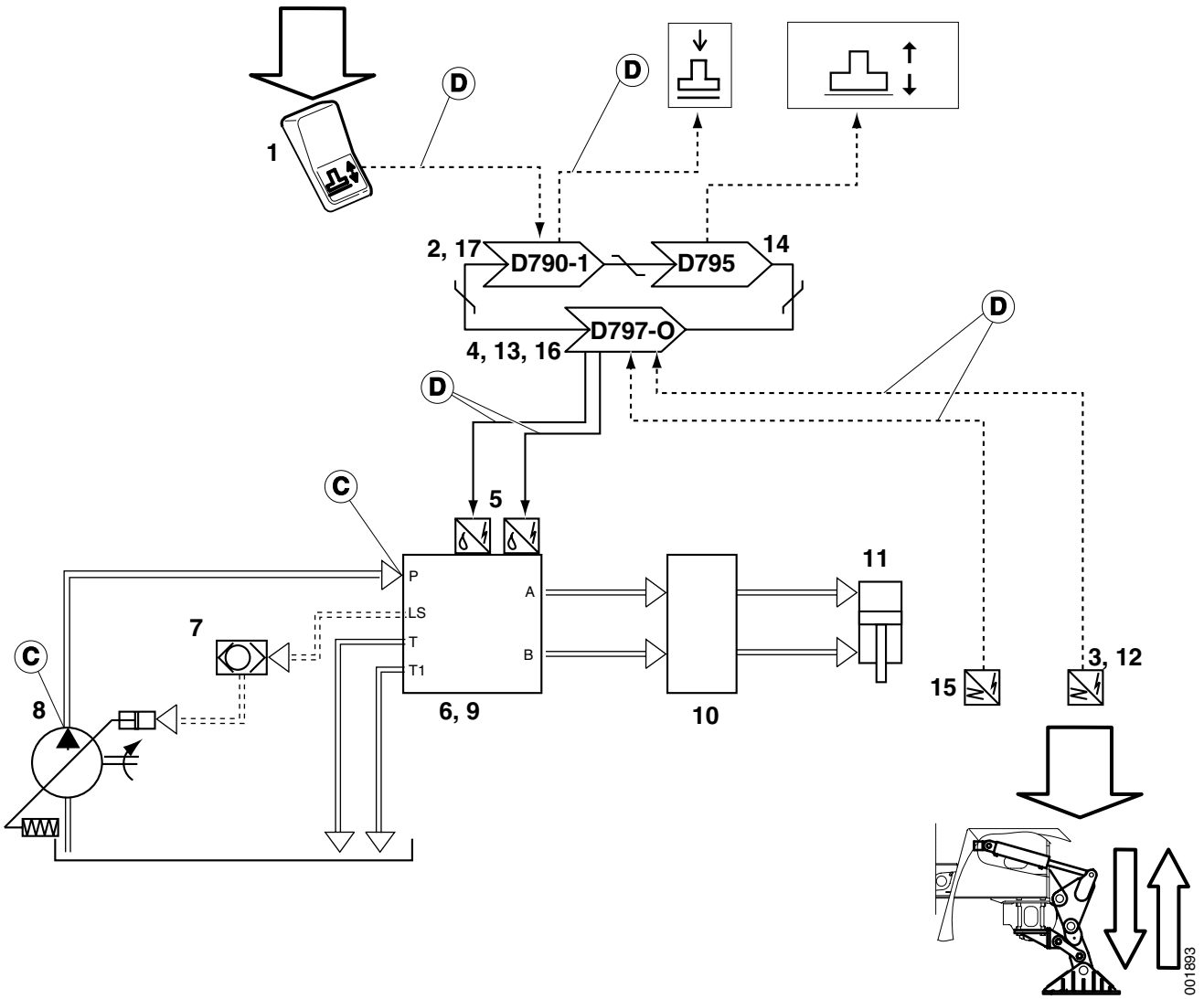
See section *10 Common hydraulics*, group *10.5.1 Pipes and hoses*.

7.10 Additional functions

7.10.1 Support jacks

Support jacks, function description

Condition	Reference value	Reference
Emergency stop	Disengaged	Section *11 Common electrics*, group *11.5.1.4 Emergency stop voltage (15E)*
Parking brake	Released	Section *4 Brakes*, group *4.5 Parking brake*
Transmission	Neutral position	Section *2 Transmission*, group *2 Transmission*
Machine stationary	speed = 0 km/h	-



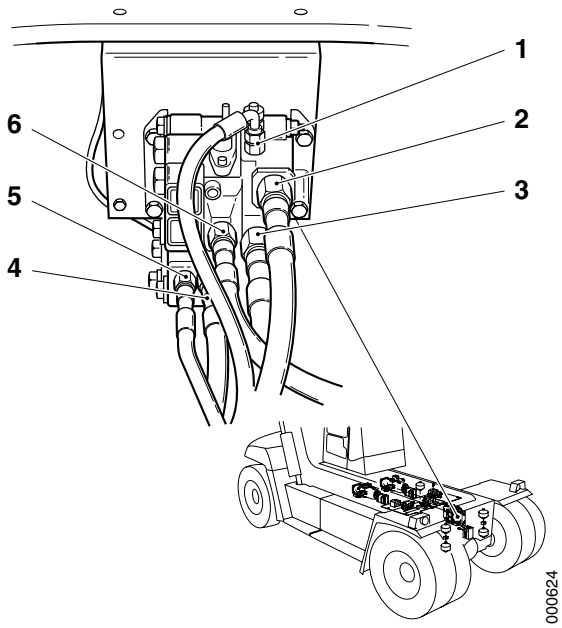
Pos	Explanation	Signal description	Reference
1	Switch support jacks (S1013) sends voltage signal to Control unit cab (D790-1).	U = 24 V	*Switch support jacks, description page 10* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.3 SUPPORT-JACKS, menu 1*
2	Control unit cab (D790-1) sends support jacks up or down on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
3	Sensor support jacks up (B7222) *or Sensor support jacks down (B7021)* sends voltage signal to Control unit frame option (D797-0).	U = 24 V	*Sensor support jacks up, description page 144* *Sensor support jacks down, description page 145* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.3 SUPPORT-JACKS, menu 2*
4	Control unit frame option (D797-0) activates Solenoid valve support jacks down (Y6064) or *Solenoid valve support jacks up (Y6063)*.	U = 24 V	*Control valve option frame, description page 142* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.3 SUPPORT-JACKS, menu 3*
5	Solenoid valve option frame down (Y6064) or *Solenoid valve support jacks up (Y6063)* pressurizes the support jack spool in Control valve option frame.	-	*Control valve option frame, description page 142* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.3 SUPPORT-JACKS, menu 3*
6	Control valve option frame sends load signal to load signal to shuttle valve.	-	*Control valve option frame, description page 142*
7	The shuttle valve sends pressure signal on to hydraulic oil pump 1 & 2	-	Section *10 Common hydraulics*, group *10.5.3 Shuttle valve*
8	Hydraulic oil pump 1 & 2 pump oil from the hydraulic oil tank.	See pressure plate on left frame beam.	Section *10 Common hydraulics*, group *10.4 Pumps*
9	Control valve option frame pressurizes valve block support jack cylinder.	-	*Control valve option frame, description page 142*
10	Valve block support jacks pressurizes hydraulic cylinder support jack.	-	*Valve block support jacks, description page 145*
11	Hydraulic cylinder lowers or raises the support jack.	-	*Hydraulic cylinder support jacks, description page 143*

Pos	Explanation	Signal description	Reference
12	Sensor support jacks down (B7221) *or Sensor support jacks up (B7022)* stops sending voltage signal to Control unit frame option (D797-O) when the support jack is lowered.	U = 24 V	*Sensor support jacks up, description page 144* *Sensor support jacks down, description page 145* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.3 SUPPORT-JACKS, menu 2*
13	Control unit frame option (D797-0) activates sends "support jacks in intermediate position" on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
14	Control unit cab (D790-1) activates Event menu support jacks and blocks shifting from neutral position.	-	*Event menu support jacks, description page 17*
15	Sensor support jacks down (B7221) *or Sensor support jacks up (B7022)* sends voltage signal to Control unit frame option (D797-0) when the support jack reaches its end position.	U = 24 V	*Sensor support jacks up, description page 144* *Sensor support jacks down, description page 145* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.3 SUPPORT-JACKS, menu 2*
16	Control unit frame option (D797-0)sends "support jacks down" *or* "*Support jacks up*" on CAN bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
17	Control unit cab (D790-1) activates the indicator light for support jacks down. When support jacks are down, Control unit cab (D790-1) changes the load curve (limit for overload protection). When support jacks are up, Control unit cab (D790-1) allows shifting from neutral position.	U = 24 V	*Indicator light support jacks down, description page 17* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.3 SUPPORT-JACKS, menu 4*

7.10.1.1 Hydraulic oil pump

Hydraulic oil pump, general

See section *10 Common hydraulics*, group *10.4.2 Axial piston pump with variable displacement*.



1. Tank return (T1)
2. Connection, steering cylinder (B)
3. Connection, steering cylinder (A)
4. Tank return (TP)
5. Load signal (LS)
6. Pressure supply (P)

7.10.1.2 Manoeuver valve option frame

Control valve option frame, description

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On machines with support jacks, the lowering/raising of support jacks is controlled by a separate section in the control valve frame option. The control valve is located on a bracket at the front end in the engine bay.

The control valve is controlled by Control unit frame option (D797-0). Control valve option frame is made up of several sections, each section controls one function. The following functions are controlled by control valve option frame.

- Support jacks ⊕
- Sliding cab/Cab lift ⊕
- Cab tilt ⊕

The control valve is an electro-hydraulically controlled, proportional and pressure compensated direction valve. Electrically controlled pressure reducing valves convert electrical current to servo pressure. The servo pressure controls the spring centred valve slides which control pressure and flow for the function in question. The valve slide has a flow limit in order that several functions can be activated simultaneously.

Valve slide support jacks

The valve slide controls the direction and speed of support jack lowering by controlling the hydraulic pressure to hydraulic cylinder support jacks.

The valve slide is controlled by servo valve support jacks up and servo valve support jacks down.

Servo valve support jacks down

Servo valve support jacks up controls servo pressure to valve slide support jacks so that it controls oil pressure for support jacks up.

Servo valve support jacks down is controlled electrically with Solenoid valve support jacks down (Y6064) which is activated by Control unit frame option (D797-0).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.3 SUPPORT-JACKS, menu 3*.

Servo valve support jacks up

Servo valve support jacks down controls servo pressure to valve slide support jacks so that it controls oil pressure for support jacks down.

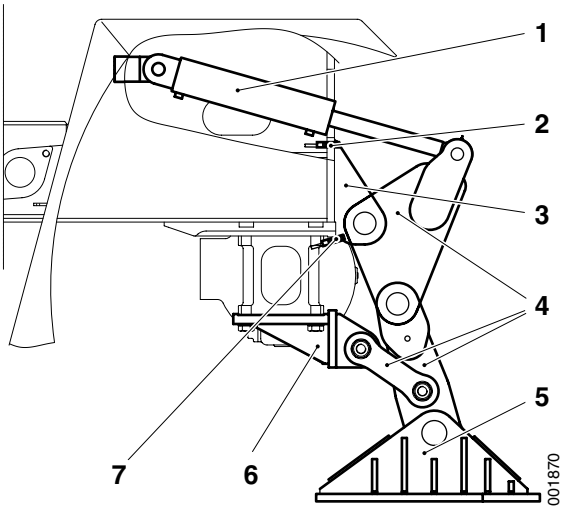
Servo valve support jacks up is controlled electrically with Solenoid valve support jacks up (Y6063) which is activated by Control unit frame option (D797-0).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.3 SUPPORT-JACKS, menu 3*.

7.10.1.3 Hydraulic cylinder support jacks

Hydraulic cylinder support jacks, description

Hydraulic cylinder support jacks lowers the support jack up and down. The hydraulic cylinder is located between support jacks and frame.



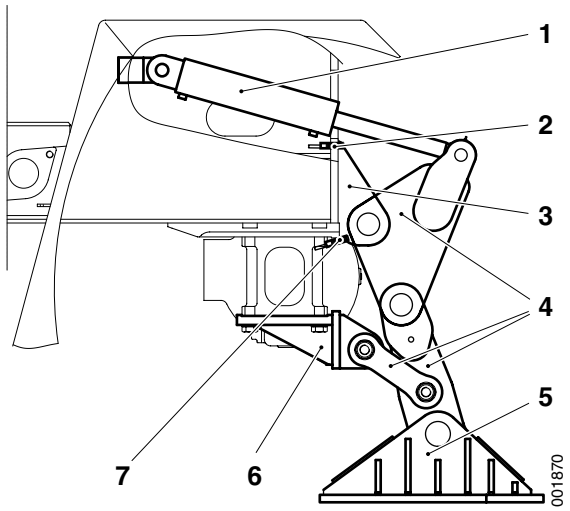
1. Hydraulic cylinder, support jacks
2. Sensor, support jacks up (B7222)
3. Upper bracket
4. Support jacks
5. Support foot
6. Upper bracket
7. Sensor, support jacks down (B7221)

7.10.1.4 Support jacks

Support jacks, description

The support jack consists of linkage and support. The linkage is designed so that it locks automatically when it is loaded from below in its lowered position.

The support jack is secured in the frame and in the drive axle's attaching bolts.



1. Hydraulic cylinder, support jacks
2. Sensor, support jacks up (B7222)
3. Upper bracket
4. Support jacks
5. Support foot
6. Upper bracket
7. Sensor, support jacks down (B7221)

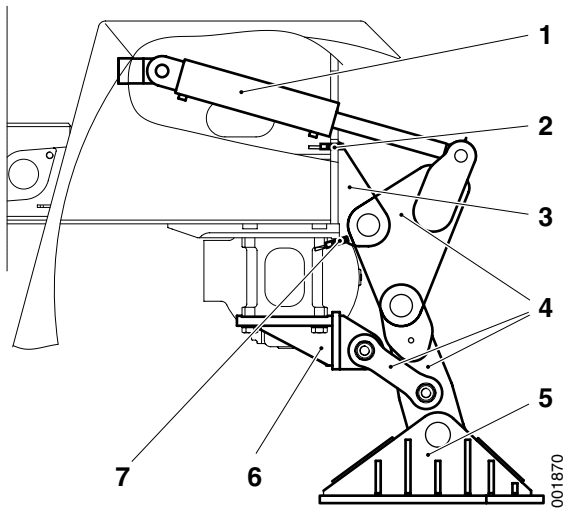
7.10.1.5 Sensor raised support jacks

Sensor support jacks up, description

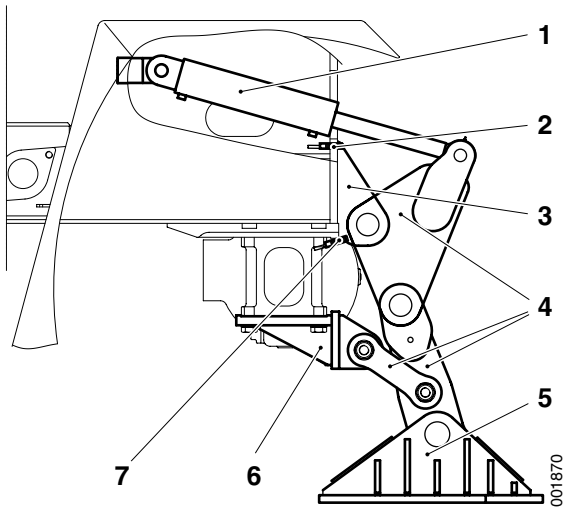
Sensor support jacks up (B7222) is located under hydraulic cylinder support jack and senses when the support jack is raised. There is a sensor for each support jack. The sensor indicates when the support jack is fully raised. This is used to control Event menu support jacks, see *Event menu support jacks, description page 17*.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.3 SUPPORT-JACKS, menu 2*.

Sensor support jacks up (B7222) sends a voltage signal to Control unit frame option (D797-0) when the support jack is completely raised.



1. Hydraulic cylinder, support jacks
2. Sensor, support jacks up (B7222)
3. Upper bracket
4. Support jacks
5. Support foot
6. Upper bracket
7. Sensor, support jacks down (B7221)



1. Hydraulic cylinder, support jacks
2. Sensor, support jacks up (B7222)
3. Upper bracket
4. Support jacks
5. Support foot
6. Upper bracket
7. Sensor, support jacks down (B7221)

Position sensor, checking and adjustment

See *Position sensor, checking and adjustment page 5*.

7.10.1.6 Sensor lowered support jacks

Sensor support jacks down, description

Sensor support jacks down (B7221) is located under support jack's upper mounting and senses when the support jack is lowered. There is a sensor for each support jack. This is used to control the support jacks and activation of Indicator light support jacks down, see *Indicator light support jacks down, description page 17*.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.3 SUPPORT-JACKS, menu 2*.

Sensor support jacks down (B7221) sends a voltage signal to Control unit frame option (D797-0) when the support jack is completely lowered.

Position sensor, checking and adjustment

See *Position sensor, checking and adjustment page 5*.

7.10.1.7 Pipes and hoses

Pipes and hoses, description

See section *10 Common hydraulics*, group *10.5.1 Pipes and hoses*.

7.10.1.8 Shuttle valve option

Shuttle valve option, description

See section *10 Common hydraulics*, group *10.5.3 Shuttle valve*.

7.10.1.9 Valve block support jacks

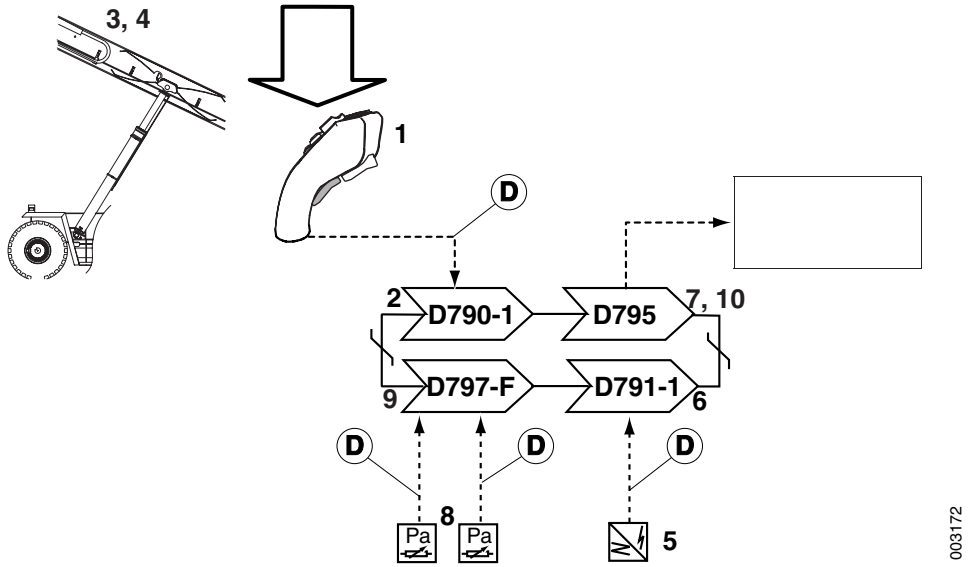
Valve block support jacks, description

Valve block support jacks is located by the hydraulic cylinders and contains a blocking valve which protects against accidental raising and lowering of the support jacks.

7.10.2 Weight indicator

Weight indicator, function description (product alternative fixed scale)

Condition	Reference value	Reference
Emergency stop	Disengaged	Section *11 Common electrics*, group *11.5.1.4 Emergency stop voltage (15E)*



Pos	Explanation	Signal description	Reference
1	The pistol trigger on the control lever sends voltage signal to Control unit cab (D790-1).	$U_{S815\text{-}T4}$ = 24 V	*Control lever, description page 7* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.4 ATTACH, menu 4*
2	Control unit cab (D790-1) sends weighing activated on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
3	Boom is lowered to measuring position, that is, when the marking on the indicator rod is lined up with the marking on the left lift cylinder	-	*Lift and lower, function description page 20*
4	The boom is operated to 60 cm protruding.	-	*Protruding, function description page 36*
5	Sensor boom length sends signal to Control unit attachment (D791-1).	U =24 V	Section *8 Control system,* group *8.2.1.6 Sensor boom length* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.5 ATTACH, menu 5*

Pos	Explanation	Signal description	Reference
6	Control unit attachment (D791-1) sends Boom length 60 cm on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
7	Control unit KID (D795) activates Operating menu scales.	-	*Operating menu fixed scale, description page 18*
8	Sensor hydraulic pressure lift cylinder piston side left (B768-12) and sensor hydraulic pressure lift cylinder piston side right side (B768-10) send voltage signal to Control unit frame front (D797-F).	U = 0.5 - 4.5 V	*Sensor hydraulic pressure lift cylinder, description page 32* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.10.3 OP, menu 3*
9	Control unit frame front (D797-F) sends weight information on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
10	Control unit KID (D795) updates weight information in display.	-	*Operating menu fixed scale, description page 18*

Weight indicator, function description (product alternative dynamic scale)

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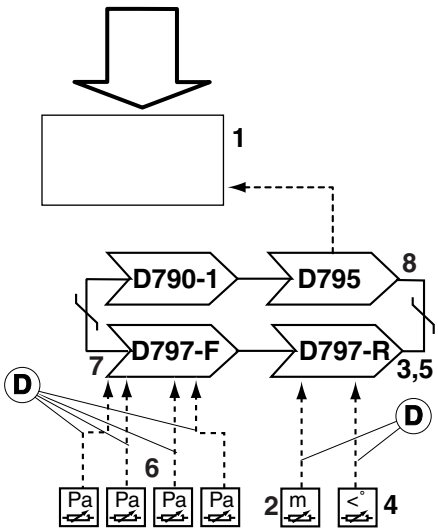
Condition	Reference value	Reference
Emergency stop	Disengaged	Section *11 Common electrics*, group *11.5.1.4 Emergency stop voltage (15E)*



Pos	Explanation	Signal description	Reference
1	Operating menu dynamic scale is selected in the display.	-	*Operating menu dynamic scale, description page 18*

Pos	Explanation	Signal description	Reference
2	Sensor boom length (B777) sends voltage signal proportional to boom length to Control unit frame rear (D797-R).	U = 0.5-4.5 V	Section *8 Control system,* group *8.2.1.6 Sensor boom length* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.10.4 OP, menu 4*
3	Control unit frame rear (D797-R) sends boom length information on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
4	Sensor boom angle (B771) sends voltage signal proportional to boom angle to Control unit frame rear (D797-R).	U = 0.5-4.5 V	Section *8 Control system,* group *8.2.1.5 Sensor boom angle* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.10.4 OP, menu 4*
5	Control unit frame rear (D797-R) sends boom angle information on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
6	Sensor hydraulic pressure lift cylinder piston side left (B768-12), Sensor hydraulic pressure lift cylinder rod side left (B768-11), Sensor hydraulic pressure lift cylinder piston side right (B768-10) and Sensor hydraulic pressure lift cylinder rod side right (B768-13) send voltage signals proportional to the hydraulic pressure in the lift cylinders to Control unit frame front (D797-F).	U = 0.5-4.5 V	*Sensor hydraulic pressure lift cylinder, description page 32* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.10.3 OP, menu 3*
7	Control unit frame front (D797-F) calculates and sends the weight on the CAN-bus The weight is calculated with a machine-unique load curve based on sensor values for boom angle, boom length and pressure in the lift cylinders. **NOTE** *The load curve is unique to each machine.*	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
8	Control unit KID (D795) show weight information in the display.	-	*Operating menu dynamic scale, description page 18*

7.10.2.1 Sensor hydraulic pressure lifting cylinder

Sensor hydraulic pressure lift cylinder, general

See *Sensor hydraulic pressure lift cylinder, description page 32*.

7.10.2.2 Sensor boom angle

Sensor boom angle, general

See section *8 Control system*, group *8.2.1.2 Sensor boom angle*.

7.10.2.3 Sensor boom length

Sensor boom length, general

See section *8 Control system*, group *8.2.1.3 Sensor boom length*.

7.10.3 Container counter

Container counter, function description (product alternative top lift)

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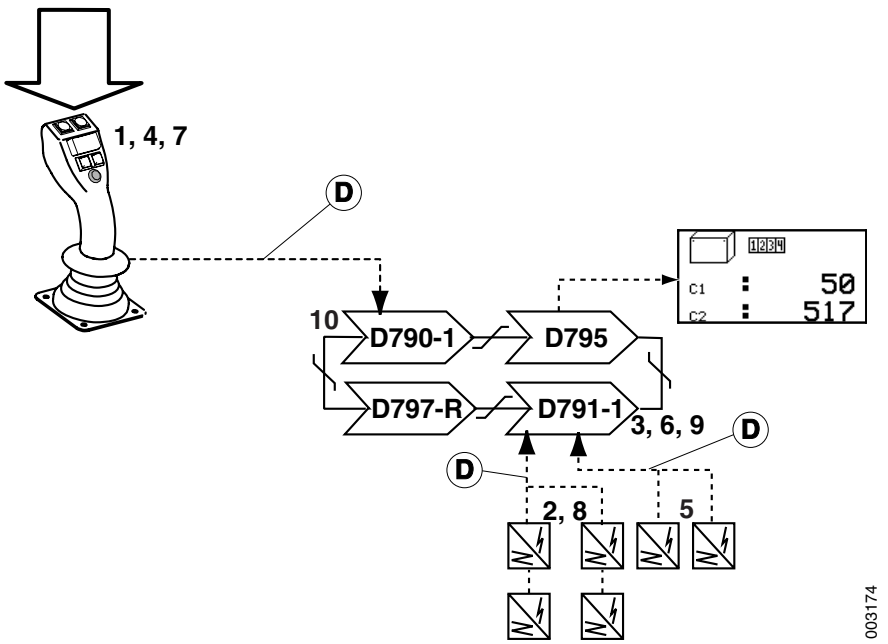
Condition	Reference value	Reference
Emergency stop	Disengaged	Section *11 Common electrics*, group *11.5.1.4 Emergency stop voltage (15E)*

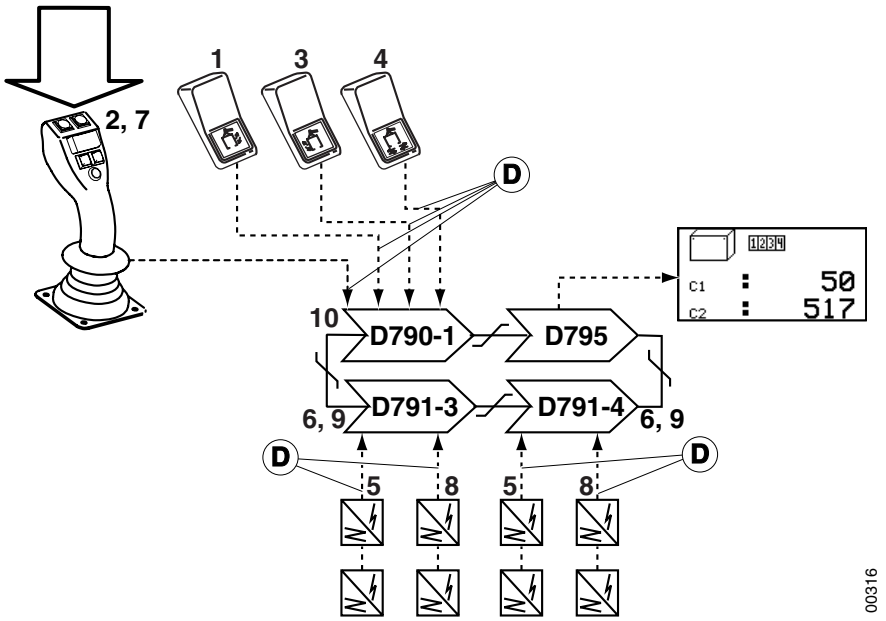


Pos	Explanation	Signal description	Reference
1	The attachment is positioned over a container with the functions *7.2 Lift and lower* as well as *7.3 Protruding*.	-	*Lift and lower, function description page 20* *Protruding, function description page 36*
2	Sensor alignment left front (7202L), Sensor alignment right front (7202R), Sensor alignment left rear (Y7203L) Sensor alignment right rear (Y7203R) send voltage signal to Control unit attachment (D791-1).	Sensor directly opposite indicator plate: U = 24 V	*Sensor alignment, description page 111* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.6 ATTACH, menu 6*

Pos	Explanation	Signal description	Reference
3	Control unit attachment (D791-1) sends alignment on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
4	Twistlocks are turned to locked position with the function *7.9.1 Twistlocks*.	-	*Twistlocks, function description page 105*
5	Sensor locked twistlocks left (B7205L) and Sensor locked twistlocks right (B7205R) send voltage signal to Control unit attachment (D791-1).	Sensor directly opposite indicator plate: U = 24 V	Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.7 ATTACH, menu 7*
6	Control unit attachment (D791-1) sends locked twistlocks on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
7	The container is lifted with the function *7.2 Lift and lower*.	-	*Lift and lower, function description page 20*
8	Sensor alignment left front (7202L), Sensor alignment right front (7202R), Sensor alignment left rear (Y7203L) Sensor alignment right rear (Y7203R) **stop** sending voltage signal to Control unit attachment (D791-1)	U = 0 V	*Sensor alignment, description page 111* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.6 ATTACH, menu 6*
9	Control unit attachment (D791-1) sends no alignment on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
10	If twistlocks remain locked for 8 seconds then Control unit cab (D790-1) counts up a lift for the container counter.	-	*Operating menu container counter page 19*

Container counter, function description (product alternative bottom lift)

Condition	Reference value	Reference
Emergency stop	Disengaged	Section *11 Common electrics*, group *11.5.1.4 Emergency stop voltage (15E)*



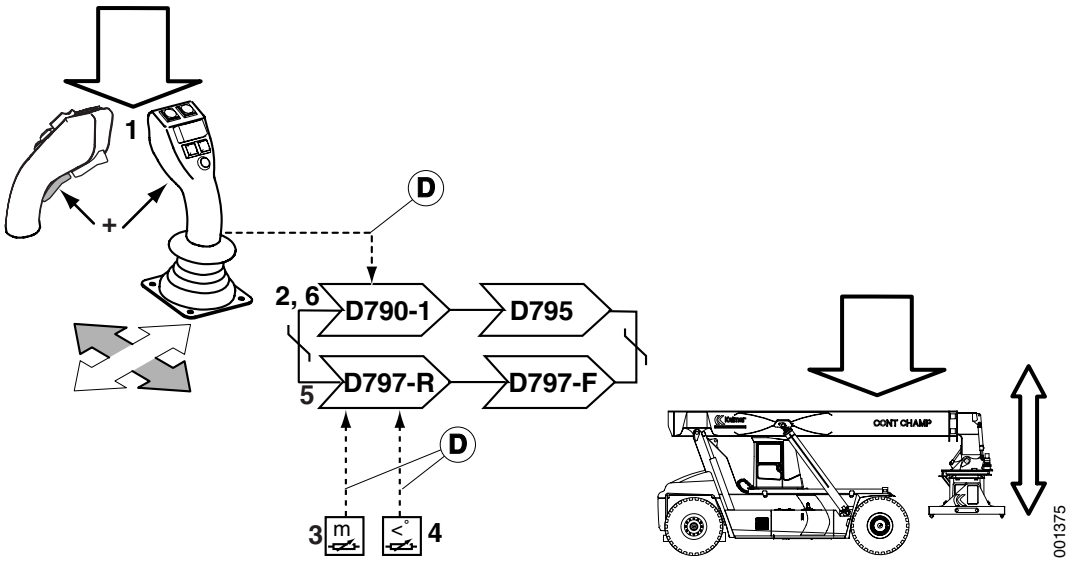
Pos	Explanation	Signal description	Reference
1	The attachment's rear lift legs are lowered to operating position with the function *7.9.2 Lift legs*.	-	*Raising/lowering of rear lift legs, function description page 118*
2	The attachment is positioned over a container with the functions *7.2 Lift and lower* as well as *7.3 Protruding*.	-	*Lift and lower, function description page 20* *Protruding, function description page 36*
3	The front lift legs are lowered with the function *7.9.2 Lift legs*.	-	*Raising/lowering of front lift legs, function description page 114*
4	The lift legs clamp around the container with the function *7.9.2 Lift legs*.	-	*Clamp with left legs, function description page 123*
5	Sensor clamping position front leg left (B7215L) and Sensor clamping position rear leg left (B7216L) send voltage signal to Control unit attachment left legs (D791-3). Sensor clamping position front leg right (B7215R) and Sensor clamping position rear leg right (B7216R) send voltage signal to Control unit attachment right leg pair (D791-4).	Sensor directly opposite indicator plate: U = 24 V	*Sensor clamping position, description page 138* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 2*

Pos	Explanation	Signal description	Reference
6	Control unit attachment left legs (D791-3) and Control unit attachment right leg pair (D791-4) sends clamping position on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
7	The container is lifted with the function *7.2 Lift and lower*.	-	*Lift and lower, function description page 20*
8	Sensor alignment front leg left (B7213L) and Sensor alignment rear leg left (B7214L) send voltage signal to Control unit attachment left leg pair (D791-3). Sensor alignment front leg right (B7213R) Sensor alignment rear leg right (B7214R) send voltage signal to Control unit attachment right leg pair (D791-4).	Sensor directly opposite indicator plate: U = 24 V	*Sensor alignment, description page 137* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.1 COMBI, menu 3*
9	Control unit attachment (D791-1) sends alignment on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
10	If twistlocks clamping position remains active for 10 seconds then Control unit cab (D790-1) counts up a bottom lift for the container counter.	-	*Operating menu container counter page 19*

7.10.4 Synchronous lift

Synchronous lift, function description

Condition	Reference value	Reference
Emergency stop	Disengaged	Section *11 Common electrics*, group *11.5.1.4 Emergency stop voltage (15E)*



Pos	Explanation	Signal description	Reference
1	The control lever for lift or lower and pistol trigger send voltage to Control unit cab (D790-1).	Lower: $U_{S815\text{-}P1}$ = 0.5–2.0 V Lift: $U_{S815\text{-}P1}$ = 3.0–4.5 V Pistol trigger: $U_{S815\text{-}T4}$ = 24 V	*Control lever, description page 7* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.8.1 BOOM, menu 1 and 8.4.9.4 ATTACH, menu 4*
2	Control unit cab (D790-1) sends synchronous lift on CAN-bus.	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*
3	Sensor boom angle (B771) sends voltage signal to Control unit frame rear (D797-R).	U = 0.5-4.5 V	Section *8 Control system,* group *8.2.1.5 Sensor boom angle* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.10.1 OP, menu 1*
4	Sensor boom length (B777) sends voltage signal to Control unit frame rear (D797-R)	U = 0.5-4.5 V	Section *8 Control system,* group *8.2.1.6 Sensor boom length* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.10.4 OP, menu 4*
5	Control unit frame rear (D797-R) sends length and angle information on CAN-bus	Controlled by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*

Pos	Explanation	Signal description	Reference
6	Control unit cab (D790-1) controls activates functions *7.2 Lift and lower* as well as *7.3 Protruding* at the same time so that the lifting movement becomes vertical.	-	*Lift and lower, function description page 20* *Protruding, function description page 36*

Table of Contents 8 Control system

8 Control system

Control system, general

The machine's functions are electrically controlled in many cases. The signals which control the machine are monitored to warn the operator or limit the machine's functions in certain dangerous situations or if faults arise in the machine.

The function control system is divided into the following functions:

- Monitoring functions
- Error codes
- Diagnostic test
- Settings
- Software

Monitoring functions describes the machine's monitoring functions that warn the operator or limit the machine's functions in the event of any dangerous situations.

Error codes notify operators and mechanics when malfunctions have been detected.

The diagnostic test is a tool to perform service and troubleshooting using menus in the machine's display.

Settings is the tool for setting and adapting the machine's functions.

The software creates the functions in the control system.

8.1 Controls and instrumentation

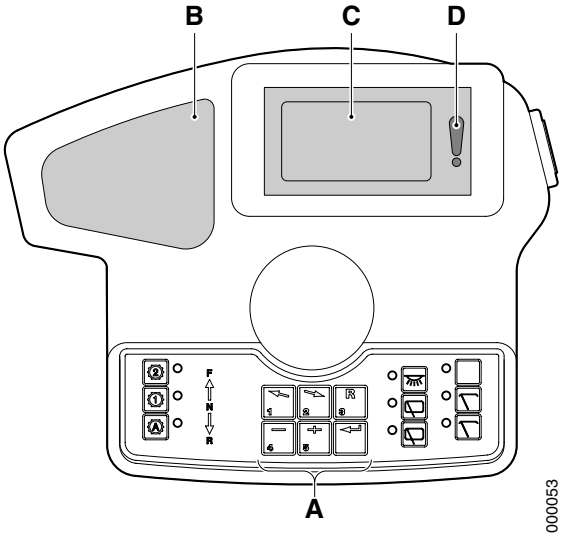
8.1.1 Information terminal

Information terminal, description

The information terminal KIT (Kalmar Information Terminal) is a unit that handles functions for gear and multi-function lever, direction indicator lever as well as start key position II and III. It also handles the function key pad (B) for the control system and its panel for warning and indicator lights (A). It's located in the steering wheel panel.

There are several individual function keys on indicator lights on unit (see figure).

For detailed information on warning and indicator lights and function keys, see operator's manual.



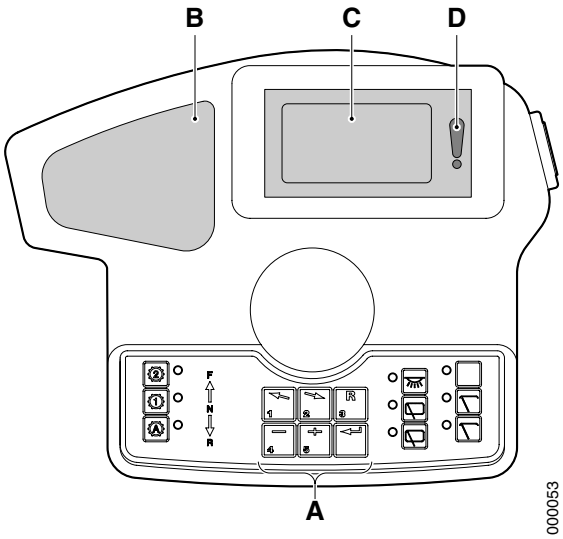
A. Function keys (KIT)
B. Warning and indicator lights
C. Display (KID)
D. Alarm indicator

Information terminal, replacement

See section *11 Common electrics,* group *11.5.3.11 Control unit KIT*.

8.1.2 Information display

Information display, description



A. Function keys (KIT)
B. Warning and indicator lights
C. Display (KID)
D. Alarm indicator

The Kalmar Information Display (KID) is the unit that shows the operator the information that the control system sends, for example, travel speed. It is located in the steering wheel panel.

There is an indicator light to the right on the display that is activated with a red light when there is a serious malfunction in the control system. The error code and information are shown on the display.

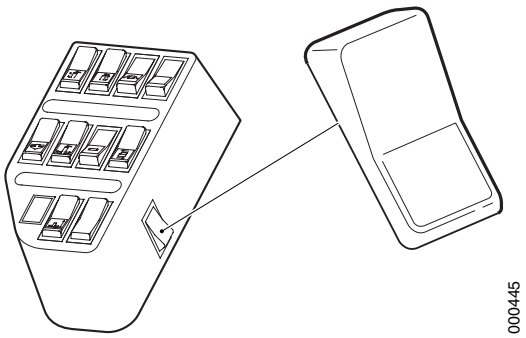
The alarm indication can be checked from the diagnostic menu, *Maintenance manual DRF 400–450,* group *8.4.3.7 CAB, menu 7*.

Information display, replacement

See section *11 Common electrics,* group *11.5.3.12 Control unit KID*.

8.1.3 Switch by-passing

Switch by-pass, description



Switch by-pass of safety system (1005) activates by-pass of the safety system that allows:

- lowering the load in case of overload.
- locking and opening twistlocks without alignment.
- Spreading 20'–40' with locked twistlocks.
- Lift, lower and extension with active error on overload protection (error code 150).
- Bottom lift without full alignment.
- Manual opening of recirculation damper when automatic EHC or ECC close the damper.
- Releasing of parking brake in case of malfunction of switch parking brake.
- Releases frozen weight if boom angle less than max. boom angle - 4°.
- Output signals to solenoid valve despite incorrect input signals.

The switch is supplied with voltage from and sends a voltage signal to Control unit, cab (D790-1).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group **8.4.10.2 OP, menu 2**.

DANGER

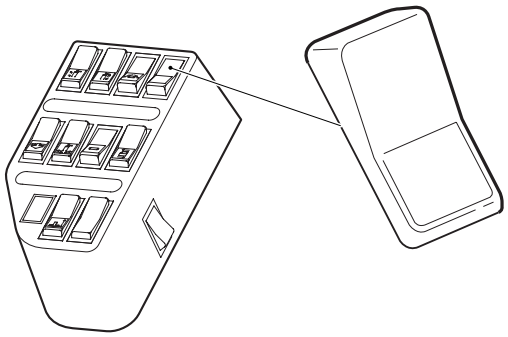
Safety catches blocked.

No safety system engaged! Risk of rolling over and tipping!

Only use by-passing in emergency situations.

8.1.4 Switch by-passing of load centre limitation and height limitation

Switch by-pass of load centre and height limitation, description



002352

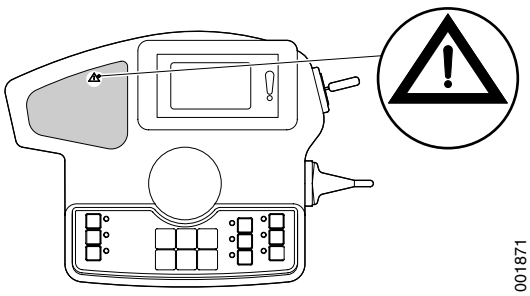
The switch by-passes load centre limitation, height limitation and makes it possible to retract the boom further when the limit for load centre limitation is reached or raise the boom over the limit for height limitation.

The switch is supplied with voltage from and sends a voltage signal to Control unit, cab (D790-1) when the switch is activated.

The signals can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450, section 8 Control system*, group *8.4.9.3 ATTACH, menu 3*.

8.1.5 Indicator light by-passing activated

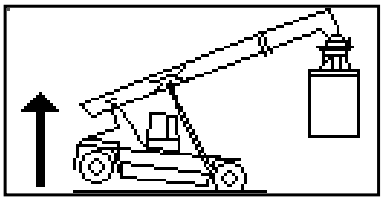
Indicator light by-pass activated, description



001871

The indicator light is activated when by-pass is activated.

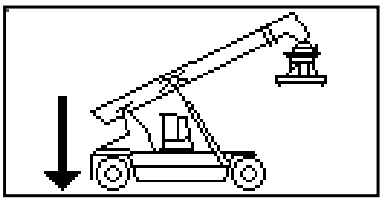
The light is supplied with voltage by Control unit, KIT (D790-2).



8.1.6 Event menu overload forward

Event menu overload forward, description

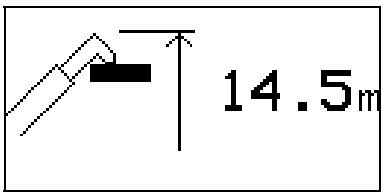
This image is activated when the control system detects overload and limits the load handling functions. See *Maintenance manual DRF 400–450,* section *8 Control system,* group *8.2.1 Overload protection*.



8.1.7 Event menu overload steering axle

Event menu overload on steering axle, description

This figure lights up to warn the operator when the control system detects overload, see *Maintenance manual DRF 400–450,* section *8 Control system,* group *8.2.1 Overload protection*.



8.1.8 Event menu height limitation

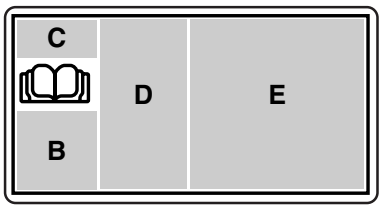
Event menu height limitation, description

This image is shown when height limitation is activated and limits lift or extension. See *Maintenance manual DRF 400–450,* section *8 Control system,* group *8.2.4 Height limitation*.

8.1.9 Event menu open door

Event menu open door, description

The display image is shown when a function that requires closed doors is activated when any door is open. For example, sliding cab.



000389

8.1.10 Error code menu

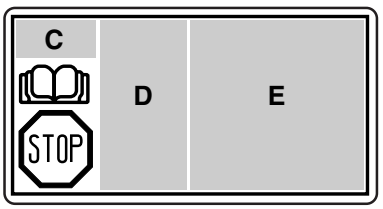
Error code menu, description

The control system's display is divided into four fields where information is shown (see figure to the left).

- Field B: Error code level shown with a symbol.
- Field C: Indicates error code.
- Field D: Indicates type of error.
- Field E: Indicates which function is affected by error code.
- The book symbol means that there's information in the operator's manual.

Field B: Error code level

The control system gives error code information in three levels which are indicated with a symbol in the lower left corner (B) on the display unit.

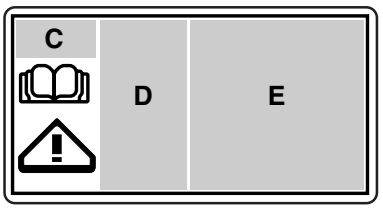


000350

- Stop

  Indicates a serious malfunction that may affect operator safety or cause machine breakdown. The error code must be dealt with immediately. Stop working with the machine and contact service immediately.

  The error code is shown automatically on the display.

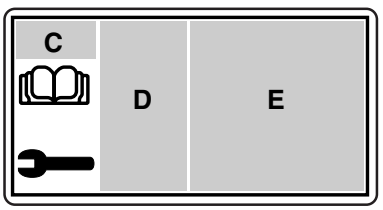


000351

- Warning

  Indicates machine malfunction that should be taken care of as soon as possible. After finished work shift with the machine, contact service as soon as possible.

  The error code is shown automatically on the display.

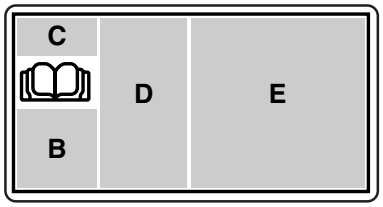


000352

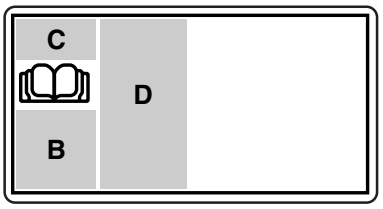
- Information

  Information for the operator that something should be taken care of, for example, a defective bulb. Rectify the cause of the error code as soon as possible. See section *6 Inspection and maintenance* .

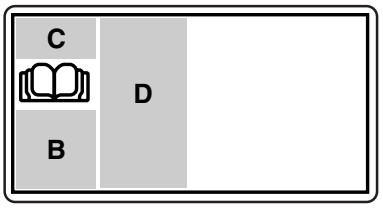
  The error code is stored in the error code list under operating menu for service.



000389



001343



001344

1 **2** **3**

4 **5** **6**

7

000396

Field C: Error code number

The control system gives error codes from three sub-systems:

- Machine:

  Shown with error code number XXX on display.

- Engine:

  Shown with error code number XXX/YY on display.

NOTE

If several error codes come from the engine, the error code level is shown for the most serious error code.

- Transmission:

  Shown with error code number XX/YY on display.

Field D: Type of error

1. Temperature too high/too low.
2. Incorrect signal to solenoid valve.
3. Incorrect hydraulic pressure.
4. Incorrect sensor signal.
5. Incorrect signal from control.
6. Incorrect signal to bulb.
7. Incorrect signal, for example, open circuit.

1	**2**	**3**
4	**5**	**6**
7	**8**	**9**
10	**11**	**12**
13	**14**	**15**
16	**17**	**18**
19	**20**	**21**
22	**23**	**24**
25	**26**	**27**
28	**29**	**30**

Field E: Affected function

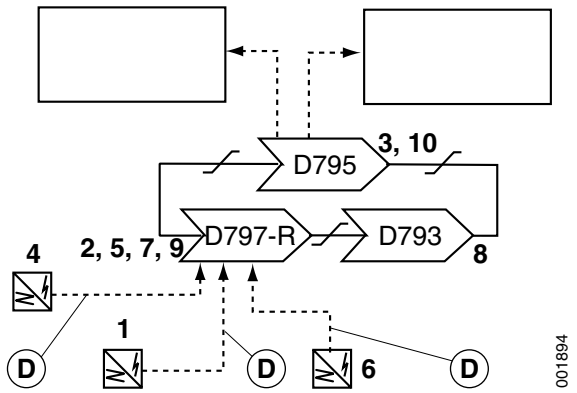
1. Attachment
2. Rotation of attachment
3. Sideshift attachment
4. Length adjustment attachment
5. Leveling attachment
6. Twistlocks
7. Tilt attachment
8. Bottom lift attachment
9. Bottom lift attachment, clamping position
10. Bottom lift attachment, legs up/down
11. Boom up/down
12. Boom in/out
13. Pressure sensor lift cylinder (overload protection, OP)
14. No overload protection.
15. Support jacks up/down
16. Hydraulic functions
17. Brake system
18. Steering
19. Engine
20. Transmission
21. Central lubrication
22. Control unit
23. Hardware-related error
24. Cab
25. Climate control unit
26. Fuel system
27. Headlights
28. Windshield wipers
29. Battery voltage
30. Bulb for lighting

8.2 Monitoring

8.2.1 Overload protection

8.2.1.1 Mechanical overload protection

Mechanical overload protection, function description



Pos	Explanation	Signal description	Reference
1	Sensor steering axle load (B7221) sends a voltage signal to Control unit, frame rear (D797-R) if load on steering axle is low.	Normal: U = 24 V Overload: U = 0 V	*Sensor steering axle load, description page 16* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.10.1 OP, menu 1*
2	Control unit, frame rear (D797-R) sends "Overload forward" on CAN-bus.	Checked by control system, error indicated with error code.	Section *11 Common electrics*, group *11.6 Communication*
3	Control unit KID (D795) shows Event menu overload forward.	-	Section *11 Common electrics,* group *11.5.3.12 Control unit KID*
4	Position sensor boom length 1.5m (B777) sends voltage signal to Control unit, frame rear (D797-R) if the boom's extension is shorter than 1.5 m.	Extension less than 1.5 m: U = 24 V Extension more than 1.5 m: U = 0 V	*Sensor boom length, description (position sensor) page 19* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.10.1 OP, menu 1*
5	Control unit, frame rear (D797-R) sends “boom length less than 1.5 m” on the CAN bus.	Checked by control system, error indicated with error code.	Section *11 Common electrics*, group *11.6 Communication*
6	Position sensor boom angle 35° (B771) sends voltage signal to Control unit, frame rear (D797-R) if boom angle is greater than 35°.	Boom angle less than 35°: U = 24 V Boom angle greater than 35°: U = 0 V	*Sensor, boom angle, description (position sensor) page 17* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.10.1 OP, menu 1*
7	Control unit frame rear (D797-R) sends “boom angle greater than 35°” on the CAN bus.	Checked by control system, error indicated with error code.	Section *11 Common electrics*, group *11.6 Communication*

Pos	Explanation	Signal description	Reference
8	Control unit transmission (D793) sends speed information on CAN-bus.	Checked by control system, error indicated with error code.	Section *11 Common electrics*, group *11.6 Communication*
9	If both Position sensor boom length 1.5m (B777) and Position sensor boom angle 35° (B771) send voltage signal when the machine is operated faster than 10 km/h then Control unit, frame rear (D797-R) sends "Overload backward" on CAN-bus.	Checked by control system, error indicated with error code.	Section *11 Common electrics*, group *11.6 Communication*
10	Control unit KID (D795) activates Event menu overload backward.	-	Section *11 Common electrics,* group *11.5.3.12 Control unit KID*

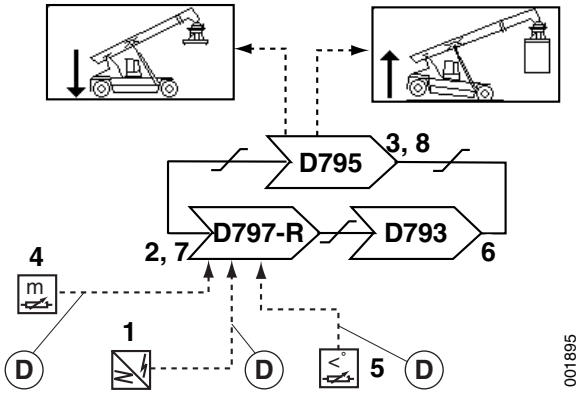
Damping

1. Position sensor boom angle damping (B769-1), see *Sensor, boom angle, description (position sensor) page 17*, sends voltage signal to Control unit frame rear (D797-R), when the boom is in its upper or lower end-position.
2. Control unit frame front (D797-F), reduces the current to the servo valve (lift or lower).
3. Position sensor boom in (B769-3) sends voltage signal to Control unit frame rear (D797-R) when the boom is in the extension's inner end-position.

   Position sensor boom out (B769-4), see *Sensor boom length, description (position sensor) page 19*, sends voltage signal to Control unit frame rear (D797-R) when the boom is in the extension's outer end-position.
4. Control unit frame front (D797-F) reduces the control current to the servo valves (boom in or boom out) if any sensor sends signal.

8.2.1.2 Mechanical overload protection with analogue sensors

Mechanical overload protection with analogue sensors, function description



Pos	Explanation	Signal description	Reference
1	Sensor steering axle load (B7221) sends a voltage signal to Control unit, frame rear (D797-R) if load on steering axle is low.	Normal: U = 24 V Overload: U = 0 V	*Sensor steering axle load, description page 16* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.10.1 OP, menu 1*
2	Control unit, frame rear (D797-R) sends "Overload forward" on CAN-bus.	Checked by control system, error indicated with error code.	Section *11 Common electrics*, group *11.6 Communication*
3	Control unit KID (D795) activates Event menu overload forward.	-	Section *11 Common electrics,* group *11.5.3.12 Control unit KID*
4	Sensor boom length (R777) sends voltage signal proportional to boom's length to Control unit, frame rear (D797-R).	Conn 1: U = 5 V Conn 2: U = 0 V Conn 3: U = 0.5 - 4.5 V	*Sensor boom length, description (analogue sensor) page 20* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.10.4 OP, menu 4*
5	Sensor boom angle (R771) sends voltage signal proportional to boom's angle to Control unit, frame rear (D797-R).	Conn 1: U = 5 V Conn 2: U = 0 V Conn 3: U = 0.5 - 4.5 V	*Sensor boom angle, description (angle sensor) page 18* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.10.4 OP, menu 4*
6	Control unit transmission (D793) sends speed information on CAN-bus.	Checked by control system, error indicated with error code.	Section *11 Common electrics*, group *11.6 Communication*
7	If boom's length is less than 1.5 m and boom's angle is greater than 35° when the machine is operated faster than 10 km/h Control unit, frame rear (D797-R) sends "Overload backward" on CAN-bus.	Checked by control system, error indicated with error code.	Section *11 Common electrics*, group *11.6 Communication*

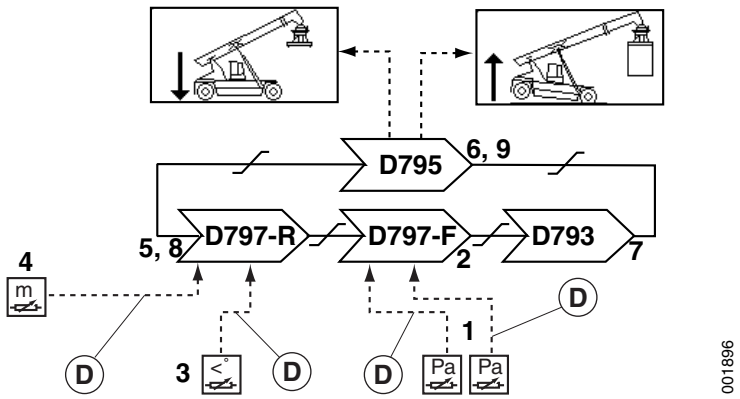
Pos	Explanation	Signal description	Reference
8	Control unit KID (D795) activates Event menu overload backward.	-	Section *11 Common electrics,* group *11.5.3.12 Control unit KID*

Damping

1. Position sensor boom angle damping (B769-1), see *Sensor boom angle, description (angle sensor) page 18*, sends voltage signal to Control unit frame rear (D797-R) when the boom is in its upper or lower end-position.
2. Control unit frame front (D797-F) reduces the current to the servo valve (lift or lower).
3. Sensor boom length (R777), see *Sensor boom length, description (analogue sensor) page 20*, sends voltage signal proportional to boom extension to Control unit frame rear (D797-R).
4. Control unit frame front (D797-F) reduces the control current to the servo valves (boom in or boom out) if boom length is < 0.4 m or (max. extension - 0.4 m).

8.2.1.3 Electrical overload protection

Electric overload protection, description



Pos	Explanation	Signal description	Reference
1	Sensor, hydraulic pressure lift cylinder left (B768-10 and B768-11) sends voltage signal proportional to pressure in lift cylinder to Control unit, frame front (D797-F). Sensor, hydraulic pressure lift cylinder right (B768-12 and B768-13) sends voltage signal proportional to pressure in lift cylinder to Control unit, frame front (D797-F).	Conn 1: U = 5 V Conn 2: U = 0 V Conn 3: U = 0.5 - 4.5 V	*Sensor hydraulic pressure lift cylinder, general page 20* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.10.3 OP, menu 3*
2	Control unit frame front (D797-F) sends pressure information on CAN-bus.	Checked by control system, error indicated with error code.	Section *11 Common electrics*, group *11.6 Communication*

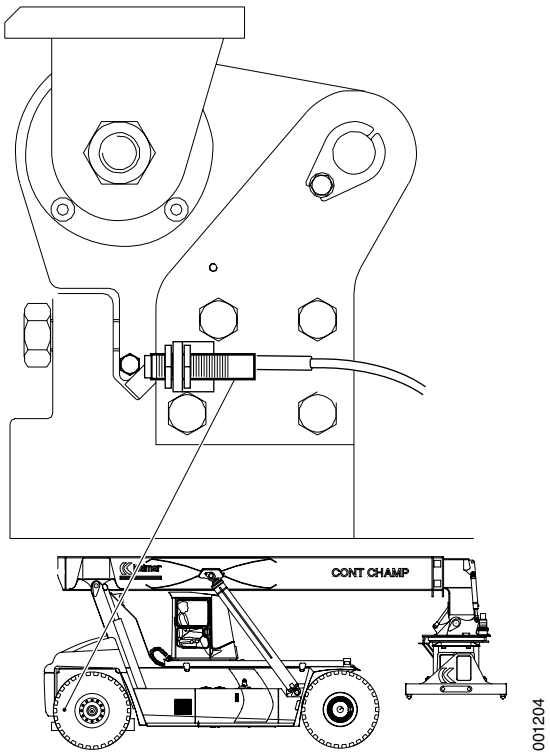
Pos	Explanation	Signal description	Reference
3	Sensor boom length (R777) sends voltage signal proportional to boom's length to Control unit, frame rear (D797-R). Alternative to Sensor boom length (R777) there may be position sensor for no or maximal boom extension.	Conn 1: U = 5 V Conn 2: U = 0 V Conn 3: U = 0.5 - 4.5 V	*Sensor boom length, description (analogue sensor) page 20* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.10.4 OP, menu 4*
4	Sensor boom angle (R771) sends voltage signal proportional to boom's angle to Control unit, frame rear (D797-R).	Conn 1: U = 5 V Conn 2: U = 0 V Conn 3: U = 0.5 - 4.5 V	*Sensor boom angle, description (angle sensor) page 18* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.10.4 OP, menu 4*
5	Control unit frame front (D797-F) calculates and sends the weight is calculated and compared with a machine-unique load curve based on sensor values for boom angle, boom length and pressure in the lift cylinders. **NOTE** *The load curve is unique to each machine.* If the load is high then Control unit frame front (D797-F) sends Overload forward on CAN-buss.	Checked by control system, error indicated with error code.	Section *11 Common electrics*, group *11.6 Communication*
6	Control unit KID (D795) activates Event menu overload forward.	-	Section *11 Common electrics,* group *11.5.3.12 Control unit KID* *Event menu overload forward, description page 7*
7	Control unit transmission (D793) sends speed information on CAN-bus.	Checked by control system, error indicated with error code.	Section *11 Common electrics*, group *11.6 Communication*
8	If boom's length is less than 1.5 m and boom's angle is greater than 35° when the machine is operated faster than 10 km/h then Control unit frame rear (D797-R) sends Overload backward on CAN-bus.	Checked by control system, error indicated with error code	Section *11 Common electrics*, group *11.6 Communication*
9	Control unit KID (D795) activates Event menu overload on steering axle.	-	Section *11 Common electrics,* group *11.5.3.12 Control unit KID* *Event menu overload on steering axle, description page 7*

Damping

1. Sensor boom angle (R771), see *Sensor boom angle, description (angle sensor) page 18*, sends voltage signal proportional to boom angle to Control unit frame rear (D797-R).
2. Control unit frame front (D797-F), reduces the current to servo valve (lift/lower) if Sensor boom angle (R771), see REF, indicates boom angle < 4° or (max. angle - 4°).
3. Sensor boom length (R777), see *Sensor boom length, description (analogue sensor) page 20*, sends voltage signal proportional to boom extension to Control unit frame rear (D797-R).
4. Control unit frame front (D797-F) reduces the control current to the servo valves (boom in or boom out) if boom length is < 0.4 m or (max. extension - 0.4 m).

8.2.1.4 Sensor load steering axle

Sensor steering axle load, description



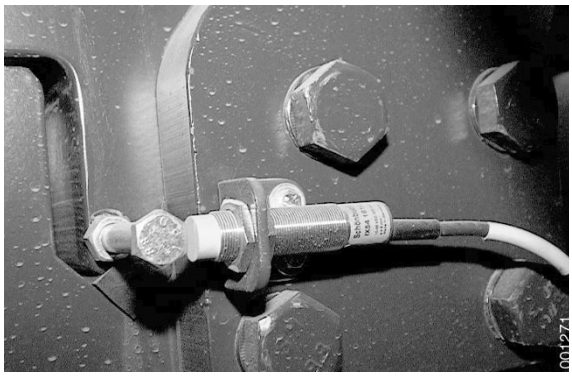
Sensor steering axle load (B7221) senses when the steering axle's rear suspension springs extend. The sensor is located on the right side of the steering axle's suspension.

Sensor steering axle load is an inductive position sensor supplied with voltage by and sends signal voltage to Control unit frame rear (D797-R).

The sensor's signals can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450, section 8 Control system*, group *8.4.10.1 OP, menu 1*.

Position sensor, checking and adjustment

See section *7 Load handling*.



Sensor, steering axle load, replacement

1 Machine in service position

2 Replace the sensor.

3 Adjust the position of the sensor, see section *7 Load handling*.

4 Turn on the main electric power and turn the start key to position I.

5 Check the overload protection, see *Maintenance manual DRF 400–450,* section *8 Control system,* group *8.2.1 Overload protection*.

8.2.1.5 Sensor boom angle

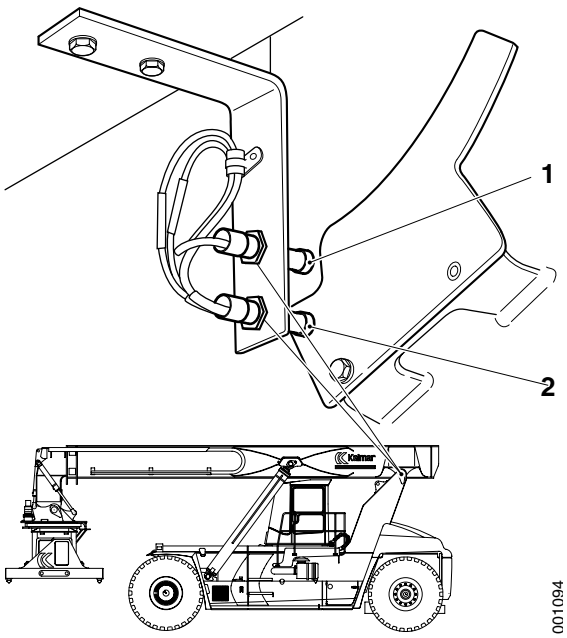
Sensor, boom angle, description (position sensor)

Three boom positions are indicated: damping position raised and lowered and boom angle 35°. Two inductive sensors fitted on a bracket under the boom are activated by an indicator plate on the tower.

Both sensors are supplied with voltage and a send 24 V signal to Control unit frame rear (D797-R) when the boom's indicator plate passes the sensor.

Position sensor damping (B769-1) sends a signal when the boom is close to being completely lowered or raised, this is used to activate damping with lift and lower, see section *7 Load handling*, group *7.2 Lift and lower*. The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.8.8 BOOM, menu 8*.

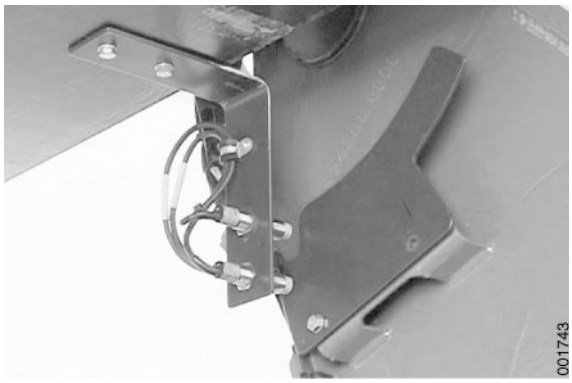
Position sensor boom angle 35° (B771) sends a signal when the boom is at an angle of 35°. This is used for overload protection of the steering axle. The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.10.1 OP, menu 1*.



1. Position sensor damping (B769-1)
2. Position sensor, boom angle 35° (B771)

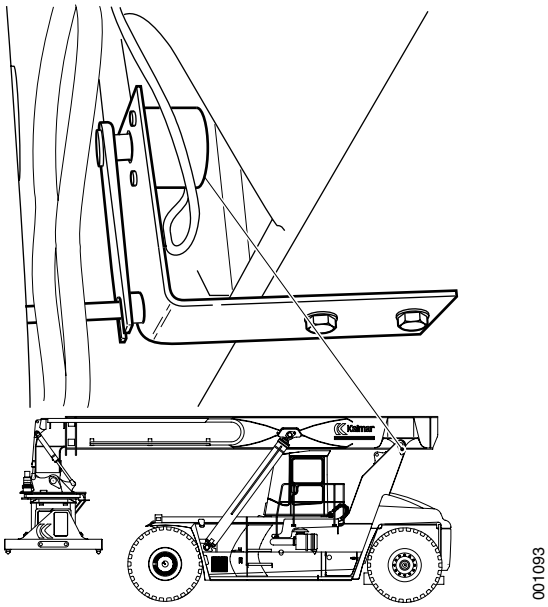
Position sensor, checking and adjustment

See section *7 Load handling*.



Sensor boom angle, replacement (position sensor)

1 Machine in service position, see section *B Safety*.
2 Replace the sensor.
3 Adjust the sensor, see section *7 Load handling*.
4 Start the engine.
5 Lift and lower the boom and check that the end position damping is working.



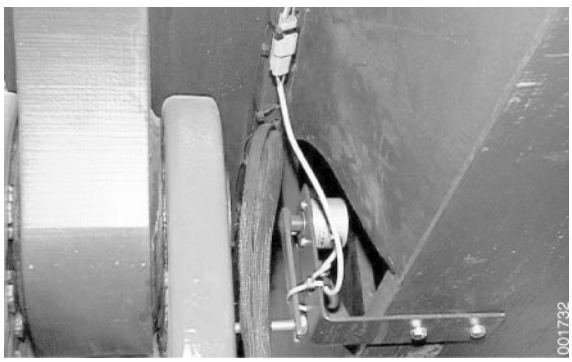
Sensor boom angle (R771)

Sensor boom angle, description (angle sensor)

The boom angle is measured by a sensor that senses the boom's angle in relation to the frame. The sensor consists of a sensor housing, potentiometer and arm. The sensor housing is mounted on the boom. The arm is connected to the frame and turns the potentiometer when the boom is angled.

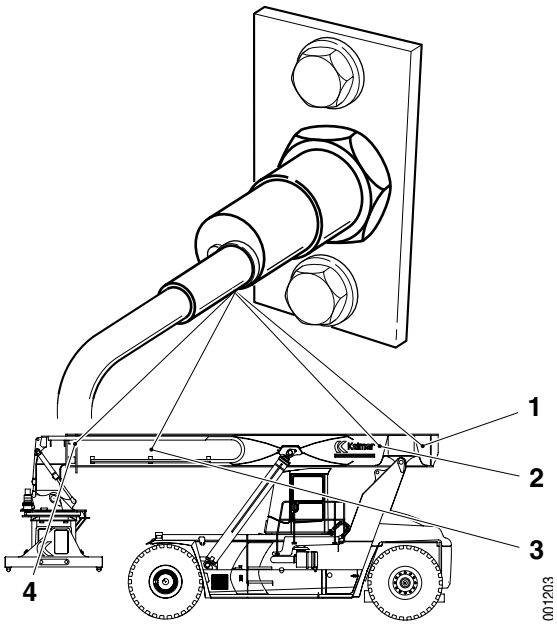
The sensor is supplied with voltage and sends a signal proportional to the angle to the Control unit frame rear (D797-R).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.10.4 OP, menu 4*.



Sensor boom angle, replacement (angle sensor)

1 Machine in service position, see section *B Safety*.
2 Replace the sensor.
3 Turn on the main electric power and turn the start key to position I.
4 Calibrate sensor, boom angle, see *Dynamic scale, calibration page 48*.
5 Check that the end position damping is working in both outer and inner end positions.



1. Position sensor, damping boom in (B769-3)
2. Position sensor 1.5 m (B777)
3. Position sensor, damping boom out (B769-4)
4. Position sensor, boom length 60 cm (B7224) ✚

8.2.1.6 Sensor boom length

Sensor boom length, description (position sensor)

Sensor boom length specifies the boom's extension and is available in two versions, position sensors or analogue sensors. Standard is three inductive position sensors. As an option there is an extra position sensor for fixed scale (60 cm extension).

Two inductive sensors, sensor damping boom in (B769-3) and sensor damping boom out (769-4), are used to control the damping of boom in and boom out. The sensors are located on the right side of the boom's outer part.

The sensors are supplied with voltage and a negative signal (grounds) to Control unit frame rear (D797-R) when the boom's indicator plate passes the sensor. Each sensor has a light-emitting diode that is activated when sensors sense the indicator plate. The light-emitting diodes can be used to check the sensor's function.

Position sensor damping extension sends a signal when the boom is close to outer and inner end positions, this is used to activate damping, see section *7 Load handling*, group *7.3 Extension*. The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.8.8 BOOM, menu 8*.

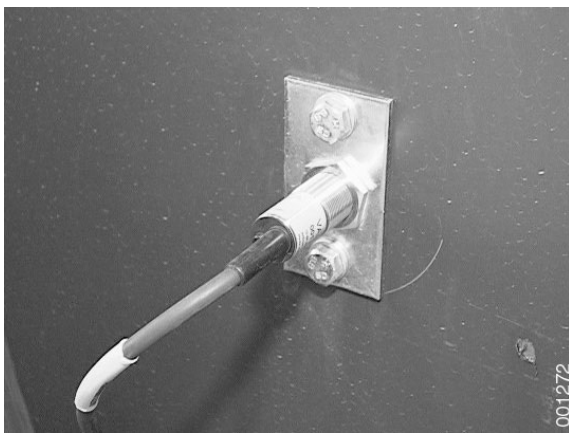
Position sensor boom length 1.5 m (B777) sends a signal when the boom's extension is 1.5 m. This signal is used for overload protection of the steering axle. The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.10.1 OP, menu 1*.

Position sensor boom length 60 cm (B7224) sends a signal when the boom's extension is in position for weighing on machines with fixed scale, see section *7 Load handling*, group *7.10.2 Weight indicator*. The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.9.5 ATTACH, menu 5*.

Position sensor, checking and adjustment

See section *7 Load handling*.

Sensor boom length (position sensor), replacement

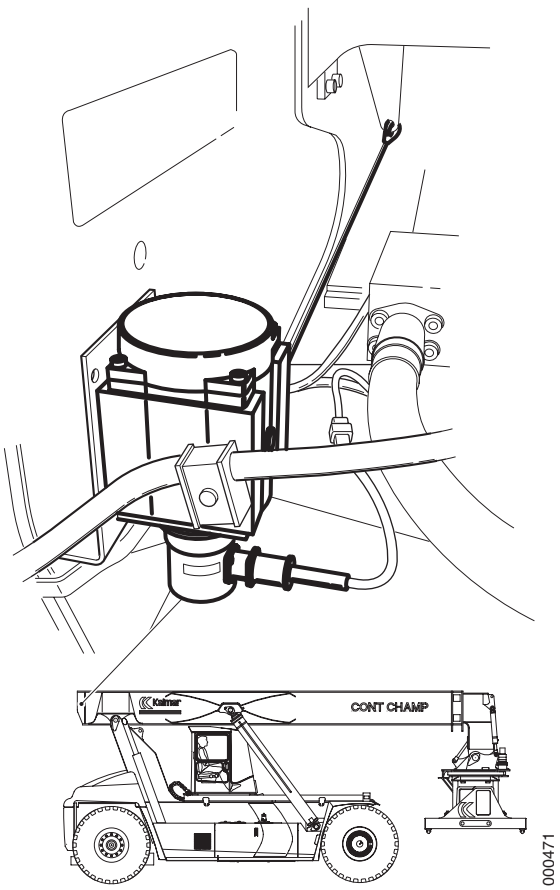


1 Machine in service position, see section *B Safety*.

2 Replace the sensor.

3 Adjust the position of the sensor, see section *7 Load handling*.

4 Check that the end position damping is working in both outer and inner end positions.



Sensor boom length (R777)

Sensor boom length, description (analogue sensor)

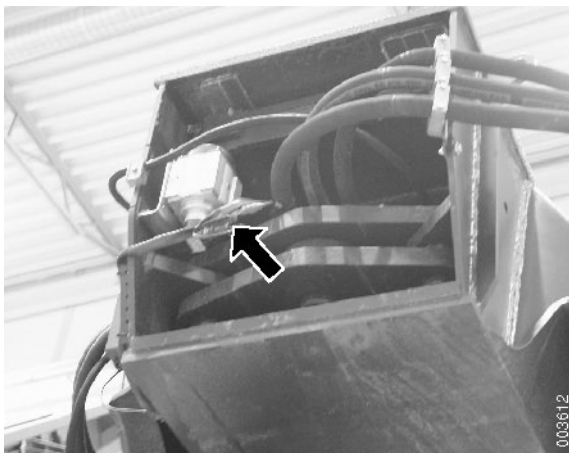
Sensor boom length (R777) senses the lift boom's extension and is located in the rear edge of the boom on the left-hand side.

The sensor is connected to a spring-loaded wire that is connected to a rotary potentiometer via a gearbox. The wire is connected to the inner boom. When the boom is extended, the wire affects the potentiometer and the signal changes.

The sensor is supplied with voltage by and sends voltage signal proportional to Control unit, frame rear (D797-R).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.10.4 OP, menu 4*.

Sensor boom length (analogue sensor), replacement



1 Machine in service position, see section *B Safety*.
2 Replace the sensor.
3 Turn on the main electric power and turn the start key to position I.
4 Calibrate sensor, see *Dynamic scale, calibration page 48*
5 Check that the end position damping is working in both the outer and the inner end positions.

8.2.1.7 Sensor hydraulic pressure lifting cylinder

Sensor hydraulic pressure lift cylinder, general

See section *7 Load handling*, group *7.2.9 Sensor hydraulic pressure lift cylinder*.

8.2.2 By-passing

By-passing, description

See *Maintenance manual DRF 400–450*.

8.2.3 Load centre limitation

Load centre limitation, description

Load centre limitation prevents the load from come too close to the machine. The load centre limitation is controlled by the control system with signals from Sensor boom angle, see *Sensor boom angle, description (angle sensor) page 18*, and Sensor boom length, see *Sensor boom length, description (analogue sensor) page 20*. For example, this is used in connection with cab lift to prevent that the container damages the cab.

For details about lift, lower and extension, see section *7 Load handling*.

8.2.4 Height limitation

Height limitation, description

Height limitation is a part of the control system and prevents the machine from lifting higher than a pre-set height without the operator being informed.

Height limitation is controlled by the control system with signals from Sensor boom angle, see *Sensor boom angle, description (angle sensor) page 18*, and Sensor boom length, see *Sensor boom length, description (analogue sensor) page 20*. When boom angle and extension indicate that permitted height is reached, lift and extension are blocked and display information height limitation is activated, see *Event menu height limitation, description page 7*.

For details about lift, lower and extension, see section *7 Load handling*.

8.2.5 Speed limitation

Speed limitation, description

See *Maintenance manual DRF 400–450*.

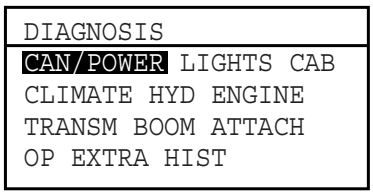
8.3 Error codes

Error codes, description

See *Maintenance manual DRF 400–450*.

8.4 Diagnostics

Diagnostic test, general



The machine has integral functions for troubleshooting termed diagnostic test. The diagnostic test consists of several menus shown in the display. The menus are grouped for faster access.

For a description of the menus see, *Maintenance manual DRF 400–450,* section *8 Control system,* group *8.4 Diagnostics*

8.5 Setup

Settings, general

Settings are integral functions to adapt the functions to the unique individual machine. The settings are made via menus in the display. Settings are divided into initiation and calibration.

Initiation

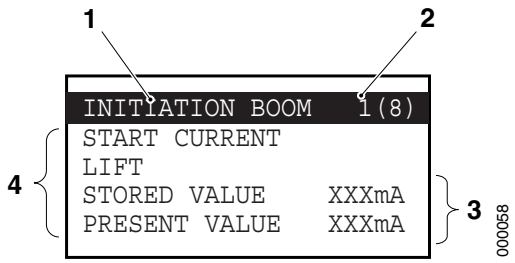
Initiation is performed before the machine is used in work and it involves setting start and stop currents for the steering and hydraulic functions. This is done to compensate for mechanical and electrical tolerances (variations between different machines).

Calibration

Calibration is performed before the machine is used in work, replacement of control units and in some cases with service or replacing components. Calibration is performed so that certain functions work correctly and display the correct values.

8.5.1 Initiation

Initiation, description



Example of initiation menu, start current for lift function.

1. Menu group
2. Menu number (in brackets, total number of menus)
3. Values
4. Current variable

DANGER

The settings affect the functions. Adjustments can impair the function. Contact Kalmar Industries Service in the event of uncertainty.

NOTE

Initiation does not need to be performed in one process but each step can be performed separately, independently of other steps.

In order that hydraulic functions shall work satisfactorily and safely, certain values must be set to operate the machine, this is known as initiation.

Initiation consists of several menus grouped according to functions. Each individual menu sets a specific variable. The menus are similar in construction and use a common terminology explained here:

PRESENT

Shows stored value when menu is opened. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back using the R key.

STORED

States the stored value for the current variable.

START CURRENT

Specifies the start current to the solenoid valve for selected function. The start current is the lowest current that can be directed, in practice it controls how slowly a function can be operated. On functions with analogue control activation (controllable) e.g. lift, this is the current directed when the lever is in the zero position. On certain functions with digital activation (off/on) which are smooth started this is the current which is directed immediately the function is activated.

END CURRENT

Specifies the maximum current to the solenoid valve for selected function. The maximum current is the highest current which can be directed, in practice it controls how quickly a function can be operated. On functions with analogue control activation (controllable) e.g. lift, this is the current directed when the lever is in the end position. On certain functions with digital activation (off/on) which are smooth started this is the current which is directed after the ramp time when the function is activated. The interval between START CURRENT and END CURRENT becomes active area for controlling the solenoid valve.

PROC DAMPING

Specifies how much control current shall be reduced during damping. The interval is specified as 0-100% of the active area between START CURRENT and END CURRENT.

Overview, initiations

Function	Menu
2 Transmission, starting gear	*INIT DRIVE-TRAIN, menu 1 page 42*
2 Transmission, speed limit shifting forward - reverse	*INIT DRIVE-TRAIN, menu 2 page 42*
2 Transmission, engine speed limit shifting forward - reverse	*INIT DRIVE-TRAIN, menu 3 page 42*
2 Transmission, engine speed limit shifting neutral - gear	*INIT DRIVE-TRAIN, menu 4 page 43*
2 Transmission, engine speed limit kickdown to 1st	*INIT DRIVE-TRAIN, menu 5 page 43*
2 Transmission, speed limit declutch	*INIT DRIVE-TRAIN, menu 6 page 43*
5.2 Power-assisted steering system (product option joystick control or mini-wheel), lever response	*INIT STEERING, menu 1 page 37*
5.2 Power-assisted steering system (product option joystick control or mini-wheel), speed dependent	*INIT STEERING, menu 2 page 38* *INIT STEERING, menu 3 page 38* *INIT STEERING, menu 4 page 39* *INIT STEERING, menu 5 page 39* *INIT STEERING, menu 6 page 40*
5.2 Power-assisted steering system (product option joystick control or mini-wheel), steering angle right	*INIT STEERING, menu 7 page 40* *INIT STEERING, menu 8 page 40*

Function	Menu
5.2 Power-assisted steering system (product option joystick control or mini-wheel), steering angle left	*INIT STEERING, menu 9 page 41* *INIT STEERING, menu 10 page 41*
7.2 Lift and lower, boom up	*INIT BOOM, menu 1 page 28* *INIT BOOM, menu 2 page 28*
7.2 Lift and lower, boom down Comments: The current value applies to unloaded machine. With a load the current value is controlled by limited lower speed.	*INIT BOOM, menu 3 page 29* *INIT BOOM, menu 4 page 29*
7.3 Extension, boom out	*INIT BOOM, menu 5 page 29* *INIT BOOM, menu 6 page 30*
7.3 Extension, boom in Comments: The current value applies to unloaded machine. With a load the current value is controlled by limited lower speed.	*INIT BOOM, menu 7 page 30* *INIT BOOM, menu 8 page 30*
7.6 Rotation, clockwise	*INIT ATTACH, menu 1 page 31* *INIT ATTACH, menu 2 page 31*
7.6 Rotation, anticlockwise	*INIT ATTACH, menu 3 page 32* *INIT ATTACH, menu 4 page 32*
7.7 Tilt	*INIT ATTACH, menu 5 page 32* *INIT ATTACH, menu 6 page 33*
7.8 Levelling	*INIT ATTACH, menu 7 page 33* *INIT ATTACH, menu 8 page 33*
9.10.4 Sliding cab, forward 9.10.5 Cab lift and lowering, up	*INIT SLID-CAB, menu 1 page 34* *INIT SLID-CAB, menu 2 page 35* *INIT SLID-CAB, menu 3 page 35*
9.10.4 Sliding cab, backward 9.10.5 Cab lift and lowering, down	*INIT SLID-CAB, menu 4 page 35* *INIT SLID-CAB, menu 5 page 36* *INIT SLID-CAB, menu 6 page 36*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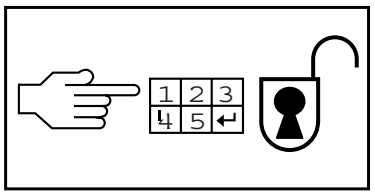

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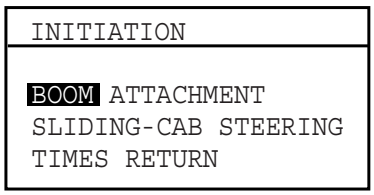

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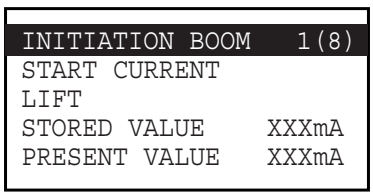

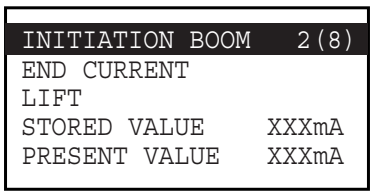

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Initiate hydraulic function, work instructions

To select a hydraulic function to initiate, proceed as follows:

Initiation is performed in the same way for all hydraulic functions.

1 Navigate to service menu.

2 Press Enter.

3 State code for initiation.

Code is obtained from Kalmar Industries Support.

NOTE

The code determines which service menu is activated (Diagnostic test, Initiation or Calibration).

4 Select group by scrolling with the arrow keys (1 and 2) and confirm with Enter.

Each initiation consists of a sequence of a number of menus. The first menu for the selected initiation appears in the display. Select the required menu using the arrow keys (1 and 2).

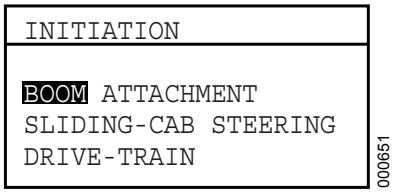
5 Change the current value with the plus and minus keys.

6 Use the function key for Enter to store required setting of current value, "STORED".

8.5.1.1 BOOM

INIT BOOM

This function menu group handles initiation of the boom functions lift, lower and extension.



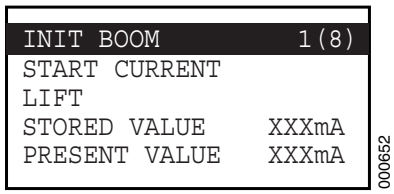
DANGER

The settings affect the functions lift, lower and extension. Adjustments can impair the function. Contact Kalmar Industries Service in the event of uncertainty.

NOTE

Initiation does not need to be performed in one process but each step can be performed separately, independently of other steps.

INIT BOOM, menu 1



START CURRENT, LIFT

Description: Start current for activation of solenoid valve lift (Y6005).

PRESENT VALUE: indicates current value for start current. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

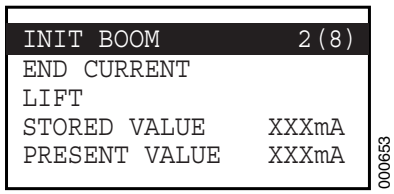
STORED VALUE: indicates stored value for start current.

Function: 7.2.5 Control valve lift, lower and extension

Component: Solenoid valve lift (Y6005)

Signal value: XXXmA = 0 - 999 mA

INIT BOOM, menu 2



END CURRENT, LIFT

Description: Control current at full lever angle for activation of solenoid valve lift (Y6005).

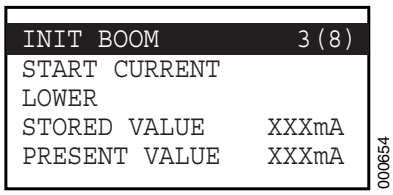
PRESENT VALUE: indicates current value for maximum current. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates stored value for maximum current.

Function: 7.2.5 Control valve lift, lower and extension

Component: Solenoid valve lift (Y6005)

Signal value: XXXmA = 0 - 999 mA



INIT BOOM, menu 3

START CURRENT, LOWER

Description: Start current for activation of solenoid valve lower (Y6004).

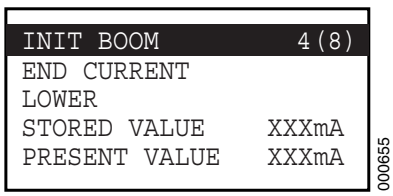
PRESENT VALUE: indicates current value for start current. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE indicates stored value for start current.

Function: 7.2.5 Control valve lift, lower and extension

Component: Solenoid valve lower (Y6004)

Signal value: XXXmA = 0 - 999 mA



INIT BOOM, menu 4

END CURRENT, LOWER

Description: Control current at full lever angle for activation of solenoid valve lower (Y6004).

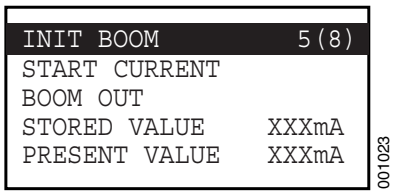
PRESENT VALUE: indicates current value for maximum current. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates stored value for maximum current.

Function: 7.2.5 Control valve lift, lower and extension

Component: Solenoid valve lower (Y6004)

Signal value: XXXmA = 0 - 999 mA



INIT BOOM, menu 5

START CURRENT, BOOM OUT

Description: Start current for activation of solenoid valve boom out (Y6006).

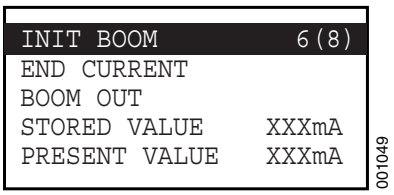
PRESENT VALUE: indicates current value for start current. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates stored value for start current.

Function: 7.2.5 Control valve lift, lower and extension

Component: Solenoid valve boom out (Y6006)

Signal value: XXXmA = 0 - 999 mA



INIT BOOM, menu 6

END CURRENT, BOOM OUT

Description: Control current at full lever angle for activation of solenoid valve boom out (Y6006).

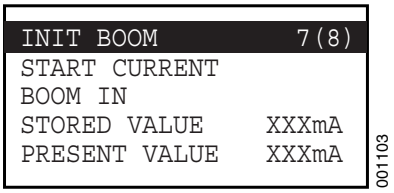
PRESENT VALUE: indicates current value for maximum current. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates stored value for maximum current.

Function: 7.2.5 Control valve lift, lower and extension

Component: Solenoid valve boom out (Y6006)

Signal value: XXXmA = 0 - 999 mA



INIT BOOM, menu 7

START CURRENT, BOOM IN

Description: Start current for activation of solenoid valve boom in (Y6007).

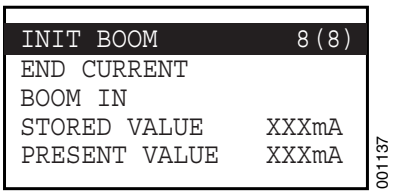
PRESENT VALUE: indicates current value for start current. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates stored value for start current.

Function: 7.2.5 Control valve lift, lower and extension

Component: Solenoid valve boom in (Y6007)

Signal value: XXXmA = 0 - 999 mA



INIT BOOM, menu 8

END CURRENT, BOOM IN

Description: Control current at full lever angle for activation of solenoid valve boom in (Y6007).

PRESENT VALUE: indicates current value for maximum current. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE indicates stored value for maximum current.

Function: 7.2.5 Control valve lift, lower and extension

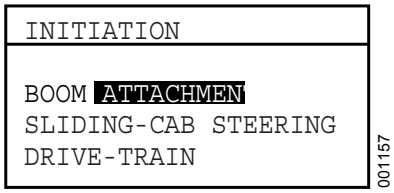
Component: Solenoid valve boom in (Y6007)

Signal value: XXXmA = 0 - 999 mA

8.5.1.2 ATTACHMENT

INIT ATTACH

This function handles initiation of the attachment functions rotation, controllable tilt and controllable levelling.



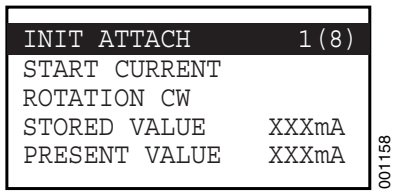
DANGER

The settings affect the functions rotation, controllable tilt and controllable levelling. Adjustments can impair the function. Contact Kalmar Industries Service in the event of uncertainty.

NOTE

Initiation does not need to be performed in one process but each step can be performed separately, independently of other steps.

INIT ATTACH, menu 1



START CURRENT, ROTATION CW

Description: Start current for activation of solenoid valve rotation clockwise (Y6008).

PRESENT VALUE: indicates current value for start current. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

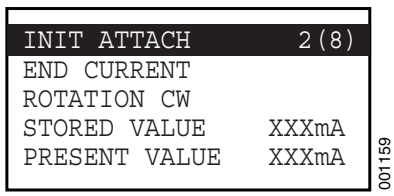
STORED VALUE: indicates stored value for start current.

Function: 7.6.3 Control valve attachment

Component: Solenoid valve rotation clockwise (Y6008)

Signal value: XXXmA = 0 - 999 mA

INIT ATTACH, menu 2



END CURRENT, ROTATION CW

Description: Control current at full lever angle for activation of solenoid valve rotation anticlockwise (Y6009).

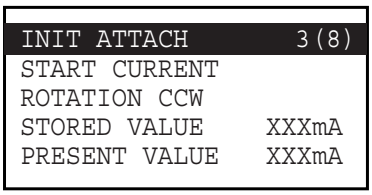
PRESENT VALUE: indicates current value for maximum current. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates stored value for maximum current.

Function: 7.6.3 Control valve attachment

Component: Solenoid valve anticlockwise (Y6009)

Signal value: XXXmA = 0 - 999 mA



INIT ATTACH, menu 3

START CURRENT, ROTATION CCW

Description: Start current for activation of solenoid valve rotation anticlockwise (Y6009).

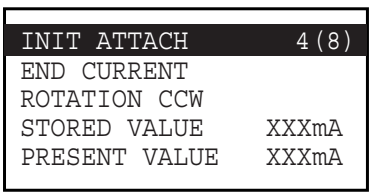
PRESENT VALUE: indicates current value for start current. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates stored value for start current.

Function: 7.6.3 Control valve attachment

Component: Solenoid valve rotation anticlockwise (Y6009)

Signal value: XXXmA = 0 - 999 mA



INIT ATTACH, menu 4

END CURRENT, ROTATION CCW

Description: Control current at full lever angle for activation of solenoid valve rotation anticlockwise (Y6009).

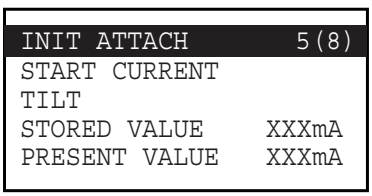
PRESENT VALUE: indicates current value for maximum current. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates stored value for maximum current.

Function: 7.6.3 Control valve attachment

Component: Solenoid valve anticlockwise (Y6009)

Signal value: XXXmA = 0 - 999 mA



INIT ATTACH, menu 5

START CURRENT, TILT

Description: Start current for activation of solenoid valve rotation tilt in (Y6010) and solenoid valve tilt out (Y6011).

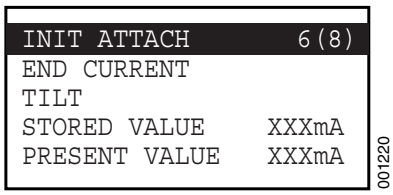
PRESENT VALUE: indicates current value for start current. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates stored value for start current.

Function: 7.7.5 Control valve attachment

Component: Solenoid valve rotation tilt in (Y6010), solenoid valve tilt out (Y6011).

Signal value: XXXmA = 0 - 999 mA



INIT ATTACH, menu 6

END CURRENT, TILT

Description: Control current at full lever angle for activation of solenoid valve rotation tilt in (Y6010), solenoid valve tilt out (Y6011).

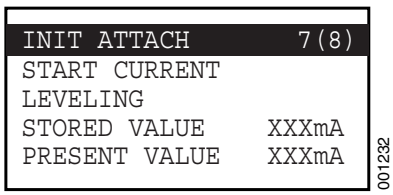
PRESENT VALUE: indicates current value for maximum current. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates stored value for maximum current.

Function: 7.7.5 Control valve attachment

Component: Solenoid valve rotation tilt in (Y6010), solenoid valve tilt out (Y6011).

Signal value: XXXmA = 0 - 999 mA



INIT ATTACH, menu 7

START CURRENT, LEVELLING

Description: Start current for activation of solenoid valve levelling right (Y6035) and solenoid valve levelling left (Y6036).

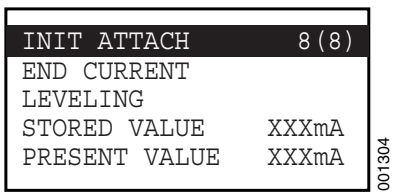
PRESENT VALUE: indicates current value for start current. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates stored value for start current.

Function: 7.8.3 Control valve attachment

Component: Solenoid valve levelling right (Y6035), solenoid levelling left (Y6036)

Signal value: XXXmA = 0 - 999 mA



INIT ATTACH, menu 8

END CURRENT, LEVELLING

Description: Control current at full lever angle for activation of solenoid valve levelling right (Y6035) and solenoid valve levelling left (Y6036).

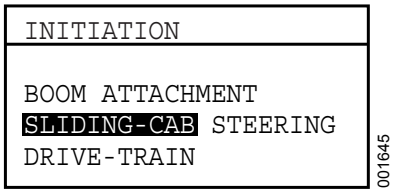
PRESENT VALUE: indicates current value for maximum current. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates stored value for maximum current.

Function: 7.8.3 Control valve attachment

Component: Solenoid valve levelling right (Y6035), solenoid levelling left (Y6036)

Signal value: XXXmA = 0 - 999 mA



8.5.1.3 SLIDING-CAB

INIT SLIDING-CAB

This function handles initiation of hydraulic sliding cab or hydraulic cab lift.

Sliding cab is smooth started by means of the control current to the solenoid valves being increased from a low start value to a maximum level. When the cab reaches an end position the speed is dampened by means of the control current being reduced.

DANGER

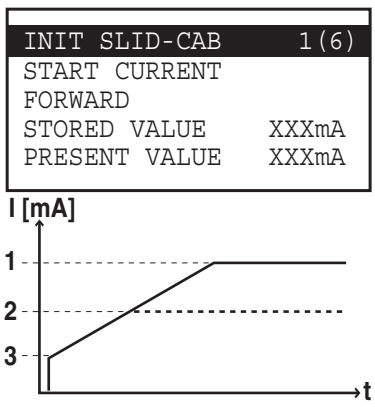
The settings affect the functions rotation, controllable tilt and controllable levelling. Adjustments can impair the function. Contact Kalmar Industries Service in the event of uncertainty.

NOTE

Initiation does not need to be performed in one process but each step can be performed separately, independently of other steps.

INIT SLID-CAB, menu 1

START CURRENT, FORWARD



1. Maximum current (END CURRENT)
2. Damping (PROC DAMPING)
3. Start current (START CURRENT)

Description: Start current to solenoid valve sliding cab forward (Y6016) at activation of sliding cab. The control current controls the start speed for sliding cab forward.

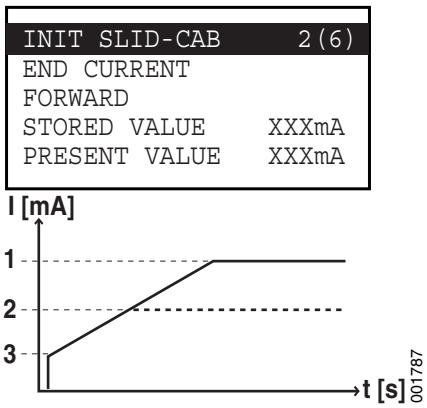
PRESENT VALUE: indicates current value for start current. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates stored value for start current.

Function: 9.10.4.3 Control valve option frame

Component: Solenoid valve sliding cab forward (Y6016)

Signal value: XXXmA = 0 - 999 mA



1. Maximum current (END CURRENT)
2. Damping (PROC DAMPING)
3. Start current (START CURRENT)

INIT SLID-CAB, menu 2

END CURRENT, FORWARD

Description: Start current to solenoid valve sliding cab forward (Y6016) after full ramp time at activation of switch for sliding cab. This current controls sliding cab maximum speed forward.

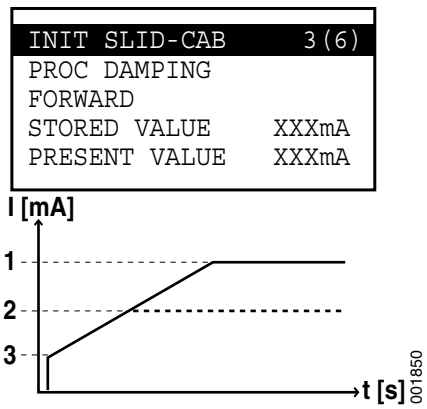
PRESENT VALUE: indicates current value for maximum current. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates stored value for maximum current.

Function: 9.10.4.3. Control valve option frame

Component: Solenoid valve sliding cab forward (Y6016)

Signal value: XXXmA = 0 - 999 mA



1. Maximum current (END CURRENT)
2. Damping (PROC DAMPING)
3. Start current (START CURRENT)

INIT SLID-CAB, menu 3

PROC DAMPING, FORWARD

Description: Percentage damping of control current to solenoid valve sliding cab forward (Y6016) when the cab reaches end position forward.

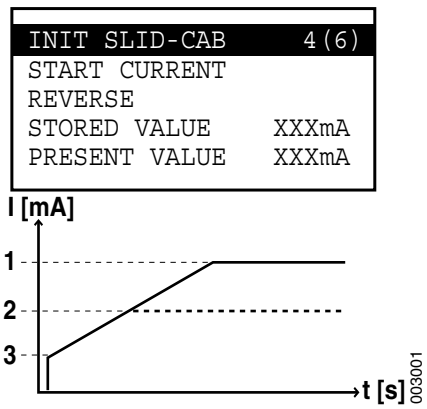
PRESENT VALUE: indicates current value for damping. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates stored value for start current.

Function: 9.10.4.3 Control valve option frame

Component: Solenoid valve sliding cab forward (Y6016)

Signal value: XXX = 0 - 100%. 100% means no damping i.e. maximum current. 0% means full damping i.e. start current



1. Maximum current (END CURRENT)
2. Damping (PROC DAMPING)
3. Start current (START CURRENT)

INIT SLID-CAB, menu 4

START CURRENT, REVERSE

Description: Start current to solenoid valve sliding cab backward (Y6017) at activation of sliding cab. The control current controls the start speed for sliding cab backward.

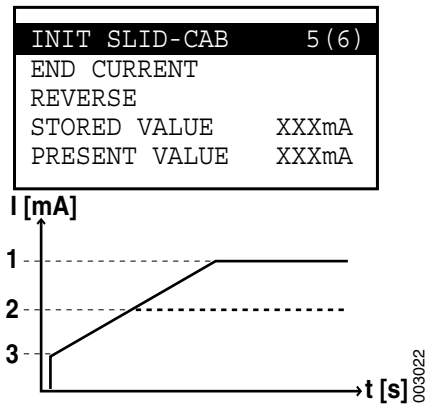
PRESENT VALUE: indicates current value for start current. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates stored value for start current.

Function: 9.10.4.3 Control valve option frame

Component: Solenoid valve sliding cab backward (Y6017)

Signal value: XXXmA = 0 - 999 mA



1. Maximum current (END CURRENT)
2. Damping (PROC DAMPING)
3. Start current (START CURRENT)

INIT SLID-CAB, menu 5

END CURRENT, REVERSE

Description: Start current to solenoid valve sliding cab backward (Y6017) after full ramp time at activation of switch for sliding cab. This current controls sliding cab maximum speed backward.

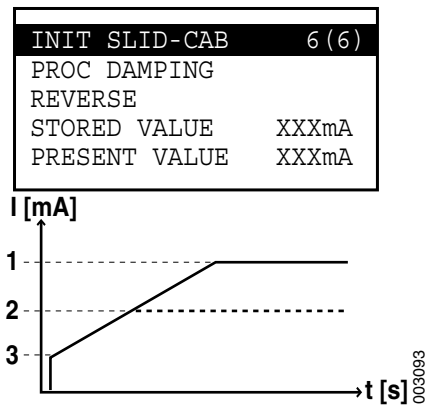
PRESENT VALUE: indicates current value for maximum current. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates stored value for maximum current.

Function: 9.10.4.3. Control valve option frame

Component: Solenoid valve sliding cab forward (Y6017)

Signal value: XXXmA = 0 - 999 mA



1. Maximum current (END CURRENT)
2. Damping (PROC DAMPING)
3. Start current (START CURRENT)

INIT SLID-CAB, menu 6

PROC DAMPING, REVERSE

Description: Percentage damping of control current to solenoid valve sliding cab backward (Y6017) when the cab reaches end position backward.

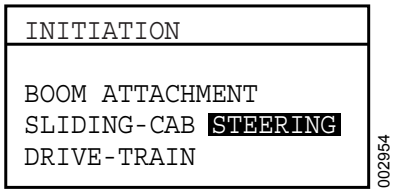
PRESENT VALUE: indicates current value for damping. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates stored value for start current.

Function: 9.10.4.3 Control valve option frame

Component: Solenoid valve sliding cab backward (Y6017)

Signal value: XXX = 0 - 100%. 100% means no damping i.e. maximum current. 0% means full damping i.e. start current



8.5.1.4 STEERING

INIT STEERING

This function handles initiation of joystick control or mini-wheel.

DANGER

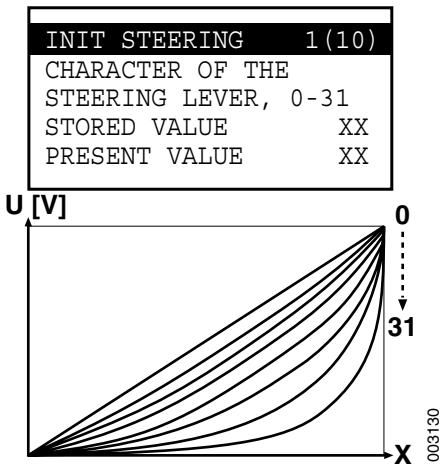
The settings affect the function of joystick control or mini-wheel. Adjustments can impair the function. Contact Kalmar Industries Service in the event of uncertainty.

NOTE

Initiation does not need to be performed in one process but each step can be performed separately, independently of other steps.

INIT STEERING, menu 1

CHARACTER OF THE STEERING LEVER



Y = Output signal to solenoid valve
X = Lever movement

Description: Indicates the responsiveness of the lever steering in accordance with 32 predefined curves (0-31) 0 means that linear wheel angle is equal in relation to lever angle during the whole lever movement. 31 means that the wheel angle is small at the beginning of the lever movement and large at the end.

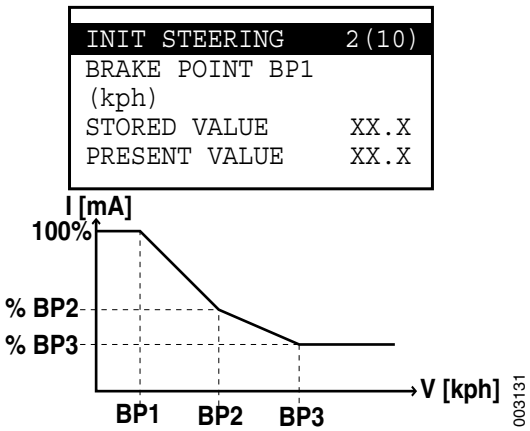
PRESENT VALUE: indicates current curve. Change curve with the plus or minus keys. Save the set curve with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates saved curve.

Function: 5.2 Power-assisted steering system (product option joystick control or mini-wheel)

Component: -

Signal value: XX = 0-31.



I [mA] = control current to solenoid valve
V [kph] = machine's speed in km/h
BP1 = speed setting for break point 1
BP2 = speed setting for break point 2
BP3 = speed setting for break point 3
%BP2 = per cent of control current to solenoid valve at BP2
%BP2 = per cent of control current to solenoid valve at BP2

INIT STEERING, menu 2

BREAK POINT BP1

Description: Speed for break point 1. The break points are used to adapt the steering angle in accordance with the machine's speed. This means that both responsive steering at low speeds and stable steering at higher speeds can be obtained.

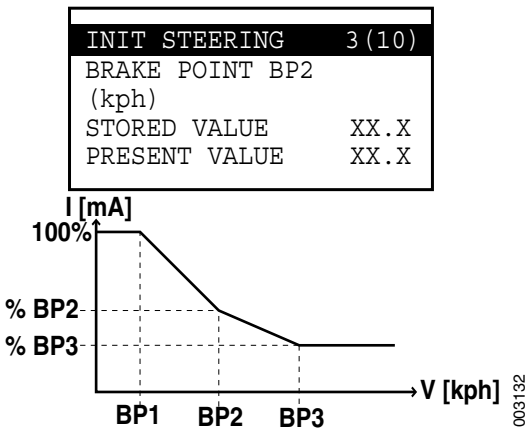
PRESENT VALUE: indicates current speed setting for break point 1. Change the speed with the plus or minus keys. Save the set speed with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates saved speed for break point 1.

Function: 5.2 Power-assisted steering system (product option joystick control or mini-wheel)

Component: -

Signal value: XX.X = speed for BP1 in km/h.



I [mA] = control current to solenoid valve
V [kph] = machine's speed in km/h
BP1 = speed setting for break point 1
BP2 = speed setting for break point 2
BP3 = speed setting for break point 3
%BP2 = per cent of control current to solenoid valve at BP2
%BP2 = per cent of control current to solenoid valve at BP2

INIT STEERING, menu 3

BREAK POINT BP2

Description: Speed for break point 2. The break points are used to adapt the steering angle in accordance with the machine's speed. This means that both responsive steering at low speeds and stable steering at higher speeds can be obtained.

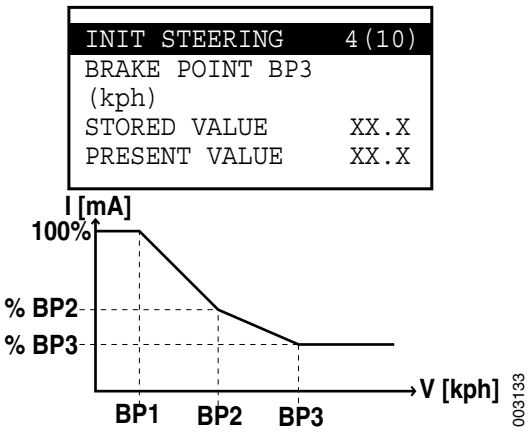
PRESENT VALUE: indicates current speed setting for break point 2. Change the speed with the plus or minus keys. Save the set speed with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates saved speed for break point 2.

Function: 5.2 Power-assisted steering system (product option joystick control or mini-wheel)

Component: -

Signal value: XX.X = speed for BP2 in km/h.



I [mA] = control current to solenoid valve
V [kph] = machine's speed in km/h
BP1 = speed setting for break point 1
BP2 = speed setting for break point 2
BP3 = speed setting for break point 3
%BP2 = per cent of control current to solenoid valve at BP2
%BP2 = per cent of control current to solenoid valve at BP2

INIT STEERING, menu 4

BREAK POINT BP3

Description: Speed for break point 3. The break points are used to adapt the steering angle in accordance with the machine's speed. This means that both responsive steering at low speeds and stable steering at higher speeds can be obtained.

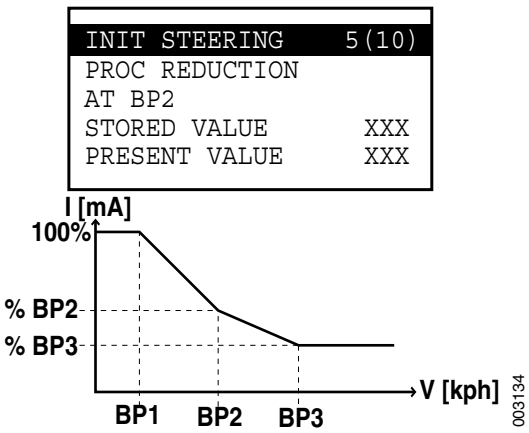
PRESENT VALUE: indicates current speed setting for break point 1. Change the speed with the plus or minus keys. Save the set speed with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates saved speed for break point 3.

Function: 5.2 Power-assisted steering system (product option joystick control or mini-wheel)

Component: -

Signal value: XX.X = speed for BP3 in km/h.



I [mA] = control current to solenoid valve
V [kph] = machine's speed in km/h
BP1 = speed setting for break point 1
BP2 = speed setting for break point 2
BP3 = speed setting for break point 3
%BP2 = per cent of control current to solenoid valve at BP2
%BP2 = per cent of control current to solenoid valve at BP2

INIT STEERING, menu 5

PROC REDUCTION, AT PB2

Description: Percentage reduction of control current to solenoid valve steering right (Y636R) and solenoid valve steering left (Y636L) at BP2.

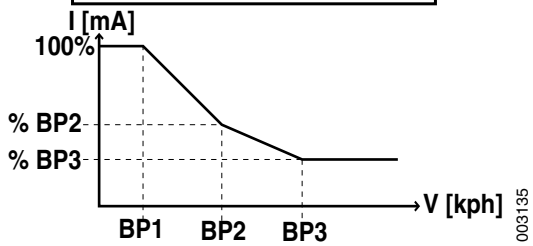
PRESENT VALUE: indicates current value reduction. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates stored value reduction.

Function: 5.2 Power-assisted steering system (product option joystick control or mini-wheel)

Component: -

Signal value: XXX = 0 - 100%. 100% means no damping i.e. maximum current. 0% means full damping i.e. start current.



I [mA] = control current to solenoid valve
V [kph] = machine's speed in km/h
BP1 = speed setting for break point 1
BP2 = speed setting for break point 2
BP3 = speed setting for break point 3
%BP2 = per cent of control current to solenoid valve at BP2
%BP2 = per cent of control current to solenoid valve at BP2

INIT STEERING, menu 6

PROC REDUCTION, AT PB3

Description: Percentage reduction of control current to solenoid valve steering right (Y636R) and solenoid valve steering left (Y636L) at BP3.

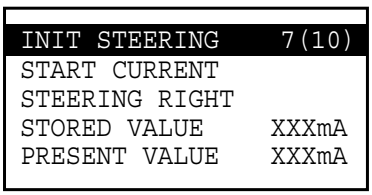
PRESENT VALUE: indicates current value reduction. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates stored value reduction.

Function: 5.2 Power-assisted steering system (product option joystick control or mini-wheel)

Component: -

Signal value: XXX = 0 - 100%. 100% means no damping i.e. maximum current. 0% means full damping i.e. start current.



INIT STEERING, menu 7

START CURRENT, STEERING RIGHT

Description: Start current to solenoid valve steering right (Y636R).

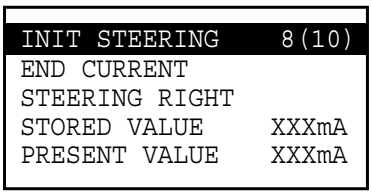
PRESENT VALUE: indicates current value for start current. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates stored value for start current.

Function: 5.2.10 Control valve joystick control or mini-wheel

Component: Solenoid valve steering right (Y636R)

Signal value: XXXmA = 0 - 999 mA



INIT STEERING, menu 8

END CURRENT, STEERING RIGHT

Description: Control current to solenoid valve steering right (Y636R) at full lever angle.

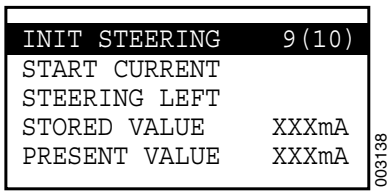
PRESENT VALUE: indicates current value for maximum current. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates stored value for maximum current.

Function: 5.2.10 Control valve joystick control or mini-wheel

Component: Solenoid valve steering right (Y636R)

Signal value: XXXmA = 0 - 999 mA



INIT STEERING, menu 9

START CURRENT, STEERING LEFT

Description: Start current to solenoid valve steering right (Y636L).

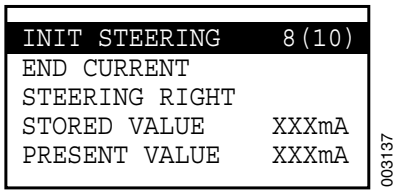
PRESENT VALUE: indicates current value for start current. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates stored value for start current.

Function: 5.2.10 Control valve joystick control or mini-wheel

Component: Solenoid valve steering right (Y636L)

Signal value: XXXmA = 0 - 999 mA



INIT STEERING, menu 10

END CURRENT, STEERING LEFT

Description: Control current to solenoid valve steering right (Y636L) at full lever angle.

PRESENT VALUE: indicates current value for maximum current. Adjust the value with the plus or minus keys. Store set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates stored value for maximum current.

Function: 5.2.10 Control valve joystick control or mini-wheel

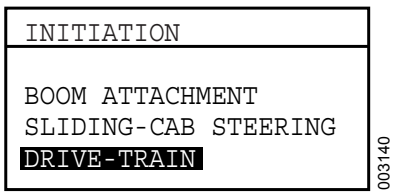
Component: Solenoid valve steering right (Y636L)

Signal value: XXXmA = 0 - 999 mA

8.5.1.5 DRIVETRAIN

INIT DRIVE-TRAIN

This function handles initiation of joystick control or mini-wheel.

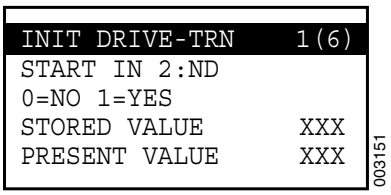


⚠ DANGER

The settings affect the function of joystick control or mini-wheel. Adjustments can impair the function. Contact Kalmar Industries Service in the event of uncertainty.

NOTE

Initiation does not need to be performed in one process but each step can be performed separately, independently of other steps.



INIT DRIVE-TRAIN, menu 1

START IN 2ND

Description: Setting to make transmission start in 2nd instead of 1st.

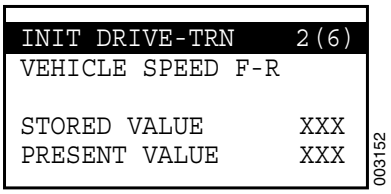
PRESENT VALUE: indicates current setting. Change the value with the plus or minus keys. Save set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates saved setting.

Function: 2 Transmission

Component: -

Signal value: XXX = 1= yes, XXX = 0 = no



INIT DRIVE-TRAIN, menu 2

VEHICLE SPEED F-R

Description: Setting of highest permitted speed for shifting between forward and reverse.

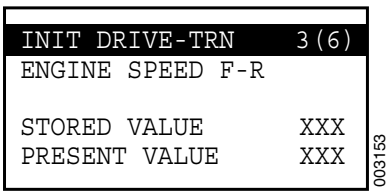
PRESENT VALUE: indicates current setting. Change the value with the plus or minus keys. Save set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates saved setting.

Function: 2 Transmission

Component: -

Signal value: XXX = speed in km/h



INIT DRIVE-TRAIN, menu 3

ENGINE SPEED F-R

Description: Setting of highest permitted engine speed when shifting between forward and reverse.

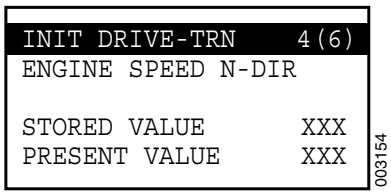
PRESENT VALUE: indicates current setting. Change the value with the plus or minus keys. Save set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates saved setting.

Function: 2 Transmission

Component: -

Signal value: XXX = engine speed (rpm)



INIT DRIVE-TRAIN, menu 4

ENGINE SPEED N-DIR

Description: Setting of highest permitted engine speed for shifting from neutral to gear.

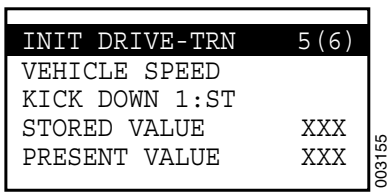
PRESENT VALUE: indicates current setting. Change the value with the plus or minus keys. Save set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates saved setting.

Function: 2 Transmission

Component: -

Signal value: XXX = engine speed (rpm)



INIT DRIVE-TRAIN, menu 5

ENGINE SPEED, KICKDOWN 1ST

Description: Setting of highest permitted engine speed for kickdown to 1st gear.

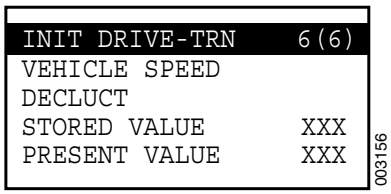
PRESENT VALUE: indicates current setting. Change the value with the plus or minus keys. Save set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates saved setting.

Function: 2 Transmission

Component: -

Signal value: XXX = engine speed (rpm)



INIT DRIVE-TRAIN, menu 6

VEHICLE SPEED, DECLUTCH

Description: Setting of highest permitted speed for declutch of the transmission.

PRESENT VALUE: indicates current setting. Change the value with the plus or minus keys. Save set value with the Enter key. Go to the next menu with the arrow keys. Go back from initiation using the R key.

STORED VALUE: indicates saved setting.

Function: 2 Transmission

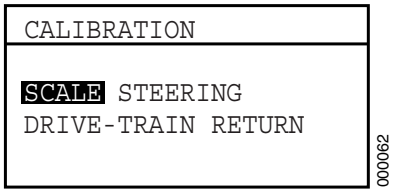
Component: -

Signal value: XXX = speed (km/h)

8.5.2 Calibration

Calibration, description

Certain functions require calibration in order to operate correctly, the control system has integral calibrations for these functions.



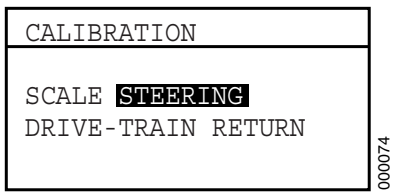
SCALE

This menu handles calibration of sensors to weight indication.

There are two variants of weight indicator, fixed or dynamic scale, see section *7 Load handling*, group *7.10.2 Weight indicator*. The current option on the machine is programmed and does not need selection, see:

Fixed scale, calibration page 46 ⊕

Dynamic scale, calibration page 48 ⊕



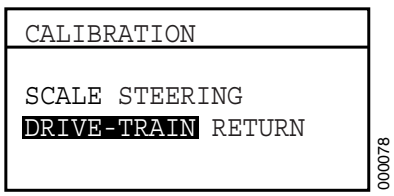
EL-STEERING

This menu handles calibration of lever steering for joystick control, see:

Joystick control, calibration page 51 ⊕

NOTE

Calibration does not need to be performed in one process but each step can be performed separately, independently of other steps.



DRIVE-TRAIN

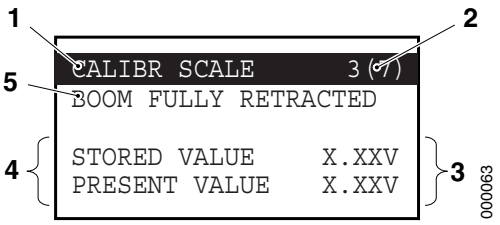
This function handles calibrations for engine and transmission. The menu loop contains two different calibrations which are not connected to each other, see:

Accelerator pedal, calibration page 52

Transmission, calibration page 53

NOTE

Calibration does not need to be performed in one process but each step can be performed separately, independently of other steps.

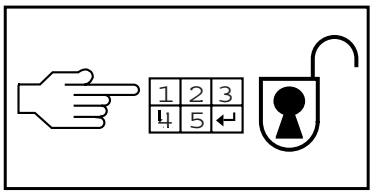


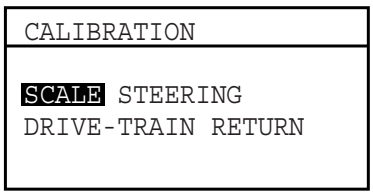
1. Menu group
2. Sequence number (in brackets, indicates total number of sequences)
3. Signal value
4. STORED indicates stored value, PRESENT indicates current value of the signal to be calibrated
5. Heading of menu figure

Calibration menu, explanation

The figure shows an example of a menu, here for calibration of boom extension inner position. The table indicates what a description contains (which follows in the next section):

Designation: Example	Description
Variable (position 4): BOOM FULLY RETRACTED	Name of the affected input signal/control signal.
Description: Setting of sensor boom length (R777) for boom extension in inner position. CALIBR VALUE: Indicates stored signal value from boom length (R777) for boom extension in inner position. PRESENT VALUE: Indicates current signal value from sensor boom length (R777).	A short description of what is calibrated and the meaning of the variables.
Function: 7.3.11 Sensor boom length	Name of current function.
Component: Sensor boom angle (R777)	Indicates the component whose signal is the basis for calibration.





Calibration, work instructions

Calibration consists of a number of menus, different numbers depending on function. All menus are similar in construction and therefore the descriptions are similar.

To select a function to calibrate, proceed as follows:

1 Navigate to service menu.

2 Press Enter.

3 State code for calibration.

Code is obtained from Kalmar Industries Support.

NOTE

The code determines which service menu is activated (Diagnostic test, Initiation or Calibration).

4 Select group by scrolling with the arrow keys (1 and 2) and confirm with Enter.

Each calibration consists of a sequence of a number of menus. The first menu for the selected calibration appears in the display. Select the next menu due with key 1 and 2 (arrow function).

8.5.2.1 Calibrate SCALE

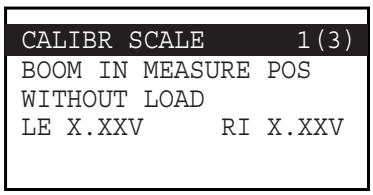
Fixed scale, calibration

NOTE

It is very important for accuracy that all steps are performed in the specified order.

1 Park the machine on level ground without load.

CALIBR SCALE, menu 1



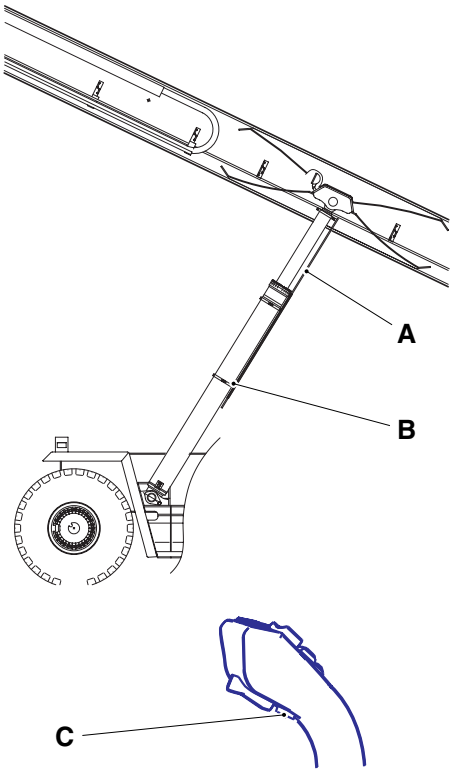
2 Go into the calibration menus and select CALIBR SCALE, menu 1, see *Calibration, work instructions page 46*

BOOM IN MEASURE POS WITHOUT LOAD

Description: Setting of zero position (unloaded machine) with boom in measuring position.

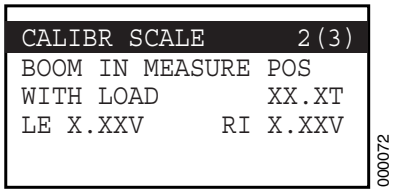
Function: 7.10.2 Weight indicator

Component: Sensor, hydraulic pressure, lift cylinder (B768)



001132

3 Move the boom to measuring position.
   1. Lift the boom above the marking on the left-hand lift cylinder.
   2. Lower the boom until the markings on the indicator rod (position A) and left-hand lift cylinder (position B) are directly in front of each other.
   3. Run out the extension approx. 2 m.
   4. Press the pistol trigger (position C) and run in the extension to centre position (display figure, fixed scale is shown).
   5. Release the pistol trigger (the calibration menu is shown again).
4 Store values with function key for Enter.



000072

CALIBR SCALE, menu 2

5 Select CALIBR SCALE, menu 2.

BOOM IN MEASURE POS WITH LOAD

Description: Setting of known weight (loaded machine) with boom in measuring position.

Function: 7.10.2 Weight indicator

Component: Sensor, hydraulic pressure, lift cylinder (B768)

6 Lift a known reference weight.

7 Park the machine on level ground.

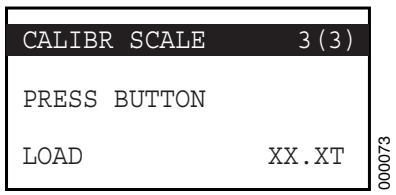
8 Move the boom to measuring position, see step 3.

NOTE

It is very important for accuracy that the boom is raised above and then lowered to the measuring position.

9 State the weight of the reference load by means of adjusting the variable WITH LOAD with the function key + and -. The weight is stated in tonnes with a decimal.

10 Store values with function key for Enter.



CALIBR SCALE, menu 3

11 Select CALIBR SCALE, menu 3.

PRESS BUTTON

Description: Control menu for fixed scale.

Function: 7.10.2 Weight indicator

Component: Sensor, hydraulic pressure, lift cylinder (B768)

12 Lift a known reference weight.

13 Park the machine on level ground.

14 Move the boom to measuring position, see step 3.

15 Check the weight with function key for Enter. Displayed weight must correspond with the reference load weight.

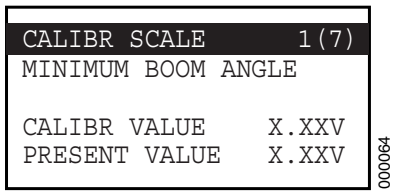
Dynamic scale, calibration

NOTE

It is very important for accuracy that all steps are performed in the specified order.

1 Park the machine on level ground without load.

CALIBR SCALE, menu 1



2 Go into the calibration menus and select CALIBR SCALE, menu 1, see *Calibration, work instructions page 46*.

MINIMUM BOOM ANGLE

Description: Setting of sensor boom angle (R771) for smallest boom angle (0°).

CALIBR VALUE: Indicates stored signal value from sensor, boom angle (R771), for smallest boom angle (0°).

PRESENT VALUE: Indicates current signal value from sensor, boom angle (R771).

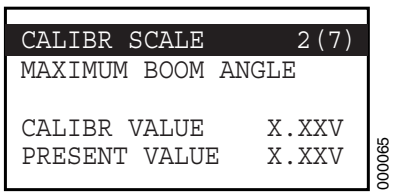
Function: 7.2.11 Sensor boom angle

Component: Sensor boom angle (R771)

3 Lower the boom to the lowest position (0°).

4 Store value with function key for Enter.

CALIBR SCALE, menu 2



5 Select menu, CALIBR SCALE, menu 2.

MAXIMUM BOOM ANGLE

Description: Setting of sensor boom angle (R771) for largest boom angle.

CALIBR VALUE: Indicates stored signal value from sensor, boom angle (R771), for largest boom angle.

PRESENT VALUE: Indicates current signal value from sensor, boom angle (R771).

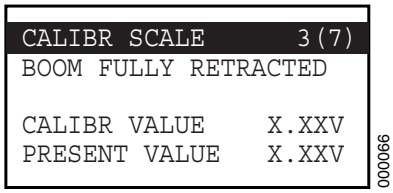
Function: 7.2.11 Sensor boom angle

Component: Sensor, boom angle (R771).

6 Raise the boom to its largest angle.

7 Store value with function key for Enter.

CALIBR SCALE, menu 3



8 Select menu, CALIBR SCALE, menu 3.

BOOM FULLY RETRACTED

Description: Setting of sensor boom length (R777) for boom extension in inner position.

CALIBR VALUE: Indicates stored signal value from boom length (R777) for boom extension in inner position.

PRESENT VALUE: Indicates current signal value from sensor boom length (R777).

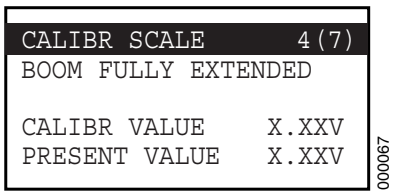
Function: 7.3.11 Sensor boom length

Component: Sensor boom angle (R777)

9 Run in the extension to its innermost position.

10 Store value with function key for Enter.

CALIBR SCALE, menu 4



11 Select menu, CALIBR SCALE, menu 4.

BOOM FULLY EXTENDED

Description: Setting of sensor boom length (R777) for boom extension in outer position.

CALIBR VALUE: Indicates stored signal value from boom length (R777) for boom extension in outer position.

PRESENT VALUE: Indicates current signal value from sensor boom length (R777).

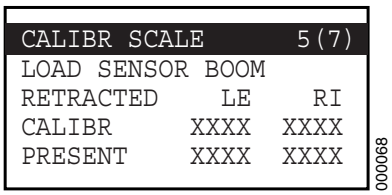
Function: 7.3.11 Sensor boom length

Component: Sensor boom angle (R777)

12 Run out the extension to its outermost position.

13 Store value with function key for Enter.

CALIBR SCALE, menu 5



14 Select menu, CALIBR SCALE, menu 5.

LOAD SENSOR BOOM RETRACTED

Description: Setting of sensor, hydraulic pressure lift cylinder, for extension in inner position without load.

CALIBR VALUE: Indicates stored signal value from sensor, hydraulic pressure lift cylinder, with boom extension in inner position and without load.

PRESENT VALUE: Indicates current signal value from sensor, hydraulic pressure lift cylinder.

Function: 7.2.9 Sensor hydraulic pressure lift cylinder

Component: Sensor, hydraulic pressure, lift cylinder (B768-10 and B768-12)

NOTE

Negative values indicate changed contacts on the pressure sensors.

Large variations between right and left indicate faults in the sensors' signals.

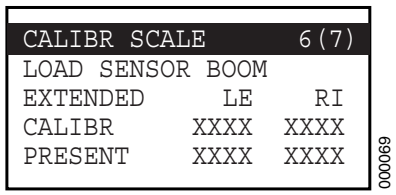
15 Run in the extension to its innermost position.

16 Move the boom to a boom angle of 5-10°.

17 Lower the boom carefully, approx. 0.5° to stabilise the pressure.

18 Store value with function key for Enter.

CALIBR SCALE, menu 6



19 Select menu, CALIBR SCALE, menu 6.

LOAD SENSOR BOOM EXTENDED

Description: Setting of sensor, hydraulic pressure lift cylinder, for extension in outer position without load.

CALIBR VALUE: Indicates stored signal value from sensor, hydraulic pressure lift cylinder, with extension in inner position and without load.

PRESENT VALUE: Indicates current signal value from sensor, hydraulic pressure lift cylinder.

Function: 7.2.9 Sensor hydraulic pressure lift cylinder

Component: Sensor, hydraulic pressure, lift cylinder (B768-10 and B768-12)

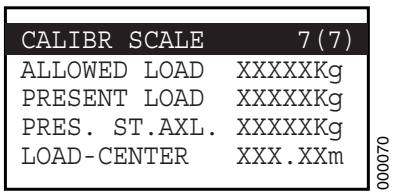
20 Move the extension to its outermost position.

21 Move the boom to a boom angle of 5-10°.

22 Lower the boom carefully, approx. 0.5° to stabilise the pressure.

23 Store value with function key for Enter.

CALIBR SCALE, menu 7



24 Select menu, CALIBR SCALE, menu 7.

Description: Menu for verifying calibration of dynamic scale. The load curve is not adjustable but is programmed at manufacture.

ALLOWED LOAD: Indicates permitted load for current TP.

PRESENT LOAD: Indicates current load.

PRES. ST.AXL: Indicates theoretical load on steering axle.

LOAD-CENTER: Horizontal distance from centre of drive axle to centre of load.

Function: 7.10.2 Weight indicator

Component: Sensor, hydraulic pressure, lift cylinder (B768)

25 Lift a reference weight and check that the control system calculates the correct weight of the load the machine is lifting, PRESENT LOAD.

26 Operate the machine without load, stop the machine and check that PRESENT LOAD = 00000 ± 250 kg.

NOTE

Check when stationary (operating generates dynamic forces).

8.5.2.2 Calibrate STEERING

Joystick control, calibration

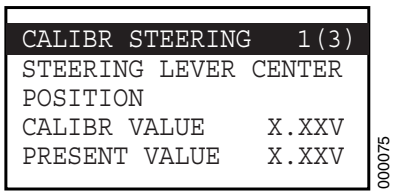
⊞

NOTE

Calibration does not need to be performed in one process but each step can be performed separately, independently of other steps.

1 Start key in operating position.

CALIBR STEERING, menu 1



2 Go into the calibration menus and select CALIBR STEERING, menu 1, see *Calibration, work instructions page 46*

STEERING LEVER CENTER POSITION

Description: Setting of centre position for Controls, joystick control (R825).

PRESENT VALUE: indicates current signal value from Controls, joystick control (R825).

STORED VALUE: indicates stored signal value from Controls, joystick control (R825).

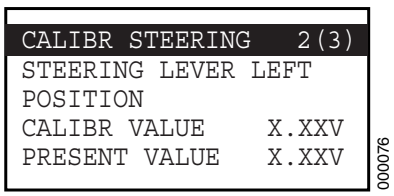
Component: Controls, joystick control (R825).

Function: 5.1.3 Lever steering

3 Move lever steering to required centre position.

4 Store the position with function key for Enter.

CALIBR STEERING, menu 2



5 Select CALIBR STEERING, menu 2.

STEERING LEVER LEFT POSITION

Description: Setting of position for maximum angle left on Controls, joystick control (R825).

PRESENT VALUE: indicates current signal value from Controls, joystick control (R825).

STORED VALUE: indicates stored signal value from Controls, joystick control (R825).

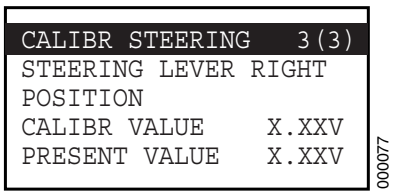
Component: Controls, joystick control (R825).

Function: 5.1.3 Lever steering

6 Move lever steering to required position for maximum angle left.

7 Store the position with function key for Enter.

CALIBR STEERING, menu 3



8 **STEERING LEVER RIGHT POSITION**

Description: Setting of position for maximum angle right on Controls, joystick control (R825).

PRESENT VALUE: indicates current signal value from Controls, joystick control (R825).

STORED VALUE: indicates stored signal value from Controls, joystick control (R825).

Component: Controls, joystick control (R825).

Function: 5.1.3 Lever steering

9 Move lever steering to required position for maximum angle right.

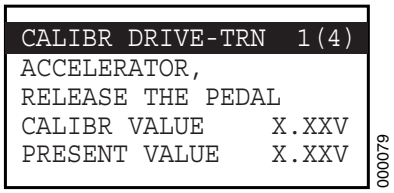
10 Store the position with function key for Enter.

8.5.2.3 Calibrate DRIVE-TRAIN

Accelerator pedal, calibration

1 Start key in operating position, engine switched off.

DRIVE-TRAIN, menu 1



2 Go into the calibration menus and select DRIVE-TRAIN, menu 1, see *Calibration, work instructions page 46*

ACCELERATOR, RELEASE THE PEDAL

Description: setting accelerator pedal zero position.

CALIBR VALUE: Indicates current calibrated control value from Accelerator pedal (R690).

PRESENT VALUE: indicates current signal value from Accelerator pedal (R690).

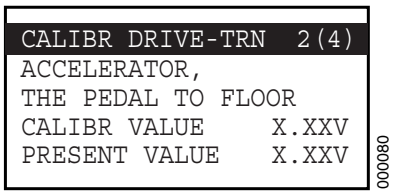
Function: 1.1.2 Accelerator pedal

Component: Accelerator pedal (R690).

3 Release the accelerator pedal.

4 Store the position with function key for Enter.

DRIVE-TRAIN, menu 2



5 **ACCELERATOR, THE PEDAL TO FLOOR**

Description: Setting of maximum acceleration position for Accelerator pedal (R690).

CALIBR VALUE: Indicates current calibrated control value from Accelerator pedal (R690).

PRESENT VALUE: indicates current signal value from Accelerator pedal (R690).

Function: 1.1.2 Accelerator pedal

Component: Accelerator pedal (R690).

6 Press the accelerator pedal down fully and keep it down until the position is stored.

7 Store the position with function key for Enter.

Transmission, calibration

DANGER

Do not leave the machine during calibration. The machine may start to move.

1 Park the machine on level ground, engage neutral position and apply the parking brake. Run the engine at idling speed.

2 Go into the calibration menus and select DRIVE-TRAIN, menu 4, see *Calibration, work instructions page 46*.

3 Check that the oil temperature is 61 °C.

If the oil temperature is too low then go to DRIVE-TRAIN, menu 4.

A. Apply the footbrake so that the machine is stationary.

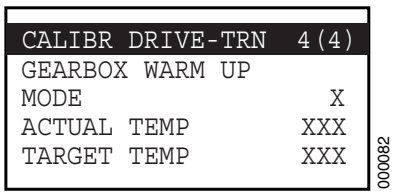
B. Select travel direction forward and apply maximum acceleration for 20 seconds.

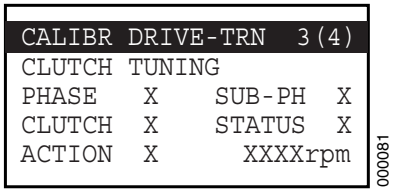
C. Engage neutral position and apply maximum acceleration for 10 seconds, run the engine at idling speed.

D. Repeat steps B and C until the oil is hot.

The engine speed may be reduced towards the end of heating as the oil from the gearbox is too hot. If this occurs, maintain neutral position and maintain an engine speed of 1200 rpm for 20 seconds.

When the temperature is correct MODE is changed from 0 to 1.





4 Select DRIVE-TRAIN, menu 3.

GEARBOX TUNING

Description: Calibration of transmission couplings.

PHASE:	Indicates current phase in the calibration. 0. Pre-filling of coupling 1. Calibration of coupling 4. Calibration complete 5. Calibration incorrect
CLUTCH:	Indicates which clutch shall be calibrated. F. Clutch forward R. Clutch reverse 1. Clutch gear 1 2. Clutch gear 2 3. Clutch gear 3 4. Clutch gear 4
ACTION:	Indicates action from mechanics (in the event of a fault) 0. No action (normal condition if no fault). 1. Increase throttle application. 2. Reduce throttle application. 3. Select neutral position. 4. Select travel direction forward. 5. Stop the vehicle. (Press the brake if the machine starts to move.) 6. Heat the transmission, see step 4. 7. No action, the engine is controlled via the transmission control unit. 8. Keep the accelerator pedal in its current position. 9. Check error codes.
SUB-PH:	Internal value for sub-phase 1 or 0.
STATUS:	Calibration status. 0. Calibration not in progress. 3. Calibration in progress

5 Check that the gear control is in neutral position.

6 Start calibration by pressing Enter

7 Calibration starts (takes approx. 15 minutes) and engine speed is raised to approx. 770 rpm.

The transmission will activate different gears during calibration.

NOTE

If the machine starts to move during calibration then use the footbrake to keep the machine stationary.

IMPORTANT

Calibration can be interrupted at any time by selecting travel direction backward.

8 When the engine speed decreases to idling and PHASE = 4 then calibration is complete.

9 Switch off the ignition to store the values.

Table of Contents 9 Frame, body, cab and accessories

9 Frame, body, cab and accessories

9.1 Controls and instrumentation

Switch, replacement

NOTE

The instructions apply universally for the switches.

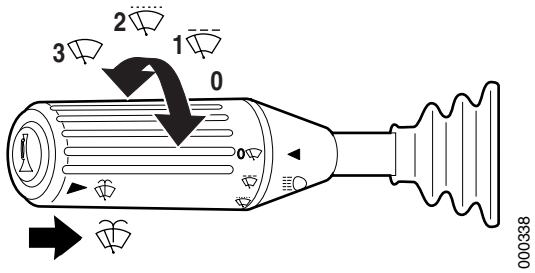
1 Machine in service position, see section *B Safety*.

2 Remove the dashboard panel.

3 Detach the connector from the switch.

4 Remove the switch from the dashboard panel. Bend in the hooks using a screwdriver.

5 Replace the switch.

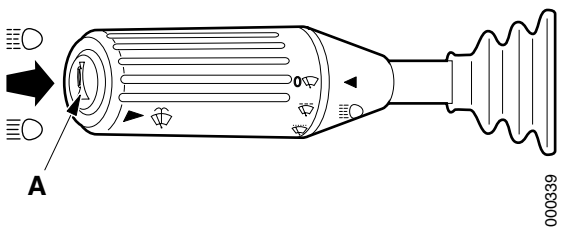


9.1.1 Gear and multi-function lever

Gear and multi-function lever, description

The following functions are handled by the gear and multi-function lever (position 2).

Movement	**Function:**
Forward/ Reverse	Travel direction (for selecting shifting program and travel direction, see section *2 Transmission*).
Inward, handle	Washing of windshield, roof window and rear window. The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.3.1 CAB, menu 1*.
Rotation	Windshield wiper front. 0 – No wiping front windshield, controls slow interval wiping for roof window and rear window. 1 – Slow interval wiping for front windshield, controls slow interval wiping for roof window and rear window. 2 – Fast interval wiping front windshield, controls fast interval wiping for roof window and rear window. 3 – Continuous wiping front windshield, controls fast interval wiping for roof window and rear window. The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.3.2 CAB, menu 2*.



Upward	Light signal
Downward	High beams (on/off) With headlights switched on: Gear and multi-function lever used for changing between high and low beam. With headlights switched off: Gear and multi-function lever used for headlamp flasher. The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.6 LIGHTS, menu 6*.
Inward, button	Horn (position A). The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.3.5 CAB, menu 5*.

Gear and multi-function lever, replacement

1 Separate the dashboard panel.

6 x attaching bolts and 2 bolts to the steering wheel shaft.

Remove the steering wheel, see *Dashboard panel, replacement page 88*.

2 Undo the attaching bolts (2 x hexagonal socket bolts).

3 Detach the connector from KIT.

4 Fit a new lever and refit the dashboard panel.

9.1.2 Indicator light full headlights

Indicator light high beams, description

The light (blue) is activated when the high beams are on.

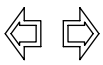
Indicator lamp, high beam, replacement

See section *11 Common electrics,* group *11.5.3.11 Control unit KIT*.

9.1.3 Indicator light direction indicators

Indicator light direction indicators, description

The light (green) is activated when the direction indicators or hazard lights are on.



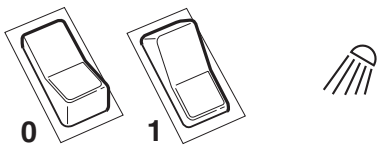
Indicator lamp, direction indicators, replacement

See section *11 Common electrics,* group *11.5.3.11 Control unit KIT*.

9.1.4 Switch work light cab roof

Switch work lights cab roof, description

The switch (orange) for work lights on cab roof and extra work lights on front fender.



Works lights are disconnected during idling. Works lights are turned off after 5 minutes and extra work lights are turned off after 2 minutes. Works lights are activated again at throttle application, shifting or activation of any load handling function.

Position 0 – Lights off.

Position 1 – Lights on.

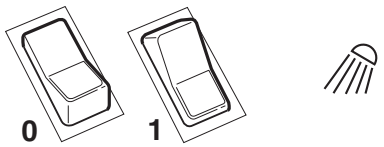
The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.1 LIGHTS, menu 1*.

Switch, work lights cab roof, replacement

See *Switch, replacement page 5*.

9.1.5 Switch work light attachment

Switch work lights attachment, description



000319

Switch (orange) for work lights attachment. Also activates the rear lights and side running lights.

Works lights are disconnected during idling. Works lights are turned off after 5 minutes and extra work lights are turned off after 2 minutes. Works lights are activated again at throttle application, shifting or activation of any load handling function.

Position 0 – Lights off.

Position 1 – Lights on.

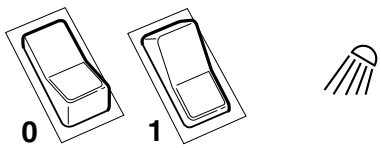
The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.2 LIGHTS, menu 2*.

Switch, work lights attachment, replacement

See *Switch, replacement page 5*.

9.1.6 Switch work light boom

Switch work lights boom, description



000320

Switch (orange) for work lights on boom. Also activates the rear lights and side running lights.

Works lights are disconnected during idling. Works lights are turned off after 5 minutes and extra work lights are turned off after 2 minutes. Works lights are activated again at throttle application, shifting or activation of any load handling function.

Position 0 – Lights off.

Position 1 – Lights on.

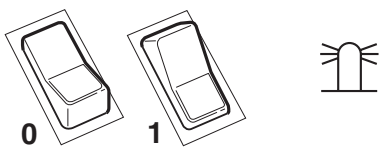
The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.3 LIGHTS, menu 3*.

Switch, work lights boom, replacement

See *Switch, replacement page 5*.

9.1.7 Switch rotating beacon

Switch rotating beacon, description



000321

Switch (green) for rotating beacon used to attract attention in connection with hazards.

Position 0 – Rotating beacon off.

Position 1 – Rotating beacon on.

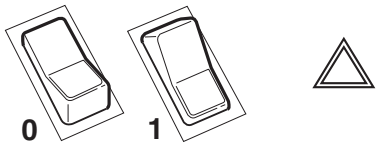
The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.9 LIGHTS, menu 9*.

Switch, revolving beacon, replacement

See *Switch, replacement page 5*.

9.1.8 Switch hazard

Switch flashing hazard lights, description



000322

Switch (red) for flashing hazard lights used to attract attention in connection with parking hazard

Position 0 – Flashing hazard lights off.

Position 1 – Flashing hazard lights on.

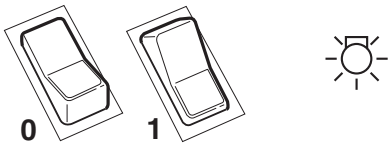
The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.7 LIGHTS, menu 7*.

Switch, hazard lights, replacement

See *Switch, replacement page 5*.

9.1.9 Switch headlights

Switch headlights, description



000323

Switch (green) for headlights. Also activates the rear lights and side running lights.

Position 0 – Headlights off.

Position 1 – Headlights on.

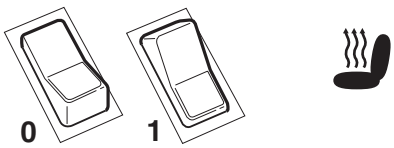
The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.4 LIGHTS, menu 4*.

Switch, headlights, replacement

See *Switch, replacement page 5*.

9.1.10 Switch seat heating

Switch seat heating, description



000324

Switch (orange) for heat in seat.

Position 0 – Seat heating off.

Position 1 – Seat heating on.

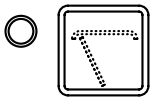
The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.3.8 CAB, menu 8*.

Switch, seat heating, replacement

See *Switch, replacement page 5*.

9.1.11 Switch wiper roof, interval

Switch windshield wiper roof, interval, description



000326

Switch (green) for interval windshield wiper on roof window.

Interval wiper activated/deactivated with press of a key.

NOTE

The interval is controlled by the selected interval for front windshield.

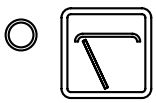
The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.3.4 CAB, menu 4*.

Switch, windscreen wiper, roof, interval, replacement

See section *11 Common electrics,* group *11.5.3.11 Control unit KIT*.

9.1.12 Switch wiper roof, continuous

Switch windshield wiper roof, continuous, description



000327

Switch (green) for continuous windshield wiper on roof window.

Wiper activated/deactivated with press of a key.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.3.4 CAB, menu 4*.

Switch, windscreen wiper, roof, continuous, replacement

See section *11 Common electrics,* group *11.5.3.11 Control unit KIT*.

9.1.13 Switch interior lighting

Switch interior lighting, description

000330

Switch (green) for interior lighting in cab.

Lighting is activated/deactivated with press of a key.

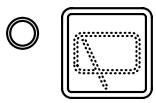
The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.12 LIGHTS, menu 12*.

Switch, interior lighting, replacement

See section *11 Common electrics,* group *11.5.3.11 Control unit KIT*.

9.1.14 Switch wiper rear, interval

Switch windshield wiper rear, interval, description



000328

Switch (green) for interval windshield wiper on rear window.

Interval wiper activated/deactivated with press of a key.

NOTE

The interval is controlled by the selected interval for front windshield.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.3.3 CAB, menu 3*.

Switch, windscreen wiper, rear, interval, replacement

See section *11 Common electrics,* group *11.5.3.11 Control unit KIT*.

9.1.15 Switch wiper rear, continuous

Switch windshield wiper rear, continuous, description

000329

Switch (green) for continuous windshield wiper on rear window.

Wiper activated/deactivated with press of a key.

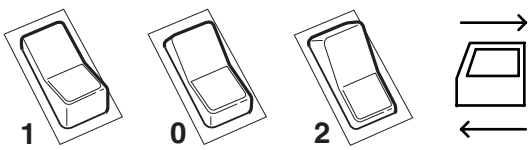
The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.3.3 CAB, menu 3*.

Switch, windscreen wiper, rear, continuous, replacement

See section *11 Common electrics,* group *11.5.3.11 Control unit KIT*.

9.1.16 Switch hydraulic longitudinal displacement of cab

Switch hydraulic sliding cab, description



000332

Switch (green) for hydraulic sliding cab. Rocker switch. Operator's door(s) must be closed and emergency stop not activated.

Position 1 – Cab slides forward. Switch must be pressed down during the entire movement.

Position 0 – Cab is stationary.

Position 2 – Cab slides backward. Switch must be pressed down during the entire movement.

NOTE

The cab can only be moved if the doors are closed.

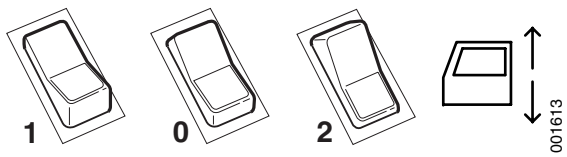
The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.2 SLIDING-CAB, menu 1*

Switch, hydraulic sliding cab, replacement

See *Switch, replacement page 5*.

9.1.17 Switch hydraulic vertically adjustable cab

Switch hydraulic cab lift and lowering, description



Switch (green) for hydraulic cab lift and lowering. Rocker switch. Operator's door(s) must be closed and emergency stop not activated.

Position 1 – Cab is lifted. Switch must be pressed down during the entire movement.

Position 0 – Cab is stationary.

Position 2 – Cab is lowered. Switch must be pressed down during the entire movement.

NOTE

The cab can only be moved if the doors are closed.

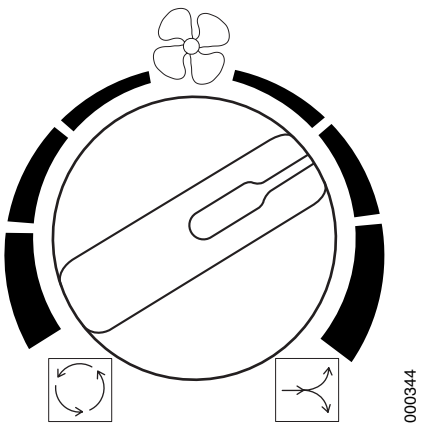
The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.2 SLIDING-CAB, menu 1*

Switch, hydraulic cab lift and lowering, replacement

See *Switch, replacement page 5*.

9.1.18 Control fan and recirculation

Control fan and recirculation, description



The control knob directs the variable setting of fresh air intake and air circulation to the cab.

The fan is off in the middle position (marked with a stop). Turn clockwise to increase fan speed with open air inlets, thus increasing fresh air into the cab. Turn anticlockwise to increase fan speed with closed air inlets, thus increasing air circulation in the cab.

NOTE

The EEC or EHC can automatically change the recirculation in order to be able to reach the desired cab temperature in the current ambient temperature conditions. The damper can be controlled manually by activating the bypass, see section 8 Control system, group 8.1.3 Switch by-passing.

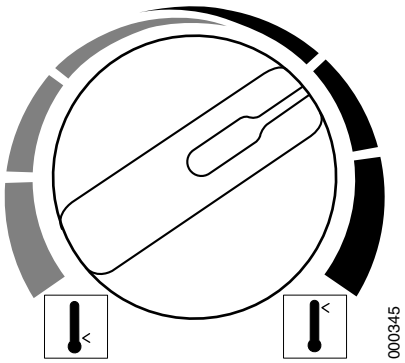
The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.4.5 CLIMATE, menu 5*.

Controls, fan and recirculation, replacement

1 Machine in service position, see section *B Safety*.
2 Remove the dashboard panel.
3 Detach the controls assembly from the dashboard panel. There are controls for the heating unit / climate control unit in the controls assembly.
4 Detach the connector from the controls.
5 Remove the controls from the controls assembly.
6 Replace the controls.

9.1.19 Control heating

Control heating, description



The control knob handles the reference value for cab temperature. The control has the following temperature ranges:

- Far left (anticlockwise) gives max. cooling and no temperature control.
- Straight to left gives 16 °C.
- Middle position gives 22 °C.
- Straight to right gives 28 °C.
- Far right (clockwise) gives max. heat and no temperature control.

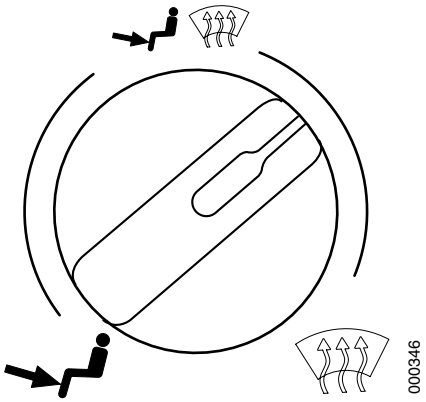
The heating system cannot supply colder air than that of the ambient air temperature.

⊞ The climate control unit cools the cab air to set temperature.

The signal can be checked from the diagnostic menu, *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.4.1 CLIMATE, menu 1* and group *8.4.4.5 CLIMATE, menu 5*.

Heating controls, replacement

See *Controls, fan and recirculation, replacement page 13*.



9.1.20 Control defroster/cab

Controls defroster/cab, description

The control knob directs the distribution of fresh air to the cab. Air is distributed to the lower cab (legs), the cab space (panel) and defroster (window). Left position for lower cab space, middle position for cab space and right position for defroster.

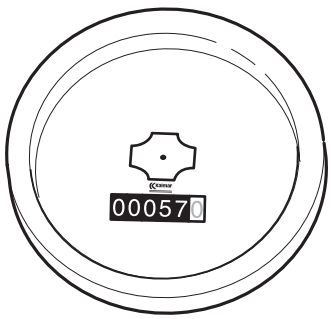
The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.4.5 CLIMATE, menu 5*.

Controls, defroster/cab, replacement

See *Controls, fan and recirculation, replacement page 13*.

9.1.21 Hour meter

Hour meter, description



The hour meter shows the number of hours that the engine has been running.

The meter is used to determine when the machine is due for periodic maintenance. All times in periodic maintenance are based on the machine's operating time in hours.

9.1.22 Switch travel direction indicator

Switch direction indicators, description

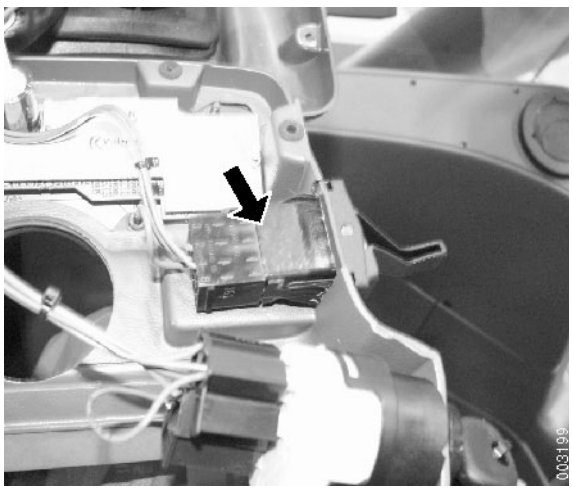
Switch, direction indicators, activates the direction indicator, the switch is located on the right-hand side of the dashboard panel, see *Maintenance manual DRF 400–450*, section *9 Frame, body, cab and accessories*, group *9.1 Instruments and controls*.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.7 LIGHTS, menu 7*.

Switch, direction indicators, replacement

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

2 Remove the steering wheel and separate the dashboard panel.



3 Detach the wiring harness from the direction indicator.

4 Press the clips on the direction indicator together and detach it from the dashboard panel.

5 Replace the direction indicator, fitting it in the reverse order.

9.2 Protection and emergency equipment

9.2.1 Emergency stop device

Emergency stop, description

See section *11 Common electrics*, group *11.1.3 Switch emergency stop*.

9.2.2 Seat belt

Seat belt, description

The seat belt is a two or three point type depending on which seat the machine is equipped with. The seat belt is mounted on the seat.

9.2.3 Fire extinguisher

Fire extinguisher, description

The fire extinguisher is located by the steps on the left frame member. There are user instructions on the fire extinguisher.

9.2.4 Seat buzzer

Seat buzzer, description

See *Sensor, operator in seat, description page 19*.

9.3 Seat

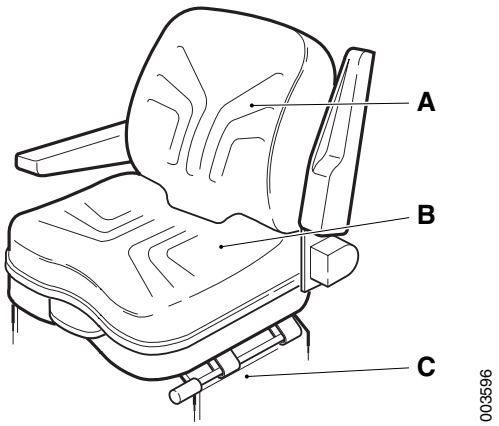
Seats, description

The seats components are:

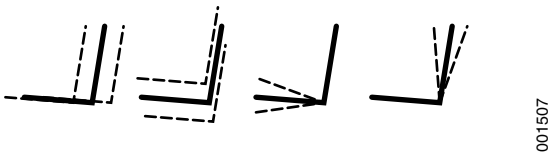
A. Backrest cushion (and heating element ⊕).

B. Seat cushion (and heating element ⊕).

C. Bumper (and compressor and air suspension ⊕).



Driver's seat, Isringhausen



Driver's seat, Bege

9.3.1 Seat cushion

Seat cushion, description

The function of the seat cushion is to provide good comfort for the operator. Beneath the seat cushion is the driver's seat frame and buzzer switch. Heating elements may be included (⊕).

For location, see *Seats, description page 17*.

9.3.2 Back cushion

Back cushion, description

The function of the backrest cushion is to provide good comfort for the operator. Beneath the backrest cushion is the driver's seat frame. Heating elements may be included (⊕).

For location, see *Seats, description page 17*.

9.3.3 Heating coils

Heating coils, description

The function of the heating elements is to warm the backrest and seat cushions in the driver's seat.

For location, see *Seats, description page 17*.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.3.8 CAB, menu 8*.

9.3.4 Shock absorbers

Bumper, description

The bumpers are integrated in the suspension unit and are self-adjusting, that is, adjust automatically to the operator's weight.

For location, see *Seats, description page 17*.

9.3.5 Air suspension

Air suspension, description

The air suspension driver's seat consists of a seat with rubber bellows and a compressor. The air suspension is self-adjusting, i.e. it adjusts automatically to the operator's weight. The compressor provides air to the suspension unit.

For location, see *Seats, description page 17*.

For user instructions, see *Operator's manual DRF 400–450*.

9.3.5.1 Compressor air-suspended seat

Compressor air-suspended seat, description

The compressor is part of the air suspension driver's seat and is located inside the seat's suspension unit.

For location, see *Seats, description page 17*.

9.3.6 Mechanical seat adjustment

Mechanical seat adjustment, description

The seat adjustment is fully mechanical and is adjusted by the operator with different controls to obtain a good seating position.

For user instructions, see *Operator's manual DRF 400–450*.

9.3.7 Passenger seat

Passenger seat, description

⊞

The passenger seat is collapsible (vertically) and is located on the left-hand side of the driver's seat.

9.3.8 Armrest

Arm rest, description

The arm rest is fixed to the backrest and is individually adjustable vertically (around the attachment point). Depending on options there is also an arm rest for the left-hand side:

- Mini-wheel ⊞
- Joystick control ⊞

9.3.9 Sensor driver in seat

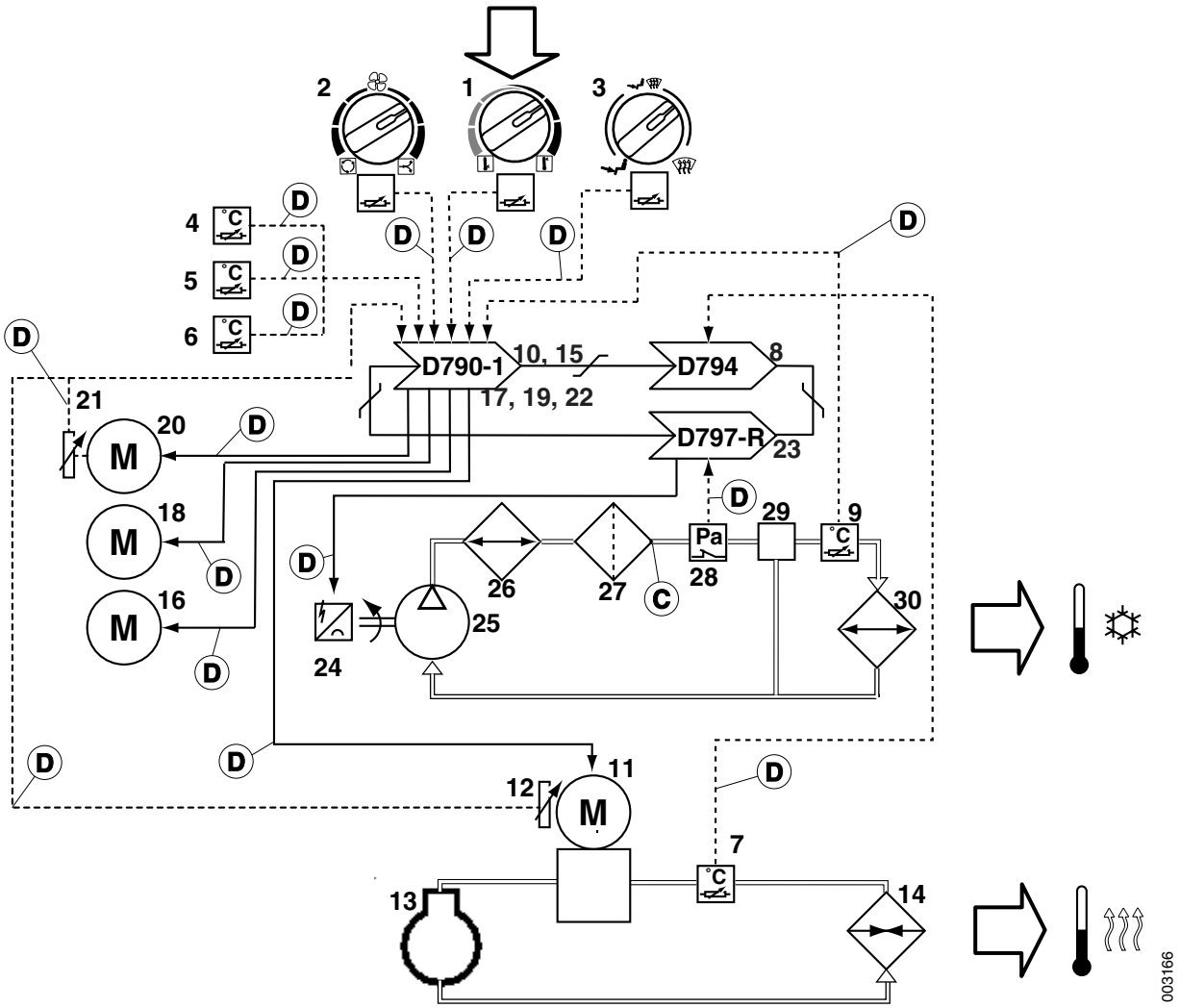
Sensor, operator in seat, description

Sensor, operator in seat, senses if the driver's seat suspension is depressed which indicates for the control system that the operator is sitting in the driver's seat. This is used to give an indication to the control system if the operator leaves the machine without applying the parking brake.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.3.6 CAB, menu 6*.

9.4 HVAC

Heating, ventilation and air conditioning, function description



Pos	Explanation	Signal description	Reference
1	Control for heat sends voltage signal proportional to position for turning of the control to Control unit, cab (D790-1).	Left: U = 0.5–2.0 V Middle: U = 2.0–3.0 V Right: U = 3.0–4.5 V	*Control heating, description page 13*. Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.4.1 CLIMATE, menu 1*.
2	The control for fan/recirculation controls air inlet to the cab. The signal goes to control unit cab (D790-1) and is proportional to the position for turning of the control.	Left: U = 0.5–2.0 V Middle: U = 2.0–3.0 V Right: U = 3.0–4.5 V	*Control fan and recirculation, description page 12*. Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.4.6 CLIMATE, menu 6*.

Pos	Explanation	Signal description	Reference
3	The control for defroster/cab controls air flow in the cab. The signal goes to control unit, cab (D790-1) and is proportional to the position for turning of the control.	Left: U = 0.5–2.0 V Middle: U = 2.0–3.0 V Right: U = 3.0–4.5 V	*Controls defroster/cab, description page 14*.
4	Sensor cab temperature sends voltage signal proportional to temperature to control unit (D790-1).	R = 10 kΩ at 25 °C	*Sensor, cab temperature, description page 47*.
5	Sensor temperature outlet fan sends voltage signal proportional to temperature to control unit (D790-1).	R = 10 kΩ at 25 °C	*Sensor, temperature outlet fan, description page 46*.
6	Sensor outdoor temperature sends voltage signal proportional to temperature to control unit (D790-1).	R = 10 kΩ at 25 °C	*Sensor, ambient temperature, description page 48*.
7	Sensor engine temperature sends voltage signal proportional to engine temperature to Control unit engine (D794).	-	Section *1 Engine*, group *1 Engine*.
8	Control unit engine (D794) sends engine temperature in cooling system on the CAN-bus.	Checked by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*.
9 ⊕	Sensor temperature in refrigerant circuit sends voltage signal proportional to temperature to control unit (D790-1).	R = 10 kΩ at 25 °C	*Sensor, temperature in refrigerant, description page 41*.
10	Control unit cab (D790-1) sends voltage signal to water valve to control heat flow from the engine's cooling system (engine must be on).	Checked by control system, error shown with error code.	*Water valve, description page 35*.
11	The water valve controls the water flow in the cooling system. It decides how much heat is given off to the cab.	-	*Water valve, description page 35*.
12	The water valve's opening (%) is sent back to control unit (D790-1). This gives information for controlling the water valve's position.	U = 0.5–4.5 V	*Water valve, description page 35*.
13	The engine develops heat during operation. It is dissipated (cooled) with the cooling system. The heat from the cooling system is used to warm the cab's air.	-	Section *1 Engine*, group *1.7 Cooling system*.
14	The heat exchanger for heat adds heat to the cab air. The heat is transmitted from the engine’s cooling system to the air in the cab.	-	*Heat exchanger heat, description page 32*.
15	Control unit cab (D790-1) sends voltage signal to actuator recirculation (M612).	Checked by control system, error shown with error code.	*Fresh air filter or recirculation damper, description page 27*.
16	Actuator recirculation (M612) sets the fresh air or recirculation damper in the desired position.	Checked by control system, error shown with error code.	*Fresh air filter or recirculation damper, description page 27*.

Pos	Explanation	Signal description	Reference
17	Control unit cab (D790-1) supplies voltage to fan motor heat (M657).	Checked by control system, error shown with error code.	*Cab fan, description page 29*.
18	Fan motor heat (M657) increases the air flow in the cab.	Checked by control system, error shown with error code.	*Cab fan, description page 29*.
19	Control unit cab (D790-1) sends voltage signal to damper motor (Y672).	Checked by control system, error shown with error code.	*Air distributor, description page 44*.
20	Damper motor (Y672) sets the air distributor in the desired position.	Checked by control system, error shown with error code.	*Air distributor, description page 44*.
21	Feedback from motor for air distributor. This gives information for controlling the damper's position.	U = 0.5–4.5 V	*Air distributor, description page 44*.
22 ⊕	If the air to the cab needs to be cooled, then Control unit cab (D790-1) sends message on the CAN-bus that the compressor has to be activated.	Checked by control system, error shown with error code.	
23 ⊕	Control unit engine (D794) supplies voltage to the magnet clutch on the compressor.	Checked by control system, error shown with error code.	*Compressor, description page 37*.
24 ⊕	Magnet clutch that deactivates or activates the compressor. Signal is sent from control unit (D797-R).	U = 24 V	*Compressor, description page 37*.
25 ⊕	The compressor draws gaseous refrigerant from the evaporator, compresses it, and forces it on to the condenser.	-	*Compressor, description page 37*.
26 ⊕	The condenser cools the refrigerant. The gaseous refrigerant condenses to liquid state and is pumped further on in the circuit.	-	*Condenser, description page 38*.
27 ⊕	The moisture filter absorbs any moisture from the cooling circuit. The fluid reservoir stores the refrigerant.	-	*Moisture filter, description page 39*.
28 ⊕	The pressure monitor cuts off the current to the compressor's magnet clutch if the pressure in the system is abnormally high or low.	U = 24 V	*Pressure monitor, description page 40*.
29 ⊕	The expansion valve controls the amount of refrigerant that is let into the evaporator. If the temperature in the evaporator's outlet pipe increases, then the expansion valve's addition of refrigerant increases so that heat dissipation in the evaporator increases.	-	*Expansion valve, description page 41*.

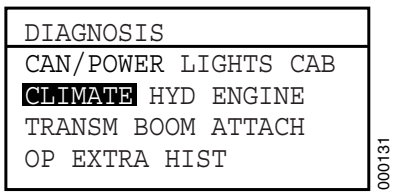
Pos	Explanation	Signal description	Reference
30 ⊕	The heat exchanger for cooling dissipates heat from the cab air. The heat is transmitted from the air to the refrigerant, and the refrigerant converts to a gaseous state.	-	*Heat exchanger cooling, description page 43*.

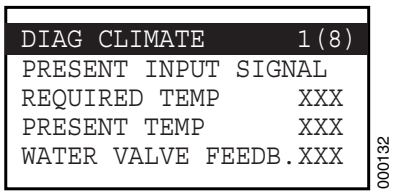
Heating, ventilation and air conditioning, checking

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

2 Go in under "Diagnosis" 54145.

3 Select CLIMATE.



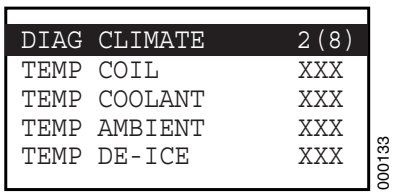


4 On page one, check the required temperature value, interior temperature sensor and the water valve.

REQUIRED TEMP must be 160 (16.0 °C) for max. cooling and 280 (28.0 °C) for max. heating. Checked with the temperature control.

PRESENT TEMP is the temperature inside the cab. This is measured by the sensor located down to the left on the dashboard (behind the rubber grommet). Blowing trough the hole increases the value.

WATER VALVE FEEDB. must show 0 (closed) when the required temperature is 160 and 100 (open) when the required temperature is 280. The water valve is located under the cab.



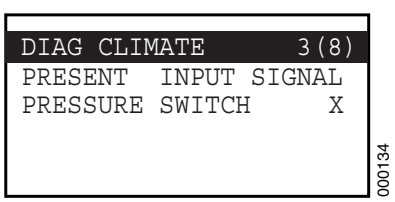
5 On page two, check the temperature sensors and that they indicate plausible values.

TEMP COIL is the temperature of the air in the nozzles. The sensor is located inside the air distributor.

TEMP COOLANT is the engine's temperature and is measured down on the engine.

TEMP AMBIENT is the external temperature and is located on the rear edge of the cab roof.

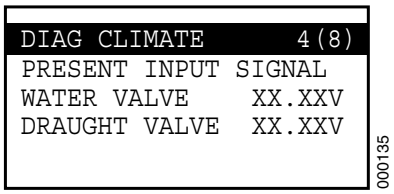
TEMP DE-ICE is the cooling circuit temperature. If the compressor is activated then the value will be low. Alternatively, if heating has been selected and the compressor is deactivated then the value will be almost the same as TEMP COIL. The sensor is located on the cooling circuit inlet pipe to the element.



6 On page three, check that the cooling circuit is filled.

PRESSURE SWITCH 0 = not filled 1 = filled.

The sensor is located on the dryer filter which is fitted right rear in the frame.

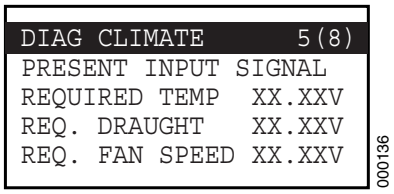


7 On page four, check the water valve and the air distributor damper.

WATER VALVE must operate between 1.0-1.24 V and 2.95-3.2 V. This is checked by turning the temperature control from min. to max.

DRAUGHT VALVE must operate in the working range 1.0-4.0 V. The difference between min. and max. must be approx. 1 V. This is checked by turning the air distributor control from floor to windscreen. At the same time, check manually that the damper moves as it should.

WARNING! RISK OF CRUSHING!



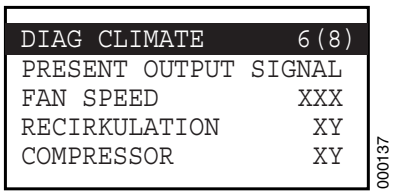
8 On page five, check heating/cooling, air distributor and fan controls.

This is checked by the controls being turned from min. to max.

REQUIRED TEMP must operate between 0.3-1.1 V and 3.9-4.7 V.

REQ. DRAUGHT must operate between 0.3-1.1 V and 3.9-4.7 V.

REQ. FAN SPEED must operate between 0.3-1.1 V and 3.9-4.7 V. In the fan's zero position (straight up) the value must be 2.2-2.8 V.

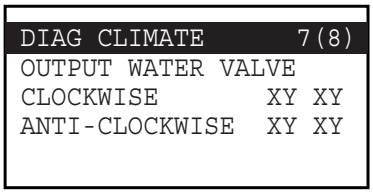


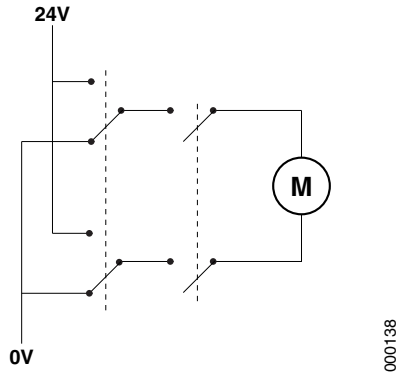
9 On page six, check the fan speed, the recirculation damper and the compressor.

FAN SPEED is checked by turning the fan control from intermediate position to one direction and then to the other direction. The value must increase from 0 to 255. This applies to both directions.

RECIRCULATION is tested by holding in the bypass button (the joystick panel) while turning the fan control to the left (recirculation). The display should show 11. Check that the damper moves correctly by removing the fresh air filter in front of the climate cover and checking manually.

COMPRESSOR is checked by selecting max. cooling on the temperature control. After approx. 45 seconds the compressor will be activated and then 11 is shown in the display. NOTE: Can only be tested when the system is filled.



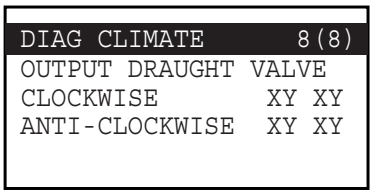


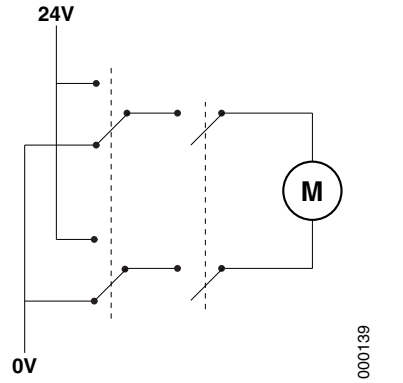
10 On page seven, check the direction selector on the water valve.

CLOCKWISE Turning the temperature control clockwise should show 11 11 after CLOCKWISE and 00 11 after ANTI-CLOCKWISE.

ANTI-CLOCKWISE Turning the temperature control anticlockwise should show 00 11 after CLOCKWISE and 11 11 after ANTI-CLOCKWISE.

NOTE: The ones are only active for a short time.





11 On page eight, check the direction selector on the air distributor valve.

CLOCKWISE Turning the air distributor control clockwise should show 00 11 after CLOCKWISE and 11 11 after ANTI-CLOCKWISE.

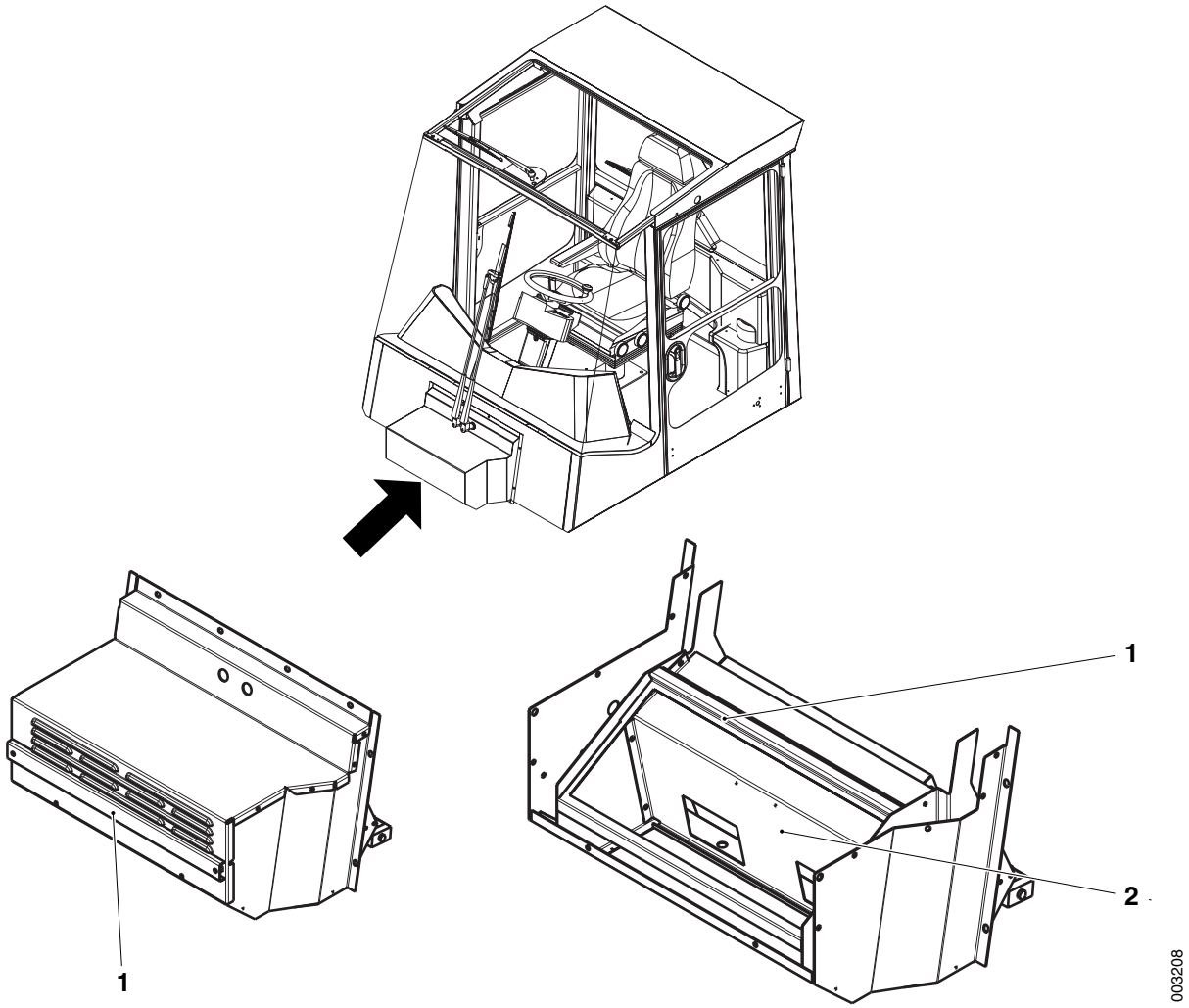
CLOCKWISE Turning the air distributor control anticlockwise should show 11 11 after CLOCKWISE and 00 11 after ANTI-CLOCKWISE.

NOTE: The ones are only active for a short time.

9.4.1 Fresh air filter

Fresh air filter, description

The fresh air filter is located under the cover in the external unit for fresh air inlet to the cab, in front of the cab fan. A finer filter can be selected (⊕) but then air flow is reduced.



Fresh air inlet cab

1. Fresh air filter
2. Fresh air filter and recirculation damper

Fresh air filter, replacement

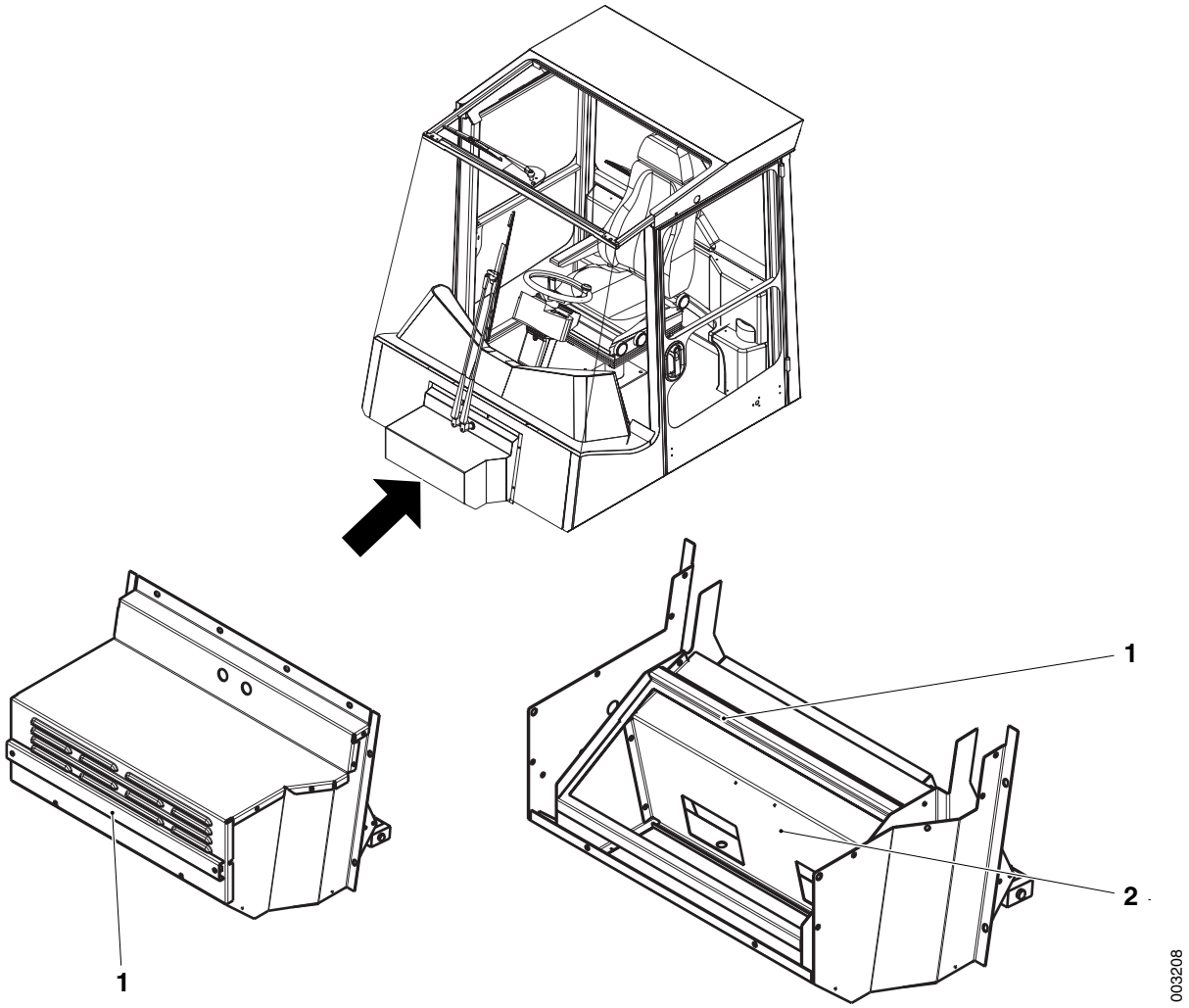
See *Maintenance manual DRF 400–450*.

9.4.2 Fresh air damper or recirculation damper

Fresh air filter or recirculation damper, description

The damper is controlled electrically and controls the air between fully open for fresh air to recirculation of air. The damper is located in the external unit for fresh air inlet to the cab.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.4.6 CLIMATE, menu 6*.



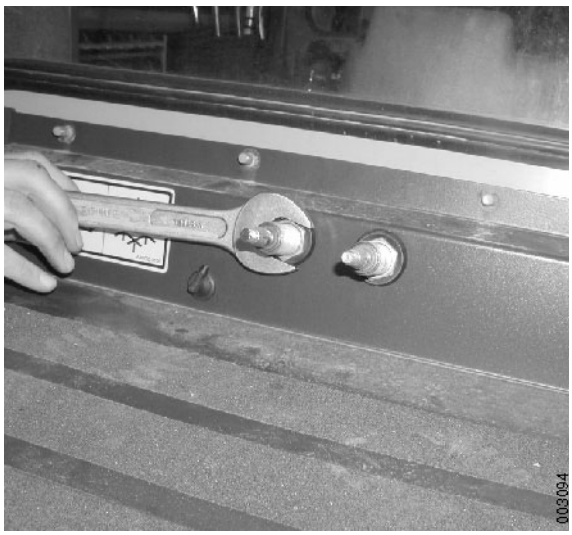
Fresh air inlet cab

1. Fresh air filter
2. Fresh air filter and recirculation damper

Motor, fresh air filter or recirculation damper, replacement

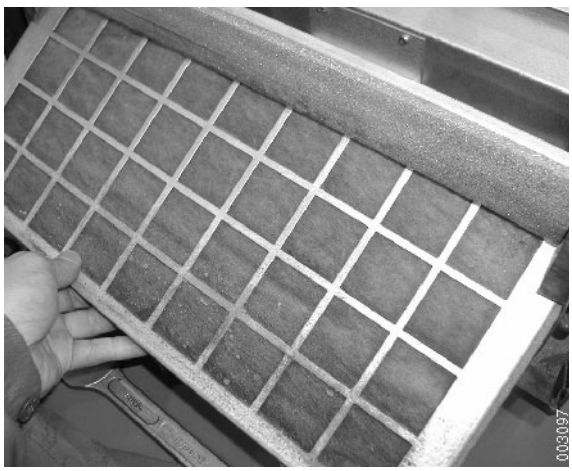
1 Machine in service position, see section *B Safety*.

2 Remove the wiper arms.



3 Remove the nuts which hold the wiper motor in the protective plate.

4 Remove the protective plate.



5 Remove the fresh air filter.

6 Remove the bolts which secure the arm and motor in the plate.

7 Detach the connector from the motor.

8 Replace the motor.

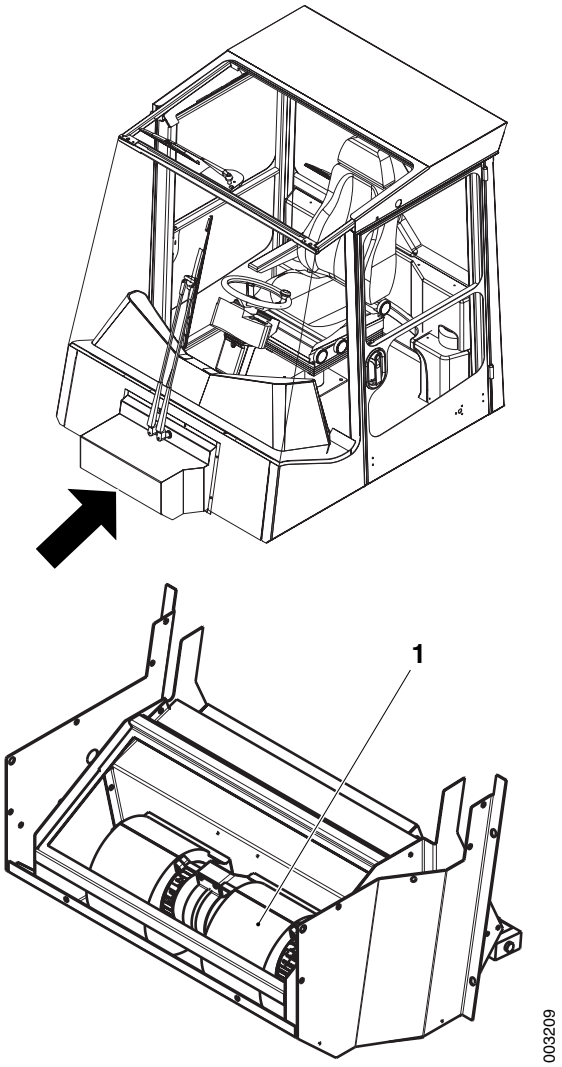
9 Fit in the reverse order. Tighten the wiper arm with 16-20 Nm.

9.4.3 Cab fan

Cab fan, description

The cab fan is located in the external unit for fresh air inlet to the cab. The fan consists of two single fans.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.4.6 CLIMATE, menu 6*.



Fresh air inlet cab
1. Cab fan

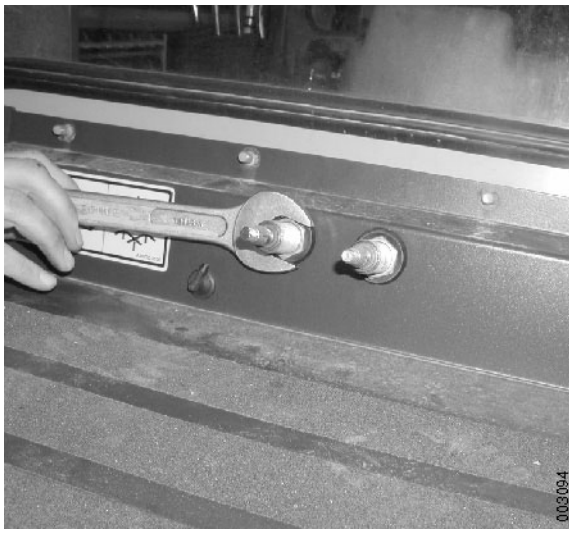
Cab fan, replacement

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

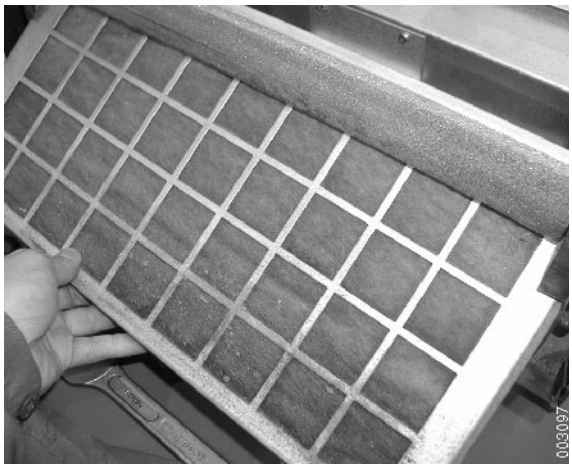
2 Remove the wiper arms.

3 Remove the bolts which secure the wiper motor in the protective plate.

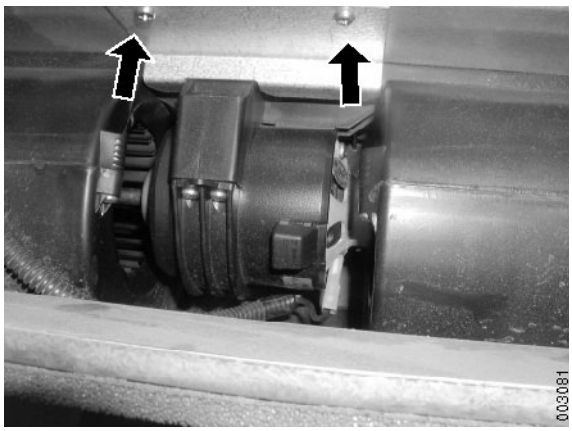
4 Remove the protective plate.



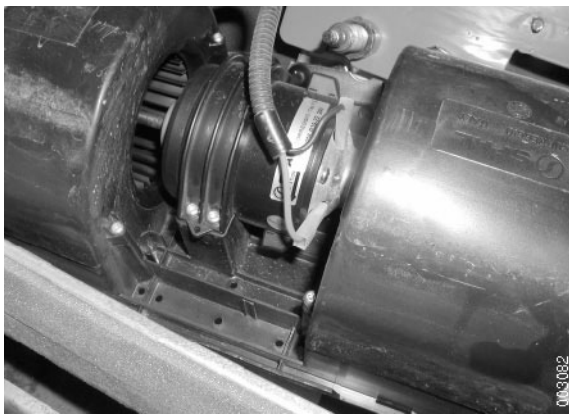
5 Detach the washer hose from the protective plate.



6 Remove the fresh air filter.



7 Remove the bolts which secure the plate and cab fan.

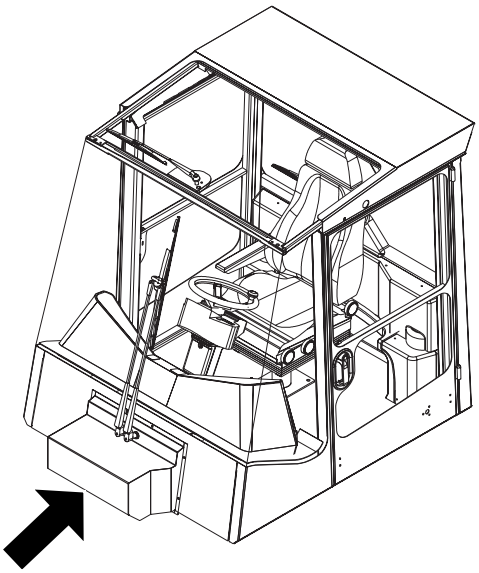


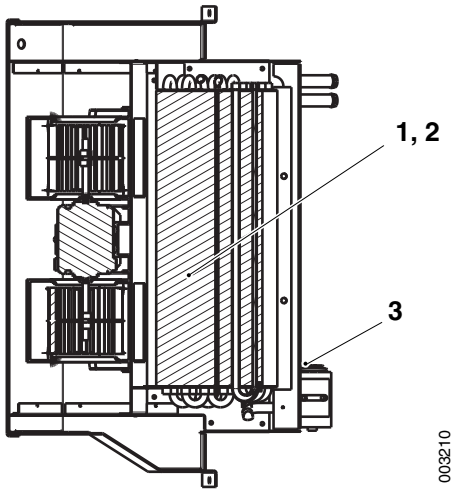
8 Detach the connector from the cab fan.

9 Remove the cab fan.

10 Replace the cab fan.

11 Fit in the reverse order. Tighten the wiper arm with 16-20 Nm.





Fresh air inlet cab
1. Heat exchanger, heating
2. Heat exchanger cooling and sensor for refrigerant temperature ⊕
3. Expansion valve

9.4.4 Heat exchanger heat

Heat exchanger heat, description

The heat from the engine's coolant is transmitted to the cab via the heat exchanger. The heat exchanger is located behind the fan in the external unit for fresh air inlet to the cab.

Heat exchanger, cooling/heating, replacement

NOTE

Requires special authorisation.

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

2 Drain the AC system of R134a refrigerant.

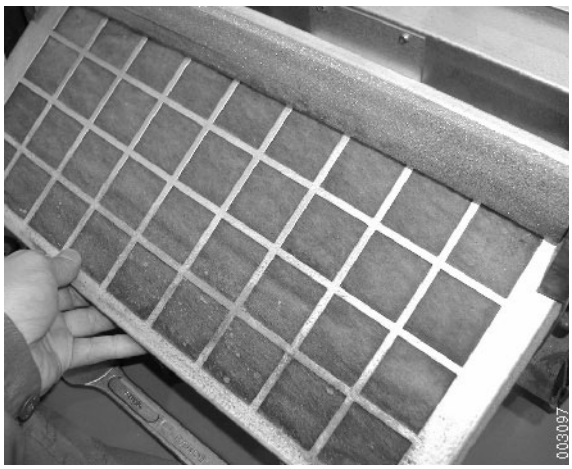
3 Detach the AC system hoses and the coolant hoses.

4 Remove the wiper arms.

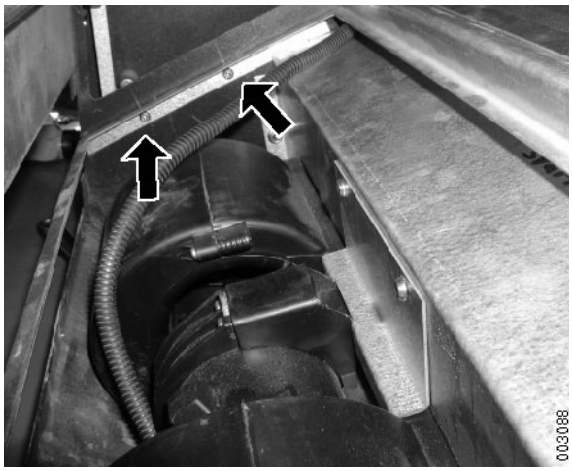
5 Remove the nuts which hold the wiper motor in the protective plate.

6 Remove the protective plate.

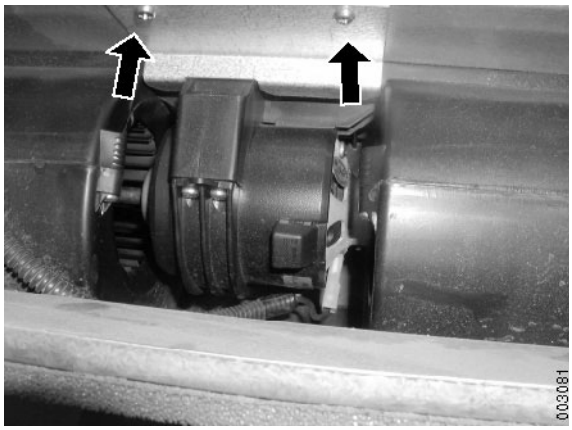
7 Detach the washer hose from the protective plate.



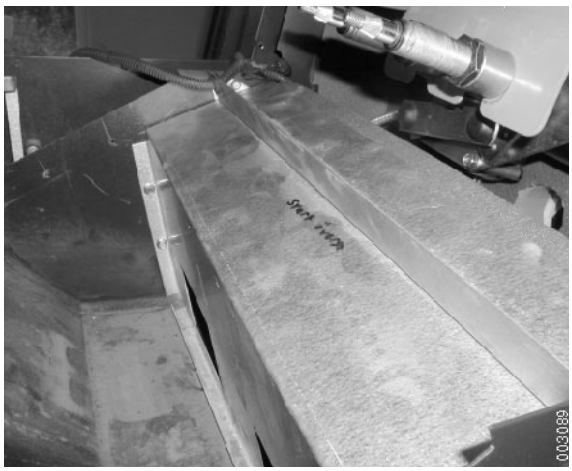
8 Remove the fresh air filter.



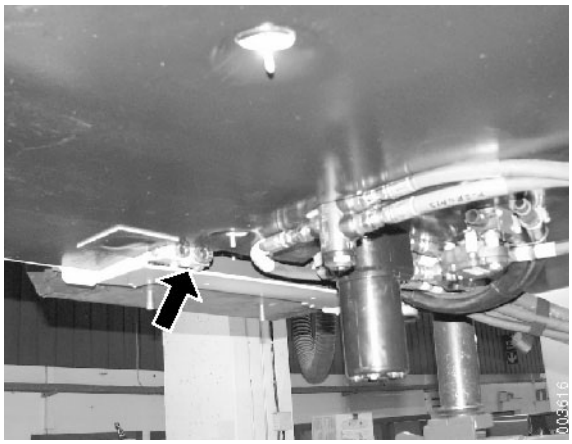
9 Remove the plate frame.



10 Remove the cab fan.



11 Remove the heat exchanger cover plate.



12 Detach all fluid inlets and outlets from the heat exchanger.

13 Lift out the heat exchanger carefully.

14 Change the heat exchanger.

15 Fit in the reverse order. Tighten the wiper arm with 16-20 Nm.

16 Refill the AC system with R134a refrigerant.

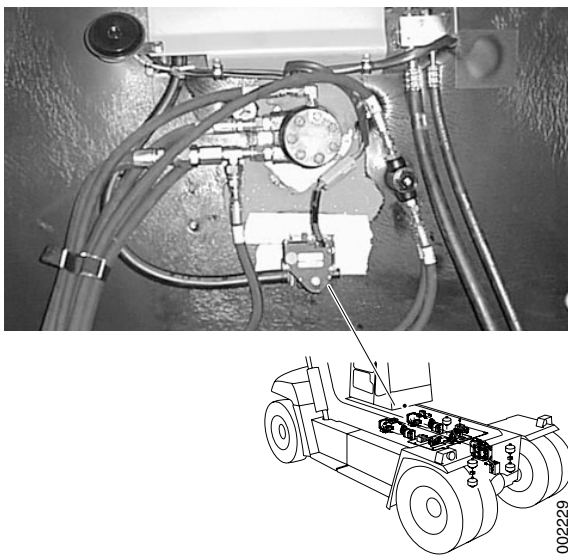
For volume, see section *F Technical data*.

9.4.5 Water valve

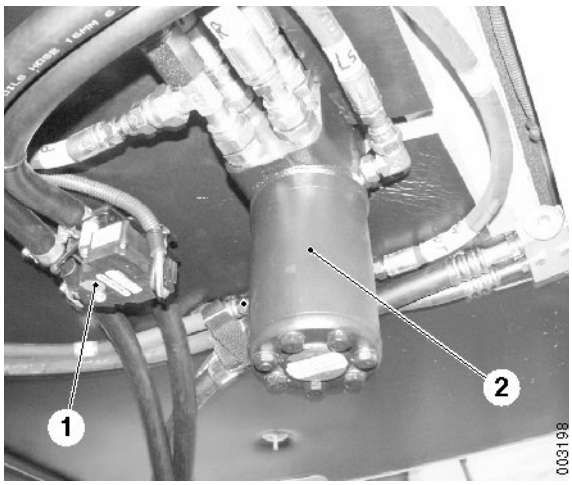
Water valve, description

The water valve controls the climate control unit's capacity for heating from 0 (closed valve) to 100 % (open valve). The water valve is electrically controlled.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.4.1 CLIMATE, menu 1*, *8.4.4.4 CLIMATE, menu 4* and *8.4.4.7 CLIMATE, menu 7*.



Water valve position under cab floor (from below)



1. Water valve
2. Steering valve

Water valve, replacement

1 Machine in service position, see section *B Safety*.
2 Detach the connector from the water valve.
3 Stop the flow of fluid to and from the water valve using hose pliers.
4 Detach the coolant hoses from the water valve.
5 Remove the water valve from the cab floor.
6 Change the water valve.
7 Fit in the reverse order.
8 Check the coolant level.

9.4.6 Sensor engine temperature

Sensor, engine temperature, description

Sensor, coolant temperature, senses the engine coolant temperature, see section *1 Engine,* group *1.7.9 Sensor coolant temperature*.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.4.2 CLIMATE, menu 2*

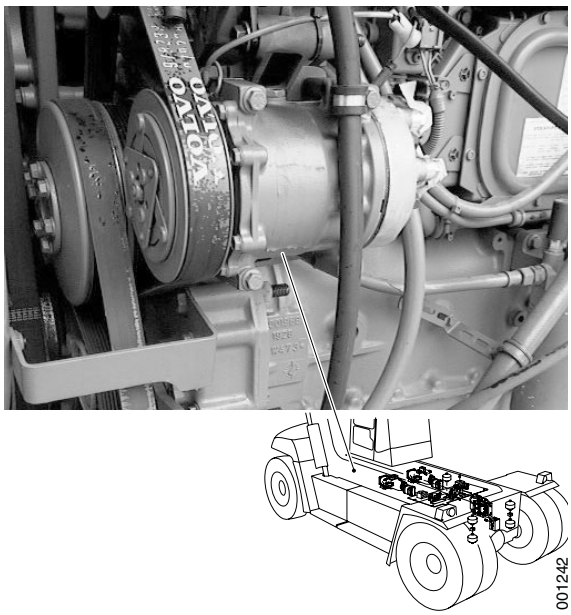
Sensor, engine temperature, replacement

See section *1 Engine,* group *1.7.9 Sensor coolant temperature*.

For replacement, see *supplier documentation engine*.

9.4.7 AC-compressor

Compressor, description



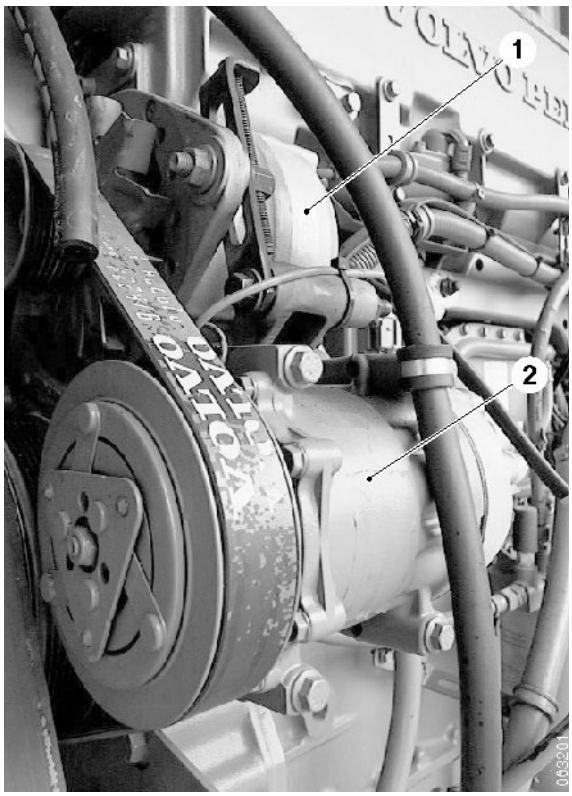
Example, engine alternative Volvo

The compressor drives the unit by working as a pump. It draws in cold, low-pressure gas from the evaporator, compresses the gas which then becomes warm, and then forces out high-pressure gas to the condenser.

The compressor is driven by V-belts directly by the machine's engine. Activation and deactivation of the compressor is handled by an electromagnet clutch, controlled by a thermostat.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.4.6 CLIMATE, menu 6*.

Compressor, replacement



1. Alternator, belt tensioner
2. Compressor

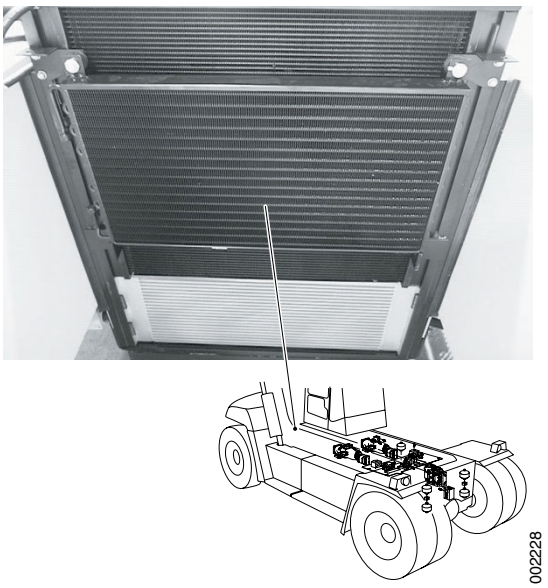
NOTE

Requires special authorisation.

1 Machine in service position, see section *B Safety*.
2 Drain the AC system of R134a refrigerant.
3 Detach the coolant hoses from the compressor.
4 Loosen the belt tensioner so that the compressor belt is released.
5 Remove the bolts which secure the compressor.
6 Replace the compressor.
7 Fit in the reverse order.
8 Refill the AC system with R134a refrigerant.
For volume, see section *F Technical data*.

9.4.8 Condenser

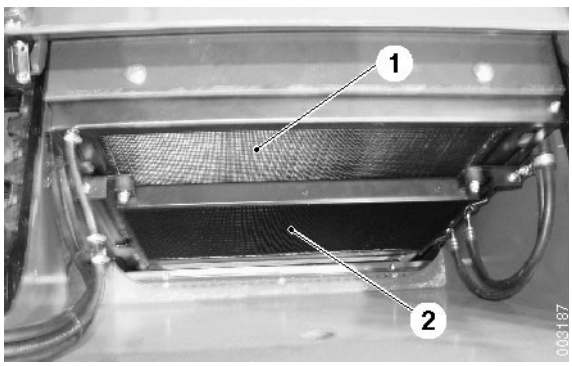
Condenser, description



The condenser is located on the radiator in the engine compartment. The function of the condenser is to convert the hot, high-pressure gas from the compressor to liquid form. Pipes and cooling fins in the condenser battery absorb the heat, which is dissipated with a fan.

The refrigerant temperature in the condenser varies from approx. 50 °C to 70 °C, and the pressure between 12 and 14 bar, depending on the ambient temperature and air flow through the condenser. When the refrigerant has condensed to liquid, it is forced on to the fluid reservoir/filter dryer.

Condenser, replacement



1. Radiator
2. Condenser

NOTE

Requires special authorisation.

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

2 Drain the AC system of R134a refrigerant.

3 Detach the inlet and outlet hoses from the condenser.

4 Remove the bolts which secure the condenser at the top edge and lift the condenser out in a suitable way.

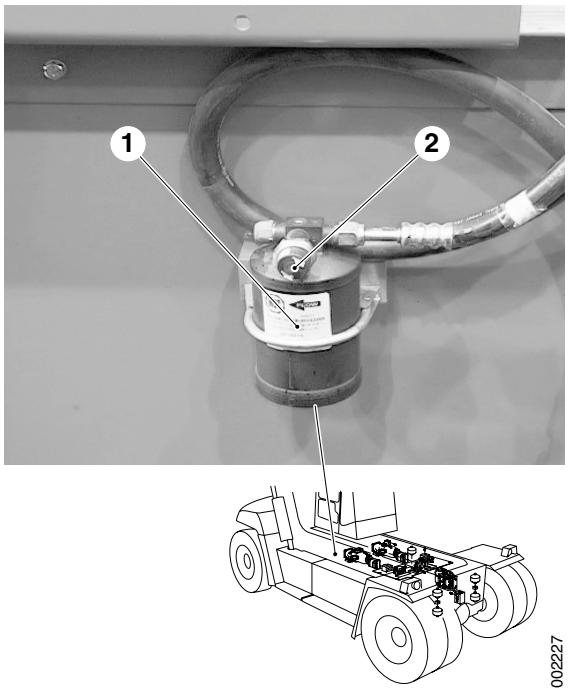
5 Replace the condenser, fitting it in the reverse order.

6 Refill the AC system with R134a refrigerant.

For volume, see section *F Technical data*.

9.4.9 Humidity filter

Moisture filter, description



1. Fluid reservoir moisture filter
2. Pressure monitor

The moisture filter collects the liquid refrigerant, binds moisture and filters impurities. The reservoir functions as an expansion tank in the cooling circuit.

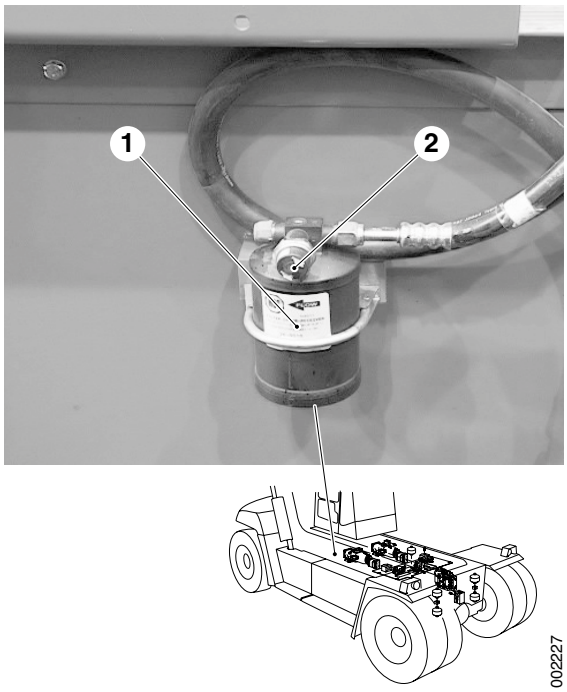
When the refrigerant has passed through the dryer in the bottom of the fluid reservoir, it rises through a standpipe. Through a sight glass, it is possible to check that flow is without bubbles and that the system is adequately filled with refrigerant.

Moisture filter, replacement

See *Maintenance manual DRF 400–450*.

9.4.10 Pressure monitor

Pressure monitor, description

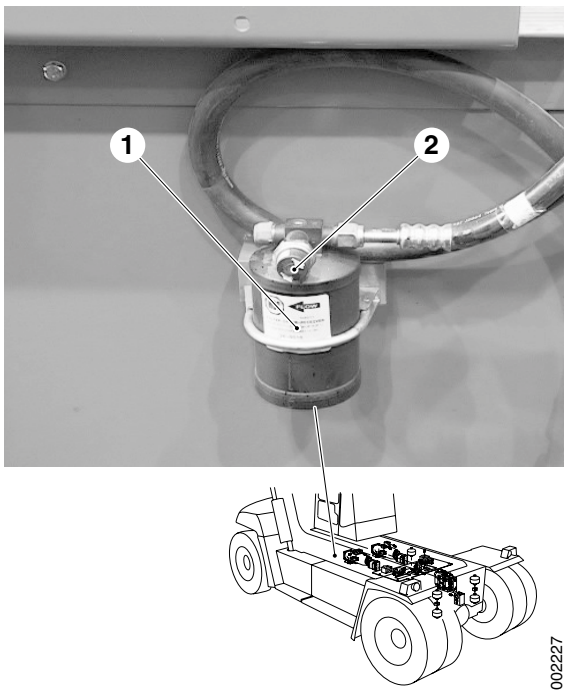


1. Fluid reservoir moisture filter
2. Pressure monitor

The pressure monitor cuts off the current to the compressor's magnet clutch if the pressure in the cooling circuit becomes abnormally high or low.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.4.3 CLIMATE, menu 3*.

Pressure switch, replacement



1. Fluid reservoir moisture filter
2. Pressure switch.

NOTE

Requires special authorisation.

1 Machine in service position, see section *B Safety*.
2 Drain the machine of R134a refrigerant.
3 Detach the connector from the pressure switch.
4 Unscrew the pressure switch from its mounting.
5 Replace the pressure switch.
6 Refill the machine with R134a refrigerant.

9.4.11 Expansion valve

Expansion valve, description

⊕

The expansion valve is the part in the circuit that separates the high-pressure side from the low-pressure side. The refrigerant arrives at the expansion valve under high pressure and leaves it under low pressure. After the expansion valve, the refrigerant converts to a gaseous state and is transported to the compressor once again.

The amount of refrigerant that passes the evaporator varies depending on the heat load. The valve works from fully open to fully closed and searches between these for an optimal evaporation point.

Expansion valve, replacement

NOTE

Requires special authorisation.

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

2 Drain the AC system of refrigerant.

3 Detach the AC system hoses.

4 Detach the coolant hoses.

5 Remove the heat exchanger for cooling/heating to access the expansion valve, see *Heat exchanger, cooling/heating, replacement page 32*.

6 Replace the expansion valve.

7 Fit in the reverse order.

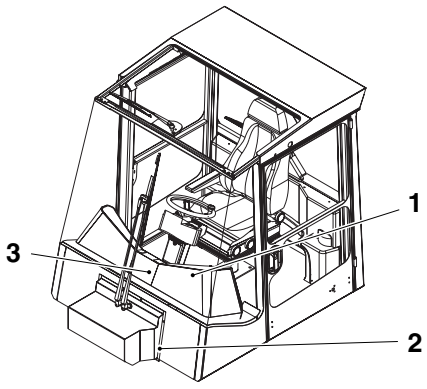
9.4.12 Sensor coolant temperature

Sensor, temperature in refrigerant, description

⊕

Sensor, refrigerant temperature (position 2), senses the refrigerant temperature in the heat exchanger cooling, this is used to control the air conditioning.

The signal can be checked from the diagnostic menu, *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.4.2 CLIMATE, menu 2*.



1. Sensor, cab temperature
2. Sensor, refrigerant temperature ⊕
3. Sensor, outlet fan temperature

Sensor, refrigerant temperature, replacement

NOTE

Requires special authorisation.

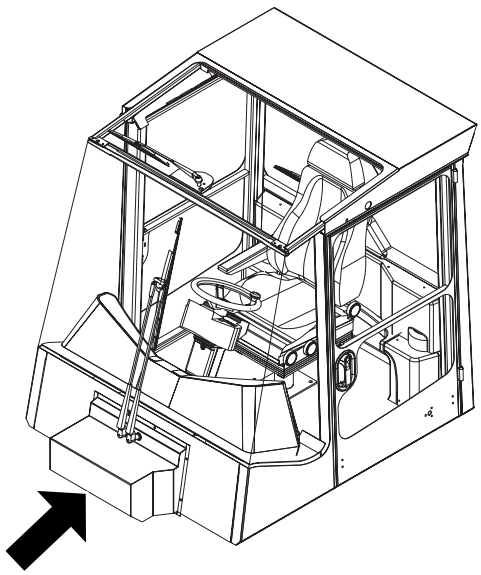
1 Machine in service position, see section *B Safety*.
2 Drain the AC system of refrigerant.
3 Detach the AC system hoses from the heat exchanger.
4 Detach the coolant hoses from the heat exchanger.
5 Detach the heat exchanger to access the refrigerant temperature sensor, see *Heat exchanger, cooling/heating, replacement page 32*.
6 Replace the temperature sensor.
7 Fit in the reverse order.

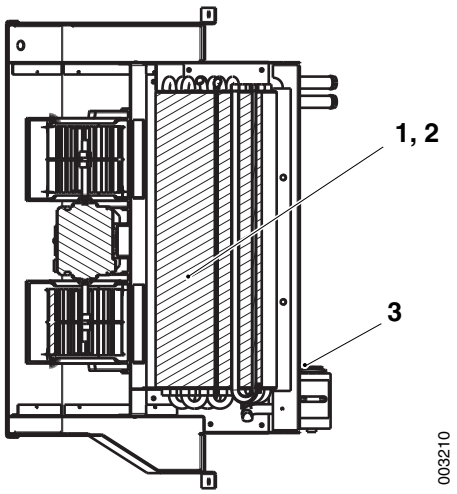
Expansion valve, replacement

NOTE

Requires special authorisation.

1 Machine in service position, see section *B Safety*.
2 Drain the AC system of refrigerant.
3 Detach the AC system hoses.
4 Detach the coolant hoses.
5 Remove the heat exchanger for cooling/heating to access the expansion valve, see *Heat exchanger, cooling/heating, replacement page 32*.
6 Replace the expansion valve.
7 Fit in the reverse order.





Fresh air inlet cab
1. Heat exchanger, heating
2. Heat exchanger cooling and sensor for refrigerant temperature ⊕
3. Expansion valve

9.4.13 Heat exchanger cooling

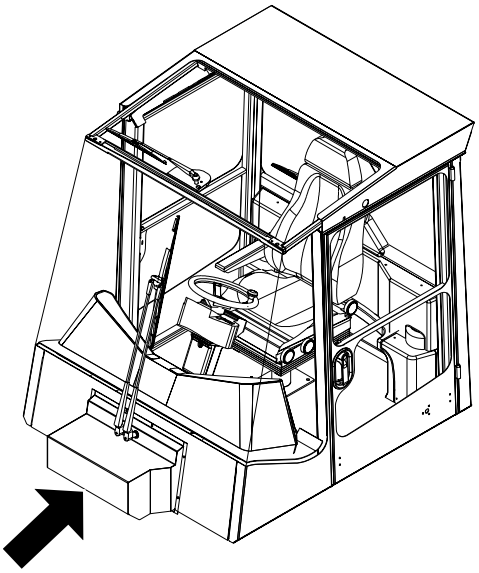
Heat exchanger cooling, description

⊕

The heat exchanger for cooling consists of pipes and cooling fins. The cab air is cooled as it passes through the cooling heat exchanger. The heat exchanger is located behind the fan in the external unit for fresh air inlet to the cab.

Heat exchanger cooling, replacement

See *Heat exchanger, cooling/heating, replacement page 32*.



9.4.14 Air distributor

Air distributor, description

The air distributor controls the air between defroster and floor and is located behind the panel inside the cab, the damper is controlled electrically by the Control system.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.4.4 CLIMATE, menu 4, 8.4.4.5 CLIMATE, menu 5* and *8.4.4.8 CLIMATE, menu 8*.

Air distributor, replacement

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

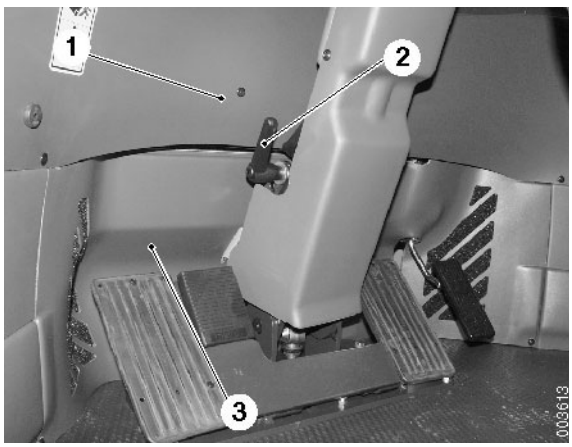
2 Remove the dashboard panel.

3 Remove the steering wheel shaft cover.

4 Detach the steering wheel shaft and angle it back against the driver's seat.

5 Remove the lower cover in front of the pedal bracket.

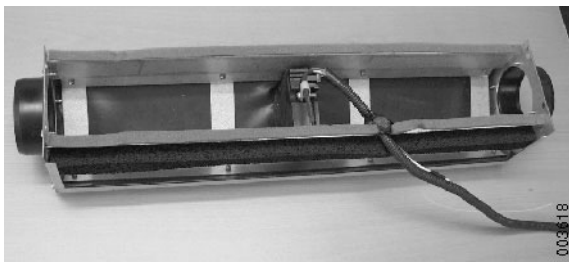
6 Detach the air hoses from the air distributor and detach the connector.



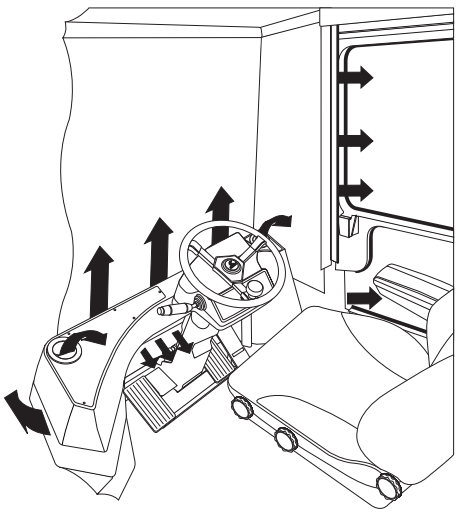
1. Dashboard panel
2. Steering wheel shaft adjustment
3. Lower protective cover

7 Remove the air distributor from its mounting.

8 Replace the air distributor, fitting it in the reverse order.



Air distributor


001839

9.4.15 Air vents

Air vents, description

There are a number of fixed air vents in the cab's interior, such as at the front of the doors and front windshield for defroster. There are also two adjustable air vents in the outside corners of the instrument panel. Adjustable flow and direction.

A bigger air vent is located towards the cab's lower part (floor) so that it's possible to infinitely adjust the air flow from the cab's lower part to defroster.

Defroster nozzles, replacement


003002

1 Machine in service position, see section *B Safety*.
2 Remove the air damper manually.
3 Remove the bolts which hold the other section of the defroster nozzle in the dashboard.

4 Detach the air hose from the defroster nozzle.

5 Replace the defroster nozzle.

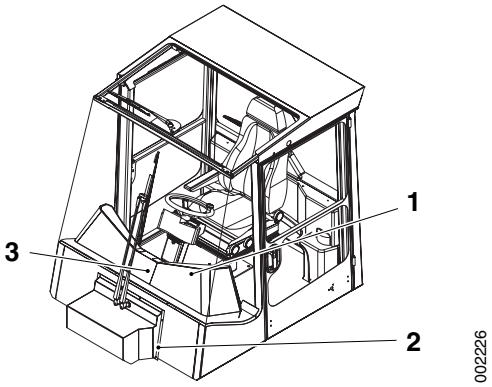
9.4.16 Sensor temperature fan air out

Sensor, temperature outlet fan, description

Sensor, temperature outlet fan (position 4) senses the temperature of the air that blows out in the defroster nozzles. The air conditioning is controlled by signals from the following sensors:

1. Sensor, cab temperature
2. Sensor, refrigerant temperature ⊕
3. Sensor, outlet fan temperature

The signal can be checked from the diagnostic menu, *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.4.2 CLIMATE, menu 2*.



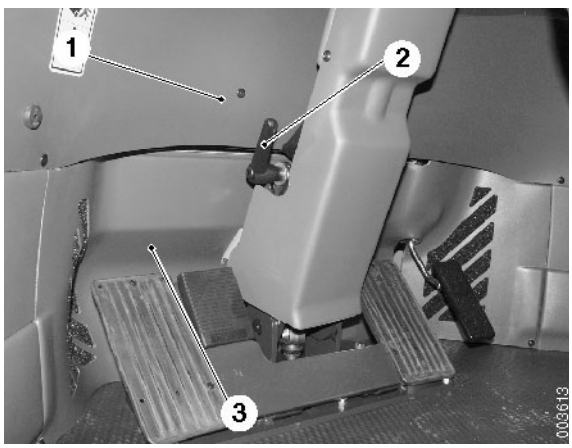
Sensor, outlet fan temperature, replacement

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

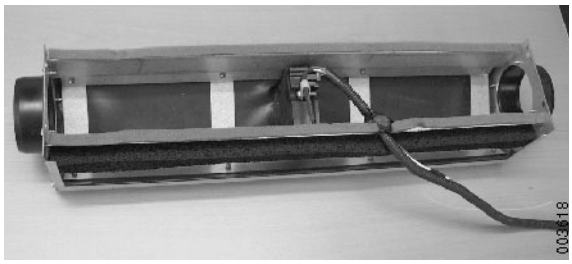
2 Remove the dashboard panel.

3 Remove the lower protective cover in front of the steering wheel shaft.

4 Detach the steering wheel shaft and angle it back against the driver's seat.



1. Dashboard panel
2. Steering wheel shaft adjustment
3. Lower protective cover



Air distributor including temperature sensor.

5 Detach the temperature sensor from the air distributor.

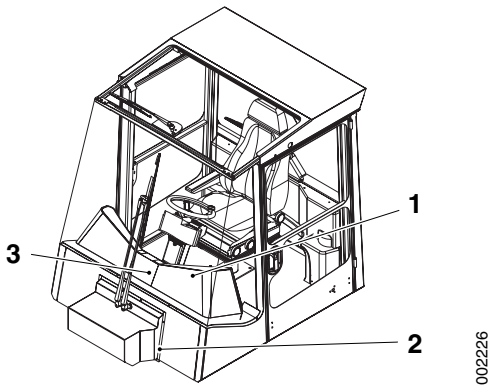
6 Fit in the reverse order.

9.4.17 Sensor cab temperature

Sensor, cab temperature, description

Sensor, cab temperature (position 1) senses the temperature of the air in the cab.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.4.1 CLIMATE, menu 1*

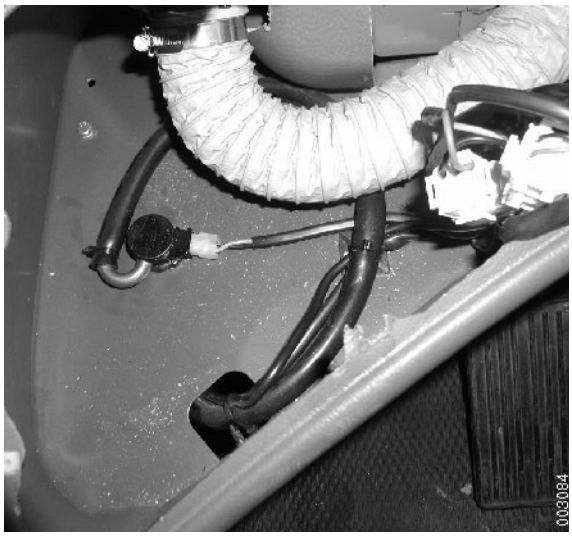


1. Sensor, cab temperature
2. Sensor, refrigerant temperature ⊞
3. Sensor, outlet fan temperature

Sensor, cab temperature, replacement

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

2 Remove the dashboard panel.



3 Detach the hose from the temperature sensor.
4 Detach the connector from the temperature sensor.
5 Remove the temperature sensor.
6 Replace the temperature sensor.
7 Fit in the reverse order.

9.4.18 Sensor outer temperature

Sensor, ambient temperature, description

Sensor, ambient temperature (position 3) senses the temperature of the air outside the cab.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.4.2 CLIMATE, menu 2*

Sensor, ambient temperature

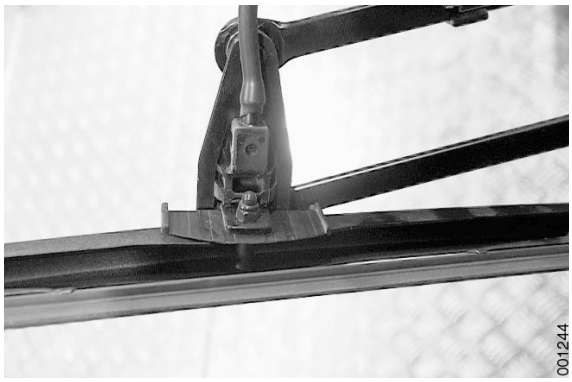
Sensor, ambient temperature, replacement

1 Machine in service position, see section *B Safety*.
2 Detach the connector from the temperature sensor.
3 Remove the temperature sensor from its mounting in the cab.
4 Replace the temperature sensor.
5 Fit in the reverse order.

9.5 Wiper/washer system

9.5.1 Wiper front

Wiper front, description



The front wiper is the parallel wiper type, i.e. the wiper blade is moved in a constant vertical manner over the windscreen.

9.5.2 Wiper roof

Wiper roof, description

The roof wiper is a sector wiper type. The wiping angle is approx. 180 degrees. There is a parallel arm type wiper unit available as a product option (see *Wiper front, description page 49*).

9.5.3 Wiper rear

Wiper rear, description

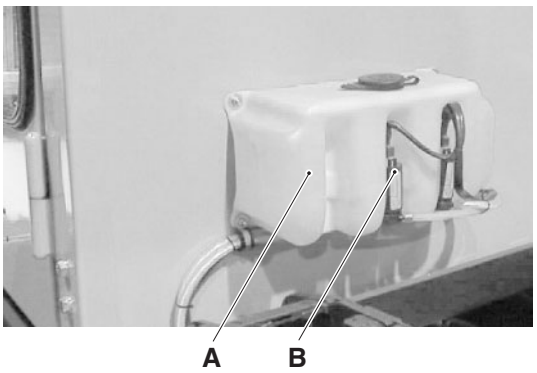
The rear wiper is a sector wiper type. The wiping angle is approx. 180 degrees.

9.5.4 Washer motor and reservoir

Washer motor and reservoir, description

Washer motor location is on the washer fluid container. There are non-return valves on the lines from the reservoir to the wiper arms. The nozzles are mounted on the wiper arms.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.3.1 CAB, menu 1.*



1. Washer fluid container
2. Washer motors

Washer motor and container, replacement

1 Machine in service position, see section *B Safety*.
2 Drain the washer fluid from the container.
3 Remove the washer motors from the fluid container.
4 Remove the bolts which secure the fluid container in the cab wall.
5 Replace the fluid container. Replace the washer motor in accordance with step 3 if necessary.

9.5.5 Wiper motor front

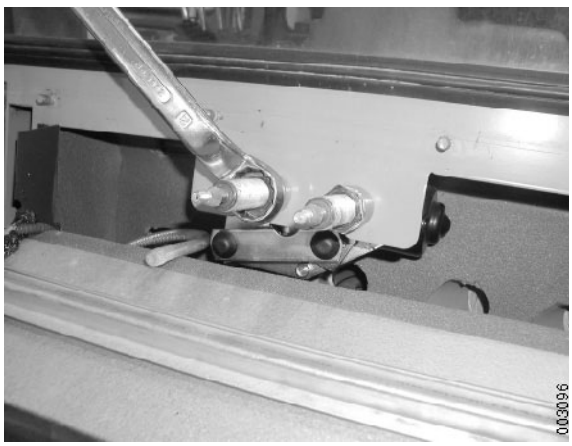
Wiper motor front, description

The wiper motor drives the front windshield's wiper. The wiper arm is mounted on the motor. The motor produces the movement of the wiper.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.3.2 CAB, menu 2.*

Wiper motor (front), replacement

1 Machine in service position, see section *B Safety*.
2 Remove the wiper arms.
3 Remove the nuts which secure the motor in the protective plate.
4 Remove the protective plate.
5 Detach the washer hose from the protective plate.



6 Remove the nuts which secure the motor in the cab.
7 Detach the connector from the wiper motor.
8 Replace the motor.
9 Fit in the reverse order. Tighten the wiper arms with 16-20 Nm.

9.5.6 Wiper motor roof

Wiper motor roof, description

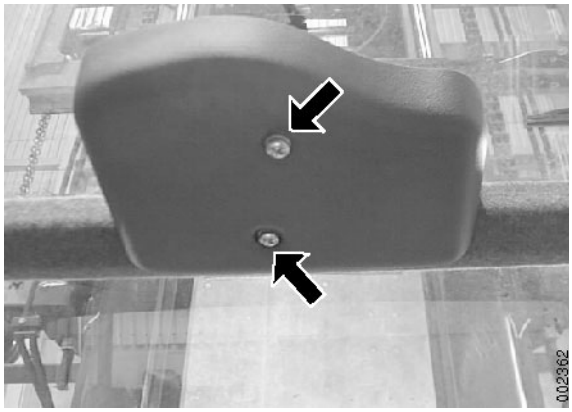
The wiper motor drives the roof window's wiper. The wiper arm is mounted on the motor. The motor produces the movement of the wiper.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.3.4 CAB, menu 4.*

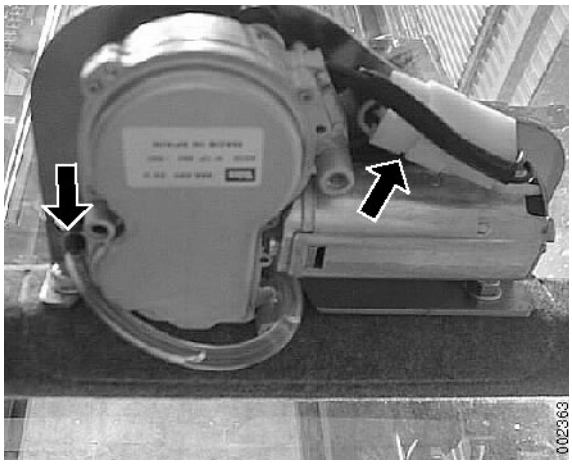
Wiper motor (roof), replacement

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

2 Remove the plastic cover.



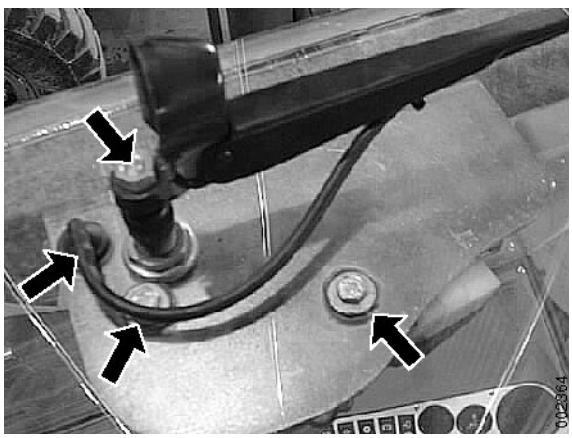
3 Detach the washer hose and the connector to the wiper motor.



4 Undo the lock nut securing the wiper arm and disconnect the washer fluid hose.

5 Remove and replace the wiper motor.

6 Fit in the reverse order. Tighten the wiper arm with 16-20 Nm.



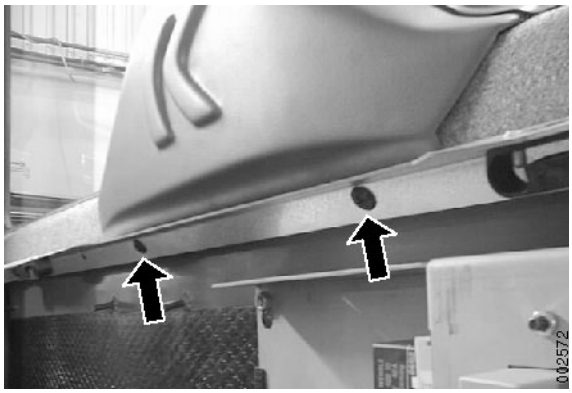
9.5.7 Wiper motor rear

Wiper motor rear, description

The wiper motor drives the rear window's wiper. The wiper arm is mounted on the motor. The motor produces the movement of the wiper.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.3.3 CAB, menu 3.*

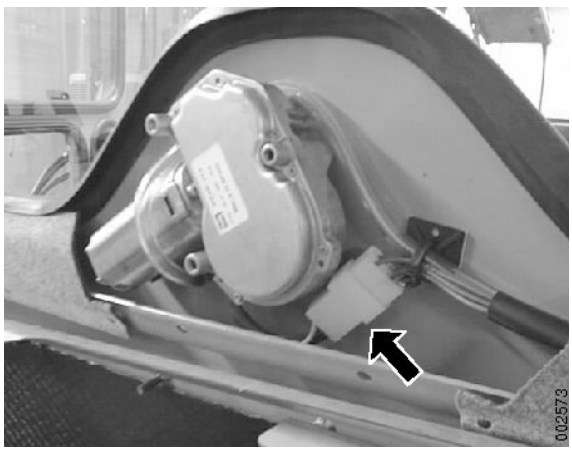
Wiper motor (rear), replacement



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

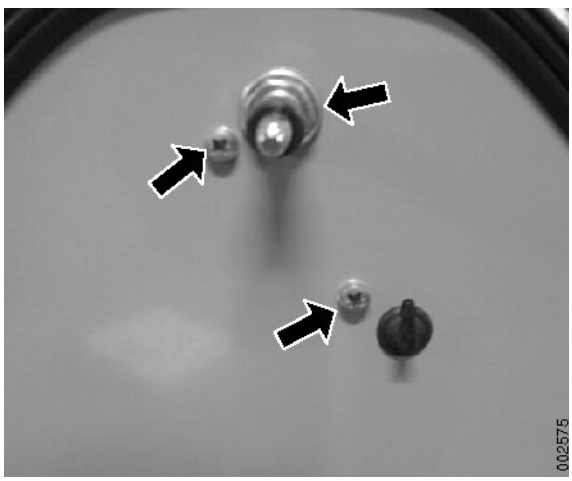
2 Remove the panels behind the operator's seat.

3 Remove the bolts which secure the plastic cover over the wiper motor.



4 Unplug the connector from the motor.

5 Raise the plastic cover and remove the nut securing the wiper arm. Disconnect the washer hose.



6 Remove the bolts which secure the motor and the lock nut on the motor.

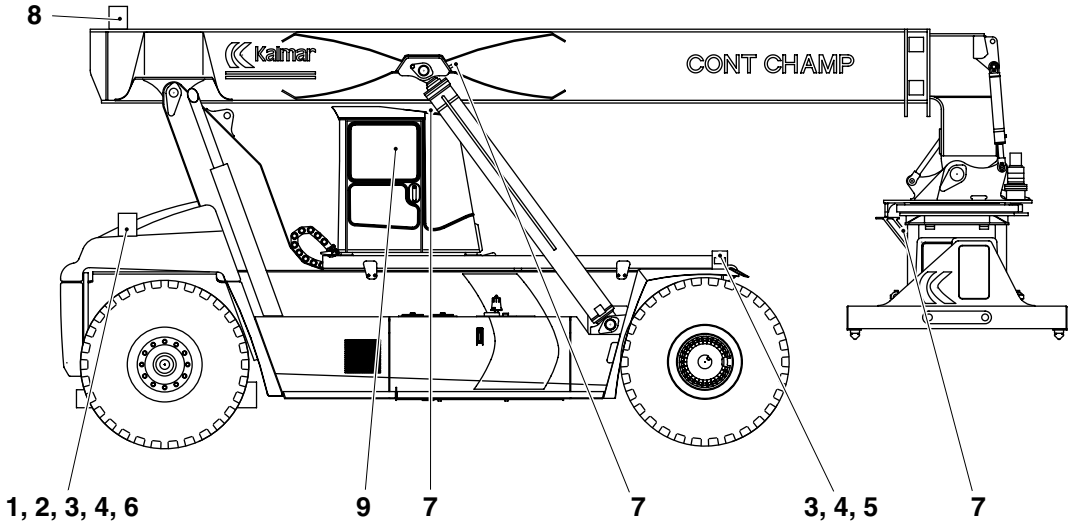
7 Change the wiper motor.

8 Fit in the reverse order. Tighten the wiper arms with 16-20 Nm.

9.6 Lighting system

Lighting system, description

The function of the lighting is to increase safety during operation and load handling. The following lighting is installed on the machine:



Lighting overview

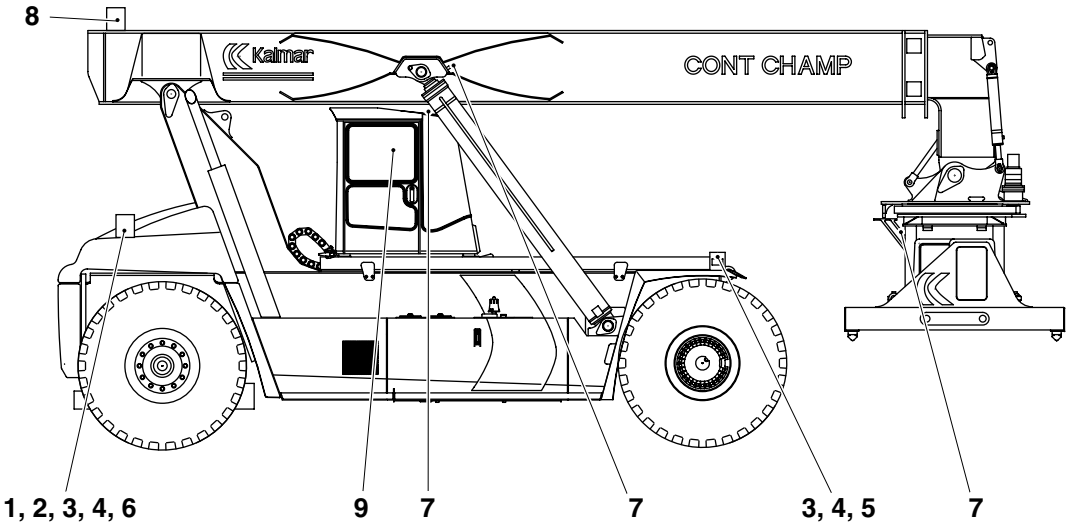
1. Rear lights, red
2. Brake lights
3. Direction indicators
4. Running lights
5. Headlights
6. Back-up lights, white
7. Work lights for cab roof, attachment and boom
8. Rotating beacon
9. Interior lighting

NOTE

It's important that the correct bulb is used for respective area. See section F Technical data.

Lighting system, function description

Function description for the machine's lighting system:



Lighting overview

Pos	Explanation	Signal description	Reference
1	Rear lights, red Activated by switch for headlights.	U = 24 V	For position of switches, see *Maintenance manual DRF 400–450*, section *9 Frame, body, cab and accessories*, group *9.1 Instruments and controls*. Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.4 LIGHTS, menu 4* and *8.4.2.5 LIGHTS, menu 5*.
2	Brake lights Activated by sensor when brake pedal is pressed down.	U = 24 V	Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.10 LIGHTS, menu 10* and *8.4.2.11 LIGHTS, menu 11*.
3	Direction indicators Activated by lever for direction indicators or function for flashing hazard lights with switch for flashing hazard lights.	U = 24 V	For position of switches, see *Maintenance manual DRF 400–450*, section *9 Frame, body, cab and accessories*, group *9.1 Instruments and controls*. Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.7 LIGHTS, menu 7* and *8.4.2.8 LIGHTS, menu 8*.
4	Running lights Activated by switch for headlights.	U = 24 V	For position of switches, see *Maintenance manual DRF 400–450*, section *9 Frame, body, cab and accessories*, group *9.1 Instruments and controls*. Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.4 LIGHTS, menu 4* and *8.4.2.5 LIGHTS, menu 5*.

Pos	Explanation	Signal description	Reference
5	Headlights Activated by switch for headlights.	U = 24 V	For position of switches, see *Maintenance manual DRF 400–450*, section *9 Frame, body, cab and accessories*, group *9.1 Instruments and controls*. Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.4 LIGHTS, menu 4* and *8.4.2.6 LIGHTS, menu 6*.
6	Back-up lights, white Activated by sensor when gear position for reverse is used. Back-up alarm is activated at the same time.	U = 24 V	Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.10 LIGHTS, menu 10* and *8.4.2.11 LIGHTS, menu 11*.
7	Work lights for cab roof, attachment and boom Activated by switch for work lights cab roof, switch for work lights attachment and switch for work lights boom.	U = 24 V	For position of switches, see *Maintenance manual DRF 400–450*, section *9 Frame, body, cab and accessories*, group *9.1 Instruments and controls*. Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.1 LIGHTS, menu 1*, *8.4.2.2 LIGHTS, menu 2* and *8.4.2.3 LIGHTS, menu 3*.
8	Rotating beacon Activated by switch for rotating beacon.	U = 24 V	For position of switches, see *Maintenance manual DRF 400–450*, section *9 Frame, body, cab and accessories*, group *9.1 Instruments and controls*. Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.9 LIGHTS, menu 9*.
9	Interior lighting Activated by switch for interior lighting or by sensor in doors.	U = 24 V	Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.12 LIGHTS, menu 12*.

9.6.1 Headlights

Headlights, description

Headlights are located in the front of the machine to give the operator enhanced view when operating in darkness, and to provide surrounding traffic and the environment an indication of the machine's position. Headlights can be selected for high beam and low beam (for meeting other traffic).

Switching between high beam and low beam is done with the gear and multi-function lever. The signal travels to the control unit (D790-1).

Low beam signals can be checked from the diagnostic menu, *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.6 LIGHTS, menu 6*.

High beam signals can be checked from the diagnostic menu, *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.6 LIGHTS, menu 6*.

9.6.2 Position lights

Running lights, description

Running lights are located on the right and left-hand sides of the machine to provide surrounding traffic and the environment an indication of the machine's position and direction of travel.

The running lights are controlled by selecting with the switch for headlights. The signal travels to the control unit (D790-1).

The lights and their signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.5 LIGHTS, menu 5*.

9.6.3 Rear lights

Rear lights, description

Rear lights are located in the rear of the machine to provide surrounding traffic and the environment an indication of the machine's position, and a limited enhancement of the view for the operator in darkness.

The rear lights are controlled by selecting with the switch for headlights. The signal travels to the control unit (D790-1).

The lights and their signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.11 LIGHTS, menu 11*.

9.6.4 Brake lights

Brake lights, description

Brake lights are located in the rear of the machine to provide surrounding traffic and the environment an indication that the machine is braking and consequently slowing down.

The brake lights are controlled by the position of the brake pedal (via acting on break contact). The signal travels to the control unit (D797-F) which in turn supplies power feed to the brake light bulbs.

The lights and their signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.11 LIGHTS, menu 11*.

9.6.5 Back-up lights

Reversing lights, description

Reversing lights are located in the rear of the machine to provide surrounding traffic and the environment an indication that the machine is travelling backwards. In addition, this provides the operator enhanced view when operating in darkness.

The reversing lights are controlled by the direction of travel. The signal travels via the CAN bus.

The lights and their signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.11 LIGHTS, menu 11*.

9.6.6 Travel direction indicators

Direction indicators, description

Direction indicators are located both front and rear on the machine to provide surrounding traffic and the environment an indication that the machine is changing direction, i.e. turning.

The direction indicator is controlled by selecting with the switch (lever) for direction indicators. The signal travels to the control unit (D797-F).

The lights and their signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.8 LIGHTS, menu 8*.

9.6.7 Warning light Hazard

Hazard lights, description

Hazard lights (hazard) are used to warn the surroundings, hazard lights activate all direction indicators at the same time.

The hazard lights are controlled by selecting with the switch for hazard lights. The signal travels to the control unit (D790-2).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.8 LIGHTS, menu 8*.

The machine for the North American market has flashing direction indicators front and rear during operation (⊞).

9.6.8 Rotating beacon

Revolving beacon, description

A revolving beacon is located high on the machine's boom (rear section). This is used to provide surrounding traffic and the environment an indication that a working vehicle is moving and at work. Indication to bystanders to exercise caution.

The revolving beacon is controlled by selecting with the switch for revolving beacon. The signal travels to the control unit (D790-1).

The light and its signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.9 LIGHTS, menu 9*.

9.6.9 Work light cab

Working lights cab, description

Work lights on the cab provide enhanced view when load handling in darkness.

The work lights are controlled by selecting with the switch for cab roof work lights. The signal travels to the control unit (D790-1) which in turn supplies power feed to the work lights bulbs.

The lights and their signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.1 LIGHTS, menu 1*.

9.6.10 Work light boom

Work lights boom, lighting

The work lights on the boom provide enhanced view when load handling in darkness.

The work lights are controlled by selecting with the switch for boom work lights. The signal travels to the control unit (D790-1).

The lights and their signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.3 LIGHTS, menu 3*.

The lift boom can be equipped with two extra work lights (⊕).

9.6.11 Work light attachment

Work lights attachment, description

Work lights on the attachment provide enhanced view when load handling in darkness.

The work lights are controlled by selecting with the switch for attachment lights. The signal travels to the control unit (D790-1).

The lights and their signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.2 LIGHTS, menu 2*.

The attachment can be equipped with two extra work lights (⊕).

9.6.12 Interior lighting

Interior lighting cab, description

Interior lighting provides light when doors are opened or by selecting with the switch for interior lighting.

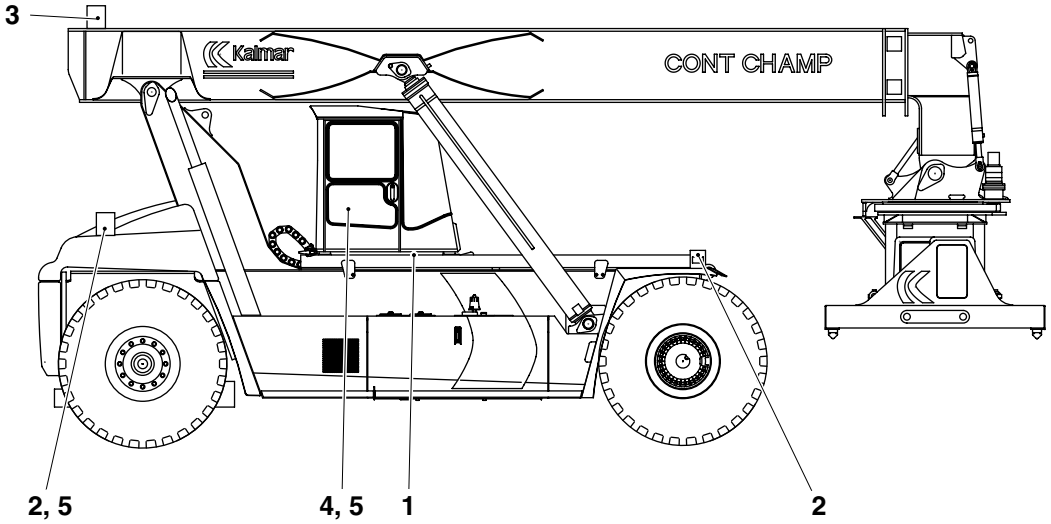
Background lighting is available in all switches, function keys and knob controls. This is so that the operator can interpret functions and settings in darkness. The intensity of the lighting is controlled by the function keys for plus and minus.

The lighting and its signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.12 LIGHTS, menu 12*.

9.7 Communication system

Signal system, description

The function of the signals is to increase safety during operation and load handling. This can be done with lights and sounds. The following signal system is installed on the machine:



Signal system overview

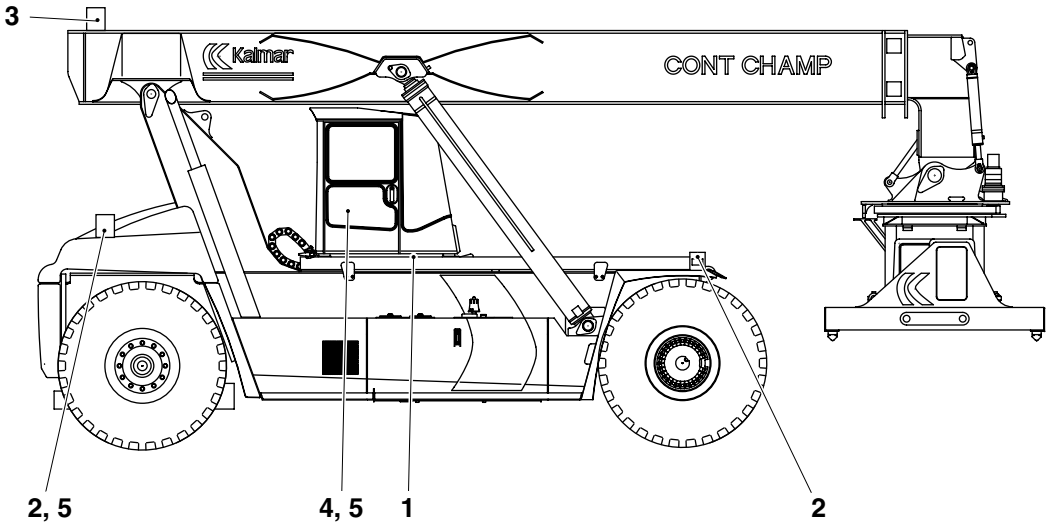
1. Horn
2. Warning light flashing hazard lights
3. Rotating beacon
4. Warning parking brake
5. Back-up alarm

NOTE

It's important that the correct bulb is used for respective area. See section F Technical data.

Signal system, function description

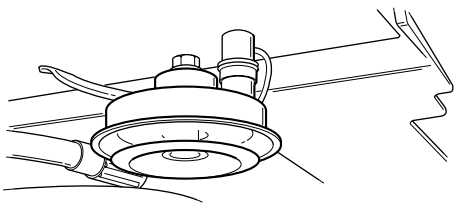
Function description for the machine's signal system:



Signal system overview

Pos	Explanation	Signal description	Reference
1	Horn Activated by switch for headlights.	U = 24 V	For position of switches, see *Maintenance manual DRF 400–450*, section *9 Frame, body, cab and accessories*, group *9.1 Instruments and controls*. Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.3.5 CAB, menu 5*.
2	Warning light flashing hazard lights Indication with indicator light for direction indicators when travel direction or flashing hazard lights are activated.	U = 24 V	For direction indicators, see *Lighting system, function description page 54*. For position of indicator light, see *Maintenance manual DRF 400–450*, section *9 Frame, body, cab and accessories*, group *9.1 Instruments and controls*.
3	Rotating beacon Activated by switch for flashing hazard lights.	U = 24 V	For rotating beacon, see *Lighting system, function description page 54*.
4	Warning parking brake Indication with indicator light for parking brake when parking brake is applied. Indication with sound if the operator leaves the operator's seat without first applying the parking brake for machine in operation.	U = 24 V	For position of indicator light, see *Maintenance manual DRF 400–450*, section *9 Frame, body, cab and accessories*, group *9.1 Instruments and controls*. Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.3.6 CAB, menu 6*.

Pos	Explanation	Signal description	Reference
5	Back-up alarm Activated by sensor when gear position reverse is used. Back-up lights are activated at the same time.	U = 24 V	For back-up lights, see *Lighting system, function description page 54*. Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.3.6 CAB, menu 6*.



9.7.1 Horn

Horn, description

The horn is electro-magnetic. Compressed air horn can be selected (⊕).

The horn is activated from the gear and multi-function lever. The horn is located under the cab (the compressed air horn is located in the rear edge of the cab roof).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.3.5 CAB, menu 5*.

9.7.2 Warning light Hazard

Hazard lights, description

See *Hazard lights, description page 57*.

9.7.3 Rotating beacon

Rotating beacon, description

See *Revolving beacon, description page 57*.

9.7.4 Warning parking brake

Warning parking brake, description

If the operator leaves the machine without applying the parking brake a buzzer sounds to alert the operator, i.e. to ensure the operator applies the parking brake.

A sensor in the driver's seat (see *Sensor, operator in seat, description page 19*) indicates for the control system if the operator leaves the seat.

The buzzer is located in the cab's electronic box.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.3.6 CAB, menu 6*.

9.7.5 Back-up alarm

Back-up alarm, description

When reverse is selected, a warning sound and the back-up lights are activated. This is to give others in traffic and the surroundings an indication that the machine is reversing. Indication to bystanders to take caution.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group 8.4.2.11 *LIGHTS, menu 11*.

9.8 Entertainment and communication

Entertainment and communication, general

For information and description of equipment, see supplier's documentation for respective product.

Maintenance and communication, repair

Repairs should be left to authorised personnel.

9.9 Glass/windows/mirrors

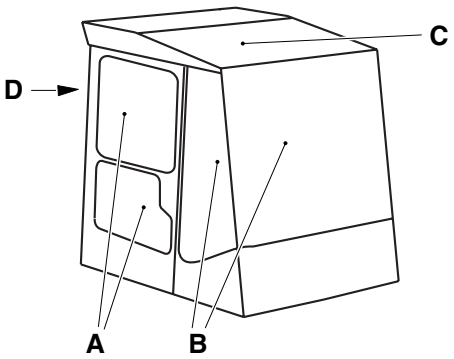
Glass/windows/mirrors, description

Glass and windows are in hardened glass on all machines with the Spirit Delta cab. The windows are tinted and can be made of laminated glass (⊕).

The rear view mirrors are the convex mirror type. The interior rear view mirror is fitted in all machines.

9.9.1 Windscreen

Windshield, description



The windows are designed to both enclose the cab and provide the operator with a good view.

A. Side windows
B. Windscreen (front window)
C. Roof window
D. Rear window

Windscreen, replacement

See *Side window, replacement page 65*, for the general procedure.

The windscreen is combined with the roof window. The join is sealed with silicone. Add a new silicone seal when replacing.

9.9.2 Side window

Side window, description

For description, see *Glass/windows/mirrors, description page 64*.

For location, see *Windshield, description page 64*.

Side window, replacement

NOTE

The method describes a general procedure.

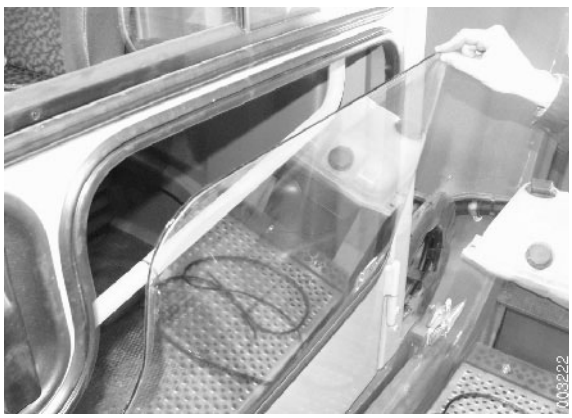
1 Machine in service position, see section *B Safety*.

2 Use special tools to detach the wedge strip.

3 Remove the wedge strip which runs around the whole window.

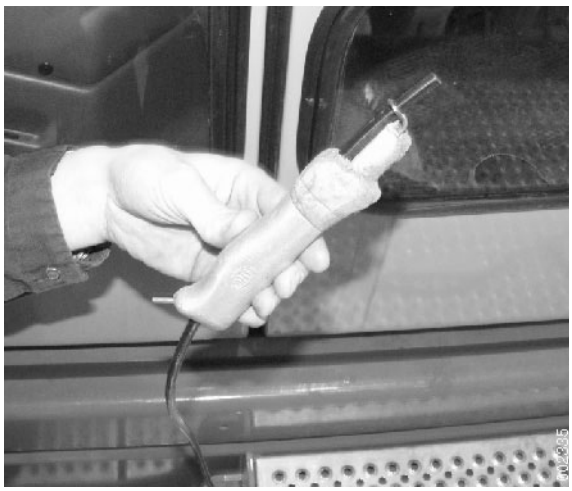
4 Carefully remove any glass remains from the rubber strip.

5 Fit the new window, secure at the bottom edge.



6 Spray soap solution on the window and rubber strip to facilitate fitting.

7 Thread the rubber strip around the whole window, use special tools.



8 Secure the wedge strip with a special tool.

9 Pull the wedge strip around the whole window.

10 Cut off the wedge strip approx. 2 cm too long.

11 Fit the other end of the wedge strip edge to edge.

12 Adjust the wedge strip so that the correct fit is obtained.

9.9.3 Roof window

Roof window, description

The roof window is made of polycarbonate plastic which provides safety for the operator by protecting from falling objects. The polycarbonate plastic sheet is elastic.

Safety is maintained within a temperature range from 120 °C to -45 °C (becomes brittle first at -110 °C, glass conversion temperature 145 °C). The roof window has a patented surface layer which increases its wear resistance as well as resistance to UV-light and chemicals.

For location, see *Windshield, description page 64*.

⚠ WARNING

The strength of the roof window may be significantly reduced in case of exposure to substances containing: aromatic hydrocarbons, ketones, esters and chlorinated hydrocarbons.

Check the outside surface of the roof window at regular intervals. Clean only with windshield washer fluid or a mild cleaning agent. Rinse thoroughly with plenty of lukewarm water. Replace a damaged roof window immediately if it is cracked or scratched!

Roof window, replacement

See *Side window, replacement page 65*, for the general procedure.

The roof window is combined with the windscreen. The join is sealed with silicone. Add a new silicone seal when replacing.

9.9.4 Back window

Rear window, description

For description, see *Glass/windows/mirrors, description page 64*.

For location, see *Windshield, description page 64*.

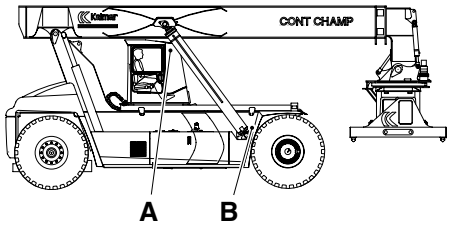
Rear window, replacement

See *Side window, replacement page 65* for the general procedure.

9.9.5 Rear-view mirror

Rear-view mirror, description

The cab has a rear-view mirror (position A) located in the cab as well as rear-view mirrors (position B) on left and right front fenders. The function of the rear-view mirror is to give the operator rearward vision.



A. Rear-view mirror
B. External mirror

9.9.6 Back-up camera

Back-up camera, description

The back-up camera is located at the trailing edge of the horizontal counterweight at the back of the machine for improved visibility when reversing. The camera image is shown on a monitor in the cab.

9.9.7 Monitor back-up camera

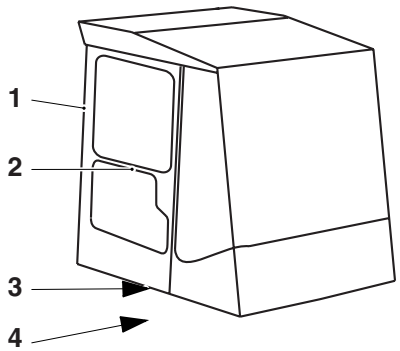
Monitor back-up camera, description

The monitor shows the image from the back-up camera. The monitor is mounted on a hinged bracket to the left in front of the door in the cab.

9.10 Cab structure and suspension

Construction and mounting, description

The cab is mounted in a cab undercarriage via strong rubber insulators located on the underside of the cab. This is to minimise vibrations from the frame to the cab. There is an insulator at four points, one at each corner. Each insulator mounting has one rubber bushing and one bolt.



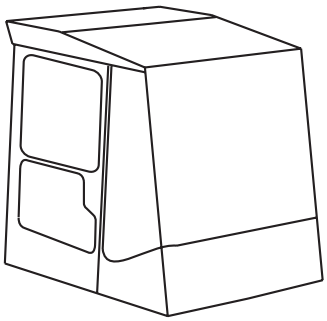
003206

Cab, Spirit Delta
1. Cab frame
2. Door
3. Cab mounting
4. Cab undercarriage

9.10.1 Framework cab

Cab frame, description

The cab frame is constructed of plate sections in high-strength steel. The cab is dimensioned to tolerate knocks and, to a certain extent, dropped load.



002210

Cab, Spirit Delta

9.10.2 Doors

Doors, description

The cab has two doors, the left is the operator's door and the right is the emergency exit. The door has:

- rail
- handle
- key lock
- openable window (passenger door ⊕)

There are switches in the doors' locks which sense if the door is open. The switch is used to light the interior lighting and warn of an open door.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.2.12 LIGHTS, menu 12* or *8.4.11.2 SLIDING-CAB, menu 1*.

9.10.3 Cab mounting

Cab undercarriage, description

The cab is mounted on a cab undercarriage via strong rubber insulators located on the underside of the cab. This is to minimise vibrations from the frame to the cab.

The cab undercarriage is fitted on the machine's chassis (frame) via a mounting. The chassis mounting depends on whether the machine is equipped with:

1. manual sliding cab
2. hydraulic sliding cab
3. hydraulic cab lift and lowering
4. hydraulic cab tilt.

9.10.3.1 Cab mounting longitudinal displacement of cab

Cab undercarriage, sliding cab, description

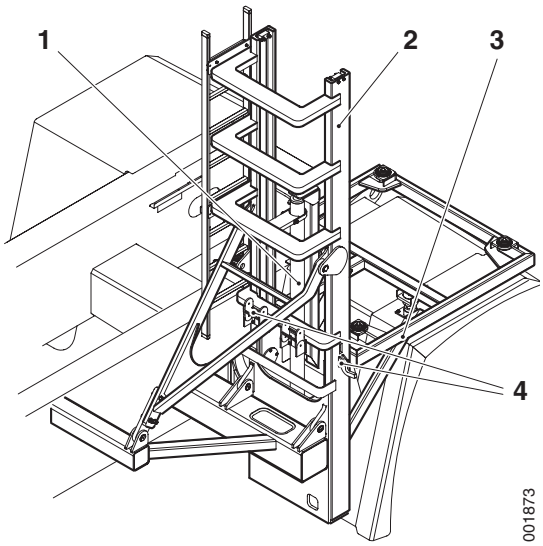
The cab undercarriage is fitted on the machine's chassis (frame) via a mounting. The mounting to the chassis consists of four ball bearing metal rollers which run in rails above the machine's frame.

9.10.3.2 Cab mounting vertically adjustable cab

Cab undercarriage cab lift and lowering, description

The cab undercarriage is fitted on the machine's chassis (frame) via a mounting. The mounting runs in a lift mast which is secured in the machine's chassis behind the right-hand front wing which means that the cab is positioned above the right-hand drive wheel.

The lift mast consists of outer mast, inner mast lift cylinder and chains. The inner mast runs in the outer mast on ball bearing rollers.



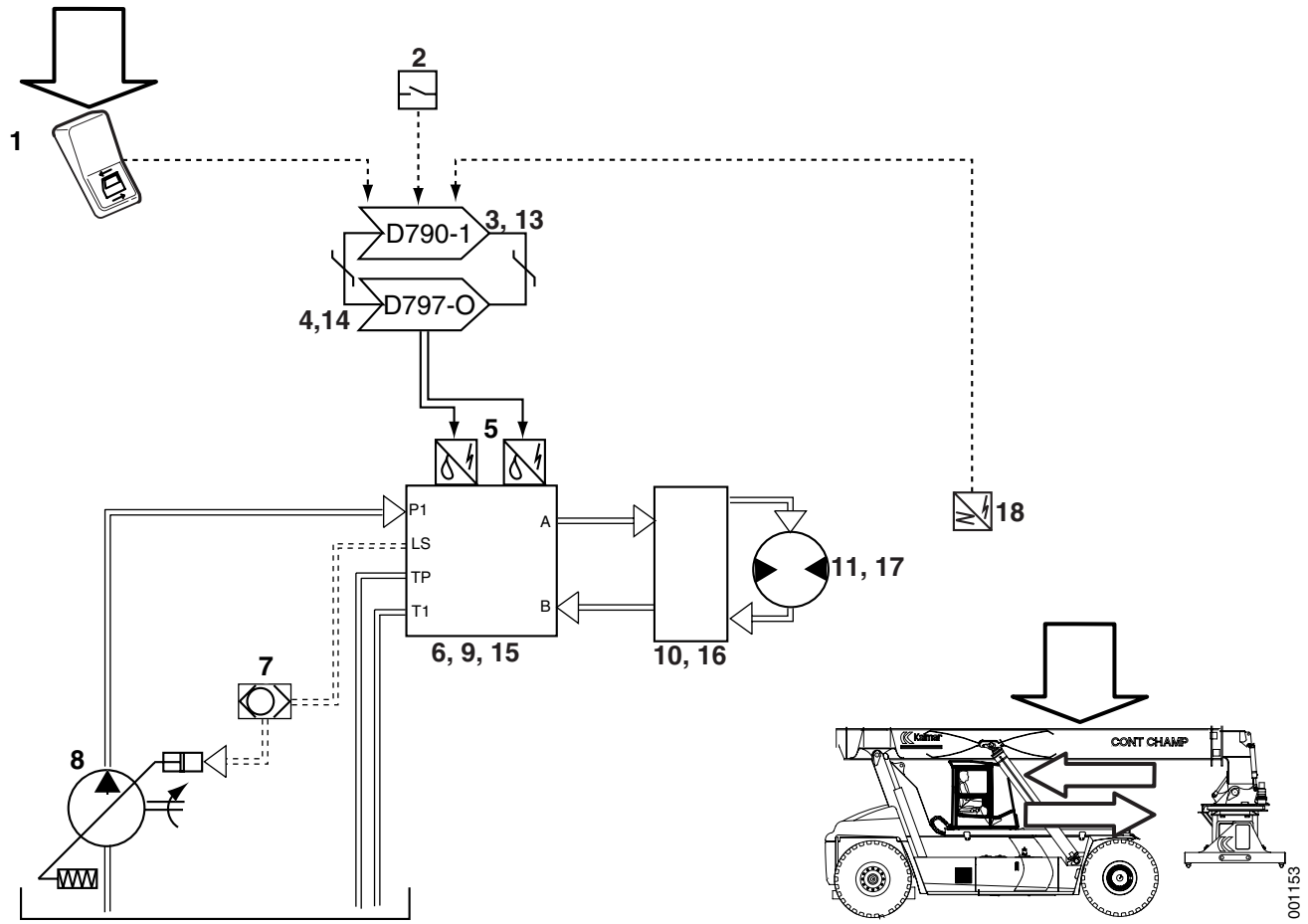
1. Hydraulic cylinder, cab lift and lowering
2. Mast, cab lift and lowering
3. Cab undercarriage, cab lift and lowering
4. Safety lock

9.10.4 Longitudinal displacement of cab

Hydraulic sliding cab, function description

⊕

Condition	Reference value	Reference
Parking brake	Applied	Section *4 Brakes*, group *4.5 Parking brake system*.
Doors	Closed	*Doors, description page 71*.



Pos	Explanation	Signal description	Reference
1	Switch (S197) cab movement sends voltage signal to Control unit, cab (D790-1).	U = 24 V	*Switch hydraulic sliding cab, description page 11*.
2	Contact closed door, sends signal to control unit cab when door is closed	U = 24 V	*Doors, description page 71*.
3	Control unit cab (D790-1) sends "cab forward" *or "cab backward"* on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*.

Pos	Explanation	Signal description	Reference
4	Control unit frame option (D797-O) supplies voltage to servo valve cab movement forward *or servo valve cab movement backward* on control valve option frame.	I = 435–650 mA	*Control valve option frame, description page 75*.
5	Servo valve cab movement forward *or servo valve cab movement backward* pressurizes the cab movement spool in control valve option frame.	-	*Control valve option frame, description page 75*.
6	Control valve option frame sends control signal to shuttle valve option.	-	*Control valve option frame, description page 75*.
7	The shuttle valve sends the strongest control signal to main pumps if several functions are activated at the same time.	-	*Shuttle valve option frame, description page 76*.
8	The main pumps pump oil from the tank.	Pressure plate "Max. pressure hydraulic oil pumps" on left frame member.	Section *10 Common hydraulics*, group *10.4.2 Axial piston pump with variable displacement*.
9	Control valve option frame pressurizes valve block cab movement.	-	*Control valve option frame, description page 75*.
10	Valve block cab movement pressurizes hydraulic motor for cab movement.	-	*Valve block, sliding cab, description page 76*.
11	Hydraulic motor cab movement pulls cab forward *or backward*.	-	*Hydraulic motor sliding cab, description page 77*.
12	Sensor end-position (B769-2) sends voltage signal to Control unit cab (D790-1) when cab is close to end-position.	U = 24 V	*Sensor damping end-position, description page 78*.
13	Control unit cab (D790-1) sends “dampen cab movement” on the CAN-bus.	Checked by control system, error shown with error code.	Section *11 Common electrics*, group *11.6 Communication*.
14	Control unit frame option (D797-O) reduces the control current to servo valve cab movement forward *or servo valve cab movement backward* in control valve option frame.	-	*Control valve option frame, description page 75*.
15	Control valve option frame reduces hydraulic pressure to valve block cab movement.	-	*Control valve option frame, description page 75*.
16	Valve block cab movement lets pressure through to hydraulic motor cab movement.	-	*Valve block, sliding cab, description page 76*.
17	Hydraulic motor cab movement reduces speed of cab movement.	-	*Hydraulic motor sliding cab, description page 77*.

9.10.4.1 Cab sleigh

Cab sleigh, description

The cab is secured on a cradle which runs on wheels in rails on the frame. See *Cab undercarriage, description page 71*.

9.10.4.2 Hydraulic oil pump

Hydraulic oil pump, description

⊞

The hydraulic cab movement (sliding cab) is supplied with pressure from hydraulic oil pump 1 and 2, see section *10 Common hydraulics*, group *10.4.2 Axial piston pump with variable displacement*.

9.10.4.3 Manouevre valve option frame

Control valve option frame, description

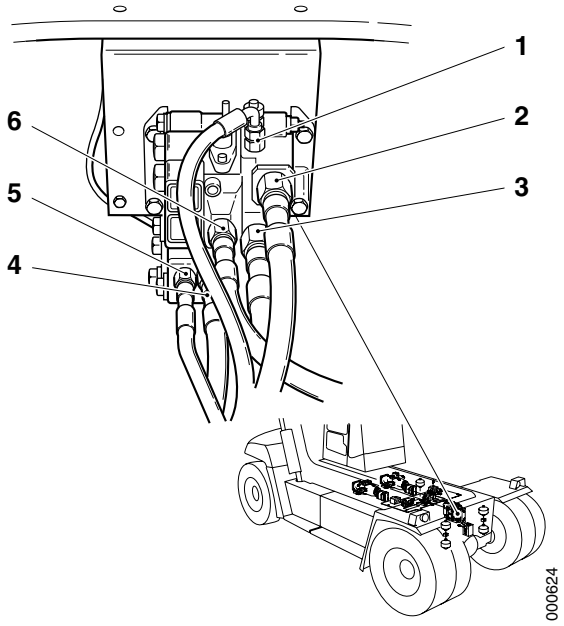
⊞

The hydraulic sliding cab is controlled by a separate section in the control valve for option frame.

The control valve is an electro-hydraulically controlled, proportional and pressure compensated direction valve. Electrically controlled pressure reducing valves convert electrical current to servo pressure. The servo pressure controls the spring centred valve slides which control pressure and flow for the function in question. The valve slide has a flow limit in order that several functions can be activated simultaneously.

The control valve is located at the front of the engine compartment and is controlled by control unit frame option (D797-O). Control valve option frame is built up of several sections, each section controls one function. The following functions are controlled by control valve option frame:

- Support jacks ⊞
- Sliding cab / Cab lift and lowering ⊞
- Cab tilt ⊞



1. Load signal (LS)
2. Pressure supply (P)
3. Tank return (T1)
4. Connection hydraulic motor (B)
5. Tank return (TP)
6. Connection hydraulic motor (A)

Valve slide, sliding cab

The valve slide controls direction and speed of sliding cab by controlling hydraulic motor pressure, sliding cab.

The valve slide is controlled by servo valve forward and servo valve backward.

Servo valve sliding cab forward

Servo valve sliding cab forward controls servo pressure to valve slide sliding cab so that this controls oil pressure to hydraulic motor sliding cab forward.

Servo valve sliding cab forward is controlled electrically with solenoid valve sliding cab forward (Y6016) which is activated by Control unit frame option (D797-O).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.2 SLIDING-CAB, menu 3*.

Servo valve sliding cab backward

Servo valve sliding cab backward controls servo pressure to valve slide steering so that this controls oil pressure to hydraulic motor sliding cab forward.

Servo valve sliding cab backward is controlled electrically with solenoid valve sliding cab backward (Y6017) which is activated by Control unit frame option (D797-O).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.2 SLIDING-CAB, menu 4*.

9.10.4.4 Shuttle valve option frame

Shuttle valve option frame, description

See section *10 Common hydraulics*, group *10.5.3 Shuttle valve*.

9.10.4.5 Valve block longitudinal displacement of cab

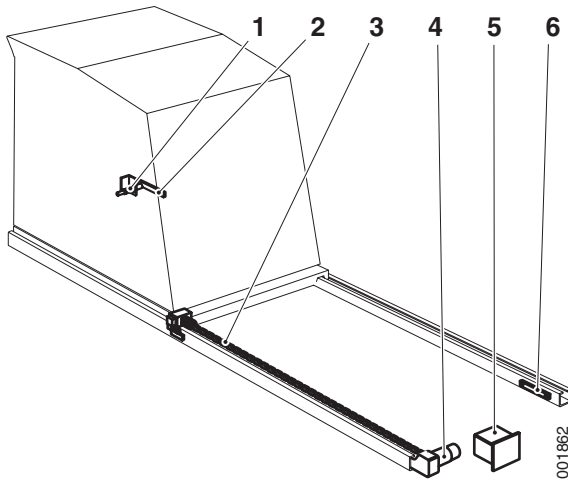
Valve block, sliding cab, description

Valve block sliding cab is located on hydraulic motor, sliding cab, and prevents the motor being turned when sliding cab is not activated.

9.10.4.6 Hydraulic motor longitudinal displacement of cab

Hydraulic motor sliding cab, description

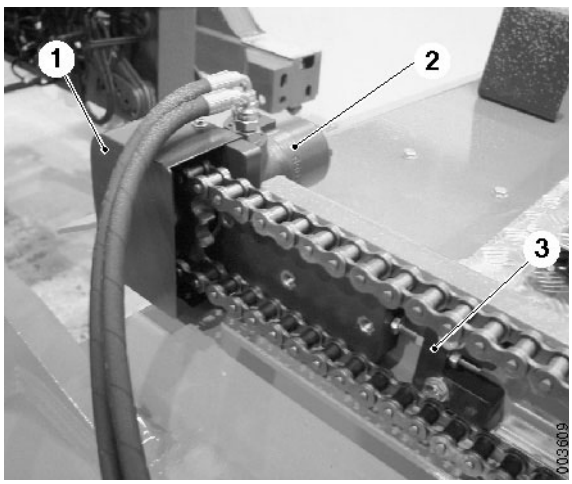
The hydraulic motor is located furthest forward on the right-hand side of the cab chain. The hydraulic motor pulls the chain which in turn pulls the cab forward and backward.



1. Sensor, damping (rear edge of cab on left-hand side)
2. Indicator plate, damping
3. Chain, sliding cab
4. Hydraulic motor, sliding cab
5. Control valve, sliding cab
6. Indicator plate, damping

Hydraulic motor, sliding cab, replacement

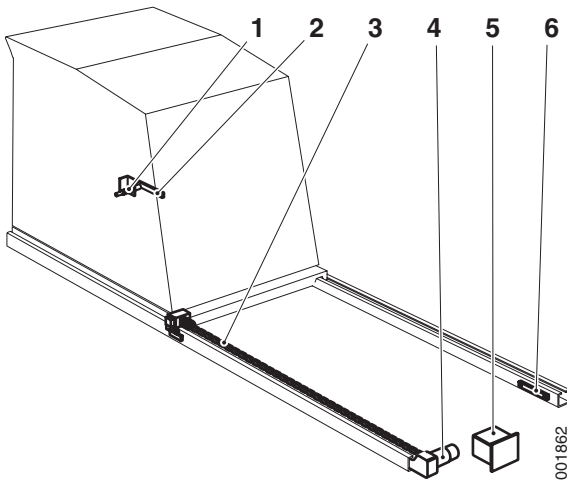
1 Machine in service position, see section *B Safety*.
2 Depressurise the hydraulic system.
3 Remove the protective cover.
4 Slacken the chain, loosen the chain tensioner and the adjusting screw.
5 Detach the chain from its mounting.
6 Detach the hydraulic hoses from the motor.
7 Remove the ring gear.
8 Remove the hydraulic motor from its mounting.
9 Replace the hydraulic motor.
10 Fit in the reverse order.



1. Protective cover
2. Hydraulic motor
3. Chain tensioner

9.10.4.7 Chain longitudinal displacement of cab

Chain sliding cab, description



1. Sensor, damping (rear edge of cab on left-hand side)
2. Indicator plate, damping
3. Chain, sliding cab
4. Hydraulic motor, sliding cab
5. Control valve, sliding cab
6. Indicator plate, damping

The chain pulls the cab forward and backward and is secured in the front and rear edges on the cab undercarriage. The chain tension is adjusted by moving the hydraulic motor for sliding cab.

Chain and chain wheel, sliding cab, replacement

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

2 Slacken the chain, loosen the chain tensioner and the adjusting screw.

3 Detach the chain at the front edge.

4 Detach the chain at the rear edge.

5 Replace the chain.

6 Fit in the reverse order.

7 Adjust the chain with the adjusting screw.

8 Tighten the chain tensioner.

9.10.4.8 Sensor damping, end position

Sensor damping end-position, description

Sensor damping end -position indicates when the cab is close to end-position and is used to activate end-position damping.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.2 SLIDING-CAB, menu 2*.

Position sensor, checking and adjustment

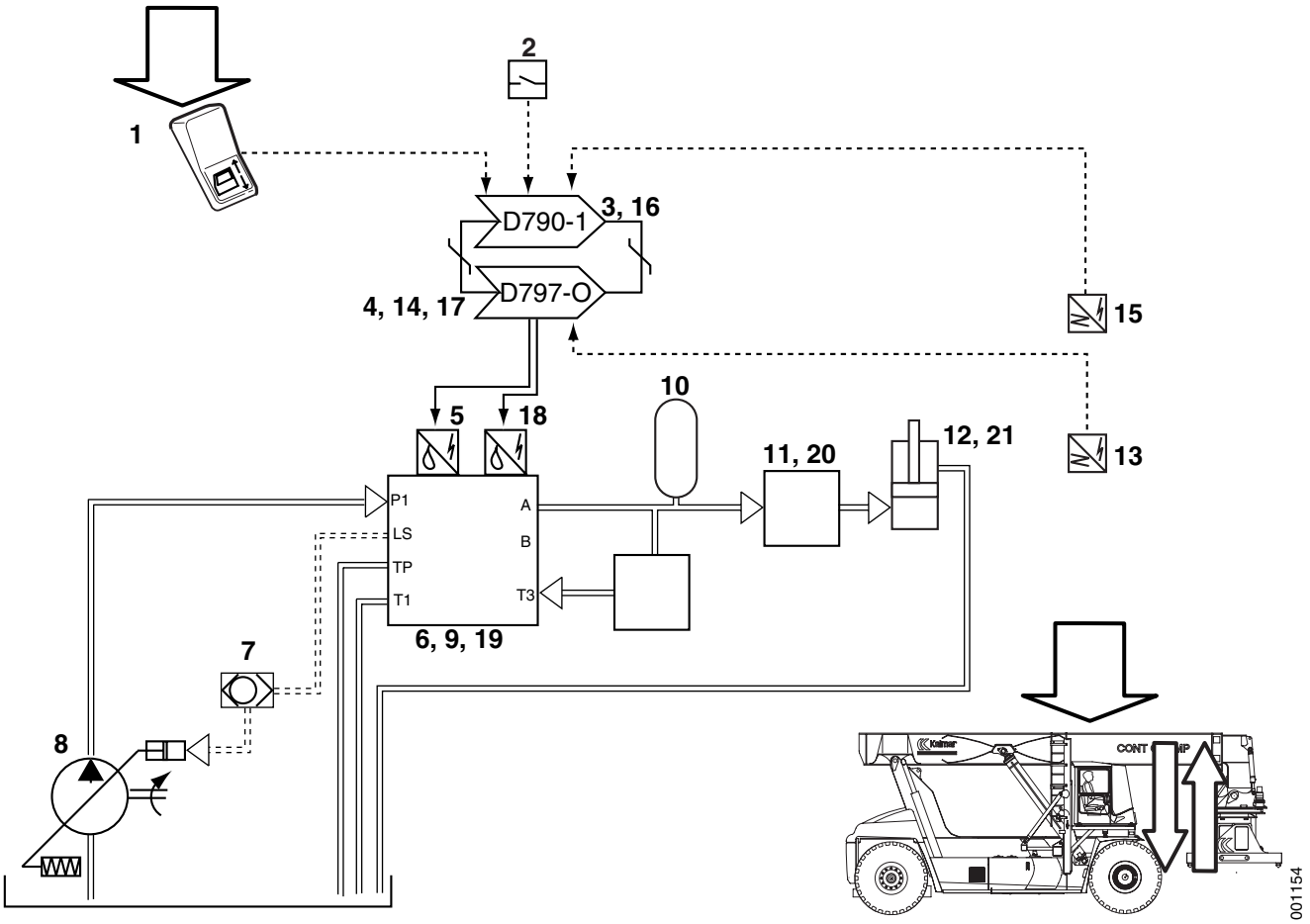
See section *7 Load handling*.

9.10.5 Vertically adjustable cab

Cab lift and lowering, function description

⊕

Condition	Reference value	Reference
Parking brake	Applied	Section *4 Brakes*, group *4.5 Parking brake system*.
Doors	Closed If the door is open with lifted cab, the lift and lower functions for the boom are limited.	*Doors, description page 71*.



Pos	Explanation	Signal description	Reference
1	Switch cab lift and lowering (S) sends voltage signals to Control unit, cab (D790-1).	U = 24 V	*Switch hydraulic cab lift and lowering, description page 12*.
2	Contact closed door, sends signal to control unit cab when door is closed	U = 24 V	*Doors, description page 71*.

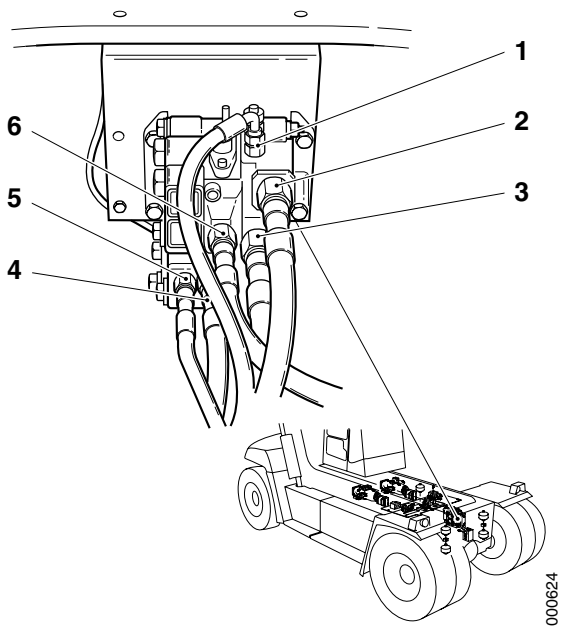
Pos	Explanation	Signal description	Reference
3	Control unit cab (D790-1) sends “cab forward” *or “cab backward”* on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics*, group *11.5.4 Control units*.
4	Control unit frame option (D797-O) supplies voltage to servo valve cab lift (Y6016) *or servo valve cab lower (Y6017)* on control valve option frame.	I = 435–650 mA	Section *11 Common electrics*, group *11.5.4 Control units*.
5	Servo valve lift cab (Y6016) *or Servo valve lower cab (Y6017)* pressurizes the cab movement spool in control valve option frame.	-	*Control valve option frame, description page 82*.
6	Control valve option frame sends control signal to shuttle valve option.	-	*Control valve option frame, description page 82*.
7	The shuttle valve sends the strongest control signal to main pumps if several functions are activated at the same time.	-	*Shuttle valve option frame, description page 76*.
8	The main pumps pump oil from the tank.	Pressure plate "Max. pressure hydraulic oil pumps" on left frame member.	Section *10 Common hydraulics*, group *10.4.2 Axial piston pump with variable displacement*.
9	Control valve option frame pressurizes the accumulator and the load control valve.	-	*Control valve option frame, description page 82*.
10	The accumulator stores pressure.	-	*Accumulator cab lift and lowering, description page 82*.
11	The load control valve lets the pressure through to hydraulic cylinder for lifting and lowering cab. When lowering, the load control valve changes position and restricts flow from hydraulic cylinder for lifting and lowering cab.	-	*Load control valve, description page 83*.
12	The hydraulic cylinder for lifting and lowering cab lifts *or lowers* the cab.	-	*Hydraulic cylinder cab lift and lowering, description page 83*.
13	Sensor lowered cab (B777-2) stops sending voltage a signal to Control unit frame option (D797-O) when the cab leaves the lowest position.	U = 24 V	*Sensor lowered cab, description page 85*.
14	Control unit frame option (D797-O) sends “cab lifted” on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics*, group *11.5.4 Control units*.

Pos	Explanation	Signal description	Reference
15	Sensor damping end-position (B769-2) sends voltage signal to control unit cab (D790-1) when the cab is close to the end-position.	U = 24 V	*Sensor damping end-position, description page 86*.
16	Control unit cab (D790-1) sends "damp cab lift" on the CAN bus.	Checked by control system, error shown with error code.	Section *11 Common electrics*, group *11.5.4 Control units*.
17	Control unit frame option (D797-O) reduces the control current to Servo valve lift cab (Y6016) *or Servo valve lower cab (Y6017)* in control valve option frame.	-	Section *11 Common electrics*, group *11.5.4 Control units*.
18	Servo valve lift cab (Y6016) *or Servo valve lower cab (Y6017)* controls the pressure to the cab movement spool in control valve option frame.	-	*Control valve option frame, description page 82*.
19	Control valve option frame reduces hydraulic pressure to valve block for lifting and lowering cab.	-	*Control valve option frame, description page 82*.
20	Valve block lift cylinder for lifting and lowering cab lets pressure through to hydraulic cylinder for lifting and lowering cab.	-	*Load control valve, description page 83*.
21	Hydraulic cylinder for lifting and lowering cab reduces speed of lifting or lowering the cab.	-	*Hydraulic cylinder cab lift and lowering, description page 83*.

9.10.5.1 Hydraulic oil pump

Hydraulic oil pump, description

The hydraulic cab movement (sliding cab) is supplied with pressure from hydraulic oil pump 1 and 2, see section *10 Common hydraulics*, group *10.4.2 Axial piston pump with variable displacement*.



1. Load signal (LS)
2. Pressure supply (P)
3. Tank return (T1)
4. Connection hydraulic cylinder (B)
5. Tank return (TP)
6. Connection hydraulic cylinder (A)

9.10.5.2 Manouevre valve option frame

Control valve option frame, description

Cabs that can be lifted and lowered are controlled by a separate section of control valve option frame, for details see *Control valve option frame, description page 75*.

Valve slide, raise/lower cab

The valve slide controls direction and speed of sliding cab by controlling hydraulic motor pressure, sliding cab.

The valve slide is controlled by servo valve raise cab and servo valve lower cab.

Servo valve lift cab

Servo valve raise cab controls servo pressure to valve slide raise/lower cab so that this controls oil pressure to hydraulic cylinder cab lift and lowering to raise the cab.

Servo valve lift cab is controlled electrically with solenoid valve (Y6016) which is activated by Control unit frame option (D797-O).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.2 SLIDING-CAB, menu 3*.

Servo valve lower cab

Servo valve lower cab controls servo pressure to valve slide raise/lower cab so that this drains hydraulic cylinder cab lift and lowering to lower the cab.

Servo valve lower cab is controlled electrically with solenoid valve (Y6017) which is activated by Control unit frame option (D797-O).

Servo valve lower cab can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.2 SLIDING-CAB, menu 4*.

9.10.5.3 Shuttle valve option frame

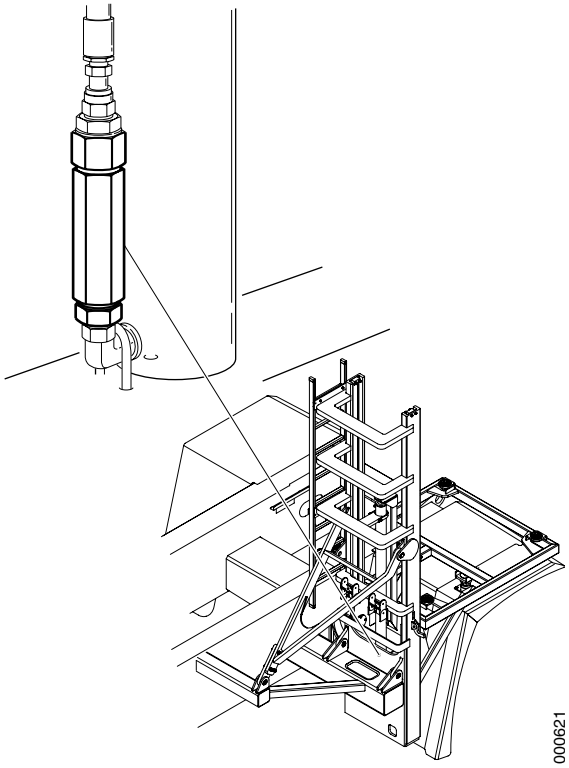
Shuttle valve option frame, description

See section *10 Common hydraulics*, group *10.5.3 Shuttle valve*.

9.10.5.4 Accumulator vertically adjustable cab

Accumulator cab lift and lowering, description

The accumulator stores pressure so that the cab does not lower if the engine stops and the machine becomes depressurised.



9.10.5.5 Load control valve

Load control valve, description

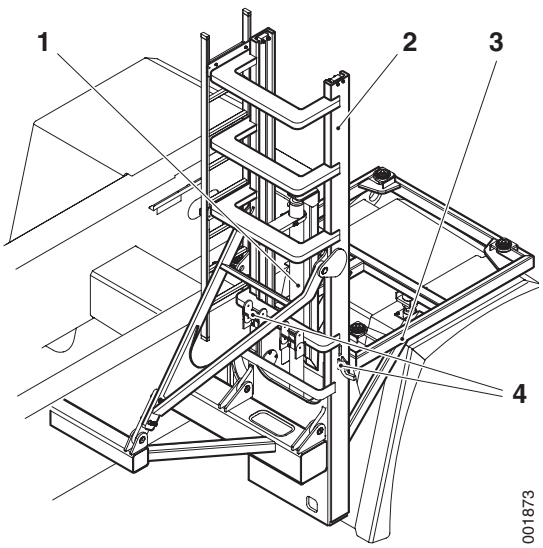
The load control valve reduces the speed when lowering the cab.

When the pressure is released behind the cab, the valve spool changes position and restricts the channel through the valve.

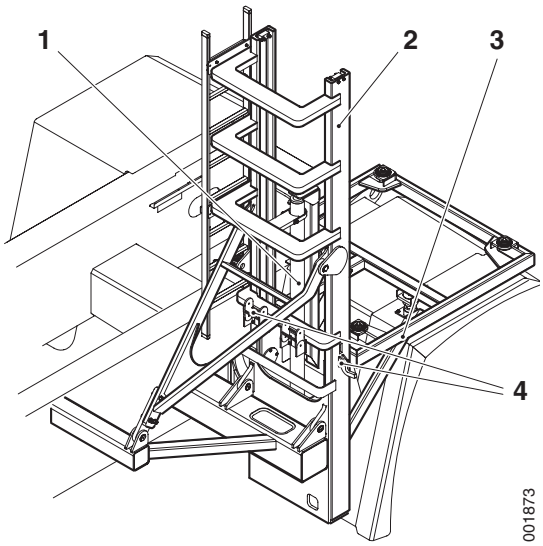
9.10.5.6 Hydraulic cylinder vertically adjustable cab

Hydraulic cylinder cab lift and lowering, description

The hydraulic cylinder lifts the inner mast and thus the cab.



1. Hydraulic cylinder, cab lift and lowering
2. Mast, cab lift and lowering
3. Cab undercarriage, cab lift and lowering
4. Safety lock



1. Hydraulic cylinder, cab lift and lowering
2. Mast, cab lift and lowering
3. Cab undercarriage, cab lift and lowering
4. Safety lock

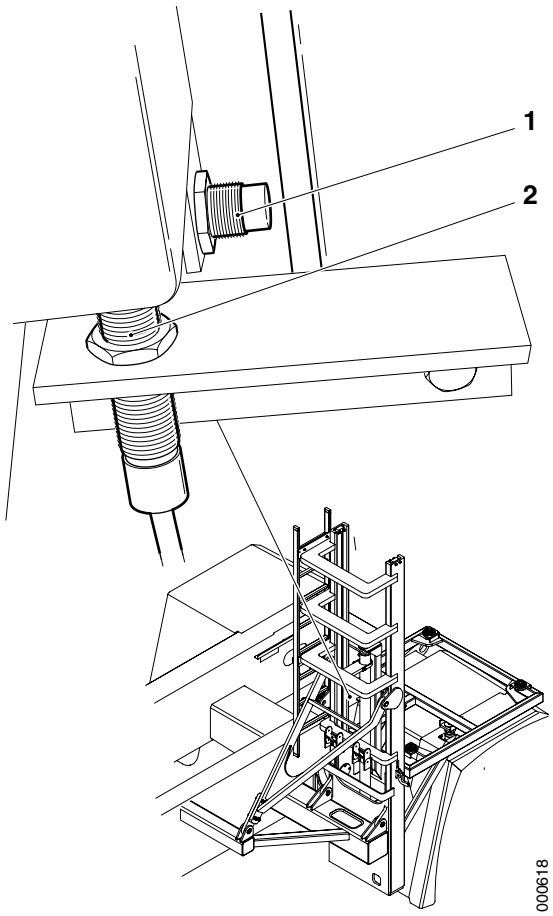
Hydraulic cylinders, repairing

See section *10 Common hydraulics,* group *10.7.1 Hydraulic cylinders*.

9.10.5.7 Mast vertically adjustable cab

Frame cab lift and lowering, description

The mast holds the cab secure and enables raising and lowering.



1. Sensor, end-position damping
2. Sensor, end-position lowered cab

9.10.5.8 Sensor lowered cab

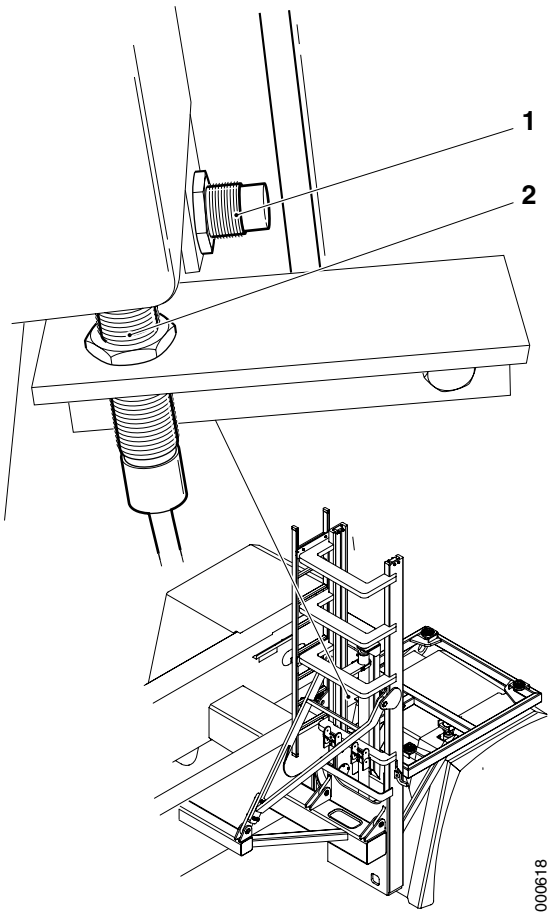
Sensor lowered cab, description

The sensor indicates when the cab is completely lowered. When the cab is lifted, the machine's speed is reduced and the transmission is locked in second gear.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.2 SLIDING-CAB, menu 2*.

Position sensor, checking and adjustment

See section *7 Load handling*.



1. Sensor, end-position damping
2. Sensor, end-position lowered cab

9.10.5.9 Sensor damping, end position

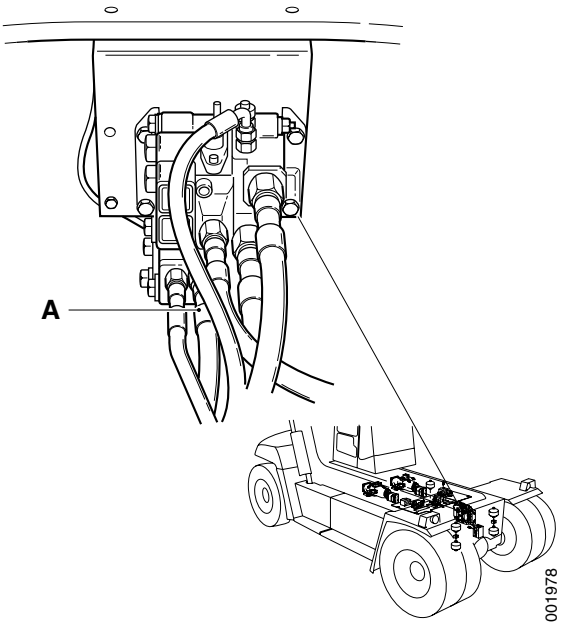
Sensor damping end-position, description

The damping sensor indicates when the cab is close to end-position. This is used to activate end-position damping. When the cab is lifted, the machine's speed is reduced and the transmission is locked in second gear.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.11.2 SLIDING-CAB, menu 2*.

Position sensor, checking and adjustment

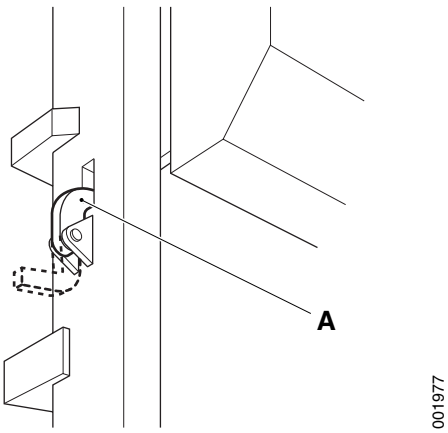
See section *7 Load handling*.



9.10.5.10 Emergency control valve

Emergency lowering valve, description

The emergency lowering valve opens a connection between the hydraulic cylinder's piston side and tank, and makes it possible to lower the cab is the machine loses all pressure or electric power.



9.10.5.11 Safety lock vertically adjustable cab

Safety lock cab lift and lowering, description

On the frame there are two lock braces that are used to secure the cab in lifted position for maintenance work with raised cab.

9.11 Cab interia

9.11.1 Instrument and control panels

Dashboard panel, description

The dashboard panel is secured to the steering column and contains warning and indicator lamps, display (KID), function keys (KIT) and switches.

See *Operator's manual DRF 400–450* for details of design and components.

Left-hand dashboard panel, description

The left-hand dashboard panel is located in the left-hand corner of the cab. It contains control knobs, switches and ventilation.

See *Operator's manual DRF 400–450* for details of design and components.

Panel for hydraulic functions, description

The hydraulic panel is combined with hydraulic controls and is fitted on the driver's seat. The panel contains switches and emergency switches for hydraulic functions.

See *Operator's manual DRF 400–450* for details of design and components.

Dashboard panel, replacement

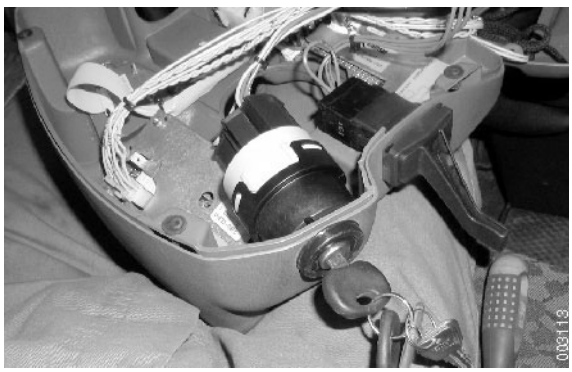
1 Machine in service position, see section *B Safety*.

2 Remove the steering wheel centre cover.

3 Remove the nut and the steering wheel.

4 Remove the bolts on the underside of the dashboard panel.

5 Remove the bolts on the top of the dashboard panel.



6 Detach the connector from the multi-function lever, ignition key lock, KIT and KID.

7 Transfer the components to the new steering wheel cover.

8 Fit in the reverse order.

9.11.2 Interior details plastic

Interior plastic parts, description

The interior of the cab consists of recyclable material.

9.11.3 Interior details textile

Interior textile/fabric parts, description

The interior of the cab consists of recyclable material.

9.11.4 Flooring material

Floor covering, description

The floor covering is a wear-resistant and recyclable material.

9.11.5 Insulation

Insulation, description

The cab insulation consists of recyclable material.

9.11.6 Sunshield curtains

Sun shades, description

Sun blinds can be specified for the front window (windscreen) and the roof window.

1. Sun visor, front window: Can be raised and lowered using a cord on the right-hand side. Stops in selected position.
2. Sun visor, roof window: Extendable forward to fasten in two hooks in the front edge of the window.

9.11.7 Terminal table

Terminal table, description

The function of terminal desk is to provide a work surface for a computer/terminal. It is located to the right of the steering wheel, easily accessible for the operator.

9.11.8 Writing-desk

Writing table, description

The writing desk with reading lamp is fitted on a jointed bracket to the right in front of the door in the cab. Work orders etc. can be attached there.

9.12 Frame

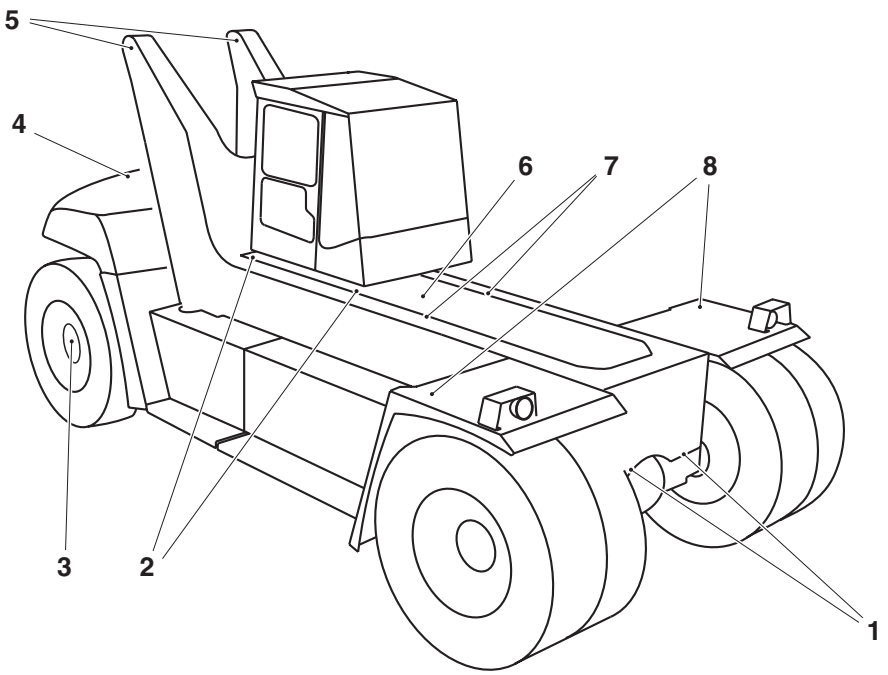
Chassis, description

The frame is a modular construction and consists of front section, rear section and a beam pair. This construction results in advantages in terms of rigidity and strength.

There are mounting points in the frame for engine, gearbox, drive axle, steering axle, fuel and hydraulic tanks, cab, boom and body parts.

The space in the rear section of the frame is used for counterweights, the amount of which is adapted to the machine in question. The counterweights are designed to allow as good a view backwards as possible.

The front wings are bolted into the frame (which has advantages when delivering the machine).

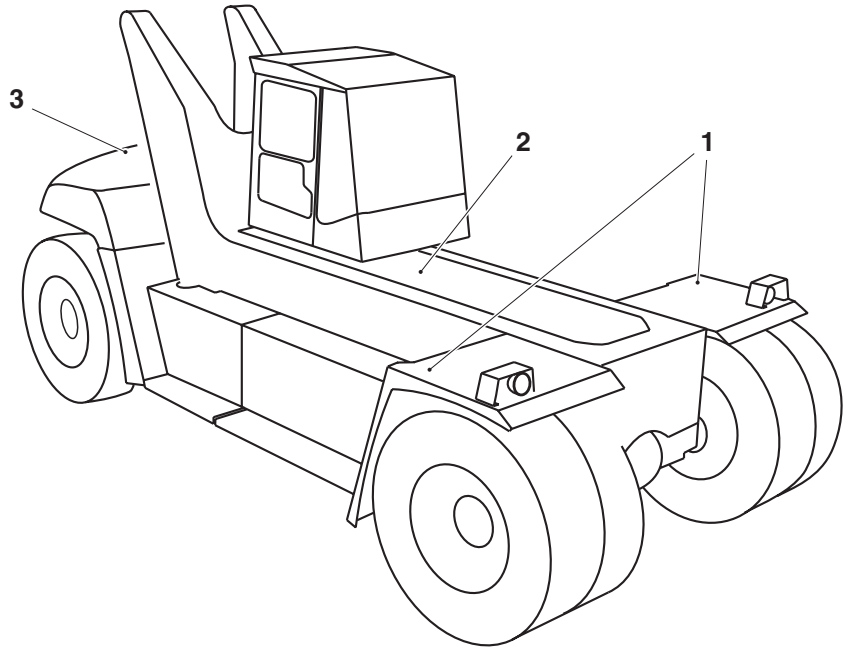


1. Frame's front part with drive axle mounting
2. Cab mounts (4 points)
3. Steering axle mounting
4. Frame's rear part with counterweights
5. Boom mounting
6. Engine compartment with mounts for engine and transmission
7. Member pair
8. Mounts front wings

9.13 Body structure

Body, description

The body's components comprise:



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1. Wings
2. Hood engine compartment
3. Counterweight

9.13.1 Fenders

Wings, description

There are wings over the wheels to protect from dirt thrown up by the wheels during operation. The design of the counterweight (see *Counterweights, description page 93*) acts as a mudguard for the rear wheels.

The wings can be equipped with extra mudguards when cleanliness requirements are high (⊕).

9.13.2 Hood engine compartment

Hood engine compartment, description

The machine's engine bay is protected by a hood. The hood is divided into several sections and they are secured with attaching bolts. The hoods are designed to fold over and they are ribbed for a good grip.

9.13.3 Footstep and rail

Steps and rails, description

The cab area has footsteps for easy access. There is a rail by the cab area.

The rail is also available with front wings (⊕).

9.13.4 Counterweights

Counterweights, description

The machine has counterweights to balance the machine's lift capacity and may therefore vary in quantity and weight.

The counterweights are located at the very back on the frame for maximal leverage.

The machine has counterweights in the following places:

- Under the steering axle
- Furthest back on the machine there are vertical counterweights secured in the rear edge of the machine, the outer has a towing eye.

  Between the outer one and the frame are smaller counterweights whose dimensions and quantity are adapted to balance the machine's lifting capacity.
- Upper horizontal counterweight.

  Under the horizontal counterweight are smaller counterweights whose dimensions and quantity are adapted to balance the machine's lifting capacity.

⚠ DANGER

The counterweights are factory fitted and are adapted according to the machine's properties.

The machine's operating characteristics are changed!

Never change the quantity of counterweights.

9.14 Central lubrication

Central lubrication, description

For a description of central lubrication, see *Maintenance manual DRF 400–450*.

For detailed information and a description of central lubrication, see the supplier's documentation.

9.15 Paint/coatings

Paint and surface finish, description

Single layer paint, thickness 120 my. The machine's colour is chosen by the customer. For colour code (RAL), see machine card.

Table of Contents 10 Common hydraulics

10 Common hydraulics

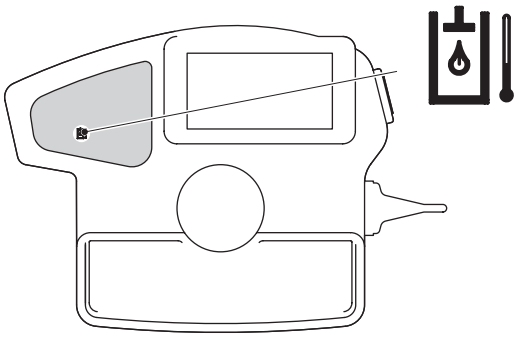
10.1 Controls and instrumentation

10.1.1 Warning light hydraulic oil temperature

Warning light hydraulic oil temperature, description

The light is activated when the hydraulic oil temperature is high.

The light in the cab is supplied with voltage by Control unit, KIT (D790-2).



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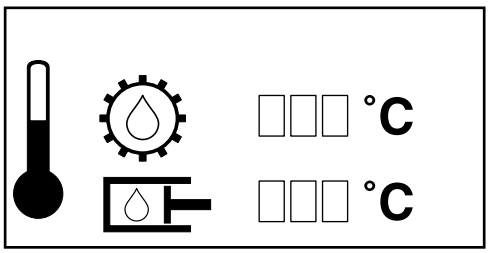
10.1.2 Operating menu hydraulic oil temperature

Operating menu hydraulic oil temperature, description

The temperature of the hydraulic oil and transmission oil is shown on the same operating menu.



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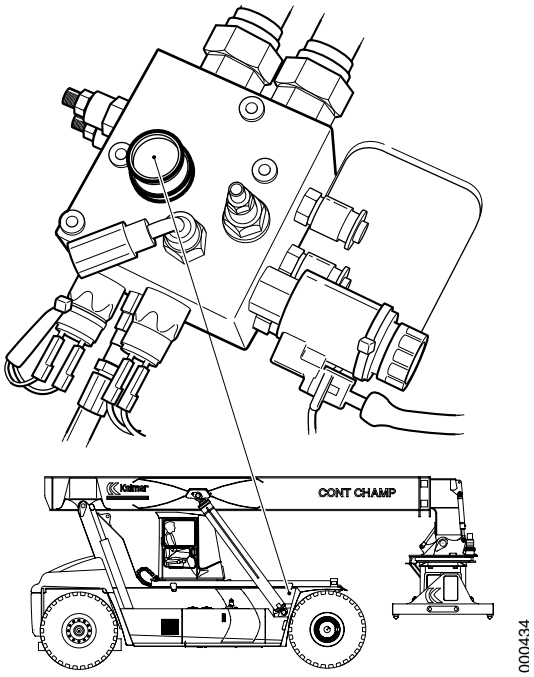
10.2 Security valves

10.2.1 Accumulator drain valve

Accumulator drain valve, description

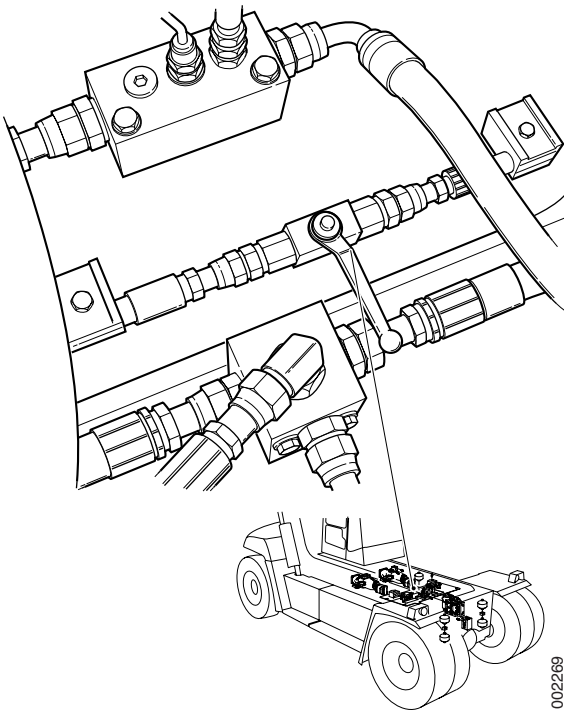
The accumulator drain valve is located on the accumulator charging valve. See section *4 Brakes*, group *4.3.3 Accumulator charging valve*.



10.2.2 Unloading valve attachment

Relief valve attachment, description

The relief valve is located on the lift cylinder beam. See section *7 Load handling*, group *7.4.8 Accumulator charging valve*.



10.2.3 Pipes and hoses

Pipes and hoses, general

See *Pipes and hoses, general page 19*.

10.3 Tanks and accumulators

10.3.1 Tank

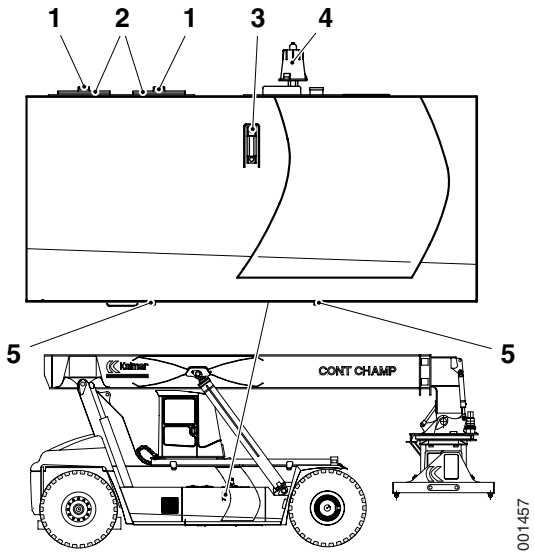
Tank, description

The hydraulic oil tank forms part of the side panel on the right-hand side of the machine. Inside the tank is the working hydraulic oil filter. These are accessible through hatches on top of the tank.

Hydraulic oil is filled directly into the tank through the filler caps on the filter manhole covers. For oil capacity and grade, see section *F Technical data*. The entire filter unit can be removed to facilitate access for cleaning. There is a drain plug at the bottom of the tank.

The tank has filtered venting which allows changes in the tank volume due to usage and temperature variations.

The oil level is checked on the level glass on the tank's side when all hydraulic cylinders are in the bottom position.

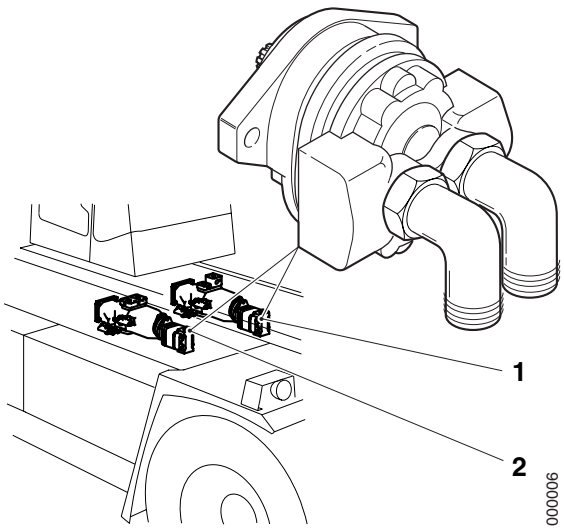


1. Filler plug hydraulic oil
2. Cap for hydraulic oil filter
3. Level glass, hydraulic oil
4. Breather filter, hydraulic oil tank
5. Drain plugs, hydraulic oil

10.3.2 Pipes and hoses

Pipes and hoses, general

See *Pipes and hoses, general page 19*.



1. Brake oil pump
2. Pump cooling and filtering

10.4 Pumps

10.4.1 Gear pump with fixed displacement

Gear pump with fixed displacement, description

There are two gear pumps with fixed displacement. One of them (position 1) pressurizes the brake system, see section *4 Brakes*, group *4.3.1 Brake fluid pump*. The other gear pump (position 2) circulates the hydraulic oil for the working hydraulics through a cooler and filters.

The gear pump pumps oil using two gears wheels that rotate opposite each other. One is driven by the pump's input shaft and the other rotates freely. The gear pump's flow is directly dependent on the speed of the input shaft.

The cooling pump is mounted on the right main pump and is driven by the main pump's shaft from the transmission's power take-off. The pump's speed is directly dependent on the engine speed. The pump's flow increases with the engine speed.

Gear pump replacement

WARNING

Hot and pressurised oil.

Personal injury, burn injury, rash or irritation

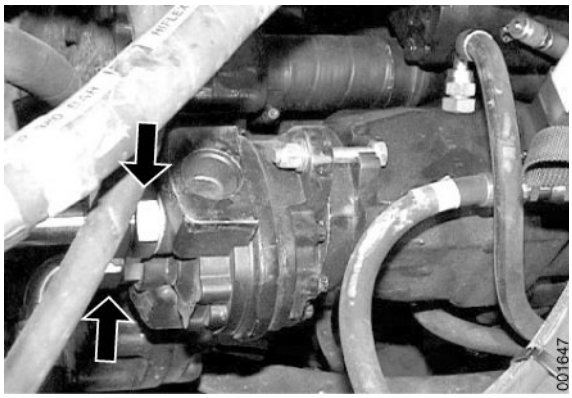
Always depressurize the hydraulic systems before starting work on any part of them. Avoid contact with the oil. Wear protective gloves.

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

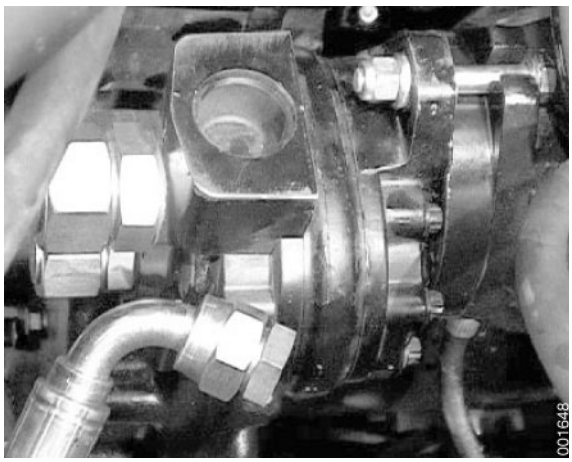
2 Clean the hydraulic oil pumps and the area round them.

3 Depressurize the brake and hydraulic systems, see section *B Safety*.

4 Place a container underneath the gearbox to collect spilled oil.



5 Mark up and release the hydraulic hoses from the gear pump.



6 Remove the gear pump.

Remove the retaining bolts, and pull the pump backwards and lift it away.

7 Transfer the connection adapters to the new gear pump.

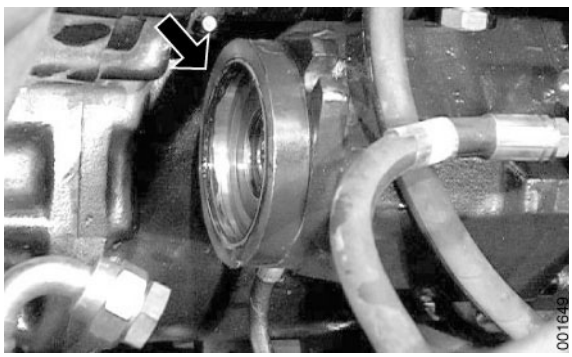
8 Remove the spacer ring from the gear pump or axial piston pump.

Clean the O-ring contact surfaces on the spacer ring.

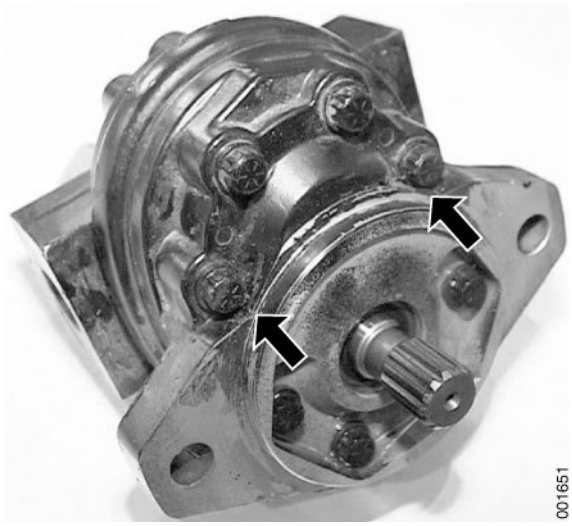
9 Inspect the O-rings and change as necessary. Fit the O-rings on the spacer ring. Coat the mating surface on the gear pump with sealing silicone, see section *F Technical data*.

NOTE

Only use silicone on one side, the side against the gear pump.



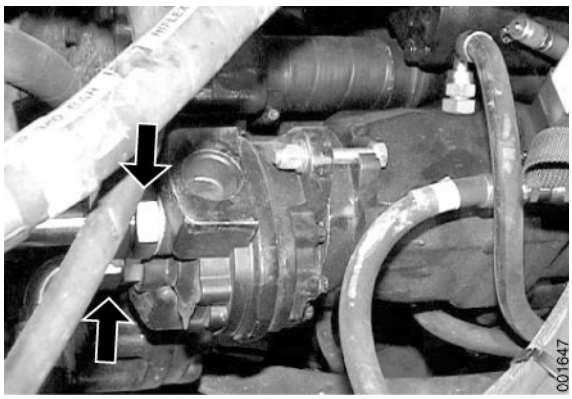
10 Fit the spacer ring on the axial piston pump.



11 Smear sealing silicone on the surface of the gear pump where the spacer ring is fitted, see section *F Technical data*.

12 Fit the gear pump and axial piston pump.

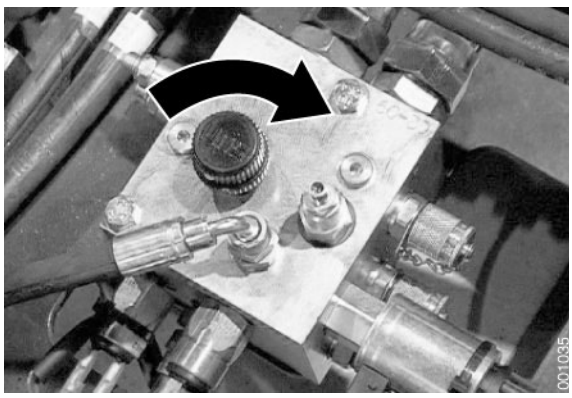
Position the pump, checking that the gear meshes with the shaft and that the spacer ring is squarely in place against the gear pump. Fit the pump retaining screws.



13 Connect the hydraulic hoses to the gear pump.

NOTE

Check that the O rings are intact and are fitted correctly.



14 Close the drain valve on the accumulator charging valve.

15 Turn on the power supply and start the engine.

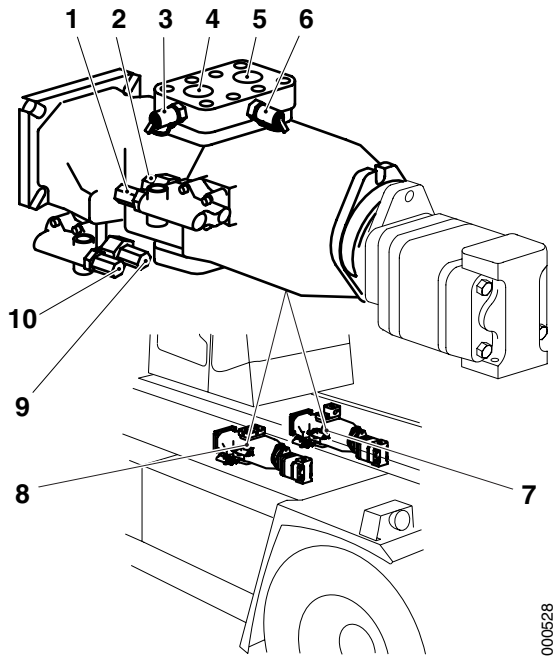
16 Check that the hose connections and seal between gear pump and axial piston pump are airtight.

17 Remove the container, treat spilled oil as environmentally hazardous waste.

18 Check the oil level in the brake or hydraulic system, depending on which pump has been changed. Top up as necessary.

NOTE

If the pump is replaced due to malfunction, change the oil and filter as well.



Hydraulic oil pump unit

1. Adjusting screw, stand-by pressure of front pump
2. Adjusting screw, max. pressure of front pump
3. Test outlet, rear pump pressure
4. Connection, pressure side of rear pump
5. Connection, pressure side of front pump
6. Test outlet, front pump pressure
7. Left hydraulic oil pump unit
8. Right hydraulic oil pump unit
9. Adjusting screw, max. pressure of rear pump
10. Adjusting screw, stand-by pressure of rear pump

10.4.2 Axial piston pump with variable displacement

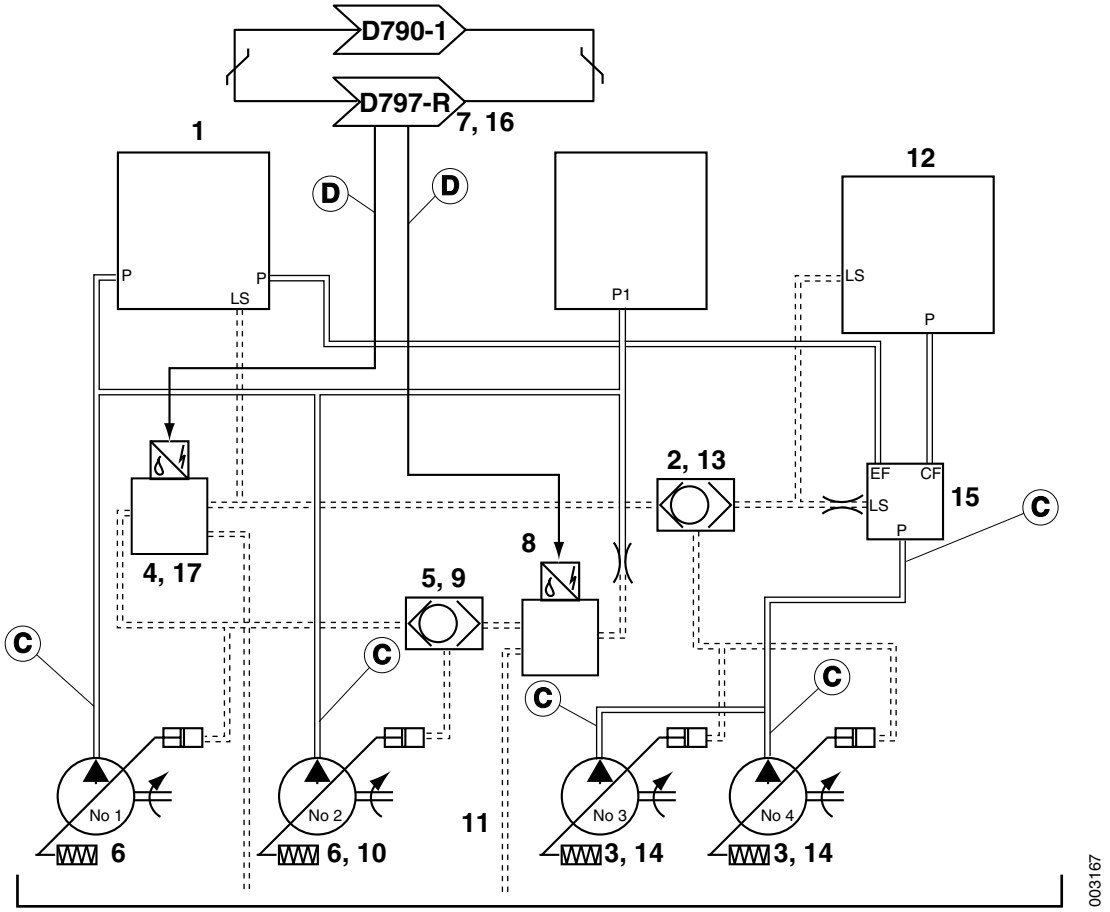
Axial piston pump with variable displacement, description

The hydraulic oil pumps are of the type variable axial piston pumps and are controlled with load signals depending on the flow demand from respective function.

The hydraulic pumps are assembled two and two with a connecting block. The connecting block directs oil to and from the pumps. On the connecting block, there's a spacer block containing test outlets for checking pump pressure. On the spacer block, there are non-return valves that prevent oil from being pumped around between the pumps instead of out into the hydraulic system.

One spacer block for the left pumps also contains a branching to the attachment hydraulics with a separate non-return valve.

Axial piston pump with variable displacement, function description



Pos	Explanation	Signal description	Reference
1	Control valve lift and extension sends load signal when a function is activated.	See pressure plate Servo pressure lift and extension on left frame member.	Section *7 Load handling*, group *7.2 Lift and lower*
2	Control signal goes to the shuttle valve that sends load signal on to hydraulic oil pump no. 3 and no. 4.	See pressure plate Servo pressure lift and extension on left frame member.	*Shuttle valve, description page 20*
3	Hydraulic oil pump no. 3 and no. 4 increase the flow.	See pressure plate Max. pressure hydraulic oil pumps on left frame member.	*Axial piston pump with variable displacement, description page 10*
4	Solenoid valve, unloading main pump (Y6062) leads load signal on to hydraulic oil pump no. 1 and the shuttle valve (position 5).	See pressure plate Servo pressure lift and extension on left frame member.	Section *7 Load handling*, group *7.2 Lift and lower*
5	The shuttle valve sends load signal on to hydraulic oil pump no. 2.	See pressure plate Servo pressure lift and extension on left frame member.	*Shuttle valve, description page 20*

Pos	Explanation	Signal description	Reference
6	Hydraulic oil pump no. 3 and no. 4 increase the flow.	See pressure plate Max. pressure hydraulic oil pumps on left frame member.	*Axial piston pump with variable displacement, description page 10*
7	If any attachment function is activated, then control unit frame rear (D797-R) activates solenoid valve top hydraulics (Y6003).	U = 24 V	Section *7 Load handling*, group *7.4 Sideshift*
8	Solenoid valve top hydraulics (Y6003) controls an unloaded constant pressure to hydraulic oil pump no. 2, this functions as a load signal.	-	Section *7 Load handling*, group *7.4 Sideshift*
9	The shuttle valve sends load signal on to hydraulic oil pump no. 2.	-	*Shuttle valve, description page 20*
10	Hydraulic oil pump no. 2 increases the flow.	See pressure plate Max. pressure hydraulic oil pumps on left frame member.	*Axial piston pump with variable displacement, description page 10*
11	When solenoid valve top hydraulics (Y6003) is not activated, the unloaded pressure is directed to tank.	-	Section *7 Load handling*, group *7.4 Sideshift*
12	The steering valve sends load signal when the steering wheel is turned.	-	Section *5 Steering*, group *5.2 Power-assisted steering system*
13	The shuttle valve sends load signal on to hydraulic oil pump no. 3 and no. 4.	-	Section *5 Steering*, group *5.2 Power-assisted steering system*
14	Hydraulic oil pump no. 3 and no. 4 increase the flow.	See pressure plate Steering pressure, on left frame member.	Section *5 Steering*, group *5.2 Power-assisted steering system*
15	Priority valve directs pressure from pumps to steering valve.	See pressure plate Steering pressure, on left frame member.	Section *5 Steering*, group *5.2 Power-assisted steering system*
16	At boom in, Solenoid valve pump unloading (Y6062) is activated.	U = 24 V	Section *7 Load handling*, group *7.3 Extension* Diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.8.2 BOOM, menu 2*
17	Solenoid valve pump unloading (Y6062) leads the pressure from the control valve to tank.	-	Section *7 Load handling*, group *7.3 Extension*

Axial piston pump with variable displacement, change

WARNING

Hot and pressurised oil.

Personal injury, burn injury, rash or irritation

Always depressurize the hydraulic systems before starting work on any part of them. Avoid contact with the oil. Wear protective gloves.

1 Remove the cover panels over the engine bay.
2 Clean the hydraulic oil pumps and the area round them.
3 Park the truck with the cab in its rearmost position and the boom fully raised and extended halfway.

CAUTION

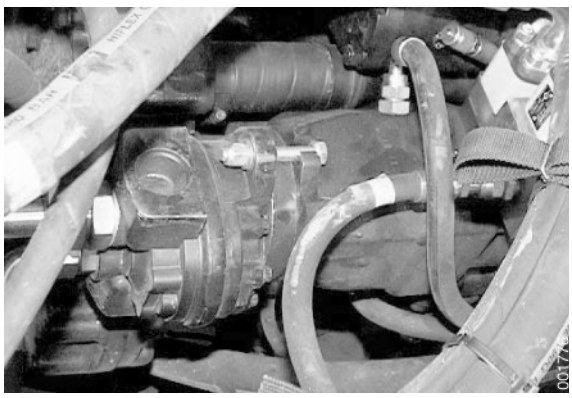
Oil discharge.

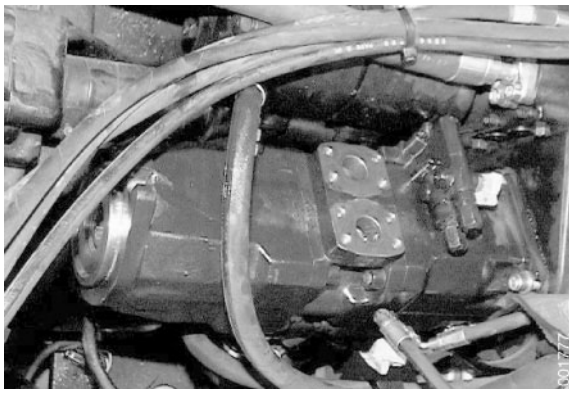
Environmental damage.

Make sure that the oil level in the hydraulic oil tank is below the mouth of the axial piston pump's suction hose.

If the premises do not permit the boom to be raised, the hydraulic oil tank will have to be drained, see *Maintenance manual DRF 400–450,* section *10 Common hydraulics,* group *10.6.8 Hydraulic oil*.

4 Disconnect the main power supply.
5 Place a receptacle under the gearbox to collect spilled oil.
6 Depressurize the brake and hydraulic systems, see section *B Safety*.
7 Detach the gear pump or cooling pump from the hydraulic oil pump, depending on which pump is to be changed.
8 Suspend the gear pump.
9 Use a plastic bag or the like to protect the connection to the gear pump.

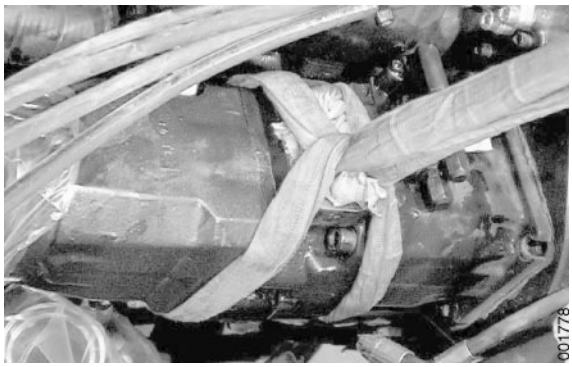




10 Mark the hydraulic hoses and disconnect them from the axial piston pump.

NOTE

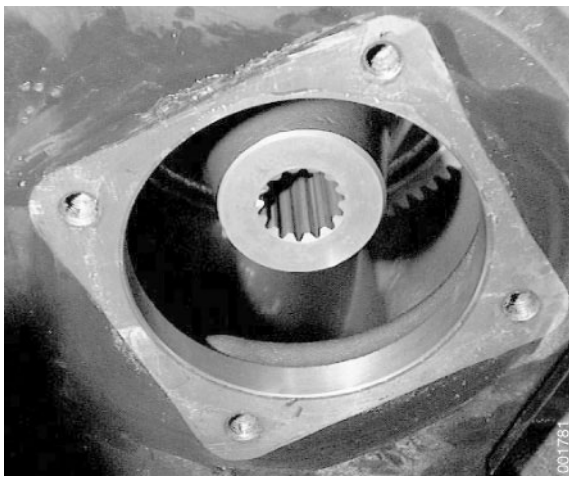
Plug all connections immediately to protect the hydraulic system from impurities.



11 Attach hoisting equipment to the axial piston pump.

12 Remove the axial piston pump.

Remove the retaining bolts and lift the pump away.



13 Clean the flange on the gearbox, removing all silicone remnants.

⚠ CAUTION

Gasket remnants could fall down into the gearbox.

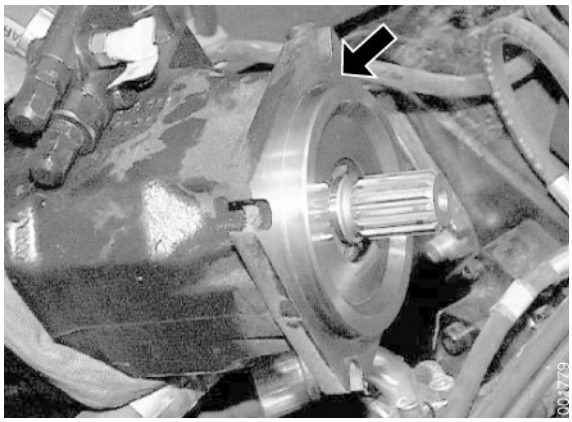
Product damage.

Exercise care to ensure that no gasket remnants fall down into the gearbox.

14 Transfer the connection adapters to the new axial piston pump.

NOTE

Check that the O-rings are intact and fitted correctly.

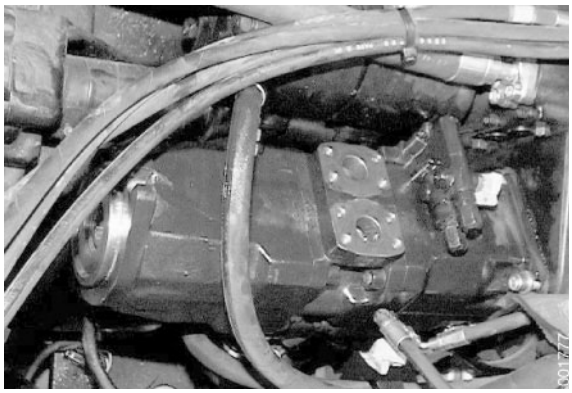


15 Coat sealing silicone on the axial piston pump flange where it mates with the gearbox, see *F Technical data*.

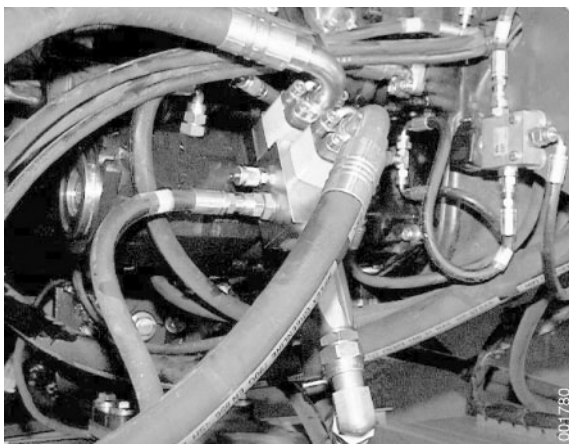
16 Fit the axial piston pump in place.

Position the axial piston pump so that the pump shaft meshes with the gearbox transmission. Fit the retaining bolts.

17 Connect the suction hose to the axial piston pump.



18 Fill the pump with oil through the connections at the top.



19 Connect the hydraulic hoses to the axial piston pump in accordance with the marking.

NOTE

Check that the O-rings are intact and fitted correctly.

20 If the spacer ring remains in place on the axial piston pump. Remove the spacer ring between the gear pump and axial piston pump.

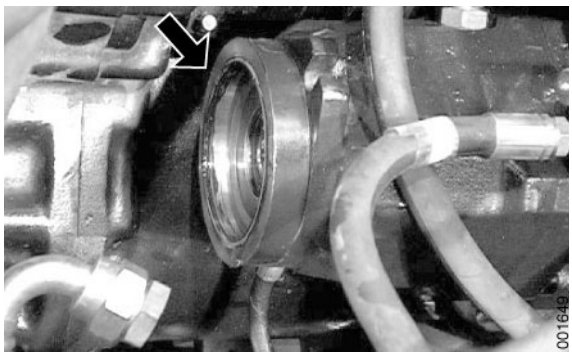
If the spacer ring remains in place on the gear pump, go to step 23.

Clean the O-ring contact surfaces on the spacer ring.

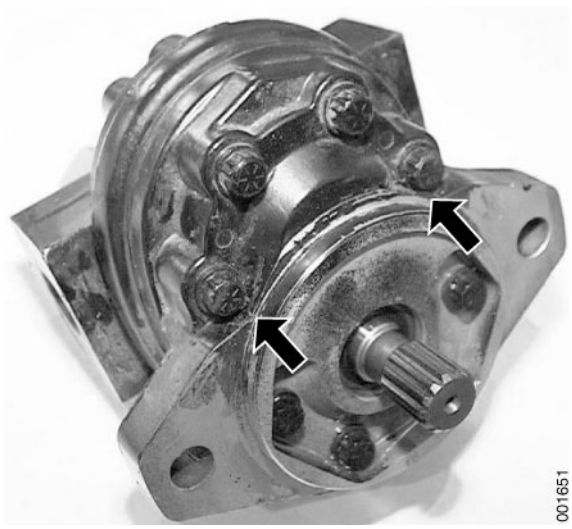
21 Inspect the O-rings and change as necessary. Fit the O-rings on the spacer ring. Coat the mating surface on the gear pump with sealing silicone, see section *F Technical data*.

NOTE

Only use silicone on one side, the side against the brake pump.

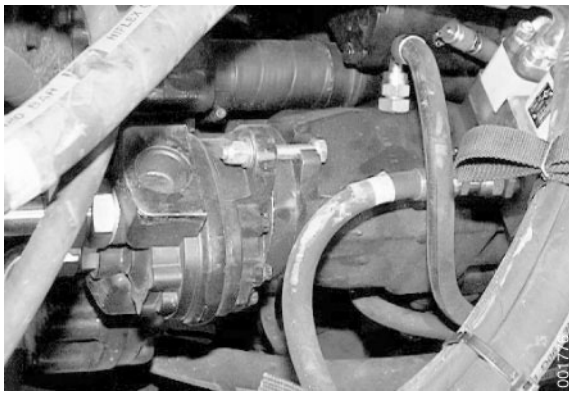


22 Fit the spacer ring on the axial piston pump.



The illustration shows a separate pump.

23 Smear sealing silicone on the surface of the gear pump where the spacer ring is fitted, see section *F Technical data*.



24 Fit the gear pump in place.

Mount the gear pump on the axial piston pump and insert the retaining bolts. Be careful to ensure that the O-ring on the spacer ring is correctly fitted and that the gear pump shaft meshes with the output shaft of the axial piston pump.

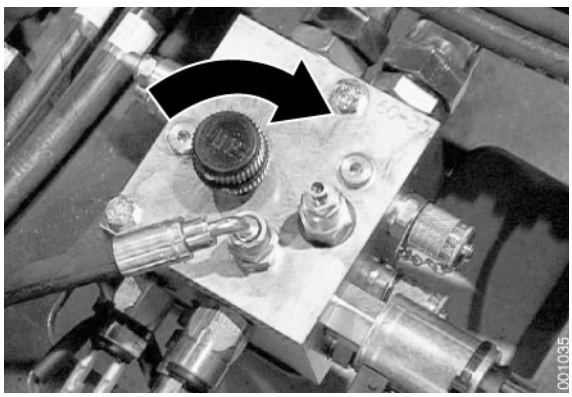
25 Vent the axial piston pump, see *Axial piston pump with variable displacement, venting page 18*.

⚠ CAUTION

Cavitation of the oil in the axial piston pump may occur.

Product damage.

Vent the axial piston pump before starting the engine.



26 Close the drain valve on the accumulator charging valve.

27 Turn on the power supply and start the engine.

28 Check that the hose connections and seal between gear pump and axial piston pump are airtight.

29 Check the pump pressures, see *Maintenance manual DRF 400–450,* section *10 Common hydraulics,* group *10.4.2 Axial piston pump with variable displacement*.

30 Remove the container, treat spilled oil as environmentally hazardous waste.

31 Fit the cover panels over the engine bay.

32 Check the oil level in the hydraulic oil tank. The oil level should reach up to the top of the sight glass. Top up if needed.

NOTE

If the pump is replaced due to malfunction, change the oil and filter in the hydraulic system as well.

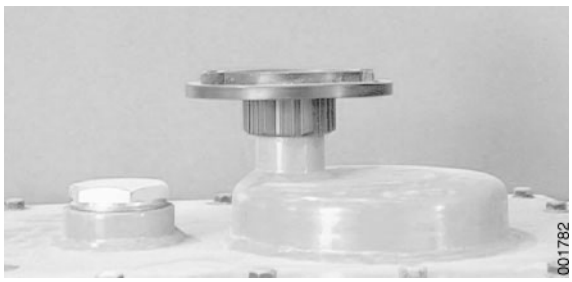
⚠ CAUTION

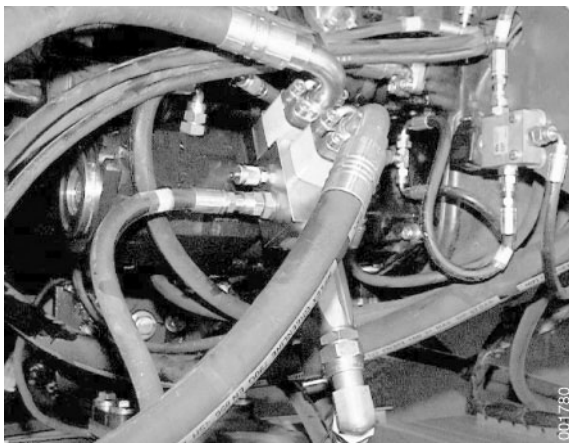
Overfilling the oil.

Leakage and environmental damage.

Check the hydraulic oil level with the boom fully lowered and retracted.

Axial piston pump with variable displacement, venting





1 Place a receptacle under the gearbox to collect spilled oil.
2 Remove the hydraulic oil tank breather filter.
3 Connect compressed air at a maximum pressure of 10 kPa to the hydraulic oil tank breather filter connection.
4 Loosen the hoses feeding the hydraulic system from the axial piston pump one at a time and allow the oil to run out. Tighten the connections when the oil running out is free from bubbles.
5 Remove the compressed air from the tank and fit the breather filter.
6 Turn on the power supply and start the engine.
7 Run the engine at idling speed for at least one minute. Check that all connections are tight and without leaks.
8 Lower the boom and raise it again very slowly so that the pump operates under minimum load while air pockets are eliminated.
9 Turn off the engine.
10 Remove the receptacle, treat the spilled oil as environmentally hazardous waste.
11 Wash the engine bay.
12 Fit the cover panels over the engine.

10.4.3 Pipes and hoses

Pipes and hoses, general

See *Pipes and hoses, general page 19*.

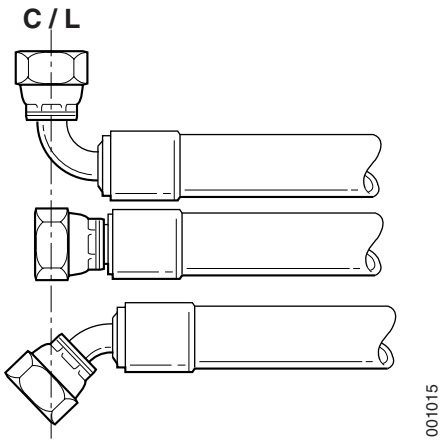
10.5 Hoses, pipes and valves

10.5.1 Pipes and hoses

Pipes and hoses, general

Hoses with ORFS couplings are used almost exclusively. For maximal service life and function, the following should be observed when changing hoses.

1. To avoid stresses in the connection, there should be a length of straight hose after the connection.
2. The hose may not be twisted. (A twist of 7% reduces service life by 90%.)
3. Minimize the number of bends by using correct couplings.
4. Avoid sharp bends.
5. Keep the hoses clean internally. Leave the plugs in place as long as possible when installing.



C/L line for measuring hose length

Hose length

The hose length is measured on a laid-out hose between the sealing surfaces. On angled connections, measure from the sealing surface's centre line [C/L] as illustrated.

Cleanliness

The function and service life of hydraulic components depend to a great extent on how clean the hydraulic oil is. Therefore, it is very important to prevent dirt from entering the brake and hydraulic system.

Some simple advice to keep the hydraulic system clean.

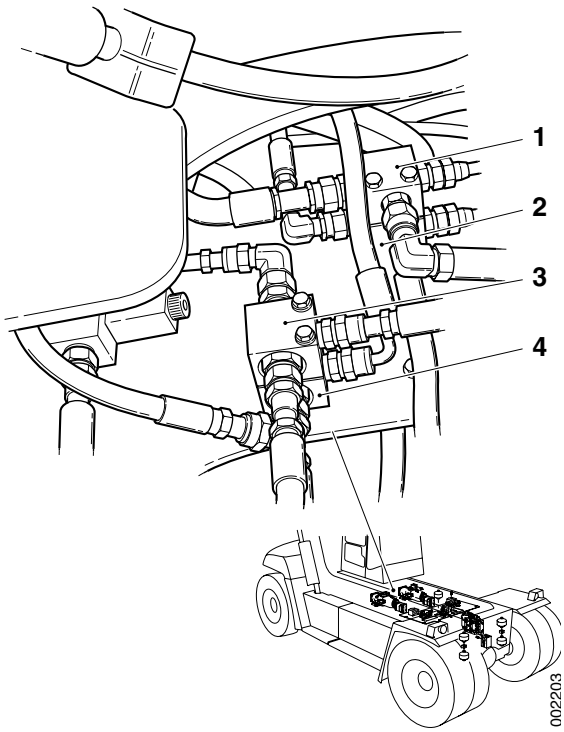
- Always clean the area around a component before starting to work.
- Plug hose connections immediately after disconnecting. If possible, use correct plugs for the connection type. If plugs are missing, use clean plastic bags and cable ties or tape to seal the connection.
- Never reuse oil that has been drained from the machine.
- If possible, filter the oil before pouring it into the machine, oil barrels often contain impurities.

  When filling hydraulic oil, fill through the caps at the hydraulic oil filters in the tank so that the oil is filtered.

10.5.2 Priority valve

Priority valve, description

See section *5 Steering*, group *5.2.2 Priority valve*.



1. Shuttle valve attachment
2. Shuttle valve control
3. Shuttle valve, mini-wheel or lever steering ⊞
4. Shuttle valve, option frame ⊞

10.5.3 Shuttle valve

Shuttle valve, description

A shuttle valve chooses between two pressure signals and sends the strongest. Shuttle valves are used to send load signals to the hydraulic oil pumps. This results in control of the pumps by the function that requires the highest pressure if several functions are activated at the same time.

Depending on options, there are two to four shuttle valves. The shuttle valves are located on a bracket for oil filling between the engine and transmission.

The shuttle valves choose between the following control signals:

1. Chooses between load signal from the control valve for lift, lower and extension as well as the control signal from the control valve for attachment. The shuttle valve sends control signals on to main pump 4, see *Axial piston pump with variable displacement, description page 10*.
2. Chooses between the load signal from the control valve for lift, lower and extension as well as the control pressure from the control valve. The shuttle valve sends the control signal on to control hydraulic pump 2, see *Axial piston pump with variable displacement, description page 10*.
3. ⊞

   Chooses between the load signal from shuttle valve (position 4) or restriction to hydraulic oil pump 3 and 4, see *Axial piston pump with variable displacement, description page 10*.

   This shuttle valve is found if the machine is equipped with joystick steering or mini-wheel.
4. ⊞

   Chooses between the load signal from shuttle valve (position 2) or control valve option frame to hydraulic oil pump 2, see *Axial piston pump with variable displacement, description page 10*.

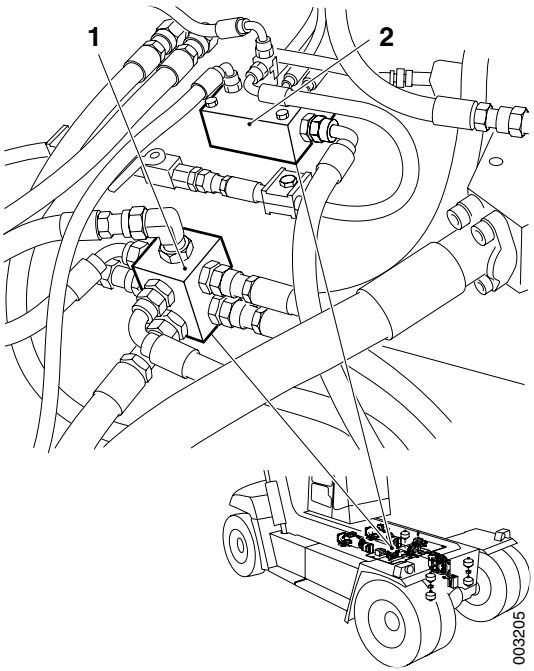
   This shuttle valve is found if the machine is equipped with support jacks, hydraulic sliding cab or cab lift and lowering.

10.5.4 Collection block filtered return

Multiblock, filtered return lines, description

The multiblock receives several return lines from different components and routes them back to the tank through the tank filters.

The block is located on top of the hoisting beam in front of the transmission.



1. Multiblock, unfiltered return lines
2. Multiblock filtered return lines

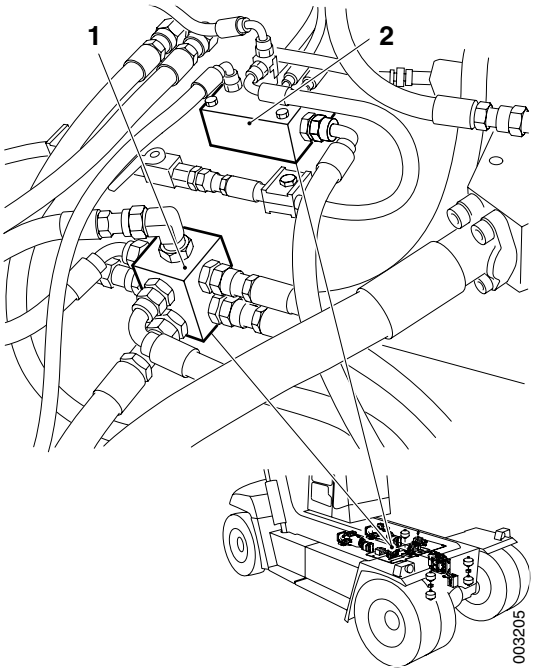
10.5.5 Collection block unfiltered return

Multiblock, unfiltered return lines, description

The multiblock receives several return drain lines from different valves and routes them straight back to the tank.

The drain lines are highly sensitive to counter pressure. If pressure builds up in the drain lines the valves will not work properly.

The block is mounted on the side of the hoisting beam in front of the transmission.



1. Multiblock, unfiltered return lines
2. Multiblock filtered return lines

10.6 Temperature control, cleaning and hydraulic oil

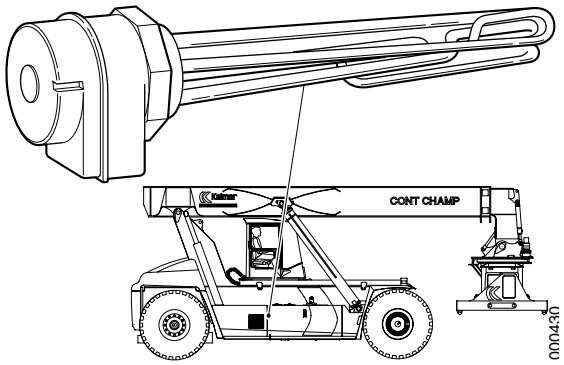
10.6.1 Tank heater

Tank heater, safety

CAUTION

The tank heater is connected to high voltage. Connection and reconnection of the tank heater may only be performed by personnel authorized for work with high voltage.

Tank heater, description



The tank can be equipped with a heater. The tank heater is designed for cold climates.

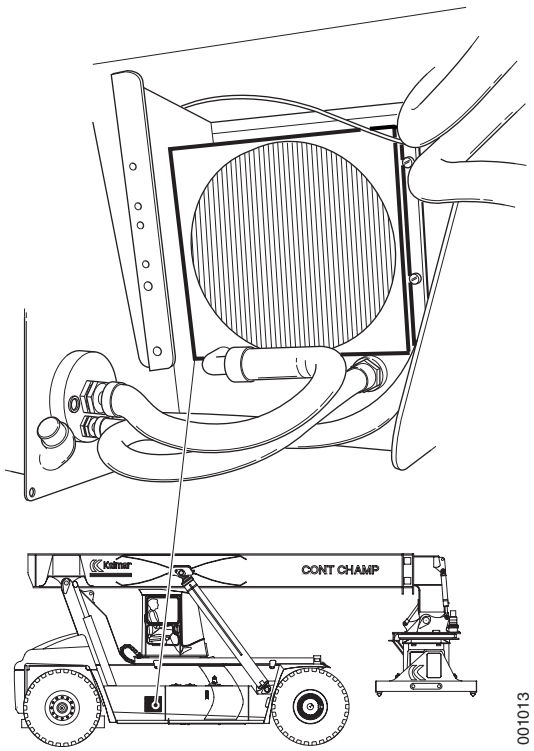
The tank heater runs off high-tension current. Heater output is adapted through different connections and adaptation to different input currents, 110, 230 or 400 V AC. Higher tensions give higher heater output. The heater is mounted in a hole in the connection cover at the bottom of the short side of the tank.

The tank heater can be fitted with an adjustable thermostat to maintain the temperature at a constant level. The thermostat is mounted directly on the heater element and can be adjusted by means of a knob on the junction box. The recommended temperature setting is 50°∠70° C.

10.6.2 Hydraulic oil cooler

Hydraulic oil cooler, description

An oil cooler of full-flow type with an electric cooling fan (same type of cooler as for the brake system) is used for the working hydraulics. The oil is cooled as it passes through the cooler. The cooler is situated behind the side panel on the right-hand side at the extreme rear in front of the steered wheels behind the hydraulic oil tank.



Hydraulic oil cooler, change

1 Turn off the engine and the main electrical power.

2 Place a receptacle under the hydraulic oil tank drain plug.

3 Remove the plug and drain the oil.

⚠ WARNING

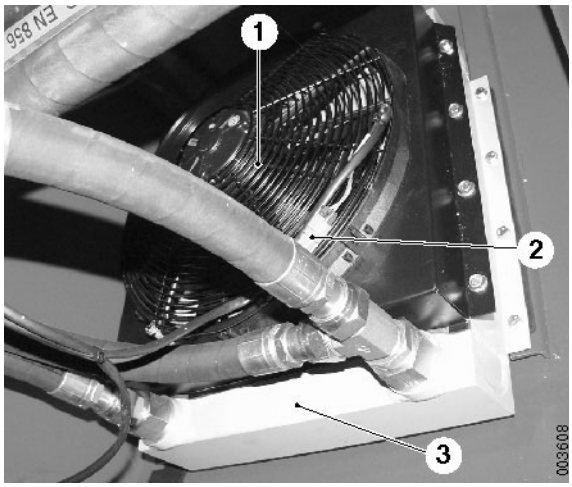
Warm oil.

Burns, rashes and irritation!

Avoid prolonged skin contact with the hydraulic oil. Use protective gloves and safety glasses.

4 Refit the drain plug when all the oil has run out.

5 Place a receptacle under the cooler to collect spilled oil.



1. Cooling fan
2. Connector
3. Cooler

6 Mark the hydraulic hoses and detach them from the cooler. Allow the oil in the cooler to run down into the receptacle.

NOTE

Plug all connections immediately to protect the hydraulic system from impurities.

7 Disconnect the cabling from the cooling fan.

8 Remove the cooler.

Undo the retaining bolts and lift the cooler away.

9 Transfer the cooling fan to the new oil cooler.

10 Fit the cooler in place.

11 Connect the cabling to the cooling fan.

12 Connect the hydraulic hoses to the cooler.

NOTE

Check that the O-rings are intact and fitted correctly.

13 Remove the receptacle, treat the spilled oil as environmentally hazardous waste.

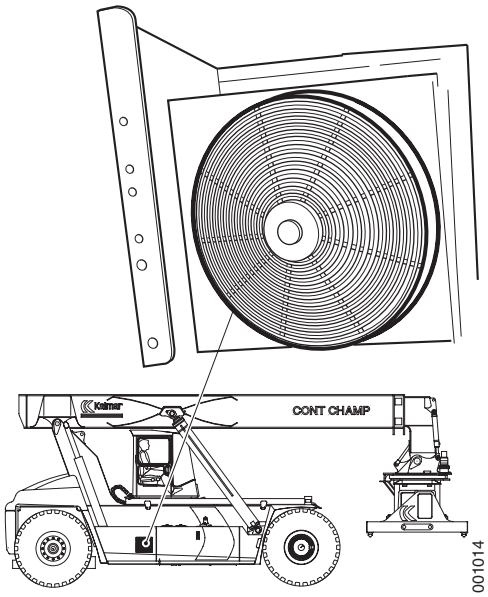
14 Fill the hydraulic oil tank with oil, see *Maintenance manual DRF 400–450,* section *10 Common hydraulics,* group *10.6.8 Hydraulic oil*. The oil level should be visible in the sight glass.

⚠ CAUTION

Overfilling the oil.

Leakage and environmental damage.

Check the hydraulic oil level with the boom fully lowered and retracted.



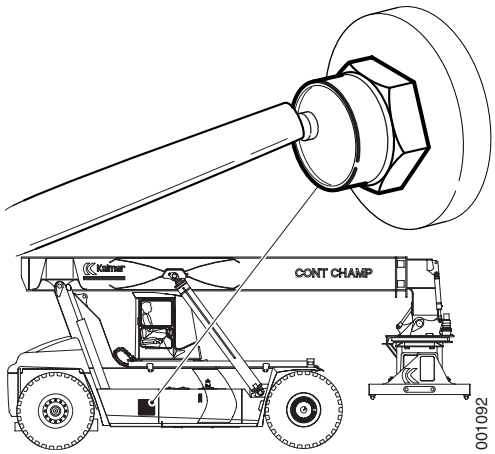
10.6.3 Cooling fan

Cooling fan, description

The electric cooling fan pushes the air. The cooling fan is located at the rear of the cooler. The fan draws air from the machine's outside through the cooler. Openings in the side cover allows air to pass through the cooler.

The cooler is supplied with voltage by Control unit frame rear (D797-R) when activated. The cooling fan is activated when the oil temperature in the hydraulic oil tank is 65 °C. The fan stops when the oil temperature is 55 °C.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.1 HYD, menu 1*.



10.6.4 Sensor hydraulic oil temperature

Sensor hydraulic oil temperature, description

Sensor hydraulic oil temperature (B776) senses the temperature of the hydraulic oil. The sensor is located on the hydraulic oil tank's rear short end.

The sensor senses the oil temperature in the tank and thus, it considers the accumulated heat in the hydraulic oil. This means that the cooling fan may continue to run after the machine has been parked and turned off.

Sensor hydraulic oil temperature (B776) is supplied with voltage by and sends a voltage signal proportional to oil temperature to Control unit, frame rear (D797-R).

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, group *8.4.5.1 HYD, menu 1*.

Hydraulic oil temperature sensor, change

1 Turn off the engine and the main electrical power.

2 Place a receptacle under the hydraulic oil tank drain plug.

3 Remove the plug and drain the oil.

WARNING

Warm oil.

Burns, rashes and irritation!

Avoid prolonged skin contact with the hydraulic oil. Use protective gloves and safety glasses.

4 Refit the drain plug when all the oil has run out.

5 Place a receptacle under the oil temperature sensor to collect spilled oil.

6 Disconnect the cabling from the oil temperature sensor.

7 Change the oil temperature sensor.

NOTE

Check that the O-rings are intact and fitted correctly.

8 Connect the cabling to the cooling fan.

9 Remove the receptacle, treat the spilled oil as environmentally hazardous waste.

10 Fill the hydraulic oil tank with oil, see *Maintenance manual DRF 400–450,* section *10 Common hydraulics,* group *10.6.8 Hydraulic oil*. The oil level should be visible in the level glass.

CAUTION

Overfilling the oil.

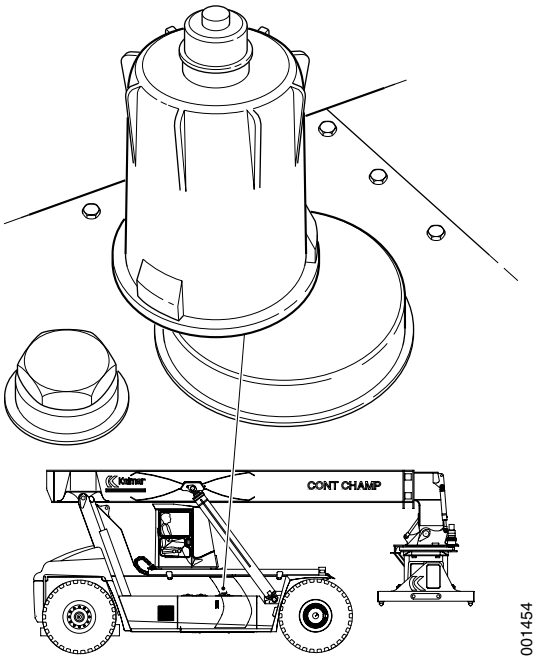
Leakage and environmental damage.

Check the hydraulic oil level with the boom fully lowered and retracted.

10.6.5 By-pass valve cooler

Cooler by-pass valve, description

The by-pass valve protects the cooler from overpressure. The valve opens a passage past the cooler straight to the tank if the resistance in the cooler becomes excessive.



10.6.6 Breather filter hydraulic oil tank

Breather filter hydraulic oil tank, description

A breather filter of insert type is mounted on the hydraulic oil tank to protect the tank from impurities. On top of the filter housing is an indicator that shows when the filter is clogged and should be changed.

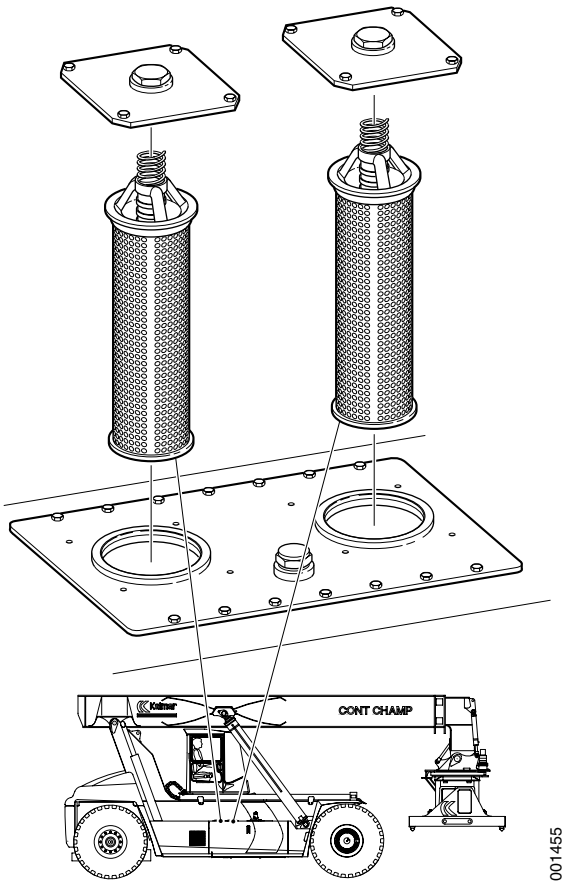
Breather filter hydraulic oil tank, changing

See *Maintenance manual DRF 400–450*.

10.6.7 Hydraulic oil filter

Hydraulic oil filter, description

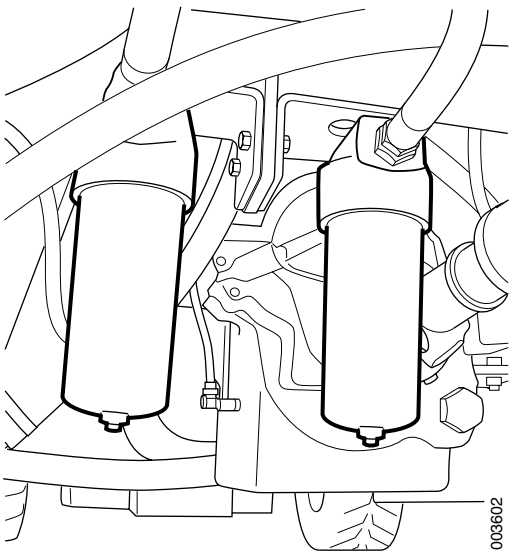
The oil in the hydraulic system is cleaned by two low-pressure filters located inside the hydraulic oil tank. The oil is pumped through the cooler and back through the filter by the cooling pump. Some of the return oil from the load handling function also passes through the filters.



Hydraulic oil filter, description (high-pressure filter)

(+)

As optional equipment the machine can be fitted with two extra high-pressure filters mounted immediately after the axial piston pumps. These filters are located in front of the gearbox under the hoisting beam. They are used together with the hydraulic oil filters in the tank.



Hydraulic oil filter, changing

See *Maintenance manual DRF 400–450*.

10.6.8 Hydraulic oil

Hydraulic oil, safety

WARNING

Rashes and irritation!

Avoid prolonged skin contact with the hydraulic oil. The oil is chemically aggressive.

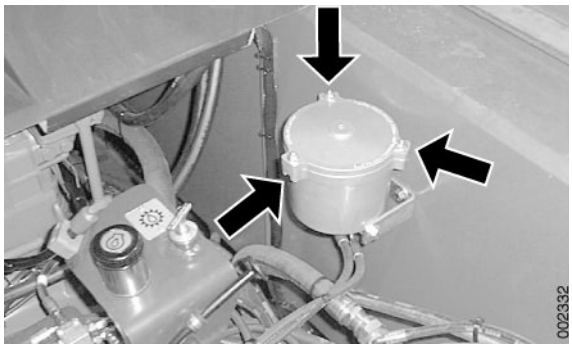
Use protective gloves and safety glasses.

Hydraulic oil, general

See section *F Technical data* and *Maintenance manual DRF 400–450*.

10.6.9 Hydraulic oil fine-filter

Fine filter hydraulic oil, description



The fine filter is mounted on the frame member in the engine bay. It is connected to the hydraulic oil pump cooling and filtration. The filter is connected in parallel with the hydraulic oil filters in the hydraulic oil tank.

The oil is pumped from the hydraulic oil tank through the fine filter and then back to the hydraulic oil tank.

The fine filter cleans a smaller volume of oil although with higher filtration when the machine is in operation.

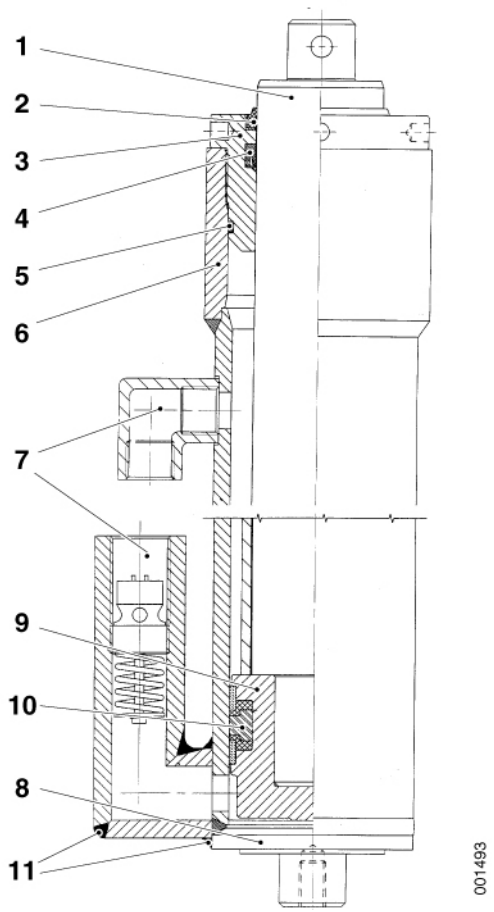
Fine filter hydraulic oil, changing

See *Maintenance manual DRF 400–450*.

10.6.10 Pipes and hoses

Pipes and hoses, general

See *Pipes and hoses, general page 19*.



1. Piston rod
2. Scraper
3. Cylinder head
4. Piston rod seal
5. O-ring with thrust ring
6. Cylinder barrel
7. Sleeve coupling
8. Welded cylinder end
9. Piston
10. Piston seal, double-acting
11. Example of weld

10.7 Hydraulic aux.

10.7.1 Hydraulic cylinders

Hydraulic cylinders, repairs

Fault tracing, leakage

CAUTION

All fault tracing should be carried out with as low a pressure in the system as possible so that the leakage can be detected. High pressure causes the seals to close tighter, which prevents detection of leaks.

1 Carefully check the source of the leakage before taking any action. It may be possible to rectify the fault without disassembly.

2 Check for external leakage:

- At cylinder end welds
- At sleeve coupling welds
- Between cylinder barrel and cylinder head

  This could be due to a defective O-ring or damaged O-ring sealing surfaces. Both faults can be rectified with the cylinder in site.
- Between cylinder head an piston rod

  This could be due to a damaged piston rod or damaged or worn piston rod seal.

3 Check for internal leakage. Pressurize the cylinder and check whether the piston sinks back.

This could be due to a worn piston seal.

Dismantling of cylinders

CAUTION

Before dismantling always check that the piston rod is clean and free from all residual paint. Also check that connections and couplings are free from burrs and impact marks. Make sure that the chamfer up to the chromium surface of the piston rod is free from burrs and residual paint.

1 Remove the cylinder from its mounting and undo the connections.

2 Plug the cylinder connections and hoses without delay.

3 If the cylinder is opened - observe the strictest cleanliness.

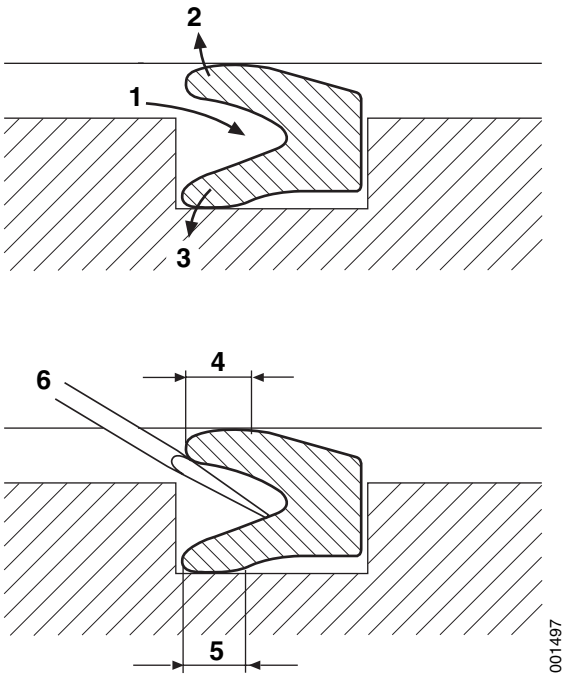
Inspection of surfaces

4 Inspect the sealing surfaces, always bearing mind the function of the seals and the type of sealing surfaces they have, see the following descriptions:

- O-ring groove, internal and external
- piston rod seal in the cylinder head
- Sealing groove on the piston
- cylinder barrel surface
- piston rod surface. The piston rod is chromium plated with a layer thickness of 20-50 m. Slight damage to the chromium plating need not necessarily be the direct cause of leakage.
- all sliding surfaces (dynamic surfaces), e.g. cylinder barrel and piston rod. These are always the hardest to seal.

⚠ CAUTION

When mounting the cylinder head: Introduce it absolutely straight, preferably by hand and never strike it with a mallet. If the cylinder head is skew as it enters, this could damage the sealing lip of the piston rod seal and its sealing function would then be lost. This applies to all types of piston rod seal



1. Hydraulic pressure
2. The sealing lip is pressed outwards against the piston rod
3. The sealing lip is pressed inwards against the cylinder head
4. Sealing surface, piston rod
5. Sealing surface, cylinder head
6. Screwdriver

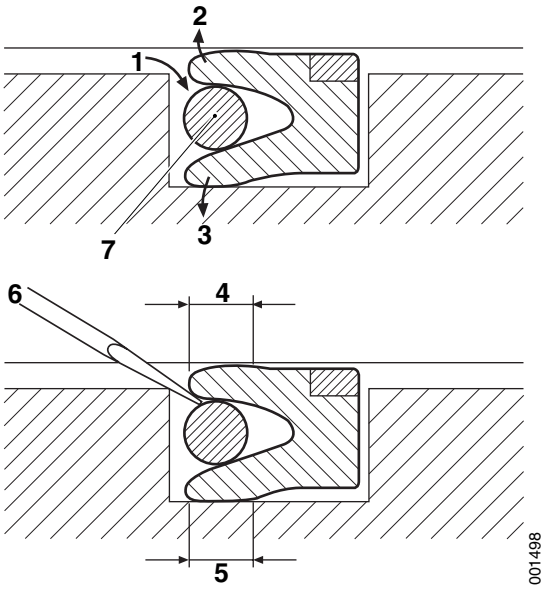
Function and removal of the seals

Piston rod seal

The piston rod seal sits in a groove in the cylinder head and seals against the piston rod. This seal is highly vulnerable as it seals both dynamically and statically, i.e. it seals against a moving surface on the piston rod while the sealing surface against the cylinder head is fixed. There are different kinds of piston rod seal:

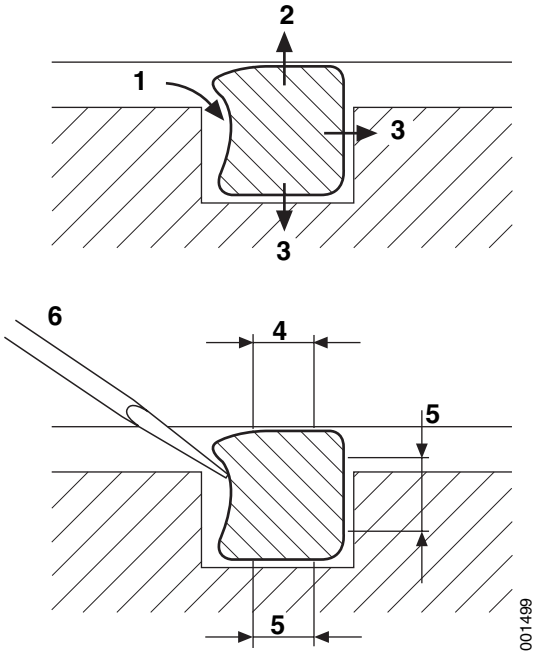
- Single V-ring seal
- Prestressed V-ring seal with thrust ring
- Compressible seal

The single V-ring seal has a V-shaped section with two lips, each sealing in its own direction. The hydraulic pressure acts in the V shape and presses the sealing lips outwards against the sealing surfaces on the piston rod and in the cylinder barrel. Even minor damage to the sealing lips can cause major leakage. Check the sealing lips by carefully feeling all round the seal with a fingernail. Use a screwdriver to remove the seal, see illustration. Lever outwards and prise up the seal. It is extremely important always to insert the screwdriver in the V shape so that it cannot touch and so damage any sealing surface. A mark made by the screwdriver on a sealing surface will have a devastating effect and give rise to serious leakage.



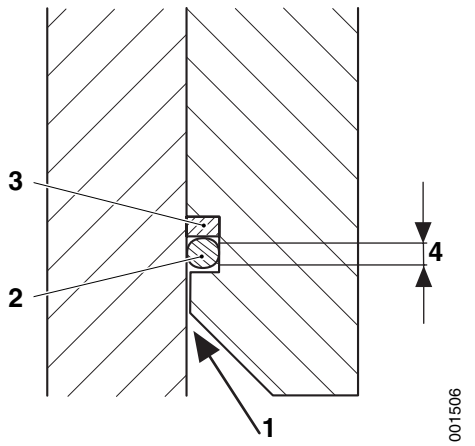
1. Hydraulic pressure
2. The sealing lip is pressed outwards against the piston rod
3. The sealing lip is pressed inwards against the cylinder head
4. Sealing surface, piston rod
5. Sealing surface, cylinder head
6. Screwdriver
7, O-ring

In addition, the prestressed V-ring seal has an O-ring in the V-shaped space of the seal. The O-ring has a highly efficient sealing effect at low hydraulic pressures as even when not under load the sealing lips are pressed outwards against the sealing surfaces. It is just as susceptible to damage as the V-ring seal. Inspect in the same way. Use a screwdriver to remove the seal, see illustration. Lever outwards and prise up the seal. It is extremely important always to insert the screwdriver in the V shape so that it cannot touch and so damage any sealing surface. A mark made by the screwdriver on a sealing surface will have a devastating effect and give rise to serious leakage.



1. Hydraulic pressure
2. The sealing lip is pressed outwards against the piston rod
3. The sealing lip is pressed inwards against the cylinder head
4. Sealing surface, piston rod
5. Sealing surface, cylinder head
6. Screwdriver

The compressible piston rod seal consists of a solid rubber section and has a larger sealing surface than the V-ring seals. Use a screwdriver to remove the seal, see illustration. Lever outwards and prise up the seal. With this type of seal where the sealing surfaces cover such a large part of the sealing groove it is especially important to ensure that the screwdriver does not slip and leave any marks



1. Hydraulic pressure
2. O-ring
3. Thrust ring
4. Sealing surface, cylinder head

Thrust ring and O-ring

The thrust ring and O-ring combination is used for sealing between two fixed surfaces, such as between cylinder barrel and cylinder head.

The purpose of the thrust ring is to lend rigidity to the O-ring so that it is not deformed. The O-ring is pressed against the thrust ring and the sealing surface by the hydraulic pressure in the cylinder.

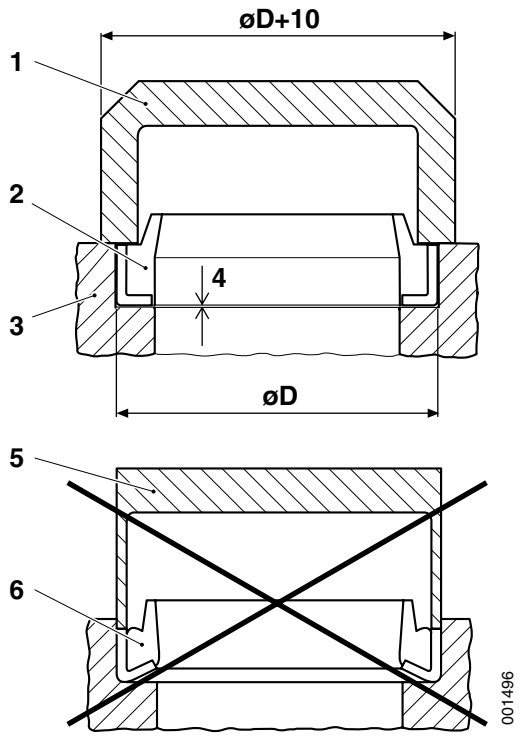
When fitting the cylinder head: Exercise care to avoid damaging the O-ring.

Scraper

The purpose of the scraper is to scrape the piston rod clean and prevent impurities from entering the cylinder barrel.

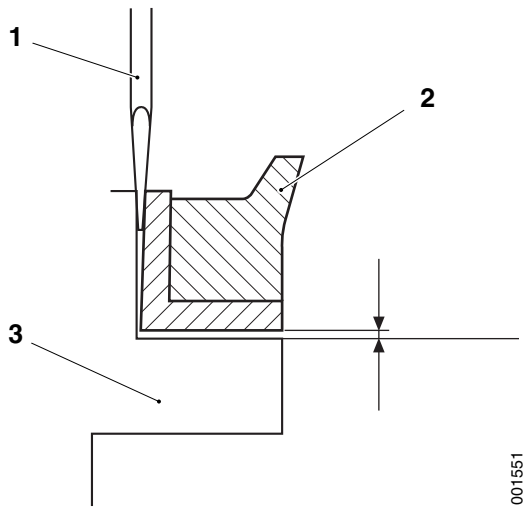
The scraper should be fitted using a special assembly tool. This tool should have a larger outside diameter than the scraper so that the pressing force exerted on the scraper ceases at the precise moment when the scraper is pressed into position. If the scraper is pressed in additionally the metal cap will be deformed (see lower illustration) with poorer scraper functionality as a result.

To prevent the scraper from bottoming in its recess in the cylinder head, the recess is slightly deeper than the width of the scraper.



1. Correct assembly tool
2. Scraper, correctly fitted
3. Cylinder head
4. Clearance between scraper and bottom of cylinder head recess
5. Incorrect assembly tool
6. Deformed scraper

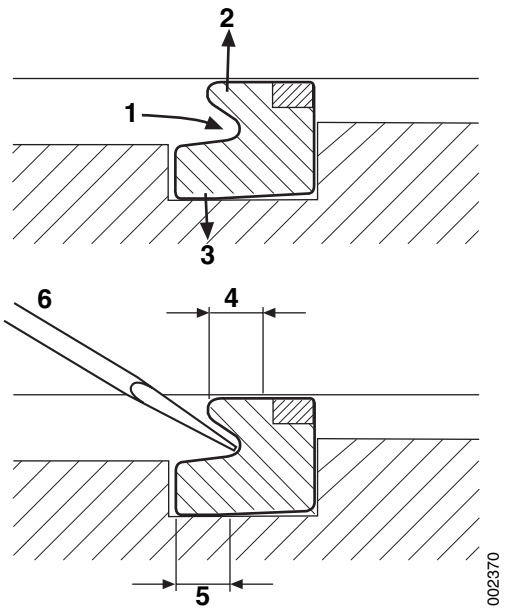
A screwdriver can be used to remove the scraper. The screwdriver should always be applied to the outer edge of the scraper, see illustration. Carefully tap the screwdriver down between scraper and cylinder head. Then prise out the scraper. Make good any damage to the cylinder head.



1. Screwdriver
2. Scraper
3. Cylinder head

CAUTION

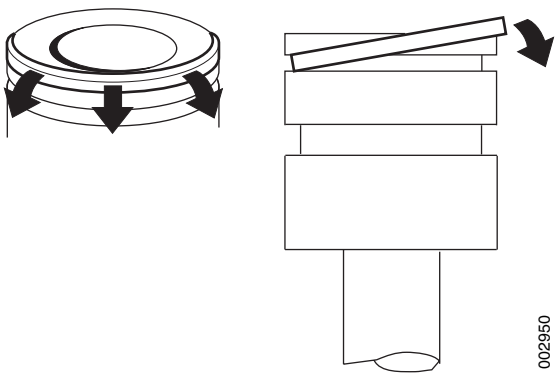
No tool must be applied from the inside. This could give rise to burrs on the cylinder head which could in turn damage the piston rod. Burrs may also damage the piston rod seal when fitting the piston.



1. Hydraulic pressure
2. The seal is pressed outwards against the cylinder barrel.
3. The seal is pressed inwards against the piston
4. Sealing surface, cylinder barrel
5. Sealing surface. piston
6. Screwdriver

On the single-acting V-ring seal it is always the long side that seals against the fixed surface and the short side that seals against the moving surface.

Use a screwdriver to remove the seal, see illustration. Lever outwards and prise up the seal. It is extremely important always to insert the screwdriver in the V shape so that it cannot touch and so damage any sealing surface. A mark made by the screwdriver on a sealing surface will have a devastating effect and give rise to serious leakage.

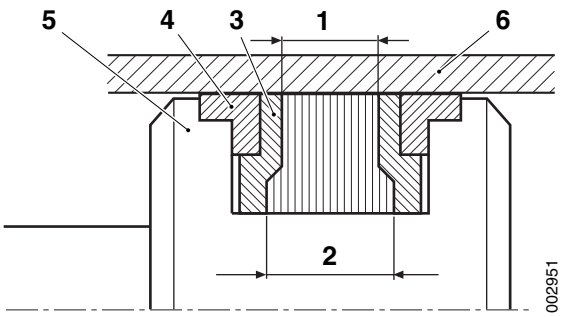


The seal must always be fitted as an assembly together with the thrust ring.

Always assemble by hand. No tools should be used as they could easily damage the surface of the piston.

For easier assembly the seal can be heated in hot water to make it soft.

Lubricate with hydraulic oil.



1. Moving sealing surface against cylinder barrel
2. Fixed sealing surface with piston
3. Guide ring
4. Thrust ring
5. Piston crown
6. Cylinder barrel

Double-acting piston seal

The double-acting seal functions with pressure from both sides, e.g. in a steering cylinder

All of the interior surface of the cylinder barrel is a sealing surface and it is therefore extremely important that it is completely free from damage.

Exercise care when fitting the piston in the cylinder barrel, making sure that the seal is not damaged by the cylinder barrel threads.

Dismantling:

1 Remove guide rings and thrust rings.

2 Move the seal over to one side of the sealing groove.

3 Press it up so that there is a gap between seal and piston.

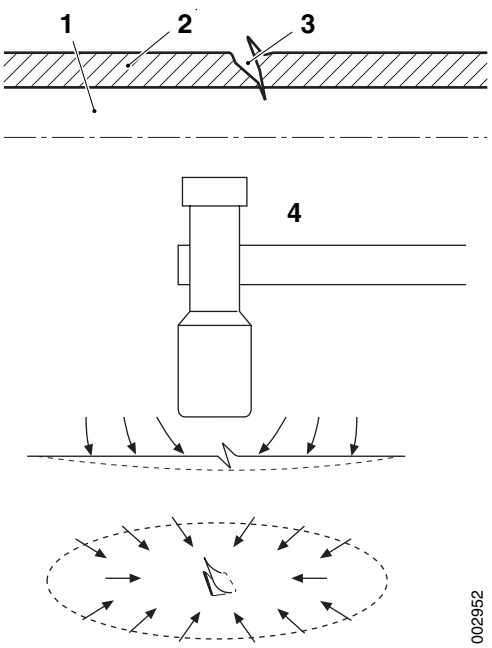
4 Without damaging the surface of the piston - cut off the seal with a knife.

5 Carefully examine the seal to find any damage that can cause leakage. This will be easier if you bend the seal sharply bit by bit and feel over the sealing surface with a fingernail.

Assembly:

6 All double-acting piston seals are of similar design: a middle sealing body. then thrust rings and farthest out guide rings.

7 First fit the sealing body, then the thrust rings and finally the guide rings - all must be done by hand without tools to avoid damage.



1. Piston rod
2. Chromium plating
3. Impact marks
4. Highly-polished hammer

Repairing the piston rod surface

A small impact mark on a piston rod may be sufficient to cause leakage. The chromium plating on the piston rod has a thickness of 20-50 m and can be treated to make good minor damage. This may be a satisfactory alternative to costly disassembly.

1 Locate the damage using your fingertips and fingernails.

2 Use a small, highly-polished hammer and work the surrounding material inwards towards the damage, starting from the outside.

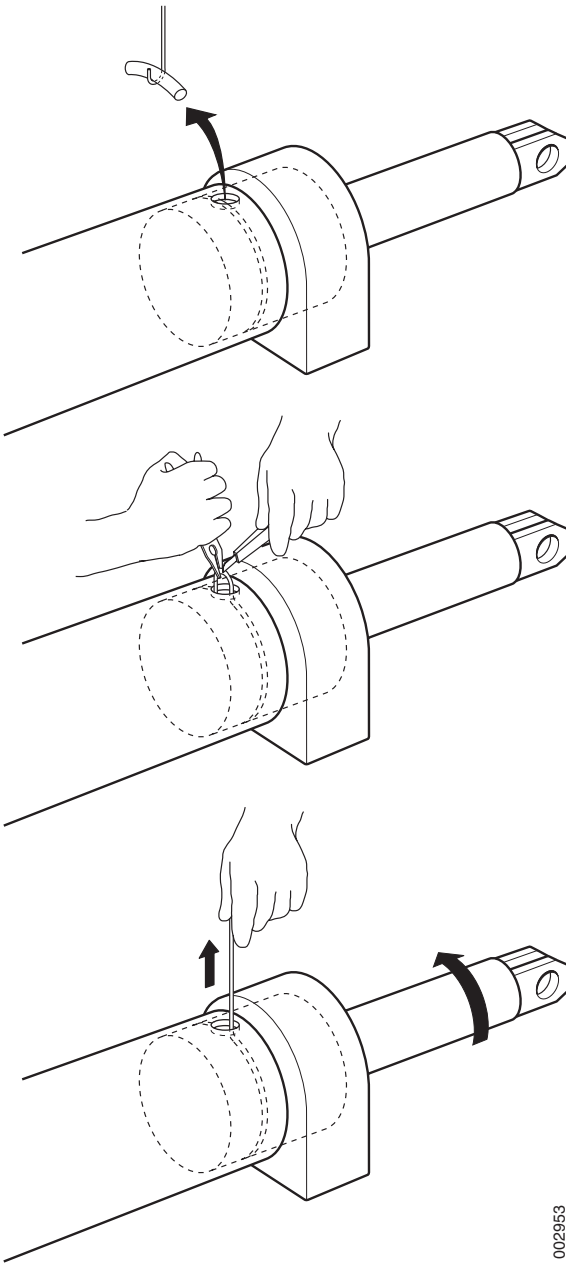
3 Instead of a small sharp mark there will now be a small uniform concavity in the chromium plating.

4 Polish with emery cloth, progressing from number 240 to 600. Wrap the emery cloth round a file to give it good support. Note that there must always be chromium plating present at the damage.

5 It is important to treat small impact marks before disassembly and assembly to avoid damaging the cylinder head.

6 Repairing larger damage on a piston rod

- fill the damage with weld metal, use chromium or stainless steel electrodes
- remove all slag completely
- file the weld down to the same level as the chrome
- polish evenly using emery cloth



Dismantling steering cylinders

It can prove extremely difficult to extract the piston rod from the cylinder barrel on steering cylinders because the O-ring in the cylinder head fastens in the retaining ring groove in the cylinder barrel. It is therefore best to remove the O-ring before trying to withdraw the piston rod from the cylinder.

1 Unscrew the end washer at the cylinder head.
2 Unscrew the connecting nipple for the hydraulic hose.
3 Introduce the piston rod with piston crown until the O-ring is visible through the nipple hole.
4 Bend the end of a length of heavy-duty steel wire, piano wire or the like into the shape of a hook. Use this to snag the O-ring.
5 Pull the O-ring up slightly and hold it with a pair of needle-nose pliers.
6 Continue to pull the O-ring out through the hole.
7 Hold the O-ring steady and cut it with a knife.
8 Rotate the piston rod while pulling the O-ring out through the hole.
9 Remove the retaining ring from the cylinder barrel.
10 Carefully extract the piston rod from the cylinder barrel.

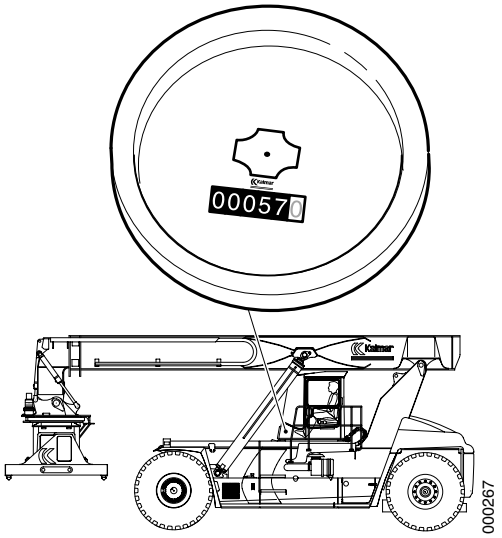
Table of Contents 11 Common electrics

11 Common electrics

11.1 Controls and instrumentation

11.1.1 Hour meter

Hour meter, description

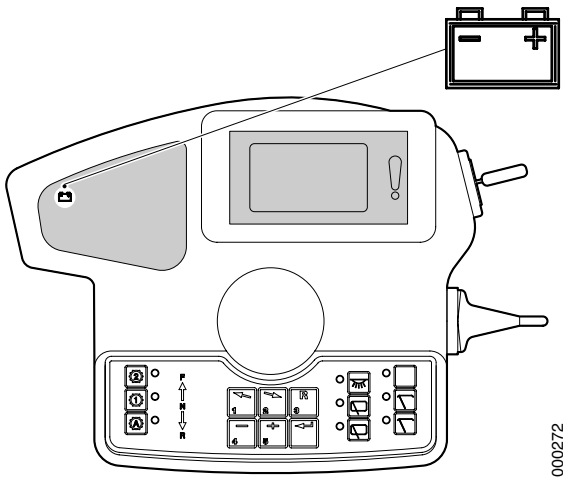


The hour meter shows the number of hours that the engine has been running. The meter records the time that the engine speed has exceeded 700 rpm.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, section *8.4.1.7 CAN/POWER, menu 7*.

11.1.2 Warning light battery charging

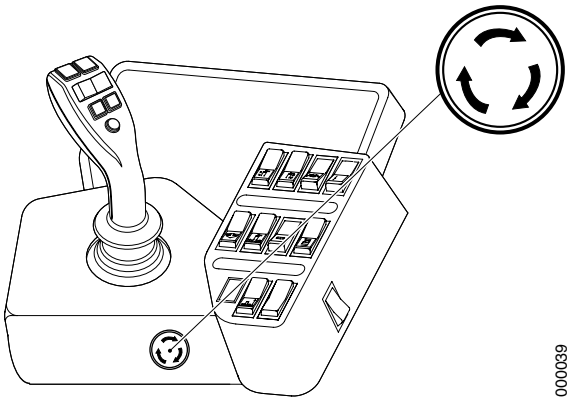
Warning light battery charging, description



The light warns in case the batteries are not being charged. The light is activated when the voltage from the alternator is lower than the battery voltage.

NOTE

The light is always activated briefly when starting. If the light remains activated, this indicates a malfunction in the charging circuit.



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11.1.3 Switch emergency stop

Switch emergency stop, description

The emergency stop switch activates emergency stop voltage. When the emergency stop is activated, all load handling functions are blocked.

The function emergency stop is reset by turning the switch in the direction of the arrows.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, section *8.4.1.5 CAN/POWER, menu 5*.

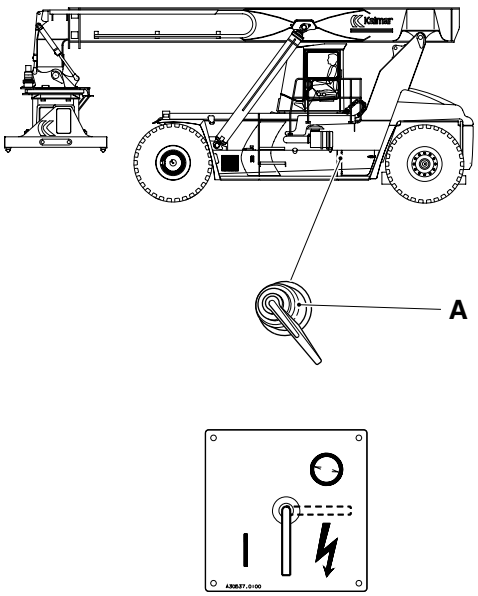
For further information about the emergency stop and emergency stop voltage, see *Emergency stop voltage (15E), description page 14*.

11.1.4 Ignition

Ignition, description

See section *1 Engine*, group *1.1.1 Ignition.*

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, section *8.4.1.4 CAN/POWER, menu 4.*



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A. Position for battery disconnector

11.2 Electric protection

11.2.1 Battery disconnector

Battery disconnector, description

The plus terminal of the series-connected batteries is connected to the machine's electrical system via the battery disconnector. The battery disconnector cuts off all voltage feed from the batteries to the machine's electrical system.

IMPORTANT

Never turn off the voltage with the battery disconnector when the engine is running, the alternator may be damaged.

The battery disconnector may not be used for emergency stop!

11.2.2 Fuses

Fuses, description

See *Maintenance manual DRF 400–450*.

Fuses, changing

Checking and changing main fuses:

1. Switch off the power supply (battery disconnector).
2. Remove the plastic cover.
3. Check whether the fuses are intact. Change when needed.

   The rating of the fuses is 25 A.

Checking and changing fuses:

1. Switch off the power supply (battery disconnector).
2. Remove the cover over the electronic box.
3. Inspect or change the fuses.

   The fuse chart provides information about each fuse.

11.2.3 Switch emergency stop

Emergency stop, description

See *Switch emergency stop, description page 4* and *Emergency stop voltage (15E), description page 14*.

11.3 Batteries

11.3.1 Start battery

Start battery, description

The machine's electrical system is supplied by two series-connected 12 V batteries.

The minus terminal is connected to the frame. The plus terminal is connected to the battery disconnector.

The batteries are charged by the alternator, see *Alternator, description page 8*.

WARNING

Battery electrolyte contains corrosive sulphuric acid

Risk of corrosive injuries, health hazard!

Electrolyte on skin should be removed immediately. Wash with soap and plenty of water. If electrolyte has splashed into the eyes, rinse immediately with plenty of water and seek immediate medical attention.

WARNING

Risk of explosion!

Personal injury!

During welding, hydrogen gas is formed at the batteries and sparks may ignite the hydrogen gas, resulting in a powerful explosion. Disconnect the battery with the battery disconnector.

WARNING

Short-circuiting of battery (means capacity is lost)

Fire hazard, personal injury!

The battery's terminals may not be connected to each other or commonly to ground (chassis).

Starter battery, change

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

2 Disconnect the cables from the battery terminals. Disconnect the negative cable first.

3 Change batteries.

4 Connect the cables to the battery terminals. Connect the negative cable last of all.

NOTE

Exercise care when reconnecting the cables to avoid a short circuit.

11.4 Alternator

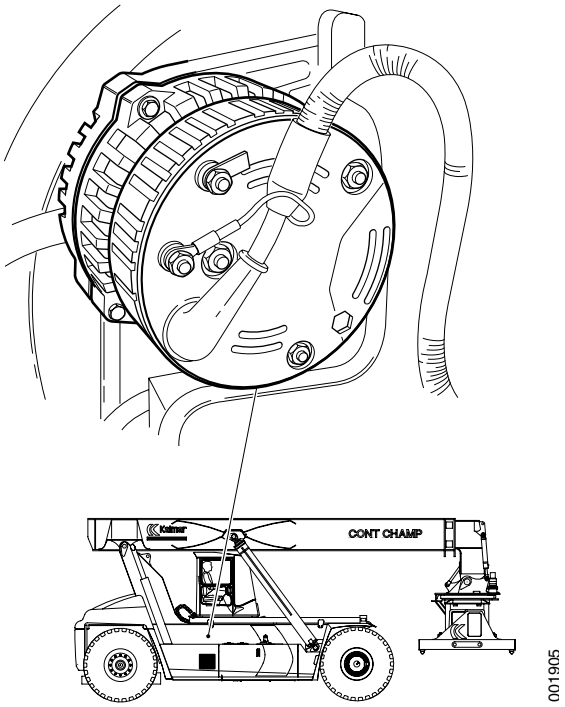
11.4.1 Alternator

Alternator, description

The alternator generates current to the batteries during operation. The alternator is of the alternating current type with built-in charging regulator.

The alternator is belt-driven by the engine. A possible malfunction is indicated by the warning light for low battery charging.

The signal can be checked from the diagnostic menu, see *Maintenance manual DRF 400–450,* section *8 Control system*, section *8.4.6.4 ENGINE, menu 4*.



The illustration shows engine alternative Volvo TWD1240VE

Alternator, change

See *subcontractor information, engine.*

11.5 Distribution of electricity

11.5.1 Voltage feed

11.5.1.1 Battery voltage (30)

Battery voltage 30-voltage, description

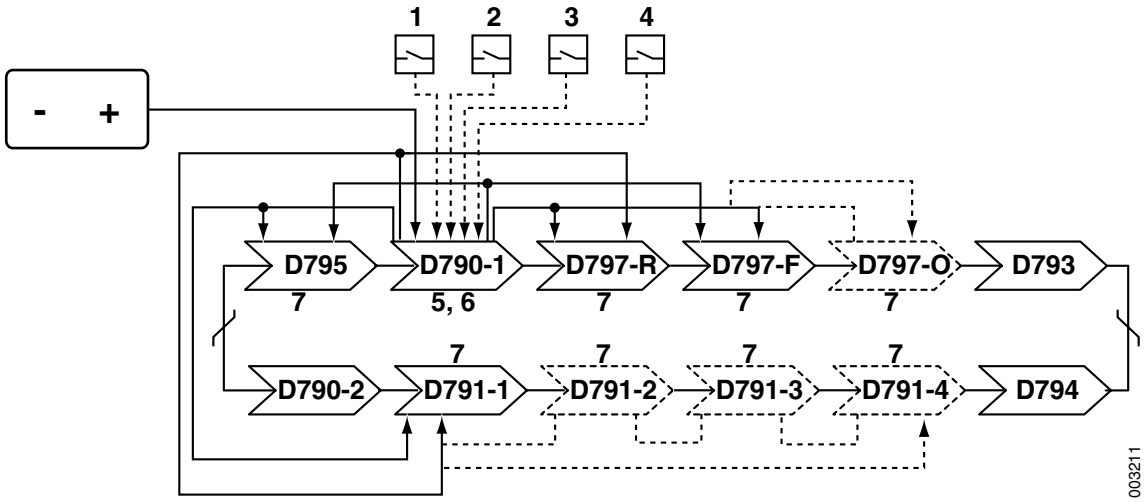
See *Maintenance manual DRF 400–450*.

11.5.1.2 Redundant voltage feed of control units

Redundant voltage feed of control units, description

See *Maintenance manual DRF 400–450*.

Redundant voltage feed for control units, description of operation



Pos	Explanation	Signal description	Reference
1	The sensor for driver door open sends a voltage signal to Control unit cab (D790-1).	U = 24 V	Section *9 Frame, body, cab and accessories,* group *9.10.2 Doors* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.2.12 LIGHTS, menu 12 or 8.4.11.2 SLIDING-CAB, menu 1*
2	Interior cab lighting sends a voltage signal to Control unit cab (D790-1).	U = 24 V	Section *9 Frame, body, cab and accessories,* group *9.6.12 Interior lighting* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.2.12 LIGHTS, menu 12*
3	Warning light sends a voltage signal to Control unit cab (D790-1).	U = 24 V	Section *9 Frame, body, cab and accessories,* group *9.6.7 Warning light Hazard* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.2.8 LIGHTS, menu 8*

Pos	Explanation	Signal description	Reference
4	The ignition switch is turned to position I and sends a voltage signal to Control unit cab (D790-1).	U = 24 V	*Ignition, description page 4* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.4 CAN/POWER, menu 4*
5	Control unit cab (D790-1) activates a holding circuit that activates the control logic of the control unit.	-	*Control unit cab, description page 20*
6	Control unit cab (D790-1) activates redundant voltage feed to other control units. Control unit cab (D790-1) has 4 outputs for redundant voltage feed, other control units have two inputs for redundant voltage feed. In the event of a fault in one feed, the control unit is supplied from the other feed.	$U_{K11:7}$ = 24 V $U_{K11:8}$ = 24 V $U_{K11:9}$ = 24 V $U_{K11:10}$ = 24 V	*Control unit cab, description page 20*

Pos	Explanation	Signal description	Reference
7	The redundant voltage feed supplies voltage to the control logic of other control units.	U = 24 V	*Control unit frame front, description page 21* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.8 CAN/POWER, menu 8* *Control unit frame rear, description page 22* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.10 CAN/POWER, menu 10* *Control unit frame option, description page 23* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.12 CAN/POWER, menu 12* *Control unit attachment, description page 24* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.16 CAN/POWER, menu 16* *Control unit KID, description page 31* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.14 CAN/POWER, menu 14* *Control unit attachment option, description page 25* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.17 CAN/POWER, menu 17* *Control unit attachment left leg pair, description page 26* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.18 CAN/POWER, menu 189* *Control unit attachment right leg pair, description page 27* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.19 CAN/POWER, menu 19*

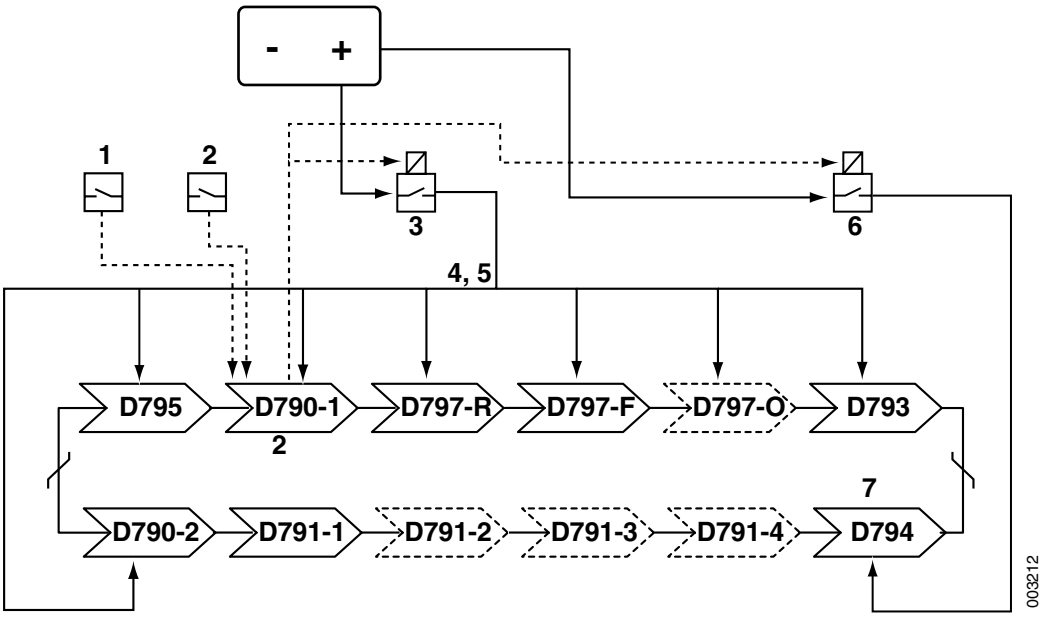
11.5.1.3 Ignition voltage (15)

Ignition voltage (15), description

See *Maintenance manual DRF 400–450*.

Ignition voltage (15), description of operation

Prior condition	Reference value	Reference
Battery disconnector	In position 1	*Battery disconnector, description page 5*
Redundant voltage feed	Activated.	*Redundant voltage feed for control units, description of operation page 9*
Redundant CAN-bus	Communication established.	*Redundant CAN-bus, description page 48*



Pos	Explanation	Signal description	Reference
1	Warning light comes on and sends a voltage signal to Control unit cab (D790-1)	U = 24 V	Section *9 Frame, body, cab and accessories,* group *9.6.7 Warning light Hazard* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.2.8 LIGHTS, menu 8*
2	The ignition switch is turned to position I and sends a voltage signal to Control unit cab (D790-1)	U = 24 V	*Ignition, description page 4* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.4 CAN/POWER, menu 4*
3	Control unit cab (D790-1) feeds voltage to power relay K1 in electrical distribution box frame and to power relay K4.	U = 24 V	*Control unit cab, description page 20* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.4 CAN/POWER, menu 4*

Pos	Explanation	Signal description	Reference
4	Relay K1, feeds voltage to fuse holder in electrical distribution box cab and in electrical distribution box frame.	U = 24 V	-
5	The fuses feed voltage to control units, relays, solenoid valves and other electronic components.	U = 24 V	*Control unit cab, description page 20* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.6 CAN/POWER, menu 6* *Control unit frame front, description page 21* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.8 CAN/POWER, menu 8* *Control unit frame rear, description page 22* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.10 CAN/POWER, menu 10* *Control unit frame option, description page 23* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.12 CAN/POWER, menu 12* *Control unit transmission, description page 28* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.15 CAN/POWER, menu 15*
6	Relay K4 feeds voltage to Control unit engine (D794).	U = 24 V	*Control unit engine, description page 29*
7	Drivetrain's CAN-bus establishes communication.		*CAN-bus drivetrain, description page 51* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.3 CAN/POWER, menu 3*

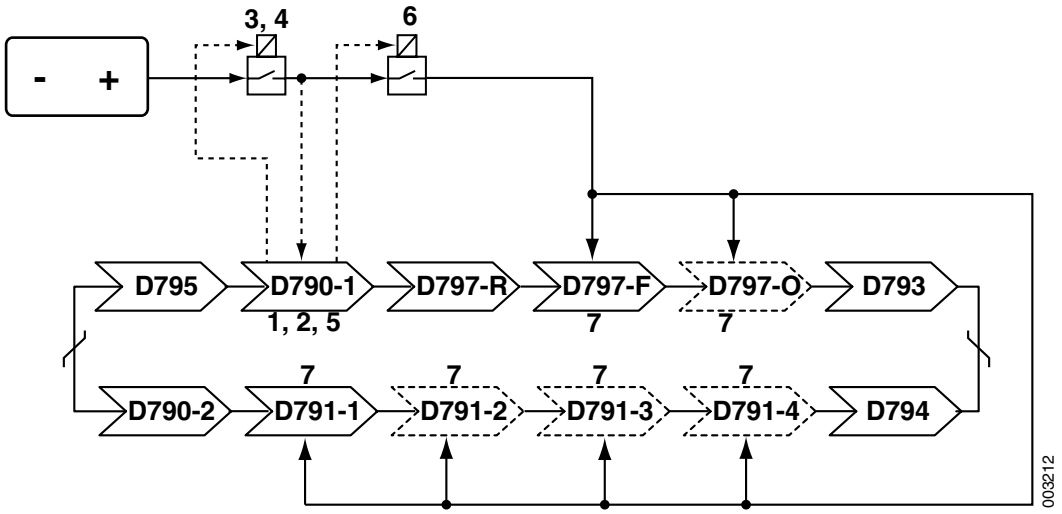
11.5.1.4 Emergency stop voltage (15E)

Emergency stop voltage (15E), description

See *Maintenance manual DRF 400–450*.

Emergency stop voltage (15E), description of operation

Prior condition	Reference value	Reference
Redundant voltage feed	Activated.	*Redundant voltage feed for control units, description of operation page 9*
Ignition voltage	Activated.	*Ignition voltage (15), description of operation page 12*
Emergency stop	Not activated	*Switch emergency stop, description page 4*



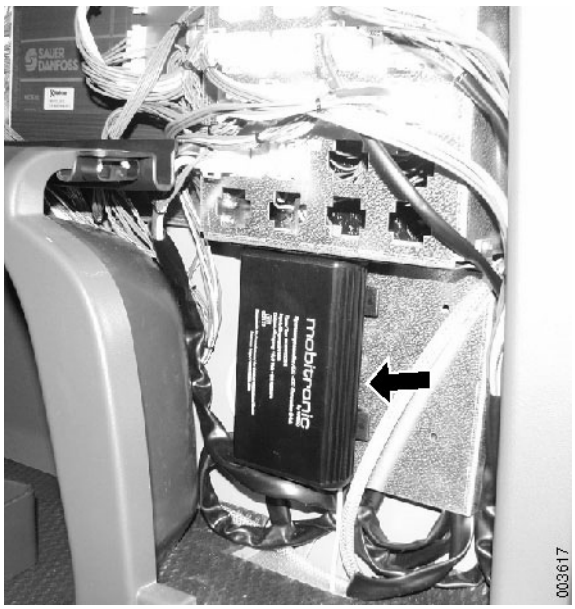
Pos	Explanation	Signal description	Reference
1	Ignition voltage is activated by Control unit cab (D790-1)	U = 24 V	*Ignition voltage (15), description of operation page 12* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.5 CAN/POWER, menu 5*
2	Control unit cab (D790-1) Activates power relay K2 in electrical distribution box frame.	U = 24 V	*Control unit cab, description page 20* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.5 CAN/POWER, menu 5*
3	Power relay K2 feeds voltage to relay K3 in electrical distribution box frame.	U = 24 V	-

Pos	Explanation	Signal description	Reference
4	Power relay K2 also sends a voltage signal to Control unit cab (D790-1) confirming that relay K2 is active but that relay K3 is inactive. This verifies that emergency stop is functional.	U = 24 V	- Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.5 CAN/POWER, menu 5*
5	Control unit cab (D790-1) Activates power relay K3 in electrical distribution box	U = 24 V	*Control unit cab, description page 20* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.5 CAN/POWER, menu 5*
6	Power relay K3 feeds voltage to the control units (not drivetrain).	U = 24 V	*Control unit frame front, description page 21* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.8 CAN/POWER, menu 8* *Control unit frame option, description page 23* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.12 CAN/POWER, menu 12* *Control unit attachment, description page 24* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.16 CAN/POWER, menu 16* *Control unit attachment option, description page 25* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.17 CAN/POWER, menu 17* *Control unit attachment left leg pair, description page 26* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.18 CAN/POWER, menu 18* *Control unit attachment right leg pair, description page 27* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.19 CAN/POWER, menu 19*

Pos	Explanation	Signal description	Reference
7	If the emergency stop switch is depressed, the ignition voltage to Control unit cab (D790-1) is cut off and so also is the control current to relays K2 and K3. Power to the control units is cut off and they stop functioning. As an extra safety measure, Control unit cab (D790-1) sends emergency stop switch status on the CAB bus. The functions are thus also stopped at signal level.	U = 24 V	*Control unit cab, description page 20* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.5 CAN/POWER, menu 5*

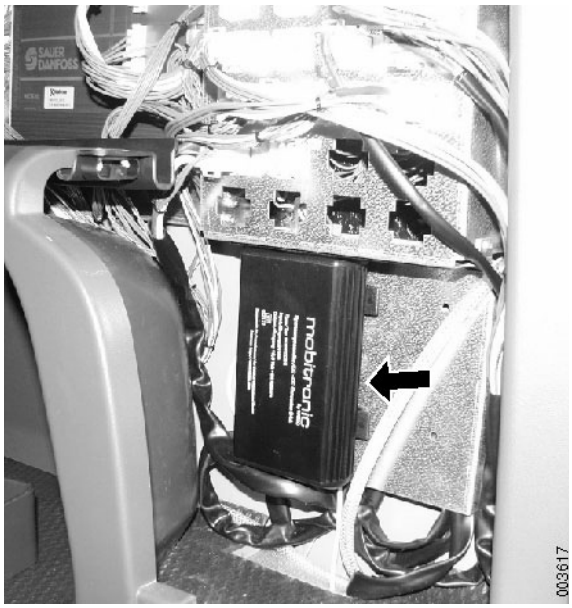
11.5.1.5 Voltage converter

Voltage converter, description



The voltage converter is located under a protective casing to the left behind the operator's seat.

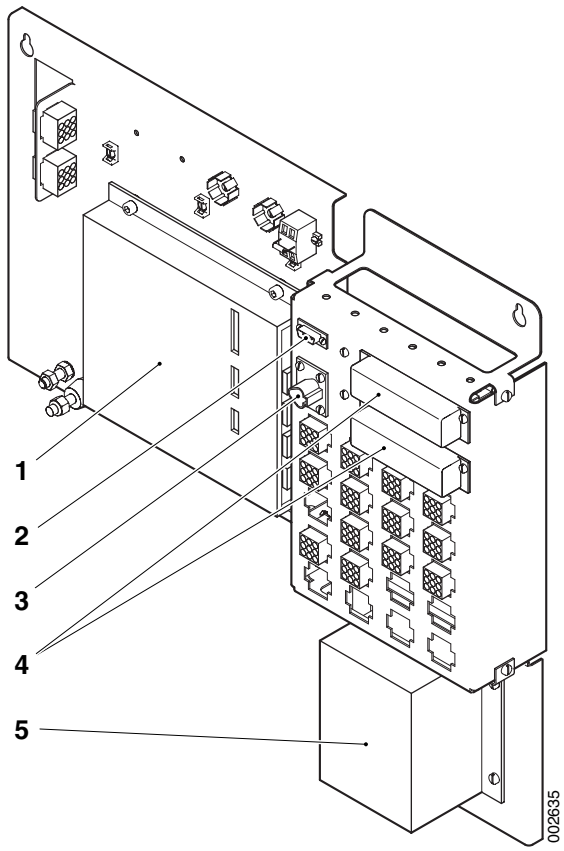
The voltage converter converts 24 Volt to 12 Volt. 12 V voltage is available for accessories with a power outlet behind the operator's seat.



Voltage converter located diagonally behind the driver seat.

Voltage converter, change

1 Machine in service position, see section *B Safety*.
2 Remove the cover panels behind the driver seat.
3 Disconnect the electric cables from the converter.
4 Remove the voltage converter.
5 Fit in reverse order.



1. Control unit cab (D790-1)
2. Socket for programming control units
3. Socket for CAN bus drivetrain
4. Fuse holder
5. Voltage converter

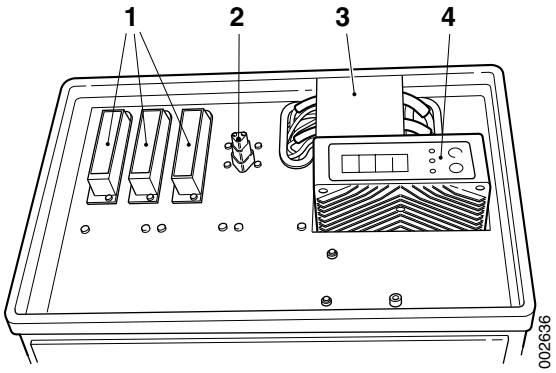
11.5.2 Electrical distribution box

11.5.2.1 Electrical distribution box cab

Electrical distribution box cab, description

The electrical distribution box is mounted on the rear wall of the cab, on the left. Located there are:

- Control unit cab (D790-1)
- Circuit fuses, for fuse chart see *Maintenance manual DRF 400–450,* section *11 Common electrics,* group *11.2.2 Fuses*.
- Buzzer for alarm if, for example, the operator leaves the machine without the parking brake being applied.
- Connectors.
- Relays.
- Voltage converter



1. Fuse holders in electrical distribution box
2. Socket for programming Control unit transmission (D793)
3. Main fuses
4. Control unit transmission (D793)

11.5.2.2 Electrical distribution box frame

Electrical distribution box frame, description

The electrical distribution box is mounted on the side of the machine. Also located there are:

- Circuit fuses, see *Maintenance manual DRF 400–450,* section *11 Common electrics,* group *11.2.2 Fuses*
- Socket for programming Control unit transmission (D793)
- Man fuses, see *Maintenance manual DRF 400–450,* section *11 Common electrics,* group *11.2.2 Fuses*
- TCU Control unit transmission (D793)

11.5.3 Control units

Control units, position

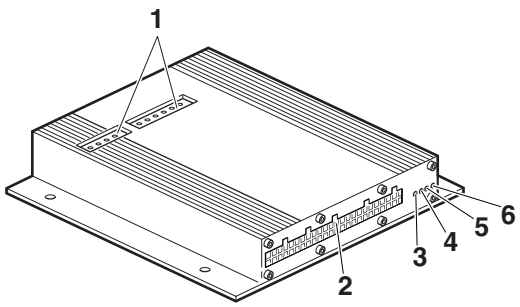
See *Maintenance manual DRF 400–450*.

11.5.3.1 Control unit cab

Control unit cab, description

Control unit cab (D790-1) is the central control unit for the control system. Control unit cab (D790-1) sends wake-up signals to other control units and controls and monitors their functions. It administers the work in the control unit network. The control unit controls the redundant voltage feed and handles communication between the CAN bus for drivetrain and redundant CAN bus communication (gateway). Control unit cab (D790-1) also handles all input signals from controls in the cab and sends out these signals on the CAN bus.

The control unit cab has four indicator lights that indicate the control unit's function (see illustration).

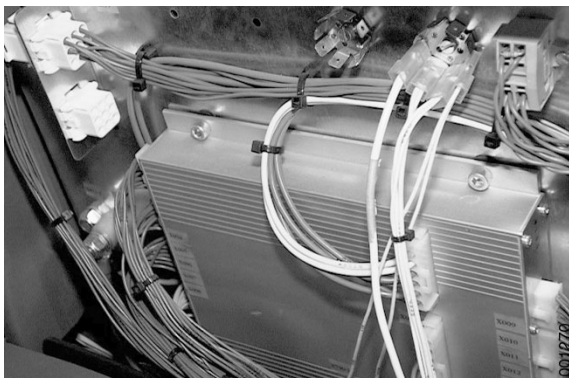


000041

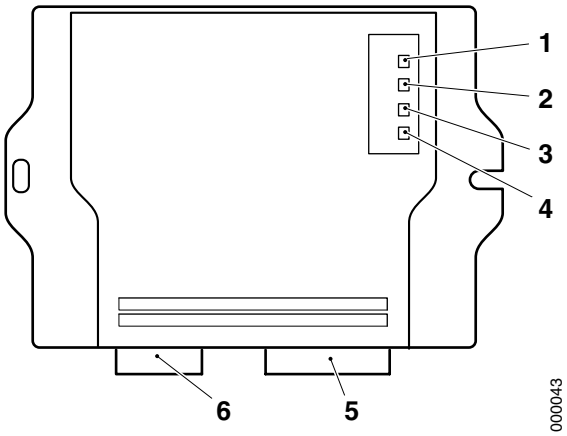
1. Connection terminals for fan, work lights, windshield washers
2. Connection terminals for other
3. Light 1, battery voltage
4. Light 2 redundant voltage feed, redundant CAN bus and power supply
5. Light 3, communication
6. Light 4, fault indication

Light 1	Green light on when there is battery voltage to unit. Light is physically controlled by voltage feed to control unit.
Light 2	Flashes green at redundant voltage feed to control units as well as CAN bus communication active. No power in system. Green light when power electronics and 15-voltage are supplied with voltage.
Light 3	Long single flash yellow at communication with Control unit display (D795), which is a basic condition for troubleshooting. Short single flash yellow at communication with Control unit engine (D794) and Control unit transmission (D793) Double flash yellow (short and long) at communication with display and engine or transmission.
Light 4	Red light on at active error.

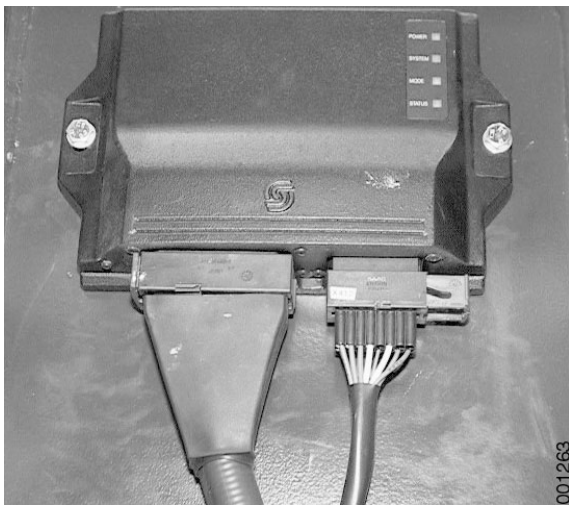
Control unit cab, change


001270

1 Machine in service position, see section *B Safety*.
2 Remove the cover from the electrical distribution box.
3 Unplug connectors from Control unit cab (D790-1).
4 Change control unit.
5 Check that the new control unit coincides with the machine truck number (Z number)
6 Calibrate the new control unit, see section *8 Control system,* group *8.5.2.3 Calibrate DRIVE-TRAIN*.



1. Light 1, battery voltage
2. Light 2, redundant voltage feed and power supply
3. Light 3, communication
4. Light 4, fault indication
5, Control signals (input and output signals)
6. Power feed (redundant voltage feed control units, redundant CAN bus) and input data



11.5.3.2 Control unit frame front

Control unit frame front, description

Control unit frame front (D797-F) handles input data from sensors and sends control signals to relays and solenoid valves in the machine's front half.

The control unit has four indicator lights that indicate the control unit's function (see illustration).

Light 1	Green light on when there is battery voltage to unit. The light is physically controlled by the voltage feed to the control unit.
Light 2	Green light flashing when there is no voltage to one of the following, redundant voltage feed left, redundant voltage feed right or 15-voltage. Green light on when there is voltage to redundant voltage feed, left, redundant voltage feed, right and 15-voltage.
Light 3	Single flash yellow at communication with display (KID) or Control unit cab (D790-1). Double flash yellow at communication with display and Control unit cab (D790-1).
Light 4	Red light on at active error.

Control unit frame front, change

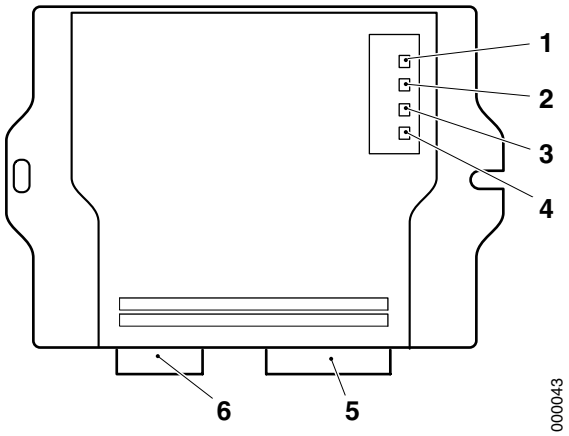
1 Machine in service position, see section *B Safety*.

2 Disconnect the cabling from Control unit Front (KDU D797-F).

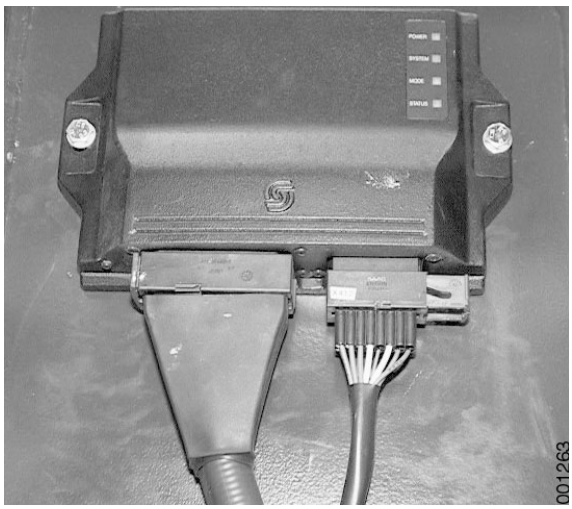
3 Change control unit.

4 Check that the new control unit coincides with the machine truck number (Z number).

5 Calibrate the new control unit, see section *8 Control system,* group *8.5.2.1 Calibrate SCALE* (pressure sensor) or section *8 Control system,* group *8.5.2.1 Calibrate SCALE* (pressure sensor).



1. Light 1, battery voltage
2. Light 2, redundant voltage feed and power supply
3. Light 3, communication
4. Light 4, fault indication
5, Control signals (input and output signals)
6. Power feed (redundant voltage feed control units, redundant CAN bus) and input data



11.5.3.3 Control unit frame rear

Control unit frame rear, description

Control unit frame rear (D797-R) handles input data from sensors and sends control signals to relays and solenoid valves in the machine's rear half.

The control unit has four indicator lights that indicate the control unit's function (see illustration).

Light 1	Green light on when there is battery voltage to unit. The light is physically controlled by the voltage feed to the control unit.
Light 2	Green light flashing when there is no voltage to one of the following, redundant voltage feed left, redundant voltage feed right or 15-voltage. Green light on when there is voltage to redundant voltage feed, left, redundant voltage feed, right and 15-voltage.
Light 3	Single flash yellow at communication with display (KID) or Control unit cab (D790-1). Double flash yellow at communication with display and Control unit cab (D790-1).
Light 4	Red light on at active error.

Control unit frame rear, change

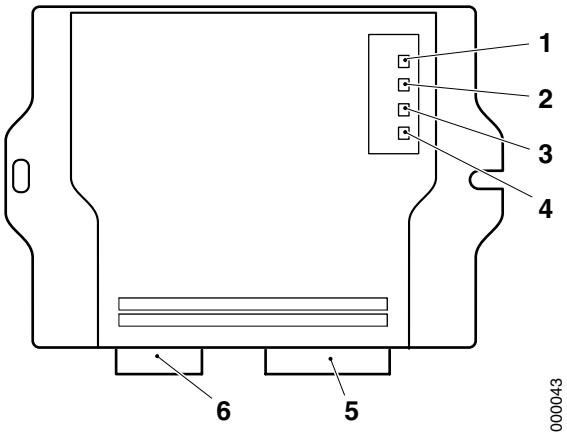
1 Machine in service position, see section *B Safety*.

2 Disconnect the cabling from Control unit Rear (KDU D797-R).

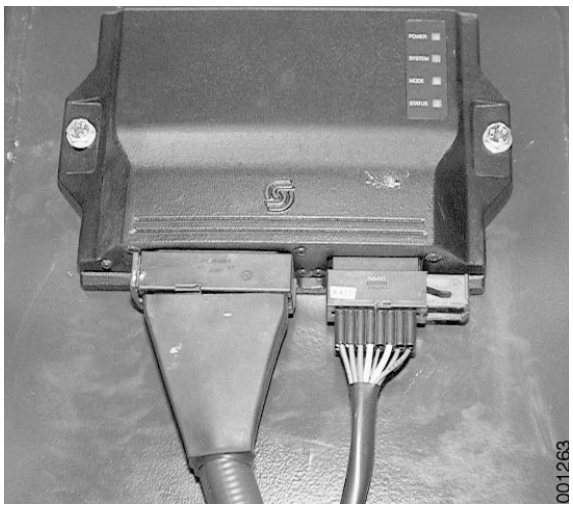
3 Change control unit.

4 Check that the new control unit coincides with the machine truck number (Z number).

5 Calibrate the new control unit, see section *8 Control system,* group *8.5.2.1 Calibrate SCALE* (length sensor, angle sensor).



1. Light 1, battery voltage
2. Light 2, redundant voltage feed and power supply
3. Light 3, communication
4. Light 4, fault indication
5, Control signals (input and output signals)
6. Power feed (redundant voltage feed control units, redundant CAN bus) and input data



11.5.3.4 Control unit frame option

Control unit frame option, description

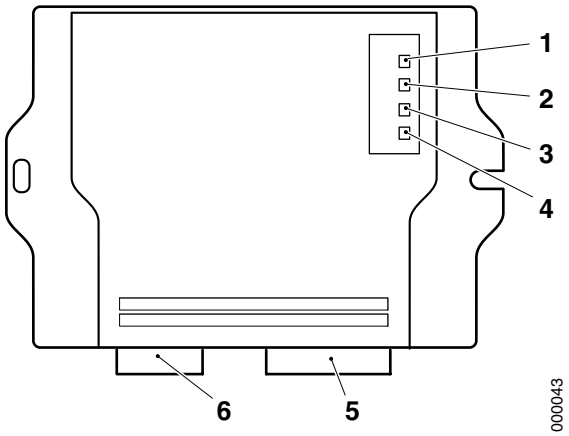
Control unit frame option (D797-O) is a unit that handles input data from sensors and sends control signals to relays and solenoid valves for optional functions in machine's front half.

The control unit has four indicator lights that indicate the control unit's function (see illustration).

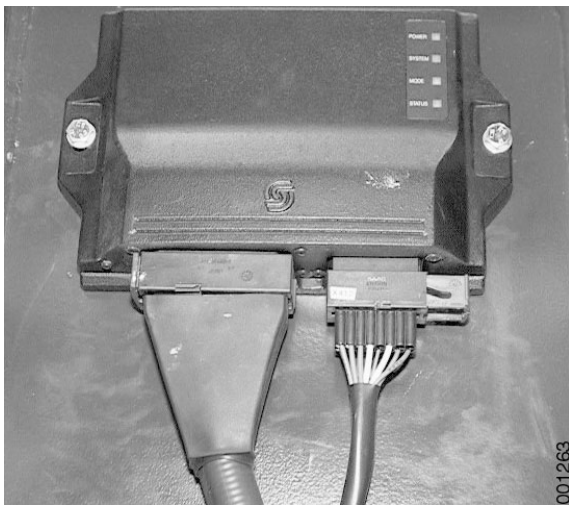
Light 1	Green light on when there is battery voltage to unit. The light is physically controlled by the voltage feed to the control unit.
Light 2	Green light flashing when there is no voltage to one of the following, redundant voltage feed left, redundant voltage feed right or 15-voltage. Green light on when there is voltage to redundant voltage feed, left, redundant voltage feed, right and 15-voltage.
Light 3	Single flash yellow at communication with display (KID) or Control unit cab (D790-1). Double flash yellow at communication with display and Control unit cab (D790-1).
Light 4	Red light on at active error.

Control unit frame option, change

1 Machine in service position, see section *B Safety*.
2 Disconnect the cabling from the control unit.
3 Change control unit.
4 Check that the new control unit coincides with the machine truck number (Z number).
5 The control unit is not calibrated.



1. Light 1, battery voltage
2. Light 2, redundant voltage feed and power supply
3. Light 3, communication
4. Light 4, fault indication
5, Control signals (input and output signals)
6. Power feed (redundant voltage feed control units, redundant CAN bus) and input data



11.5.3.5 Control unit attachment

Control unit attachment, description

Control unit attachment (D791) handles input data from sensors and sends control signals to relays and solenoid valves for functions for top lift attachment.

The control unit has four indicator lights that indicate the control unit's function (see illustration).

Light 1	Green light on when there is battery voltage to unit. The light is physically controlled by the voltage feed to the control unit.
Light 2	Green light flashing when there is no voltage to one of the following, redundant voltage feed left, redundant voltage feed right or 15-voltage. Green light on when there is voltage to redundant voltage feed, left, redundant voltage feed, right and 15-voltage.
Light 3	Single flash yellow at communication with display (KID) orControl unit cab (D790-1). Double flash yellow at communication with display and Control unit cab (D790-1).
Light 4	Red light on at active error.

Control unit attachment, change

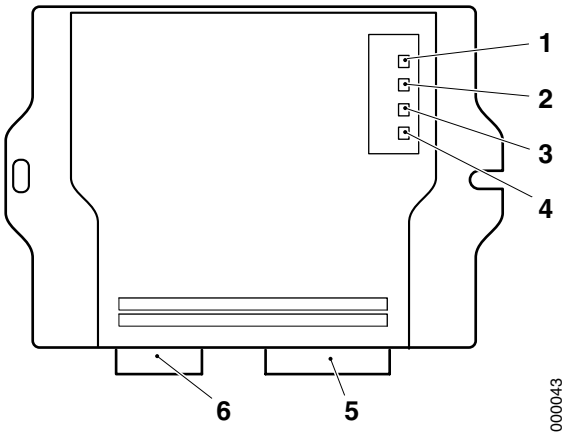
1 Machine in service position, see section *B Safety*.

2 Disconnect the cabling from the control unit.

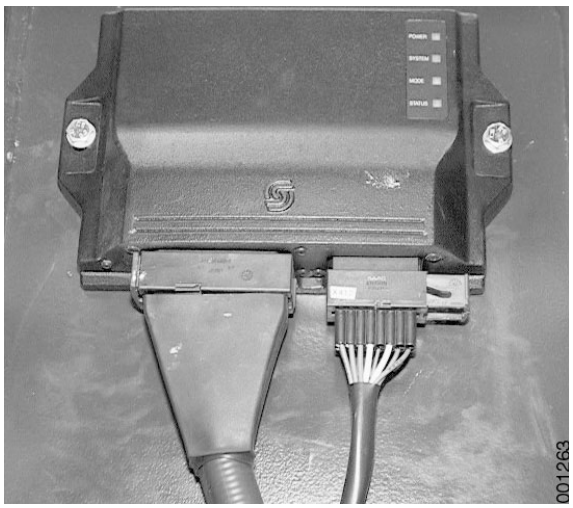
3 Change control unit.

4 Check that the new control unit coincides with the machine truck number (Z number).

5 The control unit is not calibrated.



1. Light 1, battery voltage
2. Light 2, redundant voltage feed and power supply
3. Light 3, communication
4. Light 4, fault indication
5, Control signals (input and output signals)
6. Power feed (redundant voltage feed control units, redundant CAN bus) and input data



11.5.3.6 Control unit attachment option

Control unit attachment option, description

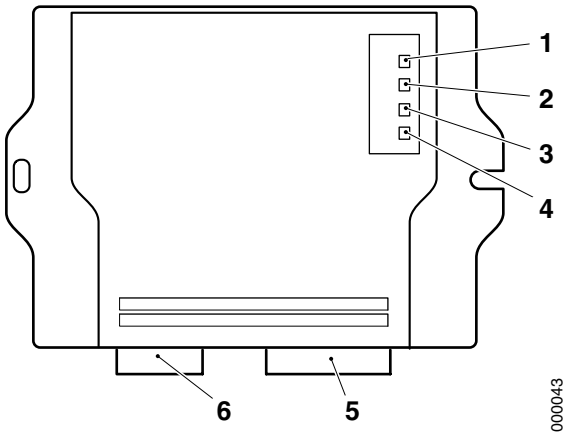
Control unit attachment option (D791-2) handles input data from sensors and sends control signals to relays and solenoid valves for optional functions on top lift attachment.

The control unit has four indicator lights that indicate the control unit's function (see illustration).

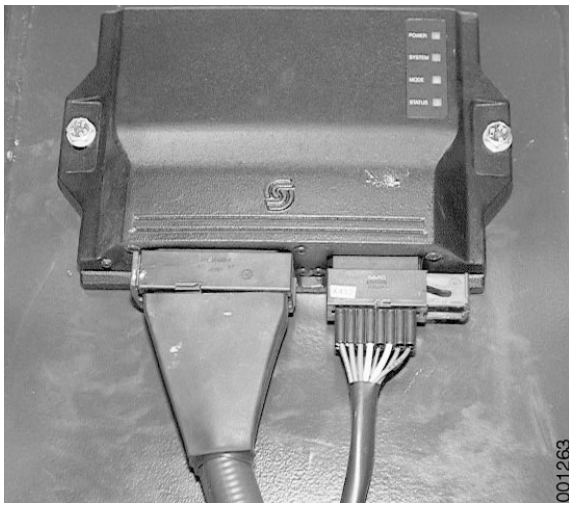
Light 1	Green light on when there is battery voltage to unit. The light is physically controlled by the voltage feed to the control unit.
Light 2	Green light flashing when there is no voltage to one of the following, redundant voltage feed left, redundant voltage feed right or 15-voltage. Green light on when there is voltage to redundant voltage feed, left, redundant voltage feed, right and 15-voltage.
Light 3	Single flash yellow at communication with display (KID) or Control unit cab (D790-1). Double flash yellow at communication with display and Control unit cab (D790-1).
Light 4	Red light on at active error.

Control unit attachment option, change

1 Machine in service position, see section *B Safety*.
2 Disconnect the cabling from the control unit.
3 Change control unit.
4 Check that the new control unit coincides with the machine truck number (Z number).
5 The control unit is not calibrated.



1. Light 1, battery voltage
2. Light 2, redundant voltage feed and power supply
3. Light 3, communication
4. Light 4, fault indication
5, Control signals (input and output signals)
6. Power feed (redundant voltage feed control units, redundant CAN bus) and input data



11.5.3.7 Control unit attachment left legs

Control unit attachment left leg pair, description

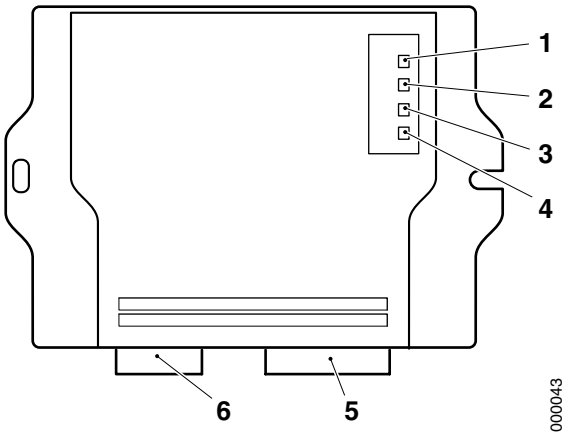
Control unit attachment left leg pair (D791-3) handles input data from sensors and sends control signals to relays and solenoid valves to control the left leg pair on attachment with lift legs. See *"Technical description, group 7.9.2 Twistlock and lift legs*.

The control unit has four indicator lights that indicate the control unit's function (see illustration).

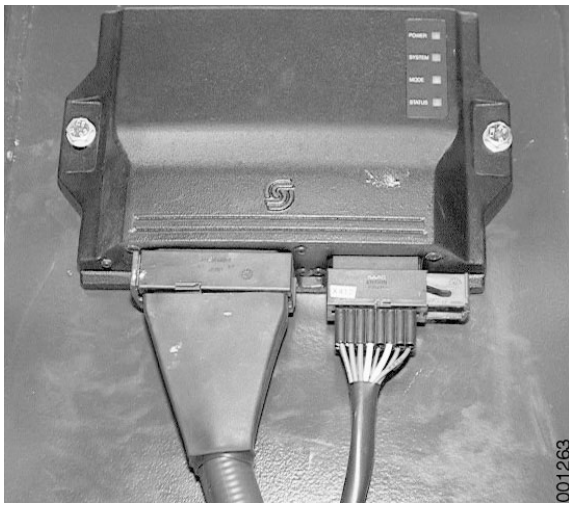
Light 1	Green light on when there is battery voltage to unit. The light is physically controlled by the voltage feed to the control unit.
Light 2	Green light flashing when there is no voltage to one of the following, redundant voltage feed left, redundant voltage feed right or 15-voltage. Green light on when there is voltage to redundant voltage feed, left, redundant voltage feed, right and 15-voltage.
Light 3	Single flash yellow at communication with display (KID) or Control unit cab (D790-1). Double flash yellow at communication with display and Control unit cab (D790-1).
Light 4	Red light on at active error.

Control unit attachment left leg pair, change

1 Machine in service position, see section *B Safety*.
2 Disconnect the cabling from the control unit.
3 Change control unit.
4 Check that the new control unit coincides with the machine truck number (Z number).
5 The control unit is not calibrated.



1. Light 1, battery voltage
2. Light 2, redundant voltage feed and power supply
3. Light 3, communication
4. Light 4, fault indication
5, Control signals (input and output signals)
6. Power feed (redundant voltage feed control units, redundant CAN bus) and input data



11.5.3.8 Control unit attachment right legs

Control unit attachment right leg pair, description

Control unit attachment right leg pair (D791-4) handles input data from sensors and sends control signals to relays and solenoid valves to control the right leg pair on attachment with lift legs. See *"Technical description, group 7.9.2 Twistlock and lift legs*.

The control unit has four indicator lights that indicate the control unit's function (see illustration).

Light 1	Green light on when there is battery voltage to unit. The light is physically controlled by the voltage feed to the control unit.
Light 2	Green light flashing when there is no voltage to one of the following, redundant voltage feed left, redundant voltage feed right or 15-voltage. Green light on when there is voltage to redundant voltage feed, left, redundant voltage feed, right and 15-voltage.
Light 3	Single flash yellow at communication with display (KID) or Control unit cab (D790-1). Double flash yellow at communication with display and Control unit cab (D790-1).
Light 4	Red light on at active error.

Control unit attachment right leg pair, change

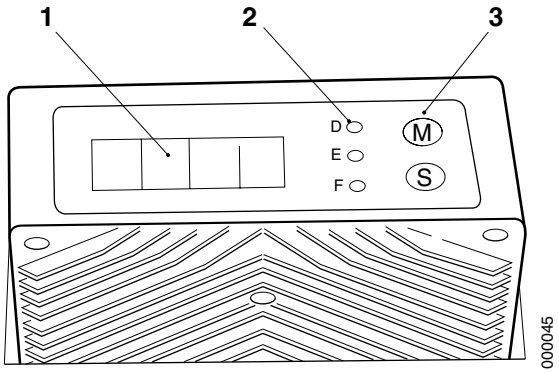
1 Machine in service position, see section *B Safety*.

2 Disconnect the cabling from the control unit.

3 Change control unit.

4 Check that the new control unit coincides with the machine truck number (Z number).

5 The control unit is not calibrated.



1. Display
2. Status lights
3. Function keys

11.5.3.9 Control unit transmission

Control unit transmission, description

Control unit transmission TCU (D793) is a part of the drivetrain's control and it handles transmission functions, selection of gear when loaded and rpm, etc.

Control unit transmission TCU (D793) is connected in a separate CAN bus communication with the engine, which is connected to Control unit cab (D790-1). Control unit cab (D790-1) sends in turn information from the drivetrain on to other units.

The control unit has two function keys and three status lights on the unit (see illustration):

Function key M	Select display group
Function key S	Select status within display group.
Status light D	Yellow light indicates test mode.
Status light E	Yellow light indicates error in unit.
Status light F	Red light indicates at reset.

Control units can show information on the display in three display groups with different status. The function keys M and S are used to move in the display and to select display group and status.

The following states are available in the display:

Display group I

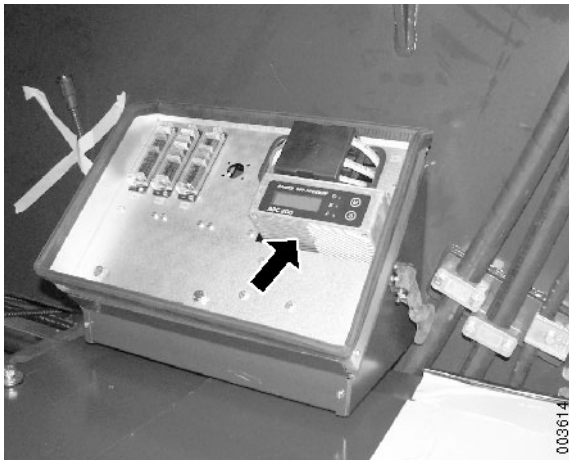
- GPOS, shows rotational direction transmission
- VSPD, shows speed in km/
- dist, shows travelled distance in km or miles

Display group II

- CPOS, shows gear position
- Tspd, shows measured turbine speed in km/h or mph
- Espd, shows measured turbine speed in rpm
- Ospd, shows measured output speed transmission in rpm
- Srat, shows relationship turbine speed (Tspd)/ engine speed (Espd)
- TQ I, shows measured torque (Nm) on transmission in
- Ttmp, shows measured temperature in oil sump (Celsius or Fahrenheit)
- Ctmp, shows measured temperature in converter (Celsius or Fahrenheit)

Display group III

- Err, shows error codes (current and history)



Control unit transmission, change

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

2 Disconnect the cabling from control unit TCU.

3 Change control unit.

4 Check that the new control unit coincides with the machine truck number (Z number).

5 Calibrate the new control unit, see section *8 Control system,* group *8.5.2.3 Calibrate DRIVE-TRAIN* and section *8 Control system,* group *8.5.2.3 Calibrate DRIVE-TRAIN*.

11.5.3.10 Control unit engine

Control unit engine, description

Control unit engine EDC (D794) is a part of the drivetrain's control and it handles engine function, fuel injection, etc.

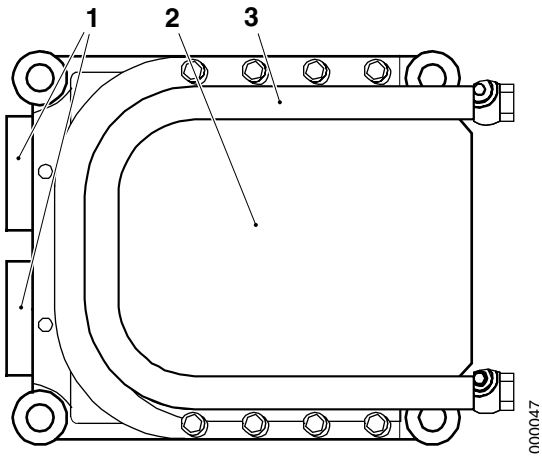
Control unit engine EDC (D794) is connected in a separate CAN bus communication with the transmission which is connected to Control unit cab (D790-1). Control unit cab (D790-1) sends in turn information from the drivetrain on to other units.

The control unit is mounted on the engine and has no function keys or display. Everything is handled via the CAN bus and an external control system.

The control unit monitors the following values to optimize engine performance.

- engine rpm
- boost pressure
- charge-air temperature
- coolant temperature
- oil pressure
- oil temperature
- coolant level

The data gives exact information about the operating conditions and makes it possible for the control unit to, for example, calculate the correct fuel volume and to check the condition of the engine.



1. Connectors
2. Control unit, engine
3. Cooling channel for control unit (fuel)

Control unit engine, change

See *supplier documentation engine*.

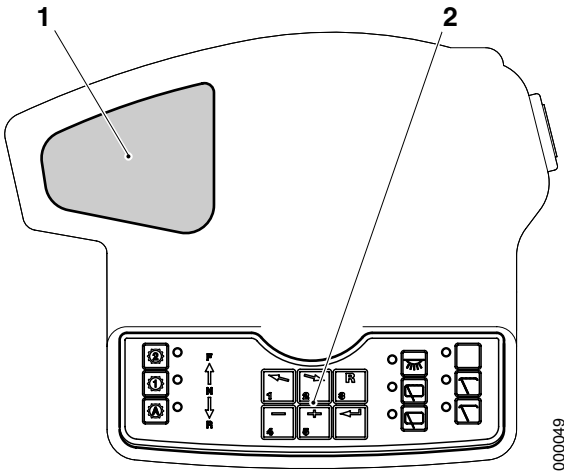
11.5.3.11 Control unit KIT

Control unit KIT, description

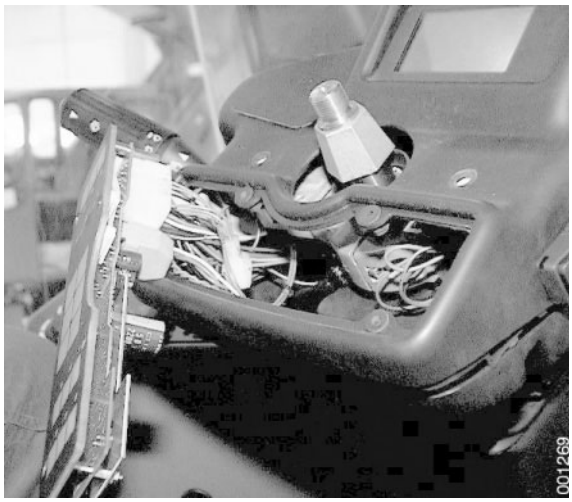
Control unit KIT (D790-2) handles functions for the gear selector lever and multi-function lever, direction indicator lever as well as start key position II and III. It also handles the panel for keys (B) for the control system and its panel for warning and indicator lights (A).

Control unit KIT (D790-2) has several separate function keys and indicator lights on the unit (see illustration).

See operator's manual for detailed information about warning lights, indicator lights and function keys.



1. Panel for warning and indicator lights
2. Panel for keys



Control unit KIT, change

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

2 Remove the steering wheel and separate the steering wheel panel.

3 Disconnect KIT from the steering wheel panel.

4 Detach the connectors.

5 Remove the warning and indicator lamp panel.

6 Fit in reverse order.

7 KIT is not calibrated.

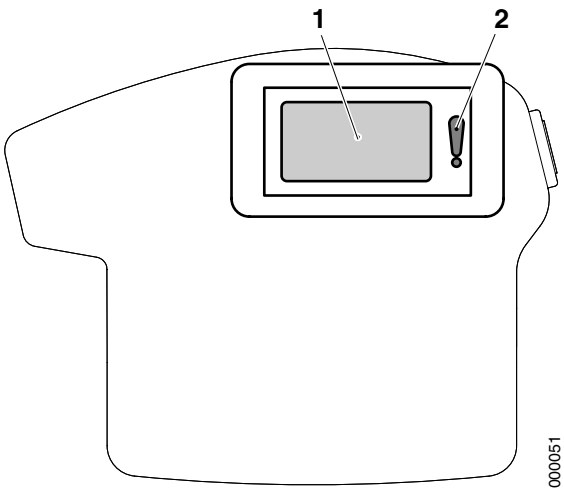
11.5.3.12 Control unit KID

Control unit KID, description

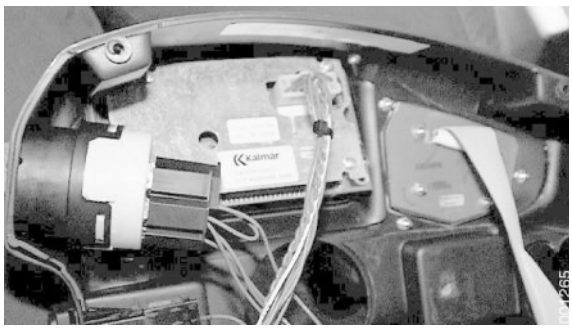
Control unit KID (D795) shows the operator the information that the control system sends in the form of messages, for example, status, error indications, etc.

There is an indicator light to the right of the display that is activated with a red light when there is a serious malfunction in the control system. Error code and information are shown on the display.

See operator's manual for detailed information about the display.



1. LCD display
2. Series of diodes that constitute indicator light for serious malfunction



Control unit KID, change

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

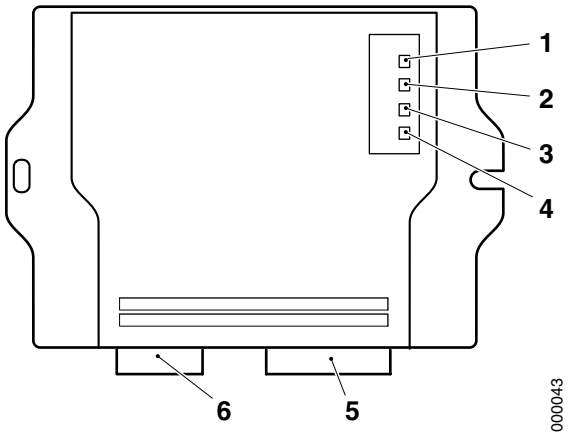
2 Remove the steering wheel and separate the steering wheel panel.

3 Detach the connector from KID.

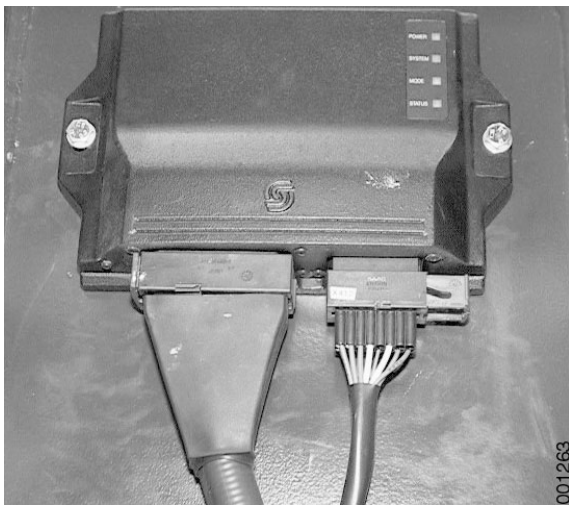
4 Detach KID from the steering wheel panel.

5 Fit in reverse order.

6 KID is not calibrated.



1. Light 1, battery voltage
2. Light 2, redundant voltage feed and power supply
3. Light 3, communication
4. Light 4, fault indication
5, Control signals (input and output signals)
6. Power feed (redundant voltage feed control units, redundant CAN bus) and input data



11.5.3.13 Control unit cab option

Control unit cab option, description

Control unit frame option D797-O only on machines with both combi unit and lever steering or combi unit and mini steering wheel. The control unit handles signals to and from the steering lever or mini steering wheel and forwards the information on the CAN bus.

The control unit has four indicator lights that indicate the control unit's function (see illustration).

Light 1	Green light on when there is battery voltage to unit. The light is physically controlled by the voltage feed to the control unit.
Light 2	Flashes green when a voltage feed is absent, redundant voltage feed left, right or 15-voltage. Lights green when redundant voltage feed, left and right, and 15-voltage are fed with voltage.
Light 3	Single flash yellow on communication with either Control unit KID (D795) or Control unit cab D790-1. Double flash yellow on communication with both Control unit KID (D795) and Control unit cab D790-1.
Light 4	Red light on at active error.

Control unit cab option, change

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

2 Disconnect the cabling from the control unit.

3 Change control unit.

4 Check that the new control unit coincides with the machine truck number (Z number).

5 The control unit is not calibrated.

11.5.5 Cable harness

Connectors, overview

List of all connectors on the machine with a brief description of their locations and to which functions the signals in them are related.

Connector	Location	Function
X001	Control unit cab (D790-1)	Power supply and earth connection Control unit cab (D790-1)
X002	Control unit cab (D790-1)	Windscreen wipers Cooling fan Actuator motor, recirculation
X004	Control unit cab (D790-1)	Climate control unit
X005	Control unit cab (D790-1)	Switch option Switch warning light (Hazard) Climate control unit Extra sensors Throttle pedal
X006	Control unit cab (D790-1)	Dimmer instrument lighting Switch work lights Switch option Seat heater Throttle pedal Brake pedal
X007	Control unit cab (D790-1)	Control lever Indicator lamp support leg down
X008	Control unit cab (D790-1)	Control lever Switch by-pass Switch emergency stop Switch, parking brake Switch, sliding cab Switch, support legs Switch 30-35 stop Switch option Switch, twistlocks
X009	Control unit cab (D790-1)	Combi unit Overheight Lever steering or mini steering wheel
X009A	Extension X009A	Lever steering or mini steering wheel

Connector	Location	Function
X010	Control unit cab (D790-1)	Sensor, end position cab Water valve Seat heating Relay, work lighting Hour counter Relay, Compressor Power supply, relays K1, K2, K3 and K4 Windscreen washing Windscreen wiper, roof
X011	Control unit cab (D790-1)	Starter switch Lighting, Control unit KID (D795) Switches, cab doors Buzzer Interior lighting Power supply, Control unit cab (D790-1) Horn Switch, seat Feedback relay K2 Seat heating
X012	Control unit cab (D790-1)	Windscreen wiper, rear Windscreen wiper, roof
X013	Control unit cab (D790-1)	CAN-bus RS232
X015	Control unit KIT (D790-2)	CAN-bus Power supply and earth connection, Control unit KIT (D790-2)
X016	Control unit KIT (D790-2)	Ignition
X017	Control unit KIT (D790-2)	Control, windscreen wipers Control, gear Control, main and dipped beams
X018	Control unit KIT (D790-2)	Sensor, steering wheel lock Switch, direction indicators
X018A	Extension X018	Sensor, steering wheel lock
X020	Control unit KID (D795)	CAN-bus RS232 Printer Power supply and earth connection, Control unit KID (D795)
X021	Control unit, cab option (D790-3)	Lever steering or mini steering wheel

Connector	Location	Function
X022	Control unit, cab option (D790-3)	Power supply and earth connection, Control unit cab option (D790-3) CAN bus, Control unit, cab option (D790-3)
X033	Climate control unit	Control, fan Control, temperature Control, air distribution
X034	Climate control unit	Heater fan Water valve
X035	Climate control unit	Valve, air distribution Sensor, air temperature
X036	Climate control unit	Actuator motor, recirculation Sensor, air temperature
X038	Instrument panel, cab	Throttle pedal Release pedal
X039	Electrical distribution box cab	Hour counter Relay, Compressor, seat with air suspension Switch warning light (Hazard) Switch, cab door Actuator motor, recirculation Fan motor, heating Water valve, ECC
X048	Electrical distribution box cab	Termination resistance
X049	Electrical distribution box cab	CAN-bus
X050	Electrical distribution box cab	D-sub RS232 Control unit cab (D790-1)
X051	Electrical distribution box cab	Power supply, Control unit cab (D790-1) CAN-bus
X052	Electrical distribution box cab	CAN-bus Steering, relays K1, K2, K3 and K4
X054	Electrical distribution box cab	Interior lighting Work lighting Warning lights
X055	Electrical distribution box cab	Windscreen wiper, roof Current, CD player Current, COM radio

Connector	Location	Function
X056	Electrical distribution box cab	Warning lights Work lighting, boom Work lighting, cab
X057	Electrical distribution box cab	Windscreen wiper, rear Power supply, rearview camera
X058	Electrical distribution box cab	Motor, windscreen washers Start interlock, engine heater
X059	Electrical distribution box cab	CAN bus Power supply, Control unit, cab option (D790-3)
X060	Electrical distribution box cab	CAN-bus Interior lighting
X060A	Extension X060	CAN-bus Interior lighting
X061	Electrical distribution box cab	Earth connection, Control unit KID (D795) Power supply, Control unit KIT (D790-2) Windscreen wipers, front Actuator, recirculation
X061A	Extension X061	Earth connection, Control unit KID (D795) Power supply, Control unit KIT (D790-2)
X062	Electrical distribution box cab	Horn Map lighting Cigarette lighter 12V
X063	Electrical distribution box cab	Seat heater Compressed-air damped seat
X064	Electrical distribution box cab	Sensor, end position cab
X071-1	Electrical distribution box cab	Power supply, cab
X071-2	Electrical distribution box cab	Earth connection, cab
X072	To Right Behind Seat	Power outlet
X073	Right side of instrument panel	Cigarette lighter socket, 12 V
X080	Instrument panel, cab	Switch work lights Switch, main beams Switch, warning lights (Hazard flashers) Switch, seat heater Switch, option

Connector	Location	Function
X081	Instrument panel, cab	Switch, option Switch warning light (Hazard) Extra sensors Hour counter
X082	Instrument panel, cab	Switch, cab door, left side
X168	Electrical distribution box frame	Switch, boom and attachment
X200	Boom attachment	CAN-bus Redundant power supply control units
X201	Electrical distribution box frame	Earth connection and power supply, Control unit transmission (D793)
X202	Boom attachment	Sensor, boom length Sensor, boom angle Sensor, damping boom out Sensor, damping boom in Sensor, damping boom up Sensor, damping boom down Earth connection and power supply, sensor boom Solenoid valve, regeneration extension Solenoid valve, blocking extension Work lighting, boom
X203	Electrical distribution box frame	Termination resistance
X205	Electrical distribution box frame	CAN-bus Control unit, transmission (D793)
X206	Boom attachment	Rotating warning beacon boom Work lighting, boom
X210	Between engine and gearbox	Power supply and earth connection, Control unit engine (D794) CAN bus, Control unit engine (D794)
X211	Control unit, frame front (D797-F)	42-pin connector for Control unit, frame front (D797-F)
X212	Control unit, frame front (D797-F)	Power supply and earth connection, Control unit, frame front (D797-F) CAN bus, Control unit, frame front (D797-F) Temperature, brake fluid Emergency stop
X221	Control unit frame rear (D797-R)	42-pin connector for Control unit, frame rear (D797-R)

Connector	Location	Function
X222	Control unit frame rear (D797-R)	Power supply and earth connection, Control unit, frame rear (D797-R) CAN bus, Control unit, frame rear (D797-R) Temperature, hydraulic oil Fuel gauge Emergency stop D+ alternator
X231	Control unit, frame option (D797-O)	42-pin connector for Control unit, frame option (D797-O)
X232	Control unit, frame option (D797-O)	Power supply and earth connection, Control unit, frame option (D797-O) CAN bus, Control unit, frame option (D797-O) Emergency stop
X233	Control unit, frame option (D797-O)	Sensor support leg Solenoid valve support leg up and down
X235	Control unit, frame option (D797-O)	Solenoid valve, steering right and left (lever steering or mini steering wheel)
X246	AC compressor	Power supply sensor pressure refrigerant
X251	Control unit transmission (D793), electrical distribution box frame	30-pin connector for Control unit, transmission (D793)
X252	Control unit transmission (D793), electrical distribution box frame	18-pin connector for Control unit, transmission (D793)
X253	Gearbox	Solenoid valves, transmission Pressure sensor, transmission
X254	Electrical distribution box frame	Power supply and earth connection, Control unit transmission (D793)
X259	Gearbox	Temperature sensor, transmission oil for radiator
X260	Electrical distribution box frame	CAN bus, Control unit transmission (D793)
X261	Electrical distribution box frame	RS232 Control unit transmission (D793)
X264	Electrical distribution box frame	Solenoid valve brake transmission
X265	Cab	Rearview camera
X270	Lamp bracket left frame	Main and dipped beams Warning lights Direction indicators Side marker lights

Connector	Location	Function
X271	Lamp bracket front	Main and dipped beams Warning lights Direction indicators Side marker lights
X272	Lamp bracket left rear	Reversing light Rear lights Brake lights Direction indicators Side marker lights
X273	Lamp bracket right rear	Reversing light Rear lights Brake lights Direction indicators Side marker lights
X278	Between engine and gearbox	Magnetic clutch, compressor Magnetic clutch, activation of hydraulics for top lift Sensor, refrigerant pressure Solenoid valve, deactivation of hydraulics
X279	Engine	Power supply and earth connection, Control unit engine (D794) CAN-bus Drivetrain
X282	Cable connected to Printer	RS232 Printer
X301	Boom attachment	Fuse holder, power supply and earth connection for boom and attachment
X400	Boom nose	Fuse holder, power supply and earth connection for boom and attachment
X401	Boom nose	CAN bus control units on boom nose and attachment Redundant power supply control units on boom nose and attachment
X403A	Attachment, right side	Sensor, abutment right side Sensor, twistlocks right side
X403B	Attachment, right side	Sensor, abutment right side Sensor, twistlocks right side
X404	Attachment left side	Sensor, abutment left side Sensor, twistlocks left side
X405	Boom nose	Indicator lamp, locked twistlocks Indicator lamp, unlocked twistlocks Indicator lamp, abutment

Connector	Location	Function
X406	Attachment centre section	Extra work lighting combi unit
X408	Boom nose	Indicator lamp overheight legs raised
X411	Control unit attachment (D791-1)	42-pin connector for Control unit attachment (D791-1)
X412	Control unit attachment (D791-1)	Power supply and earth connection, Control unit attachment (D791-1) CAN bus Control unit attachment (D791-1) Emergency stop
X414	Boom nose	CAN bus and Power supply Control unit attachment right leg pair (D791-4)
X415	Boom nose	Combi unit
X416	Attachment centre section	Rotation stop
X421	Control unit attachment option (D791-2)	42-pin connector for Control unit attachment option (D791-2)
X422	Control unit attachment option (D791-2)	Power supply and earth connection, Control unit attachment option (D791-2) CAN bus Control unit attachment option (D791-2) Emergency stop
X428	Boom	Rotating warning beacon
X431	Control unit attachment left leg pair (D791-3)	42-pin connector for Control unit attachment left leg pair (D791-3)
X432	Control unit attachment left leg pair (D791-3)	Power supply and earth connection, Control unit attachment left leg pair (D791-3) CAN bus Control unit attachment left leg pair (D791-3) Emergency stop
X433	Control unit attachment left leg pair (D791-3)	Warping Indicator lamp abutment combi unit
X434	Combi unit left side front	Sensor clamping position left front leg Sensor, abutment Left front leg
X435	Combi unit left side rear	Sensor, clamping position left rear leg Sensor, abutment left rear leg
X441	Control unit attachment right leg pair (D791-4)	42-pin connector for Control unit attachment right leg pair (D791-4)
X442	Control unit attachment right leg pair (D791-4)	Power supply and earth connection, Control unit attachment right leg pair (D791-4) CAN bus Control unit attachment right leg pair (D791-4) Emergency stop

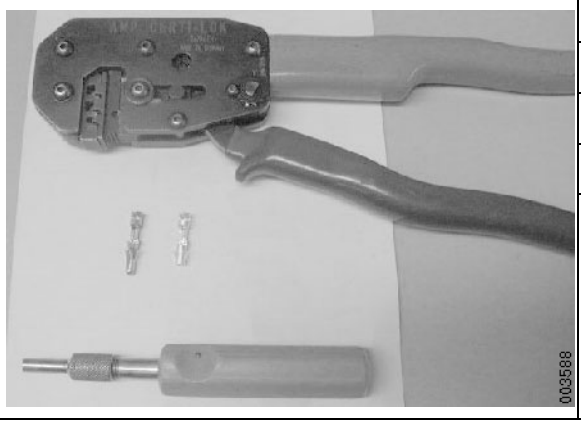
Connector	Location	Function
X443	Control unit attachment right leg pair (D791-4)	Solenoid valve tilt in and out Indicator lamps: Front Leg up and down Indicator lamps: Clamping position front and rear legs
X444	Combi unit right side front	Sensor, Clamping position right front leg Sensor, abutment right front leg
X445	Combi unit right side rear	Sensor, Clamping position right rear leg Sensor, abutment rear front leg
X489	Attachment centre section	Sensor, overheight leg up and down Indicator lamp, overheight leg up and down Solenoid valve overheight leg up and down
X901	Voltage converter, cab	Voltage converter 24V/12V or only Splice
X905	Cab panel	12 V socket for Com radio

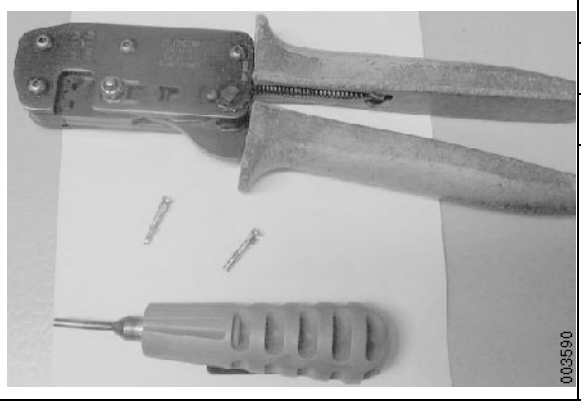
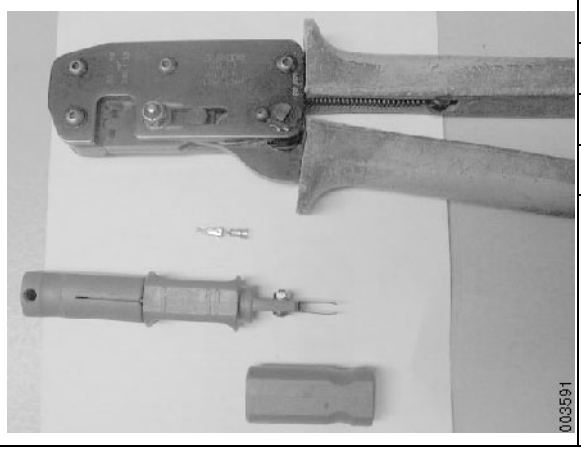
Cable repairs, general

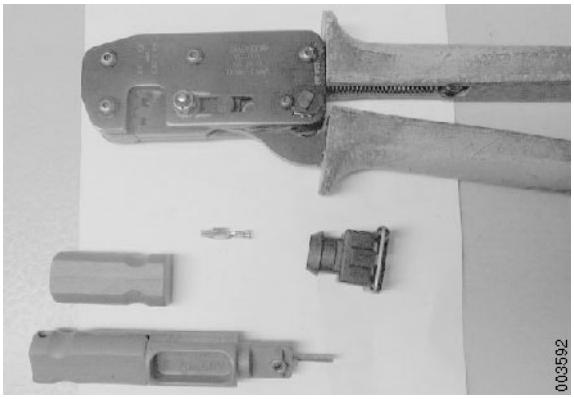
When troubleshooting cabling and carrying out repairs to same the following tools should be used to avoid causing faults or damaging components in perfect condition. It is extremely important for repairs to be carried out correctly to avoid future loss of functionality.

Components and tools can be ordered from Kalmar Industries AB quoting the appropriate part number.

The tools are sorted according to type of connector. Some tools are used for several different types of connector, in which case they are duplicated.

Tool illustration	Designation	Part number
	Cable stripper	923110.0776
Nine-pin connector, single cable (one 0.75 mm² or one 1.5 mm²)		
Tool illustration	**Designation**	**Part number**
	Crimp tool, AMP CERTI-LOCK	923110.0777
	Assembly tool	923110.0778
	Pin extractor	923110.0779
	Contact pin, socket (female)	922201.0001
	Contact pin, plug (male)	922202.0001

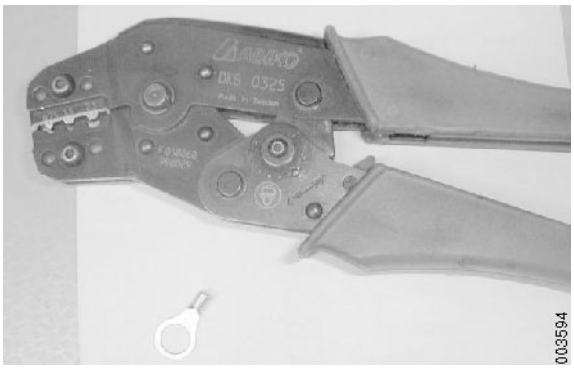
Nine-pin connector, twin cable (one 2.5 mm², two 0.75 mm²) or two 1.5 mm²		
Tool illustration	**Designation**	**Part number**
	Crimp tool, AMP AMPLIVERSAL	923110.0780
	Pin extractor	923110.0779
	Contact pin, socket (female)	922201.0002
	Contact pin, plug (male)	922202.0002
Standard connector, sensor		
Tool illustration	**Designation**	**Part number**
	Crimp tool, APM AWG-10-14	923110.0781
	Pin extractor	923110.0782
	Contact pin, socket (female)	922201.0006
	Contact pin, plug (male)	922202.0006
70-pin connector on control unit		
Tool illustration	**Designation**	**Part number**
	Crimp tool, APM AWG-10-14	923110.0781
	Pin extractor (small contact pin)	923110.0783
	Contact pin, flat (small contact pin)	923702.0003
	Pin extractor (small contact pin)	923110.0784
	Contact pin, flat (large contact pin)	923702.0004
Flat pin "timer" hydraulic valves		
Tool illustration	**Designation**	**Part number**

	Crimp tool, APMAWG-10-14	923110.0781
	Pin extractor	923110.0783
	Contact pin, flat	923702.0005

Flat pin connectors

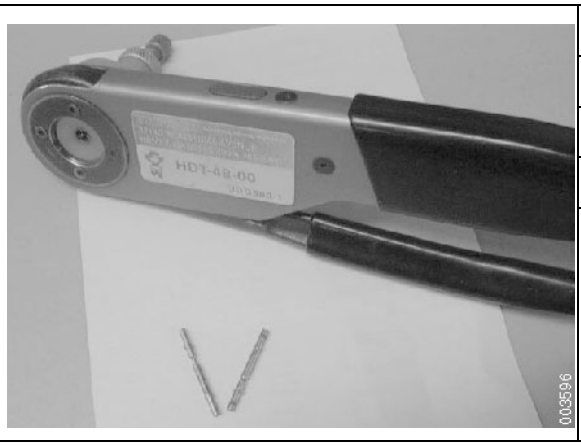
Tool illustration	Designation	Part number
	Crimp tool, KRB - 0560	923110.0787
	Pin extractor	923110.0783
	Contact pin, flat (male)	920741.014
	Contact pin, flat (male)	920741.015

Screw terminals

Tool illustration	Designation	Part number
	Crimp tool, KRB - 0560	923110.0788
	Ring cable terminal, M4, 0.5-1.5 mm^2	923748.0001
	Ring cable terminal, M5, 0.5-1.5 mm^2	923748.0002
	Ring cable terminal, M6, 0.5-1.5 mm^2	923748.0003
	Ring cable terminal, M8, 0.5-1.5 mm^2	923748.0004
	Ring cable terminal, M10, 1.0-2.5 mm^2	923748.0005
	Ring cable terminal, M4, 0.5-1.5 mm^2	923748.0006
	Ring cable terminal, M5, 1.5-2.5 mm^2	923748.0007
	Ring cable terminal, M6, 1.5-2.5 mm^2	923748.0008
	Ring cable terminal, M8, 1.5-2.5 mm^2	923748.0009

Deutsch connectors

Tool illustration	Designation	Part number

	Crimp tool, HDT-48-00	923110.0785
	Pin extractor	923110.0786
	Contact pin, small socket (female)	922201.0009
	Contact pin, large socket (female)	922201.0010
	Contact pin, plug (male)	922202.0008

Signal types, general

The control units on the machine process several different types of signal to receive signals from sensors and monitors and to control solenoid valves, lamps, etc. The different types of signal are described in the table below.

Signal type	Explanation	Area of use
Analogue input signals		
Rheostat	Resistance input 0–200 Ω. Linear working range with accuracy of 3%.	For example, sensor for fuel level.
Temperature	Rheostat input with non-linear working range. Resistance value corresponds to temperature and working range is approx. -40 to 150 °C. There are two different resistance curves, one for Control unit cab (D790-1) and one for control units on frame and attachment. Accuracy is ±0.5 °C within the range of 0 –100 °C (excluding sensor measurement error). Outside this range of 0 – 100 °C, accuracy is ±2 °C.	For example, the sensor for hydraulic oil temperature and climate control unit's temperature sensor.
Voltage	An analogue signal 0–5 V. Working range is 0.5 to 4.5 V.	For example, boom length sensor and analogue controls in cab (control lever and heater control).
Analogue output signals		
Current feedback voltage out, PWM	A modulated signal between 0 V and system voltage, that is 24 V. Working range is 0 to 2 A. A modulated signal is a digital signal translated to analogue (continuous) signal, adapted for a purpose, for example, control of solenoid valve. The resistance drops when the spool in a solenoid valve becomes warms, which gives a lower current through the valve's spool which may lead to the valve's servo pressure not changing. An internal amperemeter measures the current in the circuit and adjusts the voltage level according to this to maintain the desired current valve of the valve's spool.	Hydraulics, for example, lift/lower movement of boom. Used when output signal affects proportional solenoid valves.

Signal type	Explanation	Area of use
Voltage out, PNP PWM	A modulated signal between 0 V and system voltage, that is 24 V. Requires a grounding point as reference.	For example, interior lighting and switch illumination.
Voltage out reversed polarity, NPN PWM	A modulated signal between 0 V and system voltage, that is 24 V. Requires 24 V as reference.	For example, cab fan.
Digital input signals		
Digital input signal with pull-down and search lighting	Signal in, U < 5 V gives logical zero (0) Signal in, U > 16 V gives logical one (1) In case of no signal, the input is grounded.	For example, the input signal from a breaker switch with background lighting.
Digital input signal with pull-down	Signal in, U < 5 V gives logical zero (0) Signal in, U > 12 V gives logical one (1) In case of no signal, the input is grounded. Band width 300 Hz, that is, intended for slow sensors.	For example, position sensor (inductive sensors) and brake pressure (pressure monitors).
Digital output signals		
High-side driver, 1.5 A	Logical one (1) gives voltage out, U >= 22.5 V Max. load 1.5 A Open load 0.15 A Max. current instantaneous load, 8 A	For example, running lights, solenoid valves.
High-side driver, 5 A	Logical one (1) gives voltage out, U >= 22.5 V Max. load 5 A Open load 0.9 A Max. current instantaneous load, 35 A	For example, work lights and wiper motors.
High-side driver, 10 A	Logical one (1) gives voltage out, U >= 22.5 V Max. load 10 A Open load 1.9 A Max. current instantaneous load, 70 A	For example, cooling fan. This output is only found on the control units on the frame and attachment.
H-bridge	Logical one (1) gives voltage out, U >= 22.5 V or grounded output, U = 0 V. Max. load 0.5 A Open load 0.15 A Max. current instantaneous load, 8 A The H-bridge works with two outputs in pairs. In case of logical one (1), an output gives voltage at the same time as the other output is grounded. In case of logical zero (0), the outputs shift voltage level.	For example, water valve climate control unit (acts both ways).

11.6 Communication

11.6.1 CAN-bus

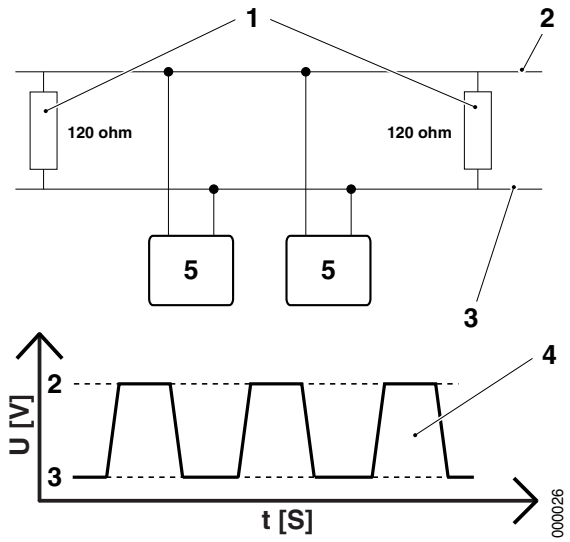
CAN-bus, description

Communication between the control units takes place using CAN-buses (Controller Area Network) based on the ISO 11898 standard and CAN specification 2.0B.

The CAN bus is a fast control bus with logic hardware circuits. A simple technique giving a high degree of reliability (low fault frequency), which essential for the ability of control signals to control systems according to changing conditions.

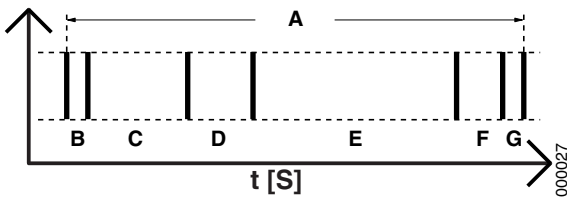
CAN specifies:

- that the signal traffic is transferred in twisted-pair conductors.
- that termination resistance (position 1) is necessary (matched to the impedance of the conductors) so that pulse trains (position 4) will not have a sharp signal.
- that the signal value is indicated by the difference in potential between the conductors, CAN + and CAN - (positions 2 and 3).
- form of signal messages.



Message continues and signal runs high (voltage high) or low (voltage low).

1. Termination resistance (120 ohm)
2. CAN + (voltage high)
3. CAN - (voltage low)
4. Pulse
5. control unit



Message continues and signal runs high (voltage high) or low (voltage low).

A. Long message
B. Start bit
C. Identity field / Priority
D. Control field (length of data segment)
E. Data segment
F. Control amount for error detection
G. Confirmation bit (Acknowledge)

Message

Messages are of two types:

- CAN Standard, has identity field of 11 bits
- CAN Extended, has identity field of 29 bits

CAN operates with messages sent in frames of 8 bytes (64 bits). A complete message is approximately 100 bits long. The illustration shows how a message is constructed.

Start bit (B)

Indicates that the transmission of a frame, i.e. a message, is now beginning.

Identity field (C)

Describes what kind of information the message contains, e.g. measurement information on engine speed.

Does not indicate the control unit address. CAN does not concern itself with addressing but all control units receive messages and pass them on.

Control field (D):

Indicates the length of the next data segment.

Data segment (E)

Contains the information that is to be forwarded to control units in the network.

Check sum for error detection (F)

Calculates a message check sum which enables error detection of sent messages by the receiving control unit.

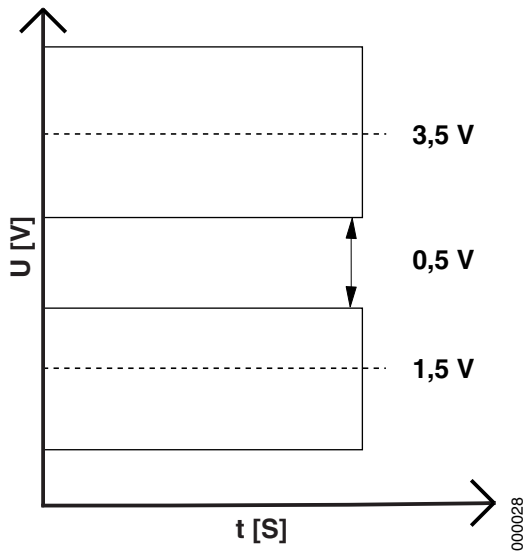
Confirmation (G)

The sending control unit sets a bit to logic one (1) when the message is being sent. The first control unit to receive the message passes it on and sets a bit to logic zero (0).

Communication

The CAN network consists of control units and segments. A segment (bus) is a twisted-pair conductor that carries CAN + and CAN - signal levels from control unit to control unit.

Each control unit measures the potential difference on its two inputs and this potential difference gives a logic zero or logic one. The illustration shows an approved area according to the standard for potential levels. CAN + has a recommended value of 3.5 V and CAN - a value of 1.5 V. In the worst case an approved potential difference may be only 0.5 V but for reliable communication in practice a potential difference of 2 V is recommended.



Potential levels CAN + and CAN -

Pulse trains can only be observed with an oscilloscope, not with a digital multimeter.

All control units in the network listen when a message is transmitted. The message is saved in a control unit and information of interest is processed. The first control unit to receive the message confirms that it has been received (sets confirmation bit). The transmitting control unit then knows that the message has been received by at least one control unit.

One control unit at a time transmits messages while other control units listen and wait until the bus is free. If two messages should be transmitted at the same time, transmission of the message with the lowest priority is terminated (highest value in identity field). This ensures that messages need not be retransmitted in the case of a communications conflict but only in the case of a bus fault (defective message).

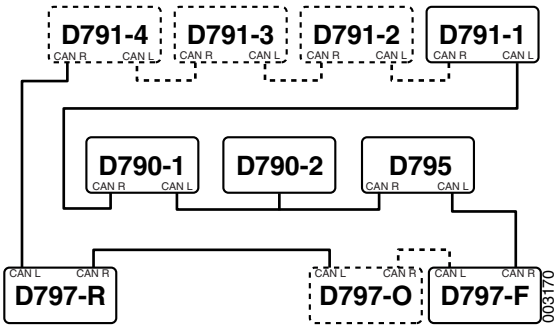
The CAN-bus exchanges around 100 messages per second in the network.

Different bus systems can be used, e.g. random transmission or primary (master) / secondary (slave).

HLP High Layer Protocol

CAN specifies only the messages and how communication is to take place, i.e. a protocol. In order to handle the network the CAN protocol needs the addition of an HLP which specifies:

- flow control
- transport of data above a length of 8 bits in 8 bit messages (division)
- how control units are addressed in networks



Schematic diagram redundant CAN bus

- how bits in the message's data field shall be interpreted

11.6.2 Redundant CAN-bus

Redundant CAN-bus, description

The redundant CAN bus handles communication between all control units on the machine except Control unit transmission (D793) and Control unit engine (D794). These have a separate CAN bus, see *CAN-bus drivetrain, description page 51*.

Redundant CAN bus means that the control units are linked together in a network that communicates via CAN bus (see *CAN-bus, description page 46*) and that there exist duplicate communications paths in the network. The network is divided up into control units and segments (a segment is the cabling between control units). The number of active segments depends on how many control units the machine in question has and this depends on its equipment (options).

The network is based on the CAN kingdom principle, which means that a control unit is the central and controlling unit (master). In this case it is Control unit cab (D790-1). Other control units in the network are secondary (slaves) and handle special areas such as components in the cab.

The control units have two connections for the CAN bus, CAN-L (left) and CAN-R (right). The control units are connected in series to each other in a loop.

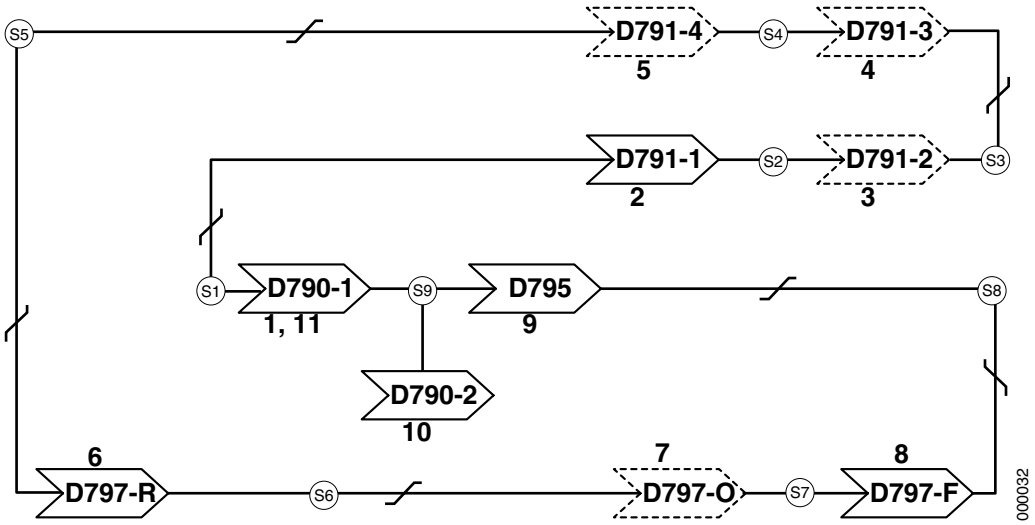
The redundant CAN bus can handle the dropout of a segment. On startup the link is analysed and if a segment is defective the message will be transmitted via another path.

Should several segments drop out, one or more control units will lose communication and operate independently, often with extremely limited functionality.

A CAN bus fault is indicated by an error code and a warning in the display. If several CAN bus segments are defective, the system only shows an error code for the first defective segment.

Connection of redundant CAN bus

Prior condition	Reference value	Reference
Battery disconnector	In position 1	*Battery disconnector, description page 5*
Redundant voltage feed	Activated.	*Redundant voltage feed for control units, description of operation page 9*



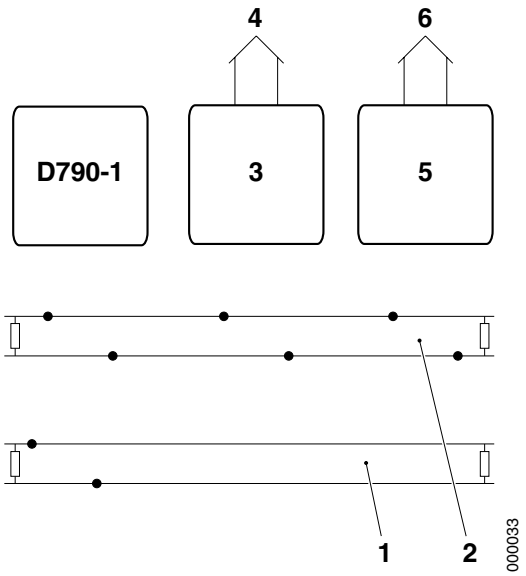
Pos	Explanation	Signal description	Reference
1	Control unit cab (D790-1) establishes redundant CAN bus communication by sending the enquiry on the CAN bus via CAN-R.	Controlled by control system, error shown with error code.	*Control unit cab, description page 20* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.1 CAN/POWER, menu 1 and 8.4.1.2 CAN/POWER, menu 2*
2	Control unit attachment (D791-1) sends an answer back on the CAN bus via CAN-L and passes on the enquiry via CAN-R. Termination resistance in the control nodes ensures communication segment by segment.	A click sound can be heard when the termination resistance is connected.	*Control unit attachment, description page 24* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.1 CAN/POWER, menu 1 and 8.4.1.2 CAN/POWER, menu 2*
3 ⊞	Control unit attachment option (D791-2) sends an answer back on the CAN bus via CAN-L and passes on the enquiry via CAN-R. Termination resistance in the control nodes ensures communication segment by segment.	A click sound can be heard when the termination resistance is connected.	*Control unit attachment option, description page 25* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.1 CAN/POWER, menu 1 and 8.4.1.2 CAN/POWER, menu 2*

Pos	Explanation	Signal description	Reference
4 ⊕	Control unit attachment left legs (D791-3) sends an answer back on the CAN bus via CAN-L and passes on the enquiry via CAN-R. Termination resistance in the control nodes ensures communication segment by segment.	A click sound can be heard when the termination resistance is connected.	*Control unit attachment left leg pair, description page 26* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.1 CAN/POWER, menu 1 and 8.4.1.2 CAN/POWER, menu 2*
5 ⊕	Control unit attachment right leg pair (D791-4) sends an answer back on the CAN bus via CAN-L and passes on the enquiry via CAN-R. Termination resistance in the control nodes ensures communication segment by segment.	A click sound can be heard when the termination resistance is connected.	*Control unit attachment right leg pair, description page 27* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.1 CAN/POWER, menu 1 and 8.4.1.2 CAN/POWER, menu 2*
6	Control unit frame rear (D797-R) sends an answer back on the CAN bus via CAN-L and passes on the enquiry via CAN-R. Termination resistance in the control nodes ensures communication segment by segment.	A click sound can be heard when the termination resistance is connected.	*Control unit frame rear, description page 22* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.1 CAN/POWER, menu 1 and 8.4.1.2 CAN/POWER, menu 2*
7 ⊕	Control unit frame option (D797-0) sends an answer back on the CAN bus via CAN-L and passes on the enquiry via CAN-R. Termination resistance in the control nodes ensures communication segment by segment.	A click sound can be heard when the termination resistance is connected.	*Control unit frame option, description page 23* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.1 CAN/POWER, menu 1 and 8.4.1.2 CAN/POWER, menu 2*
8	Control unit frame front (D797-F) sends an answer back on the CAN bus via CAN-L and passes on the enquiry via CAN-R. Termination resistance in the control nodes ensures communication segment by segment.	A click sound can be heard when the termination resistance is connected.	*Control unit frame front, description page 21* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.1 CAN/POWER, menu 1 and 8.4.1.2 CAN/POWER, menu 2*
9	Control unit KID (D795) sends an answer back on the CAN bus via CAN-L and passes on the enquiry via CAN-R. Termination resistance in the control nodes ensures communication segment by segment.	A click sound can be heard when the termination resistance is connected.	*Control unit KID, description page 31* Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.1 CAN/POWER, menu 1 and 8.4.1.2 CAN/POWER, menu 2*
10	Control unit KIT (D790-2) is not connected to the Redundant CAN bus. Control unit KIT (D790-2) Does not communicate until ignition voltage (15) is activated.	A click sound can be heard when the termination resistance is connected.	*Control unit KIT, description page 30*

Pos	Explanation	Signal description	Reference
11	If all control units have answered, Control unit cab (D790-1) disconnects the segment to Control unit attachment (D791-1). If any control unit has not answered, Control unit cab (D790-1) uses both CAN-L and CAN-R to maintain communication. In addition, analysis is performed to ascertain which segment is defective.	Controlled by control system, error shown with error code.	Diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.1 CAN/POWER, menu 1 and 8.4.1.2 CAN/POWER, menu 2*

11.6.3 CAN-bus driveline

CAN-bus drivetrain, description



1. Redundant CAN-bus
2. CAN bus drivetrain
3. Control unit engine (EDC)
4. Engine
5. Control unit, gearbox (TCU)
6. Gearbox

The drivetrain CAN-bus is based on the SAE J1939 standard where selected messages are used to control engine and transmission.

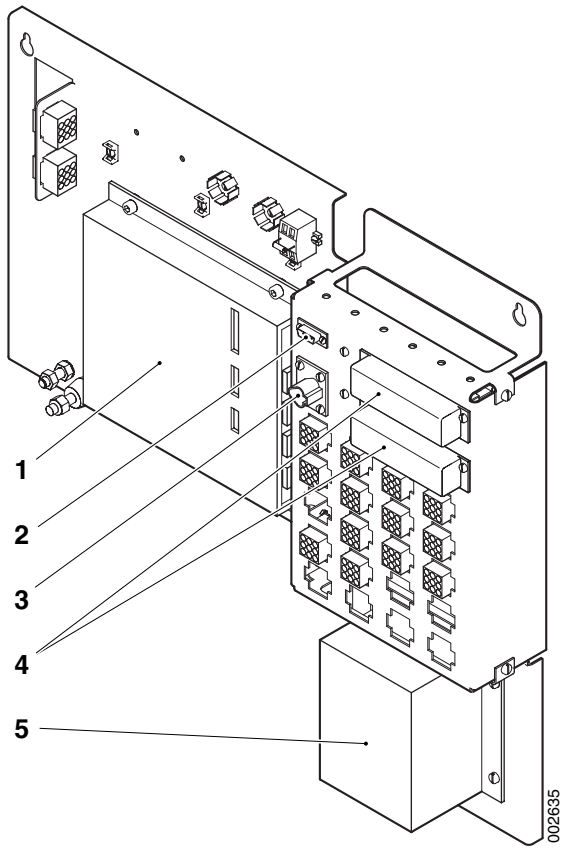
SAE J1939 is a standard from SAE (Society of Automotive Engineers) for data communication in vehicles. The standard sets forth rules governing hardware interfaces, bit times and the composition of messages.

The control units for engine and gearbox come from the respective engine and gearbox suppliers.

The machine uses only one gearbox model while several different engines are fitted. All engine alternatives use the standard and messages concerning each engine are therefore all based on the same structure.

Communication with Control unit engine (D794) and Control unit transmission (D793) is separated from the redundant CAN bus.

The signals can be checked with the diagnostic menu, see *Maintenance manual DRF 400–450*, section *8 Control system*, group *8.4.1.3 CAN/POWER, menu 3*.



Electrical distribution box cab behind driver seat on left

1. Control unit cab (D790-1)
2. Socket for programming control units
3. Socket for CAN bus drivetrain
4. Fuse holder
5. Voltage converter

11.6.4 Communication between PC and machine

Communication between PC and machine, description

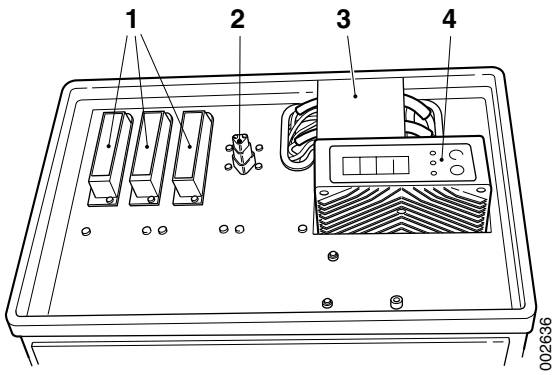
The machine has three outlets for communication between control units and PC. Two are located in electrical distribution box cab and the third in electrical distribution box frame.

Outlets for programming control units in electrical distribution box cab (pos. 2) are used for programming the control units in the cab, on the frame and on the attachment.

Outlets for CAN bus drivetrain in electrical distribution box cab (pos. 3) are used for communicating with engine and gearbox via CAN bus.

The outlet for programming Control unit transmission (D793) in electrical distribution box frame (pos. 2 below) is used for programming Control unit transmission (D793).

For further details on communication between PC and machine, contact Kalmar Industries AB.



Electrical distribution box frame

1. Circuit fuses
2. Outlet for programming Control unit transmission (D793)
3. Main fuses
4. Control unit transmission (D793)

D Error codes

Error codes

See *Maintenance manual DRF 400–450*, section *D Error codes*.

E Schematics

Schematics

See *Maintenance manual DRF 400–450*, section *E Schematics*.

Table of Contents F Technical data

F Technical data

Specifications for data and volume

Data

1 Engine	Volvo TWD1240VE	Cummins QSM11
Power acc. to ISO 3046 (net power)	246 kW at 2000 rpm	280 kW at 2000 rpm
Torque ISO 3046	1751 Nm at 1200 rpm	1898 Nm at 1100-1400 rpm
Alternator	2240 W	2800 W
Battery	2x12 V - 140 Ah	

2 Transmission	Dana TE32000
No. of gears forward – reverse	4-4

3 Driveline/axle	Meritor PRC7534	Kessler D102

4 Brakes	Wet Disc Brakes - Drive wheels
Parking brake	Spring brake - Drive wheels

5 Steering	Hydraulic servo

6 Suspension	DRF420	DRF400/450	DRF450, X
Dimensions front - rear	18.00x25/36	18.00x25/40	18.00x33/36
Tyre pressure (also see pressure plate)	1.0 MPa		

Volumes

For oil types, see *Oils and lubricants, recommendation på sidan 8*.

1 Engine	Volvo TWD1240VE	Cummins QSM11
Engine oil	31 l (excl. filter)	34 l (excl. filter)
Cooling system	68 l	40 l
Fuel system	550 l	

2 Transmission	Dana TE32000
Transmission oil	60 l when changing (80 l total)

3 Driveline/axle	Meritor PRC7534	Kessler D102
Differential	50 l	65 l
Hub reduction	2x10 l	2x12 l

4 Brakes	
Brake system	140 l

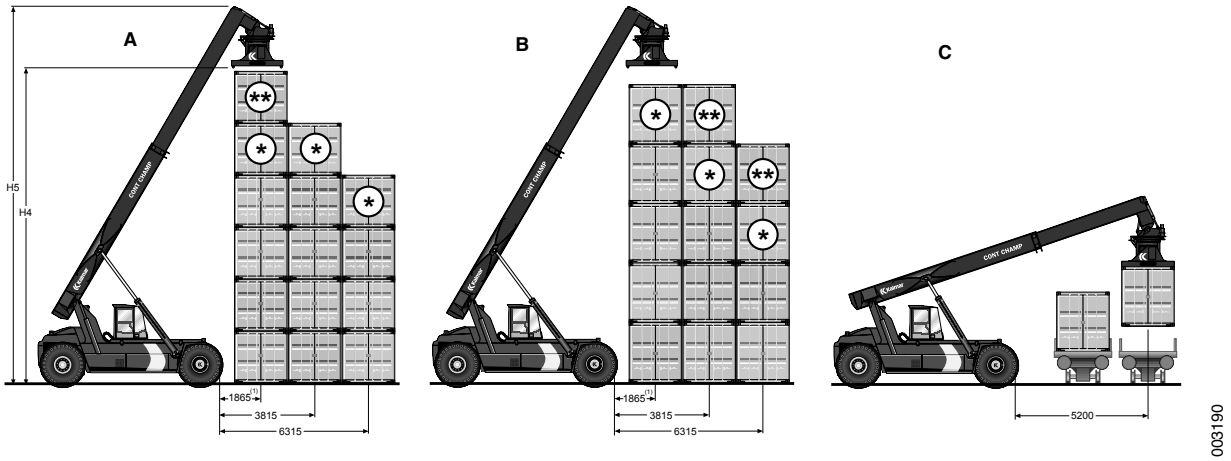
7 Load handling	
Planetary gear hydraulic motor attachment	1.6 l
Brake hydraulic motor attachment	0.6 l

9 Frame, body, cab and accessories	
Washer fluid	5 l
Refrigerant air conditioning	1800-1850 g (ZXL100 PAG oil)

10 Common hydraulics	
Hydraulic system	940 l (tank 600 l)

Specifications for lift capacity and dimensions

Capacity (tons)



A. Container 8’6’’

B. Container 9’6’’

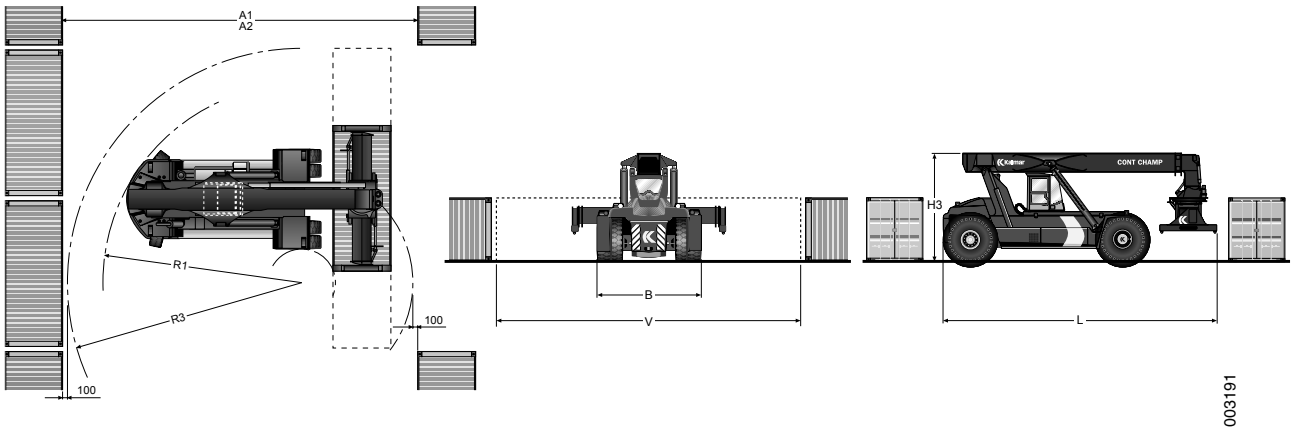
C. Rail

Model	Container 8’6’’			Container 9’6’’			Rail	Lifting height top lift attach-ment	
	Row 1	Row 2	Row 3	Row 1	Row 2	Row 3	Row 2	H4 (mm)	H5 (mm)
DRF420-60S5	41*/42	25*	11*	40*/42	25*	11*	16	15100	18100
DRF450-60S5	43*/45	27*	13*	42*/45	27*	13*	18	15100	18100
DRF450-60S5X	43*/45	35*	18*	42*/45	35*	18*	24	15200	18200
DRF420-65S5	41*/42	28*	13*	40*/42	28*	13*	18	15100	18100
DRF420-65S6	39**/ 41*/42	28*	13*	40*/42	28**	13**	18	16200	19250
DRF450-65S5	43*/45	30*	15*	42*/45	30*	15*	20	15100	18100
DRF450-65S6	42**/ 44*/45	30*	15*	43*/45	30**	15**	20	16200	19250
DRF450-65S5X	45*	36*/38*	21*	43*/45	37*/38	21*	27	15200	18200
DRF450-65S6X	42**/ 45*	35*/38	21*	43*/45	34**/ 36*/38	21**	27	16300	19350
DRF420-70S5	41*/42	30*	15*	40*/42	30*	15*	20	15100	18100
DRF450-70S5X	45*	39*/41	23*	45*	40*/41	23*	29	15100	18200

Model	Container 8'6''			Container 9'6''			Rail	Lifting height top lift attachment	
DRF450-70S5XS	45*	39*/41	23*/(31*)	45*	40*/41	23*/(31*)	29/ (35)	15100	18200
DRF450-705XS	45*	43*/45	26*/(34*)	45	45*	26*/(34*)	32/ (41)	15200	18400
DRD450-80S4X	45*	45	35	45	45*	35	44	13500	17000
DRD450-80S4XS	45*	45	35/(45)	45	45*	35/(45)	44/ (45)	13500	17000
DRD450-80S5XS	Information can be obtained when ordering								

(**)= Support jacks down, (1)= May vary depending on model

Dimensions



Model	Aisle width (mm)		Turning radius (mm)		Main dimensions (mm)						Service weight (kg)
	A1 - 20 ft	A2 - 40 ft	R1 - 20 ft	R3 - 40 ft	B	V	L	H3	Ground clearance	Tyres	
DRF420 -60S5	11200	13600	8100	9400	4150	6055-12185	11200	4500	250	18.00x25/ 36	64500
DRF450 -60S5	11200	13600	8100	9400	4150	6055-12185	11200	4500	250	18.00x25/ 40	66400
DRF450 -60S5X	11200	13600	8100	9400	4150	6055-12185	11200	4600	300	18.00x33/ 36	76500
DRF420 -65S5	11600	13600	8500	9400	4150	6055-12185	11700	4500	250	18.00x25/ 36	65000
DRF420 -65S6	11900	13900	8500	9450	4150	6055-12185	12000	4500	250	18.00x25/ 36	66200

Model	Aisle width (mm)		Turning radius (mm)		Main dimensions (mm)						Service weight (kg)
	A1 - 20 ft	A2 - 40 ft	R1 - 20 ft	R3 - 40 ft	B	V	L	H3	Ground clearance	Tyres	
DRF450-65S5	11600	13600	8500	9400	4150	6055-12185	11700	4500	250	18.00x25/40	66800
DRF450-65S6	11900	13900	8500	9450	4150	6055-12185	12000	4500	250	18.00x25/40	67800
DRF450-65S5X	11600	13600	8500	9400	4150	6055-12185	11700	4600	300	18.00x33/36	76300
DRF450-65S6X	11900	13900	8500	9450	4150	6055-12185	12000	4600	300	18.00x33/36	77200
DRF420-70S5	12100	13600	9000	9400	4150	6055-12185	12200	4500	250	18.00x25/36	65800
DRF450-70S5X	12100	13600	9000	9400	4150	6055-12185	12200	4700	300	18.00x33/36	77800
DRF450-70S5XS	12100	13600	9000	9400	4150	6055-12185	12200	4700	300	18.00x33/36	79300
DRF450-705XS	12500	13600	9400	9400	4150	6055-12185	12700	4750	300	18.00x33/36	82100
DRD450-80S4X	14900	15300	11000	11250	4500	6055-12185	14200	5150	425	21.00x35/36	102600
DRD450-80S4XS	14900	15300	11000	11250	4500	6055-12185	14200	5150	425	21.00x35/36	103100
DRD450-80S5XS	Information can be obtained when ordering										

Oils and lubricants, recommendation

The service intervals indicated by Kalmar Industries in the maintenance manual apply on the condition that oil is selected according to the following table. The table indicates recommended viscosity for different oil types and qualities depending on outdoor temperature.

Any deviation from this table must be approved in writing by Kalmar Industries, and may mean changed service intervals.

	°C -40 -30 -20 -10 0 +10 +20 +30 +40 °F -40 -22 -4 +14 +32 +50 +68 +86 +104
Oil type, quality	
Engine oil ACEA E3 and VDS-2, API CH4 or CG4 ACEA E2 and API CF4	SAE 15W40 SAE 5W30 (engine oil)
Transmission oil ATF **NOTE!** Only for TE32000.	DEXRON III (brand name)
Transmission oil UTTO oil, GM Allison C-4	SAE 5W30
Drive axle, hypoid oil API GL-5 or MIL-L-2105B	SAE 80W140 SAE 75W90
Oil brake system, UTTO oil, GM Allison C-4	SAE 5W30 (transmission oil)
Oil planetary gear hydraulic motor, hypoid oil API GL-5 or MIL-L-2105B	SAE 80W140 SAE 75W90
Oil disc brake hydraulic motor	ISO VG 46 HV
Hydraulic oil	ISO VG 46 HV Arctic ISO VG 32

Grease

Use a universal grease type EP acc. to NLGI Grade 2 with 3–5 % molybdenum sulphide content for all grease points except for slide plates (see white lubricating paste below).

White lubricating paste

Use Gleitmo 805 or equivalent when lubricating slide plates.

Sealant silicone

Use Loctite 5972 or Loctite 598 (or equivalent). If uncertain, contact Kalmar Industries.

Lighting system, technical data

Light	Rating (W)	Socket
Control lights	1.2	W2x4.6d
Interior lighting	10	S8.5
Rear lights	5	BA15s
Brake lights	21	BA15s
Direction indicators	21	BA15s
Running lights	5	W2.1x9.5d
Headlights (high and low beams)	75/70	P43t-38
Back-up lights	70	PK22s
Work lights	70	PK22s
Rotating beacon	70	PK22s

Tightening torques, recommendations

The tightening torques in the following table are recommendations when tightening bolts and nuts.

When torquing using a machine, for example, bolt runner, the tightening torque should be reduced by approx. 5%.

For mild surfaces (hardness below 200 HB), washer shall be used under both bolt head and nut. Alternatively, use flange bolt or flange nut.

Tighten to the prescribed torque without stopping.

Recommended tightening torque may vary depending on surface treatment. Certain combinations of nut and bolt require lubrication according to the table below.

State	Bolt	Nut	Lubrication
1	untreated	untreated	oil
2	bright-galvanized	untreated or bright-galvanized	dry or oil
3	hot-galvanized	untreated	dry or oil

Quality	8.8			10.9	12.9
State	1	2	3	1	1
Fine M-thread					
M81	27 Nm	24 Nm	30 Nm	39 Nm	46 Nm
M101,25	54 Nm	48 Nm	61 Nm	78 Nm	91 Nm
M121,25	96 Nm	85 Nm	108 Nm	135 Nm	162 Nm
M161.5	230 Nm	205 Nm	260 Nm	323 Nm	388 Nm
M181.5	330 Nm	294 Nm	373 Nm	466 Nm	559 Nm
M-thread					
M4	3.2 Nm	2.9 Nm	3.6 Nm	4.6 Nm	5.5 Nm
M5	6.4 Nm	5.7 Nm	7.2 Nm	9.1 Nm	11 Nm
M6	11 Nm	9.8 Nm	12.5 Nm	16 Nm	19 Nm
M8	26 Nm	24 Nm	30 Nm	38 Nm	45 Nm
M10	52 Nm	47 Nm	59 Nm	74 Nm	89 Nm
M12	91 Nm	81 Nm	103 Nm	128 Nm	154 Nm
M16	220 Nm	198 Nm	250 Nm	313 Nm	375 Nm
M20	430 Nm	386 Nm	490 Nm	620 Nm	732 Nm
M24	750 Nm	668 Nm	848 Nm	1050 Nm	1270 Nm
M30	1480 Nm	1317 Nm	1672 Nm	2080 Nm	2500 Nm

Quality	**8.8**			**10.9**	**12.9**
UNC-thread					
1/4	12.5 Nm	11.1 Nm	14.1 Nm	17.6 Nm	20 Nm
5/16	25 Nm	22.3 Nm	28.3 Nm	35 Nm	42 Nm
3/8	44 Nm	39 Nm	50 Nm	62 Nm	73 Nm
7/16	70 Nm	62 Nm	79 Nm	100 Nm	118 Nm
1/2	107 Nm	95 Nm	121 Nm	151 Nm	178 Nm
9/16	153 Nm	136 Nm	173 Nm	216 Nm	255 Nm
5/8	210 Nm	187 Nm	237 Nm	298 Nm	353 Nm
3/4	370 Nm	390 Nm	418 Nm	524 Nm	619 Nm
7/8	594 Nm	528 Nm	671 Nm	839 Nm	990 Nm
1	889 Nm	791 Nm	1005 Nm	1260 Nm	1480 Nm
1 1/8	1260 Nm	1120 Nm	1424 Nm	1780 Nm	2100 Nm
1 1/4	1760 Nm	1565 Nm	1990 Nm	2490 Nm	2940 Nm
1 3/8	2320 Nm	2065 Nm	2620 Nm	3280 Nm	3870 Nm
1 1/2	3060 Nm	2720 Nm	3455 Nm	4320 Nm	5100 Nm

Unit explanations

Unit	Abbreviation
Newton metre	Nm
Kilo pound metre	kpm
Kilo pascal	kPa
Mega pascal	MPa
Kilowatt	kW
kilojoule	kJ
British termel unit	Btu
Calorie	ca
Inch	in
Feet	ft
Yard	yd
Mile	mile
Centimetre	cm
Metre	m
Kilometre	km

Conversion table, SI-units

SI-unit	Recalculation factor	Non-SI	Recalculation factor	SI
Torque				
Nm	x 10,2	= kg·cm	x 0,8664	= lb·in
Nm	x 0,74	= lbf·ft	x 1,36	= Nm
Nm	x 0,102	= kg·m	x 7,22	= lb·ft
Pressure (Pa = N/m ^{2})				
kPa	x 4,0	= in.H_2O	x 0,249	= kPa
kPa	x 0,30	= in.Hg	x 3,38	= kPa
kPa	x 0,145	= psi	x 6,89	= kPa
bar	x 14,5	= psi	x 0,069	= bar
kp/cm ^{2}	x 14,22	= psi	x 0,070	= kp/cm ^{2}
N/mm ^{2}	x 145,04	= psi	x 0,069	= bar
MPa	x 145	= psi	x 0,00689	= MPa
Power (W = J/s)				
kW	x 1,36	= hp (cv)	x 0,736	= kW
kW	x 1,34	= bhp	x 0,746	= kW
kW	x 0,948	= Btu/s	x 1,055	= kW
W	x 0,74	= ft·lb/s	x 1,36	= W
Energy (J = Nm)				
kJ	x 0,948	= Btu	x 1,055	= kJ
J	x 0,239	= calorie	x 4,19	= J
Speed and acceleration				
m/s^2	x 3,28	= ft/s ^{2}	x 0,305	= m/s ^{2}
m/s	x 3,28	= ft/s	x 0,305	= m/s
km/h	x 0,62	= mph	x 1,61	= km/h
Horsepower/torque				
Bhp x 5252 rpm= TQ (lb·ft)			TQ x rpm 5252 = bhp	
Temperature				
^{o}C = (^{o}F – 32)/1,8	^{o}F = (^{o}C x 1,8) + 32			
Flow factor				
l/min (dm ^{3} /min)	x 0,264	= US gal/min x 3,785		= liter/min

Conversion table, length

Unit	cm	m	km	in	ft	yd	mile
cm	1	0,01	0,00001	0,3937	0,03281	0,01094	0,000006
m	100	1	0,001	39,37	3,2808	1,0936	0,00062
km	100000	1000	1	39370,7	3280,8	1093,6	0,62137
in	2,54	0,0254	0,000025	1	0,08333	0,02777	0,000015
ft	30,48	0,3048	0,000304	12	1	0,3333	0,000189
yd	91,44	0,9144	0,000914	36	3	1	0,000568
mile	160930	1609,3	1,6093	63360	5280	1760	1
1 mm = 0,1 cm - 1 mm = 0,001 mm							

Conversion table, area

Unit	cm^2	m^2	km^2	a	ft^2	yd^2	in^2
cm^2	1	0,0001	-	0,000001	0,001076	0,000012	0,155000
m^2	10000	1	0,000001	0,01	10,764	1,1958	1550,000
km^2	-	1000000	1	10000	1076400	1195800	-
a	0,01	100	0,0001	1	1076,4	119,58	-
ft^2	-	0,092903	-	0,000929	1	0,1111	144,000
yd^2	-	0,83613	-	0,008361	9	1	1296,00
in^2	6,4516	0,000645	-	-	0,006943	0,000771	1
1ha = 100a - 1$mile^2$ = 259ha = 2,59km^2							

Conversion table, volume

Unit	cm^3 = cc	m^3	l	in^3	ft^3	yd^3
cm^3 = ml	1	0,000001	0,001	0,061024	0,000035	0,000001
m^3	1000000	1	1000	61024	35,315	1,30796
dm^3 (l)	1000	0,001	1	61,024	0,035315	0,001308
in^3	16,387	0,000016	0,01638	1	0,000578	0,000021
ft^3	28316,8	0,028317	28,317	1728	1	0,03704
yd^3	764529,8	0,76453	764,53	46656	27	1
1gal (US) = 3785,41cm^3 = 231in^3 = 0,83267gal (UK)						

Conversion table, weight

Unit	g	kg	t	oz	lb
g	1	0,001	0,000001	0,03527	0,0022
kg	1000	1	0,001	35,273	2,20459
t	1000000	1000	1	35273	2204,59
oz	28,3495	0,02835	0,000028	1	0,0625
lb	453,592	0,45359	0,000454	16	1
1 ton (metric) = 1,1023 ton (US) = 0,9842 ton (UK)					

Conversion table, pressure

Unit	kp/cm^2	bar	$Pa = N/m^2$	kPa	lbf/in^2	lbf/ft^2
kp/cm^2	1	0,98067	98066,5	98,0665	14,2233	2048,16
bar	1,01972	1	100000	100	14,5037	2088,6
$Pa = N/m^2$	0,00001	0,001	1	0,001	0,00015	0,02086
kPa	0,01020	0,01	1000	1	0,14504	20,886
lbf/in^2	0,07032	0,0689	6894,76	6,89476	1	144
lbf/ft^2	0,00047	0,00047	47,88028	0,04788	0,00694	1
kg/cm^2 = 735,56 Torr (mmHg) = 0,96784 atm						

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Terminology

Explanations

Term	Description
Accumulator	Reservoir that stores (accumulates) pressure for i.e. hydraulic functions.
Attachment	Part of the machine that grabs the load when lifting.
Anti-corrosion compound	Prevents oxidation, in simple terms, rust proofing.
Working hydraulics	All load handling functions, i.e. lift and lower, tilt, sideshift, spreader and levelling.
Axle distance	Distance between drive axle and steering axle.
Bar	Unit to express pressure.
Battery disconnector	Cuts off current from battery.
Boom	Lifting member moveable vertically and fore-aft. Bracket for attachment.
Bottom lift attachment	"Lifting legs" that can be raised and lowered for handling loads. Grabs load from below.
Daily inspection	The actions that should be performed daily to ensure the machine's functionality.
Decitonne	Tenth of a tonne, measure of the machine's lift capacity.
Display	"Window" showing digital information on steering wheel panel in cab.
Operating hours	Number of hours machine has been in operation, shown on hour meter in cab.
Drive axle	Driving axle that receives the torque from the drivetrain.
Drivetrain	Parts in machine involved in power transmission; engine, torque converter, transmission, propeller shaft and drive axle with differential and hub reduction.
ECC	Electric Climate Control. Climate control unit with thermostat-controlled cooling, dehumidification and heating.
EHC	Electric Heat Control. Heating unit with automatically controlled heating.
Electrolyte level	Fluid level in battery cells.
Expansion tank	Tank for coolant.
Fixed displacement	Pump with fixed pump volume.
Hanging load	Lifted load.
Main fuse	Located by the battery. Cuts off electric power to all machine systems.
Hydraulic oil	Oil for hydraulic system. See specifications in operator's manual.
Hydraulic oil pump	Pump in hydraulic system.
Hydraulic system	System that uses oil pressure to transfer power to different functions.
Indicator	Manual "sensor", for example, shows that a filter is clogged and needs to be changed.

Term	Description
Refrigerant	Fluid/gas in climate control unit/air conditioning. May only be handled by authorized trained person.
Low-emission engine	Engine with low emissions of hazardous substances. Manufactured according to regulations.
LC	Load centre.
Lift capacity	Indicates machine's maximal lift capacity.
Lifting point	Attaching point for lift device when lifting an object.
Solenoid valve	An electro-magnetically controlled valve. See also proportional valve.
Control valve	Valves that can be used to control something, for example, to release pressure and thus lower a boom or a fork. See also control valve.
Machine model	Machine type. Indicated, for example: DRF 400-450. See also type designation.
Environmental waste	Used oils, filters, etc., must be handled according to governing national laws and regulations.
Torque converter	Hydraulic, variable clutch.
Hub reduction	Type of final drive (often next to drive wheel) that reduces rpm and increases torque from the drivetrain.
OP	Overload Protection. Overload protection to warn in case of overloaded machine.
Pilot oil pressure	A low control pressure to, for example, a valve.
Planetary gear	Type of transmission with gears in constant engagement.
Product alternative	One of several alternatives is selected for a machine, i.e. engine alternative.
Proportional valve	An electro-magnetically controlled valve. If a current is applied, the valve is activated proportional to the current's amplitude. In simple terms, infinitely variable valve, as opposed to on/off valve. For example, found on transmission's valve housing.
Reachstacker	Machine with special top lift attachment for containers.
Serial number	Unique machine designation. Found on machine plate.
Service position	How machine should be safely positioned before service may be started.
Servo	A small user movement results in a big machine movement, i.e. power steering.
Servo pressure	A low control pressure to control a higher pressure, for example, to a valve.
Sideshift	Parallel sideways movement of attachment.
Levelling	Attachment is tilted, for example, if load stands on uneven ground.
Spirit Delta	Enclosed type of cab.
Spreading	Widening of attachment.
Start up	Start procedure for control system (from powerless to supplied with voltage).
Mast	Carrier of attachment and load.
Dust reservoir	The air filter collects the coarsest particles in a dust reservoir, emptied automatically during operation.

Term	Description
Steering axle	Wheel axle with steering.
Buzzer	Acoustic alarm to catch the operator's attention.
Option	Optional equipment for machine.
Tilting	Load is leaned forward or backward.
Transmission oil	Oil for transmission and torque converter. See specifications in operator's manual.
Securing machine for transport	Actions before transporting machine.
Twistlocks	Four lock pins, one in each corner of the attachment, pushed down in corresponding holes in container and twisted to lock the container when lifting.
Type designation	Indicates type of machine and capacity. See also machine model.
Maintenance	Periodic maintenance actions so that machine functions safely and for long life.
Variable pump	Pump with adjustable flow rate.
Variable displacement	Adjustable volume (capacity) of a pump.
Wet brakes	Brake discs in oil-bath.
Valve slide	Moveable part in valve. Determines oil's path.
Rotation yoke	Rotating unit on attachment, rotates attachment in relation to lift boom.

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General

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