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Track Excavator Maintenance Safety

Safety Instructions

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or servicing machine. Read and understand the Operation & Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or service. Untrained operators and failure to follow instructions can cause death or serious injury.

Safety Messages

Refer to Operation and Maintenance Manual.

General

Safe Operation is Operator's Responsibility

Only trained and authorized personnel should operate and maintain the machine.

Follow all safety rules, regulations and instructions when operating or performing maintenance on machine.

- Do not operate machine if you are under the influence of drugs or alcohol. An operator who is taking prescription drugs must get medical advice to determine if he or she can safely operate a machine.
- When working with other personnel on a work site, be sure that all personnel know nature of work and understand all hand signals that are to be used.
- Be sure that all guards and shields are installed in their proper location. Have guards and shields repaired or replaced immediately if damaged.
- Be sure that you understand the use and maintenance of all safety features such as safety lever and seat belt. Use them properly.
- Never remove, modify or disable any safety features. Always keep them in good operating condition.
- Always check for and know the location of underground and overhead utility lines before excavating.
- Failure to use and maintain safety features according to instructions in this manual, Safety Manual and Shop Manual can result in death or serious injury.

Know Your Machine

Know how to operate your machine. Know the purpose of all controls, gauges, signals, indicators and monitor displays. Know the rated load capacity, speed range, braking and steering characteristics, turning radius and operating clearances. Keep in mind that rain, snow, ice, loose gravel, soft ground, slopes etc., can change operating capabilities of your machine.

Proper Work Tools and Attachments

Only use work tools and attachments that are recommended by HD HYUNDAI CONSTRUCTION EQUIPMENT for use on HD HYUNDAI CONSTRUCTION EQUIPMENT machines. When installing and using optional attachments, read instruction manual for attachment, and general information related to attachments in this manual. Because HD HYUNDAI CONSTRUCTION EQUIPMENT cannot anticipate, identify or test all attachments that owners may want to install on their machines, contact HD HYUNDAI CONSTRUCTION EQUIPMENT for written authorization and approval of attachments, and their compatibility with optional kits.

Attachments and attachment control systems that are compatible with the machine are required for safe and reliable machine operation. Do not exceed maximum operating weight (machine weight plus attachment) that is listed on ROPS certification plate.

Make sure that all guards and shields are in place on machine and on work tool. Depending on type or combination of work equipment, there is a potential that work equipment could interfere with the cabin or other parts of machine. Before using unfamiliar work equipment, check if there is any potential of interference, and operate with caution.

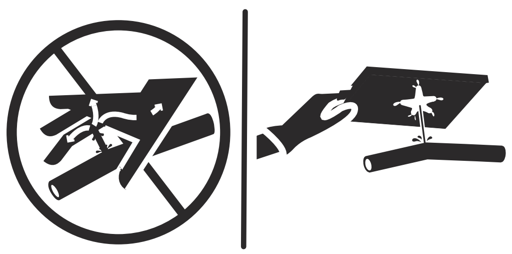
While you are performing any maintenance, testing, or adjustments to attachments, stay clear of the following areas: cutting edges, pinch points, and crushing surfaces.

Never use attachment as a work platform or man-HD HYUNDAI CONSTRUCTION EQUIPMENTlift.

Contact your HD HYUNDAI CONSTRUCTION EQUIPMENT distributor about auxiliary hydraulic kits for attachments installation. If you are in doubt about compatibility of a particular attachment with a machine, consult your HD HYUNDAI CONSTRUCTION EQUIPMENT distributor.

Pressurized Fluids

Figure 1



FG018457

Pressurized air or fluids can cause debris and/or fluids to be blown out. This could result in death or serious injury.

Immediately after operations are stopped, coolant, engine oil, and hydraulic oil are at their highest temperatures and the radiator and hydraulic tank are still under pressure. Always wait for temperature to cool down. Follow specified procedures when attempting to remove caps, drain oil or coolant, or replacing filters. Always wait for temperature to cool down, and follow specified procedures when performing these operations. Failure to do so can result in death or serious injury.

When pressurized air and/or pressurized water is used for cleaning, wear protective clothing, protective shoes, and eye protection. Eye protection includes goggles or a protective face shield.

Pressure can be trapped in a hydraulic system and must be relieved before maintenance is started.

Releasing trapped pressure can cause sudden machine movement or attachment movement. Use caution if you disconnect hydraulic lines or fittings.

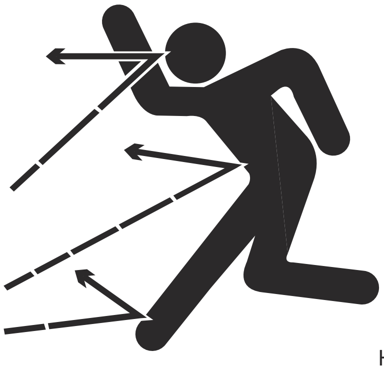
High-pressure oil that is released can cause a hose to whip or oil to spray. Fluid penetration can result in death or serious injury. If fluid enters skin or eyes, get immediate medical attention from a physician familiar with this injury.

Obey all local laws and regulations for disposal of liquids.

To prevent hot coolant from spraying out, stop engine and wait for coolant to cool. Using gloves, slowly loosen cap to relieve pressure.

Flying or Falling Objects

Figure 2



HAOA110L

On work sites where there is a potential hazard that flying or falling objects can hit operator's cabin, select and use a guard to match operating conditions for additional operator protection.

Working in mines, tunnels, deep pits, and loose or wet surfaces, could produce hazard of falling rocks or flying objects. Additional protection for operator's cabin could be required such as an Operator Protection Guard (OPG) or window guards. Contact your HD HYUNDAI CONSTRUCTION EQUIPMENT distributor for information on available protective guards.

To prevent personnel from being struck by flying objects, keep personnel out of work area.

Figure 3

HAOA100L

Personal Protective Equipment (PPE)

Figure 4

HAOA020L

Do not wear loose clothing and accessories. Secure long hair. These items can snag on controls or on other parts of equipment.

Do not wear oily clothes. They are highly flammable.

Do not forget that some risks to your health may not be immediately apparent. Exhaust gases and noise pollution may not be visible, but these hazards can cause disabling or permanent injuries. Breathing masks and/or ear protection may be required.

Wear a hard hat, safety shoes, safety goggles, mask, leather gloves, earplugs and other protective equipment, as required.

While working on machine, never use inadequate tools. They could break or slip, or they may not adequately perform intended functions.

Correction of Machine Problems

If any machine problems are found during operation and maintenance (noise, vibration, smell, incorrect gauges, smoke, oil leakage, etc.), or if any abnormal warning alerts are displayed on display monitor, stop the machine and take the necessary corrective actions. Do not operate machine until problem has been corrected.

Crushing and Cutting

Figure 5

HDO1010L

Keep objects away from moving fan blades. Fan blades can throw and cut objects.

Do not use a wire rope that is kinked or frayed, or a wire rope with any loss of diameter. Wear leather gloves when handling a wire rope.

When striking a loose retainer pin, it can fly out and can cause a serious injury. Make sure that area is clear of personnel when striking a retainer pin. To avoid injury to your eyes, wear safety goggles when striking a retainer pin.

Do not put your hand, arm or any other part of your body between movable parts. If going between movable parts is necessary, always position and secure work equipment so it cannot move. Properly support equipment before performing any work or maintenance under raised equipment.

If control levers are operated, clearance between machine and work equipment will change and this may lead to serious damage or can result in death or serious injury. Stay clear of areas that may have a sudden change in clearance with machine movement or equipment movement. Stay clear of all rotating and moving parts. Unless instructed, never attempt adjustments while machine is moving or while engine is running.

Do not depend on hydraulic cylinders to support raised equipment. Equipment can fall if a control is moved, or if a hydraulic line breaks, is loosened or disconnected.

If it is necessary to remove guards to perform maintenance, always install guards after maintenance is completed.

Hot Coolant and Oils - Burn Prevention

Figure 6

FG019095

Do not touch any part of an operating engine. Immediately after operations are stopped, coolant, engine oil, and hydraulic oil are at their highest temperatures. The radiator and hydraulic tank are still under pressure. Always wait for temperature to cool down. Attempting to remove caps, drain oil or coolant, or replacing filters may lead to serious burns, if done when hot. Relieve all pressure in air system, hydraulic oil system, lubrication system, fuel system, and cooling system, before any lines, fittings or related items are disconnected.

To prevent hot oil or coolant from spraying out, stop engine, wait for oil and coolant to cool. Using gloves, slowly loosen cap to relieve pressure.

Figure 7

FG019096

Fire and Explosion Prevention

Figure 8

HDO1C

All fuels, most lubricants and some coolant mixtures are flammable and can cause a fire resulting in death or serious injury, and property damage. Flammable fluids that are leaking or spilled onto hot surfaces or onto electrical components can cause fire.

Inspect for and remove all flammable materials such as spilled fuel and oil, and debris from machine. Do not allow any flammable materials to accumulate on machine.

Always observe the following:

- Add fuel, oil, antifreeze and hydraulic fluid to machine only in a well ventilated area. Machine must be parked with controls, lights and switches turned "OFF". Engine must be "OFF" and any flames, glowing embers, auxiliary heating units or spark causing equipment must be extinguished, or turned "OFF" and kept well clear of machine.
- Dust that is generated from repairing or grinding nonmetallic hoods or nonmetallic fenders can be toxic, flammable and explosive. Repair these components in a well ventilated area away from flames or sparks and wear dust mask when grinding painted parts.
  Figure 9

FG018458

Maintenance

The machine and some attachments have components that are at high temperatures under normal operating conditions. The primary source of high temperatures are the engine and exhaust system. If damaged or incorrectly maintained, the electrical system can be a source of arcs or sparks.

Flammable debris (leaves, straw, etc.) must be removed regularly. If flammable debris is allowed to accumulate, it can cause a fire hazard. Clean machine often to avoid this accumulation. Flammable debris in an engine compartment is a potential fire hazard.

The operator's area, engine compartment and engine cooling system must be inspected every day and cleaned. This is necessary to prevent fire hazards and overheating.

Operation

Do not use machine where exhaust, arcs, sparks or hot components can contact flammable material, explosive dust or gases.

Do not operate machine near any flame.

Exhaust shields (if equipped) protect hot exhaust components from oil spray or fuel spray in case of a break in a line, hose, or seal. Exhaust shields must be correctly installed.

Electrical

Check all electrical wiring and connections for damage daily.

Keep battery terminals clean and tight. Repair or replace any damaged part or wires that are loose or frayed. Clean all electrical connections and tighten all electrical connections.

Never check battery charge by placing a metal object across terminal posts. Use a voltmeter or a hydrometer.

Battery gas can explode and can result in death or serious injury. Follow procedures in this manual for connecting battery and for jump-starting. Do not jump-start or charge a frozen or damaged battery. Keep any flames or sparks away from batteries. Do not smoke in battery charging area.

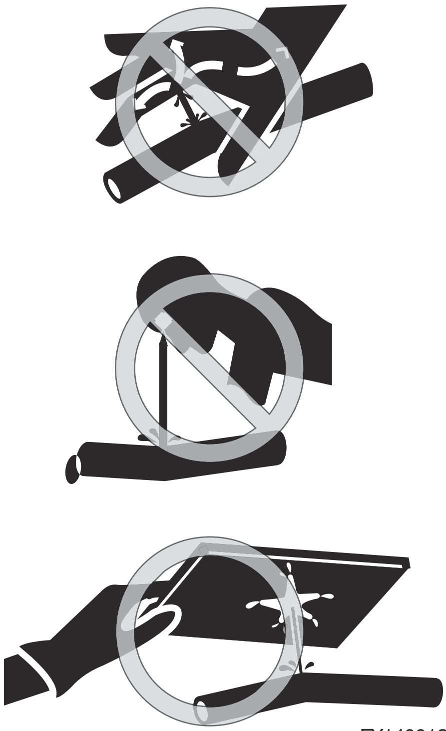
Improper jumper cable connections can cause an explosion that can result in death or serious injury. Refer to Operation and Maintenance Manual.

Do not charge a frozen battery. This can cause an explosion.

After market radios or other electric operated equipment in cabin must have a fuse in the electrical circuit.

Hydraulic System

Figure 10



EX1400129

Check hydraulic tubes, hoses and fittings for damage, wear or for leaks. Hydraulic lines and hoses must be properly routed and have adequate support and secure clamps. Leaks can cause fires. Never use a flame or bare skin to check for leaks.

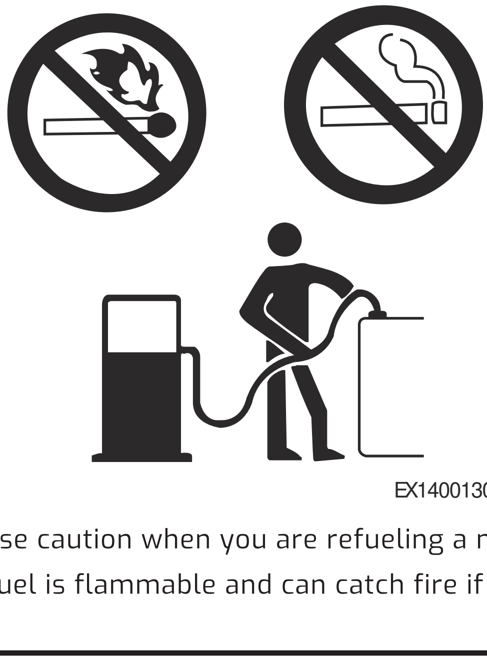
Tighten or replace any parts that show leakage.

Check that all hose and tube clamps, guards, and cushions are securely attached. If they are loose, they can vibrate during operation and rub against other parts. This can cause damage to hoses and cause high-pressure oil to spray on hot surfaces, causing a fire and death or serious injury.

Always clean fluid spills. Do not use gasoline or diesel fuel for cleaning parts. Use commercial nonflammable solvents.

Fueling

Figure 11



EX1400130

Use caution when you are refueling a machine.

Fuel is flammable and can catch fire if it is brought close to a flame.

Stop engine and let it cool before adding fuel. Do not smoke while you are refueling a machine. Do not refuel a machine near flames or sparks. Fill fuel tank outdoors.

Keep fuel and other fluid reservoir caps tight and do not start engine until caps have been secured.

Store fuels and lubricants in properly marked containers away from unauthorized personnel. Store oily rags and any flammable materials in protective containers.

Static electricity can produce dangerous sparks at fuel filling nozzle. In very cold, dry weather or other conditions that could produce a static discharge, keep tip of fuel nozzle in constant contact with neck of fuel filling nozzle, to provide a ground.

Always place plastic fuel containers on the ground before filling.

Never Use Ether Starting Aids

Figure 12

FG018458

Do not use ether or starting fluids on any engine that has glow plugs, or an electric grid type manifold heater. These starting aids can cause an explosion and result in death or serious injury.

Use procedures in this manual for connecting battery and for jump-starting.

Welding and Grinding

Always clean machine and attachment, set battery disconnect switch to "OFF" position, and disconnect wiring from electronic controllers before welding. Cover rubber hoses, battery and all other flammable parts. Keep a fire extinguisher near machine when welding.

Toxic dust or gas can be produced when grinding or welding painted parts. Grinding or welding painted parts must be done in a well ventilated area. Wear dust mask when grinding painted parts.

Dust generated from repairing nonmetallic parts such as hoods, fenders or covers can be flammable or explosive.

Repair such components in a well ventilated area away from flames or sparks.

Do not weld on lines or on tanks that contain flammable fluids. Do not flame cut lines or tanks that contain flammable fluid. Clean any such lines or tanks thoroughly with a nonflammable solvent before welding or flame cutting.

If a Fire Occurs

Figure 13

FG018459

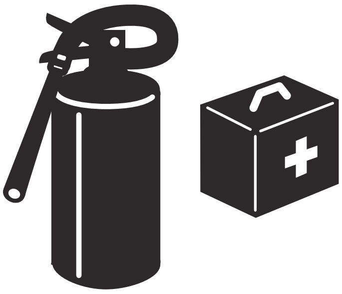
If a fire occurs:

- Do not attempt to move machine or continue operations.
- Turn starter switch to "O" (OFF) position to stop engine.
- Use handrails, guardrails and steps to get off machine.
- Immediately call for help or fire station.
- When using a fire extinguisher, always aim extinguisher at base of fire.
- If an optional fire extinguishing system is in place, be familiar with its operating procedures.

  NOTE: *Depending on job conditions, other procedures could be necessary if a fire occurs.*

Fire Extinguisher and First-aid Kit (Emergency Medical Kit)

Figure 14

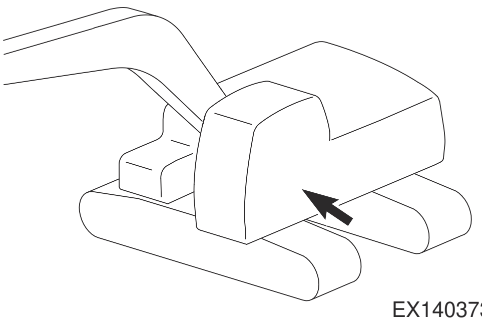


HDO1009L

To be prepared in the event of a fire:

- Make sure fire extinguishers are always available and read labels to know how to use them. It is recommended that an appropriately sized (2.27 kg (5 lb) or larger) multipurpose A/B/C fire extinguisher be mounted in cabin. Check and service fire extinguisher at regular intervals and make sure that all work site crew members are adequately trained in its use.
- Inspect fire extinguisher and service fire extinguisher regularly.
- Follow instructions on extinguisher instruction plate.
- Keep a first aid kit in storage compartment and keep another kit at work site. Check kit periodically and keep it properly supplied.
- Keep emergency numbers for doctor, ambulance service, hospital and fire department readily available.

  Figure 15



EX1403736

Electrical System and Electrical Shock

Never short across starter terminals or across batteries. Shorting could damage electrical system and engine neutral start system.

When engine is running or immediately after it has stopped, high voltage is generated at injector terminal and inside engine controller, so there is a potential for an electrical shock. Never touch injector terminal or inside of engine controller.

NOTE: *If it is necessary to touch injector terminal or inside engine controller, contact your HD HYUNDAI CONSTRUCTION EQUIPMENT distributor.*

Roll-over Protective Structure (ROPS)

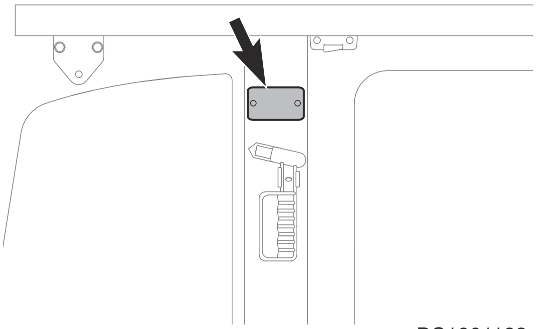
The operator's cabin is a ROPS certified structure for protecting the seat-belted operator. It absorbs the impact energy of a roll-over impact. Do not allow machine weight (mass) to exceed certified value on certification plate. If weight is exceeded, the ROPS structure will not be able to fulfill its safety function.

Do not increase machine weight beyond certified value by modifying machine or by installing attachments on machine. If weight limit of protective equipment is exceeded, protective equipment will not be able to protect operator, and this can result in death or serious injury. Always observe the following:

- This machine is equipped with a protective structure. Do not remove protective structure and perform operations without it.
- Never modify the operator's cabin by welding, grinding, drilling holes or adding attachments unless instructed by HD HYUNDAI CONSTRUCTION EQUIPMENT in writing. Changes to the cabin can cause loss of operator protection from roll-over and falling objects, and result in death or serious injury.
- When protective structure is damaged or deformed by falling objects or by rolling over, its strength will be reduced and it will not be able to adequately protect the operator. Contact your HD HYUNDAI CONSTRUCTION EQUIPMENT distributor if you have any questions about the ROPS. Never repair a damaged ROPS cabin.
- Always wear your seat belt when operating machine.

ROPS Certification

Figure 16



DS1901183

This HD HYUNDAI CONSTRUCTION EQUIPMENT excavator has an operator's cabin that meets ROPS requirements. The seat belt must be worn for roll-over protection.

The ROPS certification plate is found on the left side of the cabin on most models. It may vary slightly in its location on some models.

Check the ROPS cabin, mounting, and hardware for damage.

Never modify the ROPS cabin. Replace the cabin and hardware if damaged. See your HD HYUNDAI CONSTRUCTION EQUIPMENT distributor for parts.

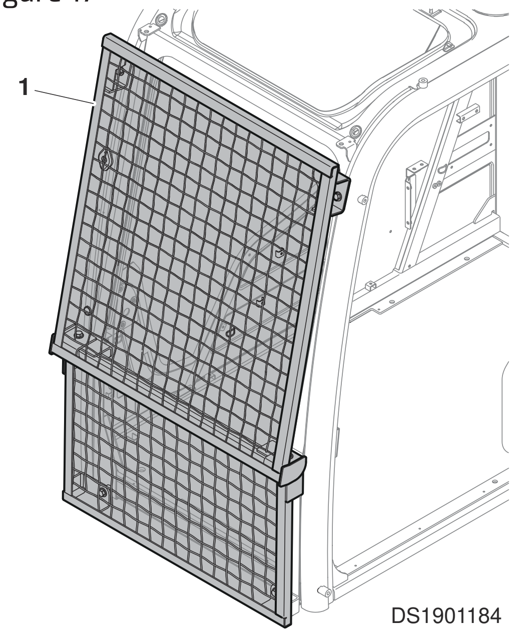
WARNING

AVOID DEATH OR SERIOUS INJURY

Never modify the operator cabin by welding, grinding, drilling holes or adding attachments unless instructed in writing by HD HYUNDAI CONSTRUCTION EQUIPMENT. Changes to the cabin can cause loss of operator protection from rollover and falling objects, and can result in death or serious injury.

Protecting Cabin from Flying or Falling Objects (If Equipped)

Figure 17



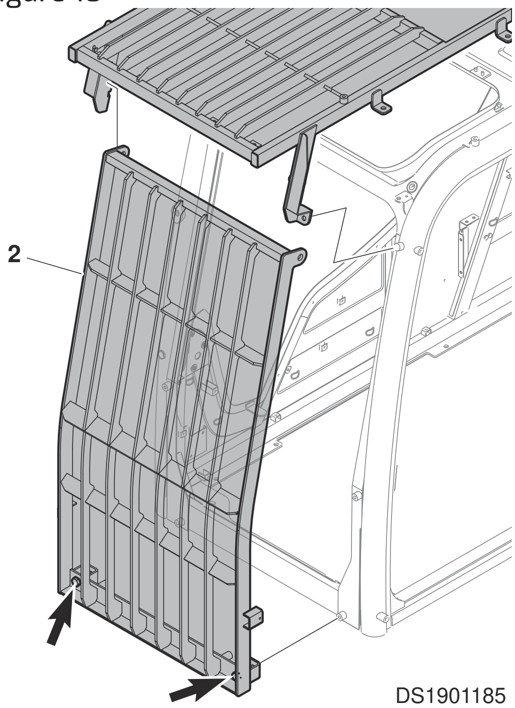
In a work site where additional operator protection is necessary from falling or flying objects, install adequate protective guards on the cabin.

For breaker operation, install a front guard (1) and apply a laminated coating sheet to front glass. Contact your HD HYUNDAI CONSTRUCTION EQUIPMENT distributor for recommendations.

When performing demolition or cutting operation, install a front guard and top guard.

When working in mines, quarries or other work sites where there is a hazard of falling rocks, install Operator Protection Guard (OPG) (2).

Figure 18



When OPG is installed, and front window needs to be cleaned, loosen bolts marked with arrows. Be sure to tighten bolts when done.

Never attempt to alter or modify any protective structure reinforcement system, by drilling holes, welding, remounting or relocating fasteners. Any serious impact or damage to system requires a complete inspection of the structure. Reinstallation, recertification and/or replacement of system may be necessary.

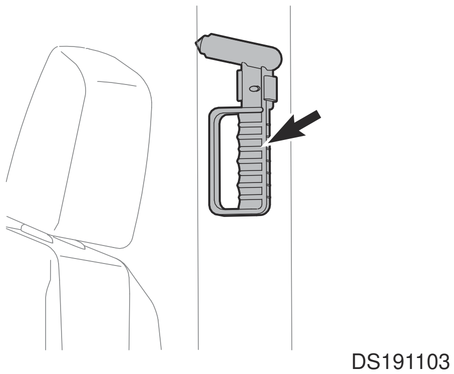
Contact your HD HYUNDAI CONSTRUCTION EQUIPMENT distributor for available safety guards and/or recommendations to protect against objects that could strike operator's cabin. Make sure that all other work site crew members are kept away from excavator when operating.

If any glass on machine is broken, replace it with new glass immediately.

NOTE: *The preceding instructions assume that conditions are for standard operations, but it may be necessary to add additional guards depending on operating conditions or local rules or regulations for the work site. Always contact your HD HYUNDAI CONSTRUCTION EQUIPMENT distributor for advice.*

Emergency Exit from Operator's Station

Figure 19



This machine is equipped with a glass breaking tool. It is found on left pillar of cabin. This tool can be used to break the glass to exit from cabin in an emergency. Grip handle firmly and use sharp point to break glass.

- Be careful also not to slip on broken pieces of glass on ground.

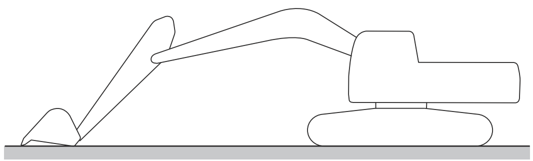
⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

Protect your eyes when breaking the glass.

Long Term Storage

Figure 20



EX1300542

When a machine is taken out of service and stored for a time exceeding 30 days, steps must be taken to protect the machine. Leaving equipment outdoors exposed to the elements will shorten its life.

An enclosure will protect the machine from rapid temperature changes and lessen the amount of condensation that forms in hydraulic components, engine, fuel tank, etc. If it is not possible to put the machine in an enclosure, cover it with a tarpaulin.

Check that storage site is not subject to flooding or other natural disasters.

After the machine has been positioned for storage and the engine stopped, perform the following operations:

Before Storage

Keep the excavator in the position shown in Figure 1 to prevent rust of the hydraulic piston rods.

- Inspect for damaged, loose or missing parts.
- Repaint necessary areas to prevent oxidation.
- Wash and clean all parts of machine.
- Store the machine in an indoor, stable place. If stored outside, cover with a waterproof tarp.
- Perform lubrication procedures on all grease points.
- Apply a coating of light oil to the exposed plated metal surfaces (such as hydraulic cylinder rods, etc.) and to all the control linkage and control cylinders. (Control valve spools, etc.)
- Remove battery from the excavator to be fully charged and stored.
- Inspect the coolant recovery tank and radiator to make sure the antifreeze level in the system is correct. Make sure that antifreeze concentration is enough for the lowest temperature anticipated during storage.
- Seal all external openings (i.e. engine exhaust outlet, crankcase and hydraulic breather, fuel vent line, etc.) with tape wide enough to cover the opening, regardless of size.

  NOTE: *When sealing with tape, be sure to extend tape approximately one inch (25 mm) beyond opening to insure a good seal.*

  NOTE: *Keep in mind that theft and burglary risk can be minimized by:*

- Removing starter key when the machine is left unattended.
- Locking doors and covers after working hours.
- Turning off electrical current with battery disconnect switch.
- Park machine where risk of theft, burglary and damage is minimized.
- Removing valuables from cabin such as cellular phone, computer, radio and bags.

During Storage

- Once a month, start the engine and follow the "Hydraulic Oil Warm-up" procedures listed in this manual.
- Operate hydraulic functions for traveling, swing and digging two or three times for lubrication after "Hydraulic Oil Warm-up". Coat all the moving parts and surfaces of the components with a new oil film after operating. At the same time, charge the battery. Rotate track to prevent track seizing".
- Every 90 days, use a hydrometer to measure the protection of the coolant. Refer to the antifreeze/ coolant protection chart to determine protection of the cooling system. Add coolant as required.

After Storage

- Before operating the work equipment, remove all grease from the hydraulic cylinder rods.
- Add grease and oil at all lubrication points.
- Adjust fan and alternator belt tension.
- Connect the charged battery.
- Check condition of all hoses and connections.
- Check the levels of engine oil, fuel, coolant and hydraulic circuit oil. If there is water in the oil, change all the oil.
- Change all filters.
- Inspect for signs of nests. (i.e. birds, rodents, etc.)
- When starting the engine after long-term storage, follow the "Hydraulic Oil Warm-up" procedures listed in this manual.

Maintenance

Improper operation and maintenance can result in death or serious injury. Read manual and safety decals before operating or maintaining the machine. Follow all instructions and safety messages.

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

Follow instructions before operating or servicing machine. Read and understand the Operation & Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments, repairs or service. Untrained operators and failure to follow instructions can result in death or serious injury.

- Never service equipment without instructions.
- Always lower bucket and blade to ground before doing any maintenance.

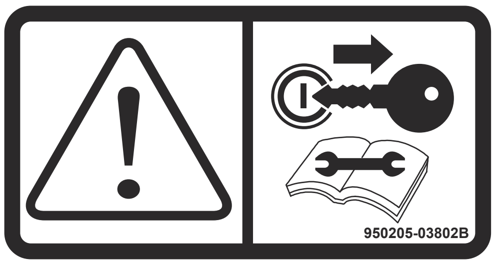
- Use correct procedure to lift and support excavator.
- Cleaning and maintenance are required daily.
- Welding or grinding painted parts must be done in well ventilated areas.
- Wear a dust mask when grinding painted parts. Toxic dust and gas can be produced.
- Vent exhaust to outside when engine must be running for service.
- Exhaust system must be tightly sealed. Exhaust fumes are hazardous and can cause death or serious injury.
- Stop and allow engine to cool and clean engine of flammable materials before checking fluids.
- Never service or adjust machine with engine running unless instructed to do so in this manual.
- Avoid contact with leaking hydraulic fluid or diesel fuel under pressure. It can penetrate skin or eyes.
- Never fill fuel tank while engine running, while smoking, or when near open flame.
- Keep body, jewelry and clothing away from moving parts, electrical contact, hot parts and exhaust.
- Wear eye protection to guard from battery acid, compressed springs, fluids under pressure and flying debris when engines are running or tools are used. Use eye protection approved for welding.
- Lead-acid batteries produce flammable and explosive gases.
- Keep arcs, sparks, flames and lighted tobacco away from batteries.
- Batteries contain acid which burns eyes or skin on contact.
- Wear protective clothing. If acid contacts body, flush well with water. For eye contact flush well and get immediate medical attention from a physician familiar with this injury.
- The maintenance procedures which are given in this manual can be performed by the owner or operator without any specific technical training. Maintenance procedures which are not in this manual must be performed ONLY BY QUALIFIED SERVICE PERSONNEL. Always use genuine replacement parts.
- Only authorized personnel should service and repair the machine. Do not allow unauthorized personnel into work area.
- Lower work equipment and stop engine before performing maintenance.
- Park machine on firm and level ground.
- Turn starter switch to "ON' position and keep safety lever in "UNLOCK" position. Cycle work levers (joysticks) back and forth, left and right at full stroke 2 to 3 times to eliminate remaining internal pressure in hydraulic circuit. Then move safety lever to "LOCK" position.
- Check that battery relay is "OFF" and main power is shut off. (Wait for approximately one minute after turning "OFF" engine starter switch key and press horn switch. If horn does not sound, the main power is shut off.)
- Put blocks under track to prevent the machine from moving.
- To prevent injury, do not perform maintenance with engine running. If maintenance must be done with engine running, perform maintenance with at least two workers and do the following:
  - One worker must always sit in the operator's seat and be ready to stop engine at any time. All workers must maintain contact with other workers.

- When maintenance operations are near fan, fan belt, or other rotating parts, there is a potential hazard of being caught in rotating parts. Keep hands and tools away.

- Never drop or insert tools or other objects into rotating fan or fan belt. Parts can break off and hit someone.
- Do not touch any control levers or control pedals. If any control levers or control pedals must be operated, always give a signal to other workers and instruct them to move away.
- When performing maintenance of engine and you are exposed to engine noise for long periods of time, wear hearing protection while working.
- If noise from the machine is too loud, it can cause temporary or permanent hearing problems.
- Do not smoke when you service an air conditioner or if refrigerant gas is present.
- Inhaling fumes either from a flame or gas from a cigarette that has contacted air conditioner refrigerant can cause death or serious injury.
- Never put maintenance fluids into glass containers. Drain all liquids into a suitable containers.
- Unless instructed otherwise, perform maintenance with equipment in servicing position. Refer to this manual for procedure for placing equipment in servicing position.

Warning Tag

Figure 21



DS1801807

Alert others that service or maintenance is being performed by attaching a "DO NOT OPERATE" warning tag to the operator's cabin controls – and other machine areas, if required. Use of a chain or cable to keep the safety lever in the fully lowered "LOCK" position, complies with OSHA's lockout requirements.

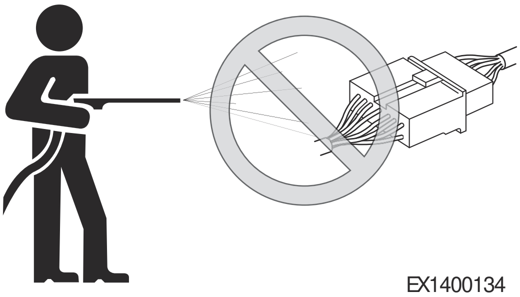
"DO NOT OPERATE" warning tags, are available from your distributor.

- Always attach "DO NOT OPERATE" warning tag to work equipment control lever in the operator's cabin to alert others that you are performing service or maintenance on the machine. Attach additional warning tags on the machine, if necessary.
- Keep warning tags in tool box while it is not used. If there is not tool box or in the owner manual storage pocket.
- If any other person starts engine, and operates control levers or control pedals while you are performing service or maintenance, it can result in death or serious injury.

Attach a "DO NOT OPERATE" warning tag to starter switch or to controls before servicing or repairing equipment. Warning tags are available from your distributor.

Cleaning

Figure 22



Clean machine before performing inspection and maintenance.

If inspection and maintenance are done when machine is dirty, it will become more difficult to locate problems, and you could slip on steps and work platform areas and injure yourself.

When washing machine, do the following:

- Wear shoes with nonslip soles to prevent slipping and falling.
- Wear safety goggles and protective clothing when washing machine with high-pressure steam or water.
- Do not spray water directly on electrical components (sensors, connectors). If water gets into electrical system, it can cause operation problems.
- Pick up any tools or hammers that are laying in workplace. Wipe up any grease or oil to prevent slippery substances, that can cause tripping or slipping.
- When cleaning cabin top window which is made of polycarbonate material, use tap water. Avoid use of organic solvents for cleaning, such as benzene, toluene or methanol. These solvents can cause a chemical reaction that will dissolve and damage the window.

Proper Tools and Clothing

Only use tools that are intended for the type of service to be done. Metal pieces from low quality or damaged tools, such as chisels or hammers, can break off and hit a service person in the eyes or face causing serious injury.

Disassembling Precautions

When using a hammer to remove pins, pins can fly out or metal particles may break off. Always do the following:

- Hitting hard metal pins, bucket teeth, cutting edges or bearings with a hammer, can cause metal pieces to break or fly off resulting in serious injury. Always wear safety goggles and leather gloves. Keep other personnel away.

Use of Lighting

When checking fuel, oil, battery electrolyte, window washer fluid, or coolant, always use proper lighting equipment to prevent arcs or sparks that could cause a fire or explosion resulting in death or serious injury.

Fire and Explosion Prevention

Figure 23

H D O 1 0

Fuels, most lubricants and some coolant mixtures are flammable. Flammable fluids that are leaking or spilled onto hot surfaces or onto electrical components can cause a fire resulting in property damage or death or serious injury.

Store all fuels and all lubricants in properly marked and approved containers and keep away from all unauthorized personnel.

Store oily rags and other flammable material in a protective container.

Tighten all fuel and oil caps.

Figure 24

FG018458

Do not smoke while you refuel machine or while you are in a refueling area.

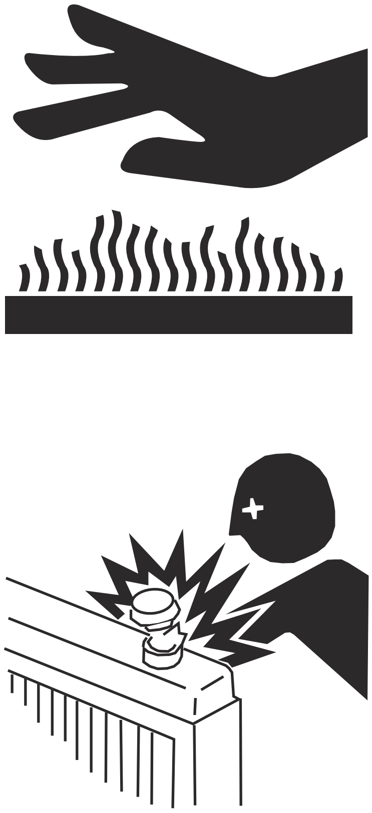
Do not smoke in battery charging areas or in areas that contain flammable material.

Clean all electrical connections and tighten all electrical connections. Check electrical wires daily for wires that are loose or frayed. Tighten all loose, and repair or replace all frayed, electrical wires before operating machine.

Remove all flammable materials and debris from the engine compartment, exhaust system components and hydraulic lines.

Burn Prevention

Figure 25



haae2090

When checking radiator coolant level, stop engine, let engine and radiator cool down, then check coolant recovery tank. If coolant level in coolant recovery tank is near upper limit, there is enough coolant in radiator.

Using gloves, loosen radiator cap slowly to release internal pressure before removing radiator cap.

If coolant level in coolant recovery tank is below lower limit, add coolant.

Cooling system conditioner contains alkali which can cause personal injury. Do not allow alkali to contact skin, eyes, or mouth.

Allow cooling system components to cool before draining cooling system.

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact skin.

Vent hydraulic tank only after engine has been stopped and hydraulic tank is cool. Using gloves, slowly tilt hydraulic tank air breather to relieve pressure.

Relieve all pressure in hydraulic oil system, in fuel system, or in cooling system before disconnecting any lines, hoses, fittings, or related components.

Batteries give off flammable fumes that can explode and start a fire.

Do not smoke while you are checking battery electrolyte level.

Electrolyte is an acid. Electrolyte can cause personal injury. Do not allow electrolyte to contact skin or eyes.

Always wear safety goggles and face protection when working with batteries.

Rubber That Contains Fluorides

Observe extra great care when it is suspected that you may have to handle rubber that contains fluorides.

Certain seals which have to withstand high operating temperatures (e.g. in engines, transmissions, axles, hydraulic motors and pumps) may be made from rubber that contains fluorides, which, when exposed to high heat (fire), forms hydrogen fluoride and hydrofluoric acid. This acid is very corrosive and cannot be rinsed or washed off from the skin. It causes very severe burns which take a long time to heal.

It usually means that damaged tissue must be surgically removed. Several hours may pass after contact with the acid, before any symptoms appear and therefore one is not given any immediate warning. The acid may remain on the machine parts for several years after a fire.

If swelling, redness or a stinging feeling appears and one suspects that cause may be contact with heated rubber that contains fluorides, contact a medical doctor immediately. If a machine, or part of a machine, has been exposed to fire or severe heat, it must be handled by specially trained personnel. In all handling of machines after a fire, thick rubber gloves and protective goggles must be used.

The area around a part which has been very hot and which may be made of rubber that contains fluorides must be decontaminated by thorough and ample washing with limewater (a solution or suspension of calcium hydroxide, i.e. slaked lime in water). After the work has been completed, the gloves must be washed in limewater and then discarded.

Rubber and Plastics

Polymer materials when heated, can form compounds that create a health hazard and can harm the environment. Scrapped rubber and plastics must never be burned. Extra precautions must be taken when servicing machines that have been in a fire or exposed to extreme heat.

If gas cutting or welding is to be done near such materials, the following safety instructions must be followed:

- Protect the material from heat.
- Use protective gloves, protective goggles and an approved respirator.

Waste Hazardous to the Environment

Painted parts or parts made of plastic or rubber which are to be scrapped must never be burned, but must be taken care of by an approved refuse handling plant.

Batteries, plastic objects and anything else which is suspected of being dangerous to the environment must be taken care of in an environmentally safe way.

Check List After Fire

When handling a machine which has been damaged by fire or been exposed to intense heat, the following protective measures must under all circumstances be followed:

Use thick, gloves made of rubber and wear goggles which are certain to protect your eyes.

Never touch burned components with your bare hands, as there is a risk that you may come into contact with melted polymer materials. First wash thoroughly with plenty of limewater (a solution or suspension of calcium hydroxide, i.e. slaked lime in water).

As a precaution, seals (O-rings and other oil seals) should always be handled as if they were made of rubber that contains fluorides.

Treat skin, which is suspected of having touched burned rubber that contains fluorides, with Hydrofluoric Acid Burn Jelly or something similar. Seek medical advice. Symptom may not appear until several hours afterwards.

Discard gloves, rags etc. which are suspected of having touched burned rubber that contains fluorides.

Welding Repairs

NOTICE

When disconnecting or connecting connectors between ECU and engine, or connector between ECU and the machine, always disconnect the battery to prevent damage to ECU.
If you do not follow this procedure, the ECU will be damaged and/or the engine will not operate properly.

NOTE: *Disconnect battery only when LED light is OFF after engine is turned OFF.*

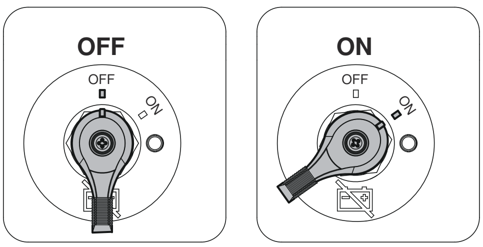
When performing welding repairs, perform welding in a properly equipped place. Repairs must be performed by a qualified welder. Welding operations, can create potential hazards, including generation of gas, fire, or electric shock. Never let an unqualified welder do welding.

A qualified welder must do the following:

- To prevent battery explosion, turn battery disconnect switch to "OFF" position.
- Disconnect the connector between ECU and machine, and the connector between ECU and engine.
- Disconnect the negative (-) cable of battery.
- To prevent generation of gas, remove paint from location of the weld.
- If hydraulic equipment, piping or component ports close to them are heated, a flammable gas or mist could result in an explosion or fire. To prevent this, protect and insulate components from excessive heat.
- Do not weld on pipes or on tubes that contain flammable fluids. Do not flame cut pipes or tubes that contain flammable fluids. Before welding on pipes or tubes, or before flaming cut pipes or tubes, clean them thoroughly with a nonflammable solvent. Make sure pressure inside pipes or tubes does not cause a rupture of the component parts.
- If heat is applied directly to rubber hoses or piping under pressure, they may suddenly break, so cover and insulate them with a fireproof covering.
- Wear protective clothing.
- Make sure there is good ventilation.
- Remove all flammable objects and make sure a fire extinguisher is available.

Preparation for Electrical Welding On Body Structure

Figure 26



EX1500481

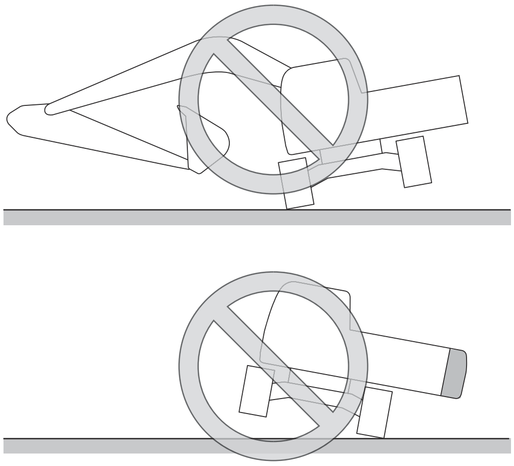
To prevent damage to ECU by electrical welding, observe the following procedures:

1. Turn battery disconnect switch to "OFF" position.
2. Disconnect the connector between ECU and machine, and the connector between ECU and engine.

3. Disconnect the negative (-) cable of battery.
4. Proceed with welding.
5. After welding, connect the connector between ECU and machine, and the connector between ECU and engine.
6. Connect the negative (-) cable of battery.
7. Clean battery compartment.
8. Turn battery disconnect switch to "ON" position.
9. Close battery compartment door.

Warning for Counterweight and Front Attachment Removal

Figure 27



WARNING

Removal of the machine counterweight, front attachment or any other part can affect the stability of the machine. This could cause unexpected movement, and result in death or serious injury.

Never remove counterweight or front attachment unless the upper structure is in-line with the lower structure.

Never rotate the upper structure once the counterweight or front attachment has been removed.

Lock Inspection Covers

When performing maintenance with inspection cover open, use lock bar to secure cover and prevent accidental lowering of the cover caused by wind or movement of the machine.

Working on Machine

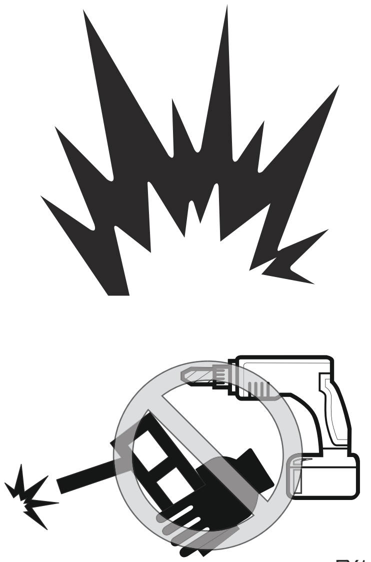
Figure 28

When performing maintenance operations on machine, prevent tripping and falling by keeping area around your feet clean and free of objects and debris. Always do the following:

- Do not spill oil or grease.
- Do not leave tools laying around.
- Watch your step when walking.
- Never jump down from machine. When getting on or off machine, use steps and handrails, and maintain a three-point contact (both feet and one hand or both hands and one foot) to support yourself.
- If job requires it, wear protective clothing.
- To prevent injury from slipping or falling, when working on hood or covers, never stand or walk on areas except areas equipped with nonslip pads.
- If it is necessary to work under raised equipment or the machine, support work equipment and machine securely with blocks and stands strong enough to support weight of work equipment and machine.
- Do not work under the machine if track shoes are lifted off ground and the machine is supported only with work equipment. If any control levers are moved, or there is damage to hydraulic system, work equipment or the machine will suddenly drop causing death or serious injury.

Accumulator

Figure 29



EX1400135

The pilot control system is equipped with an accumulator. For a short period of time after engine has been stopped, accumulator will store a pressure charge that allow hydraulic controls to be activated. Activation of any controls will allow selected functions to operate under force of gravity.

When performing maintenance on pilot control system, release hydraulic pressure in system as described in Operation and Maintenance Manual.

The accumulator is charged with high-pressure nitrogen gas. If it is improperly handled it can explode causing death or serious injury. Always observe the following precautions:

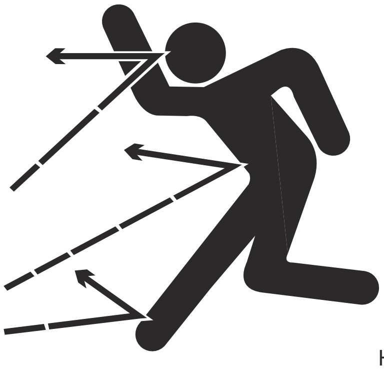
- Do not drill or punch holes in accumulator or expose it to any flames, fire or external heat source.
- Do not weld on accumulator.
- When performing disassembly or maintenance of accumulator, or when disposing of accumulator, charged nitrogen gas must be properly released. Contact your distributor for assistance.
- Wear safety goggles and leather gloves when working on an accumulator. Hydraulic oil under pressure can penetrate skin and result in death or serious injury. If fluid enters skin or eyes, get immediate medical attention from a physician familiar with this injury.

Compressed Air

- When cleaning filters, radiator or other components with compressed air, there is a hazard of flying particles that can result in serious injury.
- Always wear safety goggles, dust mask, leather gloves, and other protective devices.

Track Tension Adjustments

Figure 30



HAOA110L

Track adjusting systems use grease under high-pressure to keep track under tension. Grease under high-pressure can penetrate body and result in death or serious injury. Watch track or track spring to see if track is being loosened.

NEVER LOOSEN track tension grease valve. To release pressure from crawler frame track tension assembly, you should NEVER attempt to disassemble track adjuster or attempt to remove track tension grease valve assembly.

Keep your face and body away from grease valve. Refer to Operation or Shop Manual.

Supports and Blocking for Work Equipment

Figure 31

HDO1042L

Do not allow weight or equipment loads to remain suspended and unsupported.

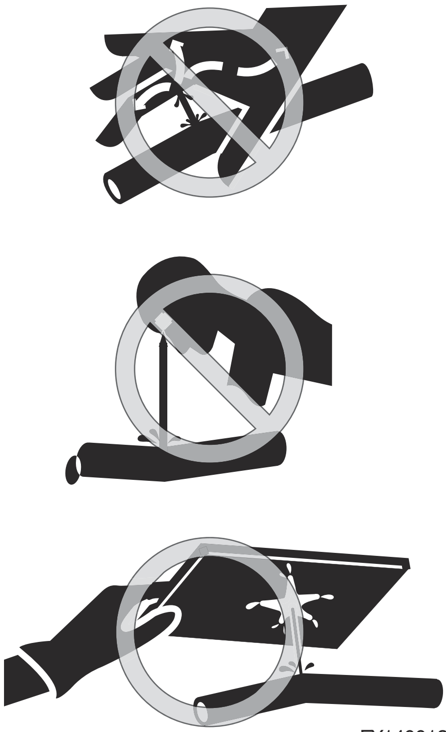
Lower work group to ground before leaving operator's seat.

Do not use hollow, cracked or unsteady wobbling supports.

Do not work under any equipment supported only by a lifting jack.

High-pressure Lines, Tubes and Hoses

Figure 32



EX1400129

When inspecting or replacing high-pressure piping or hoses, check to verify that pressure has been released from circuit. Failure to release pressure can result in death or serious injury. Release pressure as described in Operation and Maintenance Manual. Always do the following:

- Wear eye protection and leather gloves.
- Fluid leaks from hydraulic hoses or pressurized components can be difficult to see but has enough force to pierce skin and can result in death or serious injury. Always use a piece of wood or cardboard to check for suspected hydraulic leaks. Never use your hands or expose your fingers. Wear safety goggles.
- Do not bend high-pressure lines. Do not strike high-pressure lines. Do not install lines, tubes or hoses that are bent or damaged.
- Make sure that all clamps, guards and heat shields are correctly installed to prevent vibration, rubbing against other parts, and excessive heat during operation.
- Replace hose or components if any of the following problems are found:
  - Damage or leakage from hose end fitting.
  - Wear, damage, cutting of hose covering, or wire braiding is exposed on any hose.
  - Cover portion is swollen in any section.
  - The hose is twisted or crushed.
  - Foreign material is embedded in hose covering.
  - Hose end is deformed.
  - Connection fittings are damaged or leaking.

  NOTE: *Refer to Operation and Maintenance Manual, for additional European regulations.*

High-pressure is generated inside engine fuel lines when engine is running. Before performing inspection or maintenance of fuel line system, wait for at least thirty seconds after stopping engine to let internal pressure drop and tip breather cap up to release residual pressure.

Oil or fuel leaks from high-pressure hoses can cause fire or improper operation, which can result in death or serious injury. If any loose bolts are found, stop work and tighten to specified torque. If any damaged hoses are found, stop operations immediately and contact your distributor for replacement parts.

Battery

Battery Hazard Prevention

Figure 33

EX1400136

Battery electrolyte contains diluted sulfuric acid and generates hydrogen gas. Hydrogen gas is highly explosive, and improper handling can cause death or serious injury, or fire. Always observe the following precautions.

- Do not smoke or bring any flame near battery.
- When cleaning top surface of battery, wipe it with a clean, damp cloth. Never use gasoline, thinner, or any other organic solvent or detergent.
- Tighten battery caps.
- If battery electrolyte is frozen, do not charge battery or start engine with power from another source. This could cause the battery to explode and start a fire.
- When charging battery or starting with power from another source, let battery electrolyte thaw and check that there is no leakage of battery electrolyte before starting operation.
- Always remove battery from machine before charging.
- Before maintaining or working with batteries, turn starter switch to "O" (OFF) position.

  Since there is a potential hazard that sparks could be generated, always do the following:

- Do not let tools, rings or other metal objects make any contact between battery terminals. Do not leave tools or other metal objects lying near battery.
- When disconnecting battery terminals, wait for approximately one minute after turning engine starter switch key to "O" (OFF) position, and be sure to disconnect grounding terminal; negative (-) terminal first. Conversely, when connecting them, begin with positive (+) terminal and then grounding (-) terminal, Make sure that all terminals are connected securely.
- Flammable hydrogen gas is generated when battery is charged. Remove battery from machine, take it to a well ventilated place, and remove battery caps, before charging it.
- After charging, tighten battery caps securely.
- After charging, secure battery back in machine.

  When repairing or welding electrical system, wait for approximately one minute after turning engine starter switch key "OFF". Then disconnect negative (-) terminal of battery to stop flow of electricity.

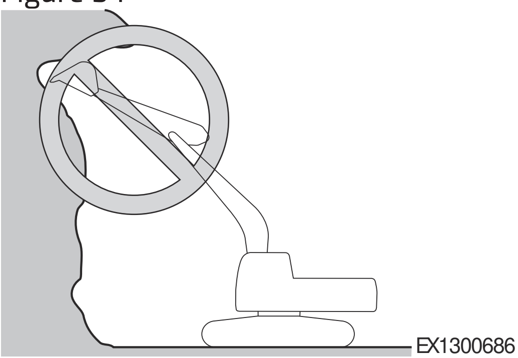
Environment and Circumstances

Work Site Areas Requiring Extra Caution

- Do not operate too close to edge of a quay, ramp, etc.
- Do not operate too close to edge of a steep slope or drop-off. Take care when working in a place where machine may tip over.
- Do not operate on soft ground or near riverbanks that could collapse or where ground may not support weight of excavator.
- Observe changes in ground and traction conditions after a rain or other changes in weather.

Digging Under an Overhang

Figure 34

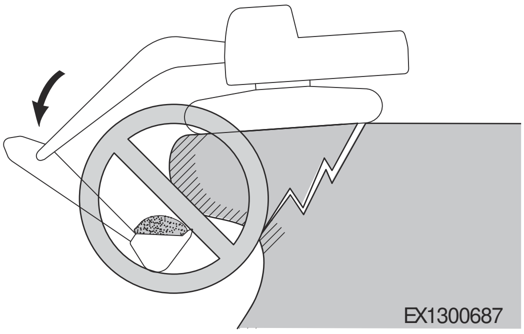


Do not dig work face under an overhang. This can cause overhang to collapse and fall on top of the machine.

- Do not perform overhead demolition work. This can cause broken objects and debris to fall on top of machine causing death or serious injury, or property damage.

Deep Digging

Figure 35



Do not perform deep digging under front of machine. The ground under machine may collapse and cause machine to fall resulting in death or serious injury.

Working heavy loads on loose, soft or uneven ground, can cause side load conditions resulting in a tip over and injury. Traveling without a load or a balanced load may also be hazardous.

Never rely on lift jacks or other inadequate supports when work is being done. Block tracks fore and aft to prevent any movement.

Use machine only for its intended purpose. Using it for other purposes will cause failures.

- Do not perform demolition work under machine. There is a hazard that the machine may become unstable and tip over.
- When working on or from top of buildings or other structures, check if structure can support weight of machine and attachment. If a building structure collapses, this can cause death or serious injury.

Drop-off or Edge

When working at edge of an excavation or near a drop-off, the machine could tip over, which can result in death or serious injury. Always fasten your seat belt. Check ground conditions of work site before operating to prevent the machine from falling or roll-over, and to prevent ground, stockpiles, or banks from collapsing.

Do not travel too close to edge of a drop-off.

Poor Visibility

For good visibility, always do the following:

- When working in dark areas, attach working lights and front lights to the machine. If necessary, set up additional lighting at work site.
- Stop operations when visibility is poor, such as in fog, mist, snow, and rain. Wait for visibility to improve before starting operation.

To avoid hitting work equipment and damaging other property, always do the following:

- When working in tunnels, on bridges, under electrical wires, or when parking the machine or performing other operations in places with limited height, be careful not to hit and damage other equipment or property.
- To prevent hitting objects, operate machine at a slow speed when working in confined spaces, indoors, or in crowded areas.
- Do not swing bucket over the top of personnel or over operator's cabin of dump truck.

Loose or Soft Ground

Do not operate on soft ground or near edge of drop-offs, overhangs, and deep ditches. The ground can collapse because of the weight of the machine causing the machine to fall or roll-over.

Check ground conditions before beginning work with the machine. If ground is soft, reposition the machine before operating.

The excavated material must not be dumped too close to edge. How far away from edge of trench excavated material must be dumped depends on soil type and moisture content. If loose clay is being excavated, place it at least 5 m (16 ft) away from edge.

If excavated material is dumped too close to edge, its weight can cause a landslide.

Thawing of frozen ground, rain, traffic, piling and blasting are other factors which increase risk of landslide. The risk also increases on sloping ground. If it is not possible to dig a trench and adequately slope its sides, always install shoring equipment.

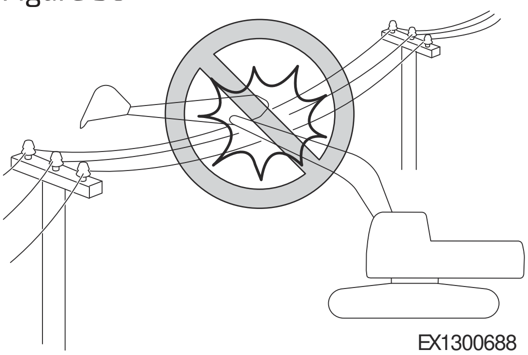
Loose ground may easily give way under weight of the machine.

When working on loose or unstable ground, it is important not to dig too deep and to carefully reposition the machine. Do not panic and do not raise bucket, if ground should begin to collapse. Lower work equipment to improve stability of machine.

Never dig under machine, if there is a potential of causing a landslide.

High-voltage Cables

Figure 36



Do not travel or operate machine near electrical cables or overhead power lines. There is a hazard of electric shock, which can cause property damage and result in death or serious injury. The bucket or other attachment does not have to make physical contact with power lines for current to cause an electrocution.

Use a spotter and hand signals to stay away from power lines not clearly visible to operator. On work sites where machine may operate close to electrical cables, always do the following:

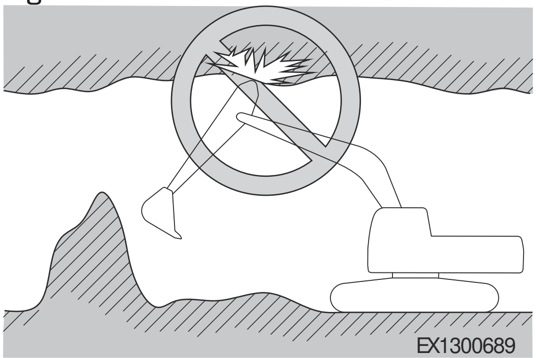
- Remember that electrical voltage determines what the minimum distance is to stay away from the power line. See the following table for minimum distances when working near electrical power lines. Electrical flashover can occur and damage machine and cause death or serious injury.

Voltage	Minimum Distance
6.6 kV	3 m (9' 10")
33.0 kV	4 m (13' 1")
66.0 kV	5 m (16' 5")
154.0 kV	8 m (26' 3")
275.0 kV	10 m (32' 10")

- Always contact the power company responsible before beginning work near high voltage power lines.

Underground Operation

Figure 37



If excavation is in an underground location or in a building, make sure there is adequate overhead clearance, and adequate ventilation.

Special equipment and engines may be required in some countries. Contact your distributor for more information.

Check that there is sufficient room for machine and load.

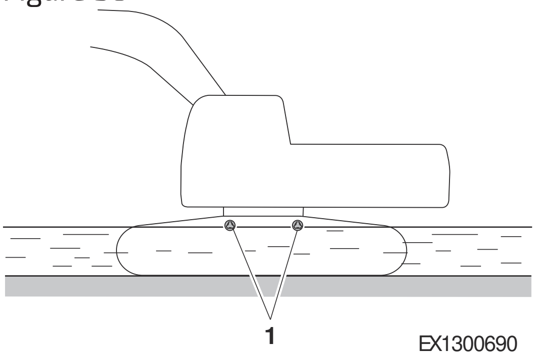
Move slowly.

Make sure that authorities or companies responsible for underground cables, utilities, and electrical lines have been contacted and that their instructions are followed. Also check which rules apply to ground personnel regarding exposing cables, utilities and electrical lines.

Consider all electrical cables as live.

Working in Water

Figure 38



Do not exceed maximum permissible water depth. The water level must not reach higher than centerline of uppertrack roller(s) (1).

After working in water, lubricate all lubrication points on undercarriage, which have been underwater so water is removed. Check that no water has entered travel gearboxes and undercarriage components.

Working in Contaminated Environment

When working within area which is contaminated or where there is a health risk, check local regulations and contact your distributor for assistance with identifying what additional safety precautions need to be taken.

Operation in Extreme Conditions

Operation In Extreme Cold

In extremely cold weather, avoid sudden travel movements and stay away from even slight slopes. The machine could slide down the slope.

Snow accumulation could hide potential hazards and slippery surfaces.

Warming up engine for a short period may be necessary to avoid operating with sluggish or reduced working capacity. The jolting shocks and impact loads caused by bumping or bottoming boom or attachment could cause severe stress in very cold temperatures. Reducing work cycle rate and workload may be necessary.

If machine is to be operated in extremely cold weather temperatures, certain precautions must be taken. The following paragraphs detail checks to be made to be certain machine is capable of operating at these temperatures.

1. Keep batteries fully charged to prevent freezing. If distilled water is added to batteries, run engine at least one hour to mix electrolyte solution. When temperature drops below -10°C, efficacy of the battery is reduced accordingly. Insulation of the battery prevents reduction of efficacy, and supports improvement of starting power of the starter.

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

Explosion of the battery can cause death or serious injury.Never attempt to directly heat the battery with open fire.

2. Keep engine in good mechanical condition for easy starting and good performance during adverse weather.
3. Use engine oil with proper specifications for expected temperatures. Refer to Operation and Shop Manual for details.
4. Always keep the fuel tank fully filled after completion of the operation. Always drain water from the fuel tank before and after the operation. In addition, check the water separator, and drain it if required. The fuel filter, if frozen, may interrupt the flow of fuel. Periodically remove water from the fuel tank, drain water from the filter, and replace the filter upon regular basis. To prevent fuel from being clogged because of formation of wax in fuel, make sure that wax formation point of fuel is lower than atmospheric temperature.

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

Explosion of the battery can cause death or serious injury.Never attempt to directly heat the battery with open fire.

5. Lubricate entire machine according to Operation and Maintenance Manual or lubrication chart on machine.
6. Start engine and allow it to reach normal operating temperature before operating.
   - If mud and ice collects and freezes on any of moving parts while machine is idle, apply heat to thaw frozen material before attempting to operate machine.
   - Operate hydraulic units with care until they have reached a temperature which enable them to operate normally.
   - Check all machine controls and functions to be sure they are operating correctly.

7. An extra outer air filter must be kept in operator's cabin to replace element that could become iced and cause restricted airflow to engine.
8. Clean off all mud, snow and ice to prevent freezing. Cover machine with a tarp if possible, keep ends of tarp from freezing to ground.

Operation in Extreme Heat

Continuous operation of machine in high temperatures can cause machine to overheat. Monitor engine and hydraulic system temperatures and stop machine to let it cool, when necessary.

1. Make frequent inspections and services of fan and radiator. Check coolant level in radiator. Check grilles and radiator fins for accumulation of dirt, debris and insects which could block cooling passages.
   - Formation of scale and rust in cooling system occurs more rapidly in extremely high temperatures. Change antifreeze each year to keep corrosion inhibitor at full strength.
   - If necessary, flush cooling system periodically to keep passages clear. Avoid use of water with a high alkali content which increases scale and rust formation.
2. Batteries self-discharge at a higher rate if left standing for long periods at high temperatures. If machine is to stand for several days, remove batteries and store in a cool place.

Do not store acid type storage batteries near stacks oftires. Acid fumes can damage rubber.

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3. Service fuel system as directed in Operation and Maintenance Manual. Check for water content before filling fuel tank. High temperatures and cooling off cause condensation in storage drums.
4. Lubricate as specified in Operation and Maintenance Manual or Lubrication Decal on machine.
5. Do not park machine in sun for long periods of time. If possible, park machine under cover to protect it from sun, dirt and dust.
   A. Cover machine if no suitable shelter is available. Protect engine compartment and hydraulics from dirt and debris.
   B. In hot, damp climates, corrosion will occur on all parts of machine and will be accelerated during rainy season. Rust and paint blisters will appear on metal surfaces and fungus growth on other surfaces.
   C. Protect all unfinished, exposed surfaces with a film of preservative lubricating oil. Protect cables and terminals with ignition insulation compound. Apply paint or suitable rust preventive to damaged surfaces to protect them from rust and corrosion.

Operation In Dusty and Sandy Areas

Operation of machine can cause dust in almost any area. However, when in predominantly dusty or sandy areas, additional precautions must be taken.

1. Keep cooling system fins and cooling areas clean. Blow out with compressed air, if possible, as often as necessary.

WARNING

AVOID DEATH OR SERIOUS INJURY
Wear goggles when using compressed air to preventface or eye injury.

2. Use care when servicing fuel system to prevent dust and sand from entering tank.

3. Service air cleaner at frequent intervals, check air restriction indicator daily and keep dust cup and dust valve clean. Prevent dust and sand from entering engine parts and compartments as much as possible.
4. Lubricate and perform services outlined on current lubrication chart on machine and Operation and Maintenance Manual. Clean all lubrication fittings before applying lubricant. Sand mixed with lubricant becomes very abrasive and accelerates wear on parts.
5. Protect machine from dust and sand as much as possible. Park machine under cover to keep dust and sand from damaging unit.

Operation in Rainy or Humid Conditions

Operation under rainy or humid conditions is similar to that as in extreme heat procedures previously listed.

1. Keep all exposed surfaces coated with preservative lubricating oil. Pay particular attention to damaged or unpainted surfaces. Cover all paint cracks and chip marks as soon as possible to prevent corrosive effects.

Operation in Saltwater Areas

Saltwater and saltwater spray is very corrosive. When operating in saltwater areas, or in or around snow, observe the following precautions:

1. When exposed to saltwater, dry machine thoroughly and rinse with freshwater, as soon as possible.
2. Keep all exposed surfaces coated with preservative lubricating oil. Pay attention to damaged paint surfaces.
3. Keep all painted surfaces in good repair.
4. Lubricate machine as prescribed on lubrication chart on machine or Operation and Maintenance Manual. Shorten lubricating intervals for parts exposed to salt water.
5. Check operating controls to ensure proper functionality and that they return to "NEUTRAL" when released.

Operation at High Altitudes

Operation instructions at high altitudes are the same as those provided for extreme cold. Before operating at high altitudes, engine fuel and air mixture may have to be adjusted according to appropriate engine manual.

1. Check engine operating temperature for evidence of overheating. The radiator cap must make a perfect seal to maintain coolant pressure in cooling system.
   - Perform warming-up operation thoroughly. If machine is not thoroughly warmed up before control levers or control pedals are operated, reaction of machine will be slow.
   - If battery electrolyte is frozen, do not charge battery or start engine with a different power source. There is a potential hazard that could cause a battery explosion or fire.
   - Before charging or starting engine with a different power source, thaw battery electrolyte and check for any leakage of electrolyte before starting.

Operation During Electrical Storms

During electrical storms, do not enter or exit machine.

- If you are off machine, keep away from machine until storm passes.
- If you are in cabin, remain seated with machine stationary until storm passes. Do not touch controls or anything metal.

Exhaust Ventilation

Figure 39

ARO1770L

Engine exhaust gases can cause unconsciousness, loss of alertness, judgment and motor control. This can result in death or serious injury.

Make sure there is adequate ventilation before starting engine in any enclosed area.

Check for and be aware of any open windows, doors or ductwork where exhaust may be carried, or blown by wind, exposing others to hazardous exhaust gases.

Ventilation for Enclosed Area

If it is necessary to start engine within an enclosed area, or when handling fuel, flushing oil, or paint; open doors and windows to ensure that adequate ventilation is provided to prevent gas poisoning.

Diesel engine exhaust contains products of combustion which can be harmful to your health.

Always run engine in a well ventilated area. If you are in an enclosed area, vent exhaust to outside.

Asbestos Information

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

Avoid exposure to dust containing asbestos as it can cause death or serious injury to the lungs and other organs(mesothelioma, lung and other cancers, and asbestosis).

Asbestos dust can be HAZARDOUS to your health if it is inhaled. Materials containing asbestos fiber can be present on work sites. Breathing air that contains asbestos fiber can ultimately cause serious or fatal lung damage or diseases such as mesothelioma, lung and other cancers, and asbestosis. To prevent lung damage from asbestos fiber, observe the following precautions:

- Use an approved respirator that is approved for use in an asbestos-laden atmosphere.
- Use water for cleaning to keep down dust.
- Always observe any regulations related to work site and working environment.
- Avoid brushing or grinding materials that contain asbestos.
- A vacuum cleaner that is equipped with a high efficiency particulate air filter can also be used.
- Comply with applicable laws and regulations for workplace.
- Stay away from areas that might have asbestos particles in air.

Silica Dust Information

⚠ WARNING

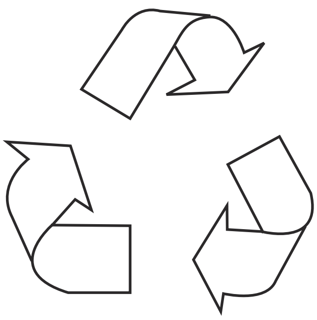
AVOID DEATH OR SERIOUS INJURY

Avoid exposure to dust containing crystalline silicaparticles as it can cause serious injury to the lungs(silicosis).

Cutting or drilling concrete containing sand or rock containing quartz can result in exposure to silica dust. Do not exceed Permissible Exposure Limits (PEL) to silica dust as determined by OSHA or other work site rules, laws and regulations. Use a respirator, water spray or other means to control dust. Silica dust can cause lung disease and is known to the state of California to cause cancer.

Disposal of Hazardous Materials

Figure 40



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Physical contact with used motor oil or gear oil could create a health risk. Wipe oil from your hands promptly and wash off any remaining residue.

Used motor oil or gear oil is an environmental contaminant and should only be disposed of at approved collection facilities. To prevent pollution of environment, always do the following:

- Never dump waste oil in a sewer system, rivers, etc.
- Always put drained oil from your machine in approved, leak proof containers. Never drain oil directly onto ground.
- Obey appropriate laws and regulations when disposing of harmful materials such as oil, fuel, solvent, filters, and batteries.

Improperly disposing of waste can threaten environment. Potentially harmful fluids must be disposed of according to local regulations.

Use all cleaning solutions with care. Report all necessary repairs.

Sound

Sound Level Information: Hearing protection may be required when machine is operated with an open operator station for extended periods or in a noisy environment.

Sound pressure level (LpA) at operator position (Measurement according to ISO 6396)	72 dB(A)
Sound power level (LwA) around the machine (Measurement according to 2000/14/EC with applicable appendices and measuring method according to ISO 6395)	103 dB(A)

Vibration Information

NOTE: *The level of vibration is influenced by many different parameters such as operator training, job site organization, weather, material, environment, machine type, machine and seat suspension system, attachments, and condition of the machine.*

Measurements are obtained on a representative machine, using measuring procedures as described in the following standards: ISO 2631/1, ISO 5349, and SAE J1166.

Vibration levels were given consideration in accordance with uncertainty (K) determined to manufacturer.

Hand/Arm Vibration Level

The vibration total value to which the hand-arm system is subjected, is less than 2.5 m/s^2.

Whole Body Vibration Level

The highest root mean square value of weighted acceleration to which the whole body is subjected, is more than 0.5 m/s^2 (less than 1.15 m/s^2).

Guidelines for Use and Working Conditions of Earth-moving Machinery to Reduce Vibration Levels (ISO/TR 25398 Annex E)

Properly adjusting and maintaining machines, operating machines smoothly, and maintaining the terrain conditions can reduce whole-body vibrations. The following can help the users of earth-moving machinery reduce whole-body vibration levels.

1. Use the right type and size of machine, equipment, and attachments.
2. Maintain machines according to the manufacturer's recommendations: (for wheeled machine)
   - Tire pressure;
   - Brake and steering systems;
   - Controls, hydraulic system and linkages.
3. Keep the terrain where the machine is working and travelling in good condition:
   - Remove any large rocks or obstacles;
   - Fill any ditches and holes;
   - Provide machines and schedule time to maintain terrain conditions.
4. Use a seat in conformance with ISO 7096 and keep the seat maintained and adjusted:
   - Adjust the seat and suspension for the weight and size of the operator;
   - Inspect and maintain the seat suspension and adjustment mechanisms.
5. Steer, brake, accelerate, shift gears, and move the attachments smoothly. (for wheeled machine)
6. Adjust the machine speed and travel path to minimize the vibration level:
   - Drive around obstacles and rough terrain conditions;
   - Slow down when it is necessary to go over rough terrain.
7. Minimize vibrations for long work cycle or long distance travelling: (for wheeled machine)
   - Use machines equipped with suspension systems;
   - Use lift arm suspensions on wheel loaders;
   - If no suspension system is available, reduce speed to prevent bouncing;
   - Haul machines long distances between worksites.

8. Back pain associated with whole-body vibrations can be caused by other risk factors. To minimize the risk of back pain:
   - Adjust the seat and controls to achieve good posture;
   - Adjust the mirrors to minimize twisted posture;
   - Provide breaks to reduce long periods of sitting;
   - Avoid jumping down from the cab or access system;
   - Minimize repeated handling and lifting of loads;
   - Minimize any shocks and jolts during sports and leisure activities.

General Specifications

General

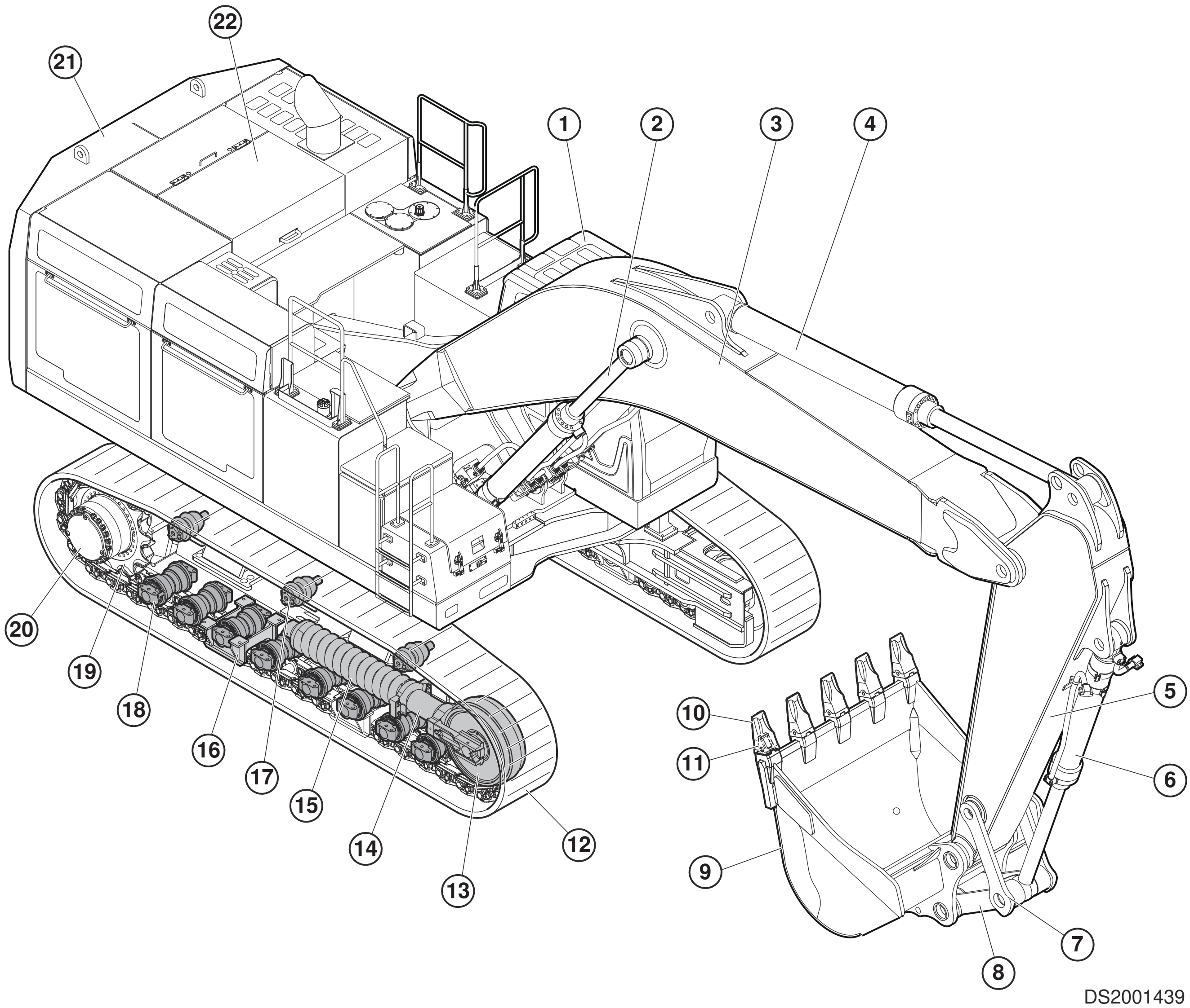
The wheel loader has three main component sections:

- The Main Structure
- The Front Attachment
- Rear Section

The following illustration identifies main components and their locations.

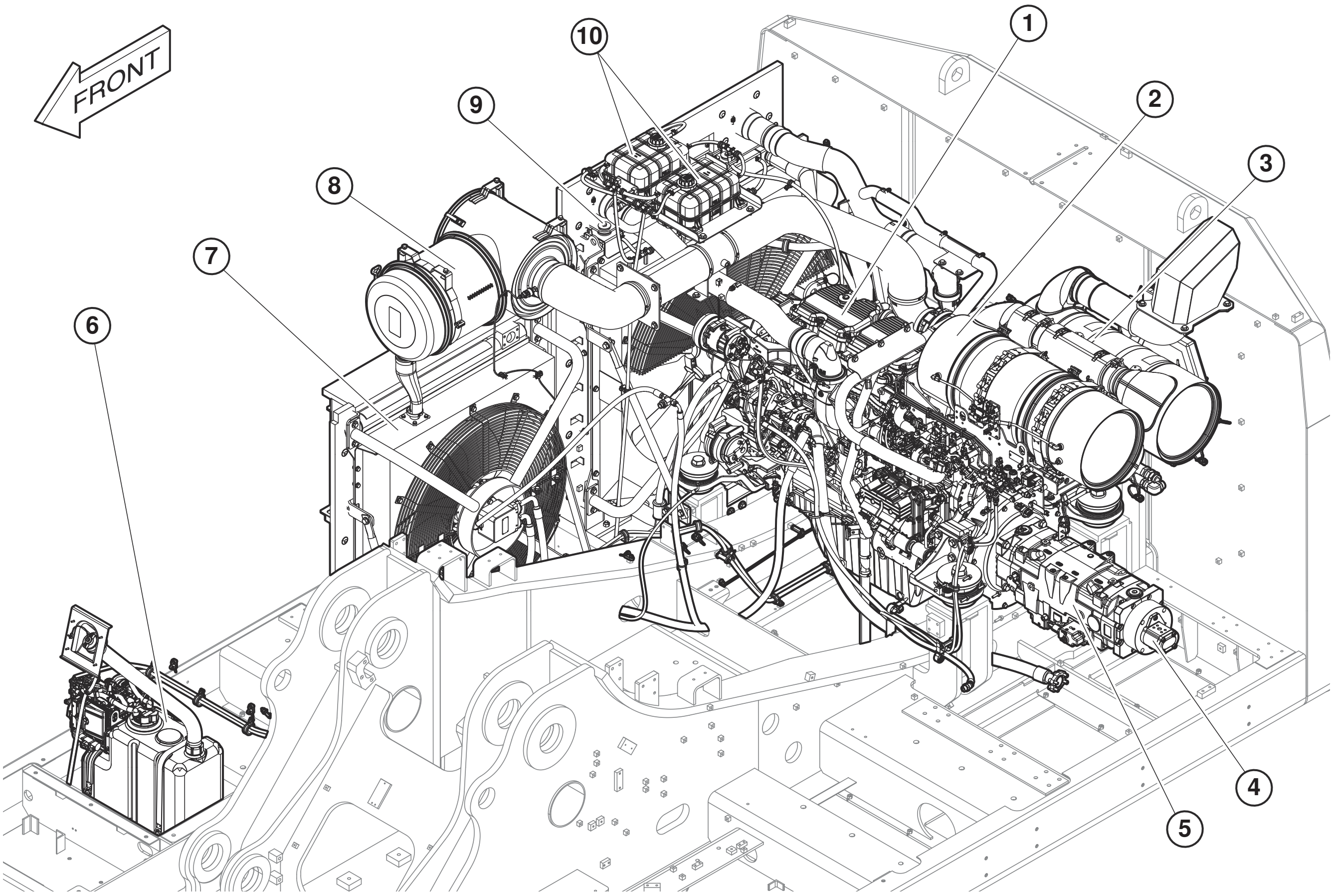
Component Locations

Figure 41



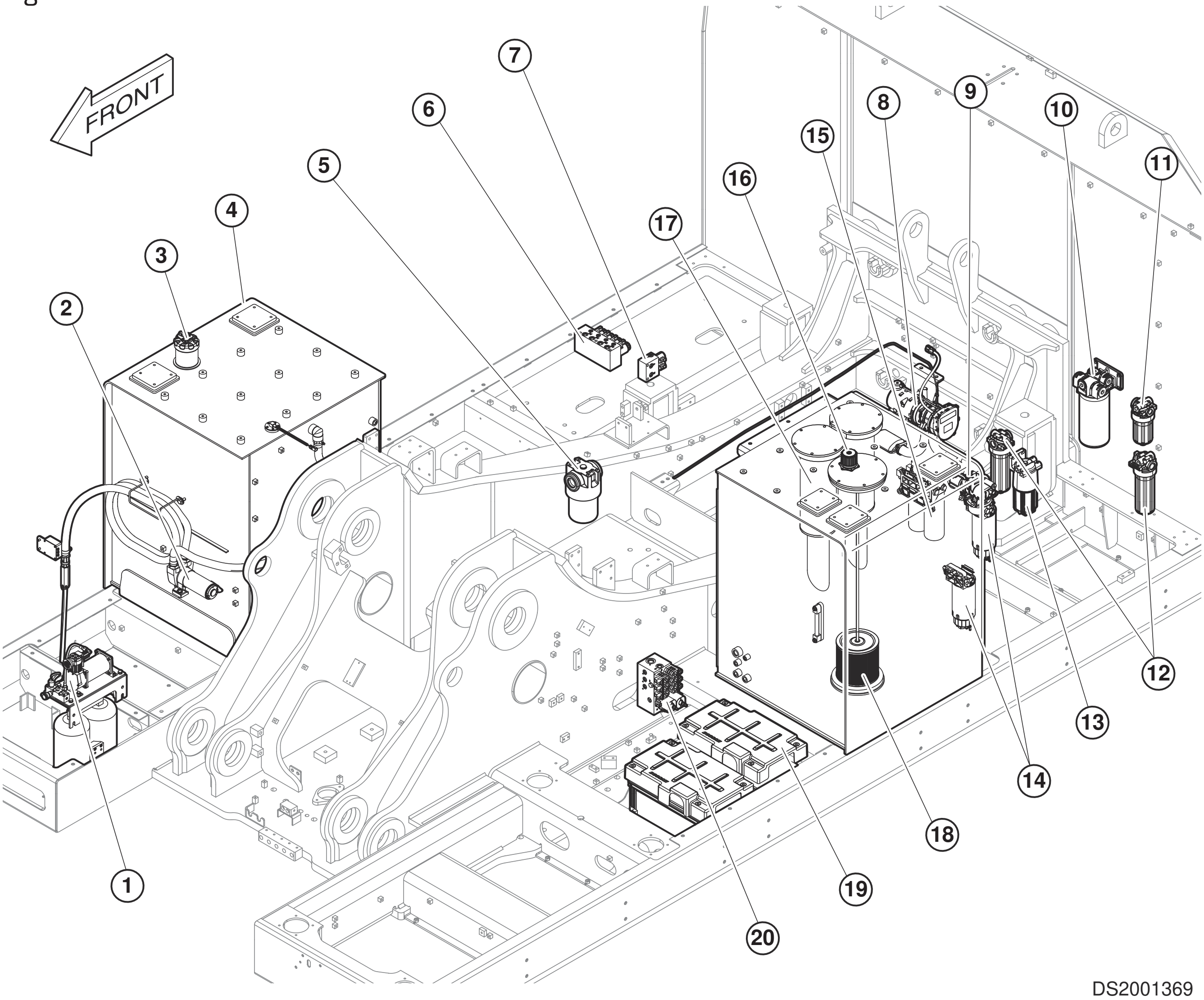
Reference Number	Description
1	Cabin
2	Boom Cylinder
3	Boom
4	Arm Cylinder
5	Arm
6	Bucket Cylinder
7	Guide Link
8	Push Link
9	Bucket
10	Tooth Point
11	Tooth Adapter
12	Track Link and Shoe
13	Idler
14	Grease Cylinder
15	Track Spring
16	Track Guard
17	Upper Roller
18	Lower Roller
19	Sprocket
20	Travel Motor
21	Counterweight
22	Hood

Figure 42



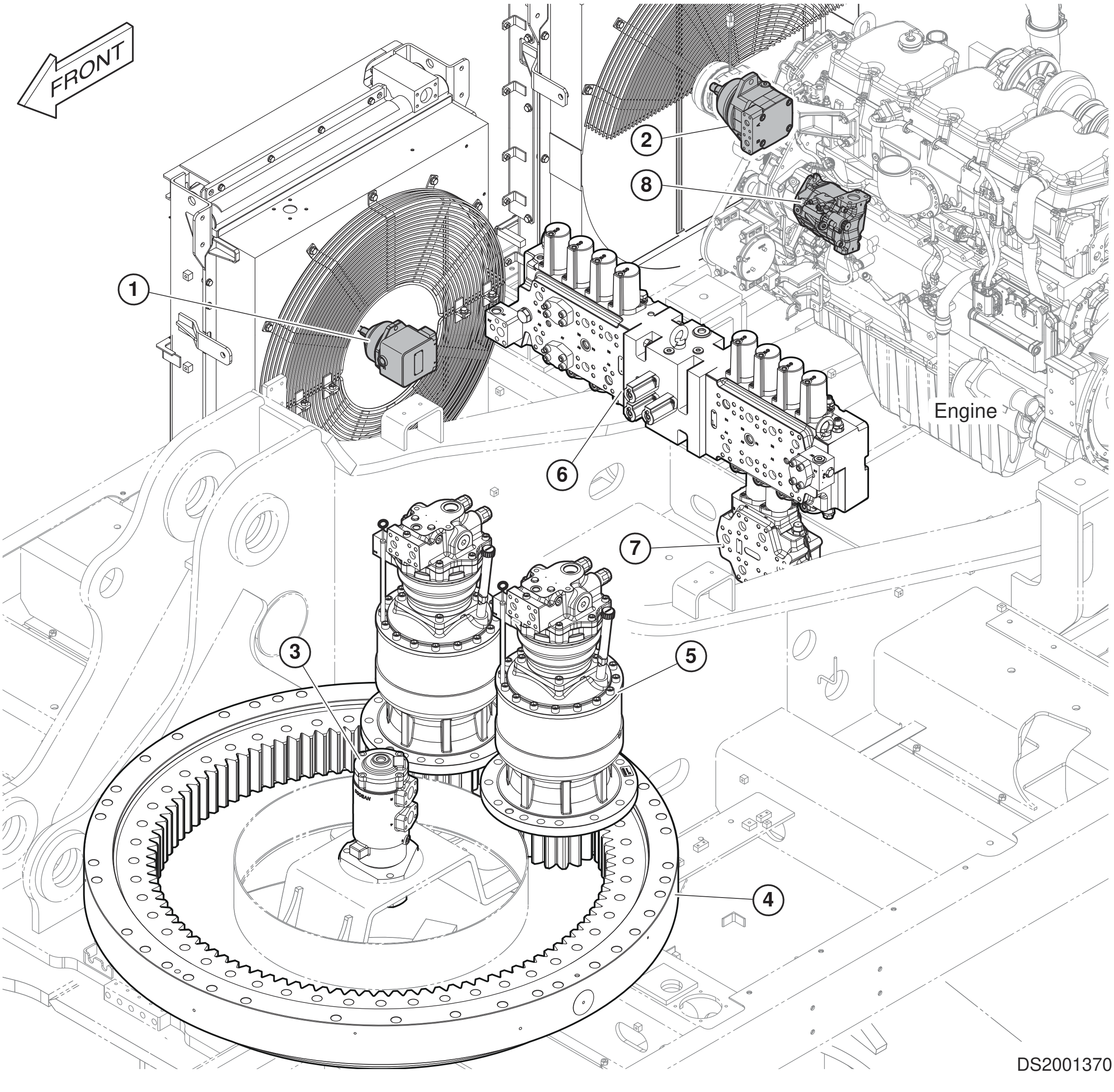
Reference Number	Description
1	Engine
2	DOC/DPF
3	SCR
4	Pilot Pump
5	Main Pump
6	DEF (AdBlue®) Tank
7	Oil Cooler
8	Air Cleaner
9	Radiator
10	Coolant Tank

Figure 43



Reference Number	Description
1	Air compressor Pump (If Equipped)
2	Fuel Filler Pump (If Equipped)
3	Fuel Cap
4	Fuel Tank
5	Breaker Filter (If Equipped)
6	EPPR Package Valve
7	Bypass Cut Valve
8	Diesel Heater (If Equipped)
9	Primary Fuel Filter Head
10	Engine Oil Filter
11	Pilot Filter
12	Drain Filter
13	Additional Water Separator (If Equipped)
14	Water Separator & Fuel Prefilter
15	Main Fuel Filter
16	Hydraulic Oil Tank Breather
17	Return Filter
18	Suction Filter
19	Battery
20	Solenoid Valve

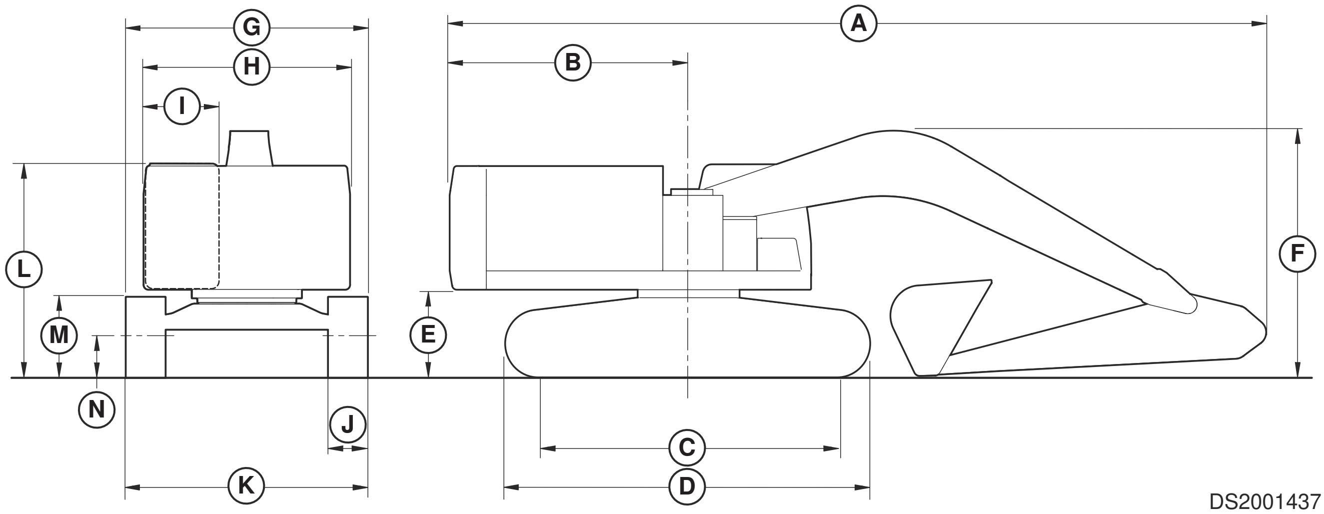
Figure 44



Reference Number	Description
1	Fan Motor (Oil Cooler)
2	Fan Motor (Radiator)
3	Center Joint
4	Swing Bearing
5	Swing Device
6	Main Control Valve #1
7	Main Control Valve #2
8	Fan Pump

Overall Dimensions

Figure 45



Dimension		7.7 m (25'3") Boom		6.65 m (21'10") Boom
		3.55 m (11' 8") Arm	2.9 m (9' 6") Arm	2.9 m (9' 6") Arm
A	Shipping Length	13,165 mm (43' 2")	13,370 mm (43' 10")	12,320 mm (40' 5")
B	Tail Swing Radius	4,010 mm (13' 2")		
C	Tumbler Distance	4,730 mm (15' 6")		
D	Track Length	5,960 mm (19' 7")		
E	Counterweight Clearance	1,490 mm (4' 11")*		
F (Boom)	Shipping Height	4,615 mm (15' 2")	4,420 mm (14' 6")	4,905 mm (16' 1")
F (Hose)	Shipping Height	4,865 mm (16' 0")	4,690 mm (15' 5")	5,125 mm (16' 10")
G	Shipping Width	3,560 mm (11' 8")		
H	House Width	3,410 mm (11' 2")		
I	Cabin Width	1,010 mm (3' 4")		
J	Shoe Width	650 mm (2' 2")		
K	Undercarriage Width	4,000 mm (13' 1")*		
L	Height Over Cabin	3,540 mm (11' 7")		
M	Track Height	1,310 mm (4' 4")*		
N	Car Body Clearance	830 mm (2' 9")*		

***: Without Grouser

Standard Specification

Component		Specification	
		Metric	English
Bucket Capacity	CECE	4.18 m^3	5.47 yd^3
	SAE (PCSA)	4.64 m^3	6.07 yd^3
Operating Weight		79.5 metric tons	87.6 tons
Engine	Model	Perkins 2506J	
	Type	4-cycle, Turbocharged after Water Cooled, MEUI (Mechanical Electronic Unit Injector)	
	Rated Output (Gross)	402 kW @2,100 rpm	539 HP (546.6 PS) @2,100 rpm
	Maximum Torque	2,468 N.m @ 1,400 rpm	1,820.3 ft lb @ 1,400 rpm
	Fuel Tank Capacity	880 L	211.3 U.S. gal.
Hydraulic Pump	Type	Axial Piston	

Component			Specification	
			Metric	English
	Discharging Pressure		345 kg/cm^2	4,907 psi
	Maximum Discharge Quantity		2 x 504 L/min	2 x 133 U.S. gpm
	Hydraulic Oil Capacity	Tank Level	435 L	114.9 U.S. gal.
		System	890 L	235.1 U.S. gal.
Performance	Swing Speed		7.4 rpm	
	Travel Speed	High-speed	4.8 km/h	2.98 MPH
		Low Speed	2.9 km/h	1.80 MPH
	Traction Force	High-speed	33.1 metric tons	36.5 tons
		Low Speed	54.4 metric tons	59.9 tons
	Gradeability		35° (70% slope)	
Track Shoe Width			650 mm	25.6 in
Upper Roller Qty.			3 per side	
Lower Roller Qty.			8 per side	

Base Option: Boom (7,700 mm), Arm (2,900 mm), Counterweight (10,700 kg)

Performance Tests

Use operational performance test procedure to quantitatively check all system and functions on the machine.

Purpose of Performance Tests

1. To comprehensively evaluate each operational function by comparing the performance test data with the standard values.
2. According to the evaluation results, repair, adjust, or replace parts or components as necessary to restore the machine’s performance to the desired standard.
3. To economically operate the machine under optimal conditions.

Kinds of Tests

1. Base machine performance test is to check the operational performance of each system such as engine, travel, swing, and hydraulic cylinders.
2. Hydraulic component unit test is to check the operational performance of each component such as hydraulic pump, motor, and various kinds of valves.

Performance Standards

"Performance Standard" is shown in tables to evaluate the performance test data.

Precautions for Evaluation of Test Data

1. To evaluate not only that test data is correct, but also in what range the test data is.
2. Be sure to evaluate the test data based on the machine operation hours, kinds and state of work loads, and machine maintenance conditions.

The machine performance does not always deteriorate as the working hours increase. However, the machine performance is normally considered to reduce in proportion to the increase of the operation hours. Accordingly, restoring the machine performance by repair, adjustment, or replacement shall consider the number of the machine's working hours.

Definition of "Performance Standard"

1. Operation speed values and dimensions of the new machine.
2. Operational performance of new components adjusted to specifications. Allowable errors will be indicated as necessary.

Preparation for Performance Tests

Observe the following rules to perform performance tests accurately and safety.

The Machine

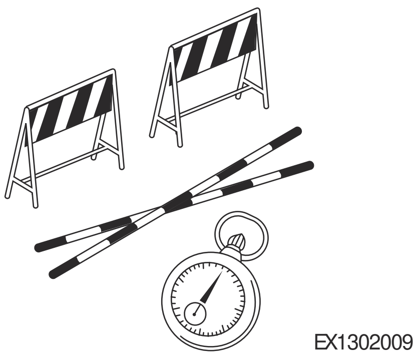
1. Repair any defects and damage found, such as oil or water leaks, loose bolts, cracks etc, before starting to test.

Test Area

1. Select a hard and flat surface.
2. Secure enough space to allow the machine to run straight more than 20 m (65 ft 7 in), and to make a full swing with the front attachment extended.
3. If required, rope off the test area and provide signboards to keep unauthorized personnel away.

Precautions

1. Before starting to test, agree upon the signals to be employed for communication among coworkers.
   Figure 46

   Once the test is started, be sure to communicate with each other using these signals, and to follow them without fail.
2. Operate the machine carefully and always give first priority to safety.
3. While testing, always take care to avoid accidents because of landslides or contact with high voltage power lines. Always confirm there is sufficient space for full swings.

4. Avoid polluting the machine and the ground with leaking oil. Use oil pans to catch escaping oil. Pay special attention to this when removing hydraulic pipings.

Make Precise Measurement

1. Accurately calibrate test instruments in advance to obtain correct data.
2. Perform tests under the exact test conditions prescribed for each test item.
3. Repeat the same test and confirm that test data obtained can be produced repeatedly. Use mean values of measurements if necessary.

Operational Performance Standard Table

Item	Model			Unit	Measuring Conditions	Performance Standard	Tolerance
Engine Speed	Working Mode	Power+ Mode		rpm	SPC Off	1,900	±25
				rpm	SPC Off + A/I On	1,800	±25
		Power Mode		rpm	SPC Off	1,700	±25
				rpm	SPC On	1,600	±25
		Standard Mode		rpm	SPC Off	1,650	±25
				rpm	SPC On	1,550	±25
		Economy Mode		rpm	SPC Off	1,600	±25
				rpm	SPC On	1,500	±25
		Lifting Mode		rpm	Dial Max.	1,500	±25
		Low Idle	Above Coolant Temp. 15°c	rpm	Dial Min.	900	±25
			Below Coolant Temp. 15°c	rpm		1,200	±25
		Auto Idle	Above Air Temp. 10°c	rpm	A/I On	1,100	±25
			Below Air Temp. 10°c	rpm		1,100	±25
	Working Mode	Relief Load	1 Pump	rpm	*Standard	1,800	Above
			2 Pump	rpm		1,800	Above
		Boom Up or Arm Dump Operation Load	Power+ Mode	rpm	Dial Max., Sudden Command.	1,800	Above
			Power Mode	rpm		1,700	±25

Item	Model			Unit	Measuring Conditions	Performance Standard	Tolerance
			Standard Mode	rpm		1,650	±25
			Economy Mode	rpm		1,600	±25
			1300 rpm	rpm	Max. Power Mode, Adjust Dial, Sudden Command	1,300	±25
			Low Idle	rpm	Dial Min., Sudden Command	Not Stop Engine	
Pressure Set	Main	Pump 1 & 2	Normal	bar	*Standard	343	0~+10
	Swing	Relief (at Motor)		bar	*Standard	286	0~+10
		Relief (at Pump)		bar	*Standard	290	0~+10
	Option	1 Way Relief		bar	*Standard, 150 lpm, 220 bar.	220	±25
		2 Way Relief		bar		343	±25
		Rotating Relief		bar	*Standard	206	±25
Hydraulic Fan	Max. Performance	Current		mA	*Standard (Radiator/Oil cooler)	200	±25
		Fan Speed		rpm		(870/1,140)	±50
	Min. Performance (A/C On)	Current		mA	A/C On (Radiator/Oil cooler)	400	-
		Fan Speed		rpm		(590/760)	±50
	Min. Performance (A/C Off)	Current		mA	A/C Off (Radiator/Oil cooler)	600	-
		Fan Speed		rpm		(220/280)	±50

- Standard Condition: Lever On, Digging Mode, Max. Power Mode, Engine Dial Max., SPC Off, A/I Off, A/C Off, Hydraulic Oil 45 ±5°C, Coolant 80 ±5°C

Operational Performance Test

Hydraulic Cylinder Cycle Time

Summary

1. Check the overall operational performance of the front attachment hydraulic system (between the hydraulic pumps and each cylinder) by measuring the cycle time of the boom, arm, bucket, and bucket dump (open/close) cylinders with the empty bucket.
2. Bucket must be empty.

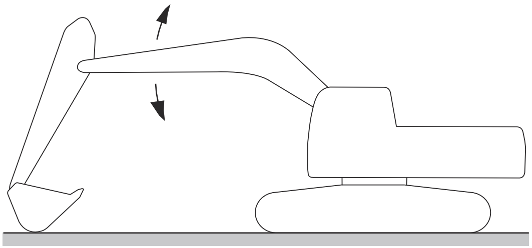
Preparation

1. Maintain the hydraulic oil temperature at 50 ±5 °C (122 ±41 °F).

Engine Control Dial	Power Mode Switch	Work Mode	Auto-idle Switch
High Idle	Power Plus Mode	Digging Mode	OFF

2. Position the front attachment as described in the following. Then, measure the operating time until cylinder reaches the stroke end by fully moving the control lever.

A. Boom cylinder
Figure 47



EX1301781

1) Boom up speed

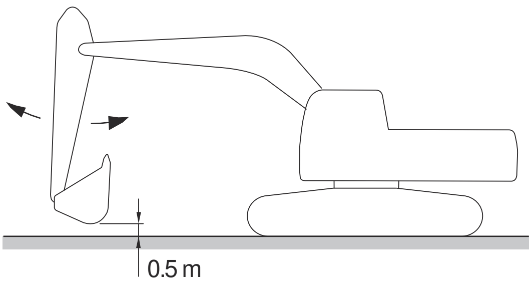
Rapidly operate the bucket from the ground, and measure the time it takes for the boom to reach the end point.

2) Boom down speed

Rapidly operate the bucket with the boom reached the end point, and measure the time it takes for the bucket to reach the ground.

3) Measuring available displacement of the cylinder: Measure and record the extension of the cylinder rod from when the bucket is resting on the ground to when the boom cylinder is extended to its maximum length.

B. Arm cylinder
Figure 48



EX1301782

1) Arm crowd speed

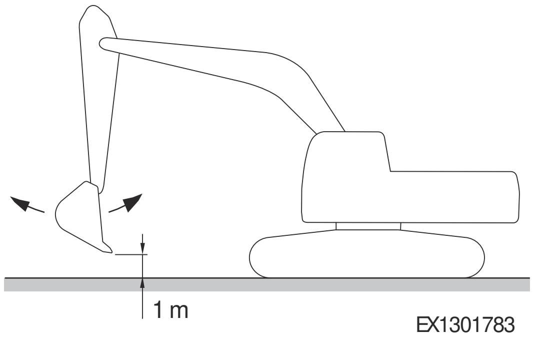
Rapidly operate the arm while kept fully dumped (extended), and measure the time it takes for the arm to fold fully.

2) Arm dump speed

Rapidly operate the arm maintained in the fully folded position, and measure the time it takes for the arm to extend fully.

3) Measuring available displacement of the cylinder: Measure and record the extension length of the cylinder rod from the point at which the arm cylinder is fully extended (crowded) to the point at which the arm cylinder is fully folded (dumped).

C. Bucket cylinder
Figure 49



1) Bucket crowd speed

Rapidly operate the bucket while fully dumped (extended), and measure the time it takes for the bucket to fold fully.

2) Bucket dump speed

Rapidly operate the bucket while fully folded, and measure the time it takes for the bucket to extend fully.

3) Measuring available displacement of the cylinder: Measure and record the extension length of the cylinder rod from the point at which the bucket cylinder is fully extended (crowded) to the point at which the bucket cylinder is fully folded (dumped).

NOTE: *Jack up the dozer of the wheel-type excavator and mini-excavator pointing forward, and measure the time taken to jack it up and to jack it back down. Measure and record the operating time of the boom swing (option) of the mini-excavator from right to left, or from left to right.*

NOTE: *Record the details of any abnormal noise heard during measurement, or any abnormal conditions observed during operation, on a blank measurement record sheet.*

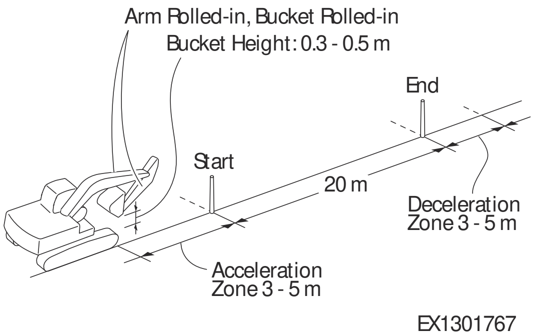
Travel Speed

Summary

Measure the time required for the excavator to travel a 20 m (65.6 ft) test track.

Preparation

1. Adjust the track sag on both side tracks equally.
Figure 50



2. Prepare a flat and solid test track 20 m (65.6 ft) in length with extra length of 3 - 5 m (9.8 - 16 ft) on both ends for machine acceleration and deceleration.

NOTICE

The bucket teeth will hit the boom if the bucket isrolled-in with the arm fully rolled-in.
As for this condition: arm fully rolled-in + bucket fullyrolled-in, set the bucket at fully rolled-in and a performarm roll-in operation.

3. Hold the bucket 0.3 - 0.5 m (12 - 20 in) above the ground with the arm and bucket rolled-in.
4. Maintain the hydraulic oil temperature at 50 ±5 °C (122 ±41 °F).

Measurement

1. Measure both the slow and fast speeds of the machine.
2. Measurement conditions are as below.

Travel Mode Switch	Engine Control Dial	Power Mode Switch	Work Mode	Auto-idle Switch
Low Mode	High Idle	Power Plus Mode	Digging Mode	OFF
High Mode	High Idle	Power Plus Mode	Digging Mode	OFF

3. Start traveling the machine in the acceleration zone with the travel levers to full stroke.
4. Measure the time required to travel 20 m (65.6 ft)
5. After measuring the forward travel speed, turn the upper structure 180° and measure the reverse travel speed.
6. Perform the measurement three times and calculate the average values.

Evaluation

Refer to Operational Performance Standard Table on page 1-1.

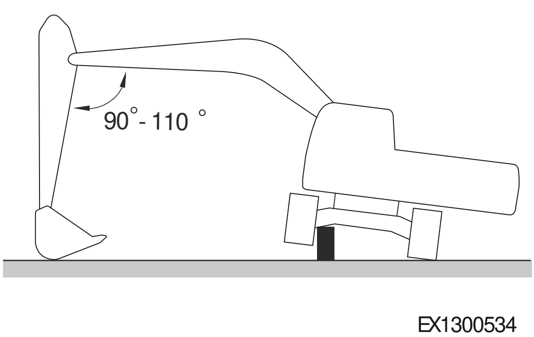
Track Revolution Speed

Summary

Measure the track revolution cycle time with the track raised off ground.

Preparation

1. Adjust the track sag of both side tracks to be equal.
2. Put the mark on the track to be measured, by using a piece of chalk.
3. Swing the upper structure 90° and lower the bucket to raise the track off ground. Keep the boom-arm angle between 90 - 110° as shown place blocks under the machine frame.
   Figure 51



⚠ CAUTION

AVOID INJURY

Secure support the raised track using wooden blocks.

4. Maintain the hydraulic oil temperature at 50 ±5 °C (122 ±41 °F).

Measurement

1. Measure the both tracks on forward and reverse directions at each travel mode.
2. Measurement conditions are as below.

Travel Mode Switch	Engine Control Dial	Power Mode Switch	Work Mode	Auto-idle Switch
Low Mode	High Idle	Power Plus Mode	Digging Mode	OFF
High Mode	High Idle	Power Plus Mode	Digging Mode	OFF

3. Operate the travel control lever of the raised track to full stroke.
4. Measure the time required for 3 revolutions in both directions after a constant track revolution speed is obtained.
5. Perform the measurement three times and calculate the average values.

   NOTE: *Record the details of any abnormal noise heard during measurement, or any abnormal conditions observed during operation, on a blank measurement record sheet.*

Evaluation

Refer to Operational Performance Standard Table on page 1-1.

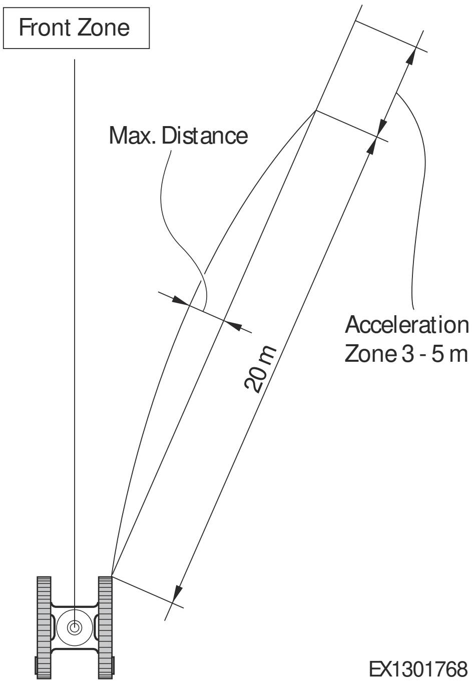
Mistrack Check

Summary

1. Allow the machine to travel 20 m (65.6 ft). Measure the maximum tread deviation from the tread chord line drawn between the travel start and end points to check the performance equilibrium between both sides of the travel device systems (from the main pump to the travel motor).
2. If measured on a concrete surface, the tread deviation has a trend to decrease.

Preparation

1. Adjust the track sag of both tracks to be equal.
   Figure 52



2. Provide a flat, solid test yard 20 m (65.6 ft) in length, with extra length of 3 - 5 m (9.8 - 16 ft) on both ends for machine acceleration and deceleration.

NOTICE

The bucket teeth will hit the boom if the bucket isrolled-in with the arm fully rolled-in.
As for this condition: arm fully rolled-in + bucket fullyrolled-in, set the bucket at fully rolled-in and a performarm roll-In operation.

3. Hold the bucket 0.3 - 0.5 m (12 - 20 in) above the ground the arm and bucket rolled-in.
4. Maintain the hydraulic oil temperature at 50 ±5 °C (122 ±41 °C).

Measurement

1. Measure the amount of mistracking in both fast, and slow travel speeds.
2. Measurement conditions are as below.

Travel Mode Switch	Engine Control Dial	Power Mode Switch	Work Mode	Auto-idle Switch
Low Mode	High Idle	Power Plus Mode	Digging Mode	OFF
High Mode	High Idle	Power Plus Mode	Digging Mode	OFF

3. Start traveling the machine in the acceleration zone with the travel levers all full stroke.
4. Measure the maximum distance between a straight 20 m (65.6 ft) tread chord line and the tread made by the machine.
5. After measuring the tracking in forward travel, turn the upper structure 180° and measure in reverse travel.
6. Perform the measurement three times and calculate the average values.

Evaluation

Refer to Operational Performance Standard Table on page 1-1.

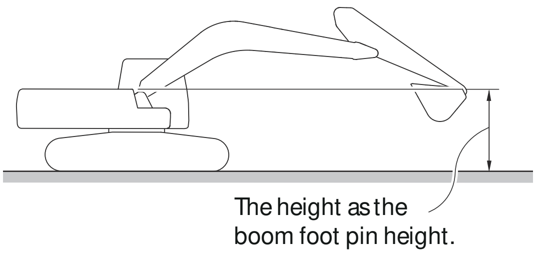
Swing Speed

Summary

Measure the time required to swing three complete turns.

Preparation

1. Check the lubrication of the swing gear and swing bearing.
   Figure 53



2. Place the machine on flat, solid ground with ample space lor swinging. Do not conduct this test on slopes.
3. With the bucket empty, position the front attachment as follows. With the arm cylinder fully retracted, and the bucket cylinder fully extended, raise the boom so bucket pin height is flush with the boom foot pin height.

   NOTE: *In case of no place to be measured, measure with the boom raised and the arm rolled-in.*
4. Maintain the hydraulic oil temperature at 50 ±5 °C (122 ±41 °F).

CAUTION

AVOID INJURY

Prevent personal injury. Always make sure that area is clear and that co-workers are out of the swing areabefore starting the measurement.

Measurement

1. Measurement conditions are as below.

Engine Control Dial	Power Mode Switch	Work Mode	Auto-idle Switch
High Idle	Power Plus Mode	Digging Mode	OFF

2. Operate swing control lever fully.
3. Measure the time required to swing 3 turns in one direction. (Record the stopwatch measurement to the second decimal place.)
4. Operate swing control lever fully in the opposite direction and measure the time required for 3 turns.
5. Perform the measurement three times and calculate the average values.

Evaluation

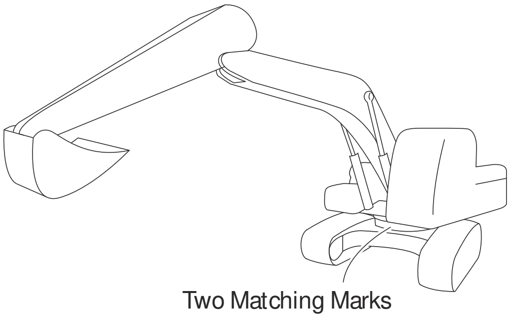
Refer to Operational Performance Standard Table on page 1-1.

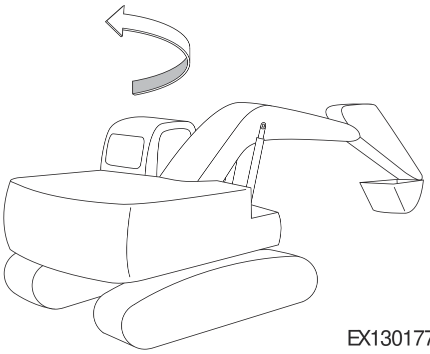
Swing Function Drift Check

Summary

Measure the swing drift on the bearing outer circumference when stopping after a 360° full-speed swing.

Preparation

1. Check the lubrication of the swing gear and swing bearing.
   Figure 54
   

2. Place the machine on flat, solid ground with ample space for swinging. Do not conduct this test on a slope.
3. With the bucket empty, position the front attachment as follow. With the arm cylinder fully retracted, and the bucket cylinder fully extended, raise the boom so bucket pin height is flush with the boom foot pin height.
4. Put the matching marks on the swing bearing and on the track frame by using a tape, as illustrated.
5. Swing the upper structure 360°.
   Figure 55
   

6. Maintain the hydraulic oil temperature at 50 ±5 °C (122 ±41 °F).

CAUTION

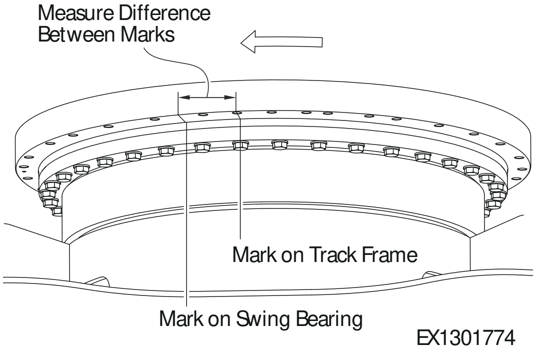
AVOID INJURY

Prevent personal injury. Always make sure that area is clear and that co-workers are out of the swing areabefore starting the measurement.

Measurement

1. Measurement conditions are as below.

   Figure 56



Engine Control Dial	Power Mode Switch	Work Mode	Auto-idle Switch
High Idle	Power Plus Mode	Digging Mode	OFF

2. Operate swing control lever fully and return it to the neutral position when the mark on upper structure aligns with that on track frame after swinging 360°.
3. Measure the time distance between the two marks.
4. Align the marks again, swing 360°, and then test in the opposite direction.
5. Perform the measurement three times and calculate the average values.

Evaluation

Refer to Operational Performance Standard Table on page 1-1.

Cylinder Creep

Summary

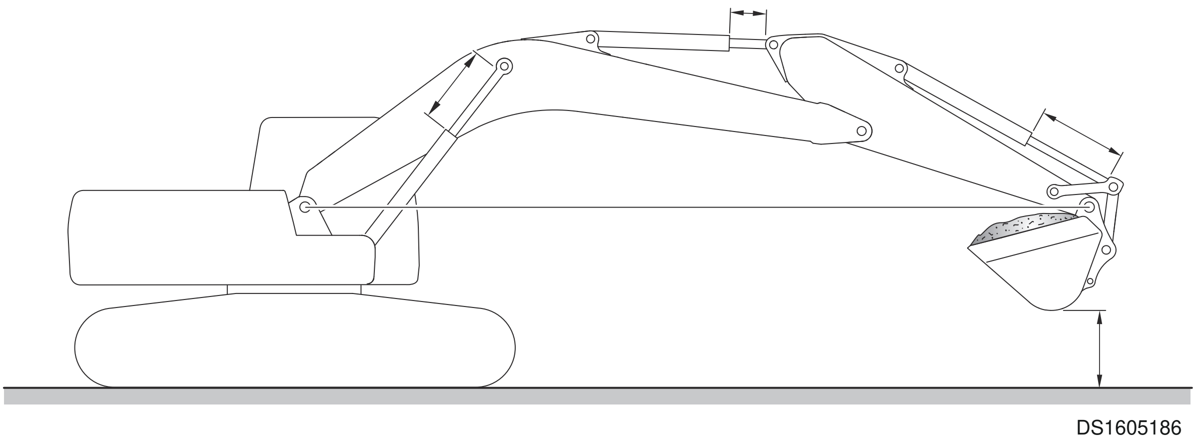
To define how to measure the drift of each cylinder installed on a excavator's front end and standards to evaluate the measurement.

Preparation

1. Record the model type of the front end mounted on the machine under test. The standard front end type is the basic option for testing.
2. Position the machine on a level ground with a gradient of 1% or below.
3. It is recommended to perform the test indoor but an outdoor test is also possible when conducted at a wind speed of 2 m/s or less.
4. The test should be performed at an ambient air temperature of 20°C (68°F) in principle, but all test results are considered valid as long as they have been made at a hydraulic oil temperature higher than the reference value.
5. Maintain the hydraulic oil temperature at 50 ±5°C (122 ±41°F).
6. Prepare a tapeline.
7. The machine's posture (Figure 11)
   A. Bucket weight: bucket capacity x 1.5 (soil)
   B. Position the arm cylinder with the rod 50 mm extended from the fully retracted position.
   C. Position the bucket cylinder with the rod 50 mm retracted from the fully extended position.

D. With the arm dump and bucket crowd, hold the bucket so that the height of the bucket pin is the same as the boom foot pin.

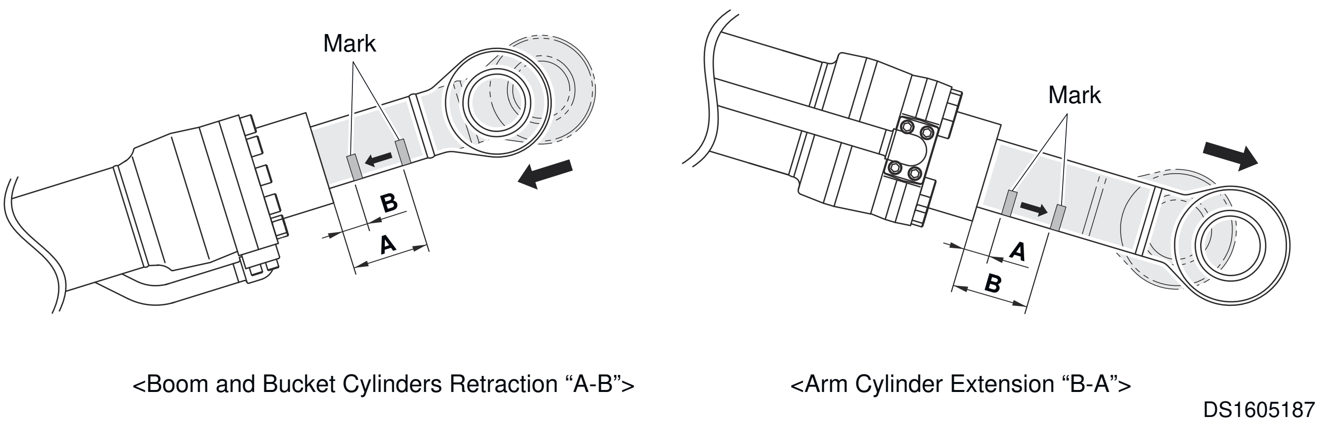
Figure 57



Measurement

1. Stop the engine.
2. Before measuring the drift of the cylinder, measure the temperatures of the hydraulic tank and cylinder tube.
3. Mark in appropriate location of the cylinder.
4. Measure the distance A.
5. Wait for 5 minutes.
6. Measure the distance B.
7. Drift value of the cylinder can be calculated as follows:
   - Boom and Bucket Cylinder: A - B
   - Arm Cylinder: B - A
8. After measuring the drift of the cylinder, measure the temperatures of the hydraulic tank and cylinder tube.

Figure 58



NOTE: *If the temperature of the hydraulic oil is found out of range for warming up (50 ±5°C/122 ±41°F) on the completion of the test, perform the test once again. And if the drift of a cylinder is measured to be high, measure its holding pressure.*

Evaluation

Refer to Operational Performance Standard Table on page 1-1.

Engine Specifications

Safety Instructions

WARNING

AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or servicing machine. Read and understand the Operation & Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or service. Untrained operators and failure to follow instructions can cause death or serious injury.

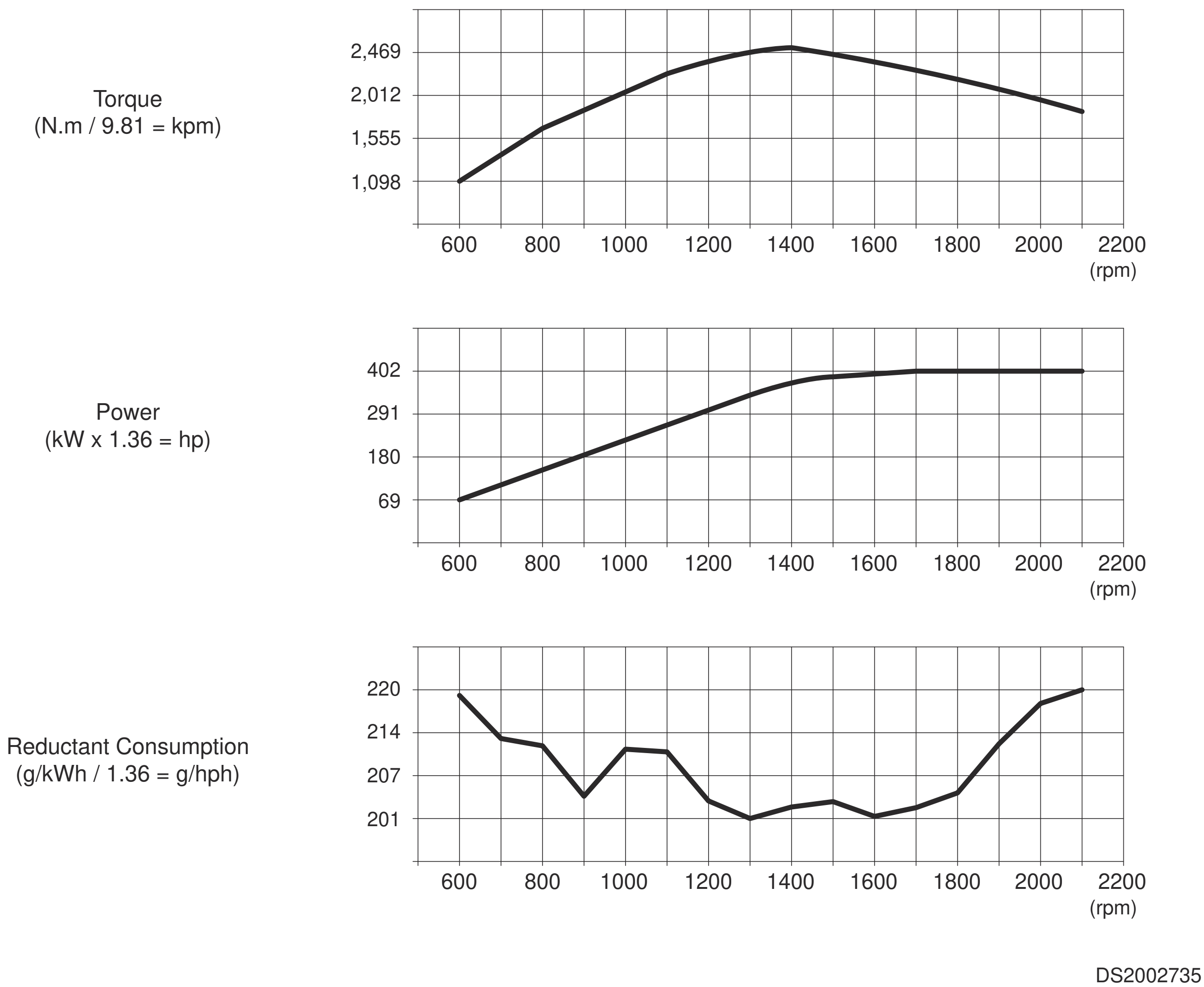
Engine Specification

Items		Specification
Engine	Rated Horse Power (ISO 14396, Gross)	402 kW (546.7 PS) @ 2,100 rpm
	Max. Torque	251.7 kg.m @ 1,400 rpm
	Fuel Consumption	219.9 g/kWh @ 2,100 rpm
	Type	Turbocharged after Water-cooled, MEUI Unit Injection
	Displacement	15.2 L
	No. Of Cylinder	6
	Bore Dia. & Stroke	Ø 137.2 X 171.4 mm
	Compression Ratio	17 : 1
	High Idle Speed	1,900 ±10 rpm
	Low Idle Speed	900 ±10 rpm
	Starting Motor	24 V x 9 kW
	Firing Order	1-5-3-6-2-4
	Rotation (Flywheel End)	Counterclockwise
Alternator	Voltage	24 V
	Rating Amperes	115 A
Battery	System Voltage	24 V
	Quantity	12 V x 2
	Capacity (AMP)	200 AH
Pump Drive	Drive Type	Flexible Coupling Joint
	Permissible Torque & rpm	540.8 kg.m, 2,500 rpm
Air Cleaner	Type	Double Element with Precleaner
	Filtration Area	16.5 m^2 (Outer), 2.58 m^2 (Inner)
	Size (Dia. x Length)	Ø 440.4 mm x 897.2 mm

Items			Specification
Muffler	Type		DOC + DPF + SCR
Fan	For Radiator	Type	Sucker, 8-blade, Plastic
		Size	Ø 1,168 mm
		At Rated Engine rpm	185 ~ 780 rpm (STD)
		Pulley Ratio	Controlled by Hydraulic Motor
	For Oil Cooler	Type	Sucker, 8-blade, Plastic
		Size	Ø 940 mm
		At Rated Engine rpm	240 ~ 1,020 rpm (STD)
		Pulley Ratio	Controlled by Hydraulic Motor
Radiator	Type		Corrugated Wave Fin
	Total Radiation Area		159.4 m^2
Oil Cooler	Type		Corrugated Wave Fin
	Total Radiation Area		100.94 m^2
Charge Air Cooler	Type		Corrugated Wave Fin
	Total Radiation Area		33.7 m^2
Fuel Cooler	Type		Corrugated Rouver Fin
	Total Radiation Area		1.92

Engine Performance Curves

Figure 59



Performance Standard	ISO 14396
Power (Max. Rated)	402 kW @ 2,100 rpm
Max. Torque	251.7 kg.m @ 1,400 rpm
Fuel Consumption (Max. Rated)	219.9 g/kWh

Tightening Torques

Normal Tightening Torque

The specifications in the tables below show the normal tightening torque for screws, nuts and unions. The values are to be used unless other values are specified in the inspection information. Always check whether there are special tightening torques given in the descriptions for the respective areas in the inspection information before using the general values for normal and special tightening torques respectively.

The following conditions apply:

- A tolerance of ±15 % applies to all values unless otherwise specified.
- All contact surfaces are to be clean and free of paint.
- Bolts and nuts are normally not lubricated regardless of surface treatment. All exceptions are specified in the inspection information.

Union Assemblies

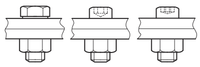
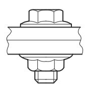
The specified values apply with a tolerance of ±5 %. The values apply to tightening with a counterhold.

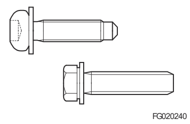
Thread Inserts

The specified tightening torques also apply to bolted joints with a thread insert (Heli-Coil).

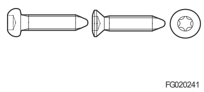
Thread inserts often provide greater strength compared to a directly screwed thread. This generates a stronger bolted joint in aluminium or the like.

NOTE: *When a damaged thread is repaired with a thread insert, the normal screw and prescribed tightening torque are to be maintained. Install the thread insert as instructed in the inspection information.*

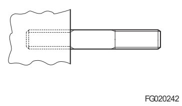
Hexagonal Screws, Hexagon Socket Screws, Six-point Socket Screws, Hexagon Nuts (Metric Thread, Course Pitch)		
Thread	**Strength Class 8.8/8 Tightening Torque (Nm)**	 FG020238
M4	2.4	
M5	5	
M6	8	
M8	20	
M10	39	
M12	70	
M14	112	
M16	180	
M18	240	
M20	350	
M22	490	
M24	600	
Flange Screws with Hexagonal Head and Hexagonal Flange Nuts (Metric Thread, Course Pitch)		
Thread	**Strength Class 8.8/8 Tightening Torque (Nm)**	 FG020239
M5	5.4	
M6	8.6	
M8	22	
M10	42	
M12	77	
M14	123	
M16	184	
Thread Forming Six-point Socket Screws and Hexagon Screws with Captive Washer (Modified Metric Thread, Course Pitch)		

Thread	Class 8	Class 10	
	Tightening Torque (Nm)		
M4	2.9	-	
M6	9.4	11	
M8	24	26	
M10	47	49	
M12	80	85	

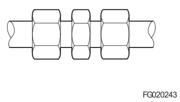
Thread Forming Six-point Socket Screws ST Thread

Thread	Tightening Torque (Nm)	
ST2.9	1.1	
ST3.5	1.9	
ST4.2	3.1	
ST4.8	4.5	
ST5.5	7.1	
ST6.3	9.7	

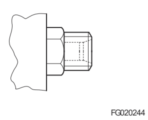
Stud Tap End in Threaded Hole, Strength Class 8.8/8 (Metric Thread, Course Pitch)

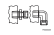
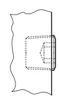
Tightening the stud tap end in the threaded hole must be done so the stud does not come loose when undoing the nut. To tighten the stud in the threaded hole, the torque must just overcome the friction in the thread and generate a preload. The torque for locking is 50% of the normal torque for hexagonal screws, hexagon socket screws, six-point socket screws, hexagon nuts.	

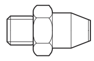
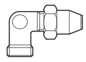
Union Nuts for Ferrule

Thread	Thread Tighteninue (±15% Nm)				
	For Pipe Diameter	Steel Pipe with Greased Steel Nut	Plastic Pipe with Steel Ferrule and Brass or Steel Nut	Plastic Pipe with Brass Ferrule and Nut with Rubber Seal	
M10x1	5	15	10	-	
M12x1.5	6	20	10	-	
M14x1.5	8	30	20	-	
M16x1.5	10	40	25	15	
M18x1.5	12	50	30	20	
M20x1.5	12	55	35	-	
M24x1.5	16	60	50	40	
M130x2	22	120	-	-	

Nuts for Lead-in Union

Thread	Thread Tightening Torque (±15% Nm)	
M12x1.5	20	
M14x1.5	25	
M16x1.5	35	

M18x1.5	50		
M24x1.5	70		
M130x2	80		
Unions with Tapered Thread for Port Connection			
Thread	Thread Tightening Torque (±15% Nm)	Tightening Torque (Nm)	
	Straight Unions	Elbow Unions	
M10x1k	10	8	
M12x1.5k	10	8	
M14x1.5k	15	10	
M16x1.5k	15	10	
M18x1.5k	20	15	
M20x1.5k	25	20	
M22x1.5k	25	20	
M26x1.5k	45	40	
Unions, Plugs and Banjo Screws with Cylindrical Threads for Seal with Flat Copper Gasket			
Thread	Thread Tightening Torque (±15% Nm)		
M8x1	10		
M10x1	20		
M12x1.5	20		
M14x1.5	25		
M16x1.5	30		
M18x1.5	35		
M20x1.5	45		
M22x1.5	50		
M24x1.5	60		
M26x1.5	70		
M28x1.5	80		
M30x1.5	110		
M30x2	115		
M32x1.5	115		
M36x1.5	160		
M38x1.5	170		
M45x1.5	270		
Plugs with Tapered Thread			
Thread	Thread Tightening Torque (±15% Nm)		 FG020247
M10x1k	15		
M12x1.5k	20		

M14x1.5k	20		
M16x1.5k	25		
M18x1.5k	40		
M20x1.5k	40		
M22x1.5k	40		
M26x1.5k	60		
Insert Connections for Port Connection			
Thread	**Thread Tightening Torque (±15% Nm)**		 FG020248
M10x1k	18		
M12x1.5k	24		
M14x1.5k	28		
M16x1.5k	35		
M22x1.5k	40		
Insert Connections for Union Connection			
Thread	**For pipe Diameter**	**Thread Tightening Torque (±15% Nm)**	 FG020249
M14x1.5k	4-8	10	
M18x1.5k	12	15	
M24x1.5k	16	25	

Hydraulic Systems And Structure Specifications

Safety Instructions

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or servicing machine. Read and understand the Operation & Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or service. Untrained operators and failure to follow instructions can cause death or serious injury.

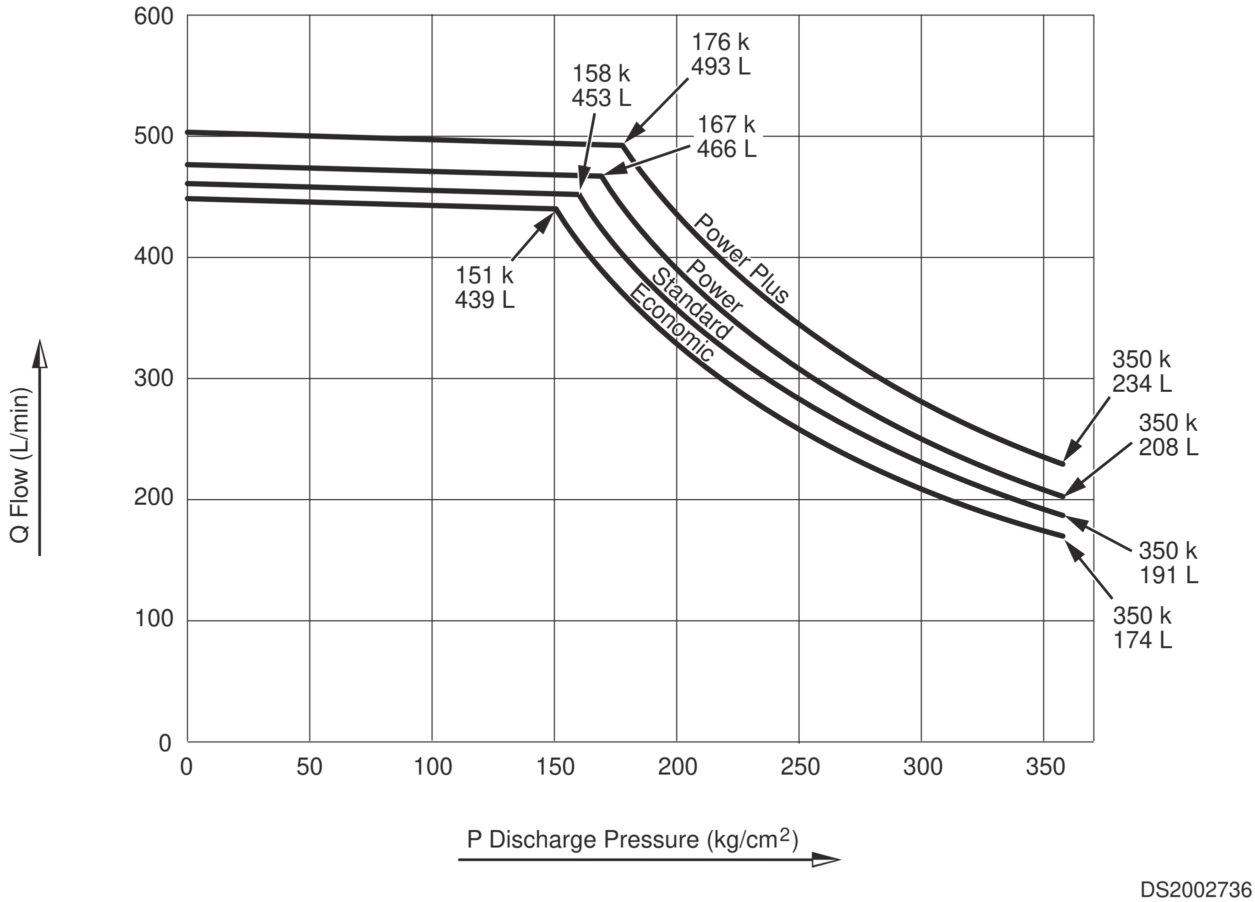
Hydraulic System

Main Pump

Type	Tandem, Axial Piston
Quantity	2
Displacement	280 x 2 cc/rev
Max. Flow Rate	2 x 504 Liter/min @ 100 bar, 1,800 rpm
Weight	316 kg (697 lb)

Performance Curves

Figure 60



Mode	Input	
	rpm	PS
Power Plus	1,800	446
Power	1,700	400
Standard	1,650	368
Economy	1,600	337

Pilot Pump

Type	Gear
Displacement	28 cc/rev
Reduction Ratio	1 : 1
Max. Flow Rate	50.4 Liter/min
Max. Pressure	210 bar (214 kg/cm^2)

Main Control Valve (8 - M8)

Type	Pilot Control
Spool Dia.	Ø 40 mm

Spool Arrangement	Boom 1, Bucket 1, Travel L, Arm 1, Bucket 2, Travel R, Option, Arm 2
Relief Valve Pressure	350 bar (357 kg/cm^2)
Port Relief Valve Pressure	370 bar (377 kg/cm^2) @ 10 Liter/min
Accessary Valves	By-pass Cut Valve, Travel Straight
Weight	490 kg (1,080 lb)

Main Control Valve (2 - MO)

Type	Pilot Control
Spool Dia.	Ø 40 mm
Spool Arrangement	Swing, Boom 2
Relief Valve Pressure	350 bar (357 kg/cm^2)
Port Relief Valve Pressure	370 bar (377 kg/cm^2)
Weight	70 kg (154 lb)

Remote Control Valve; Work / Swing

Type	Pilot, 1-Stage, 3-Button
P vs Stroke Characteristic	6.9 bar (7.0 kg/cm^2) @ 1.0 mm 27.5 bar (28.0 kg/cm^2) @ 6.5 mm
Weight	2.4 kg (5.3 lb)

Remote Control Valve; Travel

Type	Pilot, 1-Stage, With Damper
P vs Stroke Characteristic	7.4 bar (7.5 kg/cm^2) @ 1.0 mm 24.5 bar (25.0 kg/cm^2) @ 4.3 mm
Weight	7.8 kg (17.2 lb)

Package Solenoid Valve

Type	DC 24V, 8-Solenoid Valve
Function	Safety Cut Off 1/2, Free Boom Up, Straight Travel, Travel High Speed, Swing Brake Release, Hammer Operating, Hammer/ Shear Select
Weight	10 kg (22 lb)

Remote Control Manifold

Type	DC 24V, 4-EPPRV
Max. Input Pressure	100 bar (102 kg/cm^2)
Max. Control Pressure	30 bar (31 kg/cm^2)
Weight	6.8 kg (15 lb)

Accumulator

Nitrogen Charge Pressure	10 bar (10 kg/cm^2) @ 20°C
Volume	0.75 Liter
Quantity	2
Weight	2.8 kg (6.2 lb)

By-pass Valve

By-pass Valve (C1)	Size	2-Inch
	Cracking Pressure	2 bar (2 kg/cm^2) @ 10 Liter/min
By-pass Valve (C2)	Size	2-Inch
	Cracking Pressure	5 bar (5 kg/cm^2) @ 10 Liter/min

Fan Drive Pump

Type	Axial Piston
Displacement	45 cc/rev
Max. Setting Pressure	250 bar (255 kg/cm^2)
Direction Of Rotation	Counter-Clockwise
Weight	21 kg (47 lb)

Fan Motor (Radiator)

Type	Axial Piston
Displacement	58 cc/rev
Max. Setting Pressure	280 bar (286 kg/cm^2)
Direction of Rotation	Reversible
Weight	24 kg (53 lb)

Fan Motor (Oil Cooler)

Type	Axial Piston
Displacement	45 cc/rev
Max. Setting Pressure	280 bar (286 kg/cm^2)
Direction of Rotation	Reversible
Weight	17.4 kg (38.4 lb)

Boom Lock Valve

Type	Pilot Control
Spool Dia.	Ø 25 mm
Quantity	2
Relief Valve Pressure	370 bar (377 kg/cm^2)

Weight	41.5 kg (91.5 lb)

Arm Lock Valve

Type	Pilot Control
Spool Dia.	Ø 32 mm
Relief Valve Pressure	370 bar (377 kg/cm^2)
Weight	49 kg (108 lb)

Hydraulic Filters

Return Filter	Filter Material	Glass Fiber
	Quantity	2
	Filtration Area (Size)	2.9 m^2 (Ø 172 x 450 mm)
	Filtration Efficiency & Rating	99.5 % (β10 = 200), 10 μ
	By-pass Cracking Pressure	1.5 bar (1.5 kg/cm^2) @ 40 Liter/min
Pilot Filter	Filter Material	Synthetic Fiber
	Quantity	1
	Filtration Size	Ø 70.6 x 157 mm
	Filtration Efficiency & Rating	99.5 % (β10 = 200), 10 μ
	By-pass Cracking Pressure	3.5 bar (3.5 kg/cm^2)
Drain Filter	Filter Material	Synthetic Fiber
	Quantity	2
	Filtration Size	□ 70.6 x 243 mm
	Filtration Efficiency & Rating	99.5 % (β10 = 200), 10 μ
	By-pass Cracking Pressure	1.7 bar (1.7 kg/cm^2)
Suction Strainer	Filtration Size	0.54 m^2 (□ 200 x 190 mm)
	Filtration Rating	177 μ (80 mesh)

Air Breather

Type	Parer Element
Cracking Pressure	0.45 bar (0.46 kg/cm^2) @ 1 Liter/min
Vacuum Relief Pressure	0.04 ~ 0.05 bar @ 1 Liter/min
Filtration Efficiency & Rating	99.5 % (β10 = 200), 10 μ
Filtration Size	590 cm^2 (Ø 45 x 67 mm)

Swing Mechanism

Swing Motor

Type	Axial Piston
Displacement	2 x 240 cc/rev
Crossover Relief Valve Setting	294 bar (300 kg/cm^2)
Max. Supply Flow	504 Liter/min @ 1,800 rpm
Motor Shaft Speed	1,050 rpm
Motor Shaft Torque	2 x 113.1 kg.m (2 x 1,109 N.m)
Accessary Valves	Swing Reactionless Valve

Swing Reduction Gear

Drive Type	2-Stage Planetary Gear
Reduction Ratio	19.565
Max. Output Speed	53.7 rpm
Max. Output Torque	2 x 2,212 kg.m (2 x 21.692 kN.m)
Weight (Included Motor)	2 x 470.5 kg (1,037 lb)

Pinion Gear

Type	Spur Gear
Gear P.C.D.	Ø 196 mm
No. Of Teeth	14
Module	14

Swing Bearing

Type	Cross Roller Bearing, Internal Gear
Gear P.C.D.	Ø 1,400 mm
No. Of Teeth	100
Ball Dia.	Ø 54 x 54L mm
Race O.D.	Ø 1,815 mm
Race Height	138 mm
Static Thrust Load	65,037.6 kg

Swing Performance

Max. Swing Speed (Theoretical)	7.5 rpm
Max. Swing Speed (EFF. = 0.98)	7.4 rpm
Max. Swing Torque (Theoretical)	31,600 kg.m (310 kN.m)
Max. Swing Torque (EFF. = 0.81)	25,600 kg.m (251 kN.m)

Parking Brake

Control Type	Pilot Pressure, Mechanical
Brake Torque	134 kg.m (1,341 N.m)
Brake Release Pressure	23 bar (23 kg/cm^2)

Motor Accessary

Select V/V Cracking Pressure	6 bar (6 kg/cm^2)
Brake Time Delayer	6.5 sec

Travel System

Travel Motor

Type	Axial Piston, 2-Speed
Displacement	337.2 / 205.2 cc/rev
Crossover Relief Valve Setting	368 bar (375 kg/cm^2) @ 120 L/min
Max. Supply Flow	504 Liter/min @ 1,800 rpm
Motor Shaft Speed	1,495 / 2,456 rpm
Motor Shaft Torque	187.8 / 114.3 kg.m (1,841 / 1,121 N.m)
Weight	134 kg (295 lb)

Travel Reduction Gear

Type	3-Stage Planetary Gear
Reduction Gear Ratio	1 : 94.6
Max. Output Speed	26 / 15.8 rpm
Max. Output Torque	17,769 / 10,813 kg.m (173 / 106 kN.m)
Weight	660 kg (1,455 lb)

Sprocket

Sprocket P.C.D.	Ø 1,005.915 mm
Track Link Pitch	260.35 mm
No. of Teeth	12

Traveling Performance

Max. Swing Speed (Theoretical)	4.9 / 3.0 km/hr
Max. Swing Speed (EFF. = 0.98)	4.8 / 2.9 km/hr
Max. Swing Torque (Theoretical)	70.7 / 43.0 ton. (693 / 422 kN.m)
Max. Swing Torque (EFF. = 0.81)	54.4 / 33.1 ton. (533 / 325 kN.m)
Gradeability	35° (70%)

Parking Brake

Control Type	Main Pressure, Mechanical
Brake Torque	142.8 kg.m (1,400 N.m)
Brake Release Pressure	18 bar (18.4 kg/cm^2)

Under Carriage

Recoil Mechanism

Type	Hydraulic Adjusted
Recoil Spring Preload	49,986 kg
Recoil Spring Max. Load	69,008 kg
Recoil Spring Stroke	100 mm
Adjuster Type	Grease Cylinder

Rollers; Lower

Flange Type	Single
Q'ty Per Side	8
Dia. (Flange / Rail)	Ø 280 / 240 mm

Rollers; Upper

Flange Type	Single
Q'ty Per Side	3
Dia. (Flange / Rail)	Ø 224 / 190 mm

Front Idler

Type	Fabrication
Dia. (Flange / Rail)	Ø 818 / 770 mm

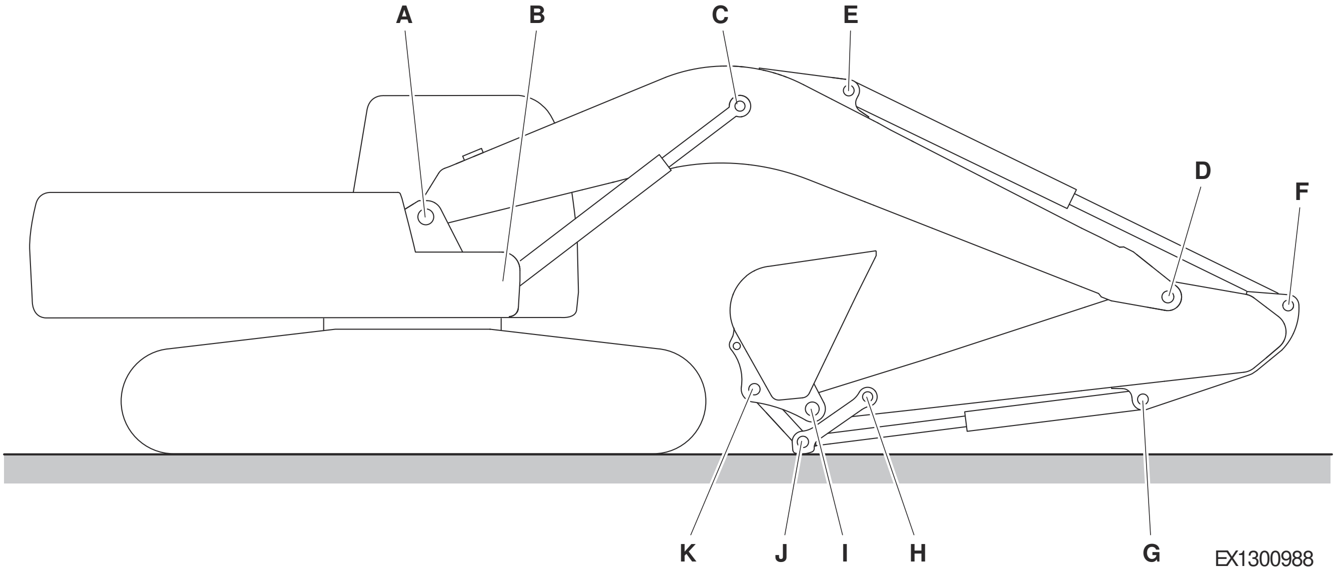
Track Link

No. of Link Per Side	48
Link Pitch	260.35 mm
Pin Dia.	Ø 57.15 mm
Bush Dia.	Ø 85.725 mm
Track Gauge (Retracted)	2,750 mm (STD)
Track Gauge (Extended)	3,350 mm (STD)
Tumbler Distance	4,730 mm

Structure

Front Link Pin Sizes

Figure 61



Point	Measuring Part	Dia.	Length
A	Boom Foot	140 mm (5.512")	369 mm (14.528")
B	Boom Cylinder Head	130 mm (5.118")	361 mm (14.213")
C	Boom Center	130 mm (5.118")	1,216 mm (47.874")
D	Boom End	140 mm (5.512")	769 mm (30.276")
E	Arm Cylinder Head	130 mm (5.118")	360 mm (14.173")
F	Arm Cylinder Rod	130 mm (5.118")	360 mm (14.173")
G	Bucket Cylinder Head	130 mm (5.118")	360 mm (14.173")
H	Arm Link	110 mm (4.331")	622 mm (24.488")
I	Arm End	140 mm (5.512")	733 mm (28.858")
J	Bucket Cylinder Rod	140 mm (5.512")	734 mm (28.898")
K	Push Link to Bucket	140 mm (5.512")	733 mm (28.858")

General Maintenance Instructions

Safety Instructions

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or servicingmachine. Read and understand the Operation & Maintenance Manual and signs (decals) on machine. Followwarnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correctfunction after adjustments repairs or service. Untrainedoperators and failure to follow instructions can cause deathor serious injury.

Welding Precautions and Instructions

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

To avoid accidents, personal injury and the possibility of causing damage to the machine or to components, welding must only be performed by properly trained and qualified personnel, who possess the correct certification (when required) for the specific welding fabrication or specialized repair being performed.

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

Structural elements of the machine may be built from a variety of steels. These could contain unique alloys or may have been heat-treated to obtain particular strength characteristics. It is extremely important that welding repairs on these types of steel are performed with the proper procedures and equipment. If repairs are performed incorrectly, structural weakening or other damage to the machine (that is not always readily visible) could result. Always consult After Sales Service before welding on integral components (loader arm, frames, car body, track frames, upper structure, attachment, etc.) of the machine. It is possible that some types of structurally critical repairs may require Magnetic Particle or Liquid Penetration testing, to make sure there are no hidden cracks or damage, before the machine can be returned to service.

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

Always perform welding procedures with proper safety equipment and adequate ventilation in a dry work area. Keep a fire extinguisher near and wear personal protective equipment.

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

Observe the following safety instructions:

1. Use adequate safety shielding and keep away from fuel and oil tanks, batteries, hydraulic piping lines or other fire hazards when welding.
2. Never weld when the engine is running. Battery cables must be disconnected before the welding procedure is started.
3. Never weld on a wet or damp surface. The presence of moisture causes hydrogen embrittle and structural weakening of the weld.
4. If welding procedures are being performed near cylinder rods then, operator's cabin window areas or any other assemblies could be damaged by weld spatters. Use adequate shielding protection in front of the assembly.
5. During welding equipment setup, always attach ground cables directly to the area or component being welded to prevent arcing through bearings, bushings, or spacers.
6. Always use correct welding rods for the type of weld being performed and observe recommended precautions and time constraints. AWS Class E7018 welding rods for low alloy to medium carbon steel must be used within two hours after removal from a freshly opened container. Class E11018G welding rods for T-1 and other higher strength steel must be used within 1/2 hour of removal from a freshly opened container.

Hydraulic System - General Precautions

Always maintain oil level in the system at recommended levels. Assemblies that operate under heavy loads, at high-speed, with extremely precise tolerances between moving parts (e.g. pistons and cylinders, or shoes and swash plates), can be severely damaged if oil supply runs dry.

Assemblies can be run dry and damaged severely in a very short time when piping or hoses are disconnected to repair leaks and/or replace damaged components. Hoses that are inadvertently switched during disassembly (inlet for outlet and vice versa), air introduced into the system or assemblies that are low on oil because of neglect or careless maintenance, could all produce sufficient fluid loss to cause damage or improper operation.

When starting the engine (particularly after long layoff or storage intervals), make sure that all hydraulic controls and operating circuits are in neutral, or "OFF". That will prevent pumps or other components that may be temporarily oil starved from being run under a load.

Replacement of any hydraulic system component could require thorough cleaning, flushing, and some amount of prefilling with fresh, clean oil if the protective seal on replacement parts has obviously been broken or if seal integrity may have been compromised. When protective seals are removed before installation and reassembly, inspect all replacement parts carefully, before they are installed. If the replacement part shows no trace of factory prelube or has been contaminated by dirt or by questionable oils, flushing and prefilling with clean hydraulic fluid is recommended.

Vibration, irregular or difficult movement or unusual noise from any part of the hydraulic system could be an indication of air in the system (and many other types of problems). As a general precaution (and to help lessen the risk of potential long-term damage), allow the engine to run at no-load idle speed immediately after initial start-up. Hydraulic fluid will circulate, releasing any air that may have been trapped in the system before load demands are imposed.

Before starting the machine, a daily walk-around safety inspection, including a quick visual inspection for any exterior evidence of leaking hydraulic fluid, can help extend the service life of system components.

NOTICE

Hydraulic system operating conditions (repetitive cycling,heavy workloads, fluid circulating under high-pressure)make it extremely critical that dust, grit or any othercontamination be kept out of the system. Observe fluid andfilter change maintenance interval recommendations andalways preclean any exterior surface of the system before itis exposed to air. For example, the reservoir fill cap andneck area, hoses that have to be disassembled, and thecovers and external surfaces of filter canisters should all becleaned before disassembly.

Maintenance Service and Repair Procedure

General Precautions

Fluid level and condition should always be checked whenever any other maintenance service or repair is being performed.

NOTE: *If the unit is being used in an extreme temperature environment (in subfreezing climates or in high temperature, high humidity tropical conditions), frequent purging of moisture condensation from the hydraulic reservoir drain tap must be a regular and frequent part of the operating routine. In more moderate, temperate climates, draining reservoir sediment and moisture may not be required more than once or twice every few months.*

Inspect drained oil and used filters for signs of abnormal coloring or visible fluid contamination at every oil change. Abrasive grit or dust particles will cause discoloration and darkening of the fluid. Visible accumulations of dirt or grit could be an indication that filters are overloaded (and will require more frequent replacement) or that disintegrating bearings or other component failures in the hydraulic circuit may be imminent or have already occurred. Open the drain plugs on the main pump casings and check and compare drain oil in the pumps. Look for evidence of grit or metallic particles.

Vibration or unusual noise during operation could be an indication of air leaking into the circuit (Refer to the appropriate Troubleshooting section for component or unit for procedures.), or it may be evidence of a defective pump. The gear type pilot pump could be defective, causing low pilot pressure, or a main pump broken shoe or piston could be responsible.

NOTE: *If equipped, indicated operating pressure, as shown on the multidisplay digital gauge on the Instrument Panel ("F-Pump" and "R-Pump") will be reduced because of a mechanical problem inside the pump. However, pressure loss could also be because of cavitation or air leakage, or other faults in the hydraulic system.*

Check the exterior case's oil drain line in the main pumps. If no metallic particles are found, make sure there is no air in the system. Unbolt and remove tank return drain line from the top part of the swing motor, both travel motors and each main pump. If there is air in any one of the drain lines, carefully prefill the assembly before bolting together the drain line piping connections. Run the system at low rpm.

Hydraulic System Cleanliness and Oil Leaks

Maintenance Precautions for Hydraulic System Service

Whenever maintenance, repairs or any other troubleshooting or service is being performed, it's important to remember that hydraulic system - including both the interior and exterior surfaces of assemblies, and every drop of operating fluid - must be protected from contamination.

Dust and other foreign contaminants are major contributors to premature wear in hydraulic circuits. The narrow tolerances, rapidly moving parts and high operating pressures of the system require that fluid be kept as clean as possible. The performance and dependability of the machine (and the service life of individual components) can be noticeably reduced if proper precautions are not observed:

- Use a noncombustible, evaporative type, low residue solvent and thoroughly clean exterior surfaces of assemblies before any part of the circuit is opened or disassembled.

  NOTE: *It's just as important to clean the cap and reservoir top before routine fluid changes or quick checks as it is before major repairs. (Accumulated dirt attracts moisture, oil and other fluids - and more dirt.)*

- Keep dismantled parts covered during disassembly. Use clean caps, plugs or tape to protect the disconnected openings of flanges, manifolds and piping.
- Do not allow cleaning solvents or other fluids to mix with the oil in the system. Use clean oil to flush any traces of solvent or other residue before reassembly.
- If metal or rubber fragments are found in the system, flush and replace all fluid in the system and troubleshoot the circuit to identify the source of contamination.

NOTICE

Make sure that cleaning solvents will be compatible withrubber materials used in the hydraulic system. Manypetroleum based compounds can cause swelling,softening, or other deterioration of system sealingelements, such as O-rings, caps and other seals.

Oil Leakage Precautions

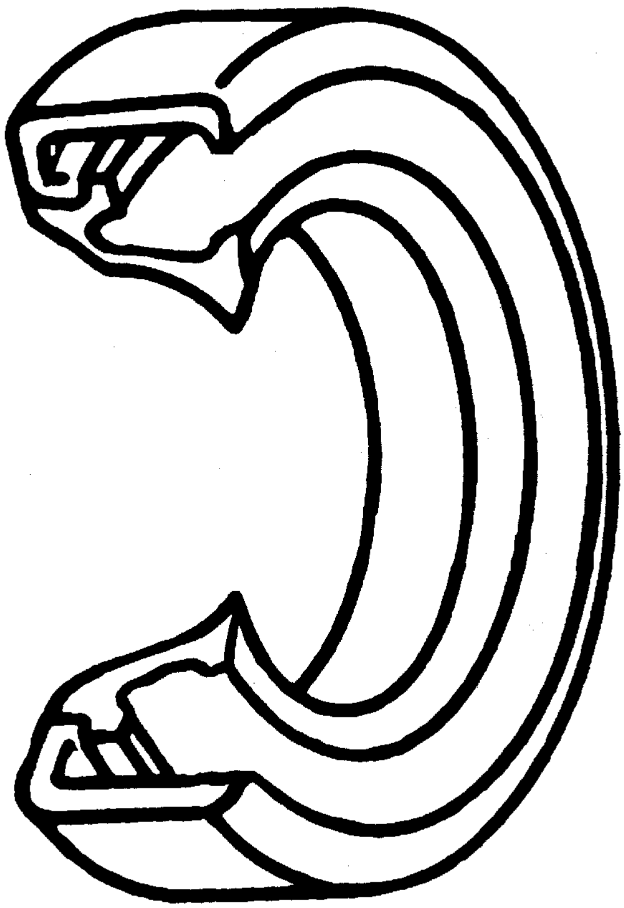
Oil that is visibly seeping from joints or seals should always serve as a "red flag" alarm.

Leaks must alert the machine operator and maintenance crew that air, water and dirt have an open, free passageway through which to enter the circuit. Corrosive salt air, freezing and thawing condensation cycles and working environments that are full of fine dust are especially hazardous. Clogging of valve spools or external piping (especially pilot circuit piping) can gradually diminish or suddenly put a stop to normal hydraulic function. You can prevent having to make these types of repairs by the following recommended assembly procedures:

1. Use new O-rings and oil seals whenever hydraulic assemblies are rebuilt.
2. Prepare joint surfaces before assembly by checking alignment and flatness. Clean and repair corrosion or any other damage.

3. Follow bolt torque recommendations and all other assembly requirements.

Figure 62



0565A

NOTE: *Grease lip seals before assembly.*

Cleaning and Inspection

General Instructions

All parts must be clean to permit an effective inspection. During assembly, it is very important that no dirt or foreign material enters unit being assembled. Even minute particles can cause malfunction of close installed parts such as thrust bearing, matched parts, etc.

WARNING

AVOID DEATH OR SERIOUS INJURY

Do not inhale vapors or allow solvent type cleaners tocontact skin. Keep solvent away from open flame, arcs orsparks or other sources of ignition that could start a fire.

1. Clean all metal parts thoroughly using a suitable cleaning fluid. It is recommended that parts be immersed in cleaning fluid and moved up and down slowly until all oils, lubricants, and/or foreign materials are dissolved and parts are thoroughly clean.
2. For bearings that can be removed, soak them in a suitable cleaning fluid for a minute or two, then remove bearings from cleaning fluid and strike flat against a block of wood to dislodge solidified particles of lubricant. Immerse again in cleaning fluid to flush out particles. Repeat above operation until bearings are thoroughly clean. To dry bearings, use moisture-free compressed air. Be careful to direct airstream across bearing to avoid spinning bearings that are not lubricated.

DO NOT SPIN BEARINGS WHEN DRYING; bearings may be rotated slowly by hand to facilitate drying process.

3. Carefully inspect all bearing rollers, cages and cups for wear, chipping or nicks to determine condition. Do not replace a bearing cone or cup individually without replacing mating cup or cone at the same time. After inspection, dip bearings in lightweight oil and wrap in clean lintless cloth or paper to protect them until installation.

   For those bearings that are to be inspected in place; inspect bearings for roughness of rotation, scoring, pitting, cracked or chipped races. If any of these defects are found, replace bearings. Also, inspect defective bearing housing and/or shaft for grooved, galled or burred conditions that indicate bearing has been turning in its housing or on its shaft.

4. It is more economical to replace oil seals, O-rings, sealing rings, gaskets and retaining rings when unit is disassembled than waiting for premature failures; refer to latest Micro Fiche and/or Parts Book for replacement items. Be careful when installing sealing members, to avoid cutting or scratching. Curling under of any seal lip will seriously impair its efficiency. Apply a thin coat of Loctite #120 to outer diameter of metal casing and on oil seals to assure an oil tight install into retainer. Use extreme care not to get Loctite on lips of oil seals. If this happens, that portion of the seal will become brittle and allow leakage.

   When replacing lip type seals, make sure spring loaded side is towards oil to be sealed.

5. If available, use magna-flux or similar process for checking for cracks that are not visible. Examine teeth on all gears carefully for wear, pitting, chipping, nicks, cracks or scores. Replace all gears showing cracks or spots where case-hardening has worn through. Small nicks may be removed with suitable hone. Inspect shafts and quills to make certain they have not been sprung, bent, or no twisted splines, and that shafts are normal condition.

   NOTE: *Spline wear is not considered detrimental except where it affects tightness of splined parts.*

   Inspect thrust washers for distortion, scores, burs, and wear. Replace thrust washer if defective or worn.

6. Inspect bores and bearing surfaces of cast parts and machined surfaces for scratches, wear, grooves and dirt. Remove any scratches and burrs with crocus cloth. Remove foreign material. Replace any parts that are deeply grooved or scratched which would affect their operation.

Bearing Inspection

The conditions of the bearing are vital to the smooth and efficient operation of the machinery. When any component containing bearings is disassembled, always carefully examine the condition of the bearings and all of its components for wear and damage.

Once the bearing is removed, clean all parts thoroughly using a suitable cleaning solution. If the bearing is excessively dirty, soak the bearing assembly in a light solution and move the bearing around until all lubricants and/or foreign materials are dissolved and the parts are thoroughly clean.

When drying bearings, moisture free compressed air can be used. Be careful not to direct the air in a direction which will force the bearing to dry spin while not being properly lubricated.

After the bearings have been cleaned and dried, carefully inspect all bearing rollers, cages and cups for wear, chipping or nicks. If the bearing cannot be removed and is to be inspected in place, check for roughness of rotation, scoring, pitting, cracked or chipped races. If any of these defects are found replace the whole bearing assembly. NEVER replace the bearing alone without replacing the mating cup or the cone at the same time.

After inspection lightly coat the bearing and related parts with oil and wrap in a clean lintless cloth or paper and protect them from moisture and other foreign materials until installation.

It is also important to inspect the bearing housing and/or shaft for grooved, galled or burred conditions that indicate the bearing has been turning in its housing or on its shaft.

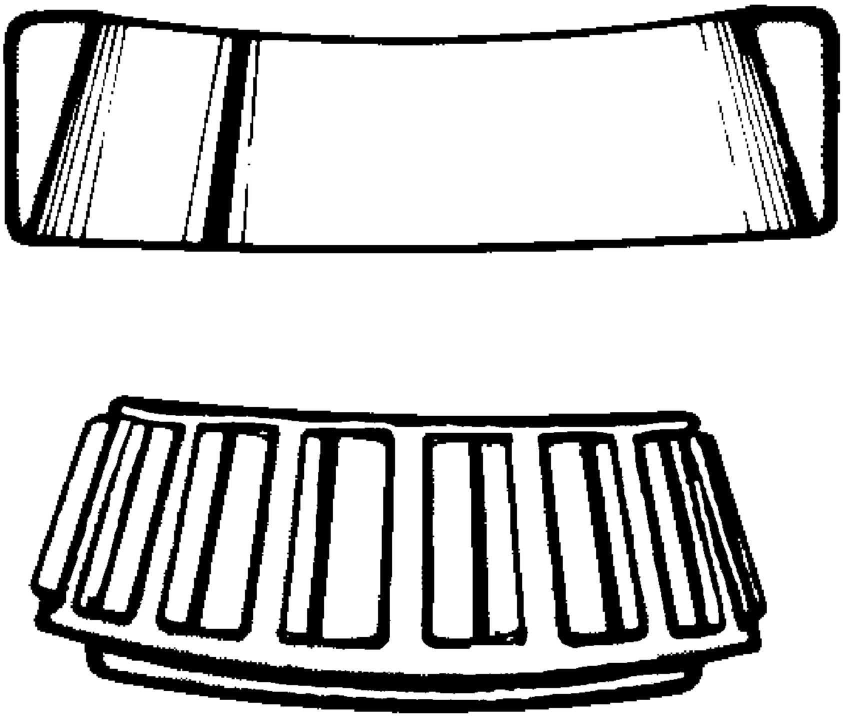
If available, use magna-flux or similar process for checking for cracks that are not visible.

The following illustrations will aid in identifying and diagnosing some of the bearing related problems.

NOTE: *The illustrations will only show tapered roller bearings, but the principles of identifying, diagnosing and remedying the defects are common to all styles and types of bearings.*

Normal Bearing

Figure 63

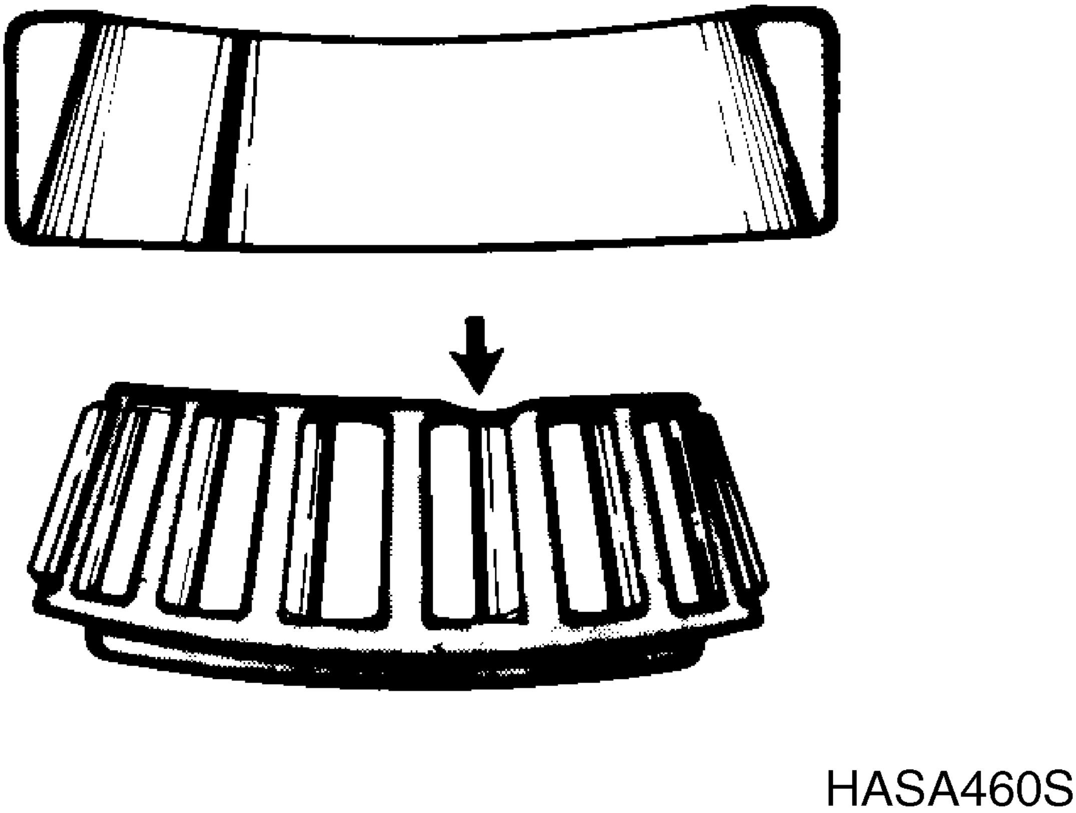


HASA620S

Smooth even surfaces with no discoloration or marks.

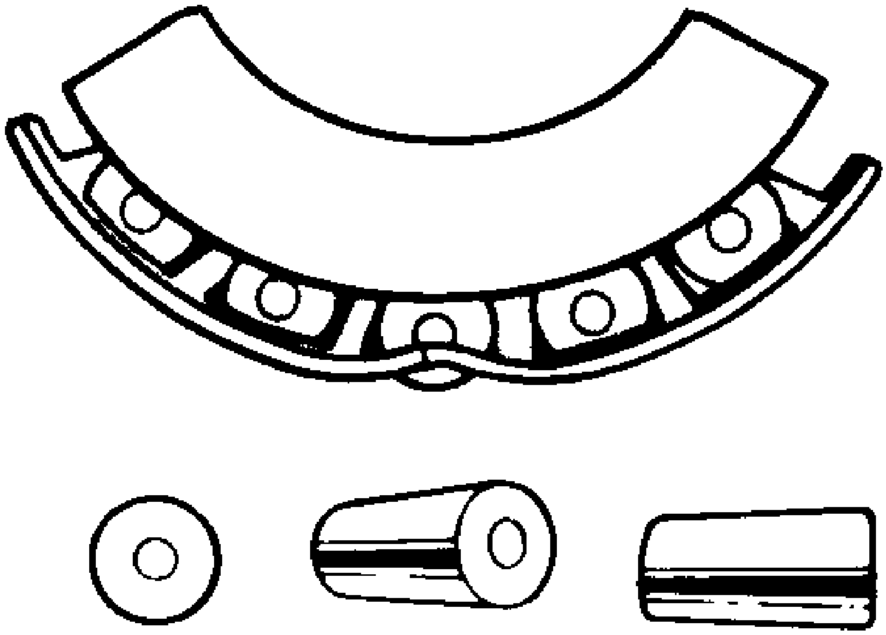
Bent Cage

Figure 64



Cage damage because of improper handling or tool usage.

Figure 65

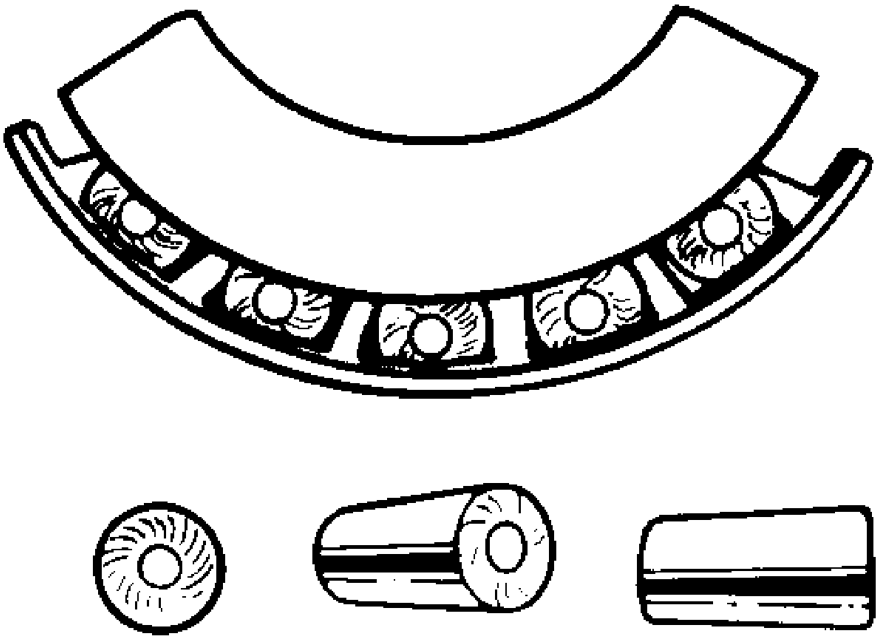


HASA470S

Replace bearing.

Galling

Figure 66



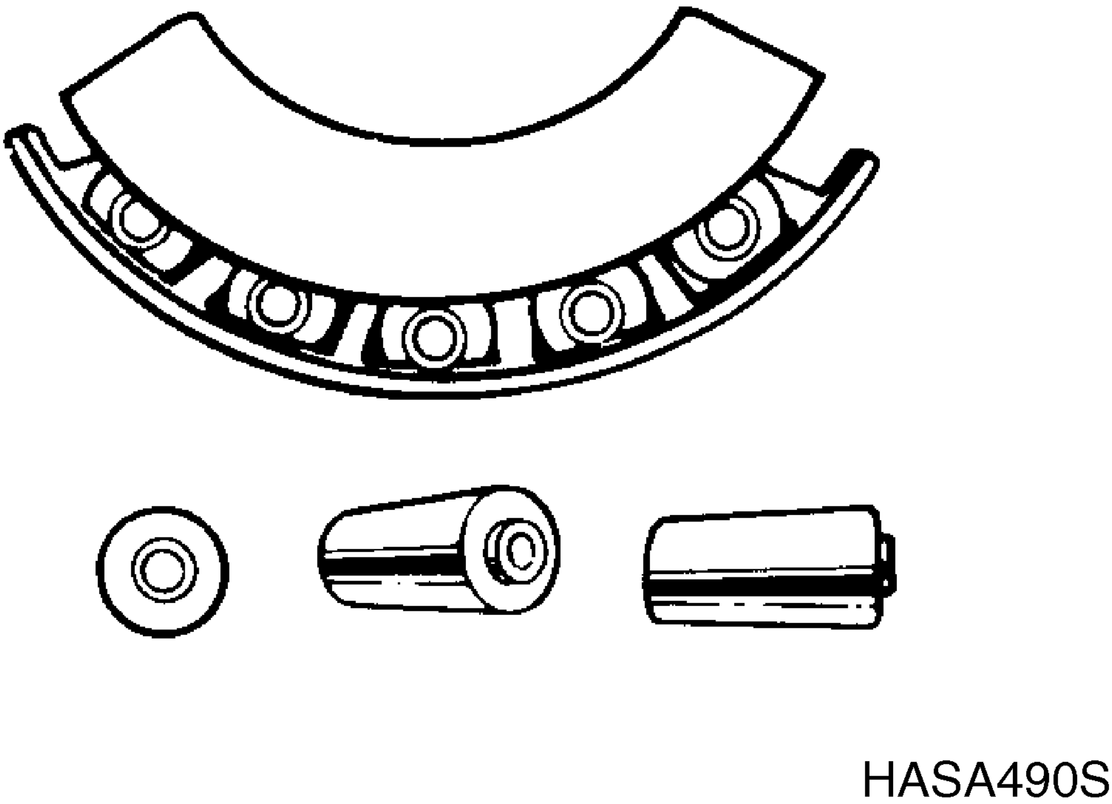
HASA480S

Metal smears on roller ends because of overheat, lubricant failure or overload.

Replace bearing - check seals and check for proper lubrication.

Abrasive Step Wear

Figure 67

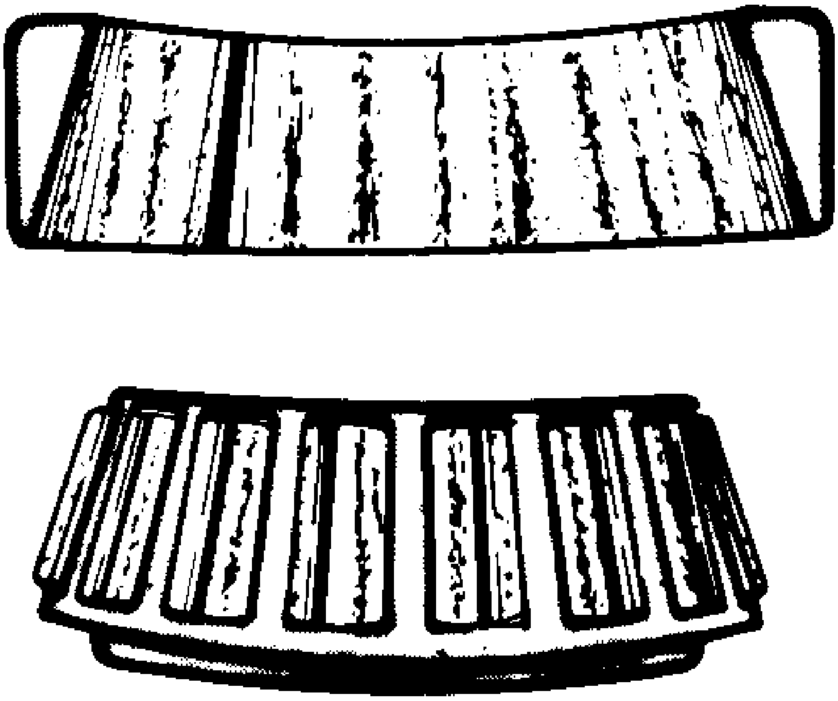


Pattern on roller ends caused by fine abrasives.

Clean all parts and housings, check all parts and housings, check seals and bearings and replace if leaking, rough or noisy.

Etching

Figure 68



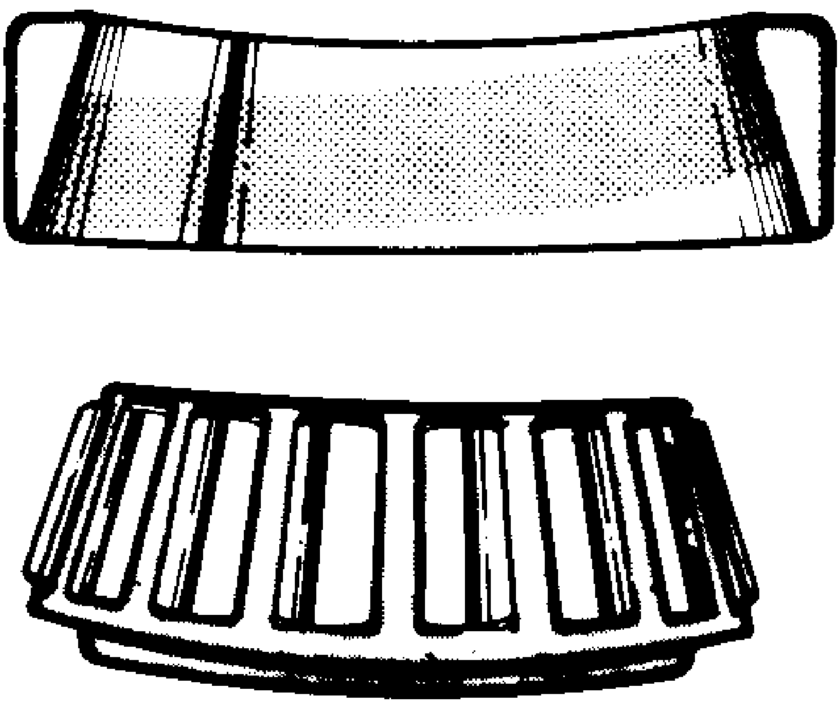
HASA500S

Bearing surfaces appear gray or grayish black in color with related etching away of material usually at roller spacing.

Replace bearings - check seals and check for proper lubrication.

Misalignment

Figure 69



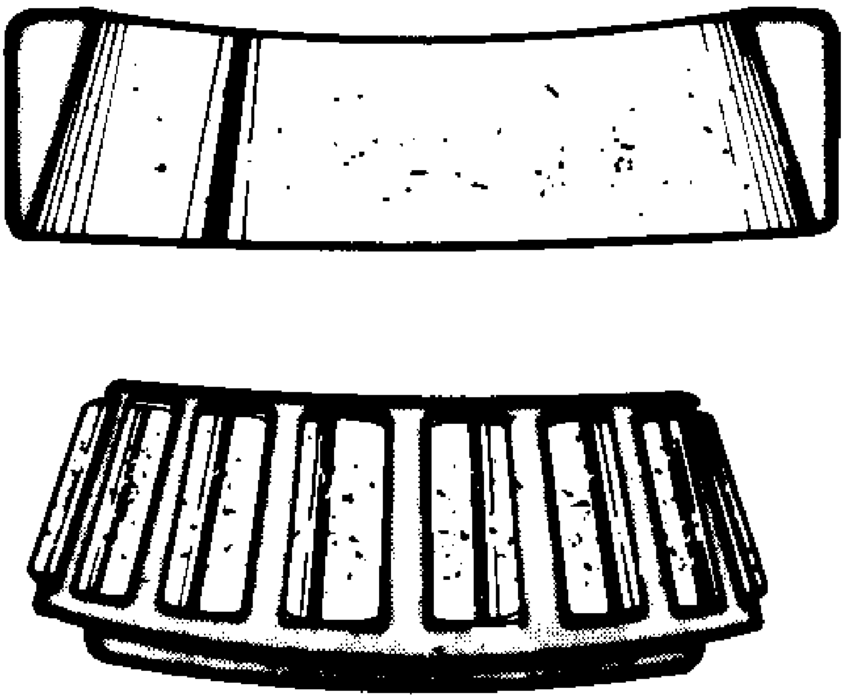
HASA510S

Outer race misalignment because of foreign object.

Clean related parts and replace bearing. Make sure races are properly seated.

Indentations

Figure 70



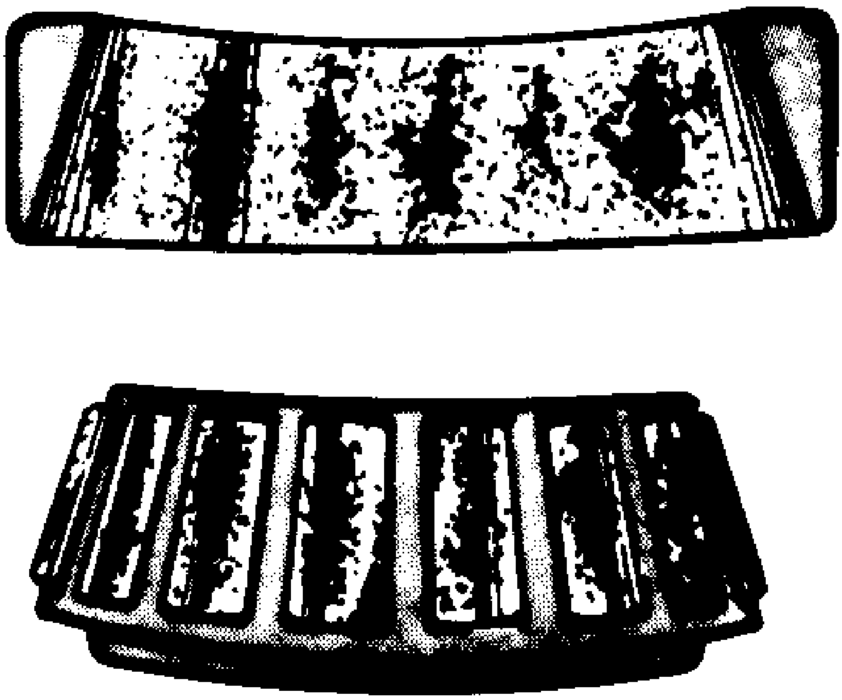
HASA520S

Surface depressions on race and rollers caused by hard particles of foreign materials.

Clean all parts and housings, check seals and replace bearings if rough or noisy.

Fatigue Spalling

Figure 71



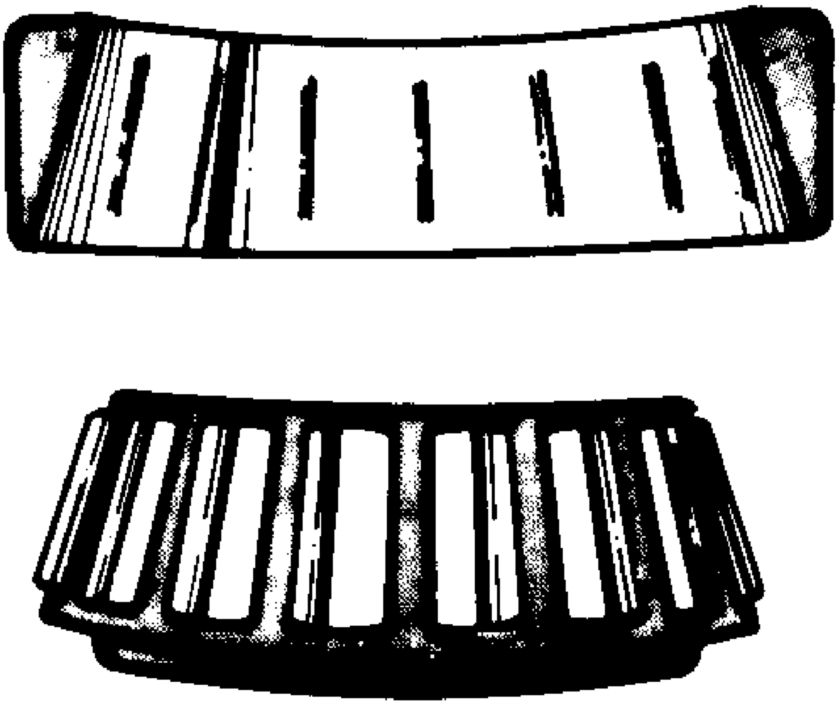
HASA530S

Flaking of surface metal resulting from fatigue.

Replace bearing - clean all related parts.

Brinelling

Figure 72



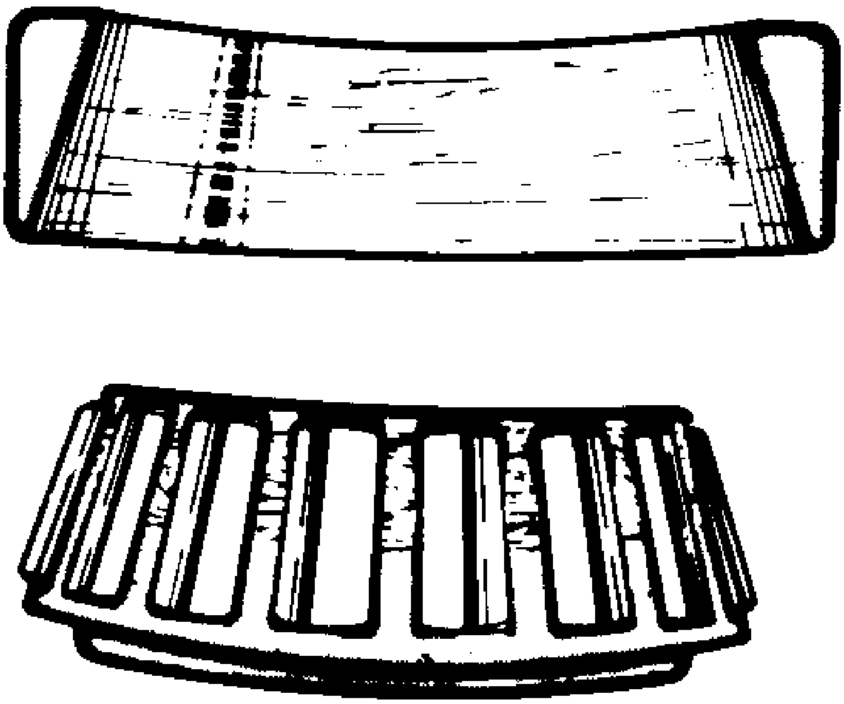
HASA540S

Surface indentations in raceway caused by rollers either under impact loading or vibration while the bearing is not rotating.

Replace bearing if rough or noisy.

Cage Wear

Figure 73



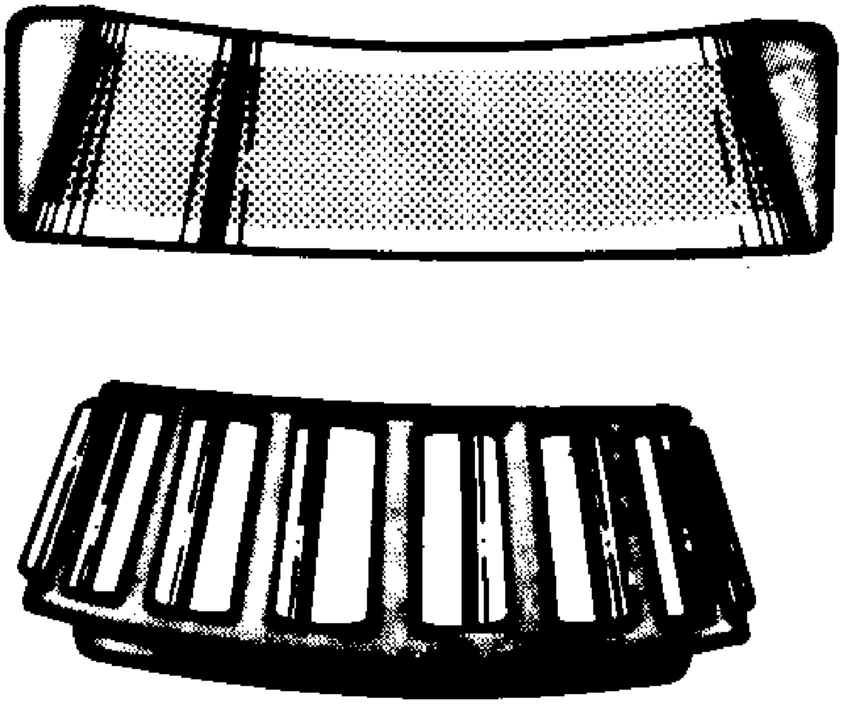
HASA550S

Wear around outside diameter of cage and roller pockets caused by abrasive material and inefficient lubrication.

Replace bearings - check seals.

Abrasive Roller Wear

Figure 74



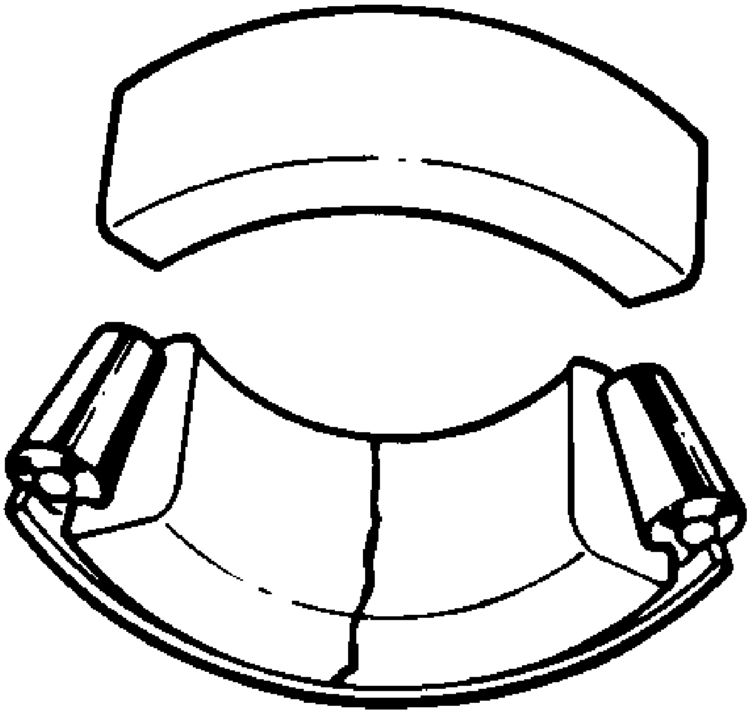
HASA560S

Pattern on races and rollers caused by fine abrasives.

Clean all parts and housings, check seals and bearings and replace if leaking, rough or noisy.

Cracked Inner Race

Figure 75



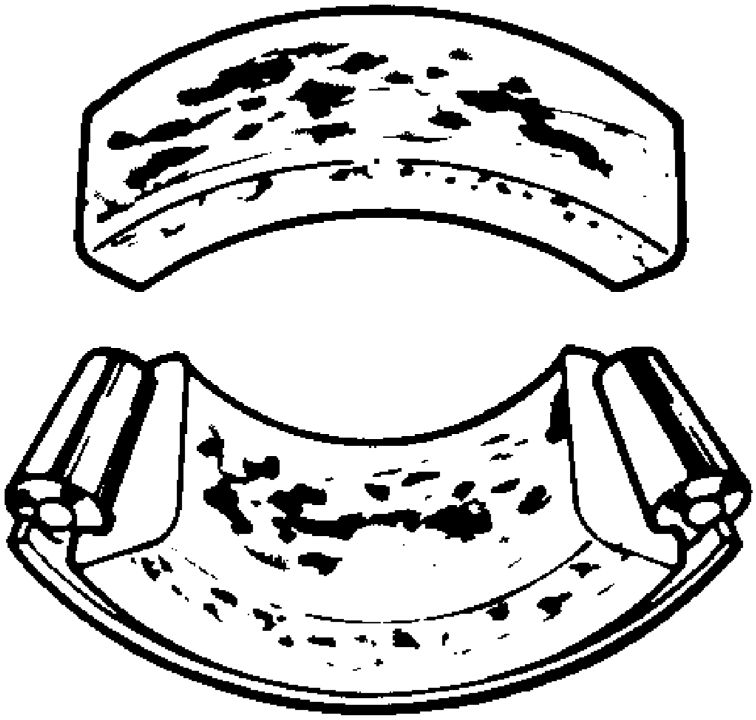
HASA570S

Race cracked because of improper installation, cocking or poor bearing seat.

Replace all parts and housings, check seals and bearings and replace if leaking.

Smears

Figure 76



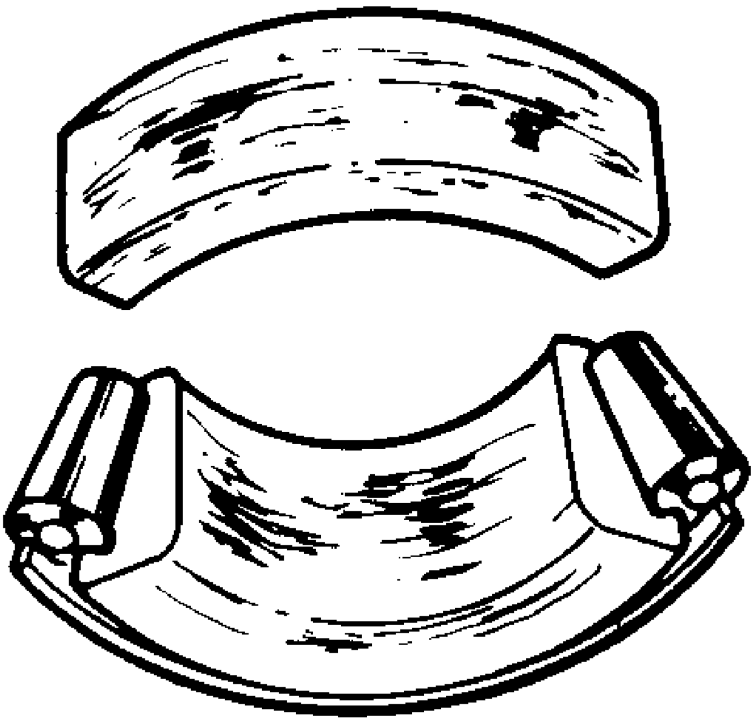
Smearing of metal because of slippage caused by poor installation, lubrication, overheating, overloads or handling damage.

Replace bearings, clean related parts and check for proper installation and lubrication.

Replace shaft if damaged.

Frettage

Figure 77



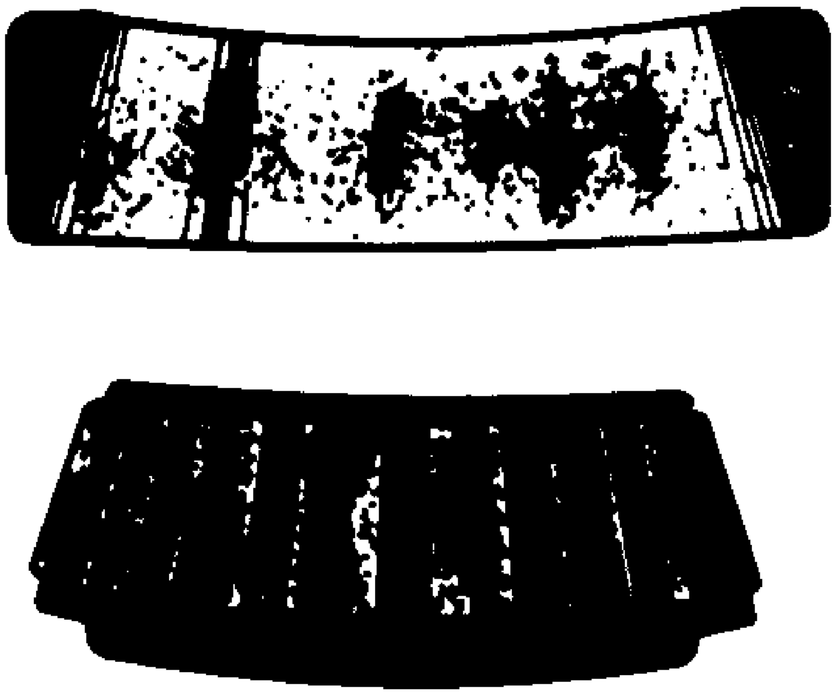
HASA590S

Corrosion set up by small relative movement of parts with no lubrication.

Replace bearing. Clean all related parts. Check seals and check for proper lubrication.

Heat Discoloration

Figure 78



HASA600S

Heat discoloration can range from faint yellow to dark blue resulting from overload or incorrect lubrication.

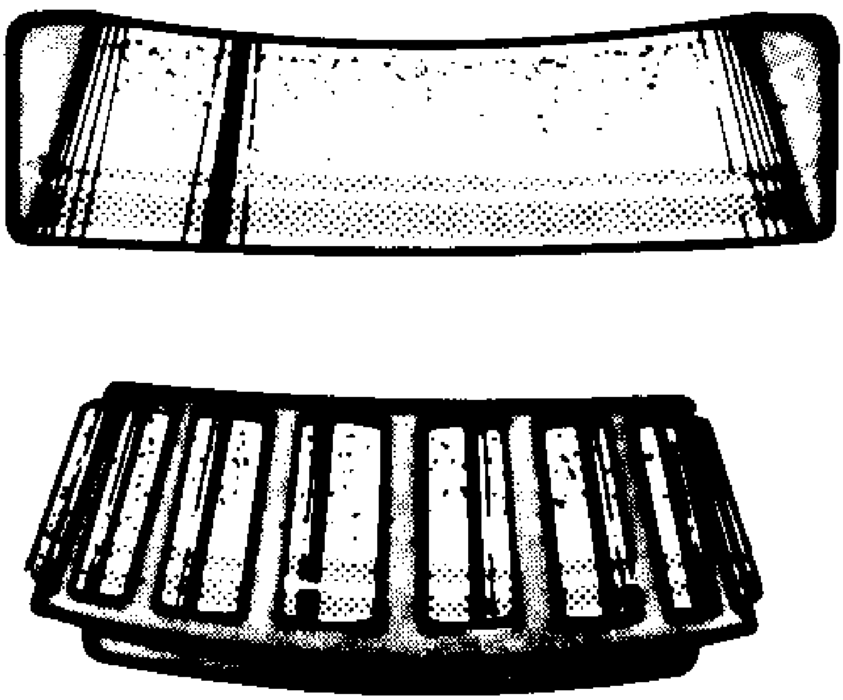
Excessive heat can cause softening of races or rollers.

To check for loss of temper on races or rollers, a simple file test may be made. A file drawn over a tempered part will grab and cut metal, whereas a file drawn over a hard part will glide readily with no metal cutting.

Replace bearing if overheating damage is indicated. Check seals and other related parts for damage.

Stain Discoloration

Figure 79



HASA610S

Discoloration can range from light brown to black caused by incorrect lubrication or moisture.

If the stain can be removed by light polishing or if no evidence of overheating is visible, the bearing can be reused.

Check seals and other related parts for damage.

Standard Torques

Safety Instructions

⚠ WARNING

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Torque Values for Standard Metric Fasteners

NOTE: *The units for the torque values are kg.m (ft lb).*

Dia. x Pitch (mm)	Grade										
	3.6 (4A)	4.6 (4D)	4.8 (4S)	5.6 (5D)	5.8 (5S)	6.6 (6D)	6.8 (6S)	6.9 (6G)	8.8 (8G)	10.9 (10K)	12.9 (12K)
M5 x Std.	0.15 (1.08)	0.16 (1.15)	0.25 (1.80)	0.22 (1.59)	0.31 (2.24)	0.28 (2.02)	0.43 (3.11)	0.48 (3.47)	0.50 (3.61)	0.75 (5.42)	0.90 (6.50)
M6 x Std.	0.28 (2.02)	0.30 (2.16)	0.45 (3.25)	0.40 (2.89)	0.55 (3.97)	0.47 (3.39)	0.77 (5.56)	0.85 (6.14)	0.90 (6.50)	1.25 (9.04)	1.50 (10.84)
M7 x Std.	0.43 (3.11)	0.46 (3.32)	0.70 (5.06)	0.63 (4.55)	0.83 (6.00)	0.78 (5.64)	1.20 (8.67)	1.30 (9.40)	1.40 (10.12)	1.95 (14.10)	2.35 (16.99)
M8 x Std.	0.70 (5.06)	0.75 (5.42)	1.10 (7.95)	1.00 (7.23)	1.40 (10.12)	1.25 (9.04)	1.90 (13.74)	2.10 (15.18)	2.20 (15.91)	3.10 (22.42)	3.80 (27.48)
M8 x 1	0.73 (5.28)	0.80 (5.78)	1.20 (8.67)	1.00 (7.23)	1.50 (10.84)	1.35 (9.76)	2.10 (15.18)	2.30 (16.63)	2.40 (17.35)	3.35 (24.23)	4.10 (29.65)
M10 x Std.	1.35 (9.76)	1.40 (10.12)	2.20 (15.91)	1.90 (13.74)	2.70 (19.52)	2.35 (19.99)	3.70 (26.76)	4.20 (30.37)	4.40 (31.18)	6.20 (44.84)	7.20 (52.07)
M10 x 1.25	1.50 (10.84)	1.60 (11.57)	2.50 (18.08)	2.10 (15.18)	3.10 (22.42)	2.80 (20.25)	4.30 (31.10)	4.90 (35.44)	5.00 (36.16)	7.00 (50.63)	8.40 (60.75)
M12 x Std.	2.40 (17.35)	2.50 (18.08)	3.70 (26.76)	3.30 (23.86)	4.70 (33.99)	4.20 (30.37)	6.30 (45.56)	7.20 (52.07)	7.50 (54.24)	10.50 (75.94)	12.50 (90.41)
M12 x 1.25	2.55 (18.44)	2.70 (19.52)	4.00 (28.93)	3.50 (25.31)	5.00 (36.16)	4.50 (32.54)	6.80 (49.18)	7.70 (55.69)	8.00 (57.86)	11.20 (81.00)	13.40 (96.92)
M14 x Std.	3.70 (26.76)	3.90 (28.20)	6.00 (13.23)	5.20 (37.61)	7.50 (54.24)	7.00 (50.63)	10.00 (72.33)	11.50 (83.17)	12.00 (86.79)	17.00(122.96)	20.00(144.66)
M14 x 1.5	4.10 (29.65)	4.30 (31.10)	6.60 (47.73)	5.70 (41.22)	8.30 (60.03)	7.50 (54.24)	11.10 (80.28)	12.50 (90.41)	13.00 (94.02)	18.50 (11.26)	22.00(158.12)
M16 x Std.	5.60 (40.50)	6.00 (43.39)	9.00 (65.09)	8.00 (57.86)	11.50 (83.17)	10.50 (75.94)	15.50(112.11)	17.90(129.47)	18.50(133.81)	26.00(188.05)	31.00(224.22)
M16 x 1.5	6.20 (44.84)	6.50 (47.01)	9.70 (70.16)	8.60 (62.20)	12.50 (90.41)	11.30 (81.73)	17.00(122.96)	19.50(141.04)	20.00(144.66)	28.00(202.52)	35.50(256.77)

Dia. x Pitch (mm)	Grade										
	3.6 (4A)	4.6 (4D)	4.8 (4S)	5.6 (5D)	5.8 (5S)	6.6 (6D)	6.8 (6S)	6.9 (6G)	8.8 (8G)	10.9 (10K)	12.9 (12K)
M18 x Std.	7.80 (56.41)	8.30 (60.03)	12.50 (90.41)	11.00 (79.56)	16.00(115.72)	14.50(104.87)	21.00(151.89)	27.50(198.90)	28.50(206.14)	41.00(296.55)	43.00(311.01)
M18 x 1.5	9.10 (65.82)	9.50 (68.71)	14.40(104.15)	12.50 (90.41)	18.50(133.81)	16.70(120.79)	24.50(177.20)	27.50(198.90)	28.50(206.14)	41.00(296.55)	49.00(354.41)
M20 x Std.	11.50 (83.17)	12.00 (86.79)	18.00(130.19)	16.00(115.72)	22.00(159.12)	19.00(137.42)	31.50(227.83)	35.00(253.15)	36.00(260.38)	51.00(368.88)	60.00(433.98)
M20 x 1.5	12.80 (92.58)	13.50 (97.64)	20.50(148.27)	18.00(130.19)	25.00(180.82)	22.50(162.74)	35.00(253.15)	39.50(285.70)	41.00(296.55)	58.00(419.51)	68.00(491.84)
M22 x Std.	15.50(112.11)	16.00(115.72)	24.50(177.20)	21.00(151.89)	30.00(216.99)	26.00(188.05)	42.00(303.78)	46.00(332.71)	49.00(354.41)	67.00(484.61)	75.00(542.47)
M22 x 1.5	17.00(122.96)	18.50(133.81)	28.00(202.52)	24.00(173.59)	34.00(245.92)	29.00(209.75)	47.00(339.95)	52.00 (44.76)	56.00(405.04)	75.00(542.47)	85.00(614.80)
M24 x Std.	20.50(148.27)	21.50(155.50)	33.00(238.68)	27.00(195.29)	40.00(289.32)	34.00(245.92)	55.00(397.81)	58.00(419.51)	63.00(455.67)	82.00(593.10)	92.00(655.43)
M24 x 2.0	23.00(166.35)	35.00(253.15)	37.00(267.62)	31.00(224.22)	45.00(325.48)	38.00(202.52)	61.00(441.21)	67.00(484.61)	74.00(535.24)	93.00(672.66)	103.00(744.99)

Torque Values for Standard U.S. Fasteners

Type	SAE Grade	Description	Bolt Head Marking
1	1 or 2	WILL HAVE NO MARKINGS IN THE CENTER OF THE HEAD. Low or Medium Carbon Steel Not Heat-treated.	
5	5	WILL HAVE THREE RADIAL LINES. Quenched and Tempered Medium Carbon Steel.	
8	8	WILL HAVE 6 RADIAL LINES. Quenched and Tempered Special Carbon or Alloy Steel.	

Recommended torque, in foot-pounds, for all Standard Application Nuts and Bolts, provided:

1. All thread surfaces are clean and lubricated with SAE-30 engine oil. (See Note.)
2. Joints are rigid, that is, no gaskets or compressible materials are used.
3. When reusing nuts or bolts, use minimum torque values.

NOTE: *Multiply the standard torque by:*

NOTE: *0.65 When finished jam nuts are used.*

NOTE: *0.70 When Molykote, white lead or similar mixtures are used as lubricants.*

NOTE: *0.75 When Parkerized bolts or nuts are used.*

NOTE: *0.85 When cadmium plated bolts or nuts and zinc bolts w/waxed zinc nuts are used.*

NOTE: *0.9 When hardened surfaces are used under the nut or bolt head.*

NOTE: *When reusing bolts and nuts in service, use minimum torque values.*

The following General Torque Values must be used where SPECIAL TORQUE VALUES are not given.

NOTE: *Torque values listed throughout this manual are lubricated (wet) threads; values must be increased 1/3 for non lubricated (dry) threads.*				
Thread Size	Heat-treated Material Grade 5 and Grade 8			
	Grade 5 (3 Radial Dashes on Head)		Grade 8 (6 Radial Dashes on Head)	
	Foot pounds (ft lb)	Newton Meter (Nm)	Foot pounds (ft lb)	Newton Meter (Nm)
1/4" - 20	6	8	9	12
1/4" - 28	7	9	11	15
5/16" - 18	13	18	18	24
5/16" - 24	15	20	21	28
3/8" - 16	24	33	34	46
3/8" - 24	27	37	38	52
7/16" - 14	38	52	54	73
7/16" - 20	42	57	60	81
1/2" - 13	58	79	82	111
1/2" - 20	65	88	90	122
9/16" - 12	84	114	120	163
9/16" - 18	93	126	132	179
5/8" - 11	115	156	165	224
5/8" - 18	130	176	185	251
3/4" - 10	205	278	290	393
3/4" - 16	240	312	320	434
7/8" - 9	305	414	455	617
7/8" - 14	334	454	515	698
1" - 8	455	617	695	942
1" - 14	510	691	785	1064
1 1/8" - 7	610	827	990	1342
1 1/8" - 12	685	929	1110	1505
1 1/4" - 7	860	1166	1400	1898
1 1/4" - 12	955	1295	1550	2102
1 3/8" - 6	1130	1532	1830	2481
1 3/8" - 12	1290	1749	2085	2827
1 1/2" - 6	1400	2034	2430	3295
1 1/2" - 12	1690	2291	2730	3701
1 3/4" - 5	2370	3213	3810	5166
2" - 4 1/2	3550	4813	5760	7810

NOTE: *If any bolts and nuts are found loose or at values less than what the chart states, it is recommended that loose bolt and/or nut be replaced with a new one.*

Type 8 Phosphate Coated Hardware

This chart provides tightening torque for general purpose applications using original equipment standard hardware as listed in the Parts Manual for the machine involved. DO NOT SUBSTITUTE. In most cases, original equipment standard hardware is defined as Type 8, coarse thread bolts, nuts and thru hardened flat washers (Rockwell "C" 38 - 45), all phosphate coated and assembled without supplemental lubrication (as received) condition.

The torques shown below also apply to the following:

1. Phosphate coated bolts used in tapped holes in steel or gray iron.
2. Phosphate coated bolts used with phosphate coated prevailing torque nuts (nuts with distorted threads or plastic inserts).
3. Phosphate coated bolts used with copper plated weld nuts.

Markings on bolt heads or nuts indicate material grade ONLY and are NOT to be used to determine required torque.

Nominal Thread Diameter	Standard Torque ±10%	
	Kilogram.meter (kg.m)	Foot pounds (ft lb)
1/4"	1.1	8
5/16"	2.2	16
3/8"	3.9	28
7/16"	6.2	45
1/2"	9.7	70
9/16"	13.8	100
5/8"	19.4	140
3/4"	33.2	240
7/8"	53.9	390
1"	80.2	580
1 - 1/8"	113.4	820
1 - 1/4"	160.4	1160
1 - 3/8"	210.2	1520
1 - 1/2"	279.4	2020
1 - 3/4"	347.1	2510
2"	522.8	3780

Torque Values for Hose Clamps

The following chart provides the tightening torques for hose clamps used in all rubber applications (radiator, air cleaner, operating lever boots, hydraulic system, etc.).

Clamp Type and Size	Torque			
	Radiator, Air Cleaner, Boots, Etc.		Hydraulic System	
	Kilogram.meter (kg.m)	Inch Pounds (in lb)	Kilogram.meter (kg.m)	Inch Pounds (in lb)
"T" Bolt (Any Diameter)	0.68 - 0.72	59 - 63	-------	-------
Worm Drive - Under 44 mm (1-3/4 in) Open Diameter	0.2 - 0.3	20 - 30	0.5 - 0.6	40 - 50
Worm Drive - Over 44 mm (1-3/4 in) Open Diameter	0.5 - 0.6	40 - 50	-------	-------
Worm Drive - All "Ultra-Tite"	0.6 - 0.7	50 - 60	0.5 - 0.6	40 - 50

ORFS Swivel Nut Recommended Torque

Dash Size	Hose I.D.	Thread Size	Torque (kg.m) Recommended
4	1/4"	9/16"	2.4 - 2.6
6	3/8"	11/16"	3.3 - 3.9
8	1/2"	13/16"	5.1 - 5.7
12	3/4"	1 3/16"	11.7 - 12.7
16	1"	1 7/16"	15.3 - 17.3
20	1 1/4"	1 11/16"	18.0 - 20.0

Torque Values for Split Flanges

The following chart provides the tightening torques for split flange connections used in hydraulic systems. Split flanges and shoulders should install squarely. Install all bolts, finger tight and then torque evenly.

NOTE: *Over torquing bolts will damage the flanges and/or bolts, which can cause leakage.*

Flange Size (*)	Bolt Size	Bolt Torque	
		Kilogram.meter (kg.m)	Foot-pounds (ft lb)
1/2"	5/16"	2.1 - 2.5	15 - 18
3/4"	3/8"	3.0 - 3.7	22 - 27
1"	3/8"	3.7 - 4.8	27 - 35
1 - 1/4"	7/16"	4.8 - 6.2	35 - 45
1 - 1/2"	1/2"	6.4 - 8.0	46 - 58
2"	1/2"	7.6 - 9.0	55 - 65
2 - 1/2"	1/2"	10.9 - 12.6	79 - 91
3"	5/8"	19.1 - 20.7	138 - 150
3 - 1/2"	5/8"	16.2 - 18.4	117 - 133

(*) - Inside diameter of flange on end of hydraulic tube or hose fitting.

NOTE: *Values stated in chart are for Standard Pressure Series (Code 61) Split Flanges.*

Torque Wrench Extension Tools

Very large diameter, high-grade fasteners (nuts, bolts, cap screws, etc.) require a great deal of turning force to achieve recommended tightening torque values.

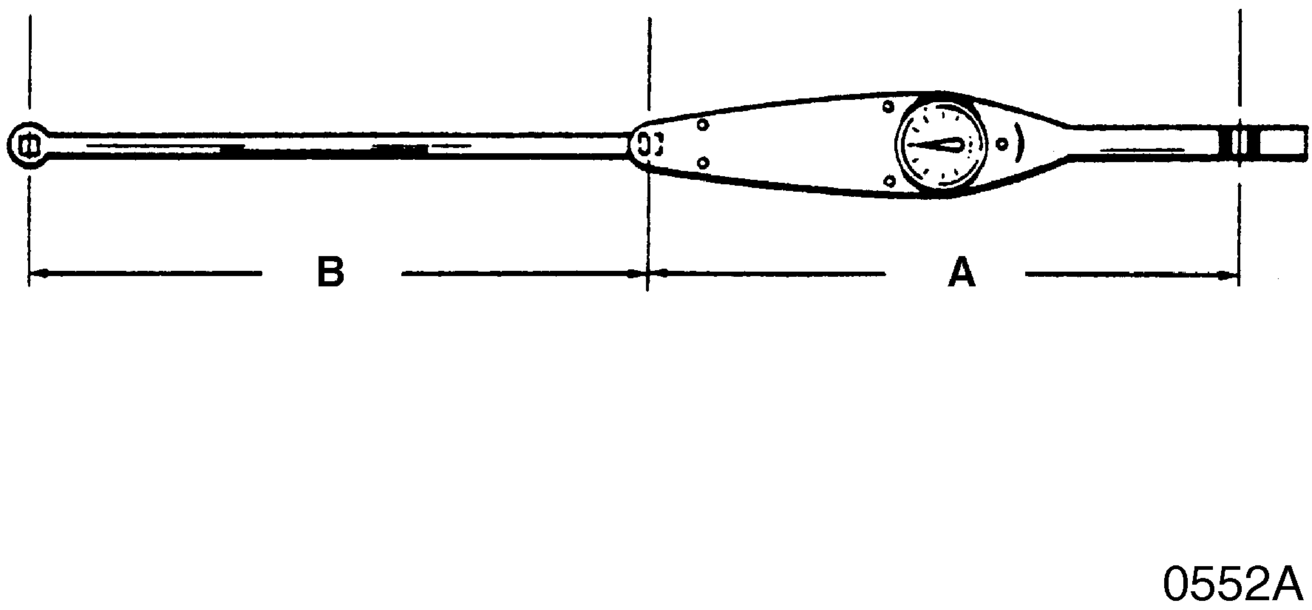
Common problems that could occur as a result are:

- Recommended torque exceeds the measuring capacity of the torque wrench.
- Specialized sockets do not fit the adapter on the front end (nose) of the torque wrench.
- Generating adequate force on the back end (handle) of the wrench is difficult or impossible.
- Restricted access or an obstruction may make use of the torque wrench impossible.
- A unique application requires fabrication of an adapter or other special extension.

Most standard torque wrenches can be adapted to suit any one of the proceeding needs or situations, if the right extension tool is used or fabricated.

Torque Multiplication

Figure 80



A wrench extension tool can be used to increase the tightening force on a high capacity nut or bolt.

For example, doubling the distance between the bolt and the back (handle) end of the torque wrench doubles the tightening force on the bolt. It also halves the indicated reading on the scale or dial of the torque wrench. To accurately adjust or convert indicated scale or dial readings, use the following formula:

I = A x T/A + B where:

I = Indicated force shown on the torque wrench scale or dial.

T = Tightening force applied to the nut or bolt (actual Torque).

A = Length of the torque wrench (between the center of the nut or bolt and the center of the handle).

B = Length of the extension.

As an example, if a 12" extension is added to a 12" torque wrench, and the indicated torque on the dial reads "150 ft lb", the real force applied to the bolt is 300 ft lb:

I =	A x T	=	12 x 300	=	3600	=	150
	A + B		12 + 12		24		

NOTE: *The formula assumes there is no added deflection or "give" in the joint between the extension and torque wrench. Readings may also be inaccurate:*

- If the extension itself absorbs some of the tightening force and starts to bend or bow out.
- If an extension has to be fabricated that is not perfectly straight (for example, an extension made to go around an obstruction, to allow access to a difficult to tighten fastener), the materials and methods used must be solid enough to transmit full tightening torque.

Other Uses for Torque Wrench Extension Tools

Torque wrench extensions are sometimes made up for reasons other than increasing leverage on a fastener.

For example, a torque wrench and extension can be used to measure adjustment "tightness" of a linkage or assembly. Specially fabricated extensions can be used to make very precise checks of the force required to engage or disengage a clutch mechanism, release a spring-applied brake assembly, or "take up" free play in most any movable linkage.

Once the value of the adjustment force is established, repeated checks at regular intervals can help to monitor and maintain peak operating efficiency. These types of adjustment checks are especially useful if physical measurements of linkage travel are difficult to make or will not provide the needed degree of precision and accuracy.

To allow the assembly or mechanism to accept a torque wrench, welding a nut or other adapter on the end of a linkage shaft or other leverage point will allow turning the shaft or assembly manually.

Loctite Applications

Tightening Torque Specifications (Metric)

(For coated threads, pre-lubricated assemblies.)

NOTICE

Disassembly, overhaul and replacement of components on the machine, installation of new or replacement parts and/or other service-related maintenance may require the use of thread or flange sealing assembly compound.
Use the information on this page as a general guide in selecting specific formulas that will meet the particular requirements of individual assembly installations. We, Machine Producer, do not specifically approve a specific manufacturer or brand name, but the following table of “Loctite” applications is included for which cross-references to other manufacturer's products should also be widely available.

NOTICE

Use primer "T" or "N" for all cold weather assembly of fastener adhesives, with Thread locker sealers 222, 242/243,262, 271, 272, or 277.

I. "Loctite" Fastener Adhesives

Product	Application	Color	Removal	Breakaway Cure Strength (in lb) of Sealer Alone
222	Low strength for 6 mm (1/4") or smaller fasteners.	Purple	Hand tools	45
242 or 243	Medium strength for 6 mm (1/4") and larger fasteners.	Blue	Hand tools	80
262	High strength for high-grade fasteners subject to shock, stress and vibration.	Red	Heat/260°C (500°F) Remove HOT (NO solvent)	160
271	Extra high strength for fine thread fasteners up to 25 mm (1") diameter.	Red	Heat/260°C (500°F) Remove HOT	160
272	High temperature/high strength for hostile environments to 232°C (450°F).	Red	Heat/316°C (600°F) Remove HOT	180
277	Extra high strength for coarse thread fasteners 25 mm (1") diameter and larger.	Red	Heat/260°C (500°F) Remove HOT	210

II. "Loctite" Pipe Thread Sealant

Product	Application	Color	Removal	Required Setup
545	"No filler/non clog" formula for high-pressure hydraulic systems. Over application will not restrict or foul system components.	Purple	Hand tools	4 Hours (or 1/2 hour with Locquic "T" Primer)
656	Solvent resistant, higher viscosity tapered thread sealer.	White	Hand tools	4 Hours (or 1/2 hour with Locquic "T" Primer)

III. "Loctite" gasket/flange sealer

Product	Application	Color	Notes
518	Gasket eliminator specifically made for aluminum flanges/ surfaces. For hydraulic systems to 34,475 kPa (5,000 psi).	Red	Use Locquic "N" primer for fast (1/2 - 4 hours) setup. Unprimed setup 4 - 24 hours.
504	Low-pressure/wide-gap gasket eliminator compound. Fills gaps to 0.762 mm (0.030"), cures to rigid seal.	Orange	Use Locquic "N" primer for faster (1/2 - 4 hours) setup. Unprimed setup 4 - 24 hours.
515	General purpose, fast setup, flexible-cure gasket eliminator. For	Purple	Use Locquic "N" primer for faster (1/4 - 2 hours) setup. Unprimed setup 1 - 12 hours.

Product	Application	Color	Notes
	nonrigid assemblies subject to shock, vibration or deflection.		

IV. "Loctite" retaining compounds

Product	Application	Color	Notes
609	For bushings, sleeves, press fit bearings, splines and collars. For gaps to 0.0002 mm (0.005"), temperatures to 121°C (250°F).	Green	Use Locquic "N" primer for increased bond strength and all cold temperature applications.
620	For high temperatures to 232°C (450°F).	Green	Same as 609, above.
680	For high strength bonds and tight clearance gaps, to 0.00008 mm (0.002").	Green	Same as 609, above.

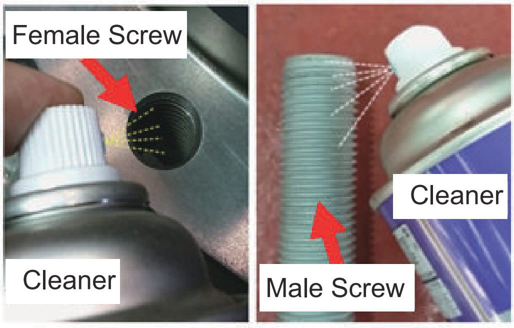
V. "Loctite" Adhesives

Product	Application	Color	Notes
380	Black Max instant adhesive for shock and vibration-resistant bonds.	Black	May take 120 hours to reach full cure strength.
454	Adhesive for porous surfaces.	Clear	Full strength in 24 hours.
480	Increased strength (+50%), shock and vibration-resistant.	Black	Full strength in 24 hours.

Tips for using thread locker

Instructions for use

1. Figure 81



DS2301334

Removal of foreign substances in the fastening area

If there is oil or foreign matter on the screw thread, clean it off with a cleaning solution.

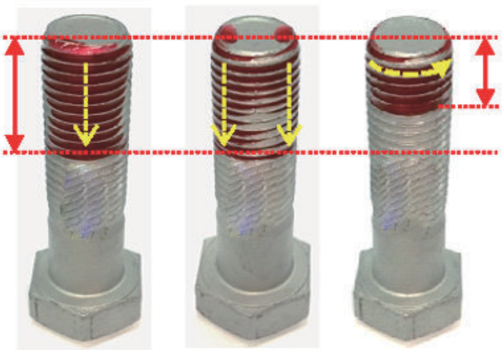
2. Figure 82

DS2301335

Application of screw locking agent

Apply evenly from the tip of the bolt to the screw thread.

3. Figure 83



DS2301336

Appearance of finished application

One line: bolted length = spread length

Double row or round: at least half the bolted length

If you do not know the length of your physique, apply about 1/3 or more of the bolt part.

The application form is less than M20 => one application, more than w22 => two lines or circular application.

If the bolts are assembled, completely remove them within 30 minutes.

NOTE: *Fastening Depth: The total length of engagement between the female thread and the male thread when tightening*

Precautions

1. To manage the cleanliness of the screw locker, keep it sealed when not in use, and do not apply it to the bolt in advance, but apply it before the bolt installation work.
2. The bolts must be fully torqued within 30 minutes after temporary assembly.

   However, if the work cannot be done within 30 minutes, do not do the temporary assembly, and proceed with the assembly when the complete torque work is possible within 30 minutes.
3. If more than 30 minutes have elapsed after the provisional fastening, unscrew the bolts, cleanly remove the screw fixing agent, reapply and then fasten.

   At this time, the hardened screw fixing agent on the female screw is cleaned with a cleaning solution.

4. If it is difficult to remove the bolts coated with the screw fixing agent, heat them over 260 degrees in Celsius to melt the screw fixing agent before removing it.

   The thread locker does not harden even when left in the air. (It hardens when it is blocked from air and comes into contact with metal - anaerobic property)

Engine

Safety Instructions

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or servicingmachine. Read and understand the Operation & Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correctfunction after adjustments repairs or service. Untrainedoperators and failure to follow instructions can cause deathor serious injury.

General Information

Foreword

California Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

This product can expose you to chemicals including ethylene glycol, which is known to the State of California to cause birth defects or other reproductive harm.
For more information go to: www.P65Warnings.ca.gov
Do not ingest this chemical. Wash hands after handling to avoid incidental ingestion.

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

This product can expose you to chemicals including lead and lead compounds, which are known to the State of California to cause cancer, birth defects, or other reproductive harm.
For more information go to: www.P65Warnings.ca.gov
Wash hands after handling components that may contain lead.

Literature Information

This manual contains safety, operation instructions, lubrication, and maintenance information. This manual should be stored in or near the engine area in a literature holder or literature storage area. Read, study, and keep the manual with the literature and engine information.

Some photographs or illustrations in this manual show details or attachments that may be different from your engine. Guards and covers may have been removed for illustrative purposes. Continuing improvement and advancement of product design may have caused changes to your engine which are not included in this manual. Whenever a question arises regarding your engine, or this manual, please consult with your dealer for the latest available information.

Safety

This safety section lists basic safety precautions. In addition, this section identifies hazardous, warning situations. Read and understand the basic precautions listed in the safety section before operating or performing lubrication, maintenance, and repair on this product.

Operation

Operating techniques outlined in this manual are basic. The operating techniques assist with developing the skills and techniques required to operate the engine more efficiently and economically. Skill and techniques develop as the operator gains knowledge of the engine and the capabilities of the engine.

The operation section is a reference for operators. Photographs and illustrations guide the operator through procedures of inspecting, starting, operating, and stopping the engine. This section also includes a discussion of electronic diagnostic information.

Maintenance

The maintenance section is a guide to engine care. The illustrated, step-by-step instructions are grouped by service hours and / or calendar time maintenance intervals. Items in the maintenance schedule are referenced to detailed instructions that follow.

Recommended service should be performed at the appropriate intervals as indicated in the Maintenance Interval Schedule. The actual operating environment of the engine also governs the Maintenance Interval Schedule. Therefore, under severe, dusty, wet, or freezing cold operating conditions, more frequent lubrication, and maintenance than is specified in the Maintenance Interval Schedule may be necessary.

The maintenance schedule items are organized for a preventive maintenance management program. If the preventive maintenance program is followed, a periodic tune-up is not required. The implementation of a preventive maintenance management program should minimize operating costs through cost avoidances resulting from reductions in unscheduled downtime and failures.

Maintenance Intervals

Perform maintenance on items at multiples of the original requirement. Each level and / or individual items in each level should be shifted ahead or back depending upon your specific maintenance practices, operation, and application. It is recommended that the maintenance schedules be reproduced and displayed near the engine as a convenient reminder. We also recommends that a maintenance record be maintained as part of the permanent record of the engine.

Mounting and Dismounting

Do not climb on the engine or the engine aftertreatment system. The engine and aftertreatment system have not been designed with mounting or dismounting locations.

Refer to the OEM for the location of foot and hand holds for your specific application.

Before Starting Engine

NOTICE

For initial start-up of a new or rebuilt engine, and for start-up of an engine that has been serviced, make provision to shut the engine off should an overspeed occur. This may be accomplished by shutting off the air and/or fuel supply to the engine.

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

Engine exhaust contains products of combustion which may be harmful to your health. Always start and operate the engine in a well ventilated area and, if in an enclosed area, vent the exhaust to the outside.

Inspect the engine for potential hazards.

Do not start the engine or move any of the controls if there is a “DO NOT OPERATE” warning tag or similar warning tag attached to the start switch or to the controls.

Before starting the engine, ensure that no one is on, underneath, or close to the engine. Ensure that the area is free of personnel.

If equipped, ensure that the lighting system for the engine is suitable for the conditions. Ensure that all lights work properly, if equipped.

All protective guards and all protective covers must be installed if the engine must be started in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

Do not start an engine when the governor linkage is disconnected.

Do not bypass the automatic shutoff circuits. Do not disable the automatic shutoff circuits. The circuits are provided in order to help prevent personal injury. The circuits are also provided in order to help prevent engine damage.

Engine Starting

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

Do not use aerosol types of starting aids such as ether. Such use could result in an explosion and personal injury.

If a warning tag is attached to the engine start switch or to the controls DO NOT start the engine or move the controls. Consult with the person that attached the warning tag before the engine is started.

All protective guards and all protective covers must be installed if the engine must be started in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

Start the engine from the operator's compartment or from the engine start switch.

Always start the engine according to the procedure that is described in the Operation and Maintenance Manual, “Engine Starting” topic in the Operation Section. Knowing the correct procedure will help to prevent major damage to the engine components. Knowing the procedure will also help to prevent personal injury.

To ensure that the jacket water heater (if equipped) is working correctly, check the water temperature gauge and/or the oil temperature gauge during the heater operation.

Engine exhaust contains products of combustion which can be harmful to your health. Always start the engine and operate the engine in a well ventilated area. If the engine is started in an enclosed area, vent the engine exhaust to the outside.

NOTE: *The engine may be equipped with a device for cold starting. If the engine will be operated in very cold conditions, then an extra cold starting aid may be required. Normally, the engine will be equipped with the correct type of starting aid for your region of operation.*

Engine Stopping

Do not stop the engine immediately after the engine has been operated under load. Abrupt stopping of the engine can cause overheating and accelerated wear of engine components. Allow the engine to run for 5 minutes before engine shutdown. Running the engine allows hot areas of the engine to cool gradually.

Electrical System

Never disconnect any charging unit circuit or battery circuit cable from the battery when the charging unit is operating. A spark can cause the combustible gases that are produced by some batteries to ignite.

To help prevent sparks from igniting combustible gases that are produced by some batteries, the negative “.” jump-start cable should be connected last from the external power source to the negative "." terminal of the starting motor. If the starting motor is not equipped with a negative "." terminal, connect the jump-start cable to the engine block.

Check the electrical wires daily for wires that are loose or frayed. Tighten all loose electrical wires before the engine is started. Repair all frayed electrical wires before the engine is started. Refer to the "Engine Starting" section of this Operation and Maintenance Manual for specific starting instructions.

Grounding Practices

Proper grounding for the engine electrical system is necessary for optimum engine performance and reliability. Improper grounding will result in uncontrolled electrical circuit paths and in unreliable electrical circuit paths.

Uncontrolled electrical circuit paths can result in damage to main bearings, to crankshaft bearing journal surfaces, and to aluminum components.

Engines that are installed without engine-to-frame ground straps can be damaged by electrical discharge.

To ensure that the engine and the engine electrical systems function properly, an engine-to-frame ground strap with a direct path to the battery must be used. This path may be provided by way of a starting motor ground, a starting motor ground to the frame, or a direct engine ground to the frame.

All grounds should be tight and free of corrosion. The engine alternator must be grounded to the negative "-" battery terminal with a wire that is adequate to handle the full charging current of the alternator.

Engine Electronics

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

Tampering with the electronic system installation or the OEM wiring installation can be dangerous and could result in personal injury or death and / or engine damage.

This engine has a comprehensive, programmable Engine Monitoring System. The Engine Control Module (ECM) will monitor the engine operating conditions. If any of the engine parameters extend outside an allowable range, the ECM will initiate an immediate action.

The following actions are available for engine monitoring control: WARNING, DERATE and SHUTDOWN. These engine monitoring modes can limit engine speed and/or the engine power.

Many of the parameters that are monitored by the ECM can be programmed for the engine monitoring functions. The following parameters can be monitored as a part of the Engine Monitoring System:

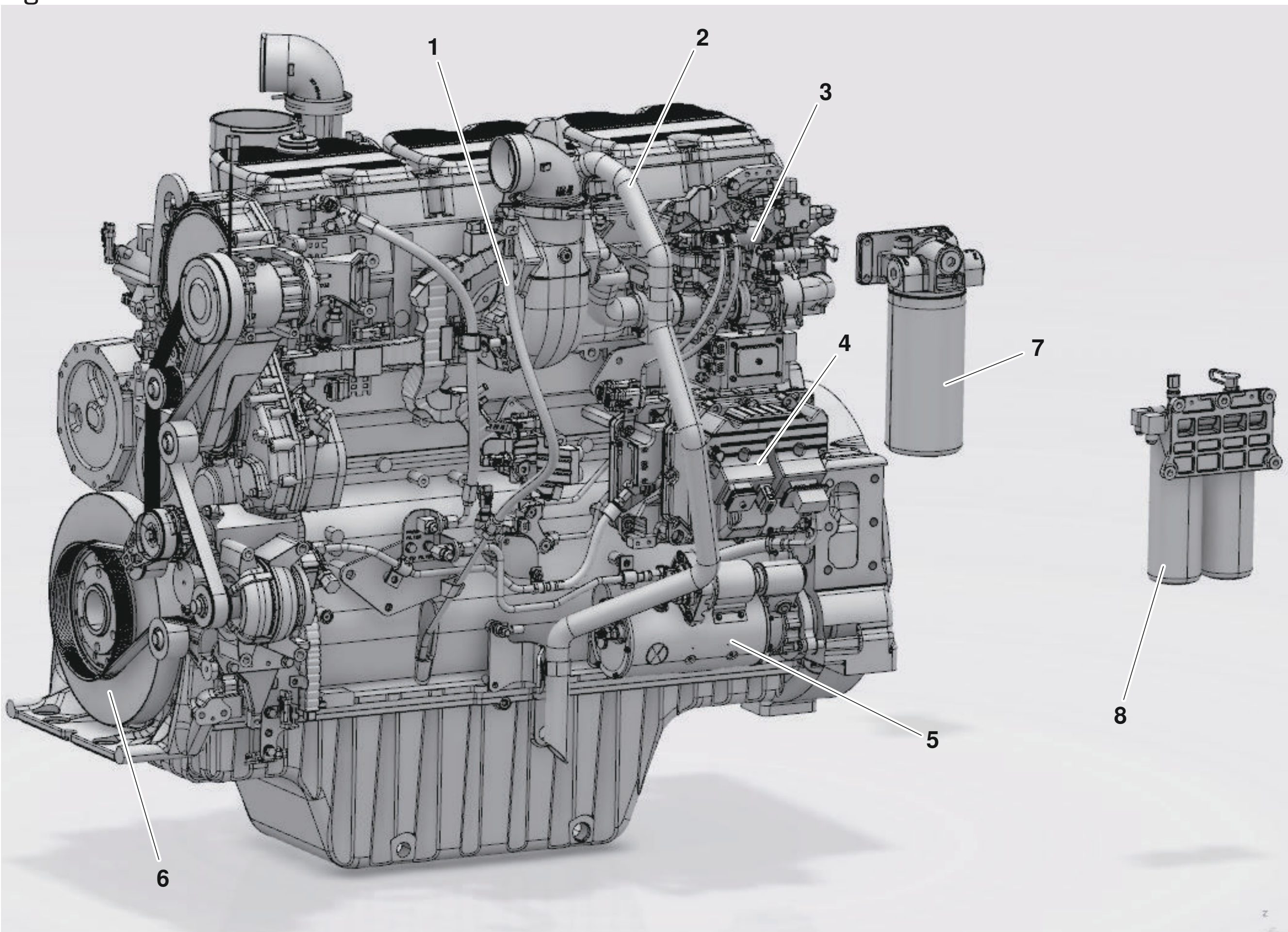
- Operating Altitude
- Engine Coolant Level
- Engine Coolant Temperature
- Engine Oil Pressure
- Engine Speed
- Fuel Temperature
- Intake Manifold Air Temperature
- System Voltage

The Engine Monitoring package can vary for different engine models and different engine applications. However, the monitoring system and the engine monitoring control will be similar for all engines.

Product Information Section

Engine Overviews

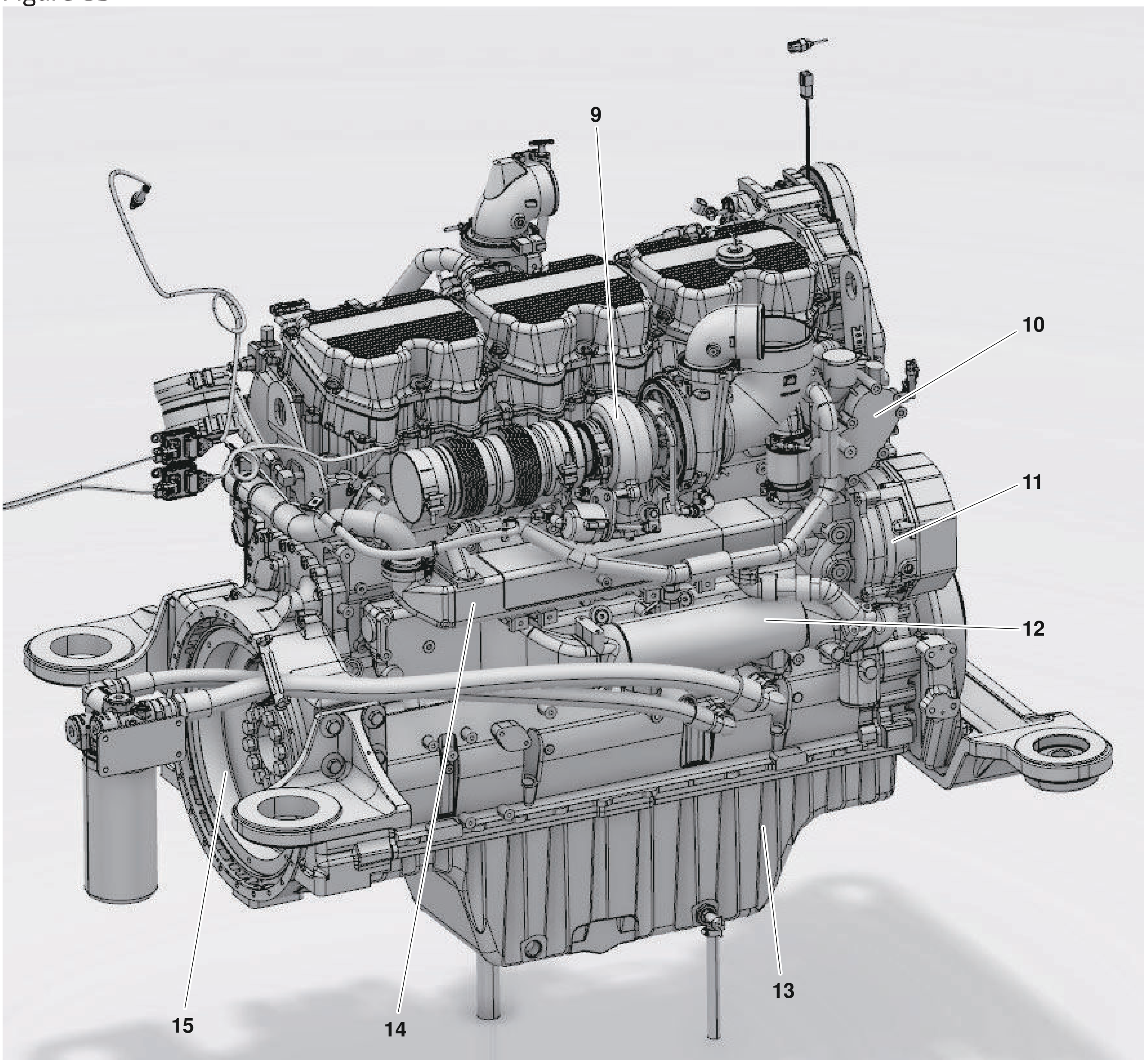
Figure 84



DS2002737

Reference Number	Description
1	Oil Gauge (Dipstick)
2	Breather Hose
3	NRS Valve
4	ECM
5	Starter Motor
6	Damper
7	Oil Filter
8	Fuel Filters

Figure 85

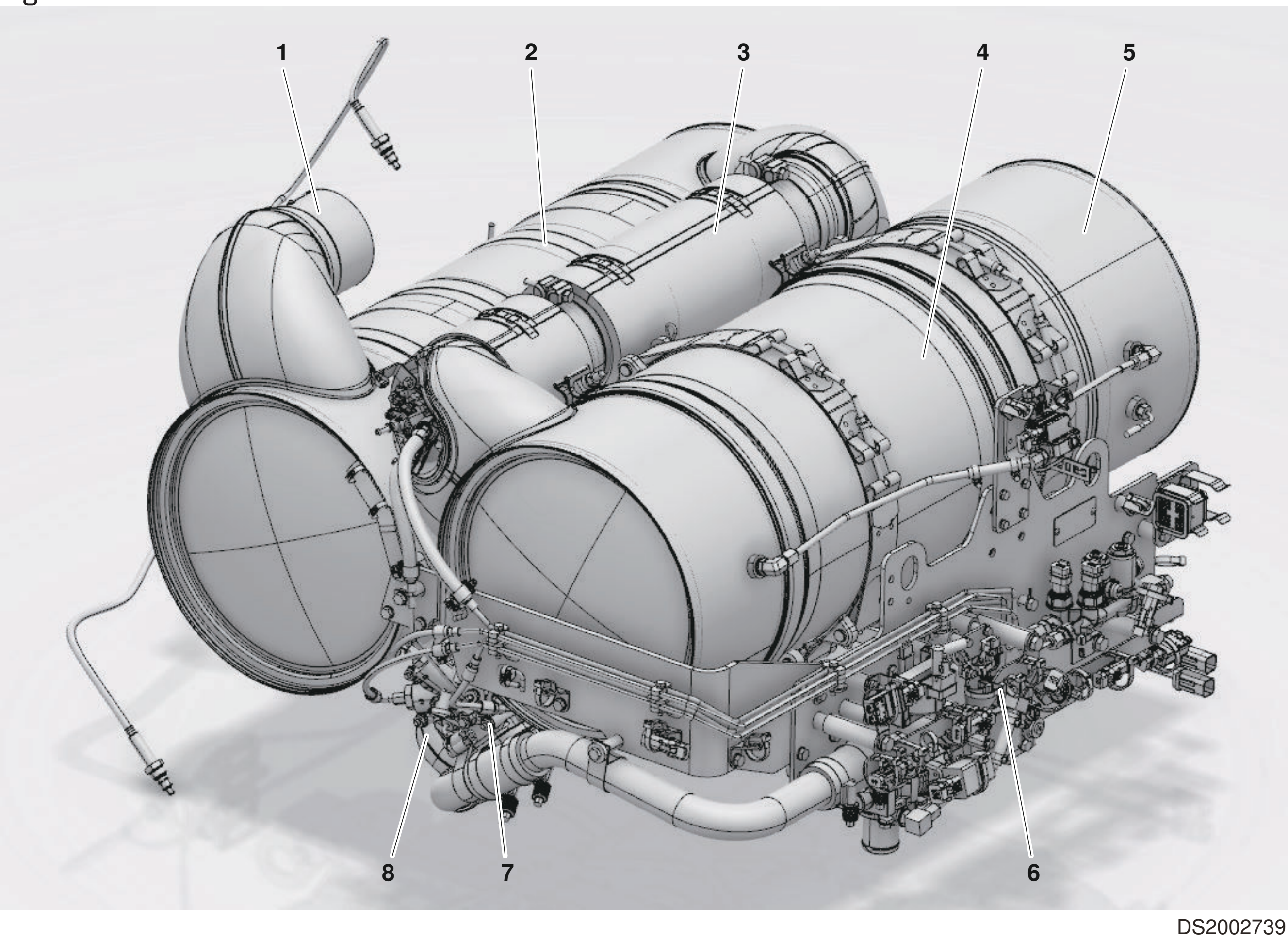


Reference Number	Description
9	Turbocharger
10	Water Temperature Regulator Housing
11	Coolant Pump
12	Oil Cooler
13	Oil Pan
14	Exhaust Cooler
15	Flywheel

Aftertreatment System

Clean Emission Module

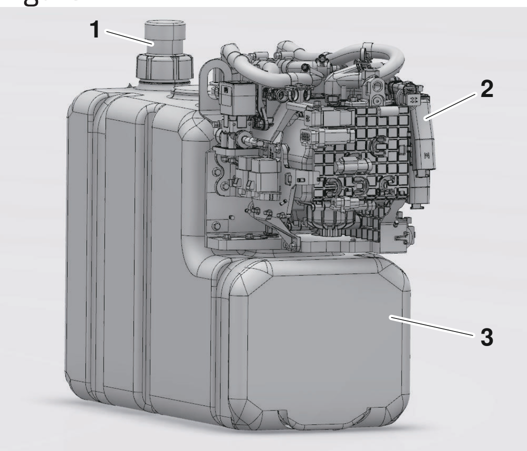
Figure 86



Reference Number	Description
1	Exhaust Outlet
2	Selective Catalytic Reduction (SCR)
3	Mixing Pipe
4	Diesel Particulate Filter (DPF)
5	Diesel Oxidation Catalyst (DOC)
6	CEM Sensors and Fuel System
7	Aftertreatment Regeneration Device (ARD)
8	Exhaust Inlet

Pump Electronic Tank Unit (PETU)

Figure 87



Reference Number	Description
1	DEF Filler Cap
2	ECM
3	DEF Tank

Product Description

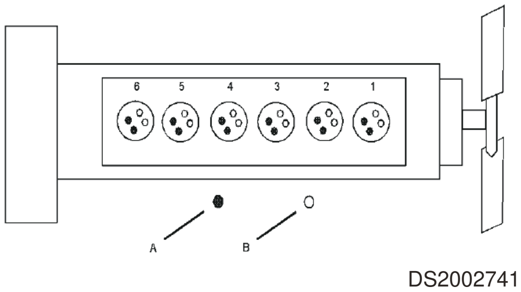
The engine has the following characteristics:

- Four-stroke cycle
- Mechanically actuated, electronically controlled fuel injection system
- Turbocharged
- Air to air charged cooled
- Aftertreatment system

The Clean Emissions Module (CEM) is constructed of four main items, the diesel Aftertreatment Regeneration Device (ARD) oxidation catalyst, the diesel particulate filter, and the Selective Catalytic Reduction (SCR). The SCR requires the use of Diesel Exhaust Fluid (DEF) to be injected into the system to lower the emissions from the engine. The (DEF) is stored and controlled by the pump electronic tank unit. The DEF tank can be installed separate from the electronic pump unit.

Engine Specifications

Figure 88



NOTE: *The front end of the engine is opposite the flywheel end of the engine. The left and the right sides of the engine are determined from the flywheel end. The number 1 cylinder is the front cylinder.*

Cylinder and valve location

Reference Number	Description
1	Exhaust Valve
2	Inlet Valve

Electronic Engine Features

The engine is designed for electronic controls. The integral on board computer controls the operation of the engine. Current operating conditions are monitored. The Electronic Control Module (ECM) controls the response of the engine to these conditions and to the demands of the operator. These conditions and operator demands determine the precise control of fuel injection by the ECM. The electronic engine control system provides the following features:

- Engine speed governor
- Automatic air / fuel ratio control
- Torque rise shaping
- Injection timing control
- System diagnostics
- Aftertreatment regeneration control
- NOX reduction system control

Extra Features

The following extra features provide increased engine fuel economy and serviceability:

- Cold starting capability
- Tampering detection
- Diagnostics

Engine Diagnostics

The engine has built-in diagnostics to ensure that all the components are functioning properly. Under certain conditions, the engine horsepower and the vehicle speed may be limited. An electronic service tool may be used to display the diagnostic code.

There are two categories of codes: diagnostic code and event code. These two categories of codes may be in two different states: active and logged.

Most of the diagnostic codes are logged and stored in the ECM. For additional information, refer to the Operation and Maintenance Manual, Engine Diagnostictopic (Operation Section).

Engine Service Life

Engine efficiency and maximum utilization of engine performance depend on the adherence to proper operation and maintenance recommendations. In addition, use recommended fuels, coolants, and lubricants. Use the Operation and Maintenance Manual as a guide for required engine maintenance.

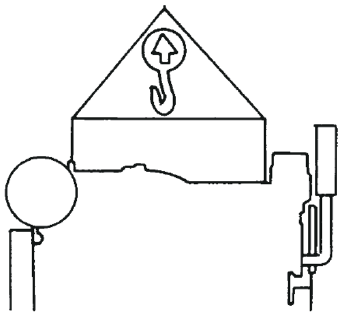
Expected engine life is predicted by the average power that is demanded. The average power that is demanded is based on fuel consumption of the engine over a time. Reduced hours of operation at full throttle and/or operating at reduced throttle settings result in a lower average power demand. Reduced hours of operation will increase the length of operating time before an engine overhaul is required. For more information, refer to the Operation and Maintenance Manual, “Overhaul Considerations” topic.

Operation Section

Lifting and Storage

Product Lifting

Figure 89



DS2002742

NOTICE

Always inspect lifting eyebolts and all other lifting equipment for damage before performing any lifting. Never bend the eyebolts and the brackets. Never perform product lifting if components are damaged. Only load the eyebolts and the brackets under tension. Remember that the capacity of an eyebolt is less as the angle between the supporting members and the object becomes less than 90 degrees.

Use a hoist to remove heavy components. Use an adjustable lifting beam to lift the engine. All supporting members (chains and cables) should be parallel to each other. The chains and cables should be perpendicular to the top of the object that is being lifted.

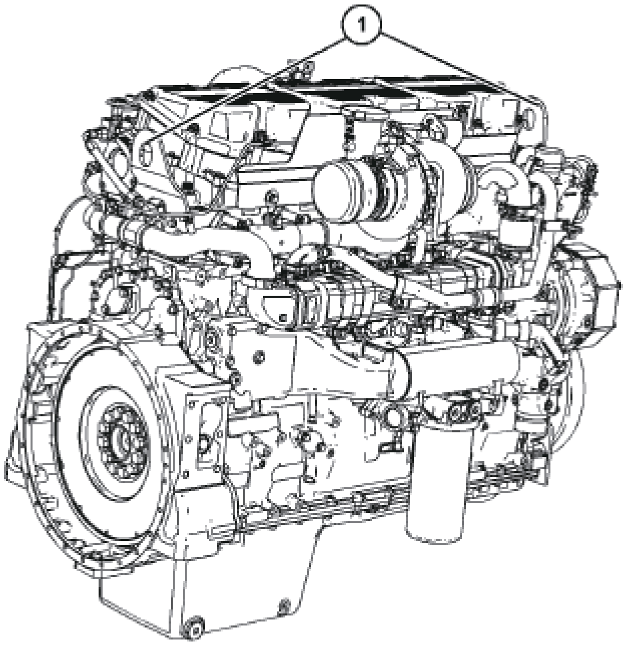
Some removals require lifting the fixtures to obtain proper balance and safety.

To remove the engine ONLY, use the lifting eyes that are on the engine.

Lifting eyes are designed and installed for the specific engine arrangement. Alterations to the lifting eyes and/or the engine make the lifting eyes and the lifting fixtures obsolete. If alterations are made, ensure that proper lifting devices are provided. Consult your dealer for information regarding fixtures for proper engine lifting.

Engine Lifting

Figure 90



Reference Number	Description
1	Engine Lifting Eyes

Engines with a factory-mounted CEM and radiator (or combination thereof) can be lifted by the engine lifting eyes using a certified spreader bar, assuming a less than 5 degree tilt angle can be maintained. For most packages, it is recommended the spreader bar be set at 142 cm (56 inch). The lift hook locations should be approximately 25 mm (1 inch) from spreader bar stop toward the front of the engine.

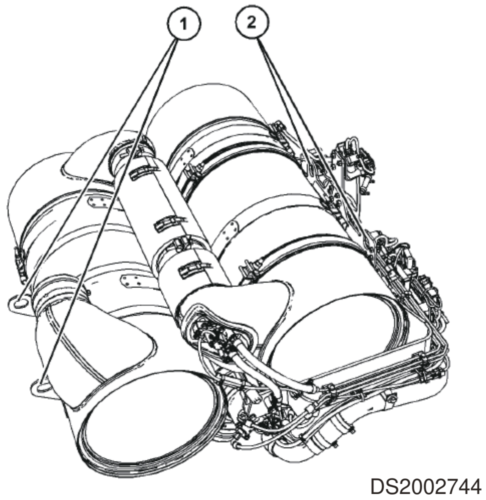
Remove any ATAAC lines, air cleaners, or other attachments that would otherwise interfere with the lift chains or other lifting devises. The engine package center of gravity will change depending on the engine attachments. Adjust the spreader bar and chains as necessary to maintain a lift within 5 degrees of horizontal in all directions.

Radiator Only

Detach the radiator, and mounting bracket at the engine front support. Add eyebolts or lifting brackets to the threaded holes marked for lifting.

Clean Emission Module (CEM) Lifting

Figure 91

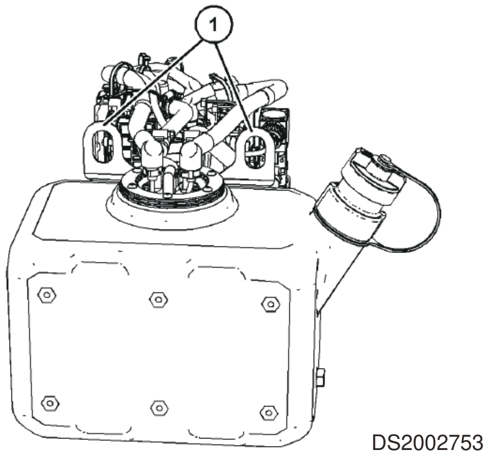


Reference Number	Description
1	CEM Lifting Eyes
2	CEM Lifting Eyes

Ensure that all 4 lifting eyes are used when lifting the CEM. Only use the lifting eyes (1) and lifting eyes (2) for lifting the CEM.

Pump Electronic Tank Unit (PETU)

Figure 92



Reference Number	Description
1	PETU Lifting Eyes

Features and Controls

Monitoring System

The monitoring system is designed to alert the operator to an immediate problem with any of the engine systems that are monitored. The monitoring system is also designed to alert the operator to an impending problem with any of the engine systems that are monitored. The monitoring system can be accessed by the electronic service tool. For more information on the electronic service tool, refer to Troubleshooting , “Electronic Tools”.

Monitoring System Indicators

	Engine Malfunction - This indicator illuminates when there is a fault with the engine or after treatment system.
	Engine STOP - This indicator will illuminate solid when a level 3 warning fault has been detected by the monitoring system.
	Diesel Particulate Filter (DPF) - This indicator will illuminate in order to show that a regeneration is needed.
	Regeneration Active - This indicator will illuminate in order to show that a regeneration is active and exhaust temperatures are elevated.
	Diesel Exhaust Fluid (DEF) Level - This gauge shows the amount of DEF in the DEF tank.
	Emission Malfunction Indicator - This indicator will illuminate when an emissions system related to DEF or SCR has failed.

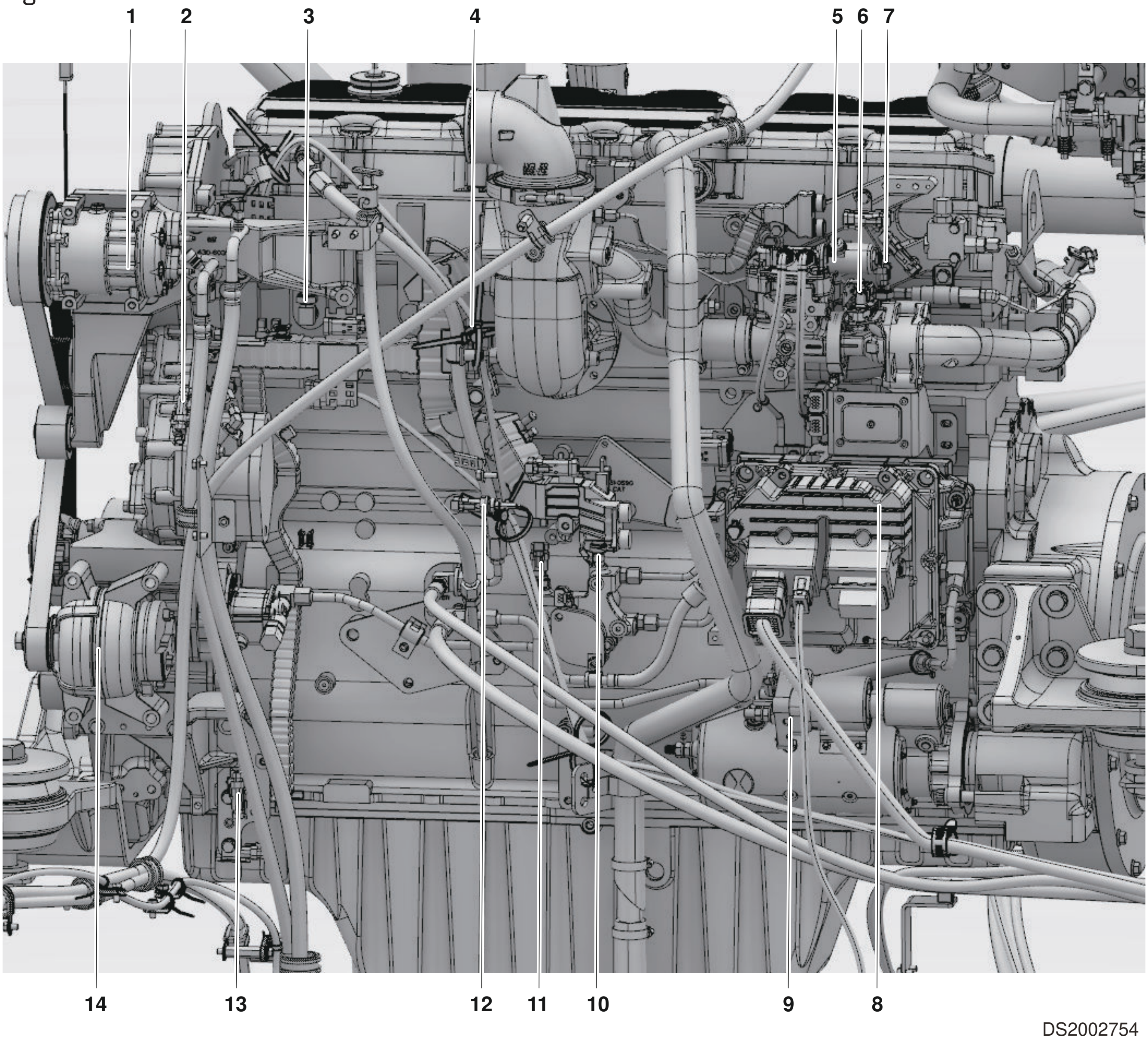
Sensors and Electrical Components

The illustrations within the following sections are typical location of the sensors or electrical components for an industrial engine. Specific engines may appear different due to differences in applications.

NOTE: *Some items have been removed from engine for clarity.*

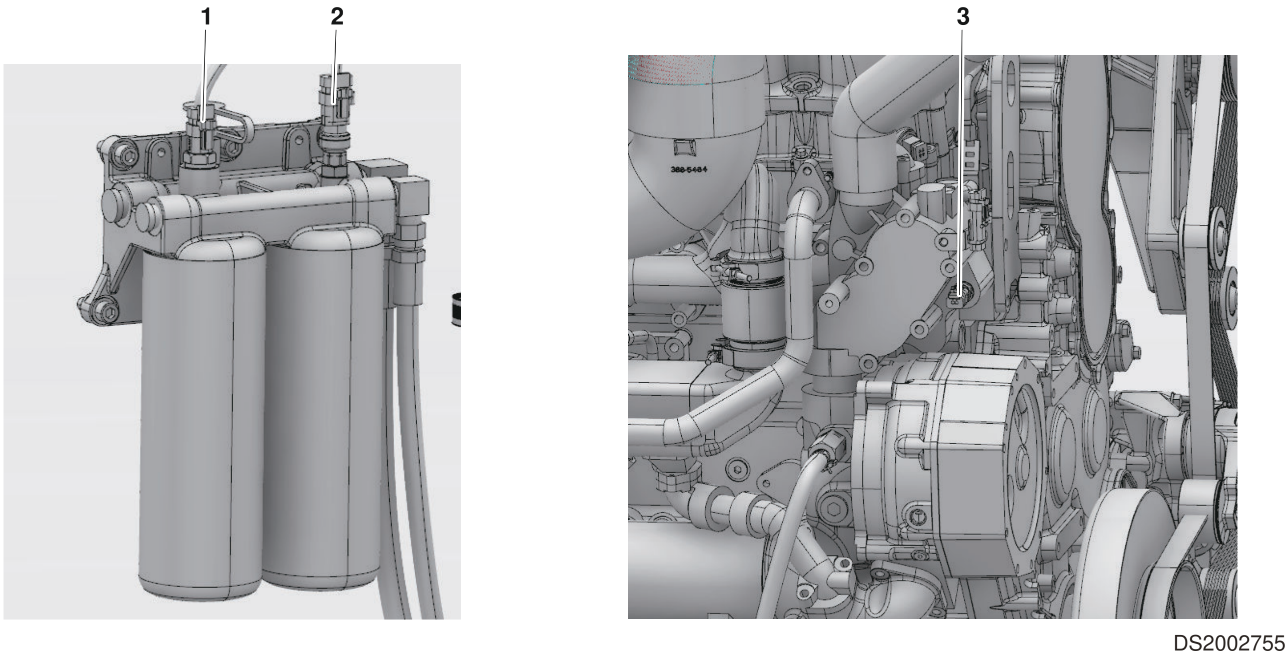
Engine

Figure 93



Reference Number	Description
1	Compressor
2	Secondary Speed / Timing Sensor
3	Boost Pressure Sensor
4	TC Probe
5	NRS Solenoid
6	Differential Pressure Sensor
7	Pressure Sensor
8	ECM Connections
9	Starter Motor
10	Oil Pressure Sensor
11	Barometer Pressure Sensor
12	Inlet Air Temperature Sensor
13	Primary Speed / Timing Sensor
14	Alternator

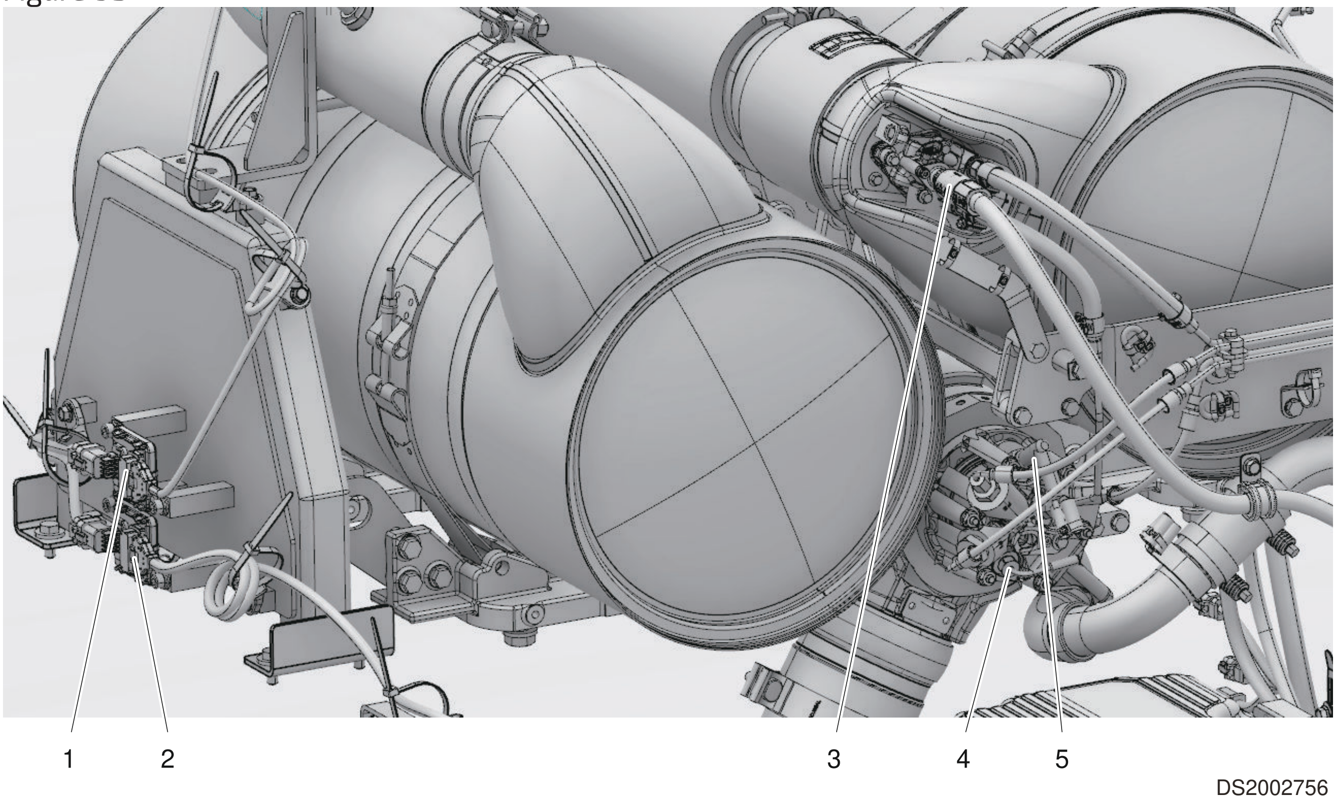
Figure 94



Reference Number	Description
1	Fuel Temperature Sensor
2	Fuel Pressure Sensor
3	Coolant Temperature Sensor

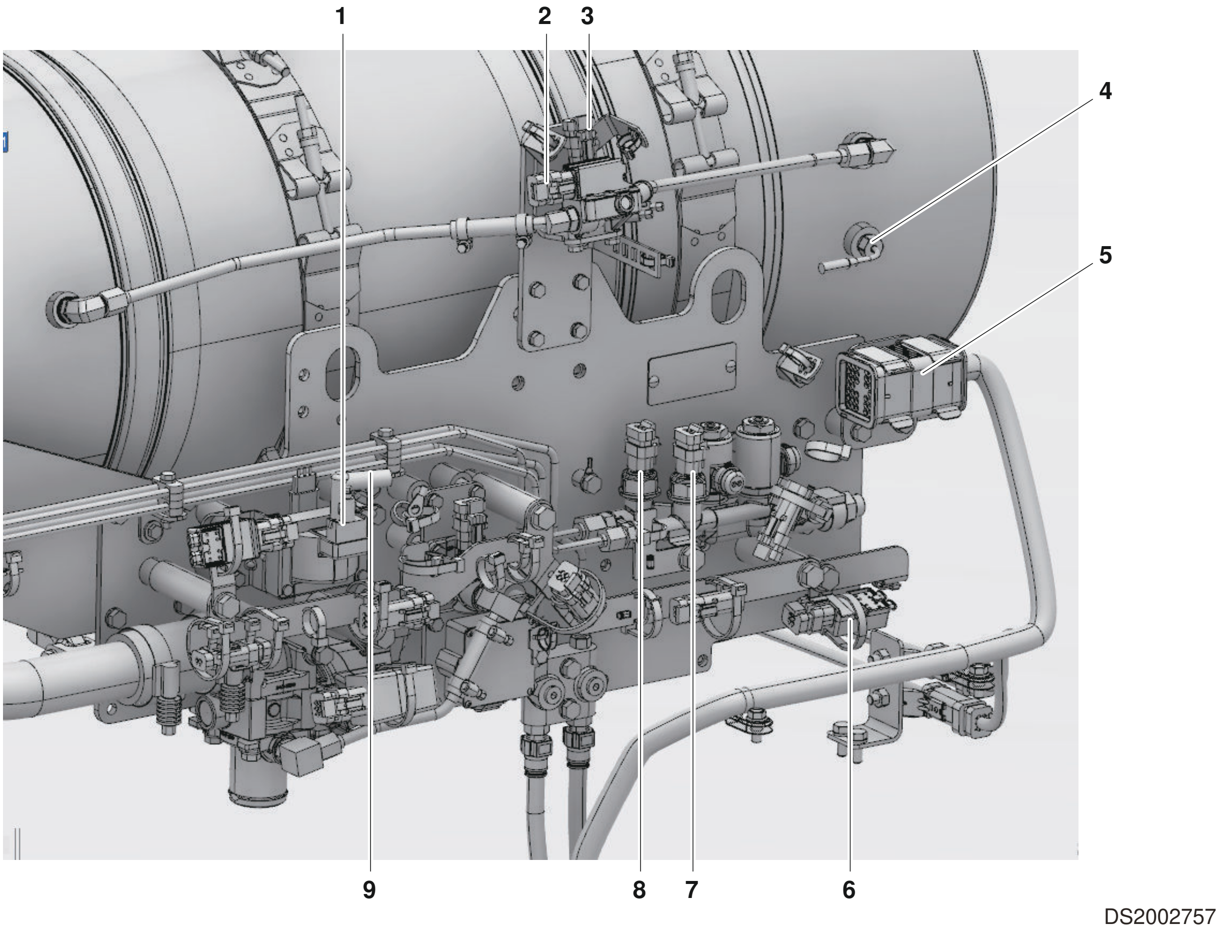
Aftertreatment System

Figure 95



Reference Number	Description
1	NOX Sensor, Downstream
2	NOX Sensor, Upstream
3	DEF Injector
4	ARD Temperature Sensor
5	Spark Plug

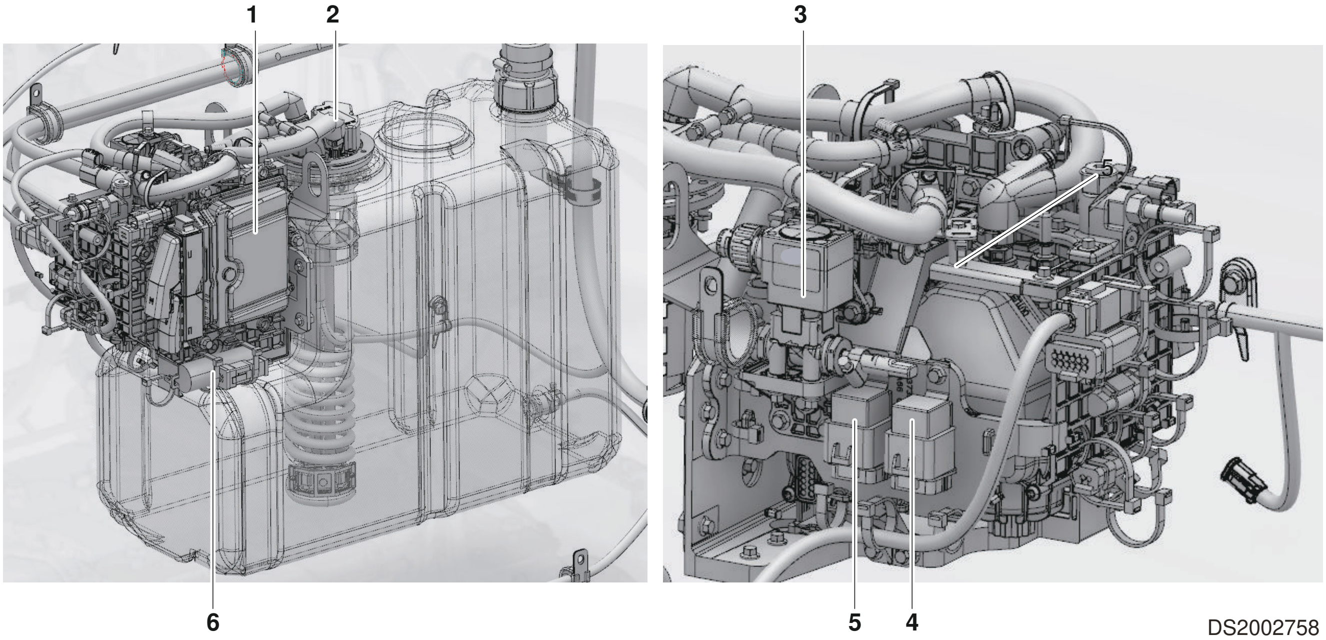
Figure 96



Reference Number	Description
1	Spark Plug Coil
2	Differential Pressure Sensor
3	DPF Pressure Sensor
4	DPF Inlet Temperature Sensor
5	40 Pin Connector
6	SCR Temperature Sensor
7	Fuel Pilot Pressure Sensor
8	Fuel Main Pressure Sensor
9	Identification Module

Pump Electronic Tank Unit (PETU)

Figure 97

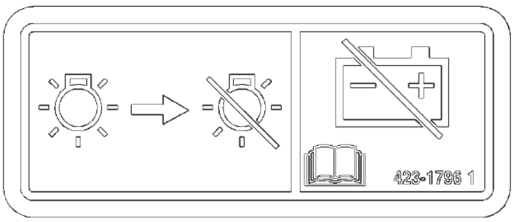


Reference Number	Description
1	DEF Control Unit (DCU)
2	DEF Sender Unit
3	Coolant Diverter Valve
4	DEF Line Heated Relay
5	Main DCU Power Relay
6	Voltage Load Protection Module (VLPM)

DEF header (1) contains level sensor temperature sensor and quality sensor.

Battery Disconnect Switch (If Equipped)

Figure 98



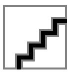
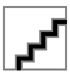
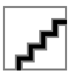
DS2002759

NOTICE

Do not turn off the battery disconnect switch until the indicator lamp has turned off. If the switch is turned off when the indicator lamp is illuminated the Diesel Exhaust Fluid (DEF) system will not purge the DEF. If the DEF does not purge, DEF could freeze and damage the pump and lines.

NOTICE

Never move the battery disconnect switch to the OFF position while the engine is operating. Serious damage to the electrical system could result.

	Battery Disconnect Switch - The battery disconnect switch can be used in order to disconnect the battery from the engines electrical system. The key must be inserted into the battery disconnect switch before the battery disconnect switch can be turned.
	ON - To activate the electrical system, insert the disconnect switch key and turn the battery disconnect switch clockwise. The battery disconnect switch must be turned to the ON position before you start the engine.
	OFF - To deactivate the electrical system, turn the battery disconnect switch counterclockwise to the OFF position.

The battery disconnect switch and the engine start switch perform different functions. The entire electrical system is disabled when you turn the battery disconnect switch to the OFF position. The battery remains connected to the electrical system when you turn the engine start switch to the OFF position.

Turn the battery disconnect switch to the OFF position and remove the key when you service the electrical system or any other engine components.

Turn the battery disconnect switch to the OFF position and remove the disconnect switch key after you operate the engine. This will prevent the battery from being discharged. The following problems can cause battery discharge:

- Short circuits
- Current draw via some components
- Vandalism

Selective Catalytic Reduction Warning System

The selective catalytic reduction (SCR) system is a system used to reduce NOx emissions from the engine. Diesel exhaust fluid (DEF) is pumped from the DEF tank and is sprayed into the exhaust stream. The DEF reacts with the SCR catalyst to reduce NOx and leaves a nitrogen and water vapor. The Exhaust Gas Recirculation (EGR) system cools, measures, and introduces recalculated exhaust gas into the intake manifold to aid in NOx reduction.

The engine and emissions control system shall be operated, used, and maintained in accordance with the instructions provided to the end user to maintain the emissions performance of the engine within the requirements applicable to the category of the engine. No deliberate tampering with, or misuse of the engine emissions control system should take place. In particular regarding deactivating, or not maintaining the SCR system.

NOTICE

Stopping the engine immediately after the engine has been working under load can result in overheating of SCR components.
Refer to the Operation and Maintenance Manual, "Engine Stopping" procedure to allow the engine to cool and to prevent excessive temperatures in the turbocharger housing and the DEF injector.

NOTICE

Allow at least 2 minutes after shutting down the engine before you turn the battery disconnect switch to OFF. Disconnecting the battery power too soon will prevent purging of the DEF lines after the engine is shut down.

Definitions

Observe the following definitions.

Self-correct - Fault condition no longer exists. An active fault code will no longer be active.

Notification - Action taken by the system to alert the operator of pending Inducement.

Inducement- Engine derates, vehicle speed limits, or other actions intended to prompt the operator to repair or maintain the emission control system.

Inducement Categories - The Inducements are separated into categories. DEF Level has its own inducement fault codes and is separate from the other inducement categories. Whilst DEF level inducements are simply based on the DEF level, the other inducement categories are based on escalating time. The escalating time inducements will always have an associated fault code along with the inducement fault code. The associated fault is the root cause. The escalating time inducement fault code is just an indicator of what level of inducement the engine is in and how much time remains until the next level of inducement. There are three inducement categories (two for European Union) that will trigger an escalating time inducement fault code.

NOTE: *The associated codes for each of the escalating time categories can be found in the Troubleshooting Guide under SCR Warning System Problem.*

First occurrence - When an escalating time inducement fault code becomes active for the first time.

Repeat occurrence - When any escalating time inducement fault code becomes active again within 40 hours of the first occurrence. Engine must run for 40 hours without tripping any escalating time inducement fault before it can get back on first occurrence times.

Safe Harbor Mode (Worldwide) - Safe Harbor Mode is a 20 minute engine run time period that the engine can be operated with full power after reaching a level 3 inducement. Once in level 3 inducement, the operator can perform a key cycle and the engine will enter Safe Harbor Mode. Safe Harbor Mode can only be implemented once. Safe Harbor Mode is not allowed for DEF level inducements with Worldwide configuration.

Safe Harbor Mode (European Union)- Safe Harbor Mode is a 30 minute engine run time period that the engine can be operated with full power after reaching a level 3 inducement. Once in level 3 inducement, the operator can perform a key cycle and the engine will enter Safe Harbor Mode. Safe Harbor Mode can only be implemented up to three times.

Figure 99Def Level Normal

NOTICE

It is essential to take prompt action to rectify any incorrect operation, use, or maintenance of the emissions SCR control system in accordance with the rectification measures indicated by the warnings listed on the following pages.

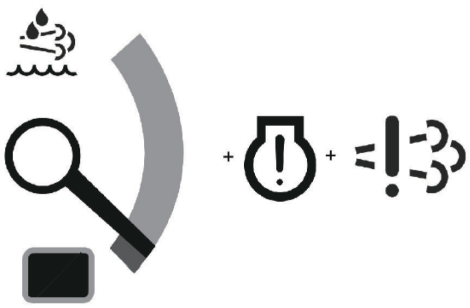
Inducement Strategy for DEF Level (European Union)

Figure 100

DS2002761

If the DEF level falls below 20%, an amber indicator will illuminate next to the DEF level gauge on the dash. To avoid further inducements, turn the key to the OFF position and add DEF to the DEF tank.

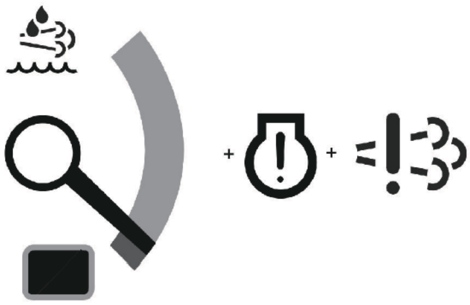
Figure 101



DS2002762

If the DEF level falls below 13.5%, a level 1 inducement event will occur. The check engine lamp and the emissions malfunction indicator lamp will illuminate. The amber indicator next to the DEF level gauge on the dash will remain lit.

Figure 102



DS2002762

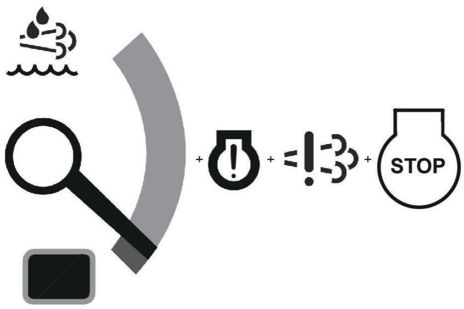
Reduced Performance

When the ECM is configured to "Reduced Performance" and the DEF level is below 1%, the engine will be in level 2 inducement. The check engine lamp and emissions malfunction indicator lamp will illuminate and flash slowly. The DEF level gauge amber lamp will remain lit. The engine will have a 50% derate. When the DEF tank has been emptied of all DEF, the engine will have a 100% derate and be limited to 1000 rpm or low idle, whichever is greater. No further inducement action will occur for "Reduced Performance" configuration. Safe Harbor Mode is allowed for three key cycles.

Reduced Time

When the ECM is configured to “Reduced Time” and the DEF level is below 7.5%, the engine will be in level 2 inducement. The check engine lamp and emissions malfunction indicator lamp will illuminate and flash.

Figure 103



DS2002763

Reduced Time

If the ECM is configured to “Reduced Time” and the DEF level is 0%, the engine will be in level 3 inducement. The check engine lamp and emissions malfunction indicator lamp will illuminate and flash at a fast rate. A red stop lamp will illuminate solid. The DEF level gauge amber lamp will remain lit. The engine will have a 100% derate and be limited to 1000 rpm or low idle, whichever is greater. If the final inducement action in ET is set to “Idle Down”, then the engine will continue to idle at derated condition. If set to “Shutdown”, engine will shut down after 5 minutes. Safe Harbor Mode is allowed for three key cycles. After Safe Harbor Mode is completed, the engine will return to idle or shut down. If in shutdown configuration, the engine may be restarted, but will only run for 5 minutes at derated condition before shutting down again. This action will continue until the issue is resolved.

NOTE: *Turn the key to the OFF position and add DEF to the DEF tank to reset the DEF level inducement.*

Inducement Strategy for Escalating Time Inducement Faults (European Union)

Reduced Performance

Figure 104

DS2002764

The check engine and emissions malfunction indicator lamp will illuminate for a level 1 inducement related fault. There are two inducement categories. If the inducement is a result of a category 1 fault, then a level 1 inducement will occur for a duration of 36 hours. If the inducement is a result of a category 2 fault, then a level 1 inducement will occur for a duration of 10 hours. There is no repeat occurrence for level 1 faults.

Reduced Time

The check engine and emissions malfunction indicator lamp will illuminate for a level 1 inducement related fault. There are two inducement categories. If the inducement is a result of a category 1 fault, then a level 1 inducement will occur for a duration of 18 hours. If the inducement is a result of a category 2 fault, then a level 1 inducement will occur for a duration of 5 hours. There is no repeat occurrence for level 1 faults.

Reduced Performance

Figure 105

DS2002764

If a fault condition exists for the entire duration of inducement level 1, the strategy advances to inducement level 2. The check engine lamp and the emissions malfunction indicator lamp will illuminate and flash slowly. If the inducement is a result of a category 1 fault, then a level 2 inducement will occur for a duration of 64 hours for first occurrence. For repeat occurrence, a category 1 level 2 inducement fault will occur for a duration of 5 hours.

If the inducement is a result of a category 2 fault, then a level 2 inducement will occur for a duration of 10 hours. For repeat occurrence, a category 2 level 2 inducement fault will occur for a duration of 2 hours.

The engine will have a 50% derate. If the fault is not corrected before the inducement duration ends, the engine will become 100% derated and be limited to 1000 rpm or low idle, whichever is greater. No further inducements will occur for “Reduced Performance” configuration. Safe Harbor Mode is allowed for three key cycles.

Reduced Time

If a fault condition exists for the entire duration of inducement level 1, the strategy advances to inducement level 2. The check engine lamp and the emissions malfunction indicator lamp will illuminate and flash slowly. If the inducement is a result of a category 1 fault, then a level 2 inducement will occur for a duration of 18 hours for first occurrence. For repeat occurrence, a category 1 level 2 inducement fault will occur for a duration of 108 minutes.

If the inducement is a result of a category 2 fault, then a level 2 inducement will occur for a duration of 5 hours. For repeat occurrence, a category 2 level 2 inducement fault will occur for a duration of 1 hour.

Reduced Time

Figure 106

DS2002765

If configured to "Reduced Time" and a fault condition exists for the entire duration of inducement level 2, the strategy advances to inducement level 3. Inducement level 3 has the same actions for all categories. The check engine lamp and emissions malfunction indicator lamp will flash at a fast rate. A red stop lamp will also illuminate solid. The engine will have a 100% derate and be limited to 1000 rpm or low idle, whichever is greater. If the final inducement action in ET is set to "Idle Down" , then engine will continue to idle at derated condition. If set to "Shutdown", engine will shut down after 5 minutes. A key cycle will allow safe harbor mode to initiate. Safe harbor is allowed up to three times. After safe harbor, the engine will be in level 3 final inducement. If set to "Shutdown", the engine may be restarted, but will only run for 5 minutes at derated condition before shutting down again. This action will continue until the issue is resolved.

NOTE: *Contact your dealer for repairs if a fault occurs.*

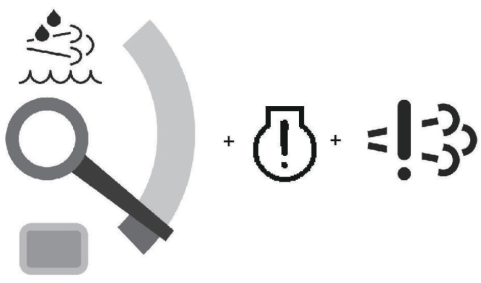
Inducement Strategy for DEF Level (Worldwide)

Figure 107

DS2002766

If the DEF level falls below 20%, an amber indicator will illuminate next to the DEF level gauge on the dash. To avoid inducements, turn the key to the OFF position and add DEF to the DEF tank.

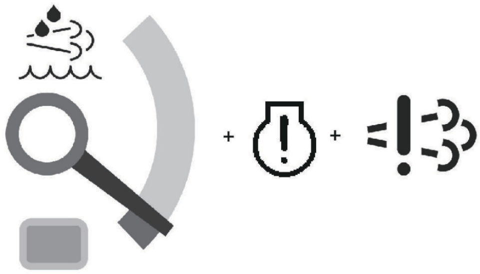
Figure 108



DS2002767

If the DEF level falls below 13.5%, a level 1 inducement event will occur. The check engine lamp and the emissions malfunction indicator lamp will illuminate. The amber indicator next to the DEF level gauge on the dash will remain lit.

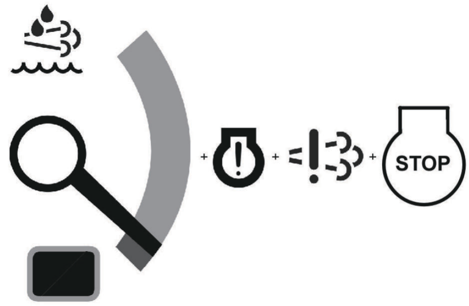
Figure 109



DS2002767

If the DEF level is below 7.5%, a level 2 inducement event will occur. The check engine lamp and the emissions malfunction indicator lamp will illuminate and flash slowly. The amber indicator next to the DEF level gauge on the dash will remain lit. If the ECM is configured to “Reduced Performance” and the DEF level has reached 1%, the machine will be limited to 75% torque.

Figure 110



DS2002763

If the ECM is configured to “Reduced Performance” and the DEF tank has been emptied of all DEF, the engine will be in a level 3 final inducement. If the ECM is configured to “Reduced Time” and the DEF level is 3%, the engine will be in a level 3 final inducement. The check engine lamp and the emissions malfunction indicator lamp will flash at a fast rate and a red stop lamp will illuminate solid. The engine will be taken too low idle or will be shut down. Once shut down, the engine can be restarted for 5 minute periods at reduced speed and torque. If set to idle, the engine will idle indefinitely at reduced torque. The amber indicator next to the DEF level gauge on the dash will remain lit.

NOTE: *Turn the key to the OFF position and add DEF to the DEF tank to reset the DEF level inducement.*

Inducement Strategy for Escalating Time Inducement Faults (Worldwide)

Reduced Performance

Figure 111

DS2002764

The check engine and emissions malfunction indicator lamp will illuminate for a level 1 inducement related fault. There are three inducement categories. If the inducement is a result of a category 1 fault, then a level 1 inducement will occur for a duration of 2.5 hours for first occurrence. For repeat occurrence, a category 1 level 1 inducement fault will occur for a duration of 5 minutes.

If the inducement is a result of a category 2 fault, then a level 1 inducement will occur for a duration of 10 hours. There is no repeat occurrence for category 2, level 1 inducement faults.

If the inducement is a result of a category 3 fault, then a level 1 inducement will occur for a duration of 36 hours. There is no repeat occurrence for category 3, level 1 inducement faults.

Reduced Time

The check engine and emissions malfunction indicator lamp will illuminate for a level 1 inducement-related fault. There are three inducement categories. If the inducement is a result of a category 1 fault, then a level 1 inducement will occur for a duration of 2.5 hours for first occurrence. For repeat occurrence, a category 1 level 1 inducement fault will occur for a duration of 5 minutes.

If the inducement is a result of a category 2 fault, then a level 1 inducement will occur for a duration of 5 hours. There is no repeat occurrence for category 2, level 1 inducement faults.

If the inducement is a result of a category 3 fault, then a level 1 inducement will occur for a duration of 18 hours. There is no repeat occurrence for category 3, level 1 inducement faults.

Figure 112

DS2002764

Reduced Performance

If a fault condition exists for the entire duration of inducement level 1, the strategy advances to inducement level 2. The check engine and emissions malfunction indicator lamp will illuminate and flash slowly for a level 2 inducement related fault. The engine will have a 50% derate. If the inducement is a result of a category 1 fault, then a level 2 inducement will occur for a duration of 70 minutes for first occurrence. For repeat occurrence, a category 1 level 2 inducement fault will occur for a duration of 5 minutes.

If the inducement is a result of a category 2 fault, then a level 2 inducement will occur for a duration of 10 hours. For repeat occurrence, a category 2 level 2 inducement fault will occur for a duration of 2 hours.

If the inducement is a result of a category 3 fault, then a level 2 inducement will occur for a duration of 64 hours. For repeat occurrence, a category 3 level 2 inducement fault will occur for a duration of 5 hours.

Reduced Time

The check engine and emissions malfunction indicator lamp will illuminate for an inducement related fault. There are three inducement categories. If the inducement is a result of a category 1 fault, then a level 1 inducement will occur for a duration of 2.5 hours for first occurrence. For repeat occurrence, a category 1 level 1 inducement fault will occur for a duration of 5 minutes.

If the inducement is a result of a category 2 fault, then a level 1 inducement will occur for a duration of 5 hours. There is no repeat occurrence for category 2, level 1 inducement faults.

If the inducement is a result of a category 3 fault, then a level 1 inducement will occur for a duration of 18 hours. There is no repeat occurrence for category 3, level 1 inducement faults.

Figure 113

DS2002765

If a fault condition exists for the entire duration of inducement level 2, the strategy advances to inducement level 3. Inducement level 3 has the same actions for all categories. The check engine lamp and the emissions malfunction indicator lamp will flash at a fast rate. A red stop lamp will illuminate solid. The engine will have a 100% derate and be limited to 1000 rpm or low idle, whichever is greater. If the final inducement action in ET is set to "Idle Down", then engine will continue to idle at derated condition. If set to "Shutdown" , engine will shut down after 5 minutes. A key cycle will allow safe harbor mode to initiate. Safe harbor is only allowed once. After safe harbor, the engine will be in level 3 final inducement. If set to "Shutdown", the engine may be restarted, but will only run for 5 minutes at derated condition before shutting down again. This action will continue until the issue is resolved.

NOTE: *Contact your dealer for repairs if a fault occurs.*

Engine Diagnostics

Self-Diagnostics

The engine has the capability to perform a self-diagnostics test. When the system detects an active problem, a diagnostic lamp is activated. Diagnostic codes will be stored in permanent memory in the Electronic Control Module (ECM).

Some installations have electronic displays that provide direct readouts of the engine diagnostic codes. Refer to the manual that is provided by the OEM for more information on retrieving engine diagnostic codes.

Active codes represent problems that currently exist. These problems should be investigated first.

Logged codes represent the following items:

- Intermittent problems
- Recorded events
- Performance history

The problems may have been repaired since the logging of the code. These codes do not indicate that a repair is needed. The codes are guides or signals when a situation exists. Codes may be helpful to troubleshoot problems.

When the problems have been corrected, the corresponding logged fault codes should be cleared.

Fault Logging

The system provides the capability of Fault Logging. When the Electronic Control Module (ECM) generates an active diagnostic code, the code will be logged in the memory of the ECM. The codes that have been logged by the ECM can be identified by the electronic service tool. The active codes that have been logged will be cleared when the fault has been rectified or the fault is no longer active. The following logged faults cannot be cleared from the memory of the ECM without using a factory password: Overspeed, low engine oil pressure, high engine coolant temperature, and aftertreatment codes.

Engine Starting

Before Starting Engine

Perform the required daily maintenance and other periodic maintenance before the engine is started. Inspect the engine compartment. This inspection can help prevent major repairs at a later date. Refer to the Operation and Maintenance Manual, "Maintenance Interval Schedule" for more information.

- For the maximum service life of the engine, make a thorough inspection before the engine is started. Look for the following items: oil leaks, coolant leaks, loose bolts and trash buildup. Remove trash buildup and arrange for repairs, as needed.
- Inspect the aftercooler for loose connections and for debris buildup.
- Inspect the cooling system hoses for cracks and for loose clamps.
- Inspect the alternator and accessory drive belts for cracks, breaks, and other damage.
- Inspect the wiring for loose connections and for worn wires or frayed wires.
- Check the fuel supply. Drain water from the water separator (if equipped). Open the fuel supply valve.

NOTICE

All valves in the fuel return line must be open before and during engine operation to help prevent high fuel pressure. High fuel pressure may cause filter housing failure or other damage.

If the engine has not been started for several weeks, fuel may have drained from the fuel system. Air may have entered the filter housing. Also, when fuel filters have been changed, some air pockets will be trapped in the engine. In these instances, prime the fuel system. Refer to the Operation and Maintenance Manual, "Fuel System - Prime" for more information on priming the fuel system.

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

Engine exhaust contains products of combustion which may be harmful to your health. Always start and operate the engine in a well ventilated area and, if in an enclosed area, vent the exhaust to the outside.

- Do not start the engine or move any of the controls if there is a "DO NOT OPERATE" warning tag or similar warning tag attached to the start switch or to the controls.
- Ensure that the areas around the rotating parts are clear.
- All of the guards must be put in place. Check for damaged guards or for missing guards. Repair any damaged guards. Replace damaged guards and/or missing guards.
- Disconnect any battery chargers that are not protected against the high current drain that is created when the electric starting motor (if equipped) is engaged. Check electrical cables and check the battery for poor connections and for corrosion.
- Reset all of the shutoffs or alarm components.
- Check the engine lubrication oil level. Maintain the oil level between the "ADD" mark and the "FULL" mark on the oil level gauge.

- Check the coolant level. Observe the coolant level in the coolant recovery tank (if equipped). Maintain the coolant level to the "FULL" mark on the coolant recovery tank.
- If the engine is not equipped with a coolant recovery tank maintain the coolant level within 13 mm (0.5 inch) of the bottom of the filler pipe. If the engine is equipped with a sight glass, maintain the coolant level in the sight glass.
- Observe the air cleaner service indicator (if equipped). Service the air cleaner when the yellow diaphragm enters the red zone, or when the red piston locks in the visible position.
- Ensure that any driven equipment has been disengaged. Minimize electrical loads or remove any electrical loads.

Starting the Engine

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

Engine exhaust contains products of combustion which may be harmful to your health. Always start and operate the engine in a well ventilated area and, if in an enclosed area, vent the exhaust to the outside.

Refer to the Owners Manual of the OEM for your type of controls. Use the following procedure to start the engine.

1. Place the transmission in NEUTRAL. Disengage the flywheel clutch in order to allow the engine to start faster, and to reduce the draining of the battery.
2. During the key on, all warning lamps will illuminate for a few seconds, in order to test the circuits. If any lamps do not illuminate, check the bulbs and replace as necessary.

   Turn the ignition switch to the ON position.

   NOTICE

   Do not engage the starting motor when flywheel is turning. Do not start the engine under load. If the engine fails to start within 30 seconds, release the starter switch or button and wait two minutes to allow the starting motor to cool before attempting to start the engine again.

3. Do not push down or hold the throttle down while the engine is cranked. The system will automatically provide the correct amount of fuel that is needed to start the engine.

   Push the start button or turn the ignition switch to the START position in order to crank the engine.
4. If the engine fails to start within 30 seconds, release the start button, or the ignition switch. Wait for 2 minutes in order to allow the starting motor to cool before attempting to start the engine again.

   NOTICE

   Oil pressure should rise within 15 seconds after the engine starts. Do not increase engine rpm until the oil pressure gauge indicates normal. If oil pressure is not indicated on the gauge within 15 seconds, DO NOT operate the engine. STOP the engine, investigate and correct the cause.

5. Allow the engine to idle for approximately 3 minutes. Idle the engine until the water temperature gauge has begun to rise. Check all gauges during the warm-up period.

NOTE: *Oil pressures and fuel pressures should be in the normal range on the instrument panel. Engines that are equipped with "WARNING" lamps do not have an operating range. The "WARNING and DIAGNOSTIC" lamp (if equipped) will flash while the engine is cranking. The lamp should turn off after proper engine oil pressure or fuel pressure is achieved. Do not apply a load to the engine or increase engine rpm until the oil pressure gauge indicates at least normal pressure. Inspect the engine for leaks and/or unusual noises.*

If the engine is operated with a low load, the engine will reach normal operating temperature sooner than idling the engine with no load. When the engine is idled in cold weather, increase the engine rpm to approximately 1000 to 1200 rpm in order to raise engine temperature. Do not exceed the recommended rpm in order to increase the speed of the warm-up. Limit unnecessary idle time to 10 minutes.

Starting Problems

An occasional starting problem may be caused by one of the following items:

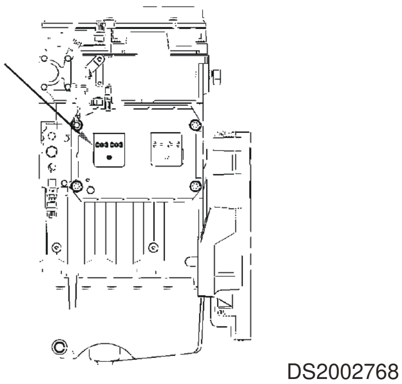
- Low battery charge
- Lack of fuel
- Problem with the wiring harness

If the engine fuel system has been run dry, fill the fuel tank and prime the fuel system.

If the other problems are suspected, perform the appropriate procedure in order to start the engine.

Problems with the Wiring Harness

Figure 114



ECM Connector J2/P2

Locate the ECM. Check the connector in order to ensure that the connector is secure. Lightly pull each of the wires in the chassis harness.

1. Pull each wire with approximately 4.5 kg (10 lb) of force. The wire should remain in the connector.
2. If a wire is loose, push the wire back into the connector. Pull the wire again in order to ensure that the wire is secure.
3. Start the engine. If the engine does not start, check for a diagnostic code and consult your dealer.

Cold Weather Starting

Startability will be improved at temperatures below 10°C (50°F) from the use of a cylinder block coolant heater or from other means that are used to heat the crankcase oil. Some engine applications use a jacket water heater to improve startability. Use of a jacket water heater will help reduce white smoke and misfire during start-up in cold weather.

NOTE: *If the engine has not been run for several weeks, fuel may have drained. Air may have moved into the filter housing. Also, when fuel filters have been changed, some air will be left in the filter housing. Refer to the Operation and Maintenance Manual, "Fuel System - Prime" (Maintenance Section) for more information on priming the fuel system.*

Ether Injection System (If Equipped)

The ether injection system is controlled by the ECM. The ECM monitors the coolant temperature, intake air temperature, ambient air temperature, and barometric pressure to determine when ether injection is needed. At sea level, ether will be used if any of the temperatures fails to exceed 0°C (32°F). This temperature is subject to an increase as barometric pressure increases.

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

Personal injury or property damage can result from alcohol or starting fluids.

Alcohol or starting fluids are highly flammable and toxic and if improperly stored could result in injury or property damage.

Follow the procedure in this Operation and Maintenance Manual, "Starting the Engine".

Starting with Jump Start Cables (Do Not Use This Procedure in Hazardous Locations that have Explosive Atmospheres)

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

The connection of battery cables to a battery and the disconnection of battery cables from a battery may cause an explosion which may result in injury or death. The connection and the disconnection of other electrical equipment may also cause an explosion which may result in injury or death. The procedures for the connection and the disconnection of battery cables and other electrical equipment should only be performed in a nonexplosive atmosphere.

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

Improper jump start cable connections can cause an explosion resulting in personal injury.

Prevent sparks near the batteries. Sparks could cause vapors to explode. Do not allow jump start cable ends to contact each other or the engine.

NOTE: *If possible, first diagnose the reason for the starting failure. Refer to Troubleshooting, "Engine Will Not Crank and Engine Cranks But Will Not Start" for further information. Make any necessary repairs. If the engine will not start only due to the condition of the battery, either charge the battery, or start the engine by using another battery with jump-start cables. The condition of the battery can be rechecked after the engine has been switched OFF.*

NOTICE

Using a battery source with the same voltage as the electric starting motor. Use ONLY equal voltage for jump starting. The use of higher voltage will damage the electrical system.

Do not reverse the battery cables. The alternator can be damaged. Attach ground cable last and remove first.

Turn all electrical accessories OFF before attaching the jump start cables.

Ensure that the main power switch is in the OFF position before attaching the jump start cables to the engine being started.

1. Turn the start switch on the stalled engine to the OFF position. Turn off all the engines accessories.
2. Connect one positive end of the jump-start cable to the positive cable terminal of the discharged battery. Connect the other positive end of the jump-start cable to the positive cable terminal of the electrical source.
3. Connect one negative end of the jump-start cable to the negative cable terminal of the electrical source. Connect the other negative end of the jump-start cable to the engine block or to the chassis ground. This procedure helps to prevent potential sparks from igniting the combustible gases that are produced by some batteries.

   NOTE: *The engine ECM must be powered before the starting motor is operated or damage can occur.*
4. Start the engine in the normal operating procedure. Refer to this Operation and Maintenance Manual, "Starting the Engine".
5. Immediately after the engine is started, disconnect the jump-start cables in reverse order.

After jump starting, the alternator may not be able to recharge fully batteries that are severely discharged. The batteries must be replaced or charged to the proper voltage with a battery charger after the engine is stopped. Many batteries which are considered unusable are still rechargeable. Refer to Operation and Maintenance Manual, "Battery - Replace" and Testing and Adjusting Manual, "Battery - Test".

After Starting Engine

NOTE: *In temperatures from 0 to 60°C (32 to 140°F), the warm-up time is approximately 3 minutes. In temperatures below 0°C (32°F), additional warm-up time may be required.*

When the engine is idling during warm-up, observe the following conditions:

- Check for fluid or air leaks at idle rpm and at onehalf full rpm (no load on the engine) before operating the engine under load. Operating the engine at idle and at one-half full rpm with no load is not possible in some applications.
- Operate the engine at low idle until all systems achieve operating temperatures. Check all gauges during the warm-up period.

  NOTE: *Gauge readings should be observed and the data should be recorded frequently while the engine is operating. Comparing the data over time will help to determine normal readings for each gauge. Comparing data over time will also help detect abnormal operating developments. Significant changes in the readings should be investigated.*

Extended Idle at Cold Ambient Temperature

The engine may automatically change speeds when the engine is idling in cold ambient temperatures (typically less than 0° C (32° F) for extended periods. The purpose of the automatic speed change is threefold: to maintain the desired operation of the NOx reduction system, to maintain the desired operation of the regeneration system and to keep the engine coolant warm. The engine speed may rise to 1600 rpm for as long as 20 minutes.

The high exhaust system temperature lamp may illuminate during extended idling conditions. This illumination signals that a diesel particulate filter (DPF) regeneration is in progress. Regenerations during cold ambient extended idling may only last up to 10 minutes.

Engine Operation

Engine Operation

Proper operation and maintenance are key factors in obtaining the maximum life and economy of the engine. If the directions in the Operation and Maintenance Manual are followed, costs can be minimized and engine service life can be maximized.

The time that is needed for the engine to reach normal operating temperature can be less than the time taken for a walk-around inspection.

The engine can be operated at the rated rpm after the engine is started and after the engine reaches operating temperature. The engine will reach normal operating temperature sooner during a low engine speed (rpm) and during a low-power demand. This procedure is more effective than idling the engine at no load. The engine should reach operating temperature in a few minutes.

Avoid excess idling. Excessive idling causes carbon buildup, engine slobber and, soot loading of the Diesel Particulate Filter (DPF). These issues are harmful to the engine.

Gauge readings should be observed and the data should be recorded frequently whilst the engine is operating. Comparing the data over time will help to determine normal readings for each gauge. Comparing data over time will also help detect abnormal operating developments. Significant changes in the readings should be investigated.

Engine Operation and the Aftertreatment System

The exhaust gases and hydrocarbon particles from the engine first pass through the Diesel Oxidation Catalyst (DOC). Some of the gases and hydrocarbon particles are oxidized as they pass through the DOC. The gases then pass through the Diesel Particulate Filter (DPF). The DPF collects the soot and any ash that is produced by the combustion in the engine. During regeneration, the soot is converted into a gas and the ash remains in the DPF. The gases finally pass through the Selective Catalytic Reduction (SCR). Before the gases pass through the SCR, Diesel Exhaust Fluid (DEF) is injected into the gas stream. The DEF is controlled by the Pump Electronic Unit (PEU). The mixtures of DEF and the exhaust gas pass through the SCR reducing the NOx in the exhaust emissions.

The engine software will control the amount of DEF that will be required to keep the exhaust emission compliant.

This design of DPF will require a service maintenance interval. Refer to this Operation and Maintenance Manual, “Maintenance Interval Schedule” for more information. The DPF can be expected to function properly for the useful life of the engine (emissions durability period), as defined by regulation, subject to prescribed maintenance requirements being followed.

Diesel Particulate Filter Regeneration

Regeneration

Regeneration is to increase the exhaust temperature for a given time. The Aftertreatment Regeneration Device (ARD) creates the heat which makes regeneration possible. The regeneration process is used to remove soot from the DPF, and warmup the Selective Catalyst Reduction (SCR) system. The DPF traps both soot and ash. The ash is removed through a manual cleaning process. Refer to Operation and Maintenance Manual, “Diesel Particulate Filter - Clean” for more information on the service of the DPF.

Regeneration Indicators

	Regeneration Active - When illuminated, this indicator shows that the system is active. This indicator shows that elevated emission temperatures are possible. This indicator will turn off when regeneration is complete.
	DPF - This indicator will illuminate to show that regeneration is required. This indicator will illuminate when “Time to Regen” is less than a pre-determined amount of time.

	Regeneration Disabled - This indicator will illuminate to show that regeneration has been disabled.

Regeneration Switch

	Force Regeneration - Press in the top switch for 2 seconds to begin regeneration.
	Disable Regeneration - Press in the bottom switch for 2 seconds to disable regeneration.

NOTE: *If equipped with a rocker style switch, the MIDDLE position of the regeneration switch is the default position for automatic regeneration.*

NOTE: *If the engine start switch key is cycled or the "Force Regeneration" switch is pressed for longer than 2 seconds the system will no longer be disabled. When the "Force Regeneration" switch is pressed and "Time to Regen" is less than 8 hours, regeneration will begin if the machine is at low idle and is parked.*

NOTE: *If the engine start switch key is cycled whilst the regeneration system is disabled via the "Disable Regeneration" switch, press and hold the "Disable Regeneration" switch for 2 seconds to reinitiate.*

Modes of Regeneration

Automatic: The Electronic Control Module (ECM) uses multiple inputs from the engine and the machine to determine the best time to perform automatic regeneration. Automatic regenerations can take place throughout the operating cycle of the engine. The regeneration active indicator will be illuminated when regeneration is being performed. Interruptions of the regeneration are acceptable. If regeneration is in progress and the regeneration needs to be stopped, it is permissible to press the "Disable Regeneration" switch.

NOTE: *Automatic adjustments of engine speed may be noticed during regenerations. If regeneration is taking place and the engine is taken to low idle, the engine speed may remain elevated to maintain the regeneration.*

NOTE: *If the machine returns to work whilst automatic regeneration is active, the regeneration may be stopped. The ECM will continue to monitor inputs to determine the best time to restart the regeneration.*

Manual: Manual regeneration is initiated by pressing the "Force Regeneration" switch. Manual regeneration will only be allowed if the "Time to Regen" is less than 8 hours. If the "Force Regeneration" switch is pressed before "Time to Regen" is less than 8 hours, then "Regen not Required" will be displayed. The machine must be stationary, the parking brake must be applied, and the engine must be at low idle to perform manual regeneration.

Disabled:When the regeneration system is in disabled mode, automatic regenerations will not be performed. The DPF indicator will illuminate if manual regeneration is required. The "Time to Regen" displayed on the performance screen will indicate that the time until the next regeneration will be required. However, the DPF indicator may illuminate with time remaining on the display. When the DPF indicator illuminates, the operator must perform manual regeneration.

Regeneration Triggers

Regeneration may be required for the following reasons:

Soot: The DPF will collect soot produced by the engine. Automatic regeneration will become active to reduce soot level.

Start-Up Regeneration: Start-up regeneration is initiated by the ECM after a cold engine start. This regeneration is performed to heat the system to a required temperature for Diesel Exhaust Fluid (DEF) dosing to begin.

SCR Maintenance: Regeneration is performed to maintain the SCR system.

ARD Maintenance: Regeneration is performed to maintain the CRS system.

Regeneration System Warning Indicators

Figure 115

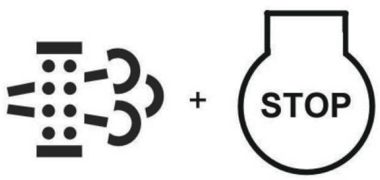
DS2002770

The DPF Indicator will illuminate solid when regeneration is required. Regeneration should be performed as soon as possible.

NOTE: *In some situations, the DPF indicator may stay illuminated after regeneration ends. The illuminated DPF indicator indicates that complete regeneration has not been performed. Complete regeneration is when the soot has been depleted or all the criteria for one of the other regeneration types have been met. If the DPF indicator stays illuminated, perform, regeneration without interruption. The DPF indicator will shut off when regeneration is complete.*

If the soot load is above a threshold or “Time to Regen” is 0 hours, then regeneration is required. The DPF indicator will illuminate and flash slowly. Engine power will be slightly derated. If the machine continues to operate without regeneration, derate will eventually reach 100%. Stop the machine and apply the parking brake. With the engine at low idle, initiate manual regeneration.

Figure 116



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Once the amount of soot collected in the DPF has reached a threshold or “Time to Regen” has been at 0 hours for a pre-determined time, the DPF indicator will illuminate and flash at a fast rate. A red stop lamp will illuminate solid.

10 minutes after the illumination of the DPF indicator and red stop lamp the engine will Shut down. The engine can be restarted by cycling the engine start switch key. The engine will return to the previous derate state before shutdown.

Once the amount of soot collected reaches a threshold level or 6.4 hours of run time has passed since the red stop lamp was illuminated without successful regeneration, the engine will have a 100% derate.

Once the amount of soot collected reaches a critical threshold level, the regeneration will be locked out. Now, regeneration can only be performed by usingelectronic service tool (ET). The engine may be restarted, but will only run for 3 minutes before shutting down again.

A fault code will be active for any DPF system-related issue. Follow the troubleshooting guide to rectify the issue.

If the DPF loses function, or is tampered with in any way, the check engine lamp, and an amber action (if equipped) will illuminate. A fault code will also annunciate. The lamps and fault code will remain active until the problem is rectified.

NOTICE

The engine and emissions control system shall be operated, used, and maintained in accordance with the instructions provided. Failure to follow the instructions could result in emissions performance that does not meet the requirements applicable to the category of the engine. No deliberate tampering with, or misuse of the engine emissions control system should take place. Prompt action is critical to rectify any incorrect operation, use, or maintenance of the emissions control system.

Carbon Dioxide (CO2) Emissions Statement

Emissions regulations require that the value of the CO2 emissions be reported to the end user. For this engine, 760 g/kWh, was determined to be the CO2 value during the EU type approval process. This value was recorded in EU type approval certificate. This CO2 measurement results from testing over a fixed test cycle, under laboratory conditions, with a parent engine representative of the engine family. This value shall not imply or express any guarantee of the performance of a particular engine.

Engaging the Driven Equipment

1. Operate the engine at one-half of the rated rpm, when possible.
2. Engage the driven equipment without a load on the equipment, when possible.

   Interrupted starts put excessive stress on the drive train. Interrupted starts also waste fuel. To get the driven equipment in motion, engage the clutch smoothly with no load on the equipment. This method should produce a start that is smooth and easy. The engine rpm should not increase and the clutch should not slip.
3. Ensure that the ranges of the gauges are normal when the engine is operating at one-half of the rated rpm. Ensure that all gauges operate properly.
4. Increase the engine rpm to the rated rpm. Always increase the engine rpm to the rated rpm before the load is applied.
5. Apply the load. Begin operating the engine at low load. Check the gauges and equipment for proper operation. After normal oil pressure is reached and the temperature gauge begins to move, the engine may be operated at full load. Check the gauges and equipment frequently when the engine is operated under load.

   Extended operation at low idle or at reduced load may cause increased oil consumption and carbon buildup in the cylinders. This carbon buildup results in a loss of power and/or poor performance.

Fuel Conservation Practices

The efficiency of the engine can affect the fuel economy. Follow the recommended procedures in order to attain optimum performance for the life of the engine.

- Avoid spilling fuel.

Fuel expands when the fuel is warmed up. The fuel may overflow from the fuel tank. Inspect fuel lines for leaks. Repair the fuel lines, as needed.

- Be aware of the properties of the different fuels.

Use only the recommended fuels. Refer to the Operations and Maintenance Manual, “Fuel Recommendations” for further information.

- Avoid unnecessary idling.

Shut off the engine rather than idle for long periods of time.

- Observe the service indicator frequently. Keep the air cleaner elements clean.
- Ensure that the turbocharger is operating correctly. For more information refer to this Operation and Maintenance Manual, "Turbocharger - Inspect"
- Maintain a good electrical system.

One faulty battery cell will overwork the alternator. This fault will consume excess power and excess fuel.

- The belt should be in good condition. Refer to the Systems Operation, Testing and Adjusting, "V-Belt Test" for further information.
- Ensure that all of the connections of the hoses are tight. The connections should not leak.
- Ensure that the driven equipment is in good working order.
- Cold engines consume excess fuel. Utilize heat from the jacket water system and the exhaust system, when possible. Keep cooling system components clean and keep cooling system components in good repair. Never operate the engine without water temperature regulators. All of these items will help maintain operating temperatures.

Engine Stopping

Stopping the Engine

NOTICE

Stopping the engine immediately after it has been working under load, can result in overheating and accelerated wear of the engine components.
See the following stopping procedure, to allow the engine to cool, and to prevent excessive temperatures in the turbocharger center housing, which could cause oil coking problems.

1. While the machine is stopped, run the engine for 5 minutes at low idle. Idling the engine allows hot areas of the engine to cool gradually.

   NOTE: *If the "Regen Active" indicator is illuminated, do not shut off the engine. Refer to Operation and Maintenance Manual, "Monitoring System" for more information on indicators. (if equipped)*

2. Turn the engine start switch to the OFF position and remove the key.

   NOTE: *The engine may delay before completely shutting down. Delayed engine shutdowns aid in cooling the engine and after-treatment (if equipped) components.*

Delayed Engine Shutdown (If Enabled)

The Delayed Engine Shutdown allows the engine to run for a time after the engine start switch key is turned to the OFF position to cool the engine and system components. The engine start switch key may be removed.

NOTE: *The DEF purge process will run for 2 minutes once the engine is shut down and must complete. The purge process may occur during delayed engine shutdown. Do not turn off battery disconnect switch during the purge process. Do not turn off the battery power disconnect switch until the battery disconnect switch indicator lamp has turned off. If the purge process does not complete, a diagnostic code will become active.*

NOTE: *There may be regulations that define the requirements for the operator and/or support personnel to be present when the engine is running.*

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

Leaving the machine unattended when the engine is running may result in personal injury or death. Before leaving the machine operator station, neutralize the travel controls, lower the work tools to the ground and deactivate all work tools, and place the lever for the hydraulic lockout control in the LOCKED position.

NOTE: *Leaving the engine unattended while running may result in property damage in the event of a malfunction.*

Turn the engine start switch to the OFF position.

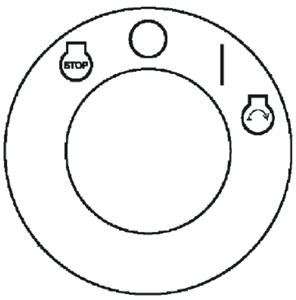
	Delayed Engine Shutdown - The delayed engine shutdown indicator will illuminate or the following text will be displayed, ENGINE COOLDOWN ACTIVE.

Delayed engine shutdown will run whenever the exhaust temperature is above a threshold at engine shutdown. Delayed engine shutdown will run for a minimum of 76 seconds and will continue to run until the engine and system components are cooled. The default maximum run time is 7 minutes.

NOTE: *An authorized dealer can change the maximum run time value up to 30 minutes, but the default setting is 7 minutes.*

NOTE: *To override delayed engine shutdown and stop the engine, turn the engine start switch to the STOP position. Overriding delayed engine shutdown may reduce engine and system component life. A warning message and/or audible alarm will be initiated and a fault code will be logged for improper engine shutdown.*

Figure 117



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NOTE: *At any time during a delayed engine shutdown, the engine start switch may be turned to the ON position. The engine may be placed back into service.*

Manual Stop Procedure

NOTICE

Stopping the engine immediately after it has been working under load can result in overheating and accelerated wear of the engine components.
If the engine has been operating at high rpm and/or high loads, run at low idle for at least three minutes to reduce and stabilize internal engine temperature before stopping the engine.
Avoiding hot engine shutdowns will maximize turbocharger shaft and bearing life.

NOTE: *Individual applications have different control systems. Ensure that the shutoff procedures are understood. Use the following general guidelines in order to stop the engine.*

1. Remove the load from the engine so that the engine has no more than 30% power.

2. Run the engine at the programmed low idle speed for at least 3 minutes.
3. After the cool down period, turn the start switch to the OFF position.

After Stopping Engine

NOTE: *Before you check the engine oil, do not operate the engine for at least 10 minutes in order to allow the engine oil to return to the oil pan.*

- Check the crankcase oil level. Maintain the oil level between the “ADD” mark and the “FULL” mark on the oil level gauge.
- If necessary, perform minor adjustments. Repair any leaks and tighten any loose bolts.
- Note the service hour meter reading. Perform the maintenance that is in the Operation and Maintenance Manual, “Maintenance Interval Schedule”.
- Fill the fuel tank in order to help prevent accumulation of moisture in the fuel. Do not overfill the fuel tank.

NOTICE

Only use antifreeze/coolant mixtures recommended in the Coolant Specifications that are in the Operation and Maintenance Manual. Failure to do so can cause engine damage.

- Allow the engine to cool. Check the coolant level.
- If freezing temperatures are expected, check the coolant for proper antifreeze protection. The cooling system must be protected against freezing to the lowest expected outside temperature. Add the proper coolant/water mixture, if necessary.
- Perform all required periodic maintenance on all driven equipment. This maintenance is outlined in the instructions from the OEM.

Cold Weather Operation

Radiator Restrictions

Airflow restriction can cause the following conditions:

- High exhaust temperatures
- Power loss
- Excessive fan usage
- Reduction in fuel economy

Reducing air flow over components will also affect under hood temperatures. Reducing air flow can increase surface temperatures during an aftertreatment regeneration and could affect component reliability.

Reducing air flow can increase surface temperatures during an aftertreatment regeneration and could affect component reliability.

If an airflow restriction device must be used, the device should have a permanent opening directly in line with the fan hub. The device must have a minimum opening dimension of at least 770 cm2 (120 in2).

A centered opening that is directly in line with the fan hub is specified in order to prevent an interrupted airflow on the fan blades. Interrupted airflow on the fan blades could cause a fan failure.

We recommend a warning device for the inlet manifold temperature and/or the installation of an inlet air temperature gauge. The warning device for the inlet manifold temperature should be set at

75 °C (167 °F). The inlet manifold air temperature should not exceed 75 °C (167 °F). Temperatures that exceed this limit can cause power loss and potential engine damage.

Fuel and the Effect from Cold Weather

NOTE: *Only use grades of fuel that are recommended by HD HYUNDAI CONSTRUCTION EQUIPMENT. Refer to this Operation and Maintenance Manual.*

Properties of the diesel fuel can have a significant effect on the engine cold start capability. It is critical that the low temperature properties of diesel fuel are acceptable for the minimum ambient temperature the engine is expected to see in the operation.

Following properties are used to define fuels low temperature capability:

- Cloud point
- Pour point
- Cold Filter Plugging Point (CFPP)

The cloud point of the fuel is the temperature at which waxes naturally found in the diesel fuel begin to form crystals. The cloud point of the fuel must be below lowest ambient temperature to prevent filters from plugging.

Cold Filter Plugging Point is a temperature at which a particular fuel will pass through a standardized filtration device. This CFPP gives an estimate of the lower operability temperature of fuel

Pour point is the last temperature before the fuel flow stops and waxing of the fuel will start.

Be aware of these properties when diesel fuel is purchased. Consider the average ambient air temperature for the engines application. Engines that are fueled in one climate may not operate well if the engines are shipped to colder climate. Problems can result due to changes in temperature.

Before troubleshooting for low power or for poor performance in the winter, check the fuel for waxing

The following components can provide a means of minimizing fuel waxing problems in cold weather:

- Fuel heaters, which may be an OEM option
- Fuel line insulation, which may be an OEM option

Winter and arctic grades of diesel fuel are available in the countries and territories with severe winters. For more information refer to the Operation and Maintenance Manual, “Fuel For Cold Weather Operation”

Another important fuel property which can affect cold start and operation of diesel engine is Cetane number. Detail and requirements of this property are given in this Operation and Maintenance Manual, “Fluid Recommendations”.

Fuel Related Components in Cold Weather

Fuel Tanks

Condensation can form in partially filled fuel tanks. Top off the fuel tanks after operating the engine.

Fuel tanks should contain some provision for draining water and sediment from the bottom of the tanks. Some fuel tanks use supply pipes that allow water and sediment to settle below the end of the fuel supply pipe.

Some fuel tanks use supply lines that take fuel directly from the bottom of the tank. If the engine is equipped with this system, regular maintenance of the fuel system filter is important.

Drain the water and sediment from any fuel storage tank at the following intervals:

- Weekly
- Oil changes
- Refueling of the fuel tank

This draining will help prevent water and/or sediment from being pumped from the fuel storage tank and into the engine fuel tank.

Fuel Heaters

Fuel heaters help to prevent fuel filters from plugging in cold weather due to waxing. A fuel heater should be installed in order for the fuel to be heated before the fuel enters the primary fuel filter.

Select a fuel heater that is mechanically simple, yet adequate for the application. The fuel heater should also help to prevent overheating of the fuel. High fuel temperatures reduce engine performance and the availability of engine power. Choose a fuel heater with a large heating surface. The fuel heater should be practical in size. Small heaters can be too hot due to the limited surface area.

Disconnect the fuel heater in warm weather.

NOTE: *Fuel heaters that are controlled by the water temperature regulator or self-regulating fuel heaters should be used with this engine. Fuel heaters that are not controlled by the water temperature regulator can heat the fuel in excess of 65°C (149°F). A loss of engine power can occur if the fuel supply temperature exceeds 37°C (100°F).*

NOTE: *Heat exchanger type fuel heaters should have a bypass provision in order to prevent overheating of the fuel in warm-weather operation.*

Maintenance Recommendations

System Pressure Release

Coolant System

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

Pressurized system: Hot coolant can cause serious burn. To open cap, stop engine, wait until radiator is cool. Then loosen cap slowly to relieve the pressure.

To relieve the pressure from the coolant system, turn off the engine. Allow the cooling system pressure cap to cool. Remove the cooling system pressure cap slowly in order to relieve pressure.

Fuel System

To relieve the pressure from the fuel system, turn off the engine.

High Pressure Fuel Lines (If Equipped)

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

The high pressure fuel lines are the fuel lines that are between the high pressure fuel pump and the high pressure fuel manifold and the fuel lines that are between the fuel manifold and cylinder head. These fuel lines are different from fuel lines on other fuel systems.

This is because of the following differences:

- The high pressure fuel lines are constantly charged with high pressure.
- The internal pressures of the high pressure fuel lines are higher than other types of fuel system.

Before any service or repair is performed on the engine fuel lines, perform the following tasks:

1. Stop the engine.

2. Wait for ten minutes.

Do not loosen the high pressure fuel lines in order to remove air pressure from the fuel system.

Engine Oil

To relieve pressure from the lubricating system, turn off the engine.

Welding on Engines with Electronic Controls

NOTICE

Because the strength of the frame may decrease, some manufacturers do not recommend welding onto a chassis frame or rail. Consult your dealer regarding welding on a chassis frame or rail.

Proper welding procedures are necessary in order to avoid damage to the engines ECM, sensors, and associated components. When possible, remove the component from the unit and then weld the component. If removal of the component is not possible, the following procedure must be followed when you weld on a unit equipped with an Electronic Engine. The following procedure is considered to be the safest procedure to weld on a component. This procedure should provide a minimum risk of damage to electronic components.

NOTICE

Do not ground the welder to electrical components such as the ECM or sensors. Improper grounding can cause damage to the drive train bearings, hydraulic components, electrical components, and other components.
Clamp the ground cable from the welder to the component that will be welded. Place the clamp as close as possible to the weld. This will help reduce the possibility of damage.

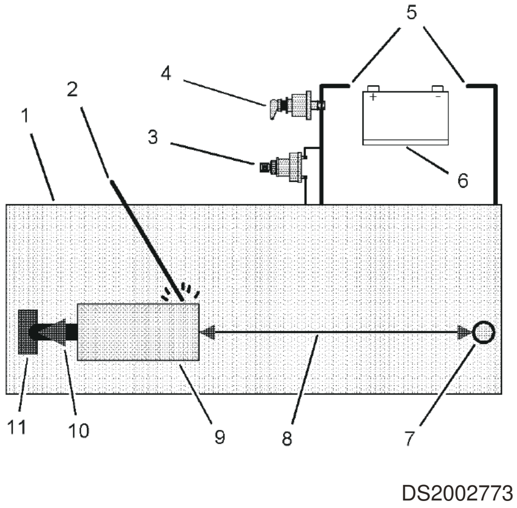
NOTE: *Perform the welding in areas that are free from explosive hazards.*

1. Stop the engine. Turn the switched power to the OFF position.
2. Ensure that the fuel supply to the engine is turned off.
3. Disconnect the negative battery cable from the battery. If a battery disconnect switch is provided, open the switch.
4. Disconnect all electronic components from the wiring harnesses. Include the following components:
   - Electronic components for the driven equipment
   - ECM
   - Sensors
   - Electric operated fuel pump
   - Electronically controlled valves
   - Relays
   - Aftertreatment ID module

   NOTICE

   Do not use electrical components (ECM or ECM sensors) or electronic component grounding points for grounding the welder.

Figure 118



Use the example above. The current flow from the welder to the ground clamp of the welder will not damage any associated components.

Reference Number	Description
1	Engine
2	Welding electrode
3	Keyswitch in the OFF position
4	Battery disconnect switch in the open position
5	Disconnected battery cables
6	Battery
7	Electrical/Electronic component
8	Minimum distance between the component that is being welded and any electrical/electronic component
9	The component that is being welded
10	Current path of the welder
11	Ground clamp for the welder

5. Connect the welding ground cable directly to the part that will be welded. Place the ground cable as close as possible to the weld in order to reduce the possibility of welding current damage to the following components. Bearings, hydraulic components, electrical components, and ground straps.

   NOTE: *If electrical/electronic components are used as a ground for the welder, or electrical/electronic components are located between the welder ground and the weld, current flow from the welder could severely damage the component.*

6. Protect the wiring harness from welding debris and spatter.
7. Use standard welding practices to weld the materials.

Severe Service Application

Severe service is the application of an engine that either exceeds the current published standards for that engine range. Or results in the engine being used at the extremes of certain operating conditions.

- Performance such as power range, speed range, and fuel consumption
- Fuel quality
- Operational altitude
- Maintenance intervals
- Oil selection and maintenance
- Coolant type and maintenance
- Environmental qualities
- Installation
- The temperature of the fluid in the engine

Refer to the standards for the engine or consult your dealer to determine if the engine is operating within the defined parameters.

Severe service operation can accelerate component wear. Engines that operate under severe conditions may need more frequent maintenance intervals to ensure maximum reliability and retention of full service life.

Due to individual applications, identification is not possible for all the factors which can contribute to severe service operation. Consult your dealer for the unique maintenance that is necessary for the engine.

The operating environment, incorrect operating procedures, and incorrect maintenance procedures can be factors which contribute to a severe service application.

Environmental Factors

Ambient temperatures. The engine may be exposed to extended operation in extremely cold environments or hot environments. Valve components can be damaged by carbon buildup if the engine is frequently started and stopped in very cold temperatures. Extremely hot intake air reduces engine performance.

Quality of the air - The engine may be exposed to extended operation in an environment that is dirty or dusty, unless the equipment is cleaned regularly. Mud, dirt, and dust can encase components. Maintenance can be very difficult. The buildup can contain corrosive chemicals.

Buildup - Compounds, elements, corrosive chemicals, and salt can damage some components.

Altitude - Problems can arise when the engine is operated at altitudes that are higher than the intended settings for that application. Necessary adjustments should be made.

Incorrect Operating Procedures

- Extended operation at low idle
- Frequent hot shutdowns
- Operating at excessive loads
- Operating at excessive speeds
- Operating outside the intended application

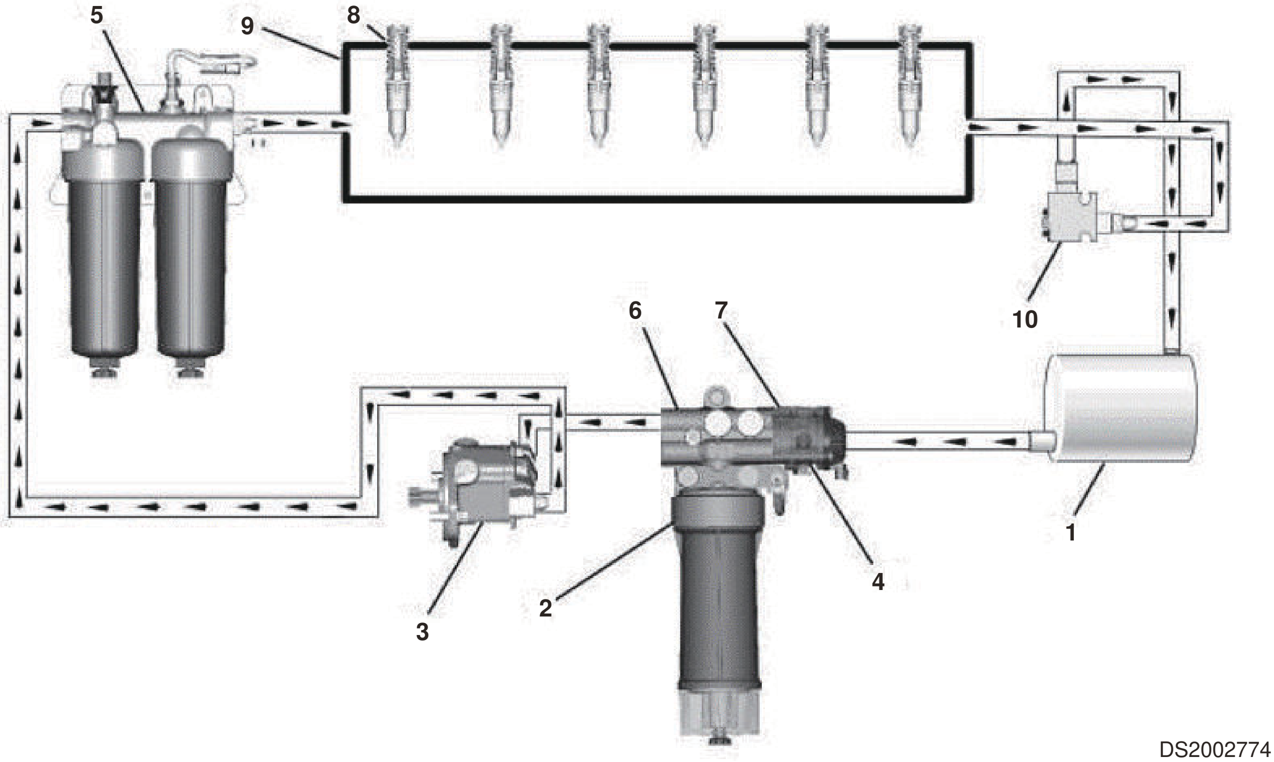
Incorrect Maintenance Procedures

- Extending the maintenance intervals
- Failure to use recommended fuel, lubricants, and coolant/antifreeze

Fuel System

Low Pressure Fuel System

Figure 119

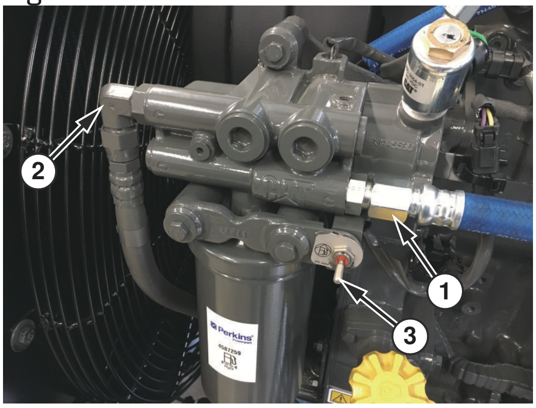


- The low-pressure fuel system supplies fuel from the fuel tank to the injectors. The low-pressure fuel system has four basic functions: Supply fuel for combustion, Supply fuel to cool the injectors, Remove air from the fuel, Warm the fuel in the fuel tank.
- Fuel is pulled from the fuel tank (1) to the primary fuel filter and water separator (2) by the fuel transfer pump (3). The primary fuel filter removes debris from the fuel that is larger than 10 microns before the fuel flows into the fuel transfer pump.
- The fuel transfer pump is a gear pump that contains a pressure relief valve that opens at approximately 414-862 kPa (60-125 psi). Fuel then flows from the outlet port of the fuel transfer pump to the secondary fuel filters (5). The 4 micron filters remove small abrasive contaminants from the fuel system, which can damage the unit injectors.
- The primary fuel filter base (6) contains an electric priming pump (7) pump that contains a pressure regulator (4) that opens at 1900 kPa (276 psi). The priming pump forces the air out of the system through the orifice on the regulator. Priming usually takes place after servicing the fuel system such as the changing of the fuel filter. When air is trapped in the fuel filters, the fuel lines, and other fuel system components, the engine could be difficult to start. This problem can also occur when the engine has not run for a long time. When there is air in the fuel line, the electric priming pump is activated by flipping a switch or by turning the start switch, in order to prime the system. The length of time for priming the fuel system depends on the size of the system, the length of the fuel line, and the size of the filter. The time that is needed in order to prime the fuel system is about 30 seconds. This value varies with different applications. The primary fuel filter base also contains a check valve that prevents reverse flow during priming. Fuel is delivered to the injectors (8) via the cylinder head (9).

- The return fuel pressure regulator (10) consists of a check valve that is spring loaded. When the engine is in the off position and the fuel pressure drops below 413 kPa (60 psi), the check valve closes. The check valve closes in order to prevent the fuel in the cylinder head from draining back into the fuel tank. Retaining the fuel in the head maintains a supply of fuel for the injectors during start-up.
- The pressure relief valve opens at approximately 413-861 kPa (60-125 psi).

Primary Fuel Filter and Electric Priming Pump

Figure 120



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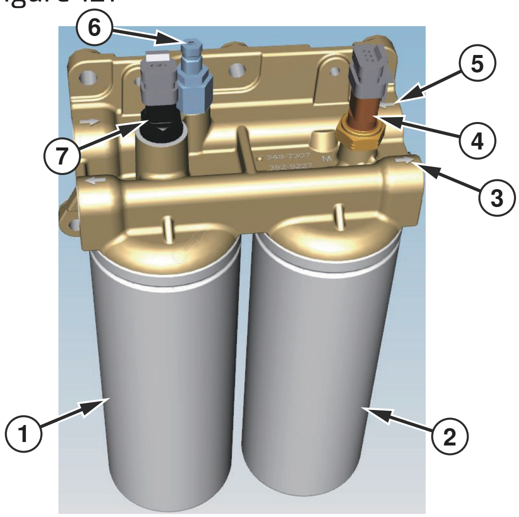
Reference Number	Description
1	Fuel from Tank
2	Fuel to Engine
3	Fuel Priming Switch

Secondary Fuel Filters

Figure 121



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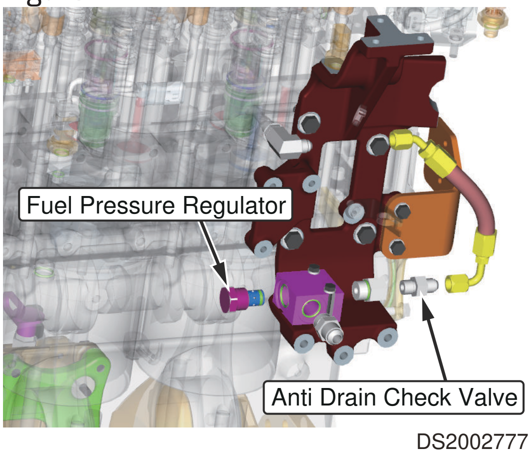
- The 4-micron secondary fuel filter (1) and tertiary fuel filter (2) are spin-on type filters incorporated into a single filter base. These two filters are mounted to the rear of the fuel filter bracket.
- Fuel from the primary fuel filter and water separator is drawn by the fuel transfer pump, which then directs the fuel flow to this dual filter base through a fuel supply line fitted to the filter base

inlet (5). The filtered fuel is returned to the fuel pump through a line fitted to the filter base outlet (3).

- A fuel pressure port (6) is installed in the fuel filter base for connecting a gauge.
- A post-filter fuel pressure sensor (4) is also installed in the fuel filter base and will signal the Engine ECM of the fuel pressure after the secondary fuel filter, but before the tertiary fuel filter.
- Once the fuel has been filtered by the secondary and tertiary fuel filters, the fuel returns to the fuel pump.
- The Engine ECM receives fuel temperature data from the fuel temperature sensor (7) on top of the fuel filter base.

Fuel Return Regulator Block

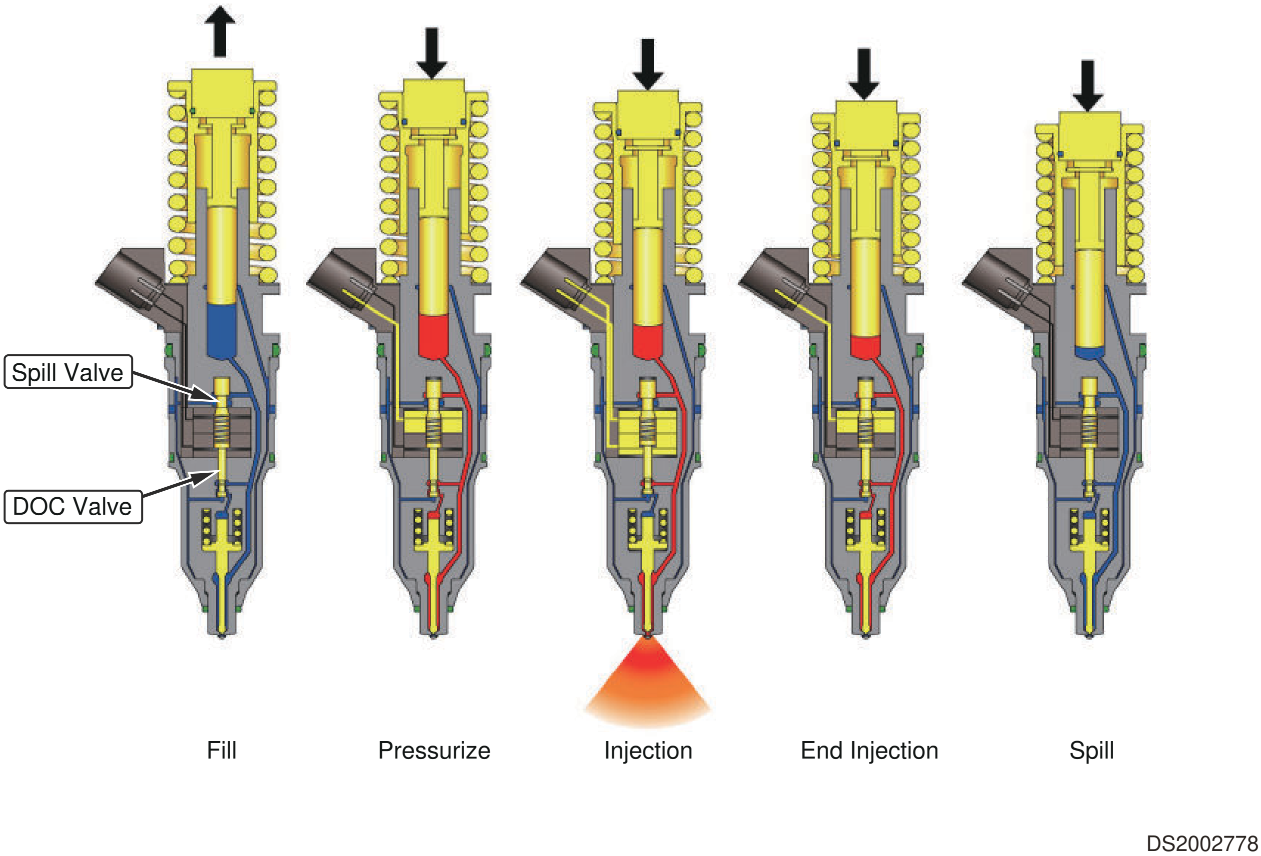
Figure 122



- Contains a low pressure anti drain check valve and main pressure regulating valve
- Anti drain check valve opens at 7 kPa (1 psi)
- Regulator operates at 560 kPa (81 psi) at 6 l/min flow

Injector Operation

Figure 123



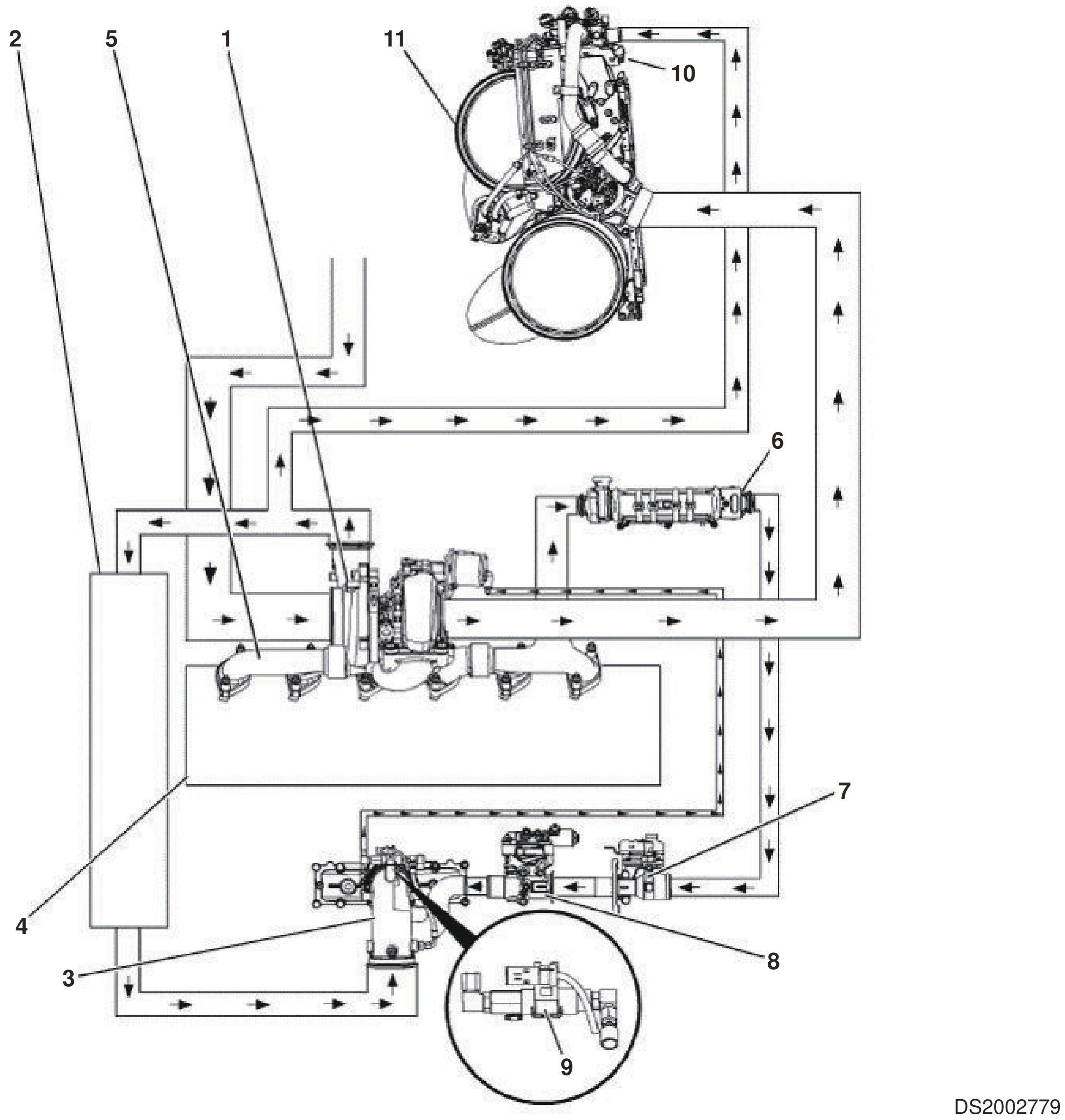
- The spill valve is normally open and fuel spills back into the fuel rail. When the spill solenoid is energized the spill valve is closed and pressure builds inside the injector. Once the pressure is greater than the valve opening pressure then the fuel is injected into the cylinder.
- The Direct Operated Check (DOC) valve controls the pressure at start-up (or the inlet fuel side) and the spill valve controls the pressure upon fuel delivery (or the fuel in the injector). The DOC valve controls the start of injection by varying the time delay between spill and DOC solenoid actuation. The injection pressure must still overcome Valve Opening Pressure (VOP) to inject, but DOC allows the check to be held closed longer to achieve higher injection pressures.
- The DOC solenoid accurately controls the start of injection, pre-load pressure and then pressurize fuel, can also rate shape and help meet emissions.
- The DOC valve controls the number of injections and can change the rate shape by varying the firing of the DOC valve. If there is excessive pressure, the DOC valve will open. When the fuel is pressurizing, the spill valve closes and the DOC valve closes that locks the check piston in place, both of these actions allow the fuel pressure to build.
- During injection, high pressure fuel is injected and the DOC valve opens, allowing the check piston to travel downward and inject the high pressure flow. During end of injection, high pressure is not injected and any residual fuel is allowed to drain. During spill, all fuel is allowed to drain and relieve pressure.

  NOTE: *The spill valve closes and allows the pressure to build for injection. The DOC valve can open and close during injection to create multiple injections at varying times.*

Intake and Exhaust System

Air Inlet and Exhaust System with Regeneration Device

Figure 124

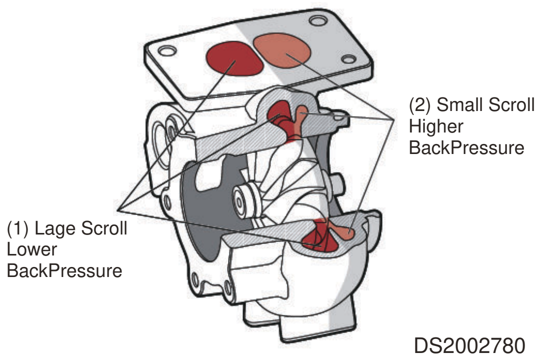


Reference Number	Description
1	Turbocharger
2	Air-to-Air Aftercooler (ATAAC)
3	Intake Manifold
4	Cylinder Head
5	Exhaust Manifold
6	NOx Reduction System (NRS) Cooler
7	NRS Venturi
8	NRS Valve
9	Exhaust Valve Solenoid (Balance Valve)

Reference Number	Description
10	ARD Air Valve
11	Clean Emissions Module (CEM)

Asymmetric Turbocharger

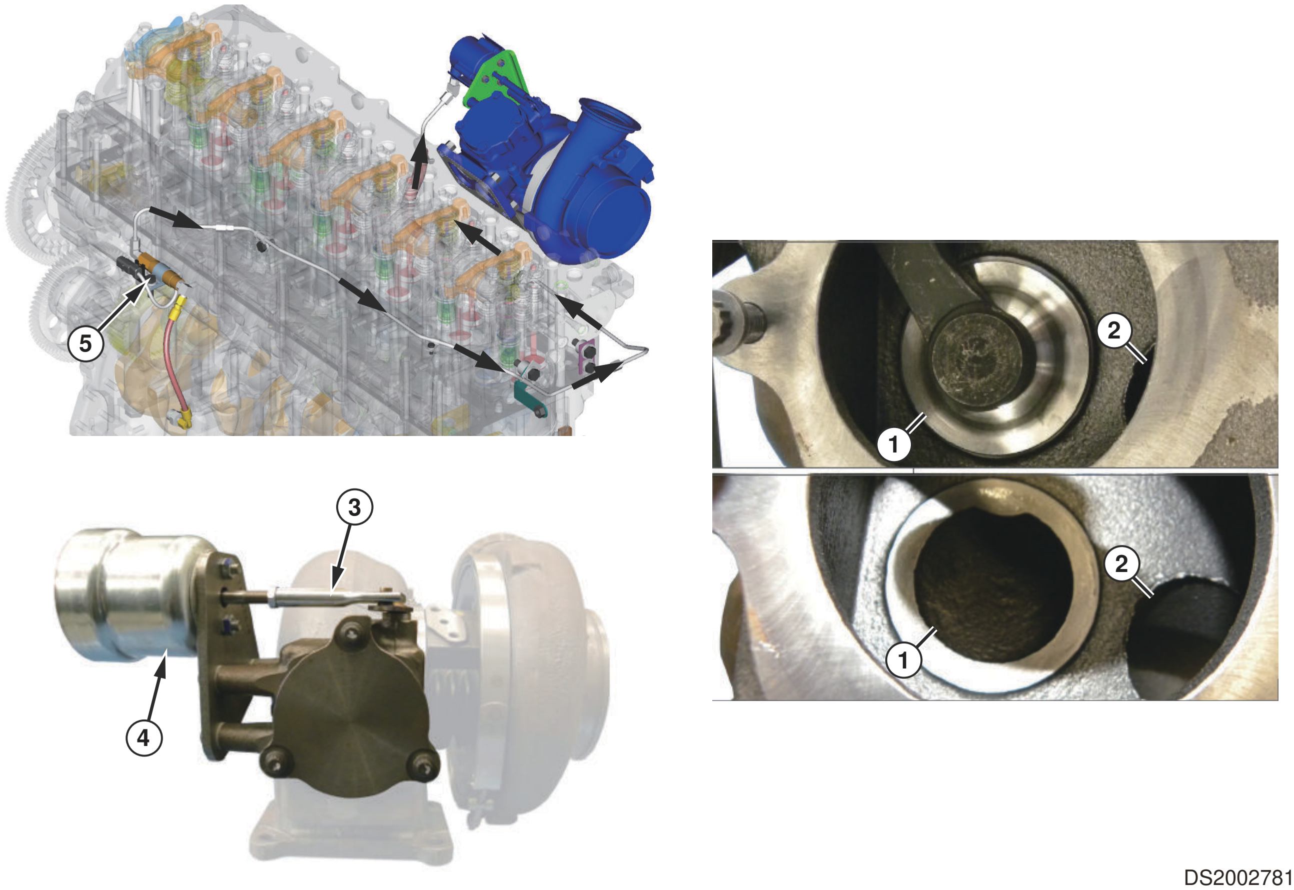
Figure 125



- Internally, the turbocharger uses a design with two different sized scrolls to stream exhaust across the turbine wheel at different velocities. This design helps the turbocharger spool up faster and create backpressure in the exhaust manifold that helps to force exhaust flow through the NRS, when the NRS is active.
- Exhaust gas from the front half of cylinders (e.g. 1, 2, and 3 on a six cylinder engine) flows directly into the smaller scroll in the turbine housing.
- Exhaust gas from the rear half of cylinders (4, 5, and 6) flows into the larger scroll in the turbine housing.
- The small scroll provides a more focused flow of exhaust gas compared to that of the larger scroll. This creates a higher velocity exhaust stream that targets the most efficient segment of the turbine wheel fin profile. The higher velocity exhaust stream helps spin the turbine wheel faster at lower engine rpm than if the scrolls were of equal size.
- The small scroll reduces turbocharger lag and produces improved engine response at lower engine speeds. The small scroll also increases exhaust back pressure (manifold pressure) for cylinders one, two, and three, which is needed to generate sufficient NRS gas flow to the air inlet mixing manifold.

Turbocharger Balance Valve

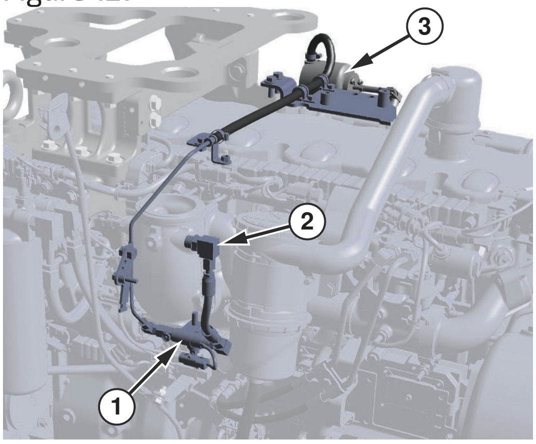
Figure 126



- Most dual scroll turbochargers on engines with EGR are equipped with a balance valve (1) to control boost. The balance valve is built into the turbine housing and controlled by a rod (3) attached to the balance valve actuator (4). When engine speed and load increase, the flow of exhaust gas also increases. To reduce turbine wheel speed and excess boost, some of the exhaust gas flowing from the first three cylinders can be diverted away from the small scroll by opening the balance valve.
- Boost pressure is used to open the balance valve on the turbocharger.
- The actuator for the exhaust balance valve receives boost pressure from the intake manifold. This boost pressure is first regulated by the balance valve solenoid (5). The balance valve solenoid then directs boost pressure to the turbocharger balance valve actuator assembly, only at times when needed.
- The actuator then opens the exhaust balance valve and allows the flowing gas from the small path of the turbine housing to enter the large path. This action causes less exhaust gas to act on the turbine wheel from the smaller flow path, thus slowing down the speed of the turbine wheel in order to protect the turbocharger. A secondary effect is reduced flow through the NOx Reduction system (NRS).

Balance Valve Solenoid Operation

Figure 127



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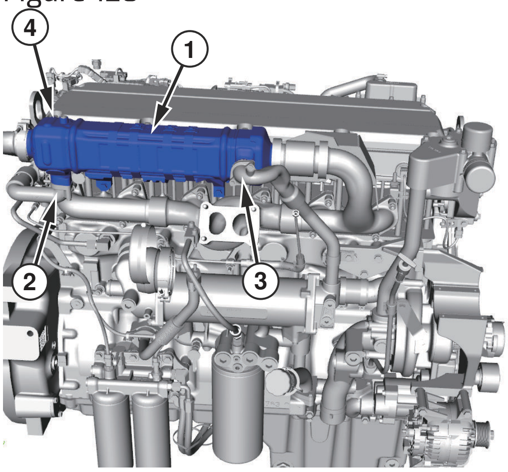
- The Engine ECM DE-ENERGIZES the balance valve solenoid (1), which allows boost pressure from the air inlet mixing manifold (2) to flow to the balance valve actuator (3). As the boost pressure overcomes the spring-loaded actuator, the actuator moves the rod linkage and the balance valve opens. This allows the exhaust gas from the exhaust manifold to flow to both scroll sections of the turbine housing. The increased volume from using both scrolls together slows the velocity of the exhaust gas. This produces less force on the turbine wheel and prevents engine over boost.
- While the balance valve is open, EGR flow is still maintained in the system due to the overall high exhaust gas flow produced by the engine's first three cylinders. The balance valve is used in systems with EGR because the valve relieves excess exhaust manifold back pressure on cylinders 1, 2, and 3 to help improve engine efficiency. This is not needed on non-EGR systems.
- The solenoid valve is unique in that it is always energized when the ECM is powered on. In order to open the solenoid valve, the electrical command is de-energized.

NRS Cooler Operation

Figure 128



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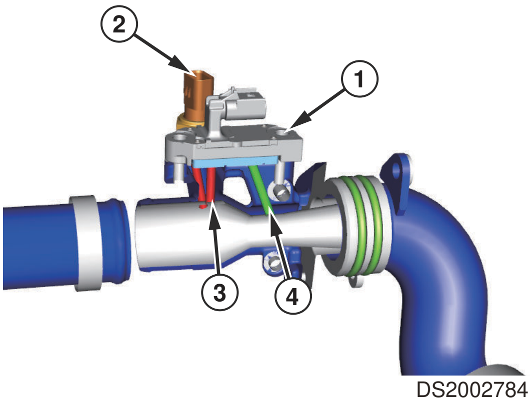
Hot exhaust gases leaving cylinders 1, 2, and 3 are routed through the NRS cooler (1). The NRS cooler cools the gas temperature by circulating coolant into the cooler at port (2) and out of the cooler at port (3). The cooler is also vented to the shunt tank through port (4)

NOTE: *When filling cooling system, do not fill faster than 19 l/min (5 gal/min) to avoid trapping air in the NRS cooler, causing damage to the cooler.*

- In order for exhaust gas to be able to mix with pressurized air from the ATAAC, back pressure is needed in the exhaust system. This back pressure is created by the turbocharger and the diesel particulate filter (DPF).
- After the hot exhaust gas is cooled in the NRS, it passes through the NRS venturi. The venturi takes a measurement of the flow of exhaust gas through the NRS system.
- After the flow is measured by the NRS venturi, the gas flows through the electronically controlled/ hydraulically actuated NRS valve.
- When the NRS valve is in the full off position, the only source of air is from the turbocharger compressor. As the valve starts to open, the flow of cooled exhaust gas from the NRS cooler mixes with the air flow from the turbocharger. As the demand for more cooled exhaust gas increases, the valve opens wider, thus increasing in the flow of cooled exhaust gas from the NRS cooler. As demand for more cooled exhaust gas increase, the demand for air flow from the engine's turbocharger decreases.

NRS Venturi Operation

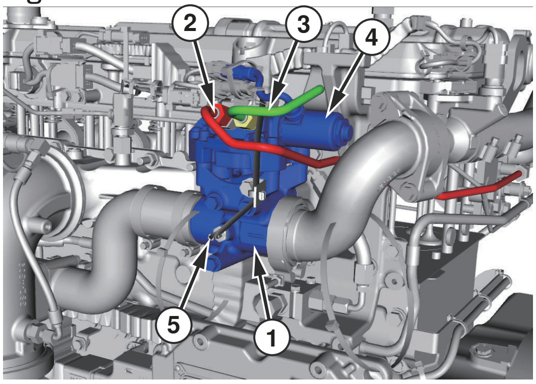
Figure 129



- Exhaust gases leave the NRS cooler and enter the NRS venturi. The venturi design produces a pressure drop as the exhaust flows through it. As the gas flow enters the venturi, cross drilled passage (3) feeds the higher pressure to the high side of the delta P sensor (1) and NRS intake pressure sensor (2). As the gas flows through to the lower pressure side of the venturi, passage (4) feeds the low side of the delta P sensor
- A venturi operates on the principle that, in a given flow of air, the pressure of the air is inversely proportional to the velocity of the air. The shape of the venturi tube starts wide, where the air pressure is greater, and then narrows. As the air flows through the narrow portion of the tube, the velocity increases and the pressure decreases. The NRS Venturi is equipped with a differential pressure sensor (1) and an NRS intake pressure sensor (2). The differential pressure sensor measures the air pressure drop between the high-pressure tap (3) positioned at the widest diameter of the venturi, and the low-pressure tap (4) positioned at the narrowest diameter of the venturi. The NRS intake pressure sensor also measures the exhaust pressure at the high-pressure tap.

NRS Valve Operation

Figure 130



- Electro/hydraulic valve used to meter the flow of exhaust gas into the engine intake
- NRS valve (1) uses engine oil to actuate a throttle valve to direct more or less exhaust gas flow to engine
- Pressurized oil enters actuator inlet (2) and returns to engine at actuator outlet (3)
- Solenoid valve (4) meters the oil flow for precise valve position
- NRS temperature sensor (5) is located in valve body

  NOTE: *Use classroom training aid to show wiper.*

DPF Regeneration Purposes

- Elevates exhaust temperatures to breakdown soot in the DPF.
- Reduces HC from DOC.
- Cleans sulfur deposits from the SCR catalyst and removes crystals that form on the DEF injector.
- Thermal management strategy: To elevate temperatures high enough for regeneration.
- Regeneration is the removal of soot from the DPF through the use of elevated exhaust temperatures.
- Regeneration includes converting soot in the DPF into gas, removing sulfur from the SCR, and removing crystals that form inside the DEF injector.
- With the advent of selective catalytic reduction (SCR), the combustion process within the engine has changed. The regeneration system will take significantly longer to build soot because of the advanced fuel timing to increase engine out NOx and decrease engine out soot. Also, increased NOx in the exhaust helps oxidize soot at lower temperatures.

Regeneration Forms

Automatic Regeneration

- Low speed regeneration:
  - Occurs when the engine is in a stationary or non-working condition
  - Allowed when soot level is between 80%-116% or time to regen is less than 6.4 hours
  - Allows for the most precise control of fuel and airflow
  - Requires the least amount of fuel to be used and a has lower duration time
- High speed regeneration
  - Typically occurs when the engine is in normal operating mode

- Can occur when the soot level is between 80%-100% or time to regen is less than 6.4 hours
- Consumes more fuel and has a higher duration time

Manual Regeneration

- The time to regen is less than 8 hours or the soot level is between 80%-116%
- The engine is in a non-work mode and the regeneration switch is pressed for two seconds

  NOTE: *The operator should not need to interact with the regeneration system. The High exhaust system temperature lamp will be illuminated during regeneration, indicating to the operator a regeneration is occurring.*

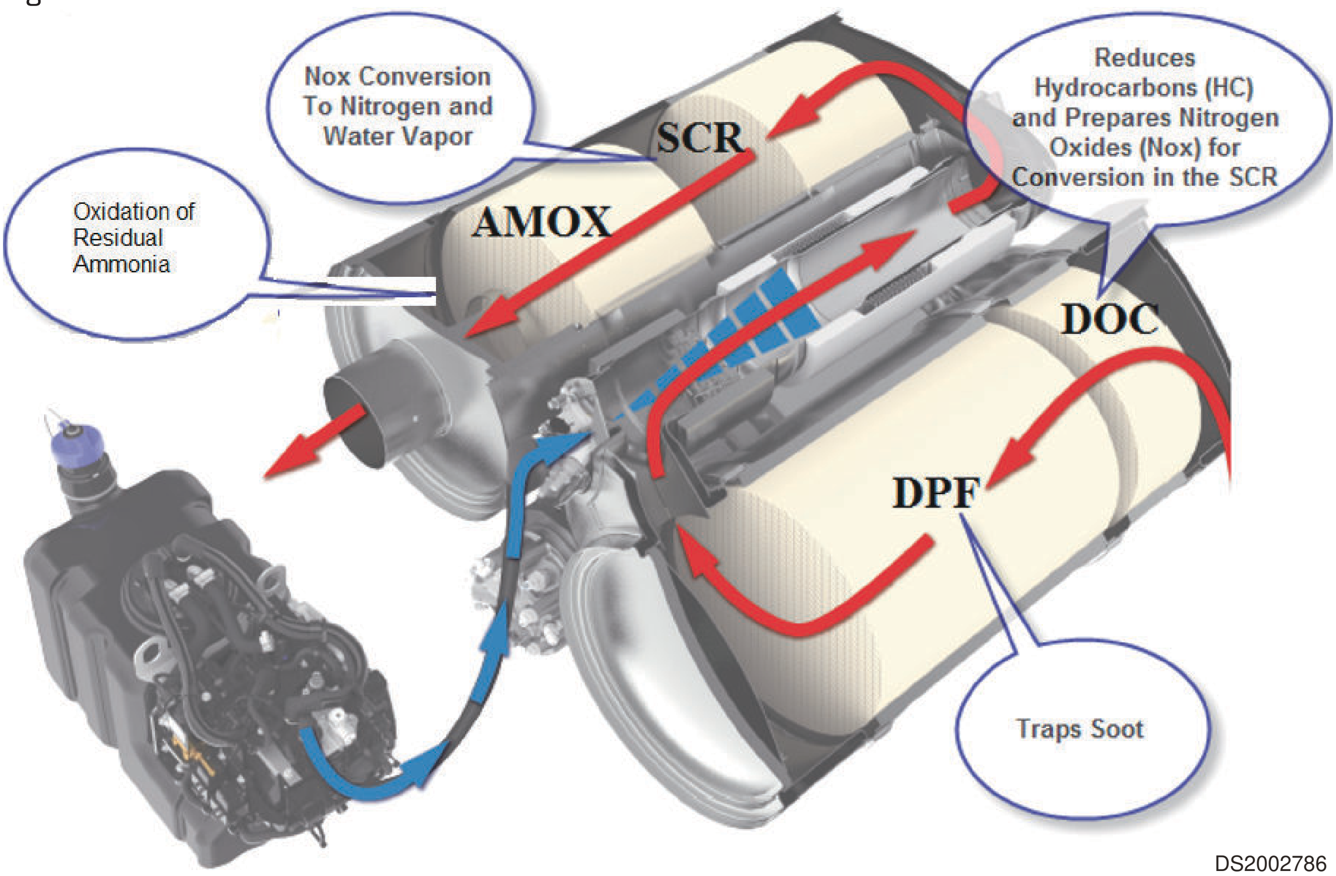
Trigger Methods

There are four methods for triggering a regeneration:

- Soot: The DPF will collect soot produced by the engine. An automatic regeneration will become active to reduce soot levels.
- Start-Up regeneration: A start-up regeneration is initiated by the ECM after a cold engine start. This regeneration is performed to heat the system to a required temperature for DEF dosing to begin.
- SCR maintenance: A regeneration is performed to maintain the SCR system. This regen is triggered when there is ammonia slip or poor NOx conversion.
- ARD maintenance: A regen is performed to maintain the ARD system. Fresh fuel must be flowed through the ARD head to allow a heated nozzle cycle. The heated nozzle cycle is used to clean the ARD nozzle.

Clean Emissions Module (CEM)

Figure 131



- The CEM consists of the following components:

- Aftertreatment Regeneration Device (ARD)
- Diesel Oxidation Catalyst (DOC)
- Diesel Particulate Filter (DPF)
- Selective Catalytic Reduction (SCR) System

• The CEM contains various mechanical and electrical components that reduce exhaust emissions emitted from the engine. The CEM uses its own ECM for aftertreatment controls, but must communicate (send and receive) with the engine ECM.

• The two major functions of the CEM are:
  - Carbon Monoxide and Hydrocarbon (HC) emitted from the engine are oxidized through the Diesel Oxidation Catalyst (DOC). The particulate matter (soot) is trapped in the Diesel Particulate Filter (DPF). The trapped particulate matter is cleaned from the DPF through a catalytic reaction and by heating the filter through a process called Regeneration
  - NOx emissions emitted from the engine are reduced through a process called Selective Catalytic Reduction (SCR)

Diesel Oxidation Catalyst (DOC)

Figure 132

DS2002787

• Exhaust gases entering the CEM first flows through the DOC. The DOC is located at the inlet of the DPF.

• The primary purpose of the DOC is to oxidize the hydrocarbons, carbon monoxide, and the soluble organic fractions that are not burnt in the exhaust gas into carbon dioxide and water.

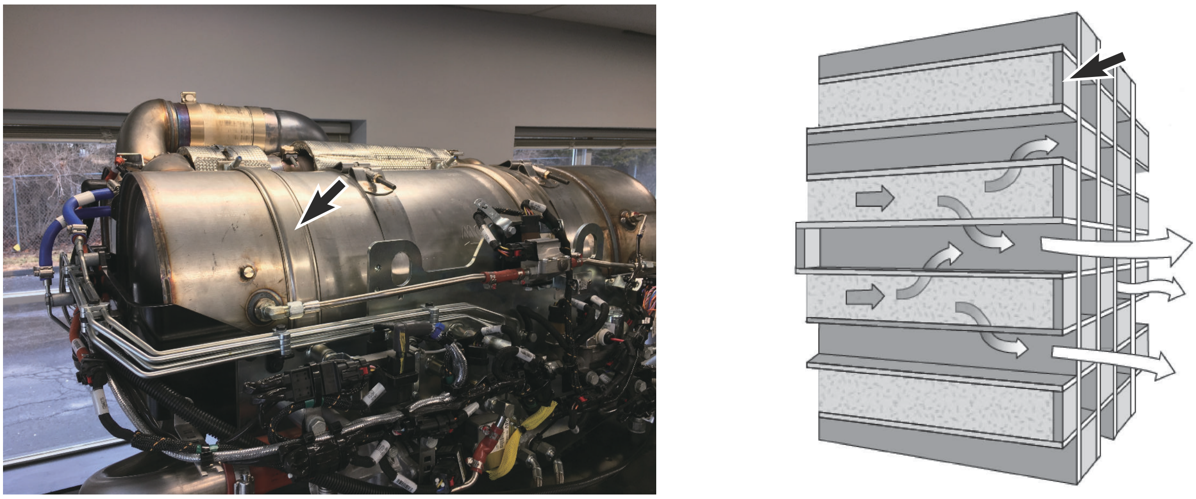
• The DOC also acts on the oxides of nitrogen to increase the nitrogen dioxide fraction for improved efficiency of the SCR system.

• The DOC is a flow through device that will continue to operate during all normal engine conditions.

NOTE: *The DPF canister contains both the Diesel Oxidation Catalyst (DOC) and the Diesel Particulate Filter (DPF).*

Diesel Particulate Filter (DPF)

Figure 133

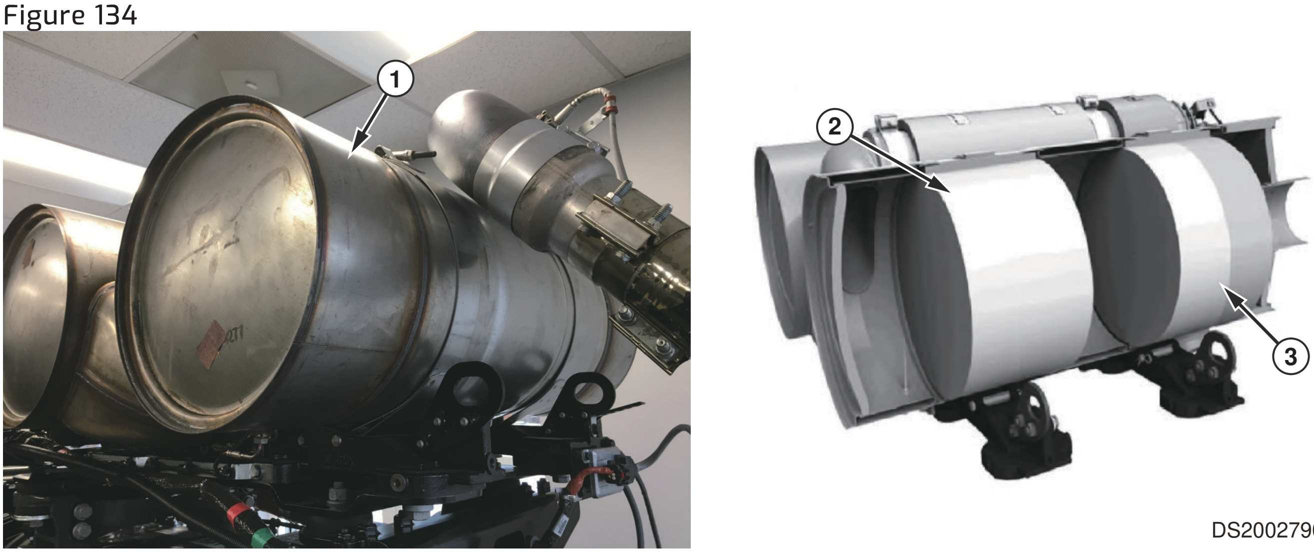


DS2002789

- Once the exhaust gases flow through the DOC, the exhaust gases enter the DPF.
- The wall flow DPF collects all solid particulate matter in the exhaust gas.
- The DPF is a catalyzed ceramic filter. The DPF is a particulate trap that is used to reduce up to 90% of particulate emissions. These filters have a cellular structure with individual channels open and plugged at opposite ends. Exhaust gases enter the open end, flow through the pores of the cell walls, and exit the filter through an adjacent channel. Soot particles that are too large to flow through the pores collect on the channel walls.
- The solid particulate matter that is collected by the DPF consists of soot (carbon) from incomplete combustion of fuel. Ash is also collected by the DPF. Ash is a noncombustible residue left behind from the burning of oil. Soot can be removed from the DPF using a process called regeneration. Ash must be removed using a special service procedure.
- The engine aftertreatment system is designed to oxidize the soot in the DPF at the same rate as the soot is produced by the engine. The oxidization of the soot will occur when the engine is operating under normal conditions. The soot in the DPF is constantly monitored.

Selective Catalyst Reduction (SCR)

Figure 134



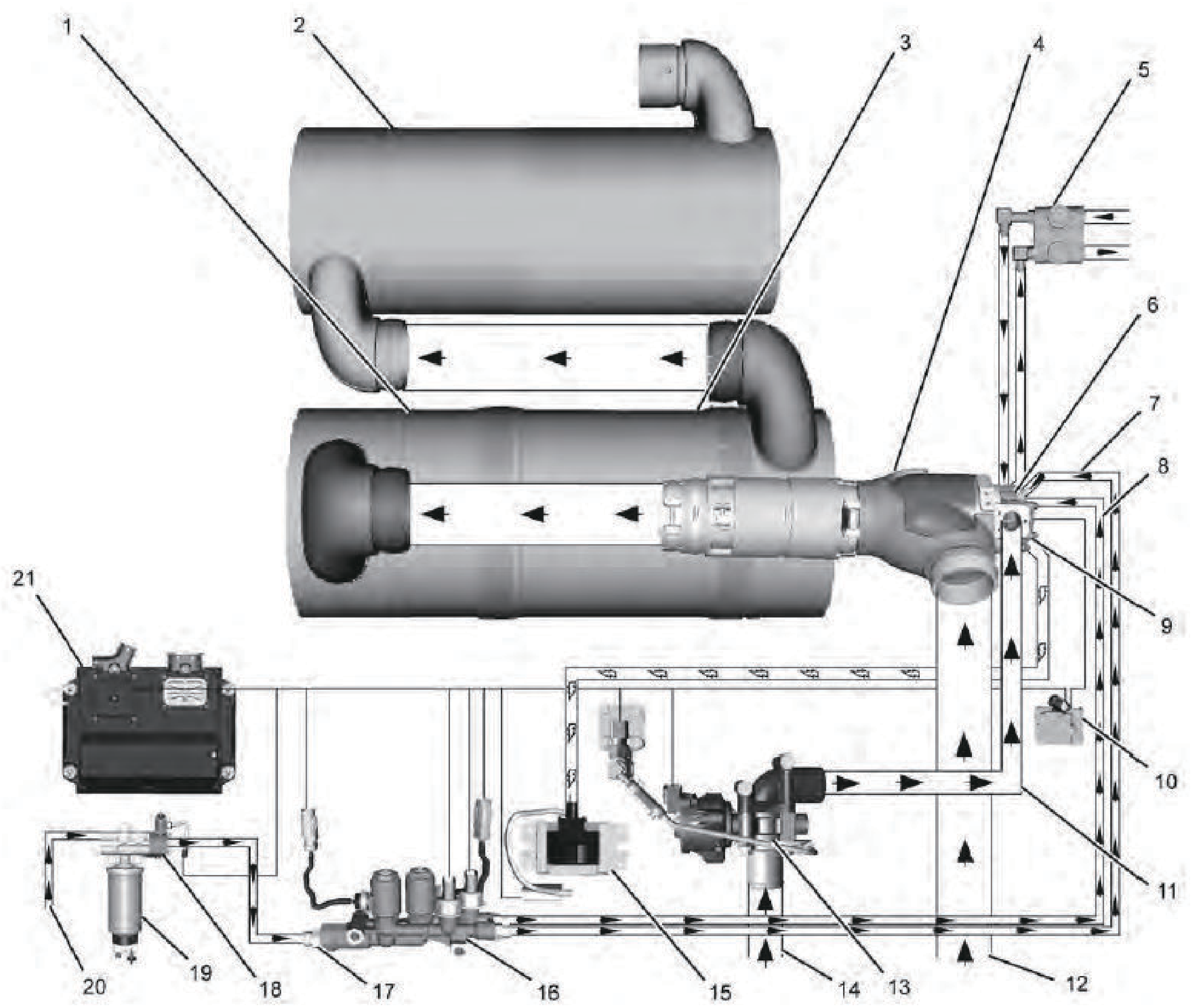
DS2002790

- After the DPF, the exhaust gases enter the SCR mixing chamber where the gases are injected with Diesel Exhaust Fluid (DEF) by a DEF injector.

- The exhaust gases and DEF are mixed in a mixing chamber, then enter the SCR canister (1).
- The mixture decomposes to form ammonia and carbon dioxide and passes to the reaction chamber (2).
- A portion of the catalyst at the outlet end has an additional coating making it a selective Ammonia Oxidation (AMOX) catalyst (3).
- Once temperatures are hot enough, the water in DEF evaporates and the urea in DEF is converted to ammonia. Once converted, the ammonia is absorbed by the catalyst. As exhaust flows through the catalyst, the oxides of nitrogen within the exhaust react with the ammonia and the catalyst, converting the gas into nitrogen and water vapor.
- The AMOX is responsible for removing excess ammonia that was not converted from the exhaust. The AMOX is primarily responsible for removing odor (ammonia slip) from the exhaust. During certain engine operating conditions, too much ammonia will be stored and may pass through the catalyst; this is called ammonia slip. The odor threshold for NH_3 is 20 ppm.

Aftertreatment Regeneration Device (ARD)

Figure 135

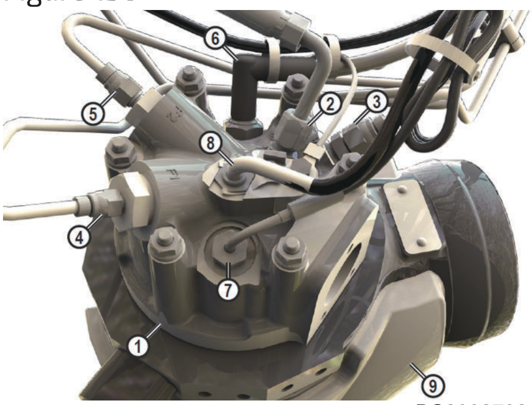


DS2002791

Reference Number	Description
1	DOC
2	SCR Catalyst
3	DPF
4	ARD Body
5	Connection for the Coolant
6	ARD Head
7	Pilot Fuel Line
8	Main Fuel Line
9	Spark Plug
10	Relay for the Heated Nozzle
11	Line for Combustion Air
12	Exhaust from Turbo
13	ARD Combustion Air Valve
14	Compressed Air from Turbo
15	Ignition Coil
16	ARD Fuel Manifold
17	In-Line Fuel Filter
18	Electric Priming Pump
19	Primary Fuel Filter
20	Fuel from Tank
21	Aftertreatment ECM

- ARD Head (1): The ARD head contains the components required to increase the exhaust gas temperatures, at the inlet to the DPF, causing high temperature regeneration to occur.

  Figure 136

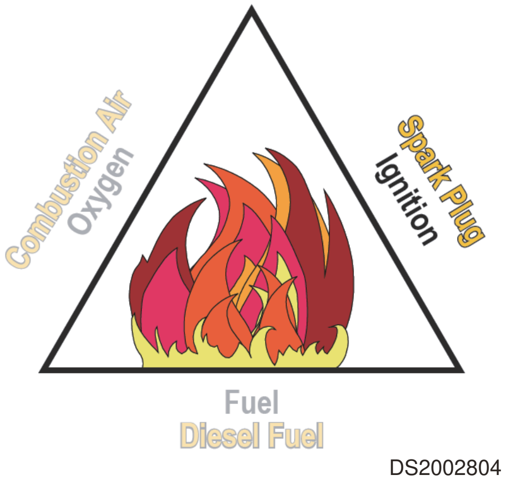


- The ARD components are as follows:
  - Coolant supply (3) and coolant return (2) lines (return flows through the DEF injector and back to the water pump)
  - Fuel supply lines, pilot (4), and main (5). Each connector fitting contains a 40 micron filer.

- Spark plug (6)
- Exhaust gas temperature #1 thermocouple (flame detect sensor) (7)
- Heated nozzle electrical connection (8), mounted inside the ARD Head.
- ARD housing (9)

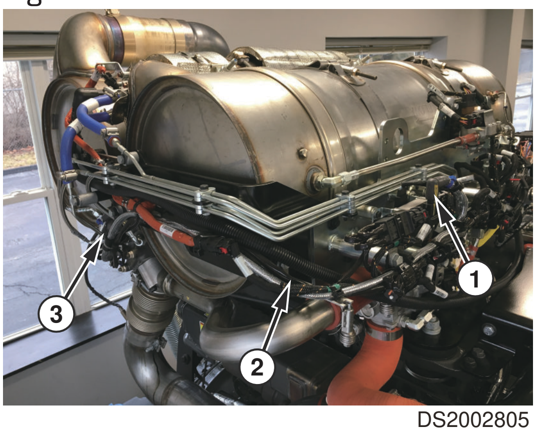
ARD Ignition System

Figure 137



- The above image illustrates the ignition system required to initiate combustion inside the ARD. The ignition coil (1) is mounted to the CEM electronics panel.

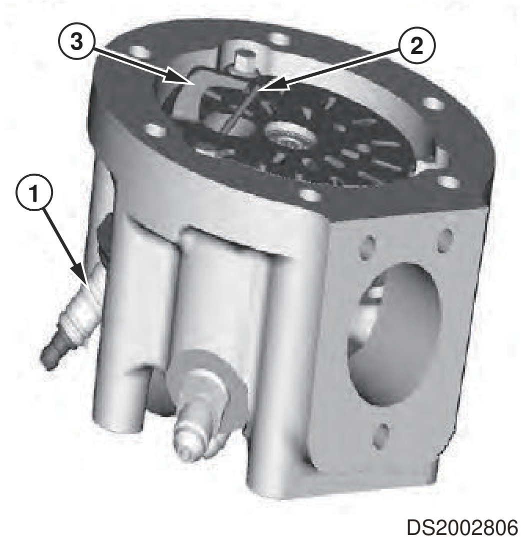
  Figure 138



- The spark plug wire (2) delivers current from the coil to the spark plug (3) installed in the ARD head. The spark plug produces approximately 18 kilovolts and should be assumed to be sparking any time the engine is running. The ARD ignition system diagnostics are somewhat limited and require an additional troubleshooting procedure to ensure the integrity of the system. If the ARD ignition system is suspected as the root cause of a failure, the technician will be required to check the spark output of the coil, wire, and spark plug using the T400025 spark tester. This procedure is outlined in the engine troubleshooting guide.

- The ARD system has two circuits. The primary circuit is located between the aftertreatment ECM and the ignition coil. The secondary circuit is located between the ignition coil and the ARD combustion head.

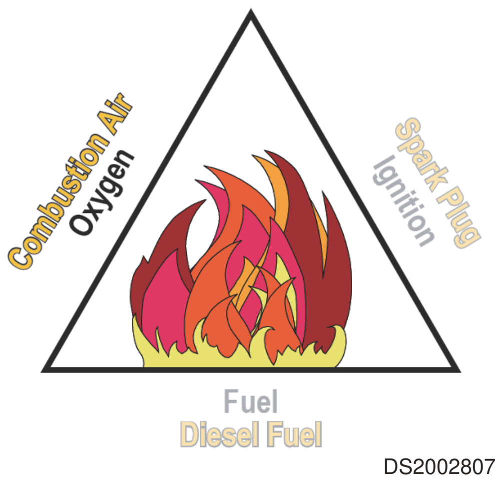
  Figure 139



- The current flow through the primary circuit indicates the condition of the primary circuit and of the secondary circuit.
- The aftertreatment ECM monitors the current through the primary circuit so it is able to detect problems with either circuit.
- The aftertreatment ECM creates an ignition pulse 12 times each second whenever engine speed is greater than 500 rpm. A signal is sent to the primary side of the ignition coil located on the panel for the electronics on the CEM.
- The ignition coil converts the ignition pulse into a high voltage signal. An ignition wire connects the ignition coil output to the spark plug (1). The spark plug is threaded into the ARD head. The spark jumps between the spark plug electrode (2) and the ground probe (3) inside the ARD combustion head, igniting the air/fuel mixture.

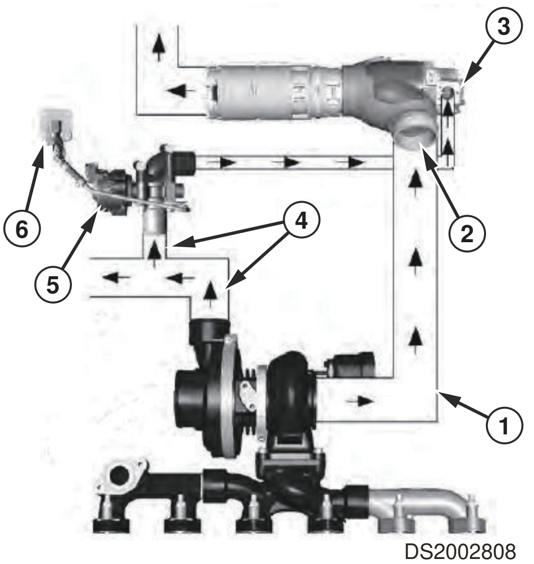
ARD Combustion Air System

Figure 140



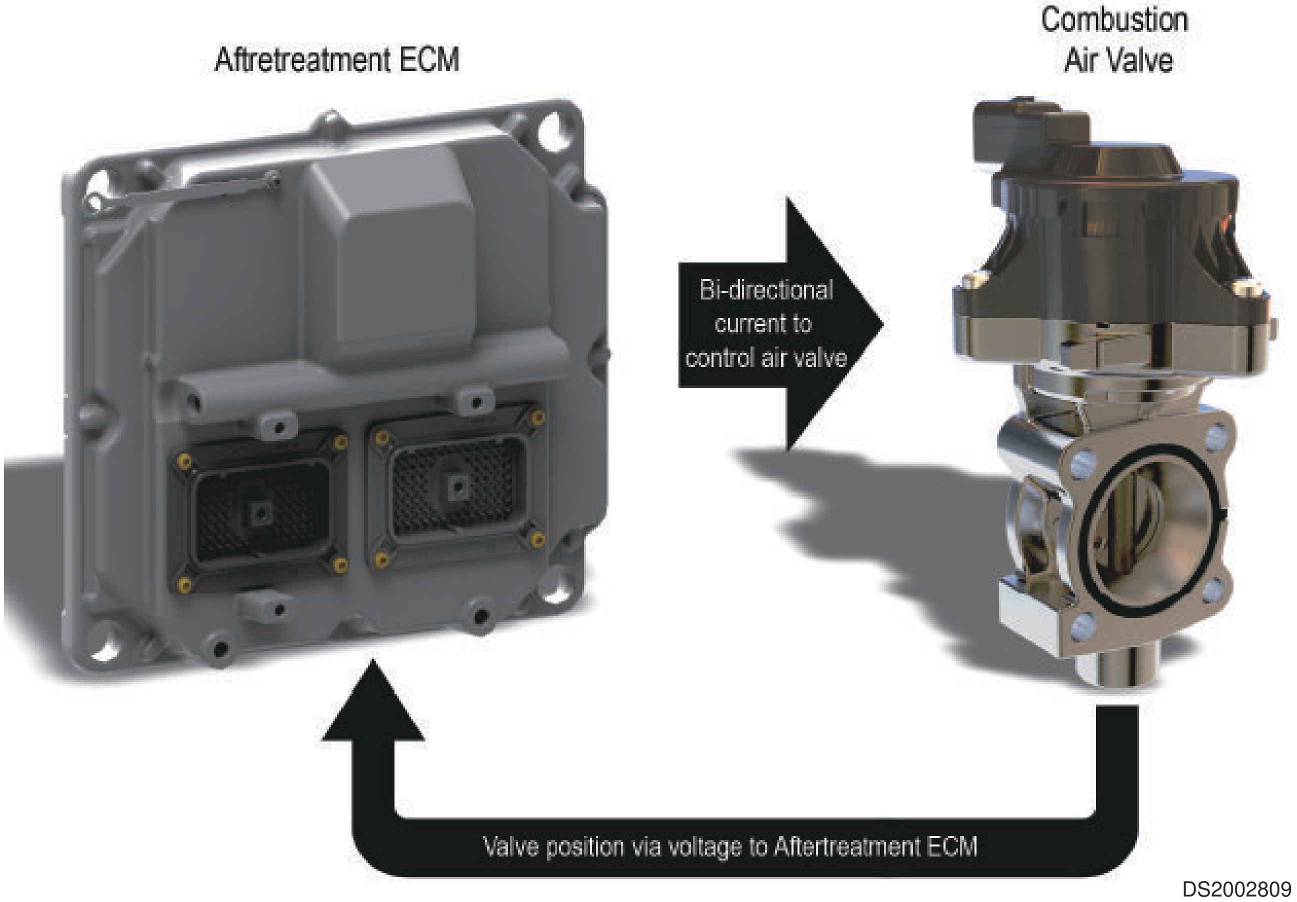
- Exhaust air flows from the turbine housing (1) to the ARD body (2). The exhaust air then flows through the DOC, DPF, and SCR.

Figure 141



- The air used to supply the ARD head (3) is taken from the turbocharger compressor outlet (4). The pressure of this air is measured at the inlet of the ARD combustion air valve (5) by the combustion air inlet pressure sensor (6)
- The air is then metered by the ARD combustion air valve with a DC motor and an analog pressure sensor. The aftertreatment ECM controls the ARD combustion air valve by sending it a desired opening position. The ARD combustion air valve moves the desired amount and the new valve position is transmitted back to the aftertreatment ECM.

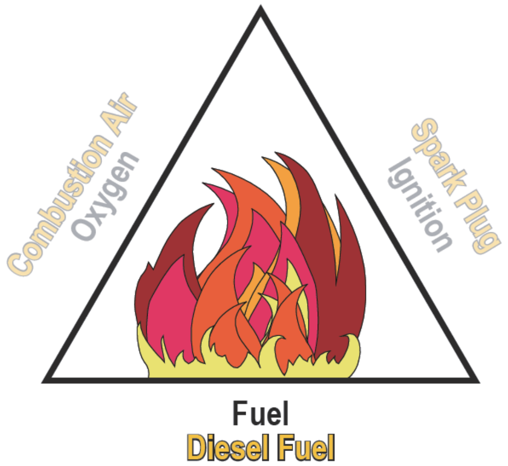
- Once the air has been metered by the ARD combustion air valve, the air enters the ARD head. The ARD head contains a swirling plate that is designed to agitate the air that is being mixed with the fuel. This agitated air allows for a precise burn of the air/fuel mixture.
  Figure 142



- The aftertreatment ECM requests the combustion air valve to open, the signal is sent directly to the valve via bi-directional current (5 volt sensor; see electrical schematic). The valve is then able to report its position directly to the aftertreatment ECM using a voltage signal.
- The aftertreatment ECM communicates to the engine ECM via the CAN (J1939) data link.
- A diagnostic trouble code (DTC) will become active if the valve does not respond and a failed regeneration occurs.
- The valve calibration is automatically controlled by the aftertreatment ECM. The calibration occurs after the aftertreatment ECM powers up and again before a regeneration starts. Any valve faults will prevent the calibration cycle from occurring.

ARD Fuel System

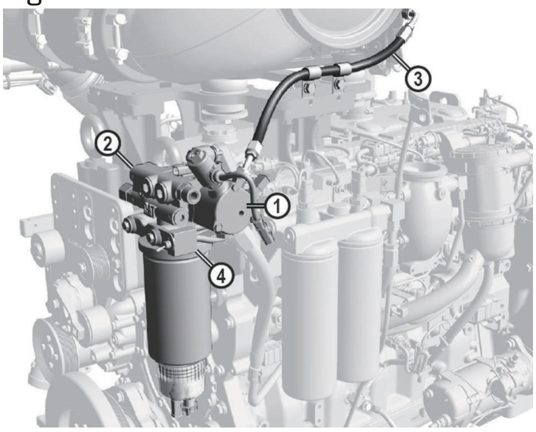
Figure 143



DS2002810

- The ARD fuel system receives its fuel supply from the engine electric fuel priming pump (1), which is located in the primary fuel filter base (2). When commanded, the electric fuel priming pump activates, providing fuel to the ARD fuel system via the CEM fuel supply line (3) for regeneration.

  Figure 144

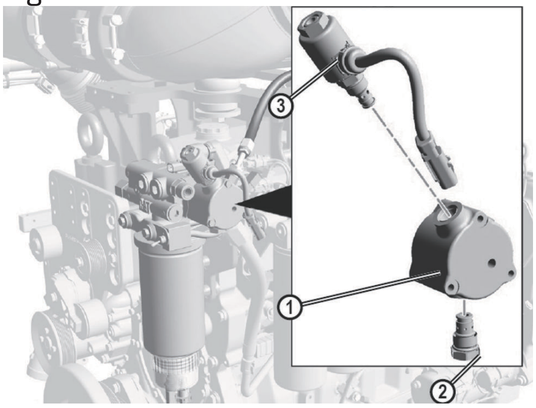
  DS2002811

- There are two possible methods for priming 2000 Series engines:
  - The first is an automatic priming function which occurs with the key ON and the engine OFF.
  - The second method requires activating the Manual Priming Switch (4), which is located on the primary fuel filter base.

    NOTE: *Depending on the application, the manual priming switch may require having the key ON or the key OFF (but not both), in order to activate the electric priming pump.*

Electric Fuel Priming Pump

Figure 145

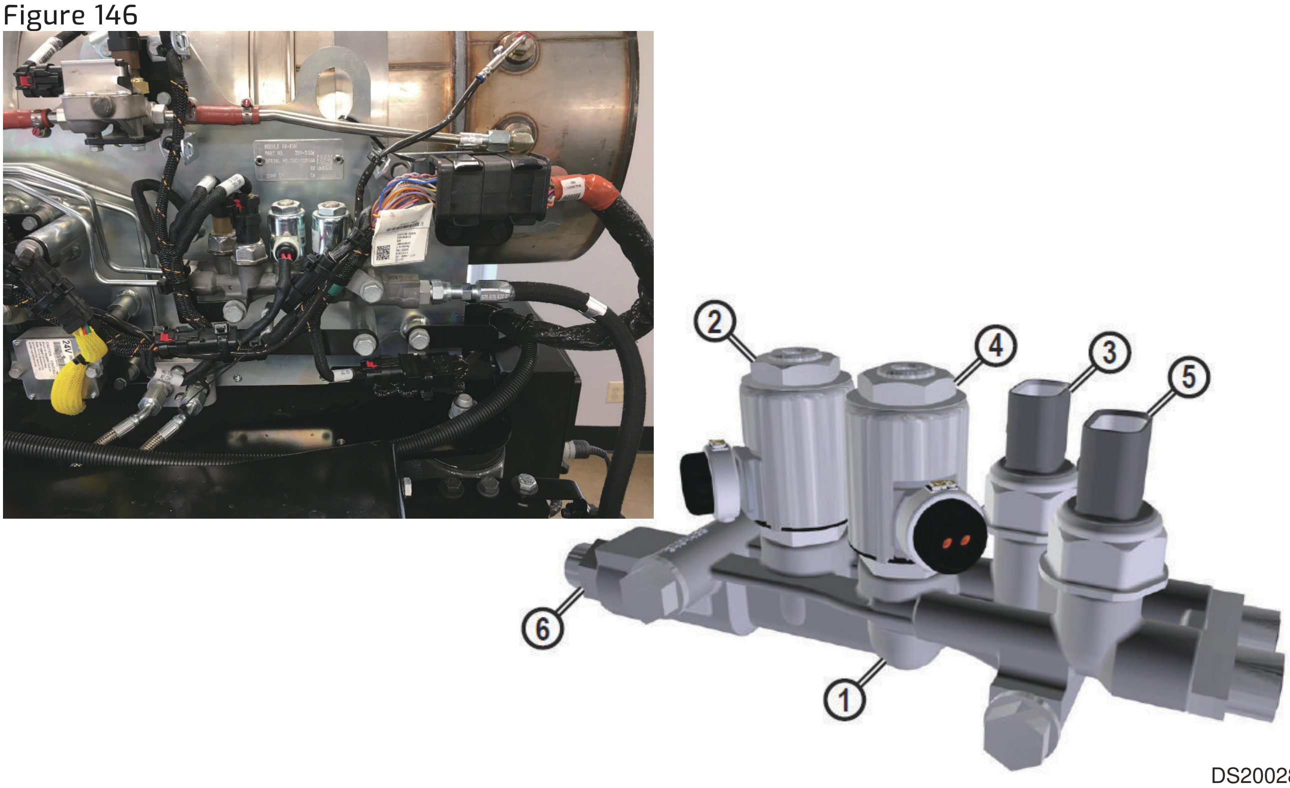


DS2002812

- During normal engine operation, the electric priming pump (1) will not be activated. The electric priming pump is activated when regeneration is desired via a signal to the relay from the aftertreatment ECM.
- The electric priming pump pulls fuel from the fuel tank through the 10 micron primary fuel filter.
- The pressure regulator (2) regulates the pressure to 1900 kPa (275 psi).
- The fuel diverter valve (3) is de-energized during regeneration. When the fuel diverter valve is de-energized, all fuel flow from the electric priming pump is sent to the ARD system. The engine will still be receiving fuel drafted from the fuel tank that bypasses the electric fuel pump when the valve is de-energized.
- When the fuel diverter valve is energized, all fuel is sent to the engine and no fuel is sent to the ARD system. The fuel diverter valve is energized during engine priming.

ARD CEM Fuel Manifold

Figure 146



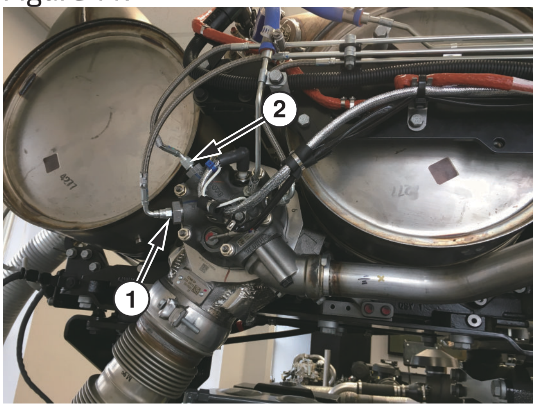
DS2002813

- Once fuel flow exits the pump housing, the fuel enters the ARD fuel manifold (1) through the CEM fuel manifold filter fitting (40 micron) (6).
- As fuel flows through the ARD fuel manifold, the fuel takes a parallel path. One path goes to the pilot fuel solenoid valve (2) and the other goes to the main fuel solenoid valve (4). Both PWM solenoids are controlled by the aftertreatment ECM.
- The pilot fuel solenoid valve is considered the primary fuel valve. Once the pilot fuel solenoid valve is fully open and more fuel is still desired, the main fuel solenoid valve will open.
- Once the fuel has passed through the pilot and main fuel solenoid valves, the fuel pressures are measured by a sensor for each circuit, pilot fuel pressure sensor (3) and main fuel pressure sensor (5).
- The pilot fuel solenoid (2) and the pilot fuel pressure sensor (3) are used in conjunction to measure and control the amount of fuel used for the pilot fuel supply. The pilot and main fuel solenoids have separate PWM drivers (controlled by the Aftertreatment ECM) which allow independent control of the two solenoids.

  NOTE: *Pilot fuel supply provides the majority of the fuel needed to increase the exhaust gas temperatures at the inlet to the DPF. The main fuel supply is used to augment and maintain the exhaust gas temp, as needed, during regeneration. It helps to think of the pilot and main like a stove. Pilot is needed to have the flame, then main is needed when more fuel is needed.*

ARD Head

Figure 147

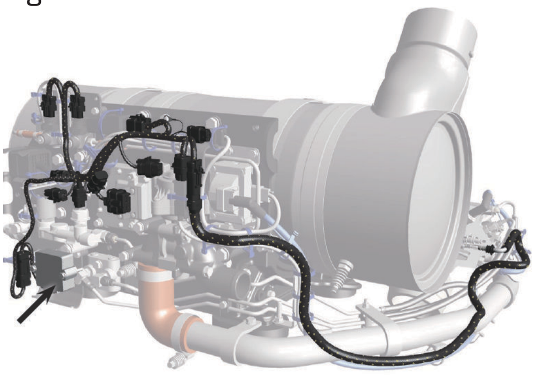


DS2002814

- Once the fuel exits the fuel manifold, the fuel enters the ARD head.
- The ARD head contains a single connection for the pilot fuel (1) and the main fuel (2). Each connection contains a 40 micron screen.
- As the fuel continues into the ARD head, the fuel opens two drain check valves (one in the pilot fuel passage and one in the main fuel passage). These drain checks keep fuel trapped between the ARD fuel nozzle and the pilot/main fuel valves when the system is not being used.

ARD Heated Fuel Nozzle

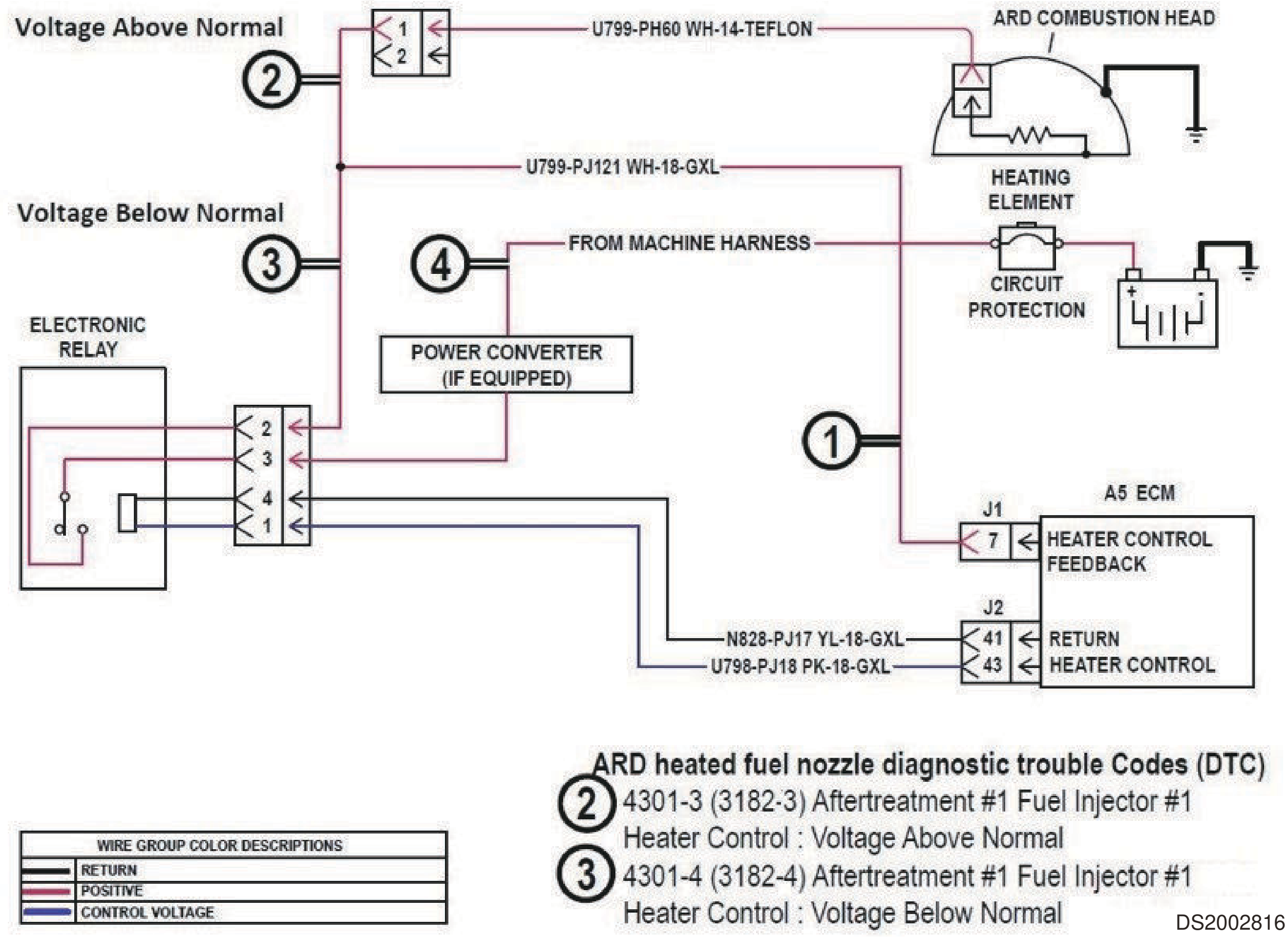
Figure 148



- The heated fuel nozzle system periodically operates to clean the nozzle of fuel coking (carbon build-up on the tip). An electric heating element is contained within a ceramic housing surrounding the nozzle inside the ARD head.
- The engine ECM periodically sends a signal to the Heated Nozzle Relay (arrow) causing battery voltage to travel to the heating element, energizing the coil. The coil can reach temperatures as high as 550C (1022F) to clean off carbon deposits.
- The heated nozzle cycle runs for 60 minutes once the cycle has started.
- The heated nozzle assemblies for 12 volt and 24 volt systems have different internal resistance values. As a result, there are separate part numbers for ARD heads associated with 12 volt and 24 volt systems.
- The heated fuel nozzle is part of an ARD head assembly and is not serviced independently of the ARD head. If the Heated Nozzle System is suspected as the root cause of a failure, the technician will be required to check the current being sent to the Heated Fuel Nozzle using a clamp-on ammeter. This procedure is outlined in the Engine Troubleshooting Guide.

ARD Heating Element

Figure 149

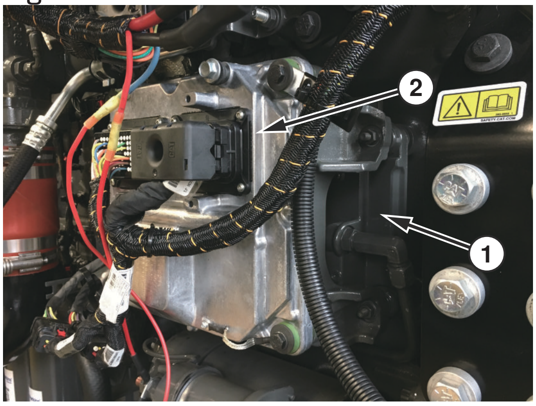


- Additional diagnostic capabilities have been built in to the ARD nozzle heater circuit. A feedback circuit from the ARD nozzle heater relay to the ARD head has been added to help complete the circuit for the Aftertreatment ECM to generate DTCs.
- The heater control feedback circuit uses a dedicated ECM input to determine If there is an malfunction within the secondary side of the nozzle heater circuit. The ECM uses the input to determine if the voltage at the heater nozzle input is close to ground potential or not, but it runs through a pull up resistor. As a result, the diagnostic trouble codes associated with the secondary side of the ARD nozzle heater are 3182-3 voltage above normal and 3182-4 voltage below normal. There is a nuance particular to these codes, each one can indicate a either short or open depending on the location of the failure.
- If an open circuit occurs either on the heater feedback wire (1) or after the splice on the secondary wire (2) up to and including the heated nozzle, a 4301-3 voltage above normal will become active when the nozzle heater is not energized at key ON.
- If an open circuit occurs before the splice on the secondary wire (3) or anywhere within the secondary circuit power supply (4), a 4301-4 voltage below normal will become active when the nozzle heater is energized.

Engine Control and Electrical System

Engine and Aftertreatment ECMs

Figure 150

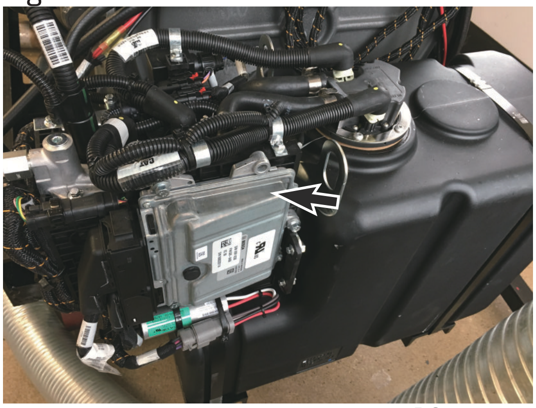


DS2002817

Reference Number	Description
1	Engine ECM
2	Aftertreatment ECM

Dosing Control Module (DCU)

Figure 151

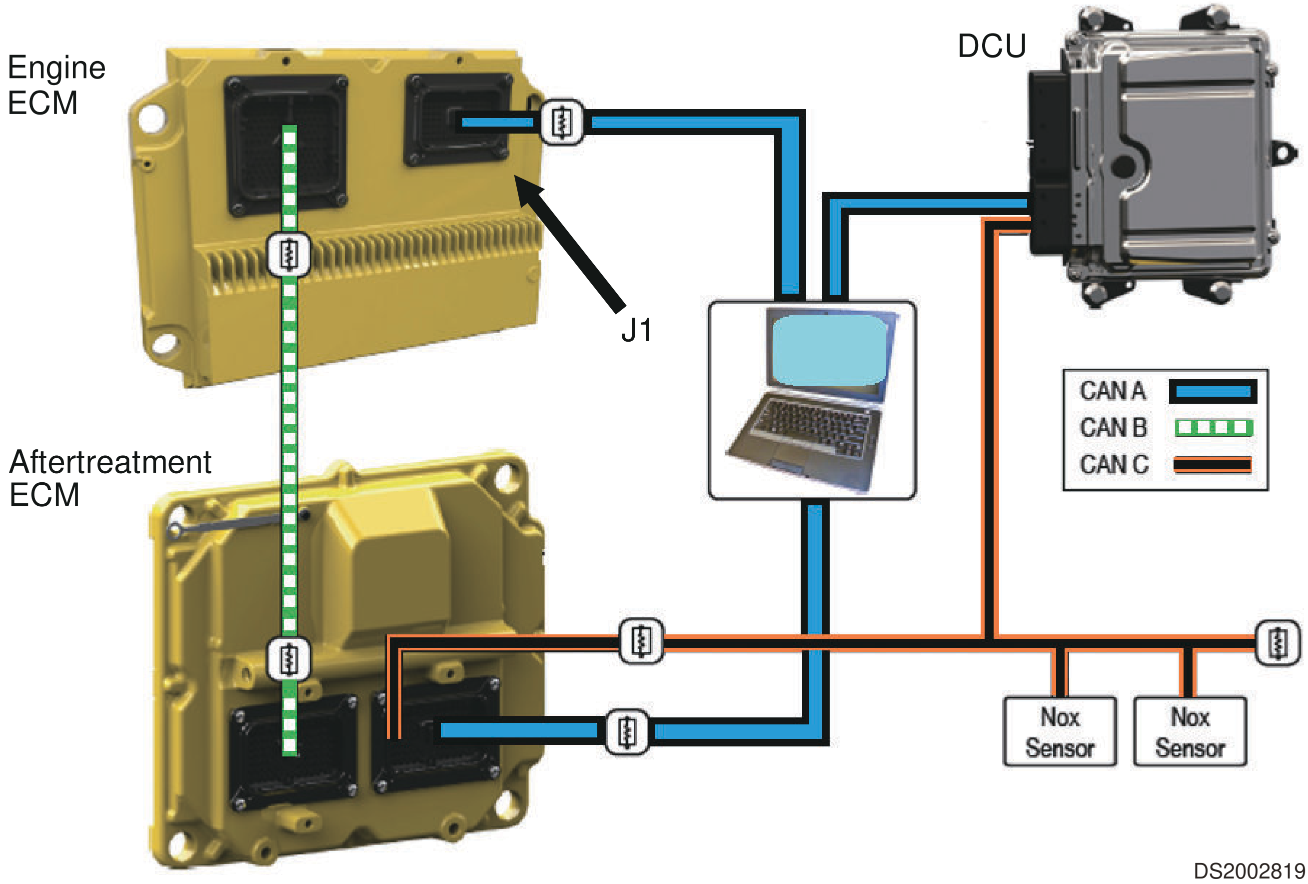


DS2002818

- The DCU controls all the electrical components on the Pump Electronics Tank Unit (PETU) and the DEF injector.

Datalink Communication

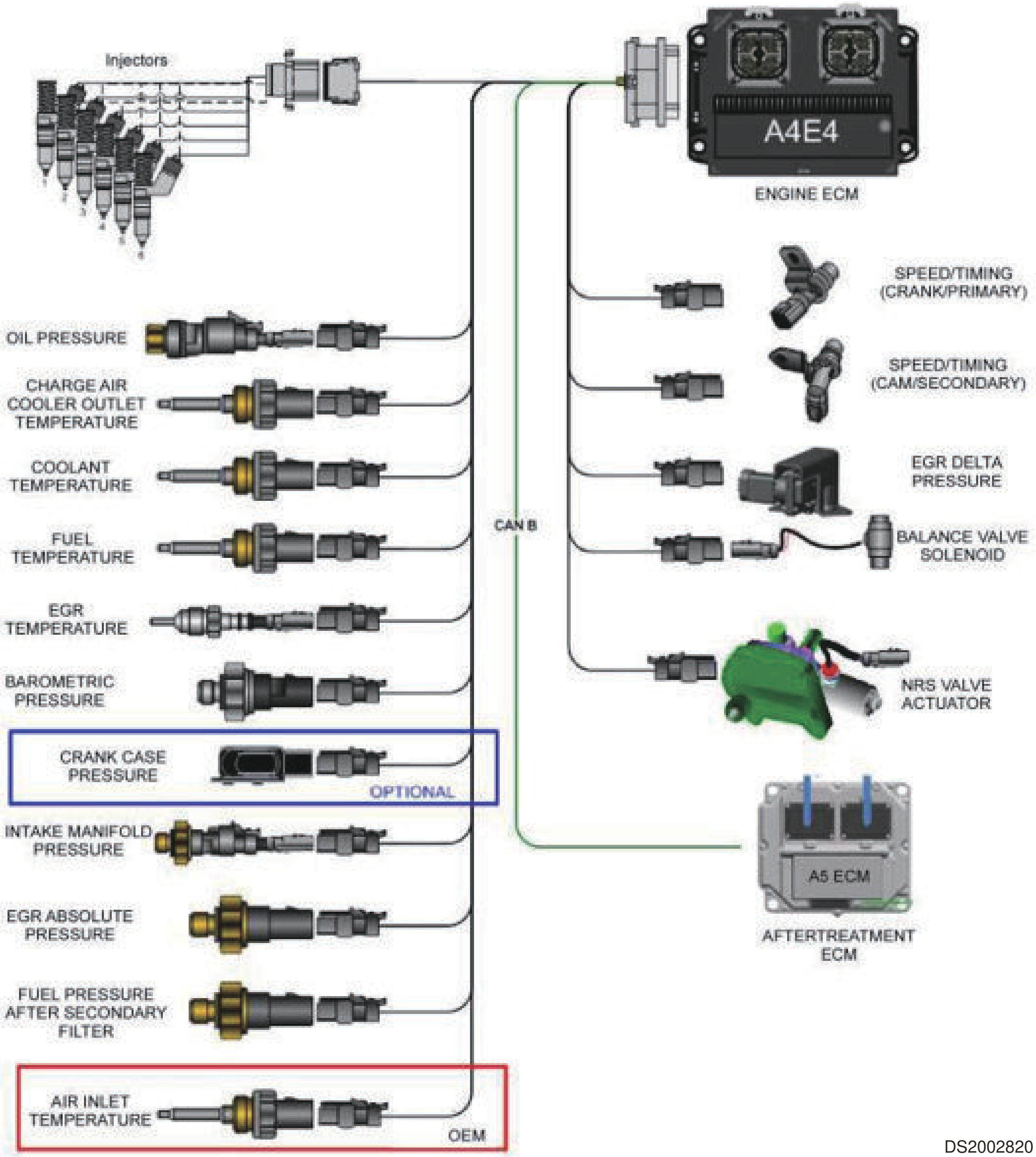
Figure 152



- Communication between the three ECMs is as follows:
  - Engine ECM (1) communicates to the aftertreatment ECM via CAN B
  - Aftertreatment ECM (2) communicates to the DCU (3) and the NOx sensors via CAN C. (The NH3 sensors, if equipped, is also on CAN C)
  - EST communicates to all three ECMs via CAN A
  - Each CAN trunk operates at 60 ohms and has two in-line 120 ohm resistors

Engine Electronic Control Circuit Diagram

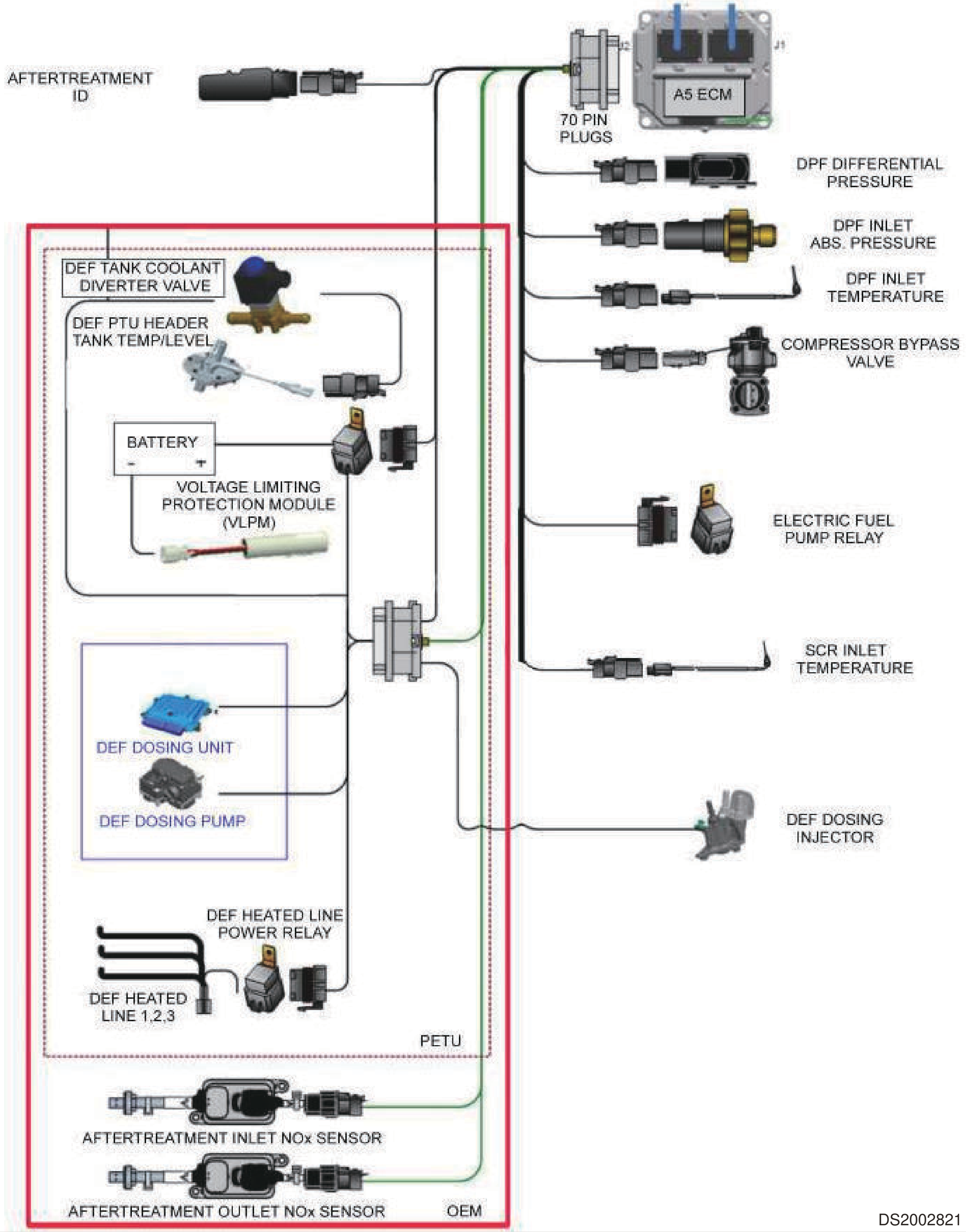
Figure 153



- The A4E4 manages the engine system sensors, actuators and fuel system components
- The A5E2 ECM manages the DPF and related aftertreatment system
- The DCU manages the SCR/DEF dosing control

Aftertreatment Electronic Control Circuit Diagram

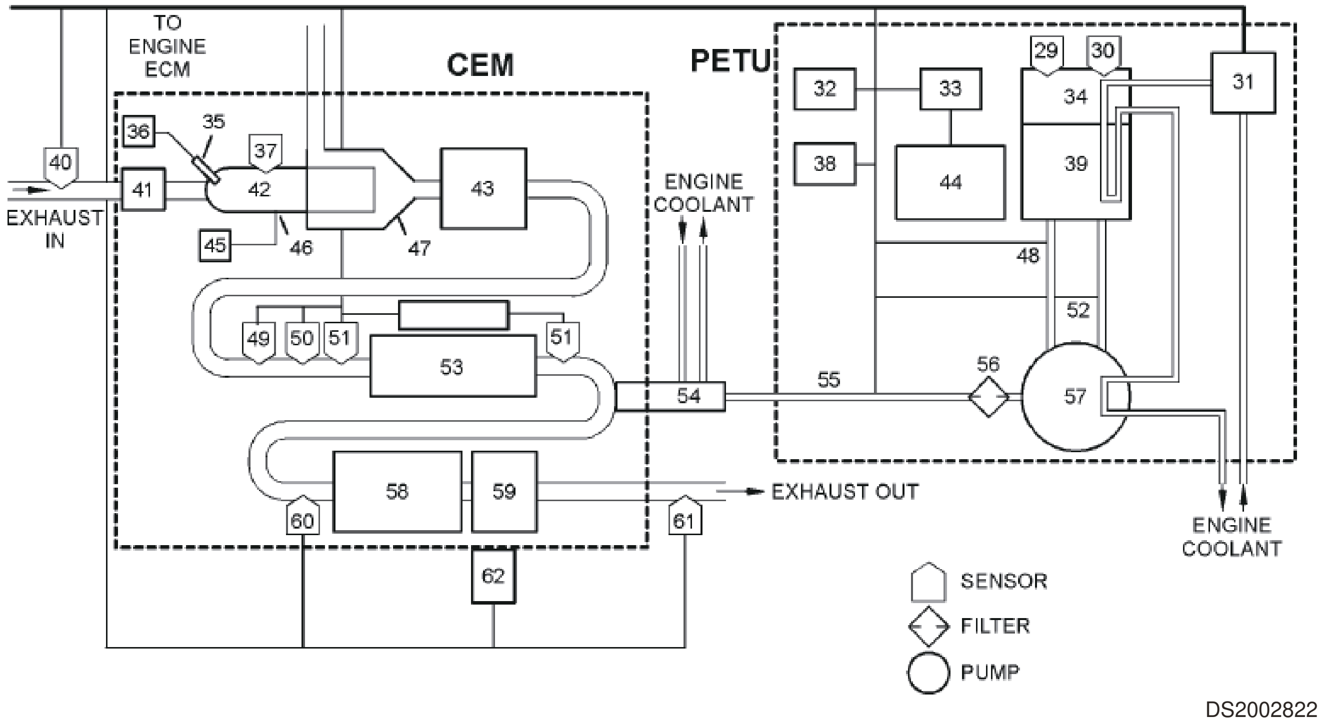
Figure 154



After Treatment System

Aftertreatment Diagram with ARD

Figure 155

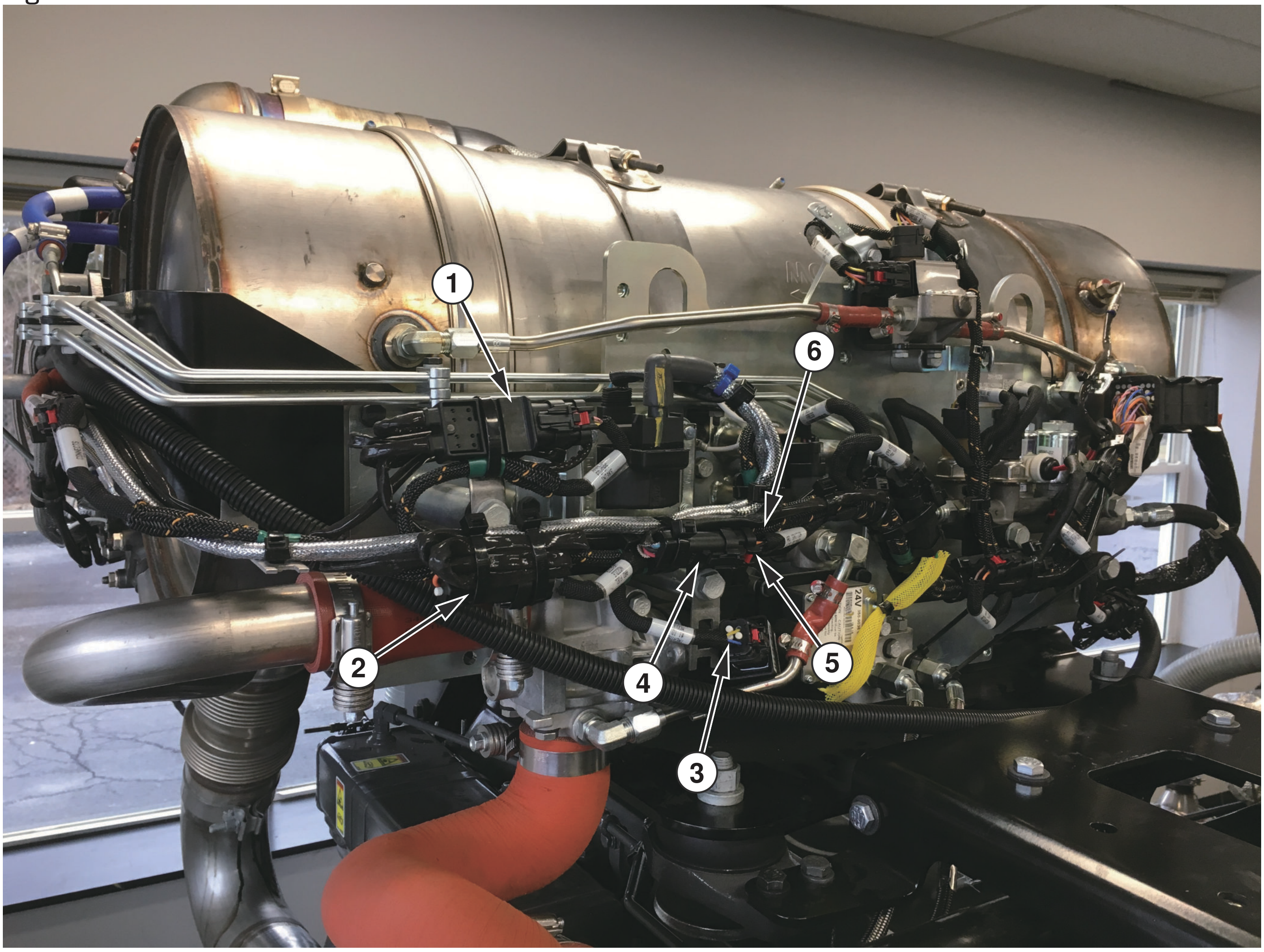


Reference Number	Description
29	DEF Level Sensor
30	DEF Temperature Sensor
31	Coolant Diverter Valve
32	PETU Relay
33	Voltage Load Protection
34	DEF Header Unit
35	Spark Plug
36	Ignition Coil
37	Flame Detection Temperature Sensor
38	Line Heater Relay
39	DEF Tank
40	Inlet NOx Sensor
41	ARD Combustion Air Valve
42	ARD Combustion Head
43	DOC
44	DCU
45	Heater Wire Relay
46	Heater Wire for the ARD Fuel Nozzle

Reference Number	Description
47	ARD Body
48	Heated DEF Line
49	DPF Inlet Temperature Sensor
50	DPF Inlet Pressure Sensor
51	DPF Differential Pressure Sensor
52	Heated DEF Line
53	DPF
54	DEF Injector
55	Heated DEF Line
56	DEF Filter
57	DEF Dosing Pump
58	SCR Catalyst
59	AMOX Catalyst
60	SCR Inlet Temperature Sensor
61	Outlet NOx Sensor
62	Identification Module

CEM Electronic Components

Figure 156



DS2002823

DPF Intake Temperature and Flame Detection sensor (1):

- The DPF Intake Temperature sensor measures the temperature entering the DPF.
- The ARD Flame Detection Temperature sensor is primarily used to determine if the flame was successfully lit during the ARD ignition process. It is used along with the DPF Intake Temperature sensor to determine if the flame has gone out during regeneration.

ARD Fuel Nozzle Heater (2)

Aftertreatment Identification (3):

- Used to sync the Aftertreatment ECM and the Engine ECM in the first 100 hours.

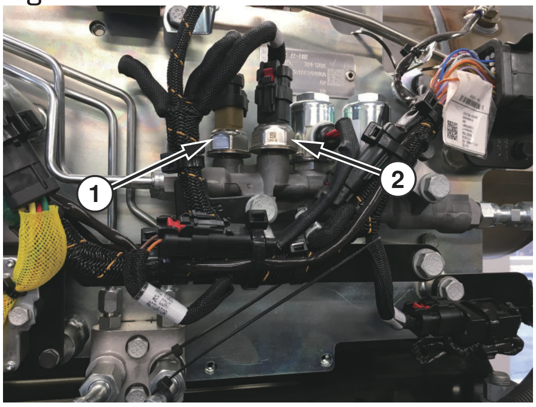
ARD Ignition Primary sensor (4)

ARD Flow Control Actuator (5)

Aftertreatment Secondary Air Pressure sensor (6)

ARD Fuel Pressure – Main (1):

Figure 157



DS2002824

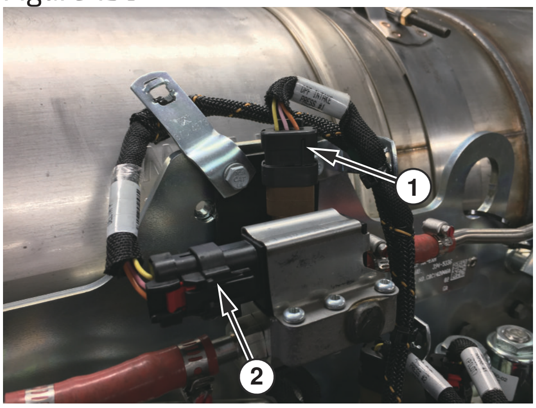
- Measures the main pressure before it exits the fuel manifold.

ARD Fuel Pressure – Pilot (2):

- Measures the pilot pressure before it exits the manifold.

DPF Intake Pressure sensor (1):

Figure 158



DS2002825

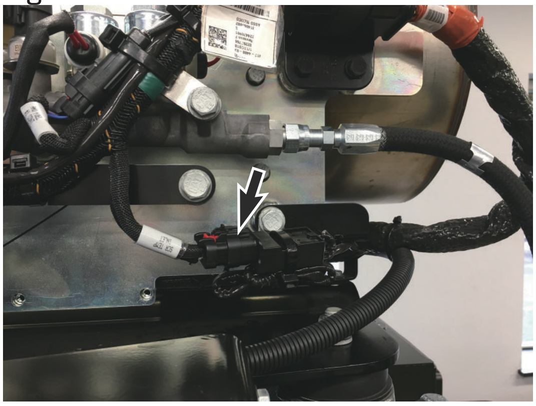
- Measures the back pressure being generated by the DPF.

DPF Delta Pressure sensor (2):

- Measures the soot collected by the DPF. The sensors measures pressure drop across the DPF. Since the delta pressure sensor is measuring flow resistance across the DPF, the sensor will also detect ash loading.

SCR Inlet Temperature sensor:

Figure 159

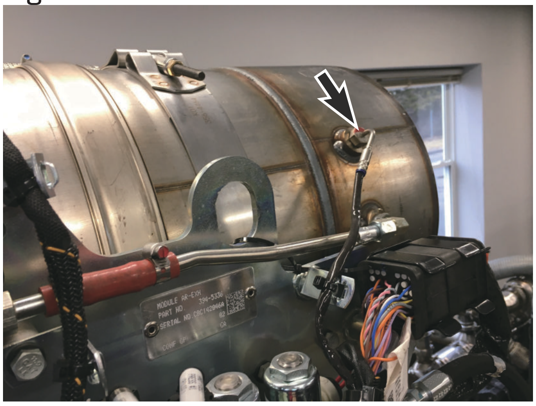


DS2002826

- Used to make sure that the temperature is hot enough in the catalyst for DEF dosing to occur and react with the catalyst.

DPF Inlet Probe

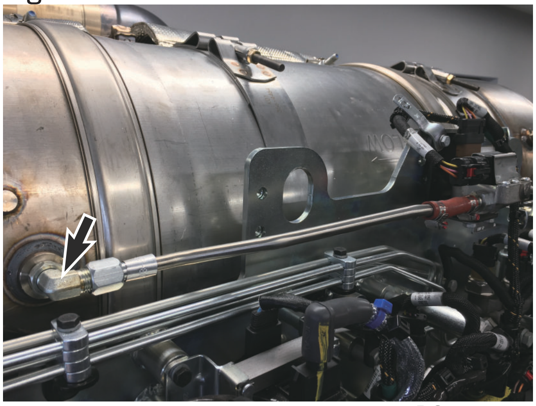
Figure 160



DS2002827

DPF Delta P Probe

Figure 161



DS2002828

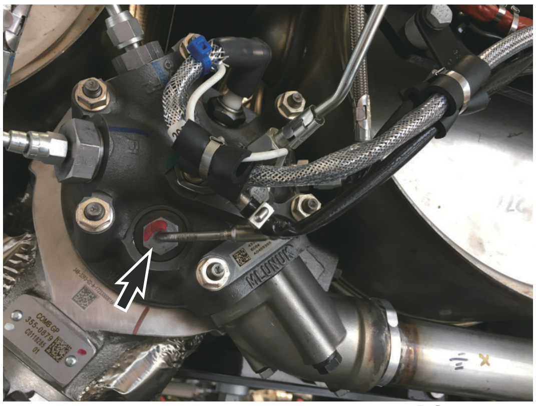
SCR Inlet Probe

Figure 162

DS2002829

ARD Flame Detect Probe

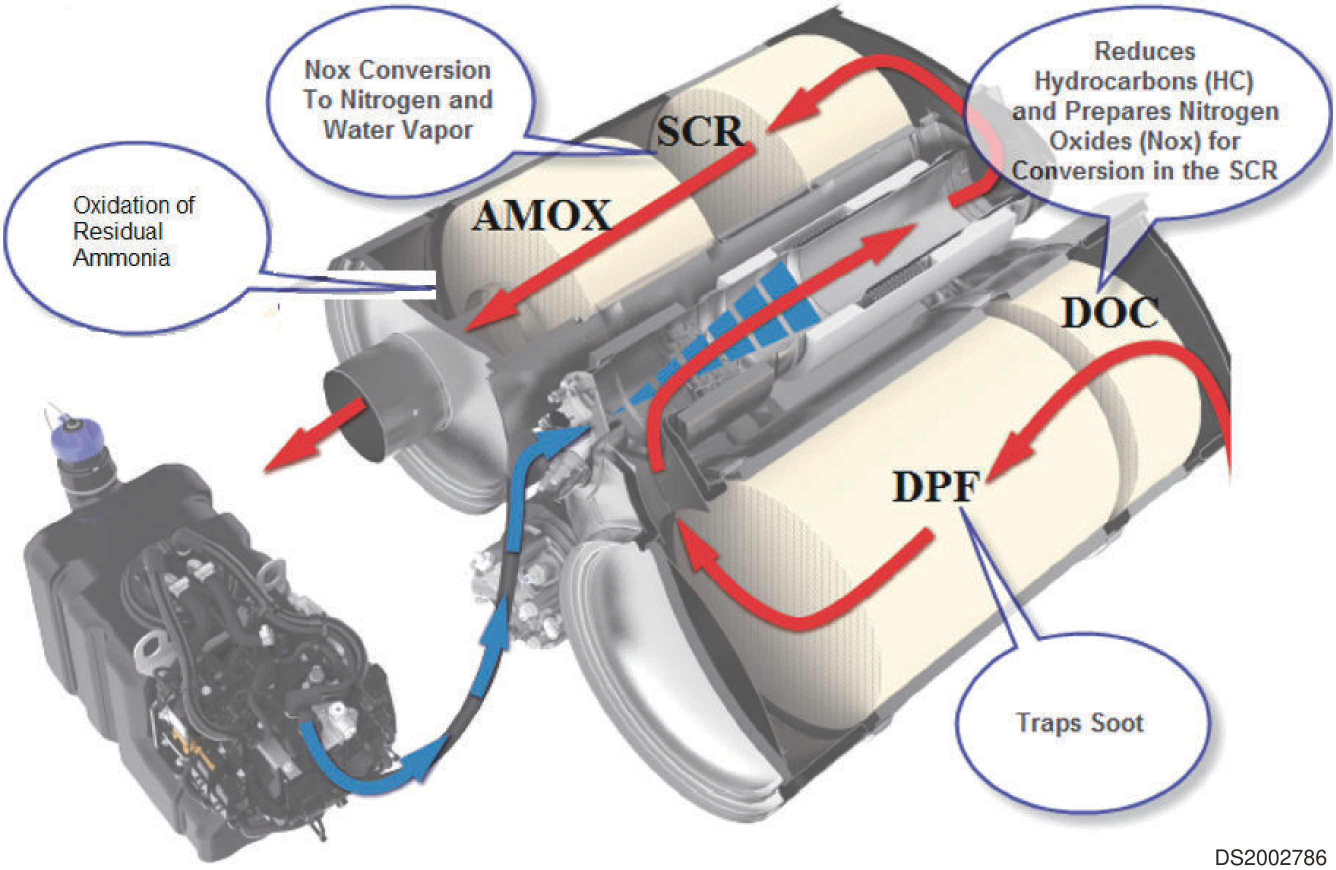
Figure 163



DS2002831

Aftertreatment Systems

Figure 164

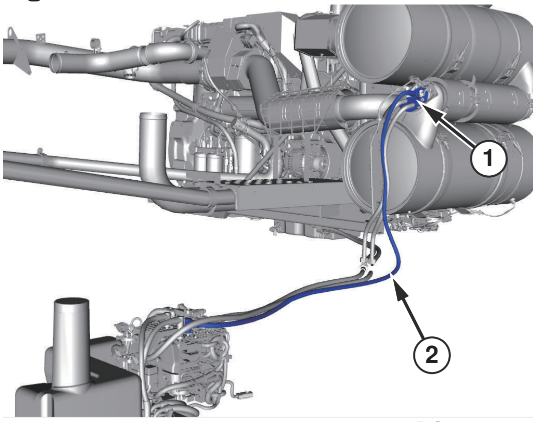


- This image shows the chemical process throughout the Clean Emissions Module (CEM).
- The purpose of Diesel Exhaust Fluid (DEF) is to create a Selective Catalytic Reduction (SCR) process to take place in the exhaust system in order to reduce Nitrogen Oxides (NOx).
- When the engine is keyed ON but not running, DEF is not being injected into the system. When the engine is running, the DEF may be too cold or frozen to be injected. When the ambient or tank temperatures are cold enough, the Dosing Control Unit (DCU) opens the coolant diverter valve to allow engine coolant to flow through the DEF tank to warm the system. The DCU also activates the heater circuits in the lines and pump to prevent DEF from freezing in the lines and pump. The time it takes to thaw the system depends on the tank temperature. Since the system always starts with empty lines, the pump activates to fill the lines with fluid before DEF injection begins.
- This is called DEF Priming Mode. Once the system is primed, the DEF will be injected when the DEF tank and SCR temperatures are warm enough. If the system does not heat up after a duration of time, the ARD system will turn on to heat up the system. The DEF dosing system must be fully functional within 70 minutes following engine start-up at very cold temperatures. If DEF injection does not start within 70 minutes, a diagnostic code will become active.

DEF Injection Strategy

- The DEF is stored in a tank. The DEF pump draws the DEF from the tank, through the pump and the DEF supply line (2), and the system pressurizes the DEF to 900 kPa (130 psi). This pressure is constant throughout the operating cycle of the engine. Finally, the DEF injector sprays the DEF into the exhaust before the SCR catalyst.

Figure 165



- The DEF injector (1) is an electronically controlled valve that sprays DEF into the exhaust stream as three solid streams. It is critical that the spray pattern is cone shaped for good mixing with the exhaust. Once started, DEF injection occurs for the duration of engine runtime.
- DEF injection rate is controlled by increasing or decreasing the duration of the DEF injector activation. If the engine is producing higher NOx, the DEF injector will be activated more frequently. To control pressure within the DEF pump, DEF will flow through the backflow line into the tank any time needed to maintain the 900 kPa (130 psi).
- The Dosing Control Unit (DCU) contains the software that controls the DEF dosing system. The DCU communicates with the Aftertreatment Electronic Control Module . The Aftertreatment ECM monitors and controls the entire aftertreatment system.

DEF Modes

The DEF system has three operation modes:

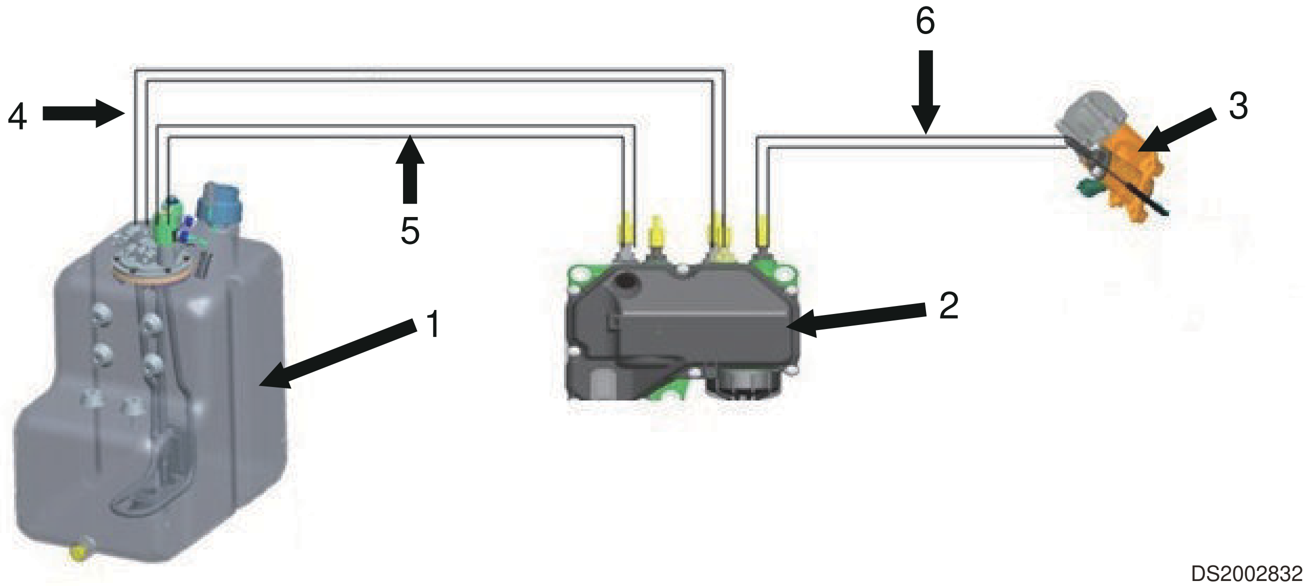
- DEF Priming Mode: Since the system always starts with empty lines, the pump activates to fill the lines with fluid before DEF injection begins. Priming will start when engine speed is greater than 450 rpm, DEF tank temp is greater than −6 °C (21.2 °F), and SCR inlet temperature is greater than 100 °C (212 °F). Once the system reads the appropriate pressures, priming is complete. The DEF dosing system must be fully functional within 70 minutes following startup or a diagnostic code will become active.
- DEF Injection Mode: Once the system is primed, the DEF will be injected when SCR inlet temperature is greater than 200 °C (392 °F). The DEF pump draws DEF from the tank and pressurizes the DEF to 900 kPa (130 psi). This pressure is constant throughout the operating cycle. The DEF injector sprays DEF into the exhaust before the SCR catalyst and continues spraying by pulsing on and off. The DEF injection rate is controlled by changing the duration of the DEF injector on time. If the engine is producing higher NOx, the DEF injector will turn on more frequently. To control the pressure to the DEF injector, a percentage of DEF will flow through the backflow line back to the tank.
- DEF Purge Mode: When a DEF related fault code becomes active or the engine is keyed OFF, the DCU enters purge mode. The system is designed to purge all DEF back to the DEF tank to prevent it from freezing in the pump and lines. The DEF injector opens and the DEF reverting valve in the DEF pump reverses the flow of the DEF. This removes the DEF from the pressure line and pumps it back to tank through the suction line. The purge takes approximately 2 minutes to remove DEF from the lines and pump. It is important not to turn OFF the battery disconnect switch during

the purge process. If the purge process does not complete and the temperature of the DEF drops below −11C (12F), the pump and lines are at risk of damage. If the purge process does not complete a diagnostic code will become active.

The amount of DEF needed is based on NOx production. The engine produces NOx as the engine operates at a specific target to meet emission standards. The engine out NOx sensor measures the amount of NOx and communicates that value to the DCU. The tailpipe out NOx sensor monitors the NOx level out of the catalyst and communicates that value to the DCU. Based on the engine out and the tail pipe out NOx sensor values, the flow rate of DEF will adjust to meet the NOx allowed per regulations.

DEF System OFF (Dormant)

Figure 166

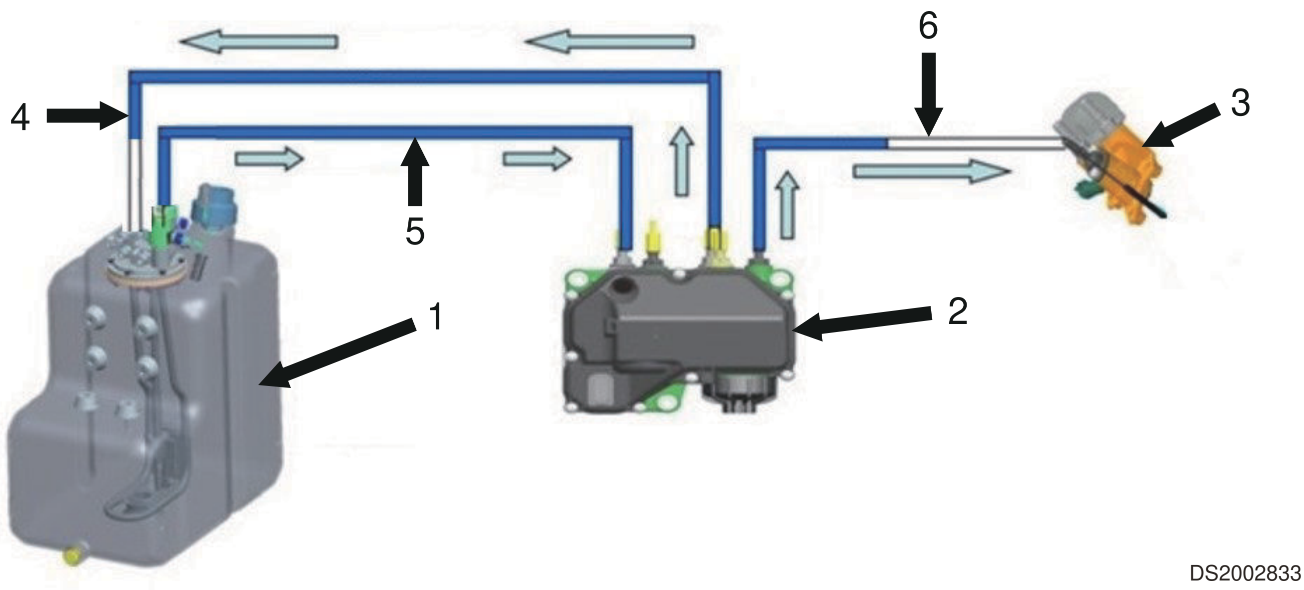


Reference Number	Description
1	DEF Tank and Header
2	DEF Pump
3	DEF Injector
4	Supply Line
5	Backflow Line
6	Pressure Line

- Initial state before priming or after purging has finished
- All DEF lines are empty and no DEF is flowing
- This is the only system state where battery power to the system can be turned off

DEF System Priming

Figure 167

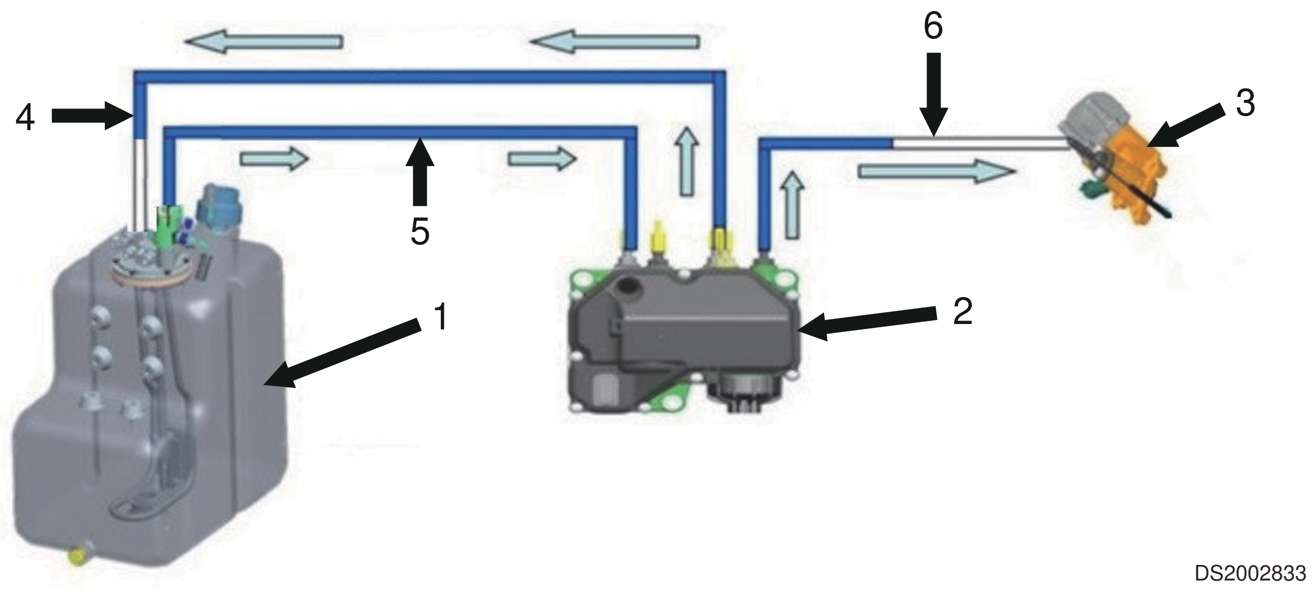


Reference Number	Description
1	DEF Tank and Header
2	DEF Pump
3	DEF Injector
4	Backflow Line
5	Supply Line
6	Pressure Line

- Priming fills the DEF lines and pump with DEF so the system can dose
- All DEF lines and the pump will be completely filled in approximately 45 seconds
- Pressure line is pressurized to approximately 900 kPa (130 psi)
- At the end of priming, a brief injection of DEF will be sprayed out of the DEF Injector to confirm priming succeeded and the system is ready to dose
- Turning off the engine key switch or shutting down the engine during priming will cause the pump to go into purge mode
- Battery power should not be removed from the system in this state
- Once priming succeeds, the pump will switch to the standby-ready to dose state

DEF System Active Dosing

Figure 168

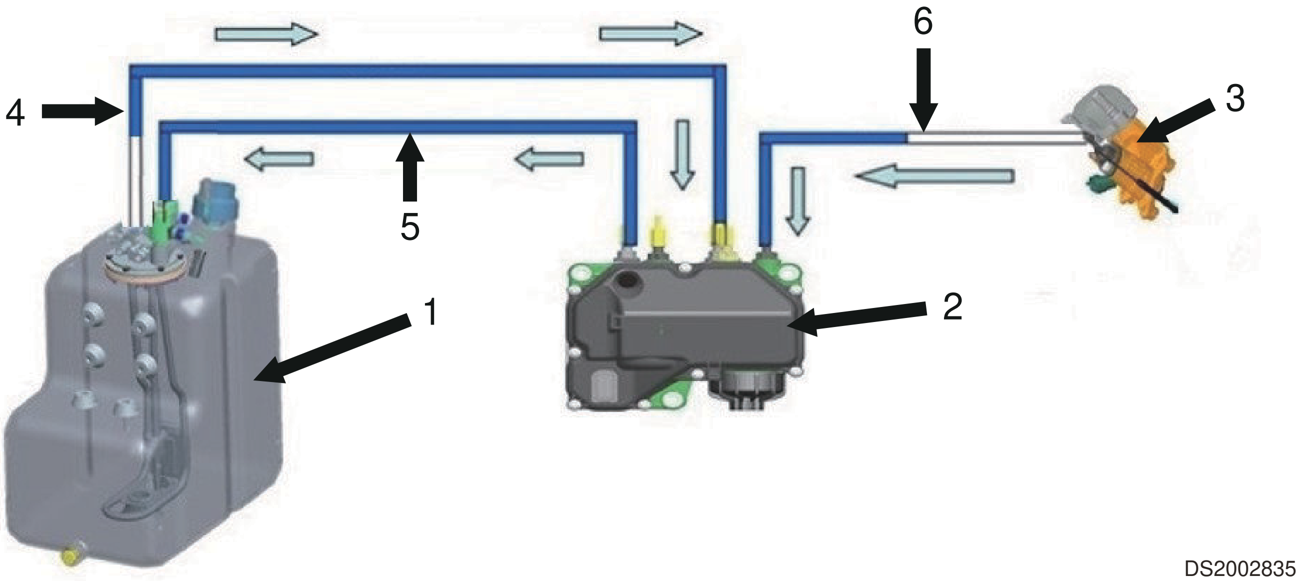


Reference Number	Description
1	DEF Tank and Header
2	DEF Pump
3	DEF Injector
4	Backflow Line
5	Supply Line
6	Pressure Line

- Entire System is filled with DEF
- DEF is actively being sprayed from the DEF Injector
- DEF is continuously being circulated out of the tank, through the supply line, and returned back through the backflow line
- Pressure line is approximately 900kPa (130psi)
- Turning off the engine key switch will cause the pump to go into purge mode
- Battery power should not be removed from the system in this state

DEF System Purging

Figure 169

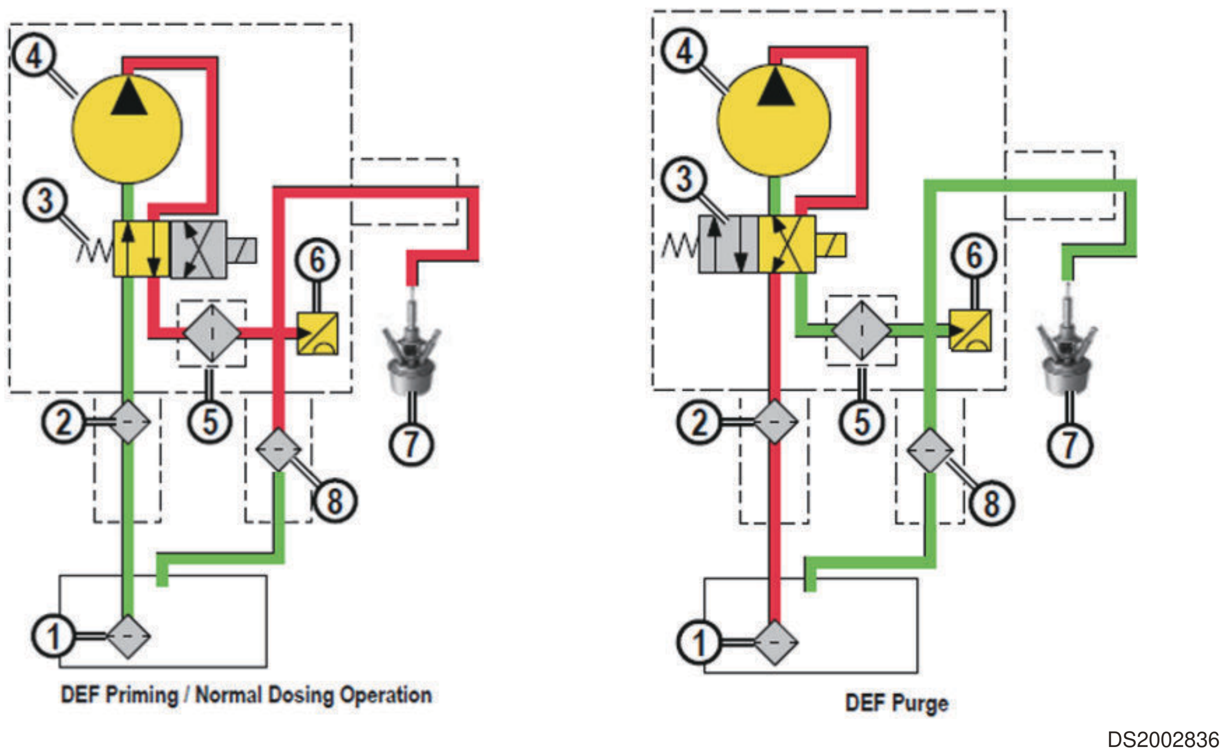


Reference Number	Description
1	DEF Tank and Header
2	DEF Pump
3	DEF Injector
4	Backflow Line
5	Supply Line
6	Pressure Line

- System will be emptied of DEF
- Purging will happen anytime the engine key switch is turned off and takes approximately 70 seconds to complete
- DEF is returned to the tank through the supply line - not the backflow line
- Turning the engine key switch back on in this mode will make the pump go into priming mode
- Battery power should not be removed from the system in this state After purging completes, the pump will switch to the off state
- This state will pull a vacuum of approximately -34 kPa to -62 kPa (-5 psi to -9 psi)

DEF Pump Flow

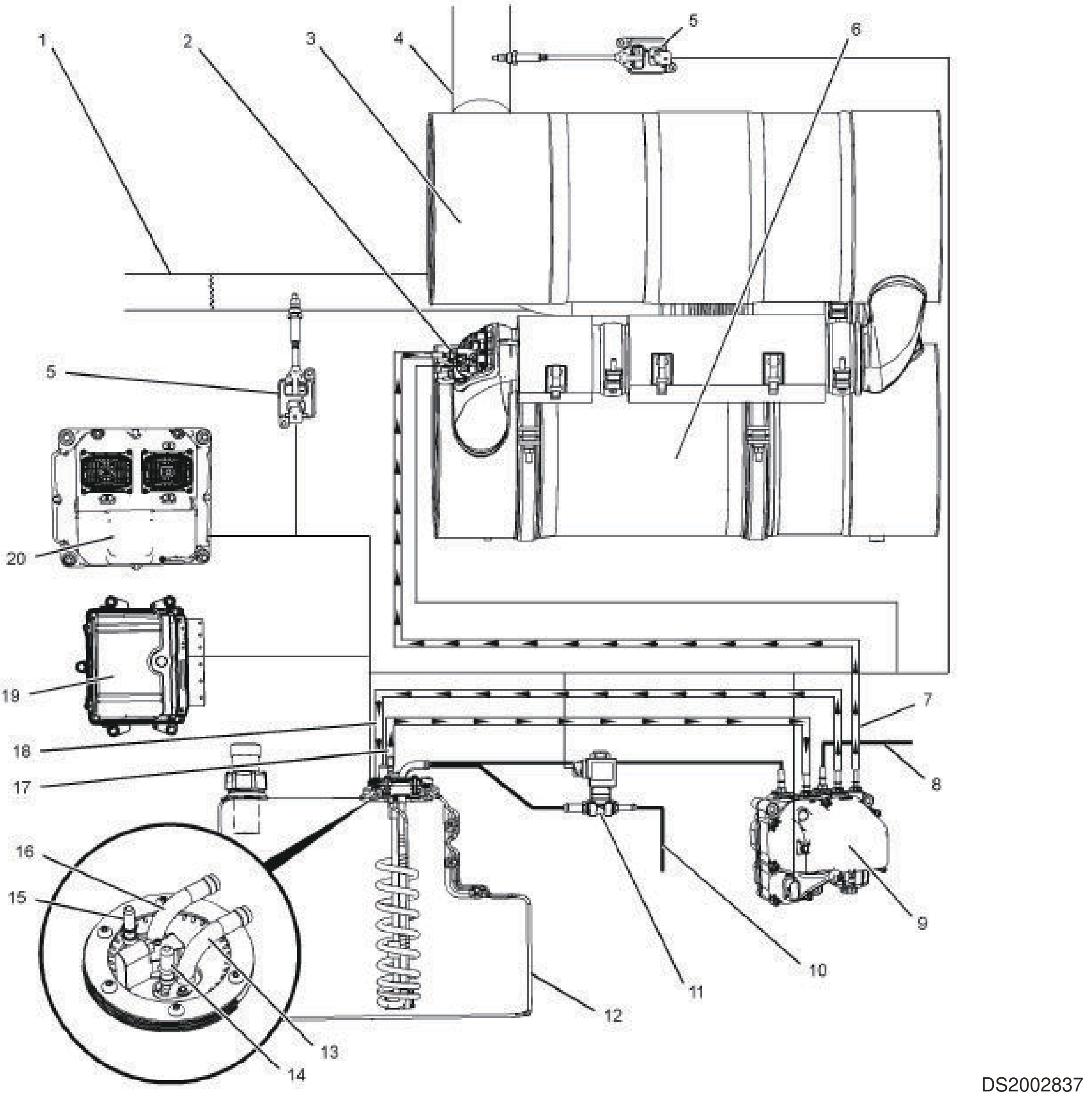
Figure 170



- During DEF priming and normal dosing operation the DEF pump (4) pulls DEF from the tank through the DEF tank filters (1), the primary DEF pump filter (2), the de-energized reverting valve (3) and the primary DEF filter (5).
- From there the DEF is pressurized to 900 kPa (130 psi) and flows through the DEF pressure line to the DEF injector (7). To control pressure within the DEF pump, DEF will also flow through the backflow line (8) into the tank any time the pump is on in order to maintain the desired pressure. There is a fixed orifice in the backflow fitting (which has an orifice, check valve, and a 130 micron screen) that purges the pressure off the pressurized circuit. This pressure relief will stabilize the pressure in the line when the DEF injector is opening and closing. There is a pressure sensor (6) to monitor the DEF pressure.
- After the key is turned OFF, the pump will start the purge mode and a pumping sound may be heard from underneath the vehicle. The sound is made by the aftertreatment DEF dosing pump while it purges any unused DEF from the system and returns it to the DEF tank. This is normal system operation and takes approximately 70 seconds to complete. The DEF injector will open and the reverting valve within the pump will be energized. This will reverse the flow of DEF through the pump and purge the pump and pressure line. This reversed flow will route any remaining DEF fluid back to the tank.

DEF Components Diagram

Figure 171

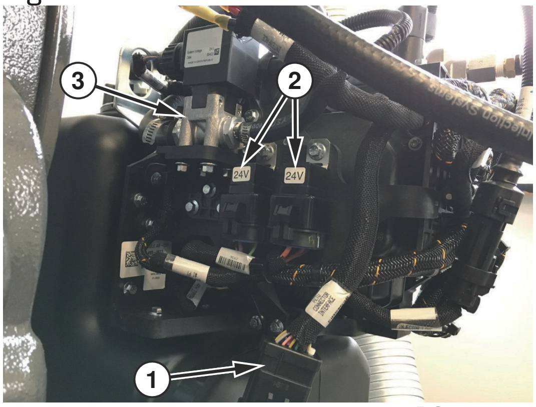


Reference Number	Description
1	Exhaust Inlet
2	DEF Injector
3	SCR System
4	Exhaust Out
5	NOx Sensors
6	DPF
7	DEF Supply Line
8	Coolant Return to Engine Line
9	DEF Pump
10	Coolant Supply from Engine

Reference Number	Description
11	Coolant Diverter Valve
12	DEF Tank
13	Coolant Supply
14	Suction Connector
15	Backflow Connector
16	Coolant Return Connector
17	DEF Suction Line
18	DEF Backflow Line
19	DCU
20	ECM

DEF Components

Figure 172

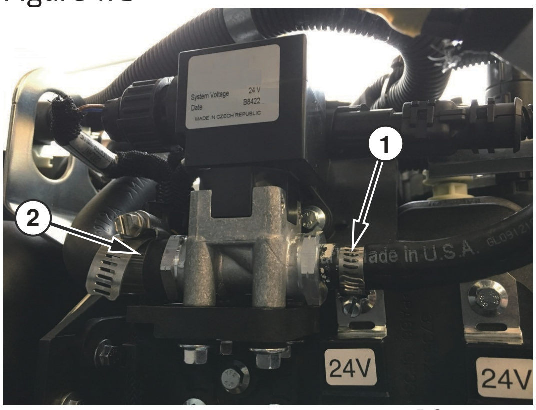


DS2002838

Reference Number	Description
1	PETU Interface Connector
2	Relays for the DEF Heated Lines
3	Coolant Diverter Valve

Coolant Diverter Valve

Figure 173



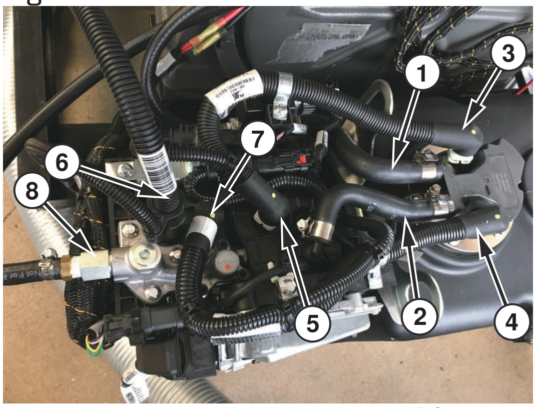
DS2002839

Reference Number	Description
1	Coolant in Supply
2	Coolant Out to Tank Header

- The coolant diverter valve is located near the top of the PETU.
- This valve is a normally closed, unidirectional valve. The system is used to thaw frozen DEF fluid in the tank before dosing occurs. Warming the system is achieved by taking warm coolant from the engine and routing the coolant through the tank and DEF pump.
- The coolant diverter valve will open when tank temperature needs to be increased. Once tank temperature is warm enough, the system will start dosing.
- The useable temperature of DEF is between -10 ° to 55 °C (14 °F to 99 °F).

Pump Electronics Tank Unit (PETU) Components

Figure 174



DS2002840

Reference Number	Description
1	Coolant in from Coolant Diverter Valve
2	Coolant out from Tank Header
3	Suction Line
4	Return Line
5	DEF Pump In
6	DEF Out to DEF Injector
7	DEF from Pump to Header
8	Coolant Return to Water Pump

DEF Tank Header

Figure 175

DS2002841

Smart header. Communicates on CAN C. 4-wire (power, ground, CAN H, CAN Low)

DEF tank header components:

- DEF pickup tube:
  - DEF is pulled from the bottom of the tank through a screen.
- DEF tank header filter:
  - A filter that wraps around the coolant tubes to filter debris from entering the pickup and backflow circuits.
- Coolant tubes:
  - Coolant supplied by the engine flows through the tubes when the coolant diverter valve opens. Coolant runs along the pickup tube to the bottom of the tank and then spirals around the level sensor. The heat from the coolant will thaw any frozen DEF in the tank or header and prevent the DEF from freezing around the pickup tube.
- DEF fluid level/temperature sensor
- DEF quality sensor

DEF Level Sensor

Figure 176

DS2002842

- There is an ultra sonic DEF level sensor integrated with a DEF tank temperature sensor located at the bottom of the DEF header assembly.
- The DEF level sensor will measure the amount of DEF in the tank. This level sensor is made up of multiple reed switches that will open and close when a magnetic float moves over these switches. The reed switch will provide a resistance reading to the DCU that will be converted to a DEF level percentage.
- The temperature sensor is a passive thermistor. The resistance of the thermistor varies with temperature. This sensors monitors the temperature of the DEF in the tank and is used turn on the coolant diverter valve.

DEF Quality Sensor

Figure 177

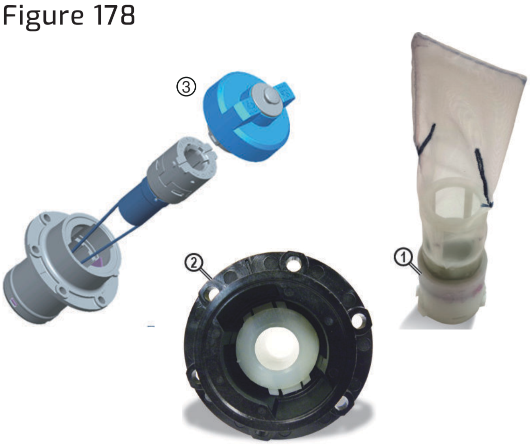
DS2002843

EPA mandated DEF quality sensor:

- Located at t he bottom of the tank header next to the DEF tank header filter.
- The DEF quality sensor uses an optical Near Infra-Red (NIR) technology that makes measurements of urea concentration by measuring the chemical properties of the DEF solution. Based on these chemical properties and fluid temperature, the sensor is able to detect urea concentration with an accuracy of up to 2%.
- If the sensor detects the quality of DEF is not within specifications, a fault code will trip, indicating the DEF concentration is not correct. The engine may derate.
- Communication is over CAN C

PETU Contamination Control

Figure 178



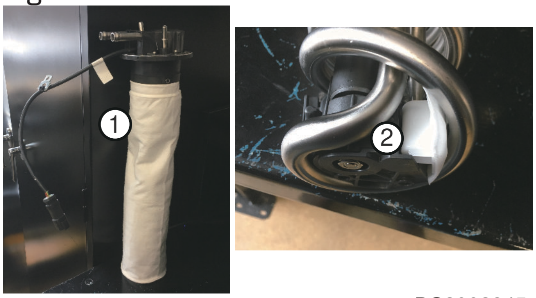
DS2002844

- To prevent the introduction of debris into the DEF tank and DEF system, a series of filter screens have been designed into the system.
- The above images show the PETU inlet screen (1) that will be located in the filler tube (2) of the DEF tank.

- DEF Tank Filler Neck Adapter Filter Screen Assembly (3) shows how the screen is assembled in the filler neck of the DEF tank. Within the PETU inlet screen is an integral magnet, which is used to engage a safety switch with available DEF dispensers.

PETU Contamination Control

Figure 179

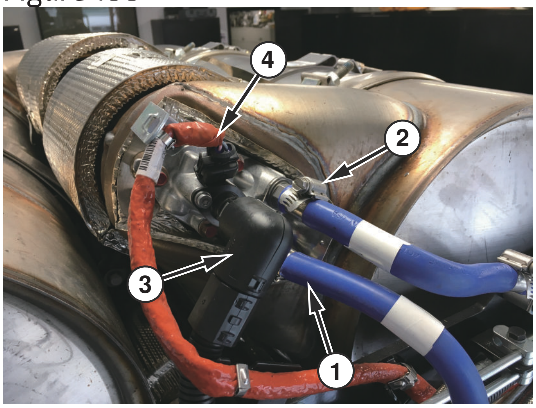


DS2002845

- The 32 micron DEF tank header "sock" (1) and the 100 micron DEF tank header filter (2) will help with filtration in the DEF tank.

DEF Injector

Figure 180



DS2002846

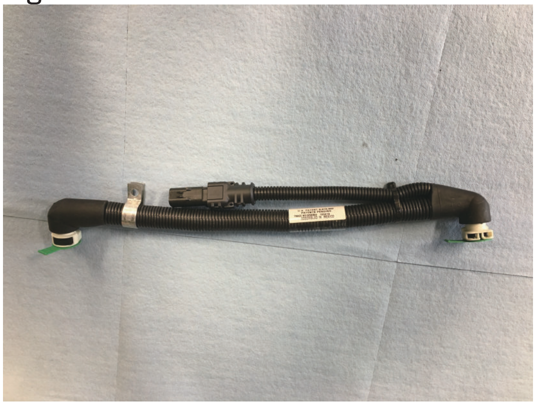
Reference Number	Description
1	Coolant in from ARD
2	Coolant Return
3	DEF Fluid In
4	Electrical Connector

- The DEF injector is mounted to the CEM. The DEF injector is a valve that injects DEF as a fine spray into the exhaust gases as an atomized mist after the DPF. The spray pattern being conical for good mixing with the exhaust is critical.
- The tip of the injector, located in the exhaust stream, is cooled by coolant that flows through an internal passage from the coolant supply. The DEF injector can become damaged when exposed to high temperatures so it is important to keep it cooled. The coolant flow, and the DEF injection process, provides cooling capability needed to protect the injector.
- High temperatures at engine shutdown can exceed the hardware limit of the DEF injector. To protect the DEF injector from high temperature at shutdown, the "Delayed Engine Shutdown" (DES) strategy will run for a time after the engine start switch key is turned off. This strategy allows the

engine to continue running to prevent high exhaust temperatures from damaging the DEF injector at shutdown.

DEF System Heated Lines

Figure 181

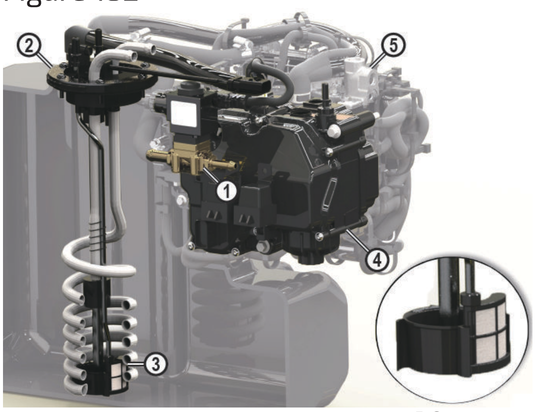


DS2002847

- The DEF flows in the heated lines from the DEF tank to the pump in the DCU.
- The DEF then travels through another heated line from the DCU to the DEF injector.
- The heated lines are heated by electrical resistance.
- Even though the system has been purged of DEF, there are small quantities of DEF that can be left behind. The DEF supply line, suction line, and backflow line are heated to thaw any remaining DEF in the lines. DEF will expand by approximately 10% when frozen.
- The heated lines will prevent restrictions in the pump and injector once the system begins to close.
- The heated lines turn on based on ambient temperature. If the ambient temperature is below 0C (32F), then the heated lines turn on. Once the ambient temperature is greater than 5C (41F), the lines turn off.
- The heated lines have the following characteristics:
  - Thermoplastic core tube with fabric reinforcement
  - Stainless steel heating wire
  - Extruded thermoplastic jacket
  - Heat/abrasion shield
  - Quick disconnector

Cold Weather Operation

Figure 182



DS2002848

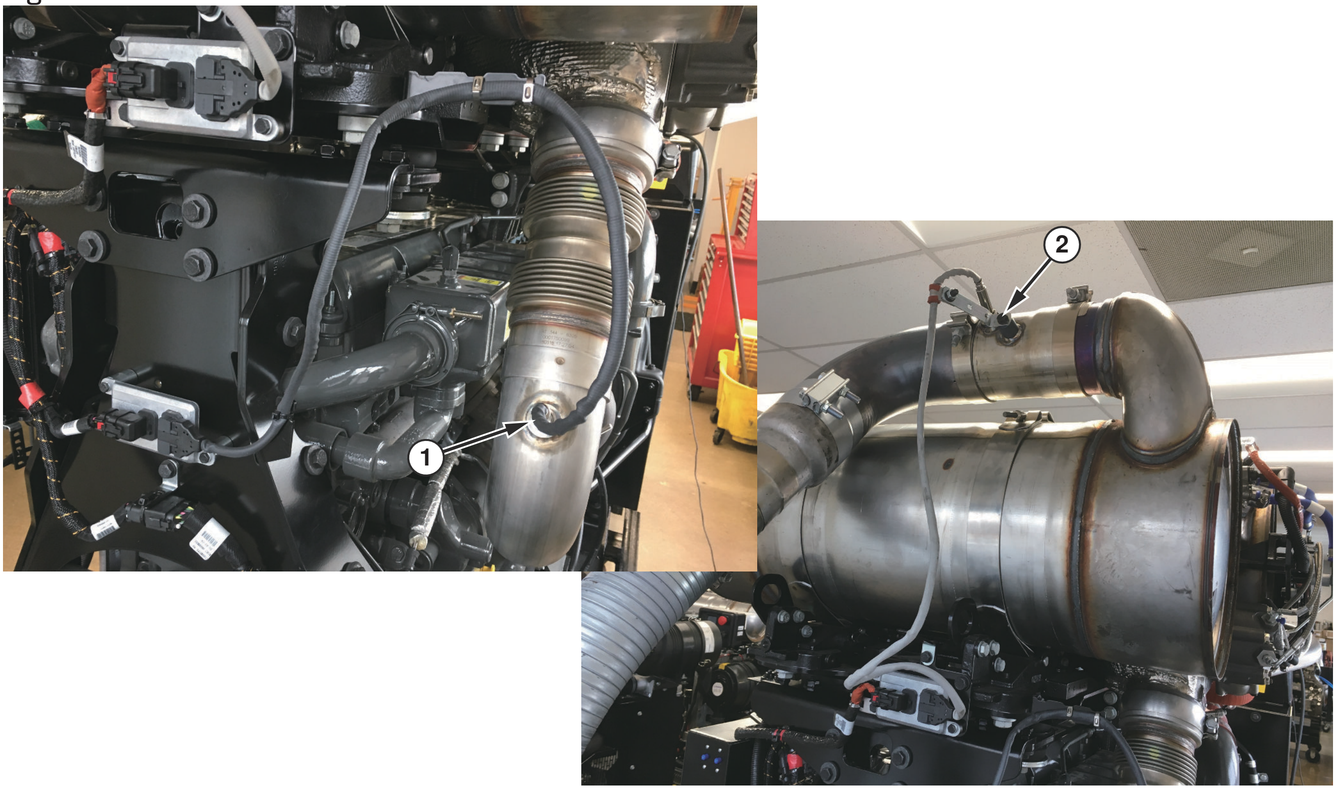
- Since DEF freezes at -11 °C (12 °F), the system must be capable to thaw before injecting DEF.
- Engine coolant is supplied to the PETU. At starting, the coolant diverter valve (1) will energize any time the DEF tank temperature is less the 15 °C (59 °F). It will allow coolant to flow to the DEF tank header (2).
- During operation, if the DEF tank temperature drops below 20 °C (68 °F) or ambient temperature falls below 0 °C (32 °F), the coolant diverter valve will energize to keep the DEF from freezing. This will also thaw DEF around the DEF level sensor float and the pickup screen (3). The coolant will then flow through the DEF pump (4) to prevent internal freezing. The coolant will then return (5) to the engine water pump inlet. DEF dosing will occur once the DEF has been thawed and the DEF tank temperature is greater than -6 °C (21 °F).
- If DEF freezes in the DEF pump or DEF lines, it may cause damage to the components. However, it will be allowed to freeze in the tank. To allow for expansion within the tank, the filler neck is designed to allow an air gap at the top of the tank.
- For additional freeze prevention, the system is designed to purge all DEF back to the DEF tank at the time the engine is shut down. To do this, the DEF injector opens and the DEF reverting valve reverses the flow of the pump. This reverses the flow of the pump, draws the DEF out of the pressure line, and pumps it back to tank through the pickup tube. This not only occurs at key OFF, but also when a DEF related fault code becomes active. The purge takes approximately two minutes to completely remove the DEF from the lines and pump.

Abnormal Shutdown

It is important to NOT turn the battery disconnect switch OFF during the purge process. Refer to Operation and Maintenance Manual “Selective Catalytic Reduction Warning System” for the proper shutdown procedure. If the purge process does not complete and the temperature of the DEF drops below -11 °C (12 °F), the pump and lines are risk of damage. If the purge process does not complete, a diagnostic code will become active for 1.5 min then moved to logged. A warranty report will include a history of these events

NOx Sensors

Figure 183



- There are two NOx sensors installed on the CEM, NOx In sensor (1) is installed in the exhaust inlet from the turbocharger (black harness) and NOx Out sensor (2) is installed in the exhaust tail pipe exiting the CEM (grey harness)
- The amount of DEF needed is based on the NOx production. The engine out NOx sensor measures the amount of NOx. The tail pipe out NOx sensor monitors the NOx level out of the catalyst. Both values are communicated to the DCU. Based on the engine out and the tail pipe out NOx sensor values, the flow rate of DEF will adjust to meet regulations.
- The NOx sensors contain a sensing element, a harness, and an ECU. The sensing element is composed of two chambers and a heater. The first chamber measures the amount of oxygen and the second chamber measures the amount of NOx and NH_3. A ceramic material attracts ions at approximately 800 °C (1472 °F) and an electrode on the chamber wall measures the electrical charge in voltage or current. The signal is received by the NOx sensor electronic unit and interpreted into a NOx concentration.
- The heater is used to maintain the sensing element temperature, because it is sensitive to moisture. If the sensor sees any moisture at 800 °C (1472 °F), then the moisture could quickly cool the element and cause damage. So the sensors will not start working until the exhaust temperature around the sensors is greater than 100 °C (212 °F) for approximately two minutes. The sensors will start reading and reporting information at approximately 193 °C (380 °F).

Systems Operation, Description And Inspection

Safety Instructions

WARNING

AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or servicingmachine. Read and understand the Operation & Maintenance Manual and signs (decals) on machine. Followwarnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correctfunction after adjustments repairs or service. Untrainedoperators and failure to follow instructions can cause deathor serious injury.

General

General Description

The hydraulic system has several improvements over conventional hydraulic systems - Electronic pump (VBO) and spool electronic control - to maximize output efficiency. The system features an electronically controlled output optimization system, which allows the operator to choose between two, distinctly different power modes: High output/rapid cycling maximum speed power mode, and a standard power mode for most types of general operation. Electronic management of hydraulic control valves assists in optimizing the application speed and overall operator control of hydraulic actuators and functions.

When referring to the schematic, refer to the following items:

- As shown in the schematic, the main pump assembly is driven by the engine. Mechanical energy is converted to hydraulic power, generating the required hydraulic flow which drives the system. Two main pumps (an A pump and a B pump) make up the main pump assembly.
- The right half of the hydraulic control valve, supplied by the A pump in the pump assembly, operates spools for bucket 2, right travel, option, arm 1, swing and boom 2 functions. The amount of oil flow to the actuators at the output end of each of those circuits is regulated through the movement of each individual spool.
- The left half of the hydraulic control valve, supplied by the B pump in the pump assembly, has control spools for boom 1, bucket 1, left travel and arm 2 operation.
- Two-stage operation is a feature of boom and arm function. All of these circuits can be operated using the output of only one half of the hydraulic pump assembly (one pump or the other), or since both halves of the control valve have a spool and available circuit for these functions the output of both pumps can be combined, allowing higher speed operation. Boom up, Arm crowd/ dumping and Bucket crowd functions can operate in any one of the two available power modes the standard or general duty mode, the high-speed/ rapid cycling mode.
- Whenever the right travel or left travel control spools are shifted, output from the main pump assembly flows through the center joint to one or both of the travel motors driving the side frame crawler tracks. A pilot solenoid valve connected to the swash plate of each travel motor changes motor capacity (and output) in direct proportion to the position of the travel switch selected by the operator.
- The hydraulic reservoir return line and the pilot circuit both have 10 micron full flow filters. The disposable elements in these two canister type filters trap and remove impurities from the oil in the system. An 80 mesh, 177 micron reservoir intake strainer also helps maintain system cleanliness and must be cleaned each time hydraulic fluid is drained and replaced. An oil cooler

in the hydraulic system helps maintain the operating temperature of the system at approximately 50°C (122°F).

- Boom, Arm and Bucket cylinder operating circuit includes overload valves which protect the hydraulic system from vacuum that could result from external shocks or other unusual conditions.

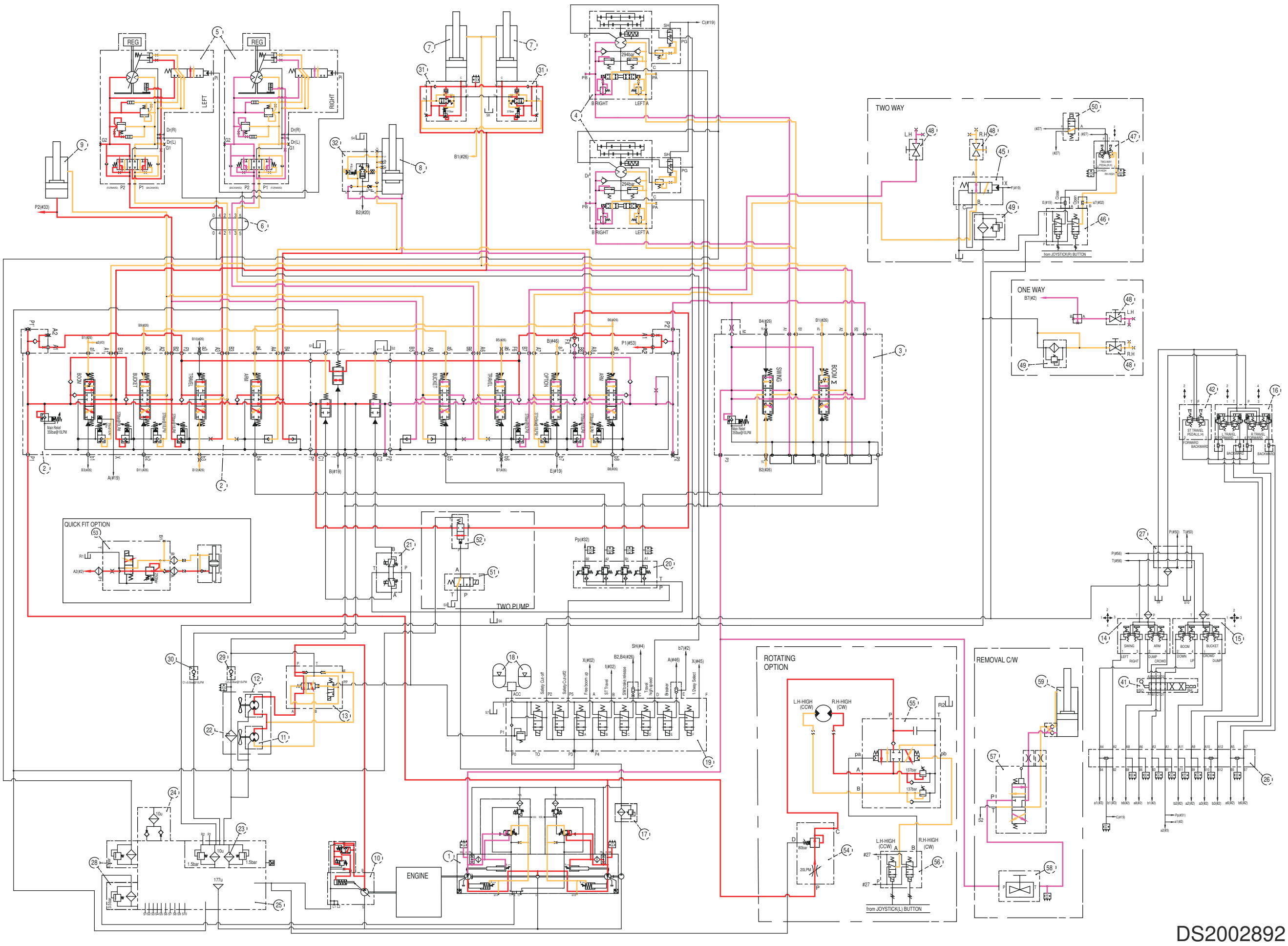
Whenever high-pressure is generated because of a shock or overload, excess pressure is dumped to the reservoir return circuit through the relief valve.

Main Oil Circuit

When the engine is running, as the main pump, pilot pump and fan drive pump operate, oil is supplied to the main control valve, fan drive motor, solenoid package valve, accumulator, and parking brake release line of the swing device. Then, the oil path changes depending on the operating signal from the actuator, and oil is supplied to the latter.

The oil flow supplied by the main pump changes depending on the accumulator pressuressensor of joystick.

Figure 184



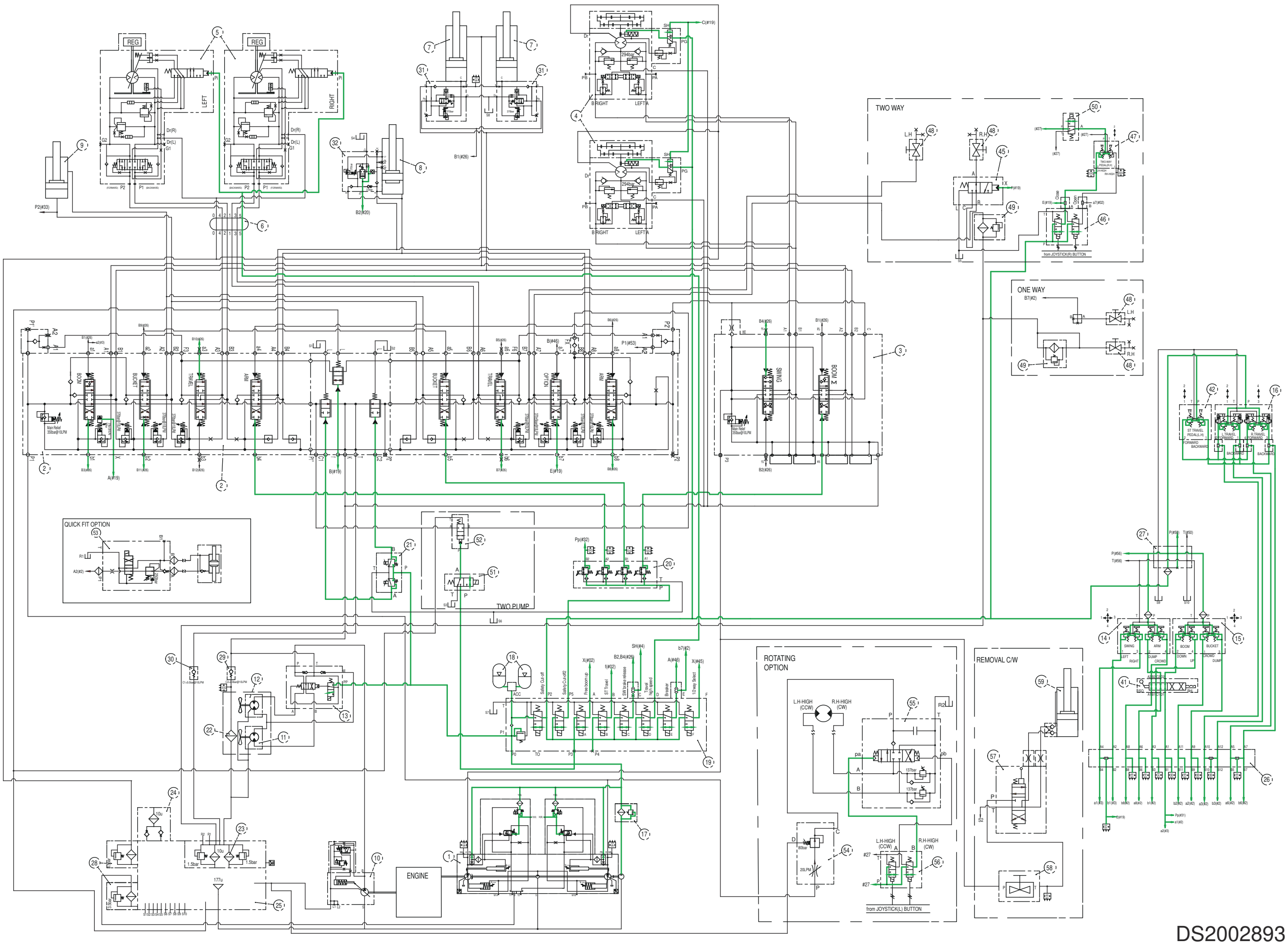
DS2002892

Pilot Oil Circuit

The pilot pump receives oil from the oil tank based on the engine rpm, and the oil passes through the pilot filter to be charged in the accumulator first in order to enhance the responsiveness of machine movements. Then, the oil is supplied to the solenoid package valve.

After passing through the safety cutoff valve in the solenoid package valve, the pilot oil is connected to joystick valves and pedal valves to control the signal pressure of combined operations. Then oil is also used as a signal for releasing the parking brake of the swing device.

Figure 185



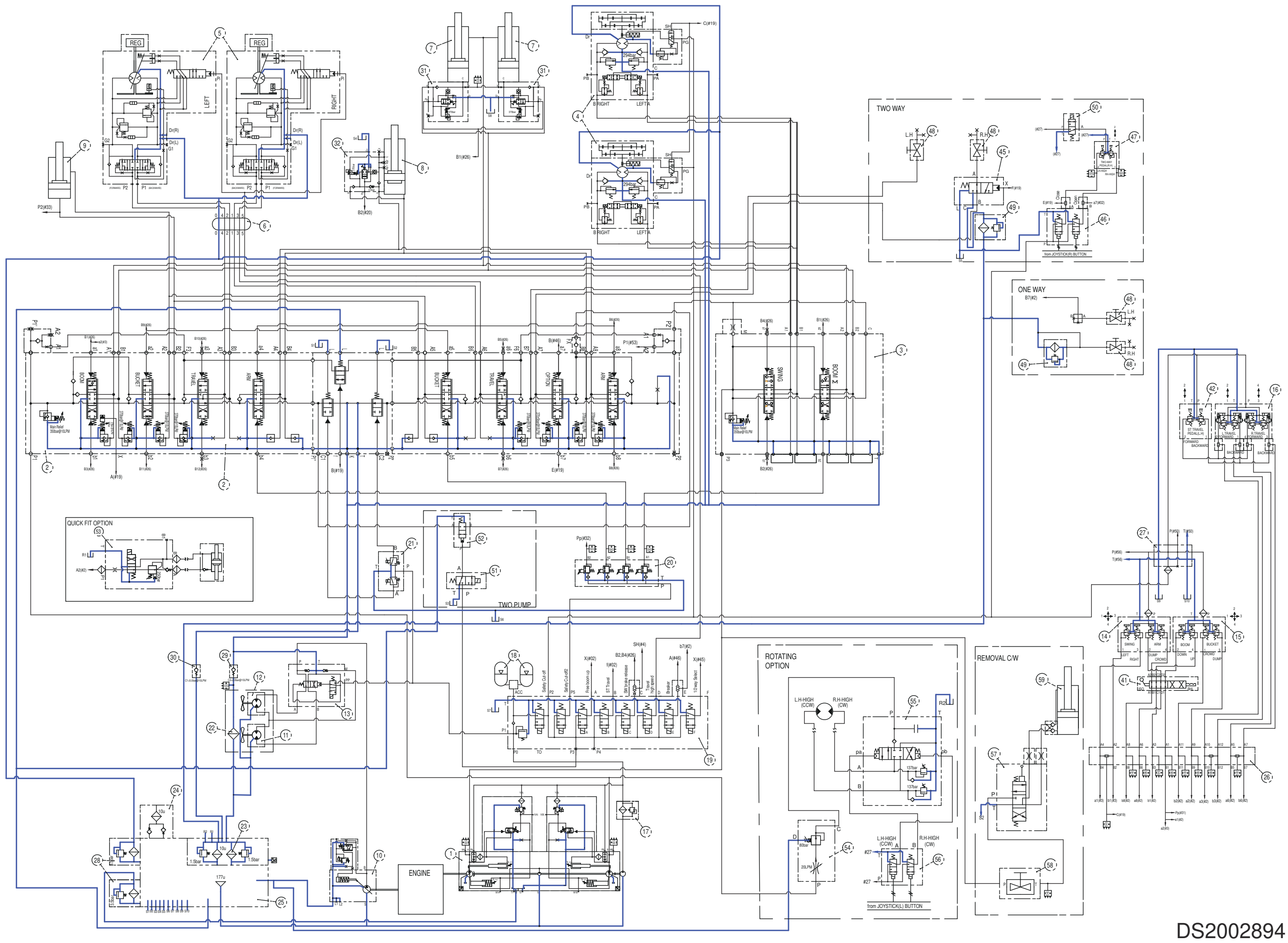
DS2002893

Return and Drain Oil Circuit

The oil in the hydraulic system is supplied from the main pump to each component, for example, Boom or Bucket.

And then the oil is drained or returned to the oil tank depending on the hydraulic system.

Figure 186



DS2002894

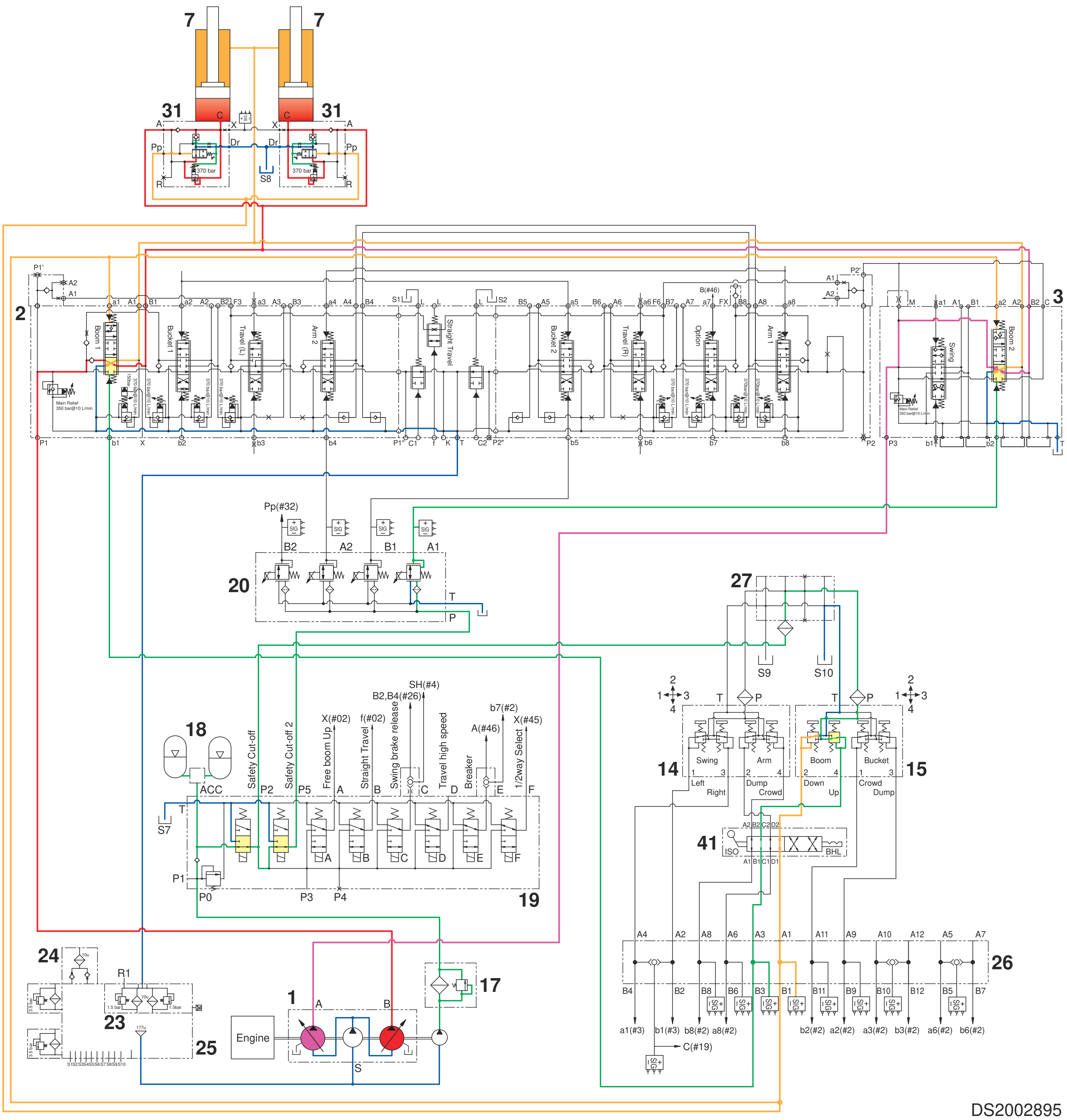
Main system operation

Boom Up Operation

If the pilot oil is supplied to boom 1 spool (b1 port) of the main control valve by the operation of the joystick valve, the spool is moved and oil of main pump supply to boom cylinder head side.

Oil supplied from the main pump is supplied to the boom cylinder head through the boom lock valve, causing the moving to take place. If the boom up operation is stopped, the oil in the boom cylinder is obstructed by the boom lock valve, and the moving of boom is blocked.

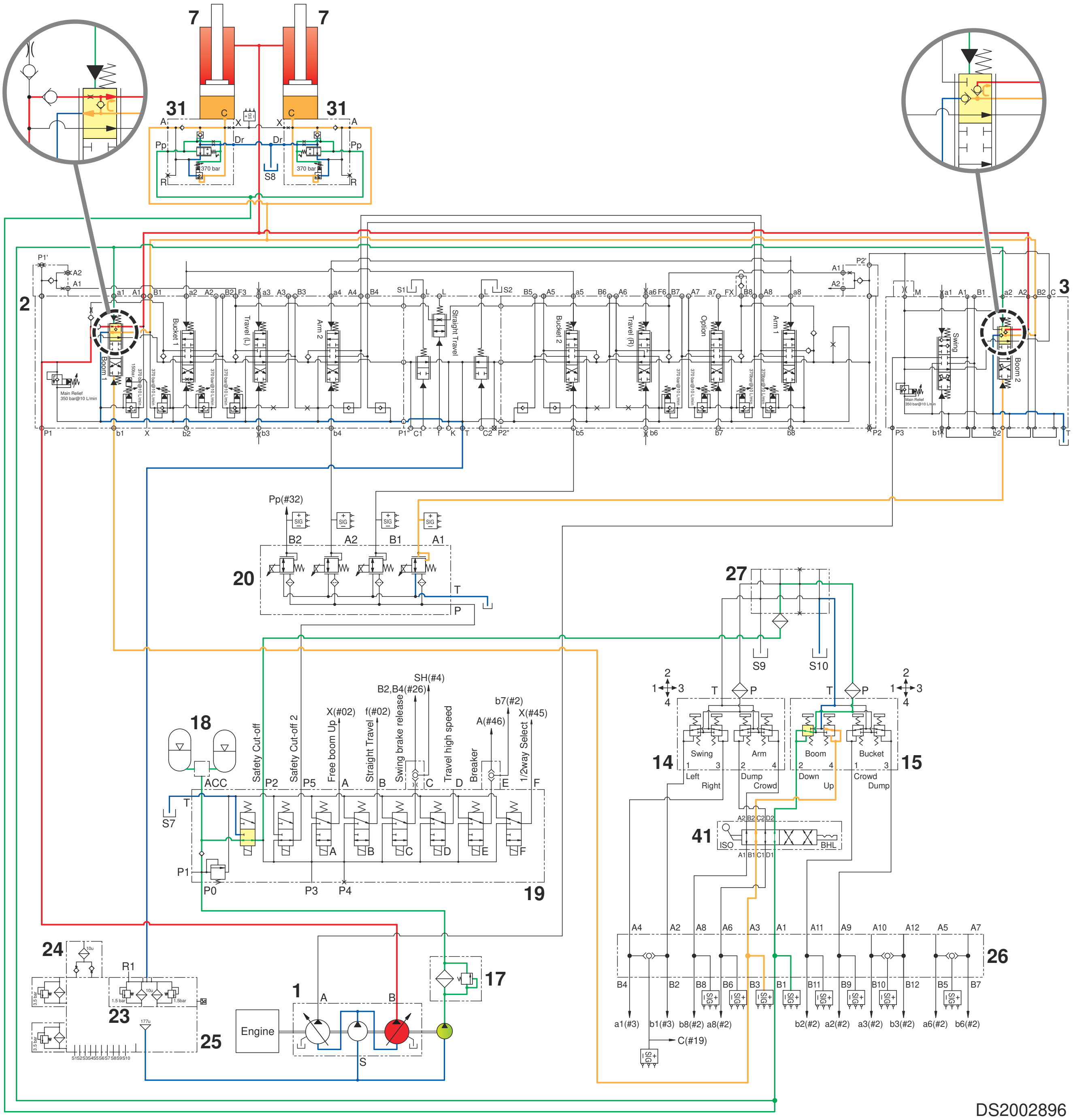
Figure 187



Boom Down Operation

If the pilot oil is supplied to boom 1 spool (a1 port) of the main control valve and boom 2 spool (a2 port) of the main control valve by the operation of the joystick valve, the spools are moved and oil of the main pump is supplied to boom cylinder rod side. Oil supplied from the main pump is supplied to the boom cylinder rod through the boom lock valve, the boom is down. When the boom down speed becomes abrupt, the cavitation phenomenon occurs on the boom rod side. To prevent this, a boom regeneration function is built in the boom spool to recirculate oil from the boom cylinder head to the rod side. In addition to cavitation prevention, increasing speed, energy-saving is possible by minimizing pump supply flow. If the boom down operation is stopped, the oil in the boom cylinder is obstructed by the boom lock valve, and the moving of boom is blocked.

Figure 188



DS2002896

Arm Dump Operation

When the pilot pressure is applied to the (a8) port by operating the left joystick lever, the arm spool moves to open the port A8. Then, high-pressure oil at the port P2' flows to the arm cylinder rod side through the port A8 to perform arm dump operation. Also, when operating the left joystick lever, the pilot pressure is applied to the (a4) port as well.

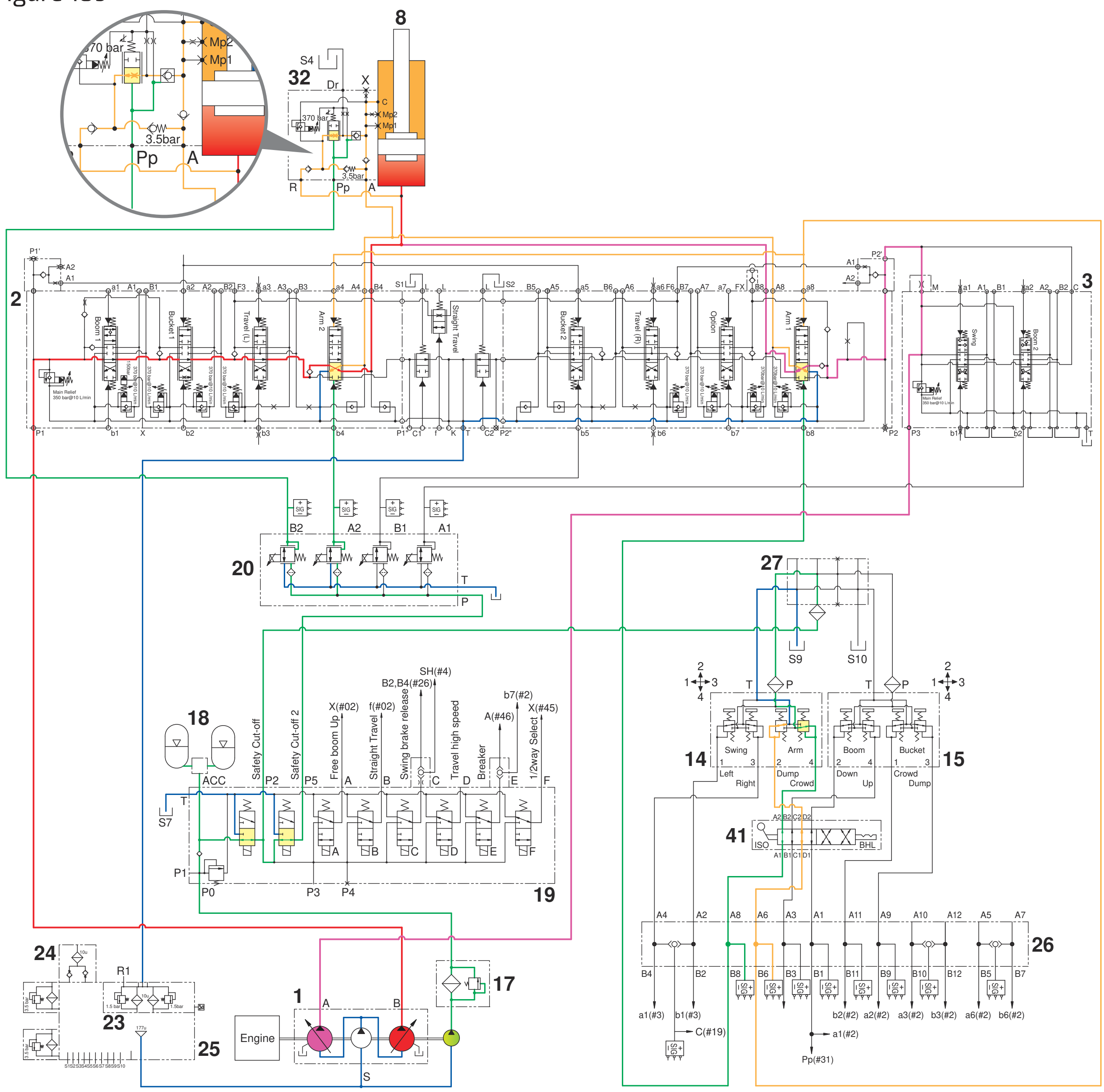
As a result, high-pressure oil of P1 joins with P2 oil as shifting of arm 2 spool and flows to the arm cylinder rod together. The arm rod side and tube side are installed with overload relief valves to protect the arm cylinder and control valve from the external force.

Arm Crowd Operation

When the pilot pressure is applied to the (b8) port of the control valve by operating the left joystick lever, the arm spool moves to open the port B8. Then high-pressure oil at the port P2' flows to the arm cylinder head side through the port B8 to perform arm crowd operation. Also, the secondary pressure is generated by the change of the A2 EPPR supply current of the EPPR valve and the pilot pressure is supplied to the port (b4) of the main control valve. As a result, high-pressure oil of P1 through the B4 port joins with P2` oil flows to the arm cylinder head together. During the arm crowd operation, pilot pressure is supplied to (Pp) port of the arm lock valve due to the switching of the EPPR (B2) of the EPPR valve to form a flow path so that the oil of the arm cylinder rod can be returned. Then the oil of the arm cylinder rod side is discharged from the (C) port of the arm lock valve to the (R) port and recirculated to the arm cylinder head side (Arm regeneration function in lock valve).

Some oil is returned to the oil tank. The arm rod side and tube side are installed with overload relief valves to protect the arm cylinder and control valve from the external force.

Figure 189



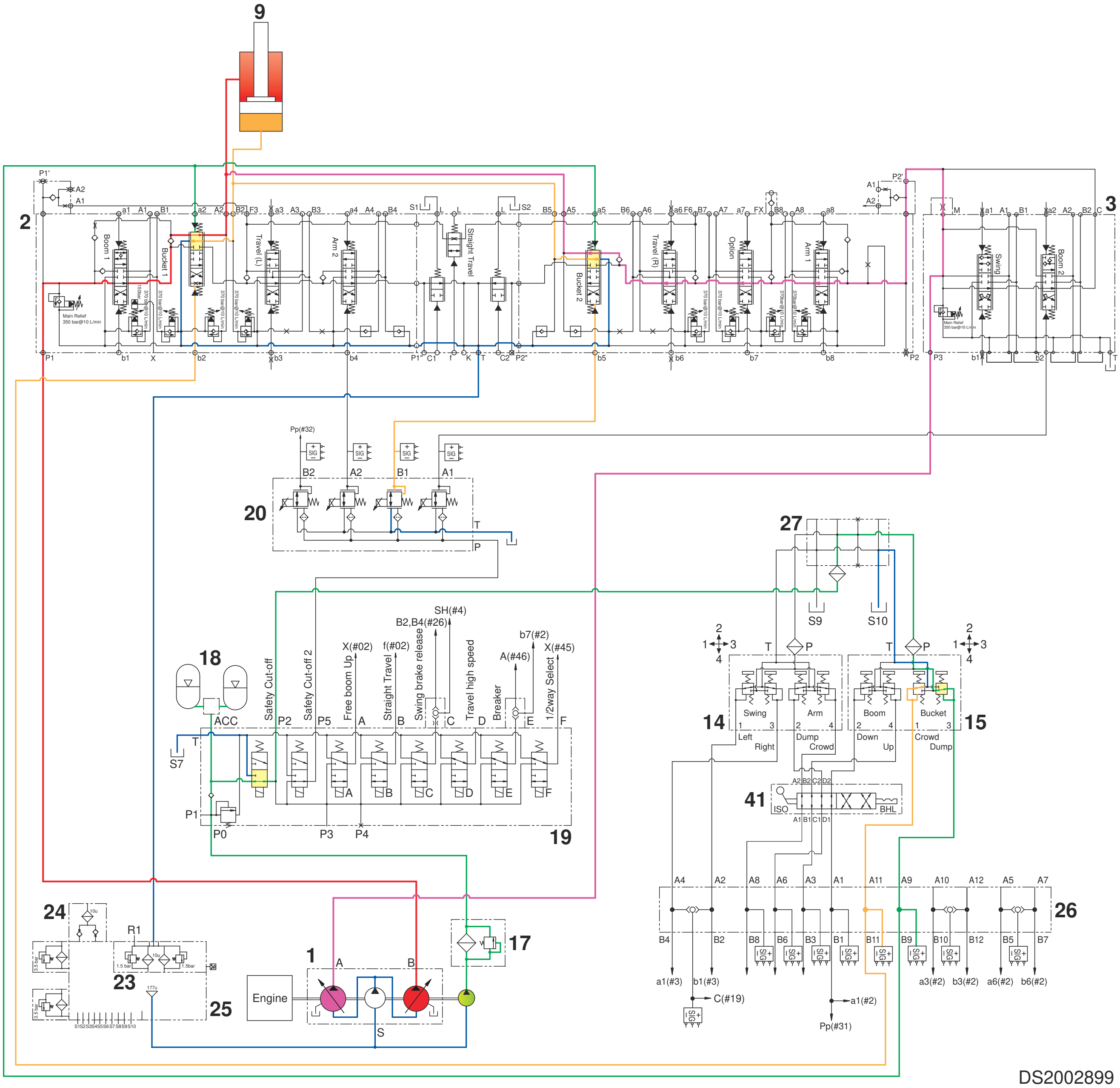
DS2002898

Bucket Dump Operation

When the pilot pressure is applied to the port by operating the right joystick lever, the bucket 1 spool moves to open the port A2. Then, high-pressure oil at the port P1 flows to the bucket cylinder rod side through the port A2 to perform bucket dump operation. Also, when operating the right joystick lever, the pilot pressure is applied to the (a5) port as well.

As a result, high-pressure oil of P2 joins with P1 oil as shifting of bucket 2 spool and flows to the bucket cylinder rod together. The bucket rod side and tube side are installed with overload relief valves to protect the bucket cylinder and control valve from the external force.

Figure 190



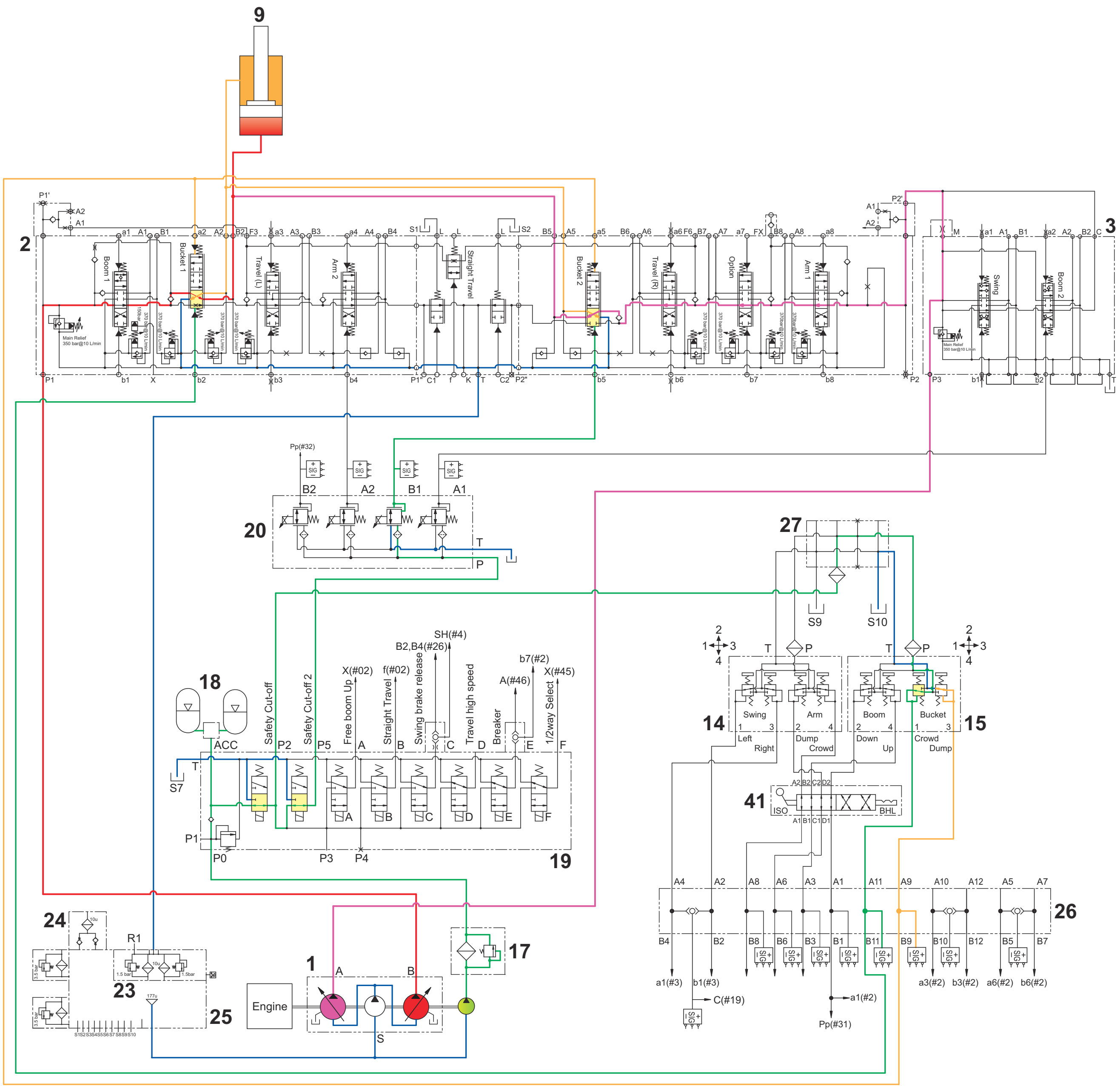
DS2002899

Bucket Crowd Operation

When the pilot pressure is applied to the port by operating the right joystick lever, the bucket spool moves to open the port B2. Then, high-pressure oil at the port P1 flows to the bucket cylinder head through the port B2 to perform bucket crowd operation. Also, the secondary pressure is generated by the change of the B1 EPPR supply current of the EPPR valve and the pilot pressure is supplied to the port of the main control valve and then bucket 2 spool shifts.

As a result, high-pressure oil of P2 through the B5 port joins with P1 oil flows to the bucket cylinder head together. And oil from bucket cylinder rod returns to the oil tank through bucket spool. The bucket cylinder rod side and tube side are installed with overload relief valves to protect the bucket cylinder and control valve from an external force.

Figure 191

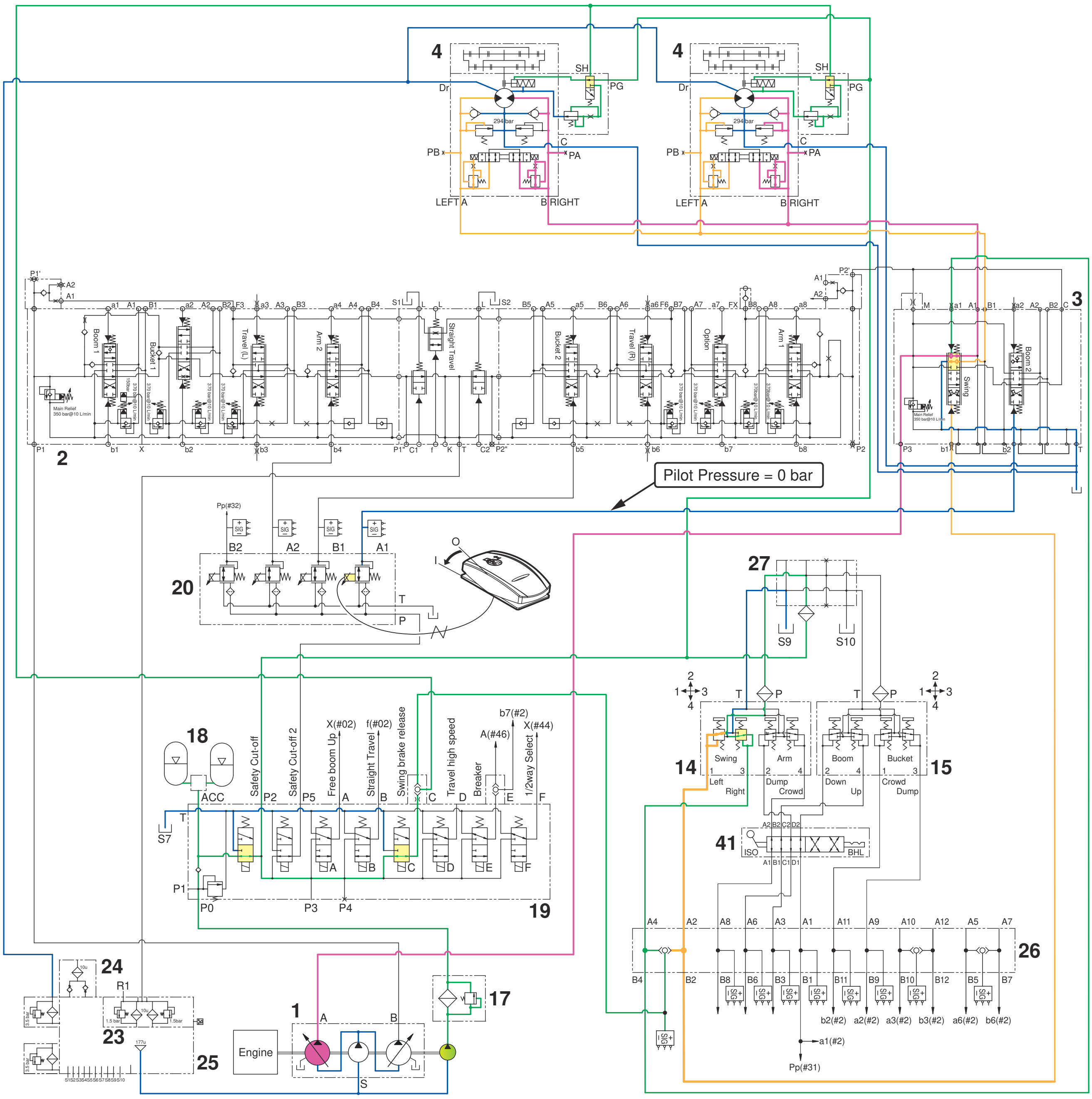


DS2202087

Swing Priority Switch "ON" Operation

The swing speed should be faster than the boom up speed in the 180-degree working condition. To do this, you can increase the swing speed by limiting the boom 2-speed spool and changing the flow distribution when the swing priority switch is "ON". That is, when swing priority mode is selected, if boom up and swing are combined, the pilot pressure can not be delivered to boom 2 spool because the current is not supplied to the A1 side of the EPPR package valve. This causes the swing speed to be faster than the boom up speed.

Figure 192

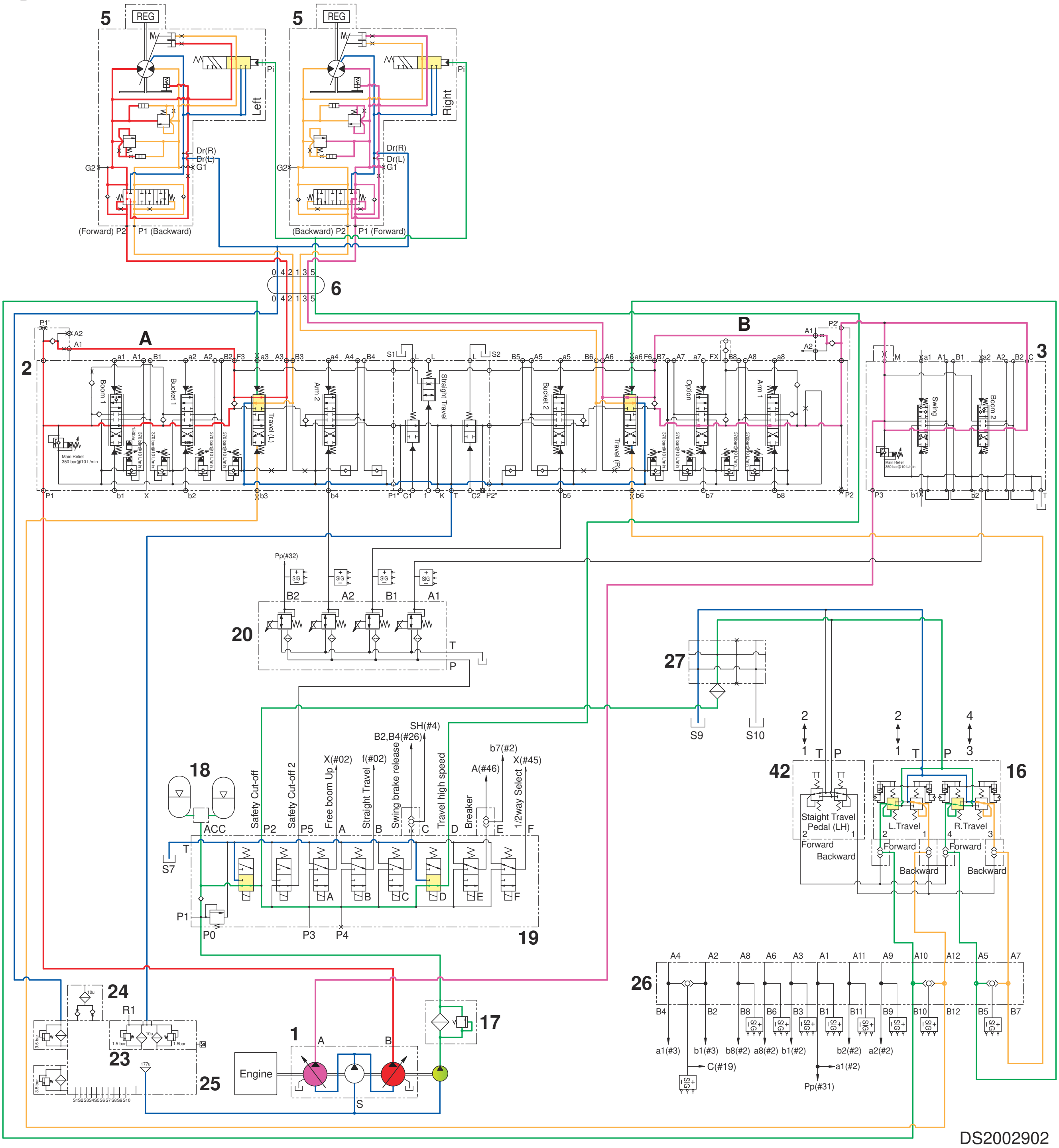


DS2002901

Travel Operation

When the travel levers are pushed or pulled forward or backward position, the travel spools in the main control valve are moved to the forward or backward travel position by the pilot signal from the pedal valve. The oil from each pump flows into the main control valve and then goes to each travel motor through the center joint. The return oil from both travel motors returns to the hydraulic oil tank through the center joint and the travel spools in the main control valve. When this happens, the machine moves forward or backward. And the high-pressure oil supplied to the travel spool is supplied in parallel in order to avoid the influence of the front operation in the combined travel and front operation.

Figure 193



DS2002902

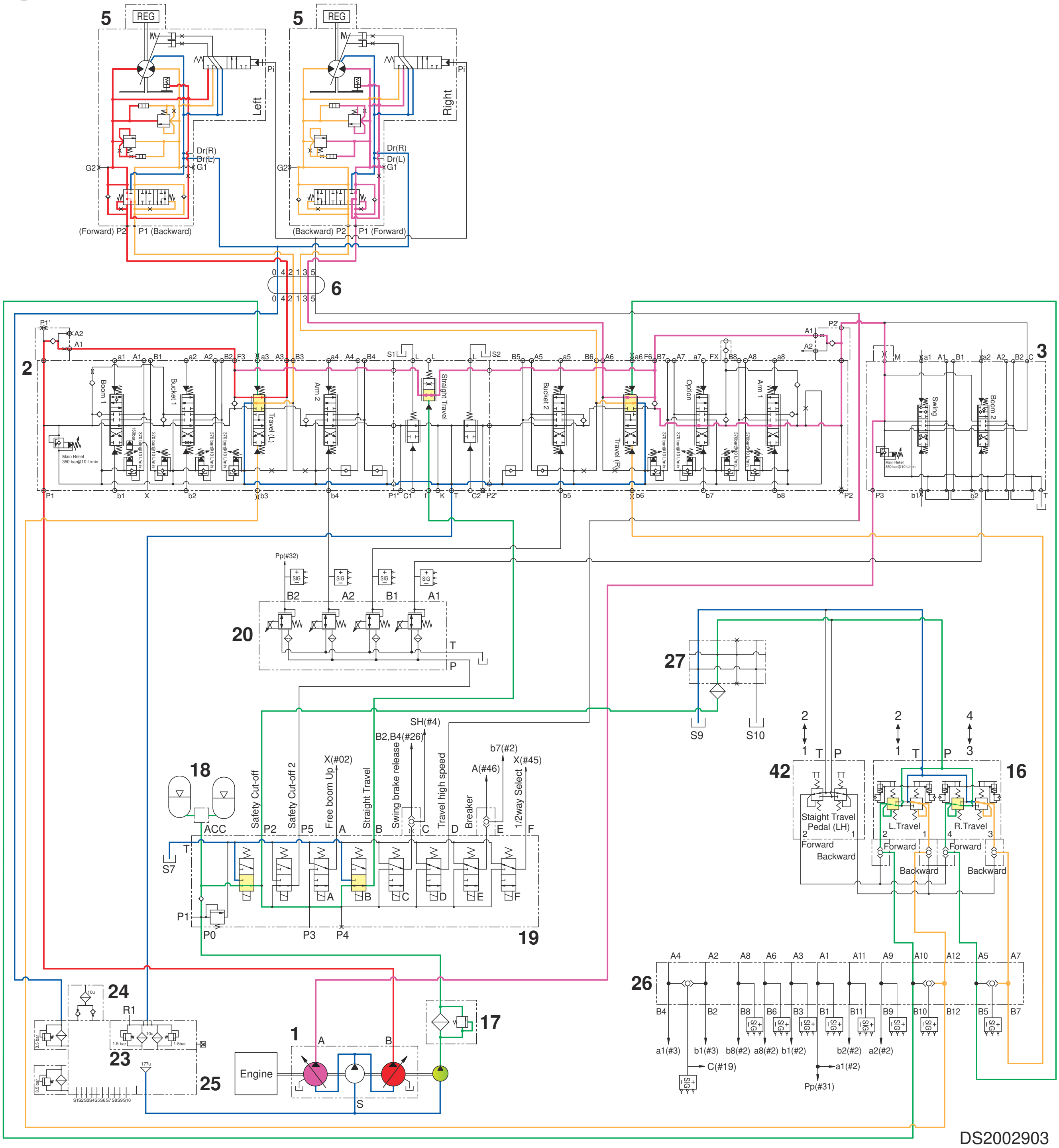
Travel Straight Operation

When the combined travel operation is performed, the travel straight spool is switched to secure the traveling

straightness. Travel composite operation senses the pressure sensor on the joint plate and opens the straight travel spool of the main control valve through the straight travel solenoid of the solenoid valve.

Therefore, the flow supplied to the left and right travel motors is supplied equally and the straight traveling is performed.

Figure 194



Pilot System Operation

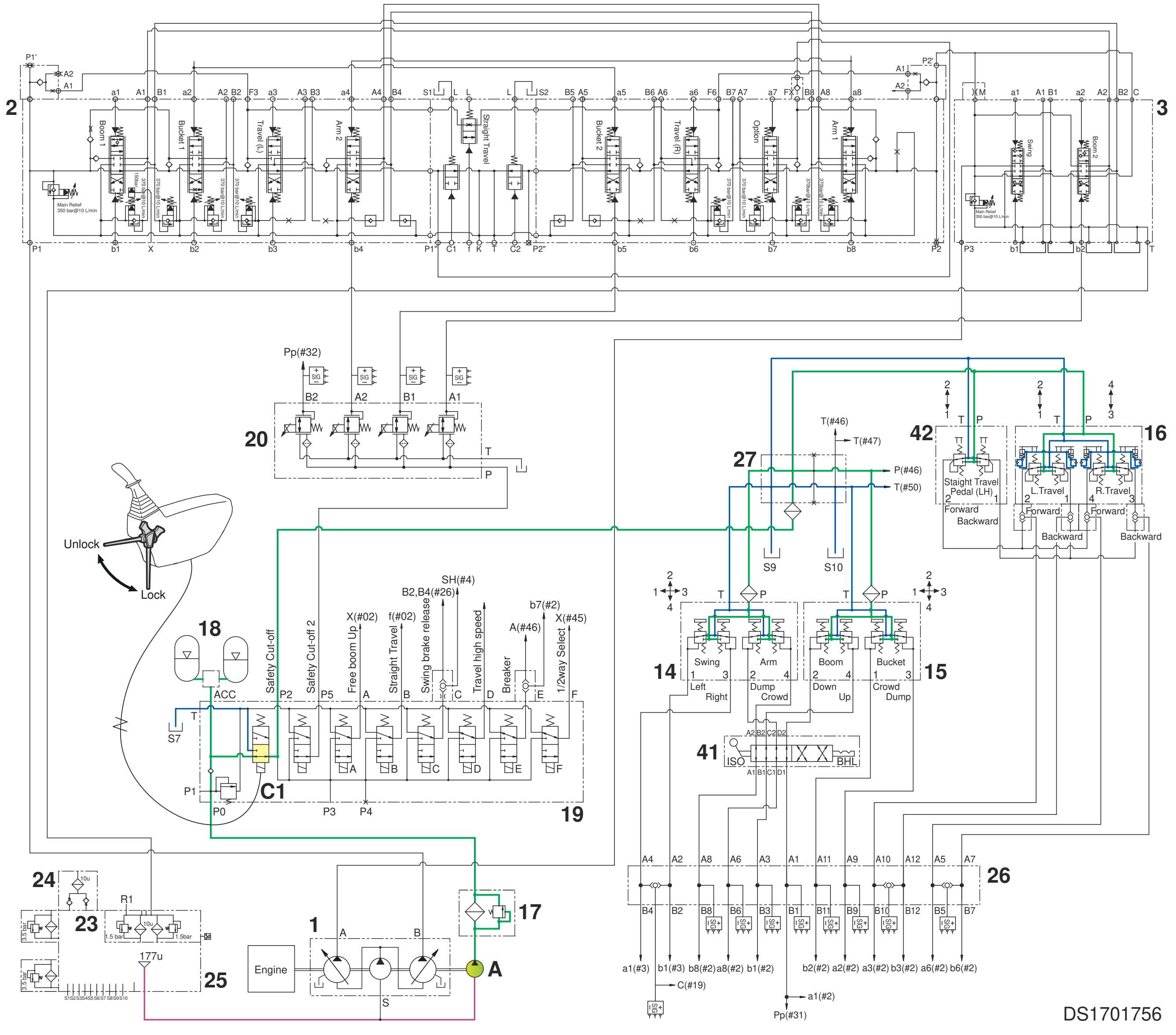
Safety Cutoff Valve Operation

Oil from the hydraulic tank fills the accumulators first after passing through pilot gear pump and pilot filter and is supplied to the solenoid package valve.

If an electric signal is inputted to safety cutoff valve installed to the solenoid package valve, the oil send to pedal valve and joystick valve is returned to hydraulic tank.

Once safety cutoff valve is operated, any operation of machine is switched to safety mode and actuator will not operate even if joystick lever is moved.

Figure 195



Boom 1
Bucket 1
Travel (L)
Arm 2
Straight Travel
Bucket 2
Travel (R)
Option
Arm 1
Swing
Boom 2
Main Relief
350 bar@10 L/min
Pp(#32)
Unlock
Lock
Safety Cut-off
Safety Cut-off 2
Free boom Up
Straight Travel
Swing brake release
Travel high speed
Breaker
1/2way Select
Engine
Left
Right
Dump
Crowd
Down
Up
Staight Travel Pedal (LH)
Forward
Backward
L.Travel
R.Travel
ISO
BHL
DS1701756

Components Operation, Description And Inspection

Safety Instructions

WARNING

AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or servicingmachine. Read and understand the Operation & Maintenance Manual and signs (decals) on machine. Followwarnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correctfunction after adjustments repairs or service. Untrainedoperators and failure to follow instructions can cause deathor serious injury.

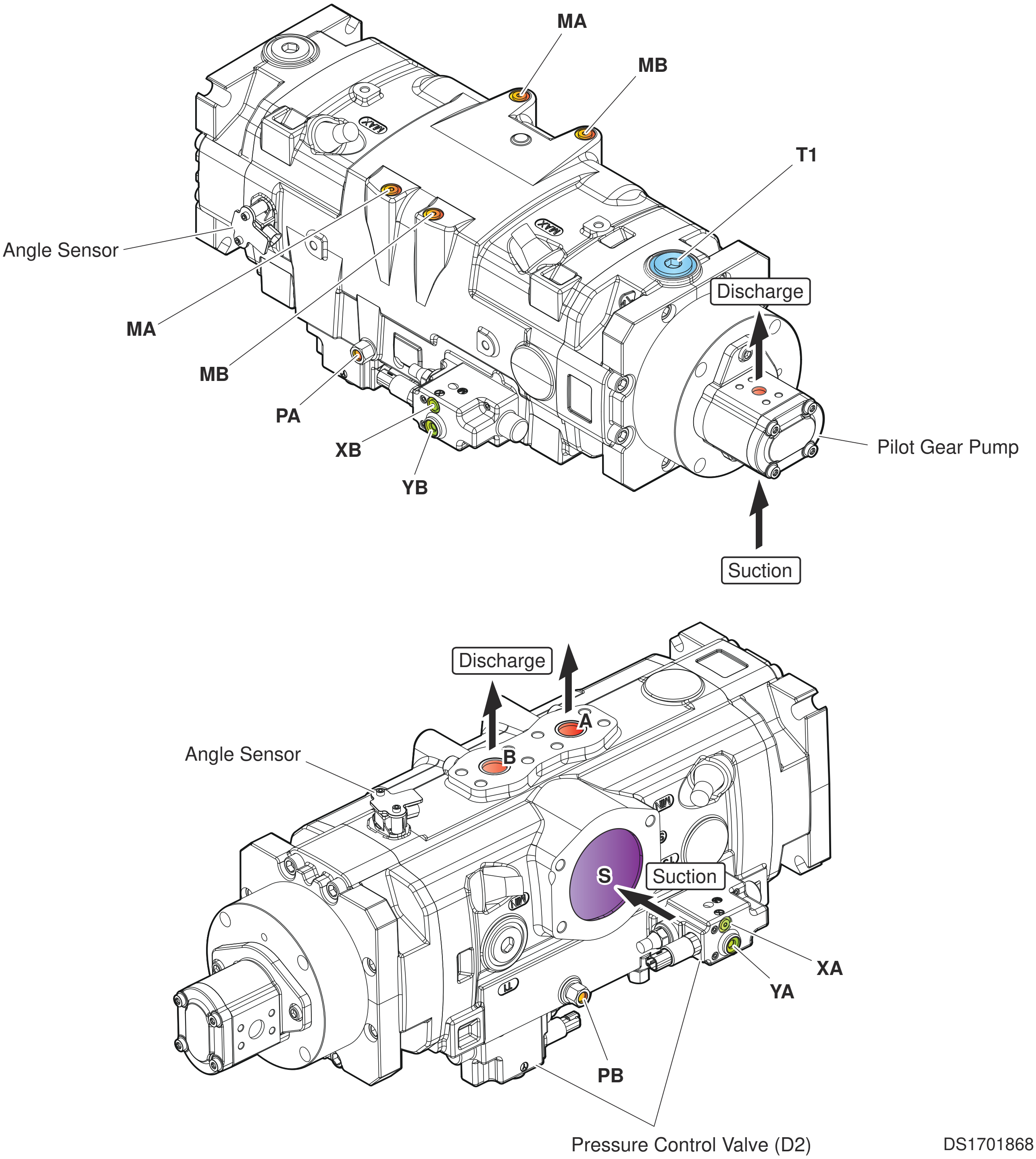
Main Pump

Overview

The pump is a variable displacement pump with an axial piston a swash plate design for hydrostatic drives in the open circuit. The oil flow is proportional to the drive speed and the displacement volume. The volumetric flow can be continuously adjusted by the adjustment of the inclined swash plate. In axial-piston units of the swash plate, the pistons are arranged axially with respect to the driveshaft. In the open circuit, the pressurized oil flows from the tank to the pump and is conveyed to the each actuators.

Port

Figure 196



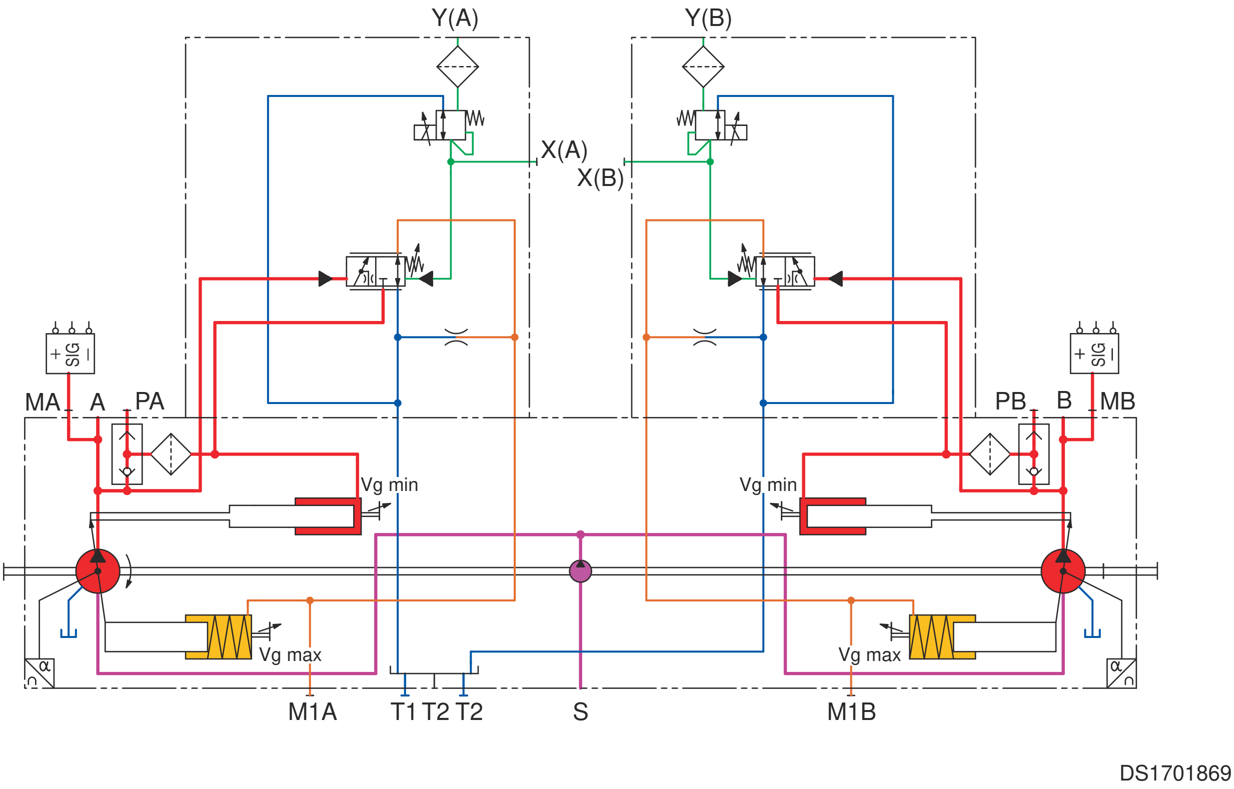
Port	Description	Size
A, B	Pump Pressure Port	SAE 1 1/2"
S	Suction Port	SAE 5"
T1	Air Bleed Port	UNF 1 5/8"-12-2B
MA, MB	Measurement Port (Operating Pressure)	UNF 9/16"-18-2B
PA, PB	Control Pressure	
XA, XB	Measurement Port (Pilot Pressure)	UNF 7/16"-20-2B

Port	Description	Size
YA, YB	Pilot Pressure	

Circuit

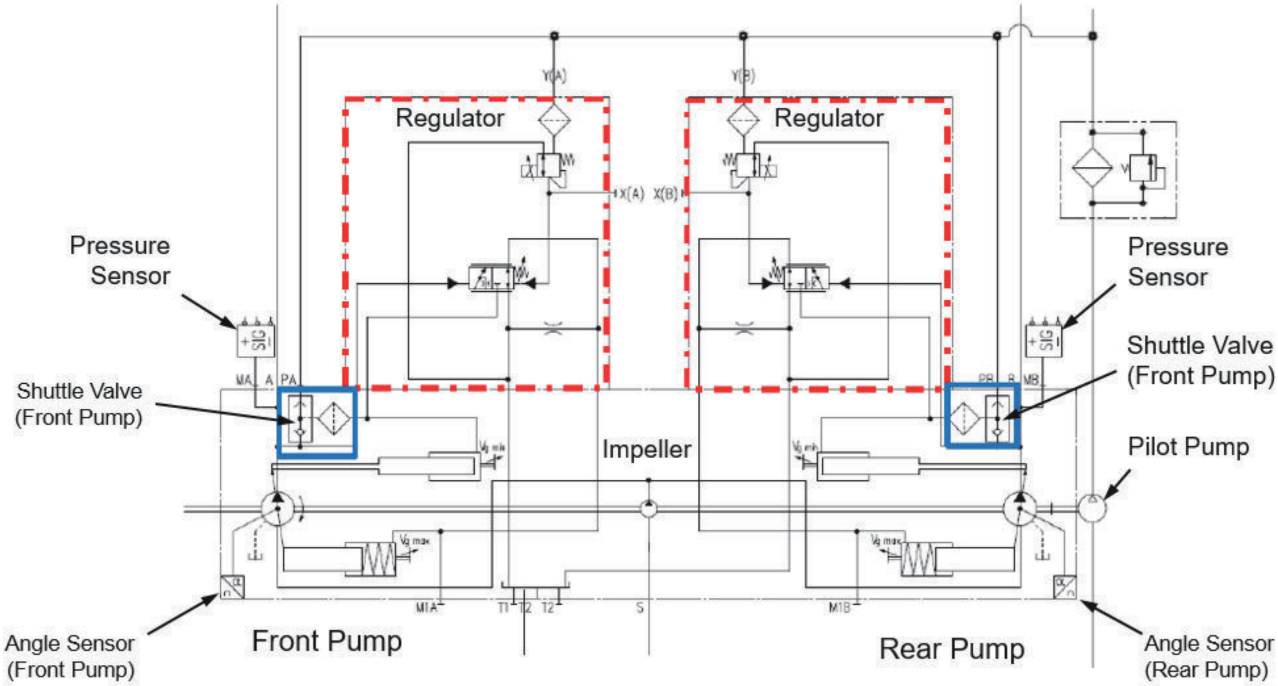
Pump Schematic

Figure 197



Main Pumps (VBO Control)

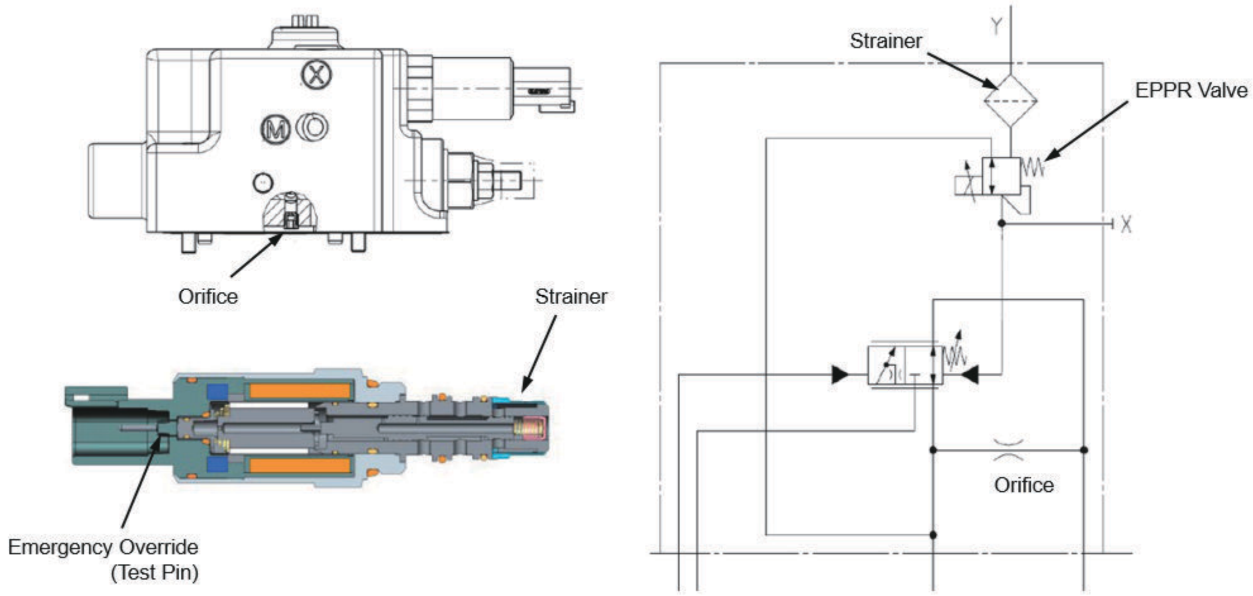
Figure 198



DS2002875

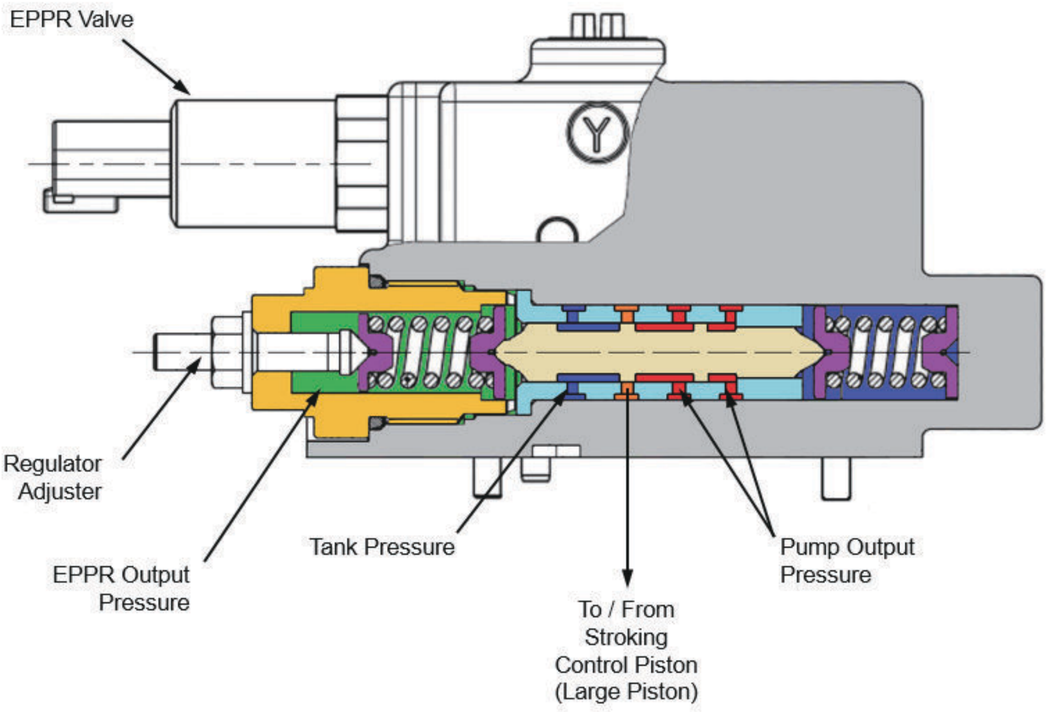
Main Pump Regulator

Figure 199



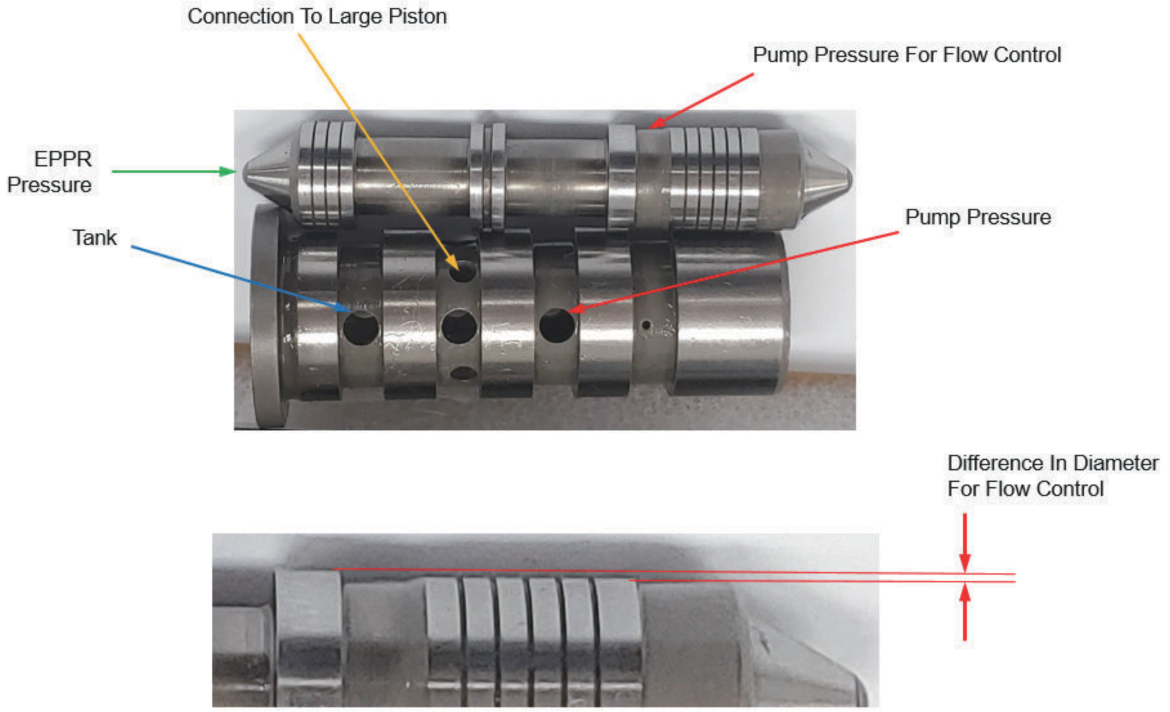
DS2002876

Figure 200



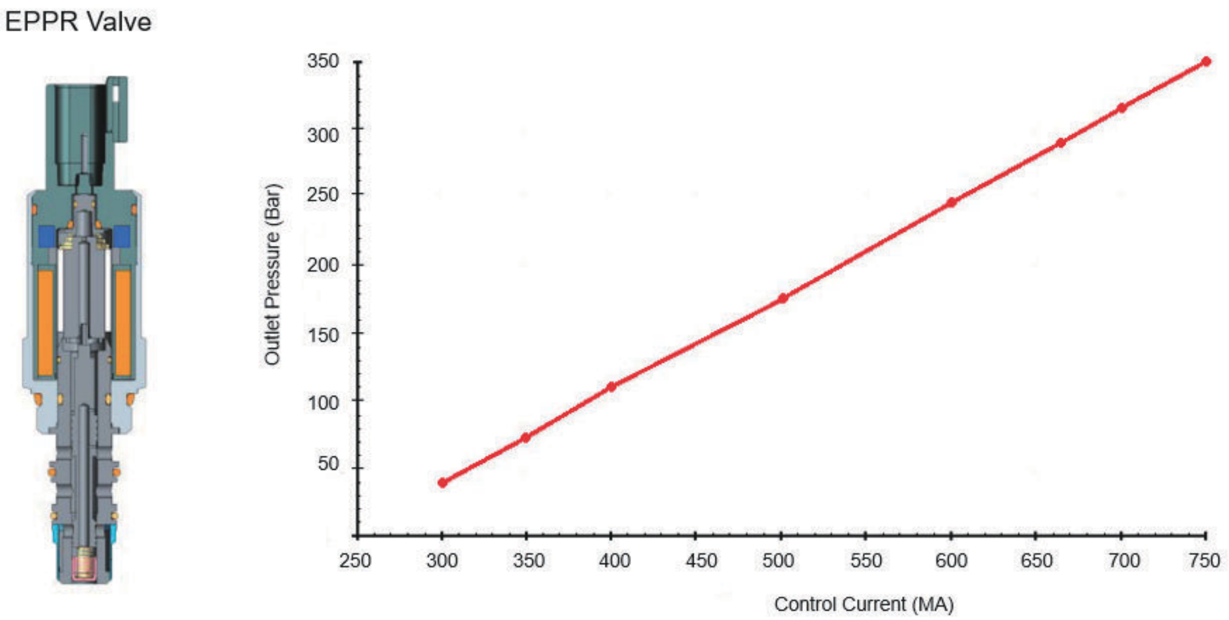
DS2002877

Figure 201



DS2002878

Figure 202



No	1	2	3	4	5	6	7	8
Current (mA)	300	350	400	500	600	664	700	750
Outlet Pressure (bar)	40	72	110	175	246	290	315	350
Tolerance (bar)	± 18	± 15	± 12	± 11	± 10	± 9	± 7	± 3.5

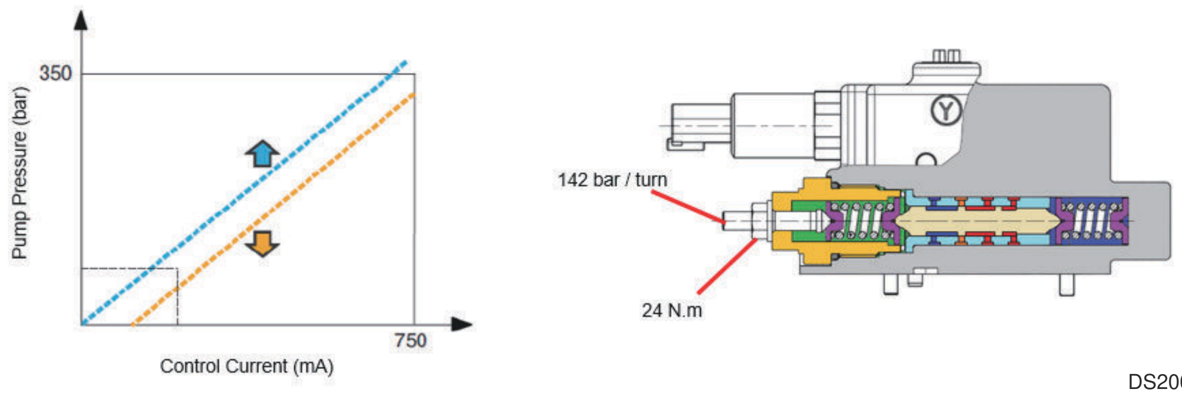
DS2002879

Flow Adjustment (Regulator)

Pump Pressure Initial Tuning

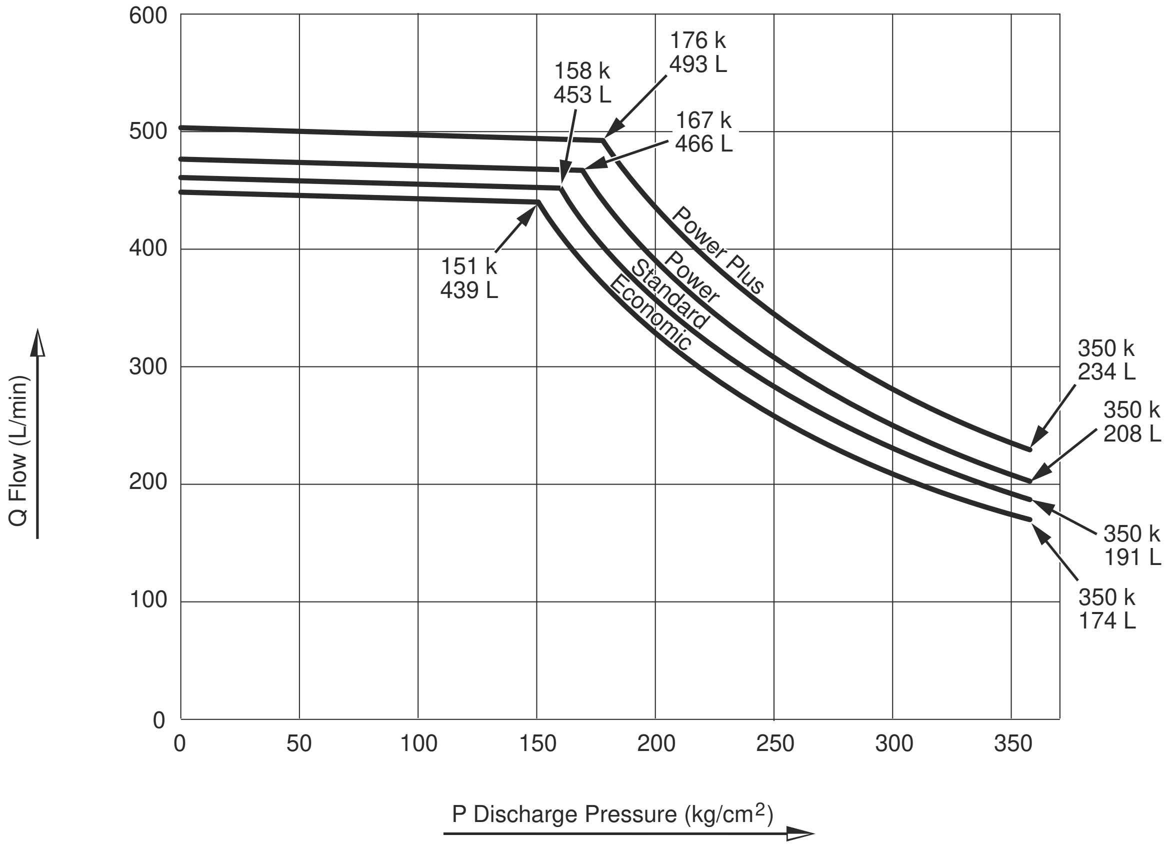
1. Turn On the engine, set the excavator to Power Mode
2. Connect DMS5, set the engine to high idle and apply a forced EPPR pump current to 750 mA to the pump to be adjusted.
3. Loosen the lock nut, then adjust the adjustment screw (1), so that the pump output pressure reaches 350 ±3.5 bar (357 ±3.6 kg/cm^2)

Figure 203



DS2002880

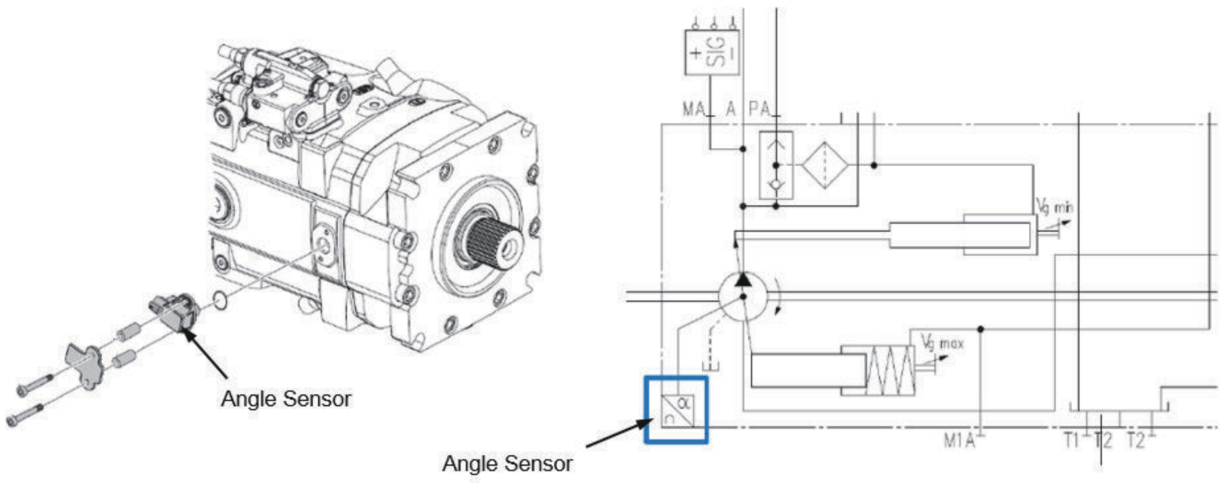
Figure 204



DS2002736

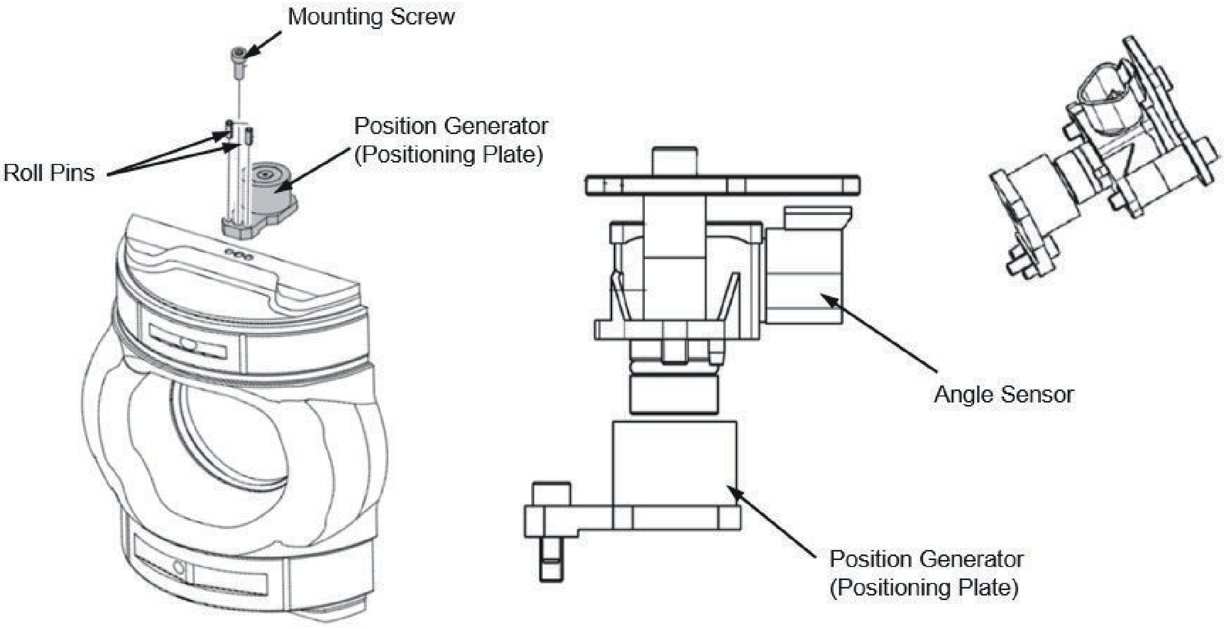
Angle Sensor

Figure 205



DS2002881

Figure 206

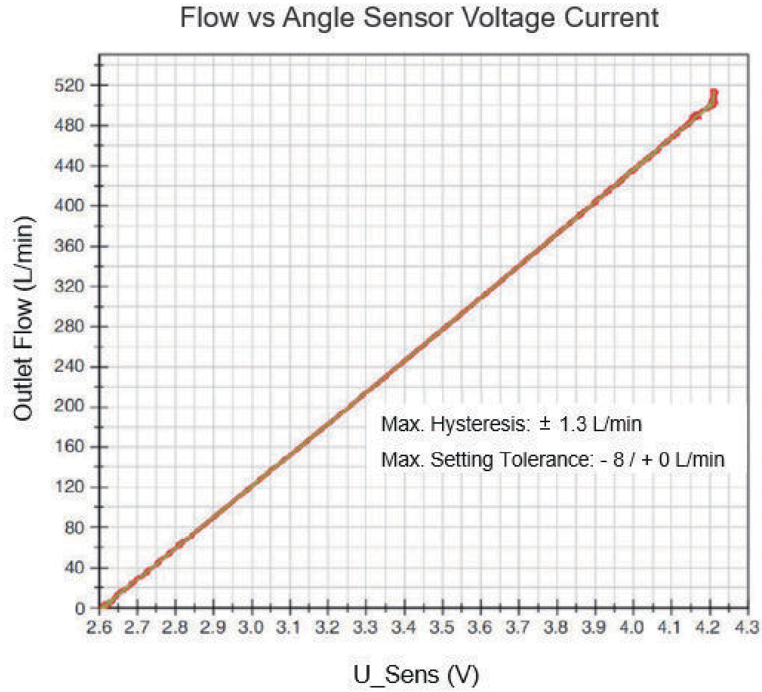


DS2002882

The Angle Sensor measures the swash plate angle position and supplies this information as a voltage signal to the EPOS Unit, to allow it to calculate the main pump output flow.

The sensor is a hall effect sensor (non contact with position generator (Positioning plate) of swash plate)

Figure 207

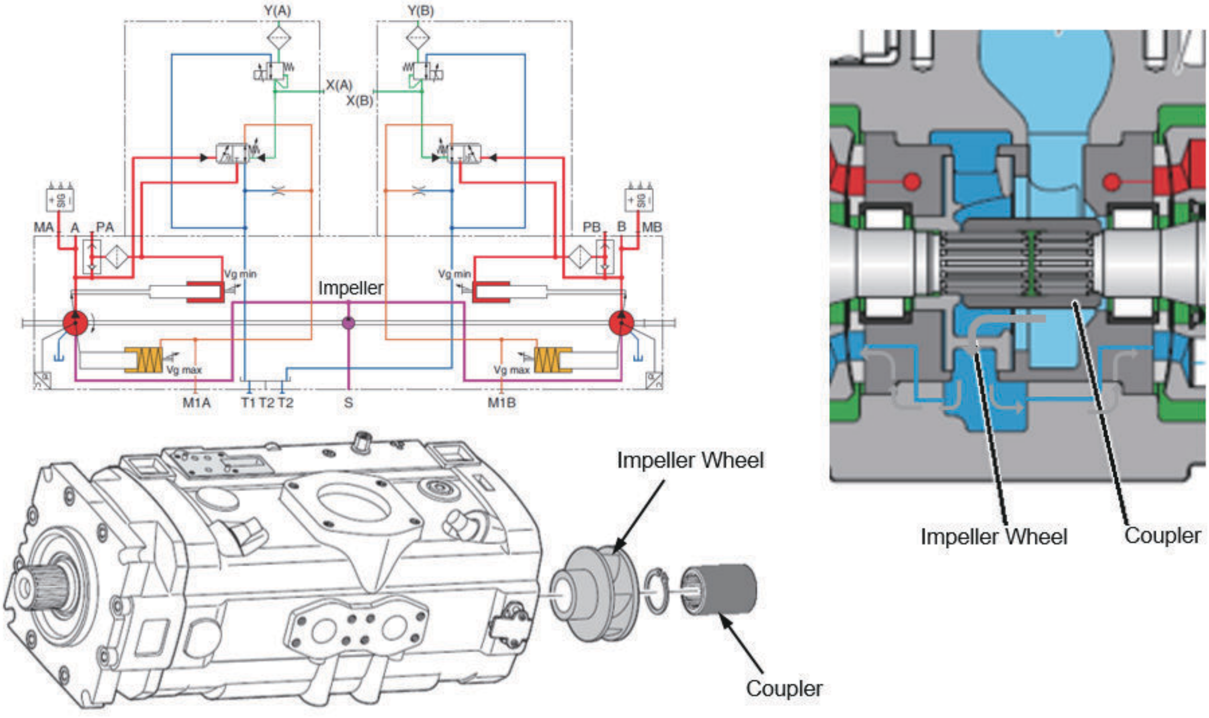


No.	1	2	3	4	5	6	7	8	9
U_Sens (mV)	2,608	2,800	3,000	3,200	3,400	3,600	3,800	4,000	4,210
Outlet Flow (L/min)	0	59.1	121.2	183.0	245.7	308.6	372.3	435.9	504.0

DS2002883

Impeller (Boost Pump)

Figure 208

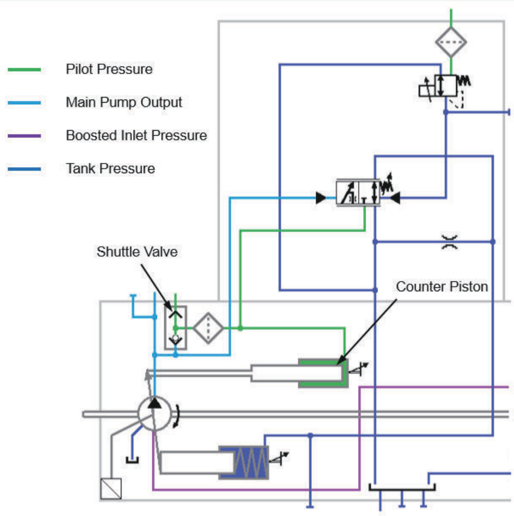


DS2002884

Main Pump Regulation (Start Up)

Start Up

Figure 209



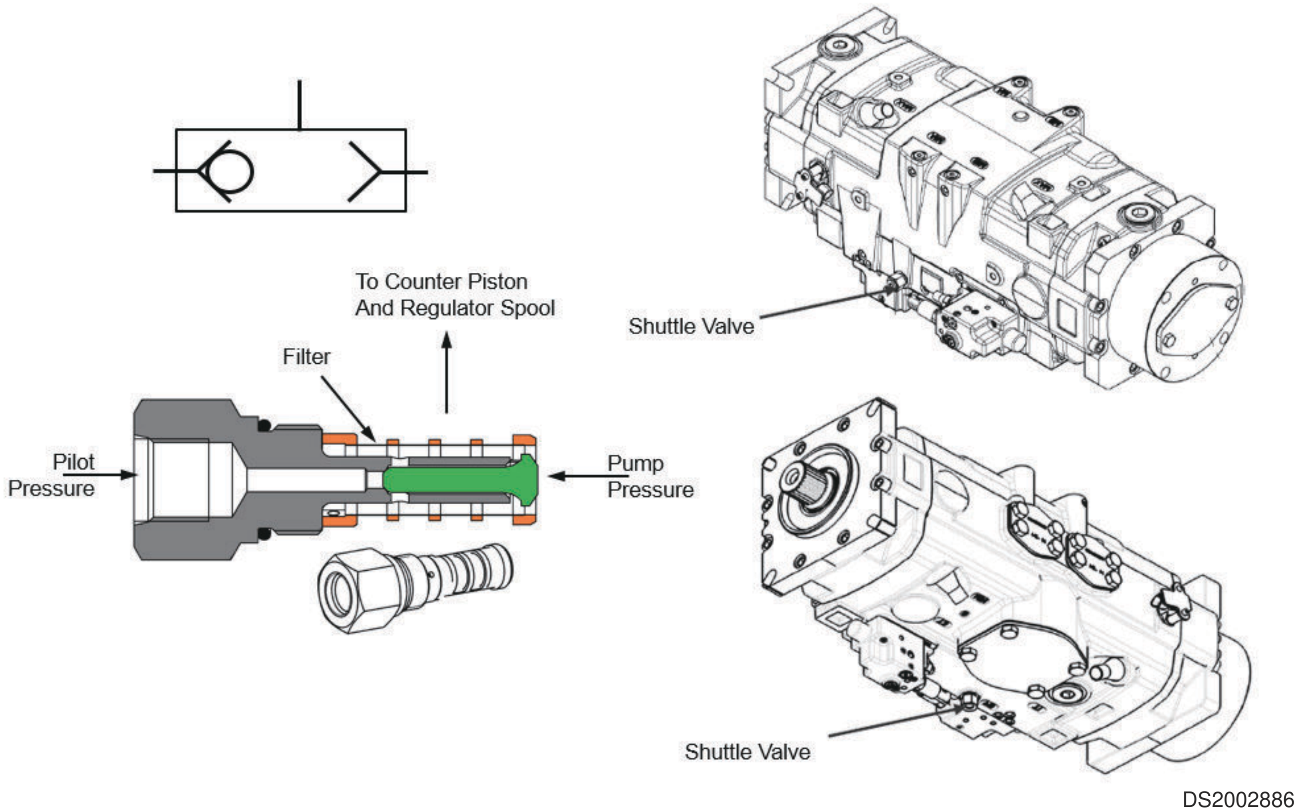
DS2002885

The main pumps swash is pushed to minimum displacement by spring force, so on initial start up, as the main control valves centre galleries are left open by EPOS, the main pumps cannot produce any pressure for its own regulation, so the pilot pumps pressure acts through the shuttle valve to push the pump towards its maximum displacement (Pushes the counter piston).

As soon as the engine speed is > 500 rpm, EPOS closes the cut spools in the main control valve centre galleries.

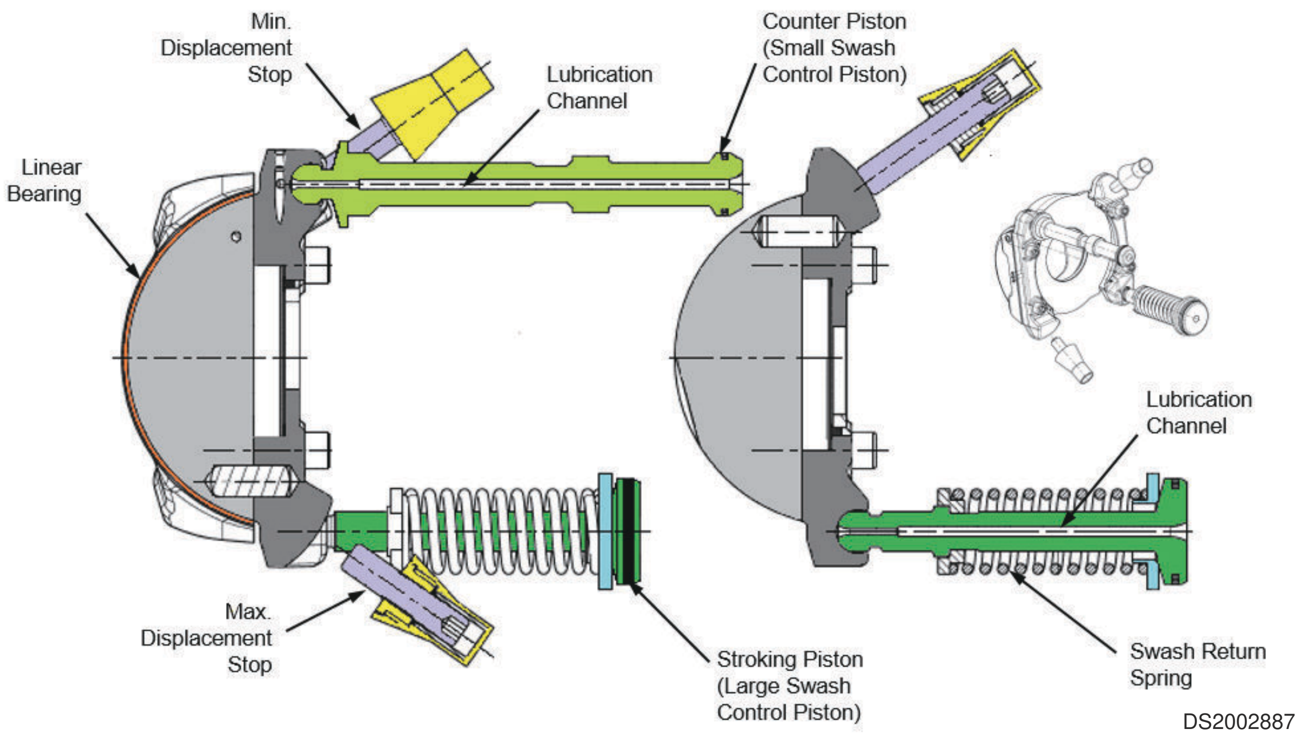
Main Pump Regulation (Shuttle Valves)

Figure 210



Main Pump Regulation (Swash Control)

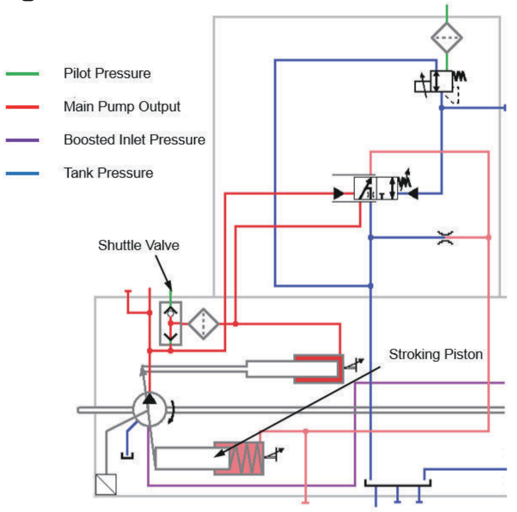
Figure 211



Main Pump Regulation (Running Neutral)

Running - Neutral

Figure 212



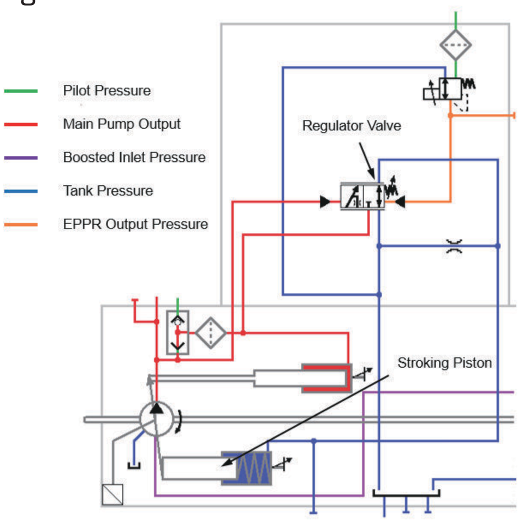
DS2002888

With the machine running (> 500 rpm), the main control valves centre galleries are closed by EPOS, so the main pumps can produce a pressure for its own regulation, so this takes over from the pilot pumps pressure as the shuttle valve shifts to allow the main pumps output pressure to reduce the pump to its minimum displacement (Supplies oil to push the stroking piston)

The Main pump will shift to produce and maintain its standby pressure.

Flow Increase

Figure 213



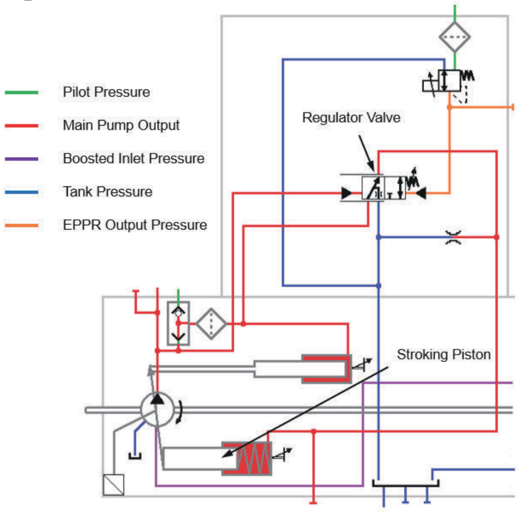
DS2002889

If the EPOS decides it needs to increase the pump flow / output pressure, it increases the current supplied to the pump EPPR valve, which then supplies a higher output pressure to shift the regulator spool to increase the pump displacement by draining oil from the stroking piston.

The pump output flow will continue to increase, until the pump output pressure is sufficient to balance the EPPR output pressure acting on the regulator valve.

Flow Decrease

Figure 214



DS2002890

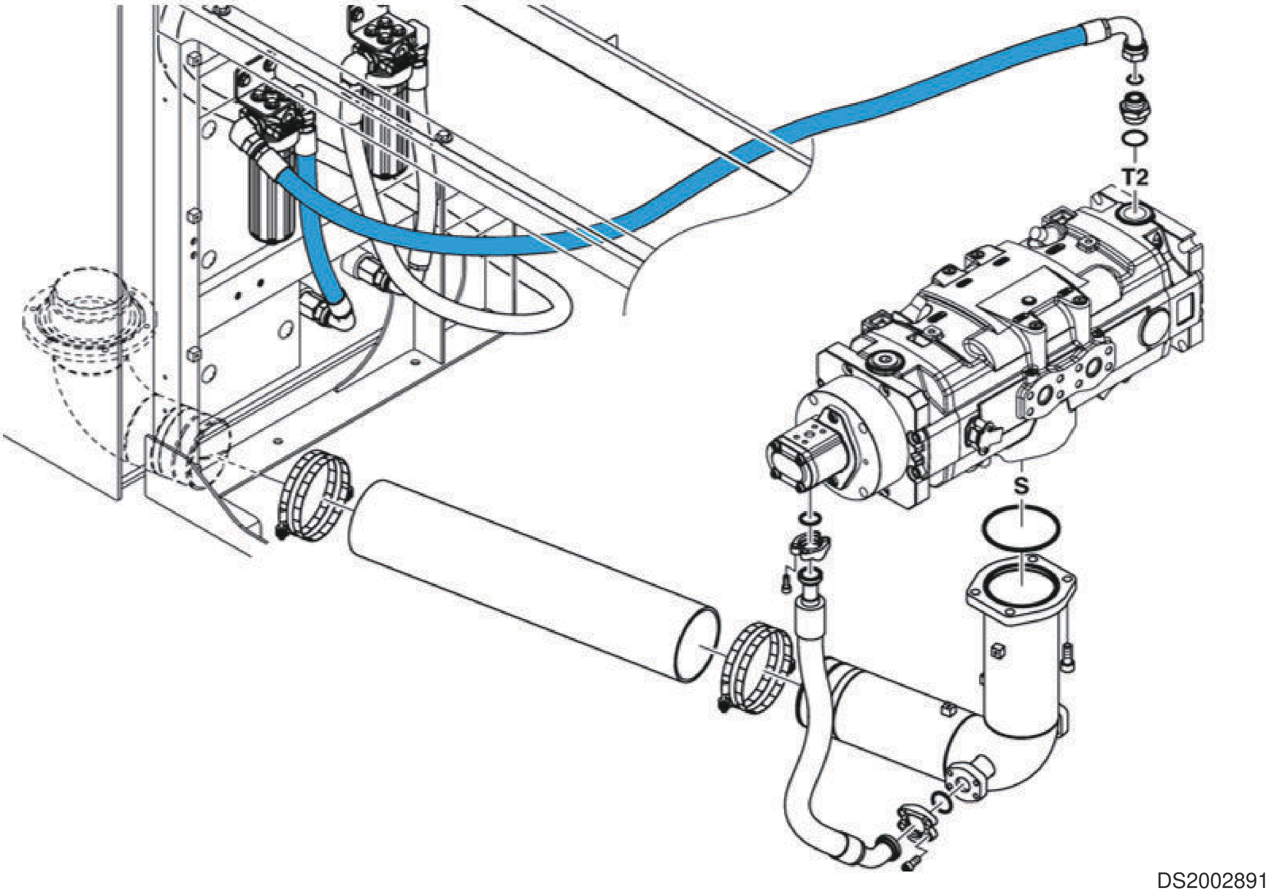
If the EPOS decides it needs to reduce the pump flow / output pressure, it decreases the current supplied to the pump EPPR valve, which then supplies a lower output pressure to shift the regulator spool allowing the pumps output pressure to shift regulator valve, allowing the pump displacement to decrease by allowing pump output pressure into the stroking piston.

The pump output flow will continue to decrease, until the pump output pressure is reduces sufficiently to balance the EPPR output pressure acting on the regulator valve.

Main Pump Regulation (Case Drain)

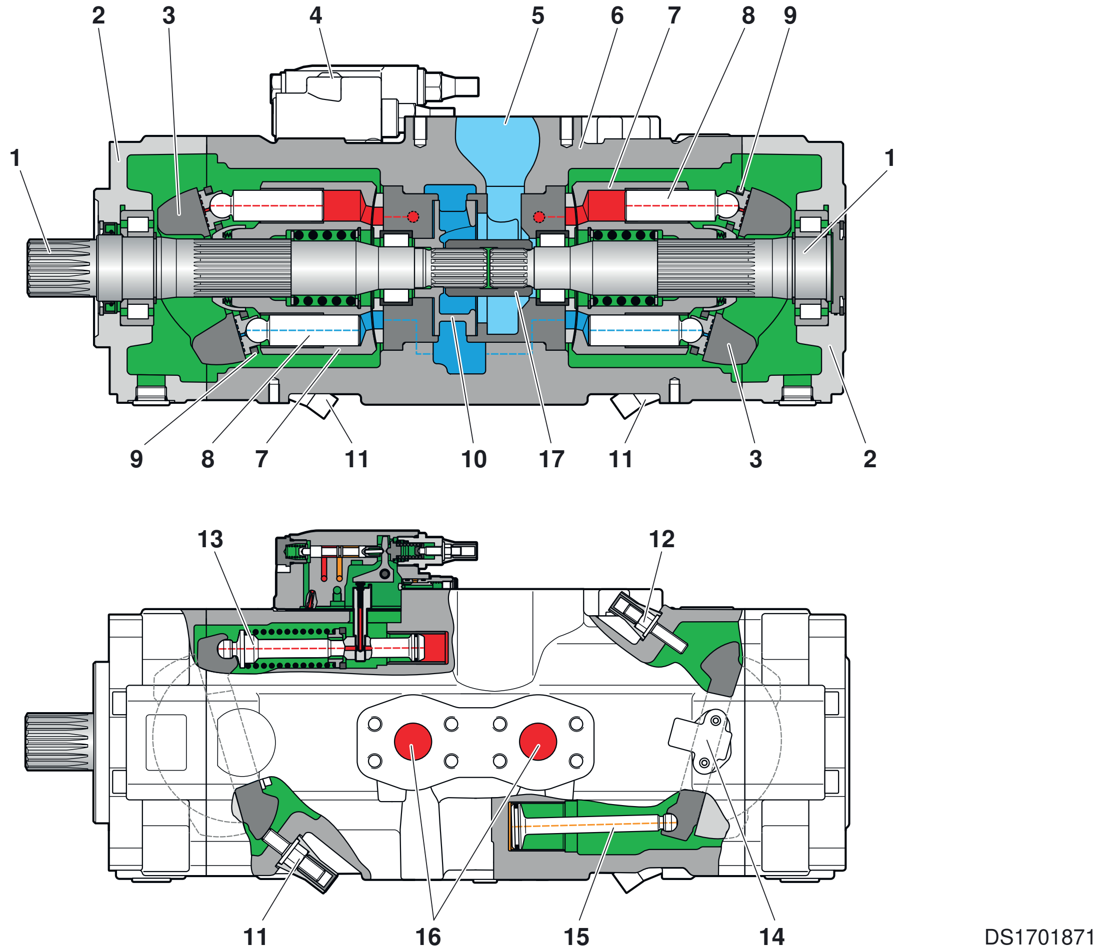
Drain filters: Change after the first 250 hours, then every 1,000 hours

Figure 215



Section View

Figure 216



Reference Number	Description
1	Driveshaft
2	Bearing Flange
3	Cradle
4	Pressure Control Valve
5	Suction Port "S"
6	Housing
7	Cylinder Block
8	Piston
9	Retainer Plate
10	Impeller Wheel (Charge Pump)
11	Setting Screw Vg max
12	Setting Screw Vg min
13	Counter Piston
14	Swivel Angle Sensor, Electronic
15	Stroking Piston

Reference Number	Description
16	High-pressure Port "A", "B"
17	Spline Coupling

Pressure Control

Decrease of Pump Pressure

1. Decrease input pressure signal to EPPRV
2. ED regulator spool moves right side and connects the pump pressure to counter piston.
3. Counter piston moves left side and decrease swash plate.
4. Decreasing flow rate decreases pump pressure.

Figure 217

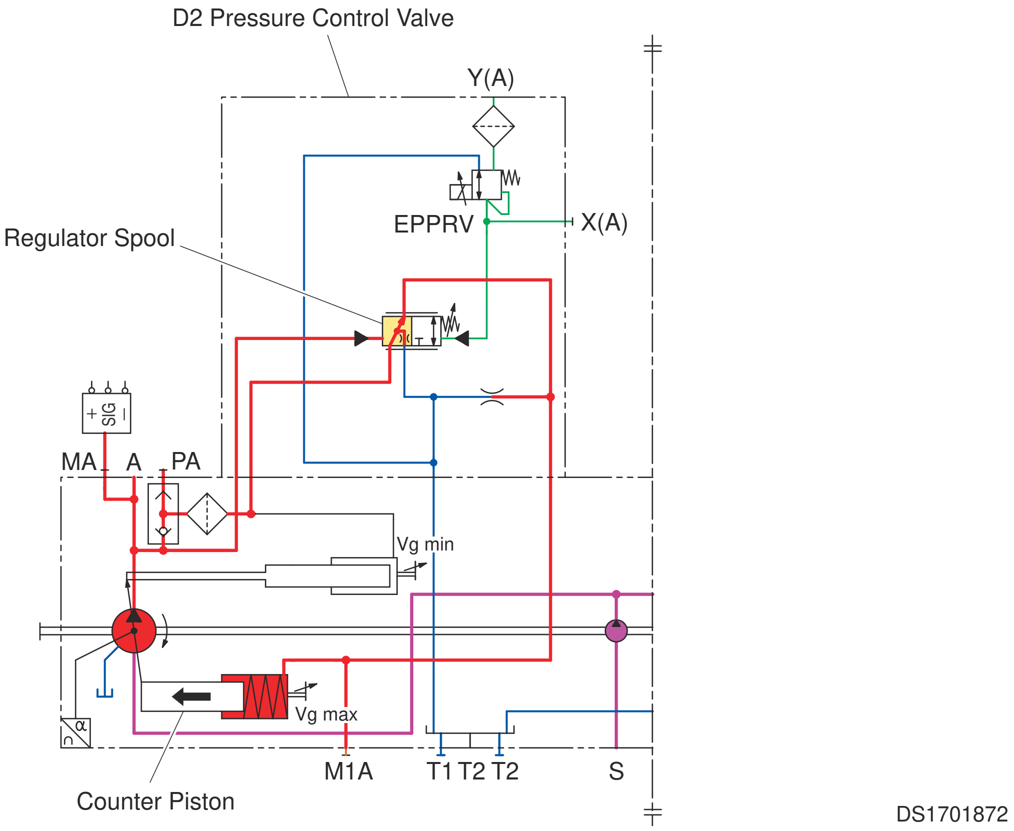
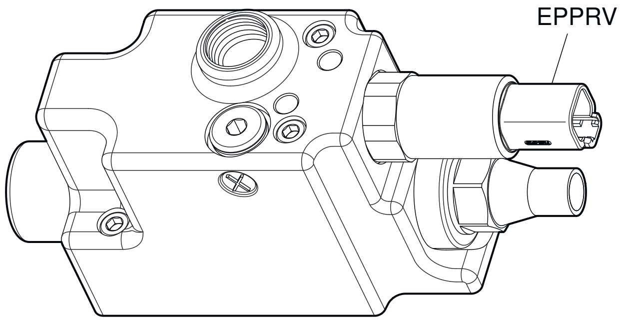
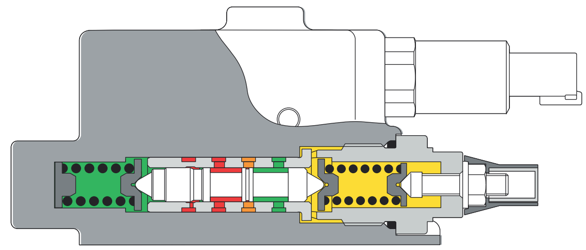


Figure 218





Increase of Pump Pressure

1. Increase input pressure signal to EPPRV.
2. ED regulator spool moves left side and connects counter piston to drain.
3. Counter piston moves right side and increases swash plate.
4. Increasing flow rate increases pump pressure.

Figure 219

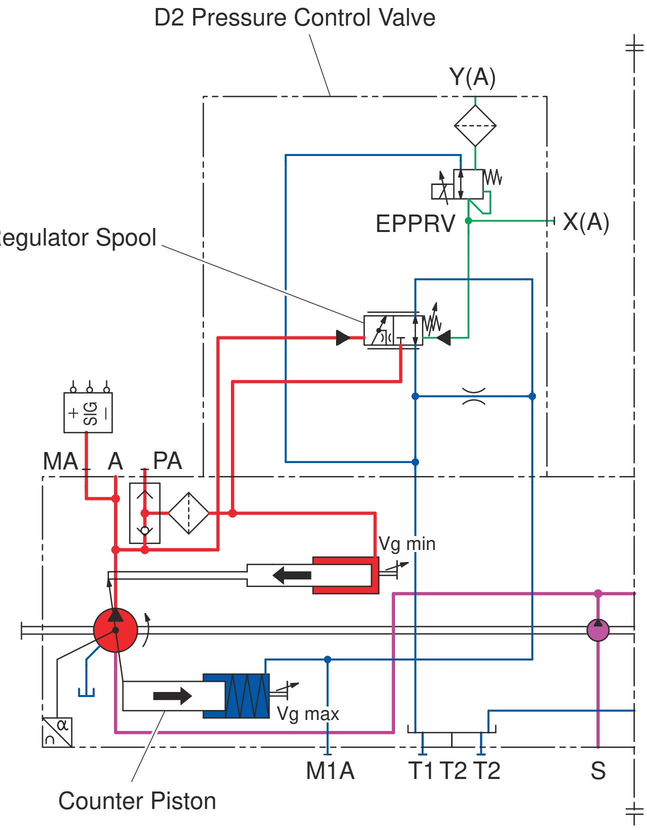
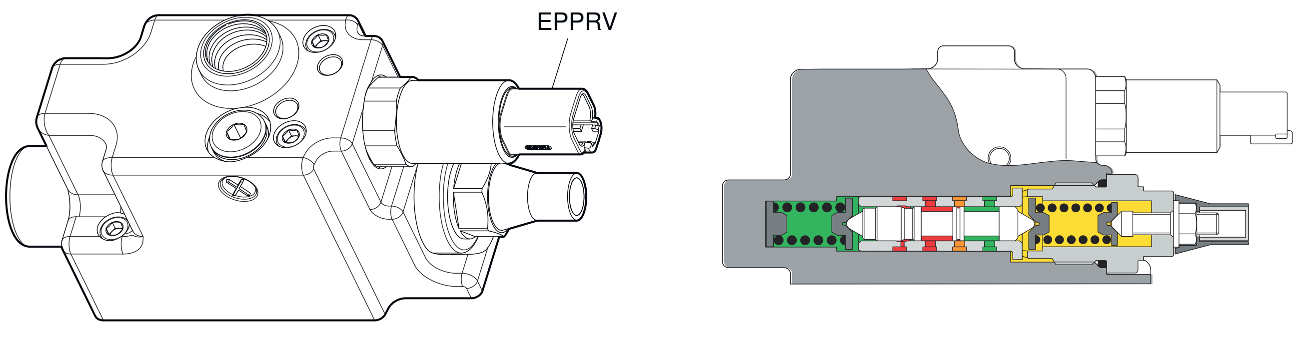


Figure 220



DS1701873

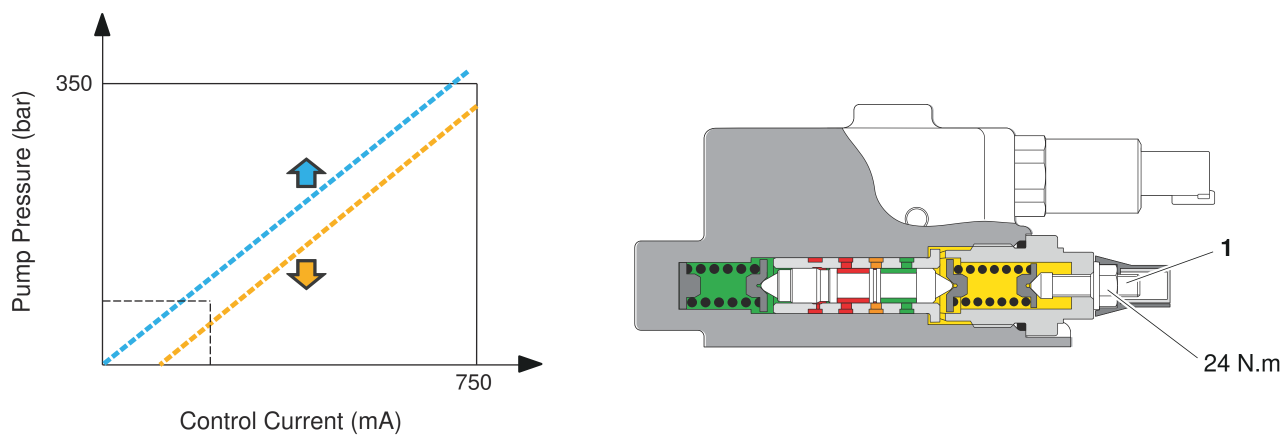
Pump Adjustment (D2 Pressure Control)

As describe in the picture, fastening the bolts will lead to the increase of initial spring force and increase of pump pressure with respect to input current signal.

Pump Pressure Initial Tuning

1. Turn on the engine, set the excavator at power mode, high idle (750 mA)
2. Loose the lock nut tighten the screw (1, Figure 26) at the top of pump pressure reaches 350 ±3.5 bar (357 ±3.6 kg/cm^2, 5,076 ±50.8 psi).

Figure 221

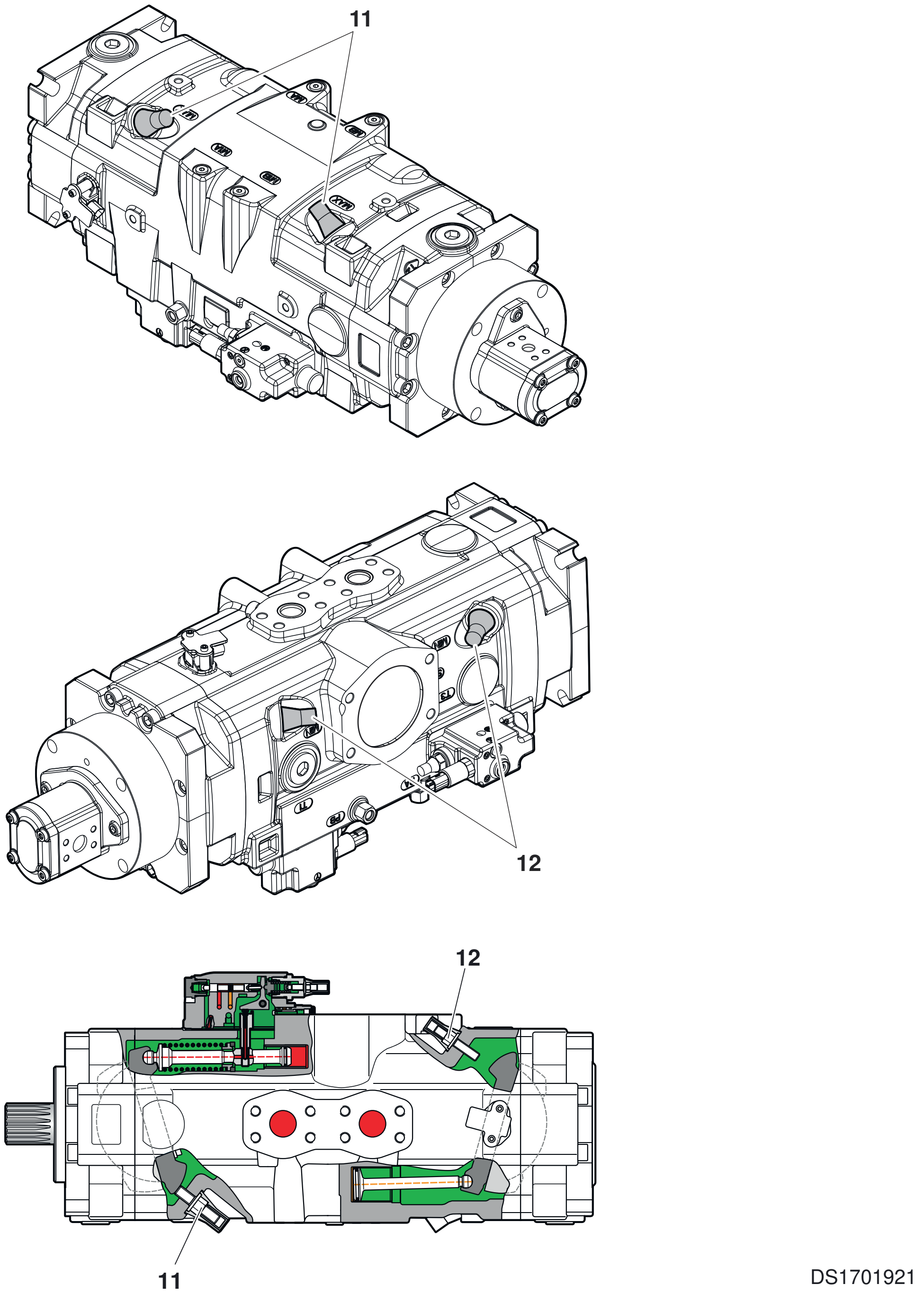


DS1701875

Min / Max Displacement Adjustment

1. Minimum displacement: Loose the lock nut (12, Figure 27) and adjust the screw for increase or decrease the minimum displacement.
2. Maximum displacement: Loose the lock nut (11, Figure 27) and adjust the screw for increase or decrease the maximum displacement.

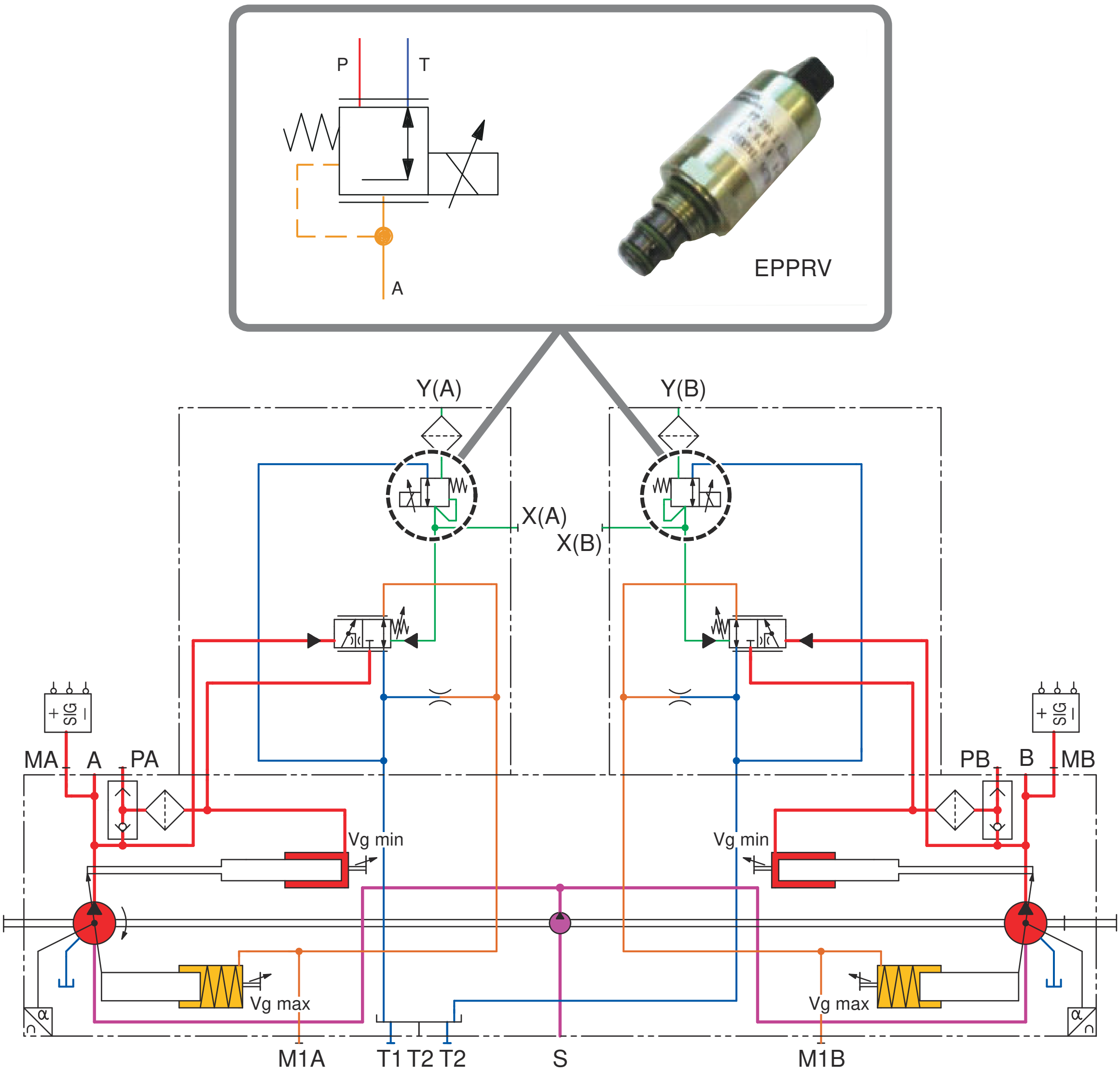
Figure 222



EPPR Valve (Electronic Proportional Pressure Reducing Valve)

Symbol

Figure 223



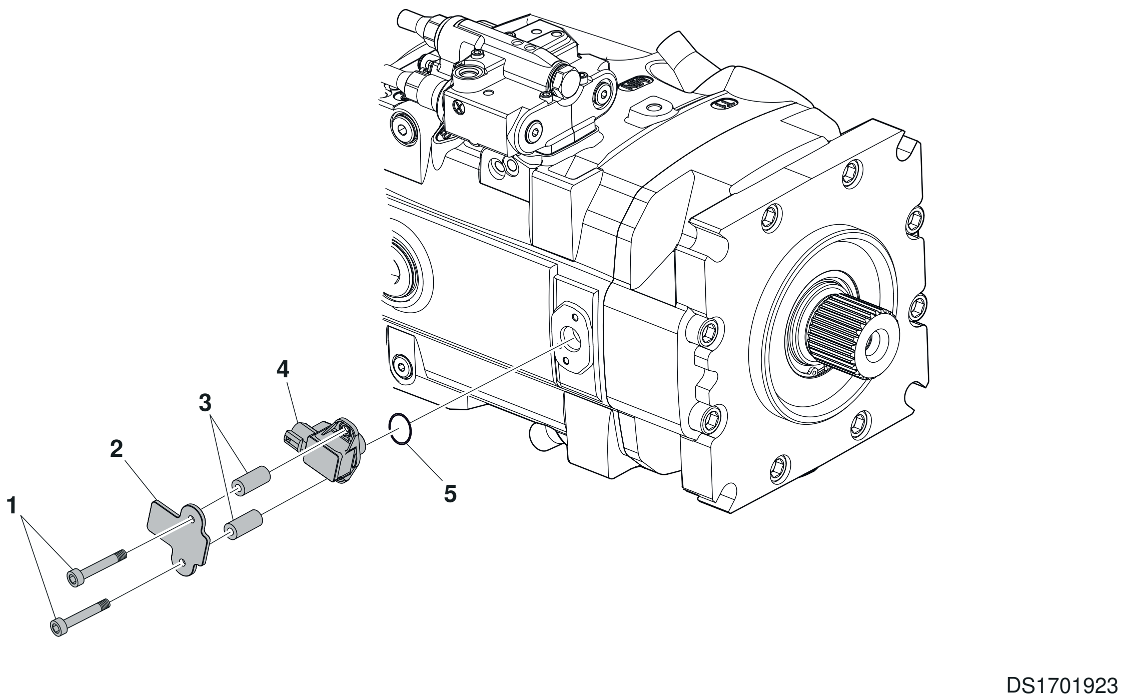
DS1701922

Angle Sensor

The discharge flow from the pump is measured with an angle sensor. Measured angle is converted into electrical signals, which in turn are converted to digital signals for use at an electric controller as the pump discharge rate.

Location of Angle Sensor

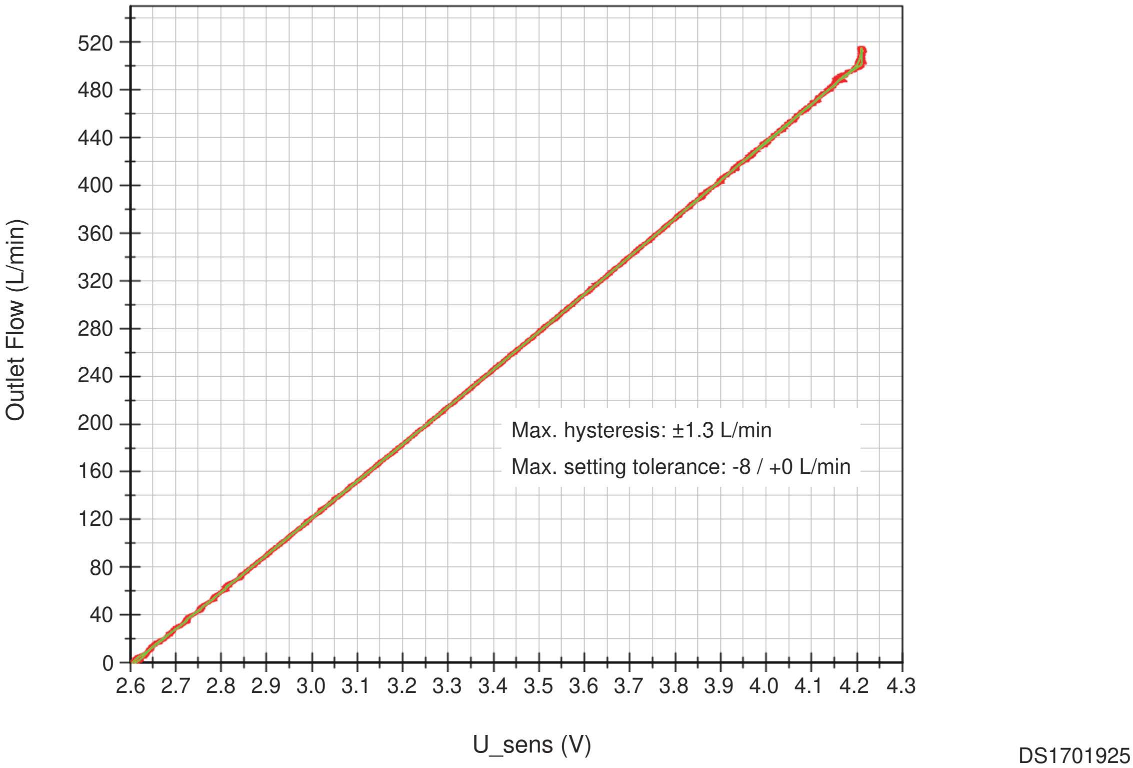
Figure 224



Reference Number	Description
1	Socket-head Screws
2	Protective Plate for Electronic Angle Indicator
3	Spacer Sleeves
4	Angle Sensor
5	O-ring

Characteristic of Angle Sensor

Figure 225

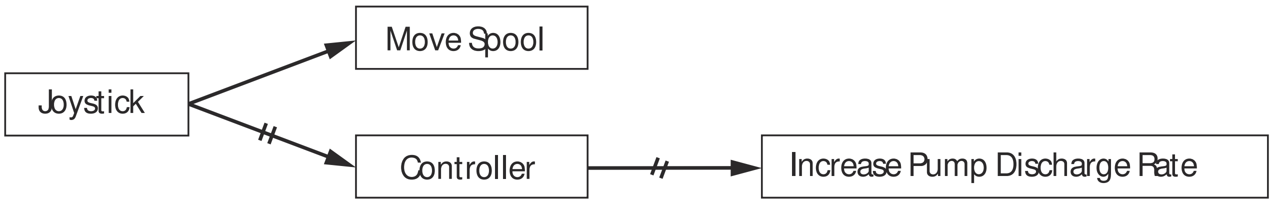


No.	1	2	3	4	5	6	7	8	9
U_sens (mV)	2,608	2,800	3,000	3,200	3,400	3,600	3,800	4,000	4,210
Outlet Flow (L/min)	0	59.1	121.2	183.0	245.7	308.6	372.3	435.9	504

VBO System

Flow Control

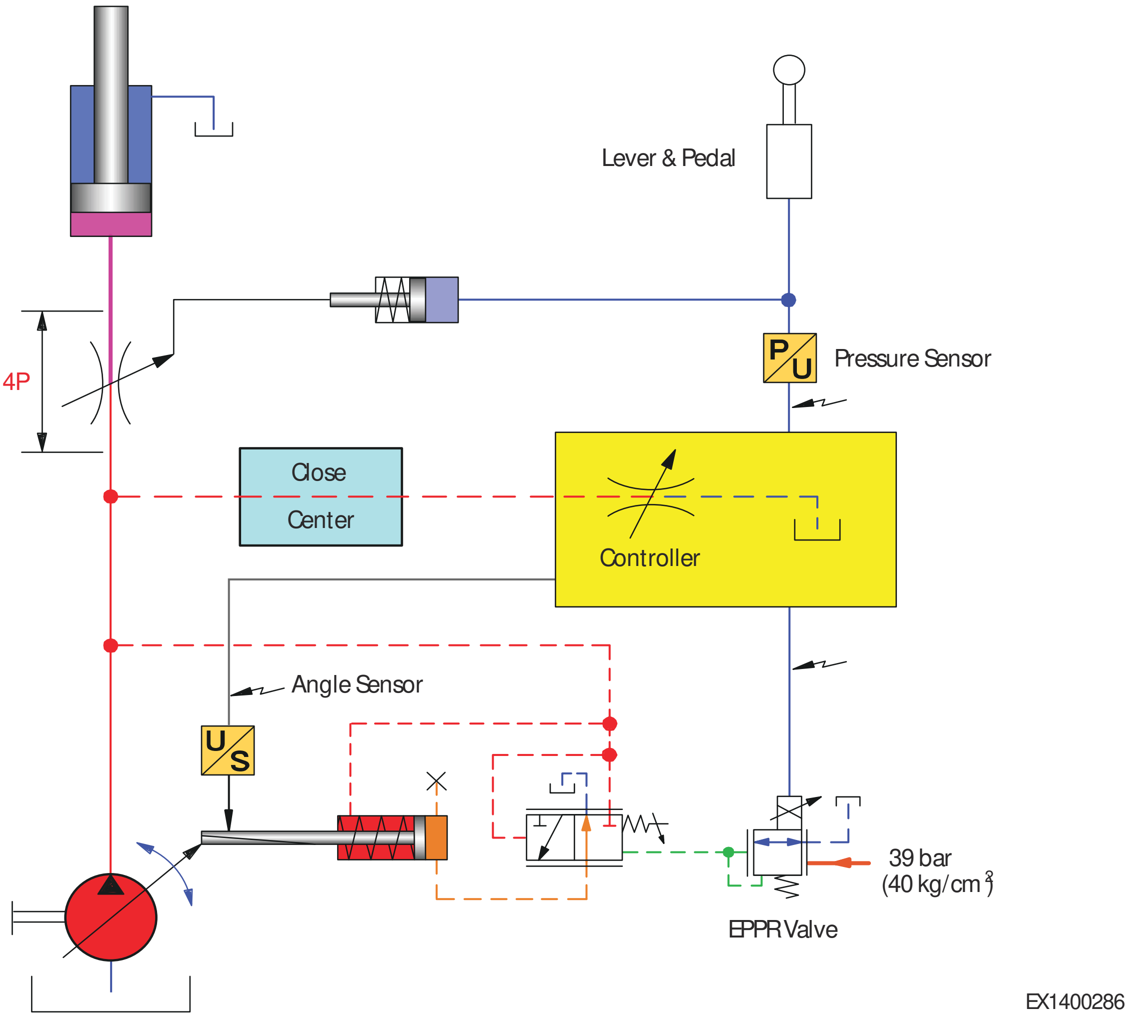
Figure 226



Control Process

Sensing a pressure of joystick to calculate flow rate (Qp) and center bypass area (Ab), VBO system control a pressure command of electronic pump to have no difference with calculated flow rate and actual flow rate (obtained by angle sensor).

Figure 227



P Pump = (12.75 x Pi) + a

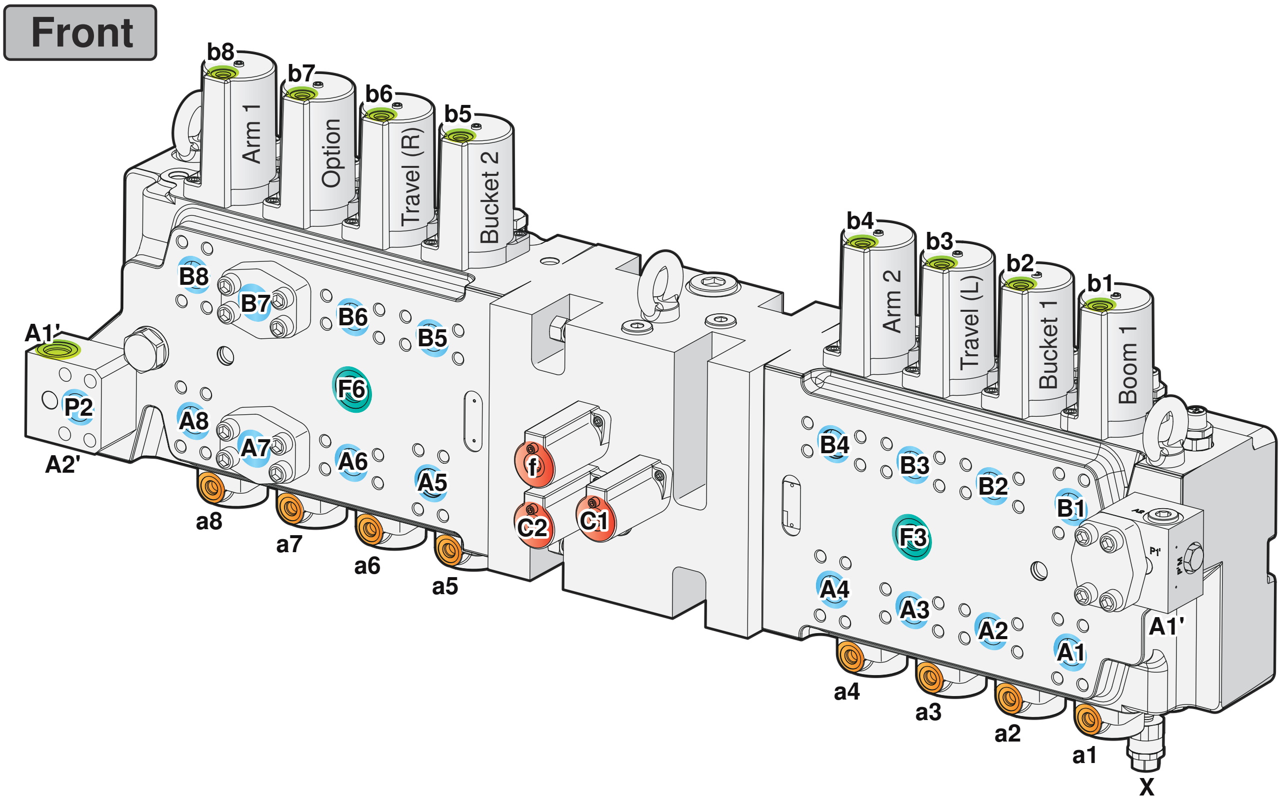
- P Pump: Pump Pressure
- 12.75: EPPR Valve Area Ratio
- Pi: Pump EPPR Secondary Input
- α: Spring Value (44 bar (45 kg/cm²))

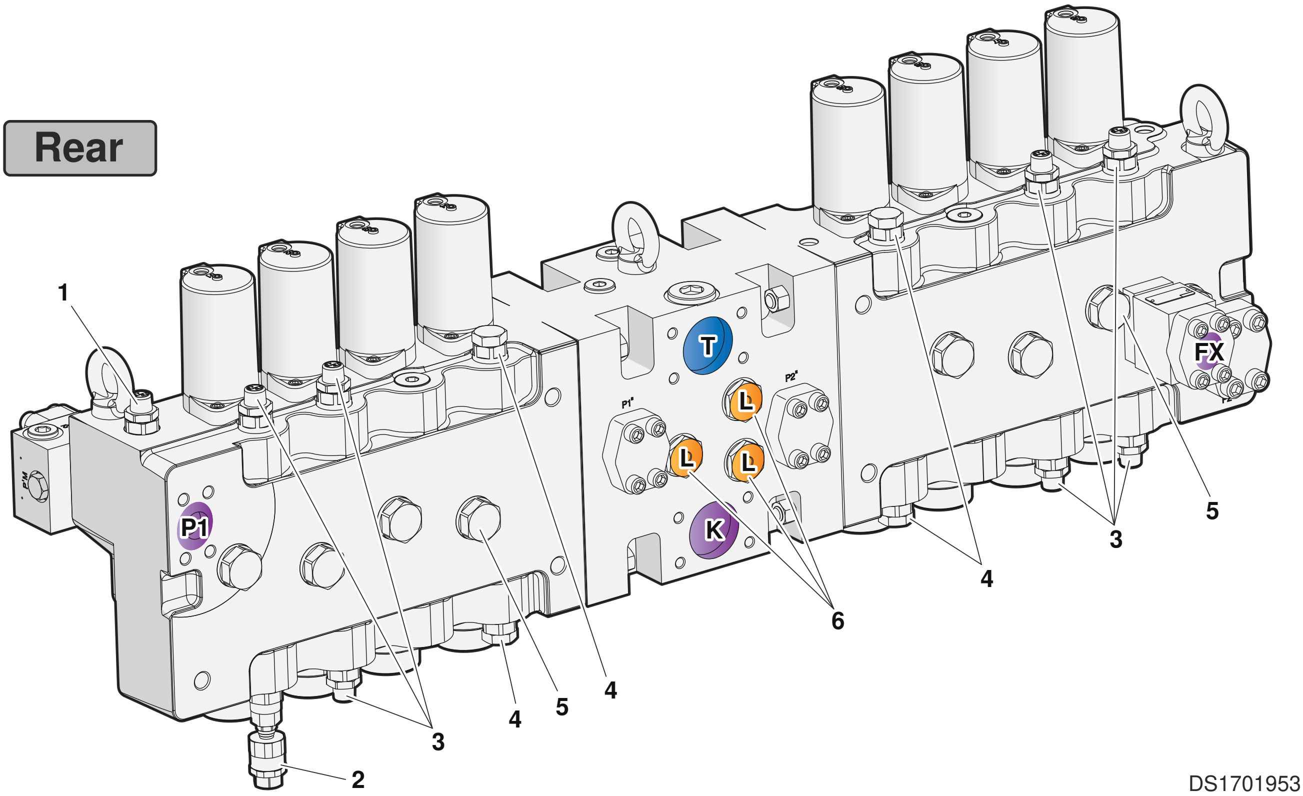
Main Control Valve

Overview

Control Valve 1

Figure 228





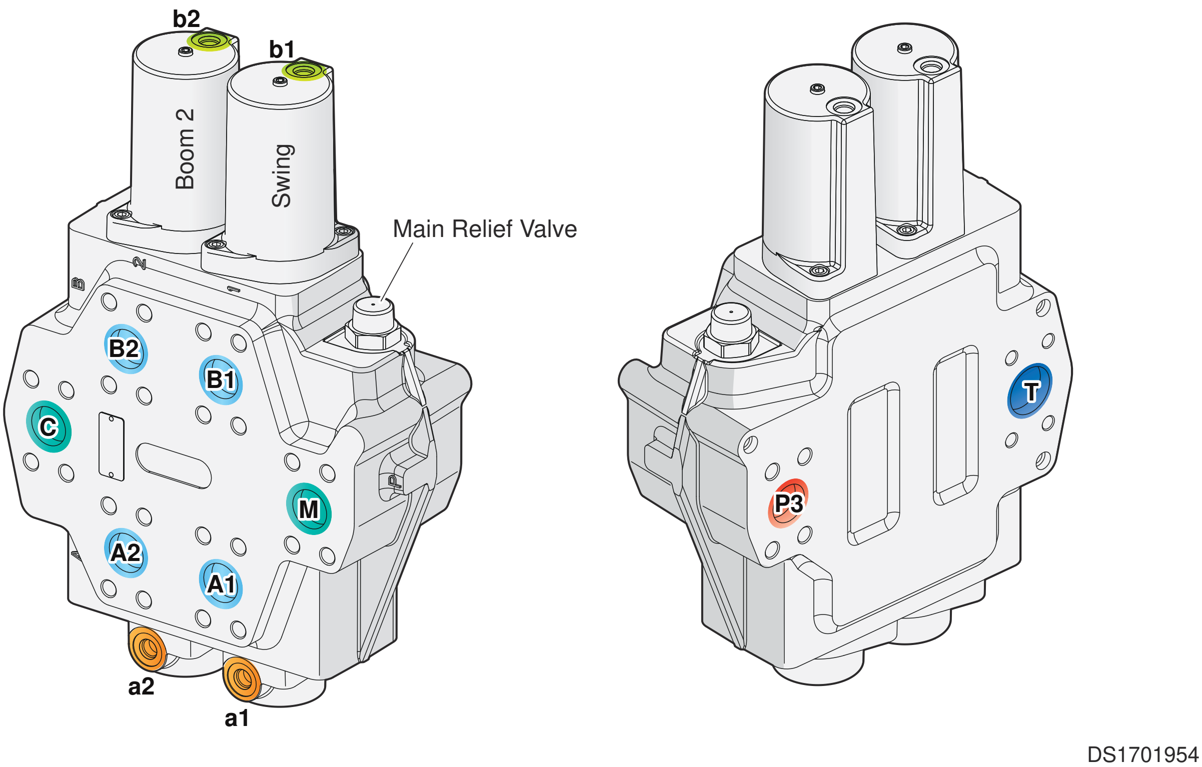
Port	Name	Size
P1	Rear Pump High-pressure Port	SAE 1 1/4" 6,000 psi
P2	Front Pump High-pressure Port	
A1	Boom Cylinder Rod Side (Boom 1)	
A2	Bucket Cylinder Rod Side (Bucket 1)	
A3	Travel Forward (LH)	
A4	Arm Cylinder Rod Side (Arm 2)	
A5	Bucket Cylinder Rod Side (Bucket 2)	
A6	Travel Forward (RH)	
A7	Two-way Option (RH)	
A8	Arm Cylinder Rod Side (Arm 1)	
B1	Boom Cylinder Tube Side (Boom 1)	
B2	Bucket Cylinder Tube Side (Bucket 1)	
B3	Travel Backward (LH)	
B4	Arm Cylinder Tube Side (Arm 2)	
B5	Bucket Cylinder Tube Side (Bucket 2)	
B6	Travel Backward (RH)	
B7	Two-way Option (LH)	
B8	Arm Cylinder Tube Side (Arm 1)	
T	Drain (to tank)	SAE 2 1/2" 3,000 psi
K	Drain (to Oil Cooler)	
a1	Boom Down Pilot (Boom 1)	UNF 9/16"-18
a2	Bucket Dump Pilot (Bucket 1)	
a3	Travel Forward Pilot (LH)	
a4	Arm Dump Pilot (Arm 2)	
a5	Bucket Dump Pilot (Bucket 2)	
a6	Travel Forward Pilot (RH)	
a7	Two-way Option Pilot (RH)	
a8	Arm Dump Pilot (Arm 1)	
b1	Boom Up Pilot (Boom 1)	
b2	Bucket Crowd Pilot (Bucket 1)	
b3	Travel Backward Pilot (LH)	
b4	Arm Crowd Pilot (Arm 2)	
b5	Bucket Crowd Pilot (Bucket 2)	
b6	Travel Backward Pilot (RH)	
b7	Two-way Option Pilot (LH)	
b8	Arm Crowd Pilot (Arm 1)	

Port	Name	Size
f	Travel Straight Pilot	
C1	By-Pass Cut Off	
C2	By-Pass Cut Off	
L	Drain (Pilot)	PF 1/4"
X	Secondary Stage Pressure Cut-off	
A1'	External Parallel Connection	UNF 1 1/16"-12
A2'	External Parallel Connection	
F6	External Parallel Connection	
F3	Quick Coupler (Option)	
FX	Two Pump (Option)	SAE 1" 6,000 psi

Seq.	Description
1	Main Relief valve (350 bar)
2	Overload Relief valve (150 bar, 370 bar) 2 Stage
3	Overload Relief valve (370 bar)
4	Check valve
5	Load Check valve
6	Reducing valve

Control Valve 2

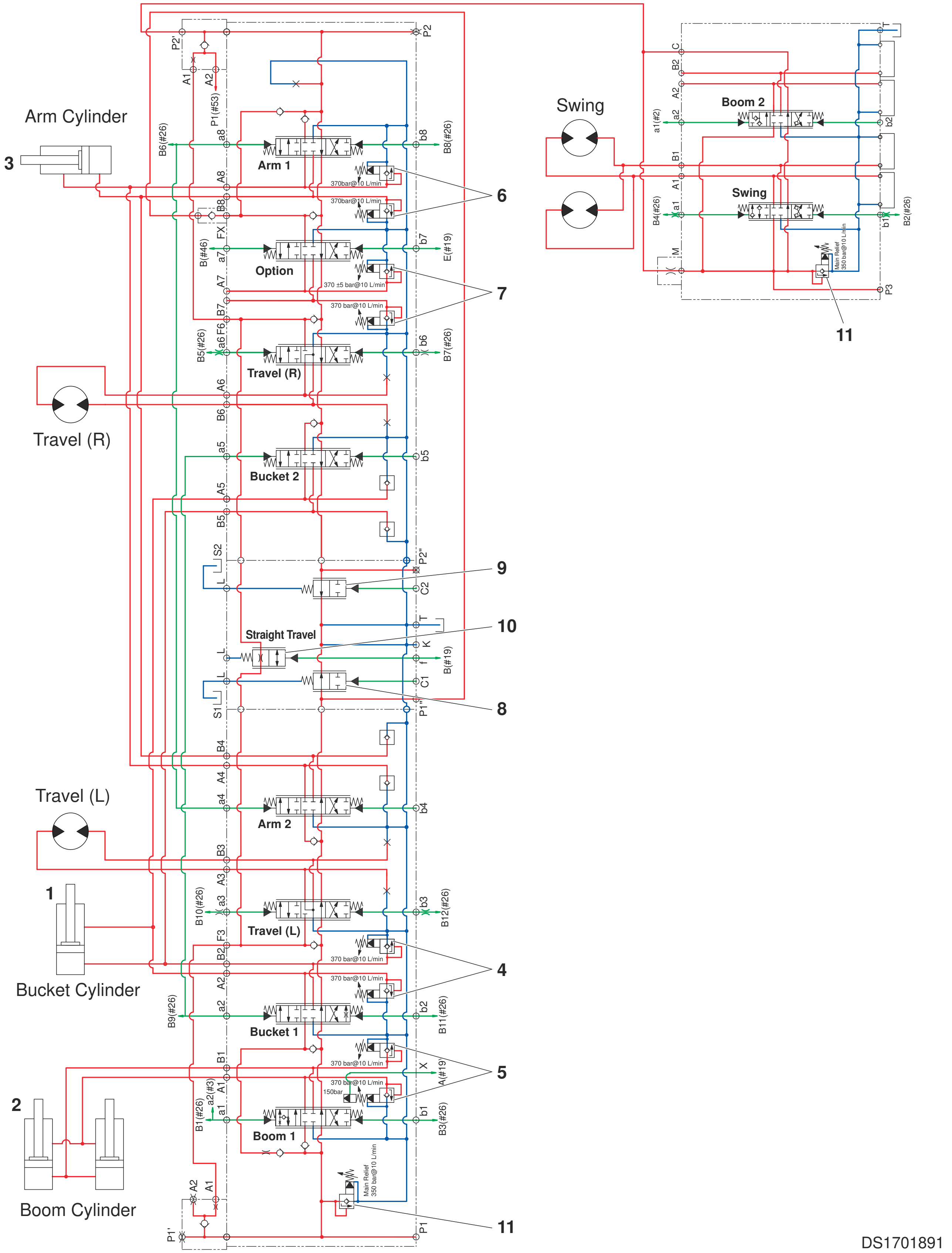
Figure 229



Port	Name	Size
P3	Front Pump High-pressure Port	SAE 1 1/4" 6,000 psi
M	Control Valve 1 Connection	
A1	Swing Left	
A2	Boom Cylinder Rod Side (Boom 2)	
B1	Swing Right	
B2	Boom Cylinder Tube Side (Boom 2)	
C	Control Valve 1 Connection	
a1	Swing Left Pilot	UNF 9/16"-18
a2	Boom Down Pilot (Boom 2)	
b1	Swing Right Pilot	
b2	Boom Up Pilot (Boom 2)	
T	Drain	SAE 1 1/2" 6,000 psi

Hydraulic Circuit

Figure 230



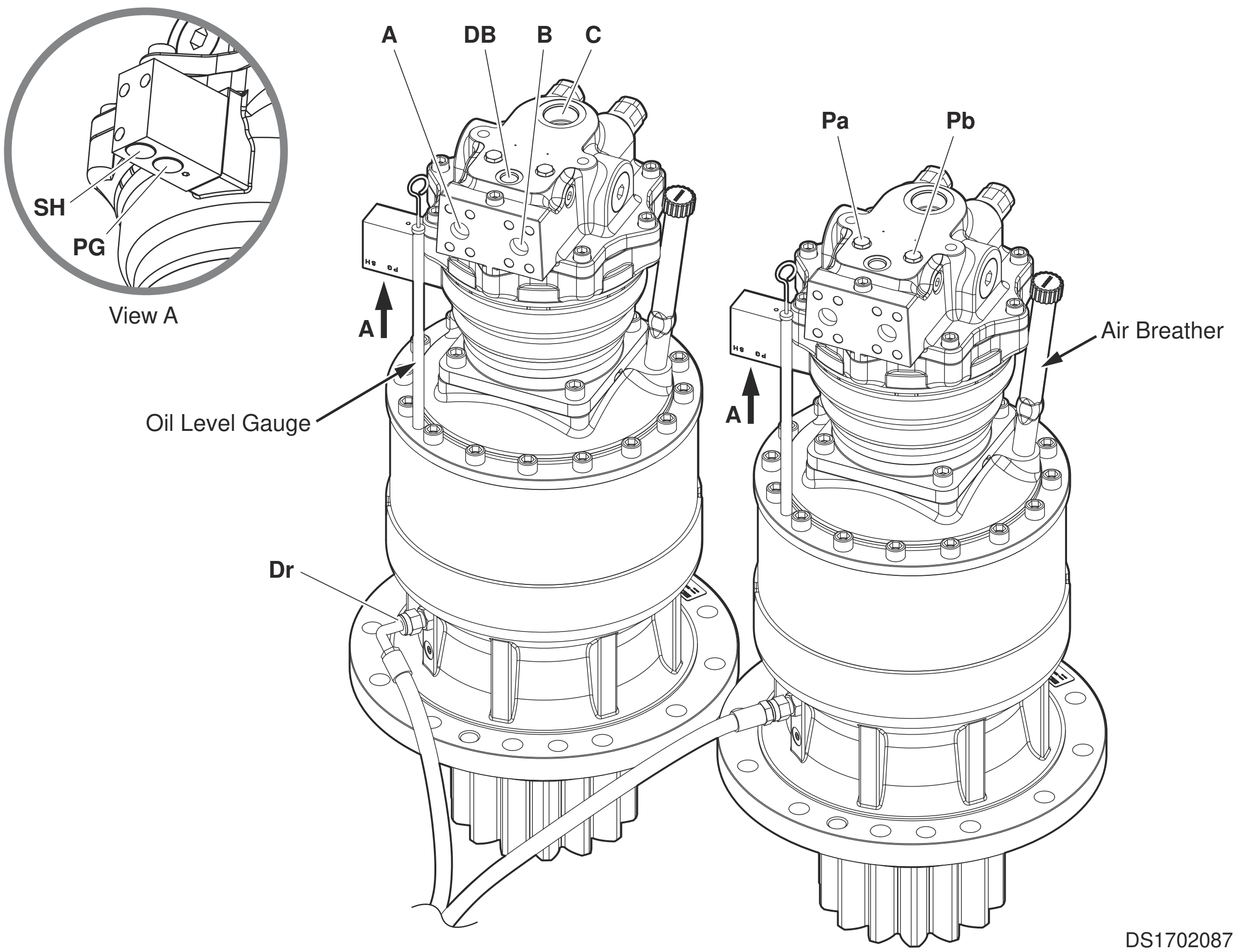
Reference Number	Description
1	Bucket Cylinder
2	Boom Cylinder
3	Arm Cylinder
4	Bucket Relief Valve
5	Boom Relief Valve
6	Arm Relief Valve
7	Option Relief Valve
8, 9	Bypass Cut Valves
11	Travel Straight Valve
12	Main Relief Valve

Swing Device

Overview

Swing device consists of a swing motor and swing reduction gear. And there are two swing devices in this machine. Swing motor includes a mechanical parking valve, relief valve, makeup valve and time delay valve.

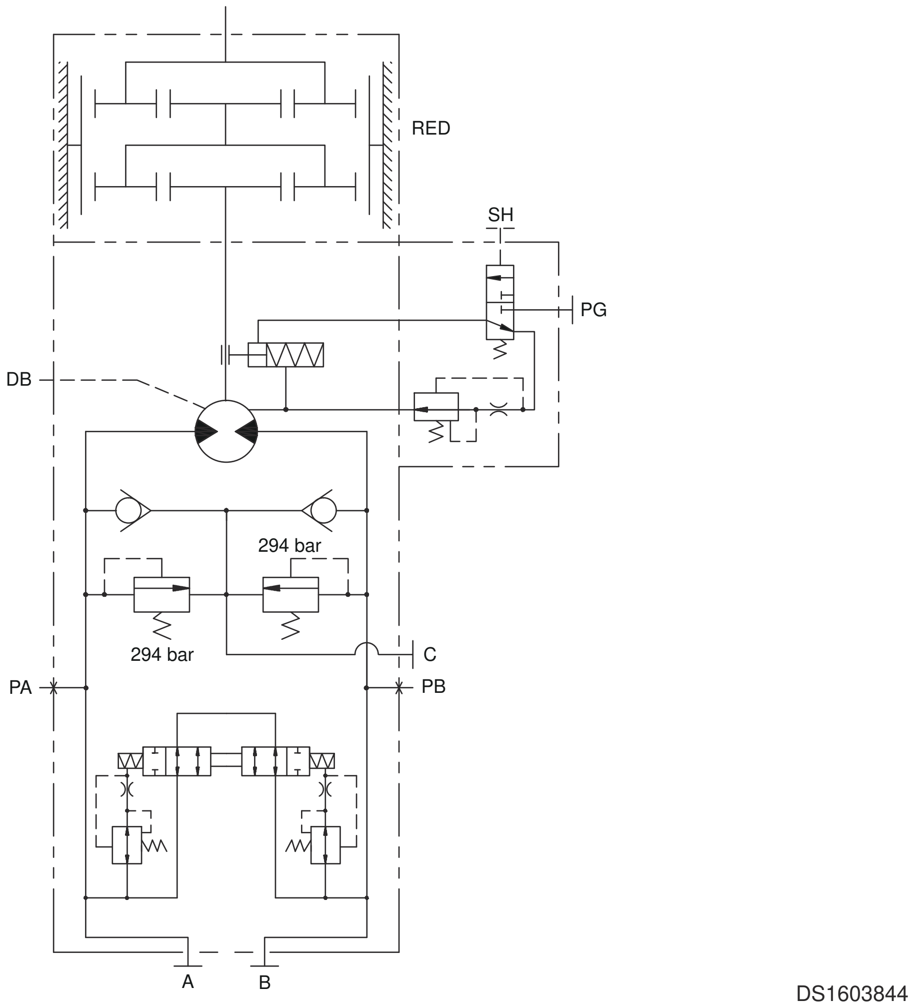
Figure 231



Port	Name	Size
A	High-pressure (Left)	SAE 1"-6,000 psi
B	High-pressure (Right)	
C	Make Up	PF 1 1/4", O-ring
DB	Motor Drain	PF 1/2", O-ring
SH	Brake Signal	PF 1/4", O-ring
PG	Brake Release	
Pa	Pressure Gauge	
Pb	Pressure Gauge	
	Air Breather	PT 3/4"
	Oil Level Gauge	
Dr	Oil Drain	PT 3/8"

Hydraulics Circuit

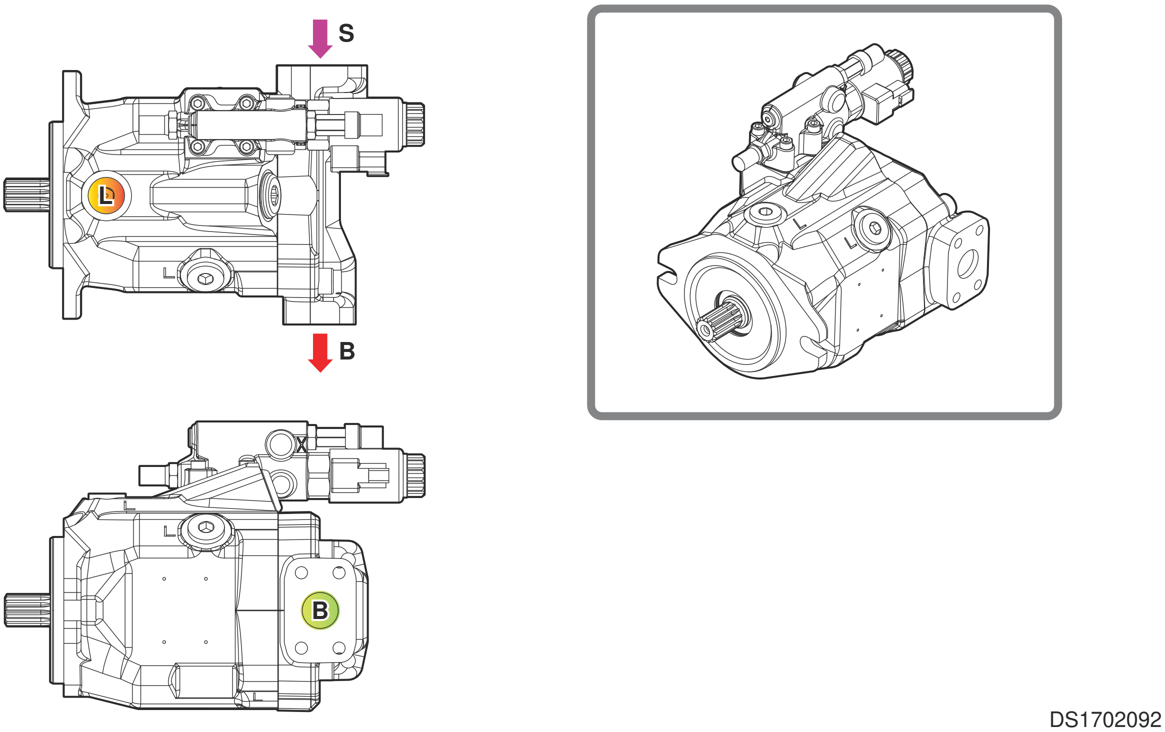
Figure 232



Fan Pump

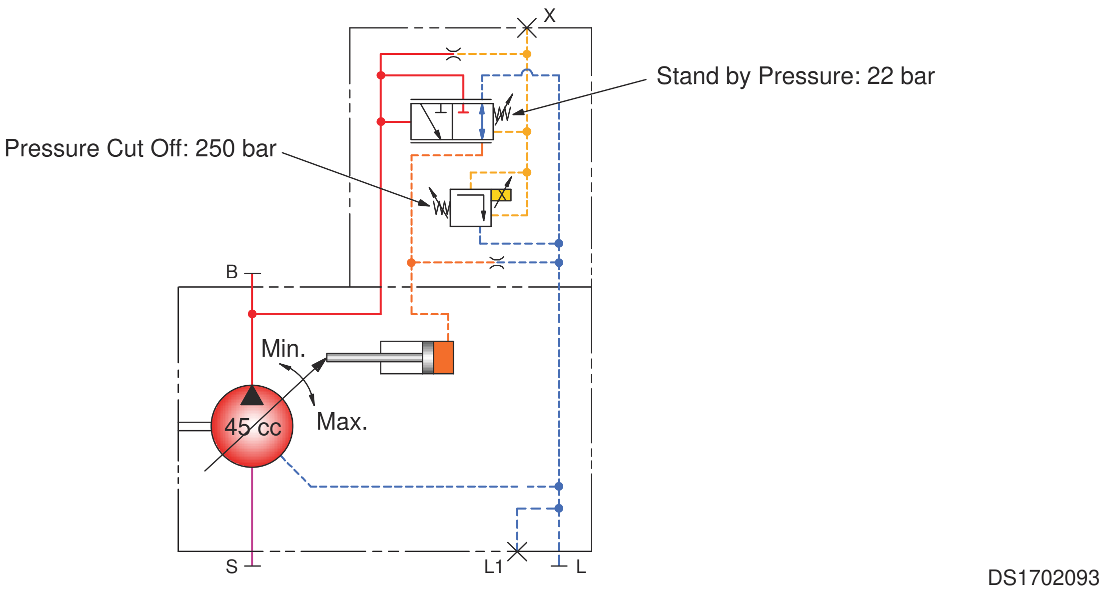
Overview

Figure 233



Port and Hydraulic Circuit

Figure 234



Port	Name	Size
B	Pressure	SAE 1"
S	Suction	SAE 1 1/2"
L	Case Drain	UNF 7/8"-14-2B

Theory of Operation

The Stand by Pressure and Pressure Cut-Off valve adjust the pump swivel angle in order to maintain the electrically set pressure level.

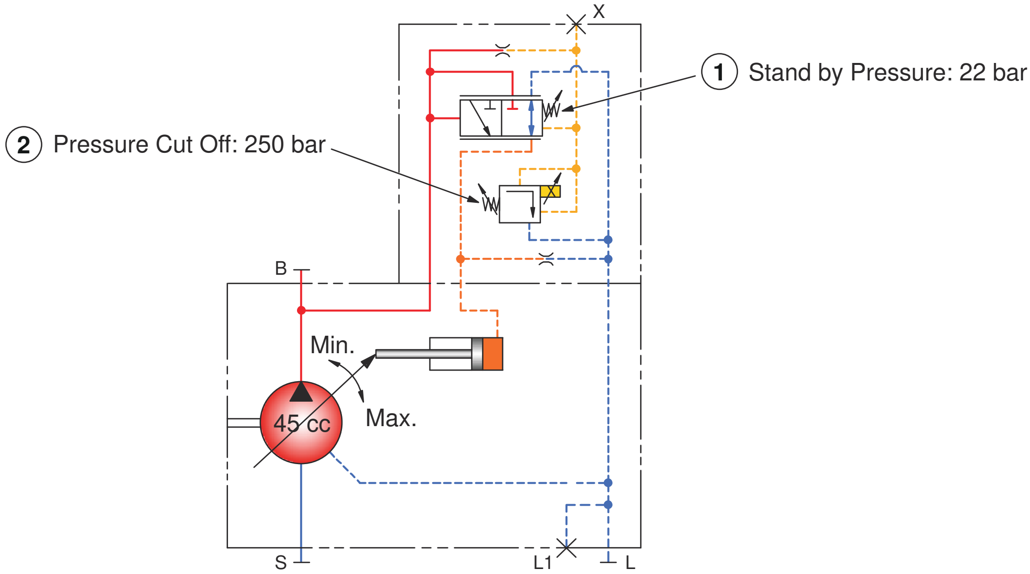
When the cutoff pressure is controlled, the P-I curve also shifts in response to the cutoff pressure (pressure measurement: X).

By controlling the discharge pressure according to the characteristics of the fan drive, volume control can be performed to control the speed of the fan.

- Stand by pressure: 22 bar (22 kg/cm^2, 319 psi)
- Pressure cut off: 250 bar (255 kg/cm^2, 3,626 psi) (at 0 mA)

Circuit

Figure 235

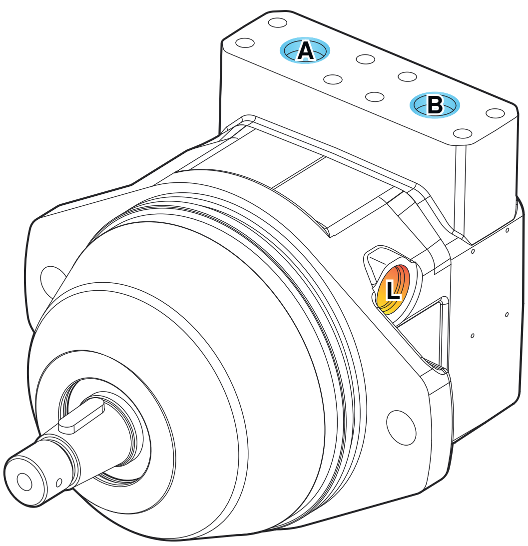


DS1702095

Fan Motor

Overview

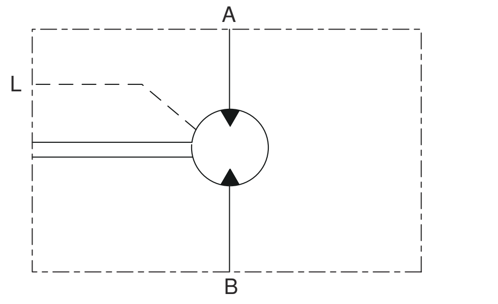
Figure 236



DS1702149

Port and Hydraulic Circuit

Figure 237



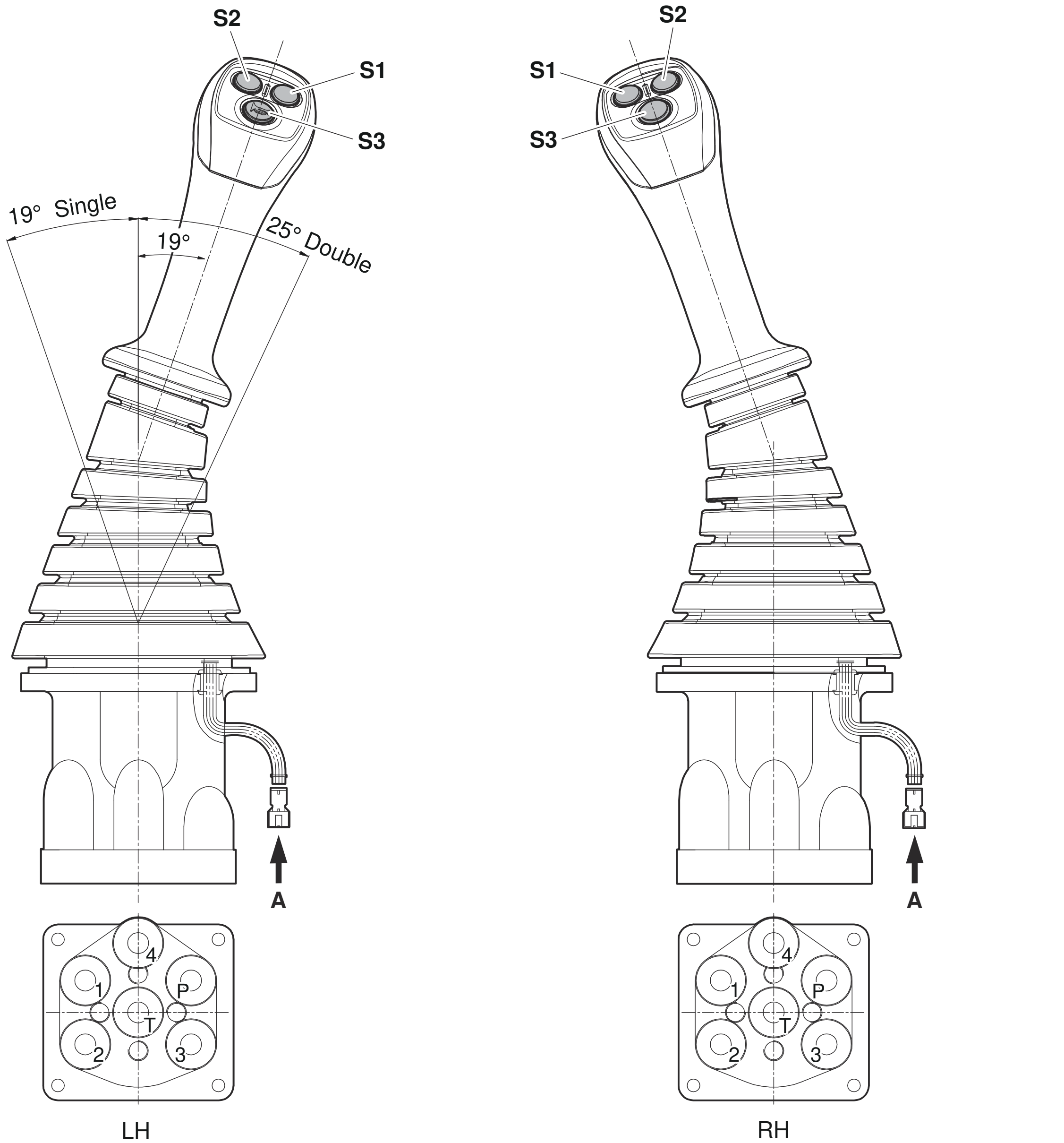
Port	Name	Size
A	Inlet	SAE 3/4"
B	Pressure	
L	Drain	UNF 7/8"-14

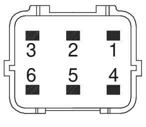
Joystick Valve

Overview

The remote control valve contains four push rods, spring holders, spools and return springs, which are in the valve casing. The valve works as a pressure reduction valve. The housing has six ports, which include input port P, tank port T, and four secondary pressure ports. The electric horn button is installed in the valve handle. Gear pump pressure is used for operating control spools.

Figure 238



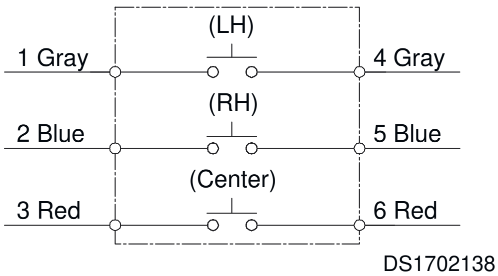
 View A	Push Button Switch		
	LH	RH	Center
	1 - Gray 4 - Gray	2 - Blue 5 - Blue	3 - Red 6 - Red

DS1702137

Port and Hydraulic Circuit

Push Button Switch

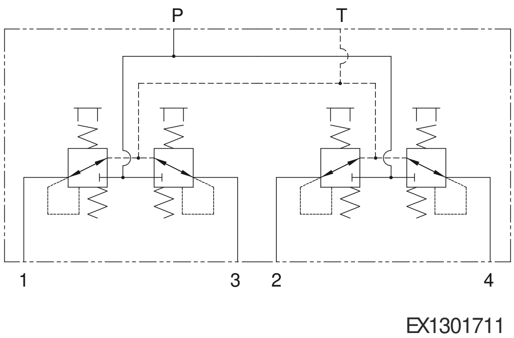
Figure 239



Button	LH	RH
S1	-	Shear Close
S2	-	Shear Open
S3	Horn Button	Breaker Button

Ports

Figure 240



Port	LH	RH	Size
1	Left Swing	Bucket Crowd	PF 3/8"
2	Arm Dump	Boom Down	
3	Right Swing	Bucket Dump	
4	Arm Crowd	Boom Up	
P	Pilot Oil Inlet	Pilot Oil Inlet	
T	Pilot Oil Return	Pilot Oil Return	

Theory of Operation

Structure

The joystick valve contains four push rods, spring seat, spools and return springs, which are in the valve casing. Moves the spool of the main control valve by reducing the pressure of the pilot pump from a first pressure to a second pressure.

The housing has six ports, which include input port P, tank port T, and four secondary pressure ports.

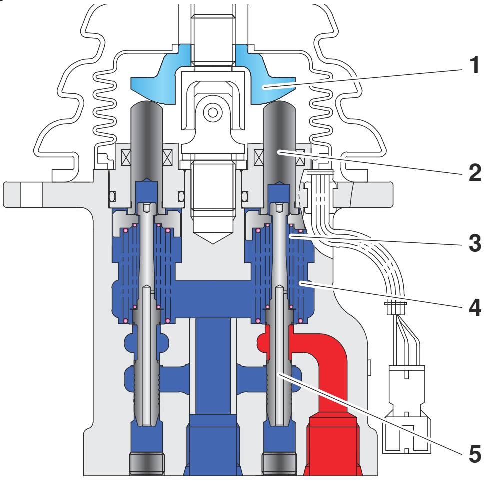
The electric horn button is installed in the valve handle.

Gear pump pressure is used for operating control spools.

Function

1. Neutral position

   Figure 241



DS1602148

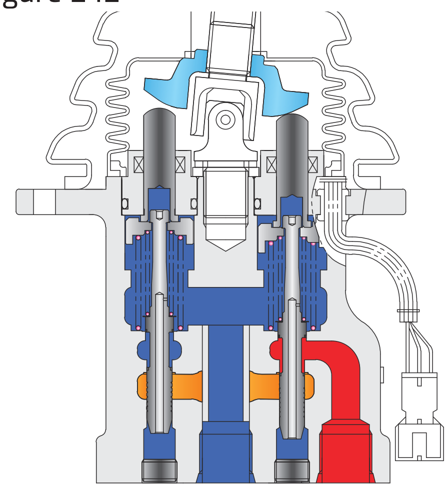
When the joystick lever is in the neutral state, the spool is pressed upward by the return spring and the spring seat.

The P-port is blocked by the lower part of the spool, and the 4 operation ports are connected to the T-port by the upperpart of the spool.

Reference Number	Description
1	Swash Plate
2	Push Rod
3	Balance Spring
4	Return Spring
5	Spool

2. Half-operated state

   Figure 242



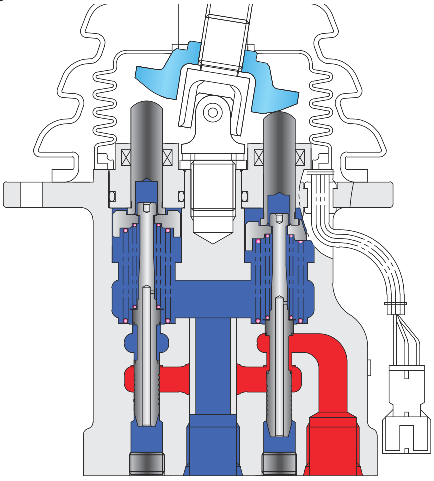
DS1602149

When the joystick lever is moved, the push rod moves downward, and the force thereof is transferred to the spool through the spring seat and the control spring. When the spool moves, the first pressure is transferred to the operation ports through the spool.

When the lever spring stops in the halfway position, the force of the compressed spring and the hydraulic pressure caused by the second pressure applied upward because of the difference in area of the upper and lower ends of the spool create a state of equilibrium, and this pressure is transferred to the spool of the control valve. That is, the first pressure is transferred to the operation ports through the spool as a hydraulic pressure (second pressure) corresponding to the force of the compressed control spring.

3. Fully operated state

Figure 243



DS1602150

When the joystick lever is moved to its full extent, the lower end of the push rod fully presses the spool seat to fully compress the control spring.

The first pressure is transferred to the operation ports through the spool, and the second pressure coming through the spool overpowers the force of the control spring, pushing the spool upward, and thus the spool is restricted from movement by the push rod.

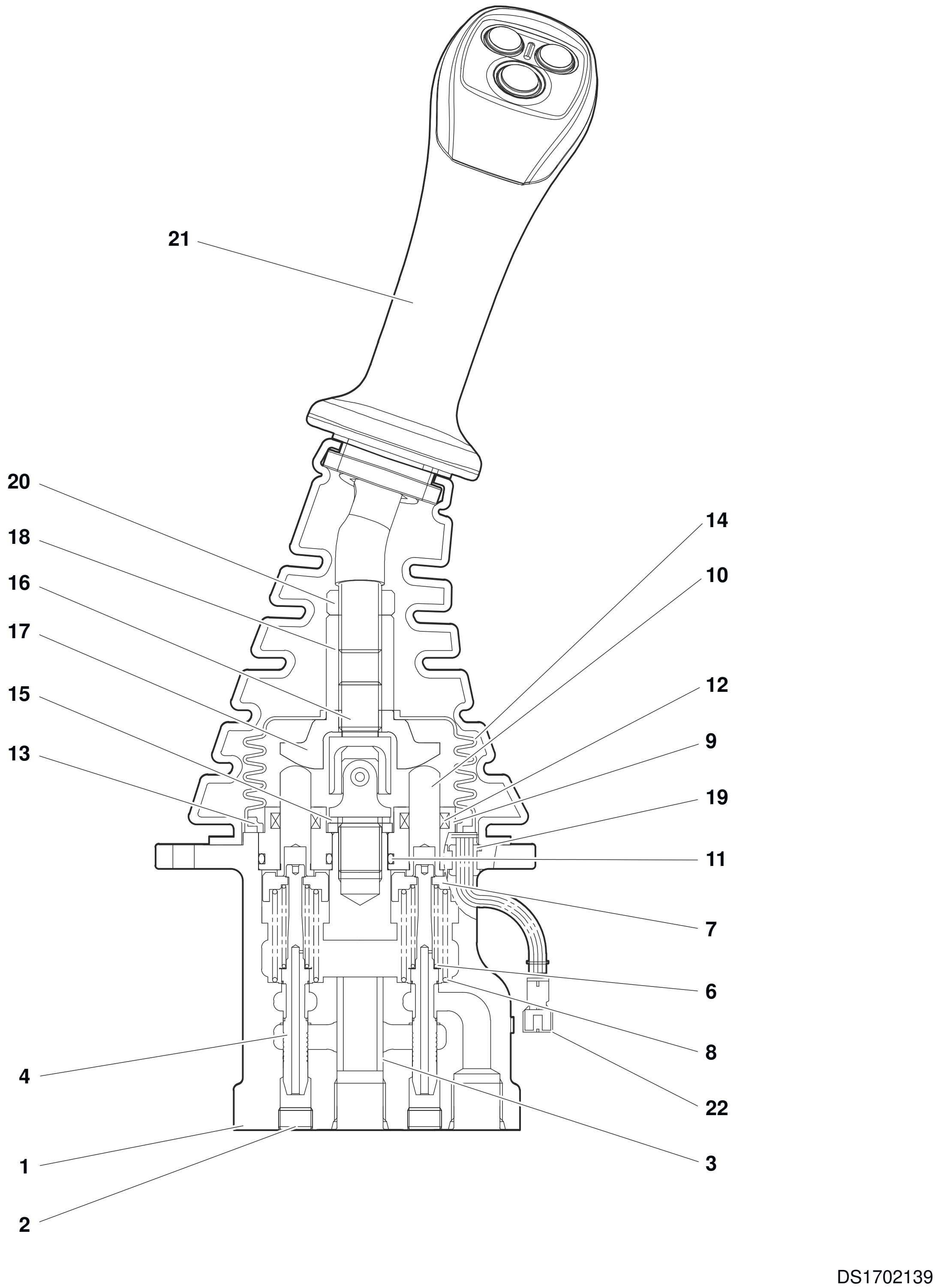
That is, when the joystick lever is fully pressed, the control spring cannot perform its function and the spool is restricted, making the first pressure and the second pressure equal.

Tools and Torques

Reference Number	Description	Torque			Tool
		N.m	kg.m	ft lb	
2	Plug	36.3	3.7	27	PT 1/8" ( )
17	Swash Plate	162.8	16.6	120	27 mm ( )
18	Hex Nut	162.8	16.6	120	22 mm ( )
21	Nut	162.8	16.6	120	22 mm ( )

Section View

Figure 244



Reference Number	Description
1	Case
2	Plug
3	Bushing
4	Spool

Reference Number	Description
5	Shim
6	Spring
7	Spring Seat
8	Spring
9	Plug
10	Push Rod
11	O-ring
12	Rod Seal
13	Plate
14	Inner Boots
15	Spacer
16	Joint Assembly
17	Swash Plate
18	Hex Nut
19	Bushing
20	Nut
21	Handle Assembly (LH)
	Handle Assembly (RH)
22	Connector Assembly

Travel Control Valve

Overview

The pilot valve is a valve that controls the spool stroke, direction, etc of a main control valve.

This function is done by providing the spring at one end of the main control valve spool and applying the output pressure (secondary pressure) of the pilot valve to the other end.

Figure 245

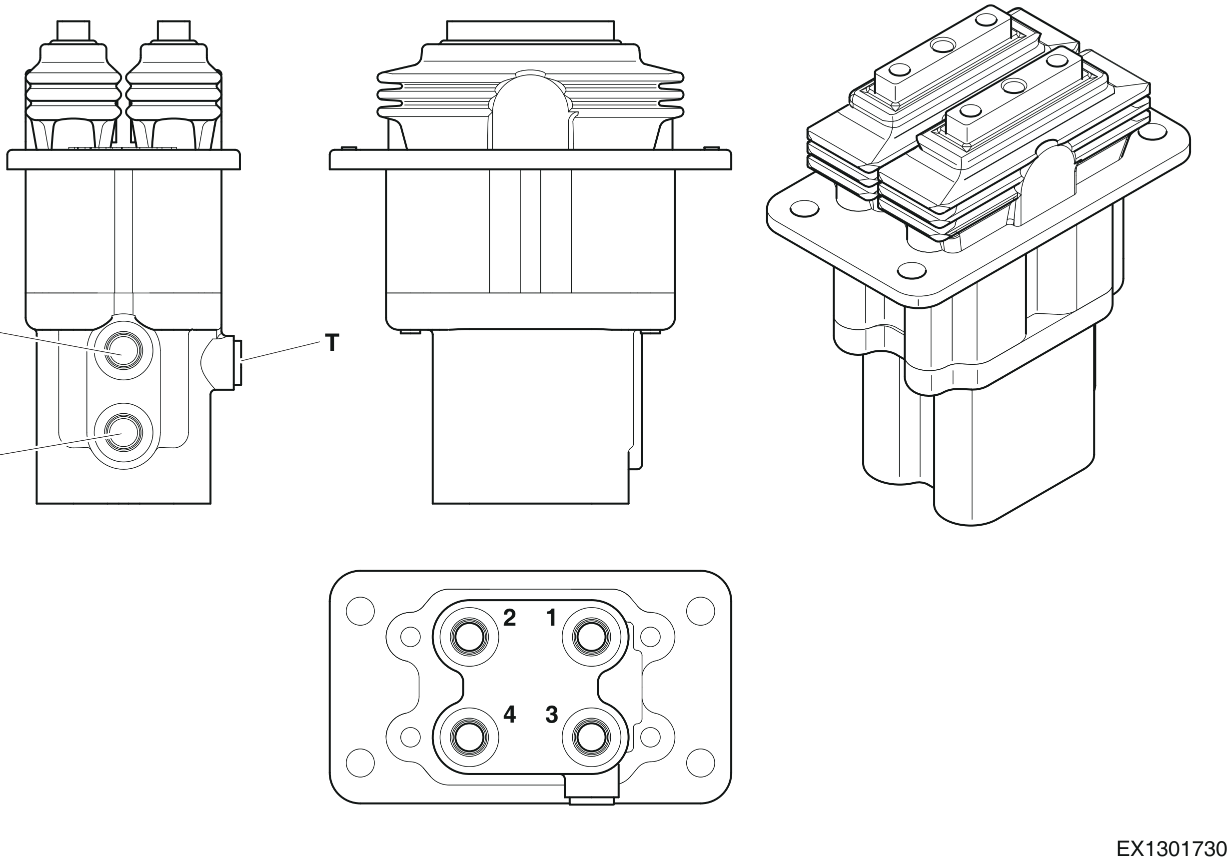
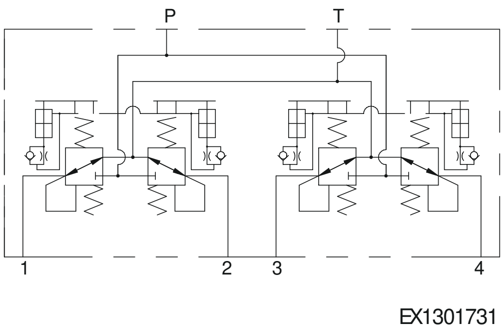


Figure 246



Port and Hydraulic Circuit

Port	Name	Size
1	Backward	PF 1/4 O-ring
2	Forward	
3	Backward	
4	Forward	
P	Pilot Oil Inlet	
T	Pilot Oil Return	

Theory of Operation

Structure

The casing (spacer) has oil inlet port P (primary pressure), and the oil outlet port T (tank). In addition the secondary pressure is taken out through ports 1, 2, 3 and 4 provided at the bottom face. It has a damper to move the push rod back position slowly.

Pressure Reducing Valve

1. Neutral position

   If pedal is in neutral, spool is pushed up by return spring and spring seat. Port (P) is blocked by bottom part of spool and four operating ports (left forward and backward, right forward and backward) are connected to port (T) through inner hole of spool.

2. Half-operated state

   If pedal is moved, push rod moves down, and they transmit this force through spring seat and control spring to spool. If spool is moved, primary pressure is transmitted through an inner hole of spool to operating port. If lever is stopped in middle position, compressed control spring force and secondary pressure transmitted through hole acts at bottom part of spool, balance is maintained by hydraulic force acted upward, and then this pressure is transmitted to traveling spool of control valve. That is, primary pressure is transmitted to operating port as secondary pressure equivalent to control spring force compressed by spool.

3. Fully operated state

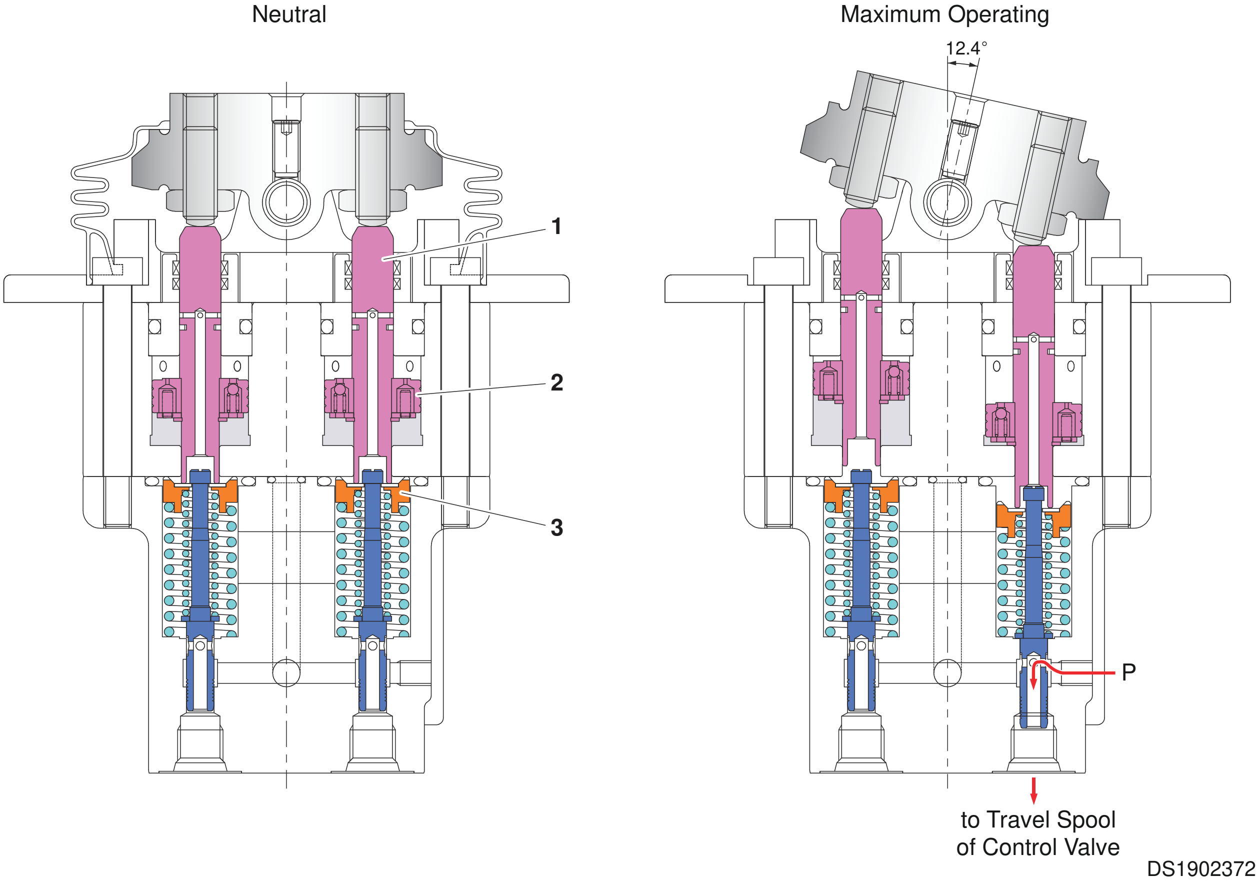
   If pedal is moved to a maximum, bottom part of push rod presses spool seat to a maximum, and compresses control spring to a maximum. Primary pressure is transmitted through inner hole of spool to operation port, secondary pressure transmitted through spool overcomes control spring force and pushes spool up, but spool is restricted by push rod and does not move any more. That is, when pedal lever is moved to a maximum, control spring does not function, spool is restricted by push rod, and then primary pressure equalizes to secondary pressure.

Damper Mechanism

1. Operation When Operating Lever When pushing pedal, pushing force pushing push rod and spool presses cylinder, return spring and hydraulic oil in cylinder is compressed, piston coming down with push rod compresses vibration prevention chamber of lower part, oil of vibration prevention chamber of lower part is flowed through orifice to oil pressure vibration prevention chamber of upperpart of low-pressure, now, ball check valve becomes closing condition because high-pressure operates to vibration prevention chamber of lower part.
2. Operation When Operating Lever In Neutral Condition Climbing restoring force acting on push rod, raises piston in oil pressure prevention chamber and compresses upper oil pressure prevention

chamber. This compression operation of upper oil pressure prevention chamber prevents the push rod from quickly rising by restoring spring, and the damping force is generated.

Figure 247



Reference Number	Description
1	Push Rod
2	Piston
3	Spring Seat

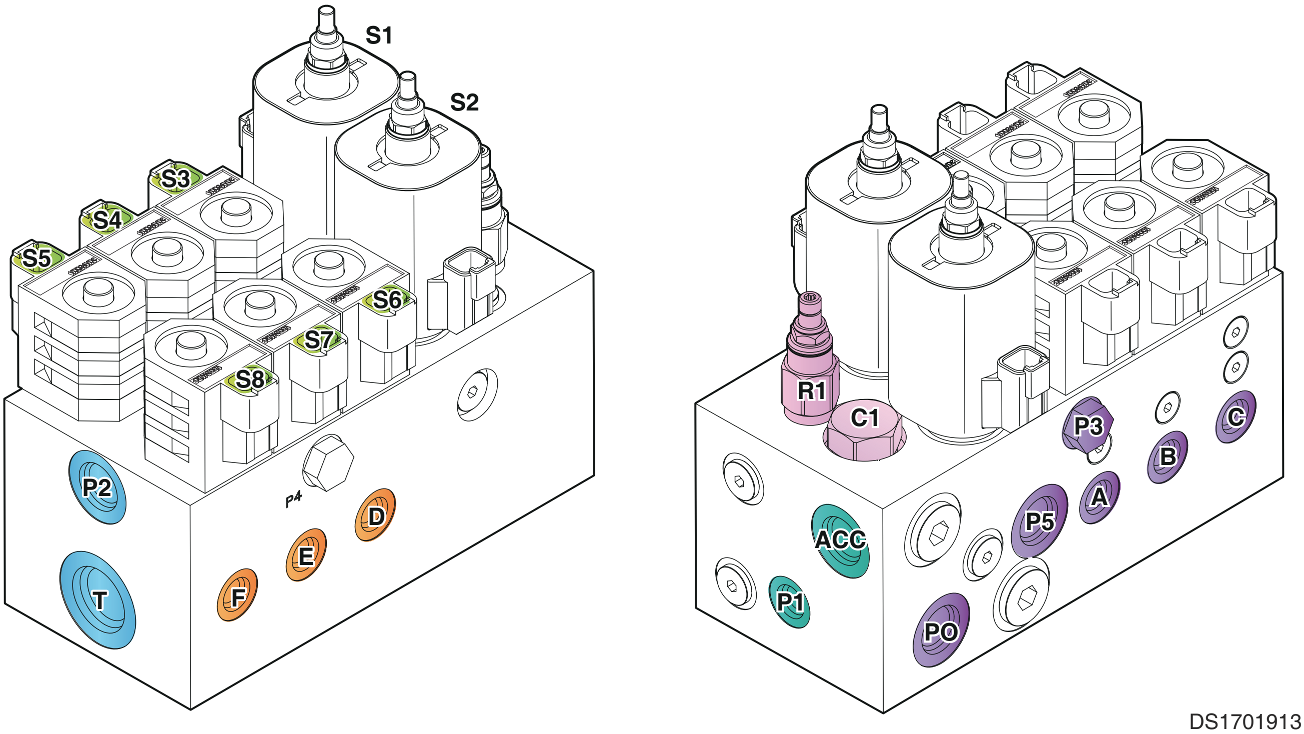
Tools and Torques

Reference Number	Description	Size	Torque			Tool
			Nm	kg.m	ft lb	
25	Socket Bolt	M6	29.4	3	6	5 mm ( )
31	Nut	M10	43.1	4.4	32	17 mm ( )

Solenoid Valve

Overview

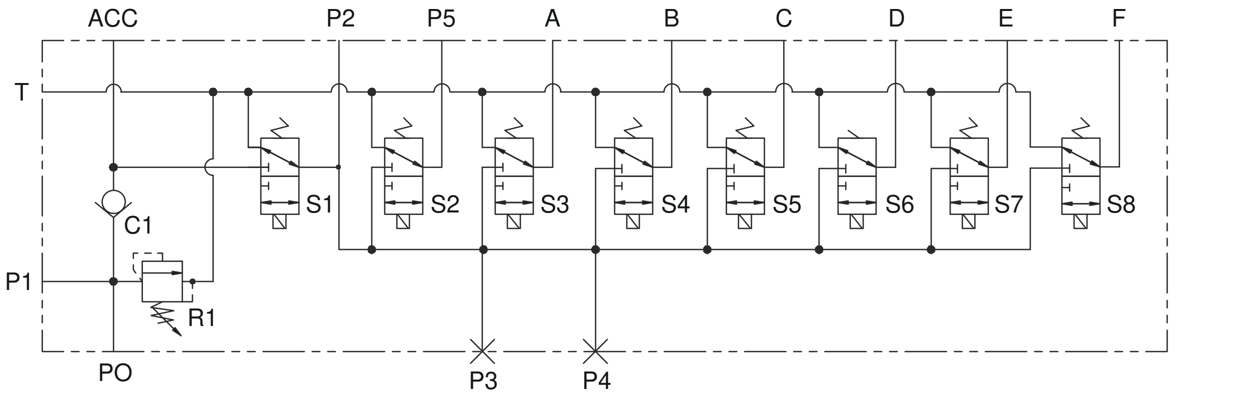
Figure 248



Reference Number	Description
S1	Safety Cut-off
S2	Safety Cut-off 2
S3	Free Boom Up
S4	Straight Travel
S5	Swing Brake Release
S6	Travel High Speed
S7	Breaker
S8	One/Two-way Select
R1	Relief Valve (40 bar)
C1	Check Valve

Port and Hydraulic Circuit

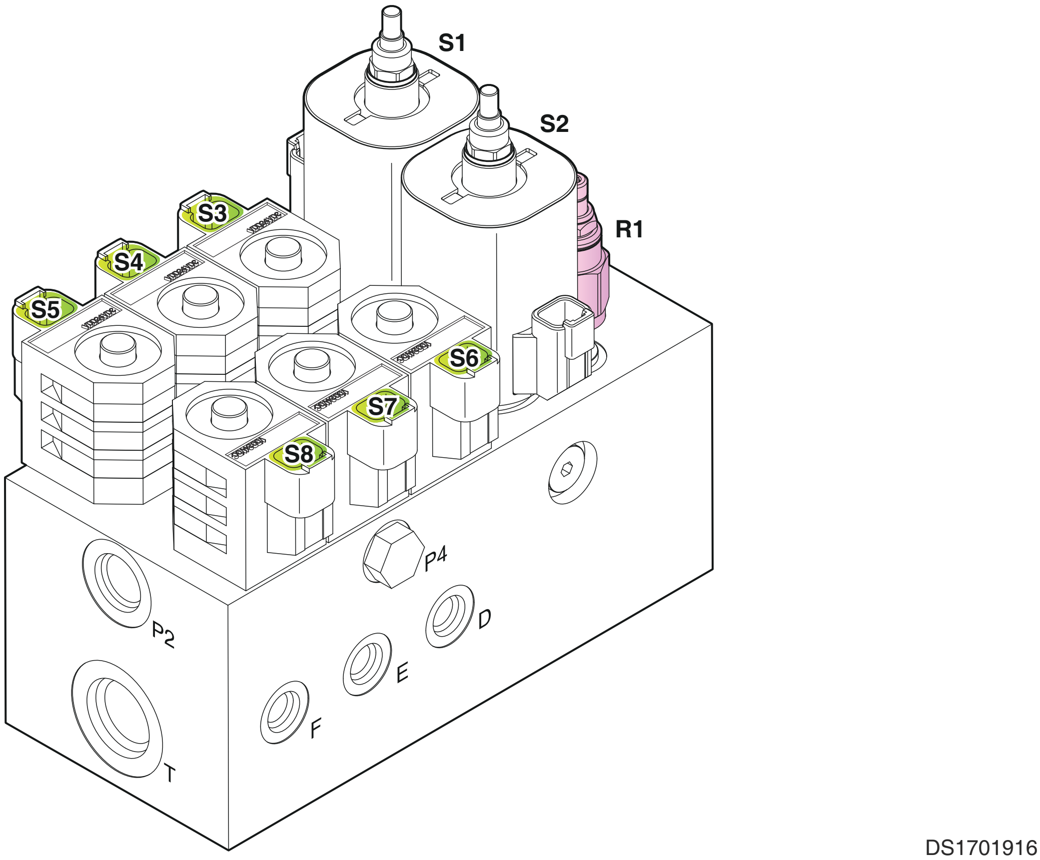
Figure 249



Port	Name	Size
PO	Pilot Pressure Inlet	PF 1/2", O-ring
P2	Safety Cut-off	
P5	Safety Cut-off 2	
ACC	Accumulator	
P1	Fan Motor Reverse	PF 1/4", O-ring
P3	Two Pump Solenoid (Option)	
A	Free Boom Up	
B	Straight Travel	
C	Swing Motor Parking Brake Release	
D	Travel High Speed	
E	Option Spool Pilot	
F	One/Two-way Select	
T	Drain	PF 3/4", O-ring

Theory of operation

Figure 250



The solenoid valve assembly controls the following functions.

1. Pilot Cut-off
2. Pilot Cut-off 2
3. Free Boom Up Operation
4. Straight Travel Operation
5. Swing Brake Release Operation
6. High/Low Travel Speed
7. Breaker Pilot Pressure Supply
8. Breaker/Shear Mode Selection

Functions and Operations of Solenoid Valves

Reference Number	Function	Operations	Remarks
S1	Pilot Cut-off	Provides pressurized oil coming from the pilot pump for the pilot pressure supply solenoid valve to operate each work system.	
S2	Pilot Cut-off 2	Supplies pilot pressure to EPPR valve.	
S3	Free Boom Up	When the function is selected, the 2nd stage overload relief valve is set to a pressure of 150 bar and relieves the boom rod pressure so that the boom does not rise unnecessarily.	

Reference Number	Function	Operations	Remarks
S4	Straight Travel	When operating in combination with front operation and travel, supply the pilot pressure to the straight travel spool of the main control valve.	
S5	Swing Brake Release	When the swing motion is not working properly, supply swing brake release pilot pressure by swing brake toggle switch operation.	
S6	High/Low Travel Speed	Sets low and high travel speed. Shifts speed between both depending on the state of the solenoid valve or a signal detected in the EPOS controller.	
S7	Breaker Pilot Pressure Supply	Supplies pilot pressure for the option spool of main control valve for breaker operation.	Option
S8	Breaker/Shear Mode Selection	According to one or two-way menu selector in the gauge panel, one or two-way mode is changed by the S8 solenoid valve.	Option

Detailed Functions and Operations of Solenoid Valves

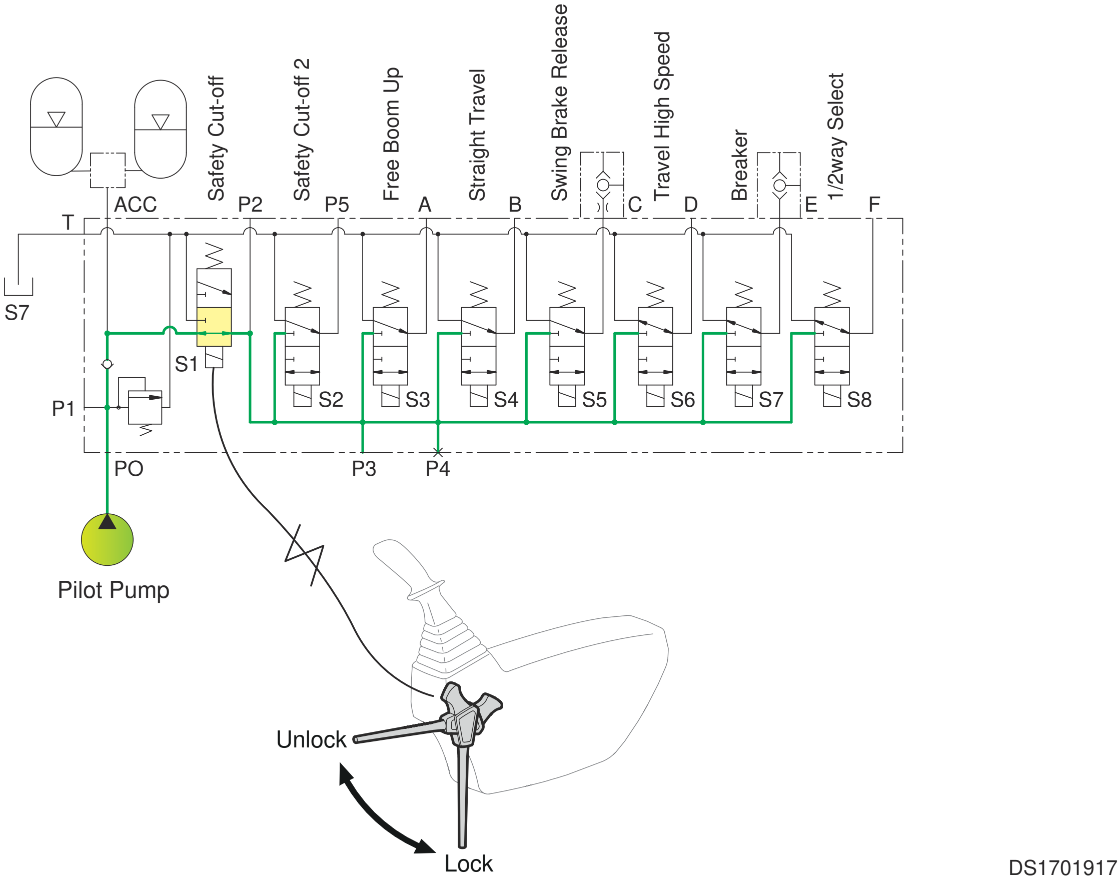
1. It provides pressurized oil coming from the pilot pump to the;

   Pilot Cut-off Solenoid Valve (S1)

   - Pilot Cut-off 2 (S2)
   - Free Boom Up Operation (S3)
   - Straight Travel Operation (S4)
   - Swing Brake Release Operation (S5)
   - High/Low Travel Speed (S6)
   - Breaker Pilot Pressure Supply (S7)
   - Breaker/Shear Mode Selection (S8)

Pulling up the safety lever, located on the left side of the operator's seat, allows the electrical power from the pilot cutoff switch to activate the pilot cutoff solenoid valve. The pilot cutoff solenoid valve then supplies pressurized oil to each of the other solenoid valves.

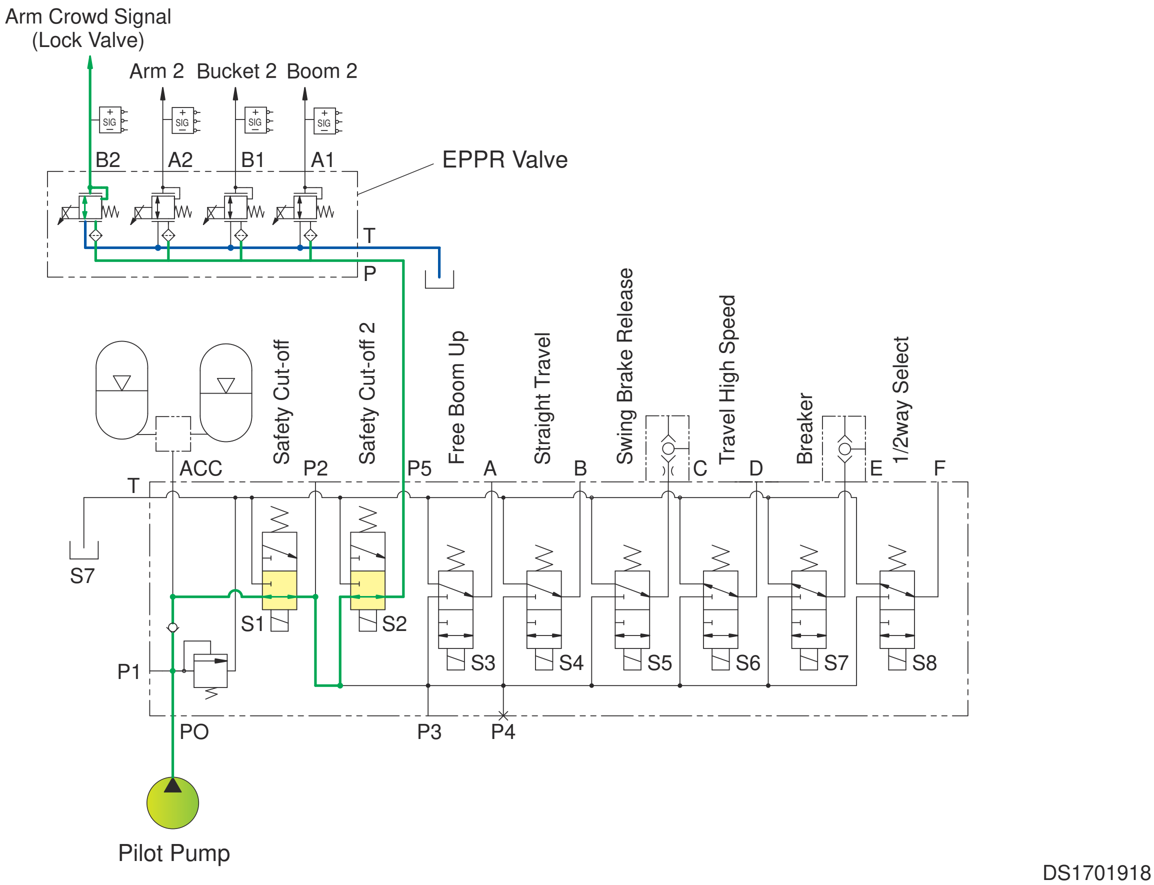
Figure 251



2. Pilot Cut-off Solenoid Valve (S2)

Pilot pressure is supplied to the EPPR valve to improve the synchronicity of the merging spool of Boom 2, Arm 2 and Bucket 2.

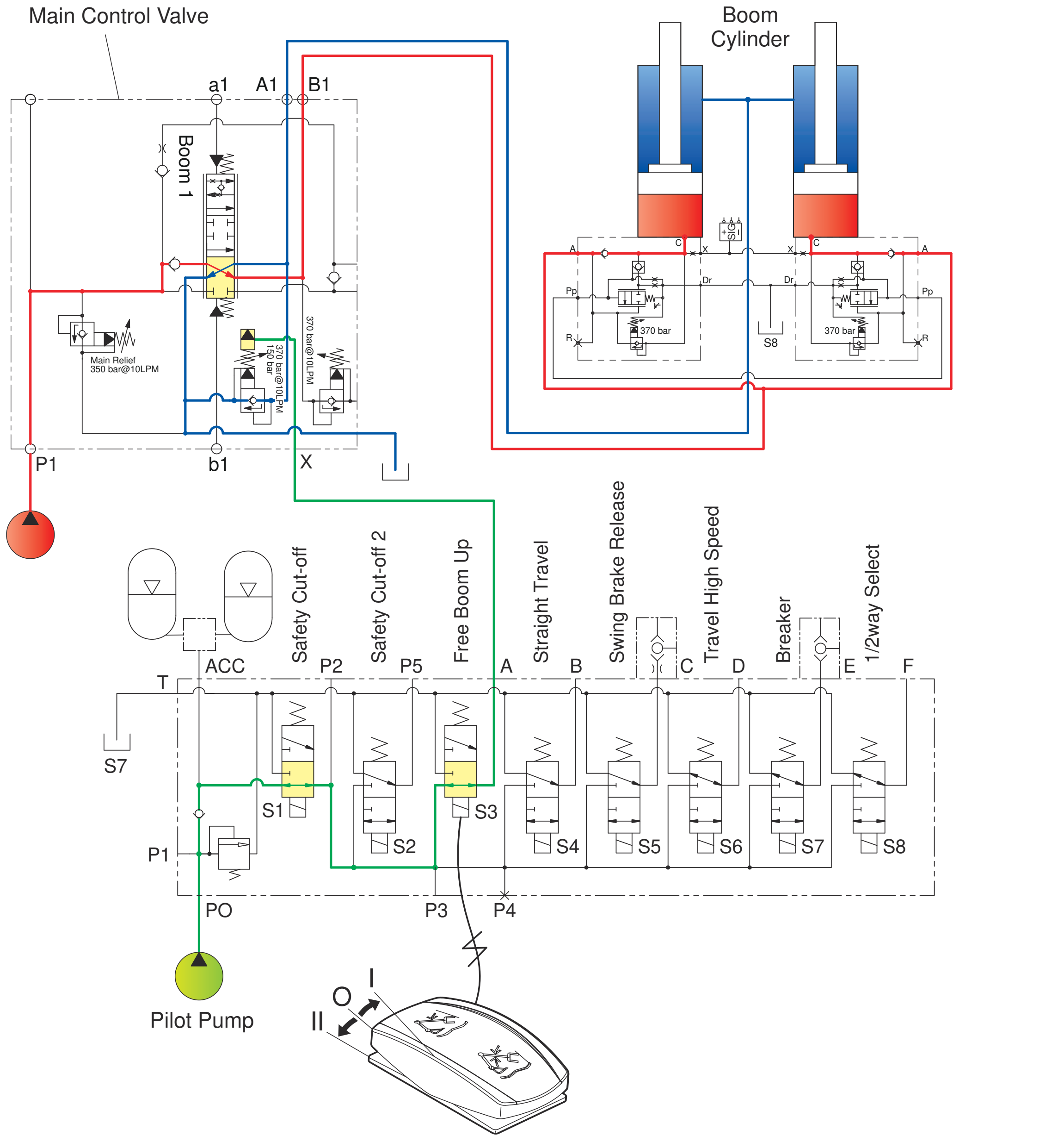
Figure 252



3. Free Boom Up Solenoid Valve (S3)

When the intelligent boom switch is activated ("I" position), the free boom up solenoid is switched and pilot pressure is supplied to the boom rod side relief valve. (Set to 150 bar).

Figure 253

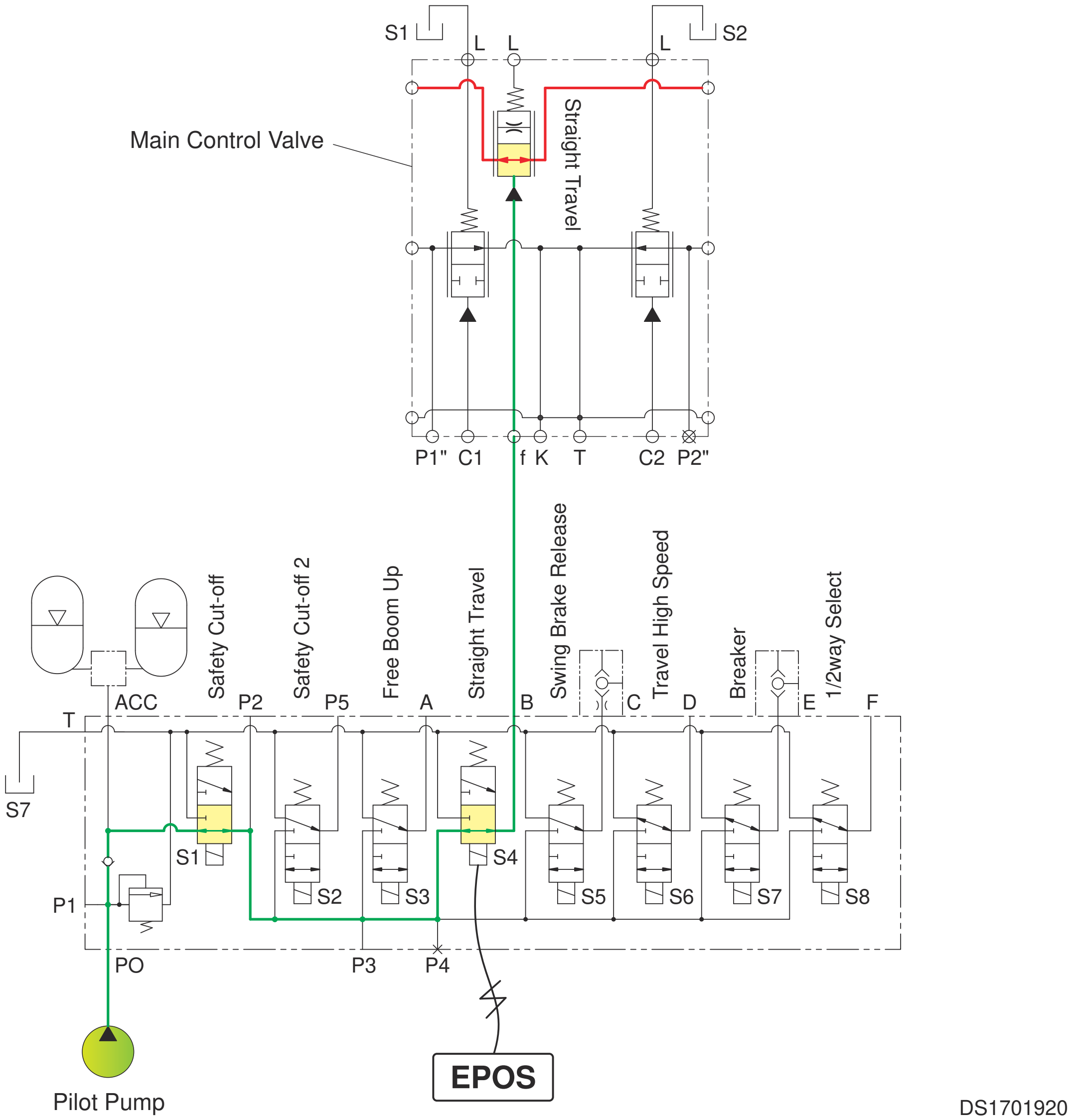


4. Straight Travel Solenoid (S4)

   When combined front and travel, EPOS detects the front pressure sensor and travel pressure sensor to switch the straight travel solenoid.

The pilot pressure is supplied to the straight travel spool in the main control valve to balance the supplied flow of both travel motors.

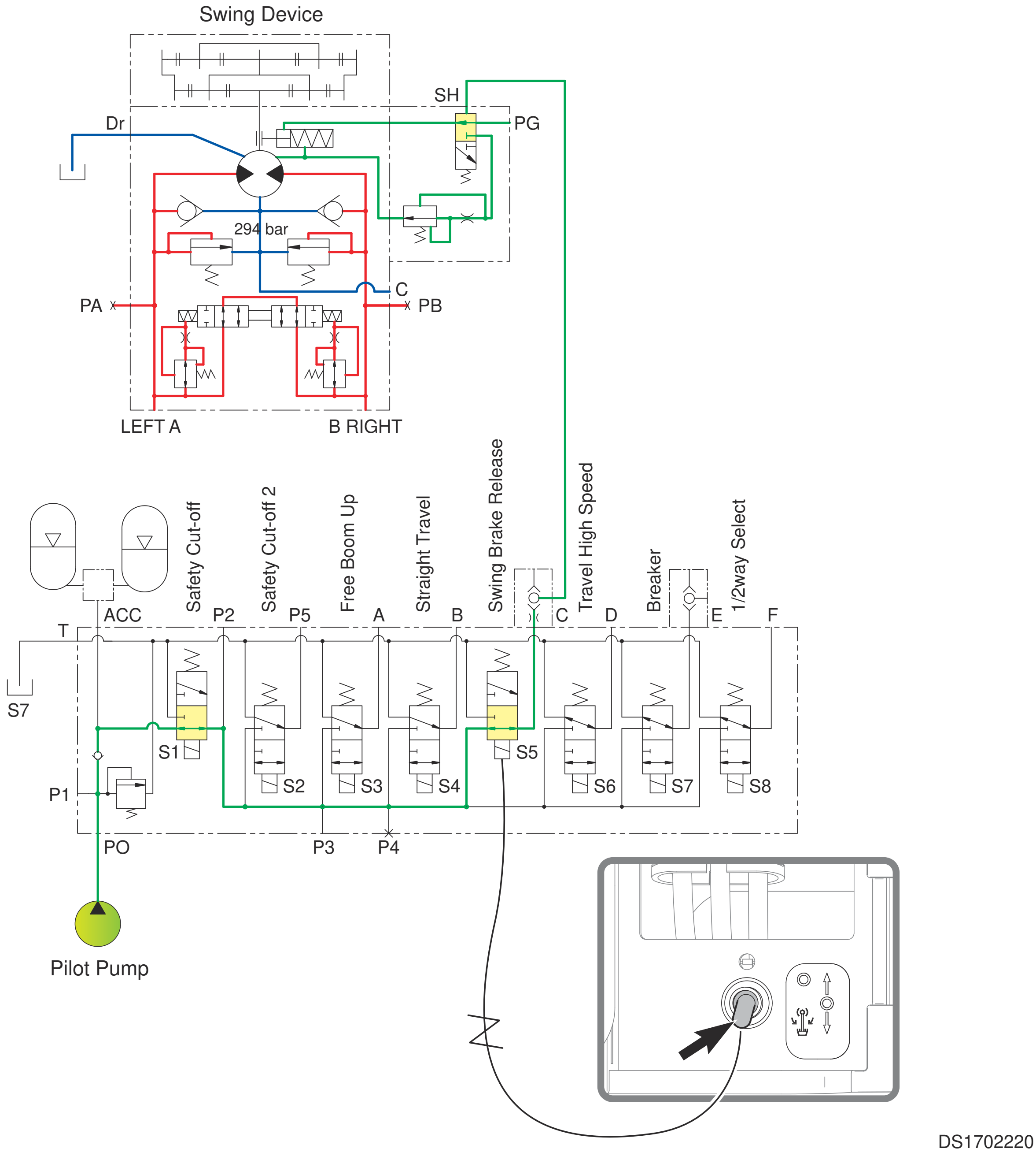
Figure 254



5. Swing Brake Release Solenoid (S5)

To manually release the swing brake when the joystick swing operation is not working, turn on the toggle switch to switch the swing brake release solenoid to supply the pilot pressure to the "SH" port of the swing motor.

Figure 255

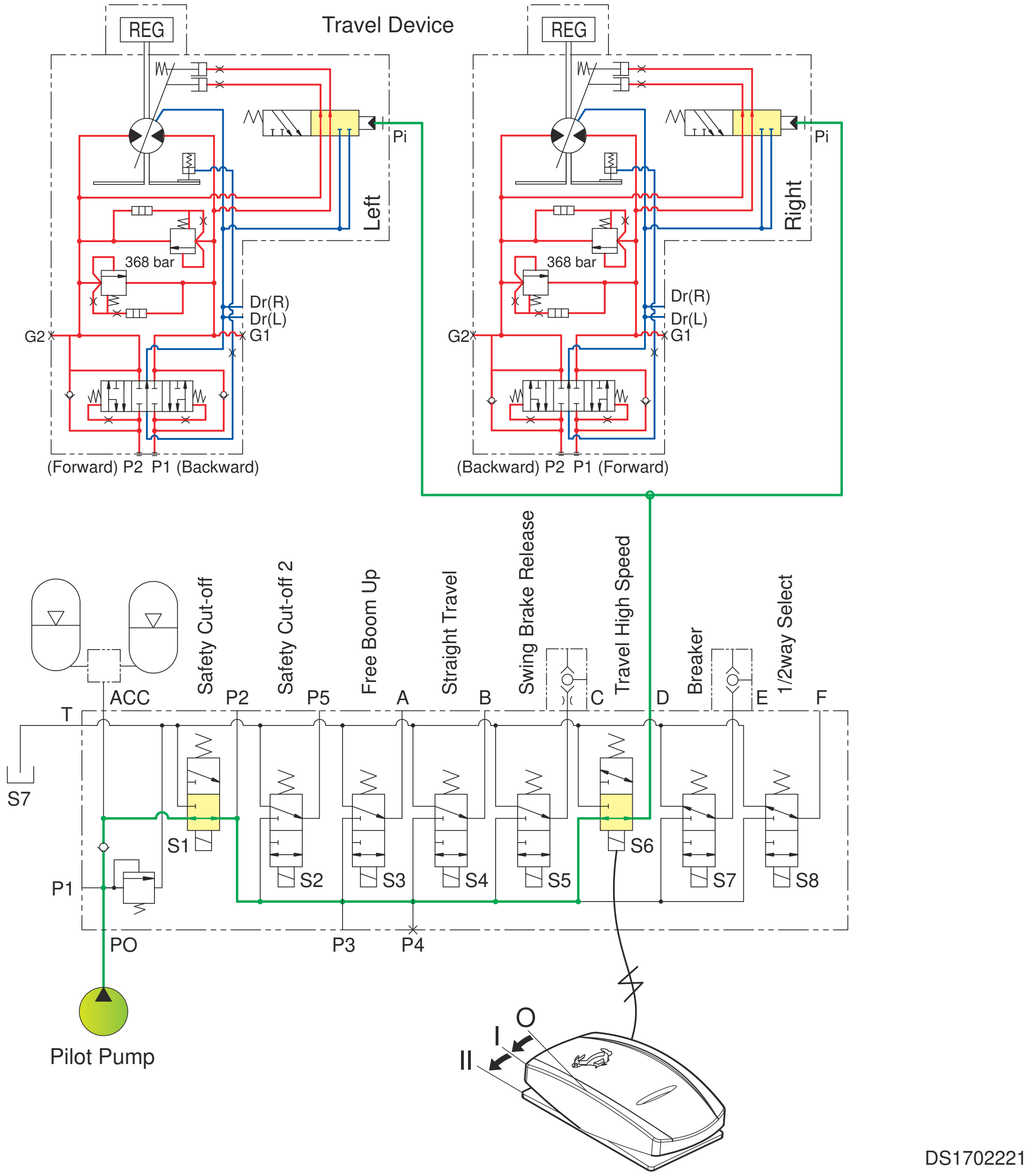


6. High/Low Travel Speed Solenoid (S6)

When the travel speed selector switch is moved to the "O" position, the travel speed is set to low speed. The solenoid valve is not activated. When the travel speed selector switch is moved to the "I" position the travel speed is set to high-speed. The solenoid valve is activated. When the travel speed selector switch is moved to the "II" position, the travel speed switches to automatic.

NOTE: *Turning the automatic travel switch to the "II" position, the EPOS controller detects the discharge pressure from the main pump, and automatically turns the high travel speed control "ON" or "OFF" depending on if the travel load is high or low to switch the travel speed to speed "I" or "II". The travel load is detected by two pressure sensors located on the discharge line of the front and rear pumps. If the load is high (pressure about 294 bar (300 kg/cm^2, 4,264 psi)), the* *solenoid valve turns "OFF" for travel at low speed. If the load is low (pressure about 157 bar (160 kg/cm^2, 2,277 psi)), the solenoid valve turns "ON" for the travel at high-speed. If the engine control dial is set to 1,350 rpm or below, however, the solenoid valve always turns "ON" for the travel at low, though the automatic travel switch is set to the automatic travel (2nd place).*

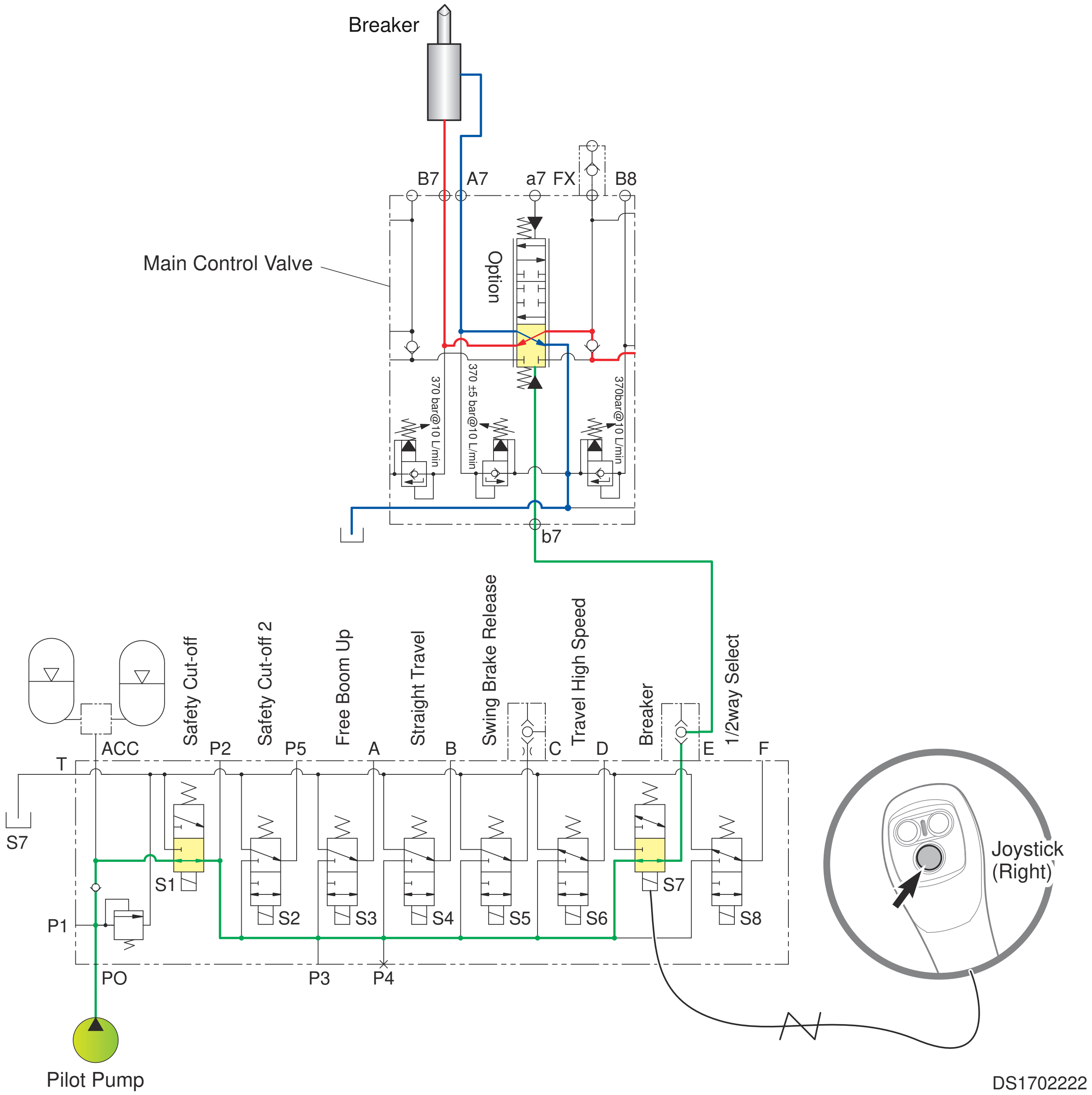
Figure 256



7. Breaker Pilot Pressure Supply Solenoid (S7)

   Pressing the breaker button on the joystick operates the breaker solenoid valve (S7). This supplies pilot pressure to the option spool in the main control valve. The pilot pressure shifts the option spool, which then allows pressurized oil from the main pump to flow to the breaker system for operation.

Figure 257

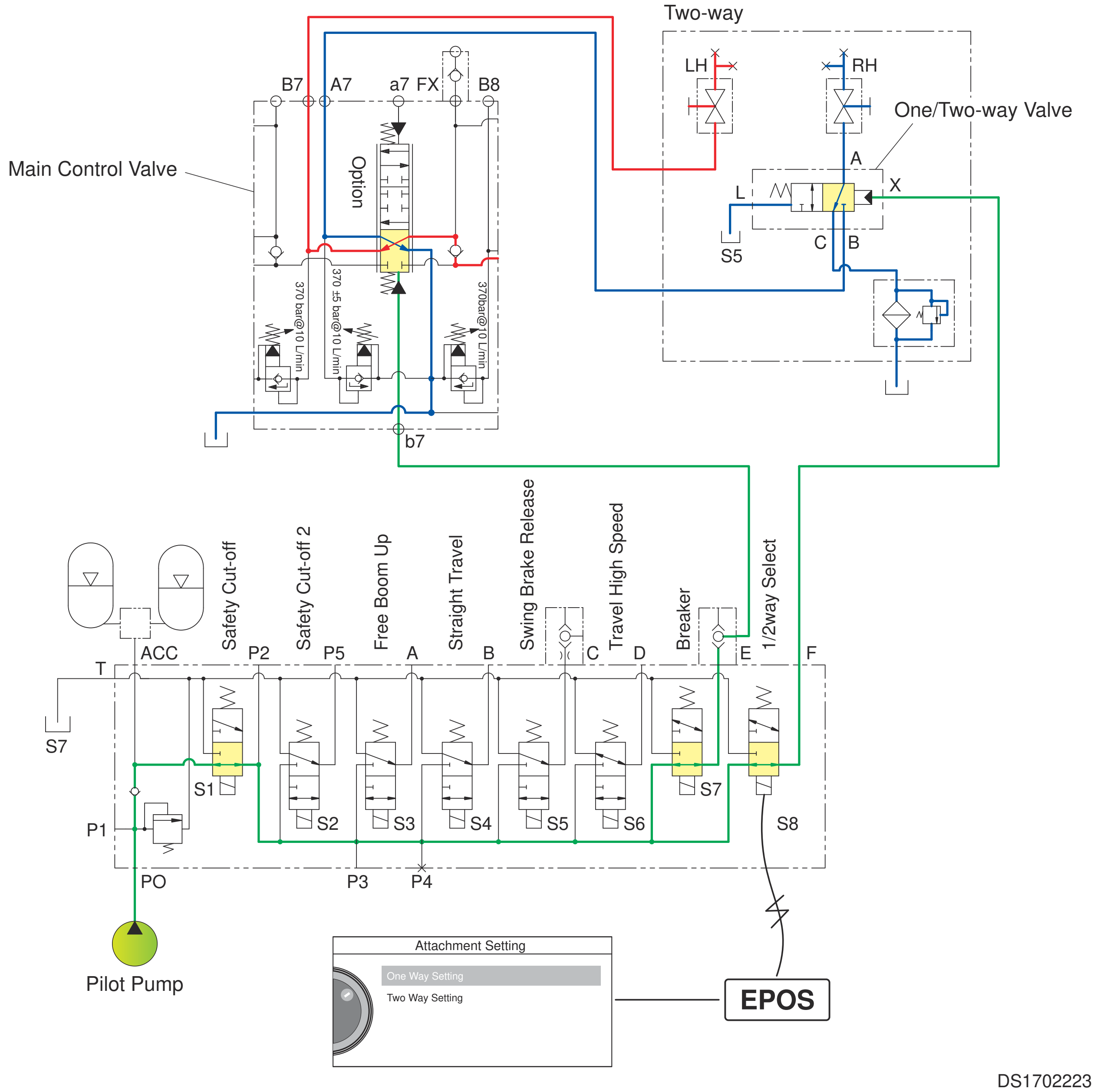


8. Breaker/Shear Mode Selection Solenoid (S8)

   In case of two-way applied machine, according to one or two-way menu selector in the gauge panel activates the solenoid valve and then the front option attachment is changed from shear to breaker (from breaker to shear).

When the switch is set to breaker, pilot pressure is supplied to one or two-way selector valve shifting the spool inside with the pressurized oil from the main pump supplied to breaker.

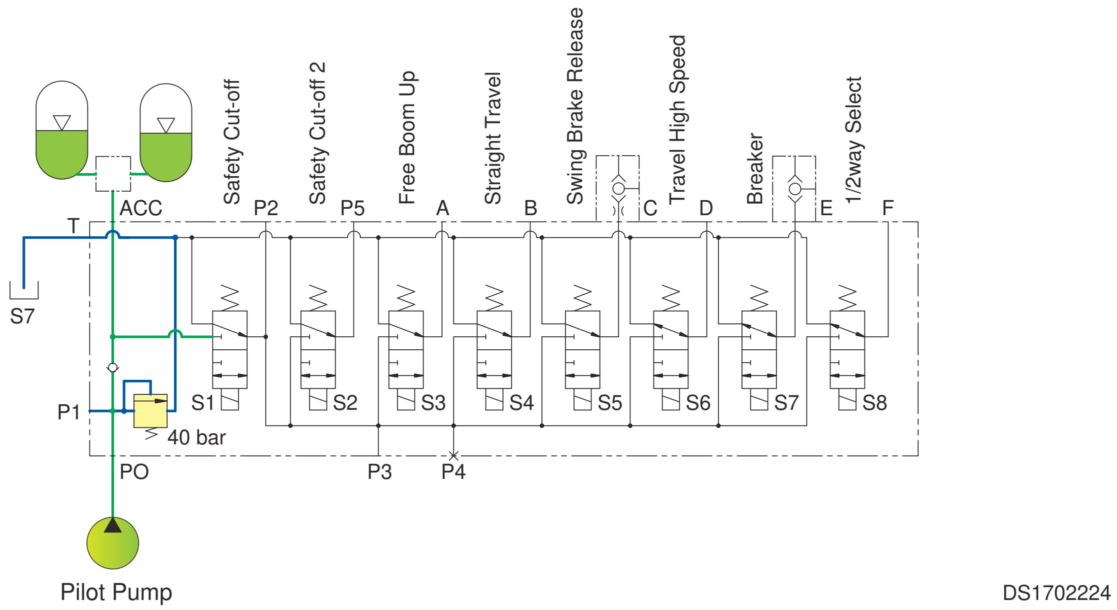
Figure 258



9. Relief Valve (R1)

Maintain the pressure from the pilot pump at 40 bar to supply the pilot line.

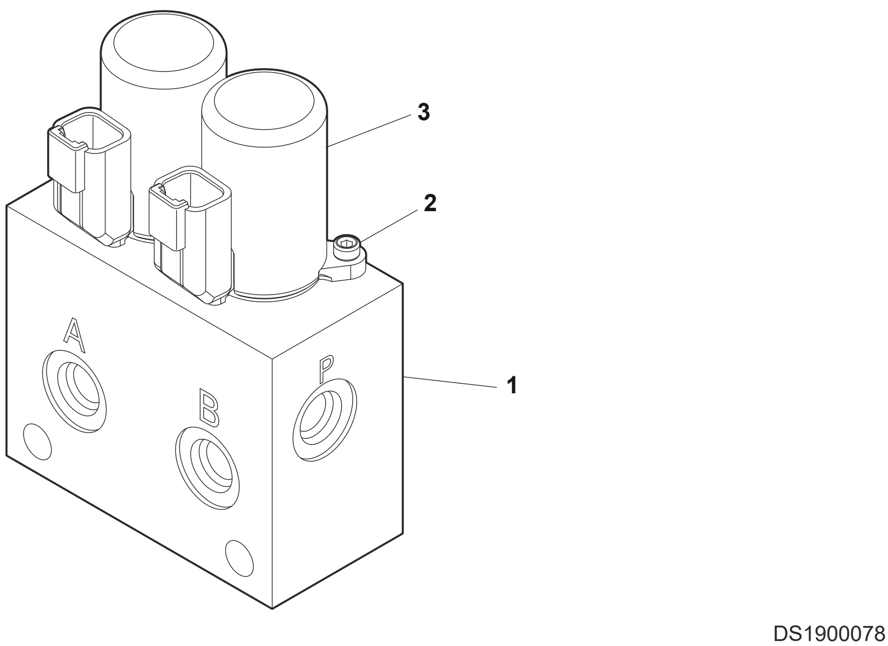
Figure 259



EPPR Valve (One or Two Way)

Overview

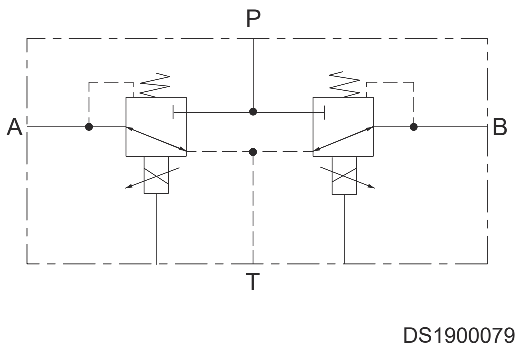
Figure 260



No.	Name	Qty.	Remarks	Torque (N·m)	Tool
1	Block	1			
2	Bolt	4	M4 bolt	1.2 ~ 1.5	3 mm torque wrench, hex socket
3	Proportional pressure reducing/relief valve	2			

Hydraulic Circuit

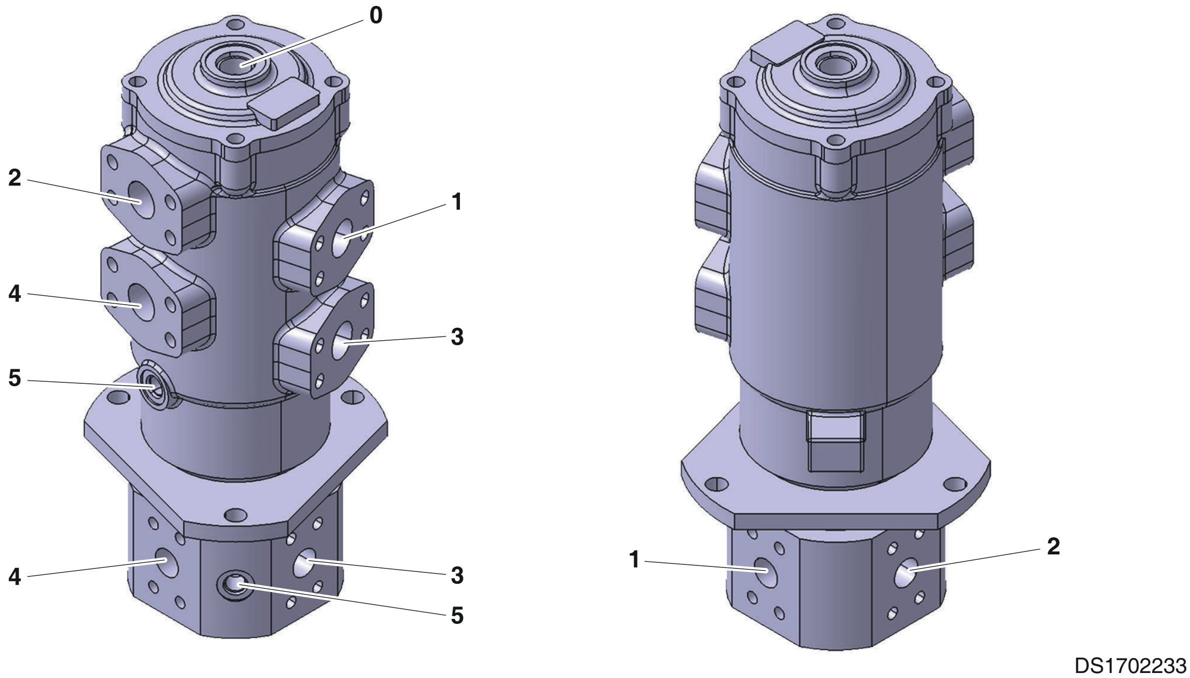
Figure 261



Center Joint

Overview

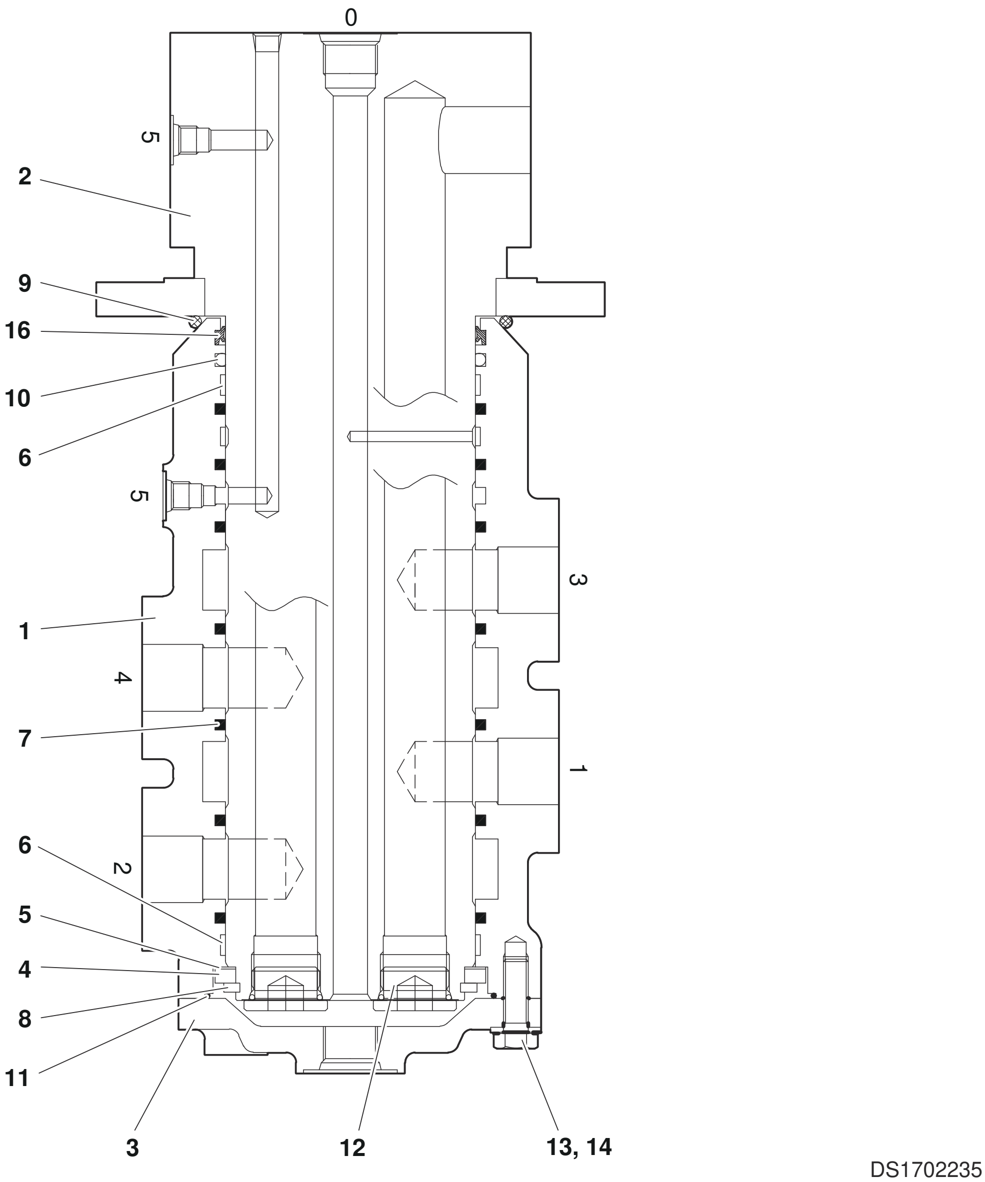
Figure 262



Port	Name	Size	
		Body	Spindle
1, 2, 3, 4	Travel Motor	SAE 1 1/4"	SAE 1"
5	Pilot	PF 1/4" O-ring	
0	Drain	PF 3/4" O-ring	

Section View

Figure 263



Reference Number	Description
1	Hub
2	Shaft Assembly
3	Cover
4	Spacer
5	Shim
6	Wear Ring
7	Slipper Seal
8	Retainer Ring
9	O-ring
10	O-ring

Reference Number	Description
11	O-ring
12	Socket Plug
13	Hex Bolt
14	Spring Washer
15	PT Plug
16	Dust Seal

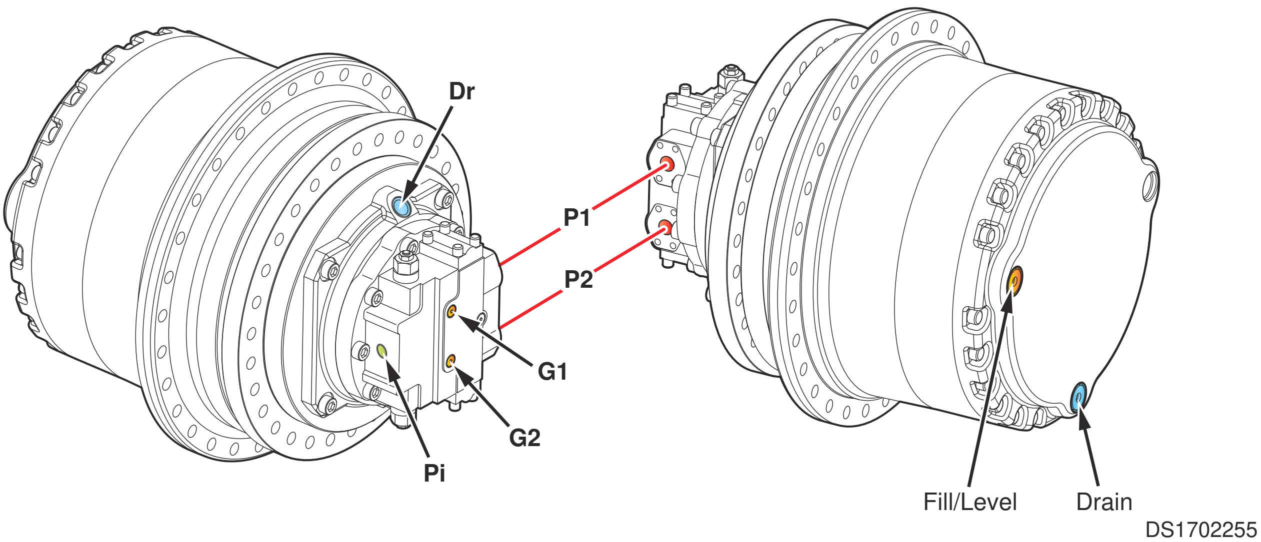
Travel Device

Overview

Travel device consists oftravel motor and gearbox.

Travel motor includes brake valve, parking brake and high/low speed changeover mechanism.

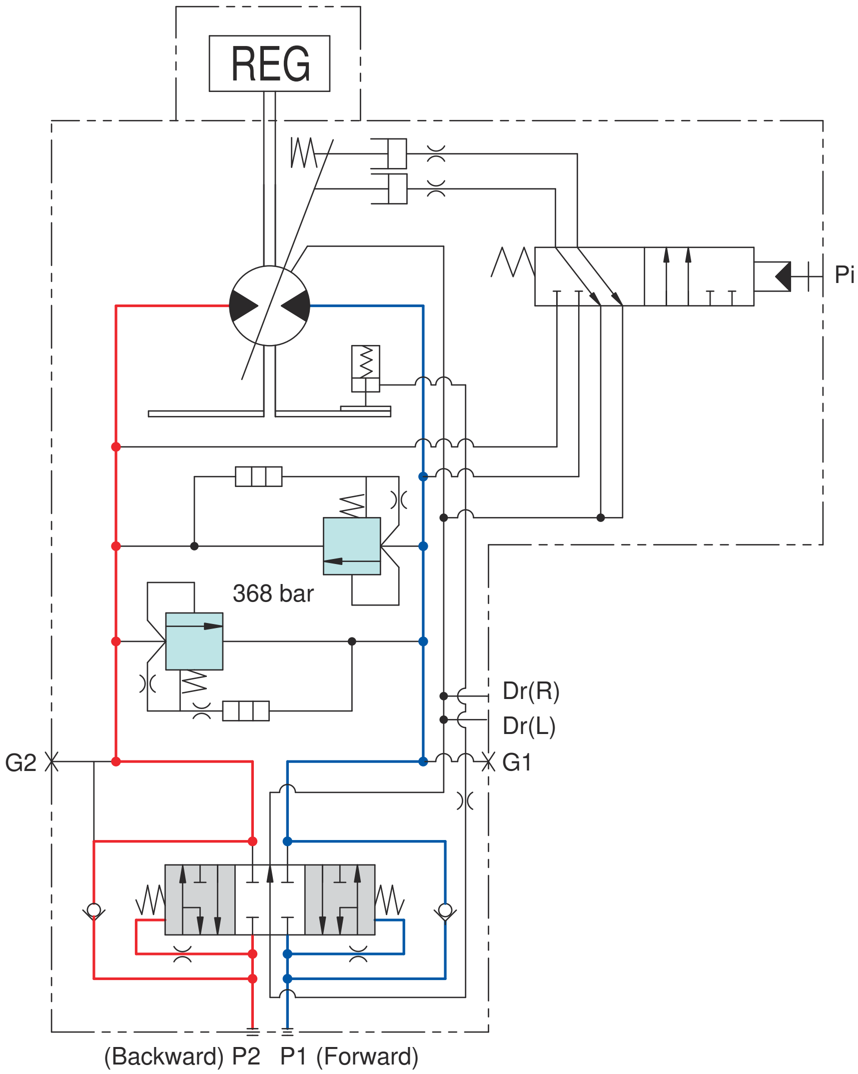
Figure 264



Port	Name	Size
P1	Inlet, Outlet	SAE 1", 6,000 psi, ø25, 27.8 x 57.2
P2	Inlet, Outlet	
Dr	Drain	PF 3/4", O-ring
Pi	Pilot (High-speed)	PF 1/4", O-ring
G1, G2	Gauge	
	Fill, Level	M30 x 2
	Drain	

Hydraulic Circuit

Figure 265



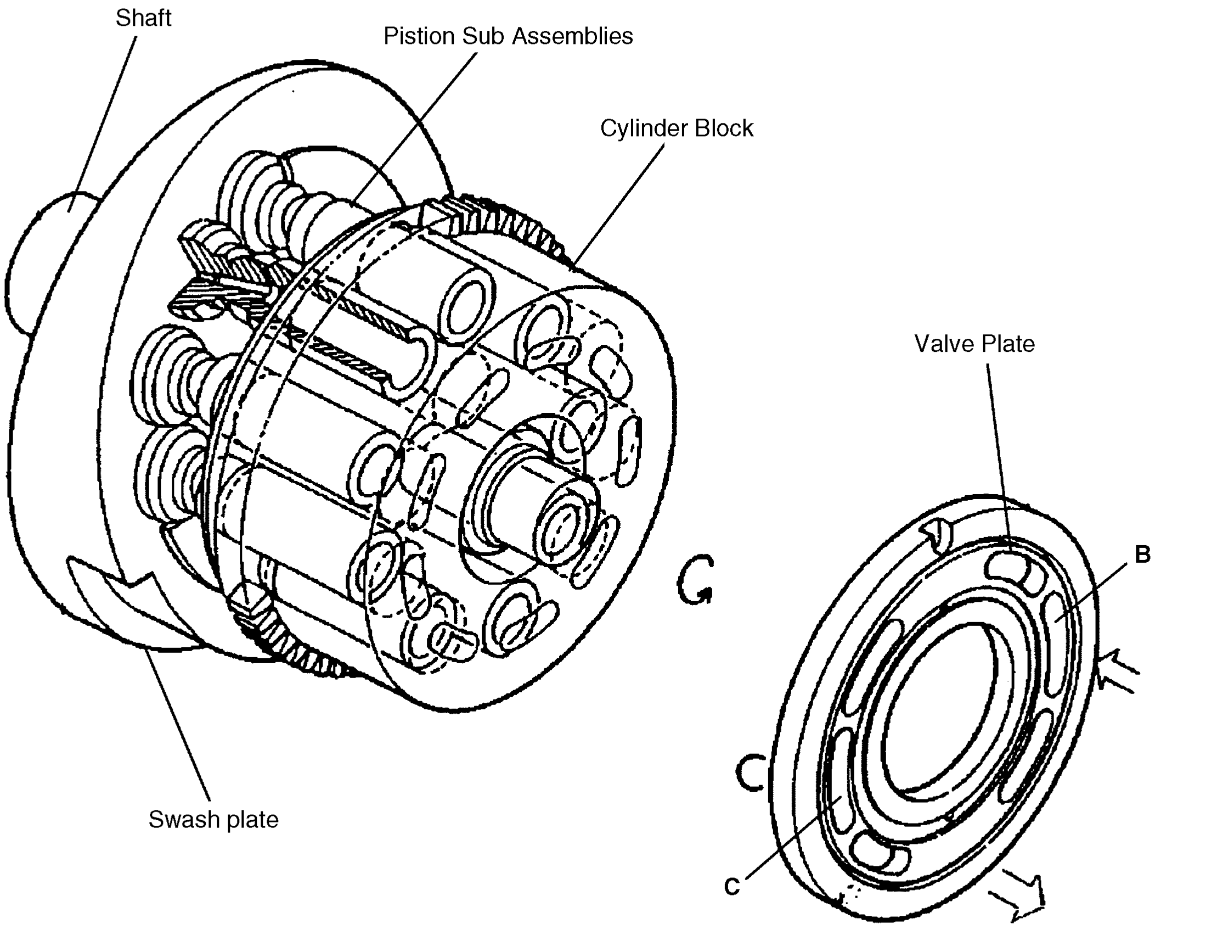
Theory of Operation

Working Principle of Swash Plate

Nine piston sub assemblies are assembled in cylinder block. The end face of cylinder block is in contact with valve plate having two half moon shaped ports, B and C (high and low pressure ports).

When supplying pressure fluid (pressure P) to B port, swash plate is pushed by the force of piston sub assemblies having F = P•A (A: Piston pressure area). Piston sub assemblies receive the reaction force against it, and produce the reaction force (Ft) in rotating direction. The total force of high-pressure side piston sub assemblies in rotating direction produces a rotating force in the cylinder block, and the torque is transmitted to shaft through the spline resulting in the rotation of the shaft.

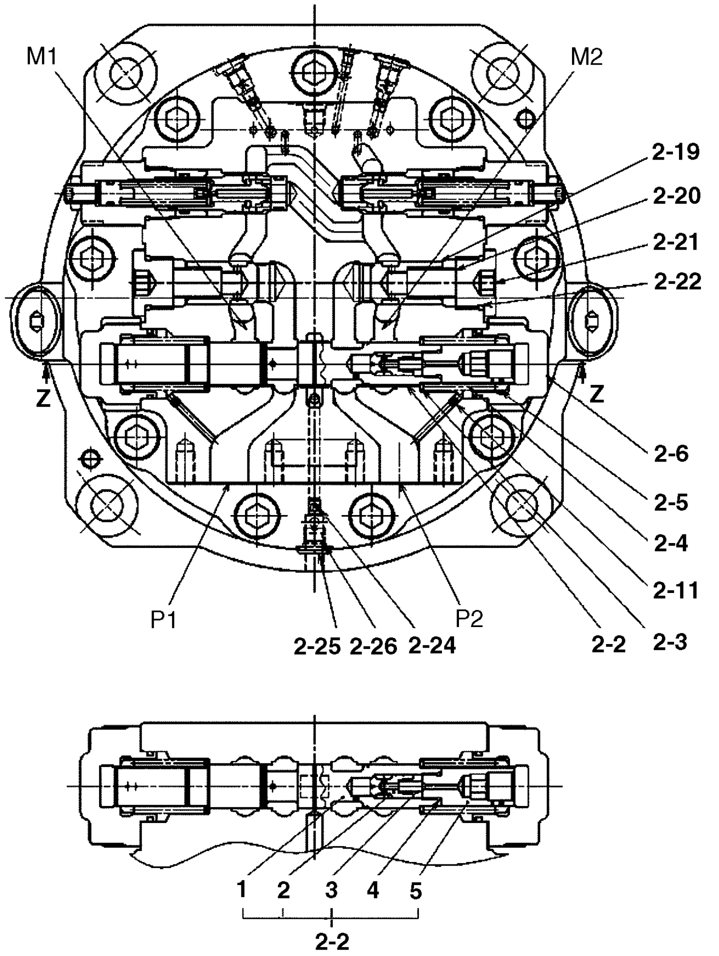
Figure 266



Working Principle of Counter Balance Valve

The counter balance valve is provided to stop the travel motor and to prevent overrun. When the control valve is set to the neutral position, there is no pressure in the ports P1 and P2, and ports M1 and M2 are blocked by spool (2-2-1) and check valve (2-19), consequently the motor does not start rotating.

Figure 267



FG016507

Function of Counter Balance Valve (Counter Balance Valve Work)

When the fluid is supplied from pump to counter balance valve port P1 through control valve, the fluid flows into travel motor through check valve "L" (2-19), and rotate the travel motor.

On the other hand, the return fluid from the travel motor flows into the counter balance valve through port M2, but the fluid is interrupted by check valve "R" (2-19), and consequently the pump delivery pressure will increase.

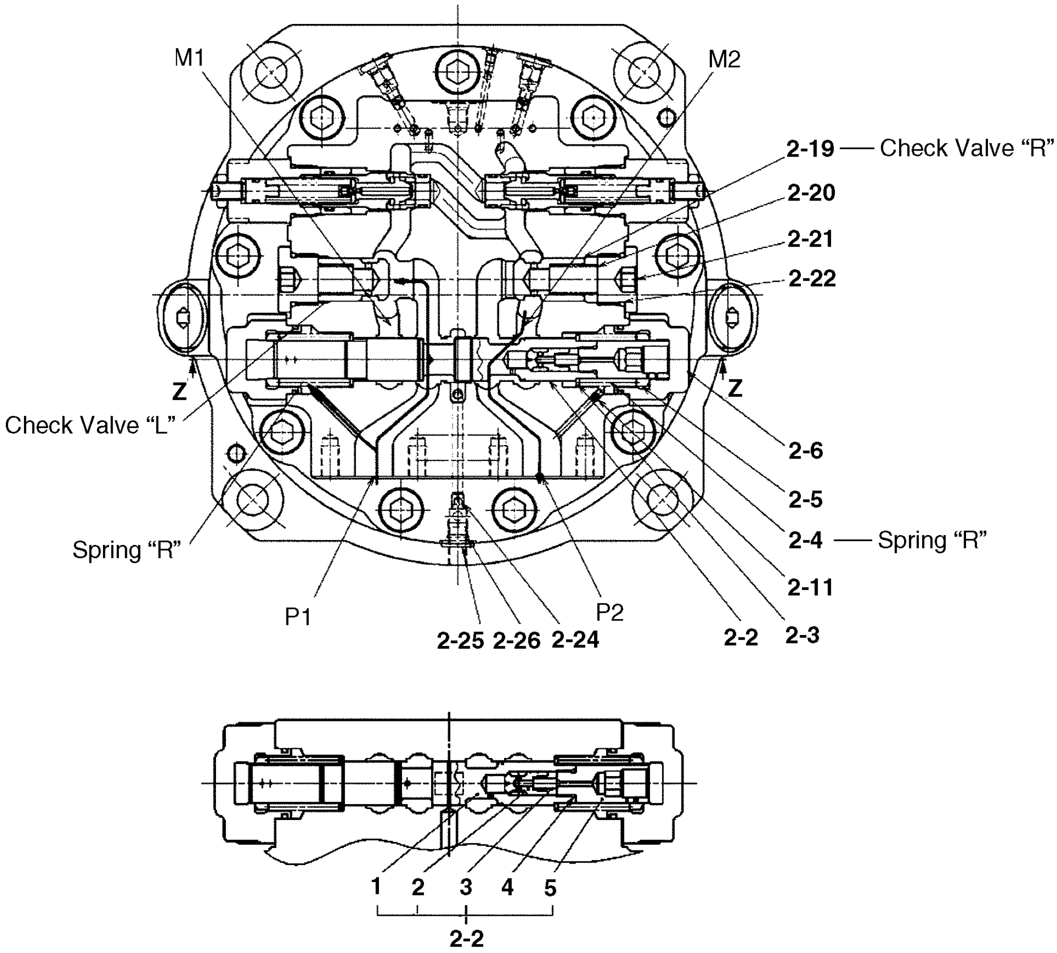
The high-pressure oil at port P1 passes through orifices "L" (2-11) pushes the end of face of spool assembly (2-2) and pushes the plunger rightward against spring "R" (2-4) on the opposite side with the force proportional to the pressure.

When the hydraulic pressure rises to a certain pressure, spool assembly (2-2) starts moving rightward, and the fluid in port M2 passes through the notch machined outer circular of spool assembly (2-2) and flows into the port P2, producing a back pressure on the port M2, finally returning into the tank through a control valve.

And when the pump delivery pressure rises, the throttling aperture of the notch in spool assembly (2-2) becomes larger, and consequently the backpressure of the port M2 becomes lower.

This way, the throttling aperture of the notch in spool assembly (2-2) automatically adjusts the area of a return side passage in order to rotate the travel motor with the appropriate speed for Port P1 side flow rate (inlet flow).

Figure 268



FG016509

Function of Counter Balance Valve (Brake Work)

Then, when the control valve returns to the neutral position, the pressurized oil from the pump is shut off and the pressures of the ports P1 and P2 become equal. Spool assembly (2-2) tries to be returned to neutral position by force of spring "R" (2-4).

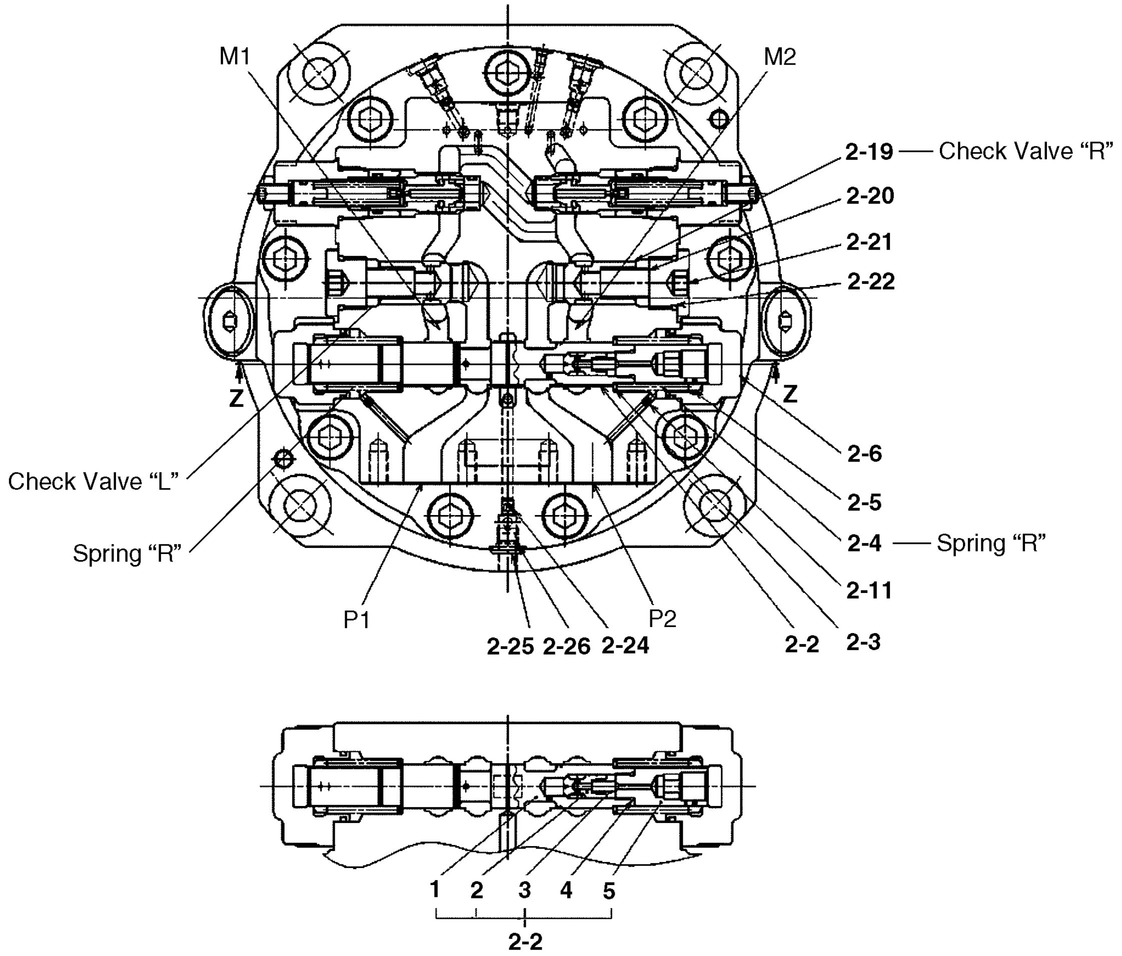
When spool assembly (2-2) moves, the throttle opening of plunger becomes small.

Travel motor tries to rotate with inertia energy (pumping action of motor) and the pressure rises on port M2.

With the movement of spool assembly (2-2), the oil of spring "L" room flows out through orifices "L" (2-11) and controls the speed of spool assembly (2-2).

By this movement, the shock pressure due to the inertia energy on the port M2 is absorbed, simultaneously preventing the cavitation on the port M1.

Figure 269



Working Principle of Two-Speed Change Mechanism

When Running at 1st Speed (Low Speed)

Swash plate has three faces, from "a" to "c", as shown in the Figure 7, and installed in the flange holder with two steel balls in the condition where it can be tilted.

When the control valve is set to the 1st speed position, spool is placed in the position shown in Figure 7 by the force of spring, and the passage of swash plate control piston passes across the Pi1 and Pi2 port positions and led to the tank port. Therefore, the force pushing up the swash plate does not act on swash plate control piston.

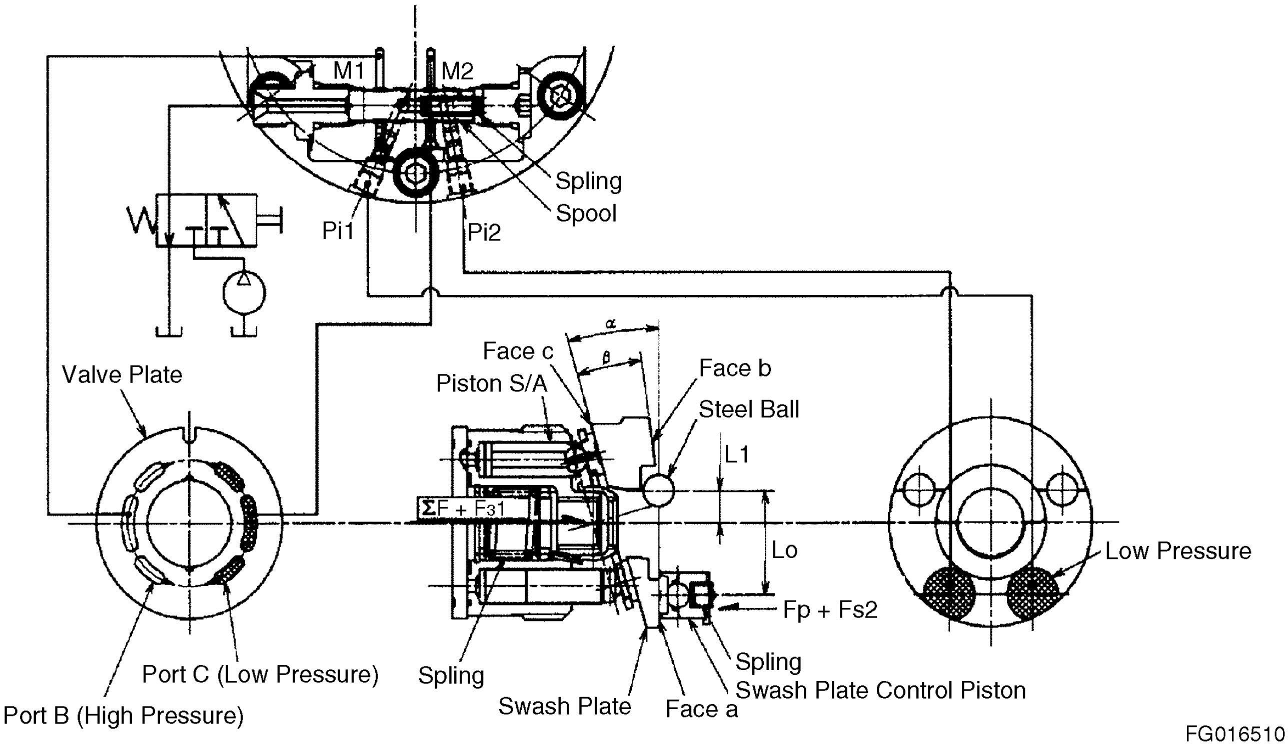
Fp = (Ap x P) = 0

Fp : Swash plate control piston thrust

Ap : Swash plate control piston pressure receiving area

P : Pressure

Figure 270



When Running at 2nd Speed (High Speed)

When control valve is set to the 2nd speed position, the pressure oil delivered by the pump is led to spool, and spool is switched to the position shown in the Figure 7. And the pressurized oil flows into each ports Pi1 and Pi2 through ports M1 and M2 and the motor driving pressure (P1: high pressure and P2: low pressure) is led to each swash plate control piston. Therefore the force pushing up the swash plate acts on swash plate control piston.

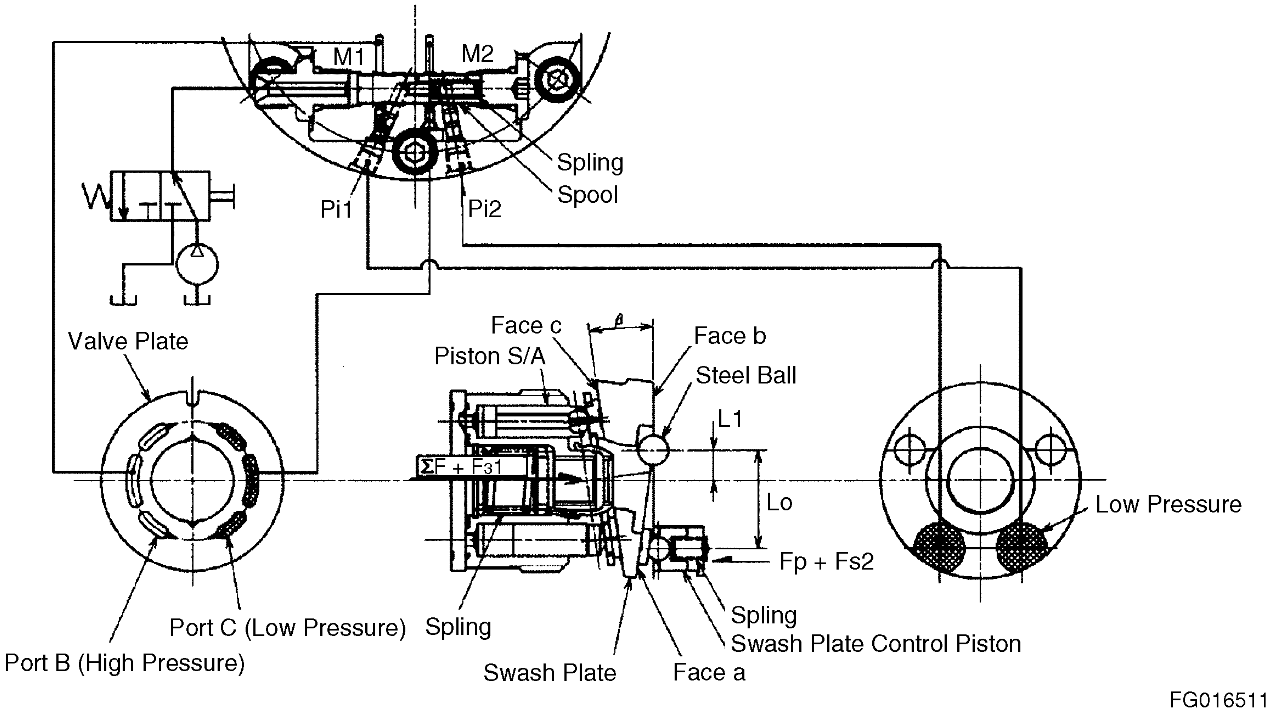
Fp1 = Ap x P1, Fp2 = Ap x P2

When steel ball is placed on the tilting center, the balance of moment acting on swash plate is in the condition of (∑F + Fs1) *L1 < (Fp + Fs2)*Lo depending on the total ∑F of driving force of piston S/A.

The face "b" of swash plate stabilizes and the swash plate angle becomes "β" angle, consequently the motor speed is the 2nd speed (high speed).

While the engine is stopped, spool is returned to the 1st speed position by the force of spring since pressurized oil does not flow. When steel ball is placed on the tilting center, the balance of moment acting on swash plate is in the condition of Fs x L1 > Fp x Lo, the face "a" of swash plate stabilizes and the swash plate angle becomes "α" angle, consequently the motor speed at starting is always the 1st speed.

Figure 271



Working Principle of Auto Two Speed Change Mechanism

Auto two-speed control mechanism consists of two spools and spring. This valve automatically changes motor displacement in portion to motor pressure. This valve works while the pilot port "Ps" is pressurized.

1. Motor pressure is low

   The motor displacement is small (high speed displacement) as shown Figure 9.

   When the two-speed spool is on the right position. Motor pressure PM1 and PM2 are connected to each side of chamber of two speed piston. So swash plate is moved to high-speed position by two-speed piston and motor displacement is kept on high-speed position.

   Pilot pressure is applied on the area "Ap" when Ps port is pressurized. Then the pressure of Ps pushes the spool to the right direction on Figure 9. At the same time, Motor inlet pressure is applied on the area "Am". So, the spool is also applied to the left direction by Am pressure. According to above, if the motor pressure is lower and keeps the following condition, the spool stays on the right position.

   Ps x Dp > Am x Pin + Kx

   Kx: the force of spring

2. Motor pressure is high

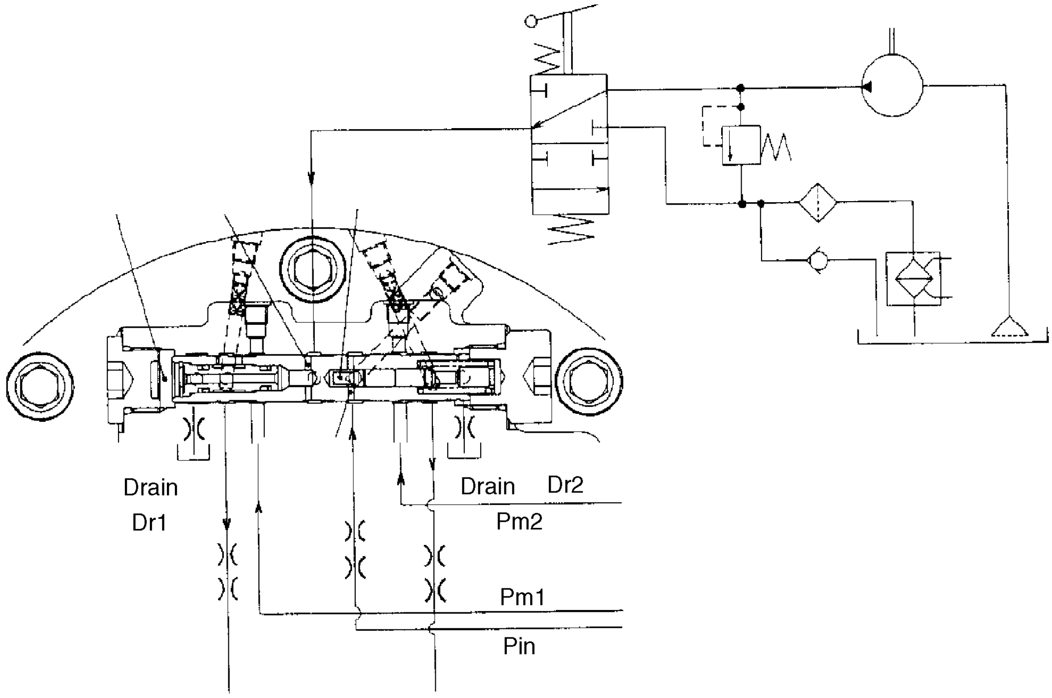
   The motor displacement is large (low speed displacement) as shown Figure 10.

   The two-speed spool is on the left position if Pin pressure is high. Then, PM1 and PM2 are shutted by the spool.

   If the motor pressure is higher and keeps the following condition, the spool stays on the left position.

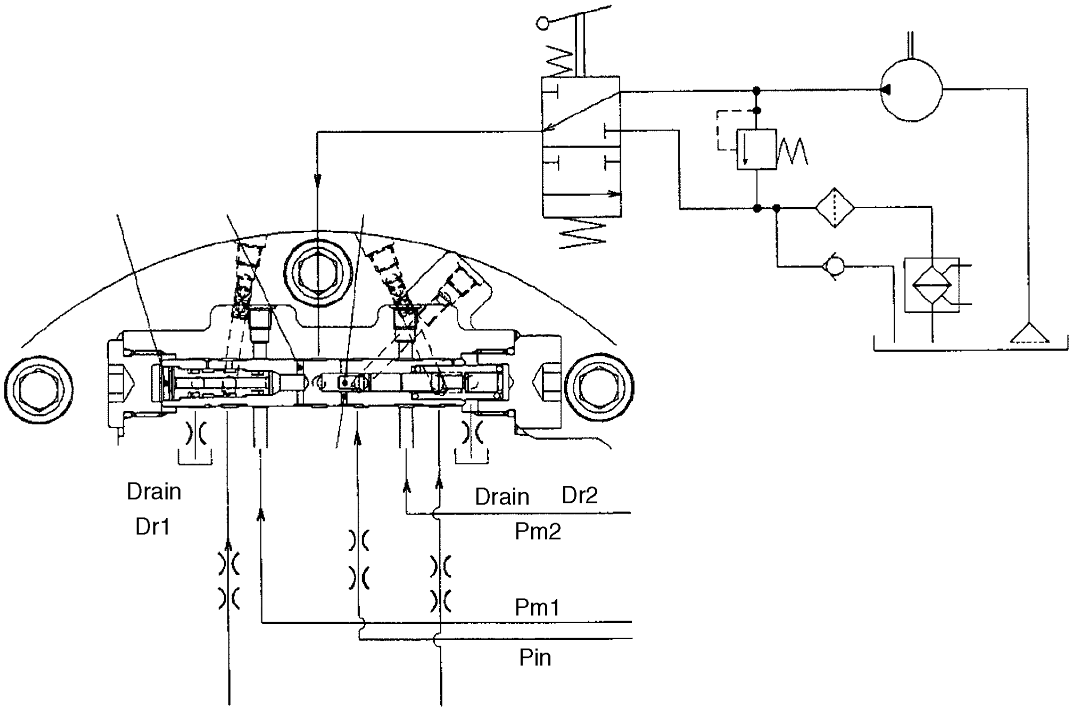
Ps x Dp < Am x Pin + Kx

Figure 272Auto Two-speed Control (Motor Pressure Is Low)



FG016512

Figure 273Auto Two-speed Control (Motor Pressure Is High)



FG016513

Systems Operation And Description

Safety Instructions

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or servicingmachine. Read and understand the Operation & Maintenance Manual and signs (decals) on machine. Followwarnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correctfunction after adjustments repairs or service. Untrainedoperators and failure to follow instructions can cause deathor serious injury.

General Schematics

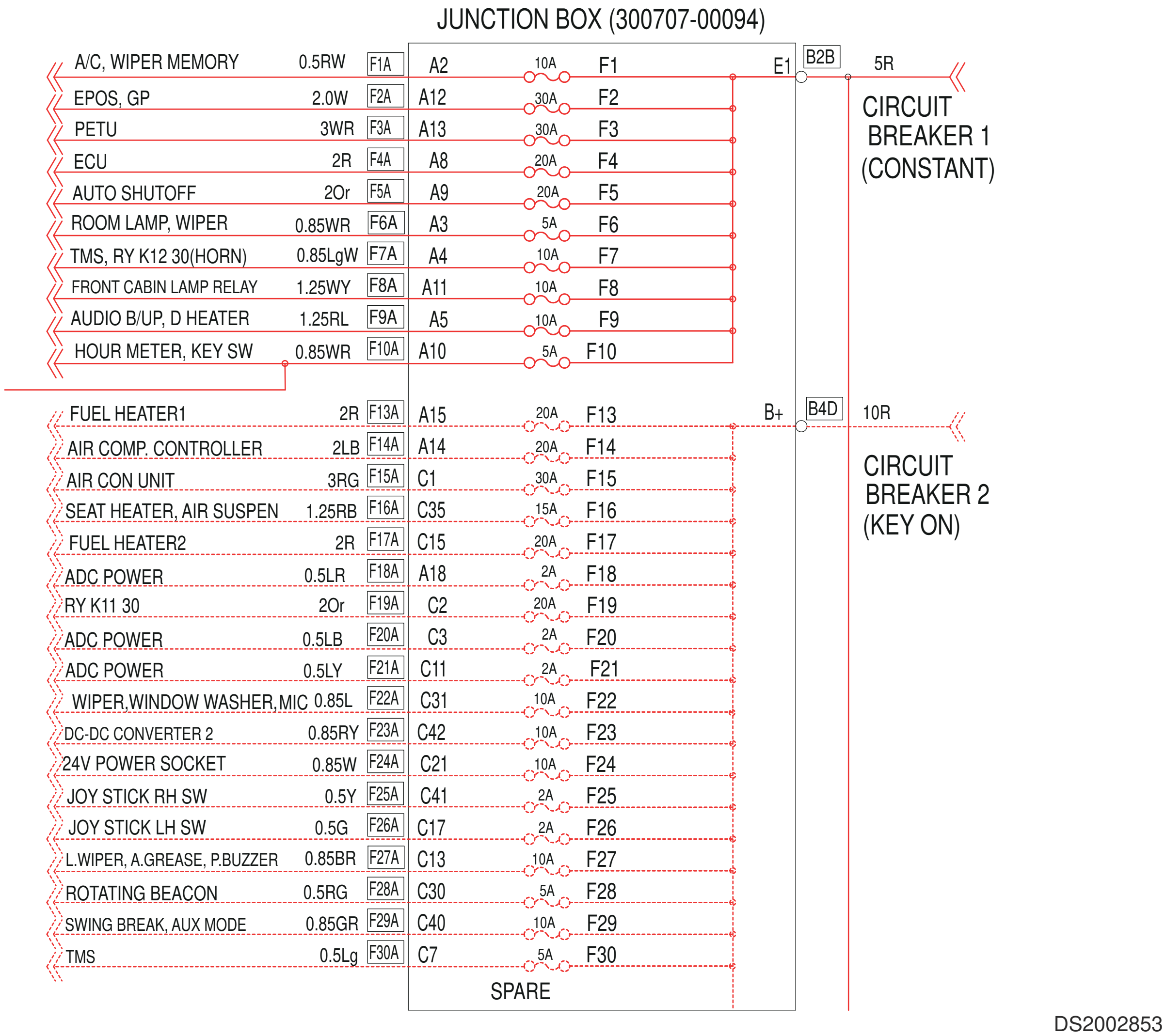
Fuse Box

The new common standard for the electric schematics has a new position and layout for the fuse box in the top right hand corner.

The fuses that are supplied by a constant supply from circuit breaker 1, are in this case fuses F1-F10.

The fuses that have a key controlled supplied from circuit breaker 2, are fuses F13-F30.

Figure 274

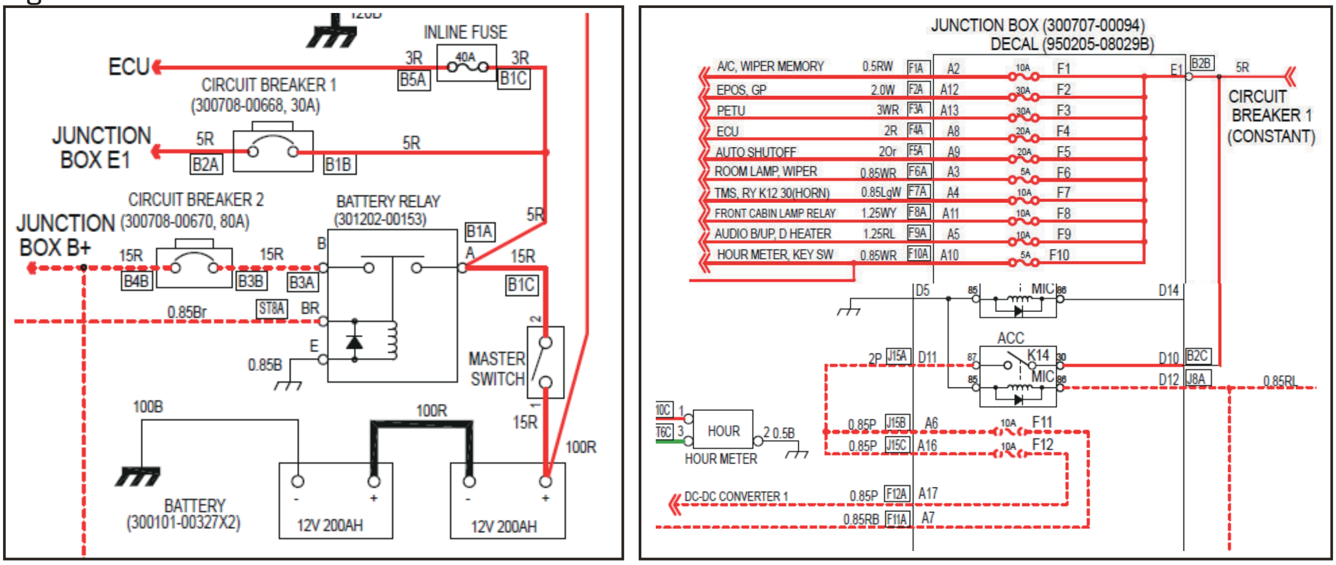


Power Supply

OFF / Constant Power Flow

With the Master Switch ON, the batteries supply power via the Circuit Breaker 1 to terminal E1 of the Junction Box. Terminal E1 then supplies power to all of the none key controlled fuses & the ACC relay.

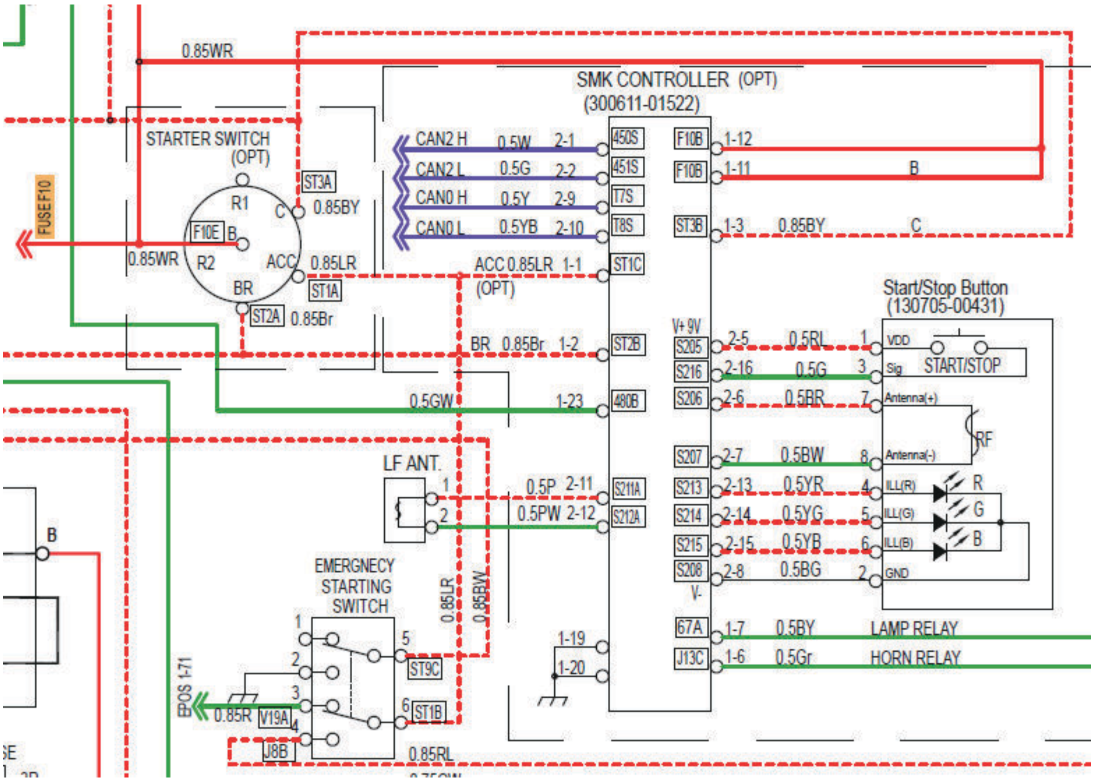
Figure 275



DS2002850

With the Standard Key/Smart Key in the OFF state, the B terminal of the switch is supplied with 24V from the none key controlled supply from fuse 10 of the Junction Box.

Figure 276

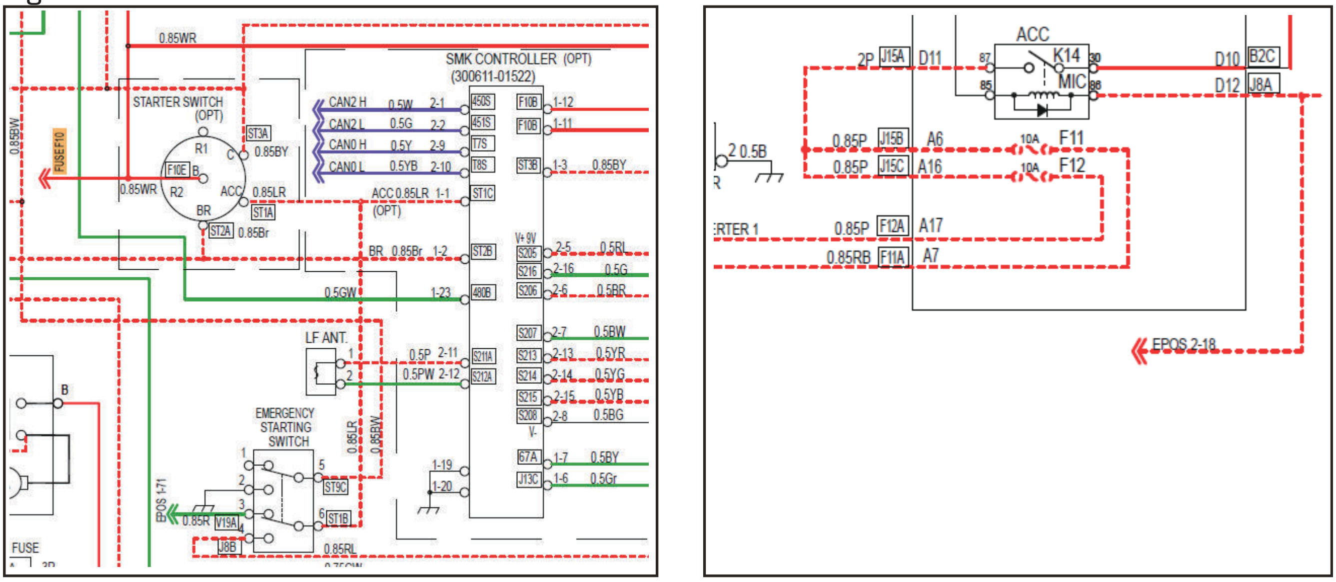


DS2002851

Key ACC

With the standard/Smart key in the ACC state, the key system supplies a 24V signal to EPOS terminal 1-71, via the Emergency Starting Switch. EPOS then outputs power from terminal 2-16 to activate the ACC relay, which then supplies power to Fuses F11 (USB Charger, Jog Switch, Handsfree, Car Stereo & Micro Antenna) & F12 (DC-DC Converter 1).

Figure 277



DS2002852

Key ON

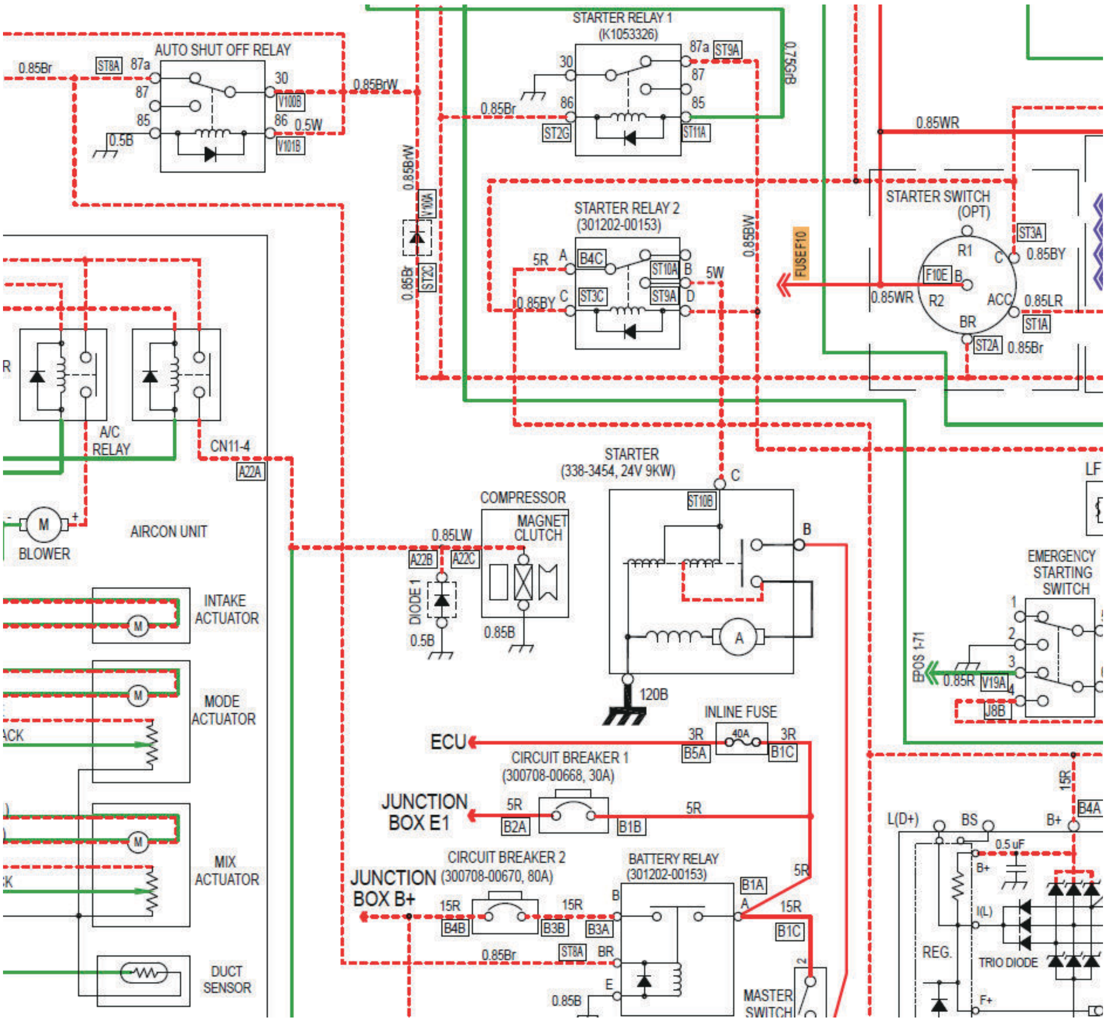
With the Standard/Smart Key in the ON State, it supplies a 24V signal to

- EPOS terminal 1-11
- Starter Relay 1 (terminal 86)

The signal also goes via the Diode to:

- EPOS terminal 2-56
- Auto Shut Off relay which then supplies to the ECU terminal 70
- Battery Relay to energize so that the rest of the fuses get feed

Figure 278



DS2002854

Starting System

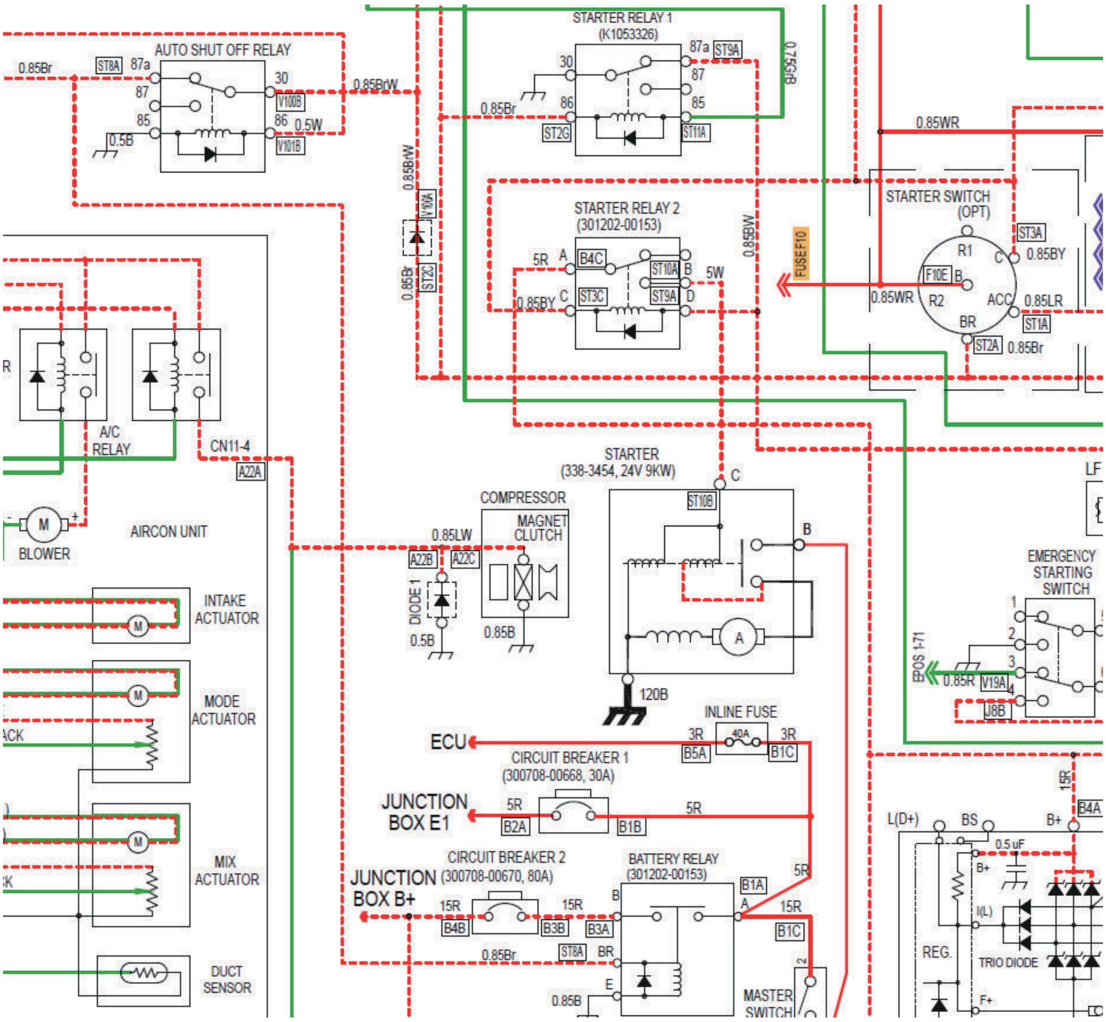
On turning the Standard/Smart Key to the Start position, it sends a 24V signal to the Starter Relay 2 & to the EPOS terminal 2-6.

The EPOS can apply a Starter Interlock by energizing the Starter Relay 1, by EPOS terminal 2-5 internally connecting to ground, which cuts the connection from the starting signal to the Starter Relay 2 energizing it.

The EPOS will apply the starter interlock because:

- Password starter interlock is applied
- The pilot isolator is OFF (raised)
- The engine is already running

Figure 279



DS2002854

Engine Overheat Protection System

If the coolant temperature increases to over 104 OC, the engine ECU sends a signal to the EPOS Controller, which makes the instrument panel overheat warning lamp on.

When the overheat temperature reaches 109 OC, the EPOS Controller notifies the instrument panel to sound the warning buzzer, change the pump power mode setting to Standard Mode (if a higher mode is currently selected), and to reduce the maximum engine speed to 800 rpm.

NOTE: *When the coolant temperature drops back below 104 OC, normal operation will resume.*

		Overheat Warning			Tropical Warning		Buzzer Sounds / RPM Reduced
Pump Maximum Output	%	100	95	90	85	80	70
Coolant Temperature	°C	104	105	106	107	108	109
Hydraulic Temperature		94	95	96	97	98	99

Emergency Start and Stop

As a common rail diesel engine cannot be stopped in an emergency by manual activation of the stop lever on the fuel injection pump, an electrical Emergency Stop switch is provided.

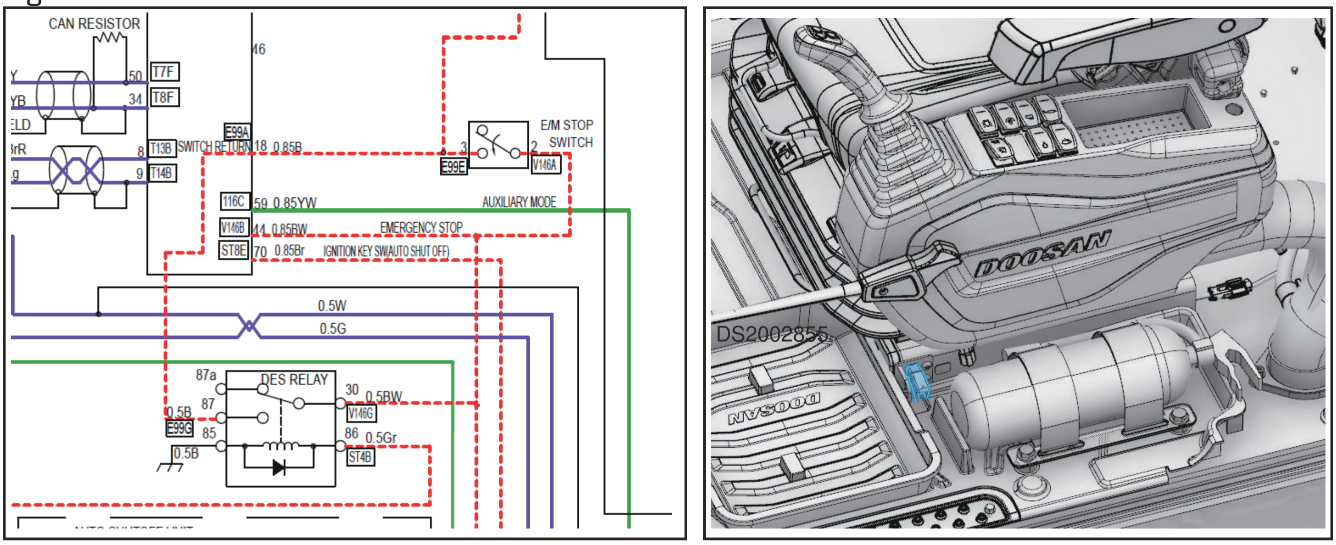
Activation of the Engine Emergency Stop Switch connects the engine ECU terminal 18 to terminal 44, instructs the engine ECU to perform an emergency stop.

The EPOS can also activate the Engine Emergency Stop function by activating the DES Relay.

When energized the DES Relay acts to connect ECU terminals 18 & 44.

NOTE: *In an Emergency, it is also possible to stop the engine by turning off the Master Switch, but this should only be done in a real emergency. Turning off the Master Switch not only disconnects the starter key-controlled power supply to the engine ECU but also cuts the none key-controlled supply, which can cause the ECU to log a failure code.*

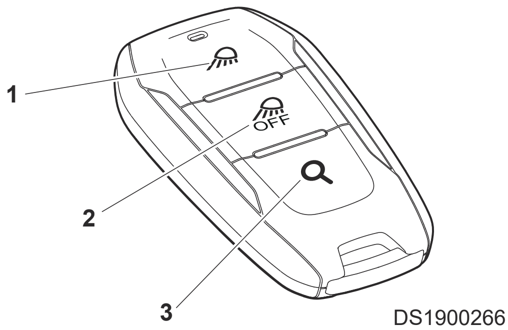
Figure 280



DS2002856

Smart Key (Option)

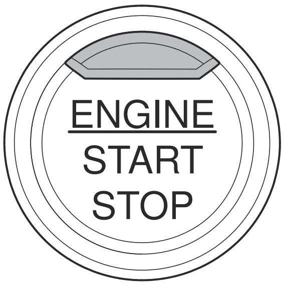
Figure 281



RF antenna - for horn, lamp

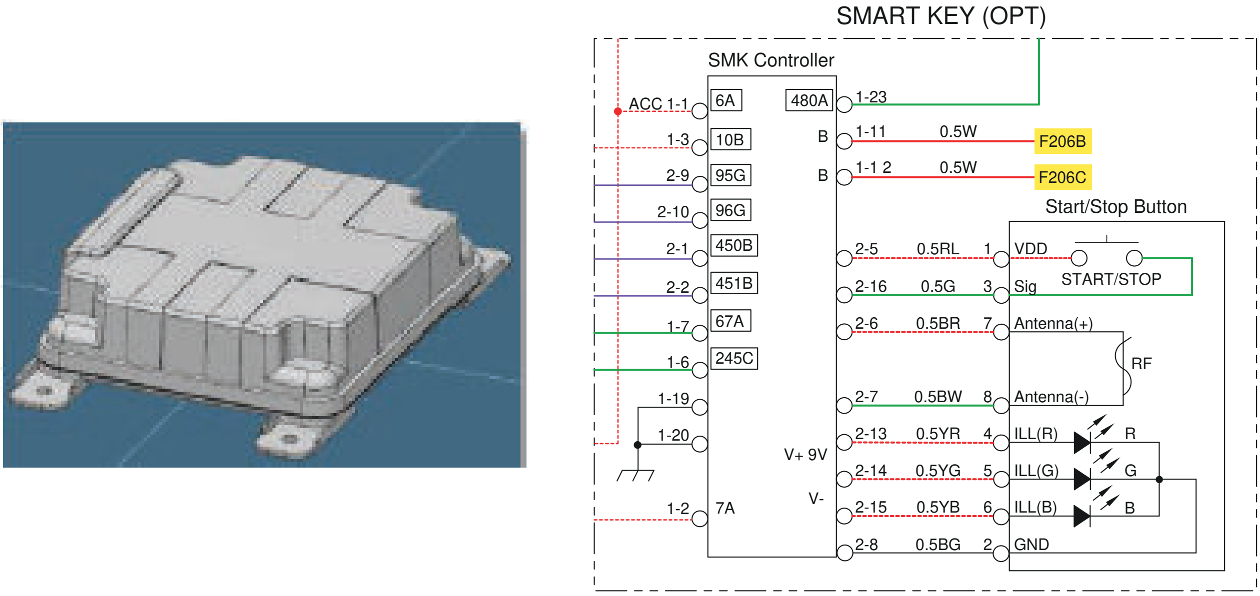
LF antenna (0.7 ~ 1.0 m) - for FOB

Figure 282



DS1901193

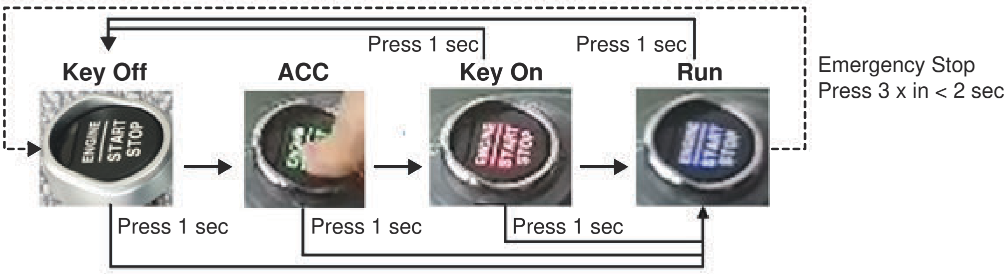
Figure 283



DS1901386

Starting System

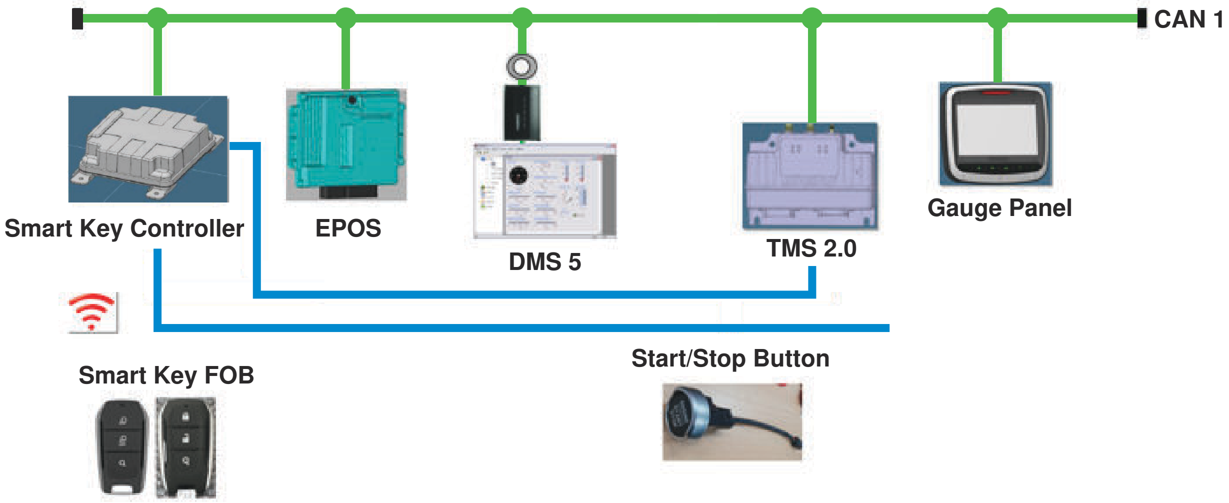
Figure 284



DS2002857

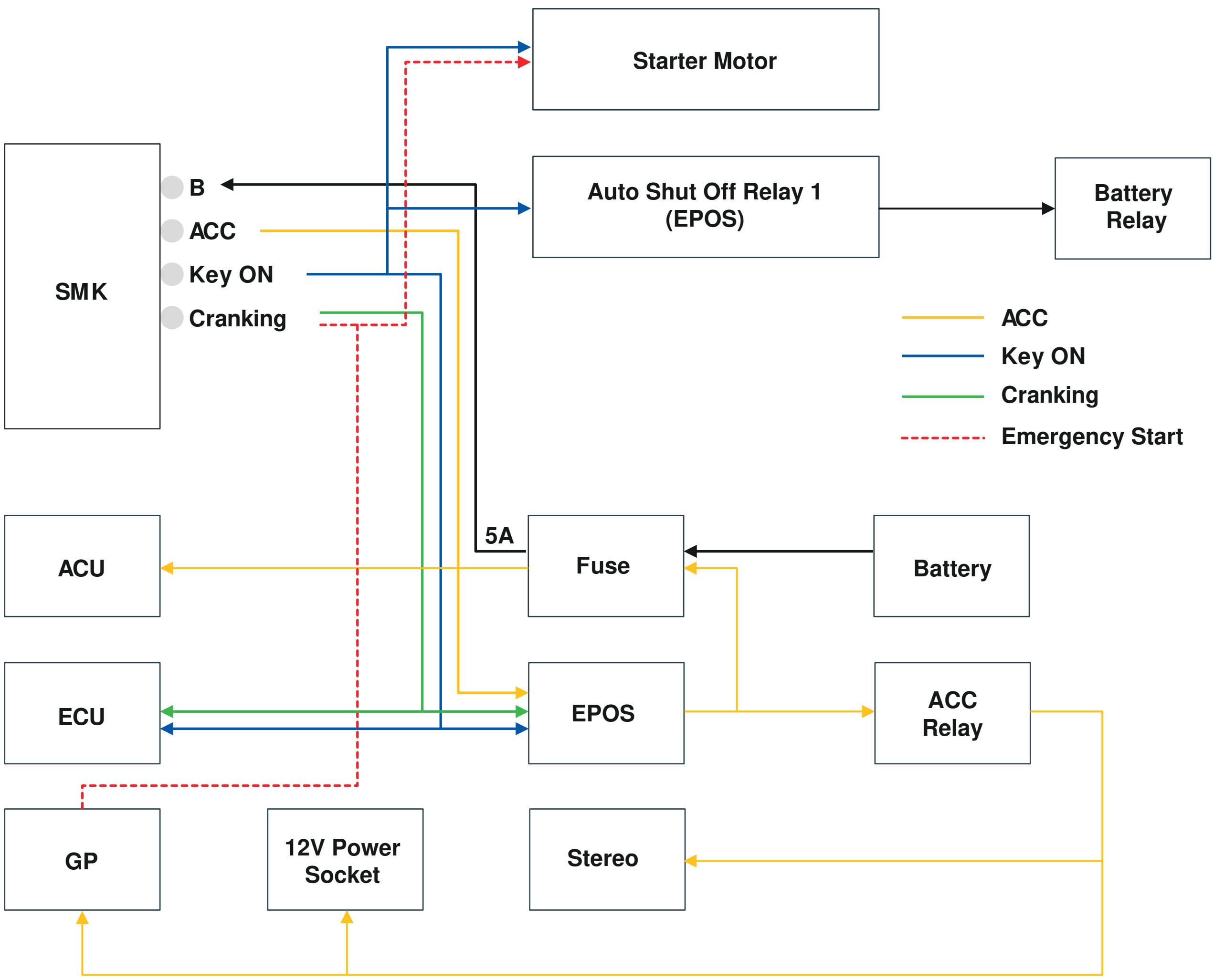
Smart Key System

Figure 285



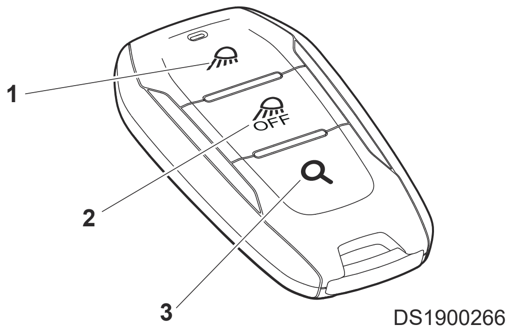
DS1901388

Figure 286



DS1903716

Figure 287



The smart key option provides a number of unique features over the standard key option:

Works as a security device by preventing machine starting if the smart key is not within a certain range of the machine. (It does not cause the machine to stop suddenly if the smart key is removed from within its specified range while the machine is operating).

Allows the operator to turn on the machines front cabin lamps for 1 minute, without having to enter the cabin or turn on the starter switch.

Press button #1 to turn on the machine working lights for 1 min.

Press button #2 to turn OFF the machines working lights (during the 1 minute activation period).

Press button #3 to locate the registered machine.

Pressing button #3 once turns on the working lights and sounds the horn 3 times on the keys 1st registered machine only.

Pressing button #3 twice turns on the working lights and sounds the horn 3 times on the keys 2nd registered machine only.

Pressing button #3 three times turns on the working lights and sounds the horn 3 times on the keys 3rd registered machine only.

Each smart key can be programmed to work with up to a maximum of 6 machines.

The start / stop switch, displays the following colors, to indicate its operating status:

- No illumination - Machine OFF
- Green illumination - Machine in ACC mode.
- Red illumination - Machine in ON mode.
- Blue illumination - Engine cranking and machine running

Pressing the start button for less than 1-second changes the machines state from:

- Off to ACC
- ACC to On
- On to Off

Pressing the start button for more than 1 second from Off, ACC or On, will make the start button activate the starter, provided no other interlocks are present (password protection, pilot isolator raised, etc)

Pressing the start button for more than 1 second with the engine running will cause the machine to stop.

NOTE: *In an emergency, pressing the start switch 3 times within 2 seconds will stop the machine.*

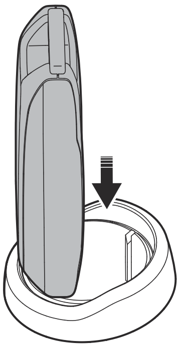
When the machine is put into the ACC condition, the smart key controller starts searching for 10 seconds for the smart key. If the smart controller fails to locate the smart key, the machine will display the smart key not present warning message on the gauge panel.

One minute after the smart key controller fails to find the smart key, the pop up will be turned off.

The smart key controller will search again twice for the smart key, once 2 minutes after ACC On and the last time 5 minutes after ACC On, then if it still does not find the smart key, the machine will be turned Off.

Limp Home Function

Figure 288



DS1900267

The smart key system is provided with a limp home function, in case of smart key battery failure or because the smart key controller cannot recognize it due to electrical noise, etc. To activate the limp home function, the smart key must be used directly on the start / stop button for 3 seconds (as shown below).

Registering Smart Keys.

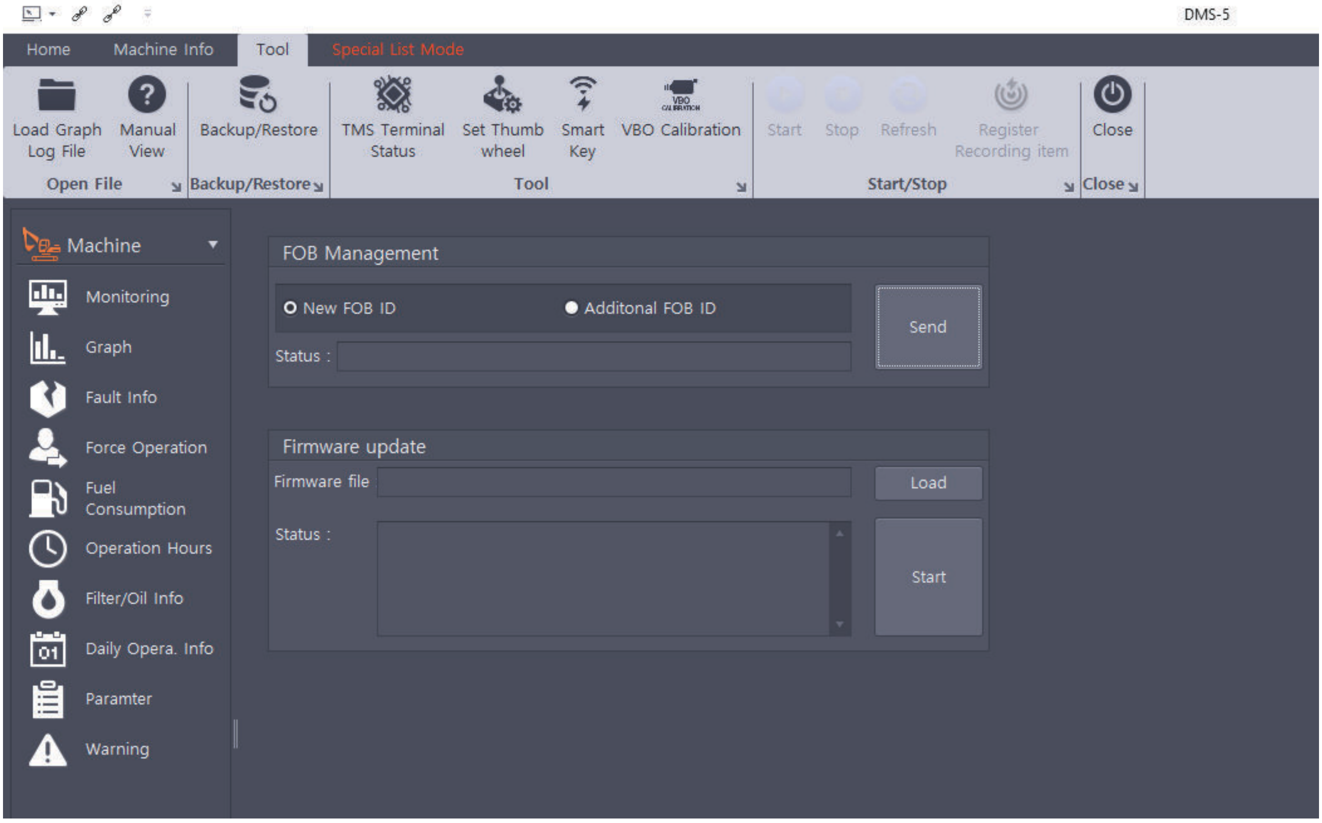
It will be possible to register a smart key to a machine by 2 methods:

- With DMS 5
- Through TMS

NOTE: *Once these methods are finalized, online learning will be made available showing both methods.*

NOTE: *Other features that use the Smart Key are under development.*

Figure 289

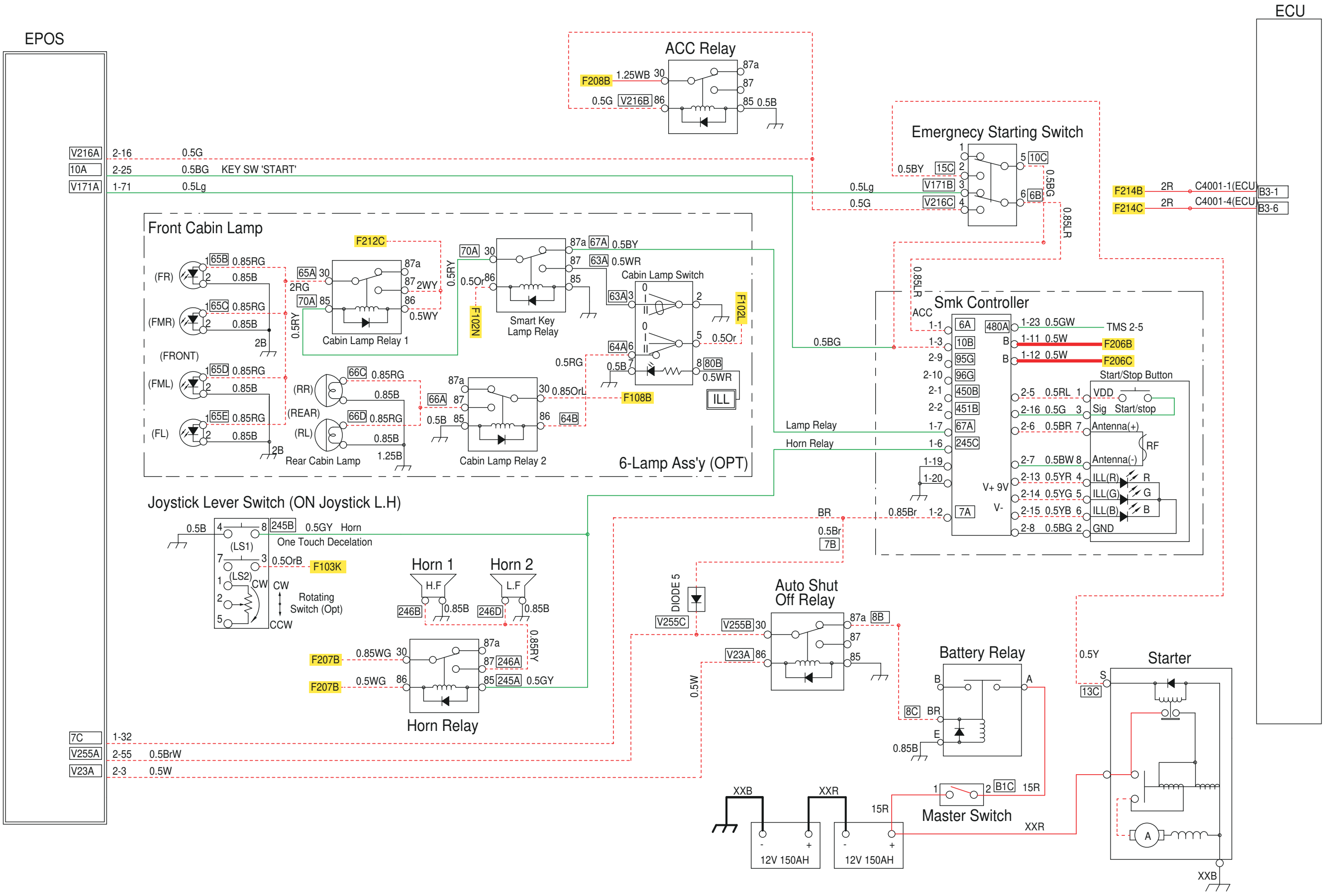


DS1901417

Smart Key (OFF Condition)

With the smart key off, the SMK controller is supplied with 24V from the none key controlled supply from fuse 6 of fuse box 2.

Figure 290

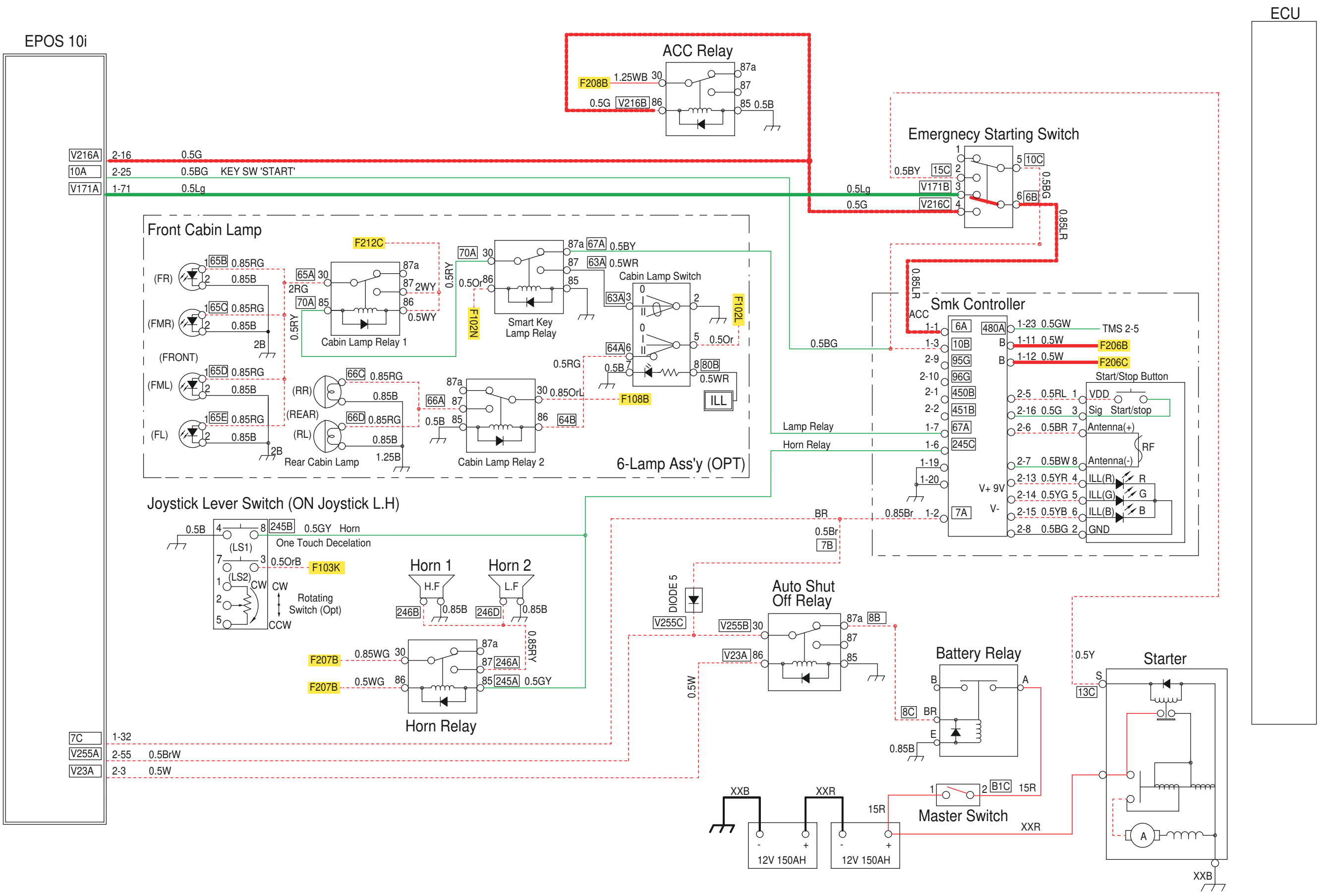


DS1903717

Smart Key (ACC Condition)

On the first press of the start / stop button, the button becomes illuminated green and the SMK controller sends a signal to EPOS terminal 1-71. EPOS then powers the ACC relay to activate the ACC powered devices.

Figure 291



DS1903718

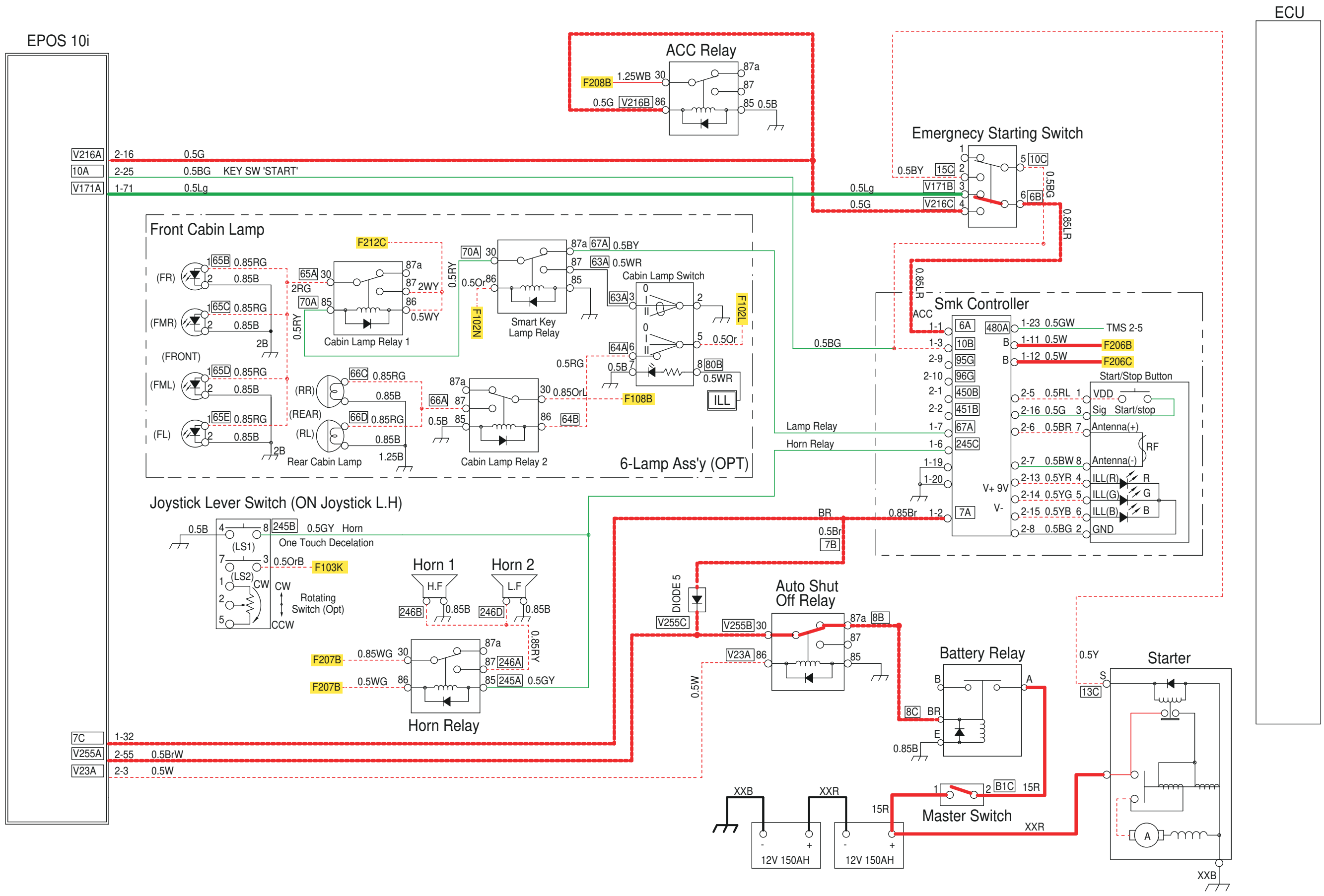
Smart Key (ON Condition)

On the second press of the start / stop button, the button illumination changes to red and the SMK controller sends a signal to EPOS terminal 1-32.

The signal also goes via the diode 5 to:

- The EPOS terminal 2-55
- To the battery relay, to energize it & so power the rest of the fuses

Figure 292



DS1903719

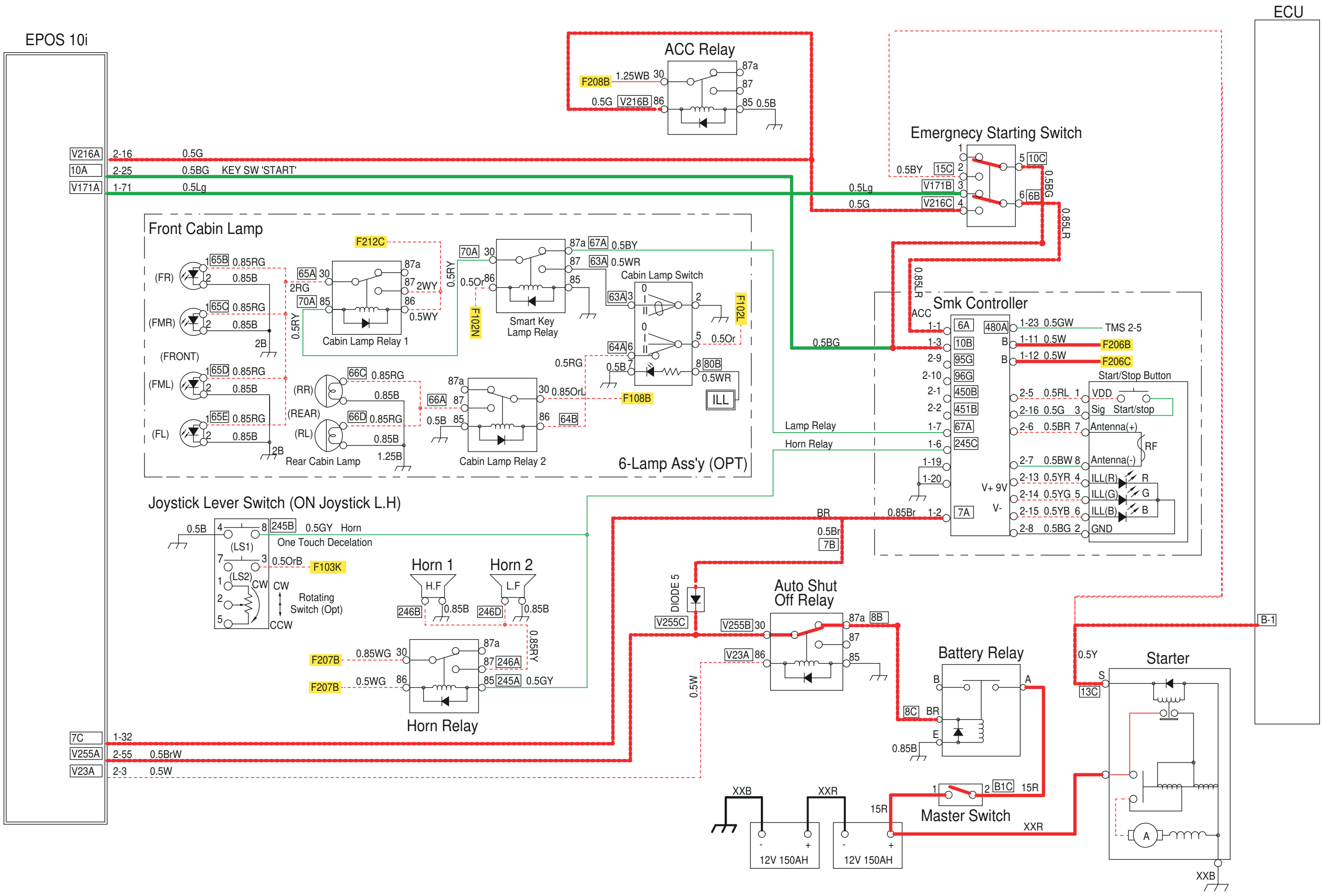
Smart Key (Start Condition)

During pressing the smart key to start, the SMK controller sends a signal to the EPOS terminal 2-25 and the emergency starting switch.

At the same time the starter motor becomes energized by ECU (B-1).

During starting the button illumination turns blue.

Figure 293

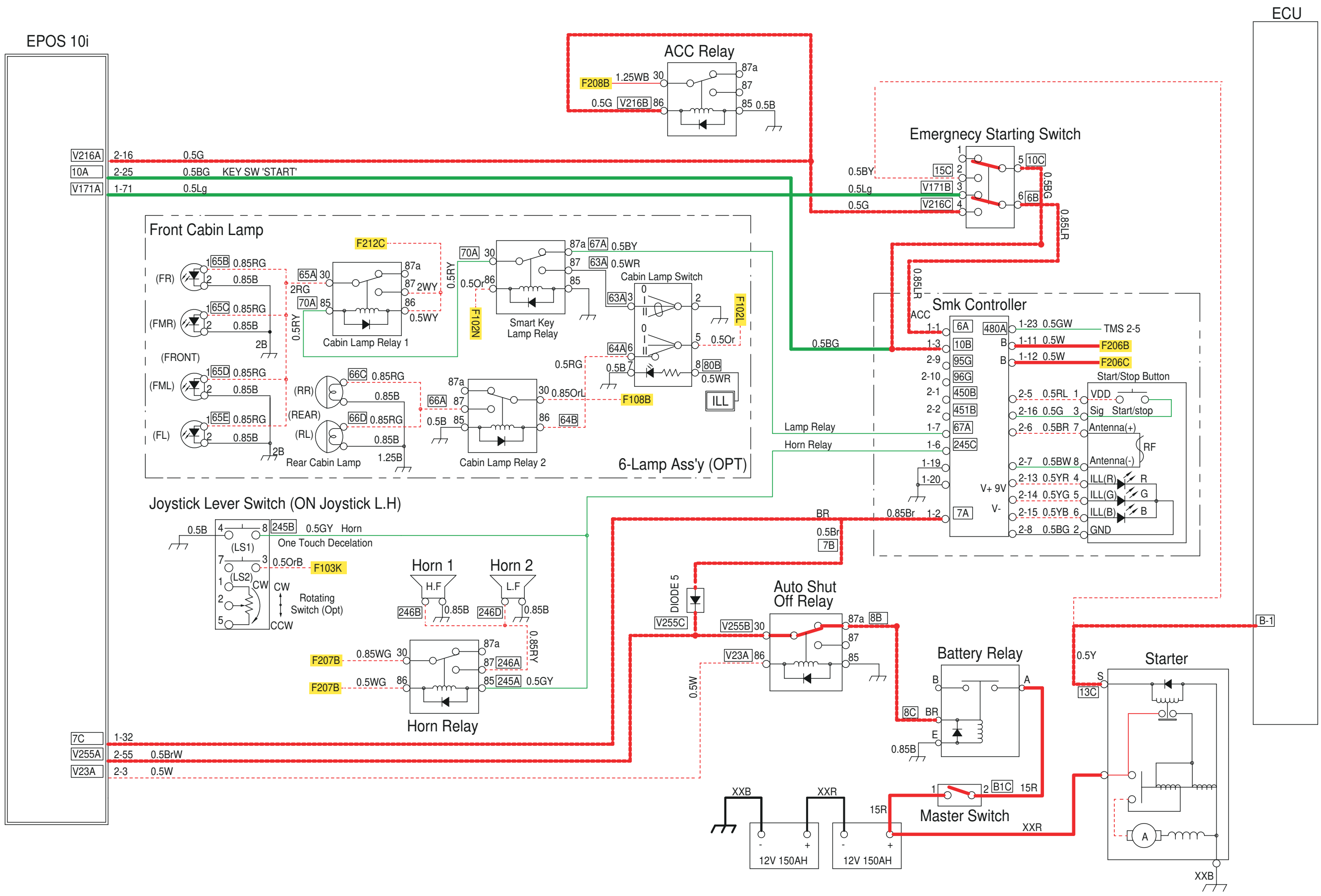


DS1903720

Once the engine speed exceeds 500 rpm the ECU cuts the supply to the starter motor to stop the starter motor.

The ECU controls the starter motor also acts to prevent the starter motor being re-engaged while the engine is running, as there is no longer a starter controller.

Figure 294

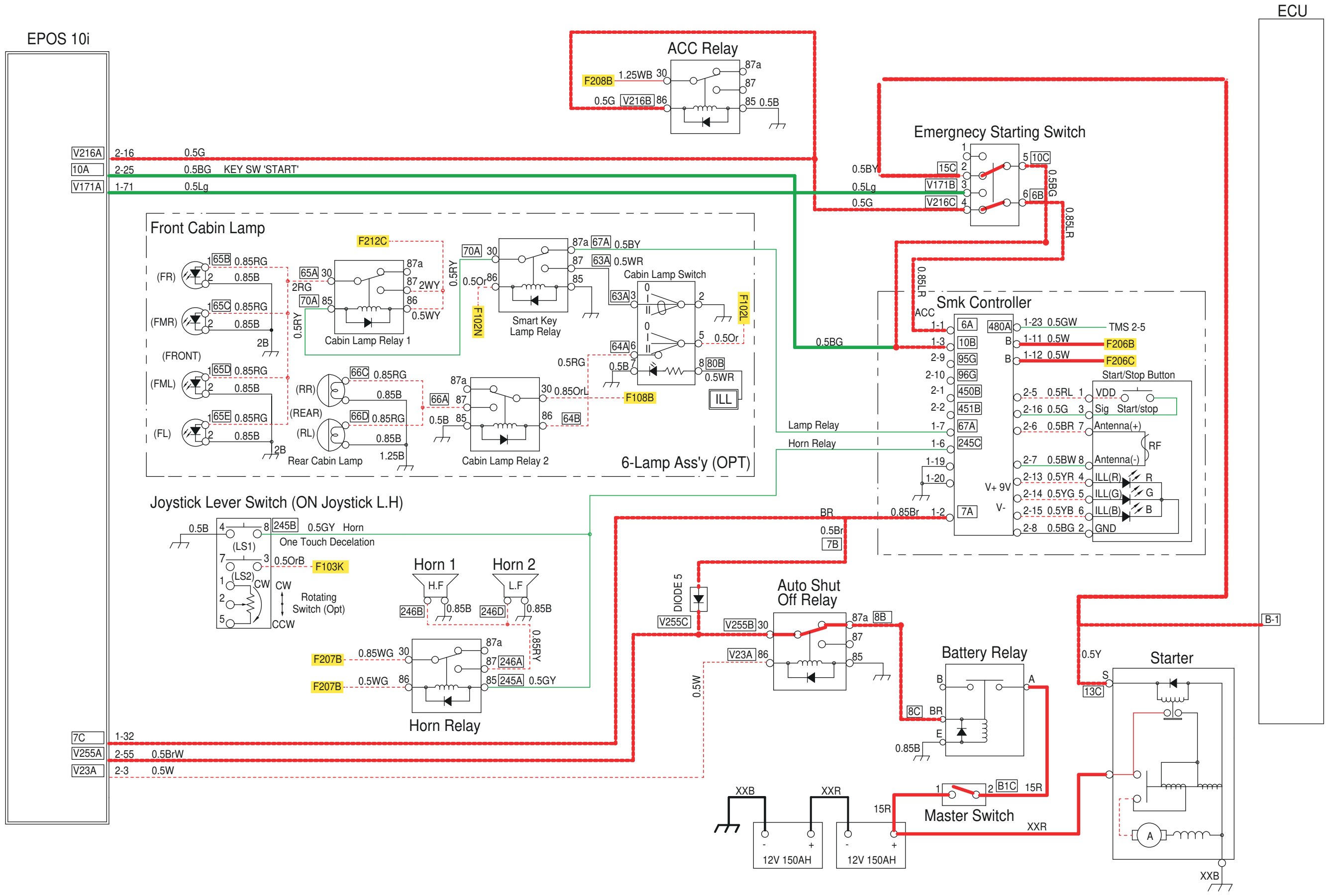


DS1903721

Smart Key (Emergency Starting Condition)

In case of EPOS Failure, the emergency starting switch is used to redirect the starting signal from the SMK controller directly to the starter relay on the starter motor.

Figure 295



DS1903722

NO Preheating / After Heating System

Stage 5 engine dose not use air heater on the intake line.

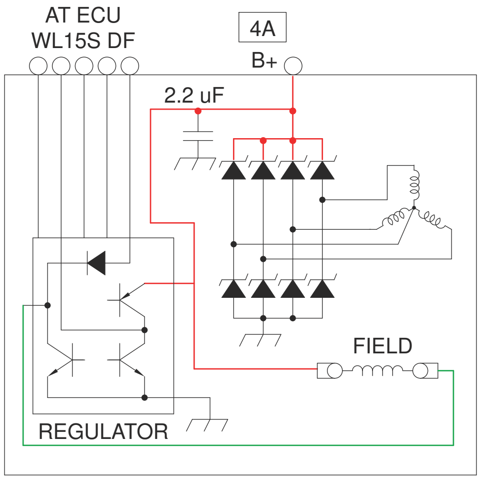
No heating control anymore.

Cold starting ability covers preheating by multifuel injection by ECU

Charging System

Alternator

Figure 296

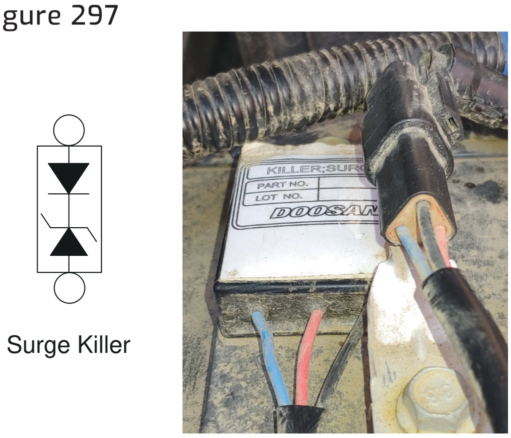


DS1903723

B: Power for electric load

Surge Killer

Figure 297



DS1901579

In order to protect the electronic components in the machine against damage caused by sudden electrical surges, a surge killer has been installed.

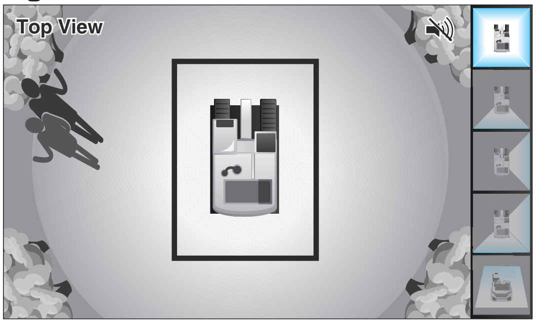
The surge killer removes the need for the zener diode on the alternator to battery relay line.

AVM System

AVM

1. AVM ECU

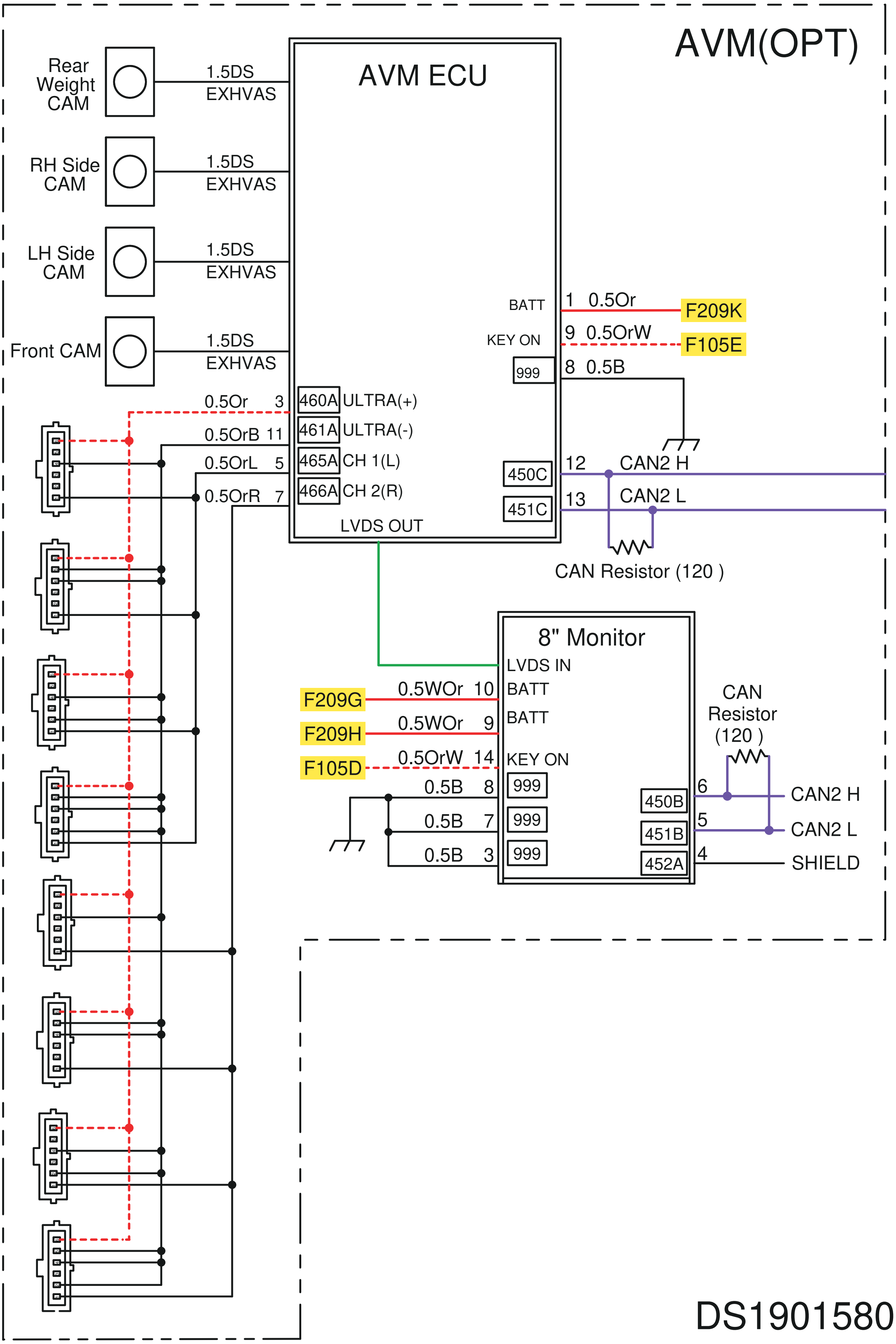
   Figure 298

   EX1503201

   - Receives the video signal from cameras
   - Makes the AVM View
   - Sends the AVM view to Monitor

2. AVM Monitor: Shows the AVM view and changes the view mode (with touch Icon)
Figure 299



EPOS system

SPC3 System

SPC 3 System uses both sensors in the boom up, arm in & swing pilot lines along with Negacon pressure sensors.

SPC 3 has no SPC switch in the console, so it is now set through the gauge panel on the Default Power Mode Setting screen.

With SPC 3 active the machine will operate 100 rpm lower than the normal operating rpm for the selected power mode until the operator's operation demands more, at which time EPOS will instruct the ECU to increase the engine rpm and change the pump power setting as required.

SPC3 does not operate in Power + mode.

SPC mode control

When Set SPC mode at Gauge panel, P / S / E mode will be activated.

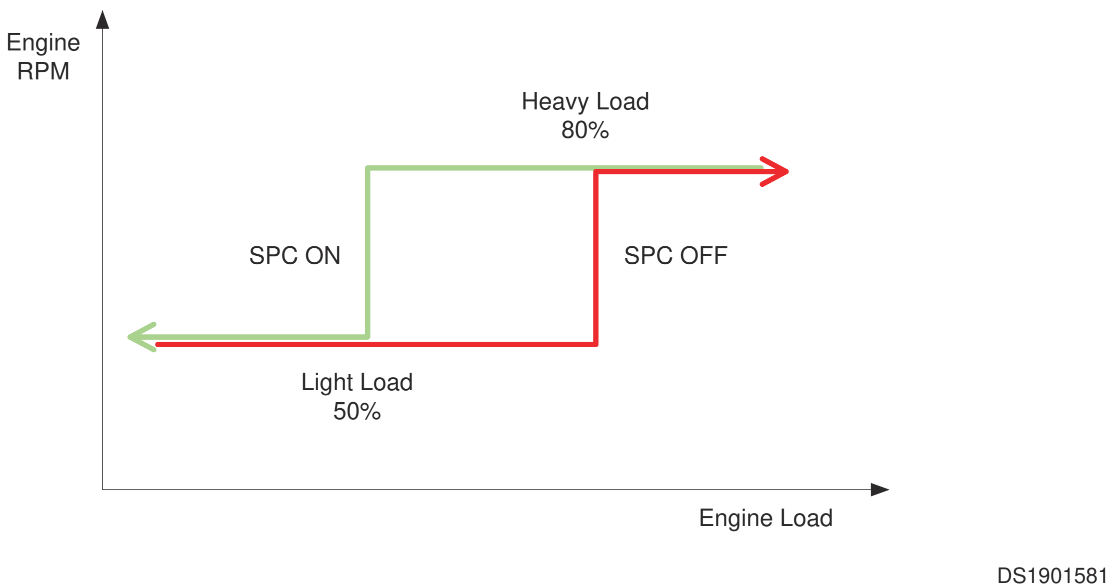
When SPC mode is activated, Engine RPM will be 100 rpm down.

Engine Torque: If the Engine Torque demand exceeds 80%, the EPOS shifts the Pump Torque Control to Heavy Load setting, and the ECU increases the engine RPM (This state will be maintained as long as the Pump Torque demand exceeds 50%)

Slow Mode is used on the increase of Pump Torque to avoid excessive load on the engine during RPM increase and so to reduce smoke production and unnecessary fuel consumption.

Item	Unit	
Boom Up Pilot Pressure	bar	20
Arm In Pressure	bar	15

Figure 300



Engine RPM Control

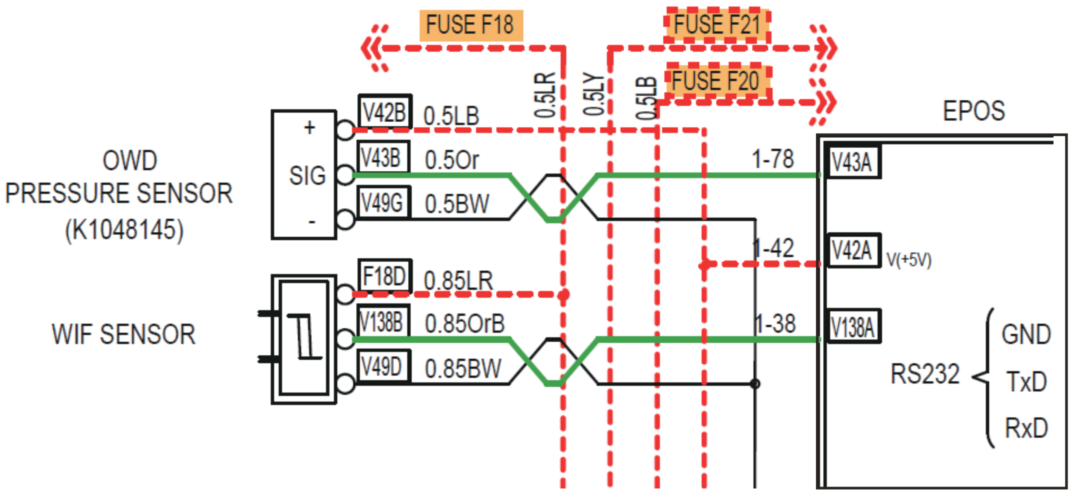
WIF

Out put signal voltage

No water: 3.5 ±0.5 V

Water in filter: 1.5 ±0.5 V

Figure 301



DS2002862

Water In Fuel Reactions

1. Pop-up and alarm buzzer:

   Once water in fuel is detected, the EPOS unit sends a pop-up message to the LCD panel and sounds the alarm buzzer.

   If the operator clears the pop-up message by pressing the ESC button but does not drain off the water, the EPOS will repeat the pop-up message and alarm buzzer after 30 seconds.

2. De-rating:

   If the operator continues to operate the machine for 30 minutes after the initial pop-up occurs, the engine power will be de-rated to have an engine speed of limp home (1,200 rpm) and the hydraulics de-rated to 70% torque setting.

   The system will be reset once the water is drained from the filter base.

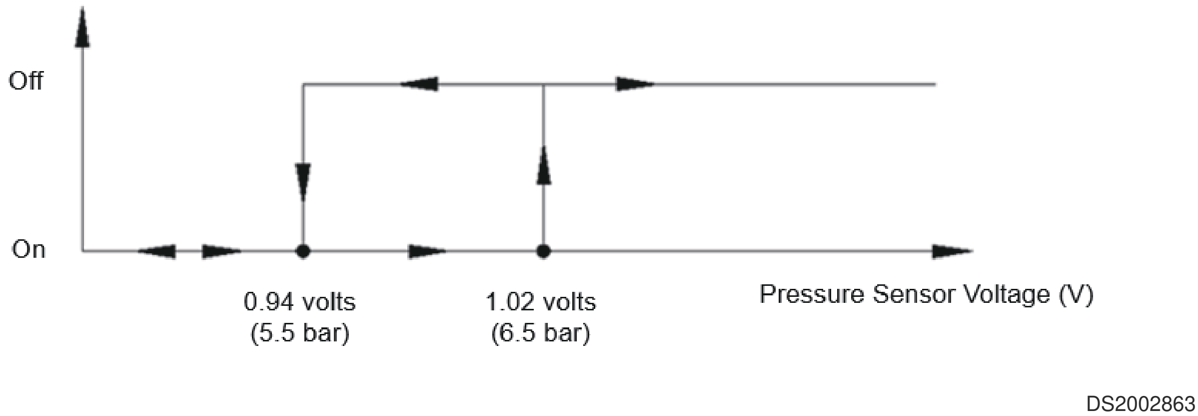
   NOTE: *Should the sensor become disconnected, the system will immediately sound the buzzer and de-rate the engine.*

Auto Idle

With the engine running, if the Auto Idle function is switched "ON" then the engine speed is controlled as follows:

- If the throttle dial set is lower than Auto Idle rpm, engine speed follows dial request.
- If the throttle dial set is above the Auto Idle setting and the EPOS signal at any terminal is above 1.02 volts (6.5 bar), then the engine speed follows the dial request according to mode selection.

- Throttle dial set above Auto Idle setting and the EPOS signal at all terminals 1-55 and 1-65 drops below 0.94 volts (5.5 bar) for more than the pre-set Auto Idle time, then the engine speed is reduced to the auto idle setting (Unless Lifting Mode is selected).
  Figure 302



Pilot Cut Off Control

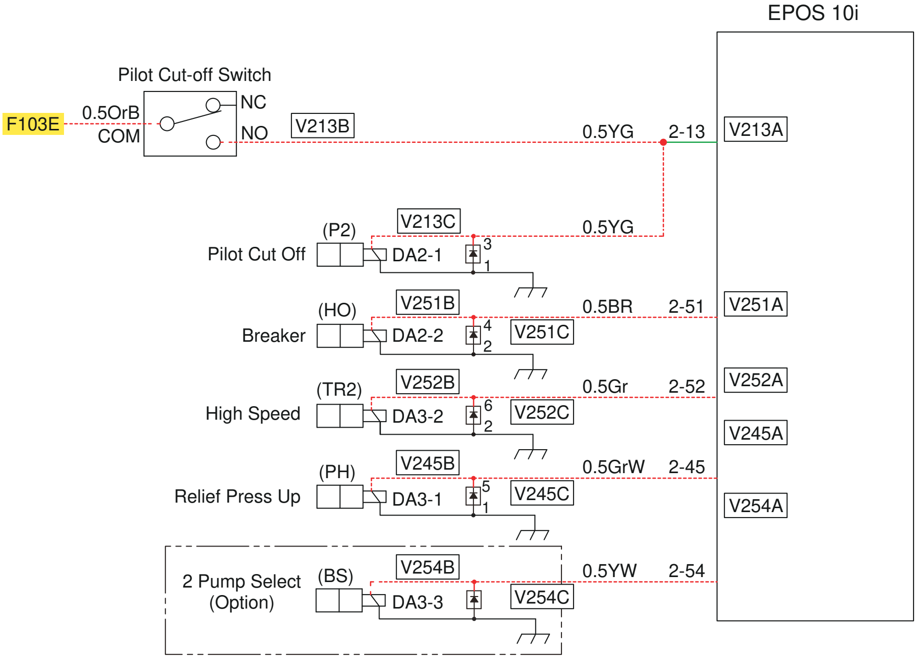
Raising the Pilot Cut Off lever, causes the Pilot Cut Off Switch to connect the "ON" Starter Switch/ Smart Key Controller output signal to the EPOS terminal 1-31 and to the Pilot Cut Off solenoid valve.

- The EPOS to instruct the gauge panel to display a warning message and to activate the Starter Relay 1, preventing the starter motor from being energized when the Starter Switch/Smart Key Controller is put in the "Start" state when the engine is not running.
- The EPOS to instruct the Engine ECU to return to the relevant engine speed, assuming the engine is running. (Dial setting or Auto Idle setting).
- The pilot cuts off the solenoid valve to allow the pilot pump supply to the pilot actuators and relevant solenoid valves.

Lowering the Pilot Cut Off lever, causes the Pilot Cut Off Switch to break the connection from the "ON" Starter Switch/Smart Key Controller output signal to the EPOS terminal 1-31 and to the Pilot Cut Off solenoid valve.

- The EPOS de-energizes the Starter Relay 1 unless a password lock is active.
- The EPOS to instruct the Engine ECU to reduce the engine speed to minimum RPM (Assuming the engine is running at higher rpm).
- The EPOS to stop/prevent operation of the joystick-controlled solenoid valves

- The pilot cut off the solenoid valve to cut the pilot supply to the pilot circuit.
  Figure 303



DS1901585

Seat Belt Alarm

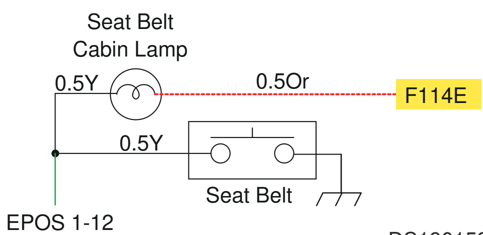
Figure 304

DS1901260

When the seat belt is not fastened (switch off), the EPOS sends the signal to the gauge panel to put the seat belt warning symbol ON.

When the seat belt is fastened (switch on), the EPOS sends the signal to the gauge panel to put the seat belt warning symbol Off and at the same time the seat belt lamp on the cabin roof is also turned ON.

Figure 305



DS1901589

Quick Coupler

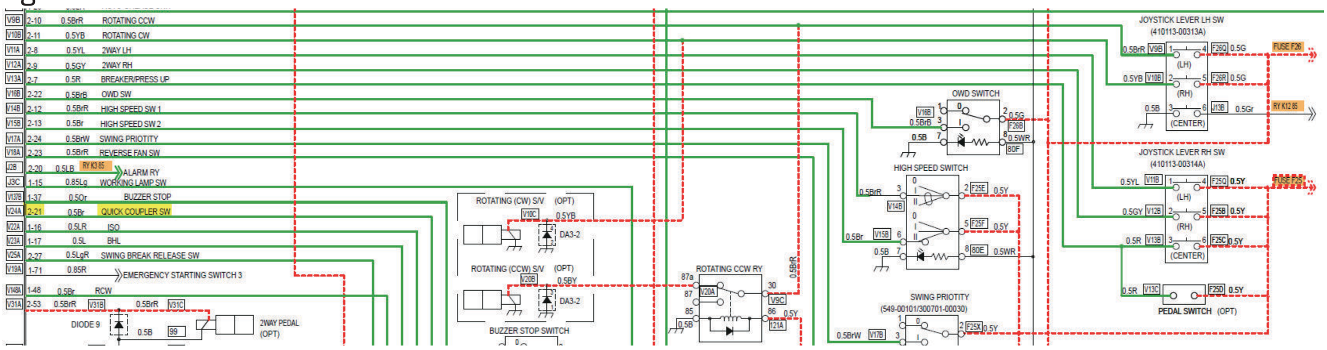
Control Workflow

When the Quick Coupler Switch is activated, it puts the power to the EPOS terminal 2-21 & to energize the Rotating CCW Relay.

EPOS then changes its actions with regards to the left joystick button on the left-hand controller.

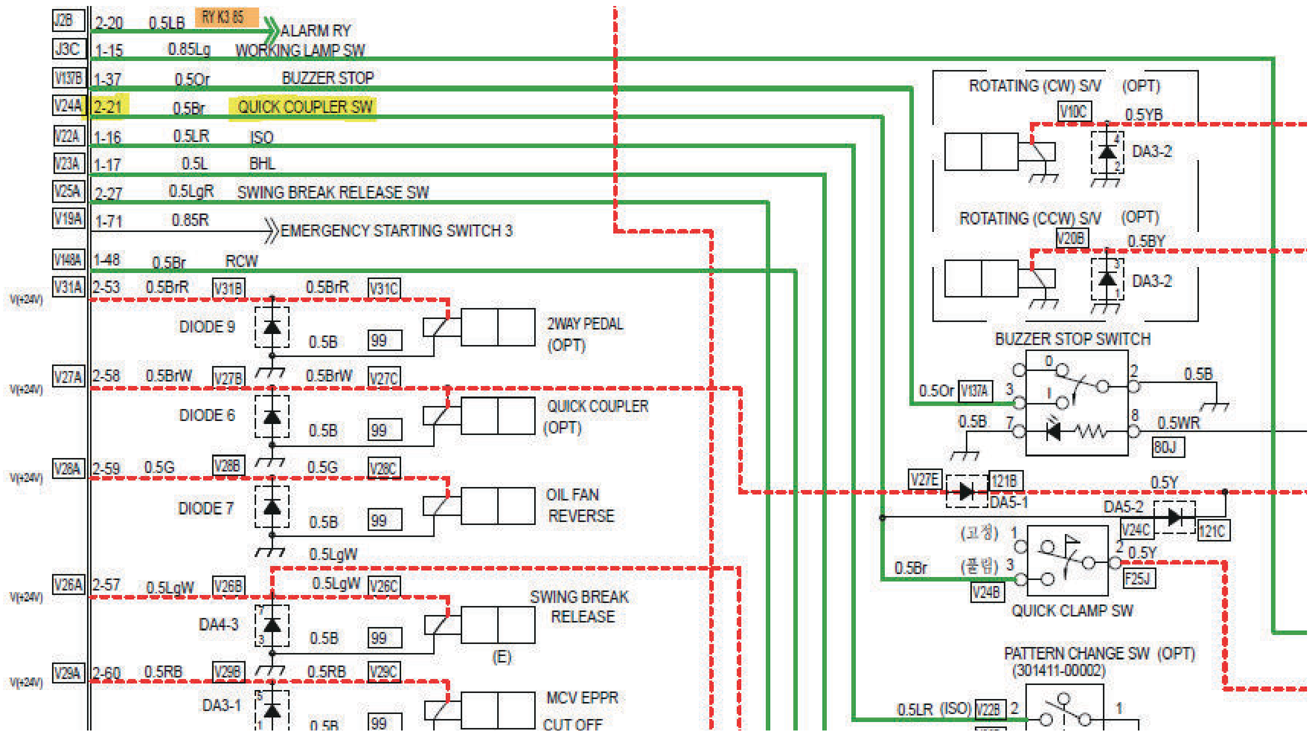
With the Quick Coupler switch activated & the left joystick button pressed at the same time, EPOS sends a pop-up message to the panel & energizes the Quick Coupler Solenoid valve.

Figure 306



DS2002864

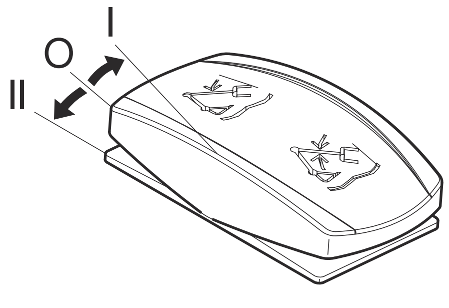
Figure 307



DS2002865

Overload Warning Device (If Equipped)

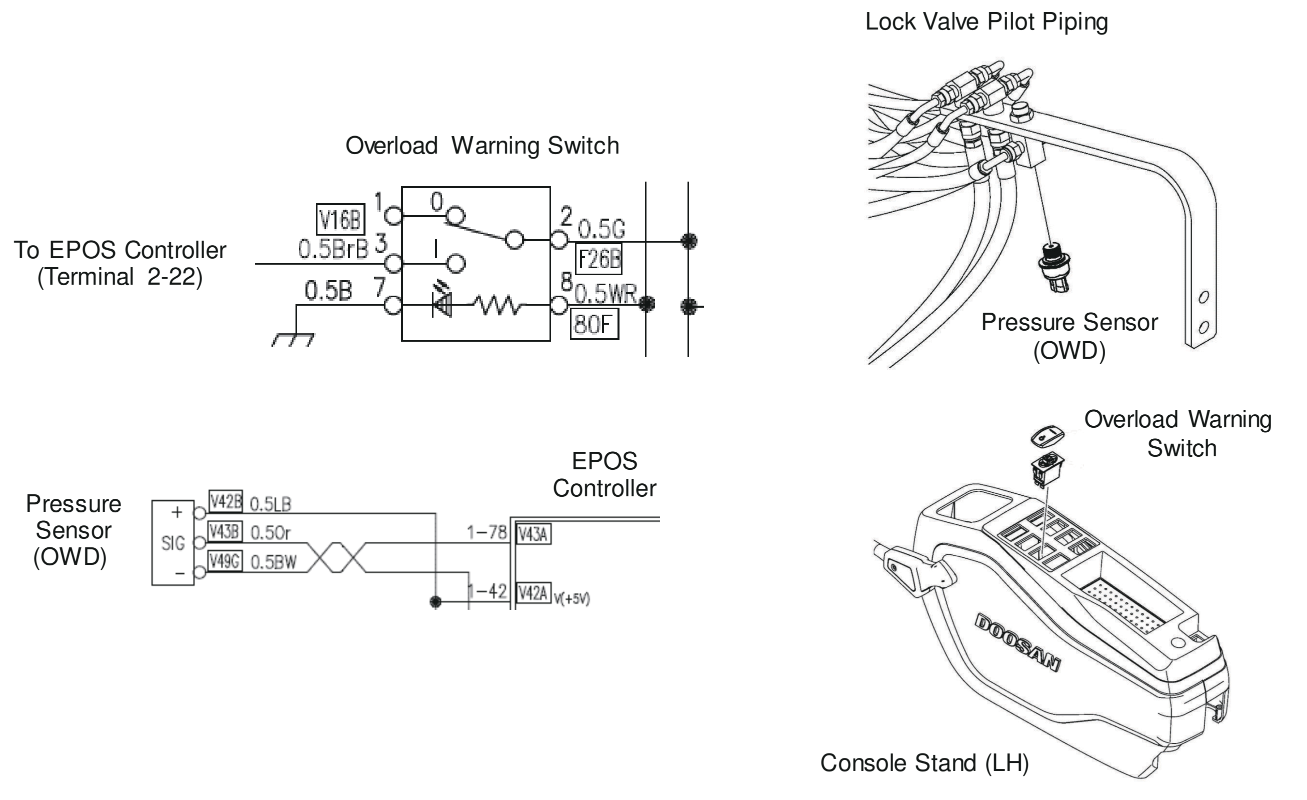
Figure 308



The Overload Warning Device Option is a basic TMI (Total Moment Indicator), which means that it works based on only the pressure in the boom raise cylinders required to meet the safe limit for the tipping load of the machine in its worst position (maximum reach when crossing carriage). So for most operating positions, this is much less than the machine's safe lifting capacity.

The pressure required to activate the Overload warning device is programmed into the EPOS unit for the machine.

Figure 309



Overload Warning Device Pressure Settings

	Units	DX800LC-7
75% of Lateral Tipping Load Pressure	kg/cm^2	270
95% of Reference Pressure		256
90% of Reference Pressure		243

At over 90% of reference pressure, the warning symbol is flashing (0.5 secs On / 0.5 secs Off) and the warning buzzer sounds.

At over 95% of reference pressure, the warning symbol is "On" constant and the warning buzzer sounds.

NOTE: *These values are present in the EPOS unit & are based on the standard boom, arm, counterweight & tracks being installed on the machine & the values cannot be changed.*

Auxiliary Mode (Swing Brake Release)

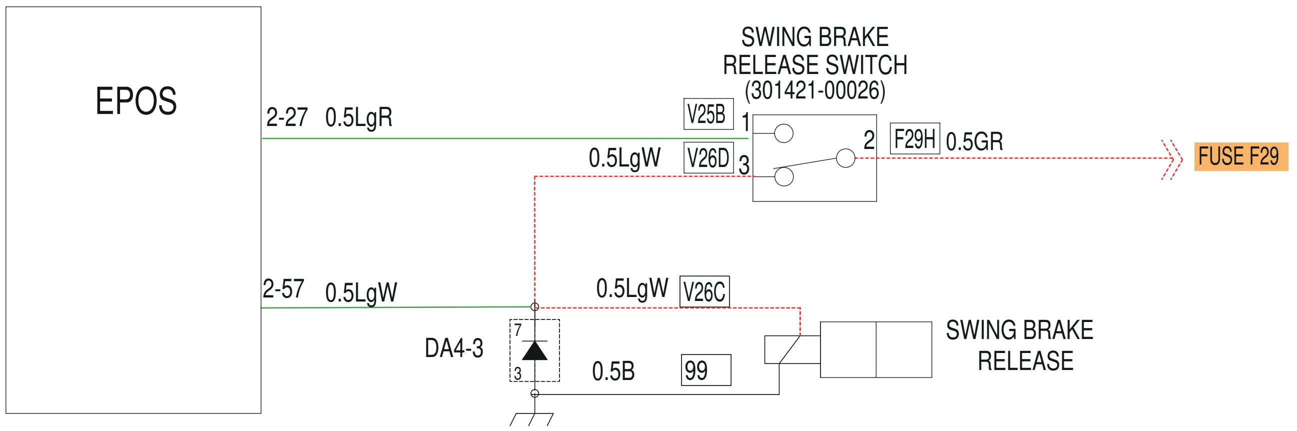
Auxiliary Swing Mode

Auxiliary Swing Mode OFF

With the Swing Brake Release Switch turned Off (Normal operation), the Swing Brake Release Switch signals EPOS it is in Normal operation mode & EPOS controls the Swing Brake Release Solenoid Valve.

NOTE: *EPOS will energize the Swing Brake Release Solenoid Valve, to release the swing brake, when it senses any front end or option service is activated. (pilot pressure service sensor)*

Figure 310

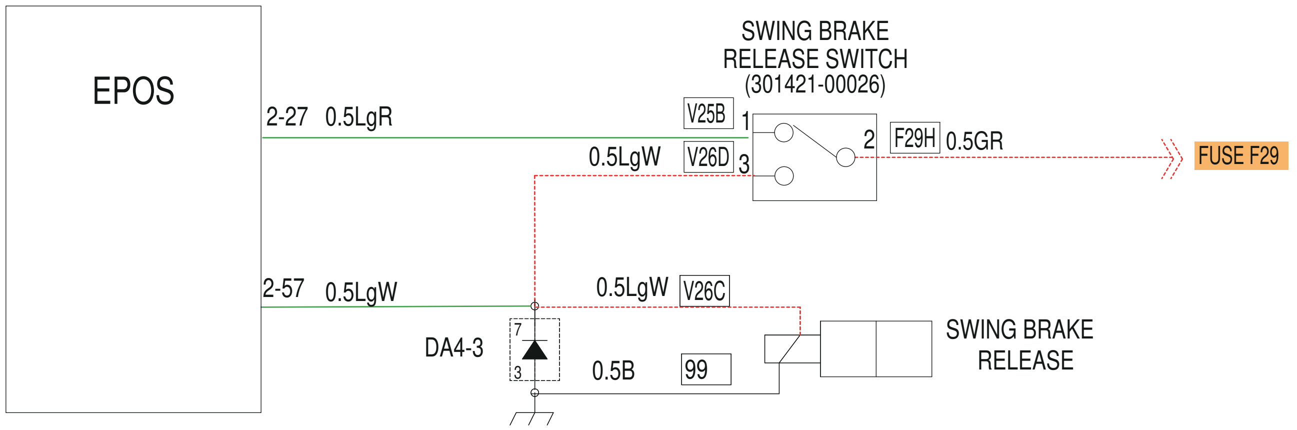


Auxiliary Swing Mode ON

With the Swing Brake Release Switch turned On (Due to EPOS failure), the Swing Brake Release Solenoid Valve is energized directly and so releases the swing brake as long as the pilot isolator is in the work position.

NOTE: *The swing brake will always be able to be released directly, by the swing pilot pressure via shuttle valves, in the case of a Swing Brake Release Solenoid Valve failure or before the operator turns on the Swing Brake Release Switch in the case of an EPOS failure.*

Figure 311

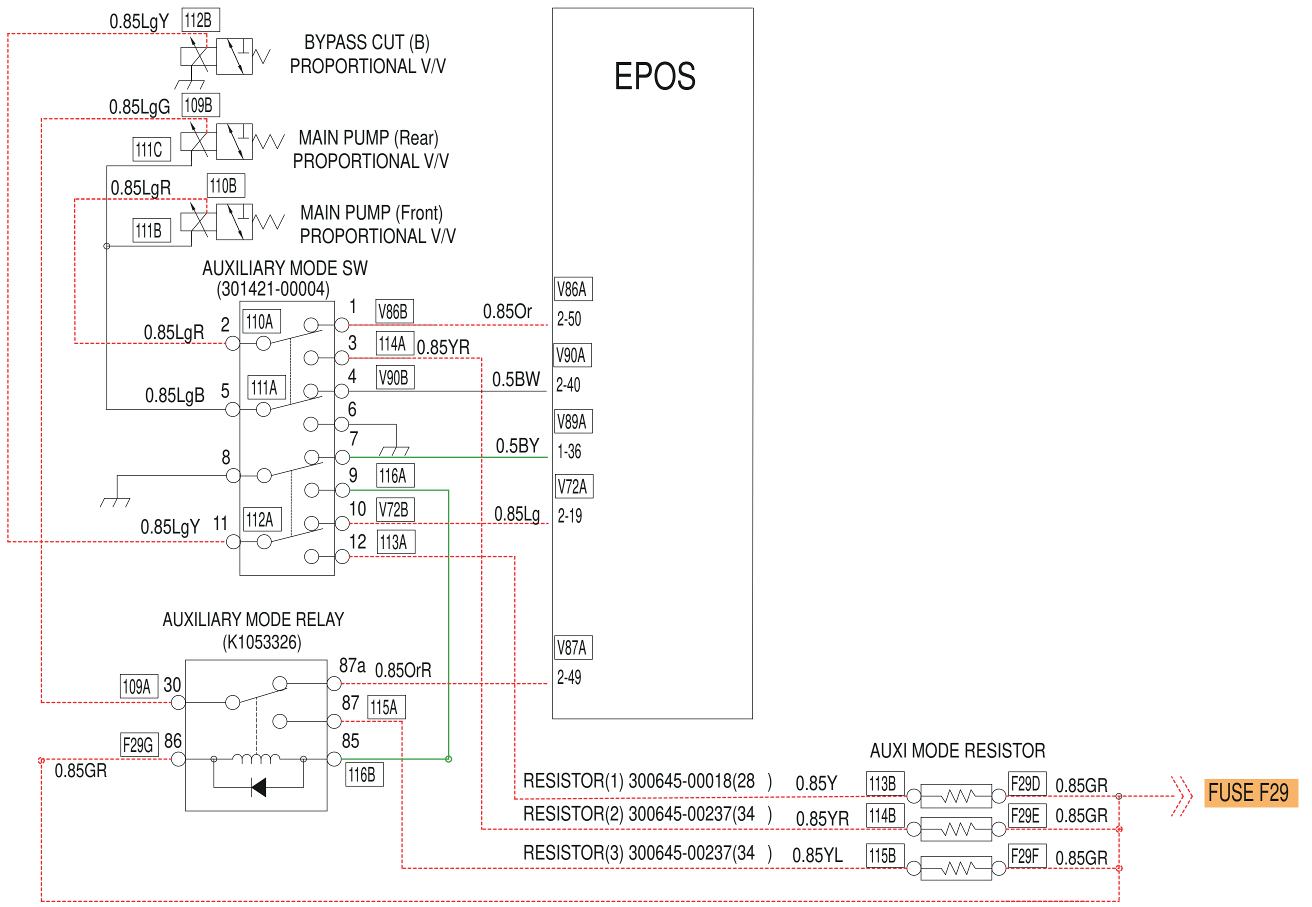


DS2002868

Auxiliary Mode OFF

With the Auxiliary Mode Switch turned Off (Normal operation), the two Pump Proportional Valves and the Bypass Cut (B) Proportional Valve are controlled and earthed directly by the EPOS unit.

Figure 312



DS2002869

Auxiliary Mode ON

With the Auxiliary Mode Switch turned On (In case of an EPOS failure), the two Pump Proportional Valves are changed from being controlled and earthed by the EPOS unit, to each Proportional Valve being supplied with a fixed current from its own Aux Mode Resistor (34 Ω).

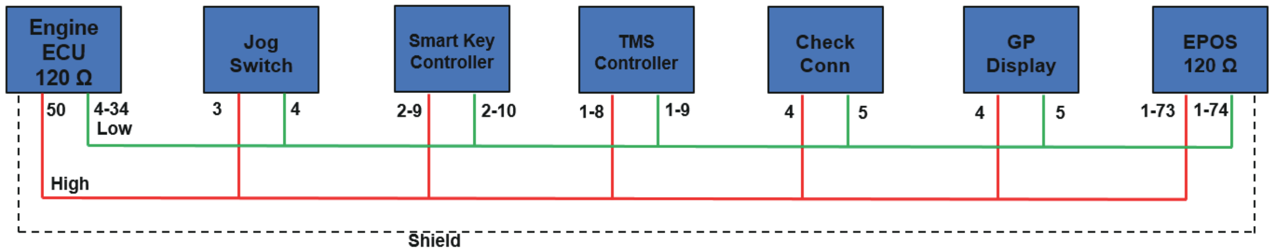
The Bypass Cut Proportional Valve B is now powered via the 28 Ω Auxiliary Mode Resistor.

CAN Communication

The different control units communicate with each other via CAN link. The nodes in the system monitors its communication links. If a fault is detected in the communication link supervision the node informs the operator about the fault.

CAN 0

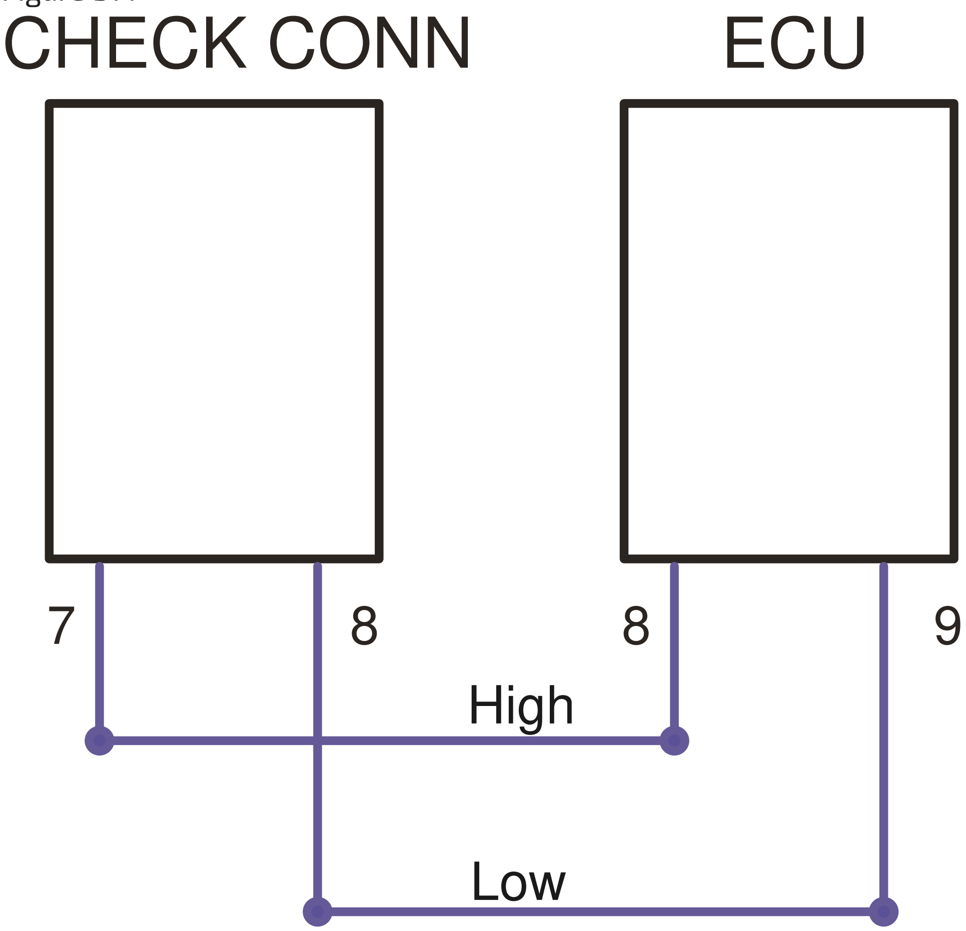
Figure 313



DS2002870

CAN 1

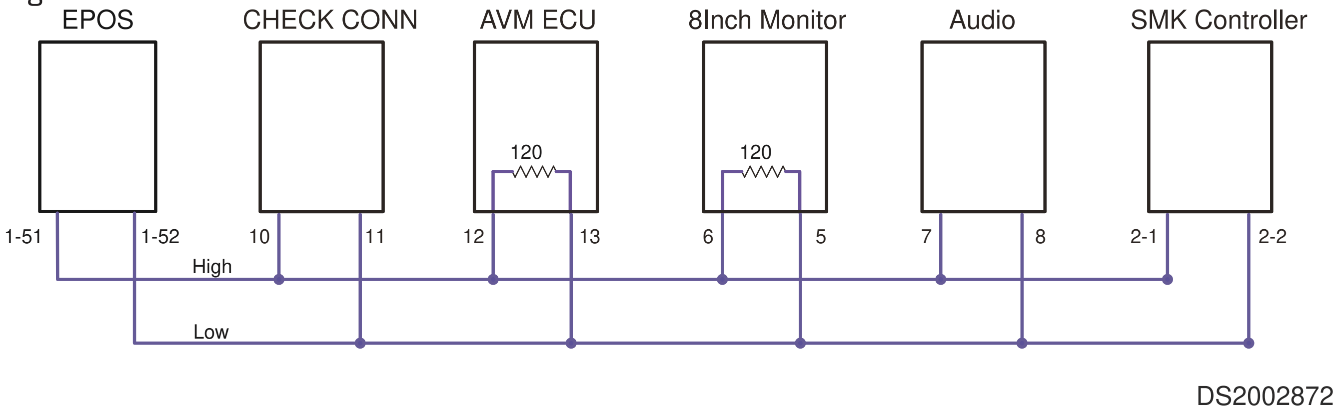
Figure 314



DS2002871

CAN 2

Figure 315



TMS (2.0)

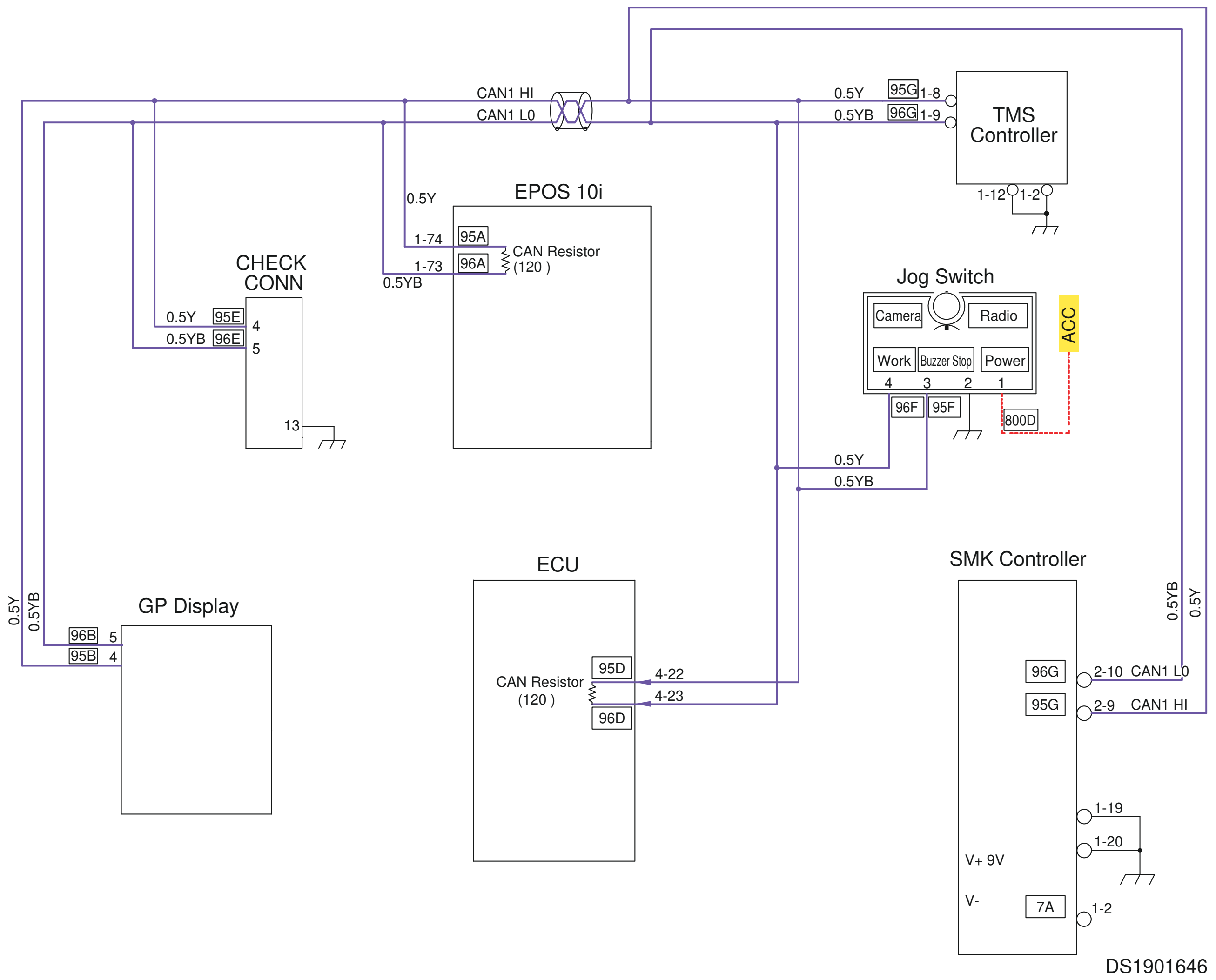
EPOS collects key information of the equipment or controls the equipment through commands transmitted from the communication server.

Main collection information: location of equipment, total running time of engine, working time, fuel status, equipment warning / fault information, etc.

- Equipment control: RPM limit, engine restart limit

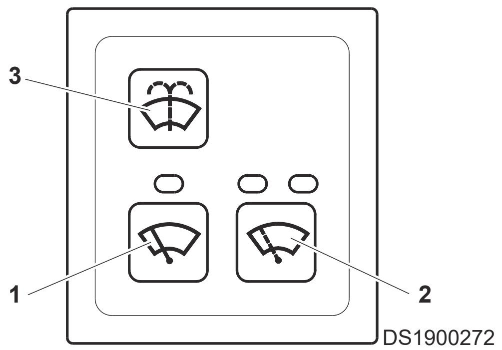
- Terminal H/W is divided into GSM only and dual mode

  Figure 316



Wiper System

Figure 317



Wiper Control Panel

This panel is only for operation of the upper windshield wiper. When the wiper stops running, it moves to right side of the cabin, resting in its support.

NOTE: *When the front window is lifted, the wiper motor will not operate.*

1. Constant Speed Button

Pressing the button turns "ON" the windshield wiper. An indicator light above the button will turn "ON" indicating that wiper is "ON". The wiper will run at a constant speed.

Pressing the button again, turns "OFF" the windshield wiper.

2. Intermittent Speed Button

   Pressing button once (first time):

   Windshield wiper runs approximately on a three second intermittent cycle. The left side indicator light will turn "ON".

   Pressing button again (second time):

   Windshield wiper runs approximately on a six second intermittent cycle. The right side indicator light will turn "ON".

   Pressing button again (third time):

   Turns "OFF" the windshield wiper. Both indicator lights will be turned "OFF".

3. Windshield Washer Button

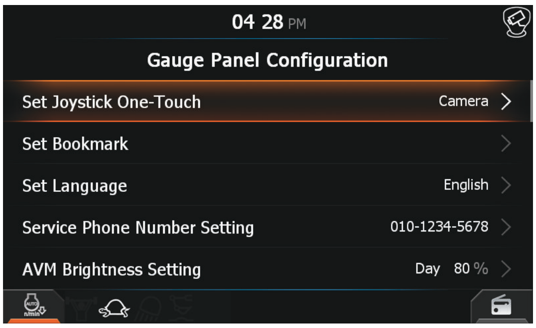
   Pressing the washer button will spray windshield washer fluid onto the windshield. Use only the proper windshield washer fluid in the system.

   NOTE: *Do not operate the windshield washer without any fluid. If operated without any fluid, the washer motor may be damaged. Check level in washer tank and add fluid as required.*

   NOTE: *Using soapy water or synthetic detergent instead of window cleaning fluid can damage the wiper blade or painted surfaces. Use standard window cleaning fluid: 55K703*

Joystick Multi-function

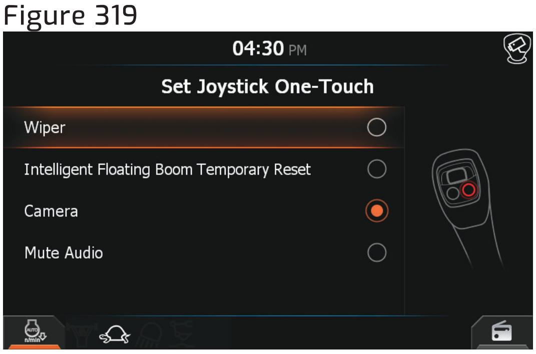
Figure 318



DS1901272

This page is to set joystick one touch.

Figure 319



DS1900355

Setting of joystick one-touch function

1. Wiper
2. Intelligent floating boom temporary reset
3. Camera
4. Mute audio

*Marking location of "joystick one-touch" function image is changed according to the two way option.

DES (Delayed Engine Shutdown)

Overview

The purpose of this is to prevent serious damage to the durability of the dosing tip when the engine is running equipped with an ATS system at a high temperature.

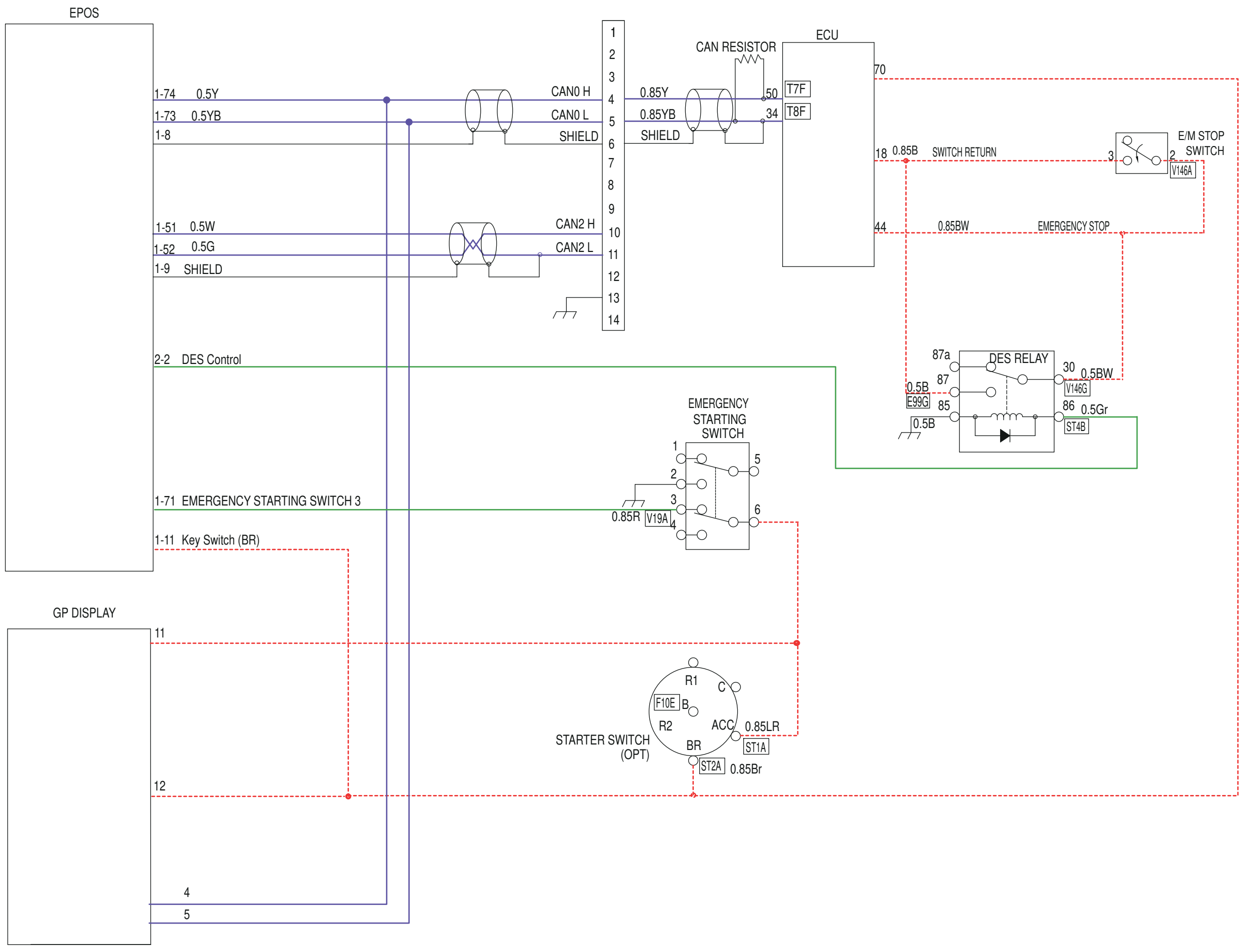
In addition, when an emergency occurs during DES logic operation, the engine is forcibly stopped to stop the DES logic.

When the engine needs to perform the DES operation, the engine does not stop when the user turns the Key Switch off, so the user is notified of the reason why the engine does not stop until the DES logic operation is completed.

NOTE: *It is possible to stop the engine immediately without completing the function during DES logic operation.*

Circuit

Figure 320

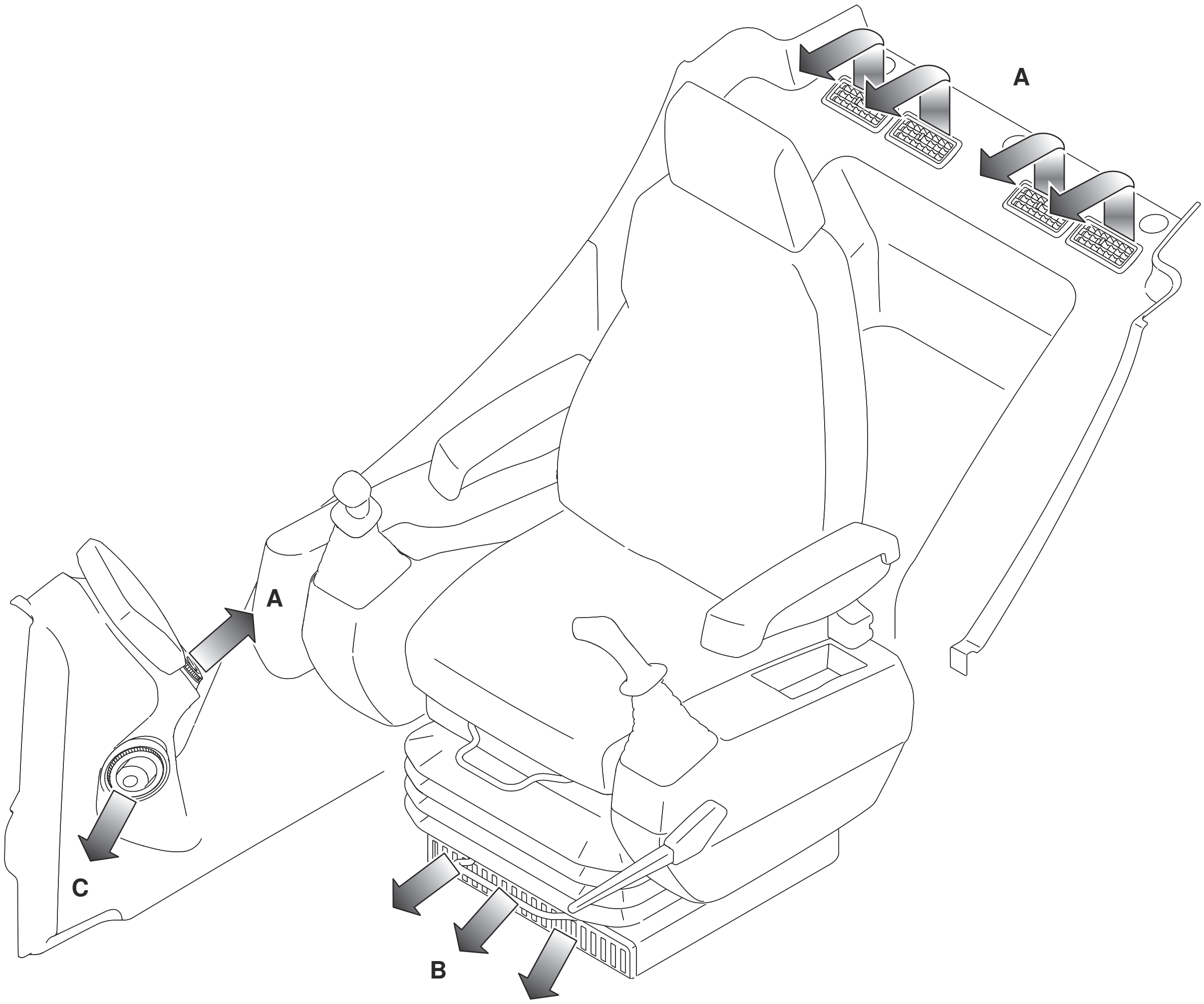


DS2002874

Air Conditioner System

Outline

Figure 321



Solid-type heater and air conditioner are installed in the cover behind the operator's seat.

Temperature of the operator's cabin is adjusted automatically to the temperature set by operator.

(Please refer to the Operation & Maintenance Manual for detailed full automatic control.

Vent mode selects the direction of discharged air.

Outlets by vent modes

Modes				
Outlets	A	A+B	B	B+C

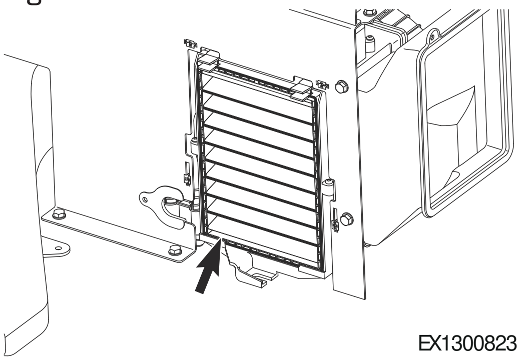
Internal and External Filters

Internal and external air purification filters are installed for the operator's room.

If machine operates in an excessively contaminated environment, filters must be cleaned more frequently and if necessary, replaced with new ones.

How to Check Internal Air Filter

1. Figure 322



EX1300823

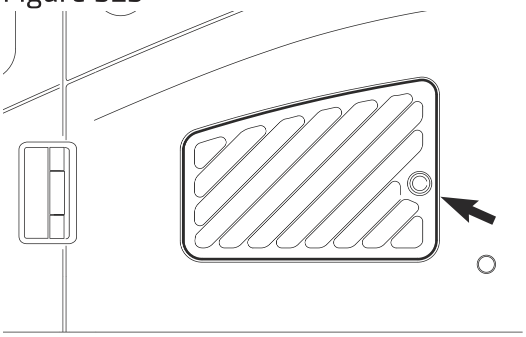
Remove cover by pulling knob outward on top of the left and right of the filter which is inside the left rear part of the cabin.

2. Remove inner filter by pulling knob outward while pressing the upper part and lower part of the filter handle.
3. Replace with new one.
4. Reassemble filter in reverse order.

How to Check External Air Filter

NOTE: *All right and left call outs are based on the operator being seated in the operator's seat facing the front.*

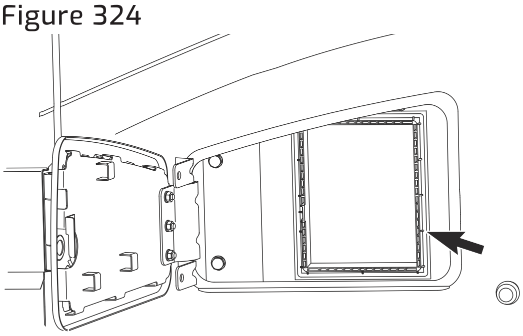
1. Figure 323



EX1300825

Open the cover by using the starter KEY in the left side of the cabin.

2. Figure 324



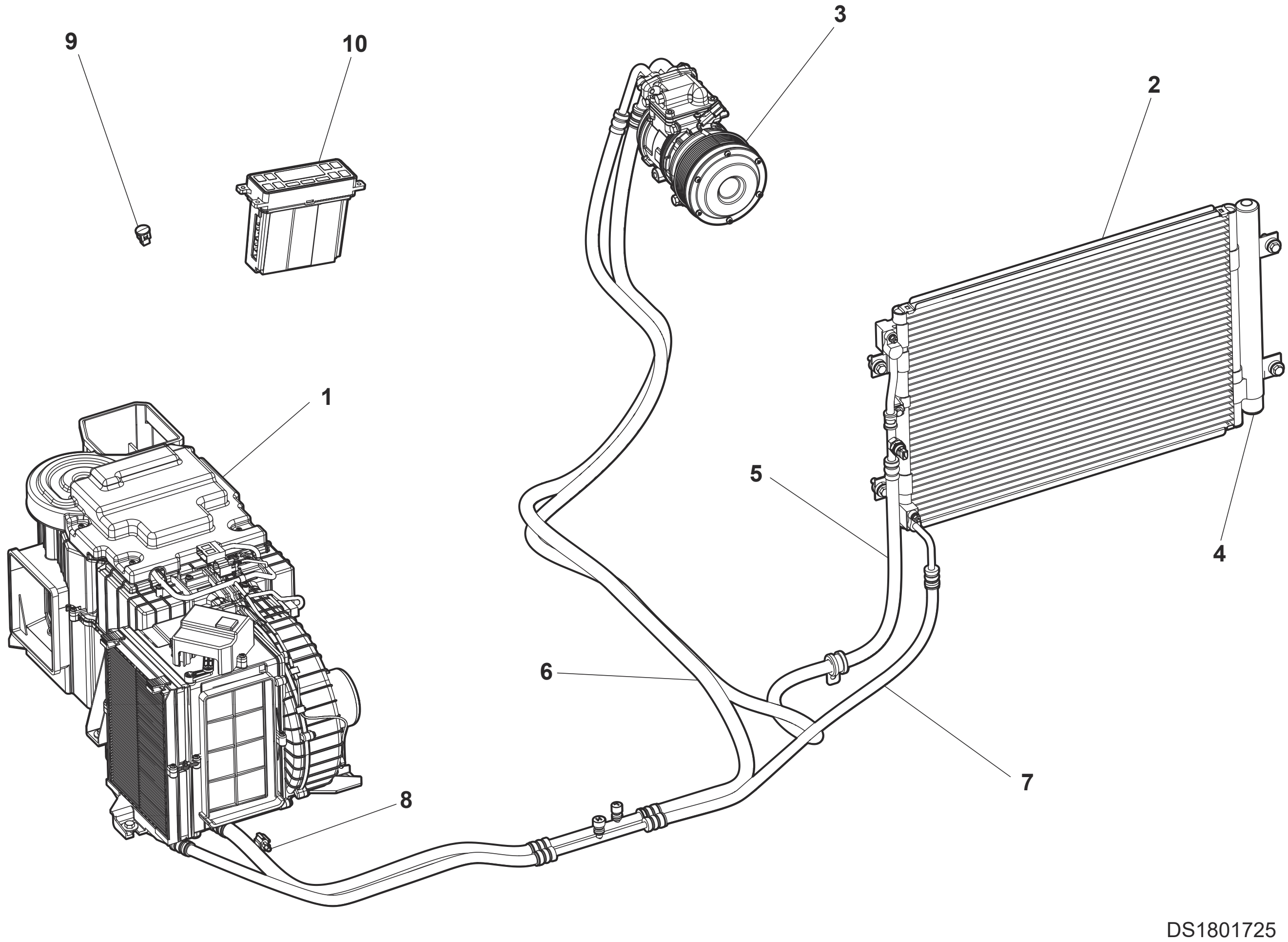
EX1403389

Remove filter and replace with new one.

3. Reassemble in reverse order.

Air-Conditioning System Layout

Figure 325

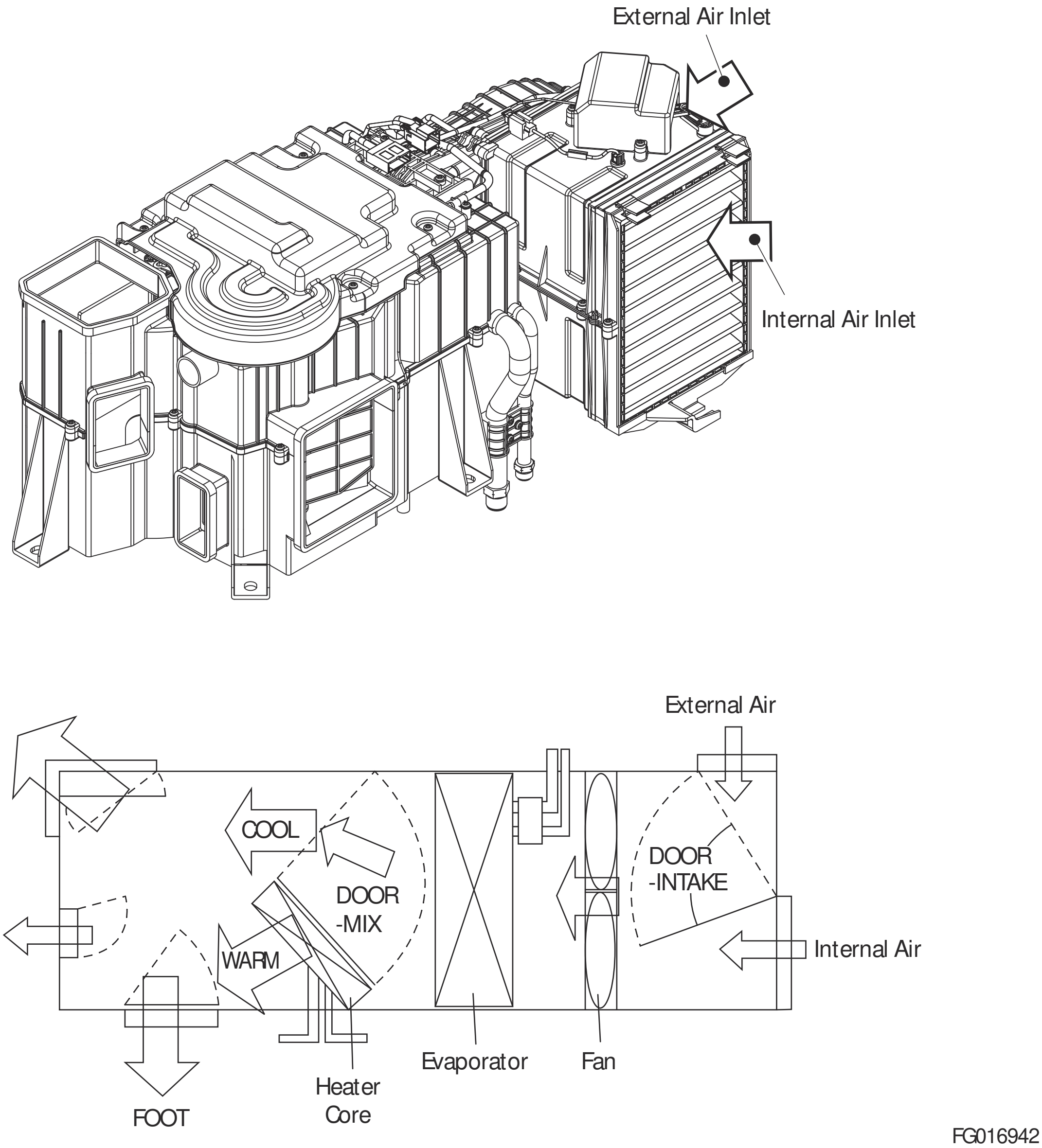


Reference Number	Description
1	Air Conditioner/heater Unit
2	Condenser
3	Compressor
4	Receiver Dryer
5	Discharge Hose
6	Suction Hose
7	Liquid Hose
8	In-car Sensor
9	Photo Sensor
10	Control Panel

Air Conditioner/Heater Unit

Airflow Diagram

Figure 326

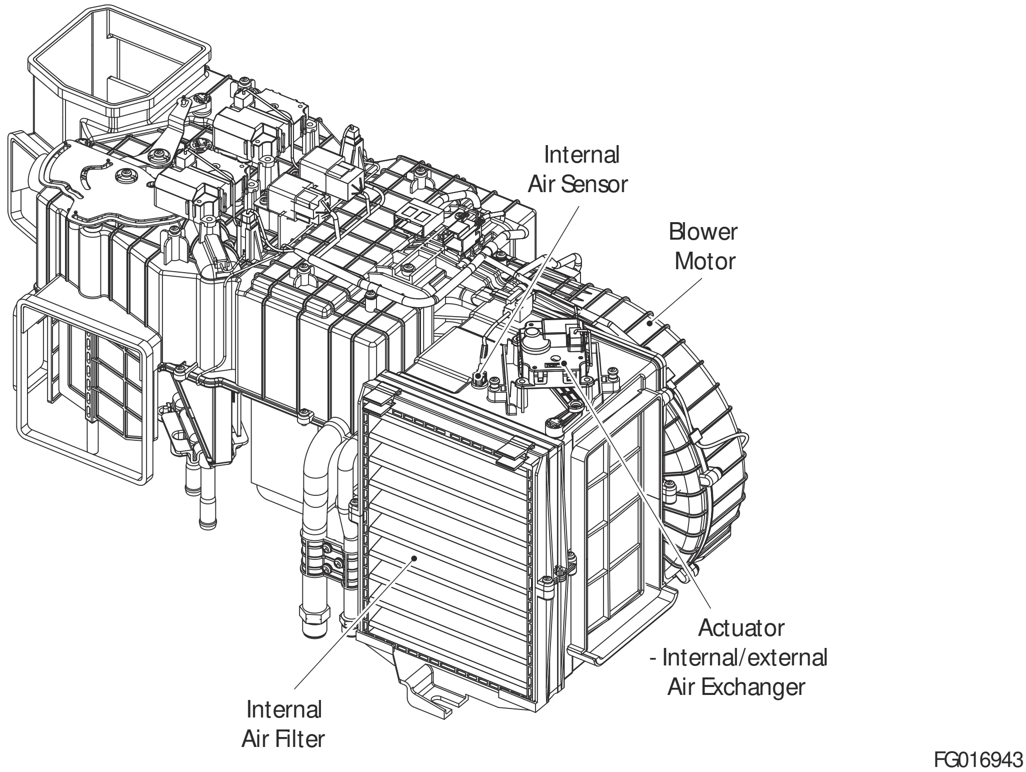


Door Open by Vent Modes

Door	Mode				
	Vent	Bi-level	Foot	Def/foot	Def
Vent	100	70	0	0	0
Foot	0	30	100	85	65
Def	0	0	0	15	35

Main Components

Figure 327



Actuator - Airflow Direction Control

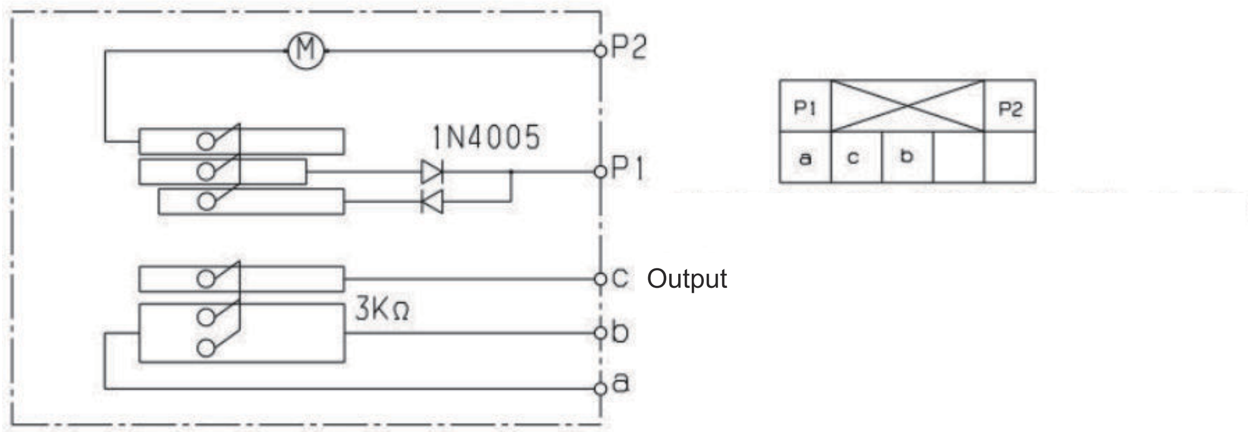
Change of discharged airflow according to selected airflow direction mode

Change of airflow direction: Direction changes in the order of VENT→ BI-LEVEL → FOOT → FOOT/DEF → VENT.

Actuator - Temperature Control

Change of discharged air temperature by controlling the position of temperature control door.

Figure 328



Actuator - Airflow Direction Control

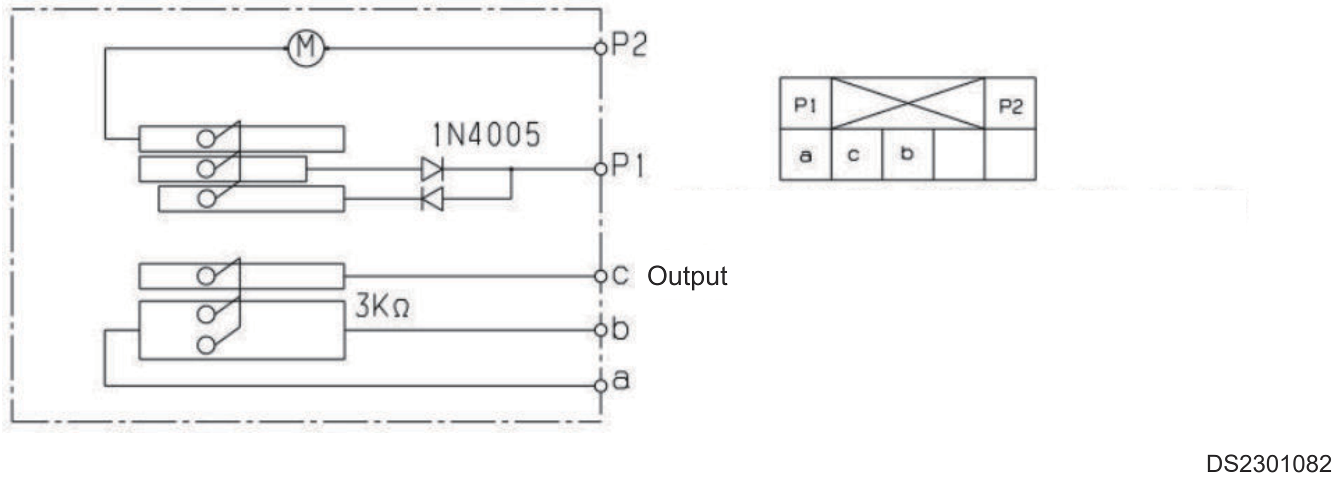
Position	Feedback (V)
Vent/Recirculation	0.53
Vent/Recirculation/Foot	1.2

Position	Feedback (V)
Foot	2.4
Mix	3.5
Defrost	4.6

When Vent/Rear mode is converted to Vent/Rear/Foot mode, after controlling the motor as much as the target feedback +0.5 V, the target feedback voltage is restored.

Actuator - Internal/External Air Exchange

Figure 329



Mode	Output Terminal	Output
Intake	P1 (+), P2 (-)	Moving of exchange door by selecting intake.
Recirculate	P1 (-), P2 (+)	Moving of exchange door by selecting recirculate.

Airflow Control Module

Airflow is controlled through the control of voltage between GATE and SOURCE.

Figure 330

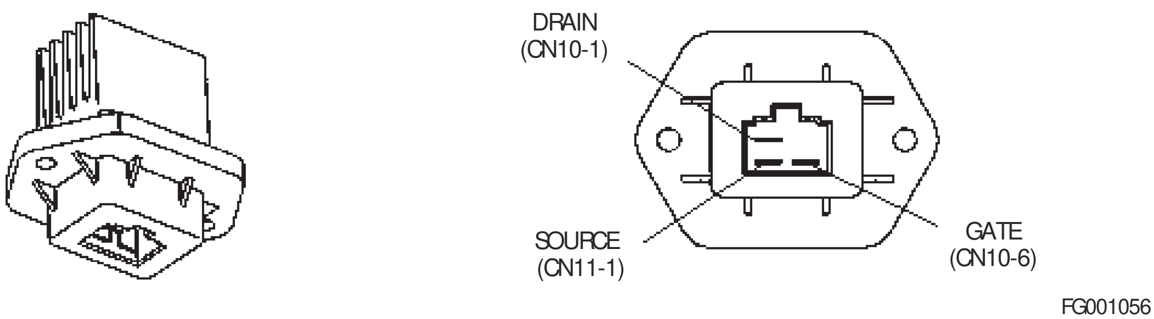
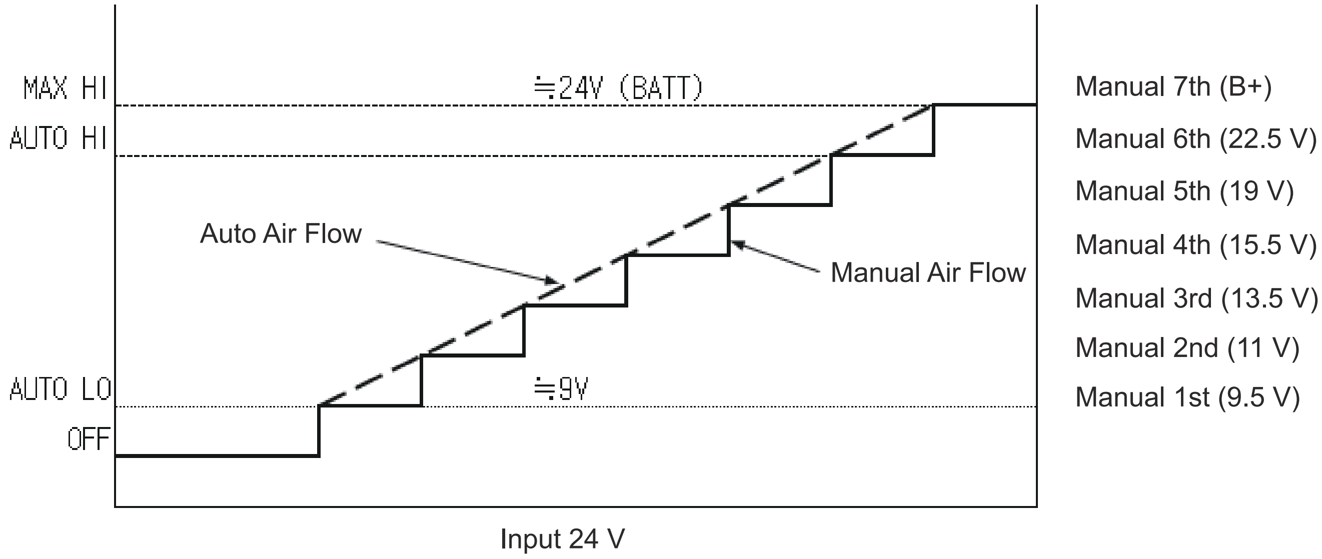


Figure 331

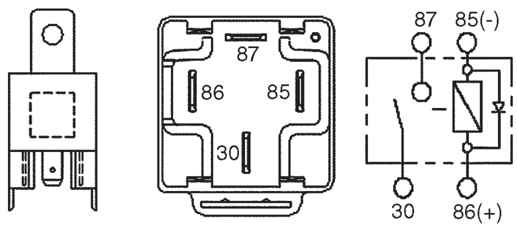


DS2301083

The airflow is based on manual set.

Relay - Blower: Power is supplied to the blower motor when the system is turned "ON".

Figure 332

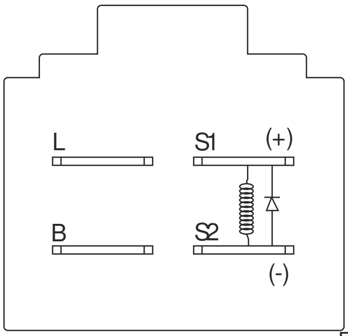


FG001057

Specifications	
Rated voltage	24V
Rated current	20A

Relay - A/C: Power is supplied to the magnetic clutch of the compressor.

Figure 333

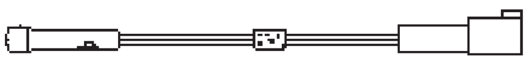


FG001058

Specifications	
Rated voltage	24V
Rated current	10A

Duct Sensor: It is inserted in the core of the evaporator to prevent freezing of the evaporator.

Figure 334



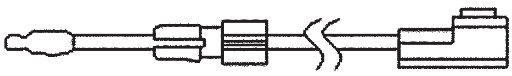
FG001059

The sensor consist of negative characteristic thermistor that resistant value increases and decreases when the temperature rises and falls, respectively.

Temperature (°C)	Resistance (KΩ)
0	11.36 ±0.1
2	10.39 ±0.2
2.5	10.17 ±0.2
3	9.95 ±0.2
3.5	9.73 ±0.2
4	9.52 ±0.2
5	9.12 ±0.2
10	7.36 ±0.15
25	4.02 ±0.08
30	3.33 ±0.07

Internal Air Temperature Sensor:Built in the internal air filter, it senses the internal temperature.

Figure 335

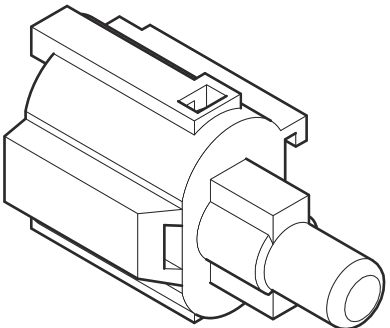


FG001061

Temperature (°C)	Resistance (KΩ)
-15	218.2 ±7.5

Temperature (℃)	Resistance (KΩ)
0	97.83 ±0.9
15	47.12 ±0.7
25	30.0 ±0.36
35	19.60 ±0.3

Figure 336



Ambient Air Temperature Sensor

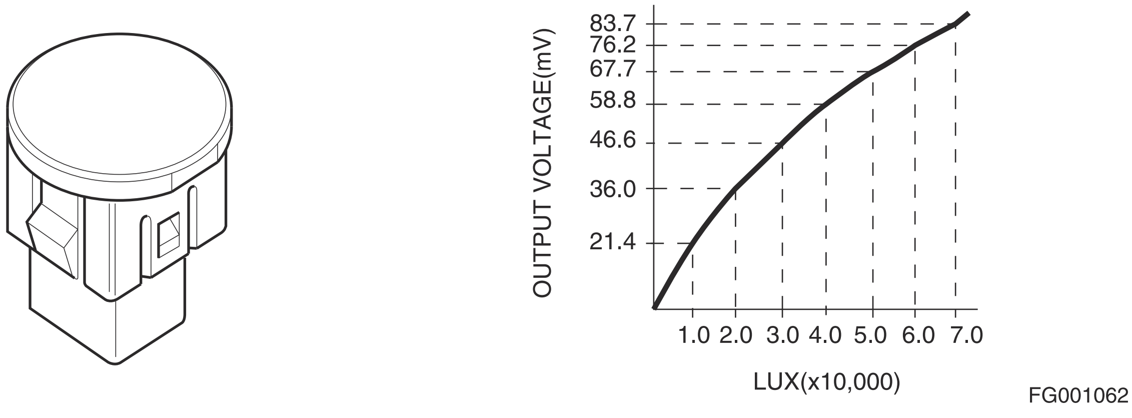
Built at the bottom of the cockpit, it senses the temperature of external air.

Temperature (℃)	Resistance (KΩ)
-10	163 ±4.9
0	96.9 ±2.9
10	59.4 ± 1.8
20	37.4 ±1.1
25	30 ±0.9
30	24.2 ±0.7

Photo Sensor

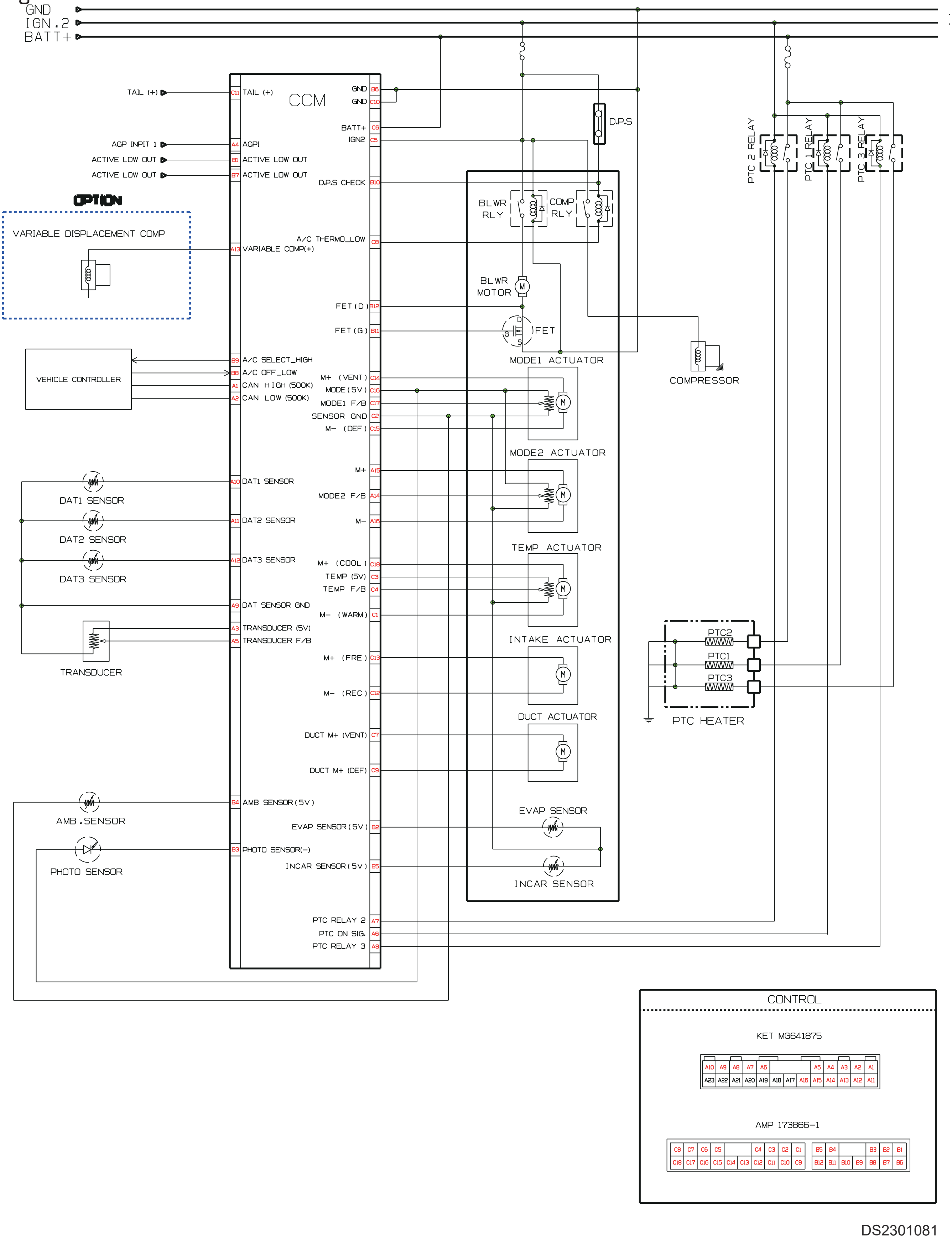
Built beside the socket of spare power, it senses the quantity of the sun radiation to regulate discharge temperature and airflow as set by operator.

Figure 337



Air Conditioner/Heater Circuit Diagram

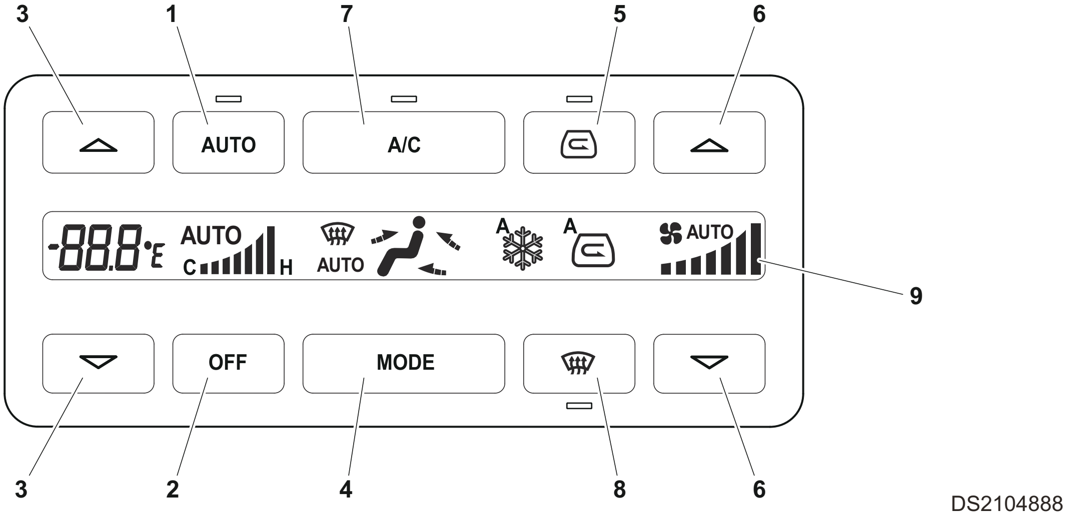
Figure 338



Control Panel

Appearance and Terminal Arrangement

Figure 339



1	Automatic Temperature Control Button	6	Fan Speed Selector Button
2	Off Button	7	Air Conditioner Button
3	Temperature Control Button	8	Defroster Button
4	Air Outlet Selector Button	9	LCD Display
5	Air Inlet Selector Button	-	-

Refer to "Air Conditioner and Heater" of operation manual.

Control Connector

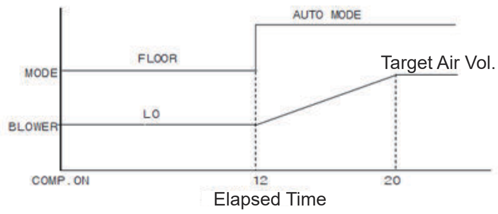
	Pin No.	Description		Pin No.	Description
Connector A	1	CAN High	Connector B	1	Active Low Out
	2	CAN Low		2	Evaporator Sensor
	3	Transducer 5V Out		3	Photo Sensor
	4	AGP Input 1		4	Ambient Sensor
	5	Transducer Feedback		5	In-car Sensor
	6	PTC 1 (Active Low Out)		6	GND
	7	PTC 2 (Active Low Out)		7	Active Low Out
	8	PTC 3 (Active Low Out)		8	Compressor Off Signal_Low
	9	DAT Sensor GND		9	A/C Select Signal_High
	10	DAT Sensor 1		10	DPS Check
	11	DAT Sensor 2		11	FET (G)_Blower Control
	12	DAT Sensor 3		12	FET (D)_Blower Feedback
	13	Variable Compressor (+)		-	-
	14	Mode 2 Feedback		-	-
	15	Mode 2 Actuator (+)		-	-

	16	Mode 2 Actuator (-)		-	-

	Pin No.	Description
Connector C	1	Temperature Actuator (Warm)
	2	Sensor GND
	3	Temperature 5V Out
	4	Temperature Feedback
	5	IGN +
	6	B +
	7	Duct Actuator (Vent)
	8	A/C Thermo Signal_Low
	9	Duct Actuator (Vent)
	10	GDN
	11	ILL +
	12	Intake Actuator (-)
	13	Intake Actuator (+)
	14	Mode Actuator (Vent)
	15	Mode Actuator (Defrost)
	16	Mode 5V Out
	17	Mode Feedback
	18	Temperature Actuator (Cool)

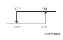
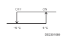
Control Logic

Categories	Inputs	System Operation
Auto	Set temperature Internal air temperature sensor Ambient air temperature sensor Sun sensor	1. Automatically adjust room temperature as set and then next items. 2. Auto mode is released when manually setting any switch except, Temperature Control switch in Auto mode. 3. Upon the releasing of Auto mode, all of functions except selected switch are controlled automatically.
Sensor compensation	Set temperature Internal air temperature sensor Ambient air temperature sensor	1. In case of sensor fault, the following defaults are applied: Temperature control actuator: - Set Temperature 17 - 24.5°C: Max cooling, Set Temperature 25 - 32°C: Max heating Airflow direction mode actuator - VENT: VENT fix, modes other than VENT: Fixed to DEF

<table>
<tr><th>Categories</th><th>Inputs</th><th>System Operation</th></tr>
<tr><td></td><td></td><td>* Sun sensor is not compensated.</td></tr>
<tr><td>Max cooling/ heating control</td><td>Auto Setting</td><td>1.
<table>
<tr><td></td><td colspan="2">Temperature</td></tr>
<tr><td>System</td><td>Low (Max. Cool)</td><td>High (Max. Hot)</td></tr>
<tr><td>Mode</td><td>Vent/Rear</td><td>Foot</td></tr>
<tr><td>Temp.</td><td>Max. Cool</td><td>Max. Warm</td></tr>
<tr><td>Intake</td><td>Recirculation</td><td>Fresh Air</td></tr>
<tr><td>Blower Speed</td><td>7th</td><td>6th</td></tr>
<tr><td>A/C</td><td>On</td><td>Off</td></tr>
</table>
DS2301085
When the set temperature is set to the maximum (Low or High), the automatically controlled functions are forcibly fixed and controlled as follows.
2. Returns to the previous mode when the function is canceled due to the change in the set temperature.</td></tr>
<tr><td>Starting Control of Cooling</td><td>Auto mode
Duct sensor</td><td>When Ignition Switch is ON, blower speed and wind direction are controlled to prevent unpleasant feeling due to rapid discharge of hot air right before A/C is turned on.
1. Start condition (AND condition): Ignition Off → On & A/C On, Blower Auto, Evaporator senses over 30°C
2. Control condition


DS2301086
3. Release Conditions (OR condition): Blower Manual Selection, A/C Off, Pressing Defrost switch
4. Priority is given to starting air volume control over the maximum cooling control function based on the set temperature.</td></tr>
<tr><td>Starting control of heating</td><td>Internal air temperature sensor
Auto mode
Set Temperature</td><td>1. Start condition (AND condition for A, B, and C), (OR condition for D and E)
A. Ignition Off (After 1 hour later) → Ignition On
B. Outdoor Temperature: Below 5°C
C. System On
D. When Mode is Floor by Auto
E. For Blower Auto</td></tr>
</table>

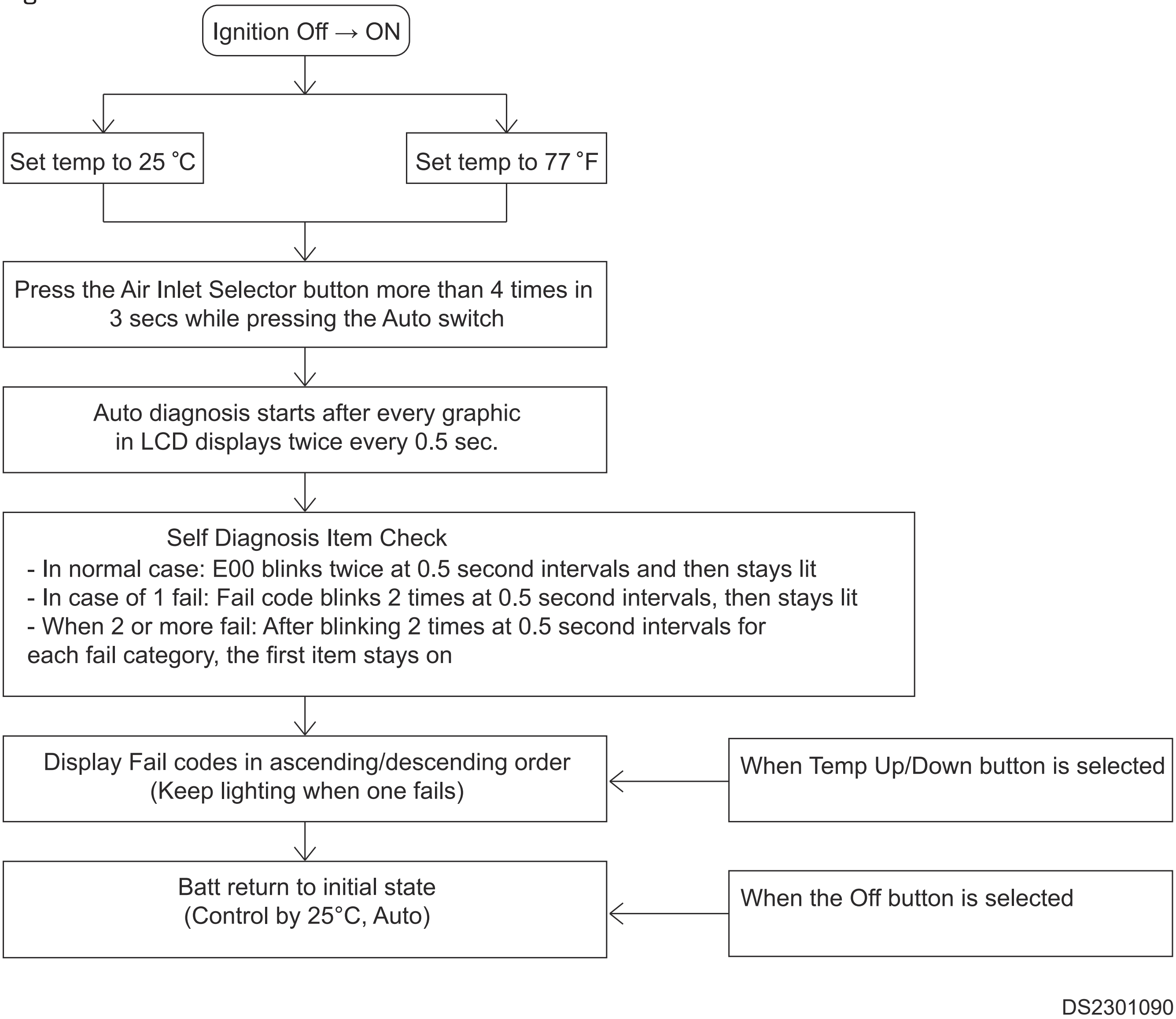
<table>
<tr><th>Categories</th><th>Inputs</th><th>System Operation</th></tr>
<tr><td></td><td></td><td>2.
<table><tr><th>Outdoor Temperature (°C)</th><th>Control Time (min.)</th></tr><tr><td>Below -15</td><td>8</td></tr><tr><td>-15 ~ -10</td><td>6</td></tr><tr><td>-9.5 ~ -1</td><td>4</td></tr><tr><td>-0.5 ~ 5</td><td>2</td></tr></table>DS2301087

Control condition
• During manual selection during heating control, the selected function is manually controlled and heating control is maintained.
• When Auto is selected in the manual control state, it operates as a heating control.
• When defrost on heating control, the switch indicator turns off.
• Max. Priority is given to heating control over the hot function.
• Max. Heating control is performed when the heating control entry condition is reached when cool is released.</td></tr>
<tr><td>Compressor control</td><td>Evaporator sensor</td><td>1. Function: Magnetic clutch of compressor is turned "ON/OFF" depending on temperature of the duct sensor to prevent the freezing of the evaporator with A/C being "ON".
2. Control pattern. </td></tr>
<tr><td></td><td>External temperature sensor</td><td>1. Function: Prevention of compressor in winter.
2. Control pattern. </td></tr>
</table>

Self-diagnosis

How to start self-diagnosis

Figure 340

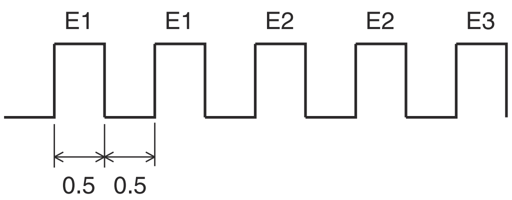


Error codes

Code	Description	Failure Judgment Condition
E0	Normal	-
E1	In-car sensor short	When In-car Feedback ≤ 0.1 V
E2	In-car sensor open	When In-car Feedback ≥ 4.9 V
E3	Ambient air temperature sensor short	When Ambient air temp. sensor Feedback ≤ 0.1 V
E4	Ambient air temperature sensor open	When Ambient air temp. sensor Feedback ≥ 4.9 V
E5	Evaporator sensor short	Evaporator sensor Feedback ≤ 0.1 V
E6	Evaporator sensor open	Evaporator sensor Feedback ≥ 4.9 V
E7	-	-
E8	Photo sensor open	Photo sensor Feedback ≤ 0.05 V
E9	-	-

Code	Description	Failure Judgment Condition
E10	-	-
E11	D.P.S open	D.P.S input is open
E12	Bad Mode actuator drive system	When the actuator does not reach the target position within 10 seconds
E13	Bad Temp. actuator drive system	When the actuator does not reach the target position within 10 seconds
E14	Mode actuator open or short	When Mode Feedback ≤ 0.1 V or Mode Feedback ≥ 4.9 V
E15	Temp. actuator open or short	When Temp. Feedback ≤ 0.1 V or Mode Feedback ≥ 4.9 V

Figure 341



FG001067

NOTE: *The position error means that it fails to move to designated place in 40 seconds.*

NOTE: *Sun sensor displays E8 in case of no sunlight.*

NOTE: *2 and more fails: Codes concerned blinks twice at a time.*

Ambient Temperature Display

Selection of both the SEL and MODE switch for more than 3 seconds indicates the ambient temperature in the set temperature display department.

- Range of temperature display: -40 - +60°C

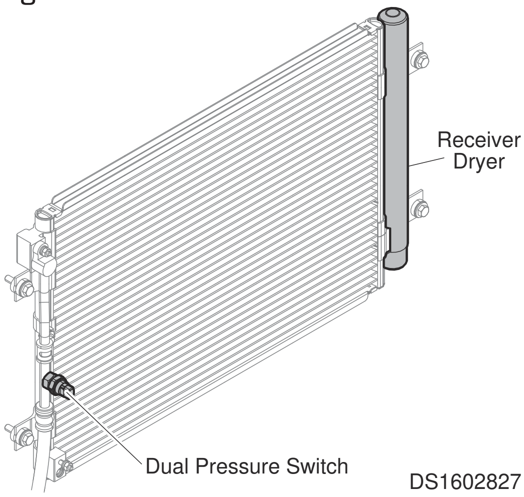
NOTE: *Display of ambient temperature may be released in the same way for its entry way.*

NOTE: *It returns automatically to default mode 5 seconds after entering the ambient air temperature display mode.*

Receiver Dryer

The receiver dryer reserves refrigerant enough to ensure smooth freezing cycle responding immediately to the change of level in the freezing cycle.

Figure 342

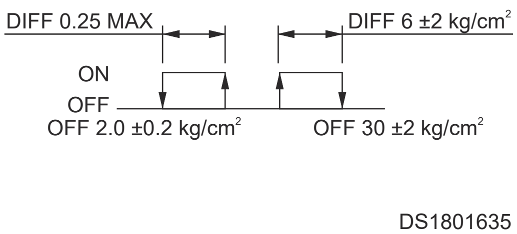


As liquid refrigerant from the condenser may contain refrigerant gas with bubbles whose presence in the expansion valve decreases the freezing power excessively, it separates liquid and gas and sends liquid only to the expansion valve.

Water in refrigerant shall be eliminated with dryer and through filter.

During refrigerant recovery and refilling, the desiccant and filter must be replaced.

- Figure 343



Refrigerant System Repairs

WARNING

AVOID DEATH OR SERIOUS INJURY

Always wear safety goggles and gloves when handling refrigerant. If refrigerant comes in contact with the skin or eyes, immediately flush with clean, running water and consult a physician.

Select a clean and well ventilated area to work.

The refrigerant container is under high-pressure and must be stored below 40°C (104°F). Be careful not to drop the container from a high location.

The contents are under high-pressure and should not be used with compressed air or near an open flame.

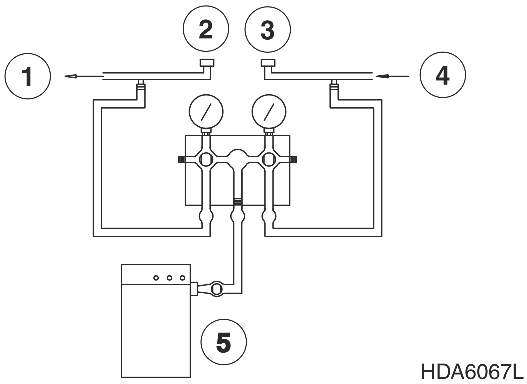
The “vacuum operation” consists of eliminating moisture in the air conditioner circuit.
If there is any moisture left inside the air conditioner circuit, various problems may occur during operation such as freezing in the small hole of the expansion valve causing the circuit to clog and rust developing in the circuit.

Refrigerant Safe Handling Procedures

The following procedures must be observed for safe handling of refrigerant during vacuum and charging process.

1. Use an approved recovery/charging device which can safely perform vacuum and charge work simultaneously.
2. When charging the refrigerant, be careful to ensure that the prescribed amount of refrigerant is filled.
3. Do not over tighten connections when working on refrigerant system.
4. The new refrigerant system standards require new tools, equipment and parts. DO NOT attempt to use equipment use in servicing the old refrigerant system.
5. The new refrigerant oil (PAG type) has a high moisture absorption characteristic. When the refrigerant system vacuum seal has been broken, immediately plug up all openings to prevent moisture from entering the system.
6. When installing flanges that use O-ring seals, apply refrigerant oil lightly to the O-ring. Be careful not to get refrigerant oil on the threaded part of the nut.
7. Be certain the O-rings are seated properly on the refrigerant line lip. Always use new O-rings when reassembling parts. Do not reuse old O-rings.
8. Refer to the refrigerant recovery and filling method for repair and replacement procedures.

Figure 344



Refrigerant Recovery

Reference Number	Description
1	To Compressor
2	Low-pressure Side
3	High-pressure Side
4	To Receiver drier

Reference Number	Description
5	Refrigerant Recovery Tank

1. Attach the manifold gauge and the refrigerant recovery unit to the refrigerant lines as shown.

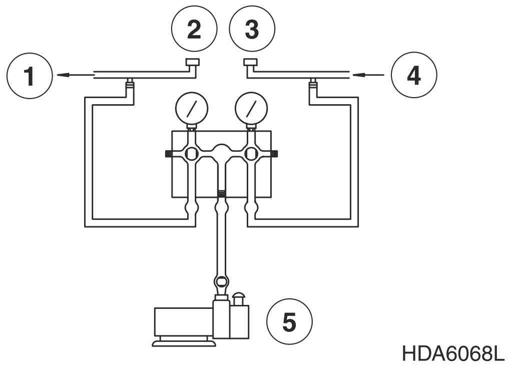
   NOTE: *Be careful not to switch the connections for the low and high-pressure valves.*

2. Open the high-pressure valve slowly to release the refrigerant to the recovery unit.

   NOTE: *Open the valve slowly, while checking to see that refrigerant is not leaking out.*

3. When the manifold gauge dial falls below 3.5 bar (50 psi), slowly open the low-pressure valve.
4. Open both the high and low-pressure valves slowly until manifold gauge dials indicates 0 bar (0 psi).

Figure 345



Vacuuming Refrigerant System

Reference Number	Description
1	To Compressor
2	Low-pressure Side
3	High-pressure Side
4	From Receiver drier
5	Vacuum Pump

1. Vacuuming Procedure

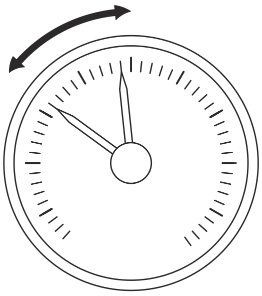
   NOTE: *When the A/C system has been exposed to the air, it must be vacuumed out. Perform vacuum process for 30 minutes for complete moisture and air evacuation.*

   A. Attach the manifold gauge and vacuum pump to the refrigerant system as shown.

   B. Turn on the vacuum pump and open both valves.

   C. After running the vacuum pump for 5 minutes, when the low pressure side gauge indicates -712~-750 mmHg (-0.95~-1 bar, -13.8~-14.5 psi), close both valves and stop the vacuum pump.

2. Figure 346



HDA6069L

Check system for vacuum leak.

Allow system to sit for 10 minutes and check whether the system is holding the pressure. If the pressure has dropped, it must be repaired before proceeding to the next step.

3. Vacuuming Procedure

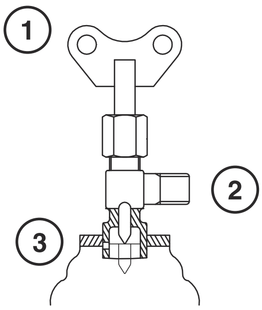
If the pressure in the unit does not fall below -675 mmHg (-0.9 bar, -13.1 psi) in 10 minutes, vacuum the system for 20 minutes.

A. Turn on the vacuum pump and slowly open both valves.

B. Run the vacuum pump for additional 20 minutes.

C. Close both valves and stop the vacuum pump.

4. Figure 347



HDA6070L

Installation of Refrigerant Container

Reference Number	Description
1	Handle
2	Hose Connection
3	Mounting Disk

A. Before mounting valve on the container, make sure the handle is in the counterclockwise most position, with the puncture pin retracted and the mounting disk is in the raised position.

B. Attach the manifold gauge center hose to the valve assembly.

C. Turn the disk in the clockwise direction and securely mount valve onto refrigerant container.

D. Turn the valve handle in the clockwise direction and puncture the container seal with the pin.

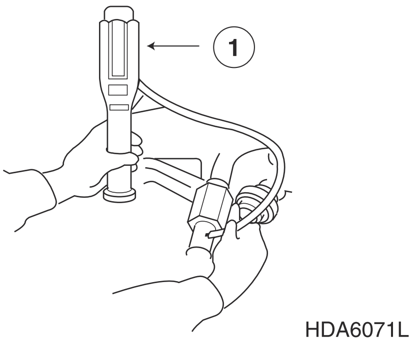
E. Once the can has been punctured, turn the handle in the counterclockwise direction so the refrigerant can flow into the manifold gauge center hose. Now, do not open the low and high-pressure valves of the manifold gauge.

F. Press the manifold gauge low side valve to eliminate the trapped air in the hose.

Leakage Check

NOTE: *Perform the leakage check after completing vacuuming process.*

1. After attaching the manifold gauge, open the high side valve.
2. Charge system until low side gauge dial indicates a pressure of 1 bar (14 psi) and close the high side valve.
3. Figure 348



Using a refrigerant leak detector or soapy water check each joint for leakage.

Reference Number	Description
1	Refrigerant Leak Detection Device

4. If a leak is detected, check for O-ring damage or correct tightening torque and replace or repair as necessary.
5. If no leaks are detected, proceed with the charging process.

WARNING

AVOID DEATH OR SERIOUS INJURY

For accurate refrigerant leak detection, perform leak detection procedure in a well ventilated area.

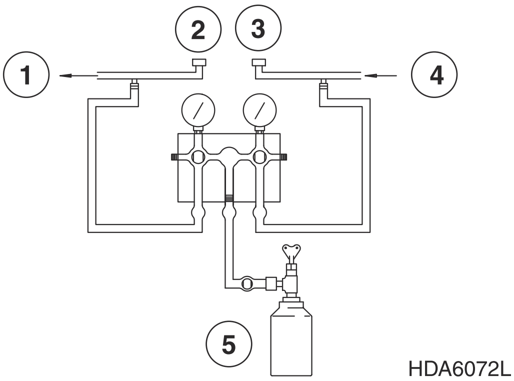
Refrigerant Charging

1. Perform the vacuuming procedure, vacuum holding and leaking tests as described in the proceeding headings.

   NOTE: *First charge the refrigerant system with 100g (3.5 ounces) of refrigerant with the engine off. Then using the manifold gauge as a guide fully charge the system with the engine running.*

NOTE: *When exchanging refrigerant containers, press the manifold gauge low side valve to eliminate air from the charging hose.*

Figure 349



Reference Number	Description
1	To Compressor
2	Low-pressure Side
3	High-pressure Side
4	To Receiver drier
5	Refrigerant Supply Container

2. Charge the system by opening the manifold gauge low side valve.

   Initial charge amount: 100 g (3.5 ounces).

3. If the refrigerant does not enter well, turn the refrigerant container upside down to inject the refrigerant.While the refrigerant is being injected, measure the weight of the refrigerant container using a scale to check if the proper amount is entered.

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

When charging refrigerant system with the engine running:

- Always keep refrigerant supply container in the upright position.
- Never open the high side pressure valve.

4. Open the manifold gauge low side valve and charge system to standard capacity.

   NOTE: *Appropriate pressure at an outside temperature of 30 - 35 °C is at High pressure: about 15 - 17 kg/cm^2, Low pressure: about 1.3 - 2.0 kg/cm^2*

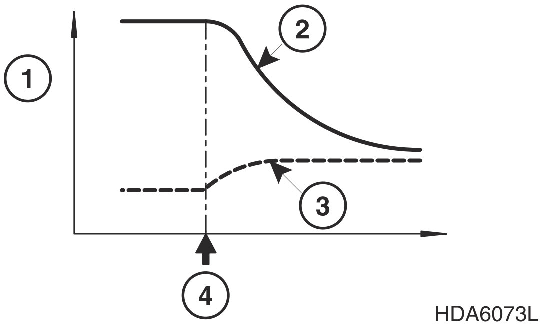
Ambient Temp. (°C)	High Pressure (PSI)	High Pressure (kg/cm^2)	Low Pressure (PSI)	Low Pressure (kg/cm^2)
21	120 - 190	8.4 - 13.3	7 - 15	0.5 - 1
27	140 - 210	9.8 - 14.7	7 - 20	0.5 - 1.4
32	170 - 240	12 - 16.8	7 - 20	0.5 - 1.4
38	190 - 270	13.3 - 19	10 - 30	0.7 - 2.1
43	210 - 300	14.7 - 21.1	10 - 30	0.7 - 2.1

NOTICE

- When outside temperature is low, warm the refrigerant supply container with warm water not exceeding 40°C (104°F). Do not allow water to come in contact with the charging adapter valve handle.
- When outside temperature is high, cool off refrigerant supply container and condenser to aid the refrigerant charging process.

5. Close low-pressure side valve.
6. Shut off engine and close refrigerant supply container adapter valve. Disconnect manifold gauge hoses from machine.

Figure 350



Inspecting System For Leakage

After completing charging procedures, clean all joints and connections with a clean dry cloth. Using a refrigerant leak detecting device or soapy water, inspect system for leaks starting from the high-pressure side.

NOTE: *When the refrigerant circulation has been stopped the high-pressure will start to decrease and the low-pressure will start to increase until they are equalized. Starting the inspection from the high side will result in an accurate test.*

Reference Number	Description
1	Pressure
2	High-pressure
3	Low-pressure
4	Compressor Stop

Inspection Procedure

1. High-pressure Side

   Compressor outlet → condenser inlet → receiver dryer inlet → air conditioner unit inlet.

2. Low-pressure side

   Compressor inlet → air conditioner unit outlet.

3. Compressor

   Compressor shaft area, bolt hole area and magnetic clutch area.

4. Receiver dryer

   Pressure switch and plug area.

5. Connection valve area

   Inspect all valve areas.

   Verify all valves are capped to prevent leaking.

   Check for foreign material inside of valve cap.

6. Interior of air-conditioning unit.

   After stopping engine, insert detector probe into drain hose. (Leave inserted for 10 seconds minimum.)

   NOTE: *When inspecting leakage from the air-conditioning unit, perform the inspection in a well ventilated area.*

Approximate Refill Capacities

When removing and installing the parts of Air Conditioning, check the each component's refrigerant oil quantity.

Each component contains the appropriate oil.The oil quantity being low will cause compressor seizing and a reduction in durability. The oil quantity being high will cause a reduction in cooling capabilities.Make sure to check the oil quantity and adjust if needed.Measure the oil quantity of the removed parts. Only this oil quantity is necessary, so subtract this quantity to determine the amount by which the oil quantity of the new parts should be reduced.Example)If the remaining oil quantity of the removed compressor is 40 g: Remove 150 g - 40 g = 110 g from the new compressor to be installed.

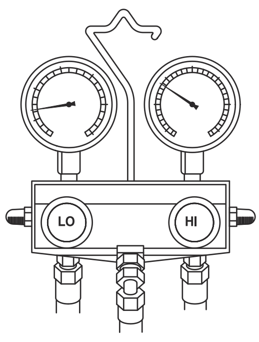
- Volume of refrigerant: R-134a, 900g
- Refrigerant Oil: PAG SP-A2, Refer to the below table for specific oil quantity.

Containing Refrigerant Oil Quantity					
Compressor	Condenser	HVAC (EVA)	Discharge Hose	Suction Hose	Liquid Hose
180 g	40 g	103 g	31 g	56 g	27 g

Troubleshooting

Refrigerant Pressure Check

1. Figure 351



HDA6074L

   Open all doors and windows.

2. Install manifold gauge set.
3. Start engine and maintain engine speed at 1,800 - 2,000 rpm.
4. Check high/low-pressure of refrigerant.

1	High-pressure: 8.0 - 10.0 bar (114 - 142 psi) Low-pressure: Approximately 1.0 bar(14 psi)		
Possible Cause: Low Refrigerant Level			
Step	Inspection Item		Remedy
1	Check for traces of refrigerant oil.	Yes	Reassemble using correct tightening torque.
		No	Go to next step.
2	Using a leak detection device or soapy water check for refrigerant leakage at all major components and joints.	Yes	Repair leaking component.
		No	Recharge system to correct pressure.

2	High-pressure: Over 23 bar (327 psi) Low-pressure: Approximately 2.5 - 3.0 bar(36 - 43 psi)		
Possible Cause: Overcharge, Frost on condenser			
Step	Inspection Item		Remedy
1	Check for condenser pin damage or contamination.	Yes	Clean, repair or replace condenser.
		No	Refrigerant overcharge.

3	High-pressure: Approximately 20 - 25 bar (285 - 356 psi) Low-pressure: Approximately 2.5 - 3.5 bar (36 - 50 psi)
Possible Cause: Air in system.	
A. Recover any remaining refrigerant. B. Vacuum out system. C. Recharge system. NOTE: *During refrigerant recovery and refilling, the desiccant and filter must be replaced.*	

4	High-pressure: Over 6 bar (85 psi) Low-pressure: Approximately 760 mmHg (Negative Pressure)		
Possible Cause: Refrigerant does not circulate			
Step	Inspection Item		Remedy
1	A. Connect manifold gauge and start engine. B. Turn on air conditioner. C. Set blower switch to HIGH position. D. Turn air conditioner OFF and wait 10 minutes.	Yes	Moisture in system, replace receiver dryer.
		No	Contaminated system, replace expansion valve. (Replace evaporator core assembly.)

4	High-pressure: Over 6 bar (85 psi) Low-pressure: Approximately 760 mmHg (Negative Pressure)		
	E. Recheck high/ low-pressure readings. Low-pressure: 1.5 - 3.3 bar (21.3 - 46.9 psi)		

5	High-pressure: Over 6 - 18 bar (85 - 256 psi) Low-pressure: 500 mmHg (Negative Pressure) - Dial indicator needle unstable.
Possible Cause: Moisture in system has iced up the expansion valve. NOTE: *When the absorbed moisture freezes the pressure readings may look normal. Careful readings must be made to determine whether pressure is in normal range.*	
A. Recover any remaining refrigerant. B. Vacuum out system. C. Recharge system. NOTE: *During refrigerant recovery and refilling, the desiccant and filter must be replaced.*	

6	High-pressure: Over 22.0 - 23 bar (313 - 327 psi) Low-pressure: 2.5 bar(36 psi)		
Possible Cause: Refrigerant pressure problem because of defective expansion valve or temperature sensor.			
Step	Inspection Item		Remedy
1	Inspect whether the temperature sensor is installed properly.	Yes	Replace expansion valve.
		No	Exchange duct sensor.

7	High-pressure: Over 7.0 - 11.0 bar (100 - 156 psi) Low-pressure: 4.0 - 6.0 bar(57 - 85 psi)
Possible Cause: Low refrigerant pressure because of poor compressor compression.	
Inspect and replace compressor if necessary.	

Removal and Installation

Engine

Safety Instructions

⚠ WARNING

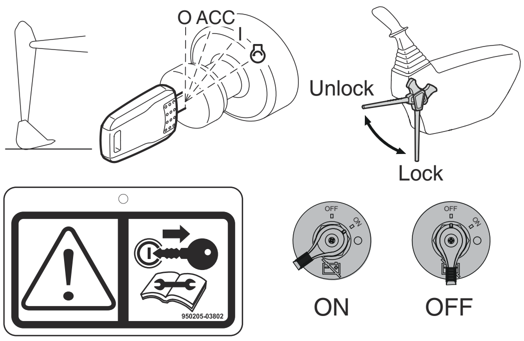
AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or servicingmachine. Read and understand the Operation & Maintenance Manual and signs (decals) on machine. Followwarnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correctfunction after adjustments repairs or service. Untrainedoperators and failure to follow instructions can cause deathor serious injury.

Before Removing and Installing

Preparatory Work

1. Park the machine on level ground. And lower front attachment to the ground.
   Figure 1

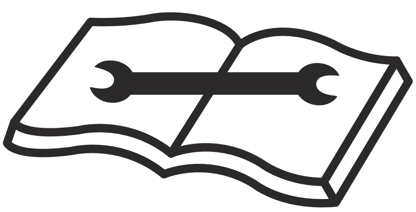


EX1504472

2. Move safety lever to "LOCK" position and then stop the engine.
3. Turn battery disconnect switch to "OFF" position.
4. Release the remaining pressure in the hydraulic circuit.
5. Cool down the hydraulic system and engine.
6. Attach a maintenance warning tag on controls.

General Precaution

1. Always read the safety section before removing and Installing.
   Figure 2



DS1901903

2. Mark the location of the bolts before removing.
3. Keep in the mind the order for tightening bolts.
4. Tighten bolts by hands, then using the tool.
5. If reusing the bolts, clean threads and apply thread locker to threads prior to installation.
6. Mark the location of wire harness connectors and hoses before disconnecting.
7. Be careful not to damage all components.
8. Do not reused gaskets, O-ring and adhesive bolts.

Completing Work

1. Check oil, coolant and fuel leak from the machine.
2. Check all oil level and if necessary, add oil.
3. Fill up the fuel tank to the standard level.
4. Apply grease to all lubrication points.
5. When fuel component has been disconnected, air must be bled from circuit.
   For details, see the Operation and Maintenance Manual.
6. When hydraulic component has been disconnected, air must be bled from circuit.
   For details, see the Operation and Maintenance Manual.
7. Start the engine and run at low idle for about 5 minutes.
8. Perform the machine performance test.

ECU (Engine Control Unit)

Repair Procedure Quick Guide

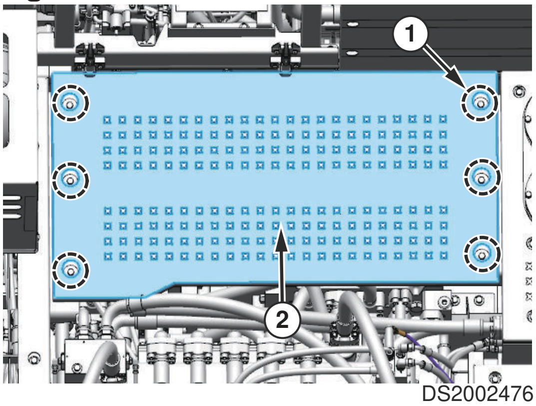
Step-A. Remove cover
Step-B. Disconnect wiring harness
Step-C. Remove ECU assembly

Removal

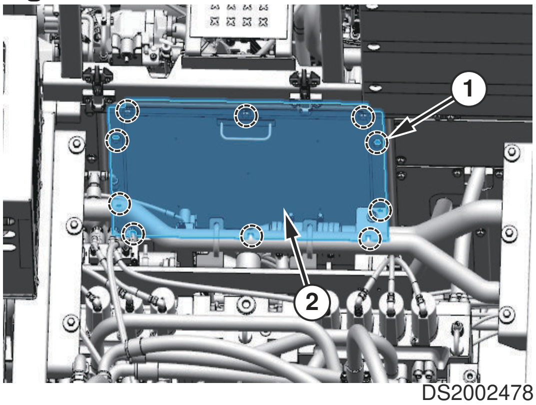
1. Open the left side door.
2. Turn OFF the battery disconnect switch.

Cover

1. Remove mounting bolts (1) from cover.
   Figure 3



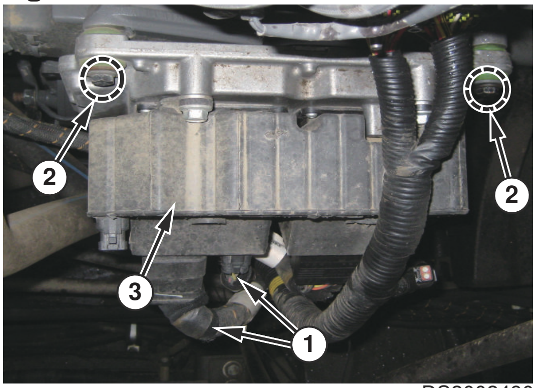
   - Tool: 19 mm ()
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
2. Remove cover (2) from frame.
   - Weight: about 39 kg (86 lb)
3. Remove mounting bolts (1) from cover.
   Figure 4



   - Tool: 19 mm ()
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
4. Remove cover (2) from frame.
   - Weight: about 9 kg (19.8 lb)

ECU Assembly

1. Disconnect wire harnesses (1) from ECU assembly.
   Figure 5



DS2002490

NOTE: *Check the location of the connectors before disconnecting. Be careful not to let water get into electrical components. If water gets into electrical system, this will cause an electrical short circuit and result in improper machine operation.*

2. Remove mounting bolts (2) from ECU bracket.

   NOTE: *Do not tighten the fasteners too hard when installing.*

3. Remove ECU assembly (3).

Installation

1. Perform installation in the reverse order to removal.

V-Belt

Repair Procedure Quick Guide

Step-A. Remove engine hood - front, rear, right

Step-B. Remove V-belt

Removal

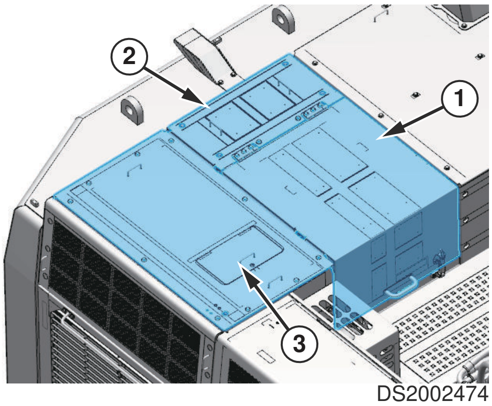
1. Open the left side door.
   Figure 6


DS2002514

2. Turn OFF the battery disconnect switch.

Engine Hood

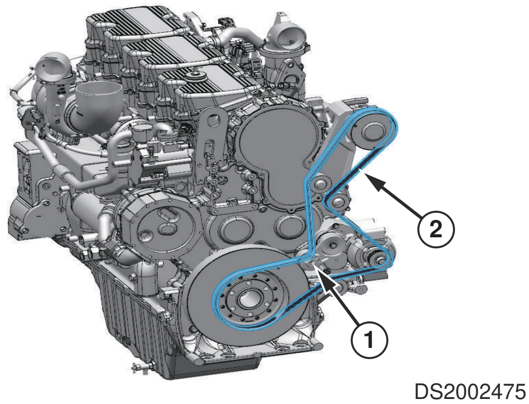
1. Open engine front hood.
   Figure 7



2. Remove stay pin.
3. Remove mounting nuts from gas spring.
4. Remove mounting bolts and engine front hood (1) from frame.
   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
   - Weight: about 54 kg (119 lb)
5. Remove mounting bolts and engine rear hood (2) from frame.
   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
   - Weight: about 17 kg (37.5 lb)
6. Remove mounting bolts and engine right hood (3) from frame.
   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
   - Weight: about 41 kg (90.3 lb)

V-belt

1. Insert the tool into the auto tensioner service hole (1).
   Figure 8



NOTE: *Before removing the belt, check the belt layout.*

2. Turn the auto tensioner with tool clockwise to loosen and put away the V-belt (2).

   NOTE: *If reusing V-belt, mark the rotation direction on the belt.*

3. Carefully release the tension.
4. Remove tool from auto tensioner service hole.

Installation

1. Perform installation in the reverse order to removal.
2. Check that V-belt is installed to the all pulley grooves.
3. Start engine.

Alternator

Repair Procedure Quick Guide

Step-A. Remove engine hood - front, rear, right

Step-B. Remove V-belt

Step-C. Remove cover

Step-D. Disconnect wiring harness

Step-E. Remove alternator

Removal

1. Open the left side door.

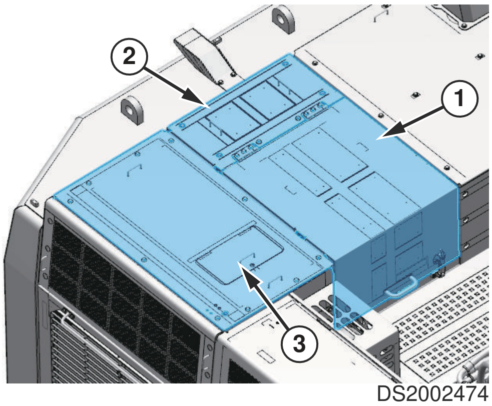
   Figure 9

DS2002514

2. Turn OFF the battery disconnect switch.

Engine Hood

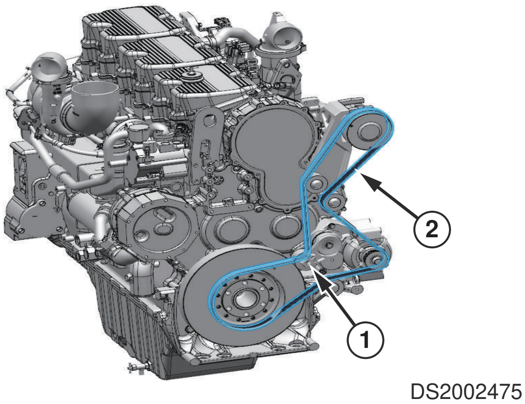
1. Open engine front hood.
   Figure 10



2. Remove stay pin.
3. Remove mounting nuts from gas spring.
4. Remove mounting bolts and engine front hood (1) from frame.
   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
   - Weight: about 54 kg (119 lb)
5. Remove mounting bolts and engine rear hood (2) from frame.
   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
   - Weight: about 17 kg (37.5 lb)
6. Remove mounting bolts and engine right hood (3) from frame.
   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
   - Weight: about 41 kg (90.3 lb)

V-belt

1. Insert the tool into the auto tensioner service hole (1).
   Figure 11



NOTE: *Before removing the belt, check the belt layout.*

2. Turn the auto tensioner with tool clockwise to loosen and put away the V-belt (2).

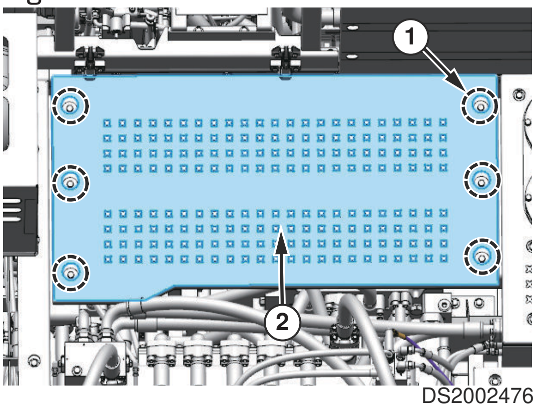
   NOTE: *If reusing V-belt, mark the rotation direction on the belt.*

3. Carefully release the tension.
4. Remove tool from auto tensioner service hole.

Cover

1. Remove mounting bolts (1) from cover.

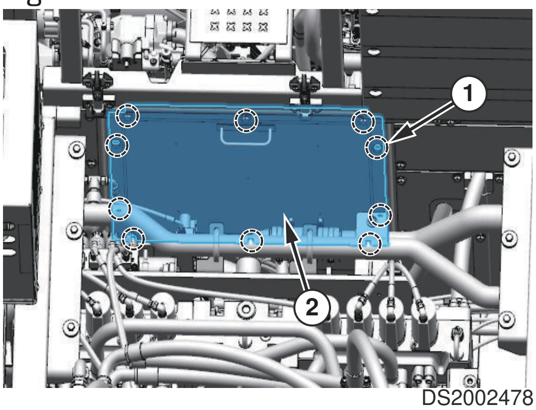
Figure 12



- Tool: 19 mm ( )
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

2. Remove cover (2) from frame.
   - Weight: about 39 kg (86 lb)
3. Remove mounting bolts (1) from cover.

Figure 13

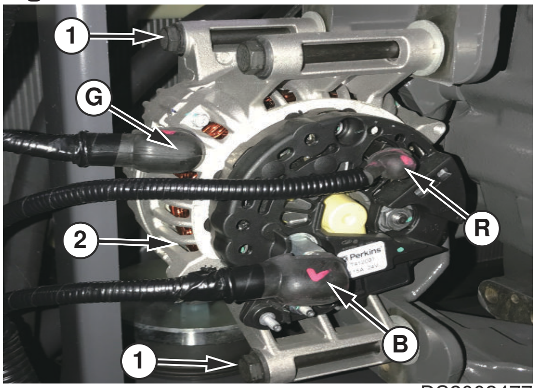


- Tool: 19 mm ( )
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

4. Remove cover (2) from frame.
   - Weight: about 9 kg (19.8 lb)

Alternator

1. Disconnect wire harness (G)
   Figure 14



DS2002477

   - Torque: 5.88 N.m (0.6 kg.m, 4.33 ft lb)
2. Disconnect wire harness (R)
   - Torque: 3.92 N.m (0.4 kg.m, 2.89 ft lb)
3. Disconnect wire harness (B)
   - Torque: 14.7 N.m (1.5 kg.m, 10.8 ft lb)
4. Remove mounting bolts (1) from engine.
   - Torque: 55 N.m (5.6 kg.m, 41 ft lb)
5. Remove alternator (2) from engine.

Installation

1. Perform installation in the reverse order to removal.
2. Check that V-belt is installed to the all pulley grooves.
3. Start engine.

Starter Motor

Repair Procedure Quick Guide

Step-A. Remove undercover
Step-B. Disconnect cable
Step-C. Remove starter motor

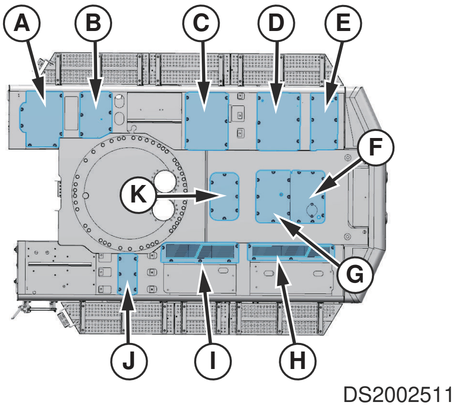
Removal

1. Open the left side door.
2. Turn OFF the battery disconnect switch.

Undercover

1. Remove the undercover (G).

Figure 15

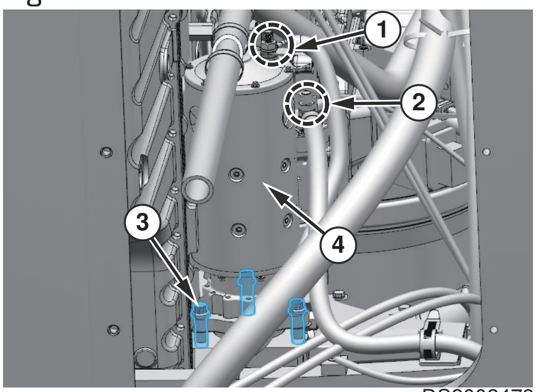


For details, refer to Undercovers - Removal and Installation.

Starter Motor

1. Remove nut (1) from starter motor.

Figure 16



DS2002479

2. Disconnect negative cable from starter motor.
3. Remove nut (2) from starter motor.
4. Disconnect positive cable from starter motor.
5. Remove mounting bolts (3) from starter motor.
   - Torque: 215 N.m (21.9 kg.m, 160 ft lb)
6. Remove starter motor (4) from engine.

Installation

1. Perform installation in the reverse order to removal.
2. Start engine.

DEF (adblue®) Heater

Repair Procedure Quick Guide

Step-A. Remove DEF (AdBlue®) cover

Step-B. Drain of DEF (AdBlue®)

Step-C. Disconnect DEF (AdBlue®) filler hose

Step-D. Remove engine sensors - DEF (AdBlue®) heater

Removal

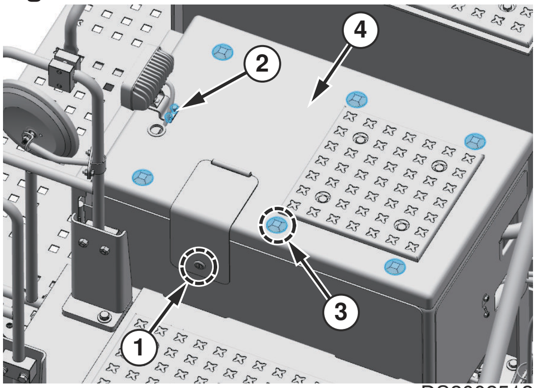
1. Open the left side door.
   Figure 17

DS2002514

2. Turn OFF the battery disconnect switch.

DEF (AdBlue®) Cover

1. Open DEF (AdBlue®) level lamp cover (1) using key.
   Figure 18



DS2002512

2. Remove work lamp mounting bolts (2).
   - Tool: 13 mm ( )
   - Torque: 29.4 N.m (3 kg.m, 21.7 ft lb)
3. Remove plug cap (3) and mounting bolts from DEF (AdBlue®) cover (4).
   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

Draining of DEF (AdBlue®)

1. Use the drain valve to drain DEF (AdBlue®).

   Figure 19

DS2002513

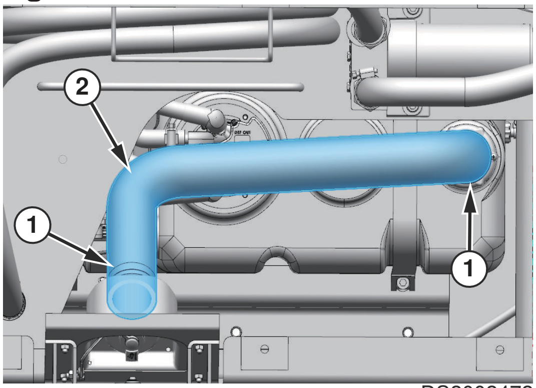
   - DEF (AdBlue®) Tank: 47 L

     NOTE: *Be sure to use vinyl gloves.*

DEF (AdBlue®) Filler Hose

1. Loosen clamps (1) from hose.

   Figure 20



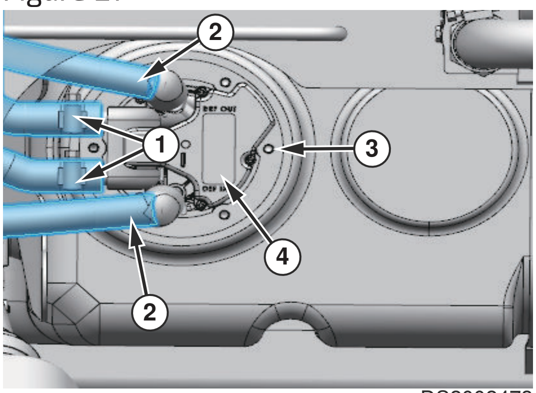
DS2002472

2. Remove DEF (AdBlue®) filler hose (2) from DEF (AdBlue®) tank.

DEF (AdBlue®) Heater

1. Disconnect clamp and hoses (1) from DEF (AdBlue®) heater.

   Figure 21



DS2002473

2. Disconnect hoses (2) from DEF (AdBlue®) heater.

   NOTE: *Check the location of the connectors before disconnecting.*

3. Remove screws (3) from DEF (AdBlue®) heater.
4. Remove DEF (AdBlue®) heater (4) from tank.

   NOTE: *Be sure to use vinyl gloves.*

Installation

1. Perform installation in the reverse order to removal.

Sensors - After Treatment

Repair Procedure Quick Guide

Step-A. Remove engine hood assembly

Step-B. Disconnect wiring harness

Step-C. Remove engine sensors - DOC temperature sensor, Differential pressure sensor, DPF pressure sensor, DOC temperature sensor, SCR temperature sensor, Upstream NOx sensor, Downstream NOx sensor

Removal

DOC Temperature Sensor

Differential Pressure Sensor

DPF Pressure Sensor

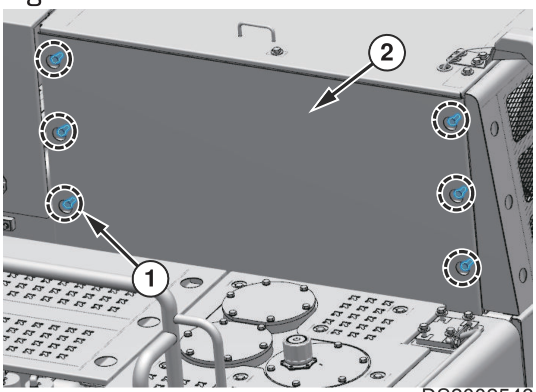
DOC Temperature Sensor

1. Open the left side door.
2. Turn OFF the battery disconnect switch.

Engine Hood Assembly

1. Remove mounting bolts (1) and engine hood (2) of muffler side.

   Figure 22

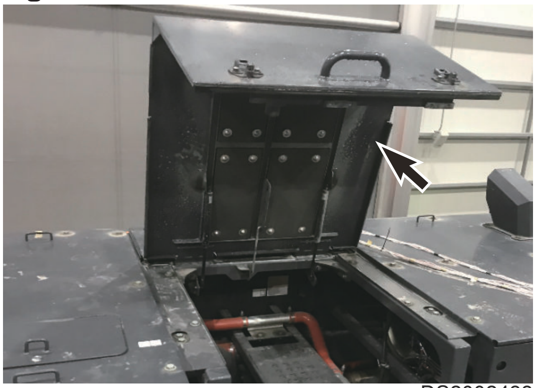


DS2002548

- Tool: 19 mm ()
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Weight: about 21 kg (151.9 lb)

2. Open engine hood assembly.

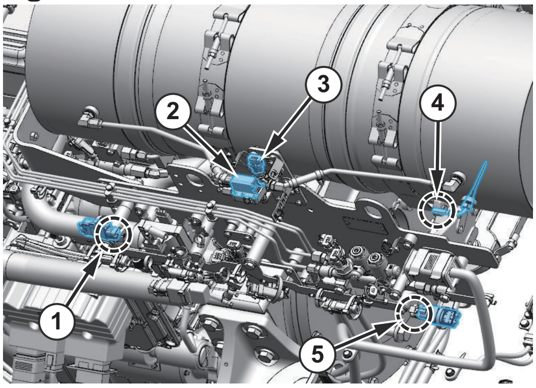
Figure 23



Wiring Harness

1. Disconnect wiring harness connector from sensors.

Figure 24

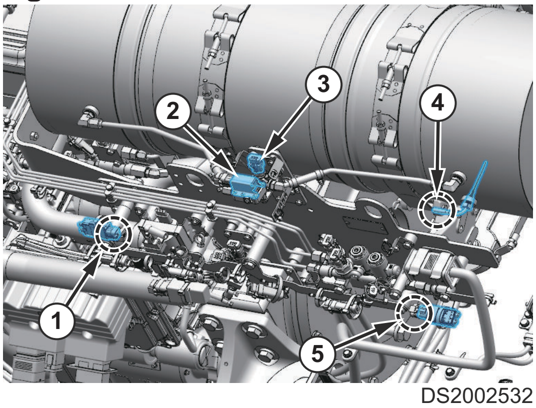


NOTE: *Be careful not to let water get into electrical components (sensor, connectors). If water gets into electrical system, his will cause an electrical short circuit and result in improper machine operation.*

- Sensor connectors location
  - DOC temperature sensor (1).
  - Differential pressure sensor (2).
  - DPF pressure sensor (3).
  - DOC temperature sensor (4).
  - SCR temperature sensor (5).

Engine Sensors - After Treatment System

1. Remove DOC temperature sensor (1).
   Figure 25



   - Torque: 45 N.m (4.58 kg.m, 33 ft lb)

     NOTE: *Apply adhesive (Loctite #771) to the mounting bolt.*

2. Remove bolts and differential pressure sensor (2) with O-ring.
   - Torque: 1.7 N.m (0.17 kg.m, 1.25 ft lb)
3. Remove DPF pressure sensor (3) and O-ring from manifold
   - Tool: 27 mm ( )
   - Torque: 10 N.m (1 kg.m, 7.37 ft lb)
4. Remove DOC temperature sensor (4) from DOC.
   - Tool: 17 mm ( )
   - Torque: 45 N.m (4.58 kg.m, 33 ft lb)

     NOTE: *Apply adhesive (Loctite #771) to the mounting bolt.*

     NOTE: *Use a brand new cable tie.*

     NOTE: *Check the location of the connectors before disconnecting.*

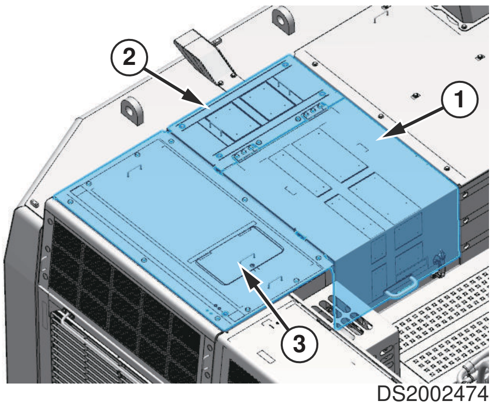
Upstream NOx Sensor

Downstream NOx Sensor

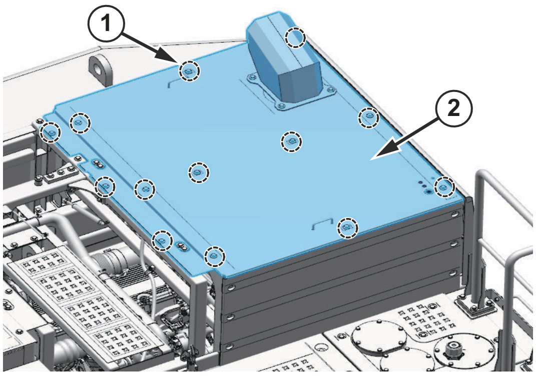
SCR Temperature Sensor

Engine Hood

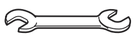
1. Open engine front hood.
   Figure 26



2. Remove stay pin.
3. Remove mounting nuts from gas spring.
4. Remove mounting bolts and engine front hood (1) from frame.
   - Tool: 19 mm ()
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
   - Weight: about 54 kg (119 lb)
5. Remove mounting bolts and engine rear hood (2) from frame.
   - Tool: 19 mm ()
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
   - Weight: about 17 kg (37.5 lb)
6. Remove mounting bolts (1) and engine left hood (2) from frame.
   Figure 27

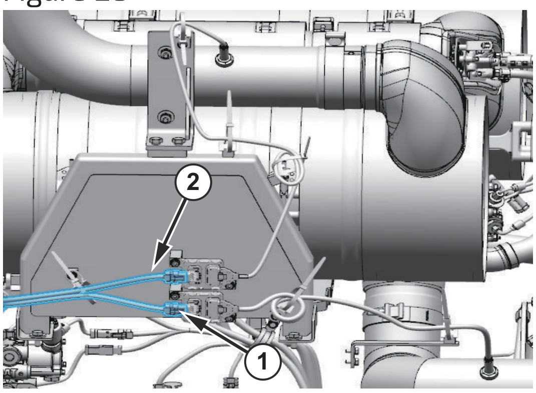


DS2002536

   - Tool: 19 mm ()
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
   - Weight: about 43 kg (94.8 lb)

Wiring Harness

1. Disconnect wiring harness connector from sensors.
   Figure 28



DS2002533

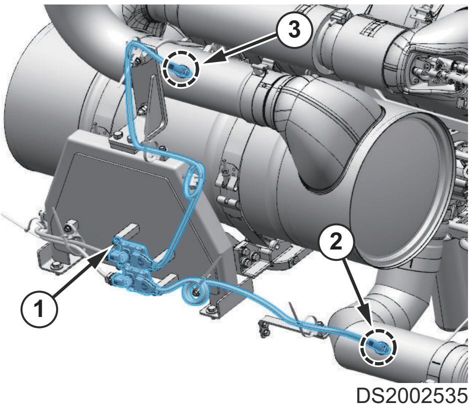
NOTE: *Be careful not to let water get into electrical components (sensor, connectors). If water gets into electrical system, his will cause an electrical short circuit and result in improper machine operation.*

- Sensor connectors location

- Upstream NOx sensor (1).
- Downstream NOx sensor (2).

Engine Sensors - After Treatment System

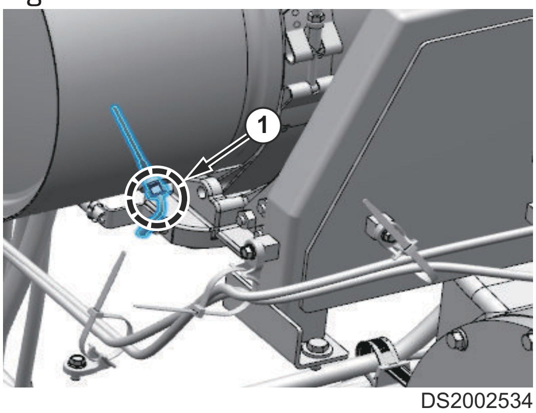
1. Remove mounting bolts (1) from bracket.
   Figure 29



   - Tool: 6 mm ( )
2. Remove upstream NOx sensor (2).
   - Tool: 22 mm ( )
   - Torque: 50 N.m (5.1 kg.m, 37 ft lb)
3. Remove downstream NOx sensor (3).
   - Tool: 22 mm ( )
   - Torque: 50 N.m (5.1 kg.m, 37 ft lb)

     NOTE: *Use a brand new cable tie.*

     NOTE: *Check the location of the connectors before disconnecting.*
4. Remove SCR temperature sensor (1) from SCR.
   Figure 30



   - Tool: 17 mm ( )
   - Torque: 45 N.m (4.58 kg.m, 33 ft lb)

     NOTE: *Apply adhesive (Loctite #C5-A) to the mounting bolt.*

     NOTE: *Use a brand new cable tie.*

     NOTE: *Check the location of the connectors before disconnecting.*

Installation

1. Perform installation in the reverse order to removal.

Engine Assembly

Repair Procedure Quick Guide

Step-A. Remove undercover

Step-B. Drain coolant

Step-C. Drain hydraulic oil

Step-D. Remove engine hood assembly

Step-E. Remove cover

Step-F. Remove support assembly - engine

Step-G. Remove DPF and SCR assembly

Step-H. Remove pump room cover assembly

Step-I. Disconnect hydraulic hoses, wiring

Step-J. Remove main pump assembly

Step-K. Remove air cleaner cover

Step-L. Remove air cleaner baffle

Step-M. Remove side cover

Step-N. Remove air hose, tube

Step-O. Remove water hose, tube

Step-P. Remove support assembly - radiator

Step-Q. Remove v-belt

Step-R. Separate air conditioner compressor

Step-S. Disconnect wiring connectors and cables

Step-T. Disconnect hydraulic hose - engine

Step-U. Engine mount

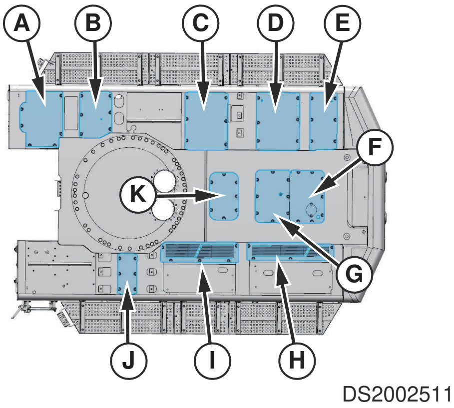
Step-V. Engine assembly

Removal

1. Open the left side door.
2. Turn OFF the battery disconnect switch.

Undercover

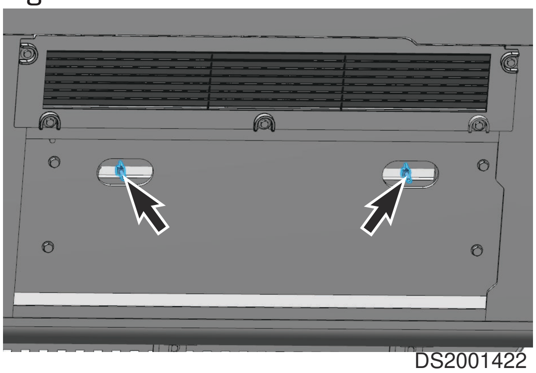
1. Remove undercovers (C, D, E, F, G, H).
   Figure 31



   For details, refer to Undercovers - Removal and Installation.

Coolant

1. Slowly open the radiator cap.
   Figure 32



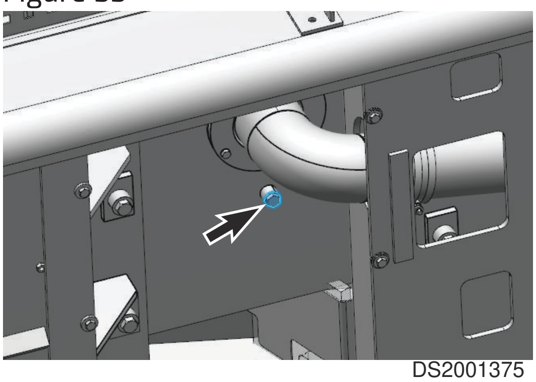
2. Open the drain plug.
3. Drain the coolant.
   - Coolant volume: 86.6 L (22.9 U.S. gal)

     NOTE: *Dispose of drained fluids according to local applicable environmental laws and regulations.*

     For details, refer to Coolant - Change of Operation Manual.

Hydraulic Oil

1. Position a container under hydraulic tank drain plug.
   Figure 33



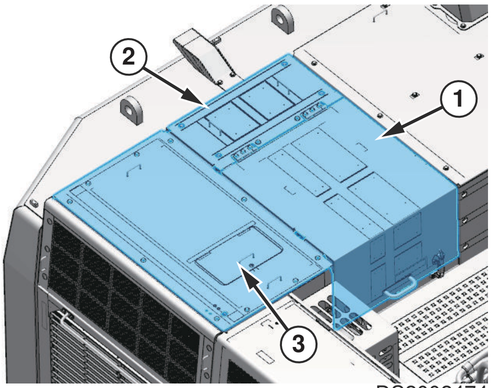
2. Loosen drain plug from bottom of tank.
3. After draining tank, install drain plug.

   NOTE: *Dispose of drained fluids according to applicable environmental laws and regulations.*

   - Hydraulic oil tank volume: 435 L (114.9 U.S. gal).

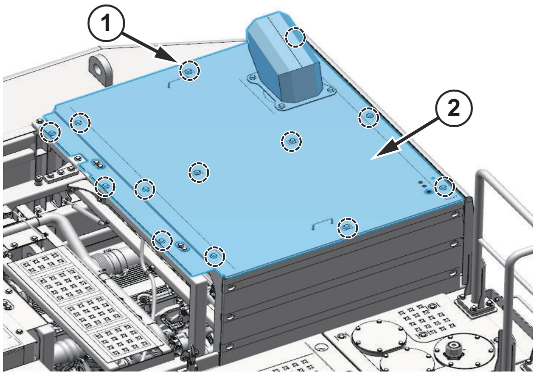
Engine Hood

1. Open engine front hood.
   Figure 34



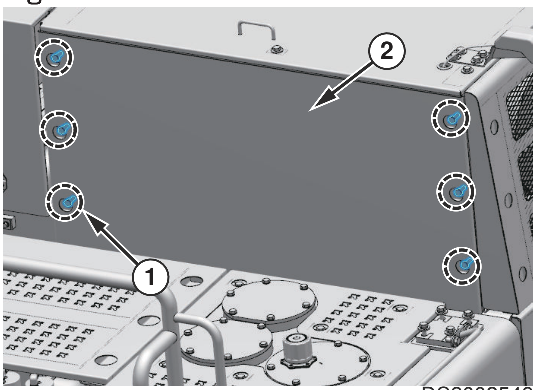
2. Remove stay pin.
3. Remove mounting nuts from gas spring.
4. Remove mounting bolts and engine front hood (1) from frame.
   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
   - Weight: about 54 kg (119 lb)
5. Remove mounting bolts and engine rear hood (2) from frame.
   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
   - Weight: about 17 kg (37.5 lb)
6. Remove mounting bolts and engine right hood (3) from frame.
   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
   - Weight: about 41 kg (90.3 lb)

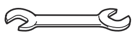
7. Remove mounting bolts and engine right hood (1) from frame.
   Figure 35



   - Tool: 19 mm ()
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
   - Weight: about 43 kg (94.8 lb)

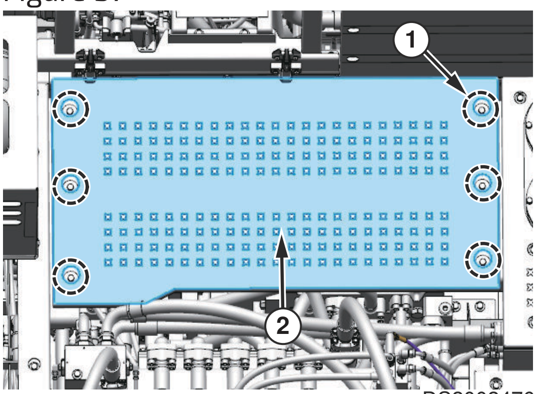
8. Remove mounting bolts (1) and engine hood (2) of muffler side.
   Figure 36

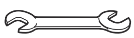


   - Tool: 19 mm ()
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
   - Weight: about 21 kg (151.9 lb)

Cover

1. Remove mounting bolts (1) from cover.
   Figure 37

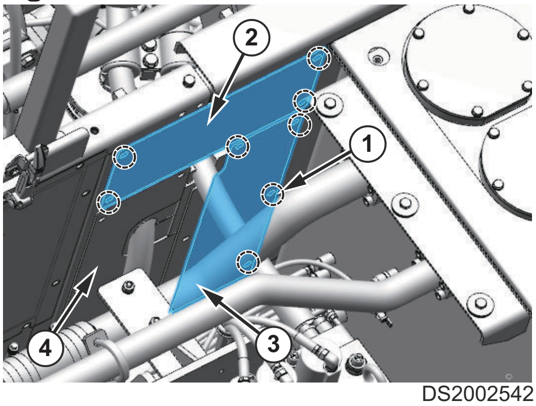


   - Tool: 19 mm ()

- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

2. Remove cover (2) from frame.
   - Weight: about 39 kg (86 lb)
3. Remove mounting bolts (1) from cover.

Figure 38



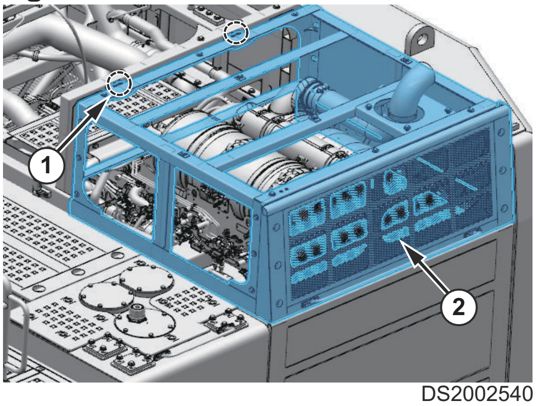
- Tool: 19 mm ( )
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

4. Remove cover (2, 3, 4) from frame.

Support Assembly

1. Remove mounting bolts (1).

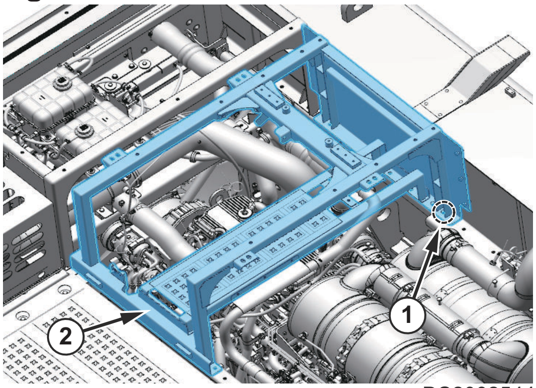
Figure 39



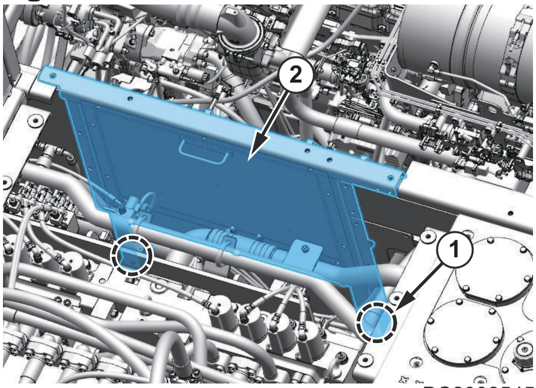
- Tool: 19 mm ( )
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

2. Remove support assembly (2).
   - Weight: about 146 kg (321.8 lb)

3. Remove mounting bolts (1).
   Figure 40



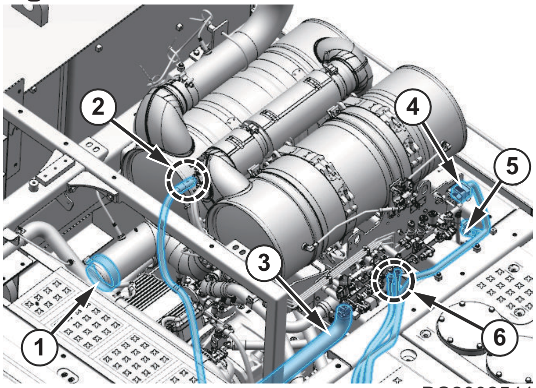
   - Tool: 19 mm ()
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
4. Remove support assembly (2).
   - Weight: about 117 kg (258 lb)
5. Remove mounting bolts (1).
   Figure 41



   - Tool: 19 mm ()
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
6. Remove support assembly (2).
   - Weight: about 50 kg (110 lb)

DPF and SCR Assembly

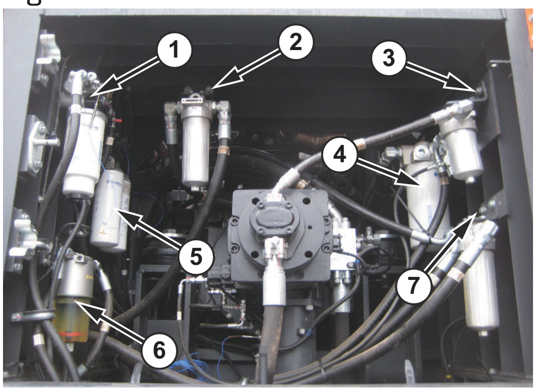
1. Loosen clamp (1) from exhaust pipe.
   Figure 42



2. Remove exhaust pipe from DPF and SCR Assembly.
3. Disconnect DEF (AdBlue®) hose (2).
4. Remove air hose (3) from DPF and SCR Assembly.
5. Disconnect wire harnesses (4).
6. Disconnect fuel hose (5) from DPF and SCR Assembly.
7. Disconnect coolant hoses (6).

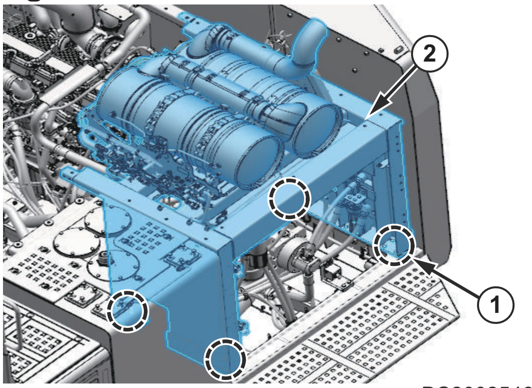
Pump Room Cover Assembly

1. Separate the all filter mounting brackets at the support.
   Figure 43



   - Fuel prefilter and water separator (1)
   - Drain filter (2)
   - Pilot filter (3)
   - Engine oil filter (4)
   - Main fuel filter (5)
   - Fuel prefilter and water separator (6)
   - Drain filter (7)
2. Disconnect any additional electrical connections as necessary.
3. Remove any parts at the support.

4. Attach a lifting device at lifting point.
   Figure 44

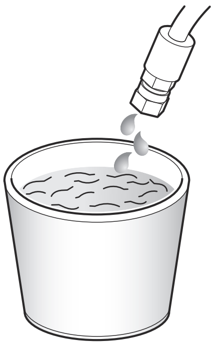


DS2002546

5. Remove mounting bolts (1).
   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
6. Remove support assembly (2).
   - Weight: about 500 kg (1,102 lb)

Hydraulic Hoses and Fittings - Transmission

Figure 45

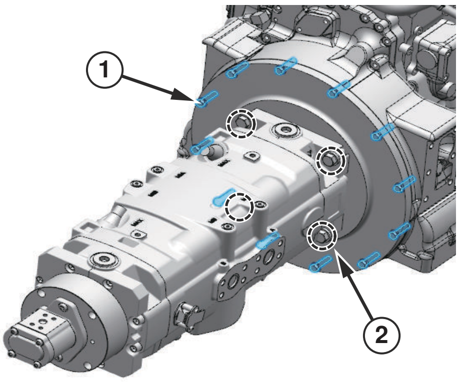


EX1504170

For details, refer to Main Pump - Removal and Installation.

Main Pump Assembly

1. Remove main pump assembly.
   Figure 46

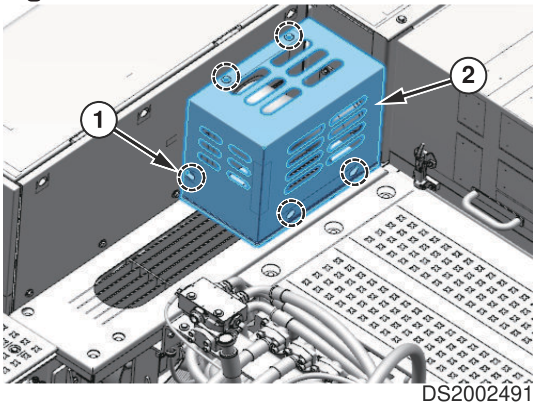


DS2002481

For details, refer to Main Pump - Removal and Installation.

Air Cleaner Cover

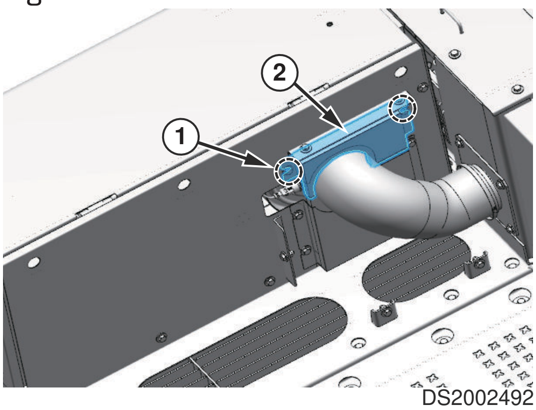
1. Remove mounting bolts (1) and air cleaner cover (2).
   Figure 47



- Tool: 19 mm ( )
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Weight: about 10 kg (22 lb)

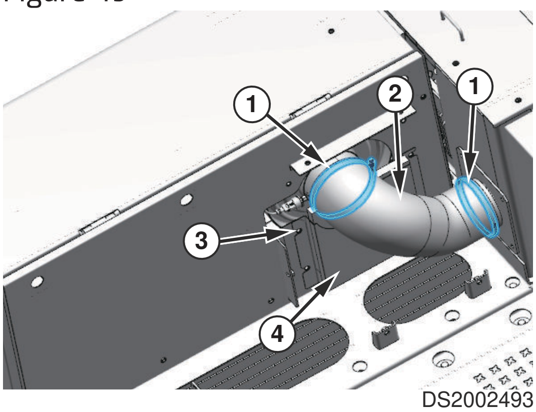
Air Cleaner Baffle

1. Remove mounting bolts (1) and air cleaner upper baffle (2).
   Figure 48



- Tool: 19 mm ( )
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

2. Loosen clamps (1) from air cleaner hose.
   Figure 49

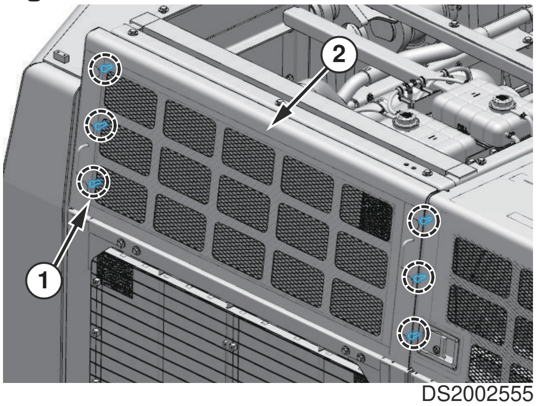


3. Remove air cleaner hose (2) from air cleaner.

4. Remove mounting bolts (3) and air cleaner under baffle (4).
    - Tool: 19 mm ( )
    - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
5. Remove mounting bolts and air pipe from support assembly.

Side Cover

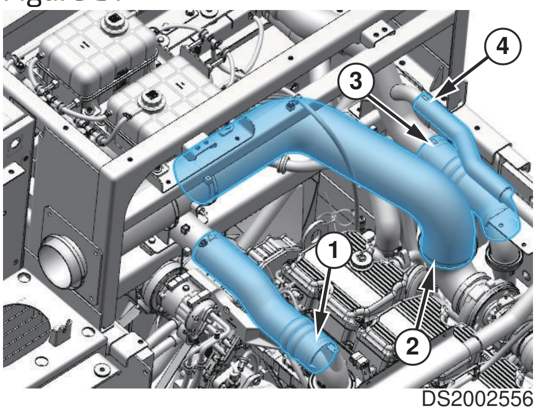
1. Remove mounting bolts (1) and side cover (2).
    Figure 50



    - Tool: 19 mm ( )
    - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
    - Weight: about 28.5 kg (62.8 lb)

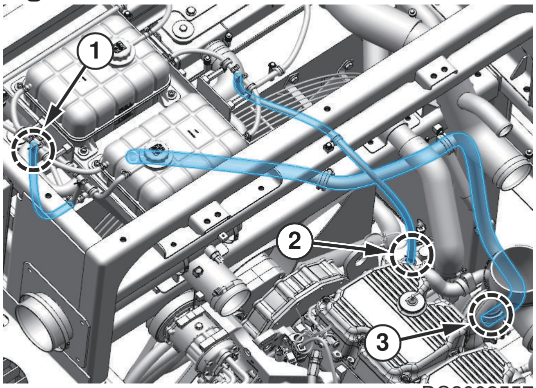
Air Hose, Tube

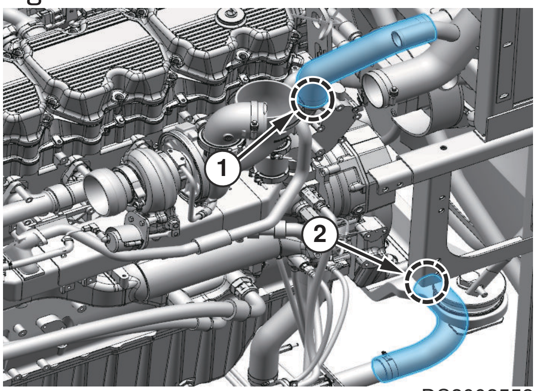
1. Loosen clamp (1) and disconnect CAC hose from engine.
    Figure 51



2. Loosen clamp (2) and disconnect air hose from turbocharger.
3. Loosen clamp (3) and disconnect CAC hose from turbocharger.
4. Loosen clamp (4) and disconnect hose from pipe.

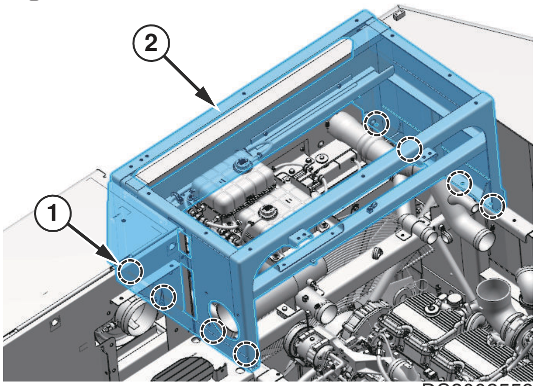
Water Hose, Tube

1. Disconnect water hose and clamp (1) from pipe.
   Figure 52
   

2. Disconnect water hose and clamp (2) from engine.
3. Disconnect water hose and clamp (3) from engine.
4. Loosen clamp (1) and disconnect water upper hose from engine.
   Figure 53
   

5. Loosen clamp (2) and disconnect water lower hose from radiator.
6. Loosen clamp and disconnect water lower hose from engine.

Support Assembly - Radiator

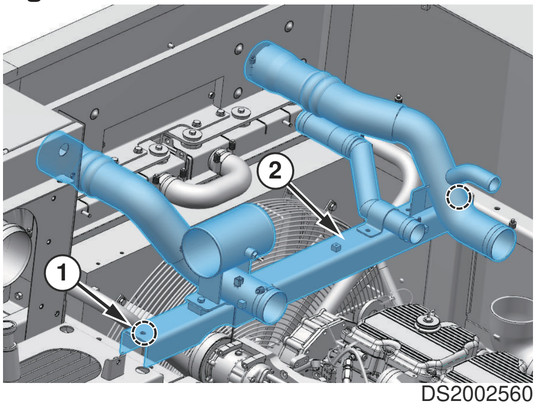
1. Remove mounting bolts (1) and support assembly (2).
   Figure 54
   

   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

- Weight: about 125 kg (275.6 lb)

2. Remove mounting bolts (1) and support assembly with pipes (2).

Figure 55

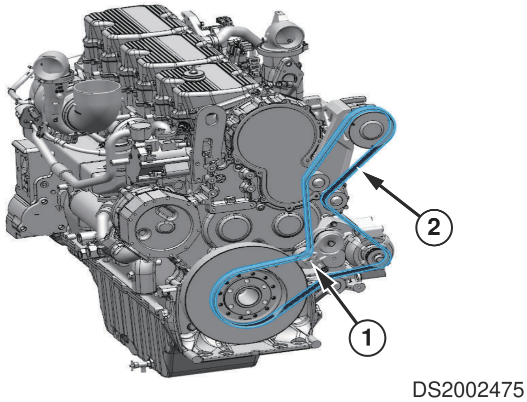


- Tool: 19 mm ( )
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

V-Belt

1. Insert the tool into the auto tensioner service hole (1).

Figure 56



NOTE: *Before removing the belt, check the belt layout.*

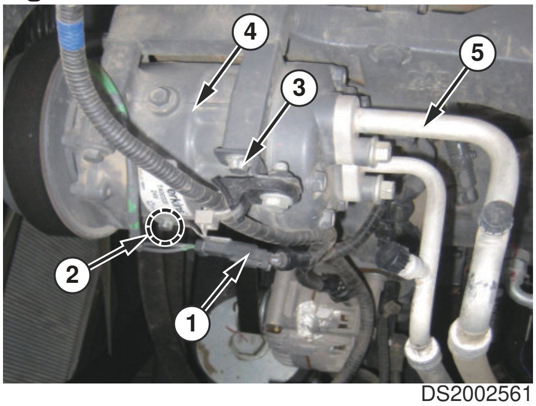
2. Turn the auto tensioner with tool clockwise to loosen and put away the V-belt (2).

NOTE: *If reusing V-belt, mark the rotation direction on the belt.*

3. Carefully release the tension.
4. Remove tool from auto tensioner service hole.

Air Conditioner Compressor

1. Disconnect wire harness connector (1) from air conditioner compressor.
   Figure 57

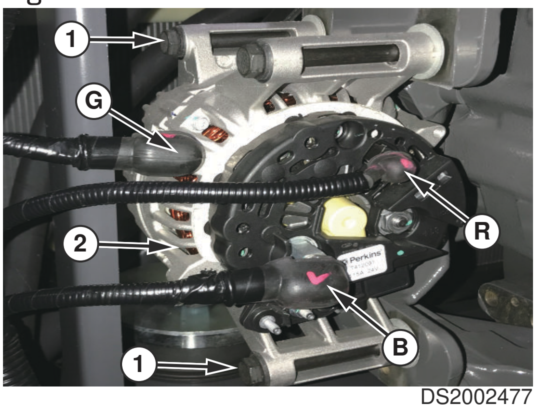


2. Remove clamp bolt (2) and wire harnesses.
3. Remove mounting bolts (3).
4. Separate air conditioner compressor (4) from engine.

   NOTE: *Do not disconnect air conditioner hoses (5) from compressor.*

Wiring Connectors and Cables

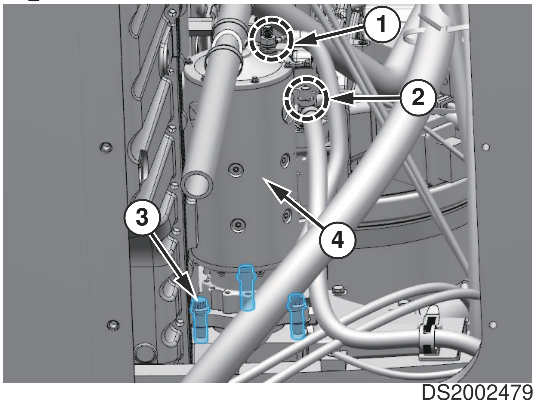
1. Disconnect wire harness (G)
   Figure 58



   - Torque: 5.88 N.m (0.6 kg.m, 4.33 ft lb)
2. Disconnect wire harness (R)
   - Torque: 3.92 N.m (0.4 kg.m, 2.89 ft lb)
3. Disconnect wire harness (B)
   - Torque: 14.7 N.m (1.5 kg.m, 10.8 ft lb)

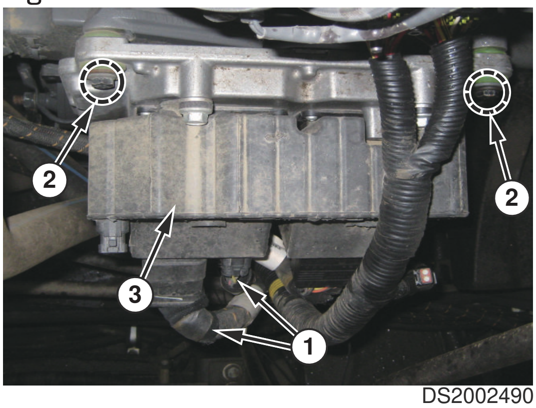
4. Remove nut (1) from starter motor.

Figure 59



5. Disconnect negative cable from starter motor.
6. Remove nut (2) from starter motor.
7. Disconnect positive cable from starter motor.
8. Disconnect wire harnesses (1) from ECU assembly.

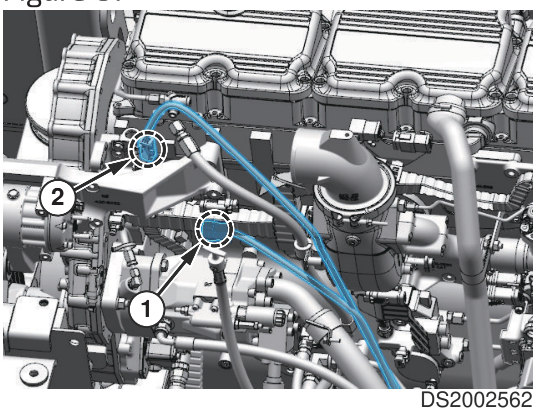
Figure 60



NOTE: *Check the location of the connectors before disconnecting. Be careful not to let water get into electrical components. If water gets into electrical system, this will cause an electrical short circuit and result in improper machine operation.*

9. Disconnect secondary fuel filter wire harness (1) from engine.

Figure 61

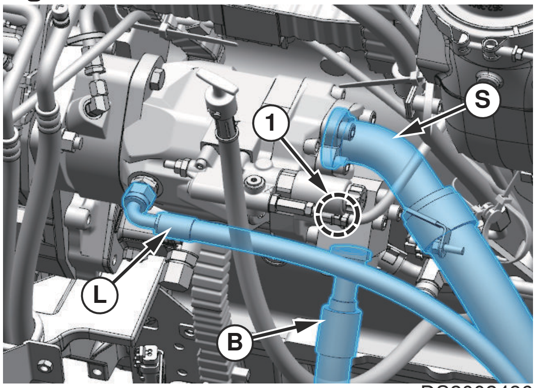


10. Disconnect primary fuel filter wire harness (2) from engine.

Hydraulic Hose - Engine

1. Disconnect wire harness (1) from fan pump.

   Figure 62

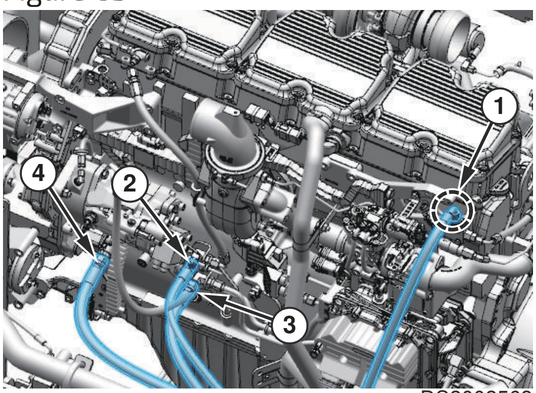
2. Disconnect hoses from fan pump.

   NOTE: *Attach identification tags to the removed hoses for reassembling. After disconnecting hoses from fan pump, plug them to prevent dirt or dust from entering. Disconnect the hoses from the bottom to top of fan pump.*

   - B port
     - Tool: 8 mm ( )
     - Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)
     - Connecting part: "to Fan Drive Valve P"
   - L port
     - Tool: 24 mm ( )
     - Torque: 58.8 N.m (6 kg.m, 43.4 ft lb)
     - Connecting part: "to Oil Tank (Drain)"
   - S port
     - Tool: 10 mm ( )
     - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
     - Connecting part: "from Oil Tank Suction Pipe"

3. Disconnect fuel hose (1) from engine.

   Figure 63

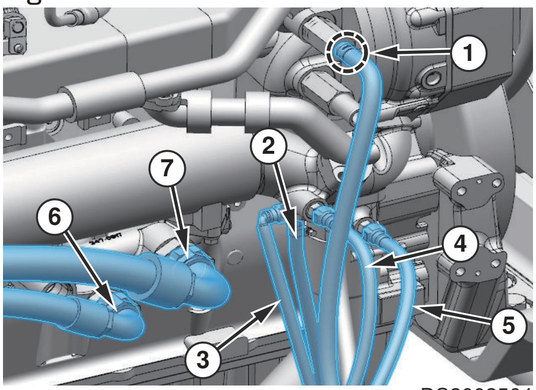
   

   - Tool: 24 mm ( )

- Torque: 58.8 N.m (6 kg.m, 43.4 ft lb)

4. Disconnect fuel supply hose (2) from engine.
   - Tool: 22 mm ( )
   - Torque: 49 N.m (5 kg.m, 36.2 ft lb)
5. Disconnect fuel return hose (3) from engine.
   - Tool: 27 mm ( )
   - Torque: 93.2 N.m (9.5 kg.m, 68.7 ft lb)
6. Disconnect fuel hose (4) from engine.
7. Disconnect heater hose and clamp (1) from engine.

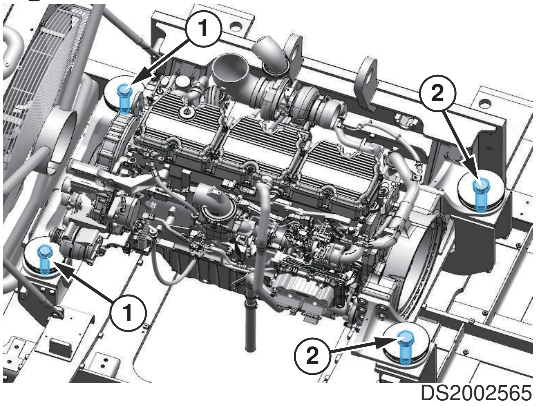
Figure 64



8. Disconnect coolant hose and clamp (2) from engine.
9. Disconnect coolant hose quick connector (3) from engine.
10. Disconnect coolant hose quick connector (4) from engine.
11. Disconnect coolant hose quick connector (5) from engine.
12. Disconnect engine oil filter hose (6) from engine.
    - Tool: 41 mm ( )
    - Torque: 205.9 N.m (21 kg.m, 151.9 ft lb)
13. Disconnect engine oil filter hose (7) from engine.
    - Tool: 50 mm ( )
    - Torque: 205.9 N.m (21 kg.m, 151.9 ft lb)
14. Disconnect any additional connections as necessary.

Engine Assembly

1. Using a suitable lifting device, attach slings to engine.
   Figure 65



2. Remove mounting bolts (1) from main frame.
   - Tool: 46 mm ( )
   - Torque: 1,000 N.m (102 kg.m, 737.7 ft lb)

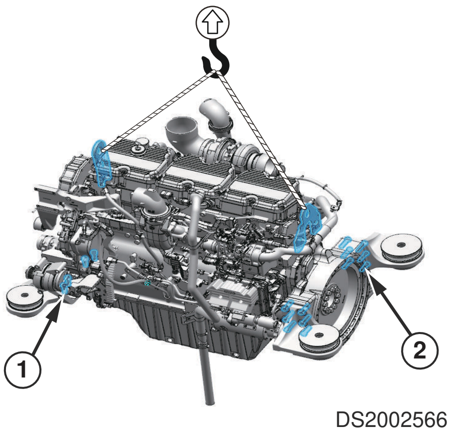
     NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*
3. Remove mounting bolts (2) from main frame.
   - Tool: 55 mm ( )
   - Torque: 1,176.7 N.m (120 kg.m, 867.9 ft lb)

     NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*
4. Remove engine assembly from main frame.

   NOTE: *Lift engine assembly slowly to prevent damaging.*

   NOTE: *Mark the location of the bolts before removing.*

   NOTE: *Check the location of the engine mounting rubbers before removing.*
   - Engine assembly weight: about 1,605 kg (3,538 lb)
5. Remove mounting bolts (1) and bracket from engine.
   Figure 66



   - Tool: 29 mm ( )
   - Torque: 369.7 N.m (37.7 kg.m, 272.7 ft lb)

     NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*

6. Remove mounting bolts (2) and bracket from engine.
   - Tool: 24 mm ()
   - Torque: 215.7 N.m (22 kg.m, 159.1 ft lb)

     NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*

Installation

1. Perform installation in the reverse order to removal.

Hydraulic Systems And Structure

Safety Instructions

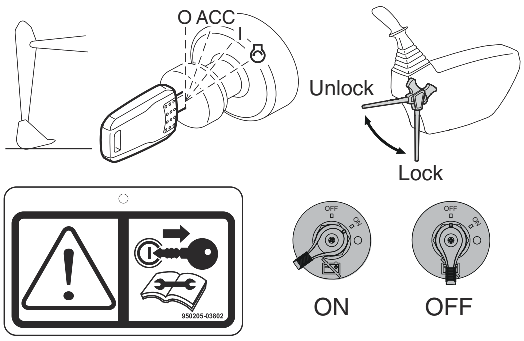
⚠ WARNING

AVOID DEATH OR SERIOUS INJURY
Instructions are necessary before operating or servicingmachine. Read and understand the Operation & Maintenance Manual and signs (decals) on machine. Followwarnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correctfunction after adjustments repairs or service. Untrainedoperators and failure to follow instructions can cause deathor serious injury.

Before Removing And Instralling

Preparatory Work

1. Park the machine on level ground. And lower front attachment to the ground.
   Figure 67

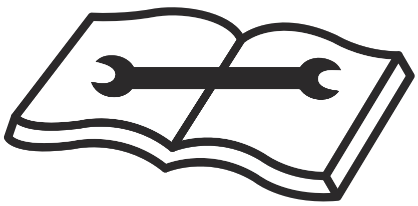


EX1504472

2. Move safety lever to "LOCK" position and then stop the engine.
3. Turn battery disconnect switch to "OFF" position.
4. Release the remaining pressure in the hydraulic circuit.
5. Cool down the hydraulic system and engine.
6. Attach a maintenance warning tag on controls.

General Precaution

1. Always read the safety section before removing and Installing.
   Figure 68


DS1901903

2. Mark the location of the bolts before removing.
3. Keep in the mind the order for tightening bolts.
4. Tighten bolts by hands, then using the tool.
5. If reusing the bolts, clean threads and apply thread locker to threads prior to installation.
6. Mark the location of wire harness connectors and hoses before disconnecting.
7. Be careful not to damage all components.
8. Do not reused gaskets, O-ring and adhesive bolts.

Completing Work

1. Check oil, coolant and fuel leak from the machine.
2. Check all oil level and if necessary, add oil.
3. Fill up the fuel tank to the standard level.
4. Apply grease to all lubrication points.
5. When fuel component has been disconnected, air must be bled from circuit.
   For details, see the Operation and Maintenance Manual.
6. When hydraulic component has been disconnected, air must be bled from circuit.
   For details, see the Operation and Maintenance Manual.
7. Start the engine and run at low idle for about 5 minutes.
8. Perform the machine performance test.

Main Pump

Repair Procedure Quick Guide

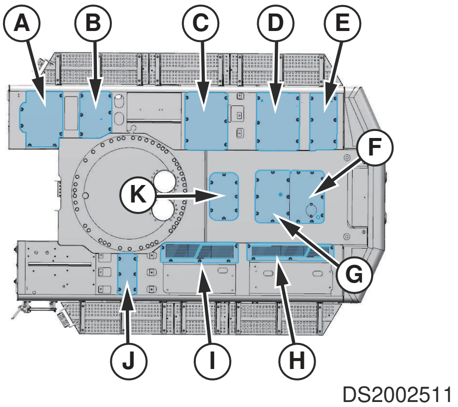
Step-A. Remove undercover
Step-B. Drain hydraulic oil
Step-C. Remove engine hood assembly
Step-D. Remove cover
Step-E. Remove support assembly
Step-F. Remove DPF and SCR assembly
Step-G. Remove pump room cover assembly
Step-H. Disconnect hydraulic hoses, wiring
Step-I. Remove main pump assembly

Removal

1. Open the left side door.
2. Turn OFF the battery disconnect switch.

Undercover

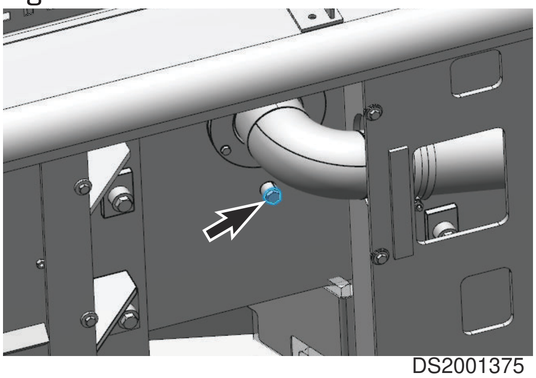
1. Remove undercover (C, D, E).
   Figure 69



For details, refer to Undercovers - Removal and Installation.

Hydraulic Oil

1. Position a container under hydraulic tank drain plug.
   Figure 70



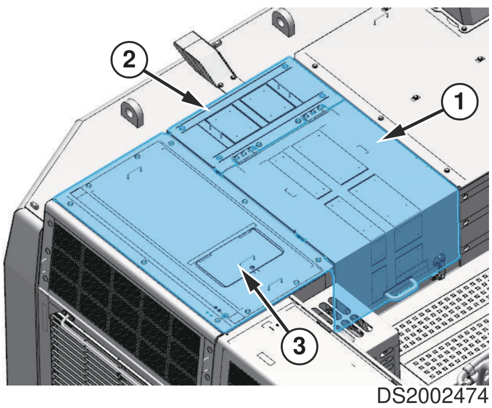
2. Loosen drain plug from bottom of tank.
3. After draining tank, install drain plug.

   NOTE: *Dispose of drained fluids according to applicable environmental laws and regulations.*

   - Hydraulic oil tank volume: 435 L (114.9 U.S. gal)

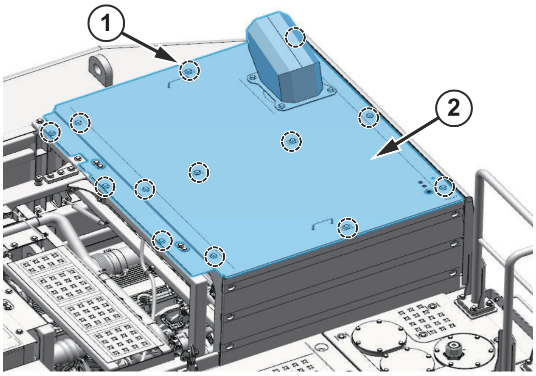
Engine Hood

1. Open engine front hood.
   Figure 71



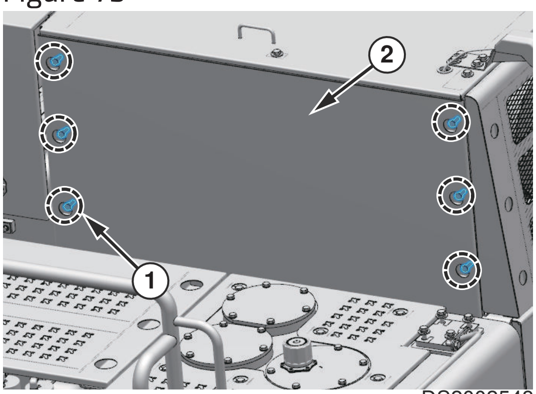
2. Remove stay pin.

3. Remove mounting nuts from gas spring.
4. Remove mounting bolts and engine front hood (1) from frame.
    - Tool: 19 mm ( )
    - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
    - Weight: about 54 kg (119 lb)
5. Remove mounting bolts and engine rear hood (2) from frame.
    - Tool: 19 mm ( )
    - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
    - Weight: about 17 kg (37.5 lb)
6. Remove mounting bolts and engine right hood (3) from frame.
    - Tool: 19 mm ( )
    - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
    - Weight: about 41 kg (90.3 lb)
7. Remove mounting bolts (1) and engine left hood (2) from frame.
    Figure 72



DS2002536

    - Tool: 19 mm ( )
    - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
    - Weight: about 43 kg (94.8 lb)
8. Remove mounting bolts (1) and engine hood (2) of muffler side.
    Figure 73

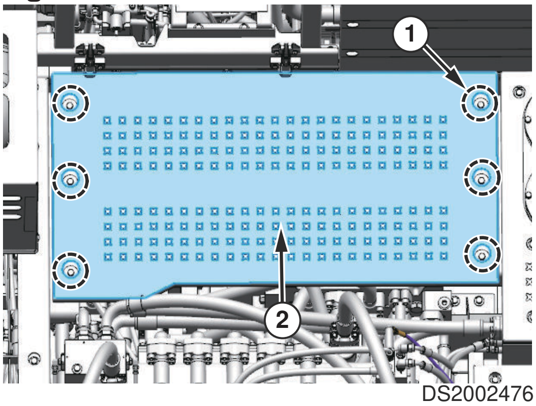


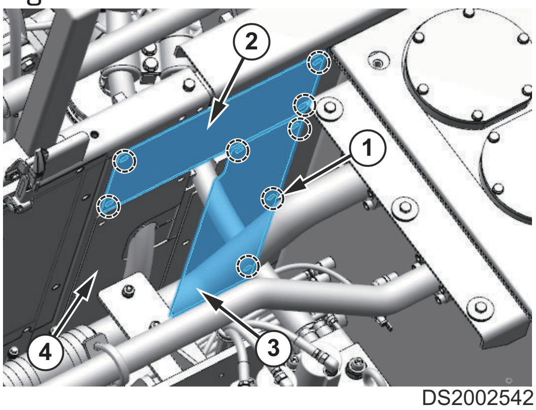
DS2002548

    - Tool: 19 mm ( )

- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Weight: about 21 kg (151.9 lb)

Cover

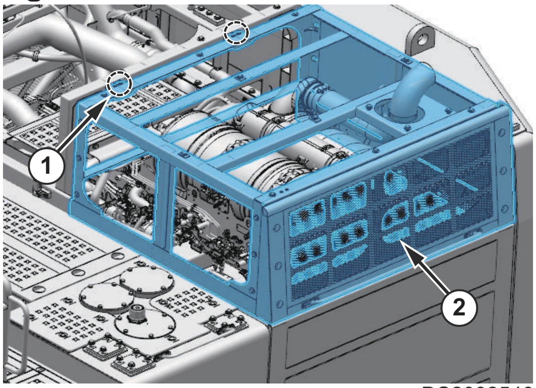
1. Remove mounting bolts (1) from cover.
   Figure 74
   

   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
2. Remove cover (2) from frame.
   - Weight: about 39 kg (86 lb)
3. Remove mounting bolts (1) from cover.
   Figure 75
   

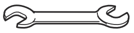
   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
4. Remove cover (2, 3, 4) from frame.

Support Assembly

1. Remove mounting bolts (1).
   Figure 76

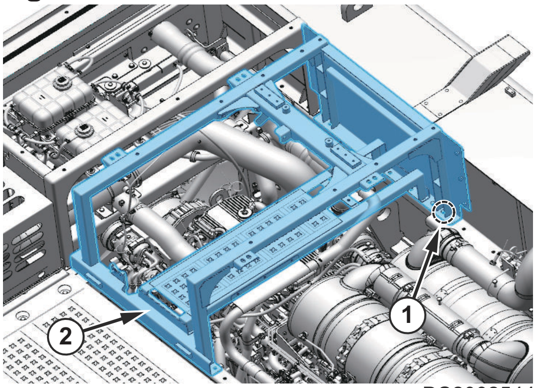


DS2002540

   - Tool: 19 mm ()
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

2. Remove support assembly (2).
   - Weight: about 146 kg (321.8 lb)

3. Remove mounting bolts (1).
   Figure 77

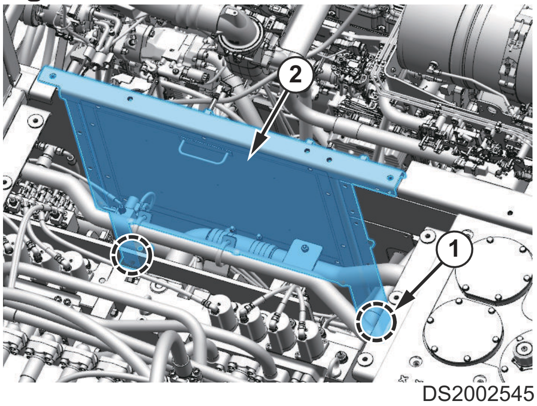


DS2002544

   - Tool: 19 mm ()
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

4. Remove support assembly (2).
   - Weight: about 117 kg (258 lb)

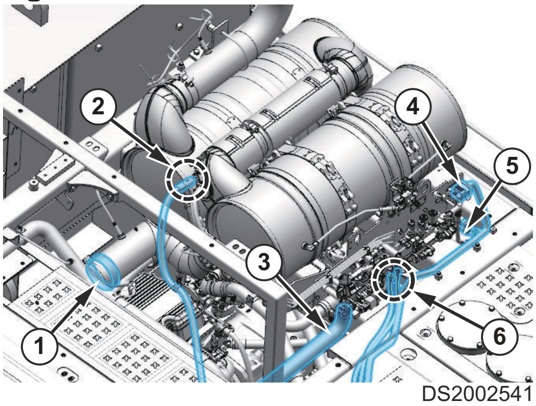
5. Remove mounting bolts (1).
   Figure 78



   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
6. Remove support assembly (2).
   - Weight: about 50 kg (110 lb)

DPF and SCR Assembly

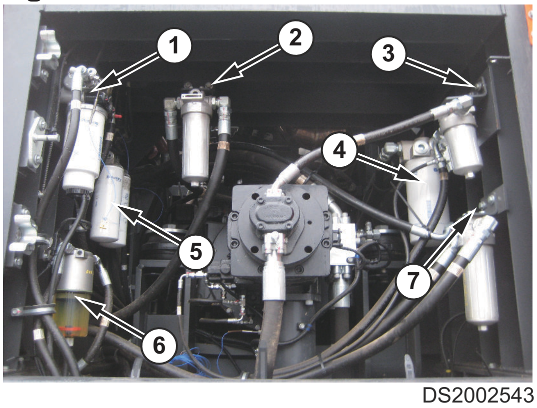
1. Loosen clamp (1) from exhaust pipe.
   Figure 79



2. Remove exhaust pipe from DPF and SCR Assembly.
3. Disconnect DEF (AdBlue®) hose (2).
4. Remove air hose (3) from DPF and SCR Assembly.
5. Disconnect wire harnesses (4).
6. Disconnect fuel hose (5) from DPF and SCR Assembly.
7. Disconnect coolant hoses (6).

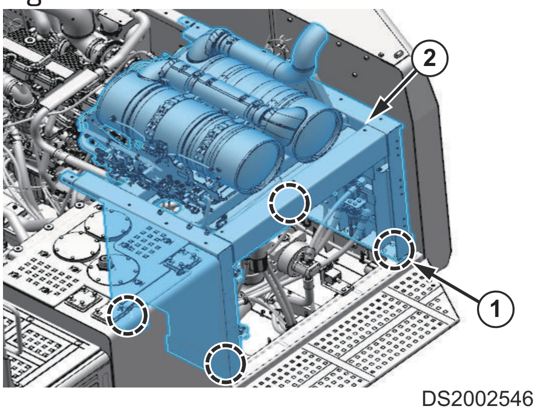
Pump Room Cover Assembly

1. Separate the all filter mounting brackets at the support.
   Figure 80



- Fuel prefilter and water separator (1)
- Drain filter (2)
- Pilot filter (3)
- Engine oil filter (4)
- Main fuel filter (5)
- Fuel prefilter and water separator (6)
- Drain filter (7)

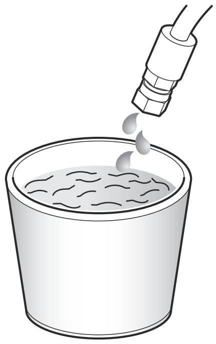
2. Disconnect any additional electrical connections as necessary.
3. Remove any parts at the support.
4. Attach a lifting device at lifting point.
   Figure 81



5. Remove mounting bolts (1).
   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
6. Remove support assembly (2).
   - Weight: about 500 kg (1,102 lb)

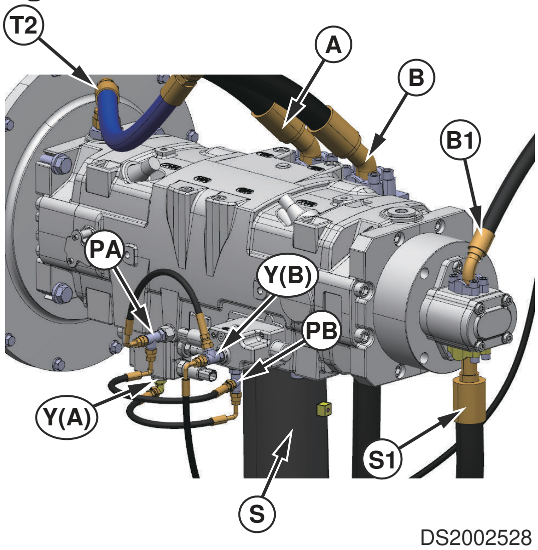
Hydraulic Hoses and Fittings

1. When disconnecting the hose, oil left in the hose may flow out. Therefore, place the end of the hose into a suitable container to prevent contamination of the ground and environment.
   Figure 82



EX1504170

2. Remove the hoses and adapters from main pump.
   Figure 83



DS2002528

NOTE: *Attach identification tags to the removed hoses for reassembling. After disconnecting hoses from main pump, plug them to prevent dirt or dust from entering. Disconnect the hoses from the bottom to top of main pump.*

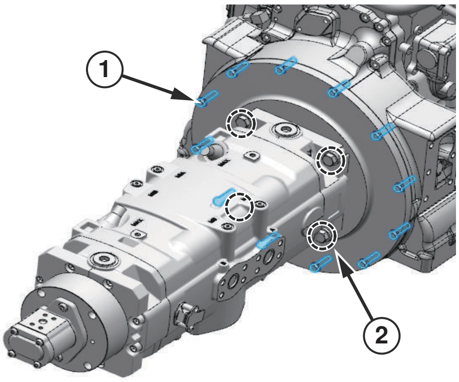
- A port
  - Tool: 12 mm ( )
  - Torque: 176.4 N.m (18 kg.m, 130.1 ft lb)
  - Connecting part: "to Main Control Valve 2 P3"
- B port
  - Tool: 12 mm ( )
  - Torque: 176.4 N.m (18 kg.m, 130.1 ft lb)
  - Connecting part: "to Main Control Valve P1"
- S port
  - Tool: 14 mm ( )
  - Torque: 264.8 N.m (27 kg.m, 195.3 ft lb)

- Connecting part: "from Oil Tank"

- S1 port
  - Tool: 8 mm ( )
  - Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)
  - Connecting part: "Connect with (Suction Pipe) S"
- B1 port
  - Tool: 8 mm ( )
  - Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)
  - Connecting part: "to Pilot Filter IN"
- T2 port
  - Tool: 41 mm ( )
  - Torque: 205.9 N.m (21 kg.m, 151.8 ft lb)
  - Connecting part: "to Drain Filter IN"
- PA port (1)
  - Tool: 19 mm ( )
  - Torque: 34.3 N.m (3.5 kg.m, 25.3 ft lb)
  - Connecting part: "Connect with Y(B)"
- PA port (2)
  - Tool: 19 mm ( )
  - Torque: 34.3 N.m (3.5 kg.m, 25.3 ft lb)
  - Connecting part: "Connect with PB"
- PB port (1)
  - Tool: 19 mm ( )
  - Torque: 34.3 N.m (3.5 kg.m, 25.3 ft lb)
  - Connecting part: "Connect with Y(A)"
- PB port (2)
  - Tool: 19 mm ( )
  - Torque: 34.3 N.m (3.5 kg.m, 25.3 ft lb)
  - Connecting part: "Connect with PA"
- Y(A) port
  - Tool: 19 mm ( )
  - Torque: 34.3 N.m (3.5 kg.m, 25.3 ft lb)
  - Connecting part: "Connect with PB"
- Y(B) port (1)
  - Tool: 19 mm ( )
  - Torque: 34.3 N.m (3.5 kg.m, 25.3 ft lb)

- Connecting part: "Connect with PA"
- Y(B) port (2)
  - Tool: 19 mm ( )
  - Torque: 34.3 N.m (3.5 kg.m, 25.3 ft lb)
  - Connecting part: "from Pilot Filter OUT"

Figure 84



Main Pump Assembly

1. Attach a lifting device around pump.
   - Weight: about 330 kg (727.5 lb)
2. Remove mounting bolts (1) from engine.
   - Tool: 16 mm ( )
   - Torque: 69.6 N.m (7.1 kg.m, 51.3 ft lb)

   NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*
3. Lift the pump from engine slowly and carefully.

Installation

1. Perform installation in the reverse order to removal.
2. After completing the work, check the oil level.
3. Start the engine and check for any oil leaks.

Drive Coupling

Repair Procedure Quick Guide

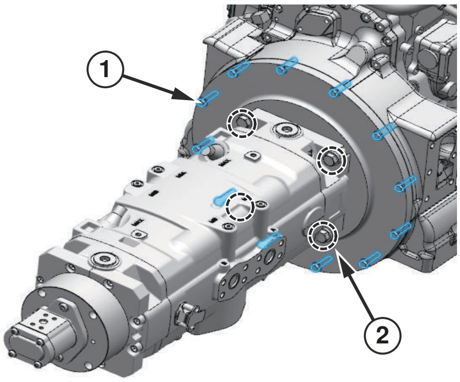
Step-A. Remove main pump assembly

Step-B. Remove drive coupling

Removal

Main Pump Assembly

1. Remove mounting bolts (1) from engine.
   Figure 85



DS2002481

- Tool: 16 mm ( )
- Torque: 69.6 N.m (7.1 kg.m, 51.3 ft lb)

  NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*

  For details, refer to Main pump - Removal and Installation.

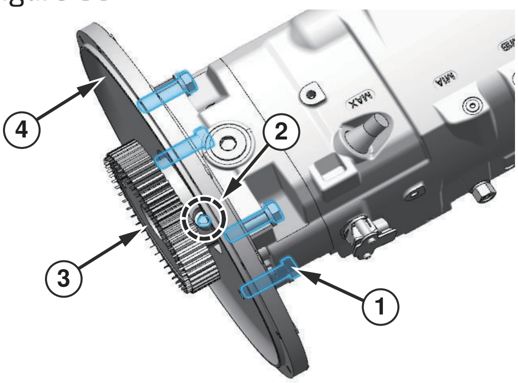
2. Loosen mounting bolts (2) from main pump cover.
   - Tool: 27 mm ( )
   - Torque: 392.2 N.m (40 kg.m, 289.3 ft lb)

     NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*

Drive Coupling Assembly

Main Pump Side

1. Remove mounting bolts (1) from main pump cover (4).
   Figure 86

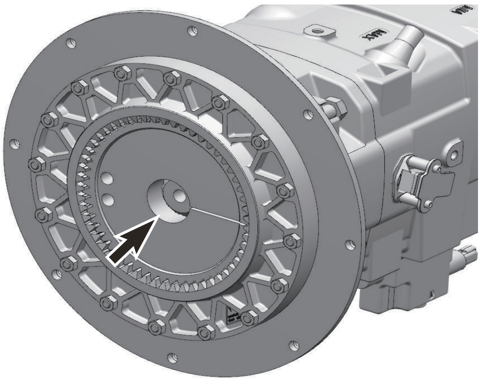


DS2002480

2. Remove bolt (2) and hub (3) from main pump shaft.
   - Tool: 14 mm ( )
   - Torque: 205.9 N.m (21 kg.m, 151.8 ft lb)

     NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*

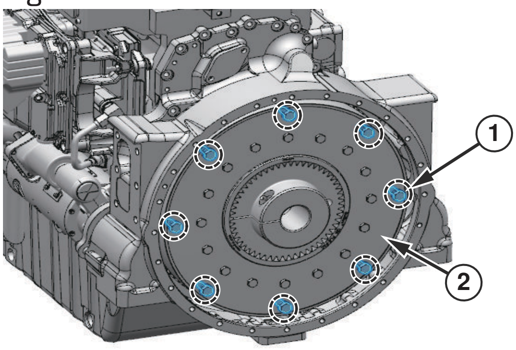
- Clearance between from pump shaft to coupling hub must be 20.5 mm.
  Figure 87



DS2002483

Engine Side

1. Remove mounting bolts (1) from flywheel.
   Figure 88



DS2002482

   - Tool: 19 mm ( )
   - Torque: 117.6 N.m (12 kg.m, 86.8 ft lb)

   NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*

2. Remove drive coupling (2) from flywheel.

Installation

1. Perform installation in the reverse order to removal.

Undercovers

Repair Procedure Quick Guide

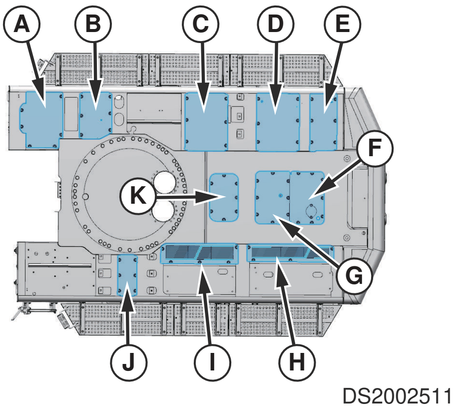
Step-A. Place the machine in the suitable service position

Step-B. Removel Undercovers

Removal

Undercovers

1. Position the machine on even, firm and level ground.
   Figure 89



2. Put attachment on ground.

   NOTE: *Place the machine in the suitable service position*

3. Remove undercovers.

   - Undercover (A)
     - Tool: 19 mm ( )
     - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
     - Weight: about 19 kg (41.9 lb)
   - Undercover (B)
     - Tool: 19 mm ( )
     - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
     - Weight: about 13 kg (28.7 lb)
   - Undercover (C)
     - Tool: 19 mm ( )
     - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
     - Weight: about 21 kg (46.3 lb)
   - Undercover (D)
     - Tool: 19 mm ( )
     - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
     - Weight: about 22.2 kg (48.9 lb)
   - Undercover (E)
     - Tool: 19 mm ( )
     - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
     - Weight: about 13.2 kg (29.1 lb)
   - Undercover (F)
     - Tool: 19 mm ( )

- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Weight: 17 kg (37.5 lb)

• Undercover (G)
  - Tool: 19 mm ( )
  - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
  - Weight: about 16 kg (35.3 lb)
• Undercover (H)
  - Tool: 19 mm ( )
  - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
  - Weight: about 10 kg (22 lb)
• Undercover (I)
  - Tool: 19 mm ( )
  - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
  - Weight: about 10 kg (22 lb)
• Undercover (J)
  - Tool: 19 mm ( )
  - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
  - Weight: about 10 kg (22 lb)
• Undercover (K)
  - Tool: 19 mm ( )
  - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
  - Weight: about 19 kg (41.9 lb)

Installation

1. Perform installation in the reverse order to removal.

Hydraulic Oil Tank

Repair Procedure Quick Guide

Step-A. Remove undercover
Step-B. Drain hydraulic oil
Step-C. Remove guardrail assembly and covers
Step-D. Disconnect oil pressure switch harness
Step-E. Remove hydraulic oil level gauge
Step-F. Disconnect hydraulic hoses and fittings
Step-G. Remove hydraulic tank assembly

Removal

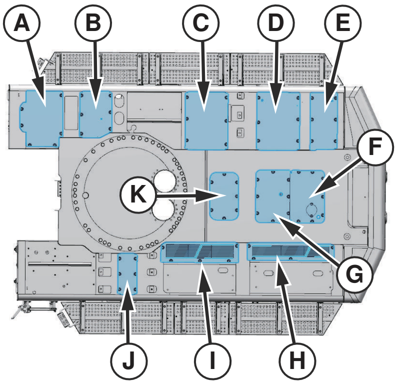
1. Open the left side door.

2. Turn OFF the battery disconnect switch.

Undercover

1. Remove undercover (C, D).

Figure 90



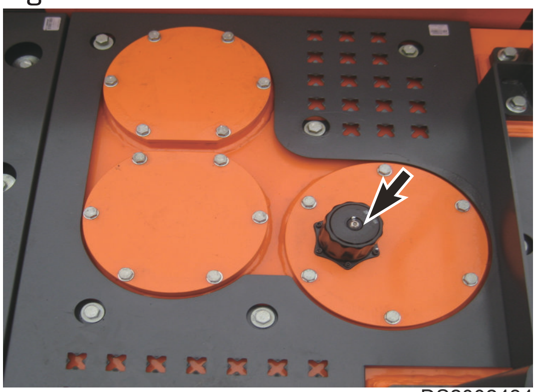
DS2002511

For details, refer to Undercovers - Removal and Installation.

Hydraulic Oil

1. Loosen the oil tank air breather slowly to release the pressure inside the hydraulic oil tank. Pulling the air breather cap upward, the check valve opens, and the air is discharged to the atmosphere from the top of the hydraulic oil tank.

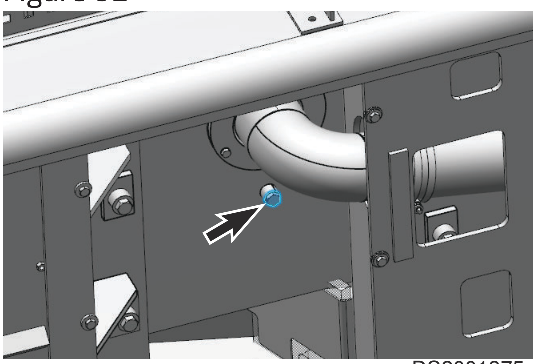
Figure 91



DS2002484

2. Position a container under hydraulic tank drain plug.

Figure 92



DS2001375

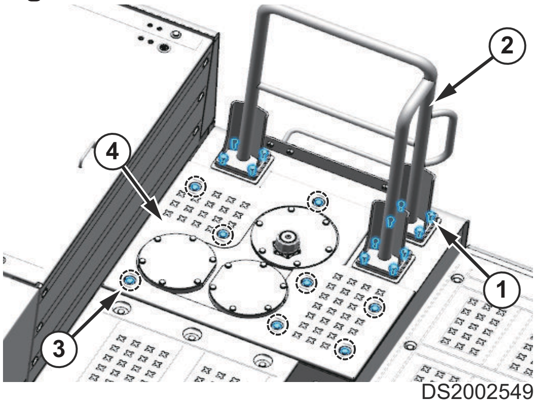
3. Loosen drain plug from bottom of tank.
4. After draining tank, install drain plug.

NOTE: *Dispose of drained fluids according to applicable environmental laws and regulations.*

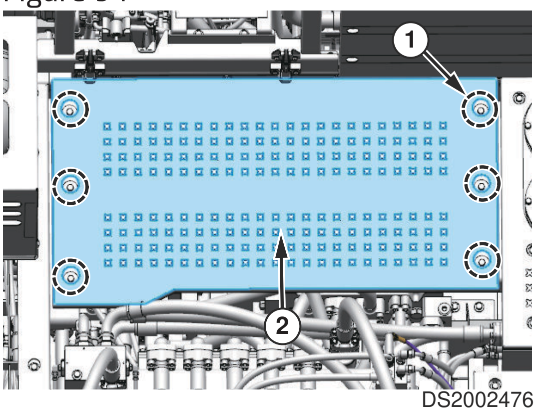
- Hydraulic oil tank volume: 435 L (114.9 U.S. gal)

Guardrail Assembly and Covers

1. Remove mounting bolts (1).
   Figure 93



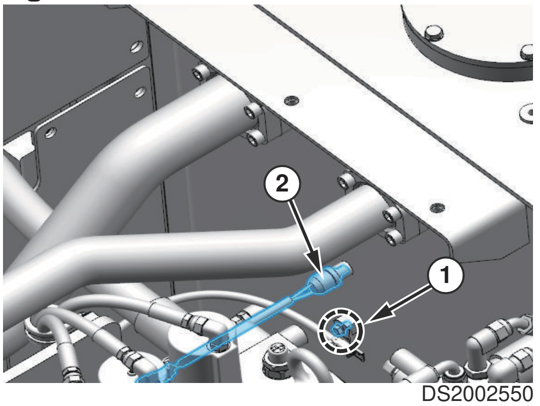
   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
2. Remove guardrail (2) from hydraulic oil tank.
   - Weight: about 30 kg (66.1 lb)
3. Remove mounting bolts (3).
   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
4. Remove cover (4) from hydraulic oil tank.
   - Weight: about 7 kg (15.4 lb)
5. Remove mounting bolts (1) from cover.
   Figure 94



   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
6. Remove cover (2) from frame.
   - Weight: about 39 kg (86 lb)

Oil Pressure Switch Harness

1. Remove mounting bolts (1) and wire harness.
   Figure 95



DS2002550

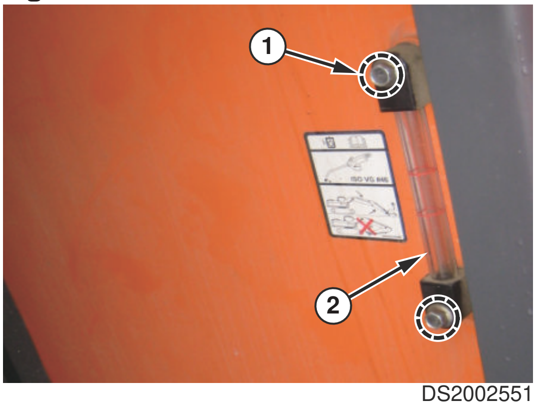
2. Disconnect wire harness from oil pressure switch.
3. Remove oil pressure switch (2) from hydraulic oil tank.

Hydraulic Oil Level Gauge

1. Open the left side door.
   Figure 96

DS2002514

2. Remove mounting bolts (1).
   Figure 97



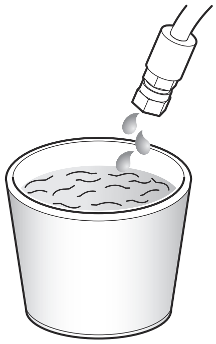
DS2002551

   - Tool: 17 mm ( )
   - Torque: 12.7 N.m (1.3 kg.m, 9.4 ft lb)
3. Remove hydraulic oil level gauge (2) from hydraulic oil tank.

   NOTE: *Grease lip seals before assembly.*

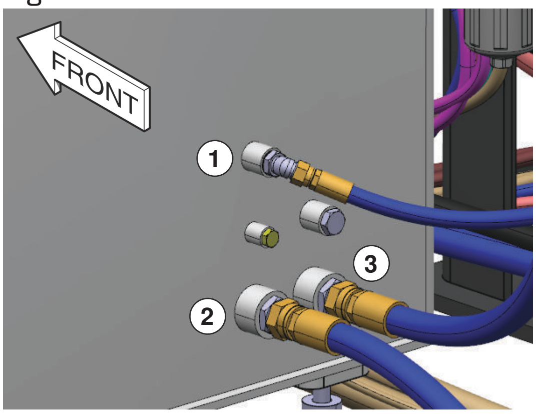
Hydraulic Hoses and Fittings

1. When disconnecting the hose, oil left in the hose may flow out. Therefore, place the end of the hose into a suitable container to prevent contamination of the ground and environment.
   Figure 98



EX1504170

2. Remove hoses and adapters from the oil tank.
   Figure 99



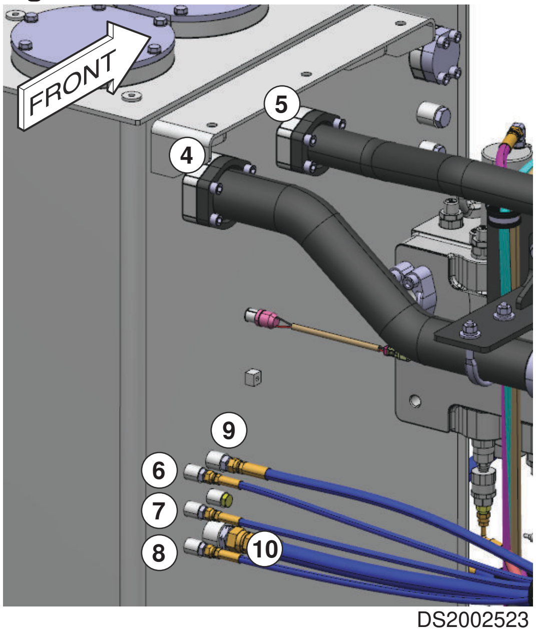
DS2002522

NOTE: *Attach identification tags to the removed hoses for reassembling. After disconnecting hoses from oil tank, plug them to prevent dirt or dust from entering. Disconnect the hoses from the bottom to top of oil tank.*

- 1 port
  - Tool: 24 mm ( )
  - Torque: 58.8 N.m (6 kg.m, 43.4 ft lb)
  - Connecting part: "from Fan Pump L1"
- 2 port
  - Tool: 41 mm ( )
  - Torque: 205.9 N.m (21 kg.m, 151.9 ft lb)
  - Connecting part: "from Drain Filter"
- 3 port
  - Tool: 41 mm ( )
  - Torque: 205.9 N.m (21 kg.m, 151.9 ft lb)
  - Connecting part: "from Drain Filter"

- 4 port

  Figure 100

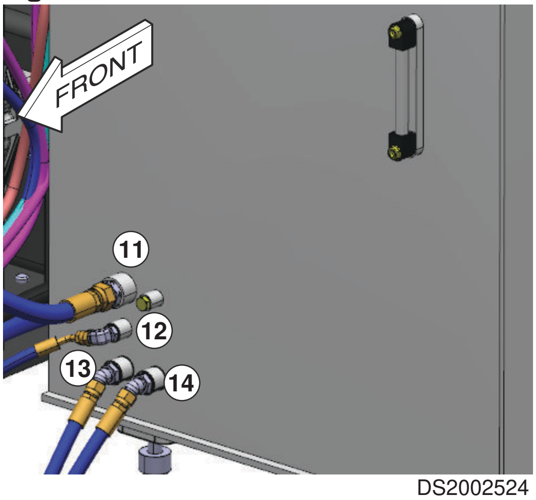
  - Tool: 10 mm ( )
  - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
  - Connecting part: "from Control Valve T"
- 5 port
  - Tool: 10 mm ( )
  - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
  - Connecting part: "from Oil Cooler"
- 6 port
  - Tool: 19 mm ( )
  - Torque: 34.3 N.m (3.5 kg.m, 25.3 ft lb)
  - Connecting part: "from Control Valve L"
- 7 port
  - Tool: 19 mm ( )
  - Torque: 34.3 N.m (3.5 kg.m, 25.3 ft lb)
  - Connecting part: "from Control Valve L"
- 8 port
  - Tool: 19 mm ( )
  - Torque: 34.3 N.m (3.5 kg.m, 25.3 ft lb)
  - Connecting part: "from Control Valve L"
- 9 port
  - Tool: 22 mm ( )
  - Torque: 49 N.m (5 kg.m, 36.2 ft lb)

- Connecting part: "from Arm Lock Valve Dr"

- 10 port
  - Tool: 36 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "from EPPR Valve T"

- 11 port

Figure 101



  - Tool: 36 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "from Solenoid Valve T"

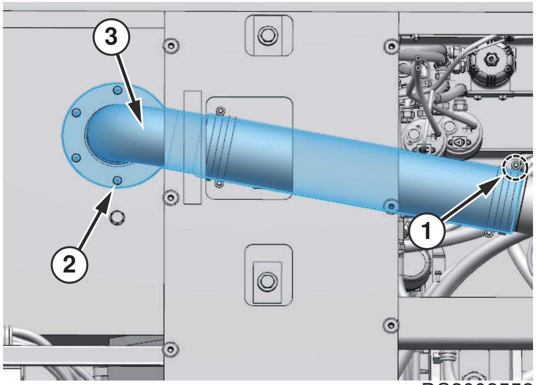
- 12 port
  - Tool: 22 mm ( )
  - Torque: 49 N.m (5 kg.m, 36.2 ft lb)
  - Connecting part: "from Boom Lock Valve Dr"

- 13 port
  - Tool: 24 mm ( )
  - Torque: 58.8 N.m (6 kg.m, 43.4 ft lb)
  - Connecting part: "from PT Block T"

- 14 port
  - Tool: 24 mm ( )
  - Torque: 58.8 N.m (6 kg.m, 43.4 ft lb)
  - Connecting part: "from PT Block T"

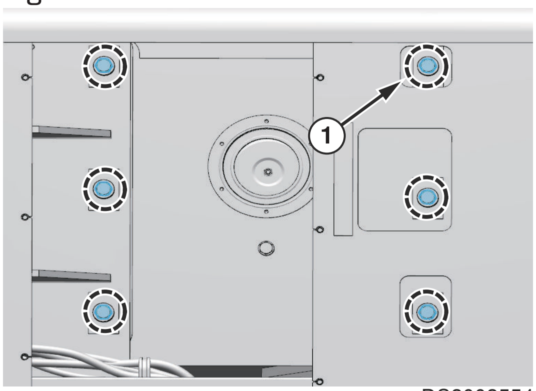
Hydraulic Tank Assembly

1. Loosen hose clamp (1).
   Figure 102



DS2002552

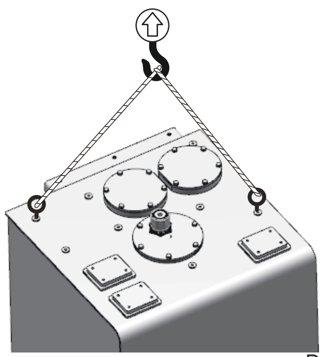
2. Remove mounting bolts (2) and suction pipe (3) from hydraulic oil tank.
   - Tool: 17 mm ( )
   - Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)
3. Remove oil tank mounting bolts and spacers (1) from the main frame.
   Figure 103



DS2002554

   - Tool: 30 mm ( )
   - Torque: 539.3 N.m (55 kg.m, 397.8 ft lb)

   NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*
4. Install eyebolts (2 ea) on the hydraulic oil tank. And tie the rope to the bolts to lift oil tank.
   Figure 104



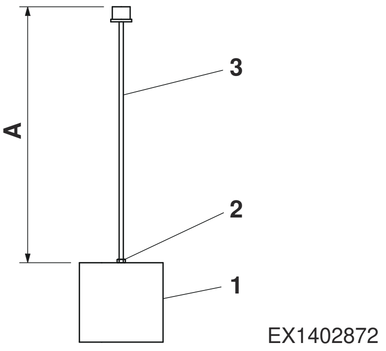
DS2002553

   - Thread of hole: M12 x 1.75

5. Lift the oil tank by crane from frame slowly and carefully.
   - Oil tank weight: about 500 kg (1,102 lb)

Installation

1. Perform installation in the reverse order of removal.
2. When assembling rod (3) to suction filter (1), adjust the assembling length.
   Figure 105



   - Length (A): 950 mm
   - Torque (2 nut): 49 N.m (5 kg.m, 36.2 ft lb)

Fuel Tank

Repair Procedure Quick Guide

Step-A. Drain fuel

Step-B. Remove guardrail assembly and covers

Step-C. Disconnect wiring harness connector

Step-D. Remove undercover

Step-E. Disconnect fuel hoses and fittings

Step-F. Remove fuel tank assembly

Removal

1. Open the left side door.
2. Turn OFF the battery disconnect switch.

Fuel

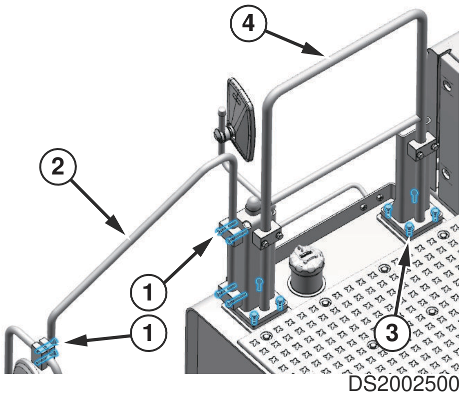
1. Open the storage box cover.
   Figure 106

2. Open fuel drain valve.
   - Fuel tank capacity: 880 L (232.5 U.S. gal)

   NOTE: *Dispose of drained fluids according to applicable laws and regulations.*

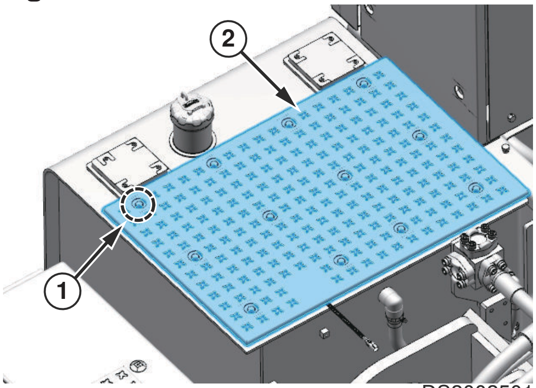
Guardrail Assembly and Covers

1. Remove mounting bolts (1) and clamp from guardrail.
   Figure 107



   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
2. Remove guardrail (2).
3. Remove mounting bolts (3).
   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
4. Remove guardrail (4) from fuel tank.

5. Remove mounting bolts (1) and fuel tank cover (2).
   Figure 108

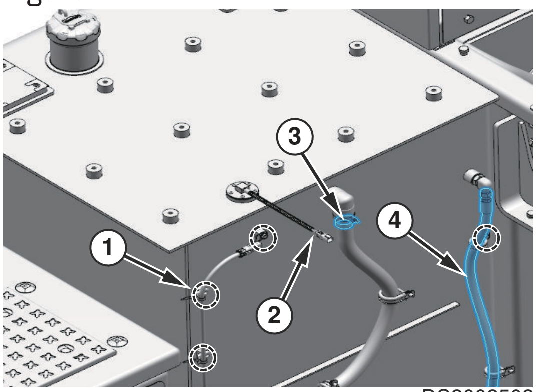


DS2002501

- Tool: 19 mm ( )
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

Wiring Harness Connector

1. Remove bolts (1) and wire harness from fuel tank.
   Figure 109



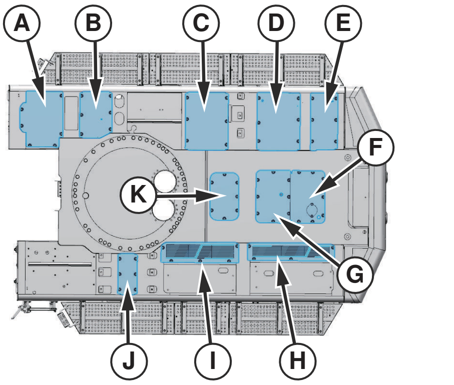
DS2002502

- Tool: 12 mm ( )
- Torque: 29.4 N.m (3 kg.m, 21.7 ft lb)

2. Disconnect fuel sensor (2).
3. Loosen clamp (3) fuel hose from fuel tank.
4. Disconnect fuel hose (4) from fuel tank.
   - Tool: 24 mm ( )
   - Torque: 58.8 N.m (6 kg.m, 43.4 ft lb)

Undercover

1. Remove undercover (J).
   Figure 110

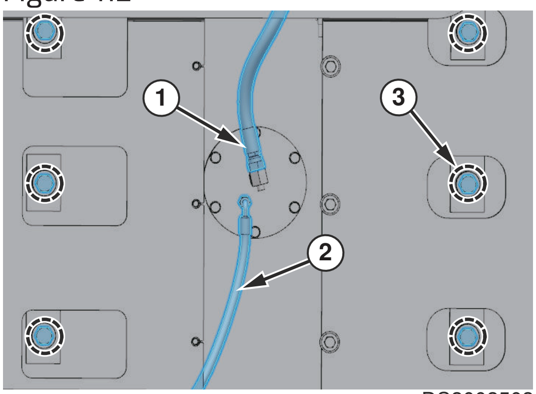


   For details, refer to Undercovers - Removal and Installation.

Fuel Hoses and Fittings

1. When disconnecting the hose, fuel left in the hose may flow out. Therefore, place the end of the hose into a suitable container to prevent contamination of the ground and environment.
   Figure 111

2. Disconnect fuel hose from fuel tank.
   Figure 112



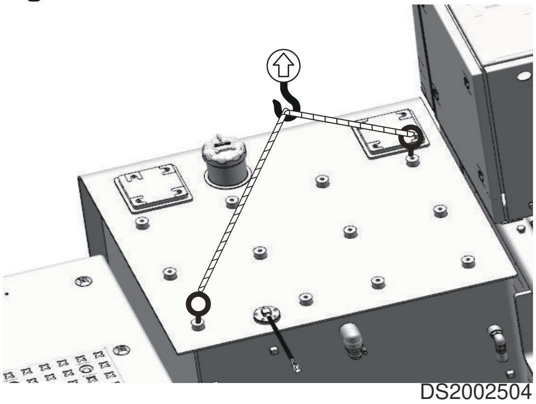
- 1 port
- Tool: 29 mm ()
- Connecting part: "to Supply Line"
- 2 port
- Tool: 21 mm ()

- Torque: 49 N.m (5 kg.m, 36.2 ft lb)
- Connecting part: "to Drain Valve"

3. Loosen mounting bolts (3) from fuel tank.

Fuel Tank Assembly

1. Remove fuel tank mounting bolts from the main frame.
   Figure 113



DS2002504

- Tool: 30 mm ( )
- Torque: 558.9 N.m (57 kg.m, 412.3 ft lb)

  NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*

2. Install eyebolts (2 ea) on the fuel tank. And tie the rope to the bolts to lift tank.
3. Completely remove tank after inspection.
   - Fuel tank weight: about 470 kg (1,036 lb)

Installation

1. Perform installation in the reverse order to remove.
   Figure 114

DS2002499

2. Make sure fuel tank drain valve right side door is closed.
3. Fill fuel tank and check for signs of leaks. Correct any problems found.
   - Fuel tank capacity: 880 L (232.5 U.S. gal)

Swing Device

Repair Procedure Quick Guide

Step-A. Disconnect hydraulic hoses and fittings

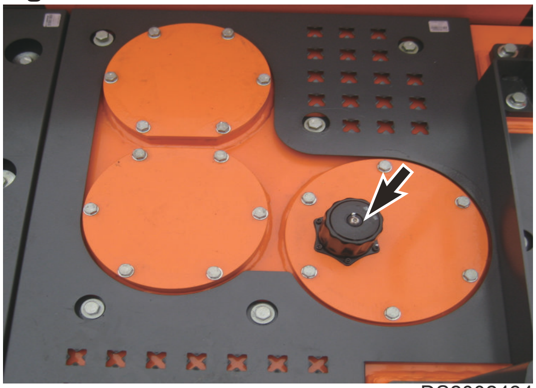
Step-B. Remove swing device

Removal

1. Open the left side door.
2. Turn OFF the battery disconnect switch.

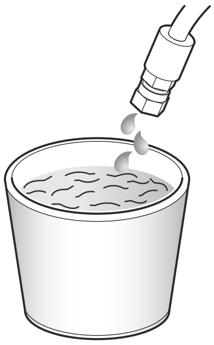
Hydraulic Hoses and Fittings

1. Loosen the oil tank air breather slowly to release the pressure inside the hydraulic oil tank. Pulling the air breather cap upward, the check valve opens, and the air is discharged to the atmosphere from the top of the hydraulic oil tank.
Figure 115



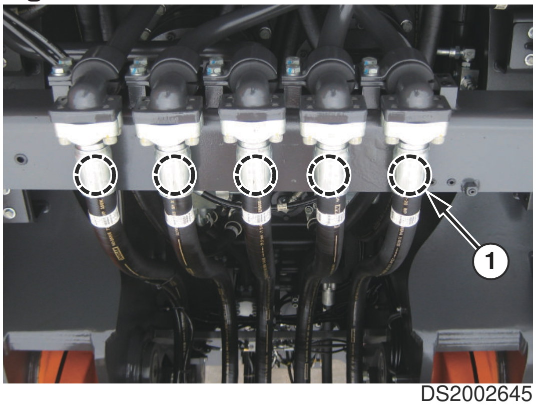
DS2002484

2. When disconnecting the hose, oil left in the hose may flow out. Therefore, place the end of the hose into a suitable container to prevent contamination of the ground and environment.
Figure 116



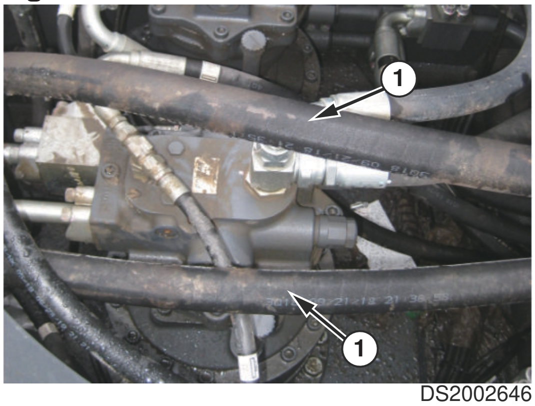
EX1504170

3. Disconnect arm and bucket hoses (1) from pipe bracket.
Figure 117



- Tool: 12 mm ( )
- Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)

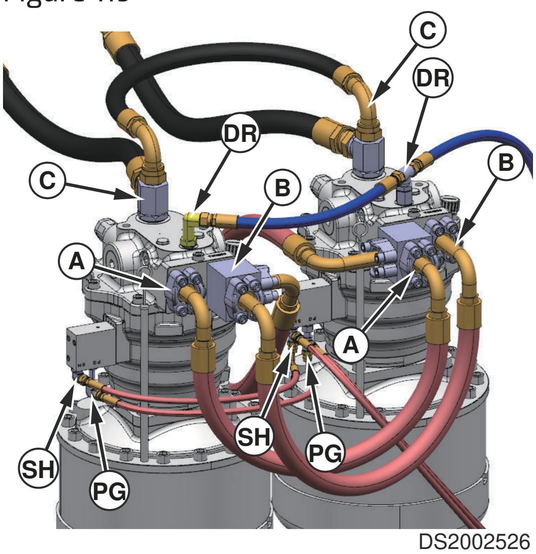
4. Disconnect hydraulic hoses from center joint.
Figure 118



For details, refer to Center Joint - Removal and Installation.

5. Disconnect any additional hydraulic connections as necessary.

6. Remove hoses and adapters from the swing device.
Figure 119

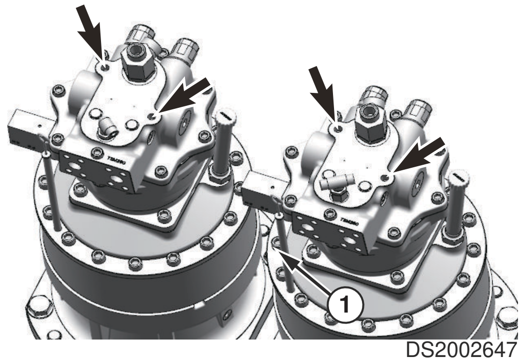


NOTE: *Attach identification tags to the removed hoses for reassembling. After disconnecting hoses from swing device, plug them to prevent dirt or dust from entering. Disconnect the hoses from the bottom to top of swing device.*

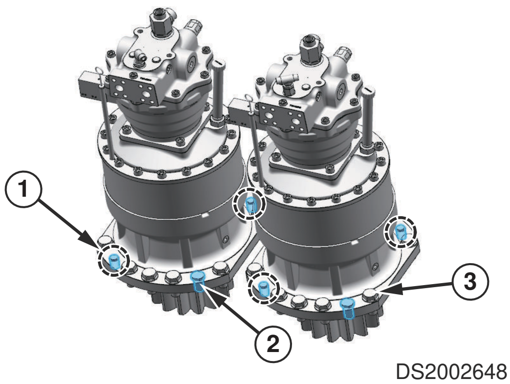
- A port
  - Tool: 10 mm ( )
  - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
  - Connecting part: "from Control Valve 2 B1"
- B port
  - Tool: 10 mm ( )
  - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
  - Connecting part: "from Control Valve 2 A1"
- C port
  - Tool: 50 mm ( )
  - Torque: 205.9 N.m (21 kg.m, 151.9 ft lb)
  - Connecting part: "from Control Valve K"
- DR port
  - Tool: 24 mm ( )
  - Torque: 58.8 N.m (6 kg.m, 43.4 ft lb)
  - Connecting part: "to Oil Tank"
- PG port
  - Tool: 19 mm ( )
  - Torque: 34.3 N.m (3.5 kg.m, 25.3 ft lb)
  - Connecting part: "from Solenoid Valve P2"
- SH port
  - Tool: 19 mm ( )
  - Torque: 34.3 N.m (3.5 kg.m, 25.3 ft lb)
  - Connecting part: "from Solenoid Valve C"

Swing Device

1. Install the eyebolts (M16 x 2.0, DP 15)
   Figure 120



2. Attach a lifting device onto the eyebolts.
3. Remove mounting bolts (3) from frame.
   Figure 121



- Tool: 36 mm ( )
- Torque: 931.6 N.m (95 kg.m, 687.1 ft lb)

  NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*

4. Remove plug cap (1) from swing device.
5. Install the back bolt to the plug position to ensure that frame and swing device can be separated.
6. Remove lock pin (2) from swing device.
7. Hoist and remove swing device from the frame.

   NOTE: *When hoisting the swing device one part of swing device will contact with the main frame. Hoist the swing device a little and push to the front side while hoisting slowly.*

   - Weight: about 2 x 472 kg (1,040 lb)

Installation

1. Perform installation in the reverse order to remove.
2. When installing the hoses, install the drain hose first.
3. When installing the swing device, slightly move the end of bucket to align it with the swing bearing gear if the swing device does not fit the gear.
   - Gear oil volume: 2 x 8L

Fan Pump

Repair Procedure Quick Guide

Step-A. Open engine hood assembly

Step-B. Remove cover

Step-C. Disconnect wiring harness

Step-D. Disconnect hydraulic hoses and fittings

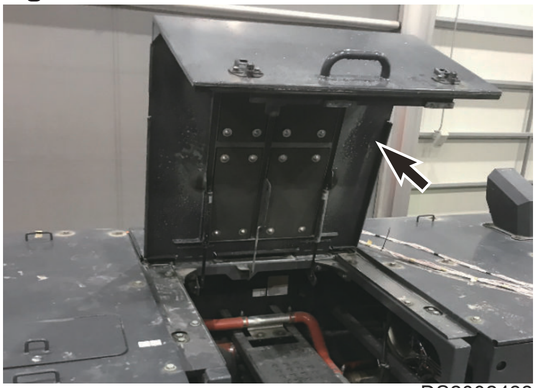
Step-E. Remove fan pump

Removal

1. Open the left side door.
2. Turn OFF the battery disconnect switch.

Engine Hood

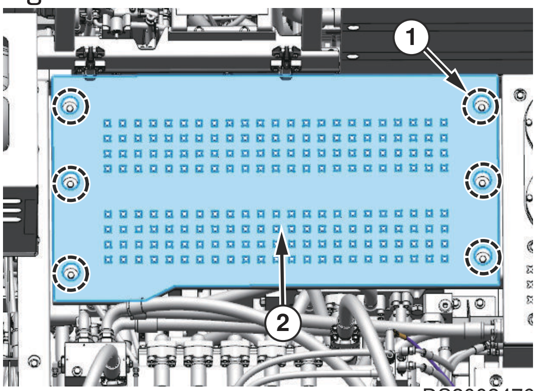
1. Open engine hood assembly.
   Figure 122



DS2002488

Cover

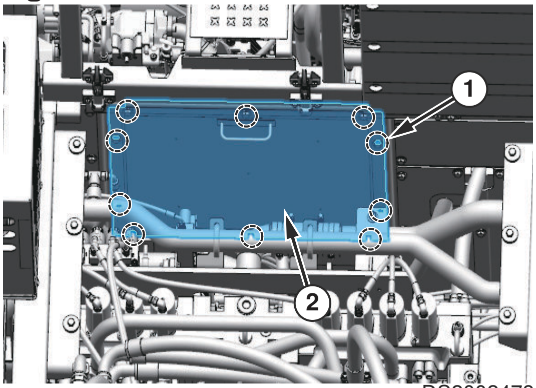
1. Remove mounting bolts (1) from cover.
   Figure 123



DS2002476

   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
2. Remove cover (2) from frame.
   - Weight: about 39 kg (86 lb)

3. Remove mounting bolts (1) from cover.
   Figure 124



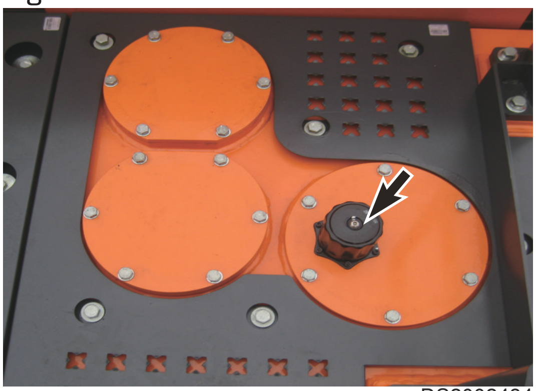
DS2002478

   - Tool: 19 mm ()
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

4. Remove cover (2) from frame.
   - Weight: about 9 kg (19.8 lb)

Hydraulic Hoses and Fittings

1. Loosen the oil tank air breather slowly to release the pressure inside the hydraulic oil tank. Pulling the air breather cap upward, the check valve opens, and the air is discharged to the atmosphere from the top of the hydraulic oil tank.
   Figure 125

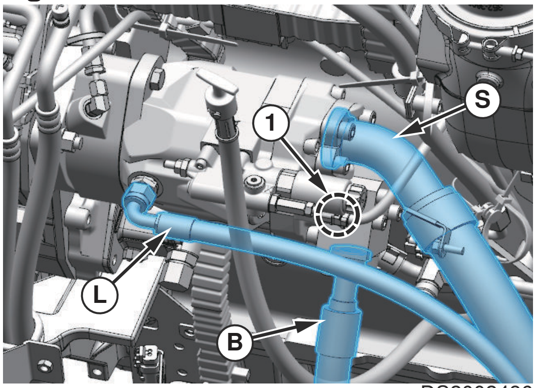

DS2002484

2. When disconnecting the hose, oil left in the hose may flow out. Therefore, place the end of the hose into a suitable container to prevent contamination of the ground and environment.
   Figure 126


EX1504170

3. Disconnect wire harness (1) from fan pump.

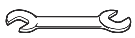
Figure 127



DS2002486

4. Disconnect hoses from fan pump.

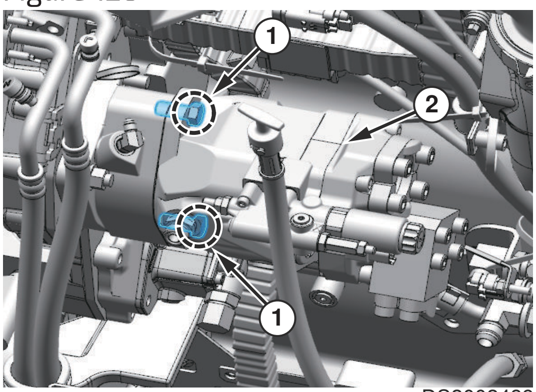
NOTE: *Attach identification tags to the removed hoses for reassembling. After disconnecting hoses from fan pump, plug them to prevent dirt or dust from entering. Disconnect the hoses from the bottom to top of fan pump.*

- B port
  - Tool: 8 mm ()
  - Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)
  - Connecting part: "to Fan Drive Valve P"
- L port
  - Tool: 24 mm ()
  - Torque: 58.8 N.m (6 kg.m, 43.4 ft lb)
  - Connecting part: "to Oil Tank (Drain)"
- S port
  - Tool: 10 mm ()
  - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
  - Connecting part: "from Oil Tank Suction Pipe"

Fan Pump

1. Tie pump with rope to lift it.

Figure 128



DS2002489

2. Remove mounting bolts (1) and fan pump (2) from engine.

- Tool: 19 mm ()
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Fan pump weight: about 21 kg (46.3 lb)

Installation

1. Perform installation in the reverse order to remove.

Oil Cooler Fan Motor

Repair Procedure Quick Guide

Step-A. Remove air cleaner cover

Step-B. Remove air cleaner baffle

Step-C. Remove oil cooler cover

Step-E. Disconnect hydraulic hoses and fittings

Step-F. Remove undercover

Step-G. Separate fan mounting bracket

Step-H. Remove fan guard

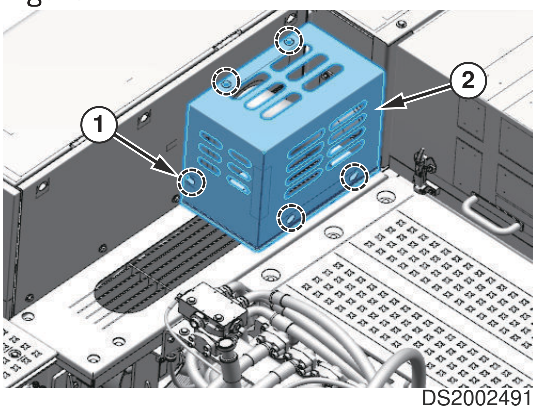
Step-I. Remove oil cooler fan motor

Removal

1. Open the left side door.
2. Turn OFF the battery disconnect switch.

Air Cleaner Cover

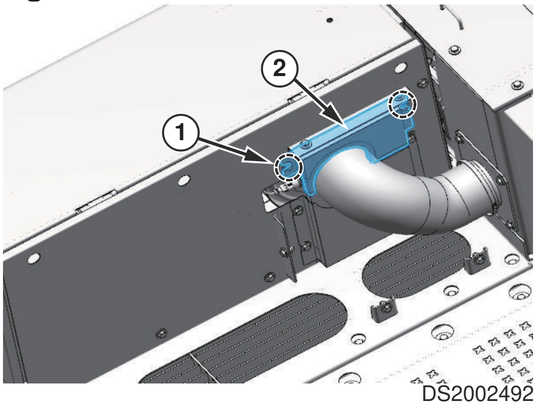
1. Remove mounting bolts (1) and air cleaner cover (2).
   Figure 129



- Tool: 19 mm ()
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Weight: about 10 kg (22 lb)

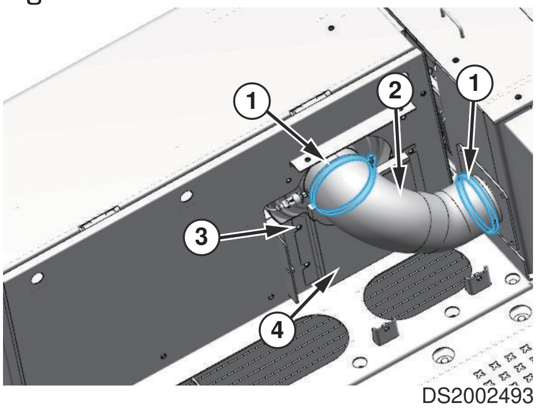
Air Cleaner Baffle

1. Remove mounting bolts (1) and air cleaner upper baffle (2).
   Figure 130



   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

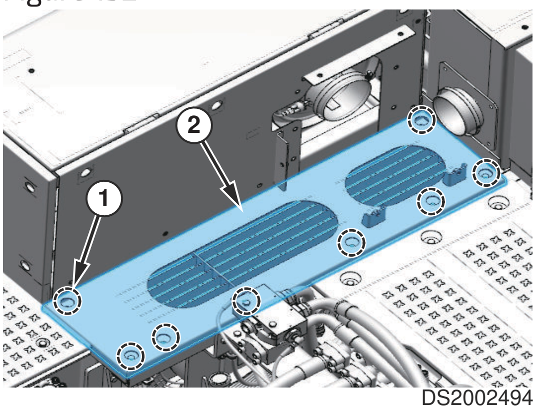
2. Loosen clamps (1) from air cleaner hose.
   Figure 131



3. Remove air cleaner hose (2) from air cleaner.
4. Remove mounting bolts (3) and air cleaner under baffle (4).
   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

Oil Cooler Cover

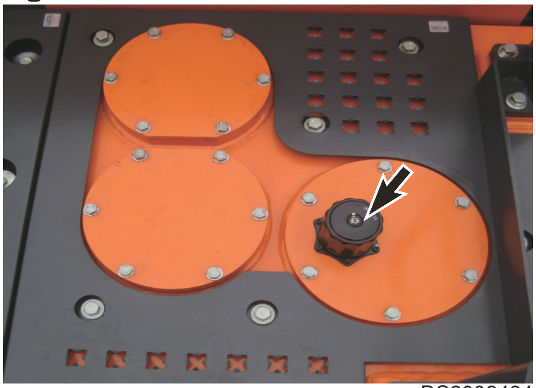
1. Remove mounting bolts (1) and oil cooler cover (2).
   Figure 132



- Tool: 19 mm ( )
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Weight: about 43 kg (311 lb)

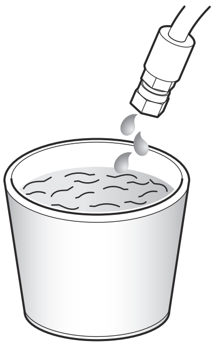
Hydraulic Hoses and Fittings

1. Loosen the oil tank air breather slowly to release the pressure inside the hydraulic oil tank. Pulling the air breather cap upward, the check valve opens, and the air is discharged to the atmosphere from the top of the hydraulic oil tank.
   Figure 133



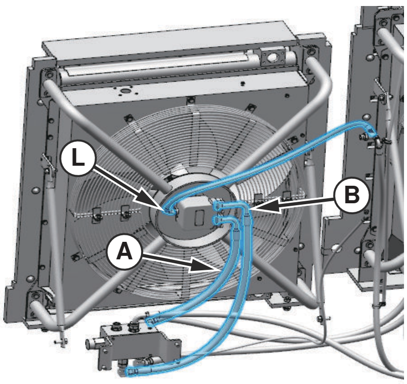
DS2002484

2. When disconnecting the hose, oil left in the hose may flow out. Therefore, place the end of the hose into a suitable container to prevent contamination of the ground and environment.
   Figure 134



EX1504170

3. Disconnect hoses from fan motor.
   Figure 135



DS2002495

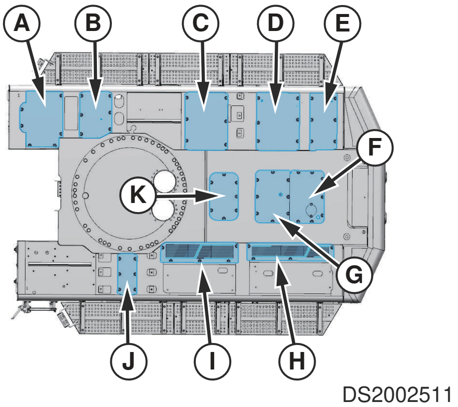
NOTE: *Attach identification tags to the removed hoses for reassembling. After disconnecting hoses from fan motor, plug them to prevent dirt or dust from entering. Disconnect the hoses from the bottom to top of fan motor.*

- A port
  - Tool: 8 mm ( )
  - Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)
  - Connecting part: "to Fan Dive Valve M"
- B port
  - Tool: 8 mm ( )
  - Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)
  - Connecting part: "from Fan Dive Valve B"
- L port
  - Tool: 24 mm ( )
  - Torque: 58.8 N.m (6 kg.m, 43.4 ft lb)
  - Connecting part: "to Oil Tank (Drain)"

Undercover

1. Remove undercover (I).

   Figure 136

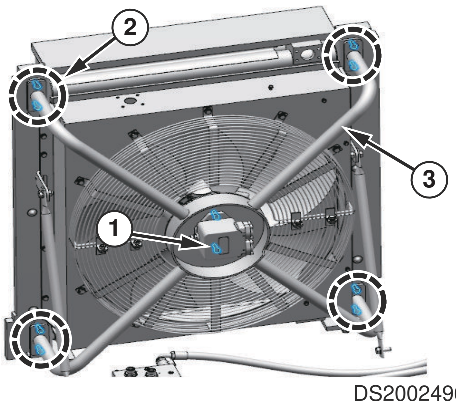


   For details, refer to Undercovers - Removal and Installation.

Fan Mounting Bracket

1. Loosen mounting bolts (1) from fan motor.

   Figure 137



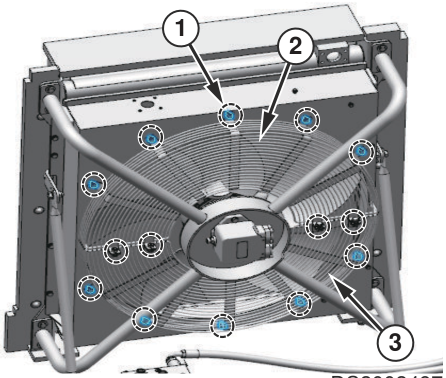
2. Remove mounting bolts (2) from oil cooler.
   - Tool: 19 mm ( )

- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

3. Separate fan mounting bracket (3).

Fan Guard

1. Remove mounting bolts (1) from oil cooler.
   Figure 138



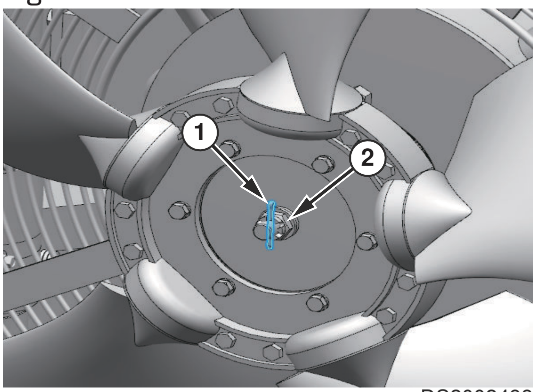
DS2002497

   - Tool: 19 mm ( )

2. Remove fan guard (2, 3) from oil cooler.
3. Remove fan from fan hub.

Oil Cooler Fan Motor

1. Remove lock pin (1) from fan motor shaft.
   Figure 139



DS2002498

2. Remove lock nut (2) from fan motor shaft.
   - Tool: 24 mm ( )
3. Remove mounting bolts fan motor from fan mounting bracket.
   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

Installation

1. Perform installation in the reverse order to removal.

Joystick Valve (Work Lever)

Repair Procedure Quick Guide

Step-A. Remove armrest

Step-B. Remove stand covers

Step-C. Remove control stand bracket

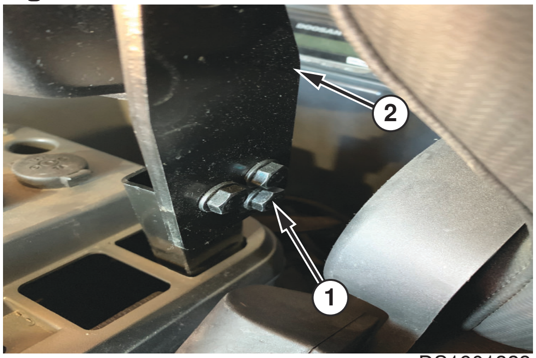
Step-D. Disconnect hydraulic hoses and fittings

Step-E. Remove joystick valve

Removal

Armrest

1. Remove mounting bolts (1) and armrest (2).
   Figure 140

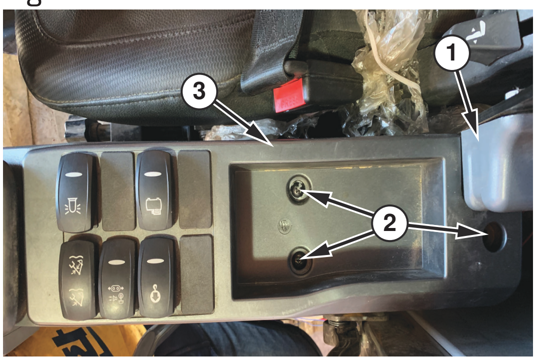


DS1901323

- Tool: 13 mm ( )
- Torque: 19.6 N.m (2 kg.m, 14.5 ft lb)

Stand Cover - Left Side

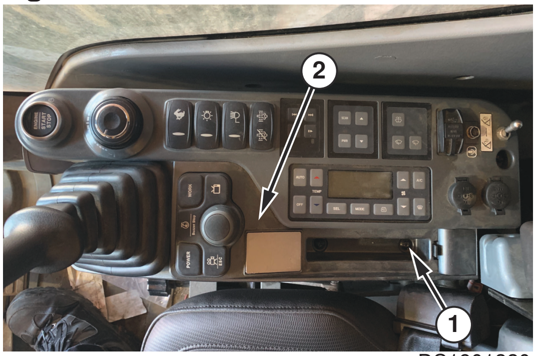
1. Remove the mounting screw and cover (1) from armrest bracket.
   Figure 141



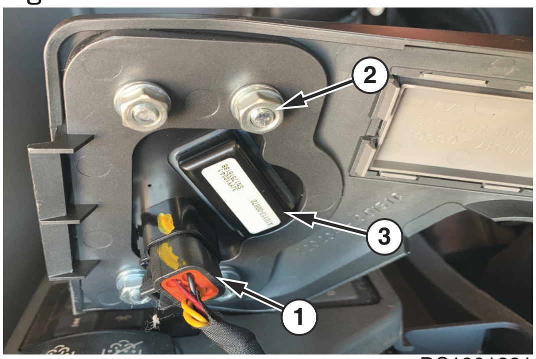
DS1901317

2. Remove the rubber pad, and screws (2).
3. Lift off the stand cover LH (3).

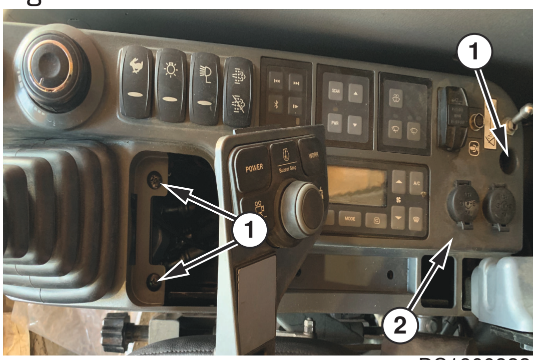
Stand Cover - Right Side

1. Remove the rubber pad, and screws (1).
   Figure 142
   

   DS1901320

2. Lift off the stand upper cover (2).
3. Disconnect wiring harness connector (1) from jog switch.
   Figure 143
   

   DS1901321

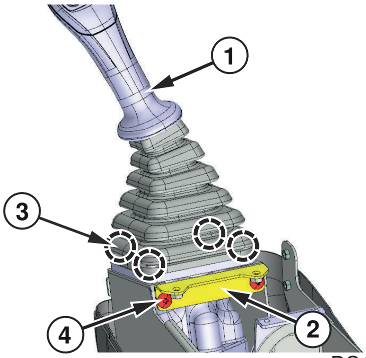
4. Remove the stand upper cover.
5. Remove the screws (1).
   Figure 144
   

   DS1900822

6. Remove the mounting screw and cover (2) from armrest bracket.

Control Stand Bracket

1. Remove screws (4) (2 ea), socket bolts and washers (3) (4 ea) of joystick valve (1).
   Figure 145

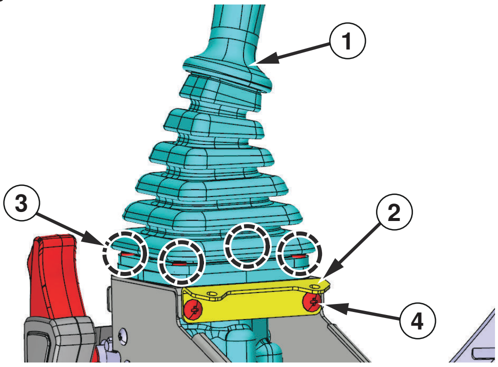


DS1602344

2. Remove bracket (2) from control stand bracket.
3. Separate joystick valve from control stand.

   Left side is same.

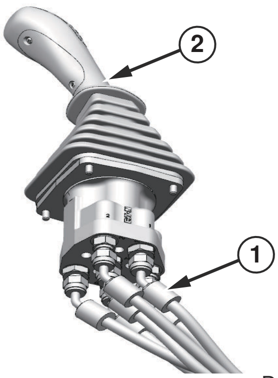
   - Tool: 5 mm ( ), Phillips screwdriver
     Figure 146



DS1900824

Hydraulic Hoses and Fittings

1. Disconnect hydraulic hoses (1) and from joystick valve (2).
   Figure 147



DS2001589

NOTE: *Attach identification tags to the removed hoses for reassembling. After disconnecting hoses from joystick valve, plug them to prevent dirt or dust from entering.*

Left Hand

- 1 port

- Tool: 22 mm ( )
- Torque: 49 N.m (5 kg.m, 36.2 ft lb)
- Connecting part: "to Joint Plate A2"

- 2 port
  - Tool: 22 mm ( )
  - Torque: 49 N.m (5 kg.m, 36.2 ft lb)
  - Connecting part: "to Joint Plate A6"
- 3 port
  - Tool: 22 mm ( )
  - Torque: 49 N.m (5 kg.m, 36.2 ft lb)
  - Connecting part: "to Joint Plate A4"
- 4 port
  - Tool: 22 mm ( )
  - Torque: 49 N.m (5 kg.m, 36.2 ft lb)
  - Connecting part: "to Joint Plate A8"
- P port
  - Tool: 19 mm ( )
  - Torque: 39.2 N.m (4 kg.m, 28.9 ft lb)
  - Connecting part: "from PT Block P"
- T port
  - Tool: 22 mm ( )
  - Torque: 49 N.m (5 kg.m, 36.2 ft lb)
  - Connecting part: "to PT Block T"

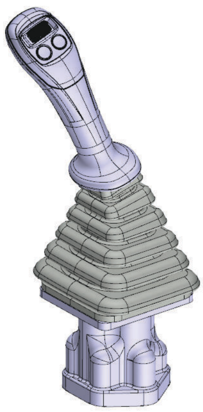
Right Hand

- 1 port
  - Tool: 22 mm ( )
  - Torque: 49 N.m (5 kg.m, 36.2 ft lb)
  - Connecting part: "to Joint Plate A11"
- 2 port
  - Tool: 22 mm ( )
  - Torque: 49 N.m (5 kg.m, 36.2 ft lb)
  - Connecting part: "to Joint Plate A1"
- 3 port
  - Tool: 22 mm ( )
  - Torque: 49 N.m (5 kg.m, 36.2 ft lb)
  - Connecting part: "to Joint Plate A9"

- 4 port
  - Tool: 22 mm ()
  - Torque: 49 N.m (5 kg.m, 36.2 ft lb)
  - Connecting part: "to Joint Plate A3"
- P port
  - Tool: 22 mm ()
  - Torque: 49 N.m (5 kg.m, 36.2 ft lb)
  - Connecting part: "from PT Block P"
- T port
  - Tool: 22 mm ()
  - Torque: 49 N.m (5 kg.m, 36.2 ft lb)
  - Connecting part: "to PT Block T"

Joystick Valve

1. Remove joystick valve from control stand.
   Figure 148



DS1602346

Installation

⚠ WARNING

INCORRECT INSTALLATION CAN CAUSE DEATH OR SERIOUS INJURY

Any change in the connections will lead to malfunctions.

- When connecting hydraulic components, observe the specified piping according to the hydraulic schematic diagram of the machine.

1. Perform installation in the reverse order to remove.
2. Keep the assembly angle when installing the hoses to joystick valve.

Travel Control Valve

Repair Procedure Quick Guide

Step-A. Remove undercover

Step-B. Disconnect hydraulic hoses and fittings

Step-C. Remove foot rest and travel pedal

Step-D. Remove travel control valve

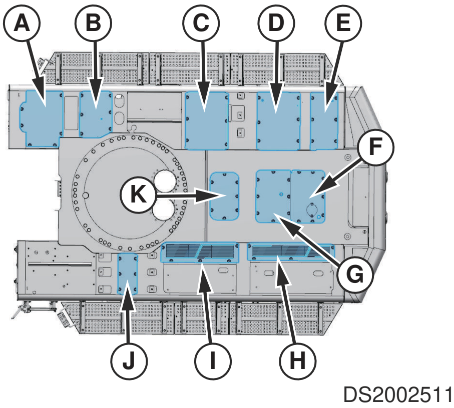
Removal

1. Open the left side door.
2. Turn OFF the battery disconnect switch.

Undercovers

1. Remove undercover (A).

   Figure 149

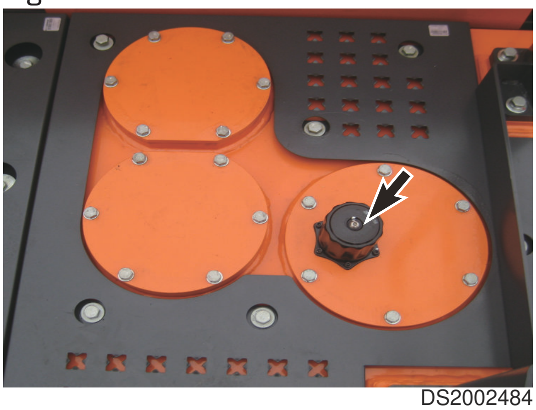


For details, refer to Undercovers - Removal and Installation.

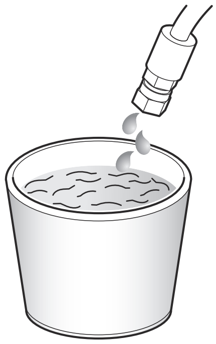
Hydraulic Hoses and Fittings

1. Loosen the oil tank air breather slowly to release the pressure inside the hydraulic oil tank. Pulling the air breather cap upward, the check valve opens, and the air is discharged to the atmosphere from the top of the hydraulic oil tank.

   Figure 150

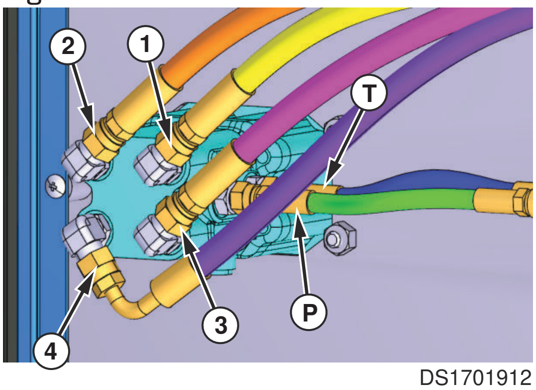


2. When disconnecting the hose, oil left in the hose may flow out. Therefore, place the end of the hose into a suitable container to prevent contamination of the ground and environment.
   Figure 151



EX1504170

3. Remove hoses and adapters from travel control valve.
   Figure 152



DS1701912

NOTE: *Attach identification tags to the removed hoses for reassembling. After disconnecting hoses from travel control valve, plug them to prevent dirt or dust from entering. Disconnect the hoses from the bottom to top of travel control valve.*

- 1 port
  - Tool: 22 mm ( )
  - Torque: 49 N.m (5 kg.m, 36.2 ft lb)
  - Connecting part: "to Joint Plate A12"
- 2 port
  - Tool: 22 mm ( )
  - Torque: 49 N.m (5 kg.m, 36.2 ft lb)
  - Connecting part: "to Joint Plate A10"
- 3 port
  - Tool: 22 mm ( )
  - Torque: 49 N.m (5 kg.m, 36.2 ft lb)
  - Connecting part: "to Joint Plate A7"
- 4 port
  - Tool: 22 mm ( )
  - Torque: 49 N.m (5 kg.m, 36.2 ft lb)

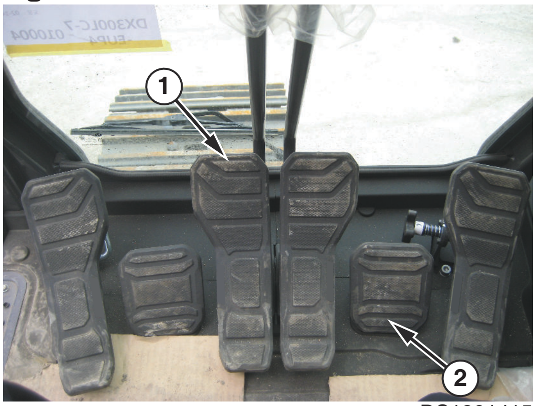
- Connecting part: "to Joint Plate A5"

- P port
  - Tool: 19 mm ( )
  - Torque: 34.3 N.m (3.5 kg.m, 25.3 ft lb)
  - Connecting part: "from PT Block P"
- T port
  - Tool: 19 mm ( )
  - Torque: 34.3 N.m (3.5 kg.m, 25.3 ft lb)
  - Connecting part: "to PT Block T"

Foot Rest and Travel Pedal

1. Remove floor mat from the cabin.

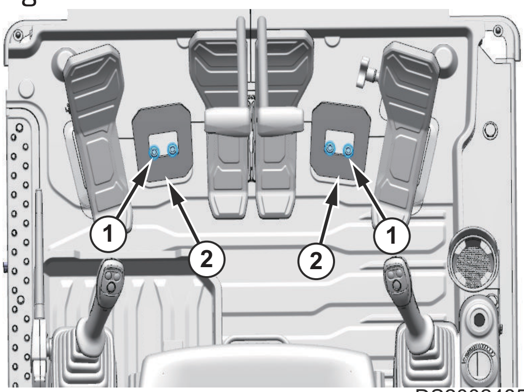
   Figure 153



DS1901415

2. Remove rubber pads (1, 2) from foot rests and travel control pedal.
3. Remove bolts (1) and foot rests (2) from cabin.

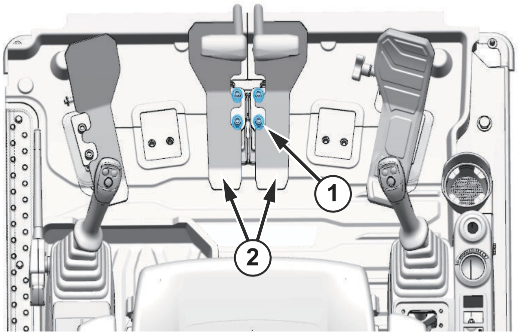
   Figure 154



DS2002485

- Tool: 8 mm ( )
- Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)

4. Remove bolts (1) and travel control pedal (2) from travel control valve.
   Figure 155

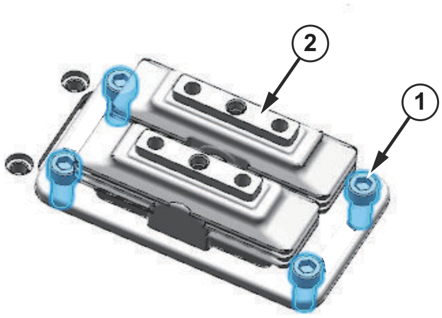


DS2002525

- Tool: 8 mm ( )
- Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)

Travel Control Valve

1. Remove bolts (1) and travel control valve (2) from cabin.
   Figure 156



DS2002487

- Tool: 8 mm ( )
- Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)
- Valve weight: about 8 kg (17.6 lb)

Installation

1. Perform installation in the reverse order to removal.
2. When installing the hose, be install the drain hose first.

Center Joint

Repair Procedure Quick Guide

Step-A. Remove undercarriage cover

Step-B. Disconnect hydraulic hoses and fittings

Step-C. Remove center joint

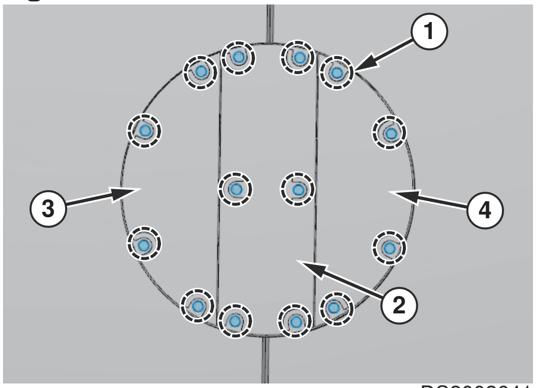
Removal

1. Open the left side door.

2. Turn OFF the battery disconnect switch.

Undercarriage Cover

1. Remove bolts (1) and under cover (2, 3, 4) from frame.
   Figure 157

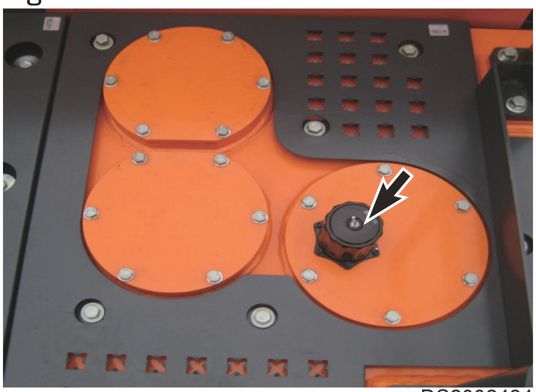


DS2002641

- Tool: 24 mm ( )
- Torque: 264.6 N.m (27 kg.m, 195.2 ft lb)
- Weight:
  - Undercarriage cover (2): about 16 kg (35.3 lb)
  - Undercarriage cover (3): about 21 kg (46.3 lb)
  - Undercarriage cover (4): about 16 kg (35.3 lb)

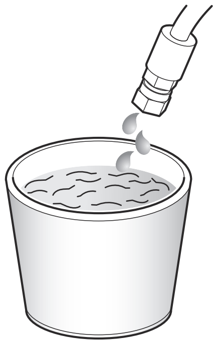
Hydraulic Hoses and Fittings

1. Loosen the oil tank air breather slowly to release the pressure inside the hydraulic oil tank. Pulling the air breather cap upward, the check valve opens, and the air is discharged to the atmosphere from the top of the hydraulic oil tank.
   Figure 158



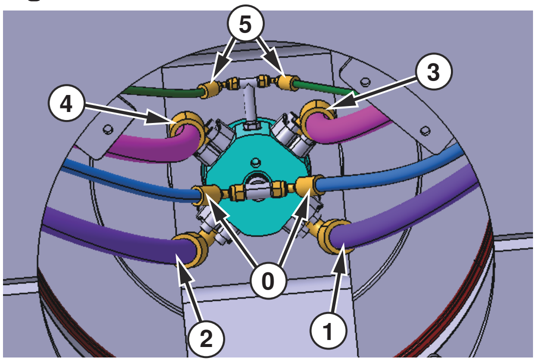
DS2002484

2. When disconnecting the hose, oil left in the hose may flow out. Therefore, place the end of the hose into a suitable container to prevent contamination of the ground and environment.
Figure 159



EX1504170

3. Remove hoses and adapters from center joint.
Figure 160



DS1601510

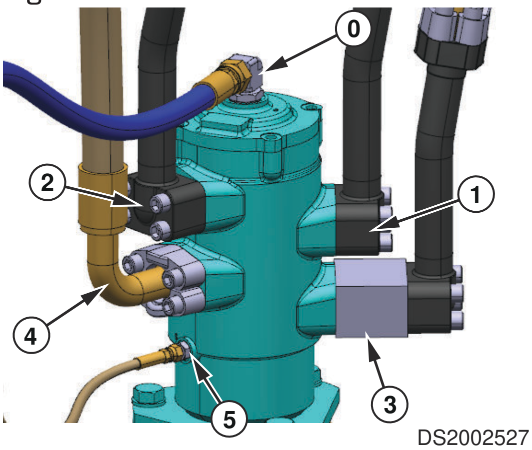
NOTE: *Attach identification tags to the removed hoses for reassembling. After disconnecting hoses, plug them to prevent dirt or dust from entering. Disconnect the hoses from the bottom to top of center joint.*

- 0 port
  - Tool: 36 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "from Travel Device Dr"
- 1 port
  - Tool: 12 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "to Travel Device (RH) P2"
- 2 port
  - Tool: 12 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "to Travel Device (LH) P1"
- 3 port
  - Tool: 12 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)

- Connecting part: "to Travel Device (RH) P1"

- 4 port
  - Tool: 12 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "to Travel Device (LH) P2"
- 5 port
  - Tool: 19 mm ( )
  - Torque: 34.3 N.m (3.5 kg.m, 25.3 ft lb)
  - Connecting part: "to Travel Device Pi"

4. Remove hoses and adapters from center joint.
   Figure 161



NOTE: *Attach identification tags to the removed hoses for reassembling. After disconnecting hoses from center joint, plug them to prevent dirt or dust from entering. Disconnect the hoses from the bottom to top of center joint.*

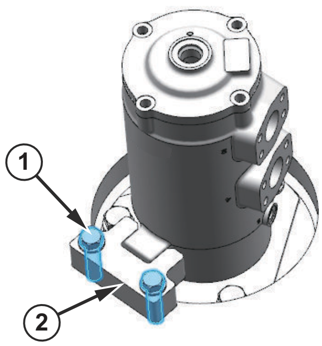
- 0 port
  - Tool: 36 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "to Oil Tank"
- 1 port
  - Tool: 12 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "from Control Valve B6"
- 2 port
  - Tool: 12 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "from Control Valve B3"
- 3 port
  - Tool: 12 mm ( )

- Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
- Connecting part: "from Control Valve A6"

- 4 port
  - Tool: 12 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "from Control Valve A3"
- 5 port
  - Tool: 19 mm ( )
  - Torque: 34.3 N.m (3.5 kg.m, 25.3 ft lb)
  - Connecting part: "from Solenoid Valve D"

Center Joint

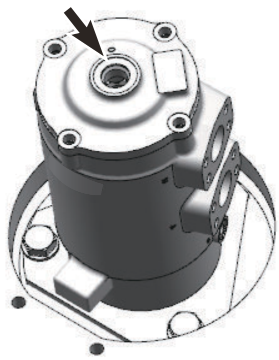
1. Remove bolt (1) and bracket (2).
   Figure 162



DS2002642

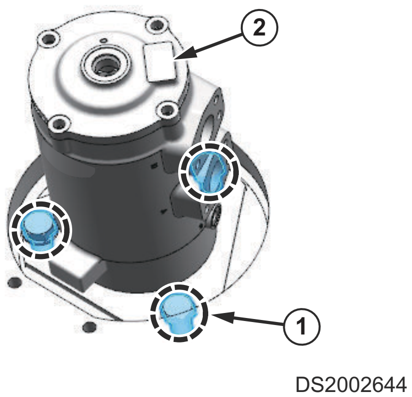
- Tool: 24 mm ( )
- Torque: 264.7 N.m (27 kg.m, 195.3 ft lb)

2. Install the eyebolts. Attach a nylon sling onto the eyebolt.
   Figure 163



DS2002643

3. Remove mounting bolts (1) from frame.
   Figure 164



- Tool: 30 mm ( )
- Torque: 539.3 N.m (55 kg.m, 397.8 ft lb)

  NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*

4. Lift the center joint (2) by crane slowly and carefully.
   - Center joint weight: about 71 kg (156.5 lb)

Installation

1. Perform installation in the reverse order to remove.
2. When installing the hoses, install the drain hose as first action.

Travel Device

Repair Procedure Quick Guide

Step-A. Release the tension of track.

Step-B. Remove master pin

Step-C. Remove upper track

Step-D. Remove track guard

Step-E. Remove sprocket and track frame cover

Step-F. Disconnect hydraulic hoses and fittings

Step-G. Remove travel device

Removal

1. Open the left side door.
2. Turn OFF the battery disconnect switch.

Tension of Track

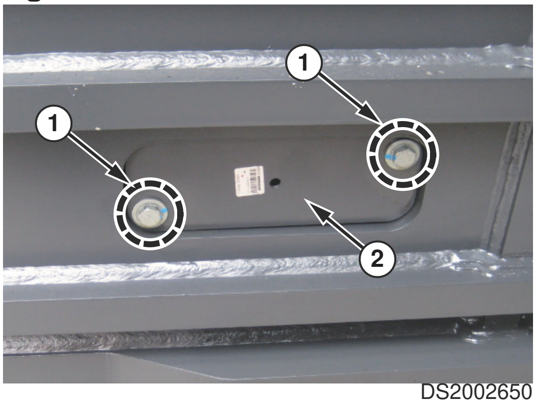
1. Position machine on a smooth level surface with adequate space.

Figure 165

DS2002649

2. Move the track until the master pin is positioned as figure.
3. Remove mounting bolts (1) and cover (2) track frame.

Figure 166



DS2002650

- Tool: 19 mm ( )
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

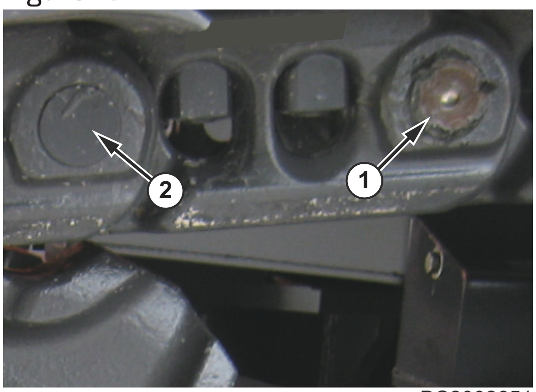
4. Loosen grease valve, and then slacken the tension of track.

For details, refer to Track tension - Operation Manual.

Master Pin

1. Locate the master pin (1) position.

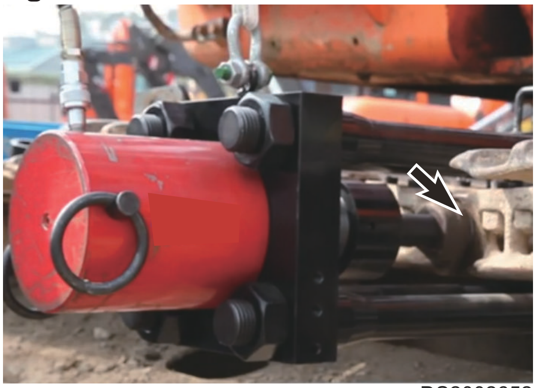
Figure 167



DS2002651

NOTE: *Do not remove regular pin (2).*

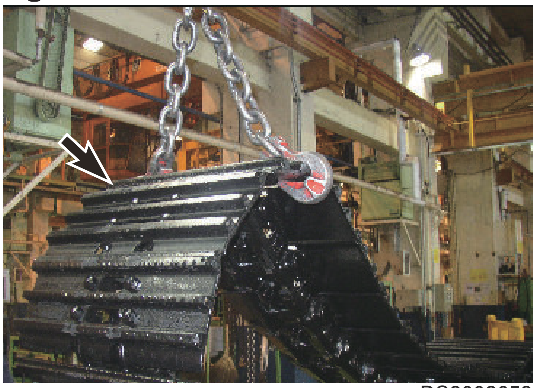
2. Remove master pin using jig or tool.
   Figure 168



DS2002652

Upper Track

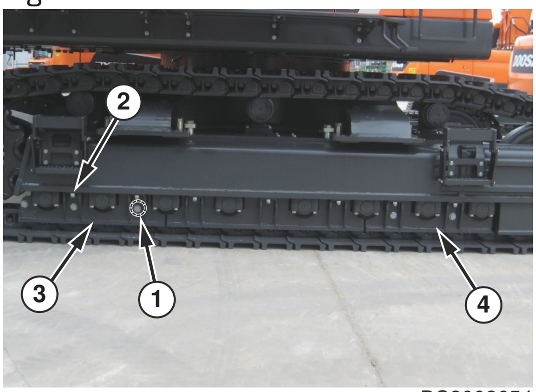
1. Remove upper track slowly and carefully.
   Figure 169



DS2002653

Track Guard

1. Remove mounting bolts (1) from track guard.
   Figure 170



DS2002654

   - Tool: 46 mm ( )
   - Torque: 1912.3 N.m (195 kg.m, 1410.4 ft lb)

   NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*

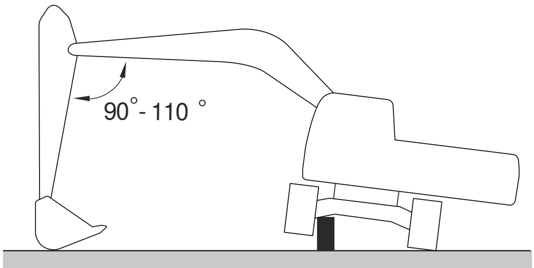
2. Remove mounting bolts (2) from track guard.
   - Tool: 36 mm ( )
   - Torque: 931.6 N.m (95 kg.m, 687.1 ft lb)

NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*

3. Remove track guard (3, 4) from track frame.

Sprocket and Track Frame Cover

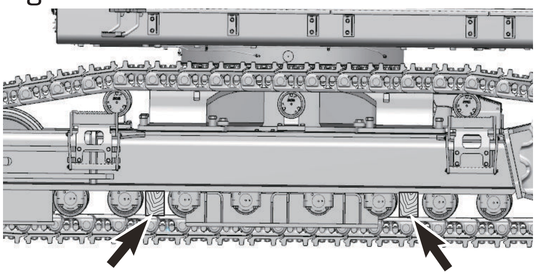
1. Turn the upper structure 90° and jack up the machine.
Figure 171



EX1300534

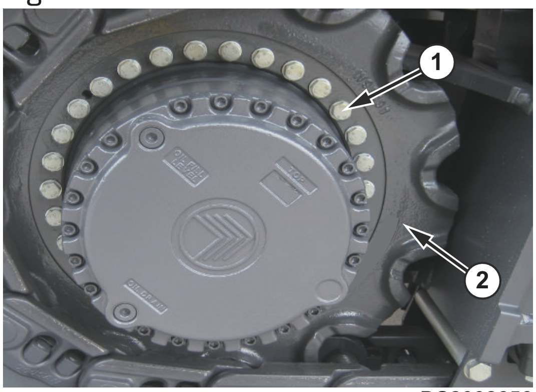
NOTE: *Jack up the machine until the track is slightly off the ground.*

2. Set the angle between boom and arm in 90 ~ 110° and support the machine by using a block.
3. Put two blocks under the track to widen the gap between sprocket and lower track.
Figure 172



DS2002655

4. Remove bolt (1)(36 ea) with sprocket (2) from travel device.
Figure 173

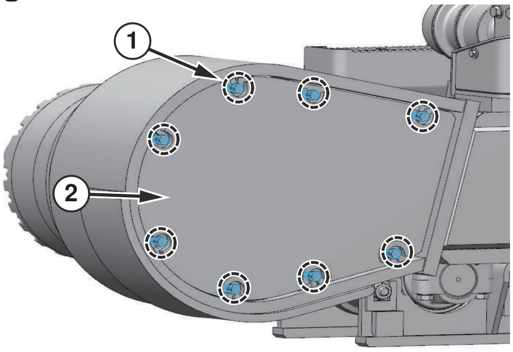


DS2002656

- Tool: 36 mm ( )
- Torque: 931.6 N.m (95 kg.m, 687.1 ft lb)
- Sprocket weight: about 237 kg (522.5 lb)

NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*

5. Remove mounting bolts (1) and cover (2) from track frame.
   Figure 174

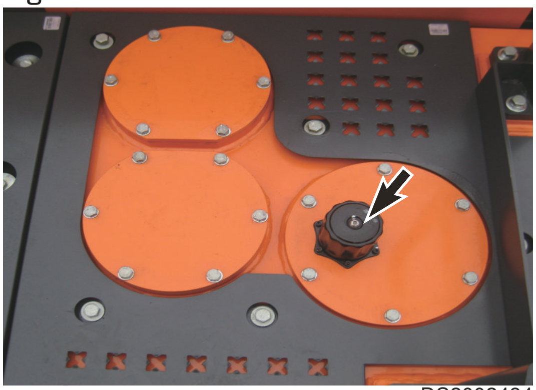


DS2002657

- Tool: 24 mm ( )
- Torque: 264.8 N.m (27 kg.m, 195.3 ft lb)
- Sprocket weight: about 37 kg (81.6 lb)

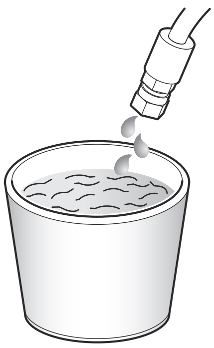
Hydraulic Hoses and Fittings

1. Loosen the oil tank air breather slowly to release the pressure inside the hydraulic oil tank. Pulling the air breather cap upward, the check valve opens, and the air is discharged to the atmosphere from the top of the hydraulic oil tank.
   Figure 175



DS2002484

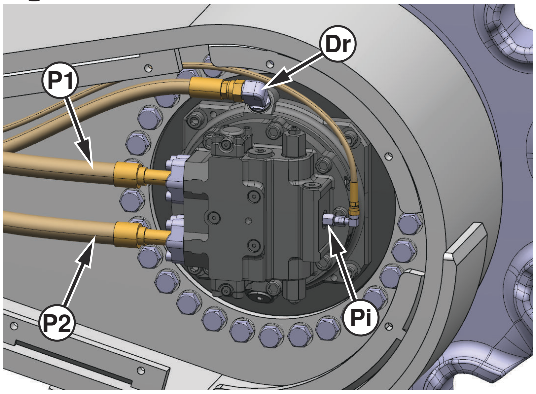
2. When disconnecting the hose, oil left in the hose may flow out. Therefore, place the end of the hose into a suitable container to prevent contamination of the ground and environment.
   Figure 176



EX1504170

3. Remove hoses and adapters from travel device.

Figure 177



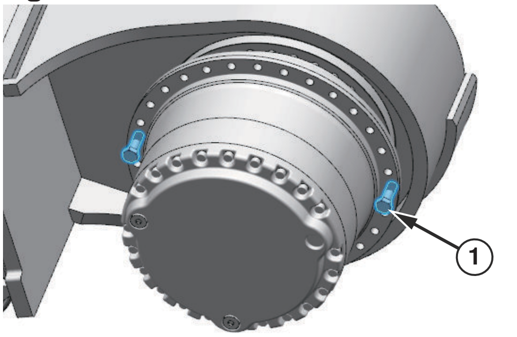
DS2002771

NOTE: *Attach identification tags to the removed hoses for reassembling. After disconnecting hoses, plug them to prevent dirt or dust from entering. Disconnect the hoses from the bottom to top of travel device.*

- P1 port (RH)
  - Tool: 10 mm ( )
  - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
  - Connecting part: "from Center Joint 3"
- P1 port (LH)
  - Tool: 10 mm ( )
  - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
  - Connecting part: "from Center Joint 2"
- P2 port (RH)
  - Tool: 10 mm ( )
  - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
  - Connecting part: "from Center Joint 1"
- P2 port (LH)
  - Tool: 10 mm ( )
  - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
  - Connecting part: "from Center Joint 4"
- Dr port
  - Tool: 36 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "to Center Joint 0"
- Pi port
  - Tool: 19 mm ( )
  - Torque: 34.3 N.m (3.5 kg.m, 25.3 ft lb)
  - Connecting part: "from Center Joint 5"

Travel Device

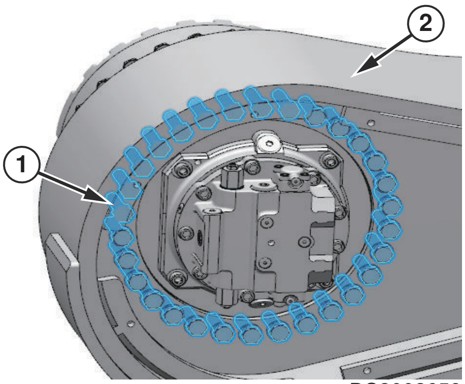
1. Install the sprocket bolts (1) to travel device, and tie the rope to the bolts to lift it.
   Figure 178

   DS2002658

   - Tool: 36 mm ( )

2. Remove mounting bolts (1) from track frame (2).
   Figure 179

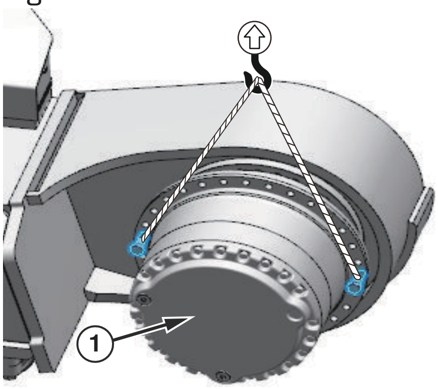
   

   DS2002659

   - Tool: 36 mm ( )
   - Torque: 931.6 N.m (95 kg.m, 687.1 ft lb)

   NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*

3. Hoist and remove travel device (1) from track frame very slowly.
   Figure 180

   DS2002660

   - Weight: about 994 kg (2,191 lb)
   - Travel device oil specification and quantity
   - Replace oil: genuine oil

- Travel device oil quantity: 20 L x 2

  NOTE: *Remove travel device on both sides according to the procedures.*

Installation

1. Perform installation in the reverse order to remove.
2. When installing the hoses, install the drain hose first.

Main Control Valve

Repair Procedure Quick Guide

Step-A. Remove air cleaner cover

Step-B. Remove air cleaner baffle

Step-C. Remove oil cooler cover

Step-D. Remove cover

Step-E. Remove undercover

Step-F. Disconnect hydraulic hoses and fittings

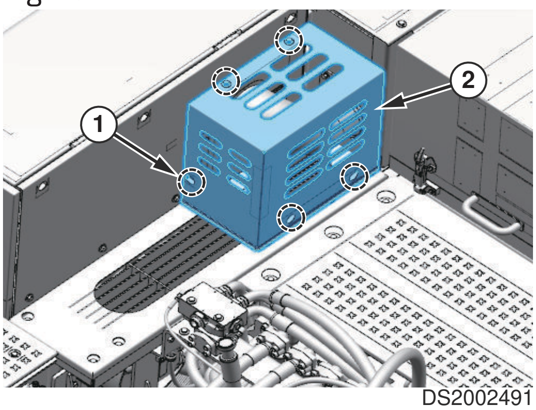
Step-G. Remove main control valve

Removal

1. Open the left side door.
2. Turn OFF the battery disconnect switch.

Air Cleaner Cover

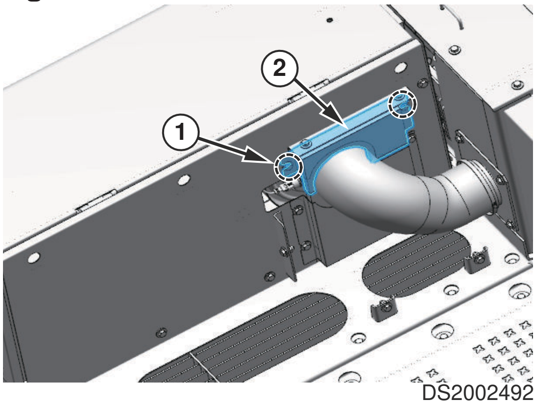
1. Remove mounting bolts (1) and air cleaner cover (2).
   Figure 181



- Tool: 19 mm ( )
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Weight: about 10 kg (22 lb)

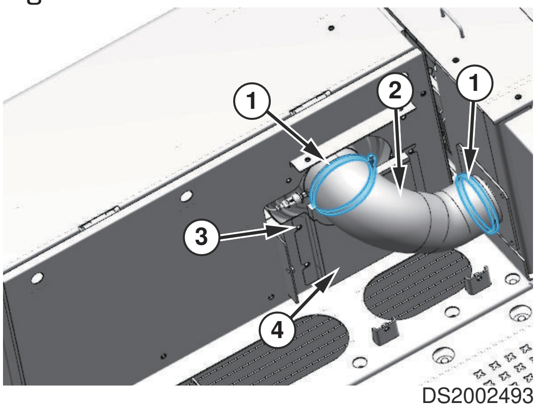
Air Cleaner Baffle

1. Remove mounting bolts (1) and air cleaner upper baffle (2).
   Figure 182



   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

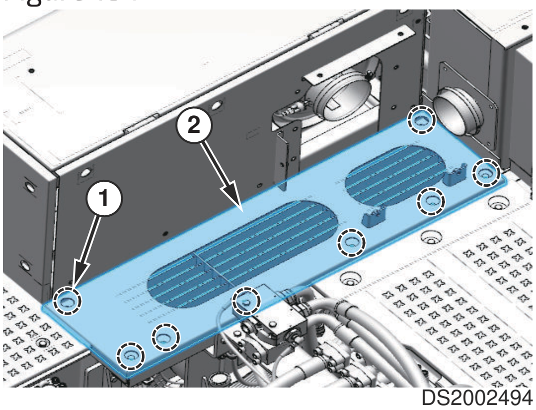
2. Loosen clamps (1) from air cleaner hose.
   Figure 183



3. Remove air cleaner hose (2) from air cleaner.
4. Remove mounting bolts (3) and air cleaner under baffle (4).
   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

Oil Cooler Cover

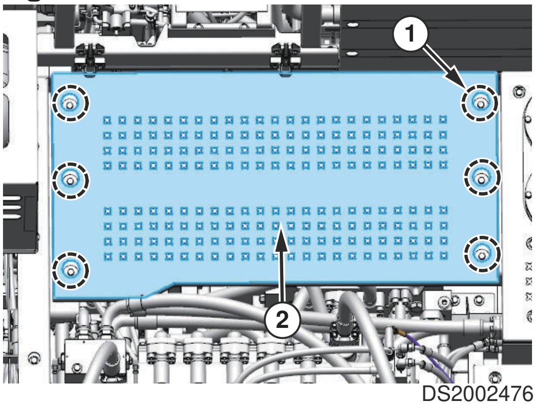
1. Remove mounting bolts (1) and oil cooler cover (2).
   Figure 184



- Tool: 19 mm ()
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Weight: about 43 kg (311 lb)

Cover

1. Remove mounting bolts (1) from cover.
   Figure 185

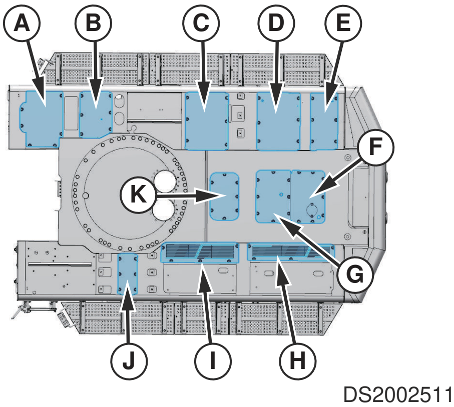


- Tool: 19 mm ()
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

2. Remove cover (2) from frame.
   - Weight: about 39 kg (86 lb)

Undercover

1. Remove undercover (K).
   Figure 186

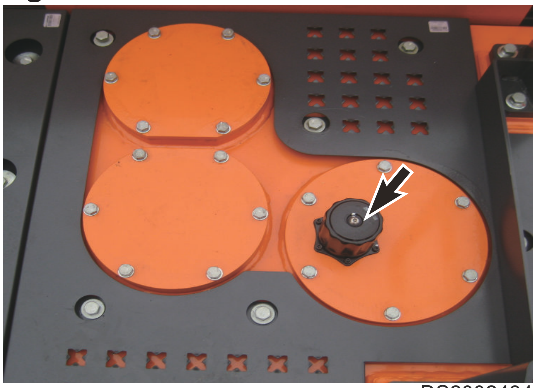


For details, refer to Undercovers - Removal and Installation.

Hydraulic Hoses and Fittings

1. Loosen the oil tank air breather slowly to release the pressure inside the hydraulic oil tank. Pulling the air breather cap upward, the check valve opens, and the air is discharged to the atmosphere from the top of the hydraulic oil tank.

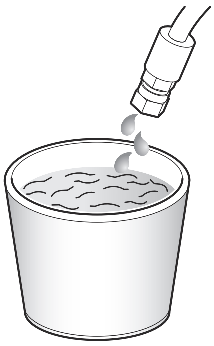
   Figure 187



DS2002484

2. When disconnecting the hose, oil left in the hose may flow out. Therefore, place the end of the hose into a suitable container to prevent contamination of the ground and environment.

   Figure 188

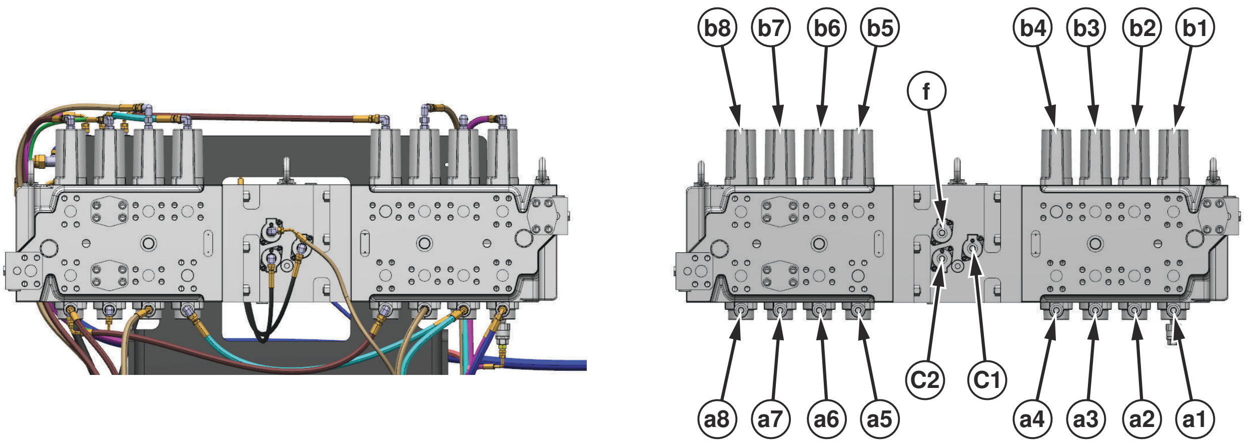


EX1504170

3. Remove hose and adapters from control valve.

   NOTE: *Attach identification tags to the removed hoses for reassembling. After disconnecting hoses from main control valve, plug them to prevent dirt or dust from entering. Disconnect the hoses from the bottom to top of control valve.*

   Figure 189



DS2002529

- a1 port (1)
  - Tool: 22 mm ( )

- Torque: 49 N.m (5 kg.m, 36.2 ft lb)
- Connecting part: "from Joint Plate B1"

• a1 port (2)
- Tool: 22 mm ()
- Torque: 49 N.m (5 kg.m, 36.2 ft lb)
- Connecting part: "Connect with (MCV 2) a2"

• a2 port (1)
- Tool: 22 mm ()
- Torque: 49 N.m (5 kg.m, 36.2 ft lb)
- Connecting part: "from Joint Plate B9"

• a2 port (2)
- Tool: 22 mm ()
- Torque: 49 N.m (5 kg.m, 36.2 ft lb)
- Connecting part: "Connect with a5"

• a3 port
- Tool: 22 mm ()
- Torque: 49 N.m (5 kg.m, 36.2 ft lb)
- Connecting part: "from Joint Plate B10"

• a4 port
- Tool: 22 mm ()
- Torque: 49 N.m (5 kg.m, 36.2 ft lb)
- Connecting part: "Connect with a8"

• a5 port
- Tool: 22 mm ()
- Torque: 49 N.m (5 kg.m, 36.2 ft lb)
- Connecting part: "Connect with a2"

• a6 port
- Tool: 22 mm ()
- Torque: 49 N.m (5 kg.m, 36.2 ft lb)
- Connecting part: "from Joint Plate B5"

• a7 port
- Tool: 22 mm ()
- Torque: 49 N.m (5 kg.m, 36.2 ft lb)
- Connecting part: "Connect with b7"

• a8 port (1)
- Tool: 22 mm ()

- Torque: 49 N.m (5 kg.m, 36.2 ft lb)
- Connecting part: "from Joint Plate B6"

• a8 port (2)
  - Tool: 22 mm ( )
  - Torque: 49 N.m (5 kg.m, 36.2 ft lb)
  - Connecting part: "Connect with a4"

• b1 port
  - Tool: 22 mm ( )
  - Torque: 49 N.m (5 kg.m, 36.2 ft lb)
  - Connecting part: "from Joint Plate B3"

• b2 port
  - Tool: 22 mm ( )
  - Torque: 49 N.m (5 kg.m, 36.2 ft lb)
  - Connecting part: "from Joint Plate B11"

• b3 port
  - Tool: 22 mm ( )
  - Torque: 49 N.m (5 kg.m, 36.2 ft lb)
  - Connecting part: "from Joint Plate B12"

• b4 port
  - Tool: 22 mm ( )
  - Torque: 49 N.m (5 kg.m, 36.2 ft lb)
  - Connecting part: "from EPPR Valve A2"

• b5 port
  - Tool: 22 mm ( )
  - Torque: 49 N.m (5 kg.m, 36.2 ft lb)
  - Connecting part: "from EPPR Valve B1"

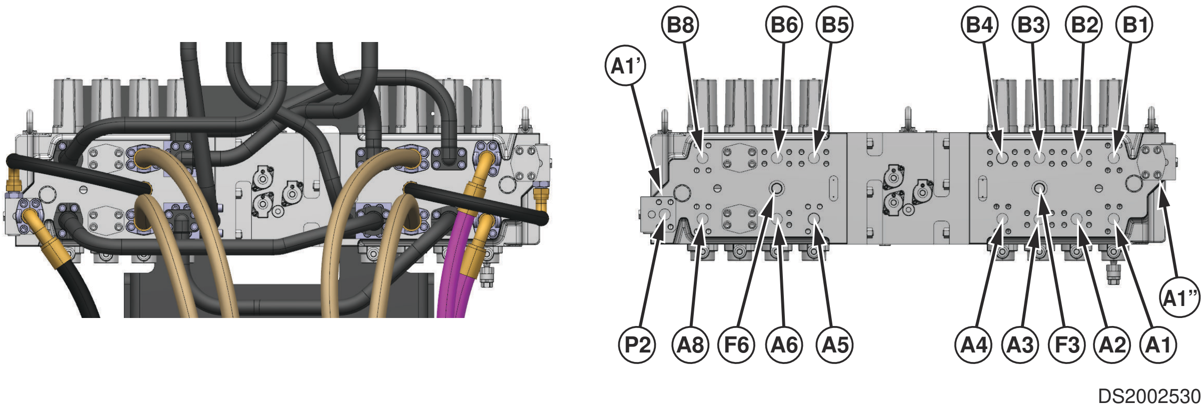
• b6 port
  - Tool: 22 mm ( )
  - Torque: 49 N.m (5 kg.m, 36.2 ft lb)
  - Connecting part: "from Joint Plate B7"

• b7 port
  - Tool: 19 mm ( )
  - Torque: 34.3 N.m (3.5 kg.m, 25.3 ft lb)
  - Connecting part: "Connect with a7"

• b8 port
  - Tool: 22 mm ( )

- Torque: 49 N.m (5 kg.m, 36.2 ft lb)
- Connecting part: "from Joint Plate B8"

- C1 port
  - Tool: 19 mm ( )
  - Torque: 34.3 N.m (3.5 kg.m, 25.3 ft lb)
  - Connecting part: "from By-pass Cut Off EPPR Valve A"
- C2 port
  - Tool: 19 mm ( )
  - Torque: 34.3 N.m (3.5 kg.m, 25.3 ft lb)
  - Connecting part: "from By-pass Cut Off EPPR Valve B"
- f port
  - Tool: 19 mm ( )
  - Torque: 34.3 N.m (3.5 kg.m, 25.3 ft lb)
  - Connecting part: "from Solenoid Valve B"
    Figure 190



- P2 port
  - Tool: 12 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "Connect with (MCV 2) M"
- A1' port
  - Tool: 41 mm ( )
  - Torque: 205.9 N.m (21 kg.m, 151.9 ft lb)
  - Connecting part: "Connect with F6"
- A1" port
  - Tool: 41 mm ( )
  - Torque: 205.9 N.m (21 kg.m, 151.9 ft lb)
  - Connecting part: "Connect with F3"
- A1 port

- Tool: 12 mm ( )
- Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
- Connecting part: "to Boom Cylinder Rod"

• A2 port
  - Tool: 12 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "Connect with A5"

• A3 port
  - Tool: 12 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "to Center Joint 4"

• A4 port
  - Tool: 12 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "to Arm Cylinder Rod"

• A5 port
  - Tool: 12 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "to Bucket Cylinder Rod"

• A6 port
  - Tool: 12 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "to Center Joint 3"

• A8 port
  - Tool: 12 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "Connect with A4"

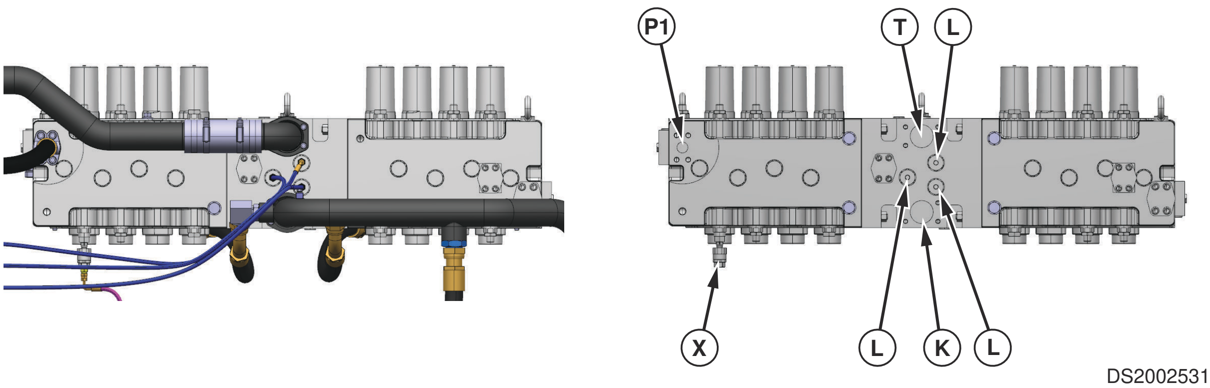
• B1 port
  - Tool: 12 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "to Boom Cylinder Head"

• B2 port
  - Tool: 12 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "Connect with B5"

• B3 port

- Tool: 12 mm ( )
- Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
- Connecting part: "to Center Joint 2"

- B4 port
  - Tool: 12 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "to Arm Cylinder Head"
- B5 port
  - Tool: 12 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "to Bucket Cylinder Head"
- B6 port
  - Tool: 12 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "to Center Joint 1"
- B8 port
  - Tool: 12 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "Connect with B4"
- F3 port
  - Tool: 41 mm ( )
  - Torque: 205.9 N.m (21 kg.m, 151.9 ft lb)
  - Connecting part: "Connect with A1""
- F6 port
  - Tool: 41 mm ( )
  - Torque: 205.9 N.m (21 kg.m, 151.9 ft lb)
  - Connecting part: "Connect with A1""
    Figure 191



- X port

- Tool: 19 mm ( )
- Torque: 34.3 N.m (3.5 kg.m, 25.3 ft lb)
- Connecting part: "from Solenoid Valve A"

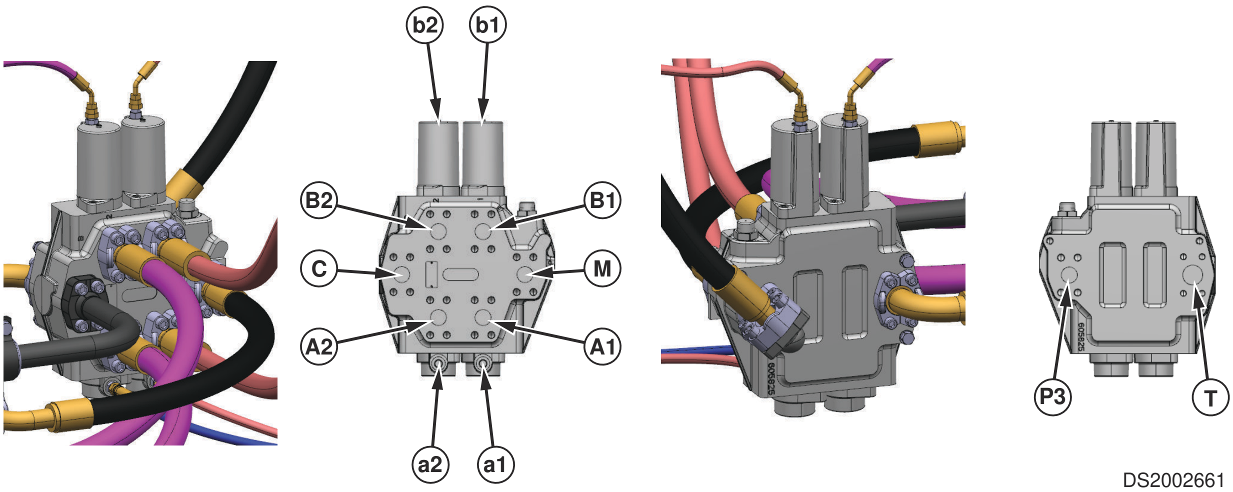
• T port
- Tool: 10 mm ( )
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Connecting part: "to Oil Tank"

• K port
- Tool: 10 mm ( )
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Connecting part: "to Oil Tank"

• L port
- Tool: 19 mm ( )
- Torque: 34.3 N.m (3.5 kg.m, 25.3 ft lb)
- Connecting part: "to Oil Tank"

• P1 port
- Tool: 12 mm ( )
- Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
- Connecting part: "from Main Pump B"

Figure 192



• P3 port
- Tool: 12 mm ( )
- Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
- Connecting part: "from Main Pump A"

• T port
- Tool: 10 mm ( )
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

- Connecting part: "Connect with K"

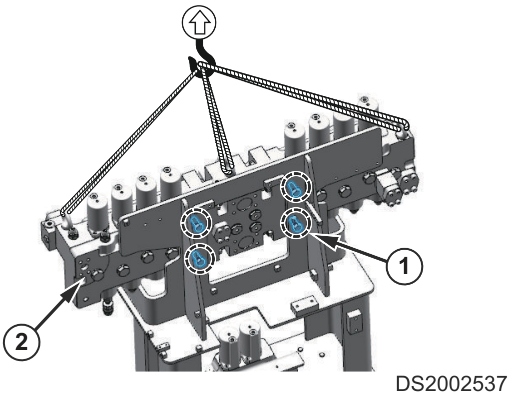
- M port
  - Tool: 12 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "Connect with (MCV 1) P2"
- C port
  - Tool: 12 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "Connect with M"
- A1 port
  - Tool: 12 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "to Swing Device B"
- A2 port
  - Tool: 12 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "to Boom Cylinder Rod"
- B1 port
  - Tool: 12 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "to Swing Device A"
- B2 port
  - Tool: 12 mm ( )
  - Torque: 176.5 N.m (18 kg.m, 130.2 ft lb)
  - Connecting part: "to Boom Cylinder Head"
- a1 port
  - Tool: 22 mm ( )
  - Torque: 49 N.m (5 kg.m, 36.2 ft lb)
  - Connecting part: "from Joint Plate B4"
- a2 port
  - Tool: 22 mm ( )
  - Torque: 49 N.m (5 kg.m, 36.2 ft lb)
  - Connecting part: "Connect with (MCV 1) a1"
- b1 port
  - Tool: 22 mm ( )
  - Torque: 49 N.m (5 kg.m, 36.2 ft lb)

- Connecting part: "from Joint Plate B2"

- b2 port
  - Tool: 22 mm ( )
  - Torque: 49 N.m (5 kg.m, 36.2 ft lb)
  - Connecting part: "from EPPR Valve A1"

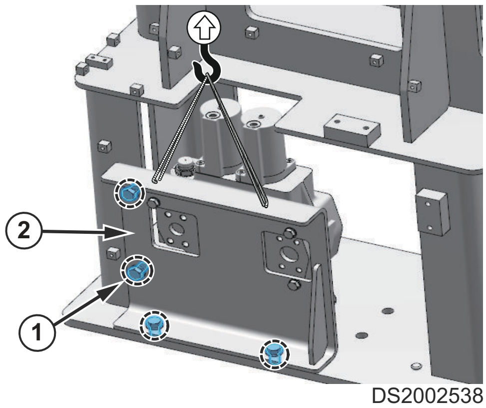
Main Control Valve

1. Tie with rope to the eyebolts to lift it and remove mounting bolts (1) from frame.
   Figure 193



   - Tool: 30 mm ( )
   - Torque: 539.3 N.m (55 kg.m, 397.8 ft lb)
   - Main control valve weight: about 348 kg (767.2 lb)

2. Lift the main control valve (2) by crane from machine slowly and carefully.
3. Install eyebolts to lift in threaded holes on top of bracket.
   Figure 194



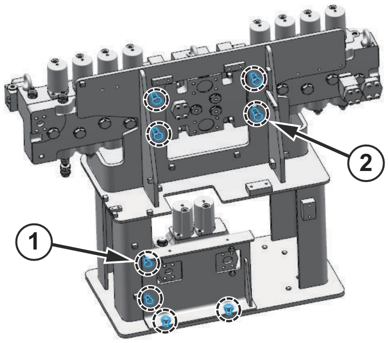
   - Thread of hole: M10

4. Remove mounting bolts (1) with bracket from frame.
   - Tool: 24 mm ( )
   - Torque: 264.8 N.m (27 kg.m, 195.3 ft lb)
   - Main control valve weight: about 134 kg (295.4 lb)
   - Bracket weight: about 14 kg (30.8 lb)

5. Lift the main control valve (2) by crane from machine slowly and carefully.

Installation

1. Perform installation in the reverse order to removal.
   Figure 195



DS2002539

2. After completing the work, check the oil level.
3. Start the engine and check for any oil leaks.

Cabin

Repair Procedure Quick Guide

Step-A. Remove undercover

Step-B. Removal lower wiper arm and blade

Step-C. Remove cabin photo sensor

Step-D. Remove cabin side cover

Step-E. Remove display monitor

Step-F. Remove cabin side cover - upper, lower

Step-G. Remove cabin center cover

Step-H. Remove air duct

Step-I. Separate electrical component

Step-J. Remove cabin

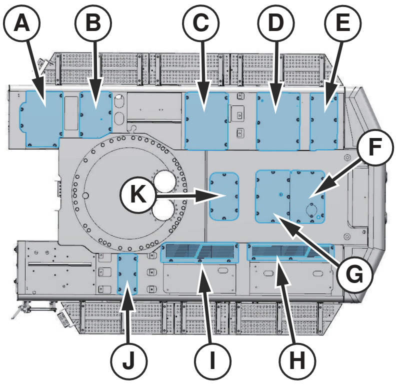
Removal

1. Open the left side door.
2. Turn OFF the battery disconnect switch.
3. Open the cabin door.

Undercover

1. Remove undercovers (A).

Figure 196

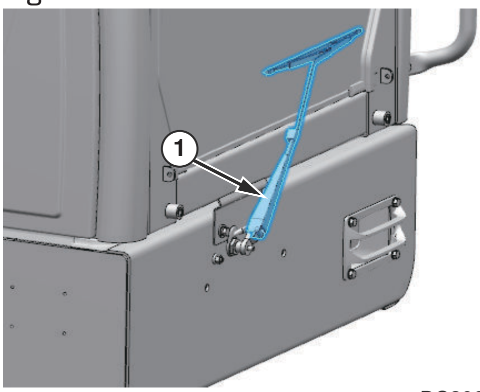


For details, refer to Undercovers - Removal and Installation.

Lower Wiper Arm and Blade

1. Disconnect washer hose from lower wiper arm and blade.

Figure 197

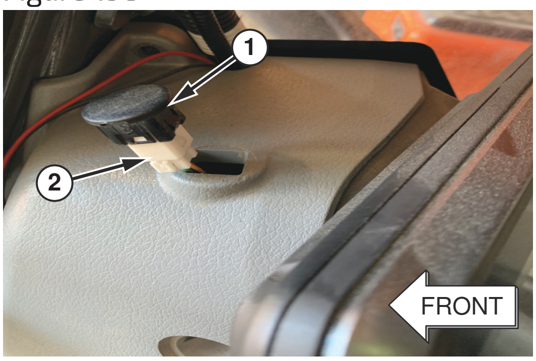


2. Remove lower wiper arm and blade (1) from the cabin.

Cabin Photo Sensor

1. Pull up cabin photo sensor (1) by using a flat-head screwdriver.

Figure 198



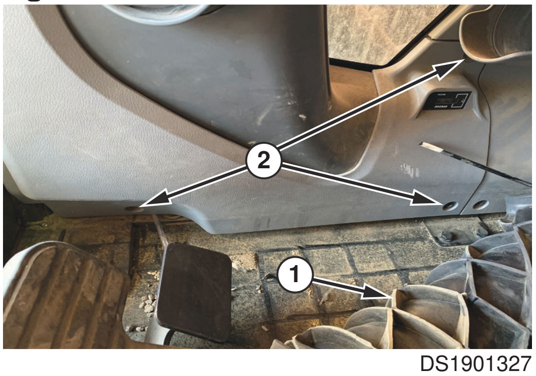
NOTE: *The cabin photo sensor is located behind the display monitor.*

NOTE: *Please find the service groove.*

2. Disconnect wiring harness (2) from cabin photo sensor.
3. Remove cabin photo sensor (1).

Cabin Side Cover

1. Put away the floor rubber mat (1).
   Figure 199



2. Remove the plug cap and screws (2) from cabin side cover.

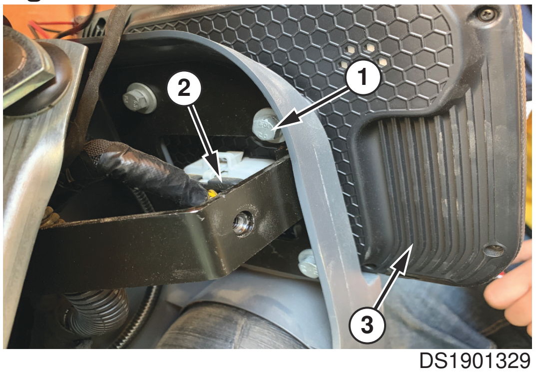
   NOTE: *Please find the service groove.*

3. Remove the plug cap and screws (1) from cabin side cover.
   Figure 200

4. Remove the cabin side cover (2).

Display Monitor

1. Remove the bolts (1) from display monitor.
   Figure 201

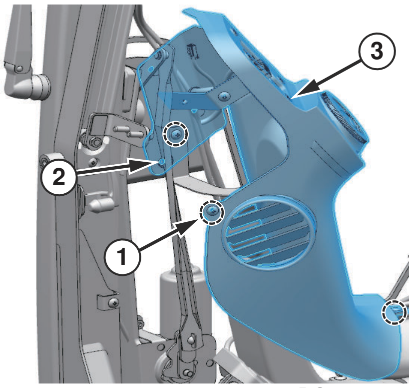


   - Refer to torque values for standard.

2. Disconnect wire harness (2) from display monitor (3).
3. Remove the display monitor from bracket.

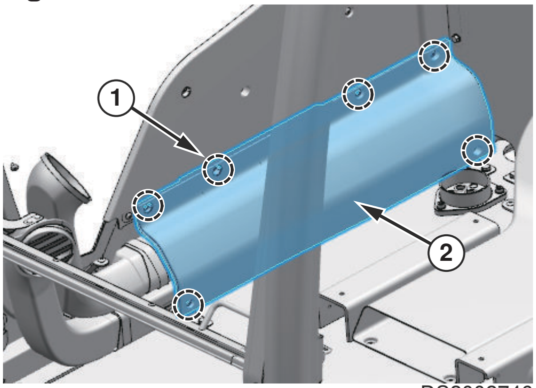
Cabin Side Cover - Upper, Lower

1. Remove screws (1) from cabin side cover.
   Figure 202



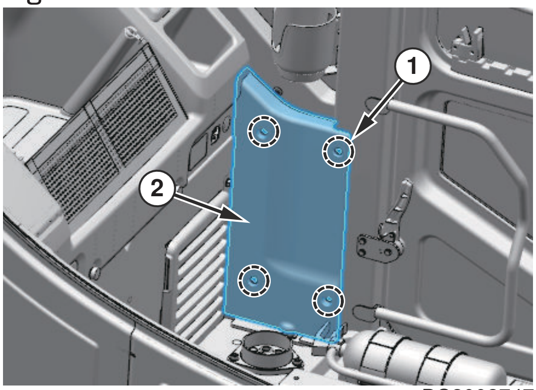
DS2002510

2. Remove mounting bolts (2)(3ea).
3. Remove cabin side cover and plate (3) from cabin.
4. Remove screws (1) from cabin side cover.
   Figure 203



DS2002746

5. Remove cabin side cover (2) from cabin.
6. Remove screws (1) from cabin side cover.
   Figure 204

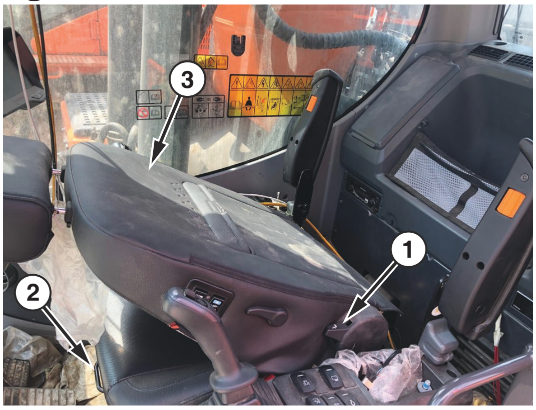


DS2002747

7. Remove cabin side cover (2) from cabin.

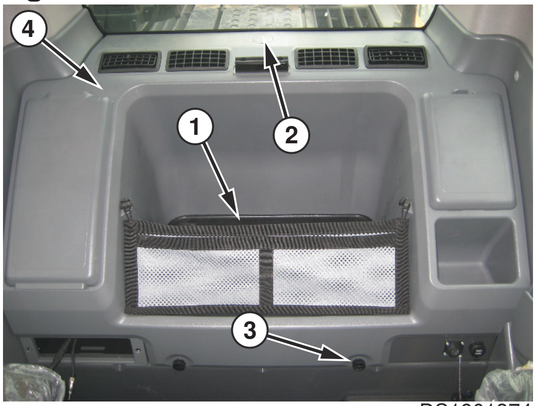
Cabin Center Cover

1. Pulling up left lever (1), fold the seat backrest (3) forward.
   Figure 205



DS1901309

2. Move the seat assembly forward using a lever (2).
3. Remove the pad (1) and two bolts under pad.
   Figure 206

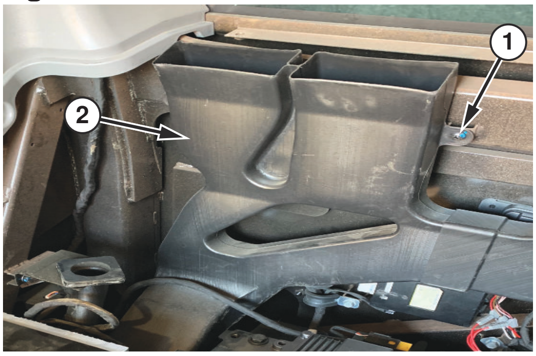


DS1901374

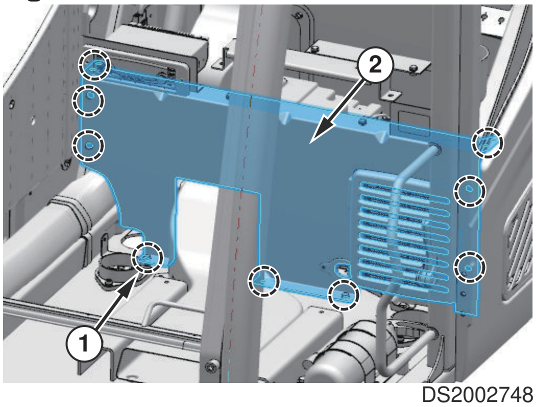
4. Remove the caps and bolt (2) from cabin center cover.
5. Remove bolts (3) from cabin center cover.
6. Remove cabin center cover (4).

Air Duct

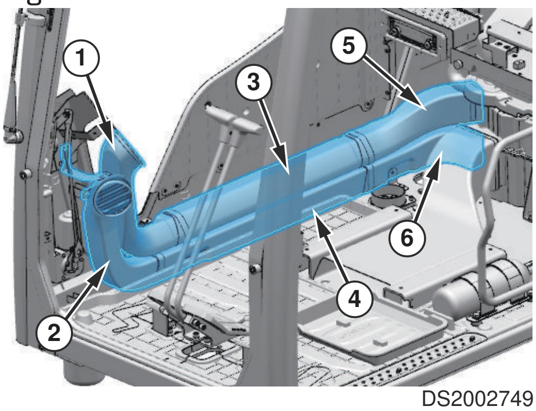
1. Remove screws (1) and air duct (2) from cabin.
   Figure 207



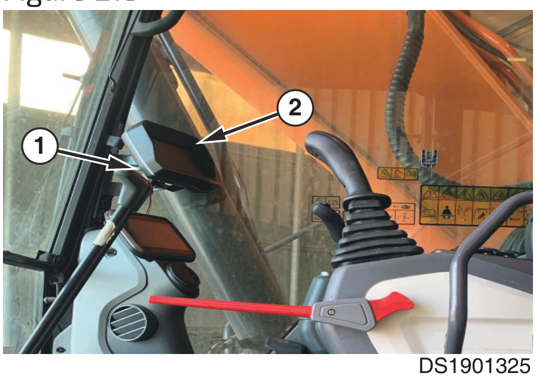
DS1901311

2. Remove mounting bolts (1) and under cover (2) from cabin.
Figure 208


- Tool: 13 mm ( )
- Torque: 29.4 N.m (3 kg.m, 21.7 ft lb)

3. Remove air ducts (1, 2, 3, 4, 5, 6) from cabin.
Figure 209


Electrical Component

1. Remove bolts (1) from around view monitor.
Figure 210


- Refer to torque values for standard.

2. Disconnect wiring harness connector from around view monitor.
3. Remove the around view monitor (2) from mounting bracket.
4. Separate microphone controller from cabin.

   For details, refer to Microphone Controller - Removal and Installation.

5. Separate AVM controller from cabin.

   For details, refer to AVM Controller - Removal and Installation.

6. Separate hands free controller from cabin.

7. For details, refer to Smart Key Controller - Removal and Installation.

   Separate smart key controller from cabin.

8. Separate TMS controller from cabin.

   For details, refer to TMS Controller - Removal and Installation.

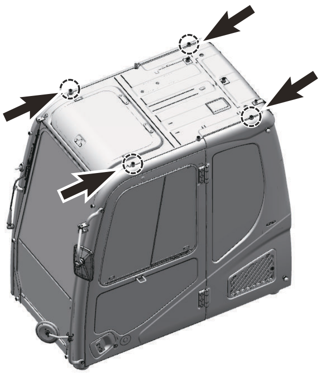
   NOTE: *Do not disconnect the wiring connector when removing the all controller.*

9. Remove TMS antenna cable from cabin.

10. Remove lamps from cabin.

Cabin

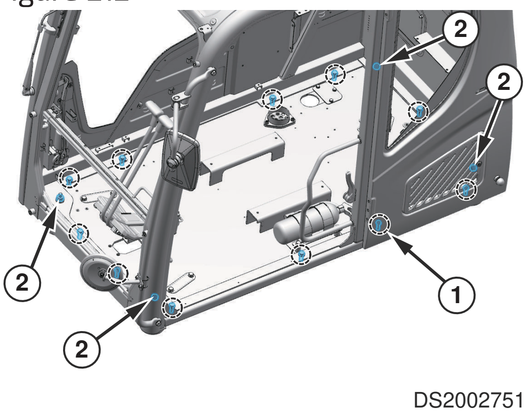
1. Remove cabin handle from top of cabin.
   Figure 211



2. Using a suitable lifting device, attach slings to four lift points on top of cabin.

   - Cabin weight: about 500 kg (1,102 lb)

3. Remove mounting bolts (1) (11 ea).
   Figure 212



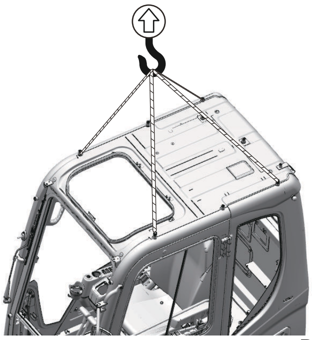
   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

4. Remove mounting nuts (2) (4 ea) from cabin floor.

   - Tool: 24 mm ( )

- Torque: 205.9 N.m (21 kg.m, 151.9 ft lb)

5. Lift cabin approximately 25 - 50 mm (1" - 2") above deck.
   Figure 213



DS2002752

6. Check that all electrical connections have been disconnected and all other items unbolted.

   NOTE: *Lift operator's cabin slowly to prevent damaging.*

Installation

1. Perform installation in the reverse order to remove.

Electric And Electronic

Safety Instructions

⚠ WARNING

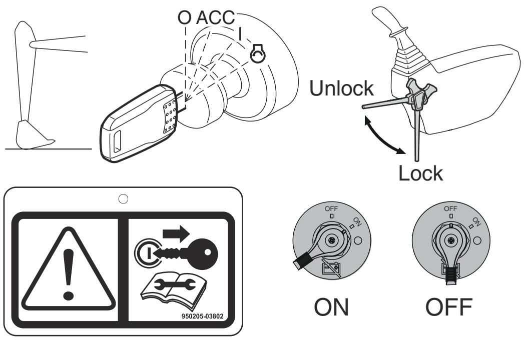
AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or servicingmachine. Read and understand the Operation & Maintenance Manual and signs (decals) on machine. Followwarnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correctfunction after adjustments repairs or service. Untrainedoperators and failure to follow instructions can cause deathor serious injury.

Before Removing and Installing

Preparatory Work

1. Park the machine on level ground. And lower front attachment to the ground.
   Figure 214

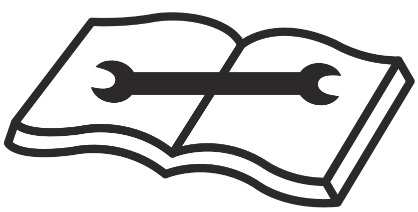


EX1504472

2. Move safety lever to "LOCK" position and then stop the engine.
3. Turn battery disconnect switch to "OFF" position.
4. Release the remaining pressure in the hydraulic circuit.
5. Cool down the hydraulic system and engine.
6. Attach a maintenance warning tag on controls.

General Precaution

1. Always read the safety section before removing and Installing.
   Figure 215



DS1901903

2. Mark the location of the bolts before removing.
3. Keep in the mind the order for tightening bolts.
4. Tighten bolts by hands, then using the tool.
5. If reusing the bolts, clean threads and apply thread locker to threads prior to installation.
6. Mark the location of wire harness connectors and hoses before disconnecting.
7. Be careful not to damage all components.
8. Do not reused gaskets, O-ring and adhesive bolts.

Completing Work

1. Check oil, coolant and fuel leak from the machine.
2. Check all oil level and if necessary, add oil.
3. Fill up the fuel tank to the standard level.
4. Apply grease to all lubrication points.
5. When fuel component has been disconnected, air must be bled from circuit.

   For details, see the Operation and Maintenance Manual.
6. When hydraulic component has been disconnected, air must be bled from circuit.

   For details, see the Operation and Maintenance Manual.
7. Start the engine and run at low idle for about 5 minutes.
8. Perform the machine performance test.

Battery Assembly

Repair Procedure Quick Guide

Step-A. Open side door - left

Step-B. Remove upper cover

Step-C. Disconnect wiring harness

Step-D. Remove battery assembly

Removal

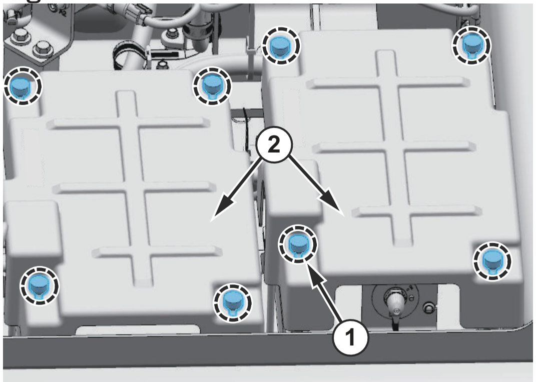
1. Open the left side door.

   Figure 216

DS2002514

2. Turn OFF the battery disconnect switch.

Figure 217

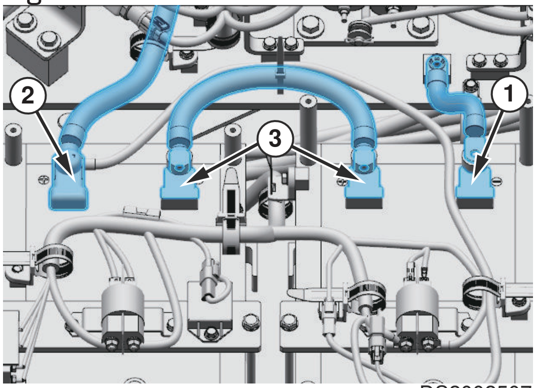


DS2002506

Upper Cover

1. Remove bolts (1) from battery bracket.
2. Remove upper covers (2).

Figure 218



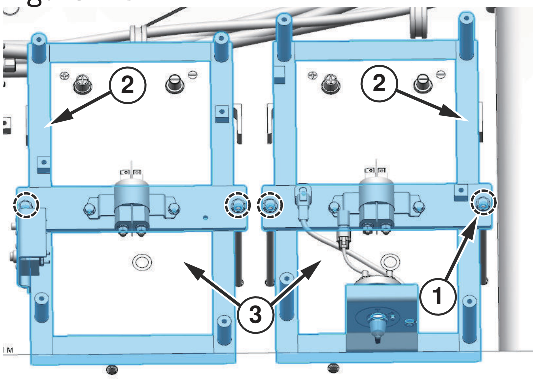
DS2002507

Wiring Harness

1. Disconnect the negative cable (1) and positive cable (2) from the batteries.
2. Disconnect any additional electrical connections as necessary.

   NOTE: *Check the location of the connectors before disconnecting. Be careful not to let water get into electrical components. If water gets into electrical system, this will cause an electrical short circuit and result in improper machine operation.*

Figure 219



DS2002515

Battery Assembly

1. Remove the bolts (1) and hold down bracket (2).
   - Tool: 17 mm ( )
2. Remove batteries (3) from frame.

Installation

1. Perform installation in the reverse order to removal.
2. Check the battery and start engine.

EPOS Controller

Repair Procedure Quick Guide

Step-A. Open side door - left

Step-B. Disconnect wiring harness

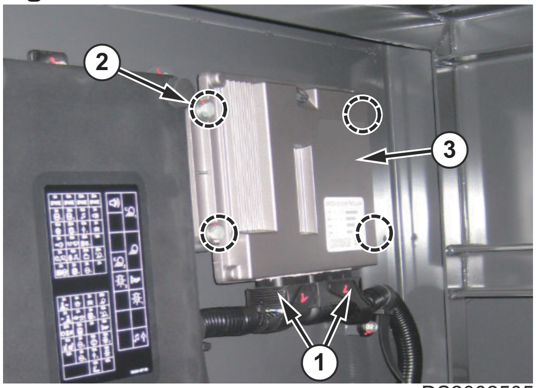
Step-C. Remove EPOS controller

Removal

1. Open the left side door.
   Figure 220

DS2002514

2. Turn OFF the battery disconnect switch.
3. Disconnect wiring harness connectors (1) from EPOS controller.
   Figure 221



DS2002505

NOTE: *Move up connector levers when disconnect.*

4. Remove mounting bolts (2) from EPOS controller.

- Tool: 13 mm ( )
- Torque: 19.6 N.m (2 kg.m, 14.5 ft lb)

5. Remove EPOS controller (3).

Installation

1. Perform installation in the reverse order to removal.

TMS Controller

Repair Procedure Quick Guide

Step-A. Open the cabin door

Step-B. Remove cabin center cover

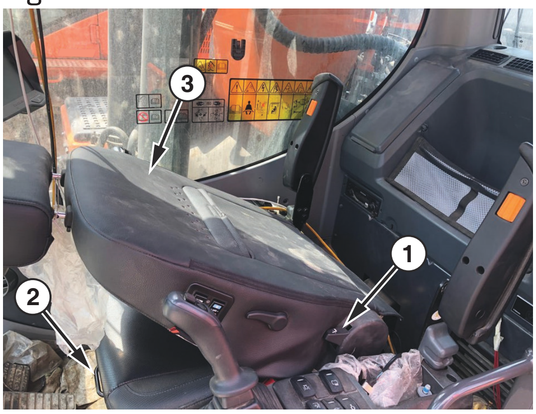
Step-C. Disconnect wiring harness

Step-D. Remove TMS controller

Removal

1. Open the left side door.

Figure 222

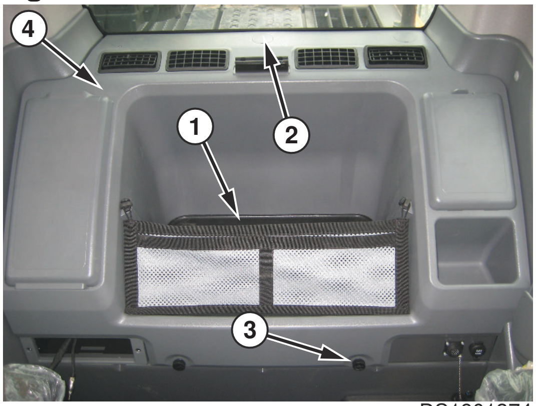


DS1901309

2. Turn OFF the battery disconnect switch.
3. Open the cabin door.
4. Pulling up left lever (1), fold the seat backrest (3) forward.
5. Move the seat assembly forward using a lever (2).

Cabin Center Cover

1. Remove the pad (1) and two bolts under pad.
   Figure 223

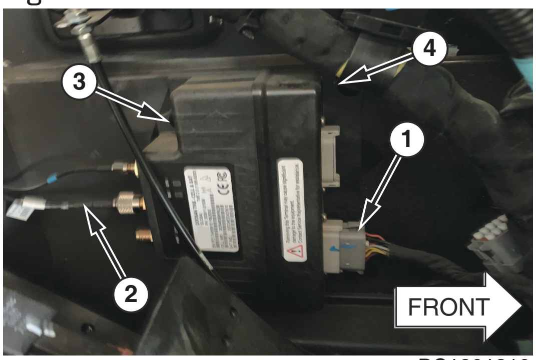


DS1901374

2. Remove the caps and bolt (2) from cabin center cover.
3. Remove bolts (3) from cabin center cover.
4. Remove cabin center cover (4).

TMS Controller

1. Disconnect wiring harness (1) and cables (2) from TMS controller.
   Figure 224



DS1901310

   NOTE: *Check the location of the connectors before disconnecting.*

2. Remove mounting bolts (3) from TMS controller.
3. Loosen mounting bolts (4).

   NOTE: *Do not tighten the fasteners too hard when installing.*

4. Remove TMS controller.

   NOTE: *Check the "UP" mark on the TMS controller. "UP" mark upward when TMS controller is mounted to the machine.*

Installation

1. Perform installation in the reverse order to removal.

AVM Controller

Repair Procedure Quick Guide

Step-A. Open the cabin door

Step-B. Remove cabin center cover

Step-C. Remove air duct

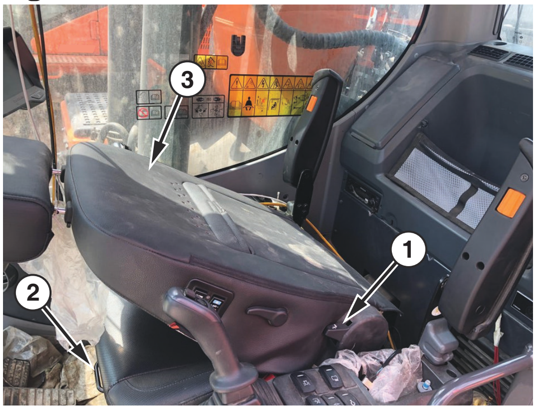
Step-D. Disconnect wiring harness

Step-E. Remove AVM controller

Removal

1. Open the left side door.

Figure 225



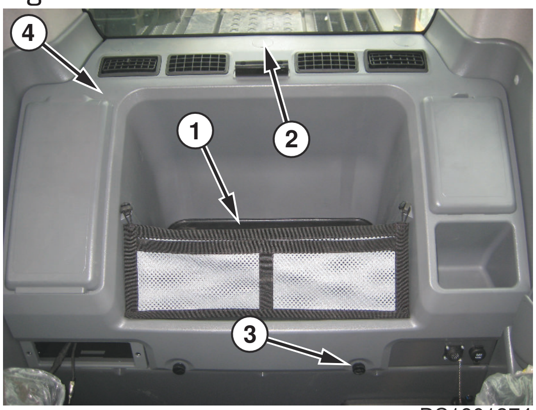
DS1901309

2. Turn OFF the battery disconnect switch.
3. Open the cabin door.
4. Pulling up left lever (1), fold the seat backrest (3) forward.
5. Move the seat assembly forward using a lever (2).

Cabin Center Cover

1. Remove the pad (1) and two bolts under pad.

Figure 226

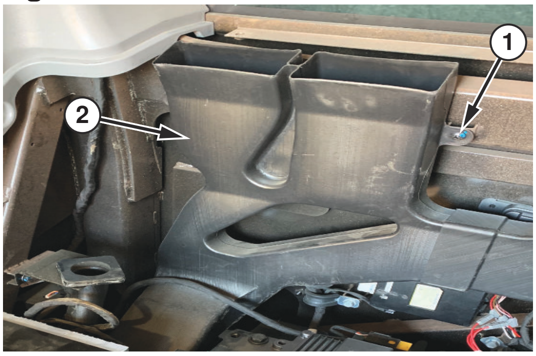


DS1901374

2. Remove the caps and bolt (2) from cabin center cover.
3. Remove bolts (3) from cabin center cover.
4. Remove cabin center cover (4).

Air Duct

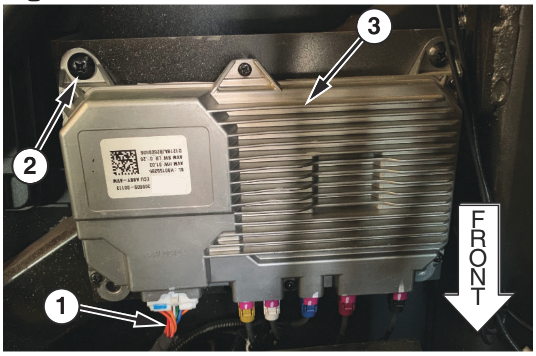
1. Remove screws (1) and air duct (2) from cabin.
   Figure 227



DS1901311

AVM Controller

1. Disconnect wiring harness connector (1) and all connectors from AVM controller.
   Figure 228



DS1901312

   NOTE: *Check the location of the connectors before disconnecting.*

2. Remove mounting screws (2) from AVM controller mounting bracket.
3. Remove AVM controller (3).

Installation

1. Perform installation in the reverse order to removal.

Microphone Controller

Repair Procedure Quick Guide

Step-A. Open the cabin door

Step-B. Remove cabin center cover

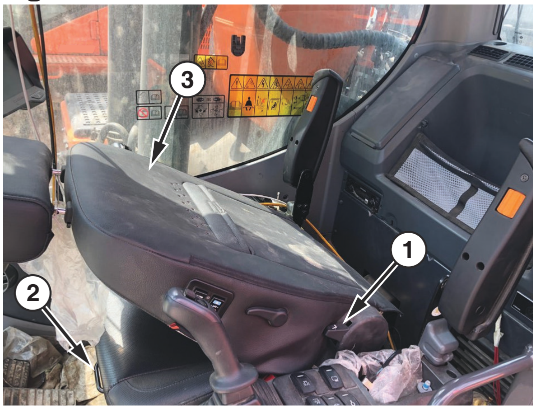
Step-C. Remove air duct

Step-D. Disconnect wiring harness

Step-E. Remove microphone controller

Removal

1. Open the left side door.
   Figure 229

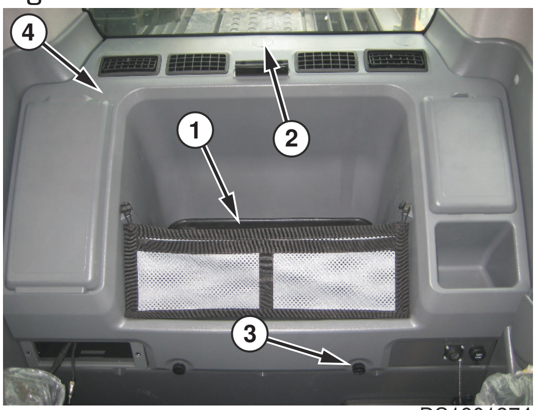


DS1901309

2. Turn OFF the battery disconnect switch.
3. Open the cabin door.
4. Pulling up left lever (1), fold the seat backrest (3) forward.
5. Move the seat assembly forward using a lever (2).

Cabin Center Cover

1. Remove the pad (1) and two bolts under pad.
   Figure 230



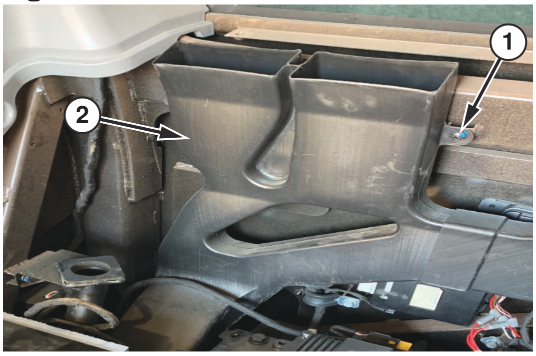
DS1901374

2. Remove the caps and bolt (2) from cabin center cover.
3. Remove bolts (3) from cabin center cover.

4. Remove cabin center cover (4).

Air Duct

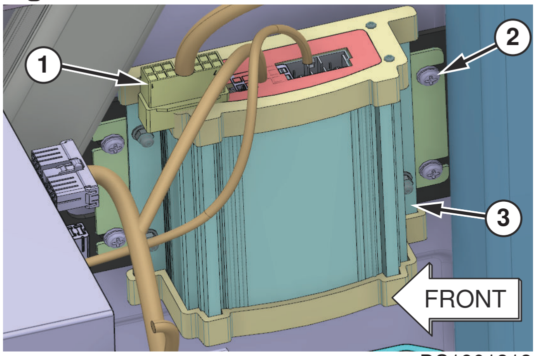
1. Remove screws (1) and air duct (2) from cabin.
   Figure 231



DS1901311

Microphone Controller

1. Disconnect wiring harness connector (1) and all connectors from microphone controller.
   Figure 232



DS1901313

   NOTE: *Check the location of the connectors before disconnecting.*

2. Remove mounting screws (2) from microphone controller mounting bracket.
3. Remove microphone controller (3).

Installation

1. Perform installation in the reverse order to removal.

Smart Key Controller

Repair Procedure Quick Guide

Step-A. Open the cabin door

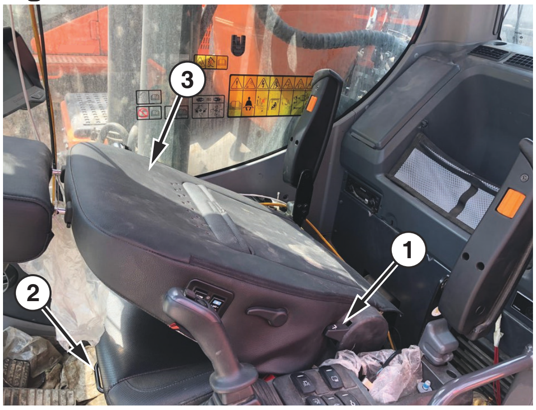
Step-B. Remove cabin center cover

Step-C. Disconnect wiring harness

Step-D. Remove smart key controller

Removal

1. Open the left side door.
   Figure 233

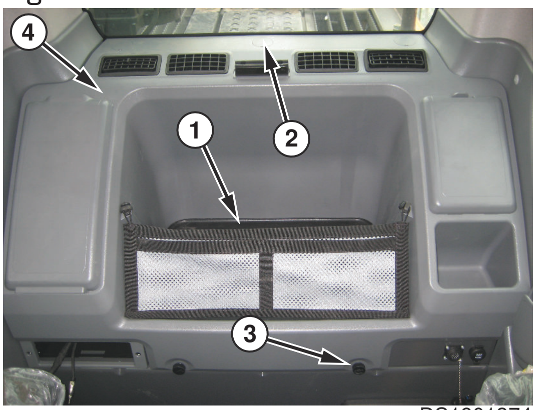


DS1901309

2. Turn OFF the battery disconnect switch.
3. Open the cabin door.
4. Pulling up left lever (1), fold the seat backrest (3) forward.
5. Move the seat assembly forward using a lever (2).

Cabin Center Cover

1. Remove the pad (1) and two bolts under pad.
   Figure 234

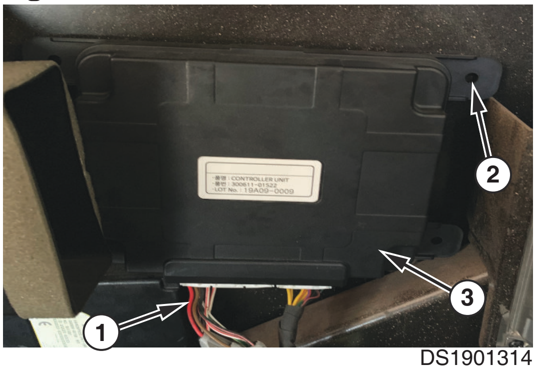


DS1901374

2. Remove the caps and bolt (2) from cabin center cover.
3. Remove bolts (3) from cabin center cover.
4. Remove cabin center cover (4).

Smart Key Controller

1. Disconnect wiring harness (1) and all connectors from smart key controller.
   Figure 235



   NOTE: *Check the location of the connectors before disconnecting.*

2. Remove mounting screws (2).
3. Remove smart key controller (3).

Installation

1. Perform installation in the reverse order to removal.

Wiper Controller

Repair Procedure Quick Guide

Step-A. Open the cabin door

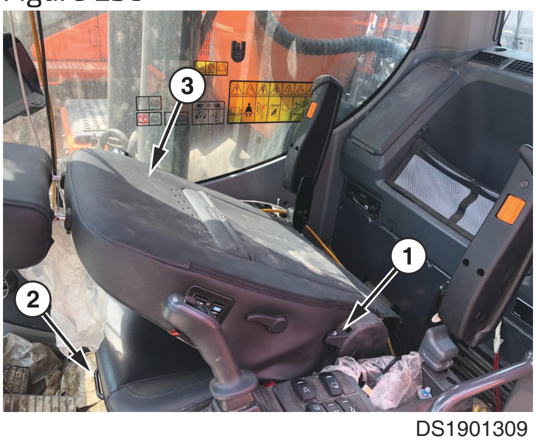
Step-B. Remove cabin center cover

Step-C. Disconnect wiring harness

Step-D. Remove wiper controller

Removal

1. Open the left side door.
   Figure 236

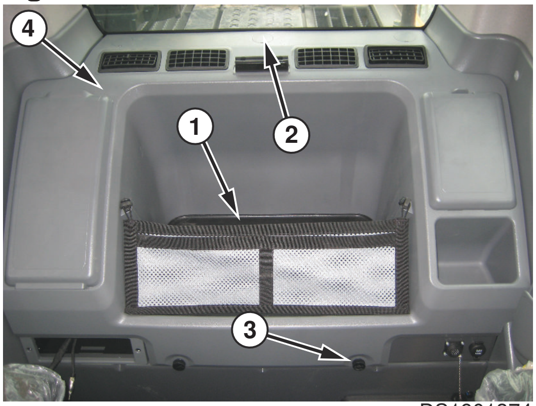


2. Turn OFF the battery disconnect switch.
3. Open the cabin door.
4. Pulling up left lever (1), fold the seat backrest (3) forward.

5. Move the seat assembly forward using a lever (2).

Cabin Center Cover

1. Remove the pad (1) and two bolts under pad.
   Figure 237

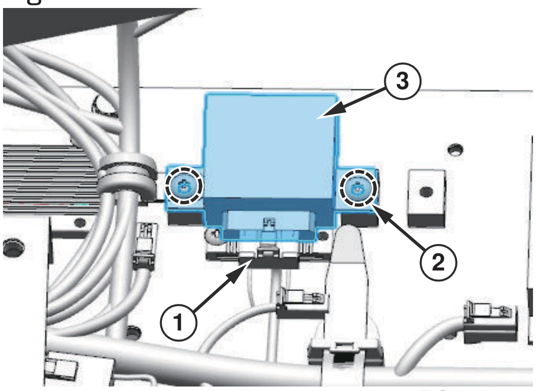


DS1901374

2. Remove the caps and bolt (2) from cabin center cover.
3. Remove bolts (3) from cabin center cover.
4. Remove cabin center cover (4).

Wiper Controller

1. Disconnect wiring harness (1) from wiper controller.
   Figure 238



DS2002508

NOTE: *Check the location of the connectors before disconnecting.*

2. Remove mounting screws (2) from wiper controller.
3. Remove wiper controller (3).

Installation

1. Perform installation in the reverse order to removal.

DC-DC Controller

Repair Procedure Quick Guide

Step-A. Open the cabin door

Step-B. Remove cabin center cover

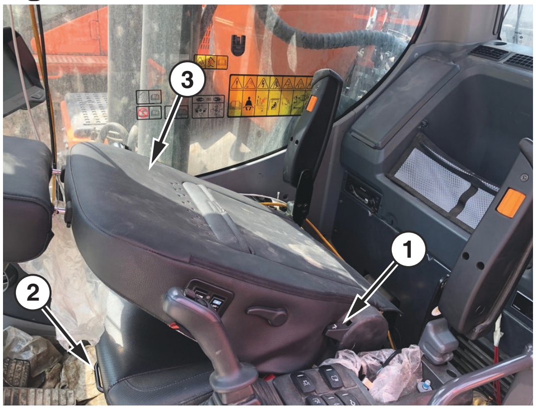
Step-C. Disconnect wiring harness

Step-D. Remove DC-DC controller

Removal

1. Open the left side door.

   Figure 239



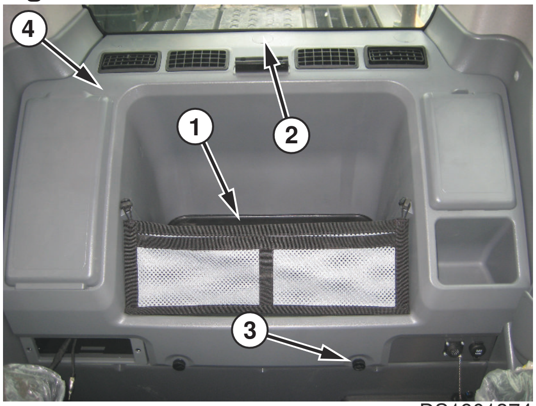
DS1901309

2. Turn OFF the battery disconnect switch.
3. Open the cabin door.
4. Pulling up left lever (1), fold the seat backrest (3) forward.
5. Move the seat assembly forward using a lever (2).

Cabin Center Cover

1. Remove the pad (1) and two bolts under pad.

   Figure 240

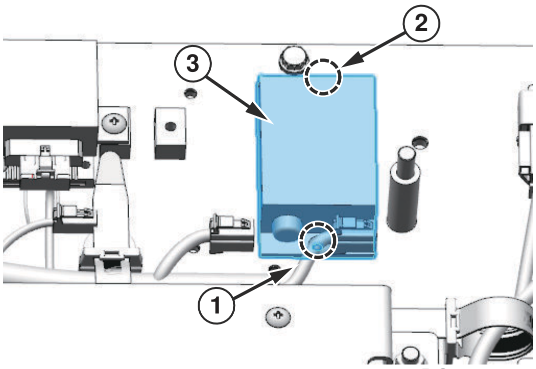


DS1901374

2. Remove the caps and bolt (2) from cabin center cover.
3. Remove bolts (3) from cabin center cover.
4. Remove cabin center cover (4).

DC-DC Controller

1. Disconnect wiring harness (1) from DC-DC controller.
   Figure 241



DS2002509

NOTE: *Check the location of the connectors before disconnecting.*

2. Remove mounting screws (2) from DC-DC controller.
3. Remove DC-DC controller (3).

Installation

1. Perform installation in the reverse order to removal.

Cabin Photo Sensor

Repair Procedure Quick Guide

Step-A. Open the cabin door

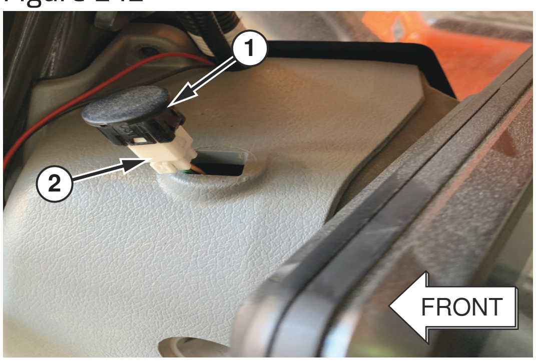
Step-B. Remove cabin photo sensor

Removal

1. Open the left side door.
2. Turn OFF the battery disconnect switch.
3. Open the cabin door.

Cabin Photo Sensor

1. Pull up cabin photo sensor (1) by using a flat-head screwdriver.
   Figure 242



DS1901316

NOTE: *The cabin photo sensor is located behind the display monitor.*

NOTE: *Please find the service groove.*

2. Disconnect wiring harness (2) from cabin photo sensor.
3. Remove cabin photo sensor (1).

Installation

1. Perform installation in the reverse order to removal.

Cabin Switches

Repair Procedure Quick Guide

Step-A. Open the cabin door

Step-B. Remove armrest

Step-C. Remove stand covers

Step-D. Disconnect wiring harness

Step-E. Remove cabin switches

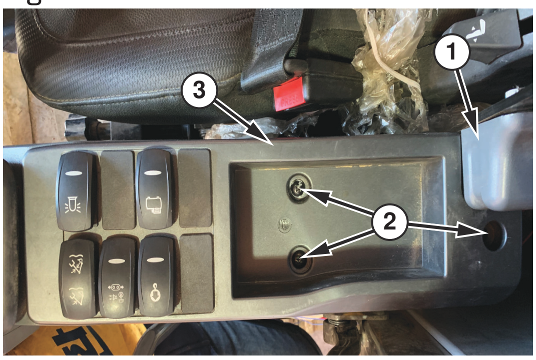
Removal

1. Open the left side door.
2. Turn OFF the battery disconnect switch.
3. Open the cabin door.

Stand Cover - Left Side

1. Remove the mounting screw and cover (1) from armrest bracket.

Figure 243



2. Remove the rubber pad and screws (2).
3. Lift off the stand cover LH (3).

Wiring Harness - Left Side

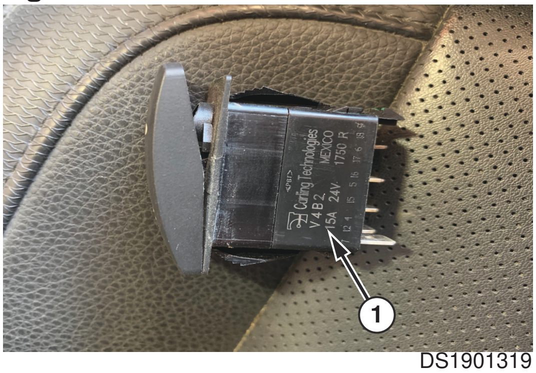
1. Disconnect wiring harness connector (1) and all connector from switches.
   Figure 244

DS1901318

NOTE: *Check the location of the connectors before disconnecting.*

Cabin Switches - Left Side

1. Pull up cabin switches (1) by using a flat-head screwdriver.
   Figure 245

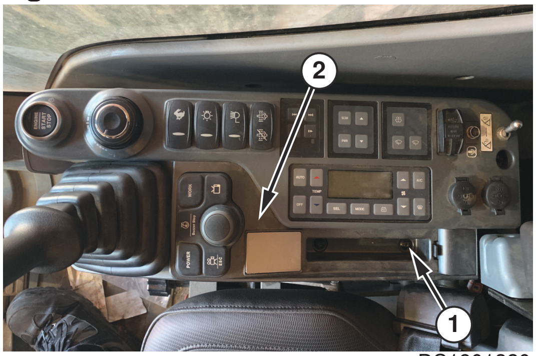


DS1901319

NOTE: *Be careful not to break the switch assembly.*

Stand Cover - Right Side

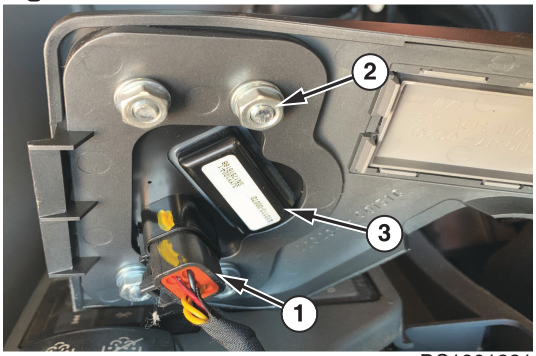
1. Remove the rubber pad and screws (1).
   Figure 246



DS1901320

2. Lift off the stand upper cover (2).

3. Disconnect wiring harness connector (1) from jog switch.
   Figure 247



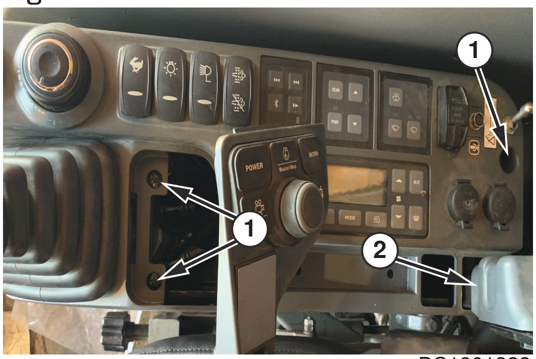
4. If you need to remove jog switch, please next following procedure.

   Remove the stand upper cover.

   A. Remove the nuts (2).

   B. Remove the jog switch (3) from stand upper cover.

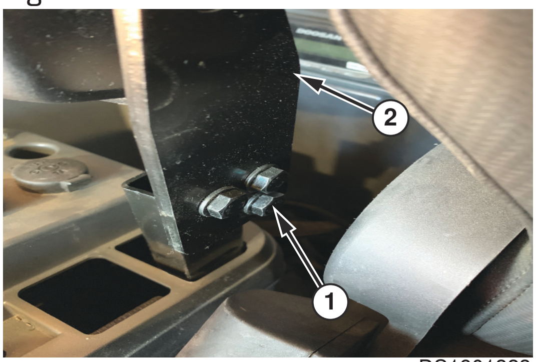
5. Remove the screws (1).
   Figure 248



6. Remove the mounting screw and cover (2) from armrest bracket.

Armrest

1. Remove mounting bolts (1) and armrest (2).
   Figure 249

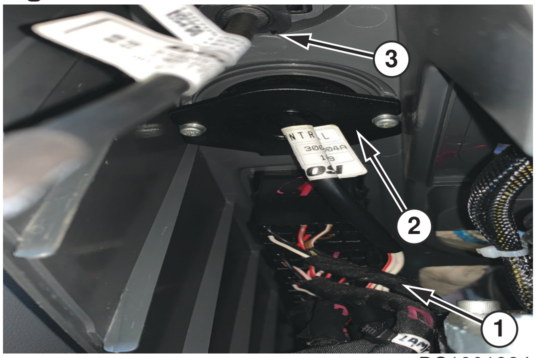


   - Tool: 13 mm ( )
   - Torque: 19.6 N.m (2 kg.m, 14.5 ft lb)

2. Remove cup holder mounting bracket and bolts.
   - Refer to torque values for standard.

Wiring Harness - Right Side

1. Lift off the stand upper cover.
   Figure 250



DS1901324

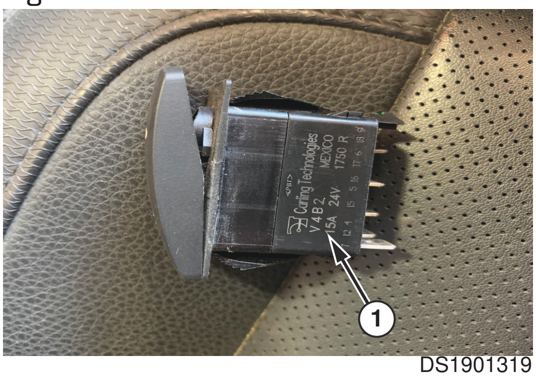
2. Disconnect wiring harness connector (1) and all connector from switches.

   NOTE: *Check the location of the connectors before disconnecting.*

3. Remove the engine speed control dial (2).
4. Remove the smart key switch (3).

Cabin Switches - Right Side

1. Pull up cabin switches (1) by using a flat-head screwdriver.
   Figure 251



DS1901319

   NOTE: *Be careful not to break the switch assembly.*

Installation

1. Perform installation in the reverse order to removal.

Around View Monitor

Repair Procedure Quick Guide

Step-A. Open the cabin door

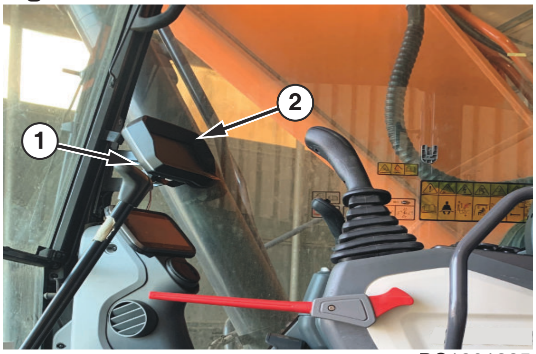
Step-B. Remove around view monitor

Removal

1. Open the left side door.
2. Turn OFF the battery disconnect switch.
3. Open the cabin door.

Around View Monitor

1. Remove bolts (1) from around view monitor.
   Figure 252



DS1901325

   - Refer to torque values for standard.
2. Disconnect wiring harness connector from around view monitor.
3. Remove the around view monitor (2) from mounting bracket.

Installation

1. Perform installation in the reverse order to removal.

Display Monitor

Repair Procedure Quick Guide

Step-A. Open the cabin door

Step-B. Remove cabin photo sensor

Step-C. Remove cabin side cover

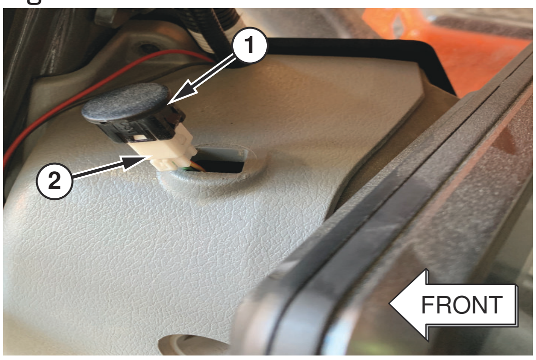
Step-D. Remove display monitor

Removal

1. Open the left side door.
2. Turn OFF the battery disconnect switch.
3. Open the cabin door.

Cabin Photo Sensor

1. Pull up cabin photo sensor (1) by using a flat-head screwdriver.
   Figure 253



DS1901316

NOTE: *The cabin photo sensor is located behind the display monitor.*

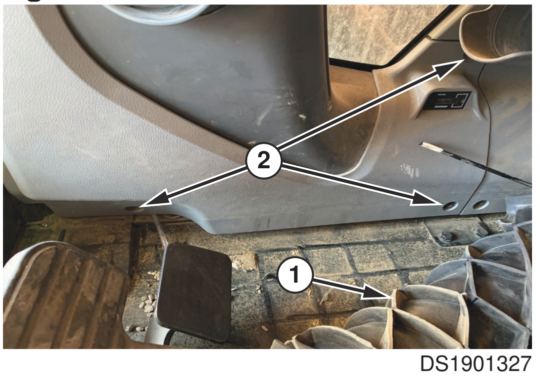
NOTE: *Please find the service groove.*

2. Disconnect wiring harness (2) from cabin photo sensor.
3. Remove cabin photo sensor (1).

Cabin Side Cover

1. Put away the floor rubber mat (1).

Figure 254



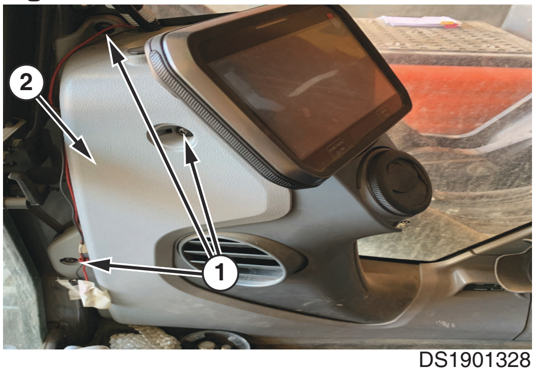
DS1901327

2. Remove the plug cap and screws (2) from cabin side cover.

NOTE: *Please find the service groove.*

3. Remove the plug cap and screws (1) from cabin side cover.

Figure 255



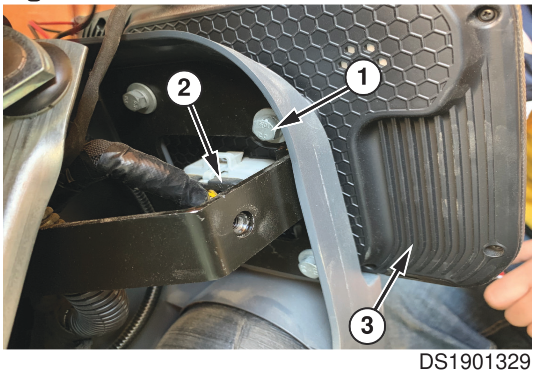
DS1901328

4. Remove the cabin side cover (2).

Display Monitor

1. Remove the bolts (1) from display monitor.

Figure 256



DS1901329

- Refer to torque values for standard.

2. Disconnect wire harness (2) from display monitor (3).
3. Remove the display monitor from bracket.

Installation

1. Perform installation in the reverse order to removal.

Hour Meter

Repair Procedure Quick Guide

Step-A. Open the cabin door

Step-B. Remove cabin side cover

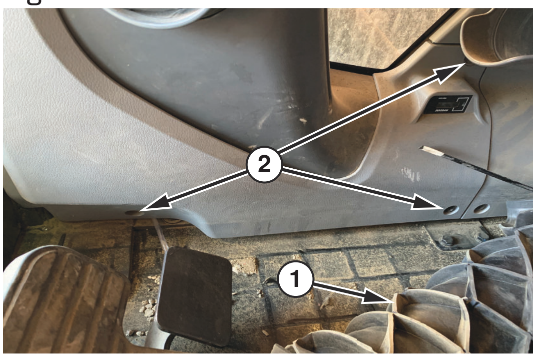
Step-C. Remove hour meter

Removal

1. Open the left side door.
2. Turn OFF the battery disconnect switch.
3. Open the cabin door.

Cabin Side Cover

1. Put away the floor rubber mat (1).
   Figure 257

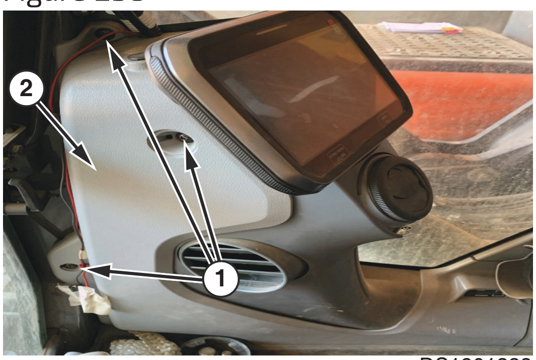


DS1901327

2. Remove the plug cap and screws (2) from cabin side cover.

   NOTE: *Please find the service groove.*

3. Remove the plug cap and screws (1) from cabin side cover.
   Figure 258

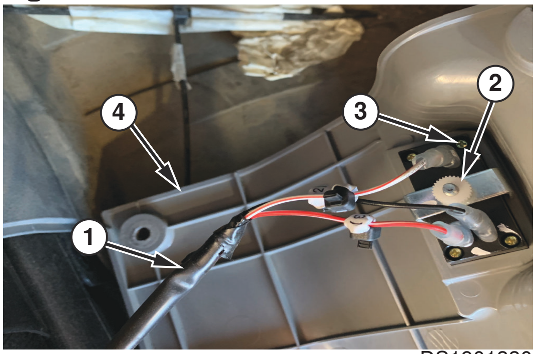


DS1901328

4. Remove the cabin side cover (2).

Hour Meter

1. Disconnect wire harnesses (1).
   Figure 259



2. Remove the fastener (2) from hour meter.
3. Remove the hour meter (3) from cabin side cover (4).

Installation

1. Perform installation in the reverse order to removal.

Wiper Motor

Repair Procedure Quick Guide

Step-A. Open the cabin door

Step-B. Remove cabin photo sensor

Step-C. Remove cabin side cover

Step-D. Remove display monitor

Step-E. Remove cabin side cover - upper

Step-F. Remove wiper arm

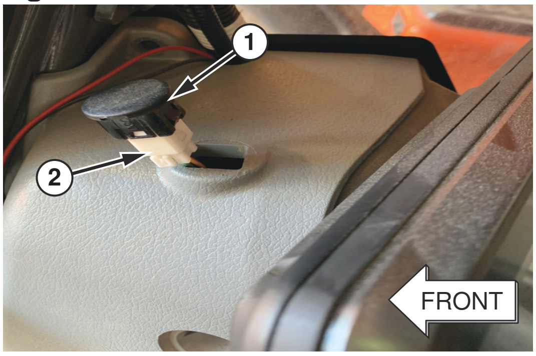
Step-G. Remove wiper motor

Removal

1. Open the left side door.
2. Turn OFF the battery disconnect switch.
3. Open the cabin door.

Cabin Photo Sensor

1. Pull up cabin photo sensor (1) by using a flat-head screwdriver.
   Figure 260



DS1901316

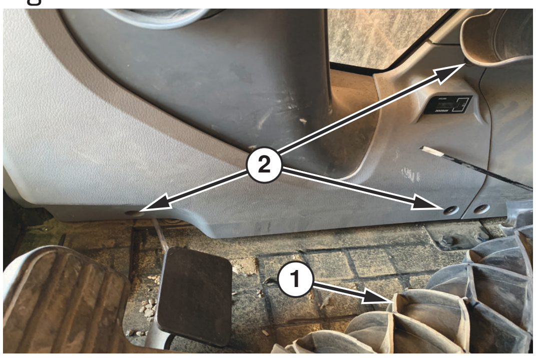
NOTE: *The cabin photo sensor is located behind the display monitor.*

NOTE: *Please find the service groove.*

2. Disconnect wiring harness (2) from cabin photo sensor.
3. Remove cabin photo sensor (1).

Cabin Side Cover

1. Put away the floor rubber mat (1).
   Figure 261

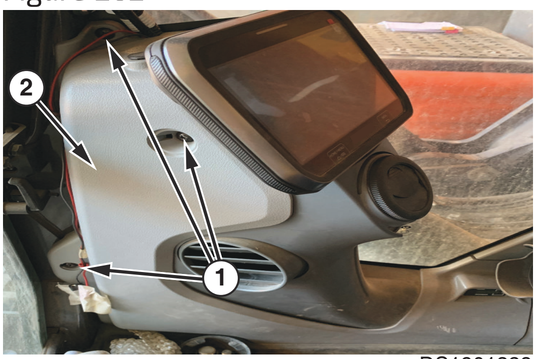


DS1901327

2. Remove the plug cap and screws (2) from cabin side cover.

   NOTE: *Please find the service groove.*

3. Remove the plug cap and screws (1) from cabin side cover.
   Figure 262

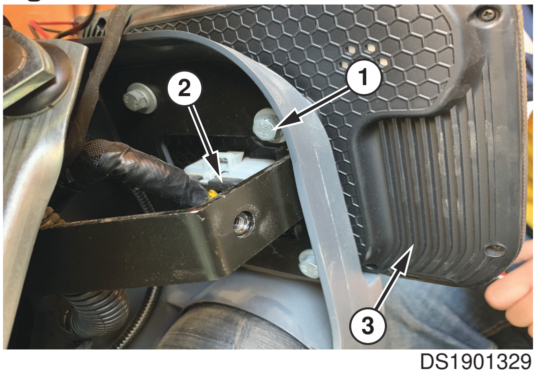


DS1901328

4. Remove the cabin side cover (2).

Display Monitor

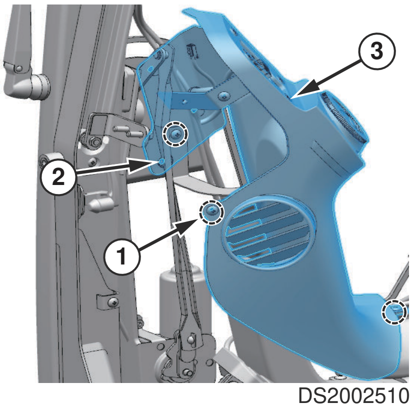
1. Remove the bolts (1) from display monitor.
   Figure 263



   - Refer to torque values for standard.
2. Disconnect wire harness (2) from display monitor (3).
3. Remove the display monitor from bracket.

Cabin Side Cover - Upper

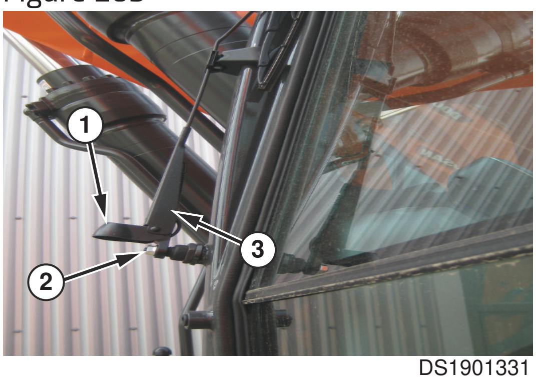
1. Remove screws (1) from cabin side cover.
   Figure 264



2. Remove mounting bolts (2) (3ea).
3. Remove cabin side cover and plate (3) from cabin.

Wiper Arm

1. Open cap (1), remove nut (2) and wiper arm (3).
   Figure 265

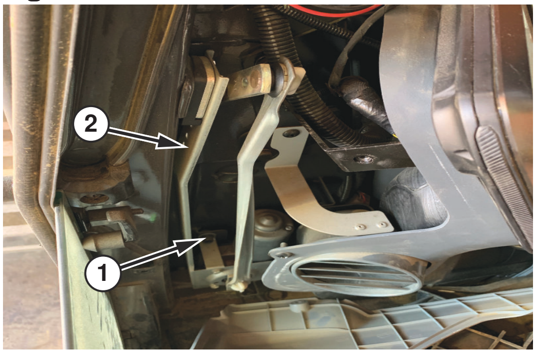


   - Tool: 13 mm ( )

- Torque: 25 N.m (2.5 kg.m, 18 ft lb)

Wiper Motor

1. Remove bolts (1) and wiper motor (2).
   Figure 266



DS1901332

2. Disconnect wire harness connector from wiper motor.

   NOTE: *Check the position of the wiper linkage when installing wiper arm.*

Installation

1. Perform installation in the reverse order to removal.

Troubleshooting Guide

Wiring Harness Layout

Safety Instructions

⚠ WARNING

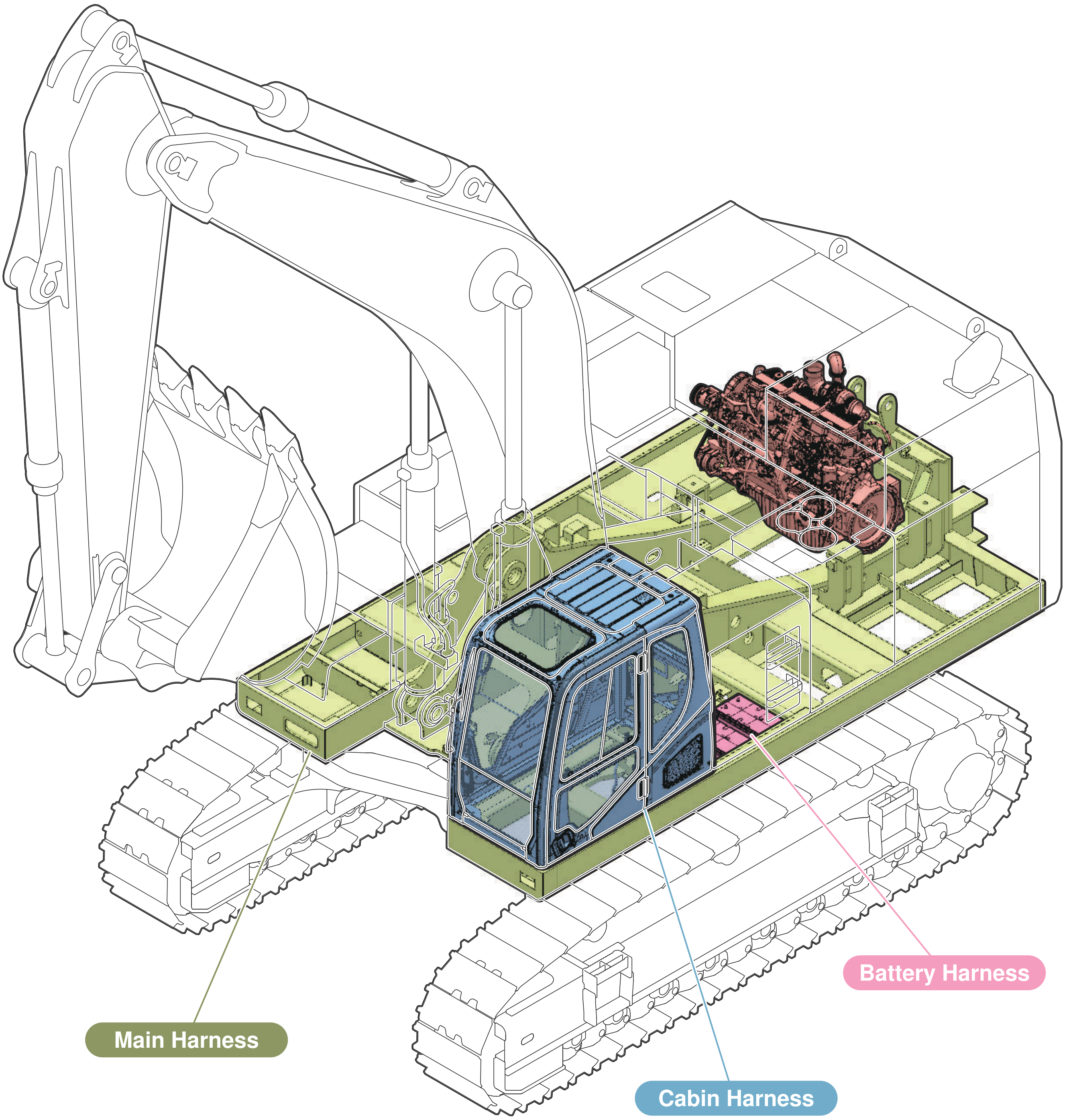
AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or servicingmachine. Read and understand the Operation & Maintenance Manual and signs (decals) on machine. Followwarnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correctfunction after adjustments repairs or service. Untrainedoperators and failure to follow instructions can cause deathor serious injury.

Wiring Device

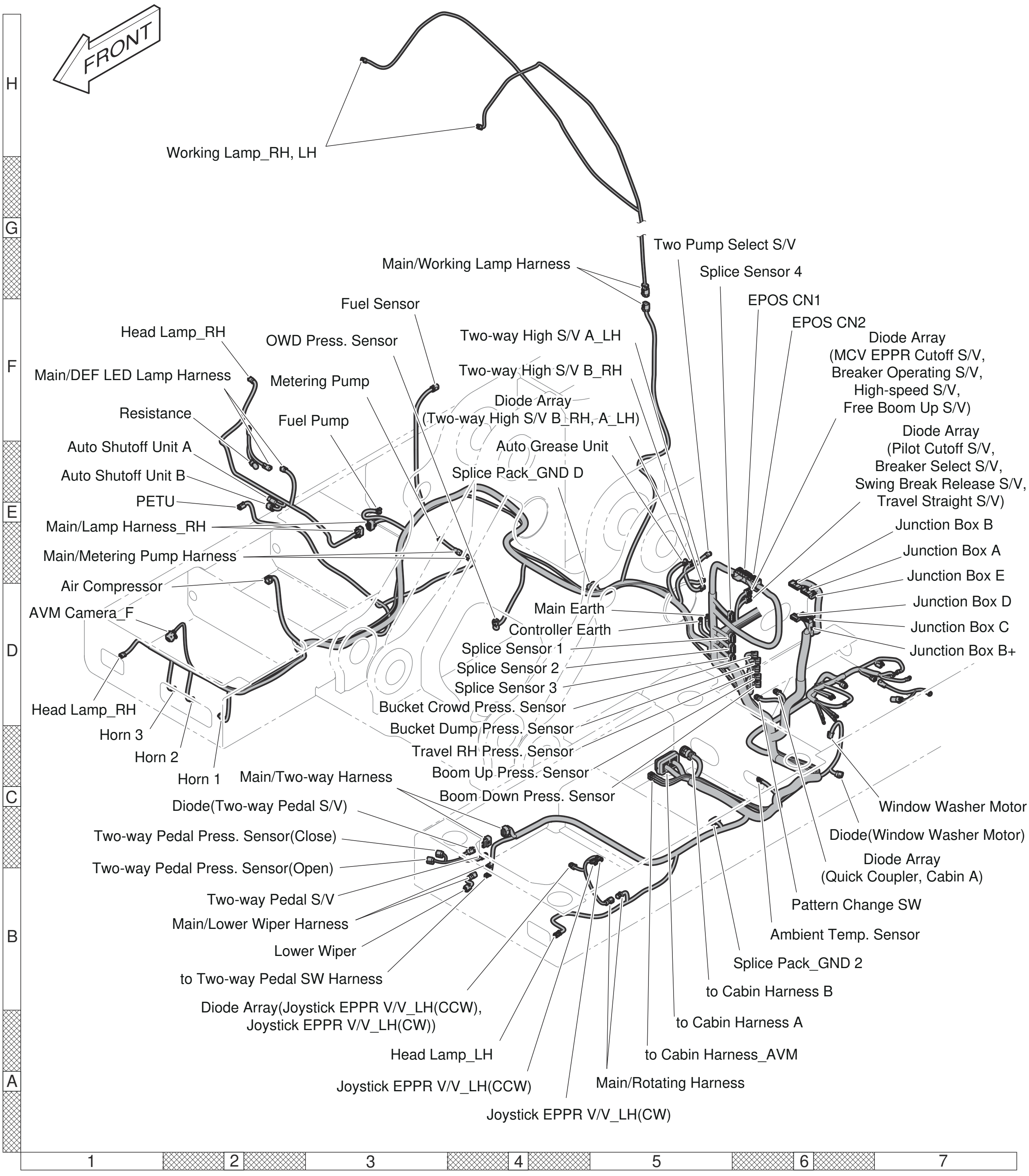
Wiring Harness Layout

Figure 1



Main Harness (1/2)

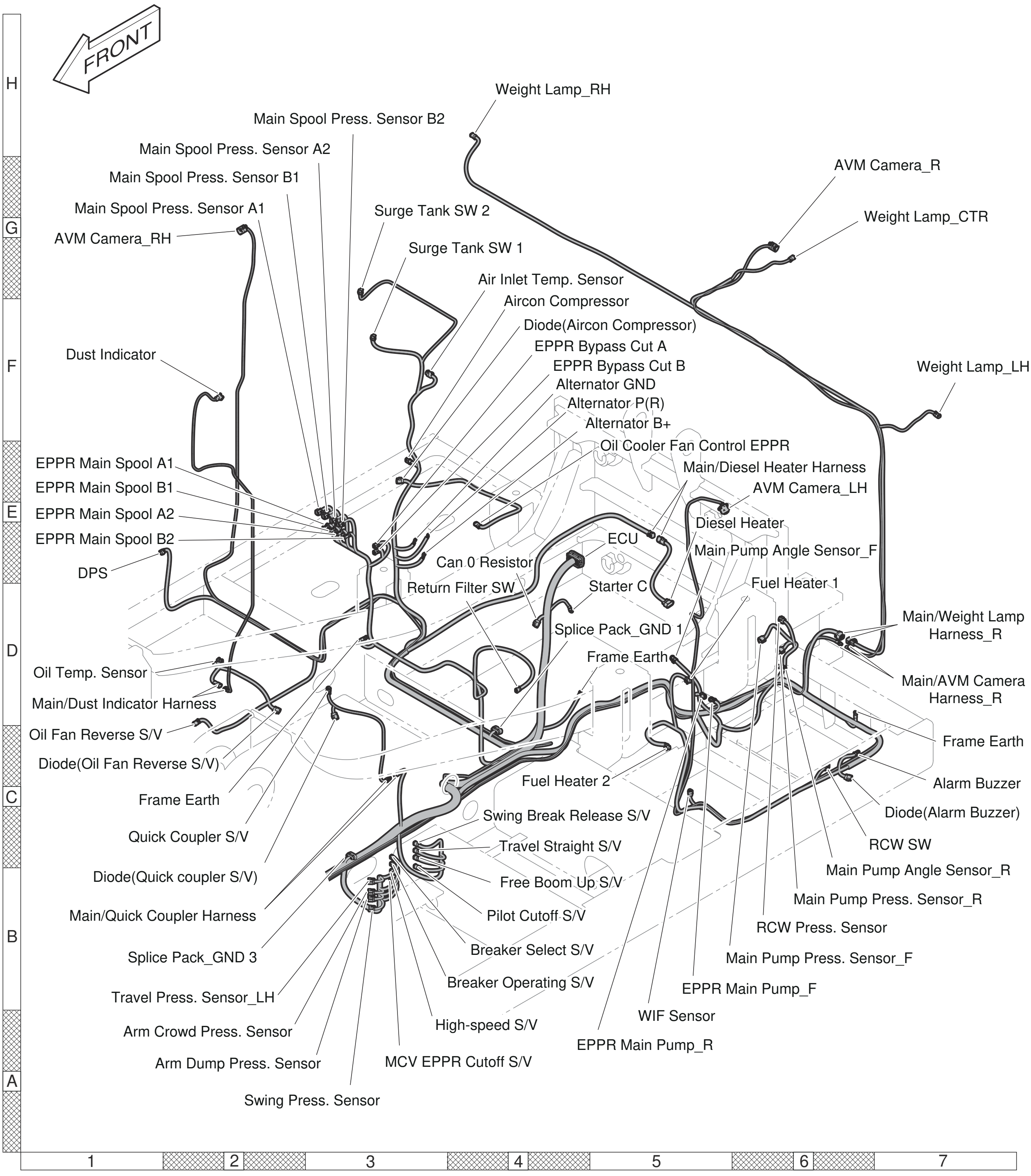
Figure 2



DS2002021

Main Harness (2/2)

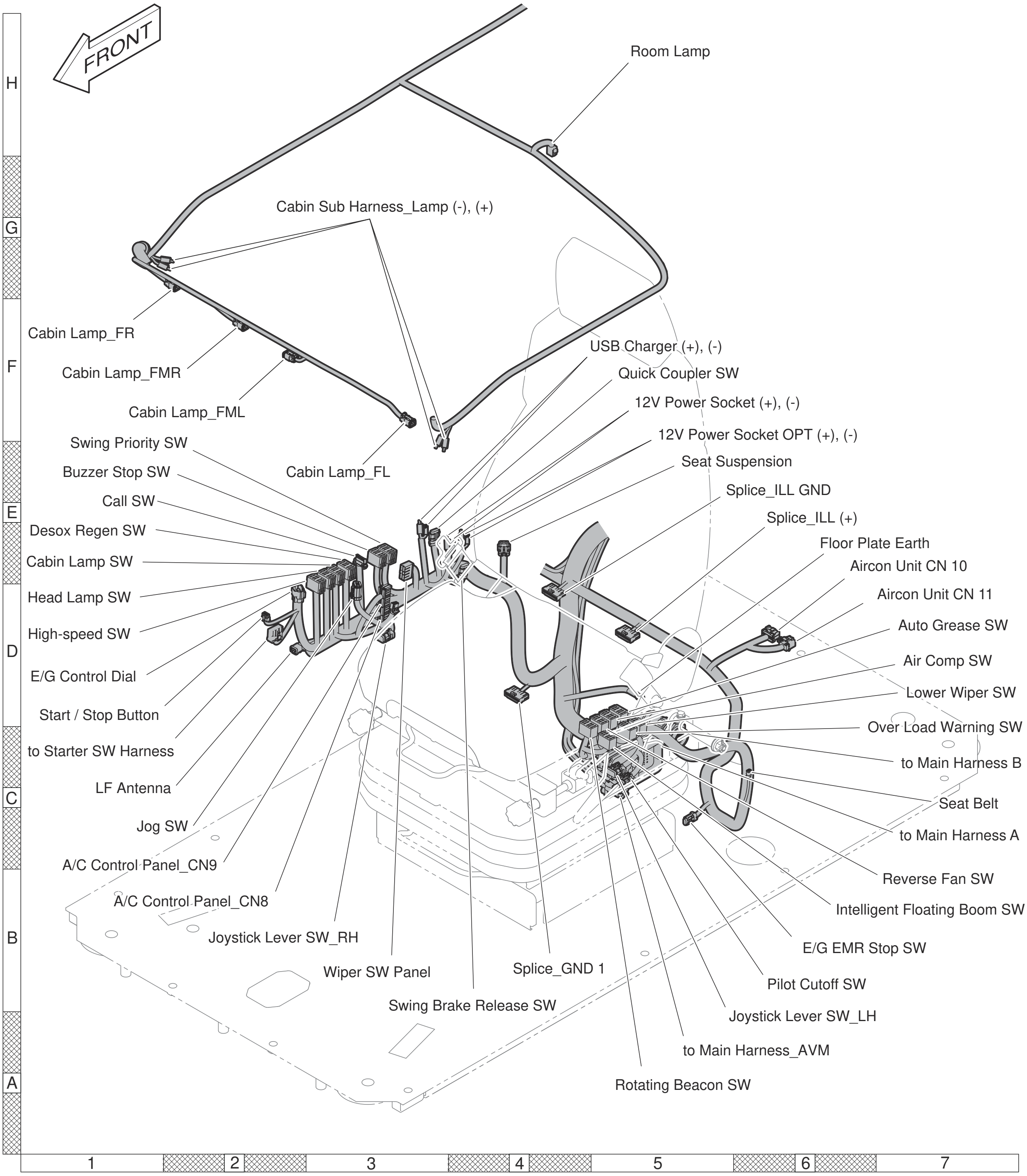
Figure 3



DS2002022

Cabin Harness (1/2)

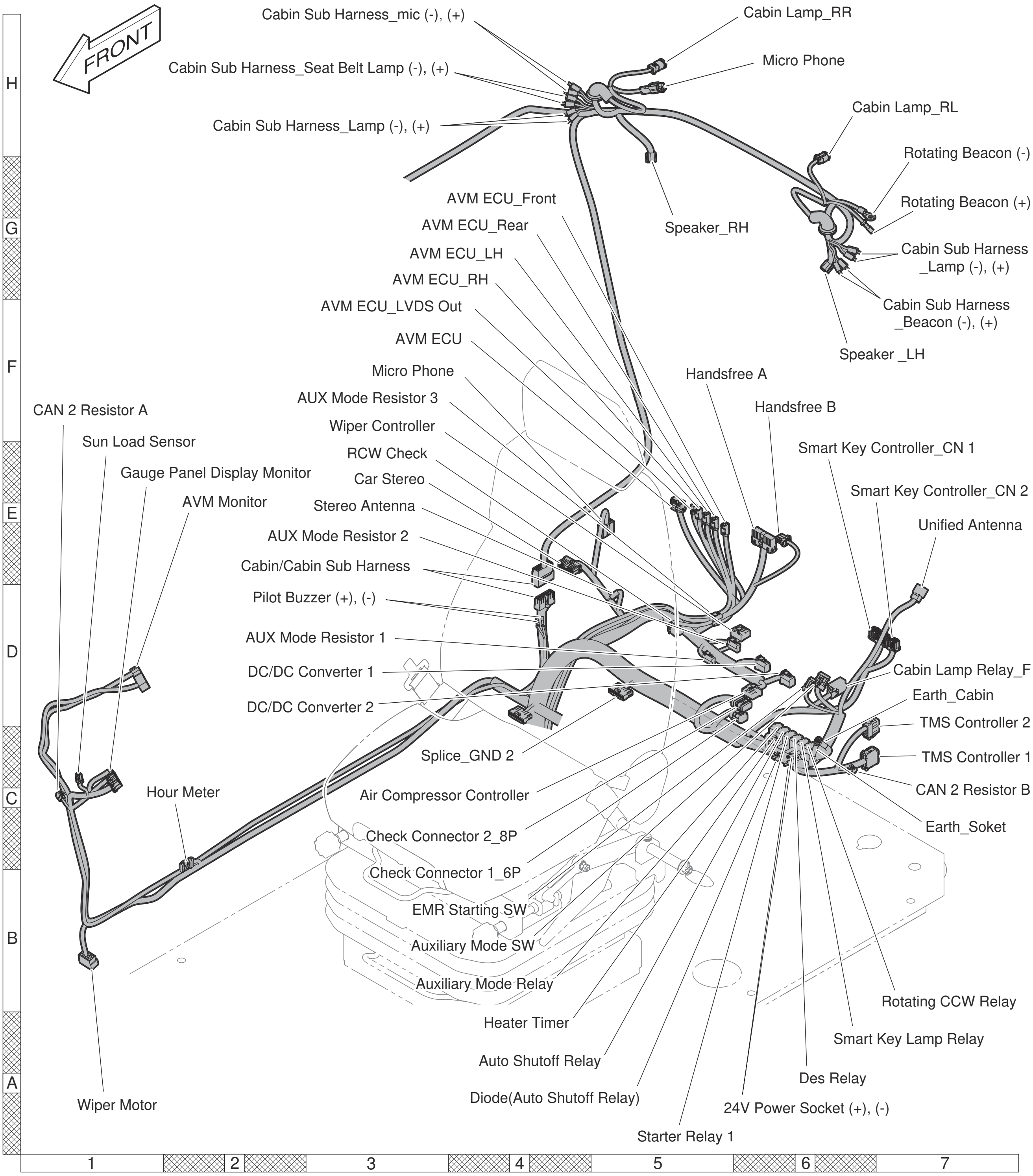
Figure 4



DS2002023

Cabin Harness (2/2)

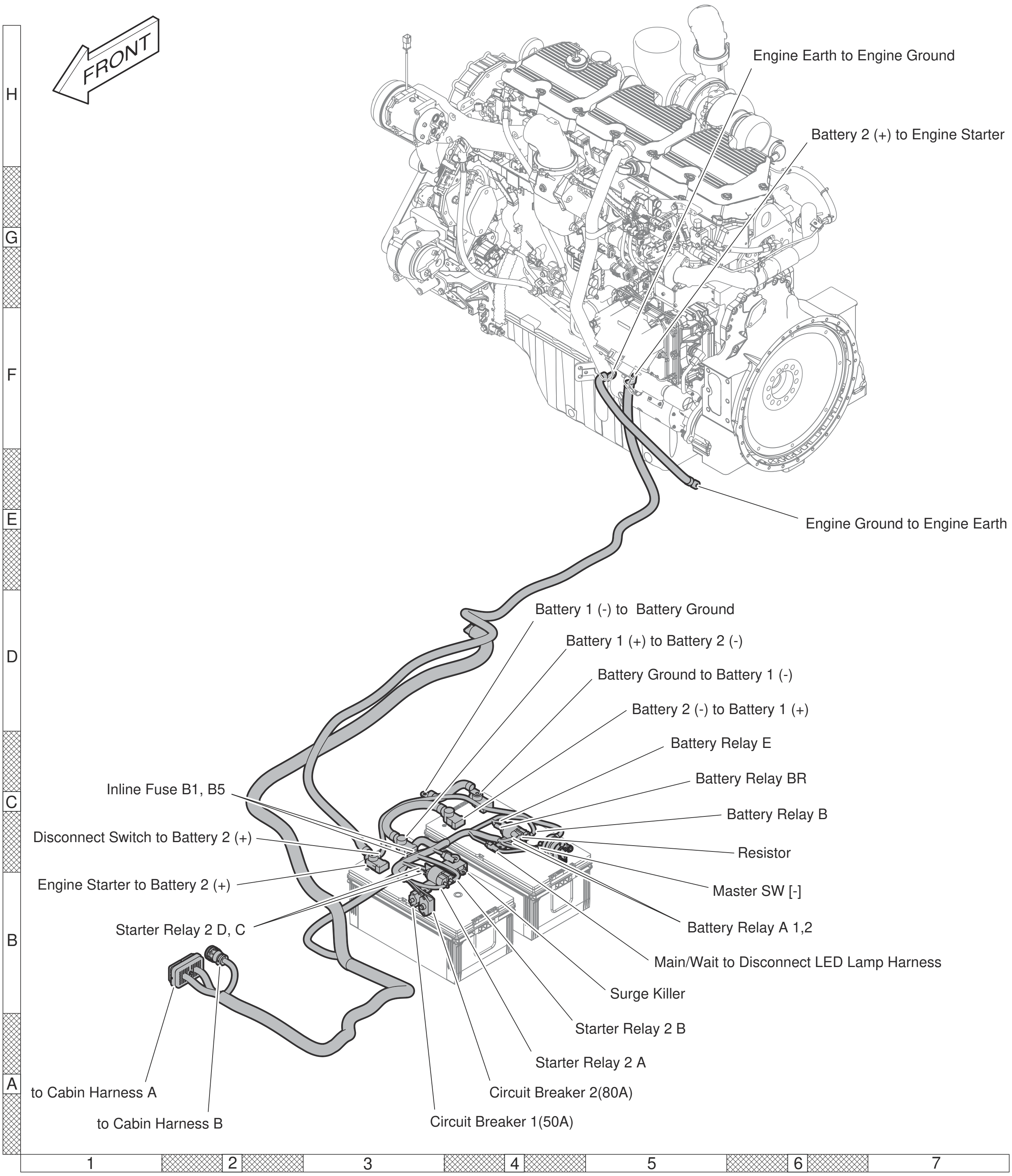
Figure 5



DS2002024

Battery Harness

Figure 6



DS2002025

Error Code

Safety Instructions

WARNING

AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or servicingmachine. Read and understand the Operation & Maintenance Manual and signs (decals) on machine. Followwarnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correctfunction after adjustments repairs or service. Untrainedoperators and failure to follow instructions can cause deathor serious injury.

EPOS Error Code

Information Mentioned in Troubleshooting Table

- The following information is summarized in the troubleshooting table and the related circuit diagram. Before performing troubleshooting, understand that information fully.

No.	Description of the Problems
1. VC0001	Gauge Panel
2. VC0002	E-ECU
3. VPV001	Pump Proportional Valve (A)
4. VPV002	Pump Proportional Valve (B)
5. VPV004	Fan Control Proportional Valve (J)
6. VPV025	Bypass Cut-off (A) Proportional Valve
7. VPV026	Bypass Cut-off (B) Proportional Valve
8. VPV027	Boom Up Summation Proportional Reducing Valve
9. VPV028	Arm Crowd summation Proportional Reducing Valve
10.VPV029	Bucket Crowd summation Proportional Reducing Valve
11.VPV030	Arm Lock Proportional Reducing Valve
12.VSV001	Breaker Operating Solenoid Valve
13.VSV003	High-speed Solenoid Valve (C)
14.VSV004	Reverse Fan Solenoid Valve
15.VSV006	Swing Brake Release Solenoid Valve (K)
16.VSV007	Option Safety Solenoid Valve
17.VSV011	2 Pump Select Solenoid Valve (I)
18.VSV018	Two Way RH-Open Solenoid Valve
19.VSV019	Two Way RH-Close Solenoid Valve
20.VSV020	Breaker Select Solenoid Valve
21.VSV034	Travel Straight Solenoid Valve
22.VSV035	Free Boom Up Solenoid Valve

No.	Description of the Problems
23.VSV037	Quick Coupler Solenoid Valve
24.VSV038	MCV Proportional Reducing Cutoff Solenoid Valve
25.VRY002	Back Buzzer Relay
26.VRY007	Starter Relay
27.VRY016	Auto Shut Off Relay
28.VRY018	ACC Relay
29.VRY019	DES (Delayed Engine Shutdown) Override Relay
30.VGC002	Urea Overcharging Warning Signal
31.VSP001	Front Pump Pressure Sensor
32.VSP002	Rear Pump Pressure Sensor
33.VSP003	Overload Warning Pressure Sensor
34.VSP006	Boom Up Pressure Sensor
35.VSP007	Bucket Crowd Pressure Sensor
36.VSP008	Boom Down Pressure Sensor
37.VSP009	Bucket Dump Pressure Sensor
38.VSP010	Arm In Pressure Sensor
39.VSP011	Arm Out Pressure Sensor
40.VSP012	Travel Pressure Sensor (LH)
41.VSP013	Travel Pressure Sensor (RH)
42.VSP014	Swing Pressure Sensor
43.VSP017	Option Pedal 1 Pressure Sensor
44.VSP018	Option Pedal 2 Pressure Sensor
45.VSP020	RCW Pressure Sensor
46.VSP045	Boom Up Summation Pressure Sensor
47.VSP046	Arm Crowd Summation Pressure Sensor
48.VSP047	Bucket Crowd Summation Pressure Sensor
49.VSP048	Arm Lock Summation Pressure Sensor
50.VSE001	Oil Temperature Sensor
51.VSE002	Fuel Sensor
52.VSE004	WIF Sensor
53.VSE007	Angle Sensor (A)
54.VSE008	Angle Sensor (B)
55.VS5005	Dial
56.VS5006	Machine Controller +5 V Output 1
57.VS5007	Machine Controller +5 V Output 2
58.VAL001	Alternator Potential

1. VC0001 Gauge Panel

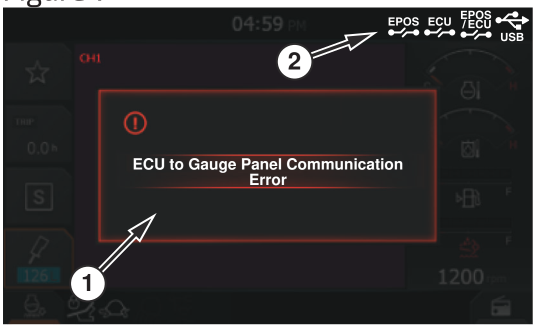
Action Level	Failure Code	Failure	Gauge Panel Communication
Gauge Panel	VC0001		
Detail of Failure	The EPOS has not received CAN data from the gauge panel for more than 10 seconds.		
Actions of Machine Monitor or Controller	• When gauge panel communications failed, a message pops up on the gauge panel screen, indicating a communication error with EPOS/ECU. • When gauge panel communications failed, the relevant communication error indicator lights up at the top right of the gauge panel. • When the communication error indicator and pop-up message disappear, the machine returns to normal.		
Problem on Machine	• Vehicle data received from the EPOS cannot be checked on the gauge panel. • It is impossible to switch to certain modes (auto idle mode/power mode/work mode).		
Related Information	1. If the CAN communication lines H and L to the gauge panel are swapped, normal communication cannot be established. 2. If either of the CAN H and CAN L lines to the gauge panel is open, normal communication cannot be established. 3. If an abnormal device out of the specification is installed to the communication line without approval, normal communication cannot be established.		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty CAN Communication Resistance	If a pop-up message, indicating a communication error with the EPOS/ECU, is displayed on the gauge panel, inspect the system according to the following instructions: 1. Turn off the master switch of the machine. 2. Measure the resistance at the pin No. 4 (CAN H) and pin No. 5 (CAN L) of the check connector which is located in the rear left section in the cabin. A. Measured resistance: 60 ±5 Ω
2	Faulty CAN Communication Resistance	If the measured resistance is not within the specified range (60 Ω) 1. Measure the CAN resistance after disconnecting the EPOS connector. A. If the measured CAN resistance is not 120 Ω 1) Possible faulty connector connection → Check the connection state of the connector. 2) Normal connector connection → Damage in ECU resistor → Replace the ECU. B. If the measured CAN resistance is 120 Ω → The CAN line is normal.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		2. Measure the CAN resistance after disconnecting the ECU connector. A. If the measured CAN resistance is not 120 Ω 1) Possible faulty connector connection → Check the connection state of the connector. 2) Normal connector connection → Damage in EPOS resistor → Replace the EPOS. B. If the measured CAN resistance is 120 Ω → The CAN line is normal.
3	Faulty CAN Communication Line	Measure the CAN resistance. If the measured CAN resistance is 60 Ω: 1. Disconnect the connector of the gauge panel to check the connection status of the CAN communication line. A. Check that the CAN H and CAN L lines are correctly connected. B. Check if the CAN H and CAN L lines are swapped.
4	Faulty Gauge Panel	If the measured CAN resistance is 60 Ω (normal state) and the CAN communication lines are correctly connected. → The CAN communication section in the gauge panel may be damaged. Therefore, the gauge panel may need to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 7



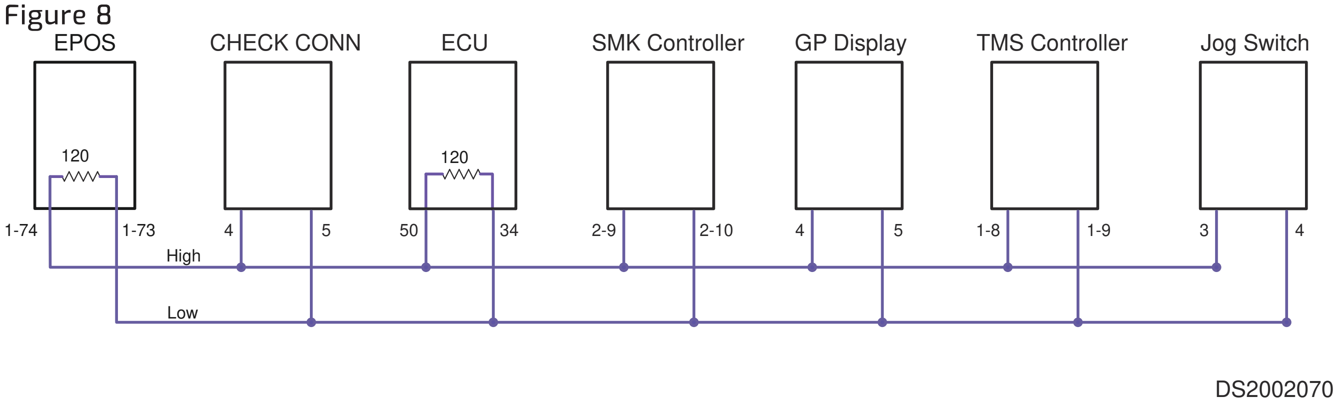
DS1901654

In the event of a gauge panel communication error, an error message (1) pops up on the gauge panel screen and the relevant communication indicator (2) lights up at the top right of the gauge panel.

- EPOS communications offline: EPOS communications offline, ECU communications online.
- ECU communications offline: EPOS communications online, ECU communications offline.
- EPOS/ECU communications offline: EPOS communications offline, ECU communications offline.

Block Diagram

Figure 8



2. VC0002 E-ECU

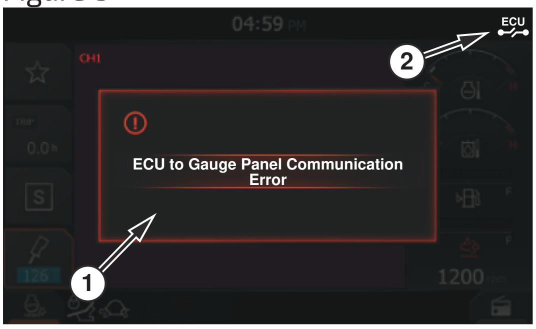
Action Level	Failure Code	Failure	E-ECU
Gauge Panel	VC0002		
Detail of Failure	The gauge panel and EPOS cannot receive data from the ECU due to abnormal CAN communication condition with the ECU.		
Actions of Machine Monitor or Controller	• A popup message, indicating a communication error with the ECU, is displayed on the monitor when communication is lost with the ECU.		
Problem on Machine	• Engine data received from the ECU cannot be checked on the gauge panel. • The rpm is not changed as the engine rpm command is not delivered to the ECU.		
Related Information	1. If the connector for the ECU is not correctly connected, normal communication cannot be established. 2. If the CAN communication lines H and L to the ECU are swapped, normal communication cannot be established. 3. If either of the CAN H and CAN L lines to the ECU is open, normal communication cannot be established. 4. If an abnormal device out of the specification is installed to the CAN communications line without approval, normal communication cannot be established.		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty CAN Communication Resistance	If a popup message, indicating a communication error with the ECU, is displayed on the gauge panel, inspect the system according to the following procedure: 1. Turn off the master switch of the machine. 2. Measure the resistance at the pin No. 4 (CAN H) and pin No. 5 (CAN L) of the check connector which is located in the rear left section in the cabin. A. Measured resistance: 60 ±5 Ω
2	Faulty CAN Communication Resistance	If the measured resistance is not within the specified range (60 Ω)

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		1. Measure the CAN resistance after disconnecting the ECU connector. A. If the measured CAN resistance is not 120 Ω 1) Possible faulty connector connection → Check the connection state of the connector. 2) Normal connector connection → Damage in ECU resistor → Replace the ECU. B. If the measured CAN resistance is 120 Ω → The CAN line is normal.
3	Faulty CAN Communication Line	Measure the CAN resistance. If the measured CAN resistance is 60 Ω: 1. Disconnect the connector of the ECU to check the connection status of the CAN communication line. A. Check that the CAN H and CAN L lines are correctly connected. B. Check if the CAN H and CAN L lines are swapped.
4	Faulty ECU	If the measured CAN resistance is 60 Ω (normal state) and the CAN communication lines are correctly connected. → The CAN communication section in the ECU may be damaged. Therefore, the ECU may need to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 9

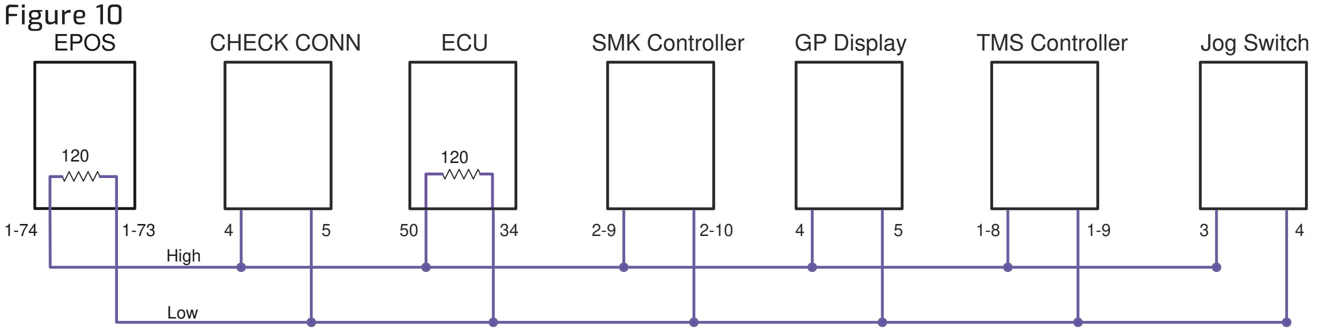


DS1901655

In the event of a gauge panel and EPOS communication error with ECU, an error message (1) pops up on the gauge panel screen and the relevant communication indicator (2) lights up at the top right of the gauge panel.

Block Diagram

Figure 10



DS2002070

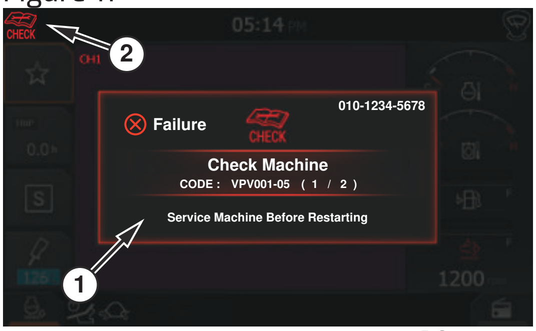
3. VPV001 Pump Proportional Valve (A)

Action Level	Failure Code	Failure	Pump Proportional Valve (A)
Gauge Panel	VPV001		
Detail of Failure	FMI 5: Pump proportional value (A), current below normal (open circuit). FMI 6: Pump proportional value (A), current above normal (short circuit).		
Action of Machine Monitor or Controller	• If the pump proportional valve (A) is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the pump proportional valve is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• The speed of the boom up, arm in and arm out operations is decreased. • The bucket, option or travel (LH) operation cannot be performed. • The boom cannot be operated if the EPPR is not operating properly both drive (rear) and idle (front) pump. • The relief pressure up function is disabled. • The machine cannot be driven straight ahead during travel. (it moves in a diagonal direction unintentionally.) • The relief cut-off function cannot be performed. • The automatic travel speed control cannot be performed.		
Related Information	1. An error code is generated when the EPPR valve's connector is disconnected. 2. An error code can be generated if the auxiliary switch located in the rear left section of the cabin is in the "I" position. A. The auxiliary switch is designed for emergency operation in case of EPOS malfunction. It should be positioned in the "O" position in a normal condition. B. Normal outputs of pump valve. 1) Not in operation: 300±30 mA 2) Pilot operation: up to 750 ±30 mA 3) Relief pressure up operation: 800 ±30 mA		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Auxiliary Switch Position	If the current malfunction information on the gauge panel indicates an open circuit in the proportional valve wiring. 1. Check if the auxiliary switch located on the rear left section in the cabin is in the "I" position. 2. If the switch is in the "I" position, move it to the "O" position.
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the EPOS and valve. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the measurement is 0 Ω, this indicates a normal connection. 3. Check that the connectors of the valve and main harness are correctly connected.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and valve. A. Check the power source, ground, and signal line for any short circuit.
4	Defective EPPR Valve	1. Turn off the master switch of the machine. 2. Measure the resistance of the valve. A. Measure the resistance of the valve coil. → If the measurement is infinite, this indicates an open circuit of the coil in the valve. B. Measure the resistance of the valve coil. → If the measurement is 0 Ω, this indicates a short circuit of the coil in the valve. 1) Resistance specification: 12 Ω ±10%

Pop-ups, Warning Symbols and Indicators

Figure 11

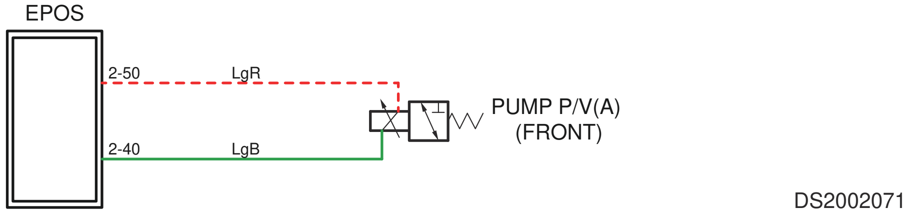


DS1901656

If the pump proportional valve malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 12



4. VPV002 Pump Proportional Valve (B)

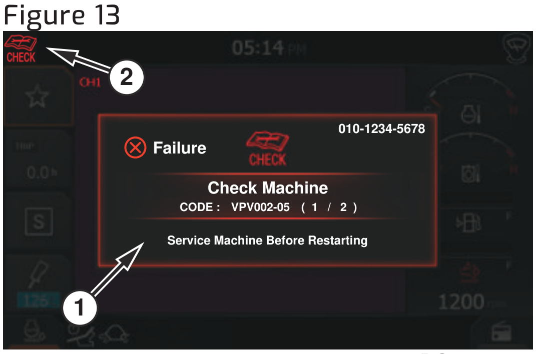
Action Level	Failure Code	Failure	Pump Proportional Valve (B)
Gauge Panel	VPV002		
Detail of Failure	FMI 5: Pump proportional value (B), current below normal (open circuit). FMI 6: Pump proportional value (B), current above normal (short circuit).		
Actions of Machine Monitor or Controller	• If the pump proportional valve (B) is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the pump proportional valve is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• The speed of the boom up, arm in and arm out operations is decreased. • The arm, swing or travel (RH) operation cannot be performed. • The boom up cannot be operated if the EPPR is not operating properly both drive (rear) and idle (front) pump. • The relief pressure up function is disabled. • The machine cannot be driven straight ahead during travel. (it moves in a diagonal direction unintentionally.) • The relief cut-off function cannot be performed.		
Related Information	1. An error code is generated when the EPPR valve's connector is disconnected. 2. An error code can be generated if the auxiliary switch located in the rear left section of the cabin is in the "I" position. A. The auxiliary switch is designed for emergency operation in case of EPOS malfunction. It should be positioned in the "O" position in a normal condition. B. Normal outputs of pump valve 1) Not in operation: 300 ±30 mA 2) Pilot operation: up to 750 ±30 mA 3) Relief pressure up operation: 800 ±30 mA		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Auxiliary Switch Position	If the current malfunction information on the gauge panel indicates an open circuit in the proportional valve wiring.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		1. Check if the auxiliary switch located on the rear left section in the cabin is in the "I" position. 2. If the switch is in the "I" position, move it to the "O" position.
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the EPOS and valve. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the measurement is 0 Ω, this indicates a normal connection. 3. Check that the connectors of the valve and main harness are correctly connected.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and valve. A. Check the power source, ground, and signal line for any short circuit.
4	Defective EPPR Valve	1. Turn off the master switch of the machine. 2. Measure the resistance of the valve. A. Measure the resistance of the valve coil. → If the measurement is infinite, this indicates an open circuit of the coil in the valve. B. Measure the resistance of the valve coil. → If the measurement is 0 Ω, this indicates a short circuit of the coil in the valve. 1) Resistance specification: 12 Ω ±10%

Pop-ups, Warning Symbols and Indicators

Figure 13

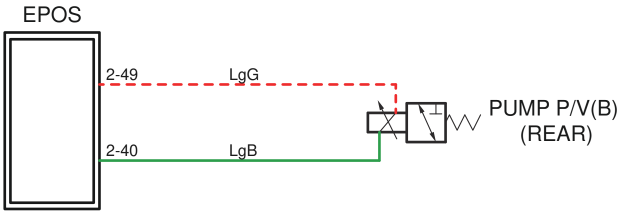


DS1902366

If the pump proportional valve malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 14



DS2002072

5. VPV004 Fan Control Proportional Valve (J)

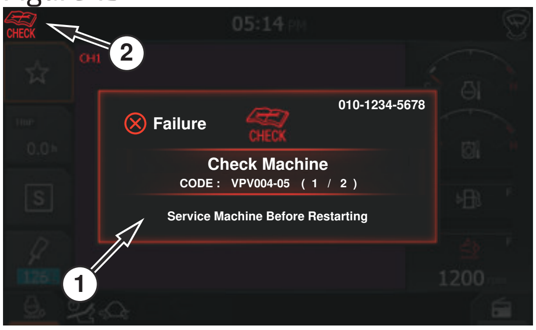
Action Level	Failure Code	Failure	Fan Control Proportional Reducing Valve (J)
Gauge Panel	VPV004		
Detail of Failure	FMI 5: Fan control proportional reducing valve (J), current below normal (open circuit). FMI 6: Fan control proportional reducing valve (J), current above normal (short circuit).		
Actions of Machine Monitor or Controller	• If the fan control proportional reducing valve (J) is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the fan control proportional reducing valve (J) is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• The fan speed cannot be controlled correctly according to changes in operating oil's temperature.		
Related Information	1. The cooling fan for preventing overheating of hydraulic oil operates at maximum performance. 2. Overheating is prevented since the fan is operating at maximum performance. However, fan noise may occur. 3. An error code is generated when the EPPR valve's connector is disconnected. A. Fan EPPR valve specifications 1) Voltage: 24 V (±20%) 2) Operating current: 50 ~ 600 mA 3) Valve coil resistance: 22.7 Ω (@20°C)		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Open Circuit in Harness	1. Turn the master switch on the machine to the "OFF" position. 2. Test for an open circuit in the harness between the EPOS and valve. A. Measure the resistance between the wirings.→ If the measured resistance is a infinite number, this indicates an open circuit. B. If the resistance between the wirings is 0 Ω, the wirings are correctly connected.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		3. Check that the connectors of the fan control proportional reducing valve and main harness are correctly connected.
2	Short Circuit in Harness	1. Turn the master switch on the machine to the "OFF" position. 2. Perform the harness short circuit test between the EPOS and valve. A. Check the power source, ground, and signal line for any short circuit.
3	Defective EPPR Valve	1. Turn the master switch on the machine to the "OFF" position. 2. Measure the resistance of the valve. A. Measure the resistance at the valve coil. → If the measured resistance is a infinite number, this indicates an open circuit of the coil in the valve. B. Measure the resistance at the valve coil. → If the measured resistance is 0 Ω, this indicates a short circuit of the coil in the valve. 1) Resistance specification: 22.7 Ω

Pop-ups, Warning Symbols and Indicators

Figure 15

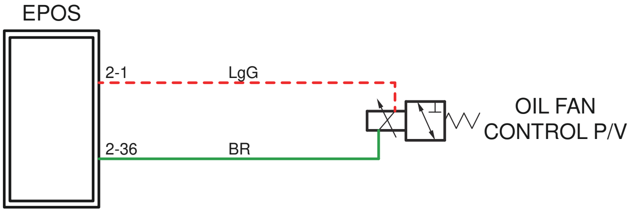


DS1901658

If the fan control proportional reducing valve malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 16



DS2002073

6. VPV025 Bypass Cut-off (A) Proportional Valve

Action Level	Failure Code	Failure	Bypass Cut-off (A) Proportional Reducing Valve
Gauge Panel	VPV025		

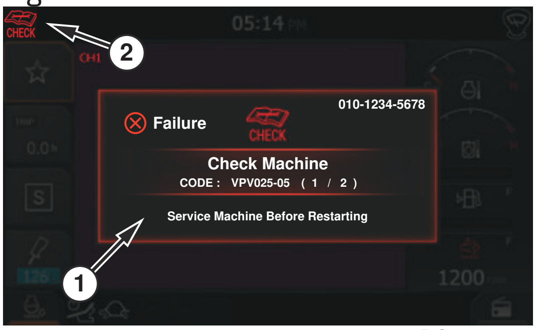
Detail of Failure	FMI 5: Bypass cut-off (A) proportional reducing valve, current below normal (open circuit). FMI 6: Bypass cut-off (A) proportional reducing valve, current above normal (short circuit).
Actions of Machine Monitor or Controller	• If the Bypass cut-off (A) proportional reducing valve is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the Bypass cut-off (A) proportional reducing valve is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.
Problem on Machine	• Arm/swing/travel (R) operations may slow down or malfunction.
Related Information	1. An error code occurs when the EPPR valve's connector is disconnected. 2. Normal output of the bypass cutoff (A) EPPR valve. A. The bypass valve opens while the engine is initially starting. 1) The bypass EPPR valve is open during engine startup (when at below 450 rpm): 0 mA 2) The bypass EPPR valve closes on the completion of engine startup (when at over 450 rpm): 600 mA B. The bypass valve opens while the engine is warming up. 1) The bypass EPPR valve is open during engine warm-up (at a coolant temperature of below 15°C): 0 mA 2) The bypass EPPR valve closes on the completion of engine warm-up (at a coolant temperature of over 15°C): 600 mA C. The bypass valve opens while the hydraulic oil is warming up. 1) The bypass EPPR valve is open during hydraulic oil warm-up using DMS: 0 mA 2) The bypass EPPR valve closes on the completion of hydraulic oil warm-up using DMS: 600 mA D. The bypass valve opens in a VBO emergency. 1) The bypass EPPR valve is open during a VBO emergency: 0 mA 2) The bypass EPPR valve stays closed when not in a VBO emergency: 600 mA

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the EPOS and valve. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		B. If the resistance between the wires measures 0 Ω, the wires are correctly connected. 3. Check that the connectors of the valve and main harness are correctly connected.
2	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and valve. A. Check the power source, ground, and signal line for any short circuit.
3	Defective EPPR Valve	1. Turn off the master switch of the machine. 2. Measure the resistance of the valve. A. Measure the resistance of the valve coil.→ If the measurement is infinite, this indicates an open circuit of the coil in the valve. B. Measure the resistance of the valve coil.→ If the measurement is 0 Ω, this indicates a short circuit of the coil in the valve. 1) Resistance specification: 5.2 Ω (@20°C ±3%)

Pop-ups, Warning Symbols and Indicators

Figure 17

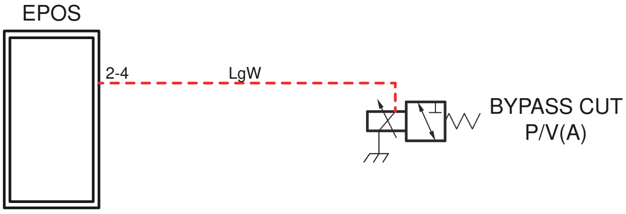


DS1902361

If the bypass cut-off (A) proportional reducing valve malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 18



DS2002074

7. VPV026 Bypass Cut-off (B) Proportional Valve

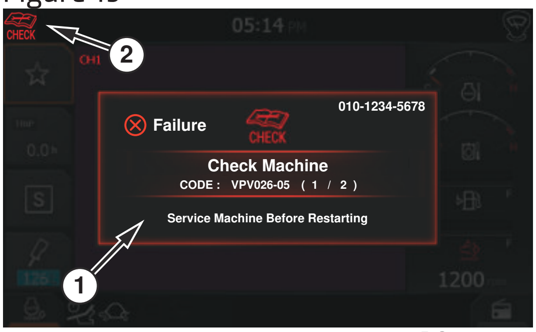
Action Level	Failure Code	Failure	Bypass Cut-off (B) Proportional Reducing Valve
Gauge Panel	VPV026		
Detail of Failure	FMI 5: Bypass cut-off (B) proportional reducing valve, current below normal (open circuit). FMI 6: Bypass cut-off (B) proportional reducing valve, current above normal (short circuit).		
Actions of Machine Monitor or Controller	• If the bypass cut-off (B) proportional reducing valve is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the bypass cut-off (B) proportional reducing valve is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• Boom/bucket/travel (L)/breaker operations may slow down or malfunction.		
Related Information	1. An error code occurs when the EPPR valve's connector is disconnected. 2. Normal output of the bypass cutoff (B) EPPR valve. A. The bypass valve opens while the engine is initially starting. 1) The bypass EPPR valve is open during engine startup (when at below 450 rpm): 0 mA 2) The bypass EPPR valve closes on the completion of engine startup (when at over 450 rpm): 600 mA B. The bypass valve opens while the engine is warming up. 1) The bypass EPPR valve is open during engine warm-up (at a coolant temperature of below 15°C): 0 mA 2) The bypass EPPR valve closes on the completion of engine warm-up (at a coolant temperature of over 15°C): 600 mA C. The bypass valve opens while the hydraulic oil is warming up. 1) The bypass EPPR valve is open during hydraulic oil warm-up using DMS: 0 mA 2) The bypass EPPR valve closes on the completion of hydraulic oil warm-up using DMS: 600 mA D. The bypass valve opens in a VBO emergency. 1) The bypass EPPR valve is open during a VBO emergency: 0 mA 2) The bypass EPPR valve stays closed when not in a VBO emergency: 600 mA		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the EPOS and valve.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected. 3. Check that the connectors of the valve and main harness are correctly connected.
2	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and valve. A. Check the power source, ground, and signal line for any short circuit.
3	Defective EPPR Valve	1. Turn off the master switch of the machine. 2. Measure the resistance of the valve. A. Measure the resistance of the valve coil. → If the measurement is infinite, this indicates an open circuit of the coil in the valve. B. Measure the resistance of the valve coil. → If the measurement is 0 Ω, this indicates a short circuit of the coil in the valve. 1) Resistance specification: 5.2 Ω (@20°C ±3%)

Pop-ups, Warning Symbols and Indicators

Figure 19

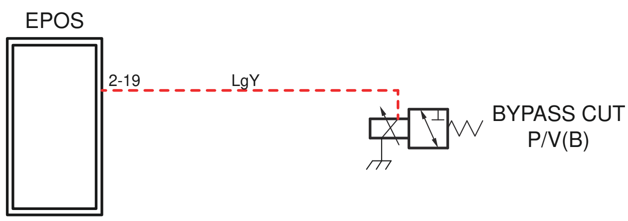


DS1902362

If the bypass cut-off (B) proportional reducing valve malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 20



DS2002075

8. VPV027 Boom Up Summation Proportional Reducing Valve

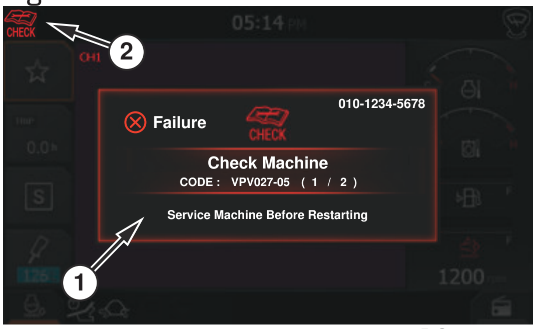
Action Level	Failure Code	Failure	Boom Up Summation Proportional Reducing Valve
Gauge Panel	VPV027		
Detail of Failure	FMI 5: Boom up summation proportional reducing valve, current below normal (open circuit). FMI 6: Boom up summation proportional reducing valve, current above normal (short circuit).		
Actions of Machine Monitor or Controller	• Boom up summation proportional reducing valve is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • Boom up summation proportional reducing valve is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• Boom up/arm crowd /bucket crowd operations may slow down or malfunction.		
Related Information	1. An error code occurs when the EPPR valve's connector is disconnected. 2. If the boom up summation proportional reducing valve is malfunctioning, EPPR valve of arm crowd summation, bucket crowd summation, arm lock and safety cutoff 2 solenoid valve are cut off.		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the EPOS and valve. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected. 3. Check that the connectors of the valve and main harness are correctly connected.
2	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and valve. A. Check the power source, ground, and signal line for any short circuit.
3	Defective EPPR Valve	1. Turn off the master switch of the machine. 2. Measure the resistance of the valve. A. Measure the resistance of the valve coil. → If the measurement is infinite, this indicates an open circuit of the coil in the valve.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		B. Measure the resistance of the valve coil. → If the measurement is 0 Ω, this indicates a short circuit of the coil in the valve. 1) Resistance specification: 5.2 Ω (@20°C ±3%)

Pop-ups, Warning Symbols and Indicators

Figure 21

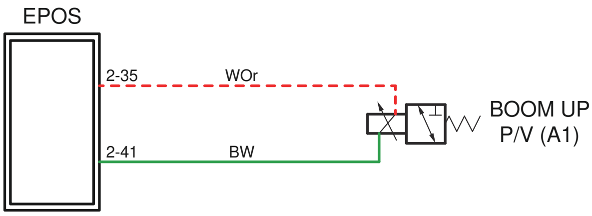


DS2002251

If the boom up summation proportional reducing valve malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 22



DS2002076

9. VPV028 Arm Crowd Summation Proportional Reducing Valve

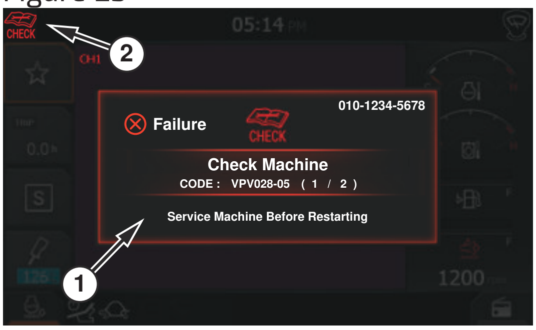
Action Level	Failure Code	Failure	Arm Crowd Summation Proportional Reducing Valve
Gauge Panel	VPV028		
Detail of Failure	FMI 5: Arm crowd summation proportional reducing valve, current below normal (open circuit). FMI 6: Arm crowd summation proportional reducing valve, current above normal (short circuit).		
Actions of Machine Monitor or Controller	• Arm crowd summation proportional reducing valve is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • Arm crowd summation proportional reducing valve is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• Boom up/arm crowd /bucket crowd operations may slow down or malfunction.		
Related Information	1. An error code occurs when the EPPR valve's connector is disconnected.		

Action Level	Failure Code	Failure	Arm Crowd Summation Proportional Reducing Valve
Gauge Panel	VPV028		
	2. If the arm crowd summation proportional reducing valve is malfunctioning, EPPR valve of boom up summation, bucket crowd summation, arm lock and safety cutoff 2 solenoid valve are cut off.		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the EPOS and valve. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected. 3. Check that the connectors of the valve and main harness are correctly connected.
2	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and valve. A. Check the power source, ground, and signal line for any short circuit.
3	Defective EPPR Valve	1. Turn off the master switch of the machine. 2. Measure the resistance of the valve. A. Measure the resistance of the valve coil. → If the measurement is infinite, this indicates an open circuit of the coil in the valve. B. Measure the resistance of the valve coil. → If the measurement is 0 Ω, this indicates a short circuit of the coil in the valve. 1) Resistance specification: 5.2 Ω (@20°C ±3%)

Pop-ups, Warning Symbols and Indicators

Figure 23

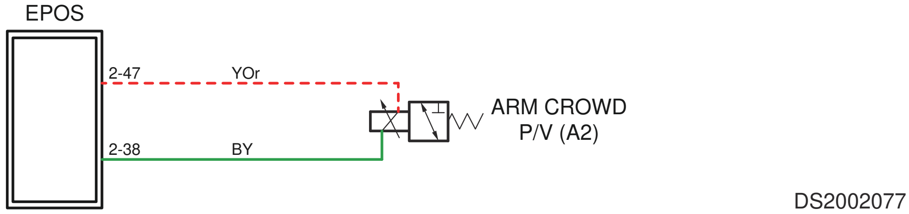


DS2002252

If the arm crowd summation proportional reducing valve malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 24



10. VPV029 Bucket Crowd Summation Proportional Reducing Valve

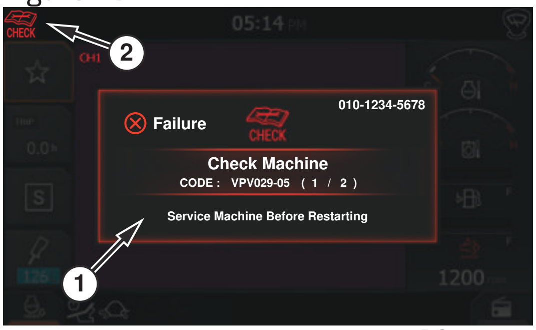
Action Level	Failure Code	Failure	Bucket Crowd Summation Proportional Reducing Valve
Gauge Panel	VPV029		
Detail of Failure	FMI 5: Bucket crowd summation proportional reducing valve, current below normal (open circuit). FMI 6: Bucket crowd summation proportional reducing valve, current above normal (short circuit).		
Actions of Machine Monitor or Controller	• Bucket crowd summation proportional reducing valve is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • Bucket crowd summation proportional reducing valve is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• Boom up/arm crowd /bucket crowd operations may slow down or malfunction.		
Related Information	1. An error code occurs when the EPPR valve's connector is disconnected. 2. If the bucket crowd summation proportional reducing valve is malfunctioning, EPPR valve of boom up summation, arm crowd summation, arm lock and safety cutoff 2 solenoid valve are cut off.		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the EPOS and valve. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected. 3. Check that the connectors of the valve and main harness are correctly connected.
2	Short Circuit in Harness	1. Turn off the master switch of the machine.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		2. Perform the harness short circuit test between the EPOS and valve. A. Check the power source, ground, and signal line for any short circuit.
3	Defective EPPR Valve	1. Turn off the master switch of the machine. 2. Measure the resistance of the valve. A. Measure the resistance of the valve coil. → If the measurement is infinite, this indicates an open circuit of the coil in the valve. B. Measure the resistance of the valve coil. → If the measurement is 0 Ω, this indicates a short circuit of the coil in the valve. 1) Resistance specification: 5.2 Ω (@20°C ±3%)

Pop-ups, Warning Symbols and Indicators

Figure 25

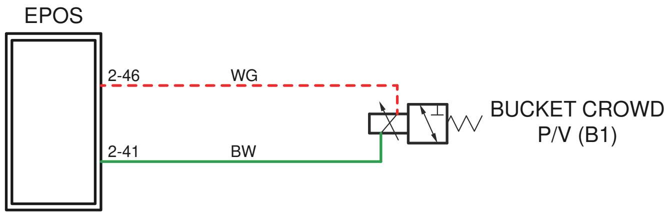


DS2002253

If the bucket crowd summation proportional reducing valve malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 26



DS2002079

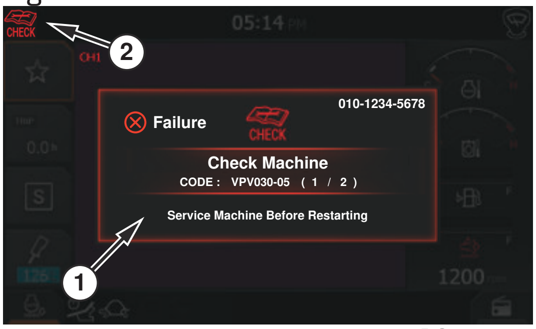
11. VPV030 Arm Lock Proportional Reducing Valve

Action Level	Failure Code	Failure	Arm Lock Proportional Reducing Valve
Gauge Panel	VPV030		
Detail of Failure	FMI 5: Arm lock proportional reducing valve, current below normal (open circuit). FMI 6: Arm lock proportional reducing valve, current above normal (short circuit).		

Action Level	Failure Code	Failure	Arm Lock Proportional Reducing Valve
Gauge Panel	VPV030		
Actions of Machine Monitor or Controller	• Arm lock proportional reducing valve is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • Arm lock proportional reducing valve is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• When the arm is operating, the operating speed may slow down or malfunction. • Boom up/arm crowd /bucket crowd operations may slow down or malfunction.		
Related Information	1. An error code occurs when the EPPR valve's connector is disconnected. 2. If the arm lock proportional reducing valve is malfunctioning, EPPR valve of boom up summation, arm crowd summation, bucket crowd and safety cutoff 2 solenoid valve are cut off.		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the EPOS and valve. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected. 3. Check that the connectors of the valve and main harness are correctly connected.
2	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and valve. A. Check the power source, ground, and signal line for any short circuit.
3	Defective EPPR Valve	1. Turn off the master switch of the machine. 2. Measure the resistance of the valve. A. Measure the resistance of the valve coil. → If the measurement is infinite, this indicates an open circuit of the coil in the valve. B. Measure the resistance of the valve coil. → If the measurement is 0 Ω, this indicates a short circuit of the coil in the valve. 1) Resistance specification: 5.2 Ω (@20°C ±3%)

Figure 27

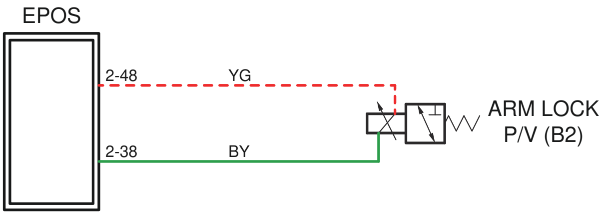


DS2002254

If the arm lock proportional reducing valve malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 28



DS2002078

12. VSV001 Breaker Operating Solenoid Valve

Action Level	Failure Code	Failure	Breaker Operating Solenoid Valve
Gauge Panel	VSV001		
Detail of Failure	The failure occurs only when the one-way is mounted. FMI 5: Breaker operating solenoid valve, current below normal (open circuit). FMI 6: Breaker operating solenoid valve, current above normal (short circuit).		
Actions of Machine Monitor or Controller	• If the breaker operating solenoid valve is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the breaker operating solenoid valve is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• The breaker won't operate when pressing the breaker operation switch (pedal) after selecting the breaker mode.		
Related Information	1. The solenoid valve won't operate if the negative (-) line of the solenoid valve is not connected with ground. 2. The solenoid valve won't operate if the connector of the solenoid valve is not correctly connected. 3. The solenoid valve won't operate if the signal line to the EPOS is not connected to the solenoid valve. A. Features of solenoid valve: 1) Voltage: 24 V DC ±10%		

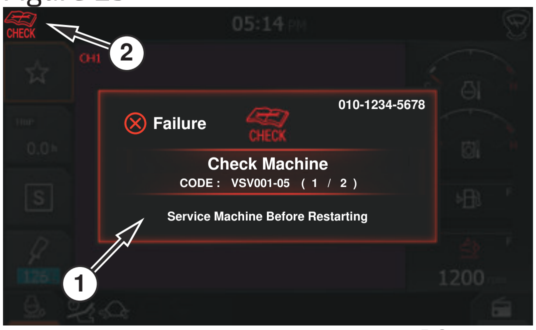
Action Level	Failure Code	Failure	Breaker Operating Solenoid Valve
Gauge Panel	VSV001		
	2) Power consumption: 22 W at 25°C 3) Current amp.: 0.84 A ±5% 4) Resistance: 27.6 Ω ±5%		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Connector Connection	If the real time failure Information on the gauge panel indicates an open circuit in the solenoid valve wiring: 1. Check whether the connector of the solenoid valve is connected correctly. A. Improperly fit connector
2	Faulty Solenoid Ground Connection	1. Check whether the (-) terminal of the solenoid valve is properly grounded.
3	Open Circuit In Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the ground and solenoid valve (-) terminal. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the EPOS and solenoid valve (+) terminal. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct.
4	Short Circuit In Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the relevant terminal of the EPOS connector and the (+) terminal of the solenoid valve connector.
5	Faulty Solenoid	1. Turn off the master switch of the machine. 2. Measure the resistance of the solenoid valve. A. Measure the resistance of the valve coil.→ If the measurement is infinite, this indicates an open circuit of the coil in the valve. B. Measure the resistance of the valve coil.→ If the measurement is 0 Ω, this indicates a short circuit of the coil in the valve. 1) Resistance specification: 27.6 Ω±5%
6	Faulty EPOS	If the harness is correctly connected:

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		1. Check if the solenoid command signal of the EPOS is correctly applied. 2. Check if the voltage of the (+) terminal of its solenoid valve measures 0 ~ 4.75 V when breaker is not operating. 3. Check if the voltage of the (+) terminal of its solenoid valve measures 24 V when breaker is operating. 4. If the voltage at the (+) terminal of the solenoid valve measures constant at 24 V or 0 V, the EPOS is faulty and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 29

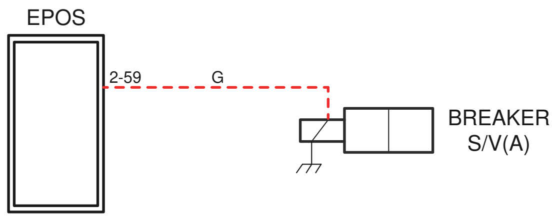


DS1901665

If the breaker solenoid valve malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 30



DS2002106

13. VSV003 High-speed Solenoid Valve (C)

Action Level	Failure Code	Failure	High-speed Solenoid Valve
Gauge Panel	VSV003		
Detail of Failure	FMI 5: High-speed solenoid valve (C), current below normal (open circuit). FMI 6: High-speed solenoid valve (C), current above normal (short circuit).		
Actions of Machine Monitor or Controller	• If the high-speed solenoid valve is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the high-speed solenoid valve is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		

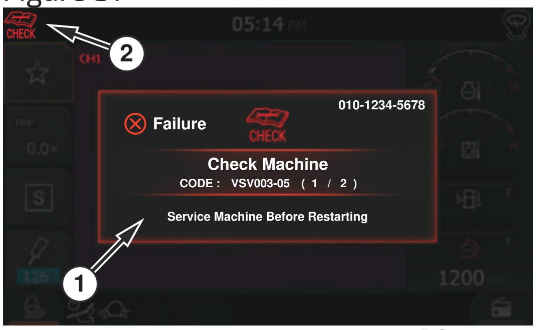
Action Level	Failure Code	Failure	High-speed Solenoid Valve
Gauge Panel	VSV003		
Problem on Machine	• Even after high-speed mode is selected for equipment traveling, high-speed traveling does not work.		
Related Information	1. The solenoid valve won't operate if the negative (-) line of the solenoid valve is not connected with ground. 2. The solenoid valve won't operate if the connector of the solenoid valve is not correctly connected. 3. The solenoid valve won't operate if the signal line to the EPOS is not connected to the solenoid valve. A. Features of the solenoid valve: 1) Voltage: 24 VDC ±10% 2) Power Consumption: 22 W at 25°C 3) Current AMP.: 0.84 A ±5% 4) Resistance: 27.6 Ω ±5%		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Connector Connection	If the real time failure information on the gauge panel indicates an open circuit in the solenoid valve wiring: 1. Check whether the connector of the solenoid valve is connected correctly. A. Improperly fit connector
2	Faulty Solenoid Ground Connection	1. Check whether the (-) terminal of the solenoid valve is properly grounded.
3	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the ground and solenoid valve (-) terminal. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the EPOS and solenoid valve (+) terminal. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct.
4	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the relevant terminal of the EPOS connector and the (+) terminal of the solenoid valve connector.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
5	Faulty Solenoid	1. Turn off the master switch of the machine. 2. Measure the resistance of the solenoid valve. A. Measure the resistance of the valve coil.→ If the measurement is infinite, this indicates an open circuit of the coil in the valve. B. Measure the resistance of the valve coil.→ If the measurement is 0 Ω, this indicates a short circuit of the coil in the valve. 1) Resistance specification: 27.6 Ω ±5%
6	Faulty EPOS	If the harness is correctly connected: 1. Check if the solenoid command signal of the EPOS is correctly applied. 2. Check if the voltage of the (+) terminal of its solenoid valve measures 0 ~ 4.75 V when high-speed function is not operating. 3. Check if the voltage of the (+) terminal of its solenoid valve measures 24 V when high-speed function is operating. 4. If the voltage at the (+) terminal of the solenoid valve measures constant at 24 V or 0 V, the EPOS is faulty and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 31

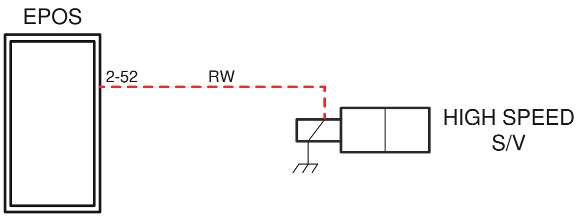


DS1901667

If the high-speed solenoid valve malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 32



DS2002107

14. VSV004 Reverse Fan Solenoid Valve

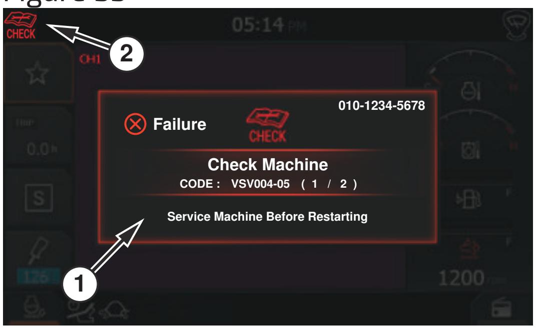
Action Level	Failure Code	Failure	Reverse Fan Solenoid Valve
Gauge Panel	VSV004		
Detail of Failure	FMI 5: Reverse fan solenoid valve, current below normal (open circuit) FMI 6: Reverse fan solenoid valve, current above normal (short circuit)		
Actions of Machine Monitor or Controller	• If the reverse fan solenoid valve is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the reverse fan solenoid valve is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• When the reverse fan switch is pressed to shake off the dust on the radiator, the cooling fan does not rotate in the reverse direction, and thus the dust on the radiator cannot be shaken off.		
Related Information	1. The solenoid valve won't operate if the negative (-) line of the solenoid valve is connected with ground. 2. The solenoid valve won't operate if the connector of the solenoid valve is not correctly connected. 3. The solenoid valve won't operate if the signal line to the EPOS is not connected to the solenoid valve. A. Features of solenoid valve: 1) Voltage: 24 VDC ±15% 2) Power consumption: 22 W at 25°C 3) Current amp.: 0.84 A ±5% 4) Resistance: 27.6 Ω ±5%		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Connector Connection	If the real time failure information on the gauge panel indicates an open circuit in the solenoid valve wiring: 1. Check whether the connector of the solenoid valve is connected correctly. A. Improperly fit connector
2	Faulty Solenoid Ground Connection	1. Check whether the (-) terminal of the solenoid valve is properly grounded.
3	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the ground and solenoid valve (-) terminal. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		3. Test for an open circuit in the harness between the EPOS and solenoid valve (+) terminal. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct.
4	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the relevant terminal of the EPOS connector and the (+) terminal of the solenoid valve connector.
5	Faulty Solenoid	1. Turn off the master switch of the machine. 2. Measure the resistance of the solenoid valve. A. Measure the resistance of the valve coil. → If the measurement is infinite, this indicates an open circuit of the coil in the valve. B. Measure the resistance of the valve coil. → If the measurement is 0 Ω, this indicates a short circuit of the coil in the valve. 1) Resistance specification: 27.6 Ω ±5%
6	Faulty EPOS	If the harness is correctly connected: 1. Check if the solenoid command signal of the EPOS is correctly applied. 2. Check if the voltage of the (+) terminal of its solenoid valve measures 0 ˜ 4.75 V when reverse fan is not operating. 3. Check if the voltage of the (+) terminal of its solenoid valve measures 24 V when reverse fan is operating. 4. If the voltage at the (+) terminal of the solenoid valve measures constant at 24 V or 0 V, the EPOS is faulty and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 33

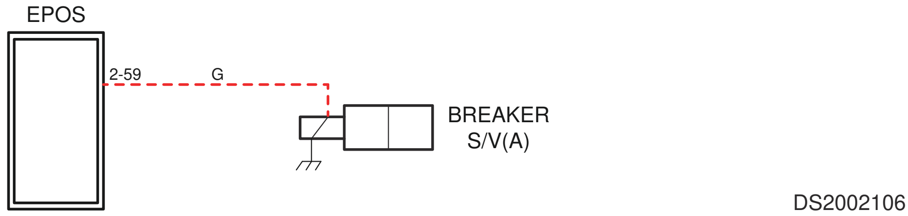


DS1903584

If the reverse fan Solenoid Valve malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 34



15. VSV006 Swing Brake Release Solenoid Valve (K)

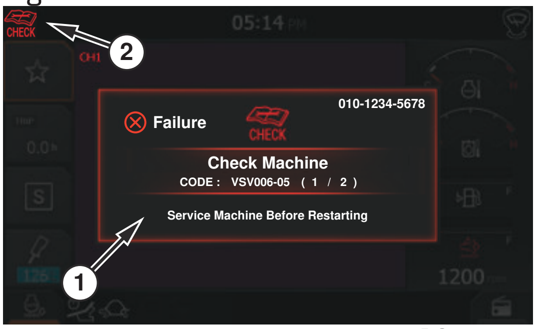
Action Level	Failure Code	Failure	Swing Brake Release Solenoid Valve (K)
Gauge Panel	VSV006		
Detail of Failure	FMI 5: Swing brake release solenoid valve (K), current below normal (open circuit). FMI 6: Swing brake release solenoid valve (K), current above normal (short circuit).		
Actions of Machine Monitor or Controller	• If the swing brake release solenoid valve is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the swing brake release solenoid valve is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• The swing function may not be operated at all or may be operated abnormally.		
Related Information	1. The solenoid valve won't operate if the nagative (-) line of the solenoid valve is connected with ground. 2. The solenoid valve won't operate if the connector of the solenoid valve is not correctly connected. 3. The solenoid valve won't operate if the signal line to the EPOS is not connected to the solenoid valve. A. Features of solenoid valve: 1) Voltage: 24 VDC ±15% 2) Resistance: 28.5 Ω ±5%		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Connector Connection	If the real time failure information on the gauge panel indicates an open circuit in the solenoid valve wiring: 1. Check whether the connector of the solenoid valve is connected correctly. A. Improperly fit connector
2	Faulty Solenoid Ground Connection	1. Check whether the (-) terminal of the solenoid valve is properly grounded.
3	Open Circuit in Harness	1. Turn off the master switch of the machine.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		2. Test for an open circuit in the harness between the ground and solenoid valve (-) terminal. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the EPOS and solenoid valve (+) terminal. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct.
4	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the relevant terminal of the EPOS connector and the (+) terminal of the solenoid valve connector.
5	Faulty Solenoid	1. Turn off the master switch of the machine. 2. Measure the resistance of the solenoid valve. A. Measure the resistance of the valve coil. → If the measurement is infinite, this indicates an open circuit of the coil in the valve. B. Measure the resistance of the valve coil. → If the measurement is 0 Ω, this indicates a short circuit of the coil in the valve. 1) Resistance specification: 28.5 Ω ±5%
6	Faulty EPOS	If the harness is correctly connected: 1. Check if the solenoid command signal of the EPOS is correctly applied. 2. Check if the voltage of the (+) terminal of its solenoid valve measures 0 ~ 4.75 V when swing brake release is not operating. 3. Check if the voltage of the (+) terminal of its solenoid valve measures 24 V when swing brake release is operating. 4. If the voltage at the (+) terminal of the solenoid valve measures constant at 24 V or 0 V, the EPOS is faulty and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 35

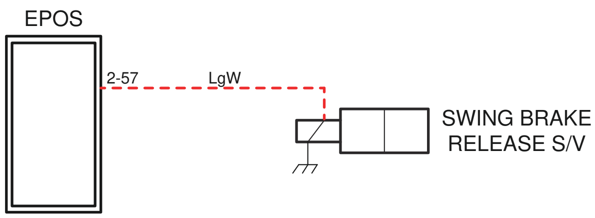


DS1902363

If the swing brake release solenoid valve (K) malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 36



DS2002109

16. VSV007 Option Safety Solenoid Valve

Action Level	Failure Code	Failure	Option Safety Solenoid Valve
Gauge Panel	VSV007		
Detail of Failure	The failure occurs only when the two-way and hydraulic pedal are mounted. FMI 5: Option safety solenoid valve, current below normal (open circuit). FMI 6: Option safety solenoid valve, current above normal (short circuit).		
Actions of Machine Monitor or Controller	• If the option pedal safety solenoid valve is malfunctioning, the "Check machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the option pedal safety solenoid is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• The attachment function may be operated abnormally or may not be operated at all if the option pedal safety solenoid valve is defective. • The option pedal function may be operated abnormally if the Two-way pedal safety solenoid valve is defective.		
Related Information	1. The solenoid valve won't operate if the negative (-) line of the solenoid valve is not connected with ground. 2. The solenoid valve won't operate if the connector of the solenoid valve is not correctly connected.		

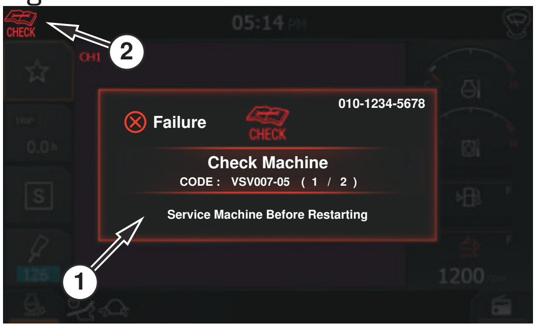
Action Level	Failure Code	Failure	Option Safety Solenoid Valve
Gauge Panel	VSV007		
	3. The solenoid valve won't operate if the signal line to the EPOS is not connected to the solenoid valve. A. Features of solenoid valve: 1) Voltage: 24 V DC ±10% 2) Power consumption: 22 W at 25°C 3) Current amp.: 0.84 A ±5% 4) Resistance: 27.6 Ω ±5%		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Connector Connection	If the real time failure information on the gauge panel indicates an open circuit in the solenoid valve wiring: 1. Check whether the connector of the solenoid valve is connected correctly. A. Improperly fit connector
2	Faulty Solenoid Ground Connection	1. Check whether the (-) terminal of the solenoid valve is properly grounded.
3	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the ground and solenoid valve (-) terminal. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the EPOS and solenoid valve (+) terminal. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct.
4	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the relevant terminal of the EPOS connector and the (+) terminal of the solenoid valve connector.
5	Faulty Solenoid	1. Turn off the master switch of the machine. 2. Measure the resistance of the solenoid valve. A. Measure the resistance of the valve coil.→ If the measurement is infinite, this indicates an open circuit of the coil in the valve.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		B. Measure the resistance of the valve coil.→ If the measurement is 0 Ω, this indicates a short circuit of the coil in the valve. 1) Resistance specification: 27.6 Ω ±5%
6	Faulty EPOS	If the harness is correctly connected: 1. Check if the solenoid command signal of the EPOS is correctly applied. 2. Check if the voltage of the (+) terminal of its solenoid valve measures 0 ~ 4.75 V when two-way option pedal function is not operating. 3. Check if the voltage of the (+) terminal of its solenoid valve measures 24 V when two-way option pedal function is operating. 4. If the voltage at the (+) terminal of the solenoid valve measures constant at 24 V or 0 V, the EPOS is faulty and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 37

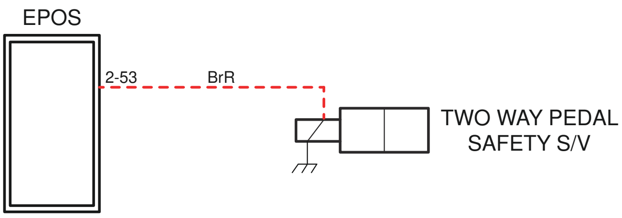


DS1901668

If the option safety solenoid valve malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 38



DS2002110

17. VSV011 2 Pump Select Solenoid Valve (I)

Action Level	Failure Code	Failure	2 Pump Select Solenoid Valve (I)
Gauge Panel	VSV011		
Detail of Failure	FMI 5: Two-pump select solenoid valve, current below normal (open circuit).		

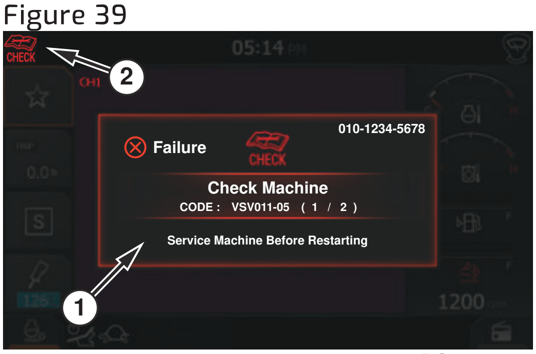
Action Level	Failure Code	Failure	2 Pump Select Solenoid Valve (I)
Gauge Panel	VSV011		
	FMI 6: Two-pump select solenoid valve, current above normal (short circuit).		
Actions of Machine Monitor or Controller	• If the two-pump select solenoid valve is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the two-pump select solenoid valve is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• Two-pump summation does not work in two-pump option equipped.		
Related Information	1. In a machine equipped with the two-pump option, the two-pump select solenoid valve is actuated when the set flow rate for the attachment exceeds the capacity of a single pump. 2. The solenoid valve won't operate if the negative (-) line of the solenoid valve is not connected with ground. 3. The solenoid valve won't operate if the connector of the solenoid valve is not correctly connected. 4. The solenoid valve won't operate if the signal line to the EPOS is not connected to the solenoid valve. A. Features of solenoid valve: 1) Voltage: 24 V DC ±10% 2) Power consumption: 22 W at 25°C 3) Current amp.: 0.84 A ±5% 4) Resistance: 27.6 Ω ±5%		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Connector Connection	If the real time failure information on the gauge panel indicates an open circuit in the solenoid valve wiring: 1. Check whether the connector of the solenoid valve is connected correctly. A. Improperly fit connector
2	Faulty Solenoid Ground Connection	1. Check whether the (-) terminal of the solenoid valve is properly grounded.
3	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the ground and solenoid valve (-) terminal. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the EPOS and solenoid valve (+) terminal.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct.
4	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the relevant terminal of the EPOS connector and the (+) terminal of the solenoid valve connector.
5	Faulty Solenoid	1. Turn off the master switch of the machine. 2. Measure the resistance of the solenoid valve. A. Measure the resistance of the valve coil. → If the measurement is infinite, this indicates an open circuit of the coil in the valve. B. Measure the resistance of the valve coil. → If the measurement is 0 Ω, this indicates a short circuit of the coil in the valve. 1) Resistance specification: 27.6 Ω ±5%
6	Faulty EPOS	If the harness is correctly connected: 1. Check if the solenoid command signal of the EPOS is correctly applied. 2. Check if the voltage of the (+) terminal of its solenoid valve measures 0 V ~ 4.75 V when two-pump summation function is not operating. 3. Check if the voltage of the (+) terminal of its solenoid valve measures 24 V when two-pump summation function is operating. 4. If the voltage at the (+) terminal of the solenoid valve measures constant at 24 V or 0 V, the EPOS is faulty and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 39

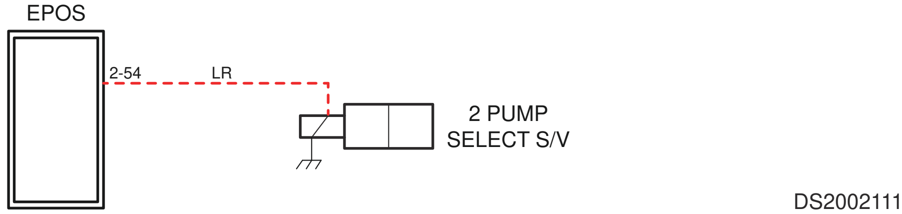


DS1901669

If the two-pump select solenoid valve malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 40



18. VSV018 Two Way RH-Open Solenoid Valve

Action Level	Failure Code	Failure	Two Way RH-Open Solenoid Valve
Gauge Panel	VSV018		
Detail of Failure	FMI 5: Two way RH-open solenoid valve, current below normal (open circuit). FMI 6: Two way RH-open solenoid valve, current above normal (short circuit).		
Actions of Machine Monitor or Controller	• If the two way RH-open solenoid valve is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the two way RH-open solenoid valve is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• The two way attachment opening operation may be operated abnormally or may not be operated at all if the two way RH-open solenoid valve is defective.		
Related Information	1. The solenoid valve won't operate if the negative (-) line of the solenoid valve is not connected with ground. 2. The solenoid valve won't operate if the connector of the solenoid valve is not correctly connected. 3. The solenoid valve won't operate if the signal line to the EPOS is not connected to the solenoid valve. A. Features of solenoid valve: 1) Voltage: 24 V DC ±10% 2) Power consumption: 22 W at 25°C 3) Current amp.: 0.84 A ±5% 4) Resistance: 27.6 Ω ±5%		

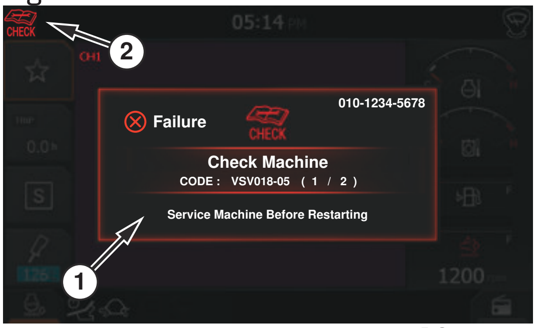
No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Connector Connection	If the real time failure information on the gauge panel indicates an open circuit in the solenoid valve wiring: 1. Check whether the connector of the solenoid valve is connected correctly. A. Improperly fit connector

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
2	Faulty Solenoid Ground Connection	1. Check whether the (-) terminal of the solenoid valve is properly grounded.
3	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the ground and solenoid valve (-) terminal. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the EPOS and solenoid valve (+) terminal. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct.
4	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the relevant terminal of the EPOS connector and the (+) terminal of the solenoid valve connector.
5	Faulty Solenoid	1. Turn off the master switch of the machine. 2. Measure the resistance of the solenoid valve. A. Measure the resistance of the valve coil. → If the measurement is infinite, this indicates an open circuit of the coil in the valve. B. Measure the resistance of the valve coil. → If the measurement is 0 Ω, this indicates a short circuit of the coil in the valve. 1) Resistance specification: 27.6 Ω ±5%
6	Faulty EPOS	If the harness is correctly connected: 1. Check if the solenoid command signal of the EPOS is correctly applied. 2. Check if the voltage of the (+) terminal of its solenoid valve measures 0 ~ 4.75 V when the operation type is not selected with the joystick after selecting the two way function or the two way function is not selected. 3. Check if the voltage of the (+) terminal of its solenoid valve measures 24 V when the two way joystick button (open) is pressed after two way function is selected and the operation type is selected with the joystick.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		4. If the voltage at the (+) terminal of the solenoid valve measures constant at 24 V or 0 V, the EPOS is faulty and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 41

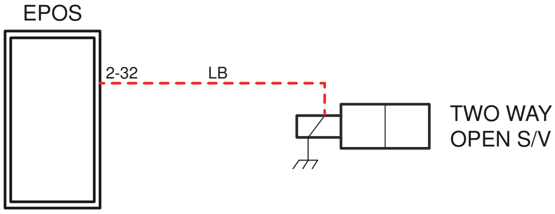


DS2002255

If the two way RH-open solenoid valve malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 42



DS2002114

19. VSV019 Two Way RH-Close Solenoid Valve

Action Level	Failure Code	Failure	Two Way RH-Close Solenoid Valve
Gauge Panel	VSV019		
Detail of Failure	FMI 5: Two way RH-close solenoid valve, current below normal (open circuit). FMI 6: Two way RH-close solenoid valve, current above normal (short circuit).		
Actions of Machine Monitor or Controller	• If the two way RH-close solenoid valve is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the two way RH-close solenoid valve is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• The Two way attachment opening operation may be operated abnormally or may not be operated at all if the two way RH-close solenoid valve is defective.		
Related Information	1. The solenoid valve won't operate if the negative (-) line of the solenoid valve is not connected with ground.		

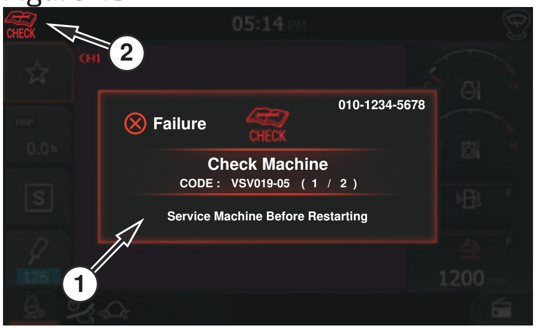
Action Level	Failure Code	Failure	Two Way RH-Close Solenoid Valve
Gauge Panel	VSV019		
	2. The solenoid valve won't operate if the connector of the solenoid valve is not correctly connected. 3. The solenoid valve won't operate if the signal line to the EPOS is not connected to the solenoid valve. A. Features of solenoid valve: 1) Voltage: 24 V DC ±10% 2) Power consumption: 22 W at 25°C 3) Current amp.: 0.84 A ±5% 4) Resistance: 27.6 Ω ±5%		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Connector Connection	If the real time failure information on the gauge panel indicates an open circuit in the solenoid valve wiring: 1. Check whether the connector of the solenoid valve is connected correctly. A. Improperly fit connector
2	Faulty Solenoid Ground Connection	1. Check whether the (-) terminal of the solenoid valve is properly grounded.
3	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the ground and solenoid valve (-) terminal. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the EPOS and solenoid valve (+) terminal. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct.
4	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the relevant terminal of the EPOS connector and the (+) terminal of the solenoid valve connector.
5	Faulty Solenoid	1. Turn off the master switch of the machine. 2. Measure the resistance of the solenoid valve. A. Measure the resistance of the valve coil. → If the measurement is infinite, this indicates an open circuit of the coil in the valve.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		B. Measure the resistance of the valve coil. → If the measurement is 0 Ω, this indicates a short circuit of the coil in the valve. 1) Resistance specification: 27.6 Ω ±5%
6	Faulty EPOS	If the harness is correctly connected: 1. Check if the solenoid command signal of the EPOS is correctly applied. 2. Check if the voltage of the (+) terminal of its solenoid valve measures 0 ~ 4.75 V when the operation type is not selected with the joystick after selecting the two way function or the two way function is not selected. 3. Check if the voltage of the (+) terminal of its solenoid valve measures 24 V when the two way joystick button (Close) is pressed after two way function is selected and the operation type is selected with the joystick. 4. If the voltage at the (+) terminal of the solenoid valve measures constant at 24 V or 0 V, the EPOS is faulty and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 43

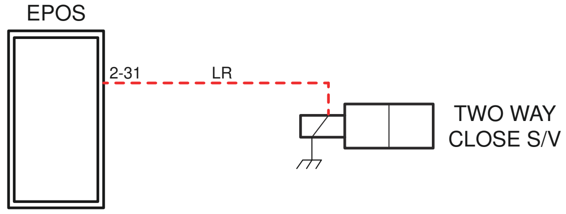


DS2002256

If the two way RH-close solenoid valve malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 44



DS2002113

20. VSV020 Breaker Select Solenoid Valve

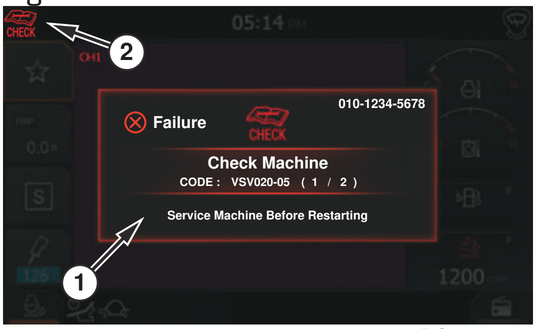
Action Level	Failure Code	Failure	Breaker Select Solenoid Valve
Gauge Panel	VSV020		
Detail of Failure	FMI 5: Breaker select solenoid valve, current below normal (open circuit). FMI 6: Breaker select solenoid valve, current above normal (short circuit).		
Actions of Machine Monitor or Controller	• If the breaker select solenoid valve is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the breaker select solenoid valve is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• When the breaker option mode is in operation, the operation of the breaker may be slowed down or the hitting force may be degraded. (This error occurs when the machine is operated in a breaker mode on a two way option is equipped.)		
Related Information	1. The breaker select solenoid valve is only applied to two way option machine. 2. The solenoid valve won't operate if the negative (-) line of the solenoid valve is not connected with ground. 3. The solenoid valve won't operate if the connector of the solenoid valve is not correctly connected. 4. The solenoid valve won't operate if the signal line to the EPOS is not connected to the solenoid valve. A. Features of solenoid valve: 1) Voltage: 24 V DC ±10% 2) Power consumption: 22 W at 25°C 3) Current amp.: 0.84 A ±5% 4) Resistance: 27.6 Ω ±5%		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Connector Connection	If the real time failure information on the gauge panel indicates an open circuit in the solenoid valve wiring: 1. Check whether the connector of the solenoid valve is connected correctly. A. Improperly fit connector
2	Faulty Solenoid Ground Connection	1. Check whether the (-) terminal of the solenoid valve is properly grounded.
3	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the ground and solenoid valve (-) terminal. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the EPOS and solenoid valve (+) terminal. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct.
4	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the relevant terminal of the EPOS connector and the (+) terminal of the solenoid valve connector.
5	Faulty Solenoid	1. Turn off the master switch of the machine. 2. Measure the resistance of the solenoid valve. A. Measure the resistance of the valve coil. → If the measurement is infinite, this indicates an open circuit of the coil in the valve. B. Measure the resistance of the valve coil. → If the measurement is 0 Ω, this indicates a short circuit of the coil in the valve. 1) Resistance specification: 27.6 Ω ±5%
6	Faulty EPOS	If the harness is correctly connected: 1. Check if the solenoid command signal of the EPOS is correctly applied. 2. Check if the voltage of the (+) terminal of its solenoid valve measures 0 ~ 4.75 V when the breaker mode is not selected in the machine equipped with two way option. 3. Check if the voltage of the (+) terminal of its solenoid valve measures 24 V when the breaker mode is selected in the machine equipped with two way option. 4. If the voltage at the (+) terminal of the solenoid valve measures constant at 24 V or 0 V, the EPOS is faulty and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 45

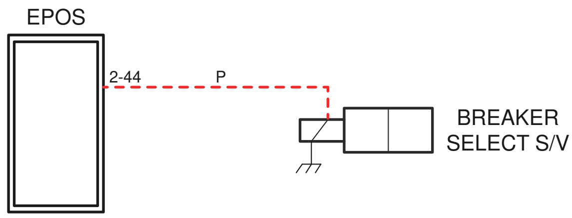


DS2002257

If the breaker select solenoid valve malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 46



DS2002115

21. VSV034 Travel Straight Solenoid Valve

Action Level	Failure Code	Failure	Travel Straight Solenoid Valve
Gauge Panel	VSV034		
Detail of Failure	FMI 5: Travel straight solenoid valve, current below normal (open circuit). FMI 6: Breaker select solenoid valve, current above normal (short circuit).		
Actions of Machine Monitor or Controller	• If the travel straight solenoid valve is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the travel straight solenoid valve is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• The machine cannot be driven straight ahead during travel. (it moves in a diagonal direction unintentionally.) • An error occurs while travel operation.		
Related Information	1. The solenoid valve won't operate if the negative (-) line of the solenoid valve is not connected with ground. 2. The solenoid valve won't operate if the connector of the solenoid valve is not correctly connected. 3. The solenoid valve won't operate if the signal line to the EPOS is not connected to the solenoid valve. A. Features of solenoid valve: 1) Voltage: 24 V DC ±10%		

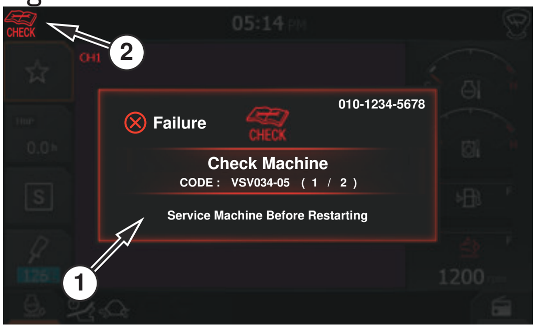
Action Level	Failure Code	Failure	Travel Straight Solenoid Valve
Gauge Panel	VSV034		
	2) Power consumption: 22 W at 25°C 3) Current amp.: 0.84 A ±5% 4) Resistance: 27.6 Ω ±5%		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Connector Connection	If the real time failure information on the gauge panel indicates an open circuit in the solenoid valve wiring: 1. Check whether the connector of the solenoid valve is connected correctly. A. Improperly fit connector
2	Faulty Solenoid Ground Connection	1. Check whether the (-) terminal of the solenoid valve is properly grounded.
3	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the ground and solenoid valve (-) terminal. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the EPOS and solenoid valve (+) terminal. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct.
4	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the relevant terminal of the EPOS connector and the (+) terminal of the solenoid valve connector.
5	Faulty Solenoid	1. Turn off the master switch of the machine. 2. Measure the resistance of the solenoid valve. A. Measure the resistance of the valve coil. → If the measurement is infinite, this indicates an open circuit of the coil in the valve. B. Measure the resistance of the valve coil. → If the measurement is 0 Ω, this indicates a short circuit of the coil in the valve. 1) Resistance specification: 27.6 Ω ±5%
6	Faulty EPOS	If the harness is correctly connected:

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		1. Check if the solenoid command signal of the EPOS is correctly applied. 2. Turn off the travel straight function whether the voltage at the (+) terminal of the solenoid valve measures between 0 ~ 4.75 V. 3. Turn on the travel straight function and check whether the voltage at the (+) terminal of the solenoid valve measures 24 V. 4. If the voltage at the (+) terminal of the solenoid valve measures constant at 24 V or 0 V, the EPOS is faulty and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 47

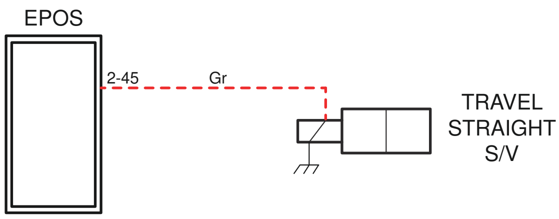


DS2002258

If the travel straight solenoid valve malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 48



DS2002116

22. VSV035 Free Boom Up Solenoid Valve

Action Level	Failure Code	Failure	Free Boom Up Solenoid Valve
Gauge Panel	VSV035		
Detail of Failure	FMI 5: Free boom up solenoid valve, current below normal (open circuit). FMI 6: Free boom up solenoid valve, current above normal (short circuit).		
Actions of Machine Monitor or Controller	• If the free boom up solenoid valve is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the free boom up solenoid valve is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		

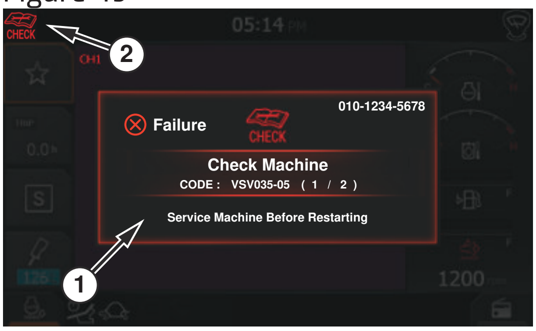
Action Level	Failure Code	Failure	Free Boom Up Solenoid Valve
Gauge Panel	VSV035		
Problem on Machine	• The Intelligent floating boom function may be operated abnormally or may not be operated at all if the free boom up solenoid valve is defective.		
Related Information	1. The solenoid valve won't operate if the negative (-) line of the solenoid valve is not connected with ground. 2. The solenoid valve won't operate if the connector of the solenoid valve is not correctly connected. 3. The solenoid valve won't operate if the signal line to the EPOS is not connected to the solenoid valve. A. Features of the solenoid valve. 1) Voltage: 24 VDC ±10% 2) Power Consumption: 22 W at 25°C 3) Current AMP.: 0.84 A ±5% 4) Resistance: 27.6 Ω ±5%		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Connector Connection	If the real time failure information on the gauge panel indicates an open circuit in the solenoid valve wiring: 1. Check whether the connector of the solenoid valve is connected correctly. A. Improperly fit connector
2	Faulty Solenoid Ground Connection	1. Check whether the (-) terminal of the solenoid valve is properly grounded.
3	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the ground and solenoid valve (-) terminal. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the EPOS and solenoid valve (+) terminal. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct.
4	Short Circuit in Harness	1. Turn off the master switch of the machine.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		2. Perform the harness short circuit test between the relevant terminal of the EPOS connector and the (+) terminal of the solenoid valve connector.
5	Faulty Solenoid	1. Turn off the master switch of the machine. 2. Measure the resistance of the solenoid valve. A. Measure the resistance of the valve coil.→ If the measurement is infinite, this indicates an open circuit of the coil in the valve. B. Measure the resistance of the valve coil.→ If the measurement is 0 Ω, this indicates a short circuit of the coil in the valve. 1) Resistance specification: 27.6 Ω ±5%
6	Faulty EPOS	If the harness is correctly connected: 1. Check if the solenoid command signal of the EPOS is correctly applied. 2. Check if the voltage of the (+) terminal of its solenoid valve measures 0 ~ 4.75 V when free boom up function is not operating. 3. Check if the voltage of the (+) terminal of its solenoid valve measures 24 V when free boom up function is operating. 4. If the voltage at the (+) terminal of the solenoid valve measures constant at 24 V or 0 V, the EPOS is faulty and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 49

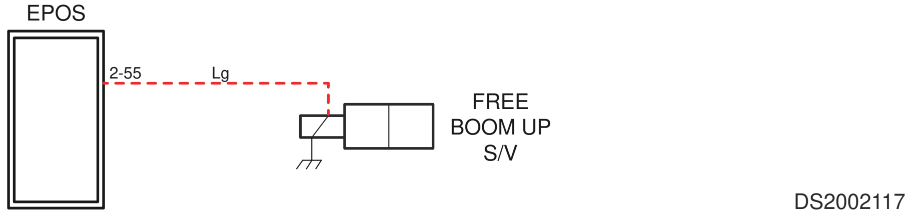


DS1901670

If the free boom up solenoid valve malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 50



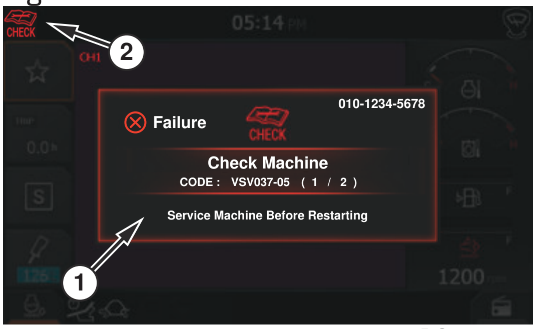
23. VSV037 Quick Coupler Solenoid Valve

Action Level	Failure Code	Failure	Quick Coupler Solenoid Valve
Gauge Panel	VSV037		
Detail of Failure	FMI 5: Quick coupler solenoid valve, current below normal (open circuit). FMI 6: Quick coupler solenoid valve, current above normal (short circuit).		
Actions of Machine Monitor or Controller	• If the quick coupler solenoid valve is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the quick coupler solenoid valve is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• The quick coupler may not be unlocked or malfunctions.		
Related Information	1. The solenoid valve won't operate if the negative (-) line of the solenoid valve is not connected with ground. 2. The solenoid valve won't operate if the connector of the solenoid valve is not correctly connected. 3. The solenoid valve won't operate if the signal line to the EPOS is not connected to the solenoid valve. A. Features of solenoid valve: 1) Voltage: 24 V DC ±10% 2) Operating voltage: 20 ~ 30 V 3) Valve coil resistance: 29.8 Ω ±5%		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Connector Connection	If the real time failure information on the gauge panel indicates an open circuit in the solenoid valve wiring: 1. Check whether the connector of the solenoid valve is connected correctly. A. Improperly fit connector
2	Faulty Solenoid Power Supply	1. Check whether the (-) terminal of the solenoid valve is properly grounded.
3	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the ground and solenoid valve (-) terminal.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the EPOS and solenoid valve (+) terminal. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct.
4	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the relevant terminal of the EPOS connector and the (+) terminal of the solenoid valve connector.
5	Faulty Solenoid	1. Turn off the master switch of the machine. 2. Measure the resistance of the solenoid valve. A. Measure the resistance of the valve coil. → If the measurement is infinite, this indicates an open circuit of the coil in the valve. B. Measure the resistance of the valve coil.→ If the measurement is 0 Ω, this indicates a short circuit of the coil in the valve. 1) Resistance specification: 29.8 Ω ±5%
6	Faulty EPOS	If the harness is correctly connected: 1. Check if the solenoid command signal of the EPOS is correctly applied. 2. Check if the voltage of the (+) terminal of its solenoid valve measures 0 ~ 4.75 V when quick coupler is not operating. 3. Check if the voltage of the (+) terminal of its solenoid valve measures 24 V when quick coupler is operating. 4. If the voltage at the (+) terminal of the solenoid valve measures constant at 24 V or 0 V, the EPOS is faulty and needs to be replaced.

Figure 51

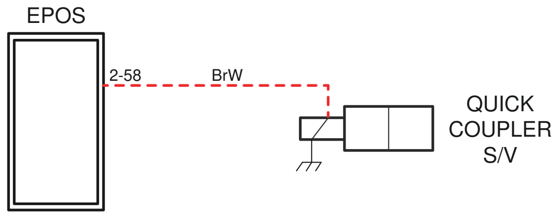


DS1901672

If the quick coupler solenoid valve malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 52



DS2002118

24. VSV038 MCV Proportional Reducing Cutoff Solenoid Valve

Action Level	Failure Code	Failure	MCV Proportional Reducing Cutoff Solenoid Valve
Gauge Panel	VSV038		
Detail of Failure	FMI 5: MCV proportional reducing cutoff solenoid valve, current below normal (open circuit) FMI 6: MCV proportional reducing cutoff solenoid valve, current above normal (short circuit)		
Actions of Machine Monitor or Controller	• If the MCV proportional reducing cutoff solenoid valve is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the MCV proportional reducing cutoff solenoid valve is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• Boom up/arm crowd /bucket crowd operations may slow down or malfunction.		
Related Information	1. If either of the boom up summation EPPR valve, arm crowd summation EPPR valve, bucket crowd EPPR valve, arm lock EPPR valve, boom up summation pressure sensor, arm crowd summation pressure sensor, bucket crowd pressure sensor or arm lock pressure sensor malfunctions, the solenoid valve is not operated. 2. The solenoid valve won't operate if the negative (-) line of the solenoid valve is not connected with ground. 3. The solenoid valve won't operate if the connector of the solenoid valve is not correctly connected.		

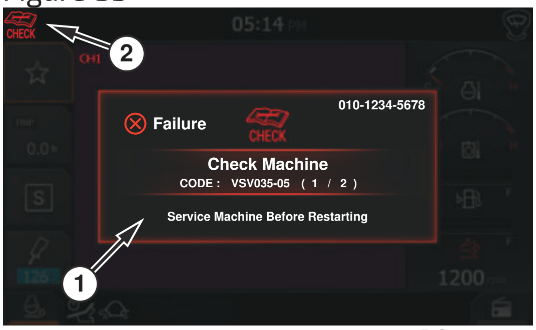
Action Level	Failure Code	Failure	MCV Proportional Reducing Cutoff Solenoid Valve
Gauge Panel	VSV038		
	4. The solenoid valve won't operate if the signal line to the EPOS is not connected to the solenoid valve. A. Features of solenoid valve: 1) Voltage: 24 V DC ±10% 2) Power consumption: 22 W at 25°C 3) Current amp.: 0.84 A ±5% 4) Resistance: 27.6 Ω ±5%		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Connector Connection	If the real time failure information on the gauge panel indicates an open circuit in the solenoid valve wiring: 1. Check whether the connector of the solenoid valve is connected correctly. A. Improperly fit connector
2	Faulty Solenoid Ground Connection	1. Check whether the (-) terminal of the solenoid valve is properly grounded.
3	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the ground and solenoid valve (-) terminal. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the EPOS and solenoid valve (+) terminal. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct.
4	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the relevant terminal of the EPOS connector and the (+) terminal of the solenoid valve connector.
5	Faulty Solenoid	1. Turn off the master switch of the machine. 2. Measure the resistance of the solenoid valve. A. Measure the resistance of the valve coil. → If the measurement is infinite, this indicates an open circuit of the coil in the valve.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		B. Measure the resistance of the valve coil. → If the measurement is 0 Ω, this indicates a short circuit of the coil in the valve. 1) Resistance specification: 27.6 Ω ±5%
6	Faulty EPOS	If the harness is correctly connected and EPPR valves and sensors are all normal: 1. Check if the solenoid command signal of the EPOS is correctly applied. 2. Check if the voltage of the (+) terminal of its solenoid valve measures 24 after starter switch is "key-on". 3. If the voltage of the (+) terminal of its solenoid valve measures less than 24 V after starter switch is "key-on", the EPOS is faulty and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 53

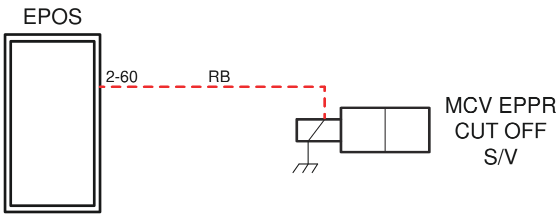


DS2002259

If the MCV proportional reducing cutoff solenoid valve malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 54



DS2002119

25. VRY002 Back Buzzer Relay

Action Level	Failure Code	Failure	Back Buzzer Relay
Gauge Panel	VRY002		
Detail of Failure	FMI 5: Back buzzer relay, current below normal (open circuit). FMI 6: Back buzzer relay, current above normal (short circuit).		
Actions of Machine Monitor or Controller	• If the backup buzzer relay is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel.		

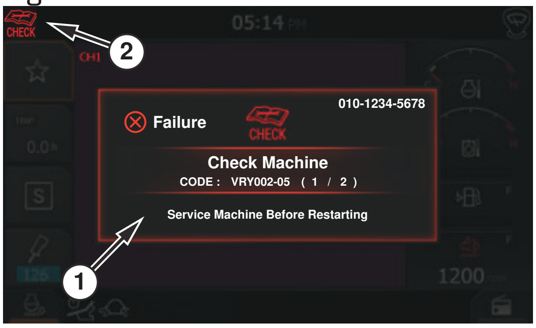
Action Level	Failure Code	Failure	Back Buzzer Relay
Gauge Panel	VRY002		
	• If the backup buzzer relay is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• In a machine equipped with the travel/swing alarm option, the back buzzer is not set off during a travel/swing operation.		
Related Information	1. The failure code is generated when the backup buzzer relay is not connected to the correct position. 2. The function may operate abnormally unless the backup buzzer relay with correct specification (24 V) is installed.		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Incorrect Relay Mounting Position	If the current malfunction information on the gauge panel indicates the relay current below normal level (open). 1. Check that the relay is connected to the correct position.
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the ground and relay terminal No. 85. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the EPOS and relay terminal No. 86 A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and relay terminal 86. A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Relay	1. Turn off the master switch of the machine. 2. Measure the resistance of the solenoid valve. A. Measure the resistance between relay terminals 85 and 86. → If the measurement is infinite, this indicates an open circuit of the coil in the valve.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		B. Measure the resistance between relay terminals 85 and 86. → If the measurement is 0 Ω, this indicates a short circuit of the coil in the valve. 1) Resistance specification: 360 Ω ±5%
5	Faulty EPOS	If the harness and relay are correctly connected: 1. Check if the relay operation command signal of the EPOS is correctly applied. → Relay terminal No. 85. 2. Measure the voltage at the relay terminal No. 85 with the backup buzzer not in operation to check if the measurement is 0 V. 3. Measure the voltage at the relay terminal No. 85 during a travel operation to check if the measurement is 24 V. 4. If the voltage at the relay terminal No. 85 is fixed to 24 V or 0 V, the EPOS is faulty and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 55

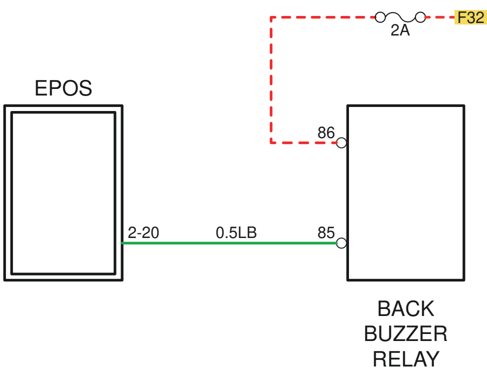


DS1901673

If the backup buzzer relay malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 56



DS2002420

26. VRY007 Starter Relay

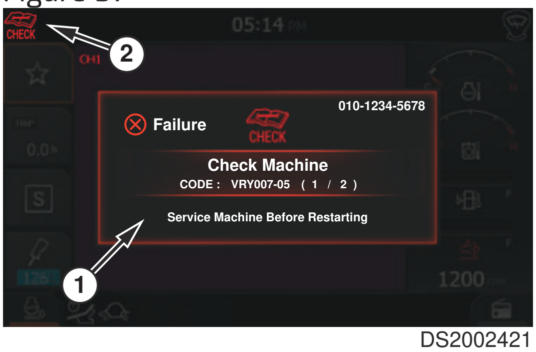
Action Level	Failure Code	Failure	Starter Relay
Gauge Panel	VRY007		
Detail of Failure	FMI 5: Starter relay, current below normal (open circuit). FMI 6: Starter relay, current above normal (short circuit).		
Actions of Machine Monitor or Controller	• If the starter relay is malfunctioning, the "Check the machine" popup and warning symbol will be displayed on the main screen of the gauge panel. • If the starter relay is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• It is not possible to prohibit engine starting in situations when engine starting should be prohibited. (Password setting, engine starting with the pilot cutoff lever is raised, engine starting prohibition is activated by TMS).		
Related Information	1. The failure code is generated when the starter relay is not connected to the correct position. 2. The function may operate abnormally unless the starter relay with correct specification (24 V) is installed.		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Incorrect Relay Mounting Position	If the current malfunction information on the gauge panel indicates the relay current below normal level (open). 1. Check that the relay is connected to the correct position.
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the ground and relay terminal No. 85. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the EPOS and relay terminal No. 86 A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and relay terminal 86.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Relay	1. Turn off the master switch of the machine. 2. Measure the resistance of the relay. A. Measure the resistance between relay terminals 85 and 86. → If the measurement is infinite, this indicates an open circuit of the coil in the valve. B. Measure the resistance between relay terminals 85 and 86. → If the measurement is 0 Ω, this indicates a short circuit of the coil in the valve. 1) Resistance specification: 360 Ω ±5%
5	Faulty EPOS	If the harness and relay are correctly connected: 1. Check if the relay operation command signal of the EPOS is correctly applied. → Relay terminal No. 86. 2. Measure the voltage at the starter relay terminal No. 85 with the starter not in operation to check if the measurement is 24 V. 3. Measure the voltage at the starter relay terminal No. 85 with the starter in operation to check if the measurement is 0 V. 4. If the voltage at the starter relay terminal No. 85 is fixed to 24 V or 0 V, the EPOS is faulty and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

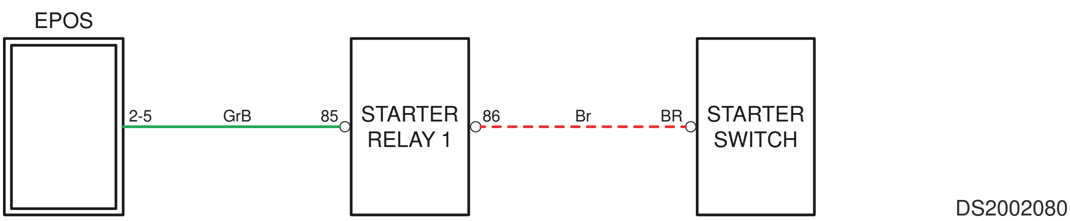
Figure 57



If the starter relay malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 58



27. VRY016 Auto Shut Off Relay

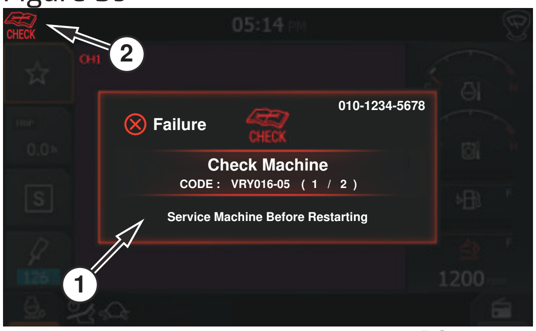
Action Level	Failure Code	Failure	Auto Shut Off Relay
Gauge Panel	VRY016		
Detail of Failure	FMI 5: Auto shut off relay, current below normal (open circuit). FMI 6: Auto shut off relay, current above normal (short circuit).		
Actions of Machine Monitor or Controller	• If the auto shut off relay is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the auto shut off relay is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• Although the conditions are met to trigger auto shutoff, the engine is not stopped, or the lamp does not turn off or malfunctions if it has been on.		
Related Information	1. The failure code is generated when the auto shut off relay is not connected to the correct position. 2. The function may operate abnormally unless the auto shut off relay with correct specification (24 V) is installed.		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Incorrect Relay Mounting Position	If the current malfunction information on the gauge panel indicates the relay current below normal level (open). 1. Check that the relay is connected to the correct position.
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the ground and relay terminal No. 85. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the EPOS and relay terminal No. 86. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and relay terminal 86.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Relay	1. Turn off the master switch of the machine. 2. Measure the resistance of the solenoid valve. A. Measure the resistance between relay terminals 85 and 86. → If the measurement is infinite, this indicates an open circuit of the coil in the valve. B. Measure the resistance between relay terminals 85 and 86. → If the measurement is 0 Ω, this indicates a short circuit of the coil in the valve. 1) Resistance specification: 360 Ω ±5%
5	Faulty EPOS	If the harness and relay are correctly connected: 1. Check if the relay operation command signal of the EPOS is correctly applied. → Relay terminal No. 86 2. Measure the voltage at the relay terminal No. 86 with the auto shut off not in operation to check if the measurement is 0 V. 3. Measure the voltage at the relay terminal No. 86 during a auto shut off operation to check if the measurement is 24 V. 4. If the voltage at the backup buzzer relay terminal No. 86 is fixed to 24 V or 0 V, the EPOS is faulty and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 59

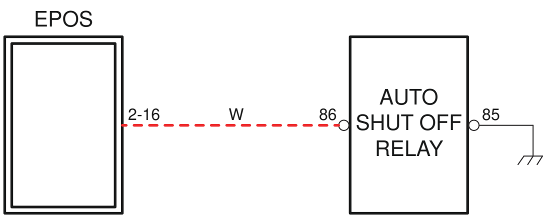


DS1901674

If the auto shut off relay malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 60



DS2002081

28. VRY018 ACC Relay

Action Level	Failure Code	Failure	ACC Relay
Gauge Panel	VRY018		

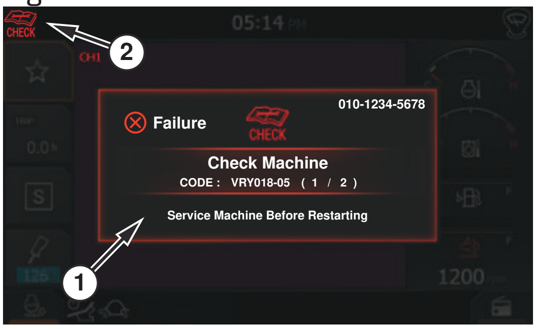
Detail of Failure	FMI 5: ACC Relay, current below normal (open circuit). FMI 6: ACC Relay, current above normal (short circuit).
Actions of Machine Monitor or Controller	• If the ACC relay is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the ACC relay is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.
Problem on Machine	• Although the key switch is in "OFF" position, Audio, USB charger, handsfree, 12 V power socket and jog shuttle powered by ACC relay do not work or malfunction.
Related Information	1. The failure code is generated when the ACC relay is not connected to the correct position. 2. The function may operate abnormally unless the ACC relay with correct specification (24 V) is installed.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Incorrect Relay Mounting Position	If the current malfunction information on the gauge panel indicates the relay current below normal level (open). 1. Check that the relay is connected to the correct position.
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the ground and relay terminal No. 85. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the EPOS and relay terminal No. 86 A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and relay terminal 86.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Relay	1. Turn off the master switch of the machine. 2. Measure the resistance of the relay. A. Measure the resistance between relay terminals 85 and 86. → If the measurement is infinite, this indicates an open circuit of the coil in the valve. B. Measure the resistance between relay terminals 85 and 86. → If the measurement is 0 Ω, this indicates a short circuit of the coil in the valve. 1) Resistance specification: 360 Ω ±5%
5	Faulty EPOS	If the harness and relay are correctly connected: 1. Check if the relay operation command signal of the EPOS is correctly applied. → Relay terminal No. 86. 2. Turn the key switch off and check if the voltage output from the relay at terminal 86 measures 0 V. 3. Set the key switch in ACC and check if the voltage output from the relay at terminal 86 measures 24 V. 4. If the voltage at the relay terminal No. 86 is fixed to 24 V or 0 V, the EPOS is faulty and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 61

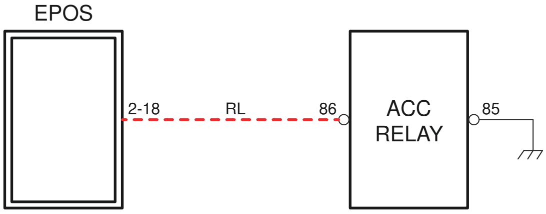


DS1901675

If the ACC relay malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 62



DS2002082

29. VRY019 DES (Delayed Engine Shutdown) Override Relay

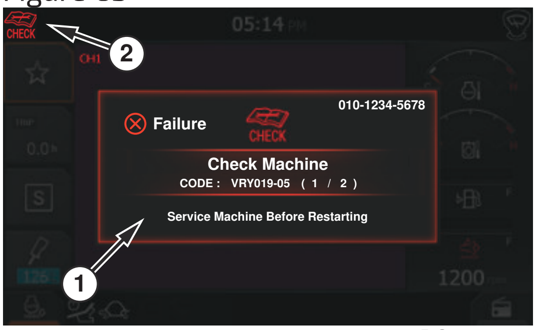
<table>
<tr><th>Action Level</th><th>Failure Code</th><th rowspan="2">Failure</th><th rowspan="2">DES (Delayed Engine Shutdown) Override Relay</th></tr>
<tr><th>Gauge Panel</th><th>VRY019</th></tr>
<tr><td>Detail of Failure</td><td colspan="3">FMI 5: DES override relay, current below normal (open circuit).
FMI 6: DES override relay, current above normal (short circuit).</td></tr>
<tr><td>Actions of Machine Monitor or Controller</td><td colspan="3">• If the DES override relay is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel.
• If the DES override relay is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.</td></tr>
<tr><td>Problem on Machine</td><td colspan="3">• During the engine's DES function, the DES function cannot be performed, the engine forced stop function cannot be performed, or a malfunction may occur.</td></tr>
<tr><td>Related Information</td><td colspan="3">1. The failure code is generated when the DES override relay is not connected to the correct position.
2. The function may operate abnormally unless the DES override relay with correct specification (24 V) is installed.</td></tr>
</table>

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Incorrect Relay Mounting Position	If the current malfunction information on the gauge panel indicates the relay current below normal level (open). 1. Check that the DES relay is connected to the correct position.
2	Open Circuit in Harness	1. Test for an open circuit in the harness between the ground and relay terminal No. 85. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 2. Test for an open circuit in the harness between the EPOS and relay terminal No. 86. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and relay terminal 86. A. Check the power source, ground, and signal line for any short circuit.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
4	Faulty Relay	1. Turn off the master switch of the machine. 2. Measure the resistance of the relay. A. Measure the resistance between relay terminals 85 and 86. → If the measurement is infinite, this indicates an open circuit of the coil in the valve. B. Measure the resistance between relay terminals 85 and 86. → If the measurement is 0 Ω, this indicates a short circuit of the coil in the valve. 1) Resistance specification: 360 Ω ±5%
5	Faulty EPOS	If the harness and relay are correctly connected: 1. Check if the relay operation command signal of the EPOS is correctly applied. → Relay terminal No. 86. 2. Measure the voltage at the relay terminal No. 86 with the DES function not in operation to check if the measurement is 0 V. 3. Measure the voltage at the relay terminal No. 86 during DES function operation to check if the measurement is 24 V. 4. If the voltage at the relay terminal No. 86 is fixed to 24 V or 0 V, the EPOS is faulty and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 63

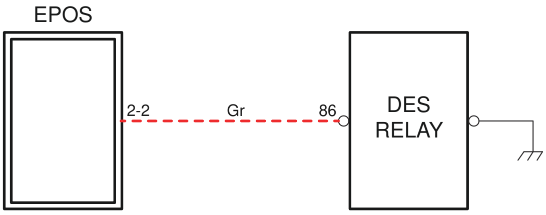


DS2002422

If the DES override relay malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 64



DS2002083

30. VGC002 Urea Overcharging Warning Signal

Action Level	Failure Code	Failure	Urea Overcharging Warning Signal
Gauge Panel	VGC002		

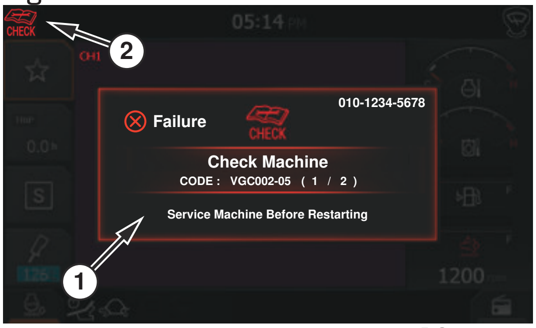
Detail of Failure	FMI 5: Urea overcharging warning signal, current below normal (open circuit). FMI 6: Urea overcharging warning signal, current above normal (short circuit).
Actions of Machine Monitor or Controller	• In the event that the urea overcharging warning signal circuit malfunctions, the main screen of the gauge panel pops up a message saying "Check the machine" and displays a warning symbol. • In the event that the urea overcharging warning signal circuit malfunctions, details of the malfunction can be checked in the Real Time Failure Information menu on the gauge panel.
Problem on Machine	• When filling the urea tank, the urea overcharging warning lamp does not light up, failing to indicate that the tank is full.
Related Information	1. The urea overcharging warning lamp will not work if is (-) line is not grounded. 2. The urea overcharging warning lamp will not work if its connector is not connected properly. 3. The urea overcharging warning lamp will not work if it is not connected to the EPOS by the signal line. 4. The urea overcharging warning lamp works only when the machine is keyed on. • Operation of the urea overcharging warning lamp (LED) A. Urea level at below 90%: LED lamp off B. Urea level at over 90%: LED lamp on

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Connector Connection Faulty	If the gauge panel indicates that the urea overcharging warning lamp is open-circuited: 1. Check whether the connector of the urea overcharging warning lamp is connected properly. A. For an improperly fit connector
2	Defective Power Supply to Urea Overcharging Warning Lamp	1. Check whether the (-) terminal of the urea overcharging warning lamp is grounded.
3	Harness Circuit Open	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the vehicle ground and the (-) terminal of the urea overcharging warning lamp connector. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for a open circuit in the harness between the relevant terminal of the EPOS connector and the (+) terminal of the urea overcharging warning lamp connector. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct.
4	Harness Circuit Short	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the relevant terminal of the EPOS connector and the (+) terminal of the urea overcharging warning lamp connector.
5	Urea Overcharging Warning Lamp Unit Faulty	1. Disconnect the urea overcharging warning lamp connector. 2. Check whether the lamp turns on when you connect 24 V power directly to the connector. 3. If the lamp does not turn on, the lamp unit is faulty and needs to be replaced.
6	EPOS unit faulty	If the harness is correctly connected: 1. Check whether the EPOS gives command signals for the urea overcharging warning lamp correctly. 2. Check whether the voltage at the (+) terminal of the urea overcharging warning lamp measures between 0 V ~ 4.75 V when the urea level is at below 90%. 3. Check whether the voltage at the (+) terminal of the urea overcharging warning lamp measures 24 V when the urea level is at over 90%. 4. If the voltage at the (+) terminal of the lamp measures constant at 24 V or 0 V, the EPOS is faulty and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 65

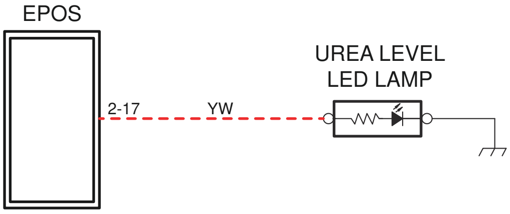


DS1902368

If the urea overcharging warning signal malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 66



DS2002112

31. VSP001 Front Pump Pressure Sensor

Action Level	Failure Code	Failure	Front Pump Pressure Sensor
Gauge Panel	VSP001		
Detail of Failure	FMI 2: The front pump pressure sensor, incorrect signal. FMI 3: The front pump pressure sensor, voltage above normal. FMI 4: The front pump pressure sensor, voltage below normal.		
Actions of Machine Monitor or Controller	• If the front pump pressure sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• The relief cutoff function won’t operate if the front pump pressure sensor is malfunctioning. • Automatic travel mode is not operative. • The pump EPPR valve’s current input is not controllable.		
Related Information	1. The pressure sensor won't operate if it is not supplied with 5 V. 2. The pressure sensor can be severely damaged if its power line and ground line are swapped. 3. The pressure value measured by the pressure sensor can be checked on the monitoring menu screen of the gauge panel. A. Features of pressure sensor 1) Operating voltage: 5 V ±5% 2) Operating current: max. 10 mA 3) Output voltage: 1 to 5 V 4) Measuring pressure: 0 to 500 bar		

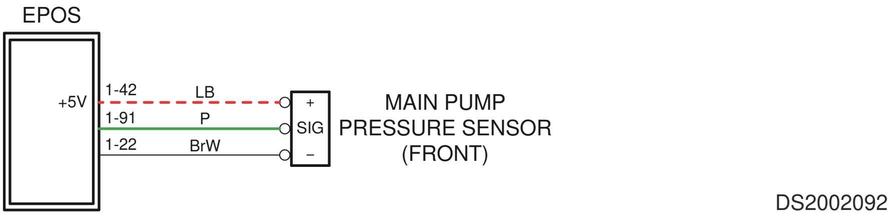
Action Level	Failure Code	Failure	Front Pump Pressure Sensor
Gauge Panel	VSP001		
	5) Measurement tolerance: ±1.5%		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the pressure sensor is correctly connected. 2. Check that the terminal No. 1 of the pressure sensor connector is correctly supplied with 5 V. 3. Check the condition of the power supply terminal of the pressure sensor
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the power supply and pressure sensor connector terminal No. 1. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the ground terminal and pressure sensor connector terminal No. 3. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 4. Test for an open circuit in the harness between the EPOS and pressure sensor connector terminal No. 2. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and pressure sensor. A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Pressure Sensor	Measure the output voltage of the pressure sensor. 1. Check if the output voltage is 1 V when it is connected under unloaded condition.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		2. Check if the output voltage of the pressure sensor is between 1 V and 5 V while the machine is in operation. 3. Check if the voltage value measured at the pressure sensor is matched with the pressure indicated on the gauge panel. A. Formula for voltage-pressure conversion: V (Voltage) = (0.00816 x Pressure) + 1 4. Operate the machine and check if the pressure value indicated on the gauge panel is changed according to changes in the pressure. If any of the above problem occurs, the pressure sensor is faulty and needs to be replaced.
5	Faulty EPOS	If the harness and pressure sensor are correctly connected: 1. Check if the pressure sensor signal is correctly applied to the EPOS. → Measure the voltage at the front of the EPOS connector to check if voltage in the correct output range is applied. If the proper sensor voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced.

Block Diagram

Figure 67



32. VSP002 Rear Pump Pressure Sensor

Action Level	Failure Code	Failure	Rear Pump Pressure Sensor
Gauge Panel	VSP002		
Detail of Failure	FMI 2: The rear pump pressure sensor, incorrect signal. FMI 3: The rear pump pressure sensor, voltage above normal. FMI 4: The rear pump pressure sensor, voltage below normal.		
Actions of Machine Monitor or Controller	• If the rear pump pressure sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• The relief cutoff function won't operate if the rear pump pressure sensor is malfunctioning. • Automatic travel mode is not operative. • The pump EPPR valve's current input is not controllable.		
Related Information	1. The pressure sensor won't operate if it is not supplied with 5 V.		

<table>
<tr><th>Action Level</th><th>Failure Code</th><th rowspan="2">Failure</th><th rowspan="2">Rear Pump Pressure Sensor</th></tr>
<tr><th>Gauge Panel</th><th>VSP002</th></tr>
<tr><td></td><td colspan="3">2. The pressure sensor can be severely damaged if its power line and ground line are swapped.
3. The pressure value measured by the pressure sensor can be checked on the monitoring menu screen of the gauge panel.
A. Features of pressure sensor
1) Operating voltage: 5 V ±5%
2) Operating current: max. 10 mA
3) Output voltage: 1 to 5 V
4) Measuring pressure: 0 to 500 bar
5) Measurement tolerance: ±1.5%</td></tr>
</table>

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the pressure sensor is correctly connected. 2. Check that the terminal No. 1 of the pressure sensor connector is correctly supplied with 5 V. 3. Check the condition of the power supply terminal of the pressure sensor.
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the power supply and pressure sensor connector terminal No. 1. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the ground terminal and pressure sensor connector terminal No. 3. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 4. Test for an open circuit in the harness between the EPOS and pressure sensor connector terminal No. 2. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and pressure sensor. A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Pressure Sensor	Measure the output voltage of the pressure sensor. 1. Check if the output voltage is 1 V when it is connected under unloaded condition. 2. Check if the output voltage of the pressure sensor is between 1 V and 5 V while the machine is in operation. 3. Check if the voltage value measured at the pressure sensor is matched with the pressure indicated on the gauge panel. A. Formula for voltage-pressure conversion: V (Voltage) = (0.00816 x Pressure) + 1 4. Operate the machine and check if the pressure value indicated on the gauge panel is changed according to changes in the pressure. If any of the above problem occurs, the pressure sensor is faulty and needs to be replaced.
5	Faulty EPOS	If the harness and pressure sensor are correctly connected: 1. Check if the pressure sensor signal is correctly applied to the EPOS. → Measure the voltage at the front of the EPOS connector to check if voltage in the correct output range is applied. If the proper sensor voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced.

Block Diagram

Figure 68

33. VSP003 Overload Warning Pressure Sensor

Action Level	Failure Code	Failure	Overload Warning Pressure Sensor
Gauge Panel	VSP003		
Detail of Failure	FMI 2: The overload warning pressure sensor, incorrect signal. FMI 3: The overload warning pressure sensor, voltage above normal. FMI 4: The overload warning pressure sensor, voltage below normal.		

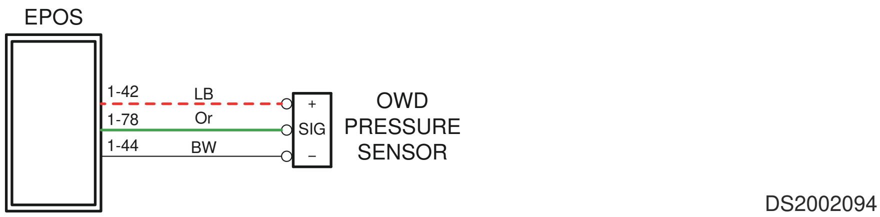
Action Level	Failure Code	Failure	Overload Warning Pressure Sensor
Gauge Panel	VSP003		
Actions of Machine Monitor or Controller	• If the overload warning pressure sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• The overload warning function cannot be operated or malfunctions if the overload warning pressure sensor is malfunctioning.		
Related Information	1. The pressure sensor won't operate if it is not supplied with 5 V. 2. The pressure sensor can be severely damaged if its power line and ground line are swapped. 3. The pressure value measured by the pressure sensor can be checked on the monitoring menu screen of the gauge panel. A. Features of pressure sensor 1) Operating voltage: 5 V ±5% 2) Operating current: max. 10 mA 3) Output voltage: 1 to 5 V 4) Measuring pressure: 0 to 500 bar 5) Measurement tolerance: ±1.5%		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the pressure sensor is correctly connected. 2. Check that the terminal No. 1 of the pressure sensor connector is correctly supplied with 5 V. 3. Check the condition of the power supply terminal of the pressure sensor.
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the power supply and pressure sensor connector terminal No. 1. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the ground terminal and pressure sensor connector terminal No. 3. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		4. Test for an open circuit in the harness between the EPOS and pressure sensor connector terminal No. 2. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and pressure sensor. A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Pressure Sensor	Measure the output voltage of the pressure sensor. 1. Check if the output voltage is 1 V when it is connected under unloaded condition. 2. Check if the output voltage of the pressure sensor is between 1 V and 5 V while the machine is in operation. 3. Check if the voltage value measured at the pressure sensor is matched with the pressure indicated on the gauge panel. A. Formula for voltage-pressure conversion: V (Voltage) = (0.00816 x Pressure) + 1 4. Operate the machine and check if the pressure value indicated on the gauge panel is changed according to changes in the pressure. If any of the above problem occurs, the pressure sensor is faulty and needs to be replaced.
5	Faulty EPOS	If the harness and pressure sensor are correctly connected: 1. Check if the pressure sensor signal is correctly applied to the EPOS. → Measure the voltage at the front of the EPOS connector to check if voltage in the correct output range is applied. If the proper sensor voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced.

Block Diagram

Figure 69



34. VSP006 Boom Up Pressure Sensor

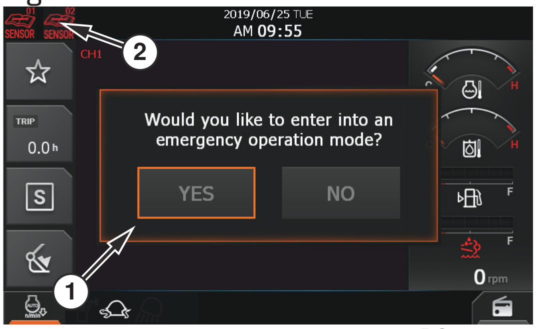
Action Level	Failure Code	Failure	Boom Up Press. Sensor
Gauge Panel	VSP006		
Detail of Failure	FMI 3: The boom up pressure sensor, voltage above normal. FMI 4: The boom up pressure sensor, voltage below normal.		
Actions of Machine Monitor or Controller	• If the boom up pressure sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• When the boom-up pressure sensor is malfunctioning, the boom-up operation may slow down or malfunction as the boom-up pressure cannot be detected.		
Related Information	1. The pressure sensor won't operate if it is not supplied with 24 V. 2. The pressure sensor can be severely damaged if its power line and ground line are swapped. 3. The pressure value measured by the pressure sensor can be checked on the monitoring menu screen of the gauge panel. A. Features of pressure sensor 1) Operating voltage: 24 V ±10% 2) Operating current: max. 20 mA 3) Output voltage: 1 ~ 5 V 4) Measuring pressure: 0 to 50 bar 5) Measurement tolerance: ±3%		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the pressure sensor is correctly connected. 2. Check that the terminal No. 2 of the pressure sensor connector is correctly supplied with 24 V. 3. Check the condition of the power supply terminal of the pressure sensor.
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the power supply and pressure sensor connector terminal No. 2. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the ground terminal and pressure sensor connector terminal No. 1.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 4. Test for an open circuit in the harness between the EPOS and pressure sensor connector terminal No. 3. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and pressure sensor. A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Pressure Sensor	Measure the output voltage of the pressure sensor. 1. Check if the output voltage is 1 V when it is connected under unloaded condition. 2. Check if the output voltage of the pressure sensor is between 1 V and 5 V while the machine is in operation. 3. Check if the voltage value measured at the pressure sensor is matched with the pressure indicated on the gauge panel. A. Formula for voltage-pressure conversion: V (Voltage) = (0.08 x Pressure) + 1 4. Operate the machine and check if the pressure value indicated on the gauge panel is changed according to changes in the pressure. If any of the above problem occurs, the pressure sensor is faulty and needs to be replaced.
5	Faulty EPOS	If the harness and pressure sensor are correctly connected: 1. Check if the pressure sensor signal is correctly applied to the EPOS. → Measure the voltage at the front of the EPOS connector to check if voltage in the correct output range is applied. If the proper sensor voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 70

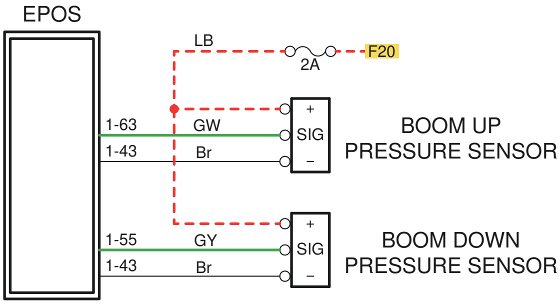


DS1902359

If the joystick sensor malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 71



DS2002096

35. VSP007 Bucket Crowd Pressure Sensor

Action Level	Failure Code	Failure	Bucket Crowd Press. Sensor
Gauge Panel	VSP007		
Detail of Failure	FMI 3: The bucket crowd pressure sensor, voltage above normal. FMI 4: The bucket crowd pressure sensor, voltage below normal.		
Actions of Machine Monitor or Controller	• If the bucket crowd pressure sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• When the bucket-crowd pressure sensor is malfunctioning, the bucket-crowd operation may slow down or malfunction as the bucket-crowd pressure cannot be detected.		
Related Information	1. The pressure sensor won't operate if it is not supplied with 24 V. 2. The pressure sensor can be severely damaged if its power line and ground line are swapped. 3. The pressure value measured by the pressure sensor can be checked on the monitoring menu screen of the gauge panel. A. Features of pressure sensor 1) Operating voltage: 24 V ±10% 2) Operating current: max. 20 mA 3) Output voltage: 1 ~ 5 V 4) Measuring pressure: 0 to 50 bar		

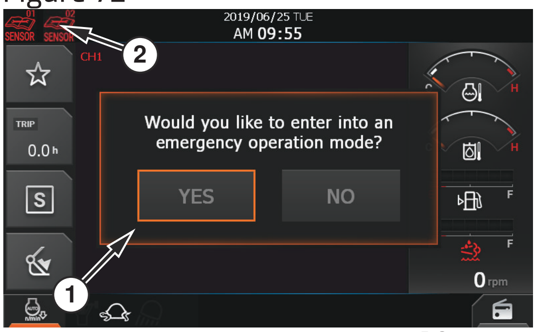
Action Level	Failure Code	Failure	Bucket Crowd Press. Sensor
Gauge Panel	VSP007		
	5) Measurement tolerance: ±3%		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the pressure sensor is correctly connected. 2. Check that the terminal No. 2 of the pressure sensor connector is correctly supplied with 24 V. 3. Check the condition of the power supply terminal of the pressure sensor.
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the power supply and pressure sensor connector terminal No. 2. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the ground terminal and pressure sensor connector terminal No. 1. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 4. Test for an open circuit in the harness between the EPOS and pressure sensor connector terminal No. 3. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and pressure sensor. A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Pressure Sensor	Measure the output voltage of the pressure sensor. 1. Check if the output voltage is 1 V when it is connected under unloaded condition.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		2. Check if the output voltage of the pressure sensor is between 1 V and 5 V while the machine is in operation. 3. Check if the voltage value measured at the pressure sensor is matched with the pressure indicated on the gauge panel. A. Formula for voltage-pressure conversion: V (Voltage) = (0.08 x Pressure) + 1 4. Operate the machine and check if the pressure value indicated on the gauge panel is changed according to changes in the pressure. If any of the above problem occurs, the pressure sensor is faulty and needs to be replaced.
5	Faulty EPOS	If the harness and pressure sensor are correctly connected: 1. Check if the pressure sensor signal is correctly applied to the EPOS. →Measure the voltage at the front of the EPOS connector to check if voltage in the correct output range is applied. If the proper sensor voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 72

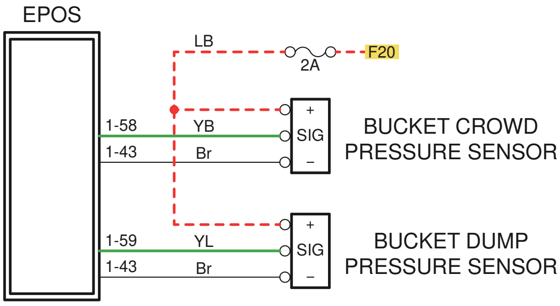


DS1902359

If the joystick sensor malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 73



DS2002095

36. VSP008 Boom Down Pressure Sensor

Action Level	Failure Code	Failure	Boom Down Press. Sensor
Gauge Panel	VSP008		

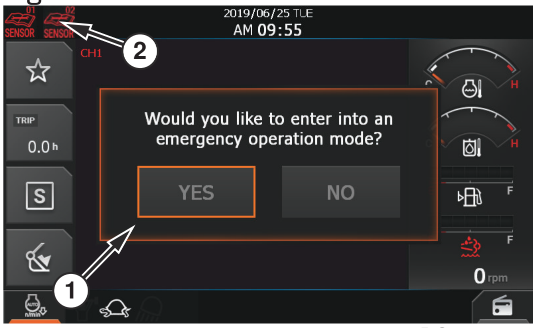
Detail of Failure	FMI 3: The boom down pressure sensor, voltage above normal. FMI 4: The boom down pressure sensor, voltage below normal.
Actions of Machine Monitor or Controller	• If the boom down pressure sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.
Problem on Machine	• When the boom-down pressure sensor is malfunctioning, the boom-down operation may slow down or malfunction as the boom-down pressure cannot be detected.
Related Information	1. The pressure sensor won't operate if it is not supplied with 24 V. 2. The pressure sensor can be severely damaged if its power line and ground line are swapped. 3. The pressure value measured by the pressure sensor can be checked on the monitoring menu screen of the gauge panel. A. Features of pressure sensor 1) Operating voltage: 24 V ±10% 2) Operating current: max. 20 mA 3) Output voltage: 1 ~ 5 V 4) Measuring pressure: 0 to 50 bar 5) Measurement tolerance: ±3%

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the pressure sensor is correctly connected. 2. Check that the terminal No. 2 of the pressure sensor connector is correctly supplied with 24 V. 3. Check the condition of the power supply terminal of the pressure sensor.
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the power supply and pressure sensor connector terminal No. 2. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the ground terminal and pressure sensor connector terminal No. 1.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 4. Test for an open circuit in the harness between the EPOS and pressure sensor connector terminal No. 3. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and pressure sensor. A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Pressure Sensor	Measure the output voltage of the pressure sensor. 1. Check if the output voltage is 1 V when it is connected under unloaded condition. 2. Check if the output voltage of the pressure sensor is between 1 V and 5 V while the machine is in operation. 3. Check if the voltage value measured at the pressure sensor is matched with the pressure indicated on the gauge panel. A. Formula for voltage-pressure conversion: V (Voltage) = (0.08 x Pressure) + 1 4. Operate the machine and check if the pressure value indicated on the gauge panel is changed according to changes in the pressure. If any of the above problem occurs, the pressure sensor is faulty and needs to be replaced.
5	Faulty EPOS	If the harness and pressure sensor are correctly connected: 1. Check if the pressure sensor signal is correctly applied to the EPOS. →Measure the voltage at the front of the EPOS connector to check if voltage in the correct output range is applied. If the proper sensor voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 74

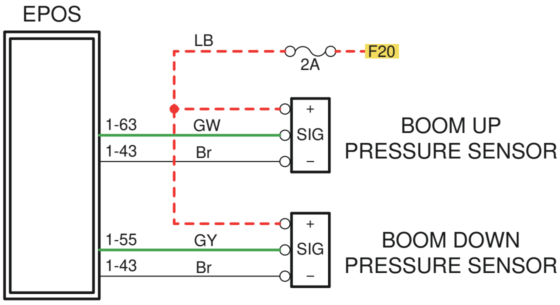


DS1902359

If the joystick sensor malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 75



DS2002096

37. VSP009 Bucket Dump Pressure Sensor

Action Level	Failure Code	Failure	Bucket Dump Press. Sensor
Gauge Panel	VSP009		
Detail of Failure	FMI 3: The bucket dump pressure sensor, voltage above normal. FMI 4: The bucket dump pressure sensor, voltage below normal.		
Actions of Machine Monitor or Controller	• If the bucket dump pressure sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• When the bucket-dump pressure sensor is malfunctioning, the bucket-dump operation may slow down or malfunction as the bucket-dump pressure cannot be detected.		
Related Information	1. The pressure sensor won't operate if it is not supplied with 24 V. 2. The pressure sensor can be severely damaged if its power line and ground line are swapped. 3. The pressure value measured by the pressure sensor can be checked on the monitoring menu screen of the gauge panel. A. Features of pressure sensor 1) Operating voltage: 24 V ±10% 2) Operating current: max. 20 mA 3) Output voltage: 1 ~ 5 V 4) Measuring pressure: 0 to 50 bar		

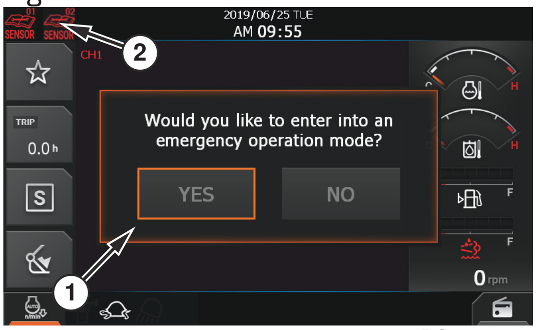
Action Level	Failure Code	Failure	Bucket Dump Press. Sensor
Gauge Panel	VSP009		
	5) Measurement tolerance: ±3%		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the pressure sensor is correctly connected. 2. Check that the terminal No. 2 of the pressure sensor connector is correctly supplied with 24 V. 3. Check the condition of the power supply terminal of the pressure sensor.
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the power supply and pressure sensor connector terminal No. 2. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the ground terminal and pressure sensor connector terminal No. 1. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 4. Test for an open circuit in the harness between the EPOS and pressure sensor connector terminal No. 3. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and pressure sensor. A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Pressure Sensor	Measure the output voltage of the pressure sensor. 1. Check if the output voltage is 1 V when it is connected under unloaded condition.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		2. Check if the output voltage of the pressure sensor is between 1 V and 5 V while the machine is in operation. 3. Check if the voltage value measured at the pressure sensor is matched with the pressure indicated on the gauge panel. A. Formula for voltage-pressure conversion: V (Voltage) = (0.08 x Pressure) + 1 4. Operate the machine and check if the pressure value indicated on the gauge panel is changed according to changes in the pressure. If any of the above problem occurs, the pressure sensor is faulty and needs to be replaced.
5	Faulty EPOS	If the harness and pressure sensor are correctly connected: 1. Check if the pressure sensor signal is correctly applied to the EPOS. →Measure the voltage at the front of the EPOS connector to check if voltage in the correct output range is applied. If the proper sensor voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 76

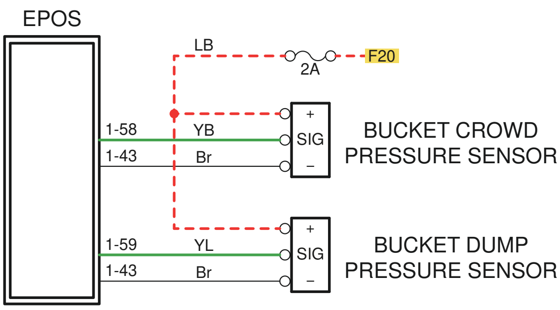


DS1902359

If the joystick sensor malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 77



DS2002095

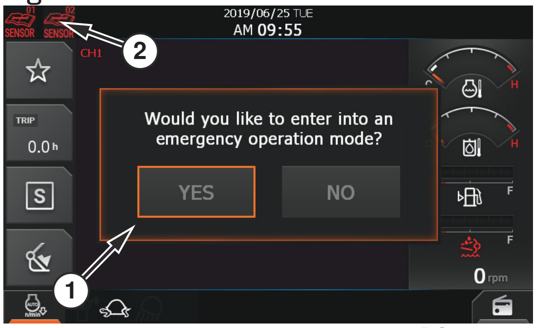
38. VSP010 Arm in Pressure Sensor

<table>
<tr><th>Action Level</th><th>Failure Code</th><th rowspan="2">Failure</th><th rowspan="2">Arm in Pressure Sensor</th></tr>
<tr><th>Gauge Panel</th><th>VSP010</th></tr>
<tr><td>Detail of Failure</td><td colspan="3">FMI 3: The arm in pressure sensor, voltage above normal.
FMI 4: The arm in pressure sensor, voltage below normal.</td></tr>
<tr><td>Actions of Machine Monitor or Controller</td><td colspan="3">• If the arm in pressure sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.</td></tr>
<tr><td>Problem on Machine</td><td colspan="3">• When the arm-in pressure sensor is malfunctioning, the arm-in operation may slow down or malfunction as the arm-in pressure cannot be detected.</td></tr>
<tr><td>Related Information</td><td colspan="3">1. The pressure sensor won't operate if it is not supplied with 24 V.
2. The pressure sensor can be severely damaged if its power line and ground line are swapped.
3. The pressure value measured by the pressure sensor can be checked on the monitoring menu screen of the gauge panel.
A. Features of pressure sensor
1) Operating voltage: 24 V ±10%
2) Operating current: max. 20 mA
3) Output voltage: 1 ~ 5 V
4) Measuring pressure: 0 to 50 bar
5) Measurement tolerance: ±3%</td></tr>
</table>

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the pressure sensor is correctly connected. 2. Check that the terminal No. 2 of the pressure sensor connector is correctly supplied with 24 V. 3. Check the condition of the power supply terminal of the pressure sensor.
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the power supply and pressure sensor connector terminal No. 2. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the ground terminal and pressure sensor connector terminal No. 1.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 4. Test for an open circuit in the harness between the EPOS and pressure sensor connector terminal No. 3. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and pressure sensor. A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Pressure Sensor	Measure the output voltage of the pressure sensor. 1. Check if the output voltage is 1 V when it is connected under unloaded condition. 2. Check if the output voltage of the pressure sensor is between 1 V and 5 V while the machine is in operation. 3. Check if the voltage value measured at the pressure sensor is matched with the pressure indicated on the gauge panel. A. Formula for voltage-pressure conversion: V (Voltage) = (0.08 x Pressure) + 1 4. Operate the machine and check if the pressure value indicated on the gauge panel is changed according to changes in the pressure. If any of the above problem occurs, the pressure sensor is faulty and needs to be replaced.
5	Faulty EPOS	If the harness and pressure sensor are correctly connected: 1. Check if the pressure sensor signal is correctly applied to the EPOS. → Measure the voltage at the front of the EPOS connector to check if voltage in the correct output range is applied. If the proper sensor voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced.

Figure 78

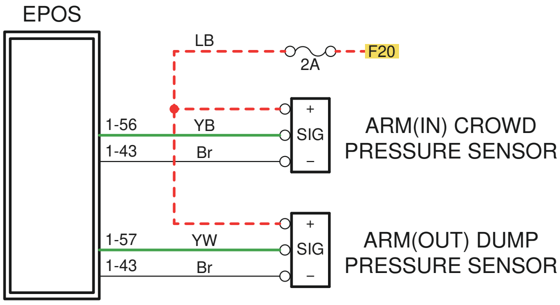


DS1902359

If the joystick sensor malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 79



DS2002097

39. VSP011 Arm Out Pressure Sensor

Action Level	Failure Code	Failure	Arm Out Pressure Sensor
Gauge Panel	VSP011		
Detail of Failure	FMI 3: The arm out pressure sensor, voltage above normal. FMI 4: The arm out pressure sensor, voltage below normal.		
Actions of Machine Monitor or Controller	• If the arm in pressure sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• When the arm-out pressure sensor is malfunctioning, the arm-out operation may slow down or malfunction as the arm-out pressure cannot be detected.		
Related Information	1. The pressure sensor won't operate if it is not supplied with 24 V. 2. The pressure sensor can be severely damaged if its power line and ground line are swapped. 3. The pressure value measured by the pressure sensor can be checked on the monitoring menu screen of the gauge panel. A. Features of pressure sensor 1) Operating voltage: 24 V ±10% 2) Operating current: max. 20 mA 3) Output voltage: 1 ~ 5 V 4) Measuring pressure: 0 to 50 bar		

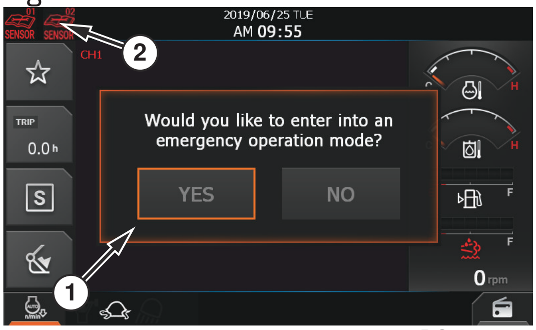
Action Level	Failure Code	Failure	Arm Out Pressure Sensor
Gauge Panel	VSP011		
	5) Measurement tolerance: ±3%		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the pressure sensor is correctly connected. 2. Check that the terminal No. 2 of the pressure sensor connector is correctly supplied with 24 V. 3. Check the condition of the power supply terminal of the pressure sensor.
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the power supply and pressure sensor connector terminal No. 2. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the ground terminal and pressure sensor connector terminal No. 1. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 4. Test for an open circuit in the harness between the EPOS and pressure sensor connector terminal No. 3. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and pressure sensor. A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Pressure Sensor	Measure the output voltage of the pressure sensor. 1. Check if the output voltage is 1 V when it is connected under unloaded condition.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		2. Check if the output voltage of the pressure sensor is between 1 V and 5 V while the machine is in operation. 3. Check if the voltage value measured at the pressure sensor is matched with the pressure indicated on the gauge panel. A. Formula for voltage-pressure conversion: V (Voltage) = (0.08 x Pressure) + 1 4. Operate the machine and check if the pressure value indicated on the gauge panel is changed according to changes in the pressure. If any of the above problem occurs, the pressure sensor is faulty and needs to be replaced.
5	Faulty EPOS	If the harness and pressure sensor are correctly connected: 1. Check if the pressure sensor signal is correctly applied to the EPOS. →Measure the voltage at the front of the EPOS connector to check if voltage in the correct output range is applied. If the proper sensor voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 80

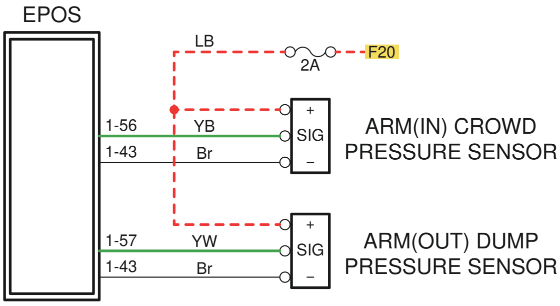


DS1902359

If the joystick sensor malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 81



DS2002097

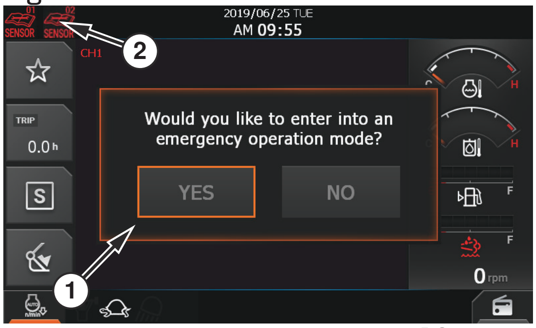
40. VSP012 Travel Pressure Sensor (LH)

Action Level	Failure Code	Failure	Travel Pressure Sensor (LH)
Gauge Panel	VSP012		
Detail of Failure	FMI 3: The travel pressure sensor (LH), voltage above normal. FMI 4: The travel pressure sensor (LH), voltage below normal.		
Actions of Machine Monitor or Controller	• If the travel pressure sensor (LH) is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• If an exclusive left travel or forward/reverse travel is performed while the left-travel pressure sensor is malfunctioning, the travel operation may slow down or malfunction (fail to travel straight) as the left-travel pressure cannot be detected.		
Related Information	1. The pressure sensor won't operate if it is not supplied with 24 V. 2. The pressure sensor can be severely damaged if its power line and ground line are swapped. 3. The pressure value measured by the pressure sensor can be checked on the monitoring menu screen of the gauge panel. A. Features of pressure sensor 1) Operating voltage: 24 V ±10% 2) Operating current: max. 20 mA 3) Output voltage: 1 ~ 5 V 4) Measuring pressure: 0 to 50 bar 5) Measurement tolerance: ±3%		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the pressure sensor is correctly connected. 2. Check that the terminal No. 2 of the pressure sensor connector is correctly supplied with 24 V. 3. Check the condition of the power supply terminal of the pressure sensor.
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the power supply and pressure sensor connector terminal No. 2. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the ground terminal and pressure sensor connector terminal No. 1.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 4. Test for an open circuit in the harness between the EPOS and pressure sensor connector terminal No. 3. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and pressure sensor. A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Pressure Sensor	Measure the output voltage of the pressure sensor. 1. Check if the output voltage is 1 V when it is connected under unloaded condition. 2. Check if the output voltage of the pressure sensor is between 1 V and 5 V while the machine is in operation. 3. Check if the voltage value measured at the pressure sensor is matched with the pressure indicated on the gauge panel. A. Formula for voltage-pressure conversion: V (Voltage) = (0.08 x Pressure) + 1 4. Operate the machine and check if the pressure value indicated on the gauge panel is changed according to changes in the pressure. If any of the above problem occurs, the pressure sensor is faulty and needs to be replaced.
5	Faulty EPOS	If the harness and pressure sensor are correctly connected: 1. If the proper sensor voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced. Check if the pressure sensor signal is correctly applied to the EPOS. →Measure the voltage at the front of the EPOS connector to check if voltage in the correct output range is applied.

Figure 82

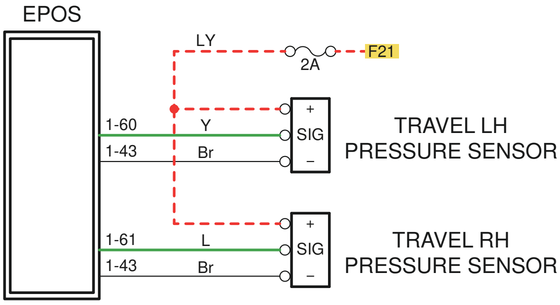


DS1902359

If the pedal pressure sensor malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 83



DS2002098

41. VSP013 Travel Pressure Sensor (RH)

Action Level	Failure Code	Failure	Travel Pressure Sensor (RH)
Gauge Panel	VSP013		
Detail of Failure	FMI 3: The travel pressure sensor (RH), voltage above normal. FMI 4: The travel pressure sensor (RH), voltage below normal.		
Actions of Machine Monitor or Controller	• If the travel pressure sensor (RH) is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• If an exclusive right travel or forward/reverse travel is performed while the right-travel pressure sensor is malfunctioning, the travel operation may slow down or malfunction (fail to travel straight) as the right-travel pressure cannot be detected.		
Related Information	1. The pressure sensor won't operate if it is not supplied with 24 V. 2. The pressure sensor can be severely damaged if its power line and ground line are swapped. 3. The pressure value measured by the pressure sensor can be checked on the monitoring menu screen of the gauge panel. A. Features of pressure sensor 1) Operating voltage: 24 V ±10% 2) Operating current: max. 20 mA 3) Output voltage: 1 ~ 5 V		

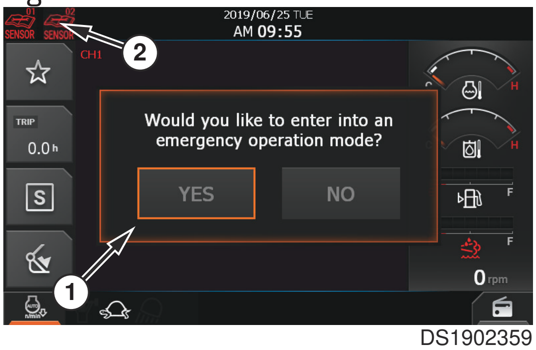
Action Level	Failure Code	Failure	Travel Pressure Sensor (RH)
Gauge Panel	VSP013		
	4) Measuring pressure: 0 to 50 bar 5) Measurement tolerance: ±3%		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the pressure sensor is correctly connected. 2. Check that the terminal No. 2 of the pressure sensor connector is correctly supplied with 24 V. 3. Check the condition of the power supply terminal of the pressure sensor.
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the power supply and pressure sensor connector terminal No. 2. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the ground terminal and pressure sensor connector terminal No. 1. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 4. Test for an open circuit in the harness between the EPOS and pressure sensor connector terminal No. 3. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and pressure sensor. A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Pressure Sensor	Measure the output voltage of the pressure sensor. 1. Check if the output voltage is 1 V when it is connected under unloaded condition.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		2. Check if the output voltage of the pressure sensor is between 1 V and 5 V while the machine is in operation. 3. Check if the voltage value measured at the pressure sensor is matched with the pressure indicated on the gauge panel. A. Formula for voltage-pressure conversion: V (Voltage) = (0.08 x Pressure) + 1 4. Operate the machine and check if the pressure value indicated on the gauge panel is changed according to changes in the pressure. If any of the above problem occurs, the pressure sensor is faulty and needs to be replaced.
5	Faulty EPOS	If the harness and pressure sensor are correctly connected: 1. Check if the pressure sensor signal is correctly applied to the EPOS. →Measure the voltage at the front of the EPOS connector to check if voltage in the correct output range is applied. If the proper sensor voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

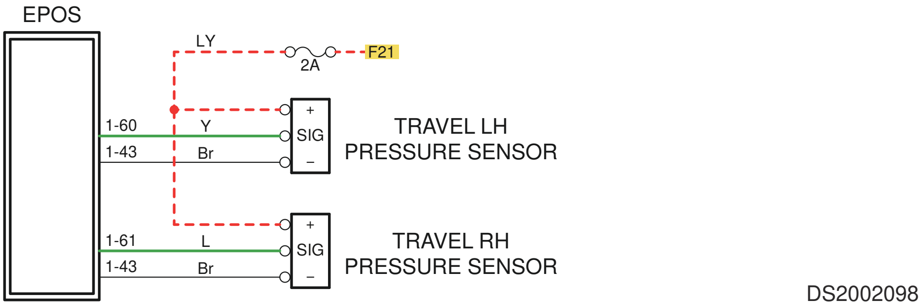
Figure 84



If the pedal pressure sensor malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 85



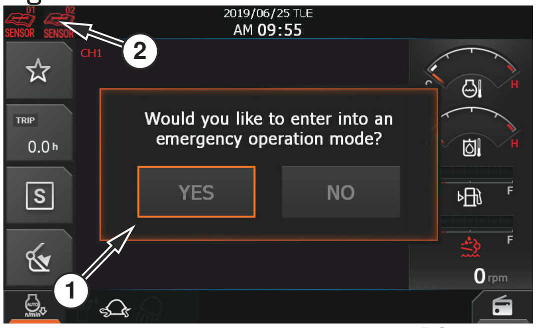
42. VSP014 Swing Pressure Sensor

Action Level	Failure Code	Failure	Swing Pressure Sensor
Gauge Panel	VSP014		
Detail of Failure	FMI 3: The swing pressure sensor, voltage above normal. FMI 4: The swing pressure sensor, voltage below normal.		
Actions of Machine Monitor or Controller	• If the swing pressure sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• When the swing pressure sensor is malfunctioning, the swing operation may slow down or malfunction as the swing pressure cannot be detected.		
Related Information	1. The pressure sensor won't operate if it is not supplied with 24 V. 2. The pressure sensor can be severely damaged if its power line and ground line are swapped. 3. The pressure value measured by the pressure sensor can be checked on the monitoring menu screen of the gauge panel. A. Features of pressure sensor 1) Operating voltage: 24 V ±10% 2) Operating current: max. 20 mA 3) Output voltage: 1 ~ 5 V 4) Measuring pressure: 0 to 50 bar 5) Measurement tolerance: ±3%		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the pressure sensor is correctly connected. 2. Check that the terminal No. 2 of the pressure sensor connector is correctly supplied with 24 V. 3. Check the condition of the power supply terminal of the pressure sensor.
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the power supply and pressure sensor connector terminal No. 2. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the ground terminal and pressure sensor connector terminal No. 1.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 4. Test for an open circuit in the harness between the EPOS and pressure sensor connector terminal No. 3. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and pressure sensor. A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Pressure Sensor	Measure the output voltage of the pressure sensor. 1. Check if the output voltage is 1 V when it is connected under unloaded condition. 2. Check if the output voltage of the pressure sensor is between 1 V and 5 V while the machine is in operation. 3. Check if the voltage value measured at the pressure sensor is matched with the pressure indicated on the gauge panel. A. Formula for voltage-pressure conversion: V (Voltage) = (0.08 x Pressure) + 1 4. Operate the machine and check if the pressure value indicated on the gauge panel is changed according to changes in the pressure. If any of the above problem occurs, the pressure sensor is faulty and needs to be replaced.
5	Faulty EPOS	If the harness and pressure sensor are correctly connected: 1. Check if the pressure sensor signal is correctly applied to the EPOS. → Measure the voltage at the front of the EPOS connector to check if voltage in the correct output range is applied. If the proper sensor voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced.

Figure 86

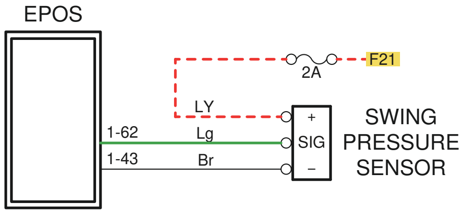


DS1902359

If the joystick sensor malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 87



DS2002099

43. VSP017 Option Pedal 1 Pressure Sensor

Action Level	Failure Code	Failure	Option Pedal 1 Pressure Sensor
Gauge Panel	VSP017		
Detail of Failure	FMI 3: The option pedal 1 pressure sensor, voltage above normal. FMI 4: The option pedal 1 pressure sensor, voltage below normal.		
Actions of Machine Monitor or Controller	• If the option pedal 1 pressure sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• If the option pedal 1 pressure sensor is malfunctioning, the option may function abnormally. • When the option pedal is operated, the option (attachment) may not work or may function abnormally.		
Related Information	1. The pressure sensor won't operate if it is not supplied with 24 V. 2. The pressure sensor can be severely damaged if its power line and ground line are swapped. 3. The pressure value measured by the pressure sensor can be checked on the monitoring menu screen of the gauge panel. A. Features of pressure sensor 1) Operating voltage: 24 V ±10% 2) Operating current: max. 20 mA 3) Output voltage: 1 ~ 5 V 4) Measuring pressure: 0 to 50 bar		

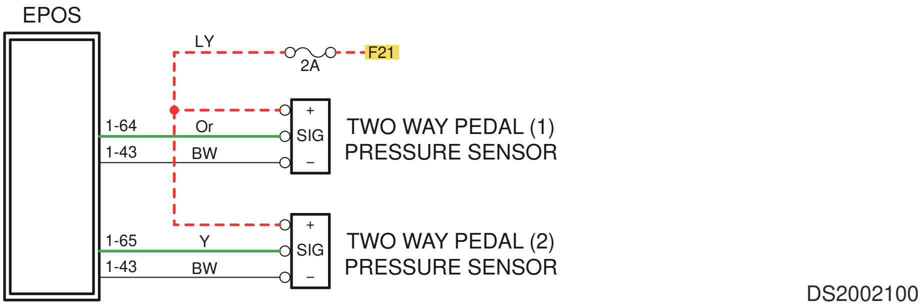
Action Level	Failure Code	Failure	Option Pedal 1 Pressure Sensor
Gauge Panel	VSP017		
	5) Measurement tolerance: ±3%		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the pressure sensor is correctly connected. 2. Check that the terminal No.2 of the pressure sensor connector is correctly supplied with 24 V. 3. Check the condition of the power supply terminal of the pressure sensor.
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the power supply and pressure sensor connector terminal No. 2. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the ground terminal and pressure sensor connector terminal No. 1. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 4. Test for an open circuit in the harness the EPOS and pressure sensor connector terminal No. 3. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and pressure sensor. A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Pressure Sensor	Measure the output voltage of the pressure sensor. 1. Check if the output voltage is 1 V when it is connected under unloaded condition.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		2. Check if the output voltage of the pressure sensor is between 1 V and 5 V while the machine is in operation. 3. Check if the voltage value measured at the pressure sensor is matched with the pressure indicated on the gauge panel. A. Formula for voltage-pressure conversion: V (Voltage) = (0.08 x Pressure) + 1 4. Operate the machine and check if the pressure value indicated on the gauge panel is changed according to changes in the pressure. If any of the above problem occurs, the pressure sensor is faulty and needs to be replaced.
5	Faulty EPOS	If the harness and pressure sensor are correctly connected: 1. Check if the pressure sensor signal is correctly applied to the EPOS. →Measure the voltage at the front of the EPOS connector to check if voltage in the correct output range is applied. If the proper sensor voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced.

Block Diagram

Figure 88



44. VSP018 Option Pedal 2 Pressure Sensor

Action Level	Failure Code	Failure	Option Pedal 2 Pressure Sensor
Gauge Panel	VSP018		
Detail of Failure	FMI 3: The option pedal 2 pressure sensor, voltage above normal. FMI 4: The option pedal 2 pressure sensor, voltage below normal.		
Actions of Machine Monitor or Controller	• If the option pedal 2 pressure sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• If the option pedal 2 pressure sensor is malfunctioning, the option may function abnormally. • When the option pedal is operated, the option (attachment) may not work or may function abnormally.		

Action Level	Failure Code	Failure	Option Pedal 2 Pressure Sensor
Gauge Panel	VSP018		

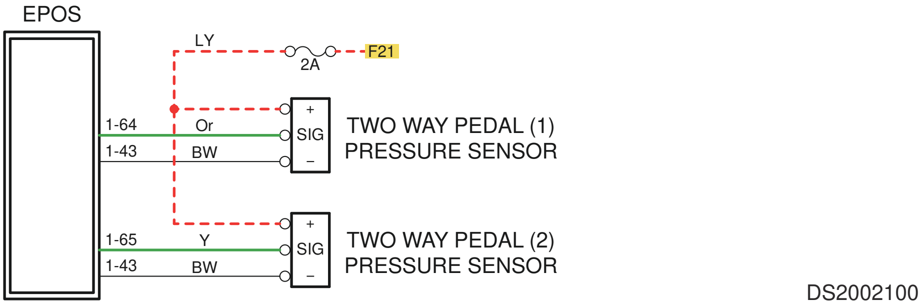
Related Information	1. The pressure sensor won't operate if it is not supplied with 24 V. 2. The pressure sensor can be severely damaged if its power line and ground line are swapped. 3. The pressure value measured by the pressure sensor can be checked on the monitoring menu screen of the gauge panel. A. Features of pressure sensor 1) Operating voltage: 24 V ±10% 2) Operating current: max. 20 mA 3) Output voltage: 1 ~ 5 V 4) Measuring pressure: 0 to 50 bar 5) Measurement tolerance: ±3%

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the pressure sensor is correctly connected. 2. Check that the terminal No.2 of the pressure sensor connector is correctly supplied with 24 V. 3. Check the condition of the power supply terminal of the pressure sensor.
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the power supply and pressure sensor connector terminal No. 2. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the ground terminal and pressure sensor connector terminal No. 1. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 4. Test for an open circuit in the harness between the EPOS and pressure sensor connector terminal No. 3. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		B. If the resistance between the wires measures 0 Ω, the wires are correctly connected.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and pressure sensor. A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Pressure Sensor	Measure the output voltage of the pressure sensor. 1. Check if the output voltage is 1 V when it is connected under unloaded condition. 2. Check if the output voltage of the pressure sensor is between 1 V and 5 V while the machine is in operation. 3. Check if the voltage value measured at the pressure sensor is matched with the pressure indicated on the gauge panel. A. Formula for voltage-pressure conversion: V (Voltage) = (0.08 x Pressure) + 1 4. Operate the machine and check if the pressure value indicated on the gauge panel is changed according to changes in the pressure. If any of the above problem occurs, the pressure sensor is faulty and needs to be replaced.
5	Faulty EPOS	If the harness and pressure sensor are correctly connected: 1. Check if the pressure sensor signal is correctly applied to the EPOS. →Measure the voltage at the front of the EPOS connector to check if voltage in the correct output range is applied. If the proper sensor voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced.

Block Diagram

Figure 89



45. VSP020 RCW Pressure Sensor

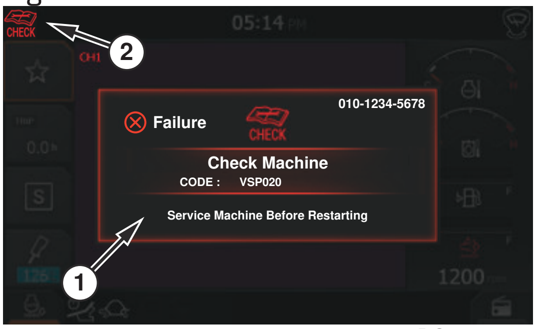
Action Level	Failure Code	Failure	RCW Pressure Sensor
Gauge Panel	VSP020		
Detail of Failure	FMI 3: The RCW pressure sensor, voltage above normal. FMI 4: The RCW pressure sensor, voltage below normal.		
Actions of Machine Monitor or Controller	• If the RCW pressure senor is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the RCW pressure senor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• If the RCW pressure sensor is malfunctioning, the option may function abnormally when the RCW switch is released.		
Related Information	1. The pressure sensor won't operate if it is not supplied with 5 V. 2. The pressure sensor can be severely damaged if its power line and ground line are swapped. 3. The pressure value measured by the pressure sensor can be checked on the monitoring menu screen of the gauge panel. A. Features of pressure sensor 1) Operating voltage: 5 V ±5% 2) Operating current: max. 10 mA 3) Output voltage: 1 ~ 5 V 4) Measuring pressure: 0 to 500 bar 5) Measurement tolerance: ±1.5%		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the pressure sensor is correctly connected. 2. Check that the terminal No.1 of the pressure sensor connector is correctly supplied with 5 V. 3. Check the condition of the power supply terminal of the pressure sensor.
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the power supply and pressure sensor connector terminal No. 1. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		3. Test for an open circuit in the harness between the ground terminal and pressure sensor connector terminal No. 3. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 4. Test for an open circuit in the harness between the EPOS and pressure sensor connector terminal No. 2. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and pressure sensor. A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Pressure Sensor	Measure the output voltage of the pressure sensor. 1. Check if the output voltage is 1 V when it is connected under unloaded condition. 2. Check if the output voltage of the pressure sensor is between 1 V and 5 V while the machine is in operation. 3. Check if the voltage value measured at the pressure sensor is matched with the pressure indicated on the gauge panel. A. Formula for voltage-pressure conversion: V (Voltage) = (0.00816 x Pressure) + 1 4. Operate the machine and check if the pressure value indicated on the gauge panel is changed according to changes in the pressure. If any of the above problem occurs, the pressure sensor is faulty and needs to be replaced.
5	Faulty EPOS	If the harness and pressure sensor are correctly connected: 1. Check if the pressure sensor signal is correctly applied to the EPOS. →Measure the voltage at the front of the EPOS connector to check if voltage in the correct output range is applied. If the proper sensor voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 90

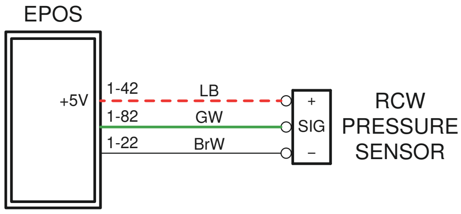


DS1903585

If the RCW pressure sensor malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 91



DS2002101

46. VSP045 Boom Up Summation Pressure Sensor

<table>
<tr><th>Action Level</th><th>Failure Code</th><th rowspan="2">Failure</th><th rowspan="2">Boom Up Summation Pressure Sensor</th></tr>
<tr><th>Gauge Panel</th><th>VSP045</th></tr>
<tr><td>Detail of Failure</td><td colspan="3">FMI 3: The boom up summation pressure sensor, voltage above normal.
FMI 4: The boom up summation pressure sensor, voltage below normal.</td></tr>
<tr><td>Actions of Machine Monitor or Controller</td><td colspan="3">• If the boom up summation pressure sensor is malfunctioning, the "Check the machine" popup and warning symbol will be displayed on the main screen of the gauge panel.
• If the boom up summation pressure sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.</td></tr>
<tr><td>Problem on Machine</td><td colspan="3">• Boom up / arm crowd / bucket crowd operations may slow down or malfunction.</td></tr>
<tr><td>Related Information</td><td colspan="3">1. If the boom up summation pressure sensor is malfunctioning, EPPR valve of arm crowd summation, bucket crowd summation, arm lock and safety cutoff 2 solenoid valve are cut off.
2. The pressure sensor won't operate if it is not supplied with 5 V.
3. The pressure sensor can be severely damaged if its power line and ground line are swapped.
4. The pressure value measured by the pressure sensor can be checked on the monitoring menu screen of the gauge panel.
A. Features of pressure sensor
1) Operating voltage: 5 V ±10%</td></tr>
</table>

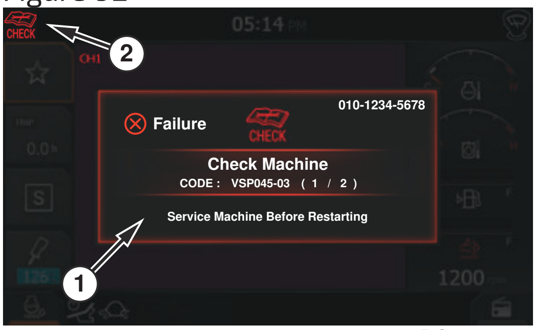
Action Level	Failure Code	Failure	Boom Up Summation Pressure Sensor
Gauge Panel	VSP045		
	2) Operating current: max. 10 mA 3) Output voltage: 0.5 ~ 4.5 V 4) Measuring pressure: 0 ~ 50 bar 5) Measurement tolerance: ±2%		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the pressure sensor is correctly connected. 2. Check that the terminal No.1 of the pressure sensor connector is correctly supplied with 5 V. 3. Check the condition of the power supply terminal of the pressure sensor.
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the power supply and pressure sensor connector terminal No. 1. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the ground terminal and pressure sensor connector terminal No. 3. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 4. Test for an open circuit in the harness between the EPOS and pressure sensor connector terminal No. 2. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and pressure sensor. A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Pressure Sensor	Measure the output voltage of the pressure sensor.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		1. Check if the output voltage is 0.5 V when it is connected under unloaded condition. 2. Check if the output voltage of the pressure sensor is between 0.5 V and 4.5 V while the machine is in operation. 3. Check if the voltage value measured at the pressure sensor is matched with the pressure indicated on the gauge panel. A. Formula for voltage-pressure conversion: V (Voltage) = (0.08 x Pressure) + 1 4. Operate the machine and check if the pressure value indicated on the gauge panel is changed according to changes in the pressure. If any of the above problem occurs, the pressure sensor is faulty and needs to be replaced.
5	Faulty EPOS	If the harness and pressure sensor are correctly connected: 1. Check if the pressure sensor signal is correctly applied to the EPOS. →Measure the voltage at the front of the EPOS connector to check if voltage in the correct output range is applied. If the proper sensor voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 92

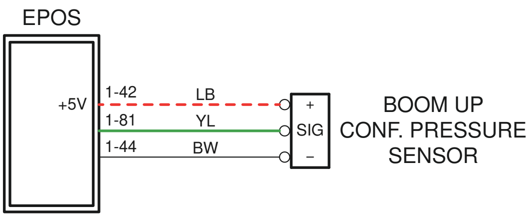


DS2002423

If the boom up summation pressure sensor malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 93



DS2002102

47. VSP046 Arm Crowd Summation Pressure Sensor

Action Level	Failure Code	Failure	Arm Crowd Summation Pressure Sensor
Gauge Panel	VSP046		

Detail of Failure	FMI 3: The arm crowd summation pressure sensor, voltage above normal. FMI 4: The arm crowd summation pressure sensor, voltage below normal.
Actions of Machine Monitor or Controller	• If the arm crowd summation pressure sensor is malfunctioning, the "Check the machine" popup and warning symbol will be displayed on the main screen of the gauge panel. • If the arm crowd summation pressure sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.
Problem on Machine	• Boom up / arm crowd / bucket crowd operations may slow down or malfunction.
Related Information	1. If the arm crowd summation pressure sensor is malfunctioning, EPPR valve of boom up summation, bucket crowd summation, arm lock and safety cutoff 2 solenoid valve are cut off. 2. The pressure sensor won't operate if it is not supplied with 5 V. 3. The pressure sensor can be severely damaged if its power line and ground line are swapped. 4. The pressure value measured by the pressure sensor can be checked on the monitoring menu screen of the gauge panel. A. Features of pressure sensor 1) Operating voltage: 5 V ±10% 2) Operating current: max. 10 mA 3) Output voltage: 0.5 ~ 4.5 V 4) Measuring pressure: 0 ~ 50 bar 5) Measurement tolerance: ±2%

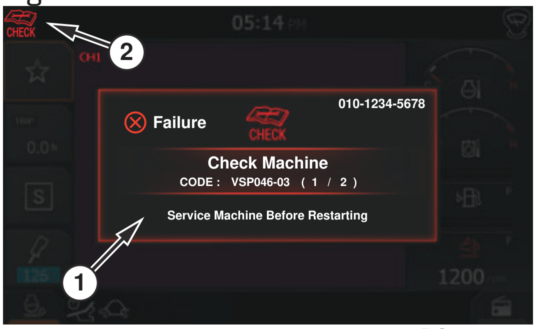
No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the pressure sensor is correctly connected. 2. Check that the terminal No.1 of the pressure sensor connector is correctly supplied with 5 V. 3. Check the condition of the power supply terminal of the pressure sensor.
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the power supply and pressure sensor connector terminal No. 1. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the ground terminal and pressure sensor connector terminal No. 3. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 4. Test for an open circuit in the harness between the EPOS and pressure sensor connector terminal No. 2. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and pressure sensor. A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Pressure Sensor	Measure the output voltage of the pressure sensor. 1. Check if the output voltage is 0.5 V when it is connected under unloaded condition. 2. Check if the output voltage of the pressure sensor is between 0.5 V and 4.5 V while the machine is in operation. 3. Check if the voltage value measured at the pressure sensor is matched with the pressure indicated on the gauge panel. A. Formula for voltage-pressure conversion: V (Voltage) = (0.08 x Pressure) + 1 4. Operate the machine and check if the pressure value indicated on the gauge panel is changed according to changes in the pressure. If any of the above problem occurs, the pressure sensor is faulty and needs to be replaced.
5	Faulty EPOS	If the harness and pressure sensor are correctly connected: 1. Check if the pressure sensor signal is correctly applied to the EPOS. →Measure the voltage at the front of the EPOS connector to check if voltage in the correct output range is applied.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		If the proper sensor voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 94

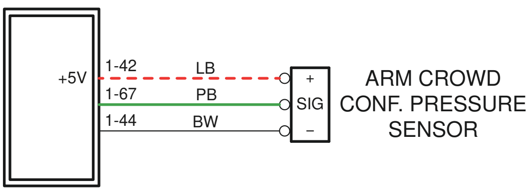


DS2002424

If the arm crowd summation pressure sensor malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 95



DS2002103

48. VSP047 Bucket Crowd Summation Pressure Sensor

Action Level	Failure Code	Failure	Bucket Crowd Summation Pressure Sensor
Gauge Panel	VSP047		
Detail of Failure	FMI 3: The bucket crowd summation pressure sensor, voltage above normal. FMI 4: The bucket crowd summation pressure sensor, voltage below normal.		
Actions of Machine Monitor or Controller	• If the bucket crowd summation pressure sensor is malfunctioning, the "Check the machine" popup and warning symbol will be displayed on the main screen of the gauge panel. • If the bucket crowd summation pressure sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• Boom up / arm crowd / bucket crowd operations may slow down or malfunction.		
Related Information	1. If the bucket crowd summation pressure sensor is malfunctioning, EPPR valve of boom up summation, arm crowd summation, arm lock and safety cutoff 2 solenoid valve are cut off. 2. The pressure sensor won't operate if it is not supplied with 5 V.		

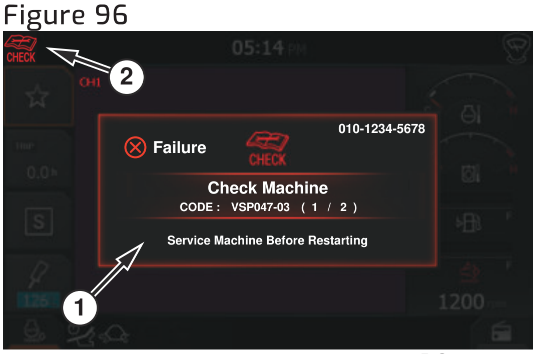
<table>
<tr><th>Action Level</th><th>Failure Code</th><th rowspan="2">Failure</th><th rowspan="2">Bucket Crowd Summation Pressure Sensor</th></tr>
<tr><th>Gauge Panel</th><th>VSP047</th></tr>
<tr><td></td><td colspan="3">3. The pressure sensor can be severely damaged if its power line and ground line are swapped.
4. The pressure value measured by the pressure sensor can be checked on the monitoring menu screen of the gauge panel.
A. Features of pressure sensor
1) Operating voltage: 5 V ±10%
2) Operating current: max. 10 mA
3) Output voltage: 0.5 ~ 4.5 V
4) Measuring pressure: 0 ~ 50 bar
5) Measurement tolerance: ±2%</td></tr>
</table>

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the pressure sensor is correctly connected. 2. Check that the terminal No.1 of the pressure sensor connector is correctly supplied with 5 V. 3. Check the condition of the power supply terminal of the pressure sensor.
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the power supply and pressure sensor connector terminal No. 1. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the ground terminal and pressure sensor connector terminal No. 3. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 4. Test for an open circuit in the harness between the EPOS and pressure sensor connector terminal No. 2. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and pressure sensor. A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Pressure Sensor	Measure the output voltage of the pressure sensor. 1. Check if the output voltage is 0.5 V when it is connected under unloaded condition. 2. Check if the output voltage of the pressure sensor is between 0.5 V and 4.5 V while the machine is in operation. 3. Check if the voltage value measured at the pressure sensor is matched with the pressure indicated on the gauge panel. A. Formula for voltage-pressure conversion: V (Voltage) = (0.08 x Pressure) + 1 4. Operate the machine and check if the pressure value indicated on the gauge panel is changed according to changes in the pressure. If any of the above problem occurs, the pressure sensor is faulty and needs to be replaced.
5	Faulty EPOS	If the harness and pressure sensor are correctly connected: 1. Check if the pressure sensor signal is correctly applied to the EPOS. →Measure the voltage at the front of the EPOS connector to check if voltage in the correct output range is applied. If the proper sensor voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 96

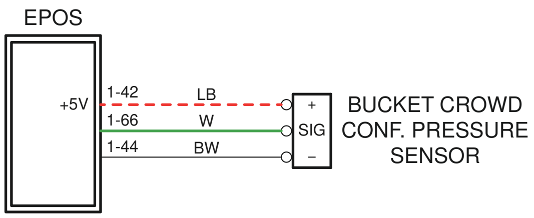


DS2002425

If the bucket crowd summation pressure sensor malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 97



DS2002105

49. VSP048 Arm Lock Summation Pressure Sensor

Action Level	Failure Code	Failure	Arm Lock Summation Pressure Sensor
Gauge Panel	VSP048		

Detail of Failure	FMI 3: The arm lock pressure sensor, voltage above normal. FMI 4: The arm lock pressure sensor, voltage below normal.
Actions of Machine Monitor or Controller	• If the arm lock pressure sensor is malfunctioning, the "Check the machine" popup and warning symbol will be displayed on the main screen of the gauge panel. • If the arm lock pressure sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.
Problem on Machine	• Boom up / arm crowd / bucket crowd operations may slow down or malfunction.
Related Information	1. If the arm lock pressure sensor is malfunctioning, EPPR valve of boom up summation, arm crowd summation, bucket crowd and safety cutoff 2 solenoid valve are cut off. 2. The pressure sensor won't operate if it is not supplied with 5 V. 3. The pressure sensor can be severely damaged if its power line and ground line are swapped. 4. The pressure value measured by the pressure sensor can be checked on the monitoring menu screen of the gauge panel. A. Features of pressure sensor 1) Operating voltage: 5 V ±10% 2) Operating current: max. 10 mA 3) Output voltage: 0.5 ~ 4.5 V 4) Measuring pressure: 0 ~ 50 bar 5) Measurement tolerance: ±2%

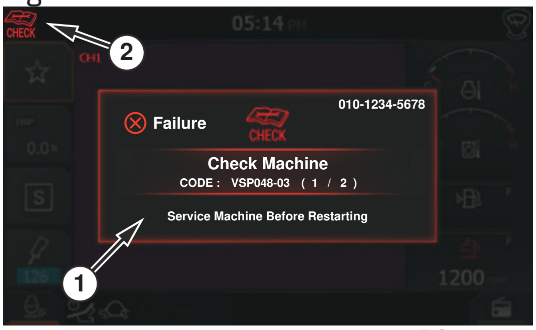
No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the pressure sensor is correctly connected. 2. Check that the terminal No.1 of the pressure sensor connector is correctly supplied with 5 V. 3. Check the condition of the power supply terminal of the pressure sensor.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the power supply and pressure sensor connector terminal No. 1. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the ground terminal and pressure sensor connector terminal No. 3. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 4. Test for an open circuit in the harness between the EPOS and pressure sensor connector terminal No. 2. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wires are correctly connected.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and pressure sensor. A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Pressure Sensor	Measure the output voltage of the pressure sensor. 1. Check if the output voltage is 0.5 V when it is connected under unloaded condition. 2. Check if the output voltage of the pressure sensor is between 0.5 V and 4.5 V while the machine is in operation. 3. Check if the voltage value measured at the pressure sensor is matched with the pressure indicated on the gauge panel. A. Formula for voltage-pressure conversion: V (Voltage) = (0.08 x Pressure) + 1 4. Operate the machine and check if the pressure value indicated on the gauge panel is changed according to changes in the pressure. If any of the above problem occurs, the pressure sensor is faulty and needs to be replaced.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
5	Faulty EPOS	If the harness and pressure sensor are correctly connected: 1. Check if the pressure sensor signal is correctly applied to the EPOS. →Measure the voltage at the front of the EPOS connector to check if voltage in the correct output range is applied. If the proper sensor voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 98

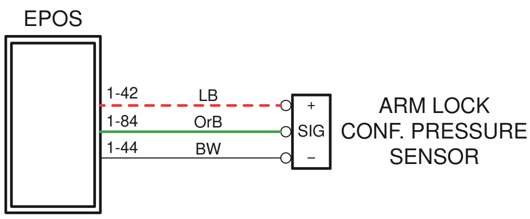


DS2002426

If the arm lock pressure sensor malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 99



DS2002104

50. VSE001 Oil Temperature Sensor

Action Level	Failure Code	Failure	Oil Temperature Sensor
Gauge Panel	VSE001		
Detail of Failure	FMI 0: The oil temperature sensor, signal above normal range. FMI 3: The oil temperature sensor, voltage above normal. FMI 4: The oil temperature sensor, voltage below normal.		
Actions of Machine Monitor or Controller	• If the oil temperature sensor is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the oil temperature sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• The operating oil gauge may operate abnormally or may not operate at all if the oil temperature sensor is defective.		

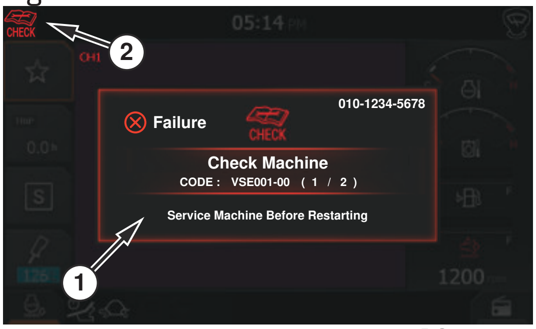
Action Level	Failure Code	Failure	Oil Temperature Sensor
Gauge Panel	VSE001		
	• The operating oil gauge's needle may be fixed to the left/right end position if the oil temperature sensor is defective.		
Related Information	1. Oil temperature sensor measurement A. Features of oil temperature sensor: 1) 25 degrees: 2,450 ±250 Ω 2) 80 degrees: 320 ±32 Ω		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Check that the connector of the sensor is correctly connected. 3. Check connection of the sensor connector terminal No. 1 and EPOS terminal. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 4. Check connection of the sensor connector terminal No. 2 and EPOS terminal A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct.
2	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and sensor. A. Check the power source, ground, and signal line for any short circuit.
3	Faulty Temperature Sensor	Measure the resistance of the sensor. 1. Measure the resistance at 25°C. 2. Measure the resistance at 80°C. 3. While operating the machine, check if the resistance value changes according to changes of temperature.
4	Faulty EPOS	If the harness and temperature sensor are correctly connected: 1. Check if the temperature sensor signal is correctly applied to the EPOS. → Measure the voltage at the front of the EPOS connector to check if voltage in the correct output range is applied.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		If the proper sensor voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 100

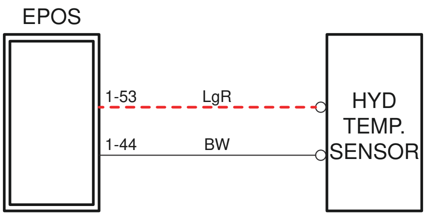


DS1901678

If the oil temperature sensor malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 101



DS2002087

51. VSE002 Fuel Sensor

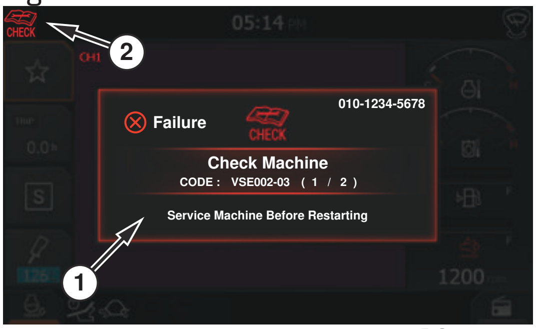
Action Level	Failure Code	Failure	Fuel Sensor
Gauge Panel	VSE002		
Detail of Failure	FMI 3: The fuel sensor, voltage above normal. FMI 4: The fuel sensor, voltage below normal.		
Actions of Machine Monitor or Controller	• If the fuel sensor is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the fuel sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• The fuel gauge may operate abnormally or may not operate at all if the fuel sensor is defective. • The fuel gauge's needle may be fixed to the left/right end position if the fuel sensor is defective.		
Related Information	1. Fuel sensor measurement. A. Features of fuel sensor: 1) Full: 500 Ω ±1.5%		

Action Level	Failure Code	Failure	Fuel Sensor
Gauge Panel	VSE002		
	2) Empty: 5000 Ω ±1.5%		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Check that the connector of the sensor is correctly connected. 3. Check connection of the sensor connector terminal No. 1 and EPOS terminal. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 4. Check connection of the sensor connector terminal No. 2 and EPOS terminal. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct.
2	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and sensor. A. Check the power source, ground, and signal line for any short circuit.
3	Faulty Temperature Sensor	Measure the resistance of the sensor. 1. Measure the resistance with the full fuel tank. 2. Measure the resistance with the empty fuel tank. 3. Remove the fuel sensor and move the float to check that the resistance is changed according to changes in float position.
4	Faulty EPOS	If the harness and fuel sensor are correctly connected. 1. Check if the fuel sensor signal is correctly applied to the EPOS. → Measure the voltage at the front of the EPOS connector to check if voltage in the correct output range is applied. If the proper sensor voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 102

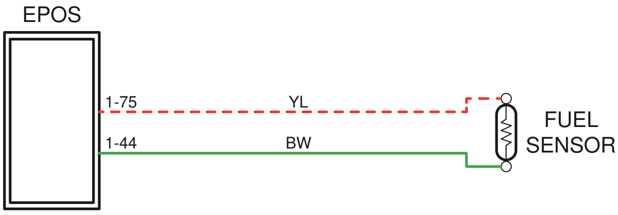


DS1901679

If the fuel sensor malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 103



DS2002088

52. VSE004 WIF Sensor

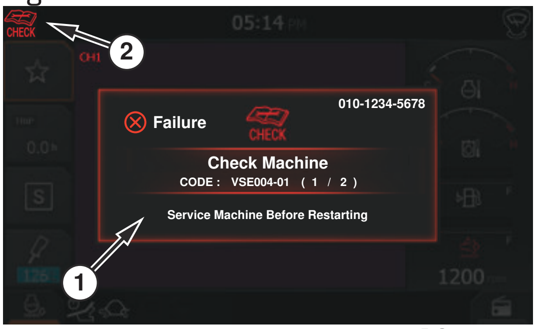
Action Level	Failure Code	Failure	WIF Sensor
Gauge Panel	VSE004		
Detail of Failure	FMI 1: Water in fuel detected. FMI 3: The WIF sensor, voltage above normal. FMI 4: The WIF sensor, voltage below normal.		
Actions of Machine Monitor or Controller	• If the WIF sensor is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the WIF sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• The WIF warning symbol may appear on the gauge panel if the WIF sensor is defective. • The buzzer may sound if the WIF sensor is defective. • Once the WIF warning symbol keeps on for 30 minutes, the engine RPM is derated.		
Related Information	1. The sensor can be severely damaged if its power line and ground line are swapped. A. WIF sensor characteristics: 1) Operating voltage: 24 V ±10% 2) If WIF sensor does not detect water: approx. 3.7 V 3) If WIF sensor detects water: approx. 1.3 V		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the sensor is correctly connected. 2. Check that the terminal No. 1 of the sensor connector is correctly supplied with 5 V. 3. Check the fuse box condition for power supply of the sensor.
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the fuse box and sensor connector terminal No. 1. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the ground terminal and sensor connector terminal No. 3. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 4. Test for an open circuit in the harness between the EPOS and sensor connector terminal No. 2. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and sensor. A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Sensor	Measure the output voltage of the sensor. 1. Check if the output voltage is approx. 3.7 V without water detection. 2. Check if the output voltage is approx. 1.3 V with water detection.
5	Faulty EPOS	If the harness and WIF sensor are correctly connected: 1. Check if the sensor signal is correctly applied to the EPOS. → Measure the voltage at the front of the EPOS connector to check if voltage in the correct output range is applied.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		If the proper sensor voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced.
6	Failure to Remove Water	1. Check if water inside the fuel of the WIF sensor is removed.

Pop-ups, Warning Symbols and Indicators

Figure 104

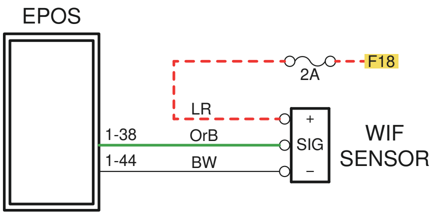


DS1901680

If the WIF sensor malfunctions or a connection warning symbol (2) lights up at the top left of the gauge panel.error occurs, an error message (1) pops up and the relevant.

Block Diagram

Figure 105



DS2002089

53. VSE007 Angle Sensor (A)

Action Level	Failure Code	Failure	Angle Sensor (A)
Gauge Panel	VSE007		
Detail of Failure	FMI 3: The angle sensor (A), voltage above normal. FMI 4: The angle sensor (A), voltage below normal.		
Actions of Machine Monitor or Controller	• If the angle sensor (A) is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the angle sensor (A) is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• The machine may operate abnormally or may not operate at all if the angle sensor (A) defective.		
Related Information	-45°: 0.5 V ±0.025 V0° : 2.5 V ±0.05 V45° : 4.5 V ±0.025 V 1. The sensor won't operate if it is not supplied with 24 V. 2. The sensor can be severely damaged if its power line and ground line are swapped.		

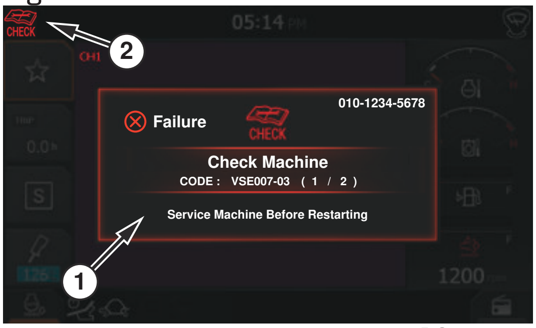
Action Level	Failure Code	Failure	Angle Sensor (A)
Gauge Panel	VSE007		
	A. Features of WIF sensor: 1) Operating voltage: 24 V ±10% 2) Output voltage: 0.5 V ~ 4.5 V		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the sensor is correctly connected. 2. Check that the terminal No. 1 of the sensor connector is correctly supplied with 24 V. 3. Check the fuse box condition for power supply of the sensor.
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the fuse box and sensor connector terminal No. 1. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the ground terminal and sensor connector terminal No. 3. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 4. Test for an open circuit in the harness between the EPOS and sensor connector terminal No. 2. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and sensor. A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Sensor	Measure the output voltage of the sensor. 1. Check if the output voltage range is between 0.5 V and 4.5 V.
5	Faulty EPOS	If the harness and sensor are correctly connected.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		1. Check if the sensor signal is correctly applied to the EPOS. →Measure the voltage at the front of the EPOS connector to check if voltage in the correct output range is applied. If the proper sensor voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 106



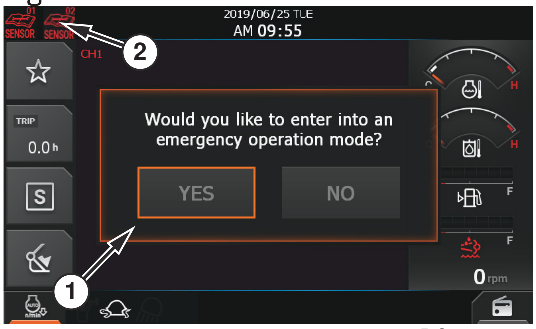
DS1902364

If the angle sensor (A) malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Pop-ups, Warning Symbols and Indicators

If the angle sensor malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

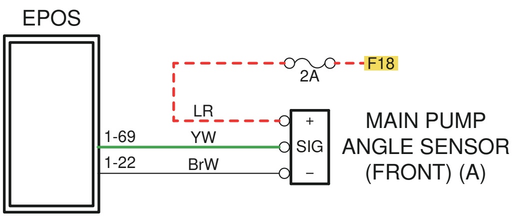
Figure 107



DS1902359

Block Diagram

Figure 108



DS2002090

54. VSE008 Angle Sensor (B)

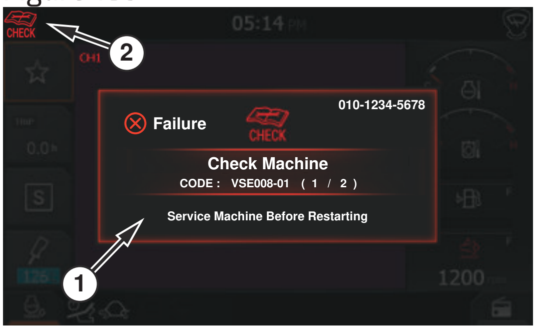
Action Level	Failure Code	Failure	Angle Sensor (B)
Gauge Panel	VSE008		
Detail of Failure	FMI 3: The angle sensor (B), voltage above normal. FMI 4: The angle sensor (B), voltage below normal.		
Actions of Machine Monitor or Controller	• If the angle sensor (B) is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the angle sensor (B) is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• The machine may operate abnormally or may not operate at all if the angle sensor (A) defective.		
Related Information	-45°: 0.5 V ±0.025 V0° : 2.5 V ±0.05 V45° : 4.5 V ±0.025 V 1. The sensor won't operate if it is not supplied with 24 V. 2. The sensor can be severely damaged if its power line and ground line are swapped. A. Features of WIF sensor: 1) Operating voltage: 24 V ±10% 2) Output voltage: 0.5 V ~ 4.5 V		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the sensor is correctly connected. 2. Check that the terminal No. 1 of the sensor connector is correctly supplied with 24 V. 3. Check the fuse box condition for power supply of the sensor.
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the fuse box and sensor connector terminal No. 1. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between the ground terminal and sensor connector terminal No. 3. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		4. Test for an open circuit in the harness between the EPOS and sensor connector terminal No. 2. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and sensor. A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Sensor	Measure the output voltage of the sensor. 1. Check if the output voltage range is between 0.5 V and 4.5 V.
5	Faulty EPOS	If the harness and sensor are correctly connected. 1. Check if the sensor signal is correctly applied to the EPOS. →Measure the voltage at the front of the EPOS connector to check if voltage in the correct output range is applied. If the proper sensor voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 109



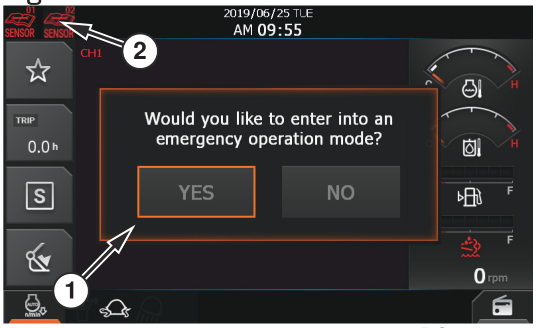
DS1902365

If the angle sensor (B) malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Pop-ups, Warning Symbols and Indicators

If the angle sensor malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

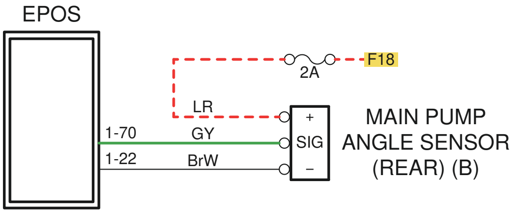
Figure 110



DS1902359

Block Diagram

Figure 111



DS2002091

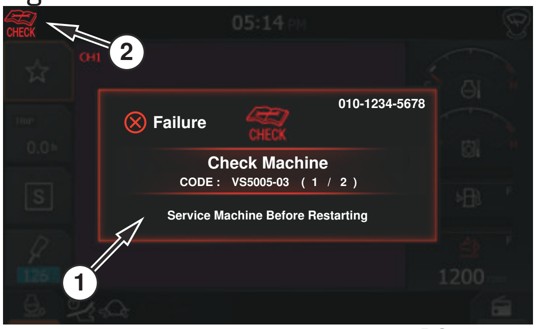
55. VS5005 Dial

Action Level	Failure Code	Failure	Dial
Gauge Panel	VS5005		
Detail of Failure	FMI 3: The dial, voltage above normal. FMI 4: The dial, voltage below normal.		
Actions of Machine Monitor or Controller	• If the dial is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the dial is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• The machine's performance may be degraded if the dial is defective. • The engine RPM may be fixed to a certain value if the dial is defective.		
Related Information	1. The switch won't operate if the dial is not supplied with 5 V. 2. The switch can be severely damaged if the dial's power line and ground line are mixed up. A. Features of dial: 1) 2nd step: 4 V 2) 7th step: 2.5 V 3) 12th step: 1 V		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the dial is correctly connected.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		2. Check that the terminal No. 1 of the dial connector is correctly supplied with 5 V.
2	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the EPOS and dial connector terminal No. 1. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Test for an open circuit in the harness between ground and dial connector terminal No. 3. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 4. Test for an open circuit in the harness between the EPOS and dial connector terminal No. 2. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct.
3	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and dial. A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Sensor	Measure the output voltage of the dial. 1. Measure the voltage while changing the dial's step. 2. Features of dial: A. 2nd step: 4 V B. 7th step: 2.5 V C. 12th step: 1 V
5	Faulty EPOS	If the harness and dial are correctly connected. 1. Check if the dial signal is correctly applied to the EPOS. → Measure the voltage at the front of the EPOS connector to check if voltage in the correct output range is applied. If the proper dial voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced.

Figure 112

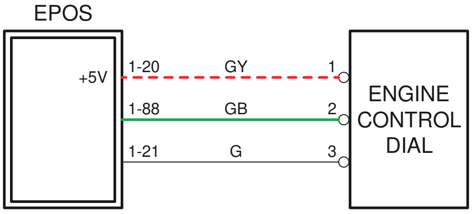


DS1901683

If the engine dial malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 113



DS2002084

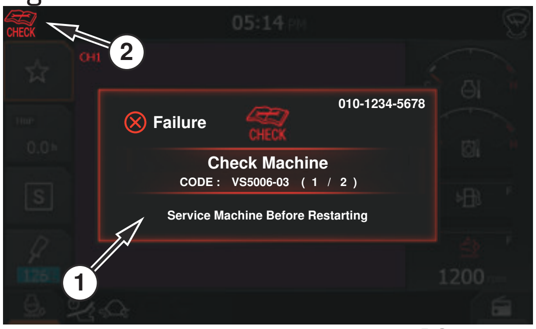
56. VS5006 Machine Controller +5 V Output 1

Action Level	Failure Code	Failure	Machine Controller +5 V Output 1
Gauge Panel	VS5006		
Detail of Failure	FMI 3: The machine controller +5 V output 1, voltage above normal. FMI 4: The machine controller +5 V output 1, voltage below normal.		
Actions of Machine Monitor or Controller	• If the 5 V power 1 output from EPOS is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the 5 V power 1 output from EPOS is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• If the 5 V power output 1 fails, the electrical components that use the power will not operate or will malfunction.		
Related Information	1. The following electrical components will not operate or will malfunction if 5 V power output 1 is not supplied by EPOS. A. Related components 1) Thumb wheel switch (RH/LH) 2) Pump pressure sensor (front/rear) 3) Overload warning pressure sensor 4) RCW pressure sensor 5) Oil temperature sensor 6) Fuel sensor		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Connector Failure	1. Check that the EPOS connector is correctly connected. 2. Check if the 5 V power is correctly output from the EPOS terminal.
2	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and electric device. A. Check the power source, ground, and signal line for any short circuit.
3	Faulty EPOS	If the harness and the EPOS connector are correctly connected: 1. If the 5 V power is not correctly measured in the EPOS terminal, it means that the EPOS is defective and must be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 114

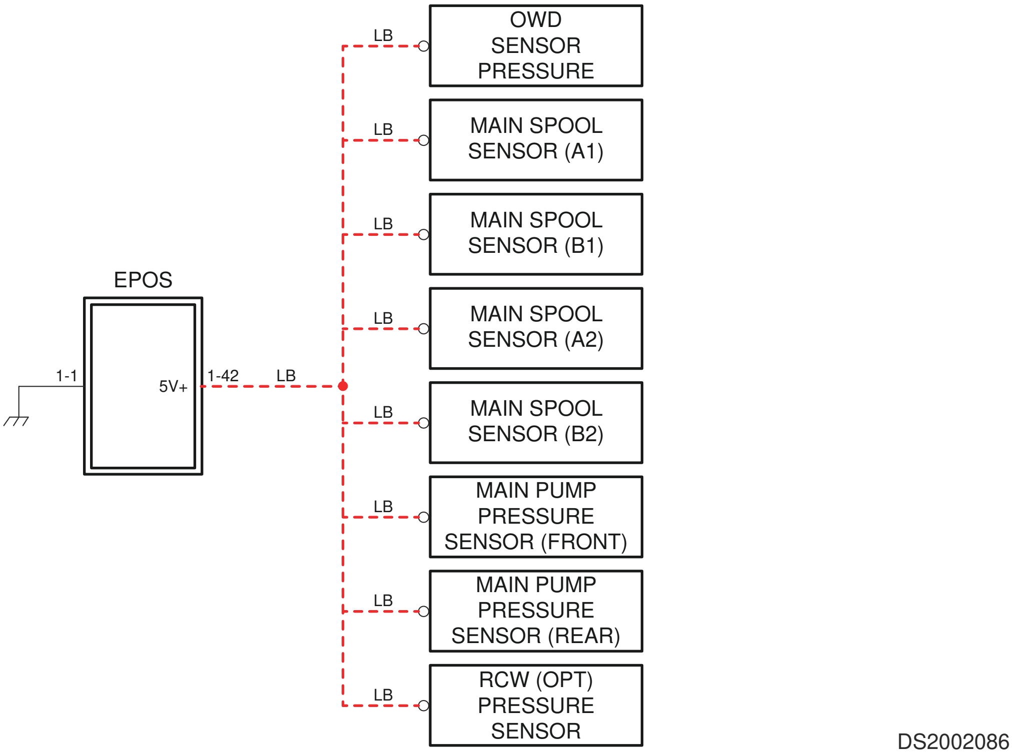


DS1901684

If the Machine controller +5 V output 1 and electrical devices malfunction or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 115



57. VS5007 Machine Controller +5 V Output 2

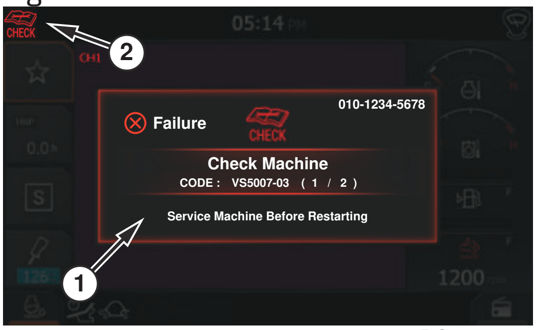
Action Level	Failure Code	Failure	Machine Controller +5 V Output 2
Gauge Panel	VS5007		
Detail of Failure	FMI 3: The machine controller +5 V output 2, voltage above normal. FMI 4: The machine controller +5 V output 2, voltage below normal.		
Actions of Machine Monitor or Controller	• If the 5 V power 2 output from EPOS is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the 5 V power 2 output from EPOS is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• If the 5 V power output 2 is malfunctioning, the electrical components that use the power will not operate or will malfunction.		
Related Information	1. The following electrical components will not operate or will malfunction if the 5 V power output 2 is not supplied by EPOS. A. Related components 1) Engine dial		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Connector Failure	1. Check that the EPOS connector is correctly connected. 2. Check if the 5 V power is correctly output from the EPOS terminal.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
2	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and electric device. A. Check the power source, ground, and signal line for any short circuit.
3	Faulty EPOS	If the harness and the EPOS connector are correctly connected: 1. If the 5 V power is not correctly measured in the EPOS terminal, it means that the EPOS is defective and must be replaced.

Pop-ups, Warning Symbols and Indicators

Figure 116

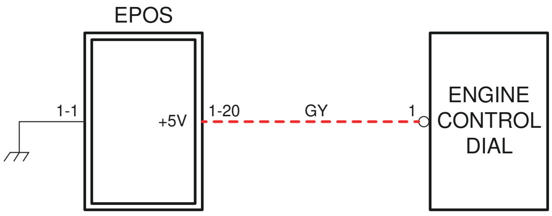


DS1901685

If the Machine controller +5 V output 2 and electrical devices malfunction, or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 117



DS2002085

58. VAL001 Alternator Potential

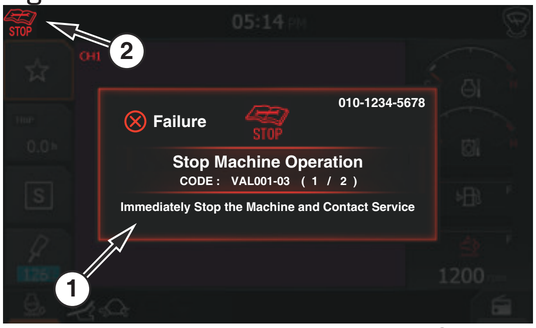
Action Level	Failure Code	Failure	Alternator Potential
Gauge Panel	VAL001		
Detail of Failure	FMI 3: Alternator voltage is above the normal range. FMI 4: Alternator voltage is below the normal range.		
Actions of Machine Monitor or Controller	• If the alternator is malfunctioning, the "Stop the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel.		

Action Level	Failure Code	Failure	Alternator Potential
Gauge Panel	VAL001		
	• If the alternator is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	• The hour meter may operate abnormally if the alternator is defective. • The engine starting status detection logic may function abnormally if the alternator is defective. • The machine performance may be degraded and the warning symbol may appear on the gauge panel if the alternator is defective.		
Related Information	1. An error is determined when the EPOS is not supplied with alternator voltage properly. 2. If the alternator voltage is over 12 V, this is considered as engine starting. 3. In a normal state, the alternator voltage is 27 V ±5 V, but it may change according to the current load.		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Open Circuit in Harness	1. Turn off the master switch of the machine. 2. Test for an open circuit in the harness between the EPOS and alternator. A. Measure the resistance between the wires. → If the measurement is infinite, this indicates an open circuit. B. If the resistance between the wires measures 0 Ω, the wiring is correct. 3. Check that the connectors of the engine harness (alternator) and main harness are correctly connected.
2	Short Circuit in Harness	1. Turn off the master switch of the machine. 2. Perform the harness short circuit test between the EPOS and alternator. A. Check the power source, ground, and signal line for any short circuit.

Pop-ups, Warning Symbols and Indicators

Figure 118

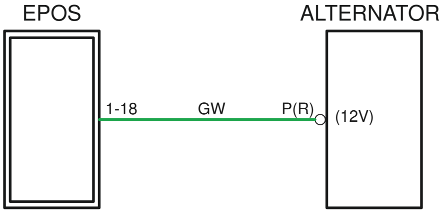


DS1901686

If the alternator malfunctions or a connection error occurs, an error message (1) pops up and the relevant warning symbol (2) lights up at the top left of the gauge panel.

Block Diagram

Figure 119



DS2002069

Engine Error Code

1. Engine Fault Code List

Gauge Panel Fault Code	Fault Code Description	Severity Level
E000020-03	Engine Coolant Pressure: Voltage Above Normal	1
E000020-04	Engine Coolant Pressure: Voltage Below Normal	1
E000020-21	Engine Coolant Pressure: Data Drifted Low	1
E000029-02	Accelerator Pedal Position 2 Data Erratic	1
E000029-03	Accelerator Pedal Position 2 Voltage Above Normal	1
E000029-04	Accelerator Pedal Position 2 Voltage Below Normal	1
E000029-08	Accelerator Pedal Position 2 Abnormal Frequency, Pulse Width, or Period	1
E000091-02	Accelerator Pedal Position 1 Data Erratic	1
E000091-03	Accelerator Pedal Position 1 Voltage Above Normal	1
E000091-04	Accelerator Pedal Position 1 Voltage Below Normal	1
E000091-08	Accelerator Pedal Position 1 Abnormal Frequency, Pulse Width, or Period	1
E000100-01	Engine Oil Pressure: Low - Most Severe (3)	2
E000100-03	Engine Oil Pressure: Voltage Above Normal	1
E000100-04	Engine Oil Pressure: Voltage Below Normal	1

Gauge Panel Fault Code	Fault Code Description	Severity Level
E000100-17	Engine Oil Pressure: Low - Least Severe (1)	1
E000100-18	Engine Oil Pressure: Low - Moderate Severity (2)	1
E000101-03	Engine Crankcase Pressure: Voltage Above Normal	2
E000101-04	Engine Crankcase Pressure: Voltage Below Normal	2
E000101-13	Engine Crankcase Pressure: Out of Calibration	2
E000101-15	Engine Crankcase Pressure: High - Least Severe (1)	2
E000101-16	Engine Crankcase Pressure: High - Moderate Severity (2)	2
E000102-01	Engine Intake Manifold #1 Pressure: Low - Most Severe (3)	2
E000102-18	Engine Intake Manifold #1 Pressure: Low - Moderate Severity (2)	2
E000105-00	Engine Intake Manifold #1 Temperature: High - Most Severe (3)	2
E000105-15	Engine Intake Manifold #1 Temperature: High - Least Severe (1)	2
E000105-16	Engine Intake Manifold #1 Temperature: High - Moderate Severity (2)	2
E000107-03	Engine Air Filter 1 Differential Pressure: Voltage Above Normal	1
E000107-04	Engine Air Filter 1 Differential Pressure: Voltage Below Normal	1
E000107-15	Engine Air Filter 1 Differential Pressure High - Least Severe (1)	1
E000107-16	Engine Air Filter 1 Differential Pressure High - Moderate Severity (2)	2
E000108-03	Barometric Pressure: Voltage Above Normal	2
E000108-04	Barometric Pressure: Voltage Below Normal	2
E000108-21	Barometric Pressure: Data Drifted Low	2
E000110-00	Engine Coolant Temperature: High - Most Severe (3)	2
E000110-03	Engine Coolant Temperature: Voltage Above Normal	1
E000110-04	Engine Coolant Temperature: Voltage Below Normal	1
E000110-15	Engine Coolant Temperature: High - Least Severe (1)	2
E000110-16	Engine Coolant Temperature: High - Moderate Severity (2)	2
E000110-17	Engine Coolant Temperature: Low - Least Severe (1)	0
E000111-01	Engine Coolant Level Low - Most Severe (3)	2
E000111-17	Engine Coolant Level Low - Least Severe (1)	1
E000111-18	Engine Coolant Level Low - Moderate Severity (2)	2
E000152-00	Number of ECU Resets: High - Most Severe (3)	0
E000152-01	Number of ECU Resets: Low - Most Severe (3)	0
E000152-02	Number of ECU Resets: Erratic, Intermittent, or Incorrect	0
E000152-03	Number of ECU Resets: Voltage Above Normal	0
E000152-04	Number of ECU Resets: Voltage Below Normal	0
E000152-05	Number of ECU Resets: Current Below Normal	0
E000152-06	Number of ECU Resets: Current Above Normal	0
E000152-07	Number of ECU Resets: Not Responding Properly	0

Gauge Panel Fault Code	Fault Code Description	Severity Level
E000152-08	Number of ECU Resets: Abnormal Frequency, Pulse Width, or Period	0
E000152-09	Number of ECU Resets: Abnormal Update Rate	0
E000152-10	Number of ECU Resets: Abnormal Rate of Change	0
E000152-11	Number of ECU Resets: Other Failure Mode	0
E000152-12	Number of ECU Resets: Failure	0
E000152-13	Number of ECU Resets: Out of Calibration	0
E000152-14	Number of ECU Resets: Special Instruction	0
E000168-03	Battery Potential / Power Input #1: Voltage Above Normal	1
E000168-04	Battery Potential / Power Input #1: Voltage Below Normal	2
E000171-03	Ambient Air Temperature: Voltage Above Normal	1
E000171-04	Ambient Air Temperature: Voltage Below Normal	1
E000172-03	Engine Air Inlet Temperature: Voltage Above Normal	2
E000172-04	Engine Air Inlet Temperature: Voltage Below Normal	2
E000174-00	Engine Fuel Temperature 1: High - Most Severe (3)	2
E000174-03	Engine Fuel Temperature 1: Voltage Above Normal	0
E000174-04	Engine Fuel Temperature 1: Voltage Below Normal	0
E000174-15	Engine Fuel Temperature 1: High - Least Severe (1)	1
E000174-16	Engine Fuel Temperature 1: High - Moderate Severity (2)	2
E000190-00	Engine Speed: High - Most Severe (3)	2
E000190-08	Engine Speed: Abnormal Frequency, Pulse Width, or Period	1
E000190-15	Engine Speed: High - Least Severe (1)	1
E000411-03	EGR Differential Pressure: Voltage Above Normal	2
E000411-04	EGR Differential Pressure: Voltage Below Normal	2
E000411-13	EGR Differential Pressure: Out of Calibration	2
E000411-15	EGR Differential Pressure: High - Least Severe (1)	2
E000411-17	EGR Differential Pressure: Low - Least Severe (1)	2
E000412-03	EGR Temperature: Voltage Above Normal	2
E000412-04	EGR Temperature: Voltage Below Normal	2
E000412-15	EGR Temperature: High - Least Severe (1)	2
E000412-16	EGR Temperature: High - Moderate Severity (2)	2
E000441-00	High Auxiliary Temperature - Most Severe (3)	2
E000441-03	Auxiliary Temperature Sensor Voltage Above Normal	1
E000441-04	Auxiliary Temperature Sensor Voltage Below Normal	1
E000441-15	High Auxiliary Temperature - Least Severe (1)	1
E000441-16	High Auxiliary Temperature - Moderate Severity (2)	2
E000442-00	High Auxiliary Temperature # 2 - Most Severe (3)	2

Gauge Panel Fault Code	Fault Code Description	Severity Level
E000442-03	Auxiliary Temperature Sensor # 2 Voltage Above Normal	1
E000442-04	Auxiliary Temperature Sensor # 2 Voltage Below Normal	1
E000442-15	High Auxiliary Temperature # 2 - Least Severe (1)	1
E000442-16	High Auxiliary Temperature # 2 - Moderate Severity (2)	2
E000593-31	Engine Idle Shut down - Occurred (1)	2
E000594-00	Engine Idle Shut down - Pending (3)	2
E000594-31	Engine Idle Shut down - Pending (2)	1
E000625-14	Proprietary Data Link: Special Instruction	2
E000626-05	Engine Start Enable Device 1: Current Below Normal	0
E000626-06	Engine Start Enable Device 1: Current Above Normal	0
E000630-02	Calibration Memory: Erratic, Intermittent, or Incorrect	1
E000631-02	Personality Module: Erratic, Intermittent, or Incorrect	0
E000637-11	Engine Timing Sensor: Other Failure Mode	1
E000637-13	Engine Timing Sensor: Out of Calibration	1
E000639-09	J1939 Network #1: Abnormal Update Rate	1
E000639-14	J1939 Network #1: Special Instruction	1
E000651-05	Engine Injector Cylinder #01: Current Below Normal	1
E000651-06	Engine Injector Cylinder #01: Current Above Normal	1
E000652-05	Engine Injector Cylinder #02: Current Below Normal	1
E000652-06	Engine Injector Cylinder #02: Current Above Normal	1
E000653-05	Engine Injector Cylinder #03: Current Below Normal	1
E000653-06	Engine Injector Cylinder #03: Current Above Normal	1
E000654-05	Engine Injector Cylinder #04: Current Below Normal	1
E000654-06	Engine Injector Cylinder #04: Current Above Normal	1
E000655-05	Engine Injector Cylinder #05: Current Below Normal	1
E000655-06	Engine Injector Cylinder #05: Current Above Normal	1
E000656-05	Engine Injector Cylinder #06: Current Below Normal	1
E000656-06	Engine Injector Cylinder #06: Current Above Normal	1
E000678-03	ECU 8 Volts DC Supply: Voltage Above Normal	1
E000678-04	ECU 8 Volts DC Supply: Voltage Below Normal	1
E000723-08	Engine Speed Sensor #2: Abnormal Frequency, Pulse Width, or Period	0
E001072-06	Engine (Compression) Brake Output #1: Current Above Normal	1
E001073-05	Engine (Compression) Brake Output #2: Current Below Normal	1
E001073-06	Engine (Compression) Brake Output #2: Current Above Normal	1
E001074-05	Engine (Exhaust) Brake Output: Current Below Normal	1
E001074-06	Engine (Exhaust) Brake Output: Current Above Normal	1

Gauge Panel Fault Code	Fault Code Description	Severity Level
E001112-05	Engine (Compression) Brake Output #3: Current Below Normal	1
E001112-06	Engine (Compression) Brake Output #3: Current Above Normal	1
E001231-09	J1939 Network #2: Abnormal Update Rate	2
E001231-14	J1939 Network #2: Special Instruction	1
E001235-09	J1939 Network #3: Abnormal Update Rate	2
E001235-14	J1939 Network #3: Special Instruction	2
E001387-00	High Auxiliary Pressure - Most Severe (3)	2
E001387-03	Auxiliary Pressure Sensor Voltage Above Normal	1
E001387-04	Auxiliary Pressure Sensor Voltage Below Normal	1
E001387-15	High Auxiliary Pressure - Least Severe (1)	1
E001387-16	High Auxiliary Pressure - Moderate Severity (2)	2
E001761-01	Aftertreatment #1 DEF Tank Volume #1: Low - Most Severe (3)	2
E001761-02	Aftertreatment #1 DEF Tank Volume #1: Erratic, Intermittent, or Incorrect	1
E001761-03	Aftertreatment #1 DEF Tank Volume #1: Voltage Above Normal	2
E001761-04	Aftertreatment #1 DEF Tank Volume #1: Voltage Below Normal	2
E001761-17	Aftertreatment #1 DEF Tank Volume #1: Low - Least Severe (1)	2
E001761-18	Aftertreatment #1 DEF Tank Volume #1: Low - Moderate Severity (2)	2
E002630-01	Engine Charge Air Cooler Outlet Temperature: Low - most severe (3)	2
E002630-03	Engine Charge Air Cooler Outlet Temperature: Voltage Above Normal	2
E002630-04	Engine Charge Air Cooler Outlet Temperature: Voltage Below Normal	2
E002659-15	EGR Mass Flow Rate: High - Least Severe (1)	2
E002659-17	EGR Mass Flow Rate: Low - Least Severe (1)	2
E002791-05	EGR Valve Control: Current Below Normal	2
E002791-06	EGR Valve Control: Current Above Normal	2
E002813-05	Air Shutoff Solenoid current above normal	1
E002813-06	Air Shutoff Solenoid current below normal	1
E002948-03	Engine Intake Valve Actuation System Oil Pressure: Voltage Above Normal	2
E002948-04	Engine Intake Valve Actuation System Oil Pressure: Voltage Below Normal	2
E002948-07	Engine Intake Valve Actuation System Oil Pressure: Not Responding Properly	2
E002948-17	Engine Intake Valve Actuation System Oil Pressure: Low - Least Severe (1)	2
E002949-05	Engine Intake Valve Actuation System Oil Pressure Control Valve: Current Below Normal	1

Gauge Panel Fault Code	Fault Code Description	Severity Level
E002949-06	Engine Intake Valve Actuation System Oil Pressure Control Valve: Current Above Normal	1
E002949-07	Engine Intake Valve Actuation System Oil Pressure Control Valve: Not Responding Properly	1
E002950-05	Engine Intake Valve Actuator #1: Current Below Normal	1
E002950-06	Engine Intake Valve Actuator #1: Current Above Normal	1
E002950-07	Engine Intake Valve Actuator #1: Not Responding Properly	2
E002951-05	Engine Intake Valve Actuator #2: Current Below Normal	1
E002951-06	Engine Intake Valve Actuator #2: Current Above Normal	1
E002951-07	Engine Intake Valve Actuator #2: Not Responding Properly	2
E002952-05	Engine Intake Valve Actuator #3: Current Below Normal	1
E002952-06	Engine Intake Valve Actuator #3: Current Above Normal	1
E002952-07	Engine Intake Valve Actuator #3: Not Responding Properly	2
E002953-05	Engine Intake Valve Actuator #4: Current Below Normal	1
E002953-06	Engine Intake Valve Actuator #4: Current Above Normal	1
E002953-07	Engine Intake Valve Actuator #4: Not Responding Properly	2
E002954-05	Engine Intake Valve Actuator #5: Current Below Normal	1
E002954-06	Engine Intake Valve Actuator #5: Current Above Normal	1
E002954-07	Engine Intake Valve Actuator #5: Not Responding Properly	2
E002955-05	Engine Intake Valve Actuator #6: Current Below Normal	1
E002955-06	Engine Intake Valve Actuator #6: Current Above Normal	1
E002955-07	Engine Intake Valve Actuator #6: Not Responding Properly	2
E003031-03	Aftertreatment #1 DEF Tank Temperature: Voltage Above Normal	1
E003031-04	Aftertreatment #1 DEF Tank Temperature: Voltage Below Normal	1
E003031-07	Aftertreatment #1 DEF Tank Temperature: Not Responding Properly	2
E003031-12	Aftertreatment #1 DEF Tank Temperature: Failure	1
E003031-16	Aftertreatment #1 DEF Tank Temperature: High - Moderate Severity (2)	2
E003031-18	Aftertreatment #1 DEF Tank Temperature: Low - Moderate Severity (2)	2
E003216-12	Aftertreatment #1 Intake NOx: Failure	2
E003217-16	Aftertreatment #1 Intake O2: High - Moderate Severity (2)	2
E003226-12	Aftertreatment #1 Outlet NOx: Failure	2
E003227-16	Aftertreatment #1 Outlet O2: High - Moderate Severity (2)	2
E003241-03	Exhaust Gas Temperature 1: Voltage Above Normal	2
E003241-04	Exhaust Gas Temperature 1: Voltage Below Normal	2
E003242-03	Aftertreatment #1 DPF Intake Temperature: Voltage Above Normal	2

Gauge Panel Fault Code	Fault Code Description	Severity Level
E003242-04	Aftertreatment #1 DPF Intake Temperature: Voltage Below Normal	2
E003242-15	Aftertreatment #1 DPF Intake Temperature: High - Least Severe (1)	1
E003242-16	Aftertreatment #1 DPF Intake Temperature: High - Moderate Severity (2)	2
E003242-18	Aftertreatment #1 DPF Intake Temperature: Low - Moderate Severity (2)	2
E003251-02	Aftertreatment #1 DPF Differential Pressure: Erratic, Intermittent, or Incorrect	1
E003251-03	Aftertreatment #1 DPF Differential Pressure: Voltage Above Normal	1
E003251-04	Aftertreatment #1 DPF Differential Pressure: Voltage Below Normal	1
E003251-13	Aftertreatment #1 DPF Differential Pressure: Out of Calibration	1
E003251-18	Aftertreatment #1 DPF Differential Pressure: Low - Moderate Severity (2)	1
E003342-01	Engine Coolant Pump Differential Pressure: Low - Most Severe (3)	1
E003342-18	Engine Coolant Pump Differential Pressure: Low - Moderate Severity (2)	1
E003358-03	EGR Inlet Pressure: Voltage Above Normal	2
E003358-04	EGR Inlet Pressure: Voltage Below Normal	2
E003358-13	EGR Inlet Pressure: Out of Calibration	2
E003358-16	EGR Inlet Pressure: High - Moderate Severity (2)	2
E003358-21	EGR Inlet Pressure: Data Drifted Low	2
E003360-03	Aftertreatment #1 DEF Controller: Voltage Above Normal	2
E003360-04	Aftertreatment #1 DEF Controller: Voltage Below Normal	2
E003360-09	Aftertreatment #1 DEF Controller: Abnormal Update Rate	2
E003360-12	Aftertreatment #1 DEF Controller: Failure	2
E003361-05	Aftertreatment #1 DEF Dosing Unit: Current Below Normal	2
E003361-06	Aftertreatment #1 DEF Dosing Unit: Current Above Normal	2
E003361-07	Aftertreatment #1 DEF Dosing Unit: Not Responding Properly	2
E003361-11	Aftertreatment #1 DEF Dosing Unit: Other Failure Mode	2
E003361-12	Aftertreatment #1 DEF Dosing Unit: Failure	2
E003361-14	Aftertreatment #1 DEF Dosing Unit: Special Instruction	2
E003362-14	Aftertreatment #1 DEF Dosing Unit Input Lines: Special Instruction	1
E003363-05	Aftertreatment #1 DEF Tank Heater: Current Below Normal	1
E003363-06	Aftertreatment #1 DEF Tank Heater: Current Above Normal	1
E003363-07	Aftertreatment #1 DEF Tank Heater: Not Responding Properly	1
E003473-31	Aftertreatment #1 Failed to Ignite	2
E003474-14	Aftertreatment #1 Loss of Combustion: Special Instruction	0
E003474-31	Aftertreatment #1 Loss of Combustion	2

Gauge Panel Fault Code	Fault Code Description	Severity Level
E003479-05	Aftertreatment #1 Fuel Pressure Control: Current Below Normal	2
E003479-06	Aftertreatment #1 Fuel Pressure Control: Current Above Normal	2
E003480-03	Aftertreatment #1 Fuel Pressure #1: Voltage Above Normal	2
E003480-04	Aftertreatment #1 Fuel Pressure #1: Voltage Below Normal	2
E003480-15	Aftertreatment #1 Fuel Pressure #1: High - Least Severe (1)	0
E003480-16	Aftertreatment #1 Fuel Pressure #1: High - Moderate Severity (2)	2
E003480-17	Aftertreatment #1 Fuel Pressure #1: Low - Least Severe (1)	0
E003480-18	Aftertreatment #1 Fuel Pressure #1: Low - Moderate Severity (2)	2
E003483-11	Aftertreatment #1 Regeneration Status: Other Failure Mode	1
E003484-05	Aftertreatment #1 Ignition: Current Below Normal	2
E003484-06	Aftertreatment #1 Ignition: Current Above Normal	2
E003487-05	Aftertreatment #1 Air Pressure Control: Current Below Normal	2
E003487-06	Aftertreatment #1 Air Pressure Control: Current Above Normal	2
E003487-07	Aftertreatment #1 Air Pressure Control: Not Responding Properly	2
E003487-13	Aftertreatment #1 Air Pressure Control: Out of Calibration	0
E003488-03	Aftertreatment #1 Air Pressure Actuator Position: Voltage Above Normal	2
E003488-04	Aftertreatment #1 Air Pressure Actuator Position: Voltage Below Normal	2
E003509-03	Sensor Supply Voltage 1: Voltage Above Normal	2
E003509-04	Sensor Supply Voltage 1: Voltage Below Normal	2
E003510-03	Sensor Supply Voltage 2: Voltage Above Normal	0
E003510-04	Sensor Supply Voltage 2: Voltage Below Normal	0
E003511-11	Sensor Supply Voltage 3: Other Failure Mode	2
E003516-02	Aftertreatment #1 DEF Concentration: Erratic, Intermittent, or Incorrect	1
E003516-11	Aftertreatment #1 DEF Concentration: Other Failure Mode	1
E003516-12	Aftertreatment #1 DEF Concentration: Failure	1
E003516-16	Aftertreatment #1 DEF Concentration: High - Moderate Severity (2)	0
E003516-18	Aftertreatment #1 DEF Concentration: Low - Moderate Severity (2)	2
E003530-31	Aftertreatment 1 Regeneration Manually Disabled	1
E003563-03	Engine Intake Manifold #1 Absolute Pressure: Voltage Above Normal	2
E003563-04	Engine Intake Manifold #1 Absolute Pressure: Voltage Below Normal	2
E003563-13	Engine Intake Manifold #1 Absolute Pressure: Out of Calibration	2
E003563-21	Engine Intake Manifold #1 Absolute Pressure: Data Drifted Low	1
E003609-03	DPF #1 Intake Pressure: Voltage Above Normal	2
E003609-04	DPF #1 Intake Pressure: Voltage Below Normal	2

Gauge Panel Fault Code	Fault Code Description	Severity Level
E003609-13	DPF #1 Intake Pressure: Out of Calibration	2
E003609-15	DPF #1 Intake Pressure: High - Least Severe (1)	1
E003609-17	DPF #1 Intake Pressure: Low - Least Severe (1)	2
E003609-18	DPF #1 Intake Pressure: Low - Moderate Severity (2)	1
E003609-21	DPF #1 Intake Pressure: Data Drifted Low	2
E003659-05	Engine Injector Cylinder #1 Actuator #2: Current Below Normal	1
E003659-06	Engine Injector Cylinder #1 Actuator #2: Current Above Normal	1
E003660-05	Engine Injector Cylinder #2 Actuator #2: Current Below Normal	1
E003660-06	Engine Injector Cylinder #2 Actuator #2: Current Above Normal	1
E003661-05	Engine Injector Cylinder #3 Actuator #2: Current Below Normal	1
E003661-06	Engine Injector Cylinder #3 Actuator #2: Current Above Normal	1
E003662-05	Engine Injector Cylinder #4 Actuator #2: Current Below Normal	1
E003662-06	Engine Injector Cylinder #4 Actuator #2: Current Above Normal	1
E003663-05	Engine Injector Cylinder #5 Actuator #2: Current Below Normal	1
E003663-06	Engine Injector Cylinder #5 Actuator #2: Current Above Normal	1
E003664-05	Engine Injector Cylinder #6 Actuator #2: Current Below Normal	1
E003664-06	Engine Injector Cylinder #6 Actuator #2: Current Above Normal	1
E003667-02	Air Intake Shutoff Detection Circuit Detected but Not Installed - Least Severe (1)	1
E003667-31	Air Intake Shutoff Closed - Most Severe (3)	2
E003695-02	Diesel Particulate Filter Regeneration Inhibit Switch - Data Erratic	1
E003696-02	Diesel Particulate Filter Regeneration Force Switch - Data Erratic	1
E003703-31	DPF Active Regeneration Inhibited Due to Inhibit Switch	2
E003711-31	DPF Active Regeneration Inhibited Due to Low Exhaust Gas Temperature	2
E003712-15	Diesel Particulate Filter Active Regeneration Inhibited Due to System Fault	1
E003714-31	DPF fully clogged. Please stop the Machine and contact service center.	2
E003715-31	DPF failed. Please stop the Machine and contact service center to replace DPF.	2
E003716-15	Diesel Particulate Filter Active Regeneration Inhibited Due to Engine Not Warmed Up	1
E003716-31	DPF Active Regeneration Inhibited Due to Engine Not Warmed Up	1
E003719-00	DPF clogged. Manual regeneration is strongly required to prevent DPF damage.	2
E003719-16	DPF clogged. Manual regeneration is required. Park the machine in a safe area.	2

Gauge Panel Fault Code	Fault Code Description	Severity Level
E003720-16	Engine derated due to DPF ash clogging. Please stop the Machine and contact � service center to clean DPF.	1
E003750-15	Manual regeneration not initiated. Check operating manual to start regeneration.	0
E003750-17	DPF clogged. Manual regeneration is strongly required to prevent DPF damage.	1
E003750-18	Engine fully derated. Please stop the Machine and contact service center.	1
E003750-31	DPF #1 Conditions Not Met for Active Regeneration	0
E003837-03	Aftertreatment #1 Secondary Air Pressure: Voltage Above Normal	2
E003837-04	Aftertreatment #1 Secondary Air Pressure: Voltage Below Normal	2
E003837-13	Aftertreatment #1 Secondary Air Pressure: Out of Calibration	2
E003837-17	Aftertreatment #1 Secondary Air Pressure: Low - least severe (1)	1
E003837-21	Aftertreatment #1 Secondary Air Pressure: Data Drifted Low	2
E004077-03	Aftertreatment #1 Fuel Pressure #2: Voltage Above Normal	2
E004077-04	Aftertreatment #1 Fuel Pressure #2: Voltage Below Normal	2
E004077-15	Aftertreatment #1 Fuel Pressure #2: High - Least Severe (1)	0
E004077-16	Aftertreatment #1 Fuel Pressure #2: High - Moderate Severity (2)	2
E004077-17	Aftertreatment #1 Fuel Pressure #2: Low - Least Severe (1)	0
E004077-18	Aftertreatment #1 Fuel Pressure #2: Low - Moderate Severity (2)	2
E004212-05	Fan Drive Bypass Command - Current Below Normal	1
E004212-06	Fan Drive Bypass Command - Current Above Normal	1
E004212-13	Fan Drive Bypass Command: Calibration Required	1
E004214-05	Engine Fan Reverse Actuator - Current Below Normal	1
E004214-06	Engine Fan Reverse Actuator - Current Above Normal	1
E004265-05	Aftertreatment #1 Transformer Secondary Output: Current Below Normal	1
E004301-03	Aftertreatment #1 Fuel Injector #1 Heater Control: Voltage Above Normal	1
E004301-04	Aftertreatment #1 Fuel Injector #1 Heater Control: Voltage Below Normal	1
E004301-05	Aftertreatment #1 Fuel Injector #1 Heater Control: Current Below Normal	1
E004301-06	Aftertreatment #1 Fuel Injector #1 Heater Control: Current Above Normal	1
E004334-03	Aftertreatment #1 DEF #1 Pressure (absolute): Voltage Above Normal	2
E004334-04	Aftertreatment #1 DEF #1 Pressure (absolute): Voltage Below Normal	2
E004334-07	Aftertreatment #1 DEF #1 Pressure (absolute): Not Responding Properly	2

Gauge Panel Fault Code	Fault Code Description	Severity Level
E004334-16	Aftertreatment #1 DEF #1 Pressure (absolute): High - Moderate Severity (2)	2
E004334-18	Aftertreatment #1 DEF #1 Pressure (absolute): Low - Moderate Severity (2)	2
E004337-08	Aftertreatment #1 DEF Doser #1 Temperature: Abnormal Frequency, Pulse Width, or Period	1
E004354-05	Aftertreatment #1 DEF Line Heater #1: Current Below Normal	2
E004354-06	Aftertreatment #1 DEF Line Heater #1: Current Above Normal	2
E004355-05	Aftertreatment #1 DEF Line Heater #2: Current Below Normal	2
E004355-06	Aftertreatment #1 DEF Line Heater #2: Current Above Normal	2
E004356-05	Aftertreatment #1 DEF Line Heater #3: Current Below Normal	2
E004356-06	Aftertreatment #1 DEF Line Heater #3: Current Above Normal	2
E004360-03	Aftertreatment #1 SCR Catalyst Intake Gas Temperature: Voltage Above Normal	2
E004360-04	Aftertreatment #1 SCR Catalyst Intake Gas Temperature: Voltage Below Normal	2
E004360-16	Aftertreatment #1 SCR Catalyst Intake Gas Temperature: High - Moderate Severity (2)	2
E004360-17	Aftertreatment #1 SCR Catalyst Intake Gas Temperature: Low - least severe (1)	0
E004360-18	Aftertreatment #1 SCR Catalyst Intake Gas Temperature: Low - Moderate Severity (2)	2
E004364-02	Aftertreatment #1 SCR Catalyst Conversion Efficiency: Erratic, Intermittent, or Incorrect	2
E004364-18	Aftertreatment #1 SCR Catalyst Conversion Efficiency: Low - Moderate Severity (2)	2
E004374-05	Aftertreatment #1 DEF Pump #1 Motor Speed: Current Below Normal	2
E004374-06	Aftertreatment #1 DEF Pump #1 Motor Speed: Current Above Normal	2
E004374-08	Aftertreatment #1 DEF Pump #1 Motor Speed: Abnormal Frequency, Pulse Width, or Period	2
E004376-05	Aftertreatment #1 DEF Return Valve: Current Below Normal	1
E004376-06	Aftertreatment #1 DEF Return Valve: Current Above Normal	1
E004376-07	Aftertreatment #1 DEF Return Valve: Not Responding Properly	2
E005246-00	Aftertreatment SCR Operator Inducement Severity: High - Most Severe (3)	2
E005246-15	Aftertreatment SCR Operator Inducement Severity: High - Least Severe (1)	2
E005246-16	Aftertreatment SCR Operator Inducement Severity: High - Moderate Severity (2)	2
E005276-05	Engine Exhaust Manifold Bank #1 Flow Balance Valve Actuator Control: Current Below Normal	1

Gauge Panel Fault Code	Fault Code Description	Severity Level
E005276-06	Engine Exhaust Manifold Bank #1 Flow Balance Valve Actuator Control: Current Above Normal	1
E005392-31	Aftertreatment #1 DEF Dosing Unit #1 Loss of Prime	2
E005423-05	Aftertreatment #1 Fuel Pump Relay Control: Current Below Normal	2
E005423-06	Aftertreatment #1 Fuel Pump Relay Control: Current Above Normal	2
E005424-05	Aftertreatment #1 Fuel Flow Diverter Valve Control: Current Below Normal	0
E005424-06	Aftertreatment #1 Fuel Flow Diverter Valve Control: Current Above Normal	0
E005425-05	Aftertreatment #1 Fuel Pressure #2 Actuator Control: Current Below Normal	0
E005425-06	Aftertreatment #1 Fuel Pressure #2 Actuator Control: Current Above Normal	0
E005480-16	Aftertreatment #1 DEF Controller Temperature: High - Moderate Severity (2)	2
E005491-05	Aftertreatment #1 DEF Line Heater Relay: Current Below Normal	2
E005491-06	Aftertreatment #1 DEF Line Heater Relay: Current Above Normal	2
E005576-02	Aftertreatment #1 Identification: Erratic, Intermittent, or Incorrect	2
E005576-08	Aftertreatment #1 Identification: Abnormal Frequency, Pulse Width, or Period	2
E005576-14	Aftertreatment #1 Identification: Special Instruction	2
E005577-02	Aftertreatment #2 Identification: Erratic, Intermittent, or Incorrect	2
E005577-08	Aftertreatment #2 Identification: Abnormal Frequency, Pulse Width, or Period	2
E005577-14	Aftertreatment #2 Identification: Special Instruction	2
E005580-03	Engine Filtered Fuel Delivery Absolute Pressure: Voltage Above Normal	0
E005580-04	Engine Filtered Fuel Delivery Absolute Pressure: Voltage Below Normal	0
E005580-16	Engine Filtered Fuel Delivery Absolute Pressure: High - Moderate Severity (2)	1
E005580-17	Engine Filtered Fuel Delivery Absolute Pressure: Low - Least Severe (1)	1
E005580-18	Engine Filtered Fuel Delivery Absolute Pressure: Low - Moderate Severity (2)	2
E005580-21	Engine Filtered Fuel Delivery Absolute Pressure: Data Drifted Low	1
E005588-14	Proprietary Network #2: Special Instruction	2
E005708-03	Engine Coolant Pressure #2: Voltage Above Normal	1
E005708-04	Engine Coolant Pressure #2: Voltage Below Normal	1
E005708-15	Engine Coolant Pressure #2: High - Least Severe (1)	1
E005708-17	Engine Coolant Pressure #2: Low - Least Severe (1)	1

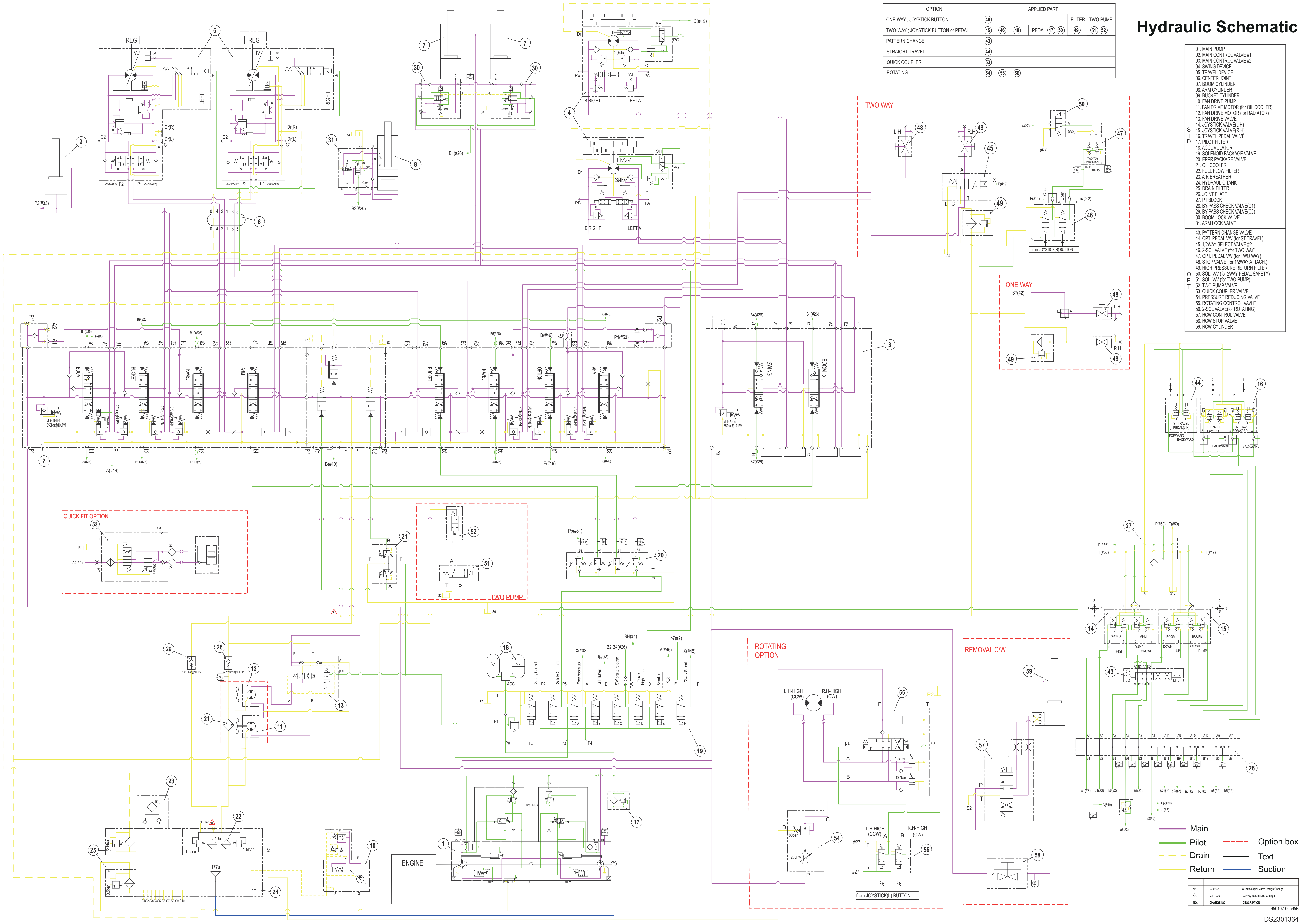
Gauge Panel Fault Code	Fault Code Description	Severity Level
E005708-21	Engine Coolant Pressure #2: Data Drifted Low	1
E005758-11	Aftertreatment #1 Intake Gas Sensor Power Supply: Other Failure Mode	2
E005759-11	Aftertreatment #1 Outlet Gas Sensor Power Supply: Other Failure Mode	2
E005798-07	Aftertreatment #1 DEF Dosing Unit Heater Temperature: Not Responding Properly	2
E005965-05	Aftertreatment #1 DEF Control Module Relay Control: Current Below Normal	2
E005965-06	Aftertreatment #1 DEF Control Module Relay Control: Current Above Normal	2
E005966-05	Aftertreatment #1 DEF Control Module Power Supply: Current Below Normal	1
E005966-06	Aftertreatment #1 DEF Control Module Power Supply: Current Above Normal	2
E006309-06	Aftertreatment #1 DEF Control Module #1 Power Supply #2: Current Above Normal	1
E006322-31	Aftertreatment #1 SCR Desulfation Too Frequent	0
E006588-31	Forced engine shut down detected during engine cooldown. Frequent forced shut down will �reduce engine life and restrict warranty.	1
E007105-31	Aftertreatment #1 Inconsistent Configuration Detected	1
E007343-31	SCR Operator Inducement Override Renewal Required	1

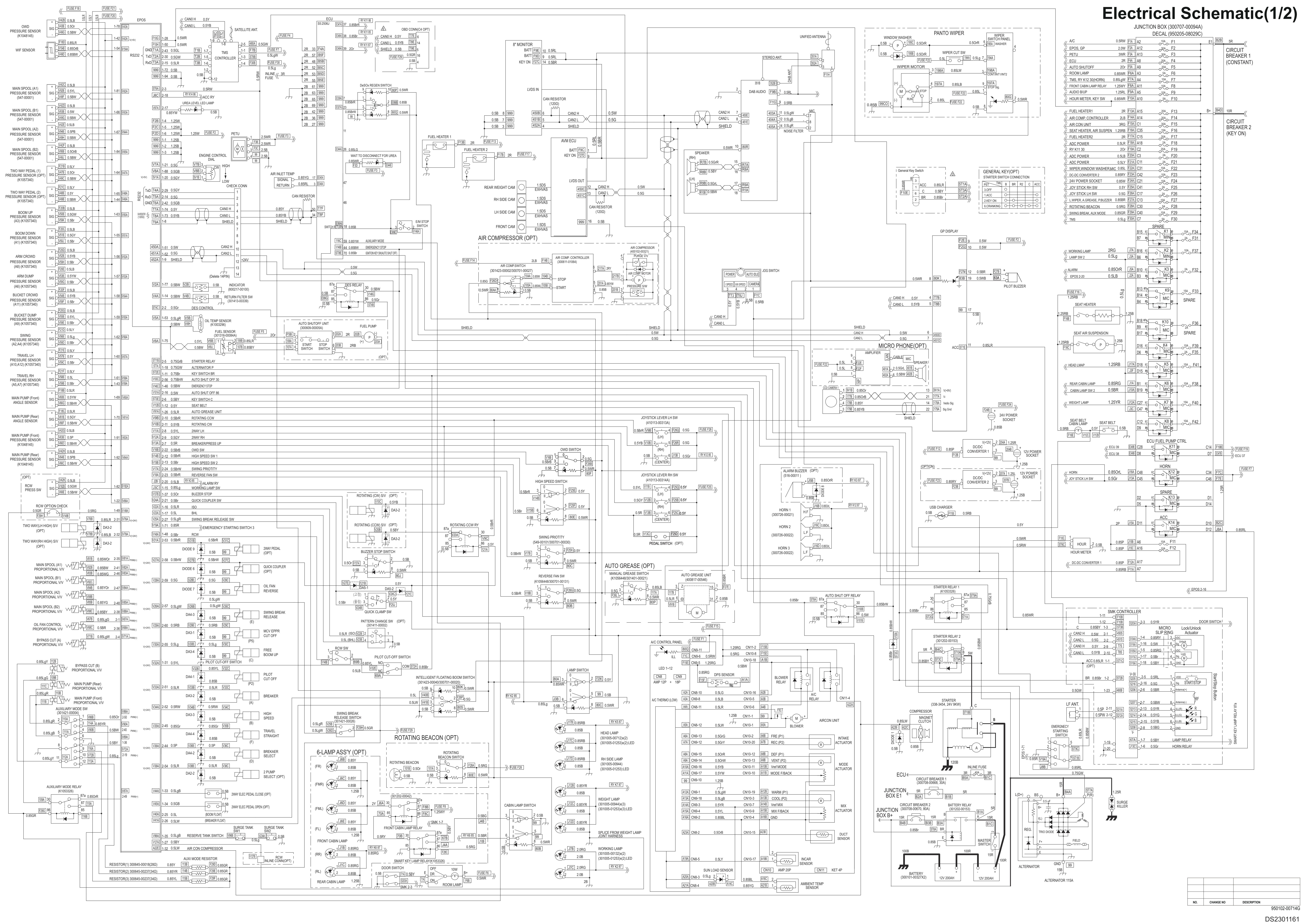
Schematics

Hydraulic Schematic

OPTION	APPLIED PART			
ONE-WAY ; JOYSTICK BUTTON	48		FILTER	TWO PUMP
TWO-WAY ; JOYSTICK BUTTON or PEDAL	45 46 48	PEDAL 47 50	49	51 52
PATTERN CHANGE	43			
STRAIGHT TRAVEL	44			
QUICK COUPLER	53			
ROTATING	54 55 56			

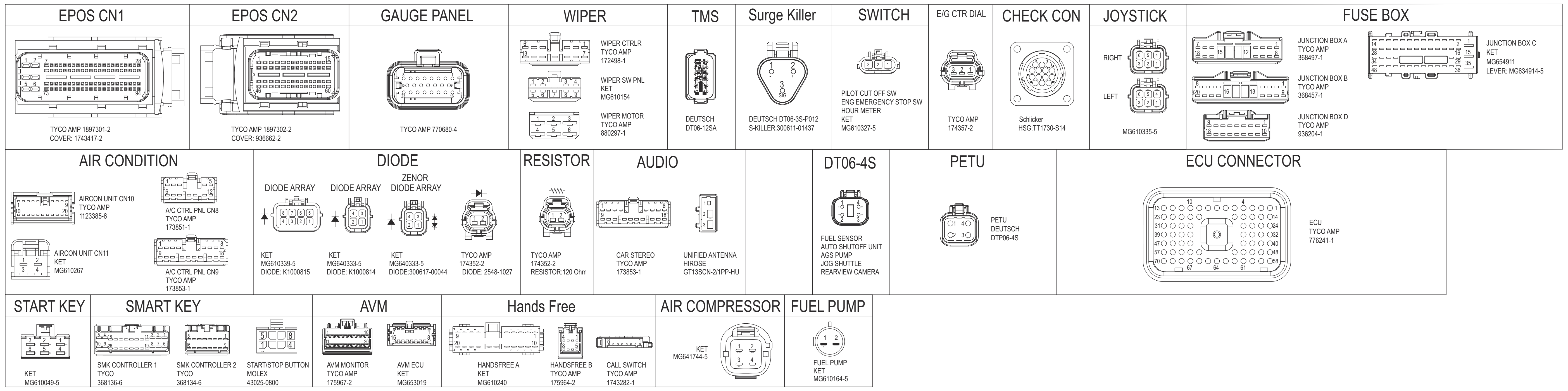
STD	01. MAIN PUMP 02. MAIN CONTROL VALVE #1 03. MAIN CONTROL VALVE #2 04. SWING DEVICE 05. TRAVEL DEVICE 06. CENTER JOINT 07. BOOM CYLINDER 08. ARM CYLINDER 09. BUCKET CYLINDER 10. FAN DRIVE PUMP 11. FAN DRIVE MOTOR (for OIL COOLER) 12. FAN DRIVE MOTOR (for RADIATOR) 13. FAN DRIVE VALVE 14. JOYSTICK VALVE(L.H) 15. JOYSTICK VALVE(R.H) 16. TRAVEL PEDAL VALVE 17. PILOT FILTER 18. ACCUMULATOR 19. SOLENOID PACKAGE VALVE 20. EPPR PACKAGE VALVE 21. OIL COOLER 22. FULL FLOW FILTER 23. AIR BREATHER 24. HYDRAULIC TANK 25. DRAIN FILTER 26. JOINT PLATE 27. PT BLOCK 28. BY-PASS CHECK VALVE(C1) 29. BY-PASS CHECK VALVE(C2) 30. BOOM LOCK VALVE 31. ARM LOCK VALVE
OPT	43. PATTERN CHANGE VALVE 44. OPT. PEDAL V/V (for ST TRAVEL) 45. 1/2WAY SELECT VALVE #2 46. 2-SOL VALVE (for TWO WAY) 47. OPT. PEDAL V/V (for TWO WAY) 48. STOP VALVE (for 1/2WAY ATTACH.) 49. HIGH PRESSURE RETURN FILTER 50. SOL. V/V (for 2WAY PEDAL SAFETY) 51. SOL. V/V (for TWO PUMP) 52. TWO PUMP VALVE 53. QUICK COUPLER VALVE 54. PRESSURE REDUCING VALVE 55. ROTATING CONTROL VAVLE 56. 2-SOL VALVE(for ROTATING) 57. RCW CONTROL VALVE 58. RCW STOP VALVE 59. RCW CYLINDER





Electrical Schematic(1/2)
JUNCTION BOX (300707-00094A)
DECAL (950205-08029C)
CIRCUIT BREAKER 1 (CONSTANT)
CIRCUIT BREAKER 2 (KEY ON)
AIR COMPRESSOR (OPT)
MICRO PHONE(OPT)
AUTO GREASE (OPT)
ROTATING BEACON (OPT)
6-LAMP ASS'Y (OPT)
950102-00714G
DS2301161

Electrical Schematic(2/2)



NO.	CHANGE NO	DESCRIPTION

950102-00714G

DS2301162