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Safety

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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 be dealer for use on 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.

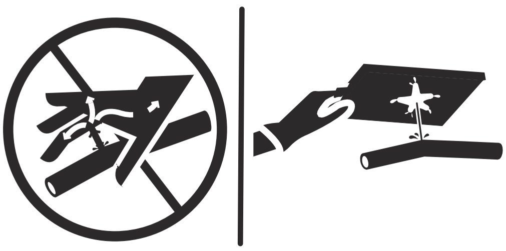
While you are performing any maintenance, testing, or adjustments to attachments, stay clear of the following areas: cutting edges, pinch points, and crushing surfaces.

Never use attachment as a work platform or manlift.

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

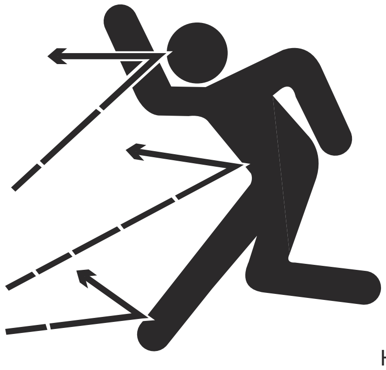
High-pressure oil that is released can cause a hose to whip or oil to spray. Fluid penetration can result in death or serious injury. If fluid enters skin or eyes, get immediate medical attention from a physician familiar with this injury.

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 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

H D O 1C

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.

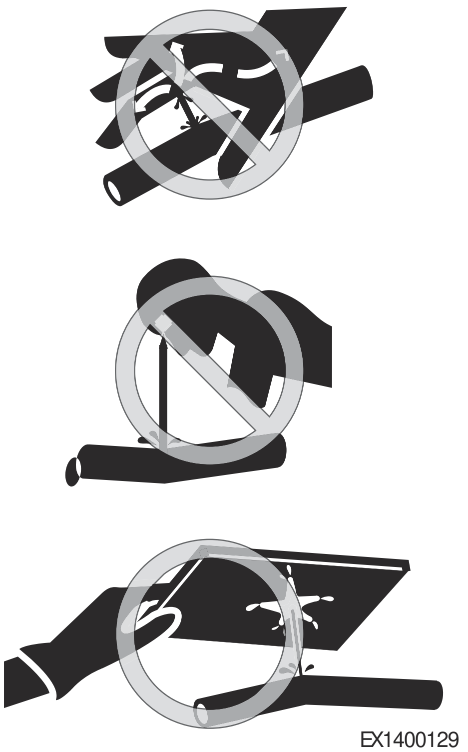
Improper jumper cable connections can cause an explosion that can result in death or serious injury. Refer to Operation and Maintenance Manual.

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



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

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

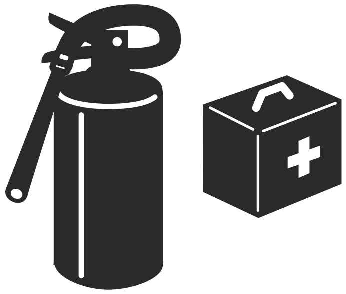
If a fire occurs:

- 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

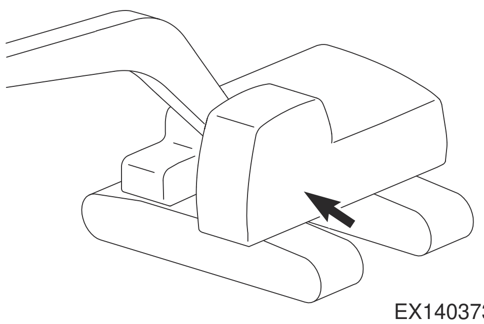


HDO1009L

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 distributor.*

Roll-over Protective Structure (ROPS)

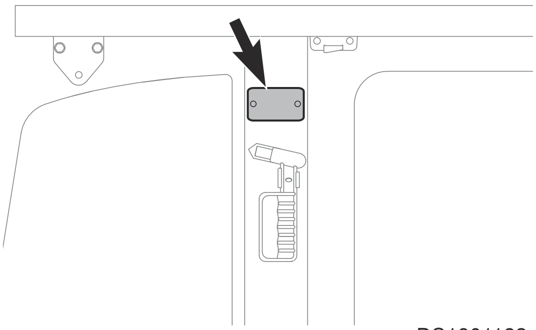
The operator's cabin is a ROPS certified structure for protecting the seat-belted operator. It absorbs the impact energy of a roll-over impact. Do not allow machine weight (mass) to exceed certified value on certification plate. If weight is exceeded, the ROPS structure will not be able to fulfill its 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 without the dealer's approval. 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 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.

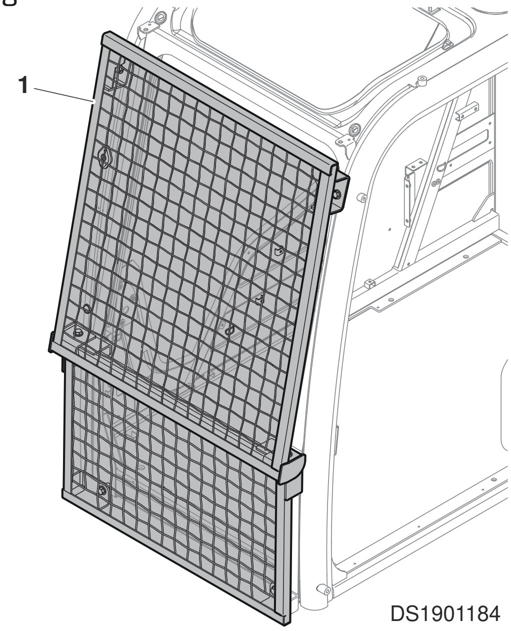
⚠ WARNING

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



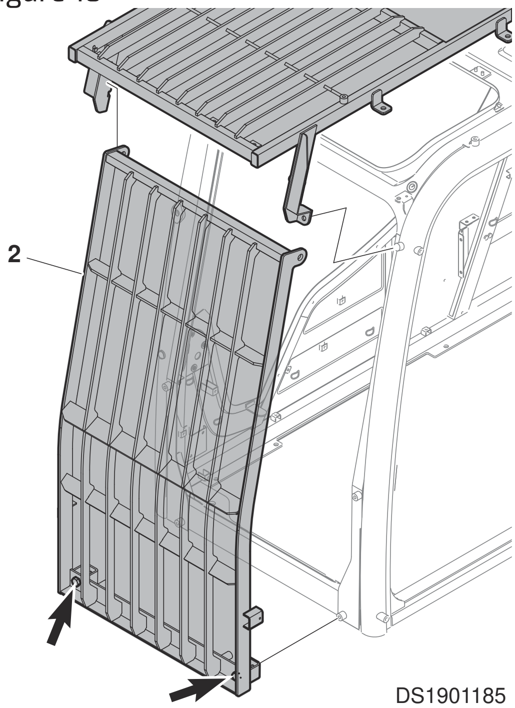
In a work site where additional operator protection is necessary from falling or flying objects, install adequate protective guards on the cabin.

For breaker operation, install a front guard (1) and apply a laminated coating sheet to front glass. Contact your 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



DS1901185

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.

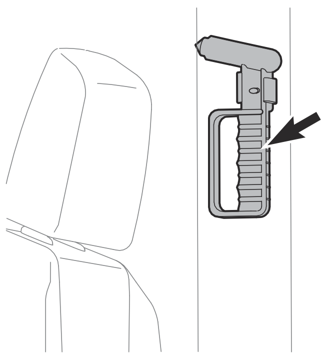
Contact your HD HYUNDAI CONSTRUCTION EQUIPMENT distributor for available safety guards and/or recommendations to protect against objects that could strike operator's cabin. Make sure that all other work site crew members are kept away from excavator when operating.

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 distributor for advice.*

Emergency Exit from Operator's Station

Figure 19



DS191103

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.

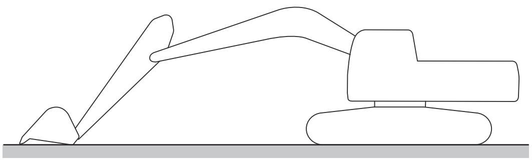
⚠ WARNING

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.

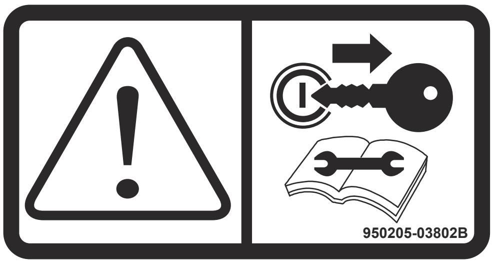
- Use correct procedure to lift and support excavator.
- Cleaning and maintenance are required daily.
- Welding or grinding painted parts must be done in well ventilated areas.
- Wear a dust mask when grinding painted parts. Toxic dust and gas can be produced.
- Vent exhaust to outside when engine must 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 genuine 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.

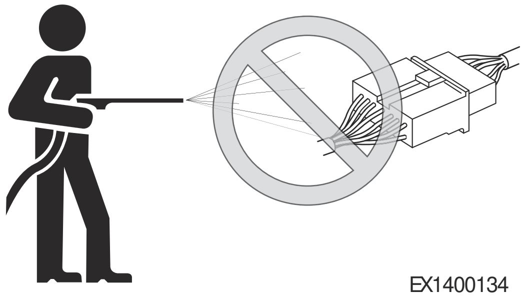
“DO NOT OPERATE” warning tags, are available from your distributor.

- 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 10

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

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

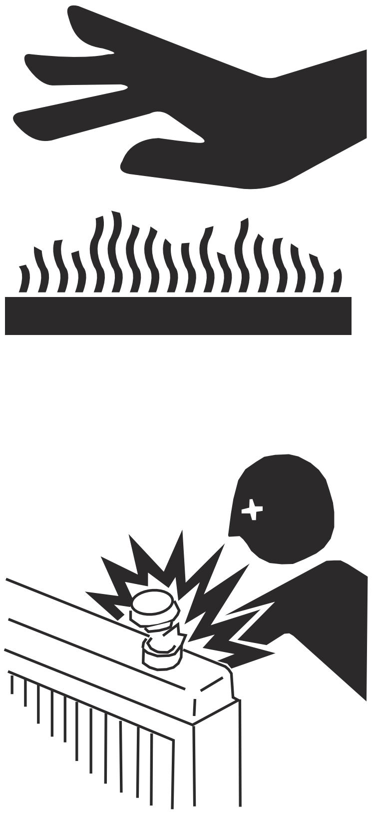
Do not smoke in battery charging areas or in areas that contain flammable material.

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



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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 lime water (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 lime water 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 lime water (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.*

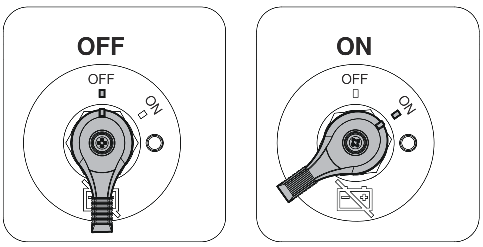
When performing welding repairs, perform welding in a properly equipped place. Repairs must be performed by a qualified welder. Welding operations, can create potential hazards, including generation of gas, fire, or electric shock. Never let an unqualified welder do welding.

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



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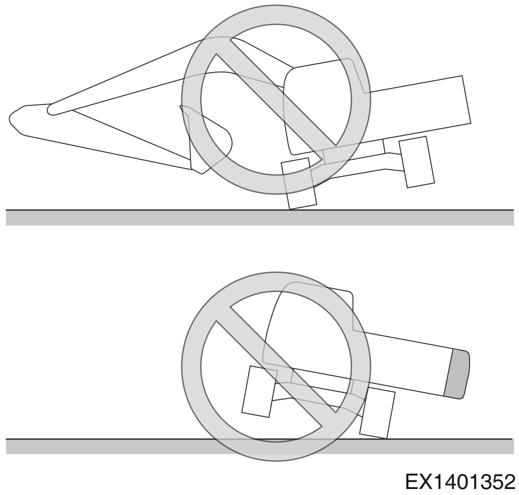
To prevent damage to ECU by electrical welding, observe the following procedures:

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

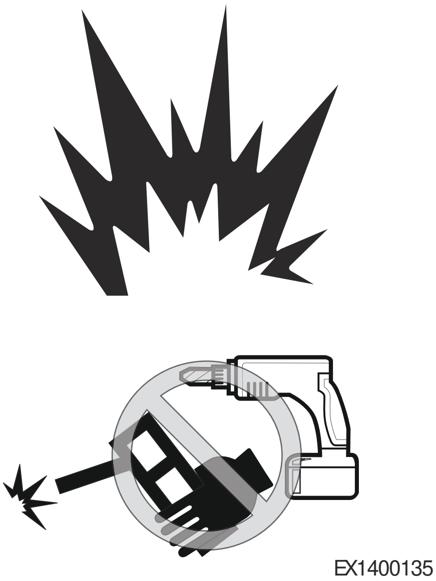
Figure 28

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



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:

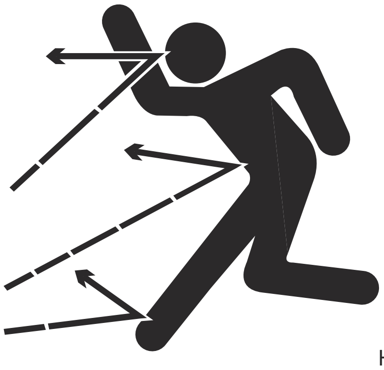
- Do not drill or punch holes in accumulator or expose it to any flames, fire or external heat source.
- Do not weld on accumulator.
- When performing disassembly or maintenance of accumulator, or when disposing of accumulator, charged nitrogen gas must be properly released. Contact your distributor 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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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.

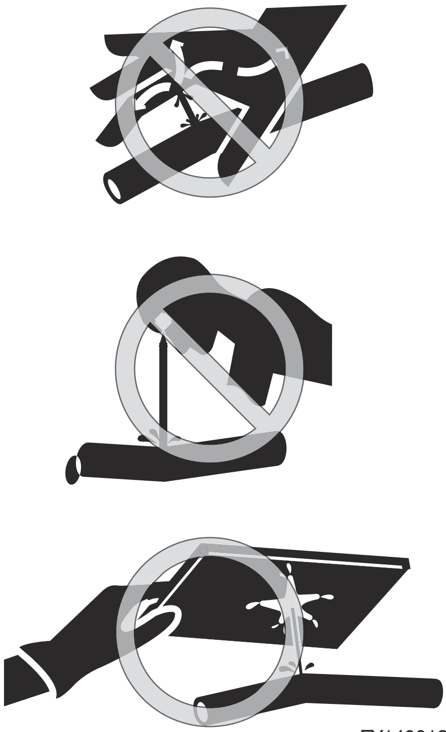
Lower work group to ground before leaving operator's seat.

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



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

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.

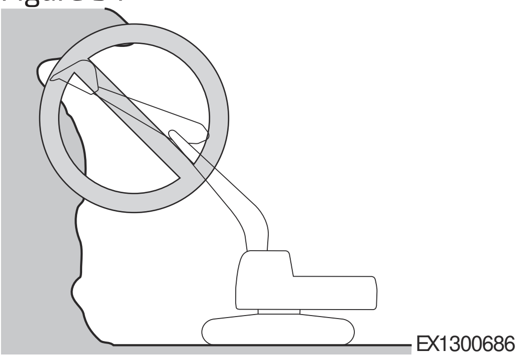
Environment and Circumstances

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

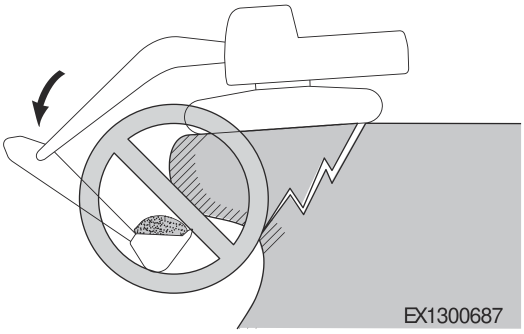


Do not dig work face under an overhang. This can cause overhang to collapse and fall on top of the machine.

- 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.

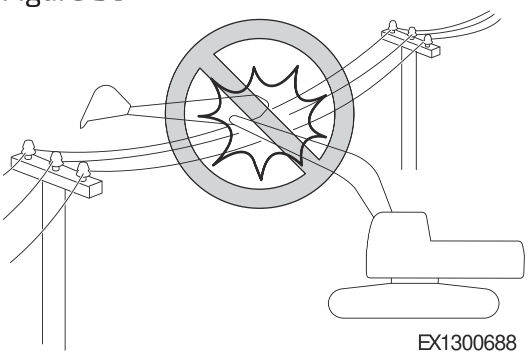
Loose ground may easily give way under weight of the machine.

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:

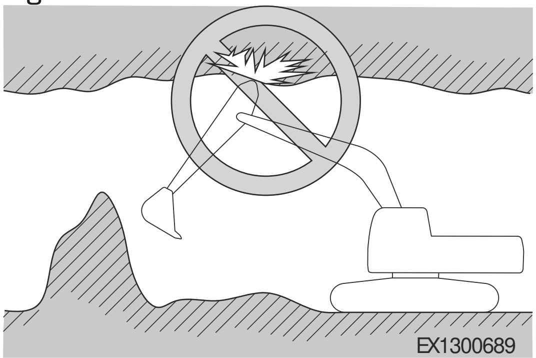
- Remember that electrical voltage determines what the minimum distance is to stay away from the power line. See the following table for minimum distances when working near electrical power lines. Electrical flash over can occur and damage machine and cause death or serious injury.

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.

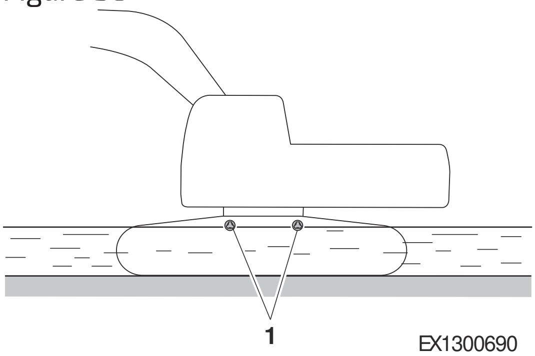
Move slowly.

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



NOTICE

Do not exceed maximum permissible water depth. The water level must not reach higher than centerline of upper track 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.

NOTICE

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

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 prevent face 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

AR01770L

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 asbestoses).

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 asbestoses. 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

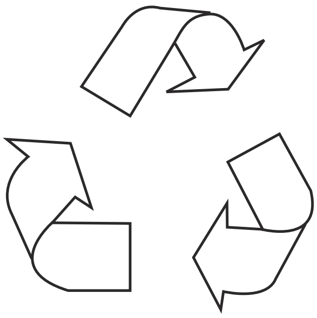
AVOID DEATH OR SERIOUS INJURY

Avoid exposure to dust containing crystalline silica particles 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 traveling 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 traveling: (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 work sites.

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.

Specifications

General 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.

General

The excavator has three main component sections:

- The Upper Structure
- The Lower Undercarriage and Track Frames
- The Excavator Front-end Attachment

The following illustration identifies main components and their locations.

Standard Specification

ITEMS		UNIT	STD.
OPERATING WEIGHT		ton	36,200
ENGINE	RATED POWER (Gross)	kW/rpm	202 / 1,800
	MAX. TORQUE	N.m/rpm	1,275 / 1,300
SYSTEM PRESSURE (Work / Travel)		bar	343 / 363
SWING SPEED (EFF. 98%)		rpm	9.61
TRAVEL SPEED (High / Low) (EFF. 98%)		km/h	5.2 / 3.2
GRADEABILITY		%(deg)	70 (35°)
GROUND PRESSURE		kg/cm 2	0.49
DIGGING FORCE(ISO)	BUCKET (Nor. / Press Up)	ton	20.3/21.5
	ARM (Nor. / Press Up)	ton	15.0/15.9
WORKING RANGE	MAX. DIGGING REACH	mm	10,820
	MAX. LOADING HEIGHT	mm	8,065
	MAX. DIGGING DEPTH	mm	6,970
	MAX. DIGGING HEIGHT	mm	11,200
	REAR SWING RADIUS	mm	1,900
	MIN. SWING RADIUS	mm	2,990

TRANSPORTATION DIMENSION	OVERALL LENGTH	mm	9,975
	OVERALL WIDTH (W/O Protector & Catwalk)	mm	3,600
	OVERALL HEIGHT	mm	3,550
	GROUND CLEARANCE (W/O Grouser)	mm	475
	TRACK HEIGHT (W/O Grouser)	mm	4,885
	TRACK LENGTH (With Grouser)	mm	4,960
	GROUSER HEIGHT	mm	36
	TRACK GAUGE	mm	2,750
	TUMBLER DISTANCE	mm	4,040
OPTION ATTACHMENT	BOOM	mm	6,245 / 6,245 HD / ARTI
	ARM	mm	2,500 / 3,100 / 3,750 / 2,500 ARTI / 3,100 ARTI / 3,750 ARTI / 2,850 HD / 3,100 HD
			2600 ARTI / 3200 ATRI / 3950 ARTI
	BUCKET(SAE)	m^3	GP : 0.80 / 1.16 / 1.27 / 1.50 / 1.75
			H Class : 1.04 / 1.2 / 1.23 (48in) / 1.47 (56in) / 1.5 / 1.6 (60in) / 1.7
			S Class : 1.2 / 1.45 / 1.57
	SHOE	mm	700TG / 800TG / 850TG / 600 DG
	COUNTER WEIGHT	kg	5,100 / 7,100
Spec. Combination Criteria	STD	BOOM(6,245), ARM(3,100), BUCKET(1.27), SHOE(850TG), CW(7,700), Non-Dozer	
	OPTION 1	BOOM(6,245), ARM(3,100), BUCKET(1.27), SHOE(850TG) , CW(5,100), Dozer(3,600)	

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

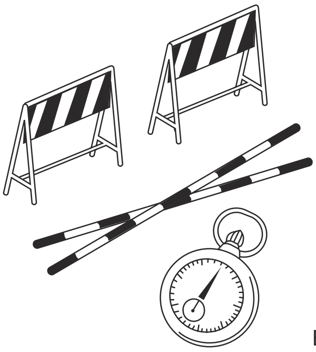
1. Repair any defects and damage found, such as oil or water leaks, loose bolts, cracks etc, before starting to test.

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 41



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   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	Rating Increasing While Crawling (*Crawler Type)	rpm	*Standard Mode, No Pedaling Before Starting Crawling	-	-
			rpm	S Mode or E Mode, No Pedaling Before Starting Crawling	-	-
		Power+ Mode	rpm	SPC Off	1,890	±25
			rpm	SPC Off + A/I On	1,800	±25
			rpm	SPC On	-	-
		Power Mode	rpm	SPC Off	1,700	±25
			rpm	SPC Off + A/I On	-	-
			rpm	SPC On	1,600	±25
		Standard Mode	rpm	SPC Off	1,600	±25

Item	Model			Unit	Measuring Conditions	Performance Standard	Tolerance
				rpm	SPC On	1,500	±25
		Economy Mode		rpm	SPC Off	1,500	±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.	800	±25
			Below Coolant Temp. 15°c	rpm		1,200	±25
		Auto Idle	Above Air Temp. 10°c	rpm	A/I On	800	±25
			Below Air Temp. 10°c	rpm		800	±25
	Working Mode	Relief Load	1 Pump	rpm	*Standard	1,800	Above
			2 Pump	rpm		1,800	Above
			3 Pump	rpm		-	-
		Boom Up or Arm Dump Operation Load	Power+ Mode	rpm	Dial Max., Sudden Command.	1,760	Above
			Power Mode	rpm		1,660	±25
			Standard Mode	rpm		1,560	±25
			Economy Mode	rpm		1,460	±25
			1300 rpm	rpm	Max. Power Mode, Adjust Dial, Sudden Command	1,260	±25
			Low Idle	rpm	Dial Min., Sudden Command	Not Stop Engine	
	Fan Revolution			rpm	*Standard	1,450	±50
EPOS	EPPR Valve Current for Pump	Working Mode	Power+ Mode	mA	Dial Max., Sudden Command, Minimum Value at Arm Crowd	280	±30
			Power Mode	mA		320	±30
			Standard Mode	mA		350	±30

Item	Model			Unit	Measuring Conditions	Performance Standard	Tolerance
			Economy Mode	mA		390	±30
			Lifting Mode	mA		280	±30
			Low Idle	mA	Dial Min.	650	±30
			Auto Idle	mA	A/I On	650	±30
Pressure Set	Main	Pump 1 & 2	Normal	bar	*Standard	343	0~+10
			Boost	bar		363	0~+10
		Pump 3	Normal	bar		-	-
	Swing	Relief (at Motor)		bar	*Standard	343	0~+10
		Relief (at Pump)		bar	*Standard	363	0~+10
	Option	Proportional Current (Proportional Decompressing By Flow Control)		mA	*Standard, Max. Flow	-	-
		Proportional Current (Proportional Decompressing By Pressure Control)		mA	*Standard, 150 lpm, 220 bar.	-	-
		1 Way Relief		bar		343	±25
		2 Way Relief		bar		222	±25
		Rotating Relief		bar	*Standard	80	±25
Front Speed	Boom	Up		sec	*Standard, Sudden Command.	3.5	±0.4
		Down		sec		-	-
		Down (with Lock Valve)		sec		3.1	±0.3
	Arm	Crowd		sec		-	-
		Crowd (with Lock Valve)		sec		3.8	±0.4
		Dump		sec		2.8	±0.3
	Bucket *Crawler Type	Speed 1	Crowd	sec		2.4	±0.2
			Dump	sec		2.5	±0.3
		Speed 2	Crowd	sec		-	-
			Dump	sec		-	-

Item	Model		Unit	Measuring Conditions	Performance Standard	Tolerance
	Arti.	Up	sec		3.4	±0.3
		Down	sec		-	-
		Down (With Lock Valve)	sec		4.3	±0.4
	Boom Swing	Left to Right	sec		-	-
		Right to Left	sec		-	-
	Dozer	Up	sec	*Standard, Actuator Speed at Machine Jack-up	4.7	±0.5
		Down	sec		5.3	±0.5
Swing Speed	Swing Speed		sec	*Standard, Max. Reach Position, Empty Bucket, 3 Rotations Time & Swing Coasting After Max. Swing Speed	18.5	±1.9
	Swing Coasting		mm		1,010	±202
With Swing	Boom Up Speed	Boom Priority	sec	*Standard, Arm Dump & Bucket Crowd, Boom Up from Ground & Sudden Swing Operation (Just Before Cushion)	-	-
		Swing Priority	sec		-	-
Travel	Track Sag	Steel Shoe	mm	Refer to The Track Sag	-	-
		Rubber Shoe	mm		-	-
	Travel Speed	1st Gear	sec	*Standard, 20 M.	23.1	±2.3
		2nd Gear	sec		14.5	±1.5
	Track Speed With Jack-up	1st Gear	sec	*Standard, 3 Turns.	35.1	±3.5
		2nd Gear	sec		21.5	±2.2
	Crawl Meandering	1st Gear	mm	*Standard, Forward/ Reverse Each, Meandering After 20 M Crawling	150	Below
		2nd Gear	mm		150	Below
Cylinder Creeping	Front	Boom Down	mm/5 min	Max. Reach, Bucket Crowd posture, (50 mm cylinder lift for Arm & Bucket to avoid cushion) Weight: General Purpose Machine – with 1.5 Times of Bucket Capacity, Special Purpose Machine – with 3.5 Ton Weight	5	Below
		Arm Crowd	mm/5 min		5	Below
		Bucket Dump	mm/5 min		20	Below
		Arti. Boom Down	mm/5 min		-	-
		Vertical Displacement of Bucket End (*S.korea Only)	mm/ 10 min	Max. Reach, Bucket Dump Posture, Empty Bucket.	-	-
	Lower	Dozer Down	mm/5 min	*Standard	-	-

Item	Model		Unit	Measuring Conditions	Performance Standard	Tolerance
Hydraulic Fan	Max. Performance	Current	mA	*Standard	210	-
		Fan Speed	rpm		1,700	±50
		Motor Port Pressure	bar		-	-
	Min. Performance (A/C On)	Current	mA	A/C On	700	-
		Fan Speed	rpm		400	±50
		Motor Port Pressure	bar		-	-
	Min. Performance (A/C Off)	Current	mA	A/C Off	500	-
		Fan Speed	rpm		650	±50
		Motor Port Pressure	bar		-	-

- 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.

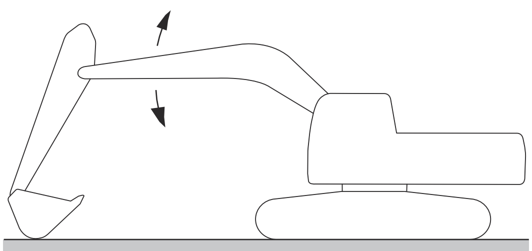
Preparation

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 42



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.

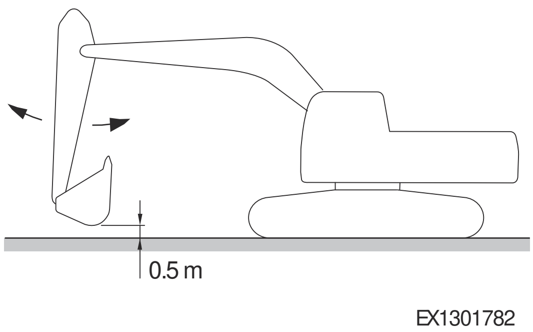
2) Boom down speed

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 43



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.

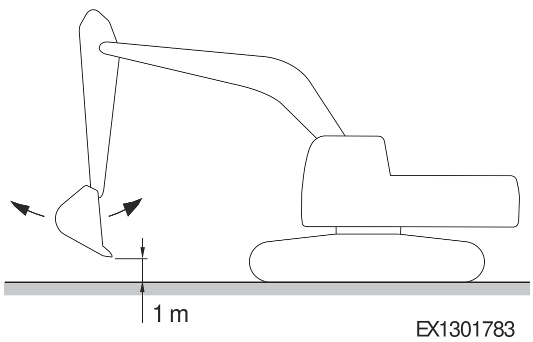
2) Arm dump speed

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 44



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.*

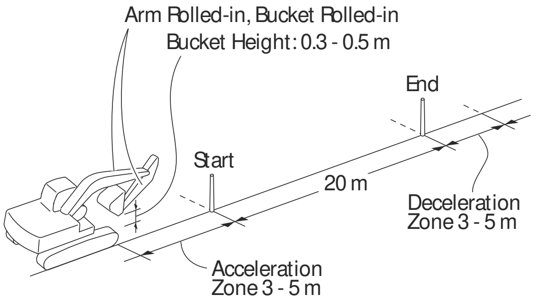
Travel Speed

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 45



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 is rolled in with the arm fully rolled in.
As for this condition: arm fully rolled-in + bucket fully rolled in, set the bucket at fully rolled in and a perform arm 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

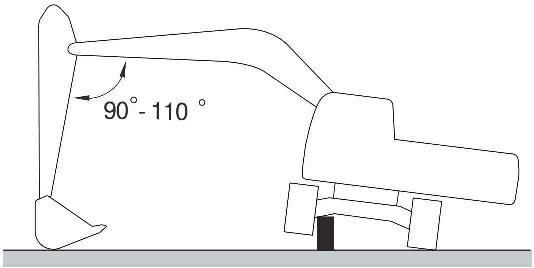
Track Revolution Speed

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 46



EX1300534

⚠ 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

NOTE: *The measurement data obtained through the raised track revolution test may have wide variations. Therefore, the evaluation based on the results obtained from the 20 m travel speed check described before is more recommendable.*

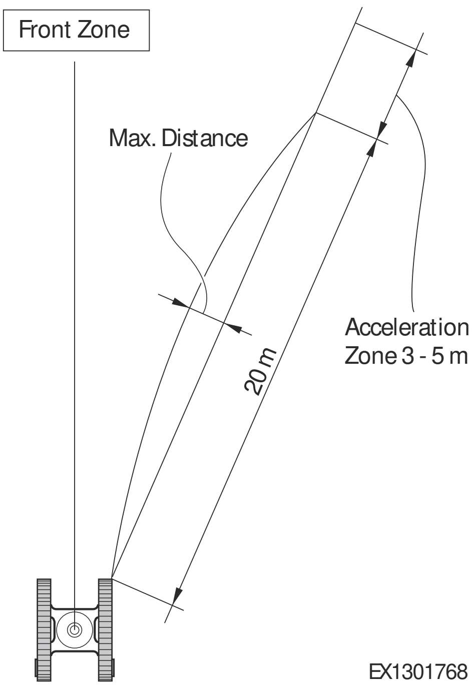
Mis track Check

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 47



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 is rolled in with the arm fully rolled-in.
As for this condition: arm fully rolled-in + bucket fully rolled in, set the bucket at fully rolled-in and a perform arm 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 mis tracking 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

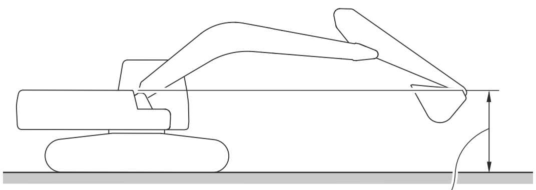
Swing Speed

Summary

Measure the time required to swing three complete turns.

Preparation

1. Check the lubrication of the swing gear and swing bearing.
   Figure 48



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 area before 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

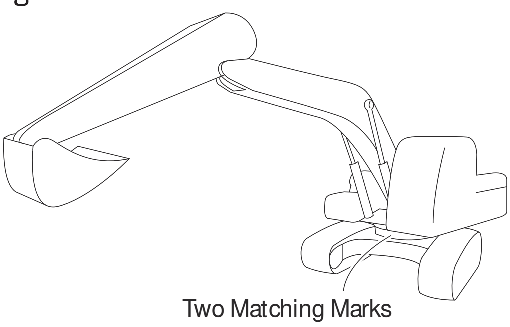
Swing Function Drift Check

Summary

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

Preparation

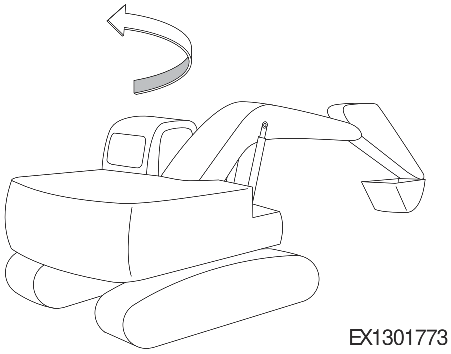
1. Check the lubrication of the swing gear and swing bearing.
   Figure 49



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 50



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

CAUTION

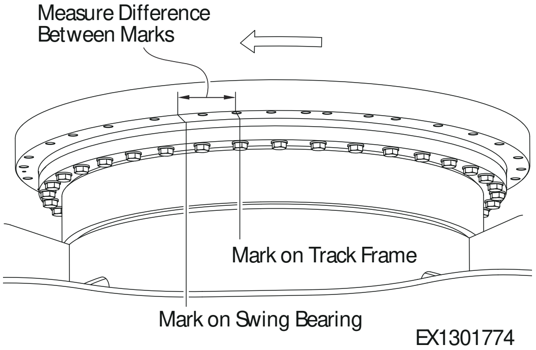
AVOID INJURY

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

Measurement

1. Measurement conditions are as below.

Figure 51



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.

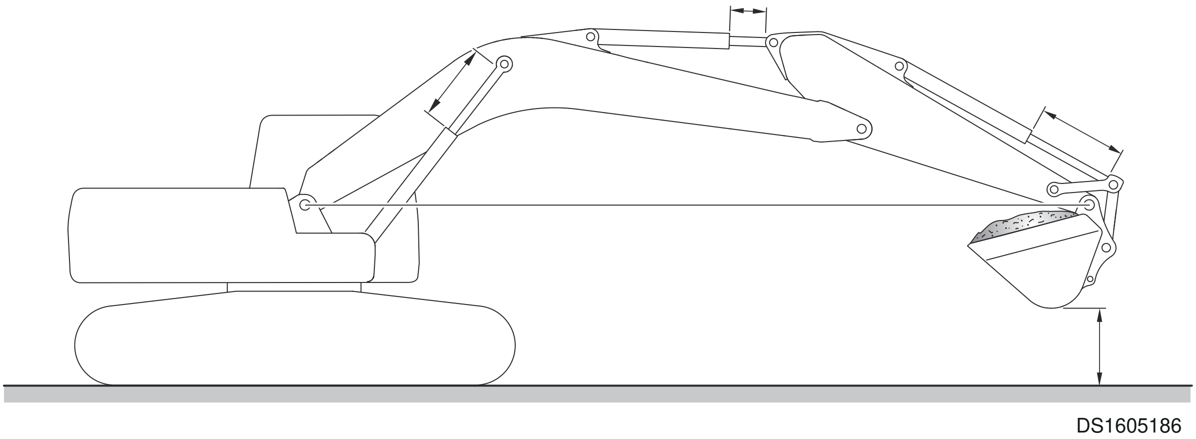
Cylinder Creep

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 52

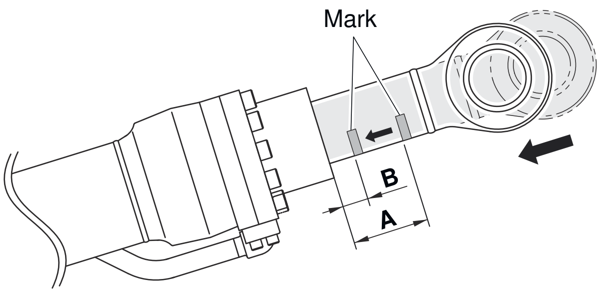


Measurement

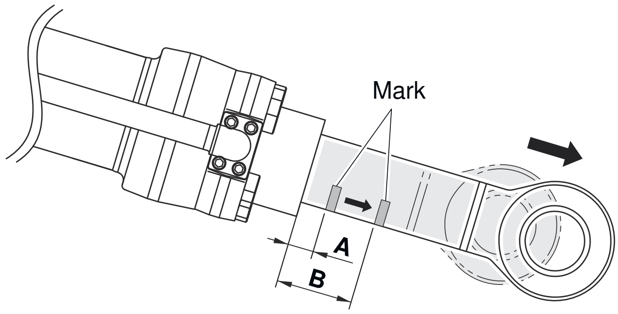
1. Stop the engine.
2. Before measuring the drift of the cylinder, measure the temperatures of the hydraulic tank and cylinder tube.
3. Mark in appropriate location of the cylinder.
4. Measure the distance A.
5. Wait for 5 minutes.
6. Measure the distance B.
7. Drift value of the cylinder can be calculated 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 53



<Boom and Bucket Cylinders Retraction "A-B">



<Arm Cylinder Extension "B-A">

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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.

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.

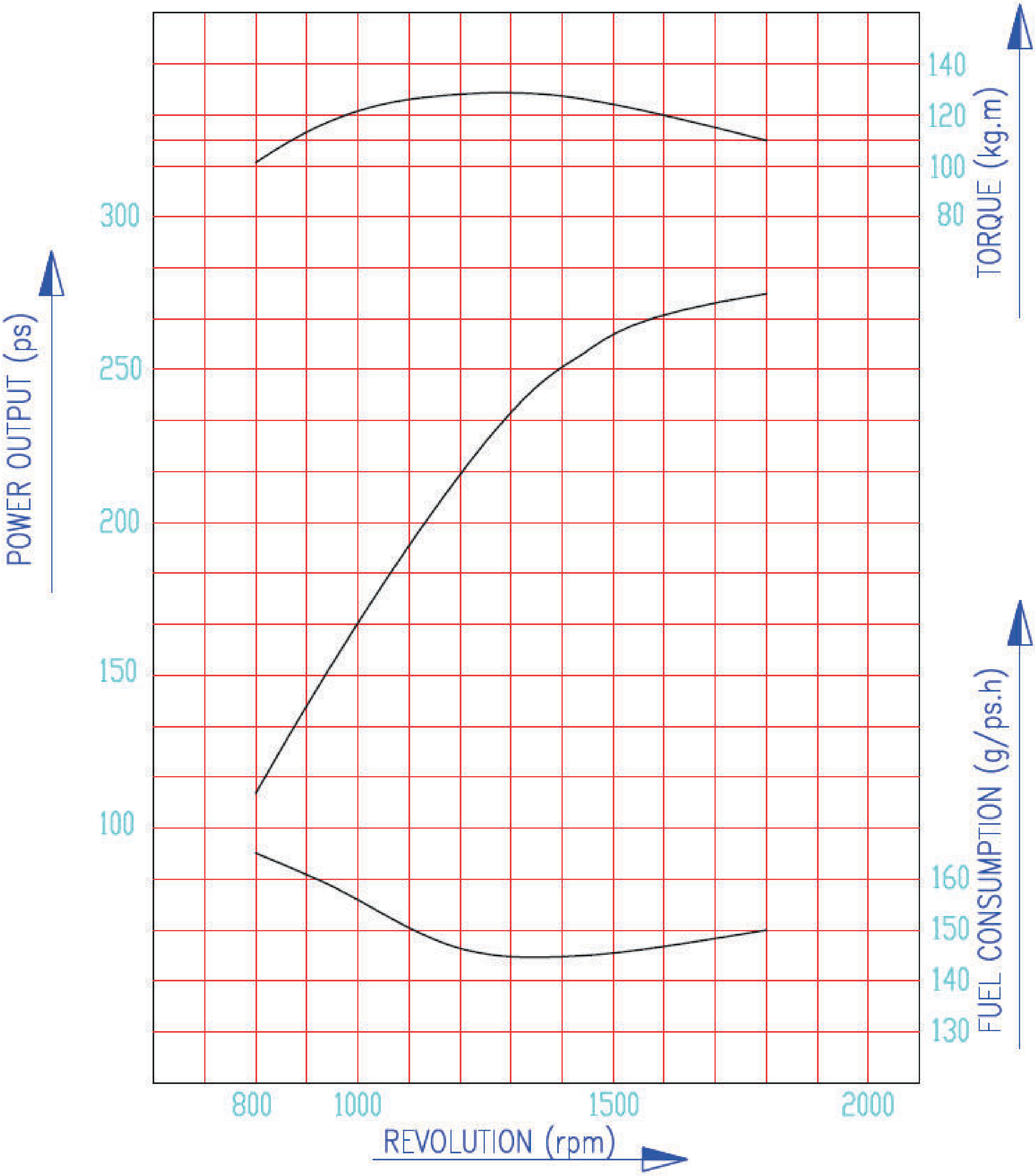
Engine Specification

Items		Specification
Engine	Type	4-Cycle, Water Cooled, Variable Geometry Turbocharge, Common Rail Direct Injection
	Emission	Tier4F
	Model	DL08
	Rated Power	271 HP (275 PS) @ 1,800 rpm (SAE J1995)
Number of Cylinders and Configuration		6, Straight
Cylinder Diameter		108 mm

Items		Specification
Piston Stroke		139 mm
Displacement		7,640 cc
Compression Ratio		17.1:1
Low Idle Speed		800 rpm
High Idle Speed		1,900 rpm
Weight, without Coolant and Oil		855 kg
Electrical System	Type	1-pin, 24 V, DC
	Starter Motor (Standard Equipment)	1-pin, 24 V, 6 kW
	Alternator (Standard Equipment)	1-pin, 24 V, 80 A

Engine Performance Curves

Figure 54



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Performance	KS-R1004
Engine power (maximum, rated)	202 kW / 1,800 rpm
Torque (max.)	1,275 N.m / 1,300 rpm
Fuel consumption (minimum, rated)	203.9 g/kW.hr

Tightening Torques

Tightening Torque of Main Parts

Main Parts	Name (Dia. × Pitch)	Tightening Torque
Cylinder block bearing cap bolt	M16 × 1.5	30 ±2.0 kg.m
Oil spray nozzle	M14 × 1.5	4.5 ±0.6 kg.m
Flywheel housing mounting bolt	M12 × 1.5	11.2 +1.2 kg.m
Crankshaft pulley mounting bolt	M16 × 1.5	26.0 ±2.6 kg.m
Vibration damper	M10 × 1.5	6.2 +0.5 kg.m
Flywheel fixing bolt	M16 × 1.5	26.0 ±6.5 kg.m
Connecting rod cap bolt	M14 × 1.5	7.0 ±0.2 kg.m + 110° (+10°)
Cylinder head bolt	M13 × 1.5	6.0 kg.m + 90° + 90° + 90°
Cylinder head cover bolt	M8	3.1 ±0.78 kg.m
Injector cable mounting nut	M4	0.1 ~ 0.2 kg.m
Rocker arm bracket mounting bolt	M8 × 1.25	6.2 ±1.1 kg.m
Rocker arm adjusting nut	M10 × 1.0	4.4 ±0.45 kg.m
Oil pump cover	M8	2.2 +0.5 kg.m
Oil pump mounting bolt	M8	2.2 +0.5 kg.m
Oil cooler mounting bolt	M8	2.2 +0.5 kg.m
Oil pan mounting bolt	M8	3.1 ±0.78 kg.m
Oil drain plug	M30 × 1.5	10 ±1.0 kg.m
Exhaust manifold mounting nut	M10 × 1.25	6.5 ±0.65 kg.m
Intake manifold mounting bolt	M10 × 1.5	4.4 ±1.1 kg.m
Starter motor	M12 × 1.5	8.0 ±2 kg.m
Alternator bracket mounting bolt	M12 × 1.5	8.0 ±2 kg.m
Engine mounting bracket	M10 × 1.5	8.0 ±2 kg.m
High-pressure fuel pump gear nut (CP pump)	M18 × 1.5	8.2 ±0.5 kg.m
Fuel injector mounting bracket bolt	M8	3.5 ±0.35 kg.m
High-pressure fuel pump mounting bolt (cylinder block)	M8	4.4 +1.1 kg.m
High-pressure fuel connector nut	M22 × 1.5	5.5 ±0.55 kg.m
Common rail mounting bolt	M8	2.2 +0.55 kg.m
High-pressure fuel pipe - High-pressure fuel connector	M14 × 1.5	4.0 ±0.4 kg.m
High-pressure fuel pipe - Common rail	M14 × 1.5	4.0 ±0.4 kg.m
High-pressure fuel pipe - High-pressure fuel pump	M14 × 1.5	4.0 ±0.4 kg.m
Fuel filter mounting bolt	M10	4.4 ±1.1 kg.m

Tightening Torque of General Bolts

Refer to the following tightening torques for bolts whose tightening torque is not included in the list of the main parts.

1. Tightening torque of general bolts

Name Dia. × Pitch (mm)	Strength										
	3.6	4.6	4.8	5.6	5.8	6.6	6.8	6.9	8.8	10.9	12.9
	(4A)	(4D)	(4S)	(5D)	(5S)	(6D)	(6S)	(6G)	(8G)	(10K)	(12K)
	Elastic limit (kg/mm^2)										
	20	24	32	30	40	36	46	54	64	90	106
	Tightening Torque (kg.m)										
M5	0.15	0.16	0.25	0.22	0.31	0.28	0.43	0.48	0.5	0.75	0.9
M6	0.28	0.30	0.45	0.4	0.55	0.47	0.77	0.85	0.9	1.25	0.5
M7	0.43	0.46	0.7	0.63	0.83	0.78	1.2	1.3	1.4	1.95	2.35
M8	0.7	0.75	1.1	1	1.4	1.25	1.9	2.1	2.2	3.1	3.8
M8 × 1	0.73	0.8	1.2	1.1	1.5	1.34	2.1	2.3	2.4	3.35	4.1
M10	1.35	1.4	2.2	1.9	2.7	2.35	3.7	4.2	4.4	6.2	7.4
M10 × 1	1.5	1.6	2.5	2.1	3.1	2.8	4.3	4.9	5	7	8.4
M12	2.4	2.5	3.7	3.3	4.7	4.2	6.3	7.2	7.5	10.5	12.5
M12 × 1.5	2.55	2.7	4	3.5	5	4.6	6.8	7.7	8	11.2	13.4
M14	3.7	3.9	6	5.2	7.5	7	10	11.5	12	17	20
M14 × 1.5	4.1	4.3	6.6	5.7	8.3	7.5	11.1	12.5	13	18.5	22
M16	5.6	6	9	8	11.5	10.5	17.9	18.5	18	26	31
M16 × 1.5	6.2	6.5	9.7	8.6	12.5	11.3	17	19.5	20	28	33
M18	7.8	8.3	12.5	11	16	14.5	21	24.2	25	36	43
M18 × 1.5	9.1	9.5	14.5	12.5	18.5	16.7	24.5	27.5	28	41	49
M20	11.5	12	18	16	22	19	31.5	35	36	51	60
M20 × 1.5	12.8	13.5	20.5	18	25	22.5	35	39.5	41	58	68
M22	15.5	16	24.5	21	30	26	42	46	49	67	75
M22 × 1.5	17	18.5	28	24	34	29	47	52	56	75	85
M24	20.5	21.5	33	27	40	34	55	58	63	82	92
M24 × 1.5	23	25	37	31	45	38	61	67	74	93	103

NOTE: *The standard torque values specified above are based on 70% of the elastic limit of bolts.*

NOTE: *The tensile force is the tensile strength multiplied by the cross-sectional area of the screw.*

NOTE: *Special screws should be tightened to only 85% of the standard value. For example, a screw coated with MoS2 should be tightened to only 60% of the standard value.*

Tightening Torque of Plug Screws

M10	M12	M14	M16	M18	M22	M24	M26	M30
5.0	5.0	8.0	8.0	10.0	10.0	12.0	12.0	15.0

Tightening Torque of Hollow Screws (Four Holes)

Materials	M8	M10	M12	M14	M16	M18	M22	M26	M30	M38
SM25C	-	1.6	2.5	3.5	4.5	5.5	9.0	13.0	18.0	30.0
SUM22L*	0.8	1.8	3.0	4.0	5.5	6.5	11.0	16.0	20.0	35.0
STS304	0.8	1.8	3.0	4.0	5.5	6.5	11.0	16.0	20.0	35.0

*: Installed in Engines

Hydraulic Systems and Structure Specifications

Safety Instructions

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

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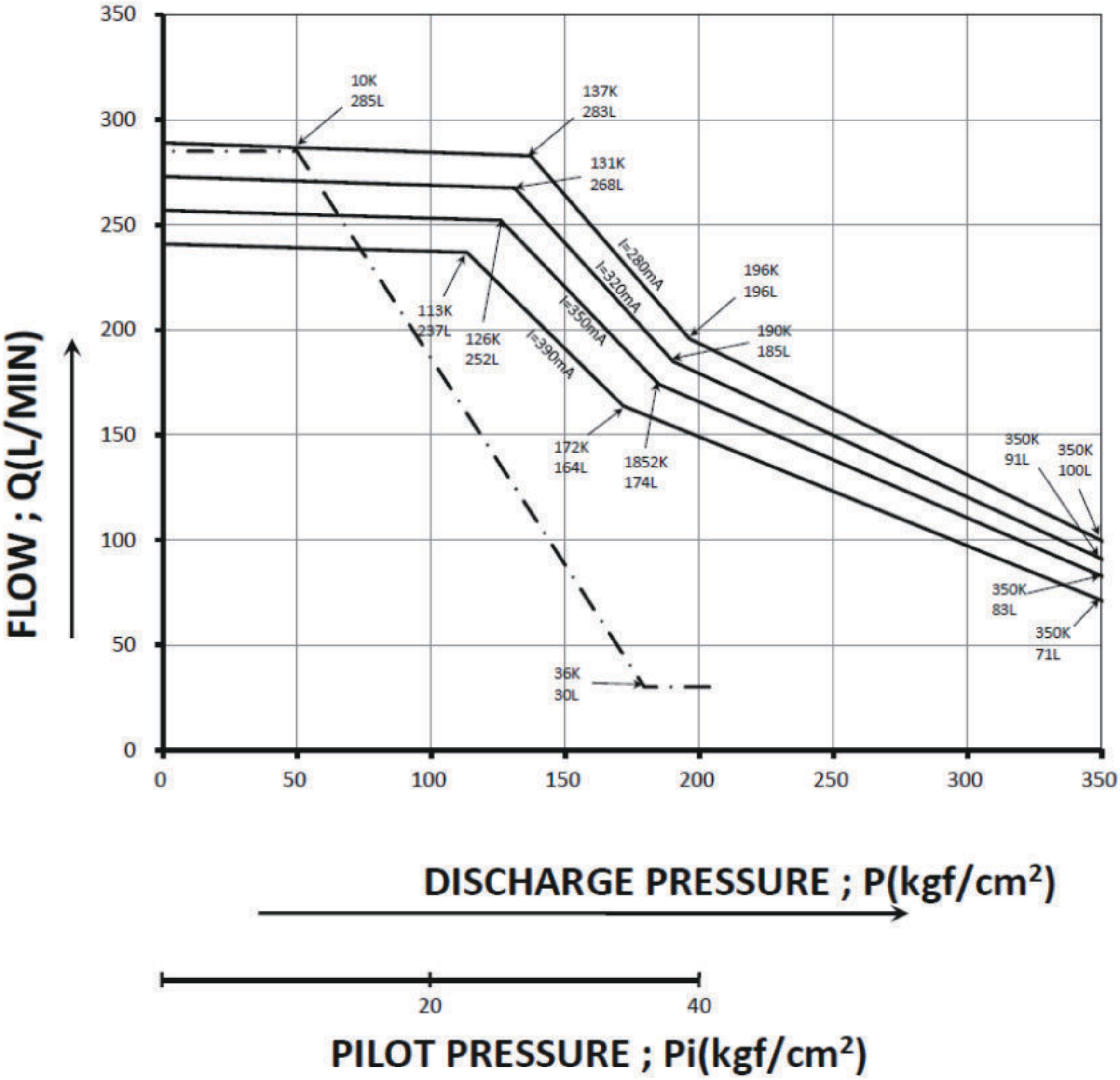
Hydraulic System

Main Pump

Type		Swash Plate, Axial Piston
Rated Speed		1,800 rpm
Displacement		2*160 cc/rev
Max. Flow		2 x 288 L/min @ 1,800 rpm

Performance Curves

1. P - Q Curve
   Figure 55



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Mode	Input	
	rpm	kW
Power Plus	1,800	152
Power	1,700	141
Standard	1,600	130
Economy	1,500	116

Pilot Pump

Type		Gear
Relief Valve Pressure		39 bar (40 $kg.f/cm^2$)
Displacement		15 cc/rev

Max. Flow Rate		27 L/min

Main Control Valve

Type	Pilot Control
Spool Diameter	Boom/Arm/Opt/Straight ø 31.2 mm, Travel/Swing/Bucket/ ø 28 mm
Relief Valve Pressure	343 bar (350 kg.f/cm^2) / 363 bar (370 kg.f/cm^2)
Port Relief Valve Pressure	373 bar (380 kg/cm^2)
Accessory Valve	Boom Holding Valve, Foot Relief Valve
Weight	251 kg

Remote Control Valve: Work/Swing

Type	Pilot, 1 stage, Thumb Wheel/3-Button
Stroke Characteristic	6.9 bar (7.0 kg.f/cm^2) @ 1.0 mm / 27.5 bar (28.0 kg.f/cm^2) @ 6.5 mm

Remote Control Valve: Travel

Type	Pilot, 1 stage, With Damper
Stroke Characteristic	6.4 bar (6.5 kg.f/cm^2) @ 1.0 mm / 24.5 bar (25.0 kg.f/cm^2) @ 4.3 mm

Fan Drive Pump

Type	Axial Piston
Displacement	28.0 cc/rev
Max. Setting Pressure	250 bar (255 kg.f/cm^2)
Direction of Rotation	Clockwise

Fan Drive Motor

Type	Gear
Displacement	26.7 cc/rev
Max. Setting Pressure	280 bar (285 kg.f/cm^2)
Direction of Rotation	Reversible

Accumulator

Nitrogen Charge Pressure	10 bar (10 kg.f/cm^2)
Volume	0.32 Liter

Swing Motor

Type	Axial Piston
Displacement	240 cc/rev
Crossover Relief Valve Setting	255 bar (260 kg.f/cm^2)
Max. Supply Flow	296 L/min
Motor Shaft Speed	1,233 rpm
Motor Shaft Torque	974 N.m (99.3 kgf.m)
Accessory Valves	Swing Reactionless Valve

Swing Reduction Gear

Type	2-Stage Planetary Gear
Reduction Ration	19.565
Crossover Relief Valve Setting	255 bar (260 kg.f/cm^2)
Max. Output Speed	63.04 rpm
Max. Output Torque	19.1 kN.m (1,943 kgf.m)

Pinion Gear

Type	Spur Gear
Gear P.C.D	ø 196 mm
No. of Teeth	14
Module	14

Swing Bearing

Type	Ball Bearing, Internal Gear
Gear P.C.D	ø 1,190 mm
No. of Teeth	85
Ball Diameter	ø 41,275 mm
Race O.D.	ø 1,474 mm

Parking Brake

Control Type	Pilot Pressure, Mechanical
Brake Torque	1,314 N.m (134 kg.m, 969 ft lb)
Brake Release Pressure	26 bar (26.5 kg/cm^2)

Travel Motor

Max. Input Speed	1,800 rpm
Max. Displacement	18 cc/rev
Max. Flow at Max	32 L/min (8.5 U.S. gal) (Theoretical Value)

Pressure Setting on EPPR Valve	120 bar (122 kg/cm^2, 1,740 psi)
Min. Pressure Setting on EPPR Valve	16 bar (16 kg/cm^2, 232 psi)

Fan Motor for Oil Cooler

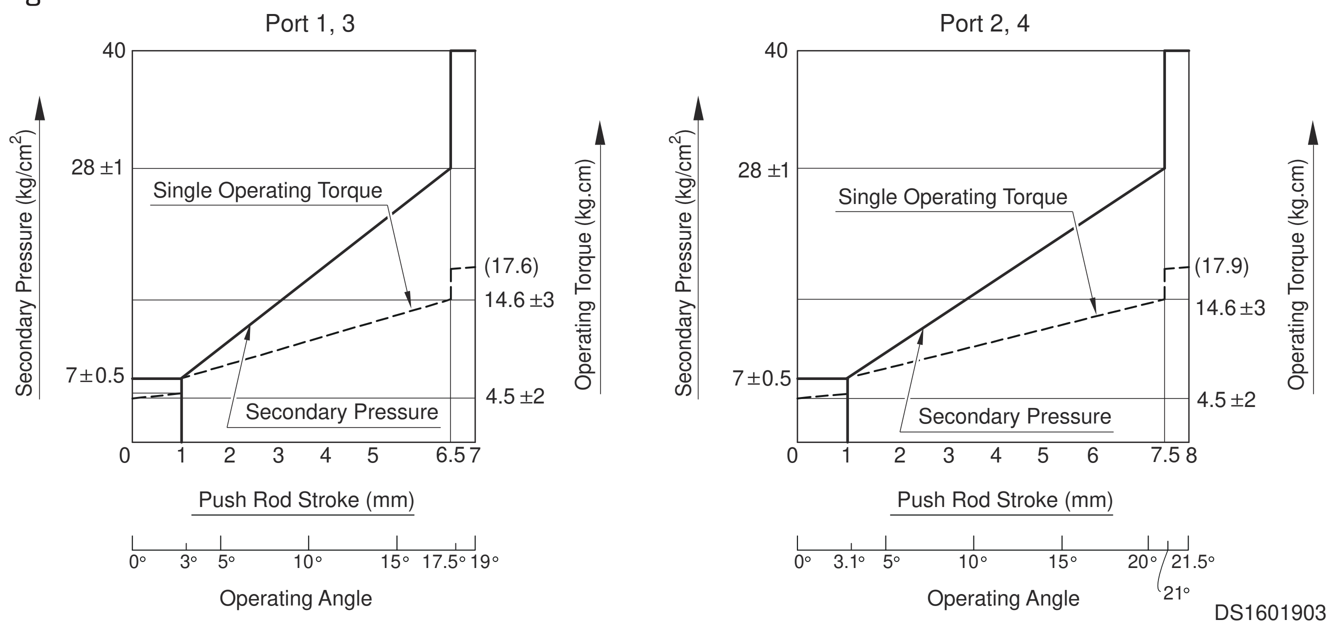
Direction of Rotation (Looking on the Driveshaft)		Reversible (R)
Displacement		19.09 cm^3/rev
Max. Continuous Pressure	P1	200 bar (204 kg/cm^2, 2,900 psi)
Max. Intermittent Pressure	P2	220 bar (224 kg/cm^2, 3,190 psi)
Max. Peak Pressure	P3	240 bar (244 kg/cm^2, 3,480 psi)
Max. Drain Line Pressure on the Reversible Rotation Motors		5 bar (5 kg/cm^2, 73 psi)
Speed	Min. P1	500 min^{-1}
	Max. P1	3,000 min^{-1}
Weight		4 kg (8.8 lb)

Joystick Valve (Work Lever)

Max. Primary Pressure		49 bar (50 kg/cm^2, 711.1 psi)
Max. Back Pressure		2.9 bar (3 kg/cm^2, 42.7 psi)
Rated Flow		20 L/min (5.3 U.S. gal)
Continuous Rated Current of Switch		DC30 V x 6 A
Internal Leakage	Oil Temperature Range	-20 ~ 90°C (-4 ~ 194°F)
	Neutrality	Max. 400 cc/min
	At Work (14.7 bar (15 kg/cm^2, 213.3 psi)	Max. 600 cc/min
Weight		2.4 kg (5.3 lb)

Performance

Figure 56

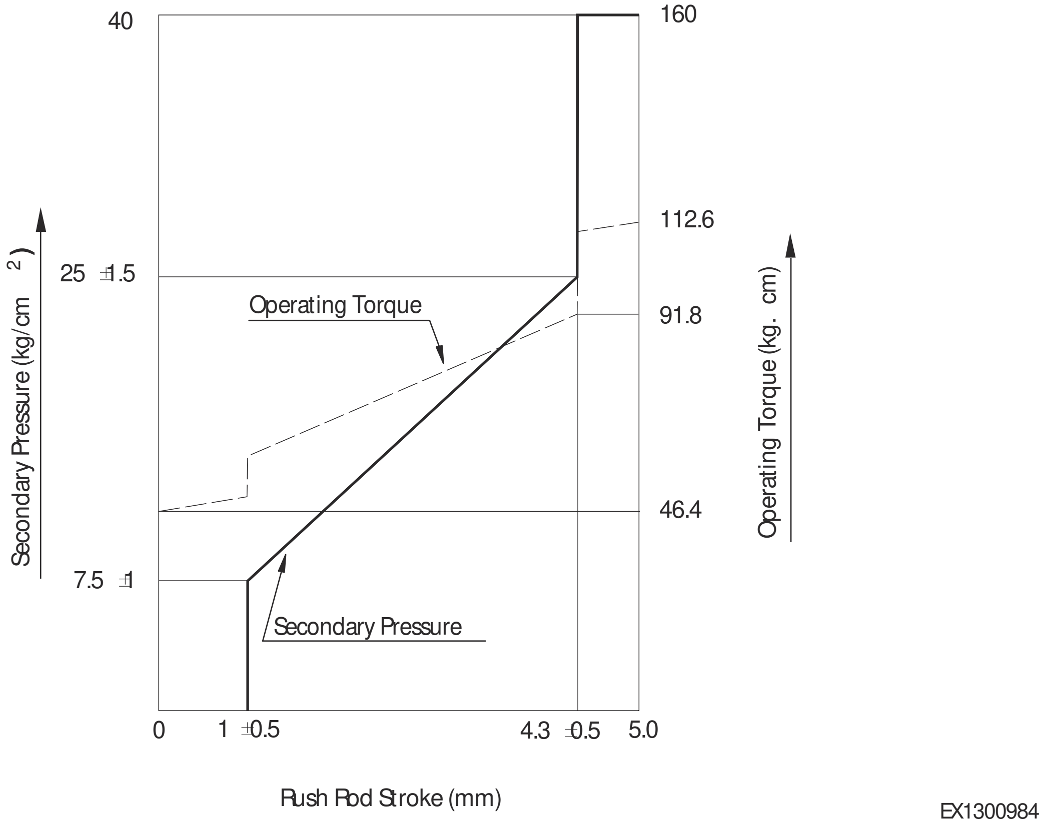


Travel Control Valve (with Damper)

Type	Pilot (with Damper)
Pressure/Stroke Characteristic	7.5 ~ 25 kg/cm^2 (7.4 ~ 25 bar) (@1 ~ 4.3 mm Stroke)
Max. Primary Pressure	100 kg/cm^2 (98 bar, 1,422 psi)
Max. Back Pressure	3 kg/cm^2 (2.9 bar, 42.7 psi)
Rated Flow	20 L/min (5.3 U.S. gal)
Weight	7.8 kg (17.2 lb)

Performance

Figure 57



Solenoid Valve (4 Solenoid)

Pressure (Max.)	71 kg/cm^2(70 bar, 1,015 psi)
Flow (Max.)	20 L/min (5.2 U.S. gal)
Leakage	40 ml/min
Solenoid Coil	
Rated Voltage	DC 24 V
Operation Voltage Range	20 - 30 V
Surge Absorber	Built in
Connector Type	Deutsch DT-02 Series
	Housing Series: DT04-2P-Type molded
	Deutsch Terminals: Pin 1060-16-0122

EPPR Valve (One or Two-way)

Max. Supply Pressure	241 bar (246 kg/cm^2, 3,500 psi)
Back Pressure	17.2 bar (17.5 kg/cm^2, 250 psi)
Max. Supply Rate	18.9 L/min (5 U.S. gal)
Weight	1.6 kg (3.5 lb)

Accumulator

System	Charge Pressure	Volume
Pilot	10 kg/cm^2(9.8 bar, 142 psi)	320 cc (19.53 in^3)

Gear Pump (Rotating)

Direction of Rotation(Looking on Driveshaft)	Clockwise
Displacement	26.7 cm^3/rev
Inlet Pressure Range for Pump	0.7 ~ 3 kg/cm^2 (0.7 ~ 3 bar, 10.1 ~ 43.5 psi)
Max. Continuous Pressure	286 kg/cm^2 (280 bar, 4,061 psi)
Max. Intermittent Pressure	306 kg/cm^2 (300 bar, 4,351 psi)
Max. Peak Pressure	316 kg/cm^2 (310 bar, 4,496 psi)
Weight	13.7 kg (30.2 lb)

One Spool Valve (Rotating)

Rated Pressure	83 bar (85 kg/cm^2, 1,209 psi)
Rated Flow	50 L/min (13 U.S. gal)
Internal Leakage	10 cc/min at 69 bar (70 kg/cm^2, 996 psi)
Main Relief Pressure Setting	78 bar (80 kg/cm^2, 1,131 psi)@50 L/min
Overload Relief Pressure Setting	98 bar (100 kg/cm2, 1,421 psi)@5 L/min

Travel Device

		1 Speed	2 Speed
Travel Motor	Type	Axial Piston 2-speed	
	Displacement	270 cc/rev	165 cc/rev
	Crossover Relief Valve Setting	343 bar (350 kg/cm2) @25 L/min	
	Max. Supply Flow	360 L/min (95 U.S. gpm)	
	Motor Shaft Speed	1,332 rpm	2,180 rpm
	Motor Shaft Torque	1,475 N.m(150.4 kg.m, 1,088 ft lb)	901 N.m(91.9 kg.m, 665 ft lb)
Reduction Gear	Type	2 - Stage Planetary Gear	
	Reduction Gear Ratio	46.12	
	Max. Output Speed	28.9 rpm	47.3 rpm
	Max. Output Torque	68,000 N.m(6,934 kg.m, 50,154 ft lb)	41,570 N.m(4,239 kg.m, 30,661 ft lb)
	Weight	405 kg (892 lb) (Included Motor)	
	Traveling Speed	3.9 km/hr	6.3 km/hr
	Traction Force	37.9 ton	23.1 ton

		1 Speed	2 Speed
	Traction Force (EFF. = 81%)	30.7 ton	18.7 ton
	Gradeability	70%	
Parking Brake	Control Type	Main Pressure, Mechanical	
	Brake Torque	853 N.m (87 kg.m, 629 ft lb) (min)	
	Brake Release Pressure	8 ±1.5 bar (8.2 ±1.5 kg/cm^2)	

General Maintenance

General Maintenance Instructions

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.

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 in correctly, structural weakening or other damage to the machine (that is not always readily visible) could result. Always consult with your dealer 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 structural critically repairs may require Magnetic Particle or Liquid Penetrant 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.

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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 embrittlement 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 pre filling 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 pre lube or has been contaminated by dirt or by questionable oils, flushing and pre filling 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 other contamination be kept out of the system. Observe fluid and filter change maintenance interval recommendations and always preclean any exterior surface of the system before it is exposed to air. For example, the reservoir fill cap and neck area, hoses that have to be disassembled, and the covers and external surfaces of filter canisters should all be cleaned 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 with rubber materials used in the hydraulic system. Many petroleum based compounds can cause swelling, softening, or other deterioration of system sealing elements, such as O-rings, caps and other seals.

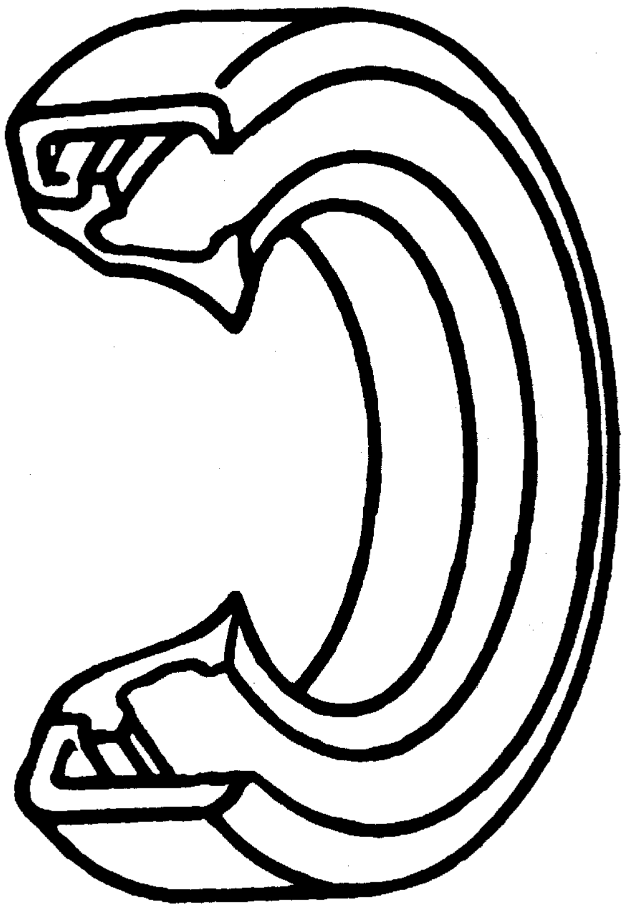
Oil Leakage Precautions

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 58



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 to contact skin. Keep solvent away from open flame, arcs or sparks 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 air stream 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.

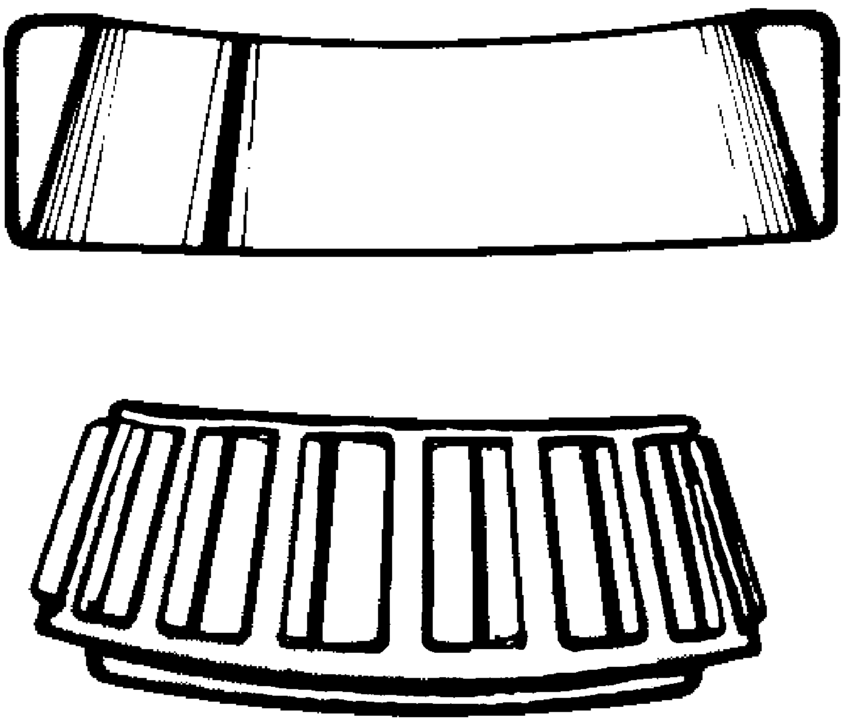
If available, use magna-flux or similar process for checking for cracks that are not visible.

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 59

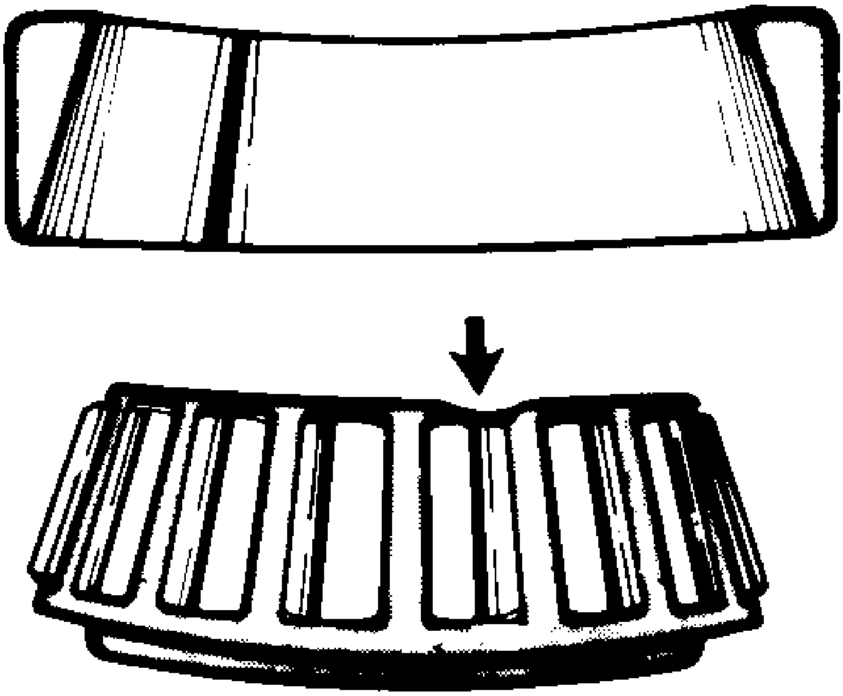


HASA620S

Smooth even surfaces with no discoloration or marks.

Bent Cage

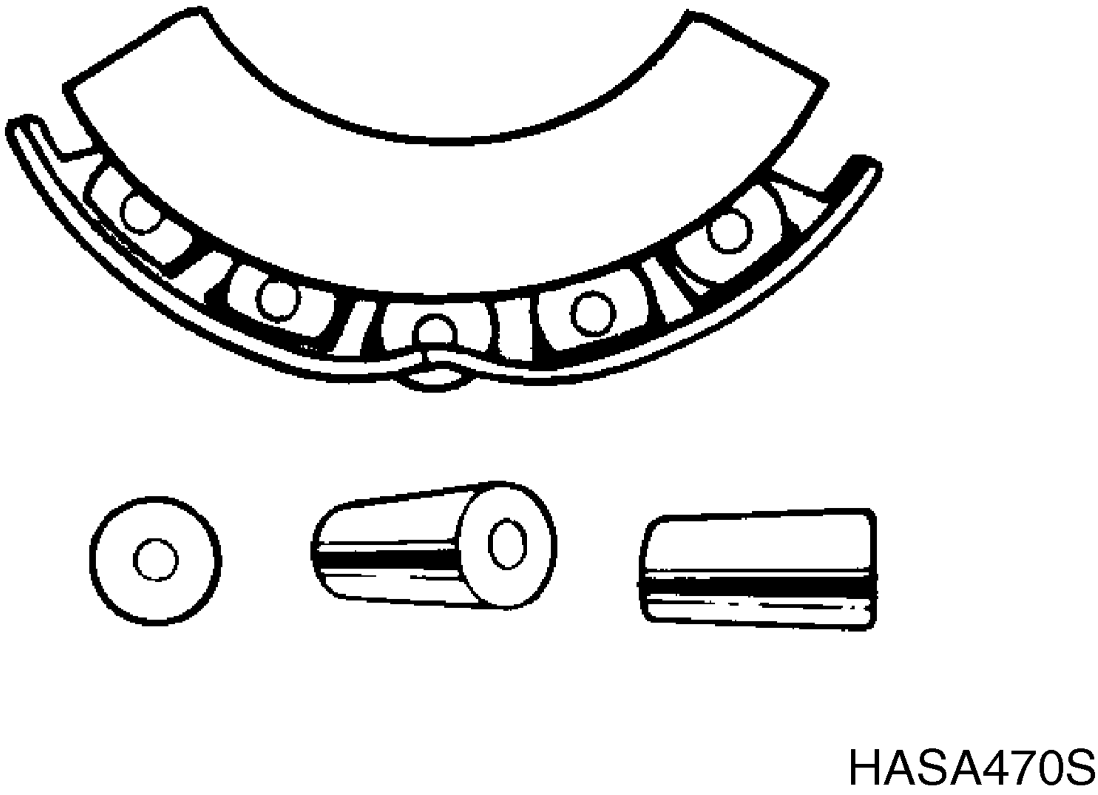
Figure 60



HASA460S

Cage damage because of improper handling or tool usage.

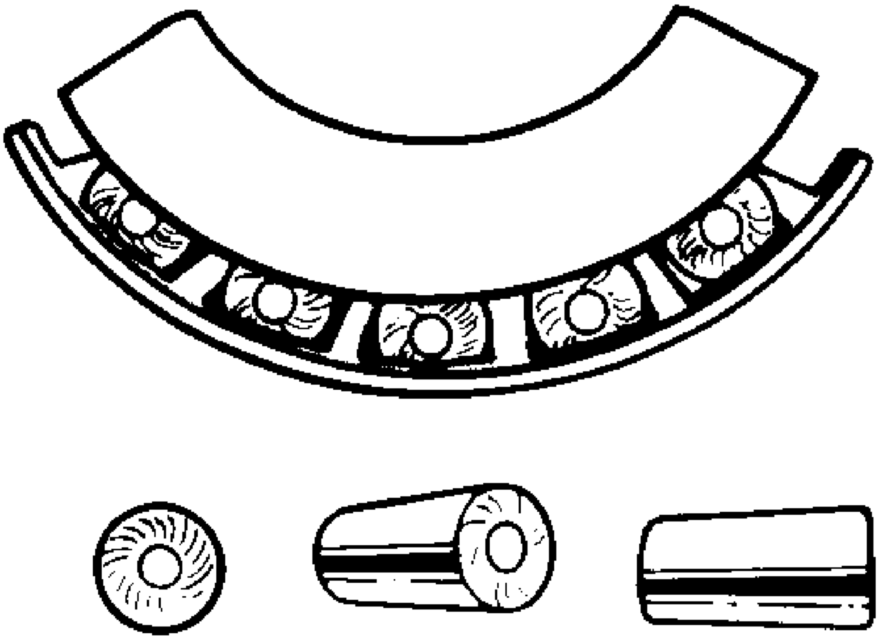
Figure 61



Replace bearing.

Galling

Figure 62



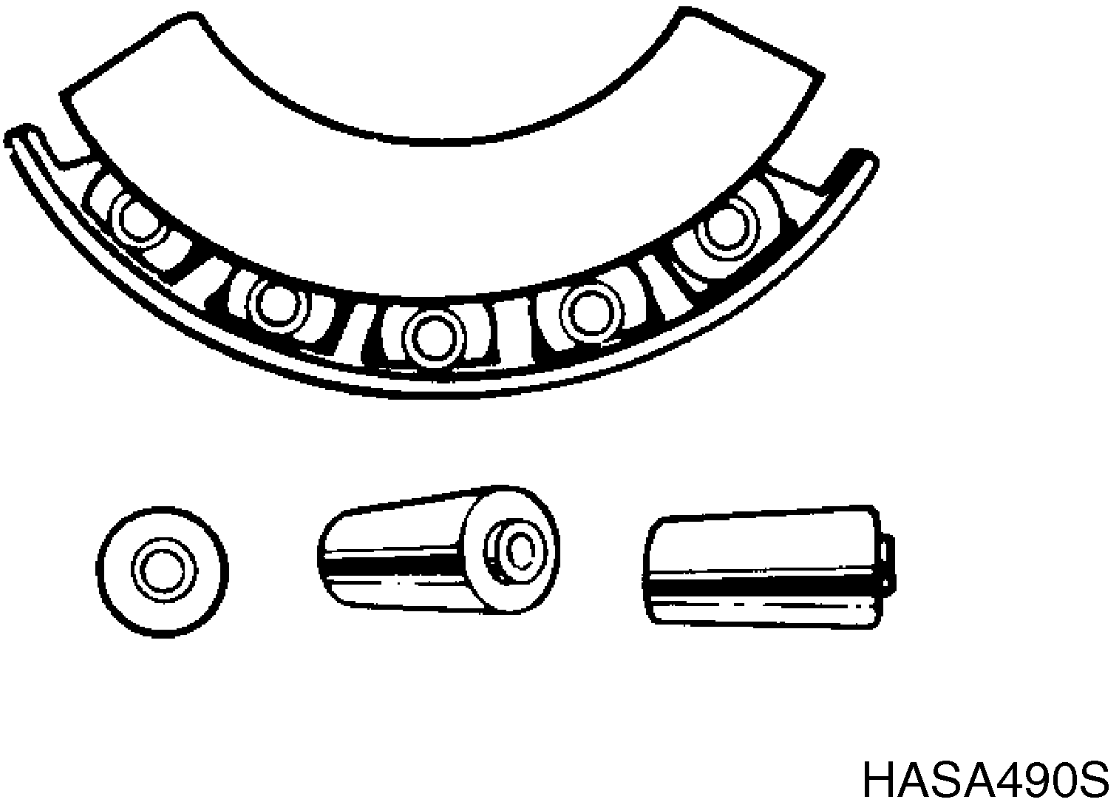
HASA480S

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 63

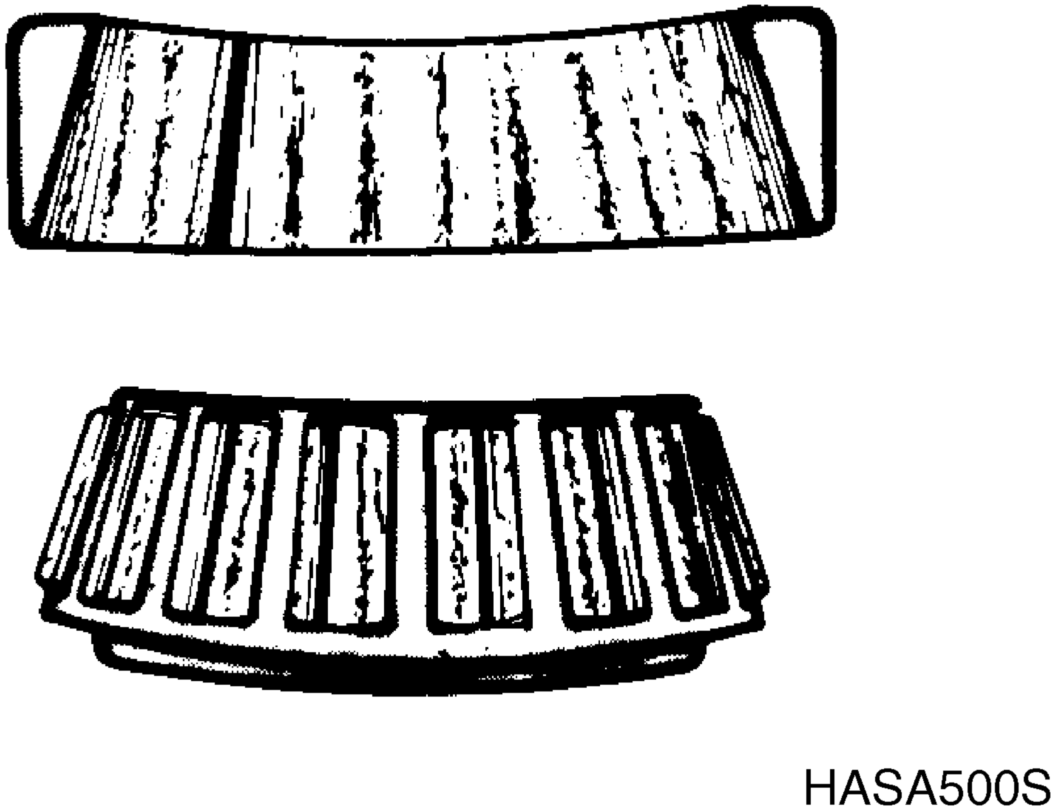


Pattern on roller ends caused by fine abrasives.

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

Etching

Figure 64

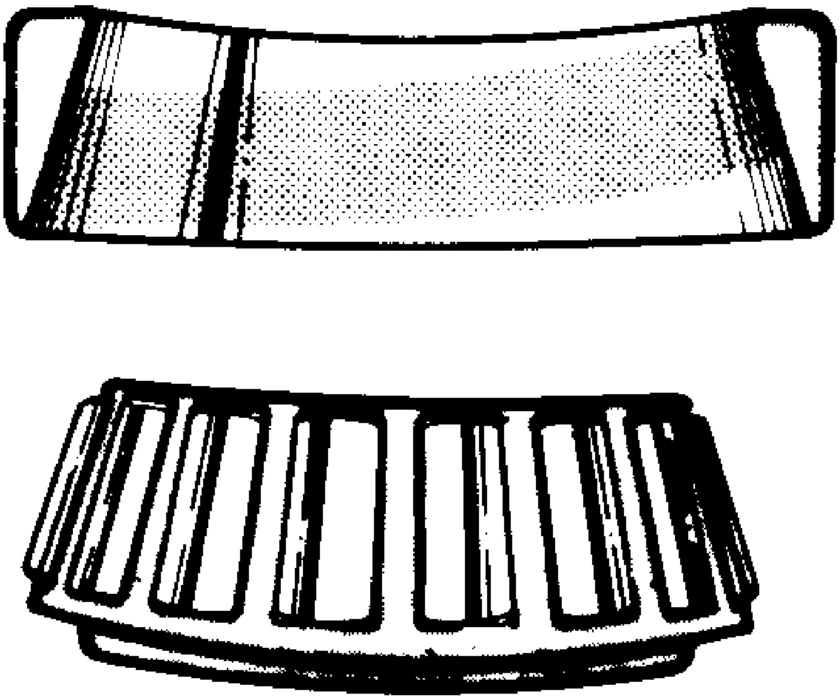


Bearing surfaces appear gray or grayish black in color with related etching away of material usually at roller spacing.

Replace bearings - check seals and check for proper lubrication.

Misalignment

Figure 65



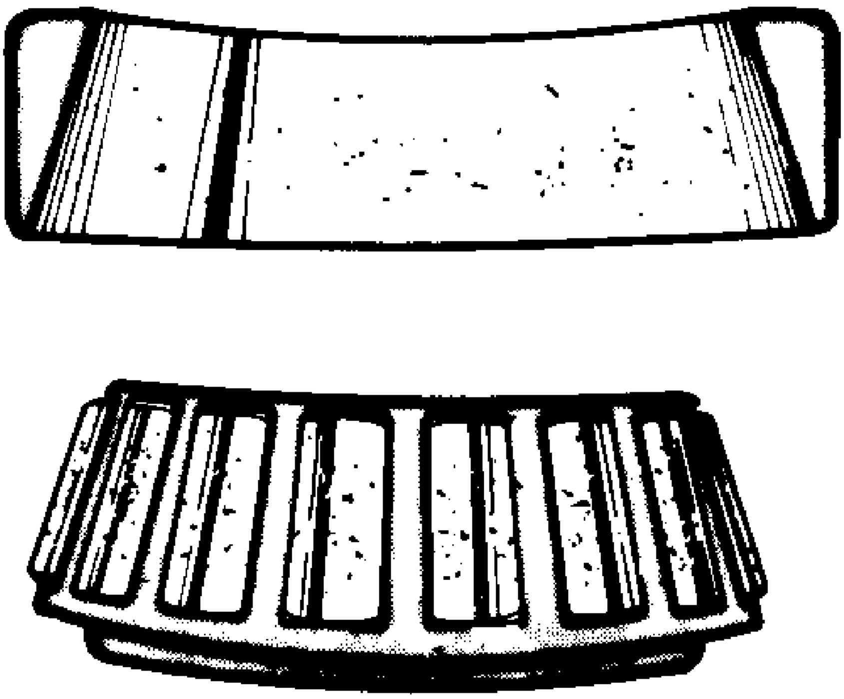
HASA510S

Outer race misalignment because of foreign object.

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

Indentations

Figure 66



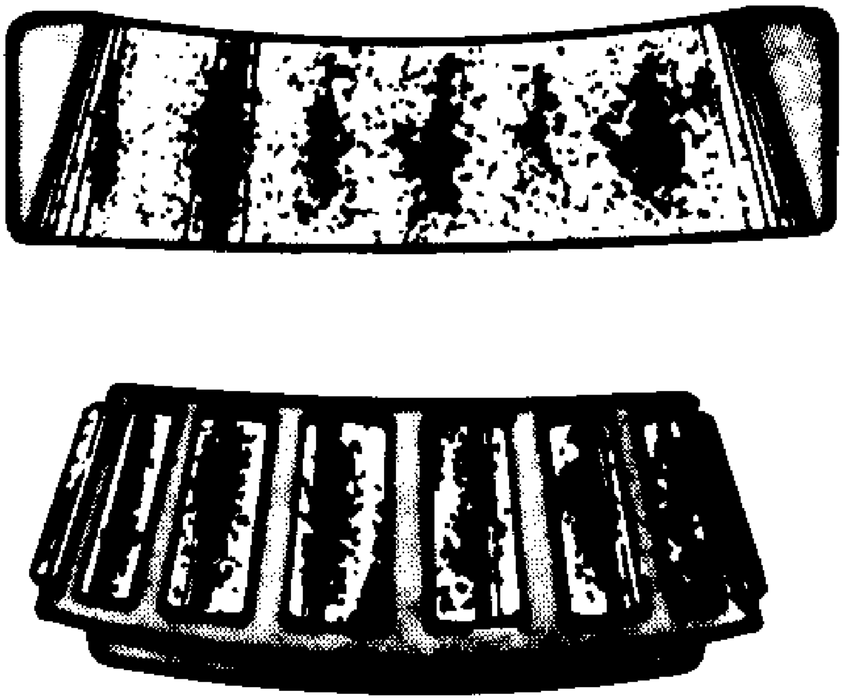
HASA520S

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 67



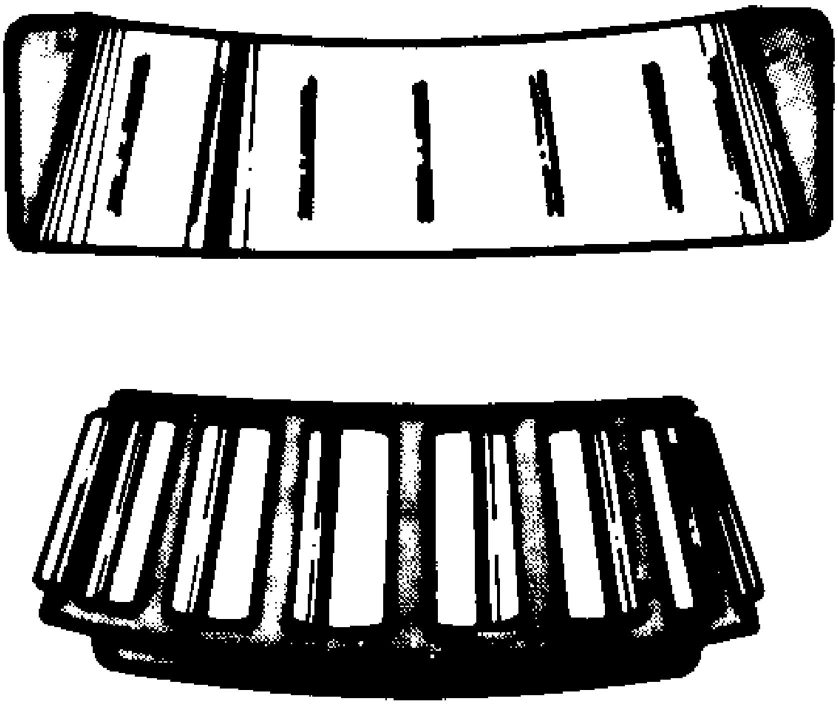
HASA530S

Flaking of surface metal resulting from fatigue.

Replace bearing - clean all related parts.

Brinelling

Figure 68



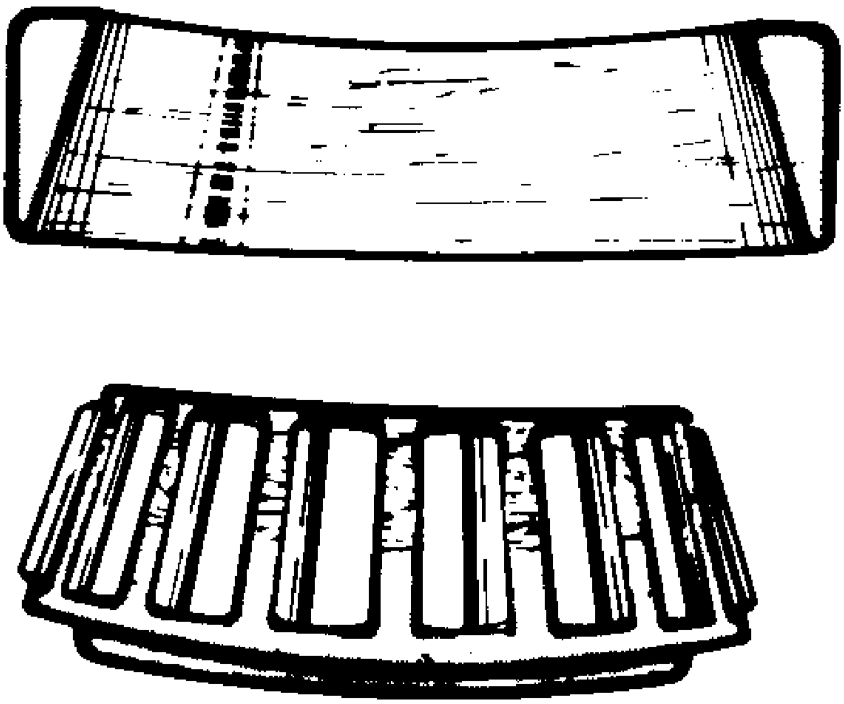
HASA540S

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 69



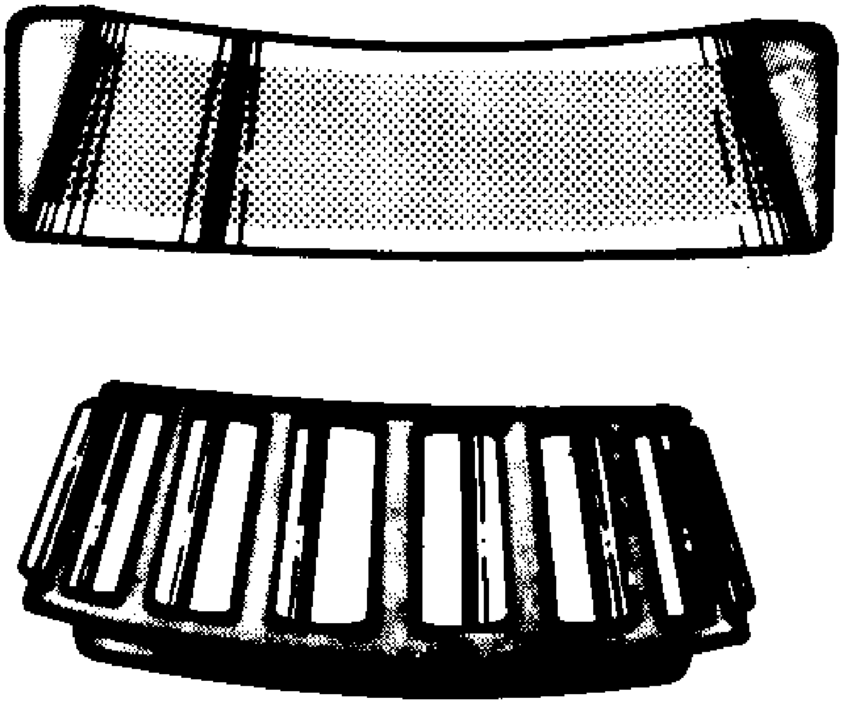
HASA550S

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

Replace bearings - check seals.

Abrasive Roller Wear

Figure 70



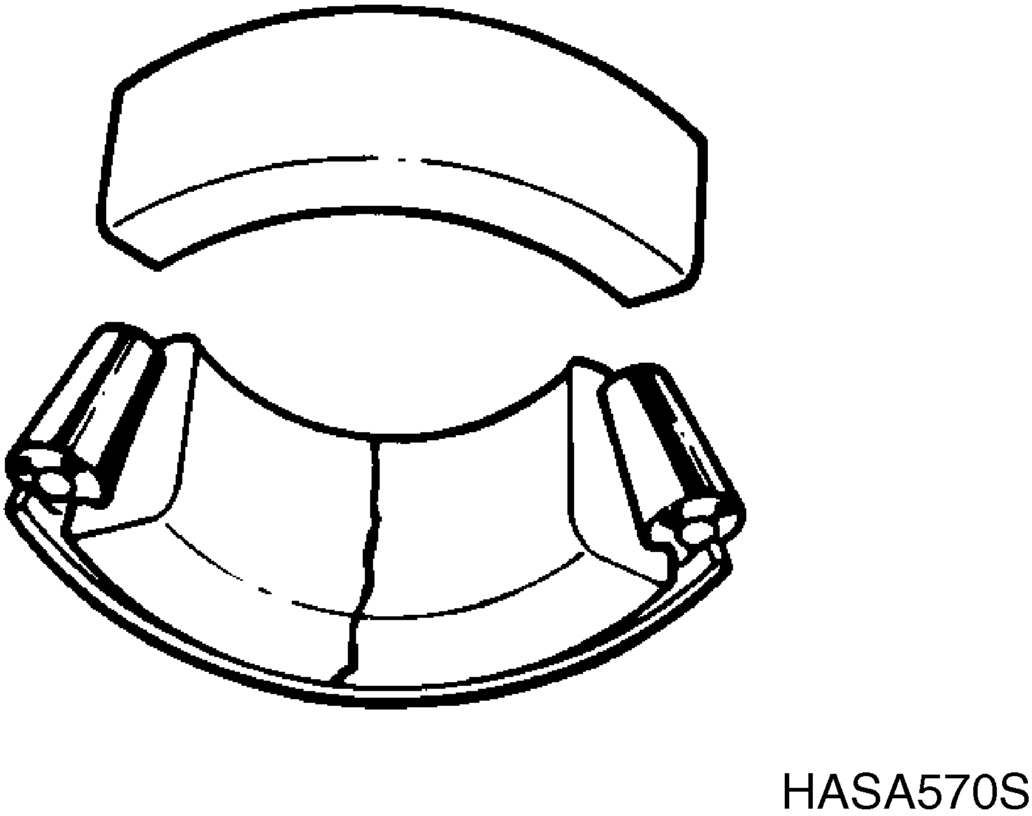
HASA560S

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 71

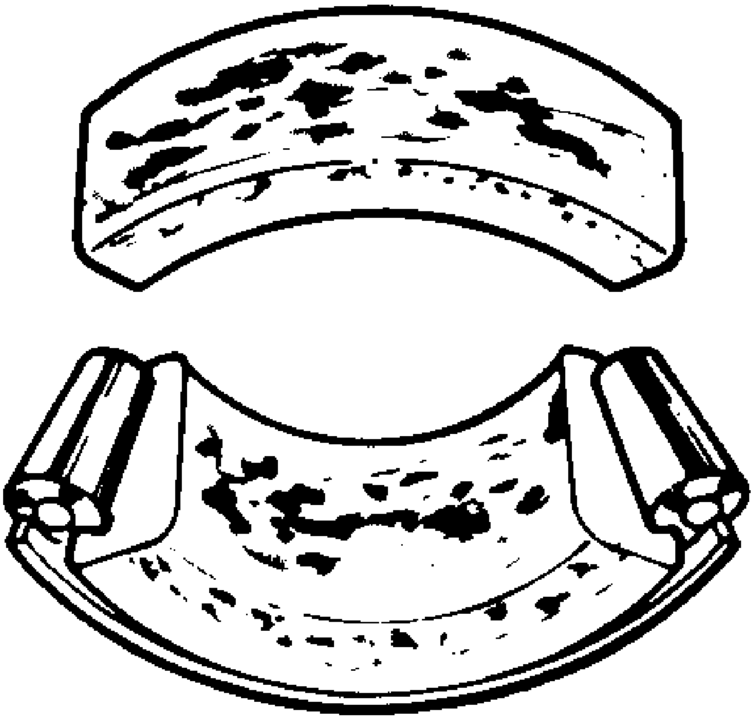


Race cracked because of improper installation, cocking or poor bearing seat.

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

Smears

Figure 72



HASA580S

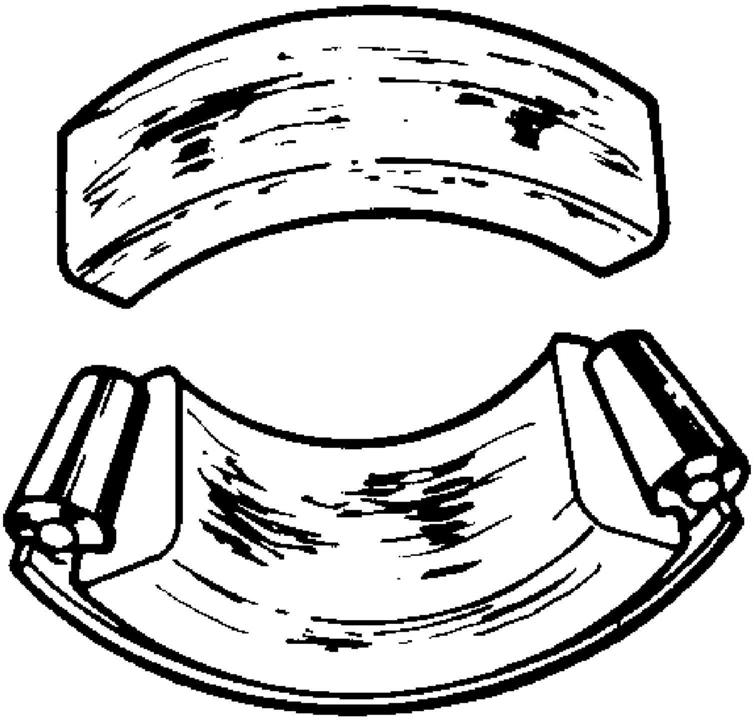
Smearing of metal because of slippage caused by poor installation, lubrication, overheating, overloads or handling damage.

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

Replace shaft if damaged.

Frettage

Figure 73

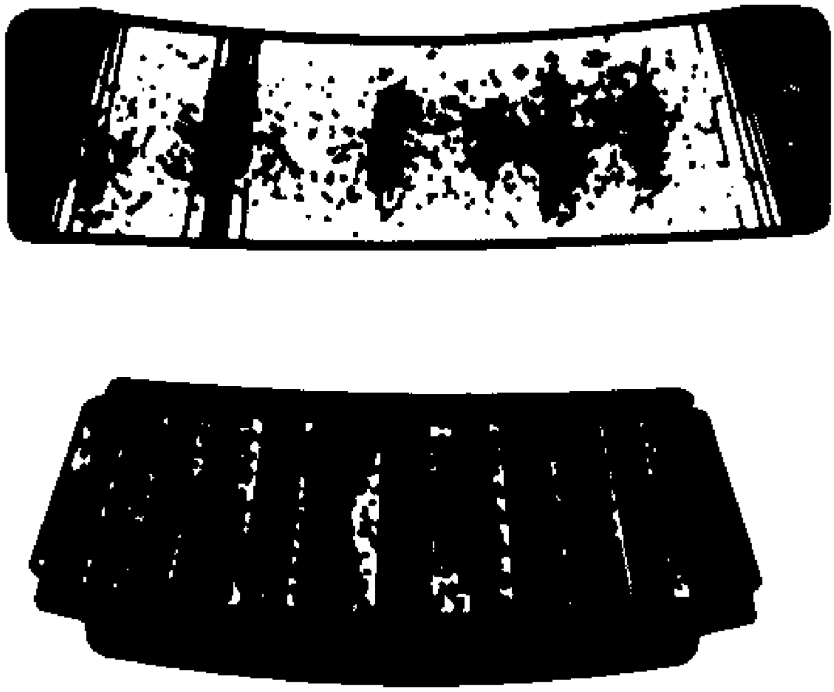

HASA590S

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 74



HASA600S

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

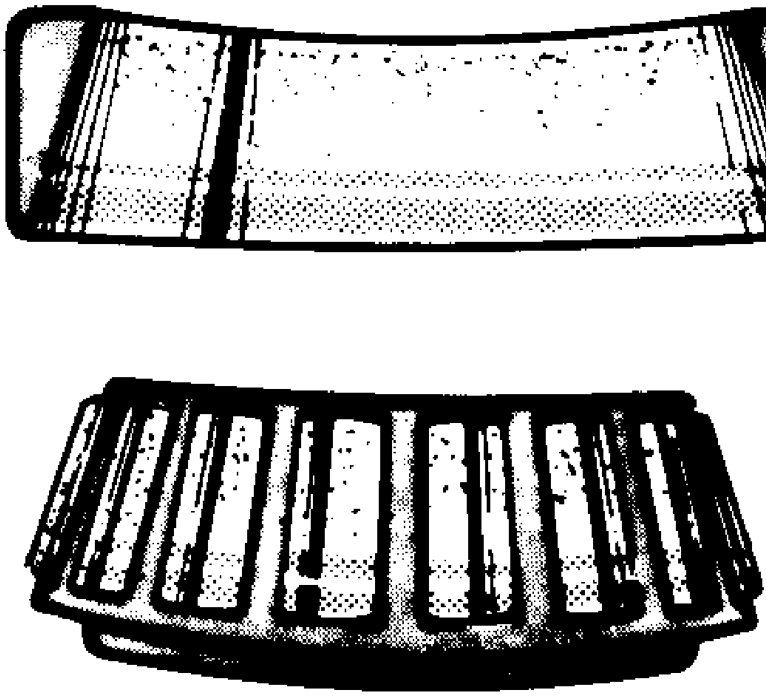
Excessive heat can cause softening of races or rollers.

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 75



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)
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: 0.65 When finished jam nuts are used. 0.70 When Molykote, white lead or similar mixtures are used as lubricants. 0.75 When Parkerized bolts or nuts are used. 0.85 When cadmium plated bolts or nuts and zinc bolts w/waxed zinc nuts are used. 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

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)
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

Dash Size	Hose I.D.	Thread Size	Torque (kg.m) Recommended
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.

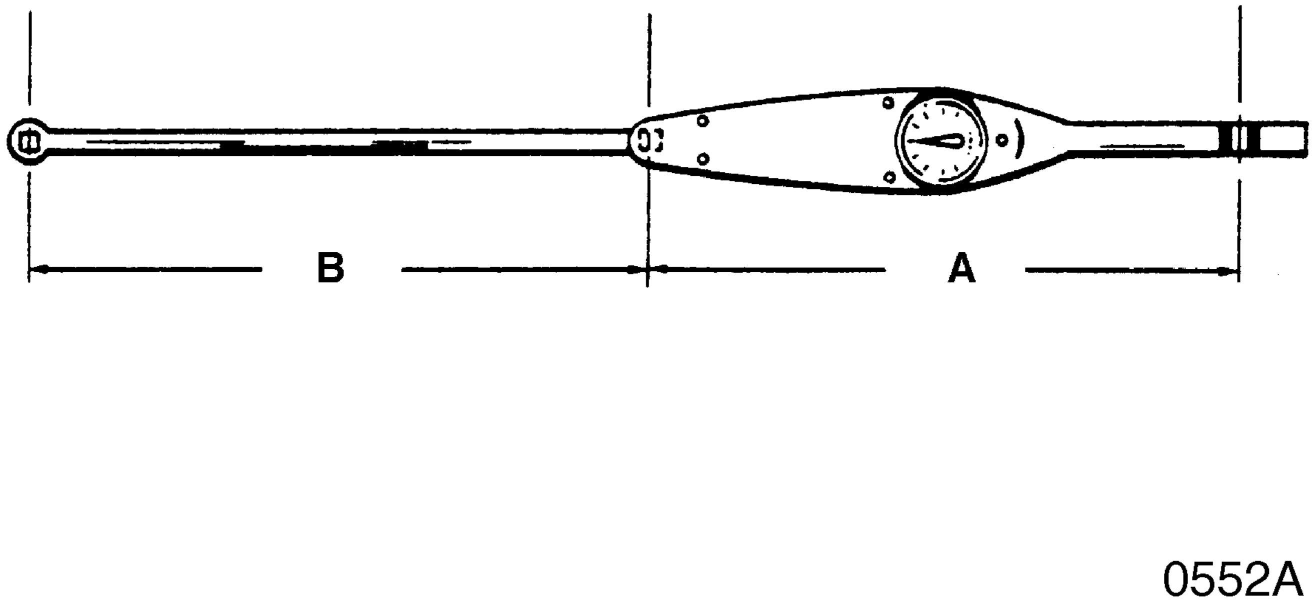
Common problems that could occur as a result are:

- 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 76



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.

Engine

Engine

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.

General Information

Engine Operation and Care

Preparing to Start

Inspect the following before starting the engine for the first time after purchasing it.

1. Check the fuel, coolant and oil levels before starting the engine; add as necessary.
2. Check whether the engine oil level lies between the upper and lower limit lines on the oil level gauge. The upper and lower limit lines on the oil level gauge indicate the maximum and minimum engine oil levels.

   ⚠ CAUTION

   AVOID INJURY

   Do not fill engine oil past the upper limit line on the oil level gauge. Overfilling oil can damage the engine.

3. When adding fuel, oil or coolant, take care not to allow foreign matter to enter the engine; store them in a clean place when not in use in order to prevent contamination. Use only fuel, oil, coolant, etc. recommended by HD HYUNDAI CONSTRUCTION EQUIPMENT. Otherwise, severe engine faults may occur.

When Starting the Engine

Follow the instructions below when starting the engine.

1. For cold starts, start the engine after preheating it sufficiently with the glow plug.
2. If the engine is started abruptly, oil cannot reach the turbocharger as well as the various parts of the engine; this lack of lubrication can lead to abnormal wear or seizure of the bearings. Hence, before starting the engine, it is necessary to run it with the starter motor to check for a rise in hydraulic pressure (until the needle on the hydraulic pressure gauge installed in the machine moves or the pressure indicator comes on).
3. Oil flow in pipes worsens after the engine has been stopped for a prolonged period of time or in cold weather. Hence, after changing the oil, replacing the oil filter cartridge or parts of the lubrication system or leaving the engine stopped for an extended period of time or in cold weather, undo the oil pipe connection at the inlet of the turbocharger and run the starter motor

until oil flows out of it. Once this step is complete, make sure to re tighten the pipe connection and start the engine.

Immediately After Starting the Engine

1. After starting the engine, do not increase the engine rpm suddenly when the engine and turbocharger are not yet rotating smoothly. The engine may be overloaded, leading to seizure in parts not yet sufficiently lubricated by oil. Hence, idle the engine after starting it to enable enough oil to reach the turbocharger.
2. Oil, air and gas leakage reduces hydraulic pressure. Oil leakage in particular may cause bearings to seize. Hence, in the event of an oil, air or gas leak, check the leaking part, locate the cause and resolve the issue.

During Operation

1. If the oil pressure is excessively low, it can lead to abnormal wear or seizure of bearings; if it is excessively high, it can cause oil leaks.
2. Continuing to run the engine with abnormal noise or vibrations may cause severe damage to the engine. Hence, in the event of abnormal noise or vibrations, lower the engine rpm slowly; then, stop the engine and determine the cause.

Stopping the Engine

Do not stop the engine abruptly after running it at a high rpm for an extended period of time. If heat transferred from the hot turbine blades reaches the bearings and causes oil to burn, it may lead to seizure of the metal bearing and rotating shaft. Hence, after operating the engine at a high rpm for a prolonged period of time, idle the engine sufficiently before stopping it.

Engine Break-in

General Information

In order to provide only engines of the highest quality, HD HYUNDAI CONSTRUCTION EQUIPMENT ensures that engines undergo a final acceptance test before releasing them from the factory. However, since the engines are not run for an extended period of time, they must complete a break-in procedure during the initial 50 hours of operation after being delivered. Proper engine break-in ensures long-term optimal engine performance.

Breaking In New Engines

As the bearings in a new engine are not sufficiently broken in initially, they tend to be broken easily due to overload or running at a high speed, thereby shortening the engine life as well. Hence, make sure to follow the instructions below during the initial 50 hours of operation after receiving the engine.

1. Before running the engine, make sure to warm it up sufficiently until the engine temperature is suitable for normal operating conditions.
2. Avoid running the engine at a high rpm under overloaded conditions or for a prolonged period of time.
3. Do not run the engine at a high speed without a load.
4. Do not start or stop the engine abruptly.
5. Do not exceed 70% of the maximum engine load.
6. Inspections, maintenance and service work must be performed by certified technicians at accredited service centers according to the applicable standards.

Inspection Items

Check and inspect the following during the break-in period of a new engine.

1. Check periodically whether the engine oil lies within the specified range between the upper and lower limit lines on the oil level gauge.

⚠ CAUTION

AVOID INJURY

In the event that the oil level cannot be checked accurately on the oil level gauge, rotate the oil level gauge 180° and stick the guide tube back in the oil level gauge; then, remove it and check the oil level again.

2. In the event that the oil warning lamp installed in the machine turns on or blinks, it means that the oil pressure is too low. Hence, check the oil level and refill if necessary. When refilling engine oil, do not exceed the upper limit line on the oil level gauge. If the oil level is normal, check related parts, such as the oil pressure sensor, oil pump and oil lines.

⚠ CAUTION

AVOID INJURY

The oil pressure may increase and decrease along with the engine speed (rpm). In addition, cold oil generally indicates a higher oil pressure at certain engine speeds (rpm) than warm oil—a phenomenon which occurs even in normal engine operating conditions.

3. Check the coolant temperature gauge installed in the machine and check whether coolant is circulating properly. If the coolant level in the auxiliary tank is too low, the needle on the coolant temperature gauge may vibrate.
4. Replace the engine oil and oil filter after the break-in period.

⚠ CAUTION

AVOID INJURY

Replace the engine oil and oil filter with engine oil and a genuine part recommended by HD HYUNDAI CONSTRUCTION EQUIPMENT.

Operation After Break-in Period

When starting the engine in extremely cold regions, the engine must be warmed up slowly. Do not increase the engine rpm abruptly before the engine has been preheated sufficiently. Oil consumption is higher until the piston rings are seated properly and the engine is running normally. Hence, the engine oil level must be checked periodically during the initial 50 hours of the break-in period.

Inspection After Starting the Engine

While the engine is in operation, always check the pressure in the engine lubrication system with the engine oil pressure gauge installed in the machine. If low oil pressure is indicated on the engine oil pressure gauge, stop the engine immediately. In addition, make sure to check whether the charge warning indicator of the generator is turned off while the engine is in operation.

1. Connect the positive (+) and negative (-) battery terminals securely to ensure that they do not come loose. The sheath on battery connector cables should not be torn or ripped.
2. If the battery charge warning indicator blinks or turns on and the engine stops suddenly while driving, check the electrical system for malfunctions.
3. If an abnormal condition, such as an abnormal emission color or odor, occurs while driving, stop the engine, locate the cause, and correct the issue.

4. Check the state of the engine during operation using the warning indicators and gauges installed in the machine.

Engine Oil Pressure

If the engine oil pressure is inconsistent while idling or the engine oil pressure does not reach the specified amount while driving at a high speed, stop the engine immediately, check the oil level and check the oil lines for leakage.

Coolant Temperature

Operating the engine with an excessively low coolant temperature increases fuel consumption and wear of the cylinder liner, thereby shortening the engine life.

Engine Speed (rpm)

In electronically controlled engines, the engine control unit (ECU) has a function which prevents the engine from running at engine speeds (rpm) exceeding the specified amount in order to protect the engine. A variety of functions—such as controlling fuel flow, delaying ignition time, and blocking fuel and ignition— are set by the memory in the engine control unit (ECU) and cannot be changed arbitrarily by the operator.

Running the Engine in Winter

Preventing Coolant Freezing

When water alone is used as coolant without mixing in antifreeze, corrosion in the engine, degradation of cooling efficiency, and freezing of the engine in winter may occur. Before stopping the engine for a prolonged period of time in extremely cold regions, make sure to completely drain the coolant from the engine. Frozen coolant can cause critical damage to the engine. When adding and replacing coolant, make sure to use coolant mixed with the specified ratio of antifreeze. Antifreeze prevents coolant from freezing.

Preventing Engine Overcooling

If the engine is cooled below the normal operating temperature, fuel efficiency drops and fuel consumption and wear of the cylinder liner increase. Hence, make sure to keep the engine running within the normal operating temperature range. If the coolant temperature remains below the normal operating temperature range in spite of running the engine for a sufficient amount of time, check the thermostat or other parts related to the cooling system.

Engine Oil

If the engine oil viscosity increases due to cold temperatures in winter or in extremely cold regions, the engine rpm may be unstable after starting the engine. In order to prevent this phenomenon, make sure to replace the engine oil with engine oil intended for use in winter or extreme cold. When replacing engine oil, please use genuine oil recommended by HD HYUNDAI CONSTRUCTION EQUIPMENT.

Engine Inspections and Maintenance

Checking Engine Parts After Prolonged Operation

The function of engine parts may be degraded by wear, corrosion, and thermal deterioration in engine parts and assemblies. In order to maintain optimal engine performance, check the engine after prolonged operation to enhance engine durability.

Even if the engine is operated normally, faults may occur in certain unpredictable and vulnerable parts as the engine is used over time. In such cases, it is difficult to maintain engine performance simply by repairing certain parts. In order to locate the causes of problems more accurately and maintain optimal engine performance, it is best to replace or repair all related parts as a whole.

In order to prevent engine malfunction in advance, performing replacements and inspections periodically enables the engine to be used safely for a longer period of time.

We recommend performing engine adjustments and preventive inspections in the spring after winter or cold temperatures have passed. In doing so, the engine can be used economically and without faults for extended periods of time.

As the following parts affect the engine output and performance, these parts should be checked and inspected periodically.

1. Components that can affect intake and exhaust
    - Air filter
    - Air cooler
    - Turbocharger, muffler
    - Misc.
2. Components that can affect lubrication and cooling performance
    - Air filter
    - Oil filter
    - Antifreeze
    - Misc.

Turbocharger Inspections and Maintenance

As turbocharger performance has a significant impact on engine performance, it is important to perform periodic inspections and maintenance, as well as to comply with the specified instructions for handling the turbocharger.

Intake System

Be careful when handling the air filter of the intake system. In the case of wet-type air filters, filtration performance is degraded when the oil level drops below the specified amount, whereas oil may enter and contaminate the case if the oil level is higher than the specified amount. With dry-type air filters, the intake resistance must be low to enable air to be drawn in smoothly.

Exhaust System

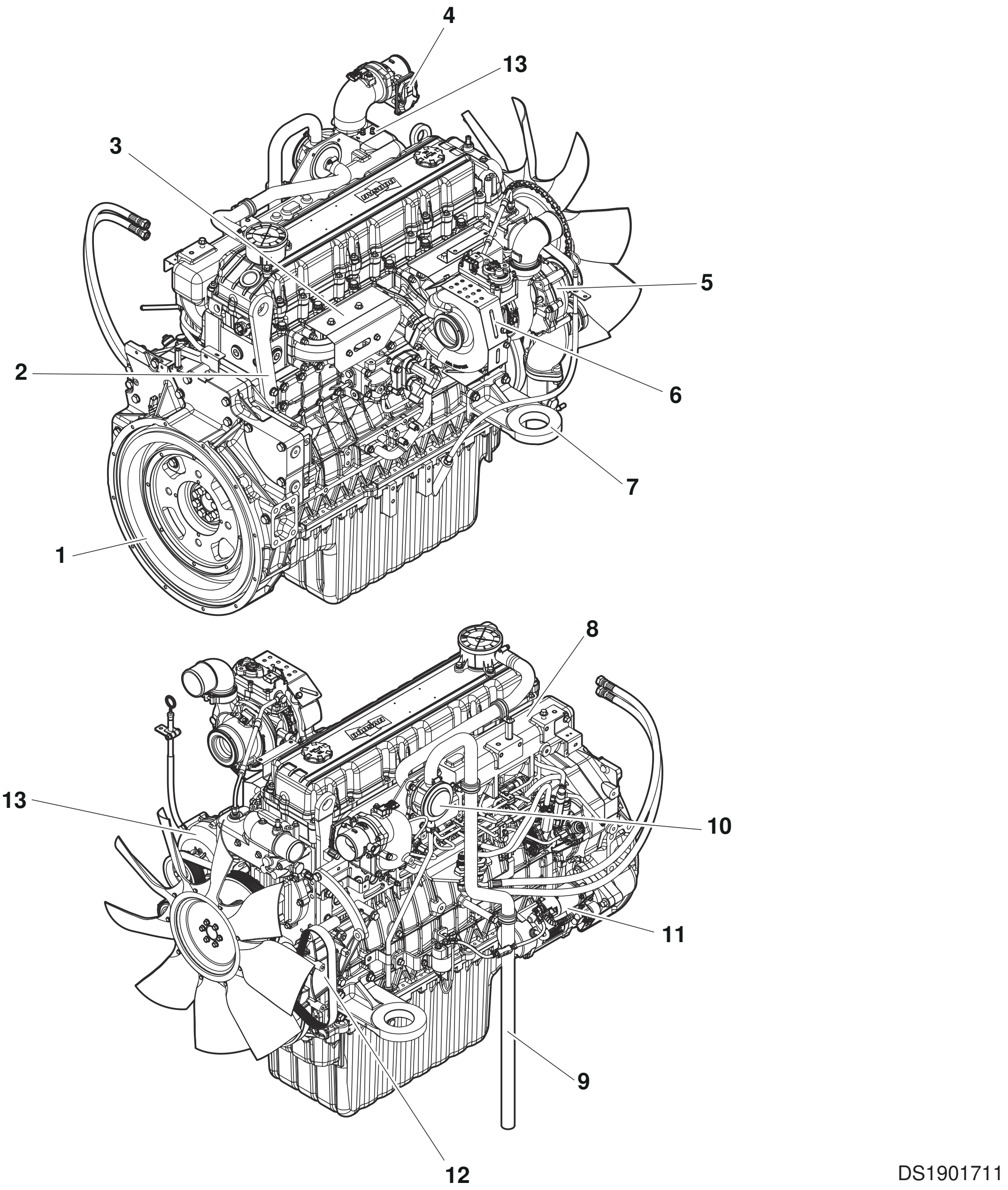
With regard to the exhaust system, if exhaust gas leaks from the connection between the exhaust manifold and the turbocharger, the efficiency of the turbocharger drops, causing a corresponding reduction in engine power. In severe cases, related parts may seize up. Parts in the exhaust system and turbocharger are used at high temperatures. Hence, it is important to keep parts organized during service work to avoid confusing bolts and nuts, etc. with ones used in other parts of the engine.

Lubrication System

Inspection and replacement of the lubrication system should be performed according to the replacement schedule for oil and the oil filter. Overheated engine oil can affect not only the engine itself, but also the engine performance.

Perspective View

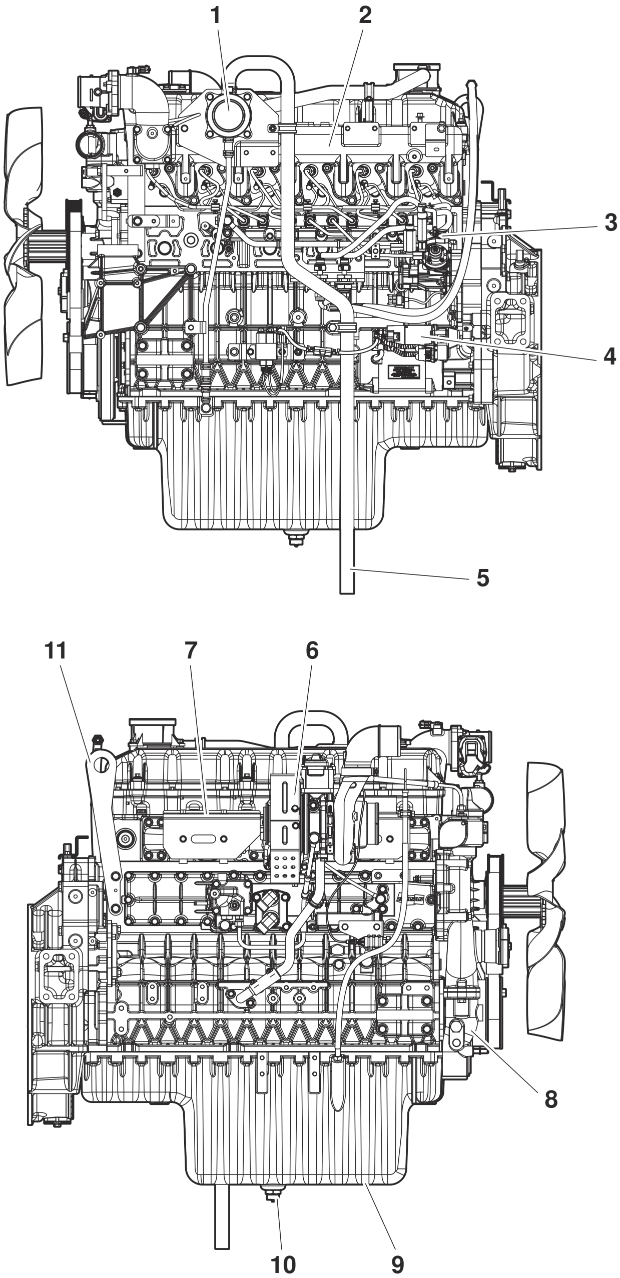
Figure 77



Reference Number	Description
1	Flywheel housing
2	Lifting hook
3	Exhaust manifold
4	Throttle valve
5	Coolant pump
6	Turbocharger
7	Mounting bracket
8	Intake manifold
9	Breather pipe
10	Breather
11	Starter motor
12	Alternator
13	Air heater

Left/Right Sectional View

Figure 78



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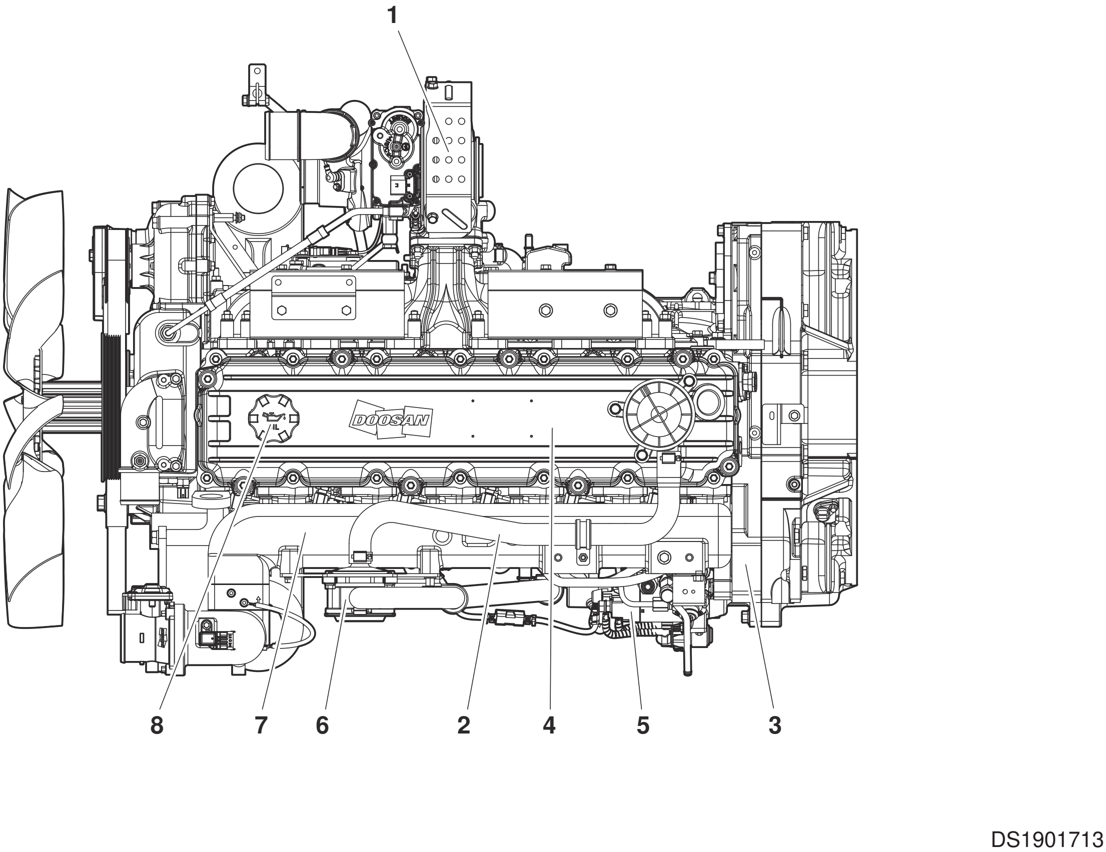
Reference Number	Description
1	Breather
2	Intake manifold
3	Injector pump
4	Starter motor
5	Breather pipe
6	Turbocharger
7	Exhaust manifold
8	Coolant pipe
9	Oil pan
10	Drain plug
11	Lifting hook

Top View

Figure 79



Reference Number	Description
1	Turbocharger
2	Breather pipe
3	Timing gear case
4	Cylinder head cover
5	Starter motor
6	Breather
7	Intake manifold
8	Oil filler cap

Regular Inspections

General Information

General Information

After purchasing the engine, the initial engine performance degrades over time due to aging of the various parts of the engine.

By performing regular inspections and part replacements according to the maintenance schedule recommended be dealer, the engine can be maintained in its optimal state for long periods of time and unanticipated accidents can be prevented.

It is the responsibility of the engine operator to operate and maintain the engine correctly. Inspections and replacements should be performed by certified technicians in service centers equipped with the specified tools and facilities. Make sure to follow the instructions below during inspections.

1. Perform inspections on flat, level ground.
2. Unless otherwise unavoidable, make sure to stop the engine before performing inspections.
3. Disconnect the negative (-) battery cable before performing inspections.
4. Perform inspections in a well-ventilated workspace.
5. When working underneath the engine, make sure to support the engine with chocks or lifters.

⚠ DANGER

AVOID DEATH

- Before inspecting the engine after it has been running, make sure to wait until it has cooled off sufficiently. Otherwise, there is a risk of being burnt.
- Running the engine in an enclosed space may cause poisoning due to exhaust gas. Make sure to perform inspections in a well-ventilated workspace.
- Unless otherwise unavoidable, do not perform inspections underneath the engine.
- Keep the engine away from open flames during inspections. Otherwise, there is a danger of a fire starting due to evaporative emissions from fuel, oil, or the battery.
- In the event that the engine must be inspected while it is running, do not wear gloves or accessories such as necklaces, rings, or watches. Severe injuries may occur if anything is caught in rotating parts.
- People with an artificial heart or artificial organs should not approach the engine while it is in operation. Artificial organs may malfunction due to the high-pressure current running through injectors and the engine control unit.

⚠ CAUTION

AVOID INJURY

- Performing inspections incorrectly may lead to engine failure.
- Cleaning an engine with liquids such as water or wax may cause electrical parts to malfunction.
- Note that batteries, cables, and electrical wiring have current running through them.
- Do not place heavy objects or apply excessive force or shock to fuel-related parts.
- Before connecting battery terminals, make sure to check the polarity (positive '+' and negative '-') of the terminals. Connecting terminals with the polarity reversed may damage parts in electrical systems and cause a fire.

Daily Inspections

1. Check whether the engine starts smoothly and whether the fuel, oil and coolant levels are normal.
2. Check the color of the exhaust gas and whether any toxic fumes are discharged from the engine.
3. Check for any abnormal noises after starting the engine.
4. Check for any oil or coolant leaks.

Cooling System

General Information

Coolant plays an important role in the prevention of overheating and freezing of the engine. However, as the engine is used over time, the antifreeze and anti corrosive performance of coolant deteriorates. Make sure to check the condition of coolant during daily inspections and replace it periodically.

Engine coolant should have a mixture of 40% antifreeze. The water used in coolant should either be clean tap water or distilled water. Make sure to inspect coolant periodically to maintain the correct concentration of antifreeze.

⚠ CAUTION

AVOID INJURY

By maintaining the mixture ratio of coolant recommended be dealer, engine corrosion can be prevented effectively and the engine can be maintained in optimum condition for long periods of time. Using contaminated water or unspecified antifreeze or additives may cause critical fault sin the cooling system.

Coolant Specifications

- Amount of antifreeze in winter

Ambient Temperature (°C)	Coolant (°C)	Antifreeze (%)
-20	67	33
-25	60	40
-30	56	44
-40	50	50

NOTE: *The concentration shall be kept at 50% and in worst case at 30% minimum for the least corrosion resistance.*

NOTE: *Replacement cycle of the HD HYUNDAI CONSTRUCTION EQUIPMENT Genuine Product is 2,000 hours or one year.*

Checking the Coolant

⚠ DANGER

AVOID DEATH

If the radiator cap is opened to add or replace coolant while the engine is overheated, hot coolant will spurt out and may cause serious burns. In the event that the radiator cap must be opened, wrap it in a cloth and turn it slowly in two steps to release the steam pressure inside. Remove the radiator cap after all steam pressure inside has been released.

1. Check the level on the auxiliary tank.
2. Check whether the engine and radiator are cool.
3. The coolant level should lie between the upper and lower limits indicated on the auxiliary tank.
4. Add coolant if necessary.
5. Open the radiator cap and check the condition of the coolant.

   Measure the coolant concentration if the coolant is contaminated or if necessary. Replace the coolant if the concentration exceeds the specified coolant concentration.

Measuring the Coolant Concentration

- Special tool

Figure	Part No. / Name
	60.99901-0038 Coolant test strip

The coolant concentration can be measured as follows.

1. When the engine coolant temperature is between 10 ~ 55°C, drain the coolant and fill a plastic cup halfway with it.

   ⚠ CAUTION

   AVOID INJURY

   It is difficult to measure the precise concentration of coolant drained from the auxiliary tank. Make sure to collect coolant for the test by removing the coolant drain plug.

2. Soak the test strip in the collected coolant for 3 ~ 5 seconds and remove the strip from the coolant. Then, shake off any excess coolant.
3. Wait approx. 45 seconds for the color of the test strip to change.

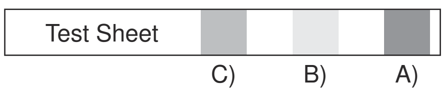
   ⚠ CAUTION

   AVOID INJURY

   Do not wait longer than 75 seconds. The color of the test strip may change drastically after a long period of time.

4. Check the color of the test strip.

   Figure 80



DS1901715

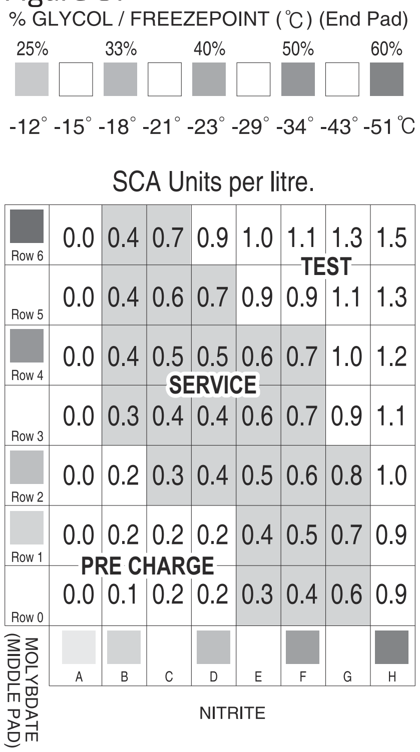
A. Compare the color of part (A) of the test strip with the color in the GLYCOL/FREEZEPOINT (End pad) section of the standard color table.

B. Compare the color of part (B) of the test strip with the color in the MOLYBDATE (Middle pad) section of the standard color table.

C. Compare the color of part (C) of the test strip with the color in the NITRITE section of the standard color table.

5. Check the color of the test strip compared to the matching color in the standard color table.

Figure 81



DS1901716

A. Compare the changed color in part (A) of the pink end of the test strip with the GLYOOL/ FREEZEPOINT (End pad) section of the standard color table on top of the storage container to determine the concentration. The concentration should be in the color range of 33 ~ 50%.

B. The point at which the color of the MOLYBDATE (Middle pad) section in the standard color table corresponding to the middle (B) part of the test strip intersects with the color of NITRITE in the standard color table corresponding to part (C) of the test strip indicates the condition of the anti corrosive additive. The color must remain in the normal green range of 0.3 ~ 0.8.

CAUTION

AVOID INJURY

- If the color of the test strip does not match any color in the standard color table, look for an intermediate color in the standard color table. For instance, if the color of part (C) of the test strip falls between D and F in the NITRITE section of the standard color table, select section E.
- It is necessary to drain coolant and add new coolant every year in order to prevent internal corrosion of the engine cooling system.

Adding Coolant

If the coolant level indicated on the auxiliary tank is below the lower limit, add coolant as follows.

1. Remove the cap on the auxiliary tank.
2. Add coolant until the coolant level is between the upper and lower limits on the auxiliary tank.
3. Install the cap on the auxiliary tank.

⚠ CAUTION

AVOID INJURY

Be careful not to allow foreign matter to enter the engine while adding coolant.

If there is no coolant in the auxiliary tank, add coolant as follows.

1. Remove the radiator cap while the engine and radiator are cold.
2. Add coolant up to the radiator inlet.
3. Start the engine to circulate the coolant throughout the engine; then, check the coolant level. Add more coolant if necessary.
4. Install the radiator cap.
5. Remove the cap on the auxiliary tank.
6. Add coolant until the coolant level is between the upper and lower limits on the auxiliary tank.

⚠ CAUTION

AVOID INJURY

- Do not open the radiator cap while the engine is overheated. Otherwise, hot coolant will spurt out and may cause severe burns. Open the radiator cap only after ensuring that the engine has cooled off sufficiently.
- Label and store coolant containers separately to avoid confusion with beverage containers. If coolant is ingested, seek medical assistance immediately.

Changing the Coolant

⚠ CAUTION

AVOID INJURY

Be careful not to spill coolant on any belts or electrical components when replacing the coolant.

1. Check whether the engine and radiator are cold.
2. Place a container in front of the coolant drain plug.
3. Remove the radiator cap.
4. Remove the coolant drain plug from the radiator and drain the coolant.
5. After draining the coolant, reinstall the coolant drain plug.
6. Drain the coolant from the auxiliary coolant tank and wash out the tank.
7. Fill the radiator inlet with water and install the radiator cap.

   NOTE: *After adding coolant slowly to allow air inside the radiator to be discharged, press on the hose connected to the radiator to drain the air inside more easily.*

8. Run the engine until the cooling fan rotates 2~3 times. Then, increase the engine rpm 2~3 times once the engine has warmed up.
9. Stop the engine and wait until the engine cools off.
10. Remove the radiator drain plug and drain the water.

11. Repeat steps 1~8 until the water drained is clean.
12. Press on the hose connected to the radiator to drain the air in the radiator more easily; then, slowly fill the radiator inlet with coolant mixed to the specified ratio.

    NOTE: *Make sure to use genuine antifreeze recommended by HD HYUNDAI CONSTRUCTION EQUIPMENT.*

⚠ CAUTION

AVOID INJURY

- Do not use a mixture of antifreezes from different manufacturers.
- Do not use a mixture of coolants with different concentrations.
- Do not add an anti-rust agent which is not recommended by HD HYUNDAI CONSTRUCTION EQUIPMENT.
- A low coolant concentration may cause corrosion or freezing, whereas a high concentration may degrade cooling performance. Use a mixture of 40% antifreeze in coolant.

13. Idle the engine after starting it. Once the cooling fan is running and coolant has circulated, remove the radiator cap and add coolant through the inlet.
14. Add coolant until the cooling fan rotates 3~5 times.
15. Add coolant up to the upper limit on the auxiliary tank; then, install the radiator cap.
16. Idle the engine until the cooling fan rotates 2~3 times.
17. Stop the engine and wait until the engine and radiator cool off.
18. Check the coolant level in the auxiliary tank and add coolant repeatedly until the coolant level in the auxiliary tank remains consistently between the upper and lower limits.

    NOTE: *Check the coolant level in the auxiliary tank for at least 2~3 days after changing the coolant.*

⚠ CAUTION

AVOID INJURY

Check the coolant level in the auxiliary tank for at least 2 ~ 3 days after changing the coolant.

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

Dispose of used coolant according to the regulations of local public institutions. Coolant can cause severe environmental pollution if it is spilled on the ground, in drains, sewers, rivers, or seas. Failing to dispose of coolant properly according to disposal regulations is punishable bylaw.

Cleaning the Cooling Circuit

If the internal cooling circuit is corroded or contaminated, its cooling efficiency is degraded. Resistance in the cooling circuit can damage the mechanical seal of the coolant pump. Using improper antifreeze or anti-corrosive or not using them can affect the cooling circuit negatively. If the coolant pump leaks or coolant is severely contaminated (cloudy or brown, gray or black according to its contamination level) after a short period of operating time (6 months), wash the cooling system as follows before removing the coolant pump.

1. Drain the coolant.
2. To wash the cooling circuit quickly, remove the thermostat.
3. Fill the cooling circuit with a mixture of water and 1.5% cleanser (Henkel P3T5175).
4. Apply a load to the engine. Once the coolant temperature reaches 60, run the engine for approx. 15 minutes.
5. Drain the cleanser.
6. Repeat steps 3 and 4 above.
7. Fill the cooling circuit with hot water.
8. Idle the engine for 30 minutes to check the drain plugs and coolant lines for leakage. Add coolant as necessary.

CAUTION

AVOID INJURY

Wash the cooling circuit periodically using cleanser.

Lubrication System

General Information

Engine oil serves to enhance engine performance and prolong engine life by lubricating, cooling, sealing, preventing corrosion and cleaning the inside of the engine. Running the machine continuously without sufficient engine oil may cause moving parts in the engine to seize up, leading to engine failure.

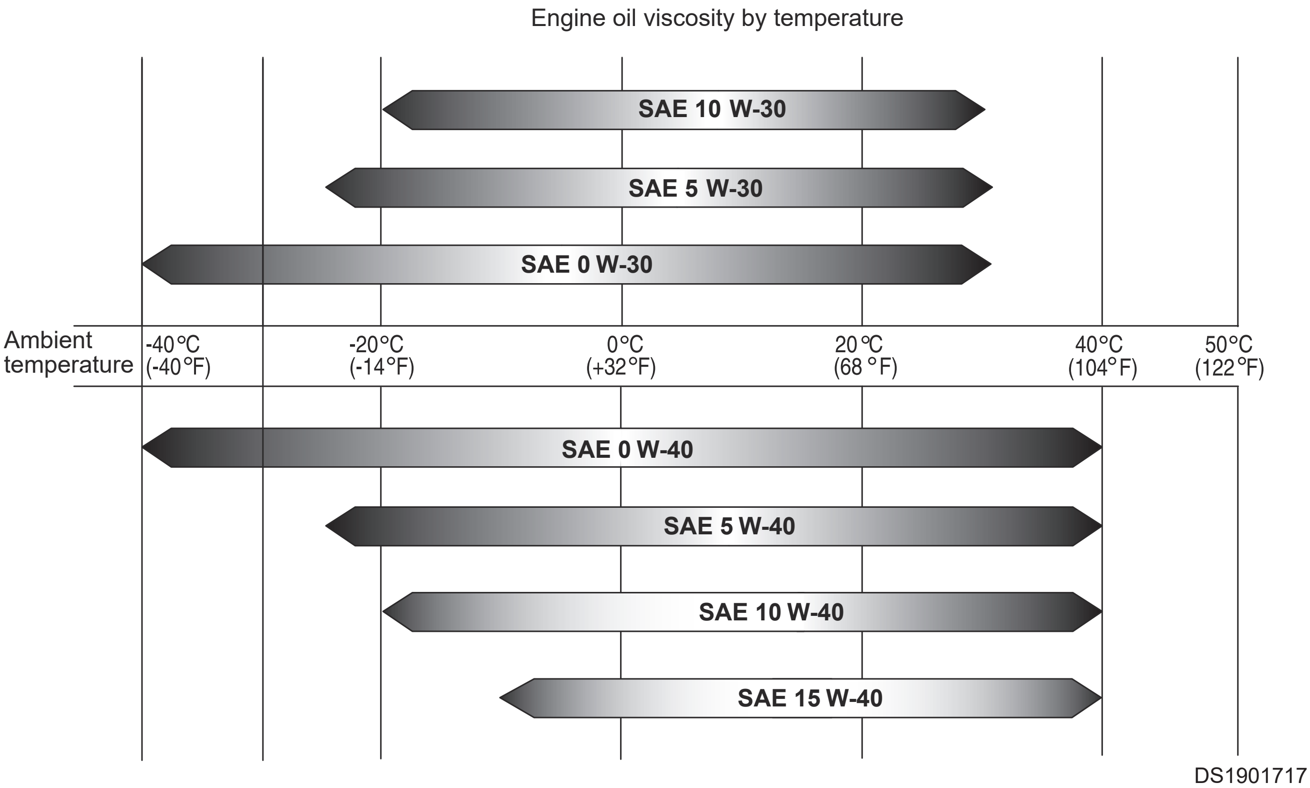
Check the engine oil level with an oil level gauge and add more engine oil if necessary. Check the oil level with the engine stopped. If the engine is running, stop the engine and measure the oil level after waiting 5~10 minutes for the engine oil to return to the oil pan. The oil level must lie between the upper and lower limits on the oil level gauge.

Engine oil must be changed regularly according to the maintenance schedule. Make sure to also replace the oil filter and cartridge when changing the engine oil.

Engine Oil Specifications

Use the specified engine oil suited to the environment and conditions where the engine will be used.

Figure 82



The following engine oil specifications are recommended:

Engine Models	SAE Classification	Oil Class
DL08V	SAE 10W40	API CJ-4 or higher / ACEA-E9 or higher

NOTE: *Use genuine oil recommended by HD HYUNDAI CONSTRUCTION EQUIPMENT.*

Engine Oil Capacity

Make sure to fill engine oil to the level recommended below.

Engine Models and Product Code	Engine Oil Capacity (L)		
	Inside the Oil Pan		Total*
	Maximum	Minimum	
DL08V (MFE00)	39	22	42

*: Including 2.0 L in the engine

Checking Engine Oil

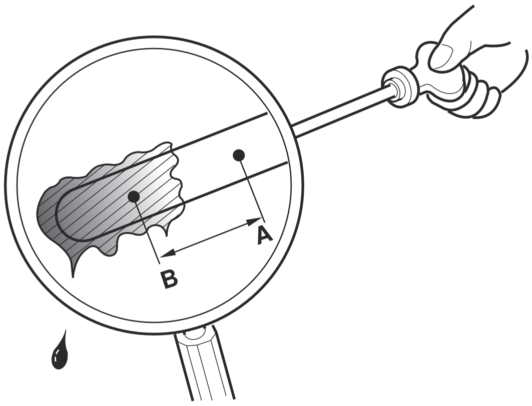
1. Move the engine to flat, level ground where the engine will remain horizontal.
2. After starting the engine, turn the engine off once it reaches a normal temperature.
3. Wait 5~10 minutes.
4. Pull out the oil level gauge.
5. Wipe off the indicator line on the oil level gauge with a clean cloth.

⚠ CAUTION

AVOID INJURY

Wiping the engine oil gauge with a contaminated cloth causes foreign matter to enter the engine, leading to engine failure.

6. Reinsert the oil level gauge.
7. Pull the oil level gauge out again and check the level and condition of the oil.
   Figure 83



DS1901718

   A. Check whether engine oil is smeared between the upper limit (A) and lower limit (B) on the oil level gauge.
   B. If engine oil is smeared below the lower limit (B) or is not smeared on the gauge at all, add engine oil.

⚠ CAUTION

AVOID INJURY

Do not add engine oil past the upper limit mark on the oil level gauge. Overfilling oil can cause engine damage.

   C. Check the viscosity and condition of the engine oil; replace the oil if necessary.

Adding Engine Oil

⚠ CAUTION

AVOID INJURY

Be careful not to allow foreign matter to enter the engine while removing the oil filler cap and adding oil.

1. Remove the oil filler cap on the top of the engine.
2. Add genuine oil recommended by HD HYUNDAI CONSTRUCTION EQUIPMENT.
   A. Add the oil a small amount at a time.
   B. Wait 1~2 minutes and check the engine oil.
   C. Check whether engine oil is smeared between the upper and lower limits on the oil level gauge.
   D. Repeat until the engine oil reaches the proper level.

⚠ CAUTION

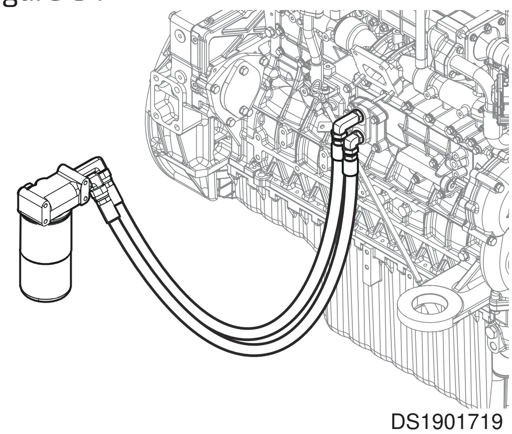
AVOID INJURY

- Be careful not to allow foreign matter to enter the engine while adding engine oil.
- Adding engine oil past the upper limit on the oil level gauge may cause engine faults. If engine oil is filled past the upper limit, the engine oil must be drained until the oil level lies between the upper and lower limits on the oil level gauge.
- Do not use unspecified engine oil additives.

3. Install the oil filler cap after adding engine oil.

Exchanging Engine Oil

1. Drain the engine oil.
   A. Place a container for draining engine oil under the engine.
   B. Remove the drain plug and drain the engine oil.
   C. Remove the oil filler cap.
2. Replace the oil filter.
   Figure 84



   A. Use a filter wrench to remove the oil filter.
   B. Wipe off the head and cartridge contact surface of the oil filter thoroughly.
   C. Make sure the oil filter cartridge is seated properly.
   D. Apply a thin layer of oil to the O-ring on the cartridge.
   E. Tighten the new oil filter by hand.
   F. Use a filter wrench to finish tightening the oil filter.

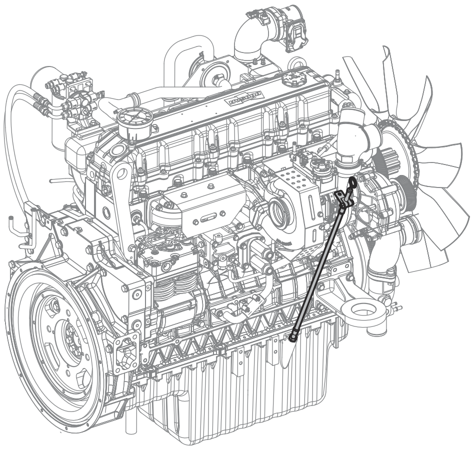
⚠ CAUTION

AVOID INJURY

- When replacing the oil filter cartridge, make sure to use a new genuine cartridge.
- The new oil filter must not contain any oil when it is installed. Do not fill the new oil filter with oil from the replaced oil filter.

3. Add engine oil.

Figure 85



DS1901720

A. Install the drain plug.

B. Add the specified amount of engine oil through the oil filler port.

⚠ CAUTION

AVOID INJURY

While adding oil, be careful not to allow dust or foreign matter to enter the system.

C. Check that the oil level is at the upper limit mark on the dipstick.

4. Once this is complete, perform a final inspection.

A. Idle the engine for a few minutes to distribute oil throughout the lubrication circuit of the engine.

B. Stop the engine and wait approx. 10 minutes.

C. Check the oil level and add oil if necessary.

⚠ CAUTION

AVOID INJURY

Adding engine oil past the upper limit on the oil level gauge may cause engine faults. If engine oil is filled past the upper limit, the engine oil must be drained until the oil level lies between the upper and lower limits on the oil level gauge.

Fuel System

General Information

Fuel quality is crucial for engine performance, engine life, and satisfying emissions standards. Engines are designed to be used with diesel fuel in the region of sale

⚠ CAUTION

AVOID INJURY

- Only use clean fuel with the specified grade. Using imitation or unspecified fuel may cause severe faults in the engine.
- When fuel needs to be refilled, make sure to add fuel while the engine is stopped.

Fuel Specifications

In order to maintain optimum engine performance, make sure to use the correct fuel by referring to the following recommended fuel selection table.

- Ultra-low-sulfur diesel (ULSD)

Fuel Ingredients			Standard
Specific gravity		(kg/lit)	0.820 ~ 0.845
Flash point		(°C)	40 or more
Kinematic viscosity (40°C)		(cSt)	1.9 ~ 5.5
Sulfur content		(wtppm)	15 or less
Cloud point		(°C)	-
Pour point		(°C)	-17.5 or less
Low-temperature filter clogging temperature		(°C)	-16 or less
Color (ASTM)			2.5 or less
Carbon residue (10%) Distillation residue (wt)		(%)	0.15 or less
Total acid number		(mg KOH/g)	0.40 or less
Copper corrosion (100 °C, 3 hours)			1 or less
Ash		(mass%)	0.01 or less
Water & sediment		(vol.%)	0.02 or less
Cetane number			45 or more
Distillation test temperature	50% distillation point		-
	90% distillation point		360 or less

NOTE: *Fuel product standards are based on SK (Inc.) ultra-low-sulfur diesel*

Fuel Filter

Remove the moisture and impurities in the fuel and pump the fuel to the fuel injection pump.

⚠ CAUTION

AVOID INJURY

- Failing to check the fuel filter periodically and drain the water in the fuel filter causes moisture to enter the engine fuel system, leading to severe faults in the fuel injection pump, fuel injection pipe, common rail, and injectors. In addition, the performance of the fuel filter may be degraded or the filter may be damaged.
- When draining water from the fuel filter, fuel may be drained as well. Fuel is a highly flammable substance. Hence, smoking or using an open flame near the engine may cause a fire.
- Only use clean fuel with the specified grade. Using imitation or unspecified fuel may cause water to accumulate in the fuel filter.
- If water is not drained from the fuel filter when the fuel filter warning light is turned on, moisture may enter the fuel system and cause the engine to turn off.
- New fuel filters must not contain any fuel when they are installed. Do not fill a new fuel filter with fuel from a replaced fuel filter or fuel in the fuel tank.

Bleeding Fuel Delivery Lines

To bleed the air in fuel lines, open the valve on the top of the secondary fuel filter and operate the priming pump of the primary fuel filter.

Intake/Exhaust System

General Information

The air filter serves to supply the engine with clean air by filtering out dust and foreign matter found in atmospheric air. The air filter has a direct impact on engine life, exhaust gas, and engine power. Hence, it must be inspected, cleaned and replaced periodically.

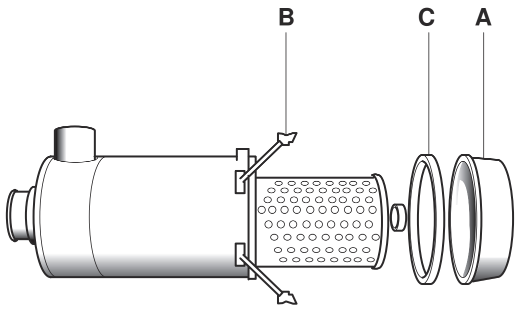
⚠ CAUTION

AVOID INJURY

- Do not run the engine without an air filter.
- Only use specified air filters. Using an imitation or unspecified air filter may cause severe faults in the engine.
- If foreign matter enters the engine, it may cause wear inside the engine.
- Be careful not to damage related electrical parts or to allow foreign matter to enter the engine while replacing the air filter.
- Replace the air filter immediately if it is damaged.
- Be careful not to allow dust to enter the engine while installing the air filter.
- If the air cleaner element is deformed, damaged or cracked, replace it with a new one.
- Clean and replace the element at regular intervals.

Cleaning the Air Filter

1. Clean the air filter.
   Figure 86



DS1901721

A. Empty the dust canister (A) periodically.

⚠ CAUTION

AVOID INJURY

Do not allow the canister to fill more than halfway with dust.

B. The dust canister can be removed by removing the two clamps (B).

C. Remove the canister cover (C) and empty the canister.

D. Install the cover and canister correctly and with care.

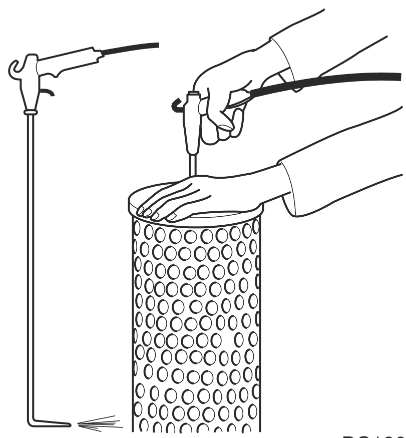
E. The cover has concave sections and the canister has convex sections to enable them to be fit together.

F. As the cleaner should be installed horizontally, check that the “TOP” mark is facing upwards.

Cleaning the Air Cleaner Element

Clean the air filter element using whichever of the following three methods is most suited to the work environment.

1. Use compressed air to clean the air filter element.
   Figure 87



DS1901722

A. Use an air gun to clean the element thoroughly. Compressed air should be shot at a right angle to the bottom of the element.

B. Move the air gun up and down along the element to blow compressed air from the inside toward the outside until dust is no longer blown out.

C. The pressure of compressed air should not exceed 5 bar.

⚠ DANGER

AVOID DEATH
Make sure to put on protective glasses before performing this task. Otherwise, dust or foreign matter from the element may enter your eyes and cause injuries.

2. Wash the element.
Figure 88

DS1901723

A. Before washing the element, clean it with compressed air as described above.

B. Then, soak the element in warm cleaning solvent for 10 minutes and shake it back and forth for approx. 5 minutes.

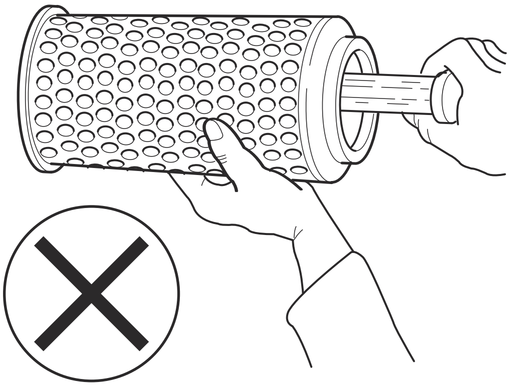
C. Rinse it with clean water, remove water from it, and leave it to air-dry. Make sure to dry the element completely before reinstalling it.

⚠ CAUTION

AVOID INJURY
Never use a steam spray, gasoline, alkaline liquid or hot cleaning agent to wash the air cleaner element.

3. In emergencies, clean the element temporarily using the following method.

A. Tap the end plate of the element with your thumb to clean it temporarily.
Figure 89



DS1901724

⚠ CAUTION

AVOID INJURY

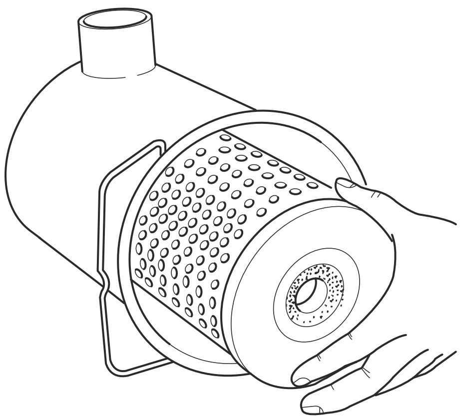
- This method should only be used in emergency situations where the element must be cleaned but there is no compressed air or cleaner available.
- Never use a hard object to tap the element in order to remove dust residue.

NOTE: *Before reinstalling the element, check it for folded paper, the condition of the rubber seal ring, and deformation.*

NOTE: *Never use a damaged element. If the quality of the element is suspicious, replace the element with a new one.*

Replacing the Air Cleaner Element

1. Replace the air filter element.
Figure 90



DS1901725

A. Unscrew the hex nut and remove the dirty element. Clean or replace it with a new one.

B. Wipe the inside of the cleaner housing and the contact surface of the element seal ring with a wet rag thoroughly.

⚠ CAUTION

AVOID INJURY

Make sure that dust does not enter the tip of the air cleaner.

Cylinder Block/Head

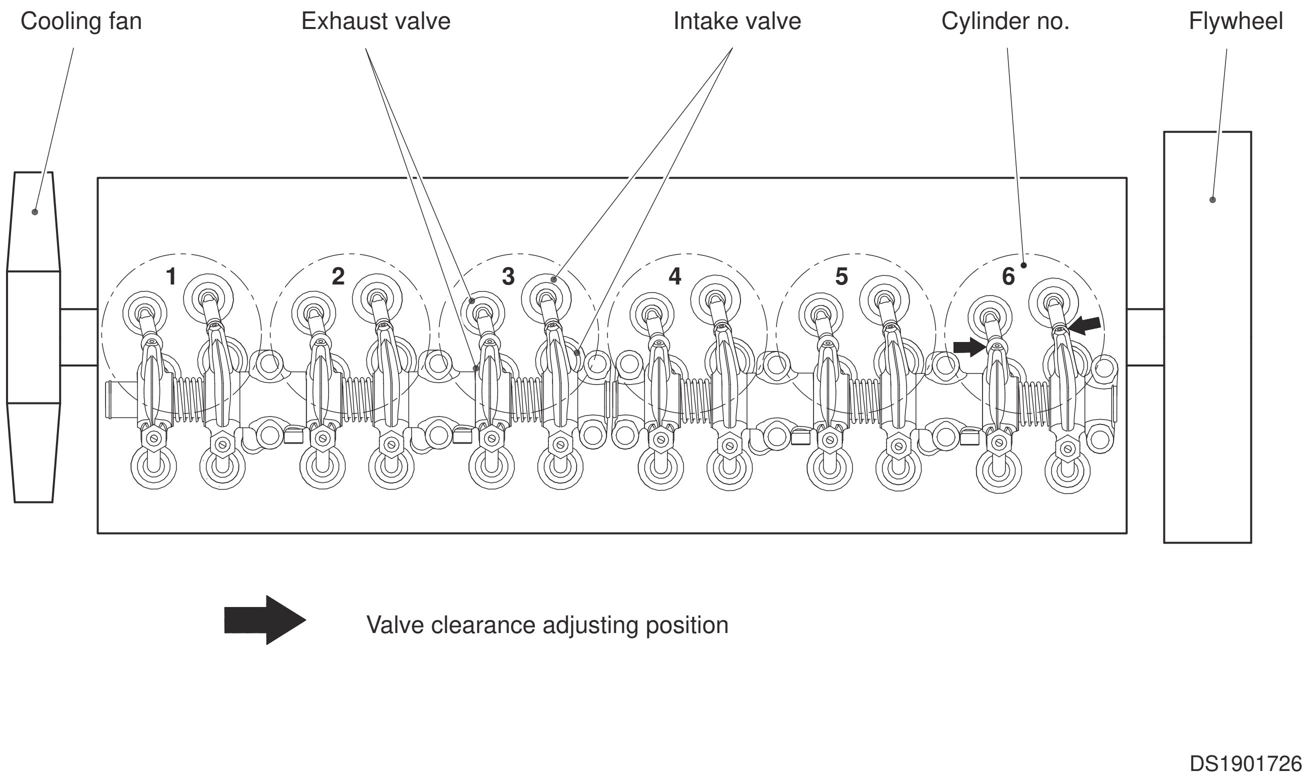
Valve Clearance

Adjust the valve clearance under the following conditions:

- When disassembling the engine or cylinder head
- When loud noise occurs in the valve connection
- When the engine is operating abnormally in spite of the fuel injection system running normally

Adjusting Sequence of Valve Clearance

Figure 91



- Valve adjustment torque: 4.4 ±0.45 kg.m

  Figure 92

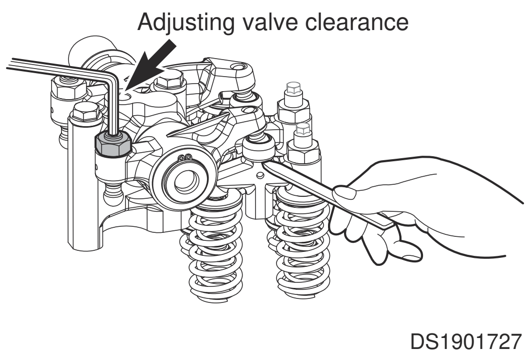
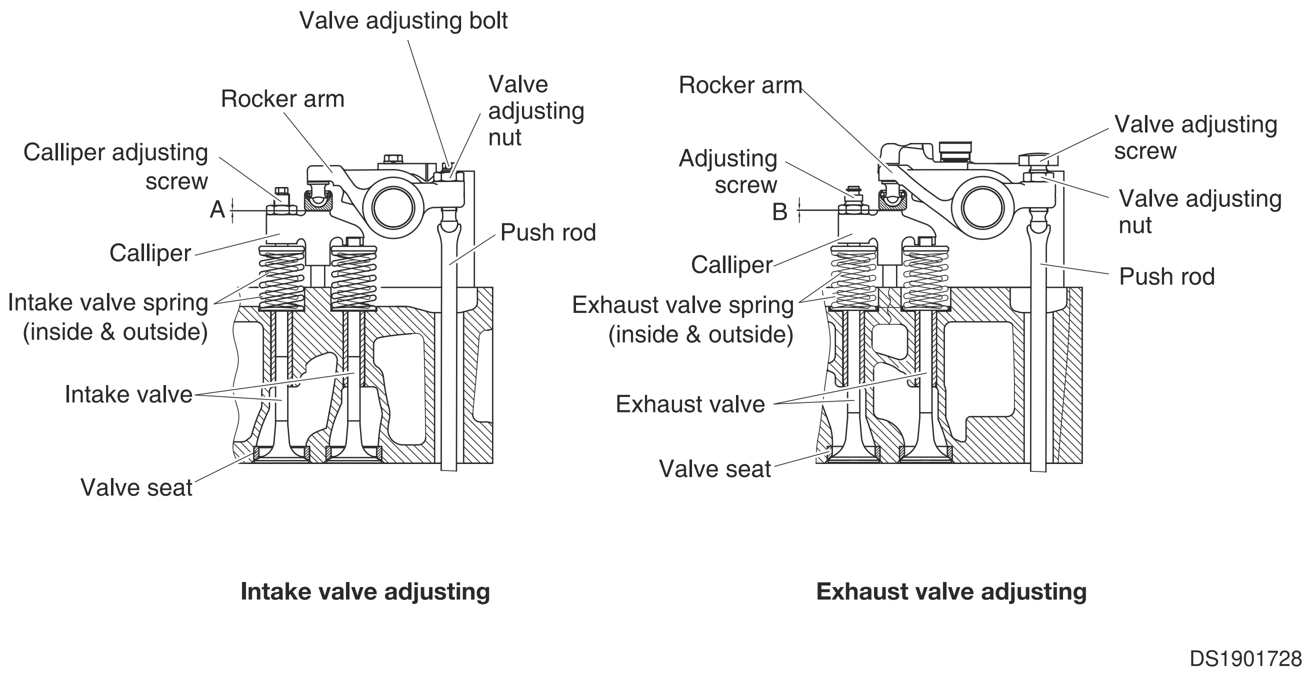


Figure 93



Method 1

1. Turn the crankshaft to set the piston in cylinder no. 1 to the TDC of the compression stroke.

   NOTE: *Cylinder no.1 can be identified by its proximity to the cooling fan.*

   NOTE: *When cylinder no.1 is at the TDC of the compression stroke, valve overlap occurs in cylinder no.6.*

2. Unscrew the rocker arm mounting nut on cylinder no.1.
3. Adjust the cylinder clearance with its adjusting nut. Then, tighten the mounting nut.

Engine Models	Intake Valve (mm)	Exhaust Valve (mm)
DL08V (MFE00)	0.3	0.4

4. Turn the crankshaft to adjust the valve clearance for each cylinder at the TDC of the compression stroke.
5. Depending on the cylinder in the valve overlap stage, adjust the valve clearance for the corresponding cylinder at the TDC of the compression stroke as follows:

No. of Cylinder in Valve Overlap Stage					
1	5	3	6	2	4
6	2	4	1	5	3
Valve Adjustment Cylinder No. (Intake & Exhaust Valves)					

Method 2

1. Turn the crankshaft to cause the valves of cylinder no.6 to overlap.

   NOTE: *When cylinder no.1 is at the TDC of the compression stroke, valve overlap occurs in cylinder no.6.*

   NOTE: *Cylinder no.1 can be identified by its proximity to the cooling fan.*

2. Adjust the valve clearance marked with ● in the table.
3. Rotate the engine 240° in the direction of rotation until the valves of cylinder no.4 overlap.

   NOTE: *When cylinder no.3 is at the TDC of the compression stroke, valve overlap occurs in cylinder no.4.*
4. Adjust the valve clearance marked with ○ in the table.
5. Rotate the engine 480° in the direction of rotation until the valves of cylinder no.5 overlap.

   NOTE: *When cylinder no.2 is at the TDC of the compression stroke, valve overlap occurs in cylinder no.5.*
6. Adjust the valve clearance marked with ◎ in the table.
7. Check the valve clearance again and adjust it as necessary.

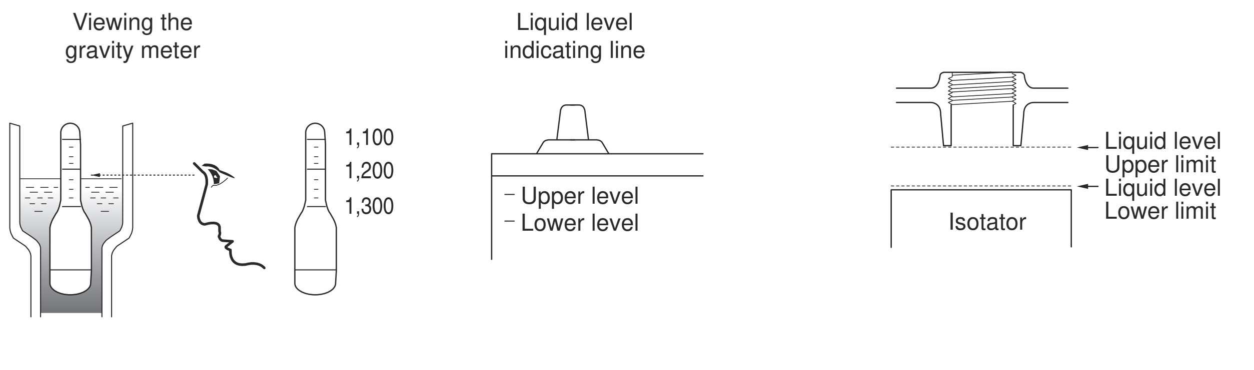
Cylinder no.	1		2		3		4		5		6	
Valve	Exh	Int	Exh	Int	Exh	Int	Exh	Int	Exh	Int	Exh	Int
No. 1 TDC	●	●						●	●			
Rotate 240°					○	○				○	○	
Rotate 480°			◊	◊			◊					◊

Electrical System

Battery

1. Check the battery for electrolyte leakage due to cracks. If it is cracked, replace it with a new one.
2. Check the battery fluid level and add distilled water as necessary.
3. Measure the specific gravity of electrolyte. If the measurement is below the specified range (1.12~1.28), add more.

   Figure 94



DS1901729

Other/Driving System

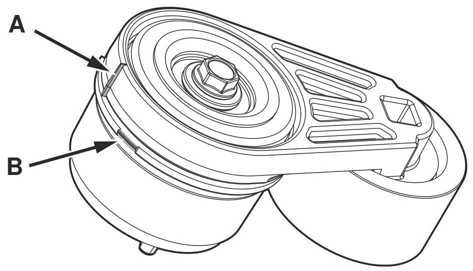
Belt Tension

Belt tension is maintained by an auto tensioner, so there is no need to adjust it. The belt must be replaced when the pointer indicates that a replacement interval is approaching.

1. Inspection conditions

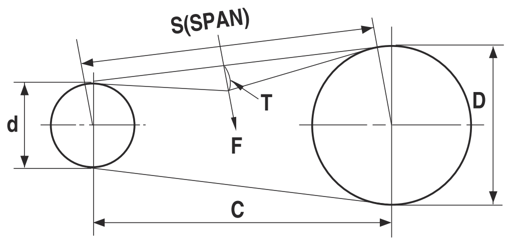
   A. Check the belt for cracks, oil residue, and deformation due to heat and wear.

2. The vertical bar (A) indicated by the arrow is the “pointer.” When this “pointer” reaches the horizontal range (B) indicated in orange, the belt must be replaced.
Figure 95



DS1901730

A. The tension of the belt can be inspected by checking the amount of deflection of the belt when applying the specified force (F) to it.
Figure 96



DS1901731

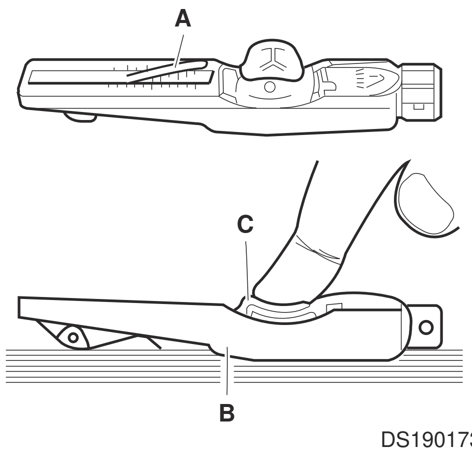
B. Adjust the belt so that the deflection (T) equals 0.015 × S (1.5 mm for 100 mm).

NOTE: *T: Deflection amount, S: Distance*

C. ${}^{*}S=\sqrt{C^{2}\ \frac{(D-d)^{2}}{2}}$

NOTE: *C: Center distance (mm), D: Large pulley dia. (mm), d: Small pulley dia. (mm)*

3. Measuring tension
Figure 97



DS1901733

A. Insert the belt in the protrusion (A) of the tension measuring instrument.

- Set the measuring instrument between the pulleys and set its contact end (B) to push the belt.
- Press the pad (C) until the sound of the spring unscrewing is heard. This force pushes the tension measuring instrument upwards.
- If there is still tension left on the belt after removing the pad (C), the measurement is not accurate.

B. Measuring tension

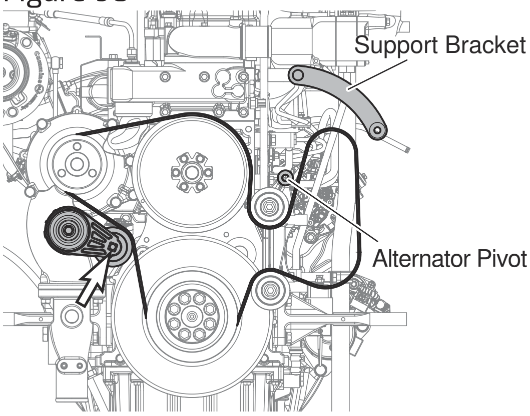
- Read the value where the top of the protrusion (A) of the tension measuring instrument is aligned with the scale.
- Before reading the value, make sure that the needle of the measuring instrument is returned back to the original position.

C. Adjusting tension and replacing the Micro-V belt

- Rotate the auto tensioner clockwise using the square groove located in the center of the idle pulley of the auto tensioner.
- Remove the old belt.
- After fitting the new belt onto all of the pulleys (check to make sure the belt covers all belt grooves), rotate the auto tensioner clockwise to wrap the belt around the auto tensioner; then, fit the tightened auto tensioner in place.

4. The belt tension is as follows:

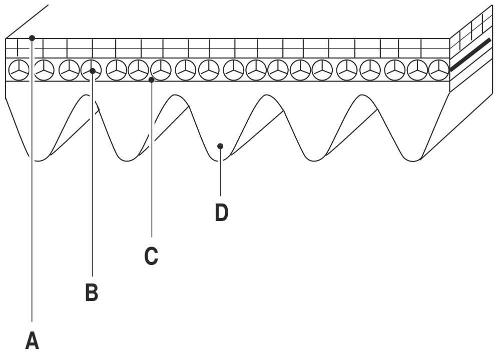
Figure 98



DS1901734

<table>
<tr><th rowspan="3">Type</th><th rowspan="3">Drive Belt Width</th><th colspan="3">Tension On the Tester</th></tr>
<tr><th colspan="2">Newly installed</th><th rowspan="2">During Service After Prolonged Operation (Replacement Interval)</th></tr>
<tr><th>Installation</th><th>10 Minutes After Operation</th></tr>
<tr><td>8PK Micro-V</td><td>27.61 mm</td><td>340 ~ 500 N</td><td>340 ~ 500 N</td><td>220 N</td></tr>
</table>

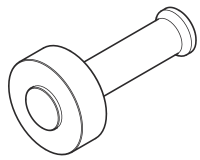
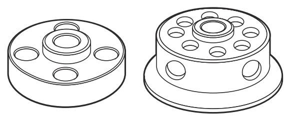
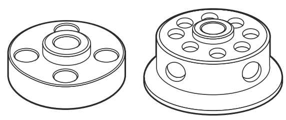
5. The belt consists of the following components:
   Figure 99

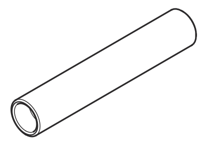
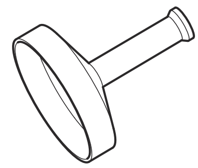
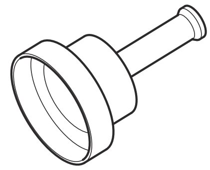
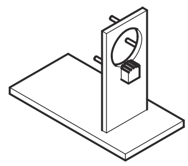
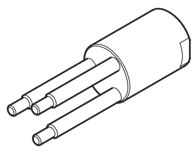
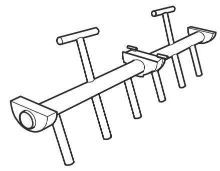


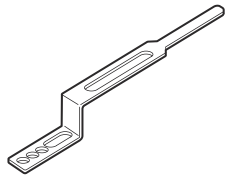
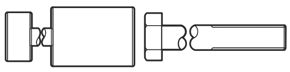
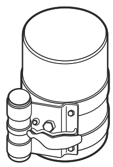
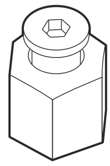
DS1901735

   A. The belt consists of the cover layer (A), cord (B), adhesive rubber (C) and belt reinforcement rubber shim (D).

Special Tools

Number	Designation	Picture	Tool Board
860104-02774	Camshaft Hole Cover Punch	 DS1901736	
860104-05438	FR Oil Seal Assembly Ass'y	 DS1901737	
860104-05437	RR Oil Seal Assembly Ass'y	 DS1901737	

Number	Designation	Picture	Tool Board
860104-06347	Valve Stem Seal Jig		
860104-03871	RR Wearing Insert		
860104-03872	FR Wearing Insert		
860104-03869	HP Pump Idle Gear		
860104-03882	Stem Idle Assembly		
860104-03892	Oil Spray Nozzle Assembly		

Number	Designation	Picture	Tool Board
860104-03391	Valve Spring Jig	 DS1901744	
860103-01548	Nozzle Tube Assembly Tool	 DS1901745	
860104-01296	Piston Sleeve Jig	 DS1901746	
860103-01614	Injector Test Cap (only electric engine)	 DS1901747	

Mechanical System

General Information

Cylinder Block/Head

Equipped with an overhead valve and turbocharger, HD HYUNDAI CONSTRUCTION EQUIPMENT diesel engines are electronically controlled engine air-cooled by a cooling fan.

Pressurized fuel generated by the high-pressure fuel pump is stored in the common rail. When the driver operates the vehicles, the optimal amount of fuel and fuel injection timing are determined based on the data set in the ECU according to the vehicle speed and operating conditions, while the ECU actuates the solenoid valve for the injector installed in each cylinder of the engine to inject fuel into the cylinders.

The crankshaft is a single forged unit. The oil seals on the crankshaft and flywheel are designed to prevent oil from entering the inside of the flywheel.

The connecting rod is a single forged unit. Its big end can be disconnected in the vertical direction, enabling it to be removed with the piston through the top of the cylinder. The moving parts of the crankshaft and connecting rod are equipped with alloy bearings.

1. Engine pistons are cooled by an oil gallery. The shape of the gallery, the shape and position of the nozzles, and the oil flow rate are all very important factors in lowering the temperature of the piston oil gallery. The cross sectional shape of the piston gallery is designed to achieve maximum cooling effectiveness with efficient oil flow.
2. The crankshaft is a forged single unit. The crankshaft and rear oil seals are designed to prevent oil from entering the inside of the flywheel housing.
3. The connecting rod is a single unit. Its big end can be disconnected diagonally, allowing it to be removed along with the piston through the top of the cylinder. Prefabricated alloy bearings are used in the moving parts of the crankshaft and connecting rods.
4. The camshaft, oil pump, and high-pressure injection pump are driven by gear connections in the timing gear case.
5. The overhead valve is operated by the valve tappets, push rods and rocker arms on the camshaft.

Other/Driving System

1. Engine pistons are cooled by an oil gallery. The shape of the gallery, the shape and position of the nozzles, and the oil flow rate are all very important factors in lowering the temperature of the piston oil gallery. The cross sectional shape of the piston gallery is designed to achieve maximum cooling effectiveness with efficient oil flow.
2. The crankshaft is a forged single unit. The crankshaft and rear oil seals are designed to prevent oil from entering the inside of the flywheel housing.
3. The connecting rod is a single unit. Its big end can be disconnected diagonally, allowing it to be removed along with the piston through the top of the cylinder. Prefabricated alloy bearings are used in the moving parts of the crankshaft and connecting rods.
4. The camshaft, oil pump, and high-pressure injection pump are driven by gear connections in the timing gear case.
5. The overhead valve is operated by the valve tappets, push rods and rocker arms on the camshaft.

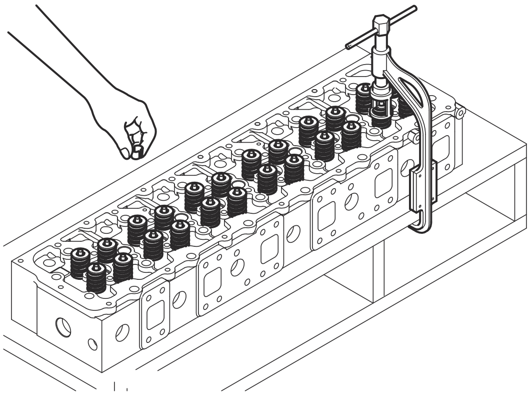
Cylinder Block

General Inspection of the Cylinder Block

1. Clean the cylinder block thoroughly and check it visually for damage.
2. If it is severely cracked or damaged, replace it with a new one; repair any minor damage.
3. Check the oil passage and coolant passage for clogging and corrosion.
4. Perform a hydrostatic test to check for cracks or air leaks.
5. Plug the coolant and oil outlets of the cylinder block and supply approx. 4 kg/cm^2 of pressure through the inlet. Then, soak the cylinder block in 70 °C water for approx. one minute and check for air leaks.

Cylinder Head

1. Disassemble the cylinder and keep the components on a shelf for later assembly.
   Figure 100



DS1901748

2. Be careful not to damage the cylinder head gasket mating surface.
3. Remove the valve cotter, spring and spring seat using a valve spring compressor.
4. Pull out the intake and exhaust valves.
5. Keep the removed parts in order.
6. Remove the valve stem seal.

Inspecting the Cylinder Head

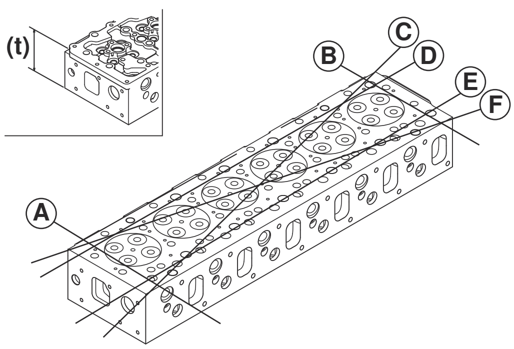
1. Inspecting the cylinder head
   A. Remove carbon residue from the bottom of the cylinder head.

⚠ CAUTION

AVOID INJURY

Be careful not to scratch the valve seat surface.Make sure to keep bolts free of oil.Wipe any oil off bolts before using them.

   B. Check the cylinder head visually for damage.
   C. Perform the hydrostatic test or magnetic particle test to check for small cracks or damage that cannot be identified with the naked eye.
2. Bottom distortion
   Figure 101



DS1901749

A. Measure the distortion of the cylinder head in the 6 directions with a feeler gauge.

B. If the measurement exceeds the allowable service limit, grind it down using fine sandpaper or a grinder.

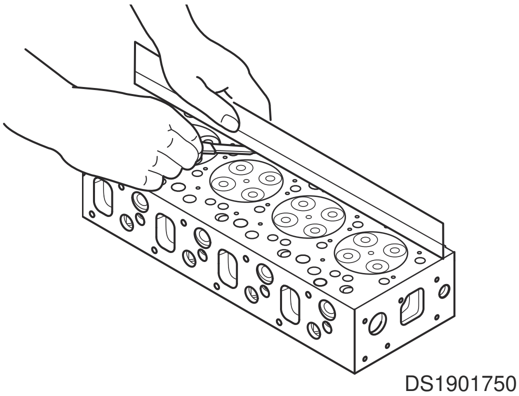
C. If the measurement exceeds the allowable limit, replace the cylinder head.

- Cylinder head distortion and height

	Reference Value	Allowable Limit
Flatness of bottom surface of cylinder head	0.08 mm or less	0.15 mm
Head height: t	114.9 ~ 115.1 mm	104.4 mm

3. Flatness

Figure 102



A. Measure the flatness of the intake/exhaust manifold mounting surface of the cylinder head with a straightedge and feeler gauge.

Reference Value	Allowable Limit
0.15 mm	0.3 mm

4. Flatness

A. The hydrostatic test for the cylinder head is performed in the same way as the test for the cylinder block.

Valves

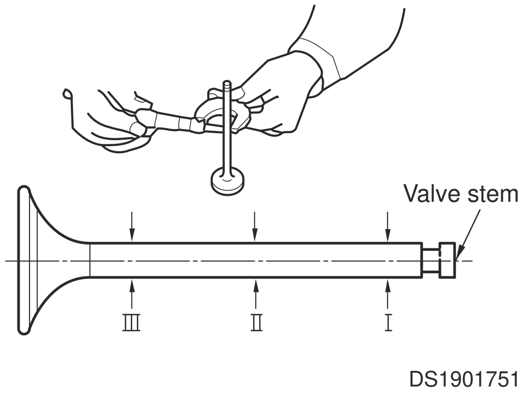
General Information

The overhead valve is operated by the cast iron tappet, push rod and rocker arm on the camshaft.

Inspecting Valves

Wash the valve with clean engine oil and inspect it as follows.

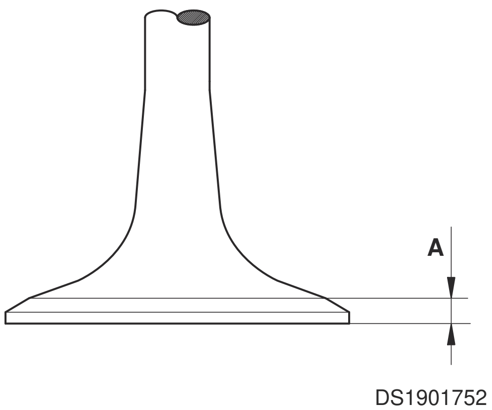
1. Valve stem outside diameter
   Figure 103



   A. Measure the valve stem outside diameter in three places (top, middle, bottom).
   B. If the amount of wear exceeds the allowable limit, replace the valve.

	Reference value	Allowable limit
Intake valve stem	Ø7.963 ~ Ø7.977 mm	Ø7.933 mm
Exhaust valve stem	Ø7.950 ~ Ø7.964 mm	Ø7.91 mm

2. Valve seat mating surface
   A. Check the valve seat mating surface for scratches or damage.
   B. If necessary, grind the surface with sandpaper. However, if the damage is severe, replace the part.
3. Valve head thickness
   Figure 104



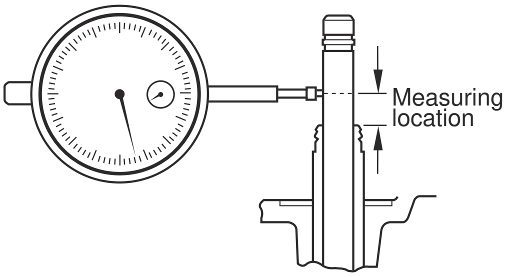
   A. Measure the thickness of the valve head.
   B. If the measurement is below the allowable limit, replace the valve.

	Reference Value	Allowable Limit
Intake valve (A)	3.3 ~ 3.7 mm	2.8 mm or less
Exhaust valve (A)	3.3 ~ 3.7 mm	2.8 mm or less

Inspecting the Valve Guide

1. Install the valve on the cylinder head.

2. Measure the clearance between the valve guide and valve arising from the movement of the valve.
Figure 105



DS1901753

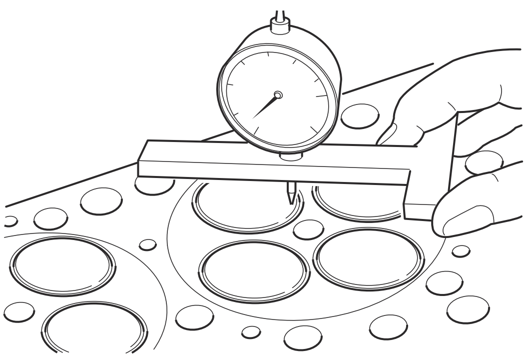
3. If the clearance is excessively large, measure the valve size. Then, replace the valve or valve guide, whichever part is more worn.
   - Valve stem play

	Reference Value	Allowable Limit
Intake valve	0.023 ~ 0.052 mm	0.1 mm
Exhaust valve	0.036 ~ 0.065 mm	0.15 mm

4. Install the valve on the cylinder head valve guide.
5. Use a special service tool to check whether the valve seat is aligned with the center.

Inspecting the Valve Seat

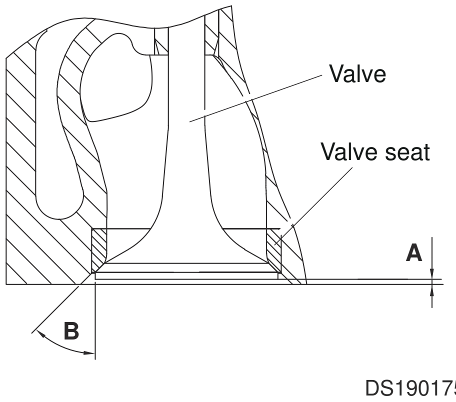
1. Amount of contact with mating surface
Figure 106



DS1901754

   A. To check the amount of wear on the valve seat, measure the height of the mating surface between the intake and exhaust valve.
   B. If the measurement exceeds the allowable limit, replace the part.
   C. Install the valve on the cylinder head valve seat.

D. Use a dial gauge to measure the insertion length of the valve from the bottom of the cylinder head.
Figure 107



- Valve step height

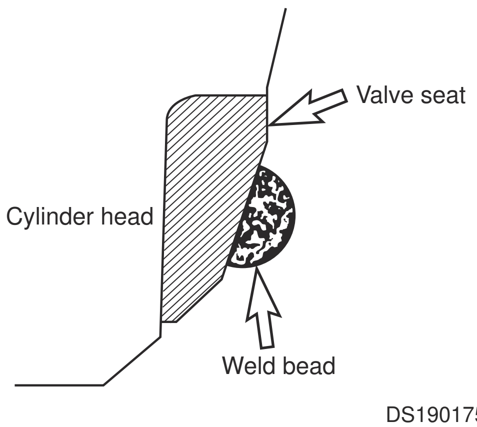
	Reference Value	Allowable Limit
Intake valve (A)	0.1 to 0.4 mm	0.6 mm
Exhaust valve (A)	0.4 to 0.7 mm	1.0 mm

- Valve angle

Intake Valve (B)	Exhaust Valve (B)
60°	45°

E. If the insertion length of the valve exceeds the allowable limit, replace the valve seat.

F. To remove the valve seat, perform arc welding in two places on the valve seat; then, use a special service tool to pull out the valve seat.
Figure 108



NOTE: *The inside diameter needs to be bored during the removal of the valve seat.*

G. Before assembling the valve seat, cool it in dry ice for approx. two hours.

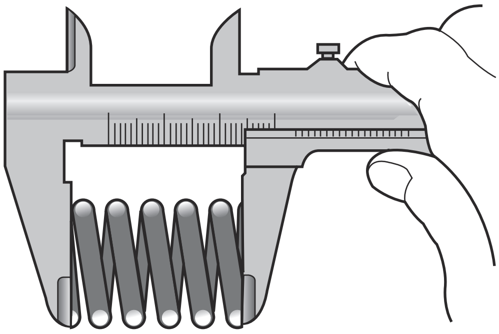
H. Use a bench press to press-fit the valve seat into the cylinder head.

I. Apply abrasive to the valve head mating surface of the valve seat.

J. Turn the valve to polish the valve seat surface until the valve is properly seated. Then, remove the abrasive completely.

Inspecting the Valve Spring

1. Perform a visual inspection of the exterior of the valve spring.
   A. Visually inspect the valve spring for external damage and replace it if necessary.
2. Check the free length of the valve spring.
   Figure 109

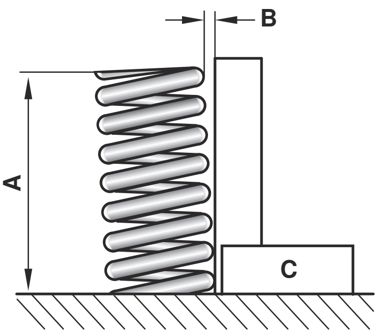


DS1901757

   A. Measure the free length of the valve spring with vernier calipers.
   B. If the measurement is below the specification, replace the valve spring.

Free Length of Spring	Reference Value
Intake valve	57.9 mm
Exhaust valve	53.5 mm

3. Check the squareness of the valve spring.
   Figure 110



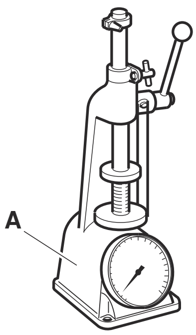
DS1901758

A	Free length
B	Squareness
C	Straightedge

   A. Use a surface plate and straightedge to measure the squareness of the valve spring.
   B. If the measurement exceeds the allowable limit, replace the valve spring.

	Specified Value	Allowable Limit
Valve spring squareness	1.7 mm or less	2.0 mm

4. Check the tension of the valve spring.
   Figure 111



DS1901759

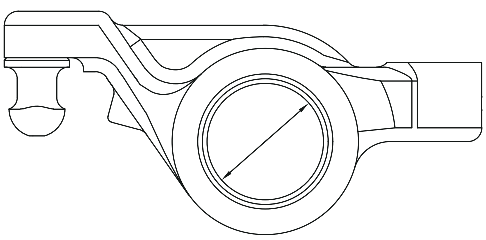
   A. Measure the tension of the valve spring with a spring tester (A).
   B. If the measurement is below the allowable limit, replace the valve spring.

Set Length		Spring Tension	Allowable Limit
Inside	37.1 mm	13.0 kg	±1.5 kg
	24.9 mm	21.4 kg	±2.0 kg
Outside	39.1 mm	21.0 kg	±2.0 kg
	26.9 mm	40.2 kg	±2.5 kg

Rocker Arms

Inspecting Rocker Arms

1. Visual check
   A. Check the adjusting screw cap assembly surface—which slides in contact with the valve stem—visually for scratches or layered wear.
   B. For minor wear, use an oily grindstone or fine sandpaper to polish the surface. In the case of severe layered wear, replace the rocker arm.
2. Rocker arm bushing I.D.
   Figure 112



DS1901760

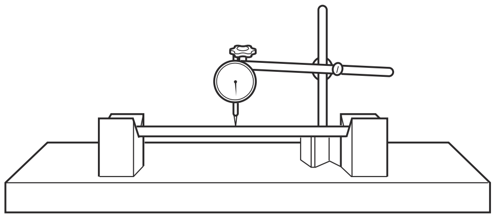
   A. Measure the inside diameter of the rocker arm bushing with a micrometer or vernier calipers.
   B. Compare the measurement with the outside diameter of the rocker arm shaft. If the clearance exceeds the allowable limit, replace either the bushing or shaft, whichever part is more worn.

Reference Value	Allowable Limit
Ø24.991 ~ Ø25.012 mm	Ø25.137 mm

	Specified Value	Allowable Limit
Clearance between rocker arm and shaft	0.031 ~ 0.073 mm	0.14 mm or less

Inspecting the Rocker Arm Shaft

1. Deflection of rocker arm shaft
   Figure 113



DS1901761

   A. Place the rocker arm shaft on two V-blocks and use a dial gauge to check the deflection of the shaft.
   B. If the deflection is minor, correct it by pressing the shaft with a press. If the deflection exceeds the allowable limit, replace the shaft.

Allowable limit	0.1 mm

2. Rocker arm shaft O.D.
   A. Use an O.D. micrometer to measure the outside diameter of the rocker arm shaft at its mounting position.
   B. If the measurement exceeds the allowable limit, replace the rocker arm shaft.

Reference Value	Allowable Limit
Ø24.939 ~ Ø24.960 mm	Ø24.90 mm

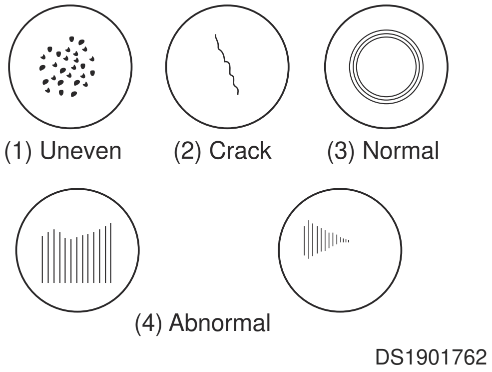
Tappets and Push rods

Inspecting the Valve Tappets

1. Tappet clearance
   A. Measure the outside diameter of the tappet and the inside diameter of the cylinder block tappet hole.
   B. If the measurement exceeds the allowable limit, replace the tappet.

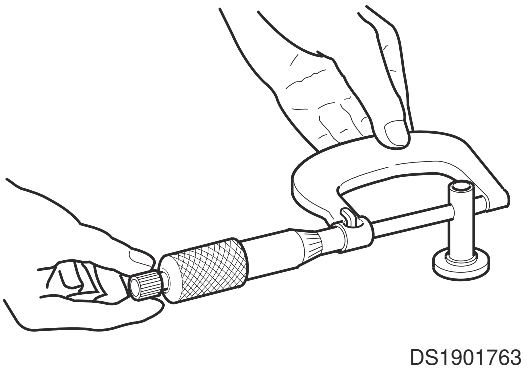
Reference Value	Allowable Limit
0.035 ~ 0.077 mm	0.15 mm

2. Inspecting the tappet visually
   Figure 114



   A. Perform a visual inspection of the tappet surface—which slides in contact with the camshaft—for cracks, scratches and any other damage.
   B. For minor wear, use an oily grindstone or sandpaper to polish the surface. If the part is severely worn, replace it.

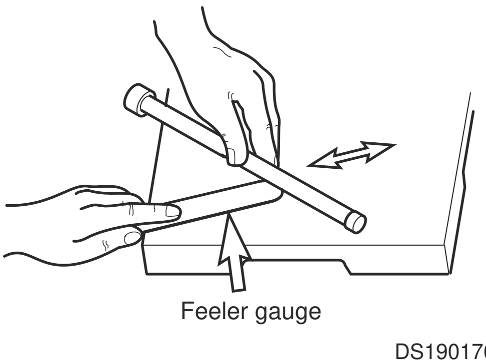
3. Tappet O.D
   Figure 115



   A. Use an O.D. micrometer to measure the outside diameter of the tappet.
   B. If the measurement exceeds the allowable limit, replace the tappet.

Reference value	Ø19.944 ˜ Ø19.965 mm

Figure 116



Checking the Warpage of Push rods

1. Place the push rod on a surface plate.
2. Rotate the push rod while measuring the amount of warpage with a feeler gauge.
3. If the measurement exceeds the allowable limit, replace the part.

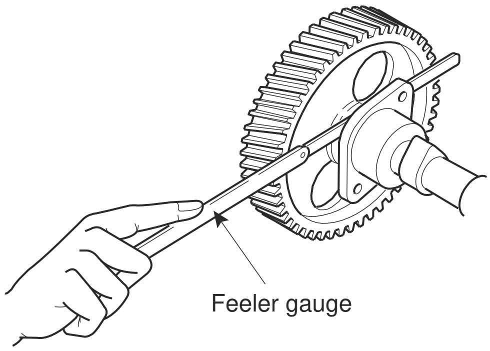
Allowable limit	0.3 mm or less

Push rod length	327.5 mm

Camshaft

Camshaft Free Play

1. Move the camshaft gear to the opposite side of the cylinder block.
Figure 117



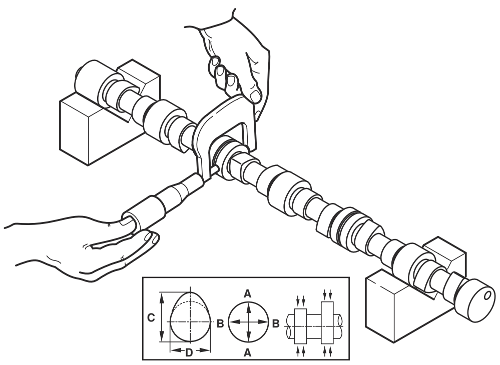
DS1901765

2. Measure the clearance between the thrust plate and camshaft gear with a feeler gauge.
3. If the free play is excessive, replace the thrust plate.

Reference Value	Allowable Limit
0.28 ~ 0.43 mm	0.5 mm

Inspecting the Camshaft

1. Measure the height of the cam lobe.
Figure 118



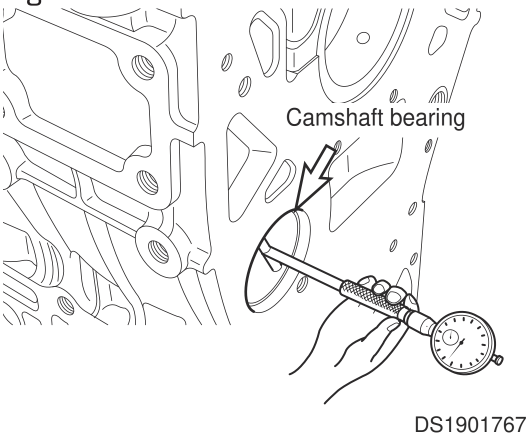
DS1901766

   A. Use a micrometer to measure the cam lobe height and journal diameter.
   B. If the measurement is below the allowable limit, replace the camshaft.

		Reference Value	Allowable Limit
Cam lobe height (C)	Intake	48.796 mm	48.5 mm
	Exhaust	49.170 mm	48.87 mm
Cam journal diameter (A, B)		Ø57.86 ~ Ø57.88 mm	Ø57.58 mm

2. Inspect the surface of the camshaft.
   A. Check the cam surface for scratches or damage.
   B. For minor layered wear or damage, use an oily grindstone or fine sandpaper to polish the surface. For severe damage, replace the cam.
3. Clearance between camshaft and bearing

   Figure 119

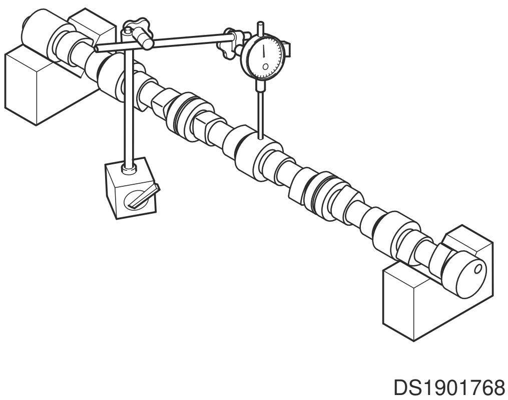


   A. Use an O.D. micrometer to measure the outside diameter of the camshaft bearing.
   B. Use a cylinder I.D. gauge to measure the inside diameter of the camshaft bearing. Then, compare the measurement with the camshaft O.D. to determine the clearance.
   C. If the measurement exceeds the allowable limit, replace the camshaft bearing.

Reference Value	Allowable Limit
0.060 ~ 0.115 mm	0.23 mm

4. Camshaft deflection

   Figure 120



   A. Place the camshaft on two V-blocks.
   B. Use a dial gauge to check the deflection of the camshaft; correct the deflection if necessary.

C. If the deflection is too severe to be repaired, replace the camshaft.

Reference Value	Allowable Limit
0.05 mm	0.15 mm

Crankshaft

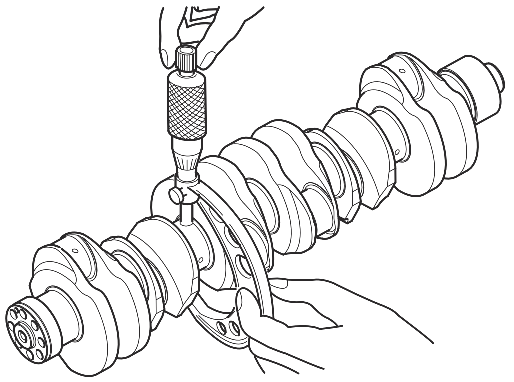
Inspecting the Crankshaft

1. Inspecting for defects

   A. Check the journals and crank pins on the crankshaft visually for scratches or cracks.

   B. Perform the magnetic particle test or dye penetrant test (color check) to check the crankshaft for cracks. If any cracks are found, replace the crankshaft.

2. Measuring wear
   Figure 121



DS1901769

   A. Use an O.D. micrometer to measure the journals and pins on the crankshaft in the direction shown in the figure in order to check the amount of wear.

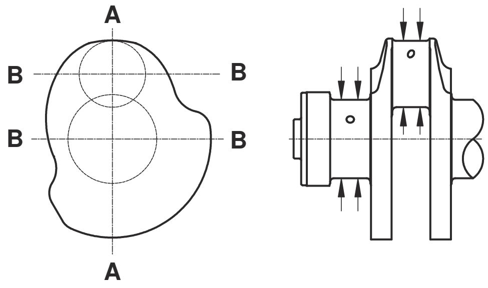
   B. If the amount of wear exceeds the allowable limit, polish the crankshaft and install an under size bearing on it.

   C. However, if the amount of wear is within the allowable limit, use an oily grindstone or fine sandpaper to polish the surface.

   NOTE: *Use sandpaper soaked in oil.*

	Reference Value	Allowable Limit
Journal O.D.	Ø83.966 ~ Ø83.988 mm	Ø82.966 mm
Outside diameter of pin	Ø70.974 ~ Ø70.993 mm	Ø69.974 mm

D. If the pin wear exceeds the allowable limit, polish the crank journal and crank pin and use an under size bearing.
Figure 122



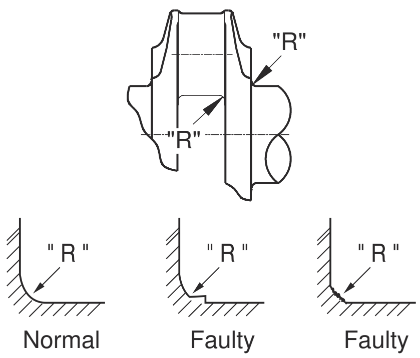
DS1901770

NOTE: *To polish the crankshaft, use sandpaper soaked into oil.*

E. There are two types of under size bearings which can be chosen according to the crankshaft and ground for use.

- Standard
- 0.25 (0.25 mm smaller than standard I.D.)
- 0.50 (0.50 mm smaller than standard I.D.)

F. Reference value for “R”
Figure 123



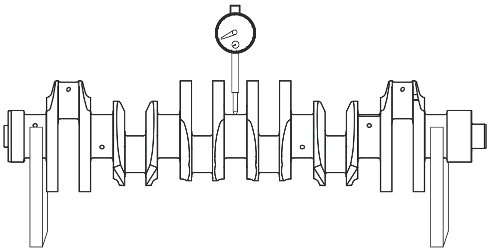
DS1901771

- “R” on the crank pin: 5.5 (+0 / -0.2)
- “R” on the crank journal: 5.0 (+0 / -0.2

CAUTION

AVOID INJURY
When grinding the crankshaft, make sure to grind part “R” on the end of the bearing precisely. There should not be any steps or burrs.

3. Crankshaft deflection
   Figure 124



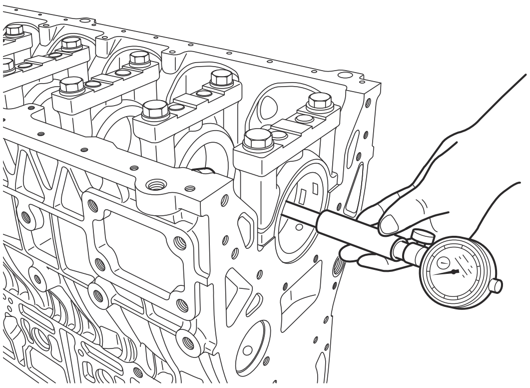
DS1901772

   A. Place the crankshaft on a V-block.
   B. Set a dial gauge on a surface plate and roll the crankshaft to measure its deflection.

Reference Value	Allowable Limit
0.06 mm	0.1 mm or less

Inspecting the Crankshaft Bearings and Connecting Rods

1. Visual check
   Figure 125



DS1901773

   A. Check the crankshaft bearings and connecting rod bearings visually for scratches, abnormal wear or damage.

2. Oil clearance between the crankshaft and bearings (method no.1: dial gauge)
   A. Main bearing clearance
      1) Install the main bearings on the cylinder block and measure the inside diameter after tightening the bearing caps to the specified torque.

Torque	294.1 N.m (30 kg.m, 216.9 ft lb)

      2) Compare the main bearing inside diameter with the crankshaft journal outside diameter to determine the oil clearance.

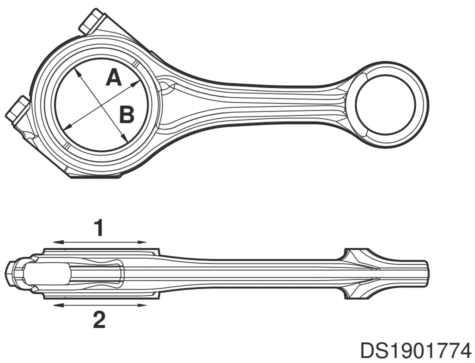
Main Bearing Oil Clearance	
Reference Value	Allowable Limit
0.052 ~ 0.122 mm	0.15 mm

B. Connecting rod bearing clearance

1) Install the connecting rod bearings in the connecting rod bearing caps, tighten the bolts to the specified tightening torque, and measure the inside diameter.

Torque	7 ±0.2 kg.m + 110° (+10°)

Figure 126



CAUTION

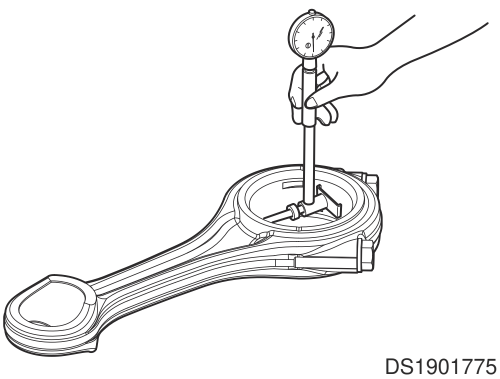
AVOID INJURY

Assemble the connecting rod bolts manually in the correct order until the connection on the bolt heads comes into contact with the bolt seat surfaces on both sides of the connecting rods. Then, use a torque wrench to perform a final tightening.

2) Compare the two measured values of the connecting rod bearing inside diameter with the outside diameter of the crankshaft pin to determine the oil clearance.

Reference Value	Allowable Limit
0.031 ~ 0.095 mm	0.15 mm

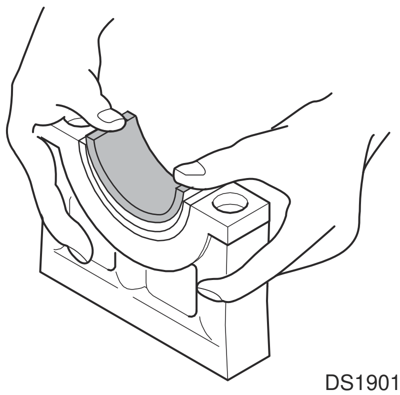
3) Figure 127



If the clearance exceeds the allowable limit, grind the crankshaft journal and pin and use an under size bearing.

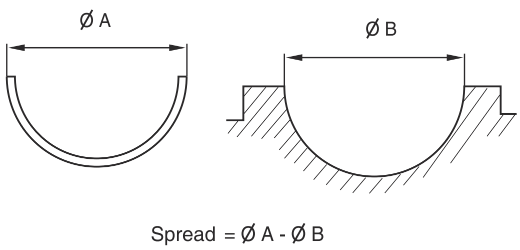
3. Oil clearance between the crankshaft and bearings (method no.2: plastic gauge)
   A. Install the crankshaft on the cylinder block.
   B. Place a plastic gauge on the crankshaft journal and pin.
   C. Install the bearing caps and tighten the bolts to the specified torque.
   D. Loosen the bolts and remove the bearing caps.
   E. Measure the thickness of the flat section of the plastic gauge with a plastic gauge measuring rule.
   F. This is the oil clearance.
4. Bearing spread and crush

Figure 128



DS1901776

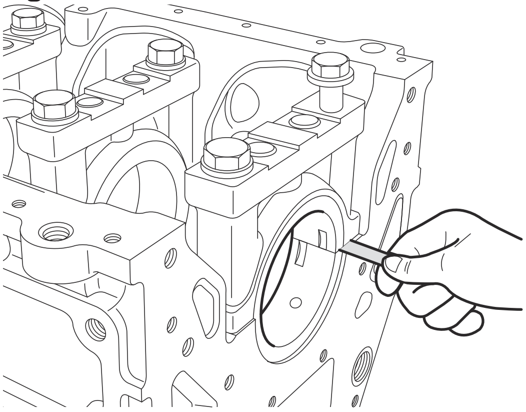
Figure 129



DS1901777

   A. Checks
      1) Check whether a considerable amount of pressure is felt with your finger when installing the bearing.

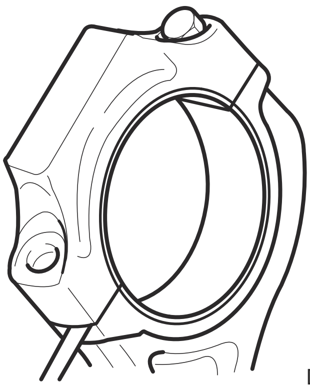
B. Bearing cap crush
Figure 130


DS1901778

1) Install the bearings and caps on the cylinder block.
2) Tighten the bolts to the specified tightening torque.
3) Loosen one of the bolts completely and use a feeler gauge to measure the clearance between the bearing caps and cylinder block.

Reference value	0.08 ~ 0.110 mm

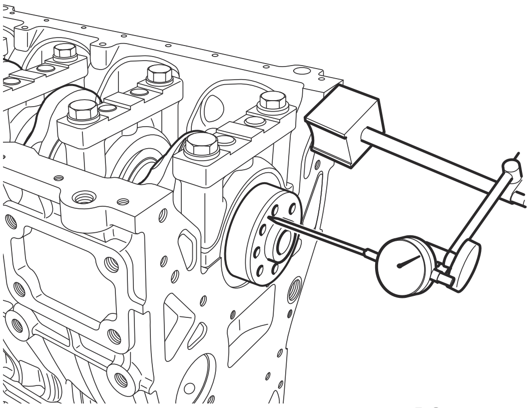
C. Connecting rod bearing crush
Figure 131


DS1901779

1) Install the bearings and caps on the big ends of the connecting rods.
2) Tighten the bolts to the specified tightening torque.
3) Loosen one of the bolts completely and use a feeler gauge to measure the clearance between the bearing caps and connecting rod big ends.

Reference value	0.04 ~ 0.07 mm

D. Axial play of crankshaft
Figure 132



DS1901780

1) Install the crankshaft on the cylinder block.

2) Use a dial gauge to measure the axial play of the crankshaft.

Reference Value	Allowable Limit
0.100 ~ 0.300 mm	0.5 mm

Pistons

Inspecting Pistons

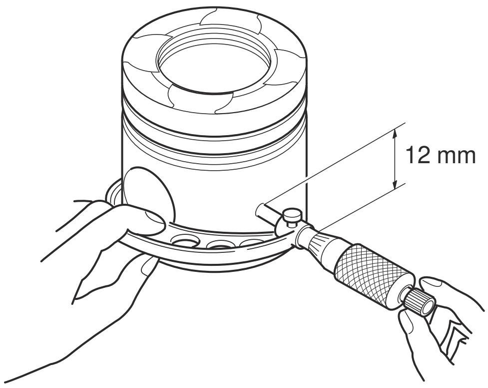
1. Visual check

   A. Check the pistons visually for cracks, scratches and wear.

   B. In particular, check whether the ring groove is worn.

2. Clearance between the piston and cylinder liner

   A. Use an O.D. micrometer to measure the outside diameter of the piston at the position 12 mm from the bottom of the piston at a right angle to the piston pin hole.
   Figure 133

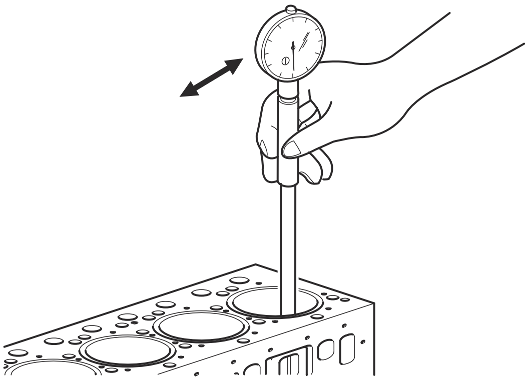


DS1901781

Reference value	Ø107.773 ~ Ø107.787 mm

B. Use a cylinder I.D. gauge to measure the inside diameter of the cylinder liner.

Figure 134



DS1901782

C. Measure the inside diameter at three locations of the cylinder liner in the 45° direction: the top ring contact section, middle section and oil ring contact section near the BDC.

D. Then, calculate the average value, excluding the minimum and maximum values.

E. The clearance is the piston O.D. subtracted from the cylinder liner I.D.

F. If this value exceeds the allowable limit, replace either the piston or cylinder liner, whichever is more worn.

Clearance Between the Piston and Liner	
Reference value	0.213 ~ 0.249 mm

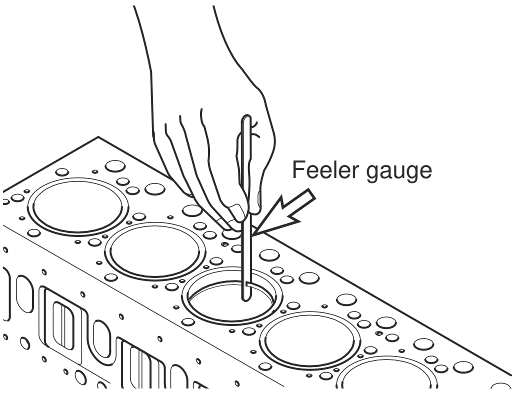
Inspecting the Piston Rings

1. Visual check

   A. If damage or wear on the piston ring is found while disassembling the engine, replace the ring with a new one.

2. Piston ring gap

   Figure 135



DS1901783

   A. Insert the piston ring into the top of the cylinder liner so that it is set at the right angle to the cylinder liner wall.

   B. Measure the gap of the piston ring with a feeler gauge.

	Reference Value	Allowable Limit
Top ring	0.30 ~ 0.50 mm	1.5 mm
Second ring	1.20 ~ 1.35 mm	1.5 mm
Oil ring	0.30 ~ 0.50 mm	1.5 mm

C. If the piston ring gap exceeds the allowable limit, replace the piston ring with a new one.

3. Piston ring side gap

A. Fit the compression ring and oil ring into the piston ring groove.

B. Use a feeler gauge to measure the side clearance of the ring.

	Reference Value	Allowable Limit
Top ring	-	-
Second ring	0.07 ~ 0.105 mm	0.15 mm
Oil ring	0.05 ~ 0.09 mm	0.15 mm

C. If the measured value exceeds the allowable limit, replace either the ring or the piston.

4. Piston ring tension

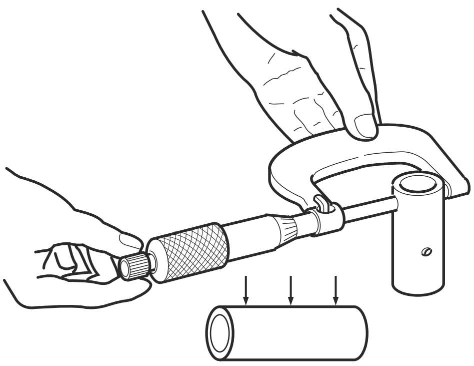
A. Measure the tension of the piston ring with a tension gauge.

B. If the measured value exceeds the allowable limit, replace the piston ring.

Item	Specified Value
Top ring	1.57 ~ 2.37 kg
Second ring	1.50 ~ 2.25 kg
Oil ring	5.09 ~ 6.91 kg

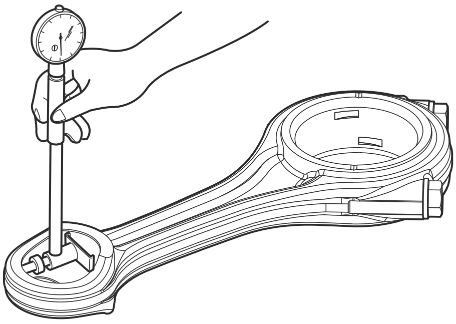
Inspecting the Pistons and Piston Pins

1. Measure the amount of wear on the piston pins; if the measured value exceeds the allowable limit, replace the pin.
   Figure 136



Piston Pin Reference Value	Allowable Limit
Ø43.994 ~ Ø44.000 mm	Ø43.94 mm

2. Measure the clearance between the piston pins and the connecting rod bushings.
   Figure 137

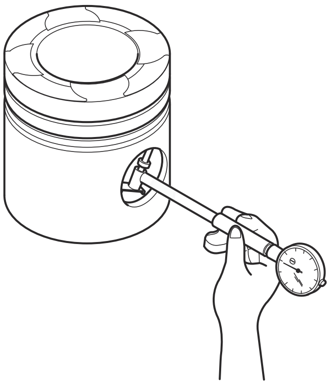


DS1901785

3. If the measured value exceeds the allowable limit, replace whichever part is more worn.

Reference Value	Allowable Limit
0.050 ~ 0.081 mm	0.13 mm

4. Check the mounting conditions of the piston and piston pin.
   Figure 138



DS1901786

CAUTION

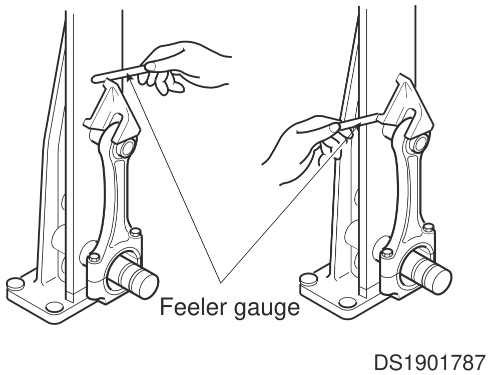
AVOID INJURY

When replacing pistons, replace the piston pin as well.

Connecting Rods

Inspecting Connecting Rods

1. Warpage
   Figure 139



   A. Check the connecting rod for distortion.

   B. Install the connecting rod on a connecting rod measuring device and use a feeler gauge to check for distortion.

   C. If the connecting rod is distorted, replace it with a new one.

2. Hole parallelism

   A. Measure the parallelism of the bushing groove at the small end and the bearing groove at the big end of the connecting rod.

   NOTE: *Use both a connecting rod measuring device and feeler gauge for this task.*

Reference Value	Allowable Limit
0.02 mm	0.1 mm or less

3. Wear

   A. Install the connecting rods on the crankshaft.

   B. Use a feeler gauge to measure the side clearance of the big end of the connecting rods.

   C. Install the connecting rods on the pistons.

   D. Measure the side clearance of the small end of the connecting rods.

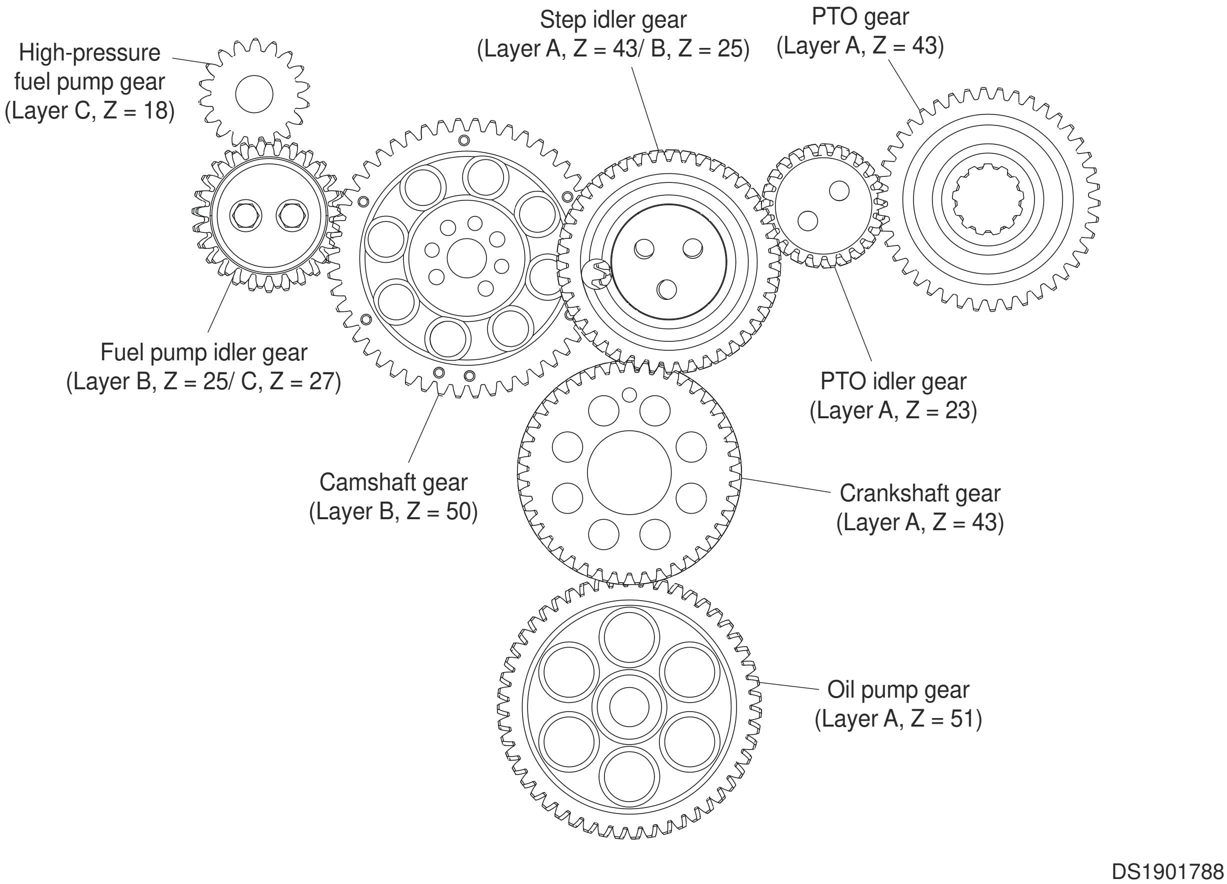
   E. If the measurement exceeds the allowable limit, replace the connecting rod.

Specified Value	Allowable Limit
0.170 ~ 0.248 mm	0.50 mm

Miscellaneous

Engine Timing

Figure 140



Fuel System

General Information

General Information

Diesel engines compress air sucked into the cylinders to produce compression heat; then, spray nozzles inject fuel which is subsequently burnt by the heat of compression.

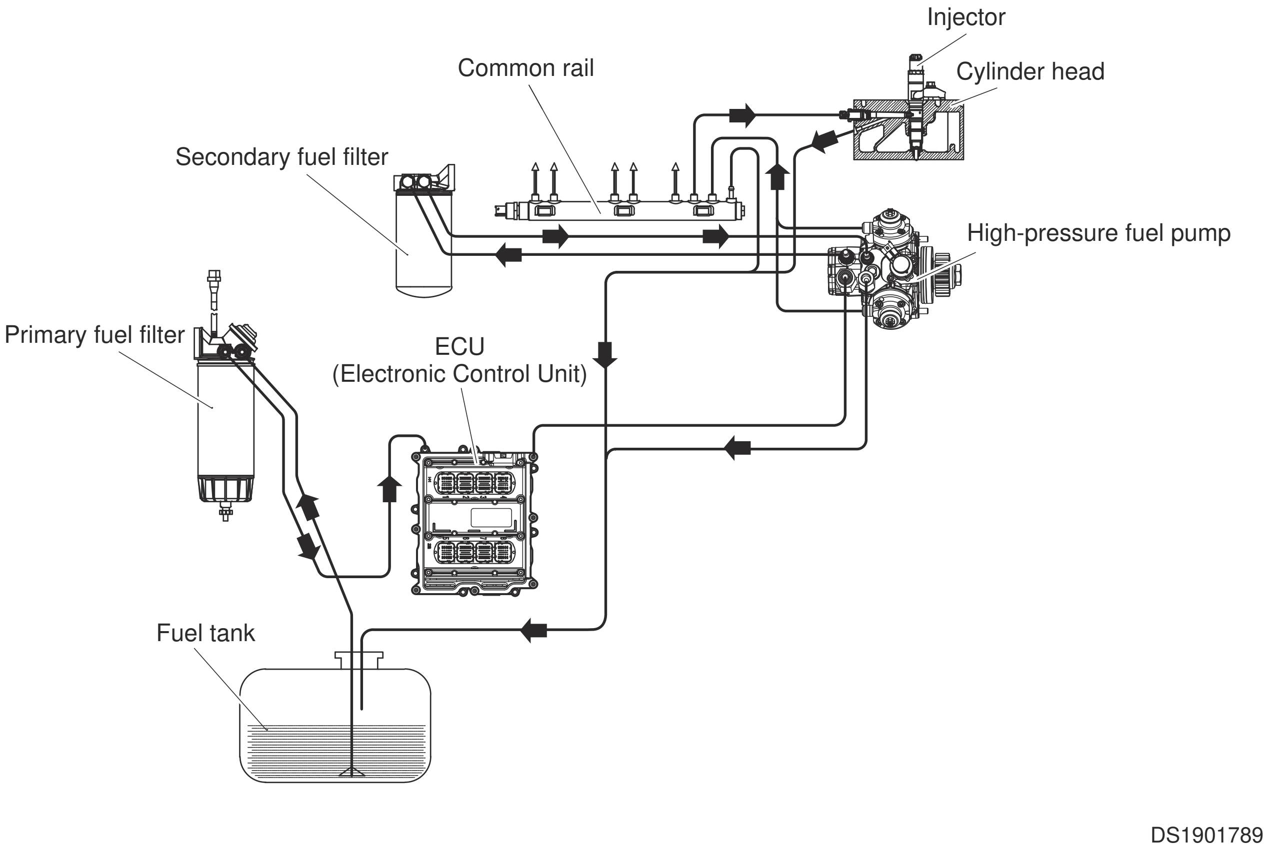
Pressurized fuel generated by the high-pressure pump is stored in the common rail, while the injection timing and injection amount are calculated by the electronic control unit (ECU). The ECU injects fuel by actuating the solenoid valve for the injector installed in each cylinder.

HD HYUNDAI CONSTRUCTION EQUIPMENT's common rail fuel injection system is divided into a high-pressure generation system and a fuel injection system. After determining the amount of fuel, injection timing, and injection pressure which will enable the engine to deliver optimal performance based on the engine operating conditions, the ECU injects fuel into the cylinders.

Pressurized fuel generated by the high-pressure fuel pump is stored in the common rail. When the driver operates the vehicles, the optimal amount of fuel and fuel injection timing are determined based on the data set in the ECU according to the vehicle speed and operating conditions, while the ECU actuates the solenoid valve for the injector installed in each cylinder of the engine to inject fuel into the cylinders.

The fuel tank must be made of non-corrosive material and be able to operate without leaks at twice the operating pressure of the low-pressure fuel pump. The pressure inside the tank must not exceed 0.3 bar.

Figure 141



High-Pressure Fuel System Components

The common rail fuel injection system consists of a low-pressure stage for the low-pressure transfer of fuel, a high-pressure stage for high-pressure transfer.

1. High-pressure fuel pump

   The high-pressure fuel pump pressurizes fuel to a pressure of approx. 1,800 bar; then, this pressurized fuel is delivered to the pipe-shaped common rail via a high-pressure line.

2. Common rail

   The fuel pressure in the common rail remains constant even after the injectors use fuel from the common rail for fuel injection. The fuel pressure is measured by a common rail pressure sensor and is maintained at the desired level by a pressure adjustment valve. Fuel pressure is controlled by a pressure control valve within the common rail up to a maximum pressure of 1,800 bar.

3. Injector

   Solenoid valves allow fuel to flow into the injector nozzles from which the injectors spray fuel directly into the combustion chamber of the engine.

   The injector nozzle opens and supplies the required amount of fuel; then, the remaining fuel returns to the tank via a return line. Fuel returned from the fuel pressure adjustment valve and low-pressure stage and fuel used to lubricate the high-pressure pump also return to the fuel tank by means of a return line.

4. High-pressure fuel pipe

   The high-pressure fuel pipes deliver high-pressure fuel at a pressure of 1,800 bar.

Hence, the pipes of the fuel lines are made of a special material designed to withstand both the maximum pressure of the system and fluctuations in pressure at the high pressures which occur during fuel injection. The high-pressure pipes have an outside diameter of 8.0 mm and an inside diameter of 3.5 mm. Furthermore, the high-pressure fuel pipes between the common rail and injectors all have an identical length and are designed to be as short as possible.

Injector

General Information

The solenoid valve allows fuel to flow into the injector nozzle from which the injector sprays fuel directly into the combustion chamber of the engine.

The injector nozzle opens and supplies the required amount of fuel; then, the remaining fuel returns to the tank via a return line. Fuel returned from the fuel pressure adjustment valve and low-pressure stage and fuel used to lubricate the high-pressure pump also return to the fuel tank by means of a return line.

The start of fuel injection and amount of injection are adjusted by a solenoid valve installed in each injector, while the injectors replace the functions of nozzles and nozzle holders in previous engines. Fuel is supplied to the injector by means of a high-pressure connector installed in the cylinder head; then, the fuel is supplied to the control valve chamber by means of a delivery hole.

The control valve chamber is opened by a solenoid valve and connected to the fuel return line via a discharge hole.

The force of the hydraulic pressure applied to the valve control plunger while the discharge hole is closed exceeds the pressure of the nozzle needle.

As a result, fuel supply to the combustion chamber is shut off by the force applied to the contact surface of the nozzle needle.

When the solenoid valve of the injector is pulled, the discharge hole is opened.

This lowers the pressure in the control chamber and reduces the hydraulic pressure acting on the plunger. The nozzle needle opens when the force of the hydraulic pressure drops below the force acting on the nozzle needle pressure.

Then, fuel is injected into the combustion chamber through the hole in the spray nozzle.

The nozzle needle is controlled by hydraulic pressure because the force required to open the needle quickly is not generated directly by the solenoid valve. The fuel control rate required to open the nozzle needle is added to the actual amount of fuel injected. Then, the used fuel is discharged into the fuel return line through the hole in the control valve chamber.

Fuel loss occurs not only during the control phase, but also in the nozzle needles and valve plunger guides.

The fuel from the control phase, as well as fuel collected from lines connected to the overflow valve, high-pressure pump, and pressure control valve, return to the fuel tank via the fuel return line.

Injector Operating Principles

Injector operation is divided into four stages involving engine operation and a high-pressure pump which generates pressure.

1. Injector closed (high fuel pressure)
2. Injector open (start of fuel injection)
3. Injector fully open (fuel injection)
4. Injector closed (end of fuel injection)

These operating stages are determined by the distribution of force acting on the injector components.

The injector nozzles do not work when the engine is stopped and there is no pressure in the common rail.

1. Injector closed (paused)

   Injectors do not work during the pause stage when power is not supplied to the injector solenoid valves. The valve ball is pressed against the seat surface of the injector discharge hole by a valve spring and magnetic force. High pressure in the common rail is maintained by the fuel control valve and the same pressure is generated in the nozzle chamber of the injector. The common rail fuel pressure acting on the end of the control valve chamber of the injector and the force applied to the injector nozzle spring are greater than the opening force of the nozzle, thereby keeping the nozzle closed.

2. Injector open (start of fuel injection)

   When power is supplied with the injector solenoid valve in its closed state, the pulling force of the solenoid valve opens the fuel discharge hole. The high current applied to the solenoid is reduced to a low current almost simultaneously. This is because the air gap in the electromagnetic circuit becomes smaller. The fuel in the control valve chamber flows through a hole in the discharge valve on top of the control valve chamber and into the fuel tank via a fuel return line.

   The discharge hole disrupts the pressure balance completely and causes the pressure in the control valve chamber to drop. This, in turn, further reduces the pressure in the nozzle chamber maintaining the pressure in the control valve chamber at the same pressure as in the common rail. The reduced pressure in the control valve chamber causes a reduction in the force applied to the control plunger and, as a result, the nozzle needle opens and fuel injection begins.

3. Injector fully open (fuel injection)

   As a result of the fuel buffer created by the discharge rate and the flow of fuel between the delivery holes, the valve control plunger comes to a rest at the top.

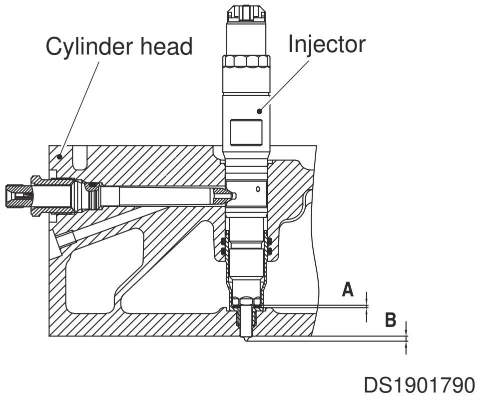
   At this time, the injector nozzle opens fully and fuel is injected into the combustion chamber at the same pressure as in the common rail.

4. Injector closed (end of injection)

   When power to the injector solenoid valve is shut off, the valve spring forces the armature downwards immediately and the valve ball closes the discharge hole. The armature consists of two parts: an armature plate guided downwards by a driving shoulder, and an overspring with a return spring installed to prevent the force acting on the armature and valve ball from being applied in the downward direction. When the discharge hole is closed, fuel enters from the delivery hole and generates pressure in the control chamber. This fuel pressure is equal to the pressure of the common rail and applies pressure to the valve control plunger through the end surface of the valve control plunger. This pressure exceeds both the force of the spring and the pressure built up in the nozzle chamber, thereby closing the nozzle needle. The closing speed of the nozzle needle is determined by the flow rate passing through the delivery hole; as soon as the nozzle needle reaches the stop position, fuel injection is shut off.

Injector Protrusion

1. Insert a seal ring into the cylinder head and assemble the injector.
   Figure 142



NOTE: *Refer to the section on engine assembly for the order of assembly.*

2. Check the protrusion of the injector from the cylinder head and adjust it if necessary.

A (thickness of seal ring)	2.0 mm
B (injector protrusion)	2.24~2.97 mm

Common Rail

General Information

HD HYUNDAI CONSTRUCTION EQUIPMENT's common rail fuel injection system is divided into a high-pressure generation system and a fuel injection system.

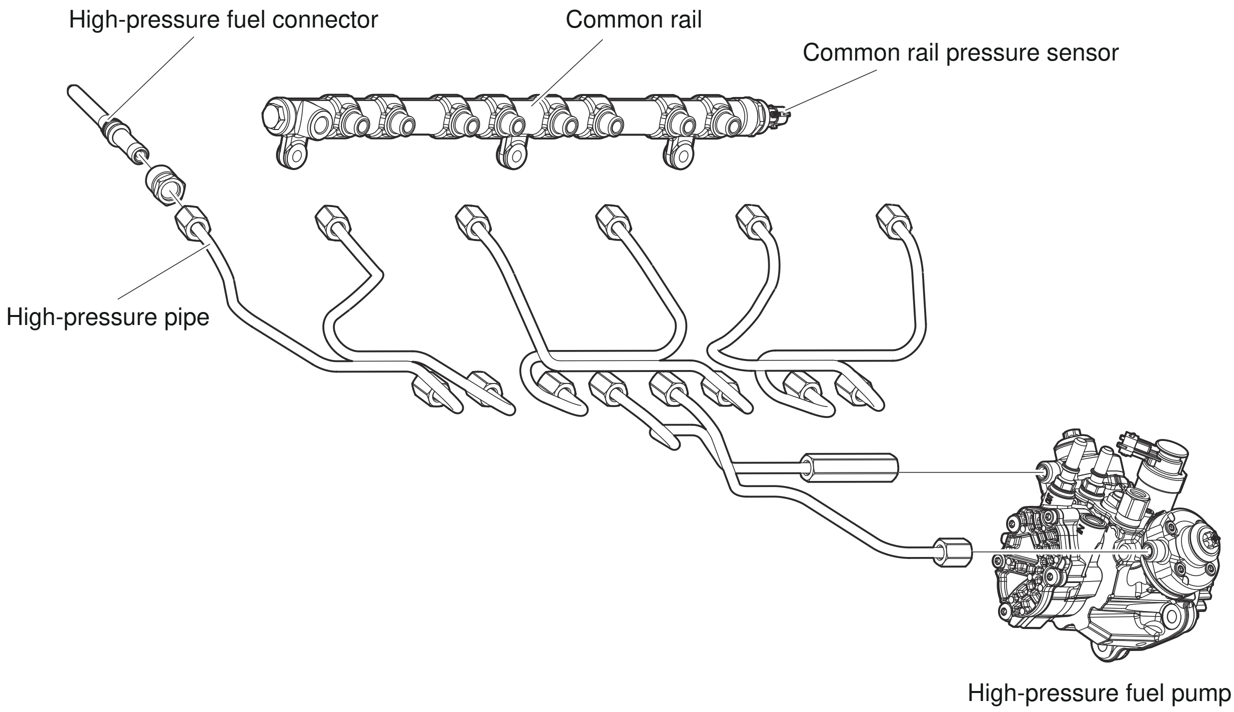
After determining the amount of fuel, injection timing, and injection pressure which will enable the engine to deliver optimal performance based on the engine operating conditions, the ECU injects fuel into the cylinders.

The common rail stores fuel pumped from the high-pressure fuel pump at a high pressure.

The fuel pressure in the common rail remains constant due to the volume of the common rail even after the injectors use fuel from the common rail for fuel injection.

The fuel pressure is measured by a common rail pressure sensor and is maintained at the desired level by a pressure adjustment valve. Fuel pressure is controlled by a pressure control valve within the common rail up to a maximum pressure of 1,800 bar.

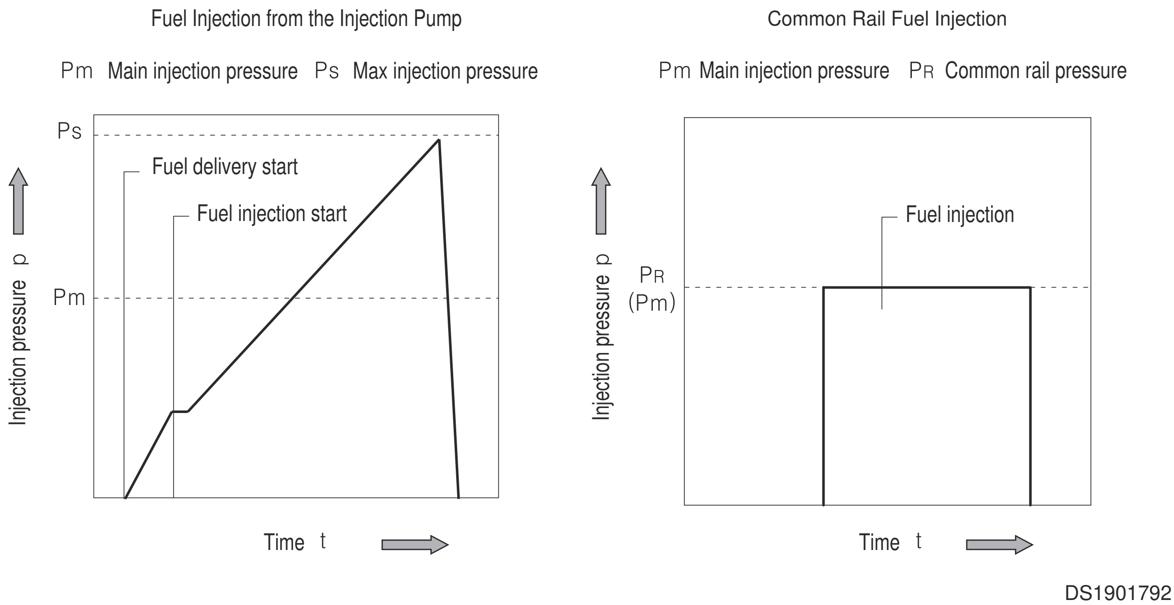
Figure 143



The main components of the common rail fuel injection system are as follows.

1. Electronic control unit (ECU)
2. Crankshaft position sensor
3. Camshaft position sensor
4. Accelerator pedal sensor
5. Fuel temperature sensor
6. Boost pressure & temperature sensor, oil pressure & temperature sensor
7. Common rail pressure sensor
8. Coolant temperature sensor
    - The ECU receives input signals from the sensors described above in response to the driver pressing the accelerator pedal and operates instantaneously according to the engine, vehicle and operating performance. The ECU also operates the switch circuits and open loop in the vehicle and engine based on this data.
    - The crankshaft position sensor measures the engine speed, while the camshaft position sensor is used to determine the firing order. Electrical signals produced by the potentiometer in the accelerator pedal sensor notify the ECU of how far the driver pushed the pedal. Furthermore, a turbocharger and intake pressure sensor are installed; the intake pressure sensor measures the intake pressure.

- In cold ambient temperatures or when the engine is cold, the ECU receives data from the coolant temperature sensor and ambient temperature sensor and adjusts the operation of the engine to suit the operating conditions.
  Figure 144



The injection characteristics of the common rail are as follows.

1. In comparison with previous injection characteristics, common rail fuel injection requires the following ideal fuel injection. The amount of fuel injected by the common rail and the injection pressure are both controlled independently of one another, thereby ensuring that all engine conditions are satisfied.
2. The injection amount during the initial stage of the fuel injection process—i.e. the ignition delay time between the start of fuel injection and the start of combustion—must be able to be lowered.
3. The common rail system is a modular system whose components—listed below—play a fundamental role in determining the injection characteristics.
   A. Injector solenoid valve installed on the cylinder head
   B. Common rail
   C. High-pressure fuel pump
   D. Electronic control unit (ECU)
   E. Crankshaft position sensor

Fuel Injection Pump

General Information

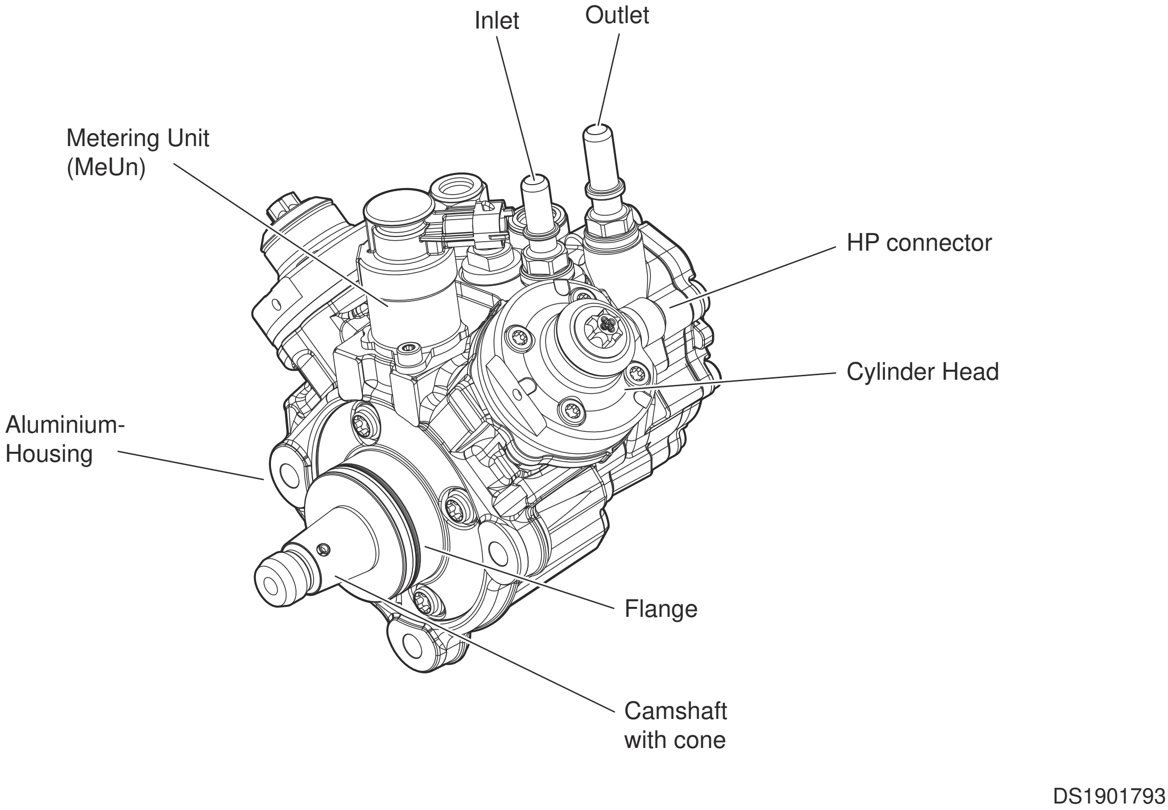
The high-pressure fuel pump uses a radial piston pump to generate high pressure. Pressure is generated independently during the fuel injection process. The rpm of the high-pressure fuel pump is directly linked to the engine rpm, regardless of the transmission gear ratio. In comparison with previous injection systems, the common rail injection system provides a constant amount of fuel.

Consisting of a nozzle and solenoid valve, injectors are connected to the common rail with high-pressure pipes. When the key switch is turned on, power is supplied to the solenoid valve by the ECU.

The solenoid valve stops injection when the key switch is turned off.

The injector solenoid valves are switched on and off by high voltage and current and operate sequentially according to the ECU settings. The engine rpm sensor uses the crankshaft sensor and camshaft sensor to adjust the start of fuel injection and injection timing.

Figure 145



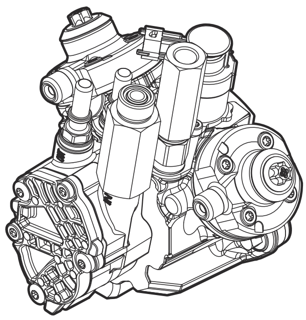
1. Functions

    A. The high-pressure fuel pump has a low-pressure and high-pressure stage. The pump serves to transfer high-pressure fuel under all operating conditions throughout the service life of the machine. Furthermore, the pump supplies the fuel required for starting the vehicle quickly or sudden changes in the pressure in the common rail. The high-pressure fuel pump continuously generates the system pressure required in the common rail.

2. Configuration of high-pressure fuel pump

    A. Inside the high-pressure fuel pump, fuel is compressed circumferentially by three pump pistons installed at 120° to one another. As three compression strokes are performed with every rotation, the pump maintains stress in the pump drive system and requires low driving force. The driving force of the common rail pump requires a load nine times less than the driving force required by previous pump systems.

3. Figure 146



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Operating principle

A. The fuel delivery pump supplies fuel from the tank to the high-pressure pump via the fuel inlet and safety valve. This delivers fuel from the safety valve to the high-pressure pump and cooling circuit for lubrication. The driveshaft has an eccentric cam which drives the pump pistons up and down according to the shape of the cam.

B. If the transfer pressure of the fuel delivery pump exceeds the full opening pressure of the safety valve, the fuel is delivered via the intake valve of the high-pressure fuel pump to the intake stroke of the pumping chamber in which the pump pistons are moving downwards. Once the pump pistons pass the BDC, the valve inlet closes and fuel is trapped in the pumping chamber; then, the fuel is compressed to a higher pressure than that at which it was delivered.

C. As soon as the fuel pressure reaches the pressure of the common rail, it closes the outlet valve. Then, the compressed fuel enters the high-pressure circuit. The pump pistons continue delivering fuel until they reach the TDC, after which the pressure drops and the outlet valve closes. Fuel remaining in the pumping chamber is decompressed and the pump pistons move back downwards. Once the pressure in the pumping chamber drops below the pressure of the fuel delivery pump, the inlet valve opens and the process described above begins again.

4. Returning delivered fuel

A. The high-pressure fuel pump is designed to deliver large quantities of fuel. Hence, excess fuel delivered while the engine is idling or running under a partial load returns to the tank via the pressure adjustment valve.

5. High-pressure fuel pump shutoff valve

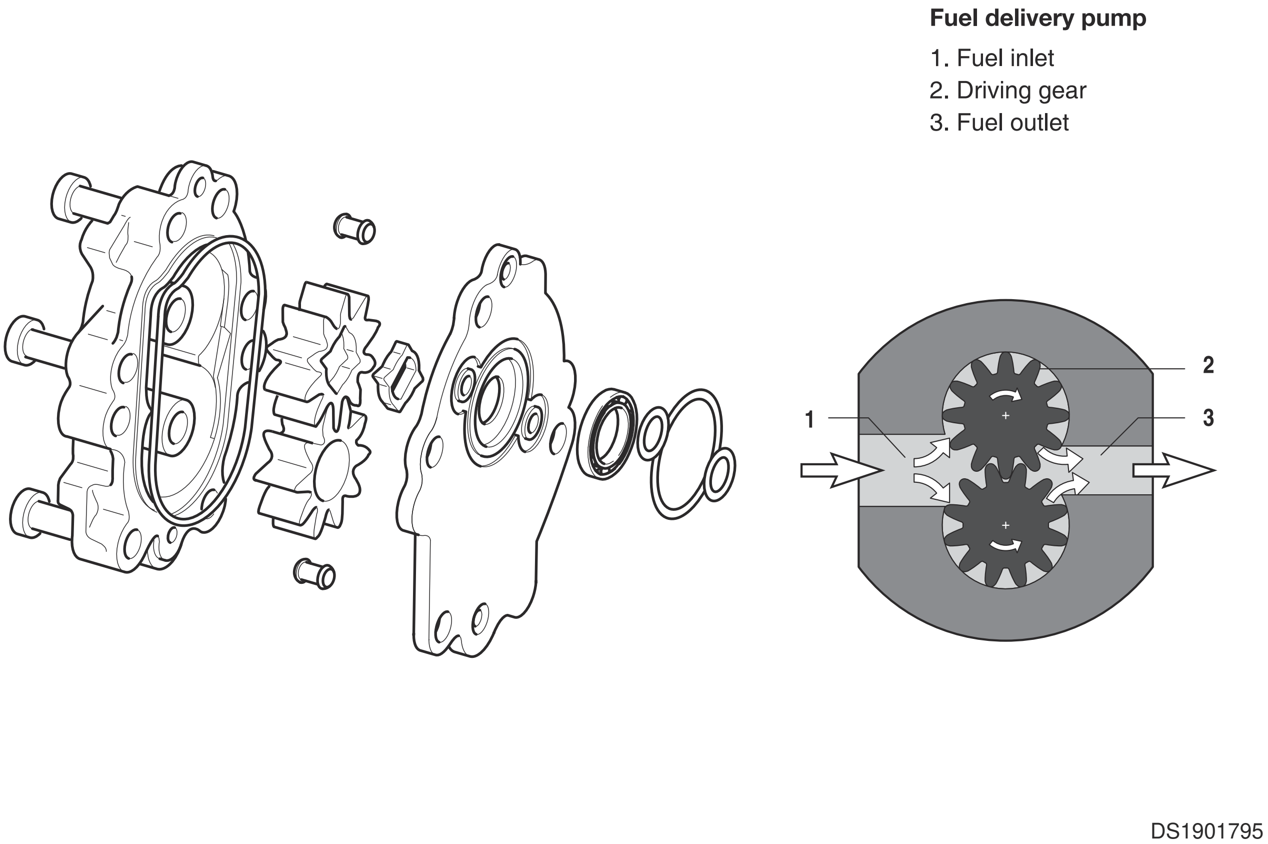
A. When the switch of the high-pressure fuel pump shutoff valve turns off, the amount of fuel delivered to the common rail increases. When the switch is turned off, the intake valve remains open and the fuel pump solenoid valve is pulled, thereby keeping the valve inlet open with the pin on the electromagnet. Thus, fuel supplied to this pumping valve cannot be compressed during the delivery stroke. No pressure is generated while the fuel returns to the low-pressure passage. Since the pump shutoff valve is actuated by a minimal amount of power, fuel delivery and shutoff take place at short intervals.

Fuel Delivery Pump

General Information

The gear-driven fuel delivery pump is a fuel pump installed on the back of the high-pressure fuel pump. The fuel delivery pump draws in fuel from the fuel tank and delivers the required amount of fuel continuously to the high-pressure pump.

Figure 147



Lubricating System

General Information

General Information

This engine is lubricated with a forced lubrication system. Oil pressure is generated and supplied by the gear rotation of the oil pump driven directly by the crankshaft gear on the back of the cylinder block.

After the oil pump sucks in oil from the oil pan through the suction pipe, the oil is sent to the main gallery of the cylinder block through the oil filter and oil cooler.

Then, it is distributed to the crankshaft bearings, camshaft bearings and rocker arms to lubricate them.

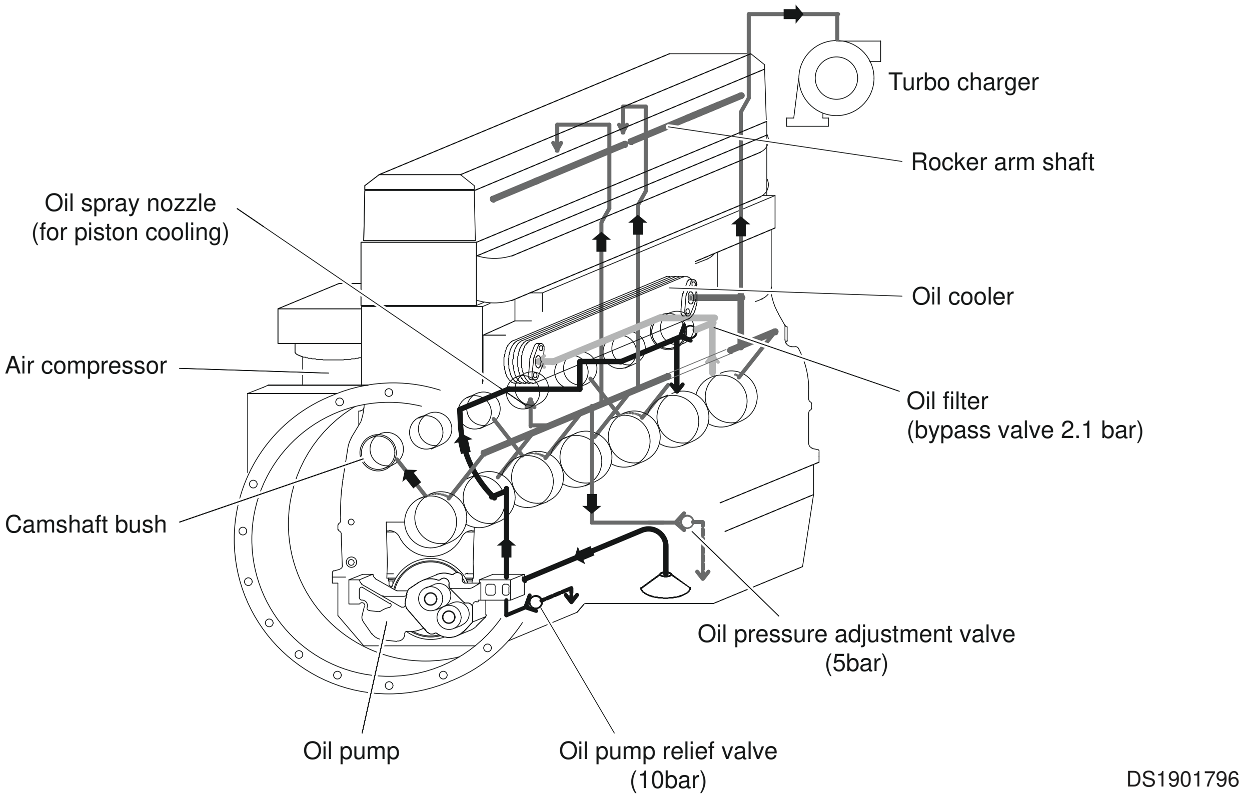
The engine lubrication circuit is also connected to the turbocharger, and oil is supplied for the operation of the engine brake.

Oil is sprayed around the cylinder block and timing gear for proper lubrication.

Each cylinder is equipped with an oil spray nozzle for cooling the inside of the piston.

Foreign matter is removed from engine oil by the oil filter.

Figure 148



Oil Pump

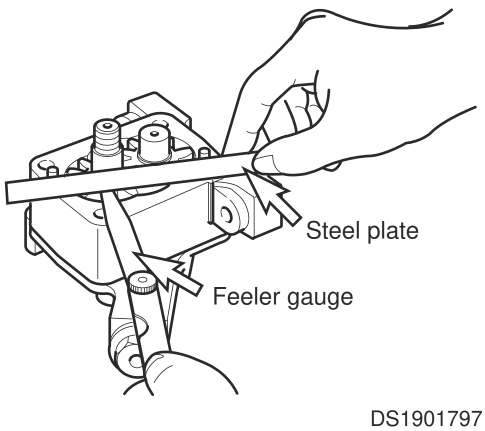
General Information

Engine oil is sucked in from the oil pan by the gear-driven oil pump and filtered through the oil cooler and oil filter. The filtered oil passes through the main oil galleries in the cylinder block and lubricates the various bearings in the engine and the turbocharger, thereby maintaining normal engine performance.

Inspecting the Oil Pump

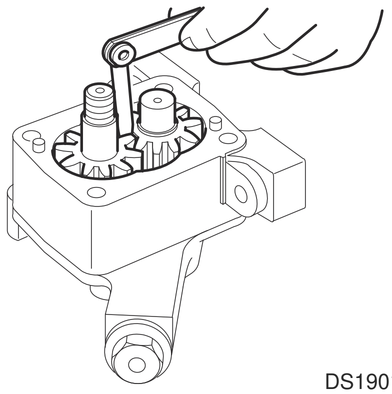
1. Use a steel rule and feeler gauge to measure the axial play of the oil pump gear. Replace it if the measured value exceeds the allowable limit.

   Figure 149



Allowable limit	0.055 ~ 0.105 mm

2. Use a feeler gauge to measure the backlash between the oil pump drive gear and driven gear. Replace it if the measured value exceeds the allowable limit.
   Figure 150



Standard	0.312 ~ 0.476 mm
Allowable limit	0.64 mm

3. Measure the clearance between the driveshaft and bushing
   A. Measure the O.D. of the driveshaft and driven shaft; if the measurement is less than the allowable limit, replace them.

Standard	Ø21.93 ~ Ø21.95 mm
Allowable limit	Ø21.90 mm

   B. Measure the I.D. of the bushing of the pump body and the O.D. of the shaft; then, compare the oil clearance with the reference value to determine whether or not to replace them.

Standard	Ø0.050 ~ Ø0.091 mm
Allowable limit	0.075 to 0.127 mm

Cooling System

General Information

General Information

This engine is water-cooled. After coolant absorbs combustion heat from the combustion chamber and heat from engine oil, it releases heat to the outside to ensure normal engine operation.

In the cooling system, coolant supplied from the coolant pump flows to the oil cooler through the coolant pipe to absorb heat from oil. Then, as it passes through the coolant jacket of the cylinder block and the cooling passage of the cylinder head, it absorbs combustion heat.

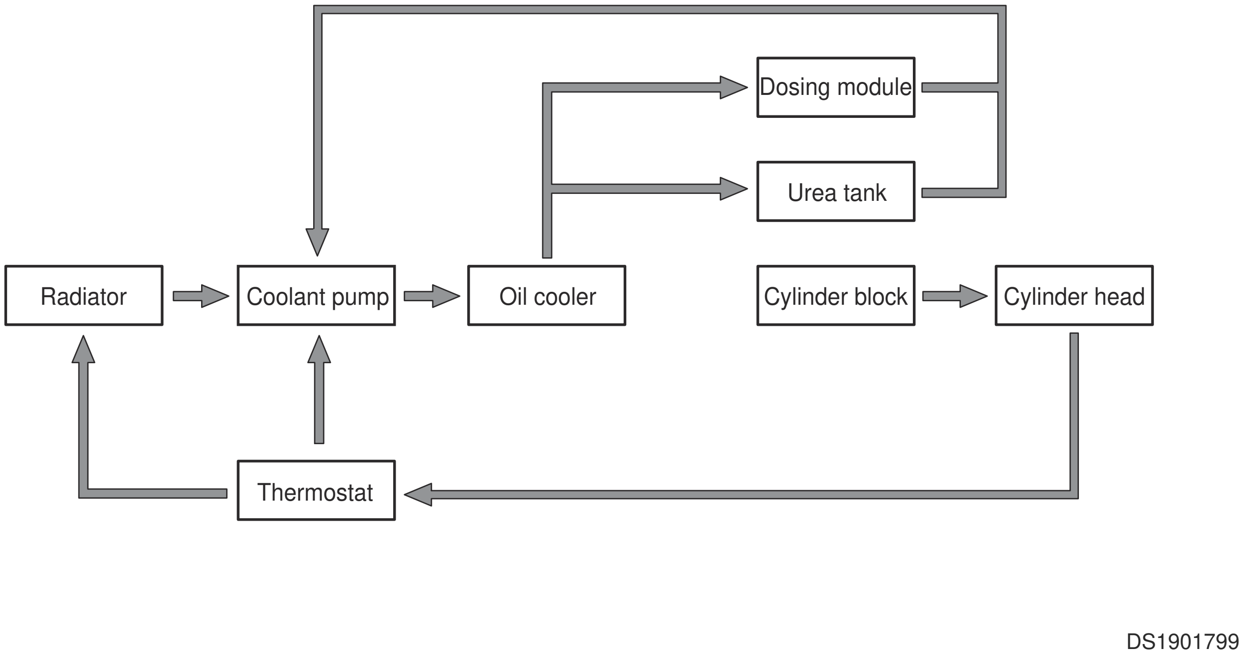
Having absorbed the heat from oil and combustion, the coolant flows into the thermostat through the coolant pipe.

If the coolant temperature is lower than the valve opening temperature of the thermostat, it is returned to the coolant pump.

Otherwise, it flows to the radiator.

In the radiator, coolant releases heat by means of the cooling process and is returned to the coolant pump.

Figure 151



Thermostat

General Information

The thermostat is used to maintain a constant coolant temperature in the engine and prevent heat loss in order to enhance the engine's thermal efficiency.

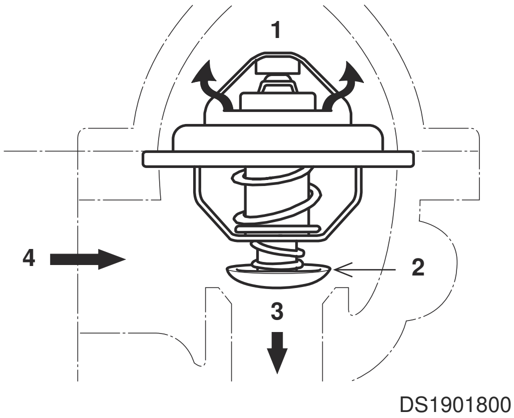
In the event that the coolant temperature is lower than normal, the thermostat closes and coolant is bypassed directly into the coolant pump. If the coolant temperature is higher than normal, the thermostat valve opens completely and the bypass circuit closes, causing coolant to flow to the radiator.

⚠ CAUTION

AVOID INJURY

- The reaction time of the wax pellet type against changes in the coolant temperature is slower than that of the bellows type. This is because the wax pellet type has higher thermal capacity. Hence, the engine must be idled sufficiently first to prevent a rapid rise in the engine coolant temperature. In cold weather, avoid overloading or over speeding immediately after starting the engine.
- When draining coolant from or adding coolant to the engine cooling system, drain or pour it slowly to allow enough air to escape from the system.
- If the thermostat is defective, replace it with a new one.

Figure 152



1	Heat exchanger
2	Bypass valve
3	Coolant pump
4	Coolant pipe

Cautions for Replacing and Handling the Thermostat

1. Cautions for handing

   The reaction time of the wax pellet type against changes in the coolant temperature is slower than that of the bellows type.

   This is because the wax pellet type has higher thermal capacity.

   Hence, the engine must be idled sufficiently first to prevent a rapid rise in the engine coolant temperature. In cold weather, avoid overloading or over speeding immediately after starting the engine.

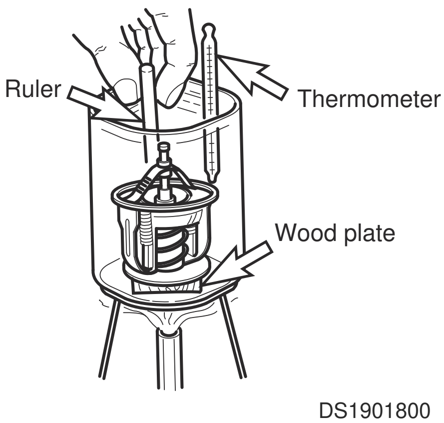
2. When draining coolant from or adding coolant to the engine cooling system, drain or pour it slowly to allow enough air to escape from the system.

3. Replace the thermostat

   If the thermostat is defective, replace it with a new one.

Inspecting the Thermostat

1. Check the wax pellet and spring for damage.
   Figure 153



2. Submerge the thermostat in water and heat the water slowly to check whether the thermostat operates properly.

   If the thermostat begins opening at a water temperature of 83°C and opens completely at a water temperature of 95°C, the thermostat is operating normally.

3. Check the inside of the thermostat for foreign matter.

   NOTE: *Use an air gun to clean out the inside of the thermostat.*

4. Check the inside and outside of the hose for damage and foreign matter.

Intake/Exhaust System

General Information

General Information

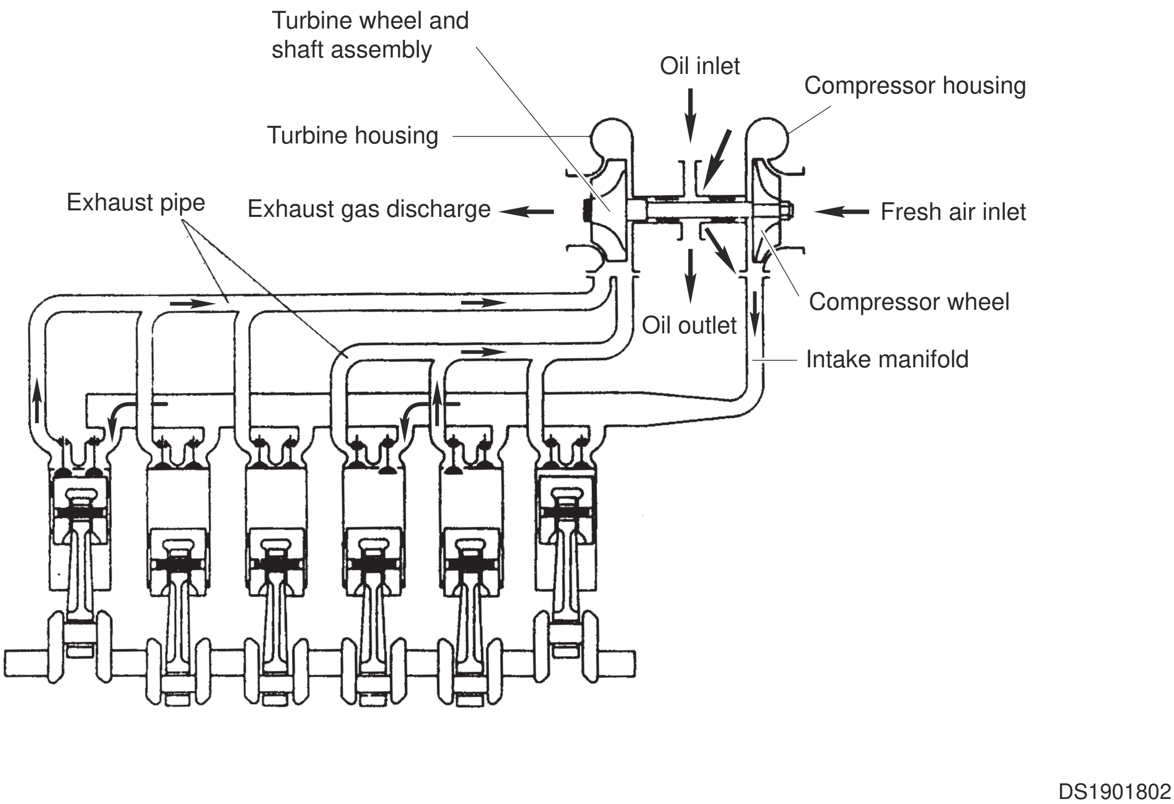
Engines are designed to satisfy stringent emissions regulations and are equipped with the full range of engine technologies for enhancing fuel economy and reducing emissions.

Turbocharger

General Information

The turbocharger is designed to use the thermal energy of exhaust gas and supply high-density air to the engine cylinders in order to increase the engine power.

Figure 154

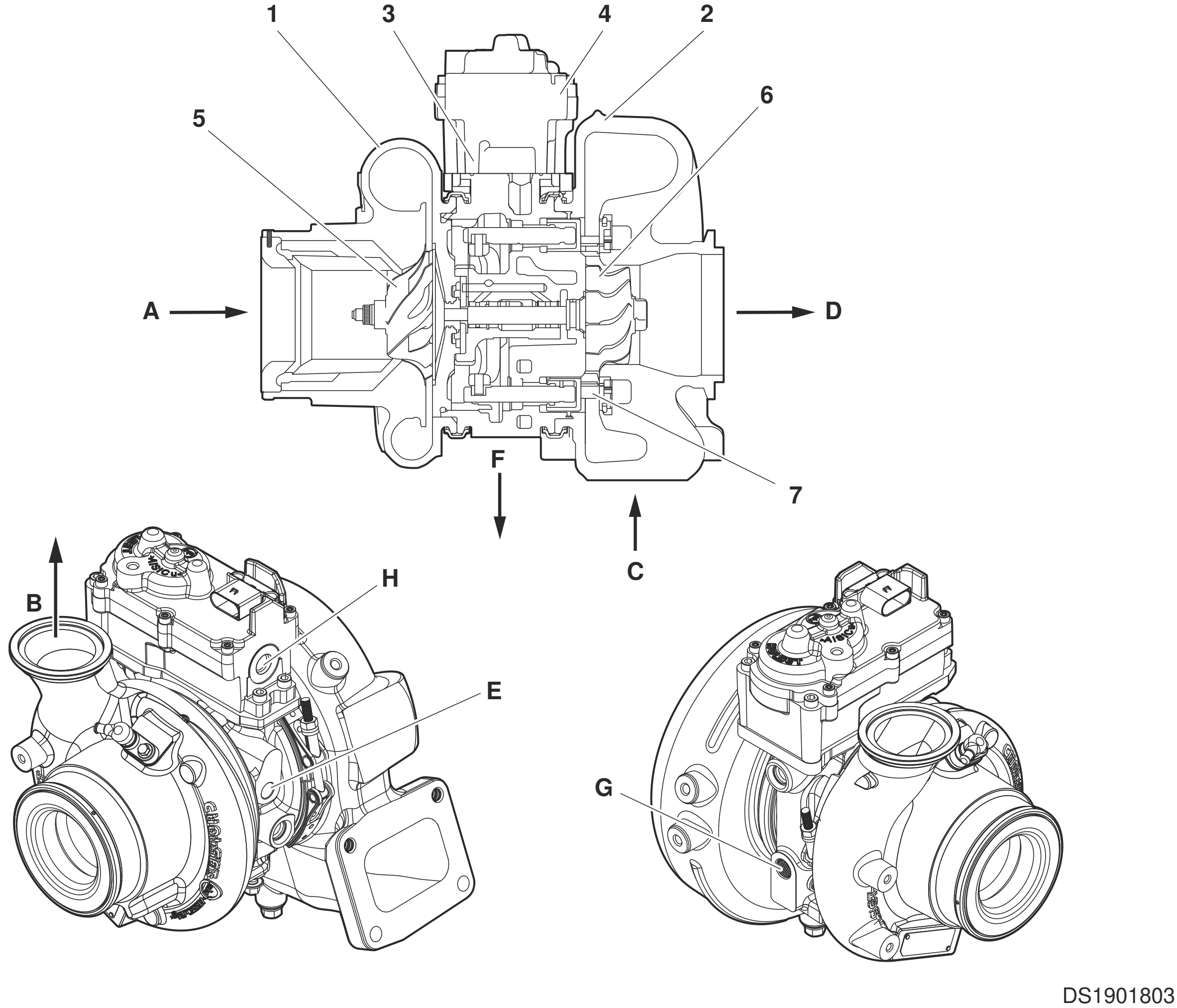


1. Engine power is determined by the amount of fuel delivered and engine efficiency.
2. In order to burn the supplied fuel completely and convert it into effective work for the engine, a sufficient amount of air should be supplied for complete fuel combustion.

3. The engine power is actually determined by the volume of cylinders. If compressed air is delivered to a given volume of cylinders, the amount of air in the cylinders increases, enabling more fuel to be burnt and increasing engine power.
4. Delivering compressed air to cylinders in this way is referred to as "supercharging," while supercharging with exhaust gas discharged from the combustion chamber is known as "Turbocharging."
5. The main functions of the turbocharger are as follows.
   A. Turbine: As exhaust gas discharged from the combustion chamber passes through the turbine housing, its energy is transferred to the turbine blades, rotating the turbine shaft. The part where this takes place is known as a turbine. The turbine is equipped with a seal ring and heat shield to prevent exhaust gas from having an adverse effect on the bearing.
   B. Compressor: Connected to the same shaft as the turbine and rotating in conjunction with it, the compressor receives rotating force from the turbine shaft to suck in, compress and supply air to the intake manifold. This is the basic operating principle of the compressor.
   C. Bearings:
      - Thrust bearing: Axial force acts upon the turbine wheel. This is to prevent the shaft from moving due to this axial force.
      - Journal bearing: The floating bearing creates a dual oil film on the inside and outside of the bearing, enabling the bearing to rotate independently. The dual oil film acts as a buffer which keeps the sliding speed of the bearing surface below the rotating speed of the shaft, ensuring stable operation.
   D. Compressor shaft seal ring: The seal plate and seal ring form a dual structure to prevent leakage of compressed intake air and lubricant.

Structure

Figure 155



Reference Number	Description
1	Compressor housing
2	Turbine housing
3	Bearing housing
4	Actuator
5	Impeller
6	Turbine
7	Nozzle
A	Air inlet
B	Air outlet
C	Gas inlet
D	Gas outlet
E	Oil supply
F	Oil drain

Reference Number	Description
G	Coolant delivery
H	Coolant drain

Handling the Turbocharger

1. Cautions for engine operation

   A. Follow the instructions below when starting, running and stopping the engine:

Item	Caution	Reason
When starting the engine	Check the oil level	
	Before starting the engine, make sure to run it with the starter motor to check for a rise in hydraulic pressure (until the needle on the hydraulic pressure gauge moves or the pressure indicator turns on).	If the engine is started abruptly, oil cannot reach the turbocharger or the various parts of the engine; this lack of lubrication can lead to abnormal wear or seizure of the bearings.
	After changing the oil, replacing the oil filter cartridge or lubrication system component or leaving the engine stopped for an extended period of time or in cold weather, undo the oil pipe connection at the inlet of the turbocharger and run the starter motor until oil flows out of it. Once this step is complete, make sure to retighten the pipe connection and start the engine.	Oil flow in pipes worsens after the engine has been stopped for a prolonged period of time or in cold weather.
Right after starting	Idle the engine for 5 minutes after starting it.	If the engine is overloaded abruptly right after it is started, the turbocharger is still not rotating freely and the lack of lubrication can lead to seizure of parts.
	Check each part for oil leaks, gas leaks and air leaks, and take any necessary measures to resolve the issues.	Oil leaks, gas leaks and air leaks (especially oil leaks) can drop hydraulic pressure and oil loss can cause bearings to seize up.
During operation	Check the following:	
	Hydraulic pressure During idling : 1.5 ~ 3.0 kg/cm^2 Under a full load : 3.0 ~ 5.5 kg/cm^2	Excessively low oil pressure can lead to abnormal wear or seizure of bearings. If it is excessively high, it can cause oil leaks.
	If abnormal noise or vibrations occur, lower the speed slowly and stop the engine to locate the cause.	Continuing to drive with abnormal noise or vibrations can severely damage the engine beyond repair.
When stopping	Before stopping the engine, idle the engine for 5 minutes first.	Stopping the engine abruptly after overloaded operation causes heat to be transferred from the hot turbine blades to the bearings. Since this heat burns the oil on the bearings, the metal bearings and rotating shaft may seize up.

2. Cautions for handing

   A. If the engine rpm is increased abruptly after starting the engine, the crankshaft rotates at an excessive speed before the crankshaft journal bearing has been lubricated sufficiently. If the turbocharger rotates in this state, bearings may seize up due to the lack of cooling and lubrication, leading to damage in related parts.

   B. After replacing the engine oil or oil filter, make sure to idle the engine for at least two minutes before driving to ensure that enough lubricant circulates throughout the turbocharger.

   C. After operating the engine at a high speed for a prolonged period of time, idle the engine sufficiently before stopping it. Otherwise, the turbine wheel continues rotating without any hydraulic pressure in the turbocharger and an oil layer is not formed on the turbocharger center bearing and journal bearing, leading to wear and shortening of the turbocharger life.

   D. In extremely cold temperatures or after a prolonged period of inactivity of the engine, idle the engine for a sufficient amount of time after starting it until the hydraulic pressure in the engine reaches a normal level.

   E. The turbocharger turbine spins at extremely high speeds of 50,000 ~ 200,000 rpm. Hence, the oil supply of bearings has a significant impact on the turbocharger life, so make sure to use genuine engine oil recommended be dealer and check and replace the engine oil periodically.

   F. Using a contaminated air cleaner for a prolonged period of time can cause critical damage to the turbocharger, so make sure to check and replace the air cleaner regularly.

   G. The turbocharger is a highly complex unit of precision machinery which should only be handled by certified technicians.

   H. Operating the turbocharger without the intake or exhaust manifold installed may severely damage the engine or cause physical injuries to workers. The turbocharger must only be operated with all of the parts installed properly in their designated positions.

   I. Do not lift the turbocharger by the actuator. It may be damaged by the weight of the turbocharger.

   J. The turbocharger is a heavy unit. When lifting the turbocharger to remove or mount it, workers should lower their center of gravity or hold the turbocharger closely. Otherwise, the turbocharger may fall, damaging the parts and causing physical injuries to workers.

Inspecting the Turbocharger

1. Daily inspection and service

   Turbocharger performance depends largely on the state of engine maintenance.

   Hence, it is important to maintain the engine as instructed.

   A. Intake system

      In the intake system, pay attention to the maintenance of the air filter. For a wet-type air filter, if the oil level is below the specified level, its filtering performance is degraded. On the other hand, if the oil level is too high, it sucks in oil, contaminating its case. In particular, if the rotor is contaminated, the finely tuned balance is lost, causing vibrations. In addition, a massive load is applied to the bearing, causing seizure and abnormal wear. Thus, use of the air filter is essential for full use of the machine. For a dry-type air filter, intake air resistance should be as low as possible.

   B. Exhaust system

In the exhaust system, if exhaust gas leaks from the exhaust manifold or turbocharger connection, the turbocharger performance is degraded. Hence, particular care should be taken to prevent gas leaks and seizure.

Since heat-resistant steel nuts are used for components that become hot during operation, such as the turbine chamber, these nuts should not be confused with other general nuts.

In addition, mounting nuts should be coated with an anti-sticking agent if specified.

C. Lubrication system

In the lubrication system, pay attention to the oil quality and oil filter cartridge replacement interval. Degraded engine oil can affect the turbocharger as well as the engine itself adversely.

2. Periodic inspection and service

The condition and contamination of the turbocharger should be checked regularly.

A. Inspecting the rotation of the rotor

To check the rotating state of the rotor, listen for any abnormal noise during rotation.

If a sound rod is used, touch the tip of the rod to the turbocharger housing and rev up the engine slowly.

If a high-pitched noise persists, there is a problem with the part.

In this case, the bearing or rotor may be operating abnormally, so the turbocharger must either be replaced or repaired.

B. Checking the free play of the rotor

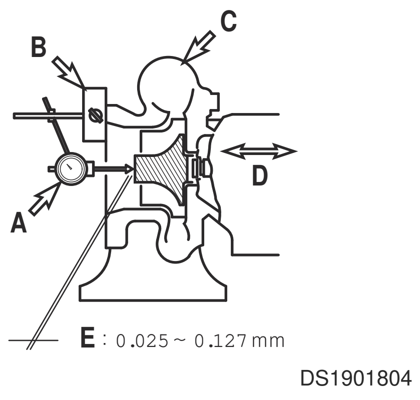
Remove the turbocharger from the engine and check both the axial and radial play of the rotor.

When removing the turbocharger, make sure to seal the oil inlet and outlet with tape, etc.

During rotation, the wheel must rotate smoothly without any interference.

- Rotor axial play

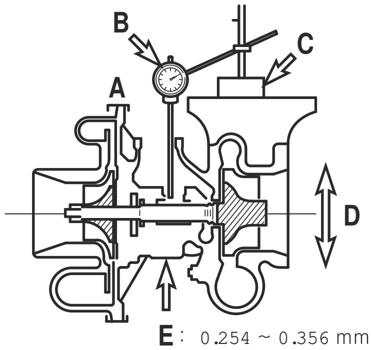
Figure 156



A	Dial gauge
B	Magnetic vice
C	Turbine chamber
D	Move the turbine shaft in the axial direction.
E	Maintenance standard (0.025 ~ 0.127 mm)

- Rotor radial play

  Figure 157



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A	Oil outlet
B	Dial gauge
C	Magnetic vice
D	Move the turbine shaft side to side in the radial direction simultaneously.
E	Maintenance standard for radial play (0.254 ~ 0.356 mm)

- If the axial or radial play exceeds the wear limit, either replace the turbocharger or remove and repair it.

C. Removing and inspecting the turbocharger

Remove the turbocharger from the engine to clean or inspect it.

When doing so, make sure to seal the oil inlet and outlet with tape, etc.

D. Cautions for turbocharger assembly

When mounting the turbocharger on the engine or handling it after assembly, follow the instructions below. Take particular care to ensure that foreign matter does not enter the turbocharger.

- Lubrication system
  - Before mounting it on the engine, add fresh oil through its oil filler port and turn the turbine shaft by hand to lubricate the journal bearing and thrust bearing.
  - Wash the pipe between the engine and oil inlet and the pipe from the oil outlet; then, check them for damage or foreign matter.
  - Tighten each oil pipe connection firmly to prevent oil leaks.
- Intake system
  - Check the intake system for foreign matter.
  - Install it securely so that there are no air leaks from the various connections in the intake system and air filter.
- Exhaust system
  - Check that there is no foreign matter in the exhaust system.

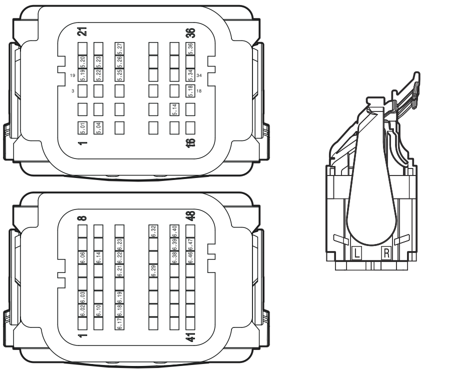
- Use heat-resistant steel bolts and nuts and keep them separate from general bolts and nuts during assembly. Apply an anti-sticking agent to bolts and nuts.
- Install it securely to prevent gas leaks from the exhaust system connections.

Engine Control System

Circuit Diagram

General Information

1. This section provides information on the engine wire harnesses and the circuit number of connectors.
   Figure 158



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2. The wire colors are as follows.
   - B: Black
   - Brn: Brown
   - Gra: Gray
   - L: Blue
   - O: Orange
   - W: White
   - Y: Yellow
   - R: Red
3. The ECU pin no. refers to the number of each pin in the engine connectors.
4. The sensor pin no. refers to the number of each pin in the sensor connectors.

Engine Connectors

Figure 159

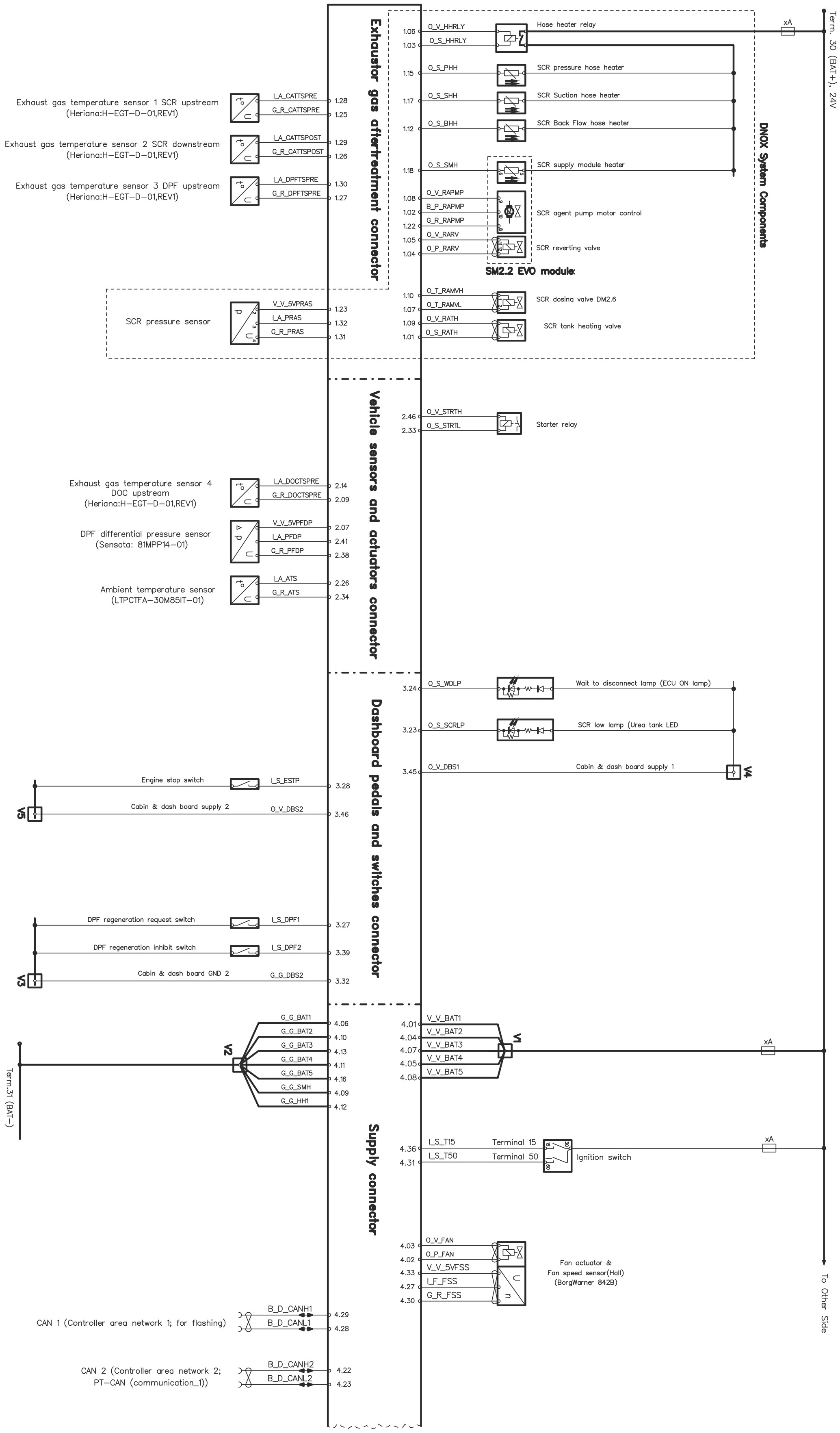

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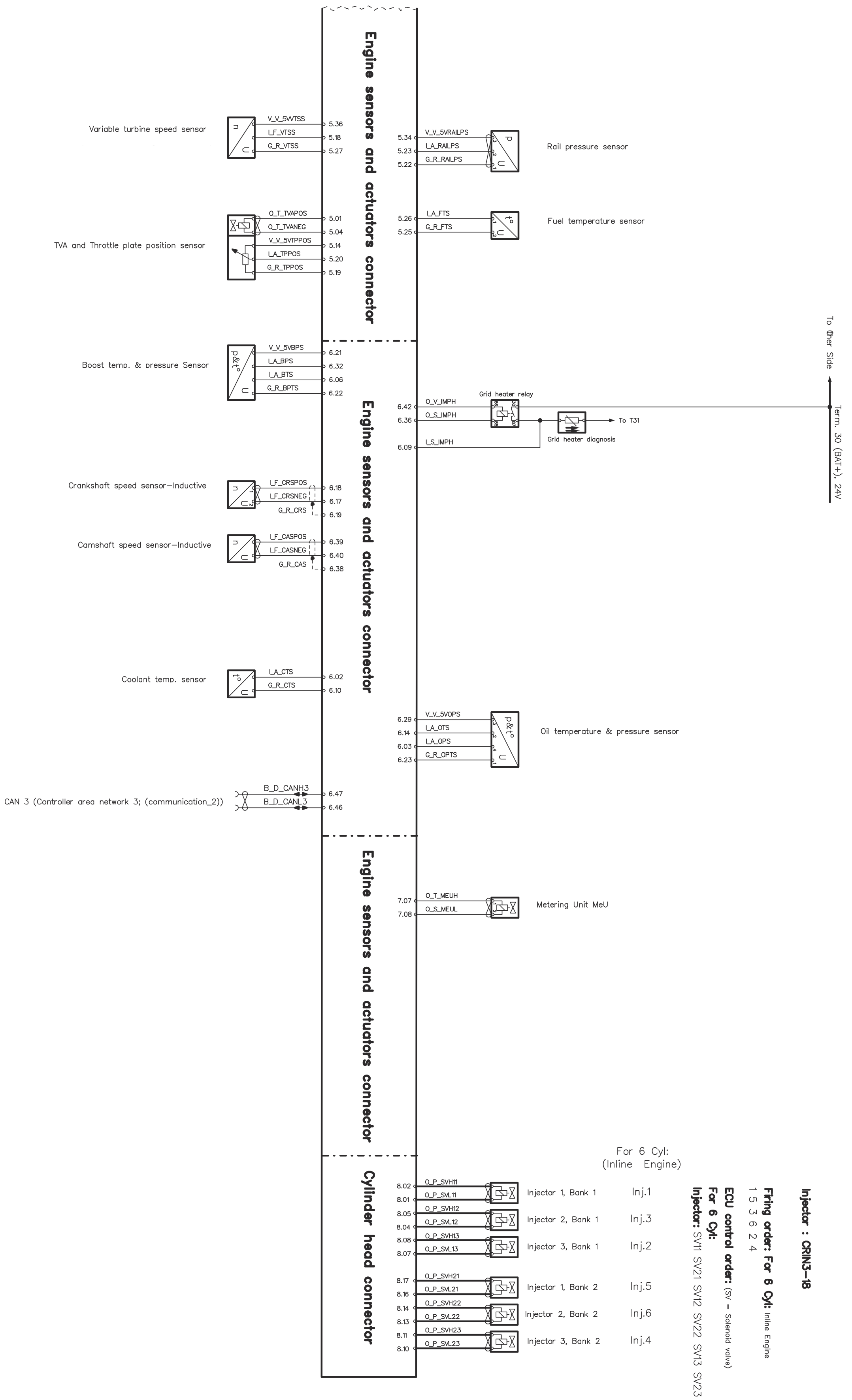
Figure 160



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Engine Control Unit (ECU) Engine Connectors

No.	Wire Label	Size (mm^2)	Color	Circuit Description	From	No.	To	No.	Remark
1	8.16	1.50	B	Injector 1, Bank 2 Low	ECU 8	16	Injector Connector (INJ)	10	Twisted Pair (8.16/8.17)
2	8.13	1.50	B	Injector 2, Bank 2 Low	ECU 8	13	Injector Connector (INJ)	12	Twisted Pair (8.13/8.14)
3	8.10	1.50	B	Injector 3, Bank 2 Low	ECU 8	10	Injector Connector (INJ)	8	Twisted Pair (8.10/8.11)
4	5.01	1.0	R	Throttle Plate Actuator POS	ECU 5	1	Throttle Plate Actuator/ Position Sensor (TVA)	6	Twisted Pair (5.01/5.04)
5	6.23	0.75	B	Oil Press/ Temp Sensor GND	ECU 6	23	Oil Press Temp Sensor (OPTS)	4	
6	6.21	0.75	O	Boost Press/ Temp Sensor PWR	ECU 6	21	Boost Press Temp Sensor (BPTS)	2	
7	5.34	0.75	O	Rail Press Sensor PWR	ECU 5	34	Rail Press Sensor (RPS)	3	Shielded 5.34/5.23
8	5.26	0.75	R	Fuel Temp Sensor Signal	ECU 5	26	Fuel Temp Sensor (FTS)	1	
9	6.14	0.75	Brn	Oil Temp Sensor Signal	ECU 6	14	Oil Press Temp Sensor (OPTS)	3	
10	5.20	0.75	B	Throttle Plate Actuator/ Position Sensor SIG	ECU 5	20	Throttle Plate Actuator/ Position Sensor (TVA)	5	
11	6.47	0.75	R	DEF Can High	ECU 6	47	Inter Conn 3 (INT3)	9	Twisted Pair (6.47/6.46)
12	6.47B	0.75	R	VGT Can High	6.47	SP 6.47	VGT	3	Splice 6.47/ Twisted Pair (6.47B/ 6.46B)
13	6.46	0.75	Brn	DEF Can Low	ECU 6	46	Inter Conn 3 (INT3)	10	Twisted Pair (6.47/6.46)
14	6.46B	0.75	Brn	VGT Can Low	6.46	SP 6.46	VGT	2	Splice 6.46/ Twisted Pair (6.47B/ 6.46B)
15	8.17	1.50	L	Injector 1, Bank 2 High	ECU 8	17	Injector Connector (INJ)	9	Twisted Pair (8.16/8.17)

No.	Wire Label	Size (mm^2)	Color	Circuit Description	From	No.	To	No.	Remark
16	8.14	1.50	L	Injector 2, Bank 2 High	ECU 8	14	Injector Connector (INJ)	11	Twisted Pair (8.13/8. 14)
17	8.11	1.50	L	Injector 3, Bank 2 High	ECU 8	11	Injector Connector (INJ)	7	Twisted Pair (8.10/8.11)
18	5.04	1.0	Y	Throttle Plate Actuator NEG	ECU 5	4	Throttle Plate Actuator/ Position Sensor (TVA)	2	Twisted Pair (5.01/5.04)
19	6.29	0.75	R	Oil Press/Temp Sensor Power	ECU 6	29	Oil Press Temp Sensor (OPTS)	2	
20	5.14	0.75	W	Throttle Plate Position Sensor PWR	ECU 5	14	Throttle Plate Actuator/ Position Sensor (TVA)	1	
21	6.03	0.75	Y	Oil Press Sensor Signal	ECU 6	3	Oil Press Temp Sensor (OPTS)	1	
22	5.23	0.75	W	Rail Press Sensor Signal	ECU 5	23	Rail Press Sensor (RPS)	2	Shielded 5.34/5.23
23	6.06	0.75	Y	Boost Temp Sensor Signal	ECU 6	6	Boost Press Temp Sensor (BPTS)	3	
24	6.02	0.75	W	Coolant Temp Sensor Signal	ECU 6	2	Coolant Temp Sensor Signal (CTS)	2	
25	5.19	0.75	Brn	Throttle Plate Position Sensor GND	ECU 5	19	Throttle Plate Actuator/Position Sensor (TVA)	3	
26	8.02	1.50	L	Injector 1, Bank 1 High	ECU 8	2	Injector Connector (INJ)	1	Twisted Pair (8.02/8.01)
27	8.05	1.50	L	Injector 2, Bank 1 High	ECU 8	5	Injector Connector (INJ)	5	Twisted Pair (8.05/8.04)
28	8.08	1.50	L	Injector 3, Bank 1 High	ECU 8	8	Injector Connector (INJ)	3	Twisted Pair (8.08/8.07)
29	7.07	0.75	R	Fuel Metering Unit +	ECU 7	7	Fuel Metering Unit (FMU)	1	Twisted Pair (7.07/7.08)
30	5.25	0.75	B	Fuel Temp Sensor GND	ECU 5	25	Fuel Temp Sensor (FTS)	2	
31	6.10	0.75	B	Coolant Temp Sensor GND	ECU 6	10	Coolant Temp Sensor (CTS)	1	
32	5.22	0.75	B	Rail Press Sensor GND	ECU 5	22	Rail Press Sensor (RPS)	1	Shield Drain (5.34/5.23)

No.	Wire Label	Size (mm^2)	Color	Circuit Description	From	No.	To	No.	Remark
33	6.17	0.75	O	Crank Shaft Speed Sensor NEG	ECU 6	17	Crank Shaft Speed Sensor (CRS)	2	Shielded (6.17/6.18)
34	6.18	0.75	W	Crank Shaft Speed Sensor POS	ECU 6	18	Crank Shaft Speed Sensor (CRS)	1	Shielded (6.17/6.18)
35	6.19	0.75	B	Crank Shaft Speed Sensor Shield	ECU 6	19	CRS Shielding Wire		Shield Drain (6.17/6.18)
36	6.40	0.75	B	Cam Shaft Speed Sensor NEG	ECU 6	40	Cam Shaft Speed Sensor (CAS)	2	Shielded (6.40/6.39)
37	6.39	0.75	W	Cam Shaft Speed Sensor POS	ECU 6	39	Cam Shaft Speed Sensor (CAS)	1	Shielded (6.40/6.39)
38	6.38	0.75	B	Cam Shaft Sensor Shield	ECU 6	38	Cam Shaft Speed Sensor (CAS)	3	Shield Drain (6.40/6.39)
39	8.01	1.50	B	Injector 1, Bank 1 Low	ECU 8	1	Injector Connector (INJ)	2	Twisted Pair (8.02/8.01)
40	8.04	1.50	B	Injector 2, Bank 1 Low	ECU 8	4	Injector Connector (INJ)	6	Twisted Pair (8,05/8.04)
41	8.07	1.50	B	Injector 3, Bank 1 Low	ECU 8	7	Injector Connector (INJ)	4	Twisted Pair (8.08/8.07)
42	7.08	0.75	Brn	Fuel Metering Unit -	ECU 7	8	Fuel Metering Unit (FMU)	2	Twisted Pair (7.07/7.08)
43	6.32	0.75	W	Boost Press Sensor Signal	ECU 6	32	Boost Press Temp Sensor (BPTS)	1	
44	6.22	0.75	B	Boost Press/Temp Sensor GND	ECU 6	22	Boost Press Temp Sensor (BPTS)	4	
45	5.36	0.75	W	VGT Speed Sensor POS	ECU 5	36	VGT Speed Sensor (VSS)	1	
46	5.27	0.75	Y	VGT Speed Sensor NEG	ECU 5	27	VGT Speed Sensor (VSS)	2	
47	5.18	0.75	Brn	VGT Speed Sensor SIG	ECU 5	18	VGT Speed Sensor (VSS)	3	
48	13B	2.0	W	Start S	Inter Conn1 (INT1)	7	Start S (STS)	1	
49	99I	8.00	B	Alternator E	ALT E(GND)	1	Engine Earth (EGND)	1	
50	4A	8.00	W	Alternator B	ALT B (BAT)	1	KL4A	SPKL4A	Splice KL4A
51	4J	5.00	W	Alternator B	KL4A	SPKL4A	Inter CONN4 (INT4)	1	Splice KL4A

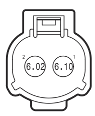
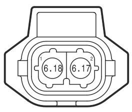
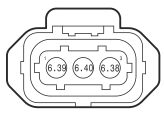
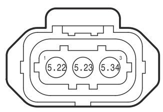
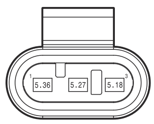
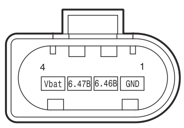
No.	Wire Label	Size (mm^2)	Color	Circuit Description	From	No.	To	No.	Remark
52	4M	5.00	W	Alternator B	KL4A	SPKL4A	Inter CONN4 (INT4)	2	Splice KL4A
53	14A	1.25	W	Alternator R	Inter Conn1 (INT1)	1	ALT R (R)	1	
54	9A	2.00	W	Alternator I	Inter Conn1 (INT1)	2	ALT I (I(L))	1	
55	29C	0.75	Y	Compressor +	Inter Conn1 (INT1)	3	Compressor (COMP)	+	
56	99H	0.75	B	Compressor -	99I	SP99I	Compressor (COMP)	-	Splice 99I
57	99G	0.75	B	Diode 4A	99I	SP99I	Diode 4 (DIO4)	A	Splice 99I
58	29B	0.75	Y	Diode 4K	29C	SP29C	Diode 4 (DIO4)	K	Splice 29C
59	1.10	1.50	L	Dosing Valve High Side	Inter Conn for SCR 2 (ICS2)	4	Inter CONN 3 (INT3)	4	Twisted Pair (1.10/1.07)
60	1.07	1.50	B	Dosing Valve Low Side	Inter Conn for SCR 2 (ICS2)	3	Inter CONN 3 (INT3)	3	Twisted Pair (1.10/1.07)
61	2.14	0.75	Y	DOC Upstream Signal	Inter Conn for SCR 2 (ICS2)	2	Inter CONN 3 (INT3)	2	
62	2.09	0.75	Brn	DOC Upstream Ground	Inter Conn for SCR 2 (ICS2)	1	Inter CONN 3 (INT3)	1	
63	1.28	0.75	W	SCR Upstream Signal	Inter Conn for SCR 2 (ICS2)	8	Inter CONN 3 (INT3)	8	
64	1.25	0.75	B	SCR Upstream Ground	Inter Conn for SCR 2 (ICS2)	7	Inter CONN 3 (INT3)	7	
65	1.29	0.75	R	SCR Downstream Signal	Inter Conn for SCR 2 (ICS2)	6	Inter CONN 3 (INT3)	6	
66	1.26	0.75	B	SCR Downstream Ground	Inter Conn for SCR 2 (ICS2)	5	Inter CONN 3 (INT3)	5	

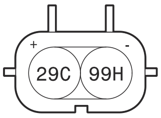
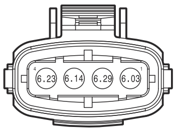
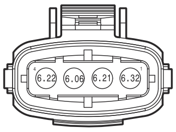
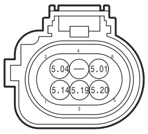
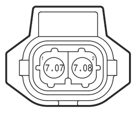
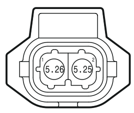
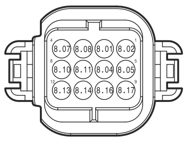
No.	Wire Label	Size (mm^2)	Color	Circuit Description	From	No.	To	No.	Remark
67	12A	1.50	O	Master NOX Sensor Ubatt	Inter Conn for SCR 2 (ICS2)	12	Inter CONN 3 (INT3)	12	
68	11A	1.50	Gra	Master NOX Sensor GND	Inter Conn for SCR 2 (ICS2)	11	Inter CONN 3 (INT3)	11	
69	6.46C	0.75	Brn	Master NOX Sensor CAN Low	Inter Conn for SCR 2 (ICS2)	10	6.46B	SP6.46B	Twisted Pair (6.47C/ 6.46C), Splice 6.46B
70	6.47C	0.75	R	Master NOX Sensor CAN High	Inter Conn for SCR 2 (ICS2)	9	6.47B	SP6.47B	Twisted Pair (6.47C/ 6.46C), Splice 6.47B
71	1.30	0.75	O	DPF Upstream Temp Signal	Inter Conn for SCR 1 (ICS1)	1	Inter Conn2 (INT2)	1	
72	1.27	0.75	B	DPF Upstream Temp Ground	Inter Conn for SCR1 (ICS1)	2	Inter Conn2 (INT2)	2	
73	2.07	0.75	R	DPF DP Sensor 5V Sensor Supply 1B	Inter Conn for SCR1 (ICS1)	3	Inter Conn2 (INT2)	3	
74	2.41	0.75	Brn	DPF DP Sensor Flex I/O 18	Inter Conn for SCR1 (ICS1)	4	Inter Conn2 (INT2)	4	
75	2.38	0.75	B	DPF DP Sensor GND	Inter Conn for SCR1 (ICS1)	5	Inter Conn2 (INT2)	5	
76	119D	0.75	Brn	FAN Drive Control P/V 1	Inter Conn (INT1)	5	FAN Drive Control P/Valve (FAN)	1	
77	120D	0.75	B	FAN Drive Control P/V 2	Inter Conn (INT1)	10	FAN Drive Control P/Valve (FAN)	2	

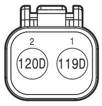
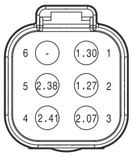
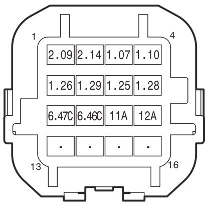
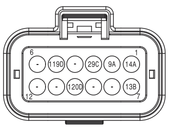
No.	Wire Label	Size (mm^2)	Color	Circuit Description	From	No.	To	No.	Remark
78	Vbat	0.75	R	24V (Vbat)	Inter Conn for Vehicle (ICV) 1	1	VGT Connector (VGT)	4	
79	GND	0.75	B	GROUND	Inter Conn for Vehicle (ICV) 2	2	VGT Connector (VGT)	1	

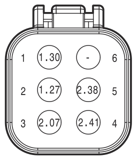
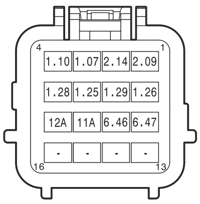
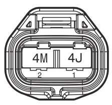
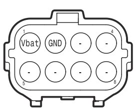
Switches and Sensors

Electronic Control Unit

Shape	Symbol	Pin No. Harness Side	Pin No. ECU Side	Circuit Name
Coolant Temp Sensor 	CTS	1	6.10	Coolant temperature sensor signal
		2	6.02	Coolant temperature sensor ground
Crank Shaft Speed Sensor 	CRS	1	6.18	Crankshaft position sensor positive
		2	6.17	Crankshaft position sensor negative
Cam Shaft Speed Sensor 	CAS	1	6.39	Camshaft position sensor positive
		2	6.40	Camshaft position sensor negative
		3	6.38	Camshaft position sensor shield ground
Rail Pressure Sensor 	RPS	1	5.22	Rail pressure sensor ground
		2	5.23	Rail pressure sensor signal
		3	5.34	Rail pressure sensor power
VGT Speed Sensor 	VSS	1	5.36	VGT speed sensor positive
		2	5.27	VGT speed sensor negative
		3	5.18	VGT speed sensor signal
VGT Connector 	VGT	1	-	Vbat (battery 24V)
		2	6.46	CAN LOW
		3	6.47	CAN HIGH
		4	-	GND (battery ground)

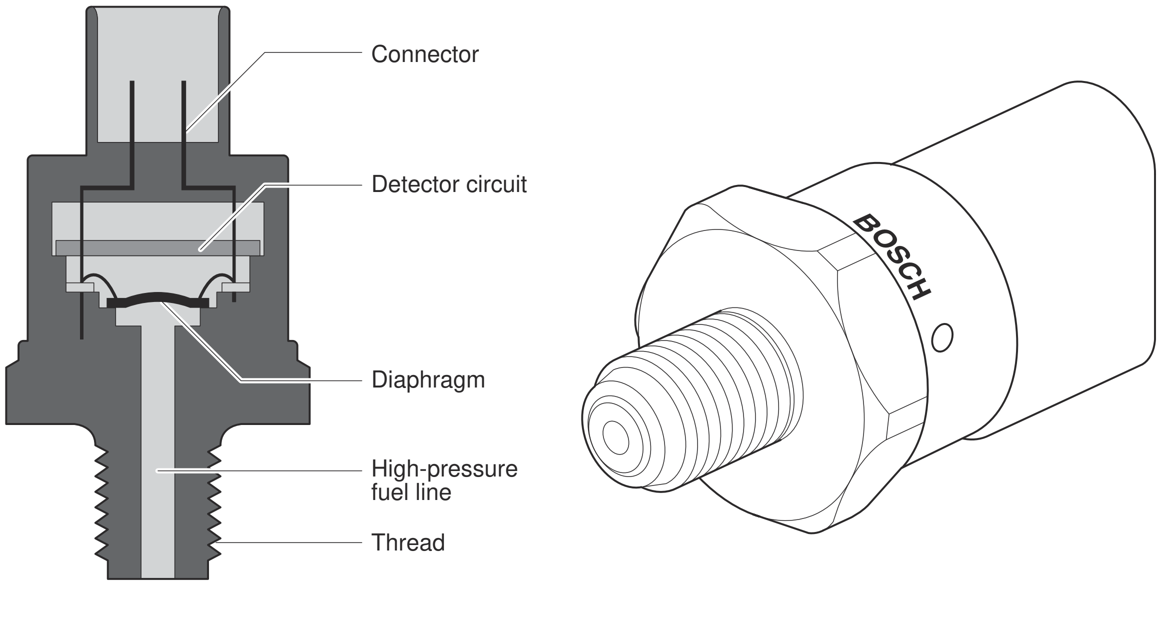
Compressor 	COMP	1	-	29C (Inter connector 1 → Vehicle side)
		2	-	99H (Engine ground)
Oil pressure temperature sensor 	OPTS	1	6.03	Oil pressure sensor signal
		2	6.29	Oil pressure temperature sensor power
		3	6.14	Oil temperature sensor signal
		4	6.23	Oil pressure temperature sensor ground
Boost Pressure Temperature Sensor 	BPTS	1	6.32	Boost pressure sensor signal
		2	6.21	Boost pressure temperature sensor power
		3	6.06	Boost temperature sensor signal
		4	6.22	Boost pressure temperature sensor ground
Throttle Plate Actuator Position Sensor 	TVA	1	5.14	Throttle plate position sensor power
		2	5.04	Throttle plate actuator negative
		3	5.19	Throttle plate position sensor ground
		4	-	
		5	5.20	Throttle plate position sensor signal
		6	5.01	Throttle plate actuator positive
Fuel Metering Unit 	FMU	1	7.07	Fuel metering unit +
		2	7.08	Fuel metering unit -
Fuel temperature sensor 	FTS	1	5.26	Fuel temperature sensor signal
		2	5.25	Fuel temperature sensor ground
Injector Connector 	INJ	1	8.02	Injector 1, bank 1 high
		2	8.01	Injector 1, bank 1 low
		3	8.08	Injector 3, bank 1 high
		4	8.07	Injector 3, bank 1 low
		5	8.05	Injector 2, bank 1 high
		6	8.04	Injector 2, bank 1 low
		7	8.11	Injector 3, bank 2 high
		8	8.10	Injector 3, bank 2 low
		9	8.17	Injector 1, bank 2 high

		10	8.16	Injector 1, bank 2 low
		11	8.14	Injector 2, bank 2 high
		12	8.13	Injector 2, bank 2 low
Fan Drive Control P/Valve 	FAN	1	-	119D (Fan drive control p/valve 1)
		2	-	120D (Fan drive control p/valve 2)
Inter Connector for SCR1 	ICS1	1	1.30	DPF upstream temperature signal
		2	1.27	DPF upstream temperature ground
		3	2.07	DPF DP sensor 5V sensor supply 1
		4	2.41	DPF DP sensor flex I/O 18
		5	2.38	DPF DP sensor ground
		6	-	
Inter Connector for SCR2 	ICS2	1	2.09	DOC upstream ground
		2	2.14	DOC upstream signal
		3	1.07	Dosing Valve Low Side
		4	1.10	Dosing Valve High Side
		5	1.26	SCR downstream ground
		6	1.29	SCR downstream signal
		7	1.25	SCR upstream ground
		8	1.28	SCR upstream signal
		9	6.47	CAN HIGH
		10	6.46	CAN LOW
		11	-	11A (Master NOX sensor ground)
		12	-	12A (Master NOX sensor Vbatt)
		13	-	
		14	-	
		15	-	
		16	-	
Inter Connector1 	INT1	1	-	14A (Alternator R)
		2	-	9A (Alternator I)
		3	-	29C (Compressor +)
		4	-	-
		5	-	119D (Fan drive control p/valve 1)
		6	-	-
		7	-	13B (Starter signal)
		8	-	-
		9	-	-

		10	-	120D (Fan drive control p/valve 2)
		11	-	-
		12	-	-
Inter Connector 2 	INT2	1	1.30	DPF upstream temperature signal
		2	1.27	DPF upstream temperature ground
		3	2.07	DPF DP sensor 5V sensor supply 1
		4	2.41	DPF DP sensor flex I/O 18
		5	2.38	DPF DP sensor ground
		6	-	
Inter Connector 3 	INT3	1	2.09	DOC upstream ground
		2	2.14	DOC upstream signal
		3	1.07	Dosing Valve Low Side
		4	1.10	Dosing Valve High Side
		5	1.26	SCR downstream ground
		6	1.29	SCR downstream signal
		7	1.25	SCR upstream ground
		8	1.28	SCR upstream signal
		9	6.47	CAN HIGH
		10	6.46	CAN LOW
		11	-	11A (Master NOX sensor ground)
		12	-	12A (Master NOX sensor Vbatt)
		13	-	
		14	-	
		15	-	
		16	-	
Inter connector4 	INT4	1	-	4J (Alternator B)
		2	-	4M (Alternator B)
Inter Connector for Vehicle 	ICV	1	-	Vbat (24V Battery)
		2	-	GND (battery ground)
		3	-	
		4	-	
		5	-	
		6	-	
		7	-	
		8	-	

Boost Pressure and Temperature Sensor

1. The boost pressure and temperature sensor is connected to the exhaust manifold with an O-ring and measures the absolute pressure and temperature in the exhaust manifold.
2. The output signal is transmitted to the ECU which calculates the boost pressure
   Figure 161



   based on the programmed characteristics curve.

Engine Oil Pressure and Temperature Sensor

The engine oil pressure and temperature sensor detects the pressure and temperature and relays the data to the electronic control unit (ECU).

Coolant Temperature Sensor

The engine coolant temperature sensor detects the engine coolant temperature and relays the data to the electronic control unit (ECU).

Common Rail Pressure Sensor

Fuel flows into the common rail pressure sensor via a passage running from the common rail.

The tip of the sensor is sealed with a diaphragm, and pressurized fuel

reaches the sensor diaphragm through a hole.

Connected to this diaphragm, the sensor converts fuel pressure into an electrical signal; then, the signal generated by the sensor amplifies the measurement signal and transmits it to the ECU where it enters the evaluation circuit.

Crankshaft Position Sensor

The position of pistons in the combustion chambers plays a very important role in fuel injection.

In every engine, pistons are connected to the crankshaft with connecting rods.

The crankshaft position sensor installed in the flywheel housing provides information on the position of every piston.

The rotation speed is defined as the number of crankshaft rotations per minute.

The main input variables are calculated in the ECU using the signals received from the crankshaft position sensor.

Camshaft Position Sensor

The camshaft position sensor controls the engine intake and exhaust valves.

Rotating at half the speed of the crankshaft, this sensor determines whether the camshaft is on the compression stroke or exhaust stroke as the pistons move towards the TDC.

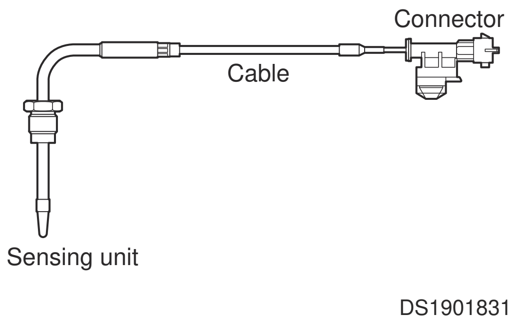
This data cannot be detected by the crankshaft position sensor.

However, as long as the engine is operating normally, the data generated by the crankshaft position sensor is sufficient for determining the state of the engine.

This means that the ECU receives information on the state of the engine from the crankshaft position sensor if the camshaft position sensor malfunctions while the vehicle is in operation.

Exhaust Gas Temperature Sensor

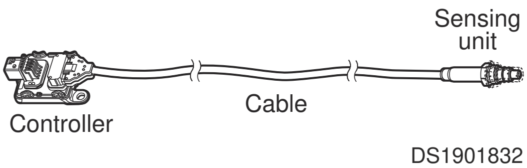
1. This sensor measures the exhaust gas temperature in each part of the after treatment system and relays the data to the electronic control unit (ECU).
   Figure 162



2. The sensor measures upstream of the exhaust reduction system (DPF) and upstream/downstream of the selective catalytic reduction (SCR) system.

NOx Sensor

1. This sensor measures the amount of NOx using the amount of oxygen in the exhaust gas and relays the data to the electronic control unit (ECU).
   Figure 163



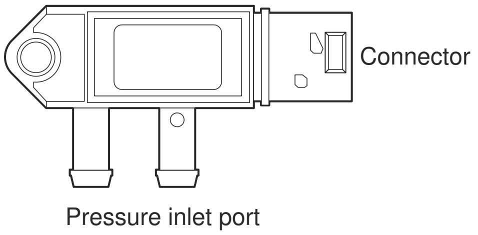
2. The sensor measures upstream of the diesel oxidation catalyst (DOC) and downstream of the selective catalytic reduction (SCR) system.

DEF Quality Sensor

1. This sensor measures the DEF concentration, temperature, and DEF level in the tank and relays the data to the electronic control unit (ECU).
2. Installed on the top of the DEF tank, the sensor is connected to the coolant line to thaw the DEF in cold weather.

DPF Delta P Sensor, DPF Pressure Sensor

1. This sensor measures the upstream/downstream pressure of the exhaust gas reduction system (DPF) and relays the calculated differential pressure to the electronic control unit (ECU).
   Figure 164



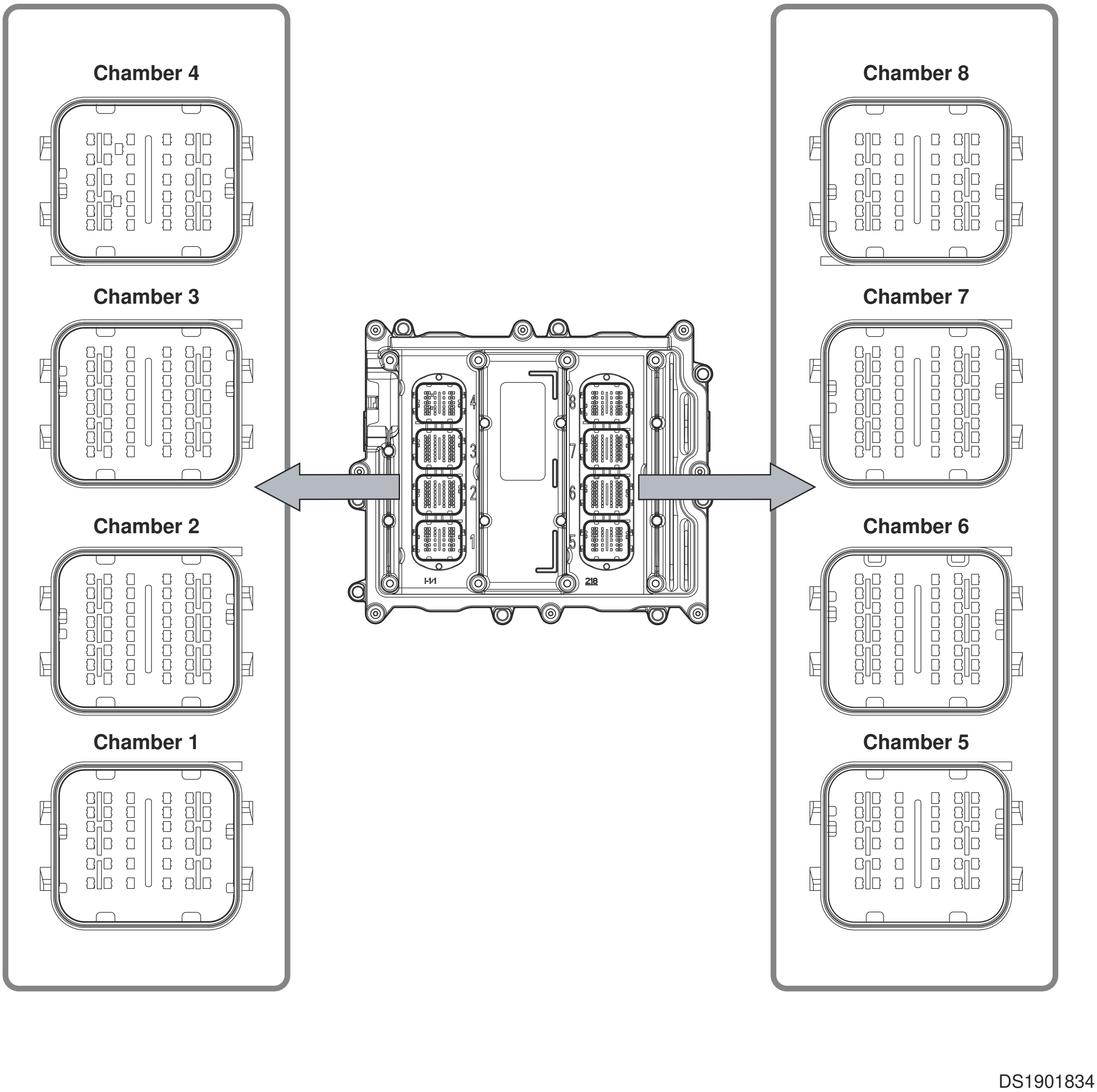
DS1901833

Engine Control Unit (ECU)

Engine Control Unit (ECU) Connectors

Engine control unit (ECU) connectors consist of connectors for connecting to the vehicle and connectors for connecting to the engine.

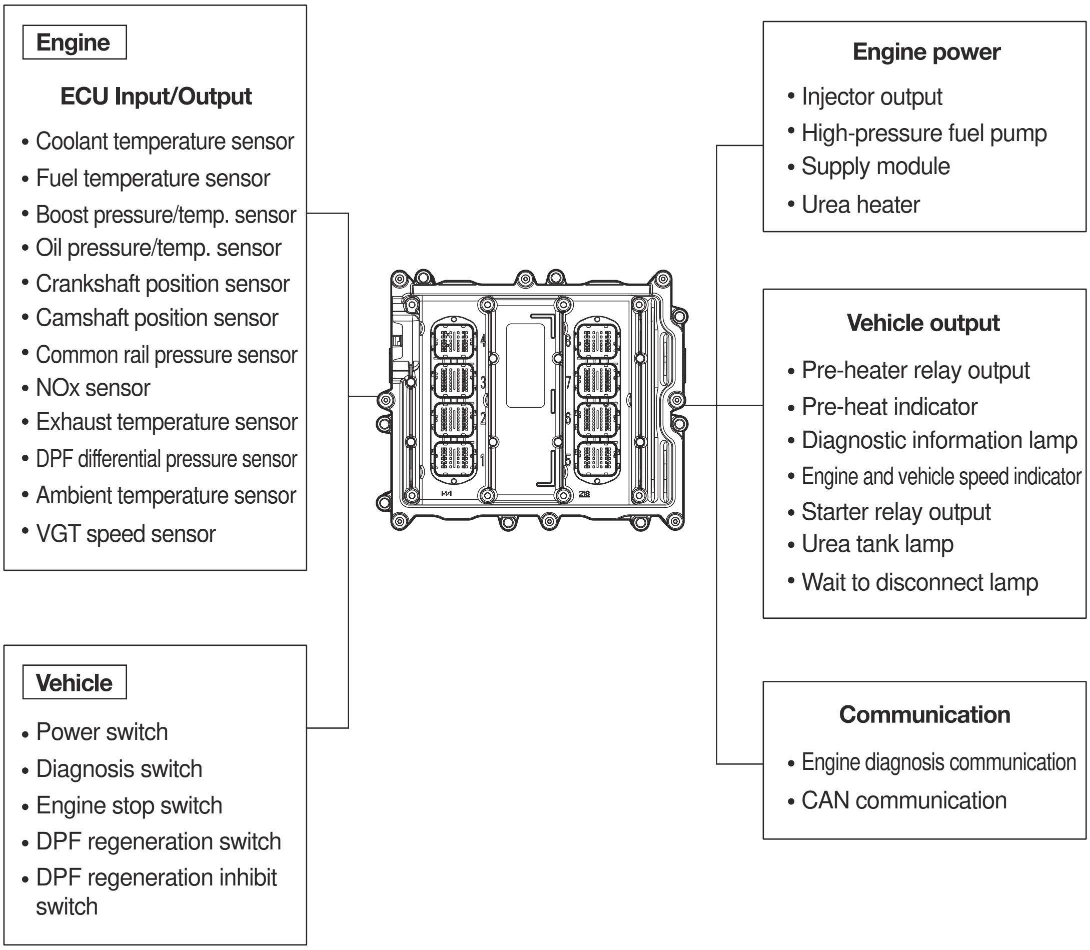
Figure 165



Chamber 4
Chamber 3
Chamber 2
Chamber 1
Chamber 8
Chamber 7
Chamber 6
Chamber 5
4
3
2
1
8
7
6
5
DS1901834

Engine Control Unit (ECU) Input/Output

Figure 166



DS1901835

Engine Control Unit (ECU) Operating Conditions

1. Starting the engine
   A. To set the reference temperature for determining whether or not to perform preheating, the ECU sets the lowest temperature among the coolant temperature, fuel temperature, intake air temperature, and oil temperature as the reference temperature.
   B. To set the reference temperature for determining the amount of fuel, the ECU sets the engine coolant temperature as the reference temperature.
   C. After determining a suitable amount of fuel for starting the engine, the ECU supplies the fuel to the engine and uses the crankshaft position sensor to measure the engine rpm signal.
2. Driving the vehicle
   A. The ECU calculates essential data required for driving the vehicle, such as CAN data received from the vehicle control unit and the engine rpm.
3. Adjusting the engine rpm to the needs of the driver
   A. The ECU controls the engine rpm according to the needs of the driver and controls the engine according to the engine rpm required by the vehicle control unit.

4. Limp Home function
   A. This function enables the vehicle to be driven to a service center under the minimum but safest conditions required for vehicle operation in the event that an error code occurs.
   B. The Limp Home function activates under the following conditions.
      - Accelerator pedal malfunction: The engine rpm remains constant even when the accelerator pedal is pressed.
      - Sensor malfunction: Certain alternate values are used in the event of a malfunction in any of the sensors.
      - Limited output: The amount of fuel delivered to the engine is limited depending on the type of fault. There are a total of four levels depending on the severity of the fault. The more severe the fault, the more the amount of fuel is limited.
      - Diagnostic information lamp: Data regarding faults which have occurred is provided to the driver to ensure safe operation of the vehicle.
5. Failure diagnosis
   A. The fault diagnosis information lamp on the gauge panel activates in the event of a fault.
   B. The fault diagnosis information lamp can be used to check the fault code.

      NOTE: *It can also be checked using the fault diagnosis information on the gauge pale.*
   C. The type of fault can be diagnosed by connecting a diagnostic tool to the check connector on the back of the driver's seat.
6. Driving record
   A. Driving-related information is recorded in the engine control unit.
   B. Information such as the fuel consumption rate, engine operating time, and engine control unit operating time is recorded in the engine control unit.
   C. Information can be monitored using the ECU diagnostic system.

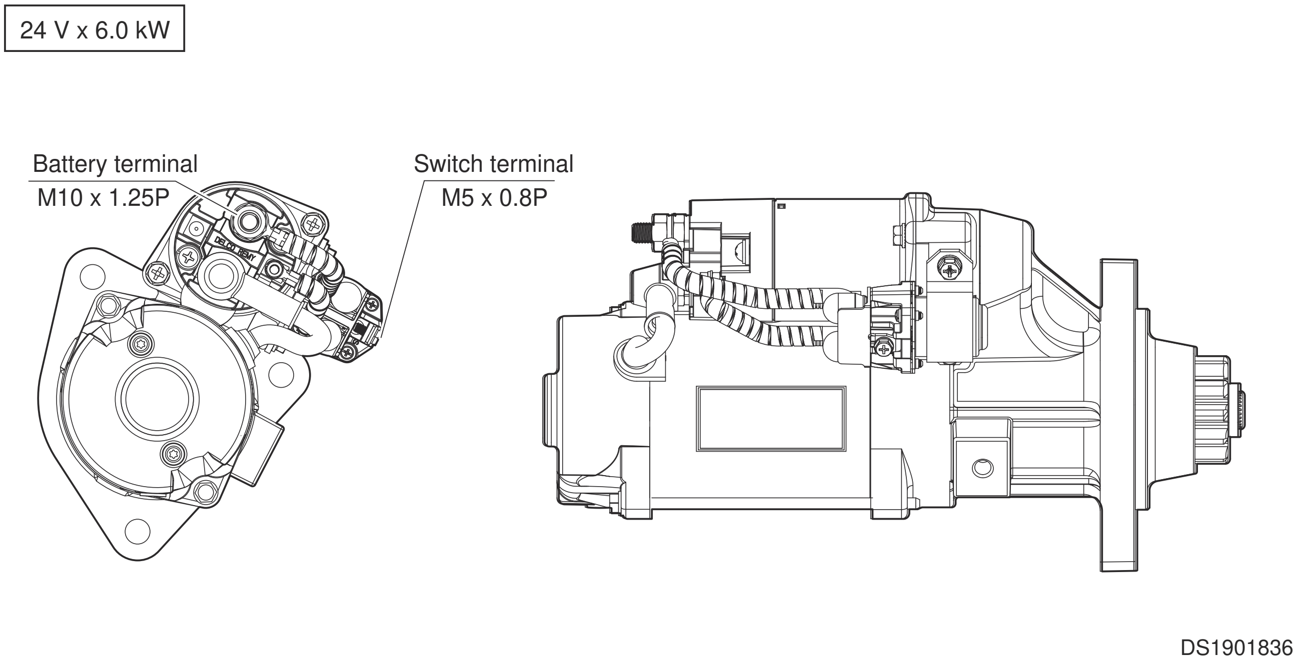
Starter Motor

General Information

The starter motor is mounted on the back of the flywheel housing.

When disassembling the engine, soak the starter motor pinion gear and ring gear in fuel and clean them thoroughly with a brush. Then, apply grease to them to prevent rust.

Figure 167



CAUTION

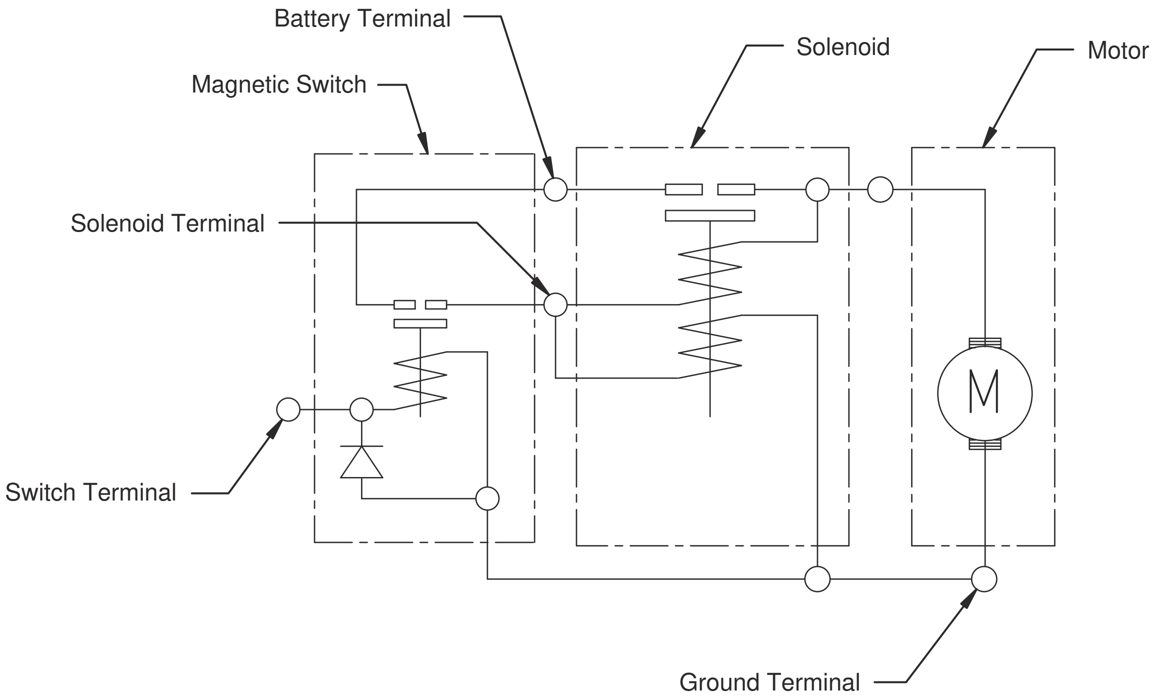
AVOID INJURY

The starter motor should always be protected from moisture.

Circuit Diagram

Figure 168

Circuit Diagram



DS1901837

CAUTION

AVOID INJURY

Before working on any electrical system, disconnect the negative ('-') battery cable (ground cable). To prevent a short circuit, connect the ground cable only after work is complete.

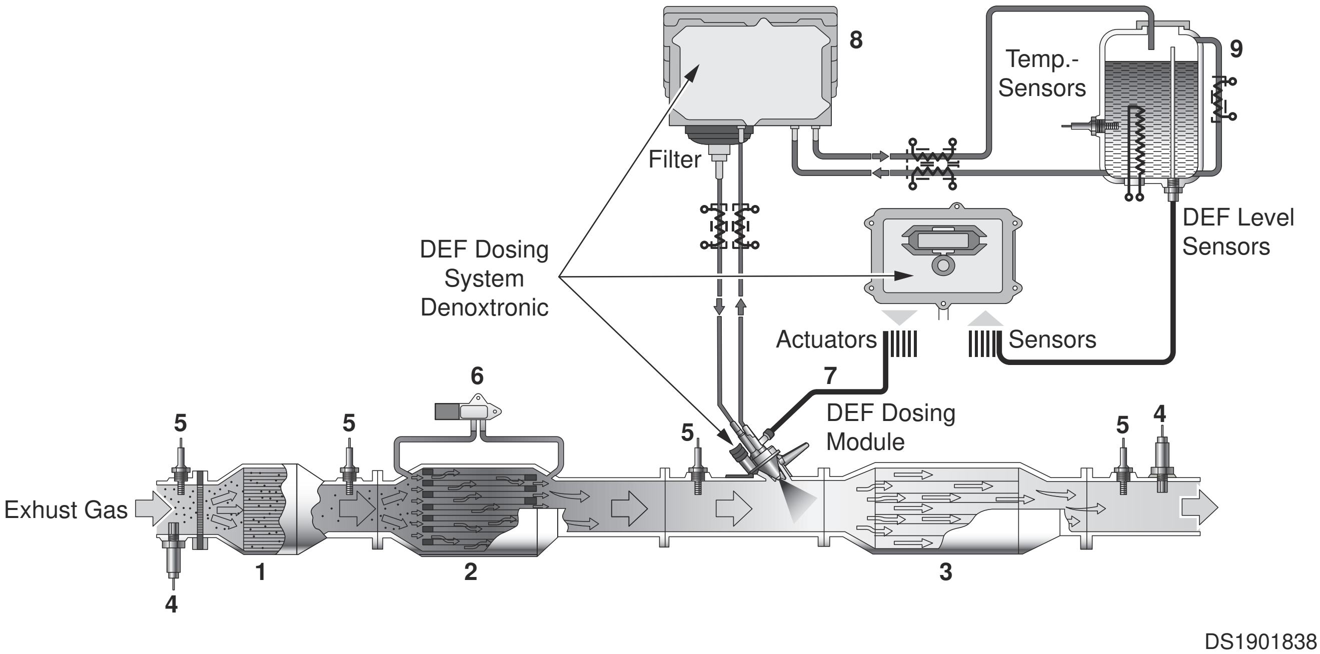
After Treatment System for T4F engine

Exhaust gas reduction system

General instructions

This engine is designed to satisfy Tier 4F emissions regulations using DOC (Diesel Oxidation Catalyst), and SCR (Selective Catalytic Reduction) systems. The SCR system consists of a dosing module, supply module, ECU (Engine Control Unit), and various other components. In the SCR system, DEF (Diesel Exhaust Fluid, urea) is stored in the DEF tank before being pressurized by the supply module and supplied to the dosing module at a constant pressure. The dosing module is installed on the muffler in the aftertreatment system and injects DEF into a compact mixer located upstream of the SCR.

Figure 169

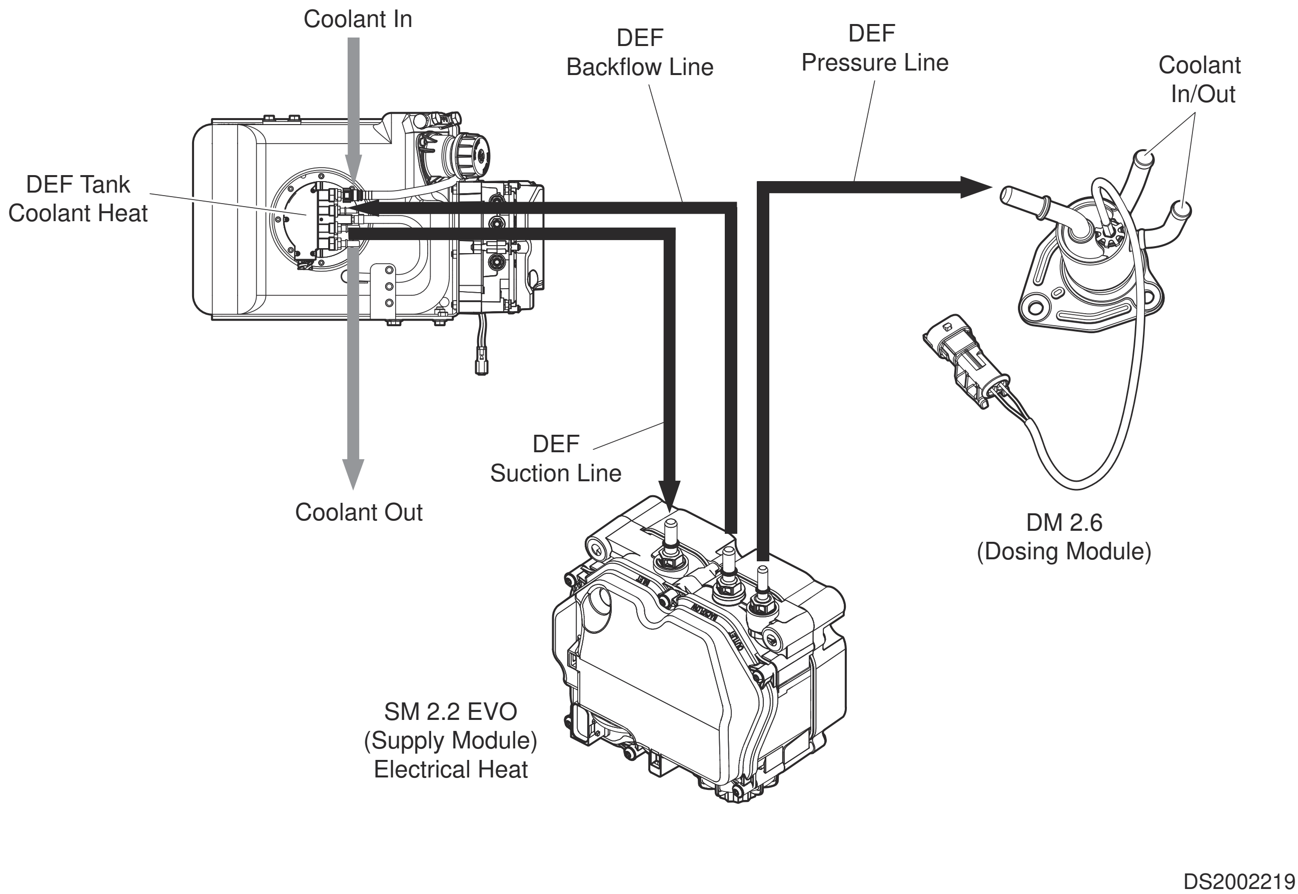


No.	Part Name	Quantity
1	Diesel Oxidation Catalyst	1
2	Diesel Particulate Filter	1
3	SCR/AOC	1
4	NOx Sensor	2
5	Temp. Sensor	4
7	Dosing Module	1
8	Supply Module	1
9	DEF Tank	1

DNOX 2.2 EVO system

The DNOX 2.2 EVO system injects DEF (Diesel Exhaust Fluid, urea) into the SCR catalyst to reduce NOx (nitrogen oxide) emissions. The system consists of a supply module acting as a pump, a dosing module which injects DEF, an ECU which controls the entire system, a DEF tank for storing DEF, and DEF/coolant lines.

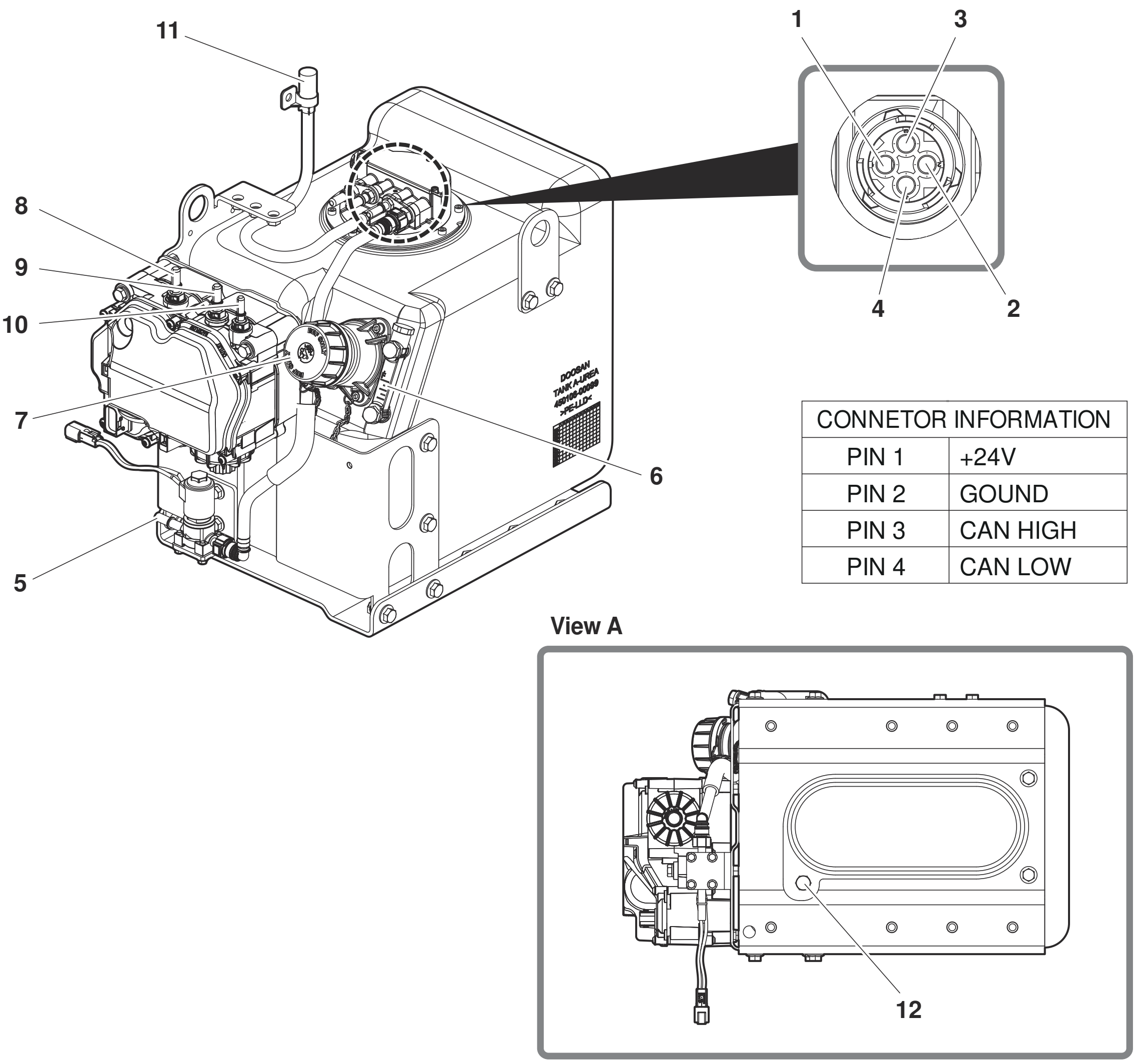
Figure 170



DEF Tank

The DEF tank is used to store DEF (urea). Be sure to install connecting lines in their designated positions. Take care not to apply any excessive force or shocks to the DEF tank.

Figure 171



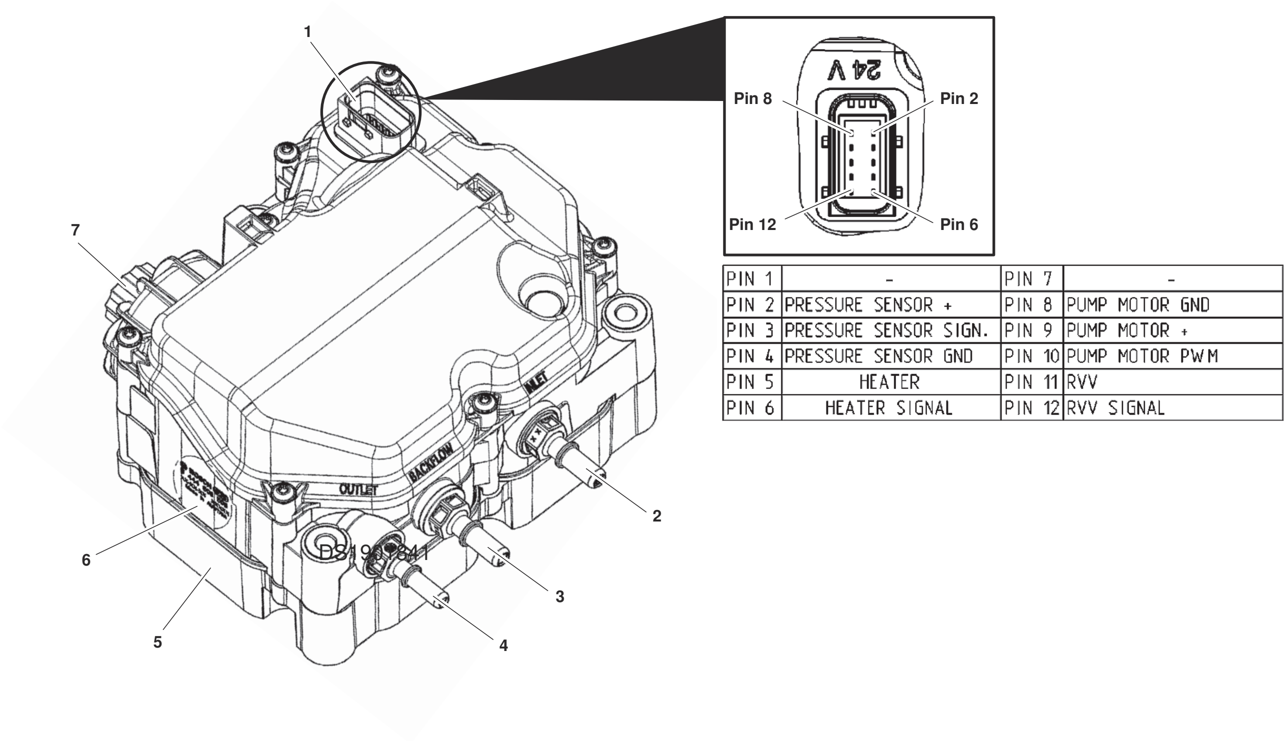
DS2002220

Reference Number	Description
1	+24V (Pin No.1)
2	Ground (Pin No.2)
3	CAN HIGH (Pin No.3)
4	CAN LOW (Pin No.4)
5	Coolant Inlet
6	Level Indicator
7	DEF Tank Cap
8	Inlet
9	Back flow
10	Outlet
11	Breather Filter
12	Drain Plug

Supply Module

The supply module is a device which pressurizes DEF in the DEF tank to a constant pressure and delivers it to the dosing module.

Figure 172



PIN 1	-	PIN 7	-
PIN 2	PRESSURE SENSOR +	PIN 8	PUMP MOTOR GND
PIN 3	PRESSURE SENSOR SIGN.	PIN 9	PUMP MOTOR +
PIN 4	PRESSURE SENSOR GND	PIN 10	PUMP MOTOR PWM
PIN 5	HEATER	PIN 11	RVV
PIN 6	HEATER SIGNAL	PIN 12	RVV SIGNAL

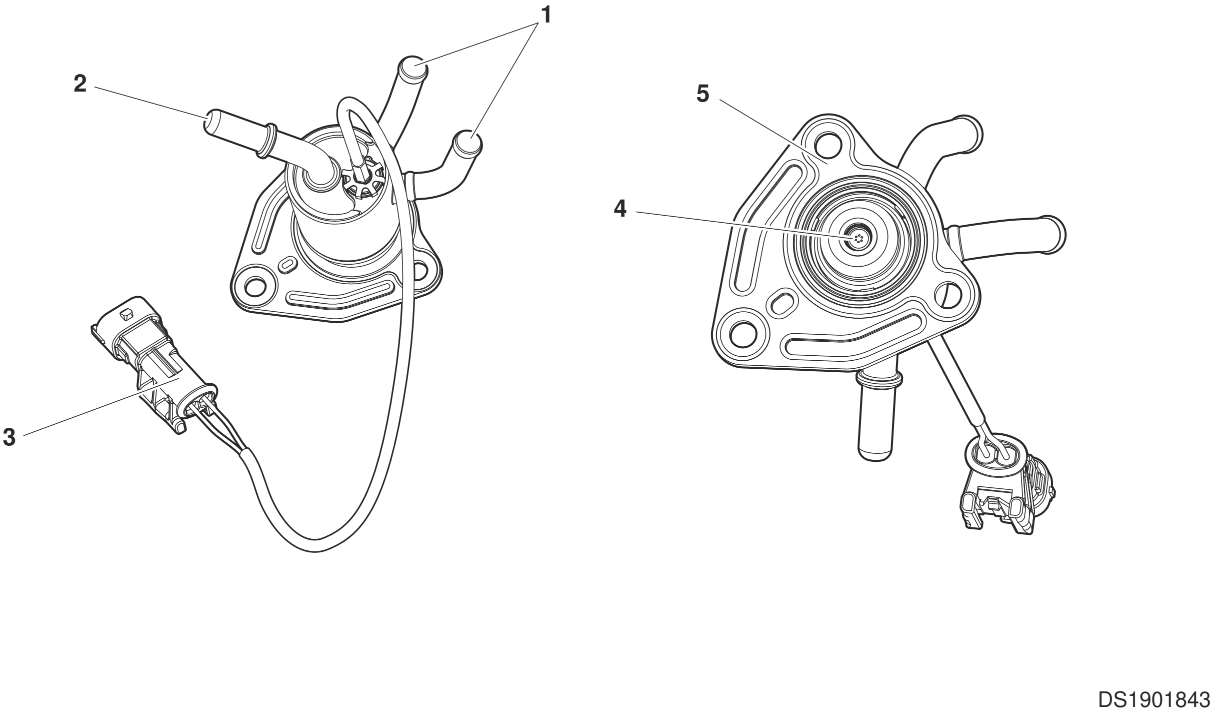
DS1901842

Reference Number	Description
1	Connector
2	DEF Outlet
3	DEF Back flow Outlet
4	DEF Outlet
5	Cover Plate
6	Detailed Display
7	Filter Cover

Dosing Module

Installed on the compact mixer located upstream of the SCR, the dosing module is a device which injects DEF supplied by the supply module into the compact mixer.

Figure 173



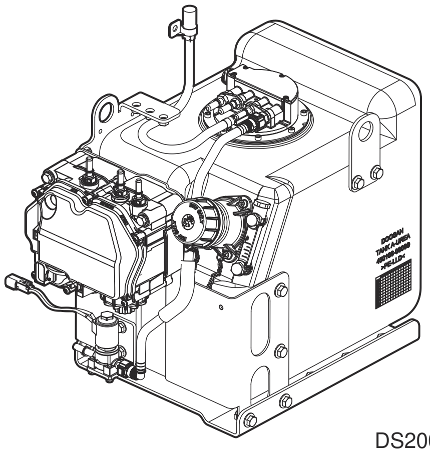
Reference Number	Description
1	Coolant Inlet/Outlet
2	DEF Inlet
3	Connector
4	DEF Outlet
5	Flange

Components of the DNOX 2.2 EVO system

1. The components of the DNOX 2.2 EVO are installed throughout the vehicle where they are most essential. Each part is designed to be protected from damage due to the surroundings.

NOTE: *The DEF tank and supply module are both installed in the same cabin.*

Figure 174

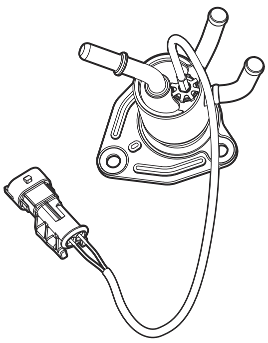


DS2002217

2. The dosing module (DM) is mounted on the compact mixer between the DPF and SCR. It is connected both to a DEF line passing through the SM and an engine coolant line, as well as to the connector of pin no.2 which controls the DEF dosing valve.

Inspecting the DNOX 2.2 EVO system for faults

1. Figure 175



DS1901855

Dosing Module

Dosing module malfunctions may be caused by the tip of the DEF injection nozzle being exposed to high temperatures, a faulty connection in the electrical harness, or a damaged or improperly connected DEF hose line.

The following DM fault inspection items can be checked visually.

A. Air leak due to insufficiently tightened bolt or DM and bolt damaged due to overtightened bolt during replacement or installation of DM.

B. Improperly installed electrical connector or connector contaminated by foreign matter.

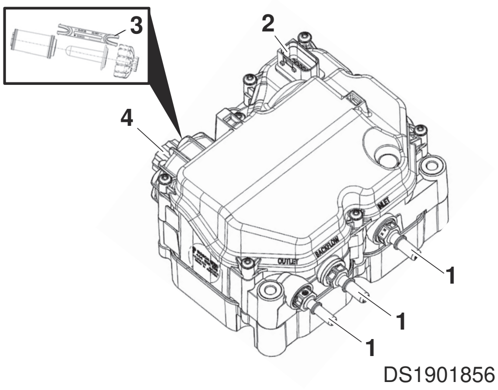
C. DEF leak due to improperly connected DEF line.

D. Coolant leak due to improperly connected coolant line or DM exposed to high temperatures due to disconnected coolant line.

E. DM exposed to high temperatures due to improperly installed gasket.

F. DEF leak due to reuse of gasket.

2. Figure 176



Supply Module

Supply module (SM) fault modes may be caused by damaged or improperly connected DEF lines and electrical connectors.

Faults may occur due to incorrect installation during regular replacements of the main urea filter.

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

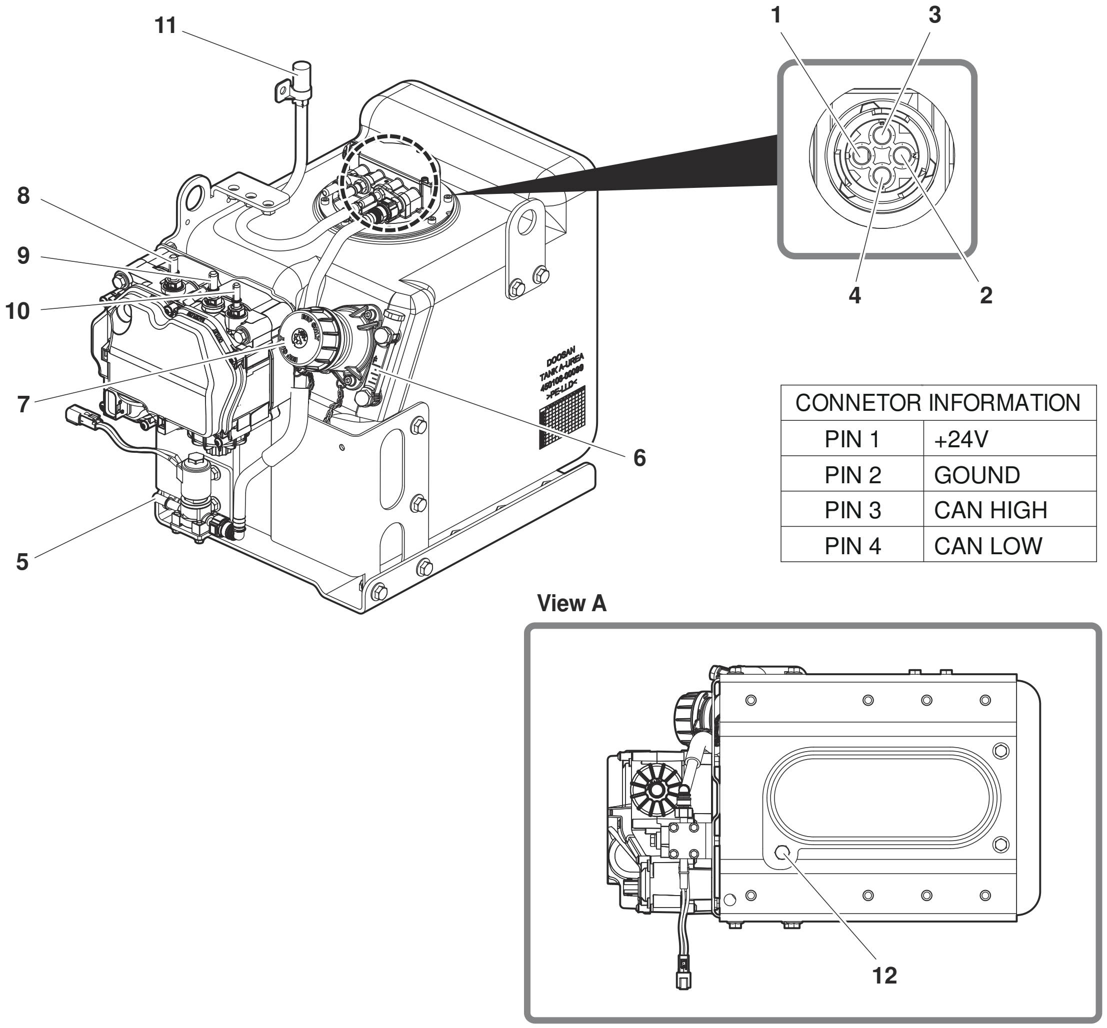
When replacing a filter, remove the packaging on the new filter immediately before performing the replacement.

A. Fault due to improper assembly or improperly connected line while connecting DEF lines.
B. Improperly installed electrical connector or connector contaminated by foreign matter.
C. Filter damaged due to use of improper tools during replacement of SM filter or residue build-up in SM filter.
D. Cap damaged by overtightening of DEF cap during replacement of filter or filter loose due to incorrect installation.

3. The DEF tank is used to store DEF (urea). Be sure to install connecting lines in their designated positions. Take care not to apply any excessive force or shocks to the DEF tank.

DEF Tank

Figure 177



CONNETOR INFORMATION	
PIN 1	+24V
PIN 2	GOUND
PIN 3	CAN HIGH
PIN 4	CAN LOW

DS2002220

A. Do not mix up the DEF inlet hose and backflow hose. To install connectors, insert them until a click is heard, taking care not to damage the connectors.

WARNING

AVOID DEATH OR SERIOUS INJURY

The DEF inlet hose is shown in red, whereas the backflow hose is shown in yellow.

B. Check whether the DEF tank mounting bracket has been tightened. Failing to tighten it may lead to damage due to vibrations.

C. Check the tank temperature and the connection of the level sensor connector, taking care to avoid damaging or contaminating the connector with foreign matter

D. Coolant lines must be installed in their proper positions. Failing to tighten coolant lines may cause coolant leakage.

E. Check the connection of the DEF line heater (2-PIN). There is a risk of freezing and bursting in winter if the heater is not working.

4. There is no need to replace, remove, or change the position of the installed muffler and various pipes except in the event of a fault or problem due to external factors.

Muffler and other pipes

When replacing or removing them due to a fault or problem, be sure to tighten each part to its specified tightening torque in order to prevent air leaks.

DEF (Diesel Exhaust Fluid, urea)

Component	Unit	Range		Test Method
		Minimum	max	
Urea concentrationa	% (m/m)[b]	31.8	33.2	ISO 22241-2 Annex B[c]ISO 22241-2 Annex C[c]
Density (at 20°C[d])	kg/m^3	-	1,093	ISO 3675 or ISO 12185
Deflection (at 20°C[e])	-	-	1.3843	ISO 22241 2 Annex C
Ammonia alkaline	% (m/m)[b]	-	0.2	ISO 22241 2 Annex D
Biuret	% (m/m)[b]	-	0.3	ISO 22241 2 Annex E
Aldehydes	mg/kg	-	5	ISO 22241 2 Annex F
Insoluble matter	mg/kg	-	20	ISO 22241 2 Annex G
Phosphate (PO4)	mg/kg	-	0.5	ISO 22241 2 Annex H
Calcium	mg/kg	-	0.5	ISO 22241 2 Annex I
Iron	mg/kg	-	0.5	
Copper	mg/kg	-	0.2	
Zinc	mg/kg	-	0.2	
Chrome	mg/kg	-	0.2	
Nickel	mg/kg	-	0.2	
Aluminium	mg/kg	-	0.5	
Magnesium	mg/kg	-	0.5	
Sodium	mg/kg	-	0.5	
Potassium	mg/kg	-	0.5	
Identity	-	Identical		ISO 22241 2 Annex J

1. Reference value: 32.5% (m/m).
2. The unit “%(m/m)” is used to express the mass of matter as a fraction according to international standards.
3. Calculated without subtracting nitrogen from ammonia.
4. Reference value: 1,090 kg/m3
5. Reference value: 1.3829

AUS 32 requires the addition of a tracer element. Take care to ensure that the quality of AUS 32 indicated in the table and the tracer element do not damage the SCR system.

NOTE: *The conditions of ISO 4259 must be applied between the maximum and minimum values within the specified range. Be sure to take the minimum difference of 4 x R (R is the reproducibility of the test method) into account. However, for the sake of maintaining high quality, 4 x R is not factored into the urea concentration.*

NOTE: *The urea concentration, density and deflection are the actual values. (For the actual values, please refer to ISO 4259)*

NOTE: *The values defined in notes a, d and e are standard among AUS 32 manufacturers.*

NOTE: *Be sure to check whether the DEF (Diesel Exhaust Fluid, urea) satisfies the required specifications. Be sure to apply the conditions of ISO 4259.*

Diesel oxidation catalyst (DOC)

Outline

The diesel oxidation catalyst (DOC) is a device which oxidizes and eliminates HC (hydrocarbon) and CO (carbon monoxide) emissions.

Hydraulic System And Components

Components Operation, Description and Inspection

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.

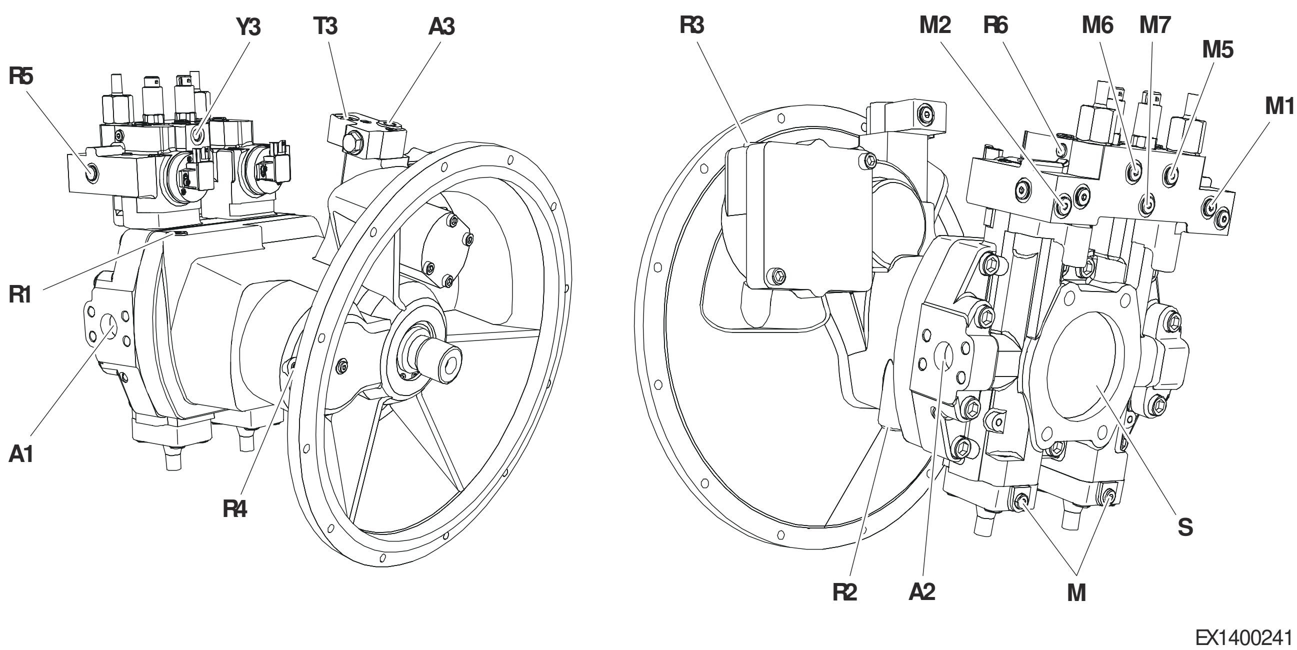
Main Pump

Overview

The pump is a pressure-controlled type, structured in axle piston variable dual pump system, provided with two slope piston rotary groups designed with joint shafts for hydraulic drive. the pump system further comprises: an EPPR valve that controls the pump pressure; a regulator that controls the swivel angle of the pump using the EPPR valve; an angle sensor that converts the discharge flow rate of the pump into electrical signals to provide inputs in addition to a pilot sensor; PTO for the gear pump and option pump for pilot pressure; and a pump cover coupled with the engine to attach the pump.

Port

Figure 178



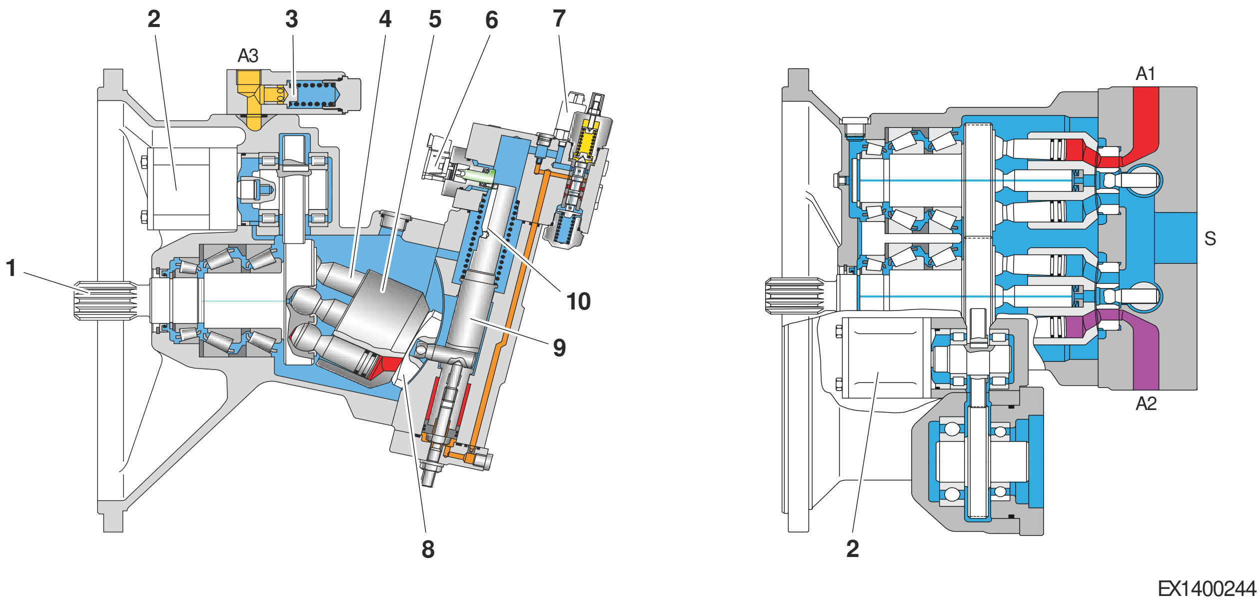
Port	Description	Size
A1, A2	Piston Pump Delivery Port	1 1/4 In
A3	Gear Pump Delivery Port (39 bar (40 kg/cm^2))	M14 x 1.5

Port	Description	Size
S	Piston Pump Suction Port	5 In
T3	Gear Pump Drain Port	M18 x 1.5
R1, R3	Air Bleed Port	M22 x 1.5
R2	Drain Port Line	M22 x 1.5
R4	Flushing Port	3/4-16UNF-2B
R5, R6	Air Bleed Port	M10 x 1
M	Measurement Port Servo Piston	M12 x 1.5
M1	Measurement Port A1	M14 x 1.5
M2	Measurement Port A2	M14 x 1.5
M5, M6	Measurement Port PPRV	M14 x 1.5
M7	Measurement Port Gear Pump (39 bar (40 kg/cm^2))	M14 x 1.5
Y3	Gear Pump Pressure Port (39 bar (40 kg/cm^2))	M14 x 1.5

Theory of Operation

The axial piston variable double pump with two axial tapered piston rotary groups with bent-axis design for open-circuit hydrostatic drives. The axial piston variable double pump has a common suction port (S) for both circuits and the auxiliary pump. It generates two flows for supplying two separate circuits. Flow is proportional to drive speed and displacement. By adjusting the bent-axis rotary groups, the two flows can be step less changed independent of one another. For axial piston units with bent-axis design, the pistons (4) are arranged at an angle to the driveshaft (1). When the driveshaft is turned, the cylinder (5) is picked-up and set into motion cardan free by the pistons, which are arranged in a ring on and flexibly connected to the driveshaft flange. The cylinder then rotates over the spherical control lens (8), in which two kidney-shaped control slots have been incorporated. As they turn, each of the pistons moves from top to bottom dead center and back, executing a stroke that depends on the swivel angle. The driveshaft flange of both rotary groups, which lie parallel next to one another, are interlocked. The rotary group with the long driveshaft drives the second rotary group by the interlocked driveshaft flange. On the low-pressure side, fluid flows into the enlarging piston chamber. At the same time, on the pressure side the fluid is pushed out of the cylinder chamber into the hydraulic system by the pistons. The pistons are braced against the driveshaft flange by the load of the hydraulic pressure.

Figure 179

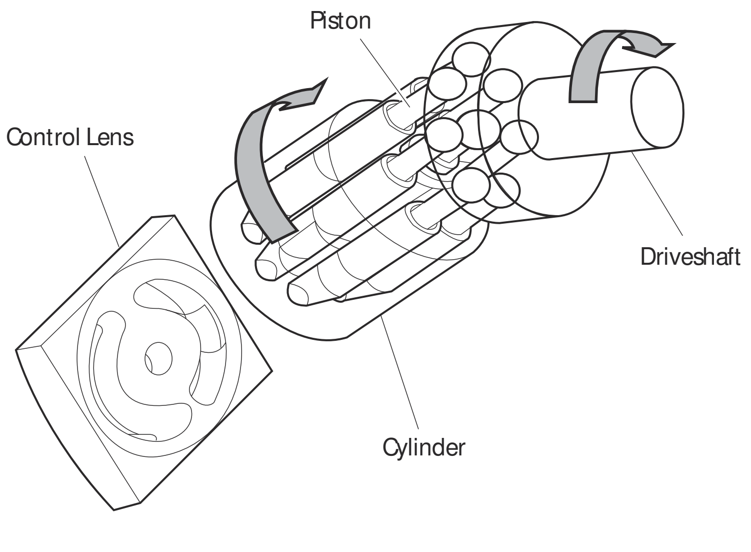


Reference Number	Description
1	Driveshaft
2	Gear Pump (Pilot)
3	Relief Valve
4	Piston
5	Cylinder
6	Angle Sensor
7	EPPR Valve
8	Control Lens
9	Positioning Piston
10	Positioning Trunnion
S	Suction Port
A1, A2	High-pressure Delivery Port
A3	Pilot Port

Engine torque is transferred to the shaft and the seven plungers, causing the cylinder block to rotate while sliding along the valve plate surface.

The plunger oscillates in the cylinder block bores and alternately hydraulic oil is drawn and delivered.

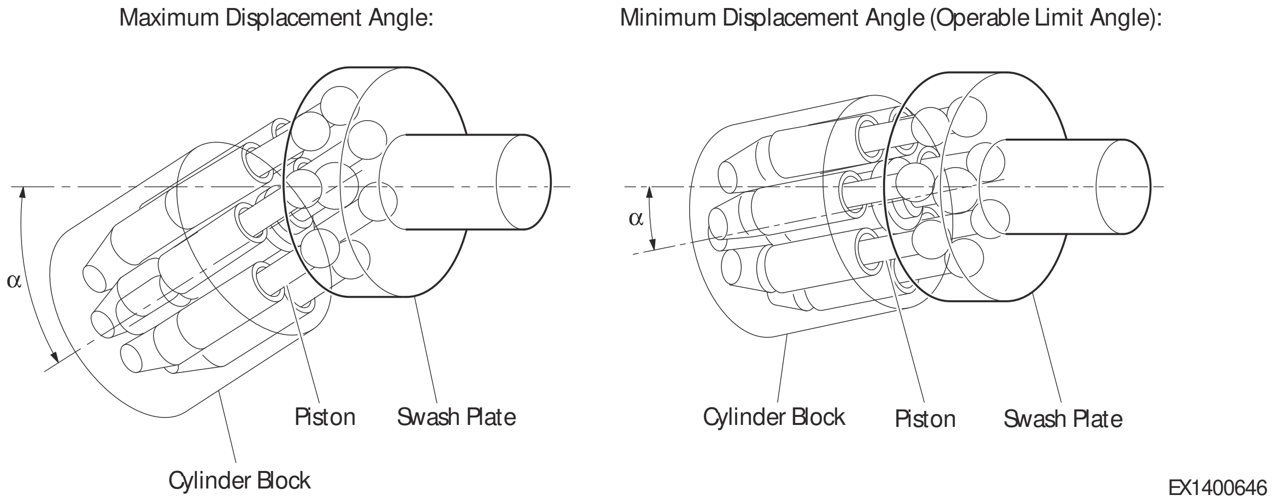
Figure 180



Increasing and Decreasing Flow Rate

Changing inclination of cylinder (5, Figure 2) causes the piston (4, Figure 2) stroke to increase or decrease depending on the slant angle to control the main pump flow rate. Up-down movement of positioning piston (9, Figure 2) changes inclination of cylinder (5, Figure 2). Positioning piston (9, Figure 2) is interlocked with control lens (8, Figure 2) and positioning trunnion (10, Figure 2). The one end of cylinder (5, Figure 2) is kept in contact with the surface of control lens (8, Figure 2) and slides along it.

Figure 181



Pressure Control

Decrease of Pump Pressure (Flow)

Decrease input pressure signal to EPPR valve from EPOS, 2ndly pressure after EPPR valve is decreased on regulator spool. And regulator spool moves right side by pump pressure itself and the other side chamber of the spool is connected to the tank. Finally, the pump pressure connects to the head side of the control piston.

Control piston moves right side and decreases the angle between shaft and cylinder (move to Minimum displacement position).

Decreasing flow rate decreases pump pressure.

Figure 182

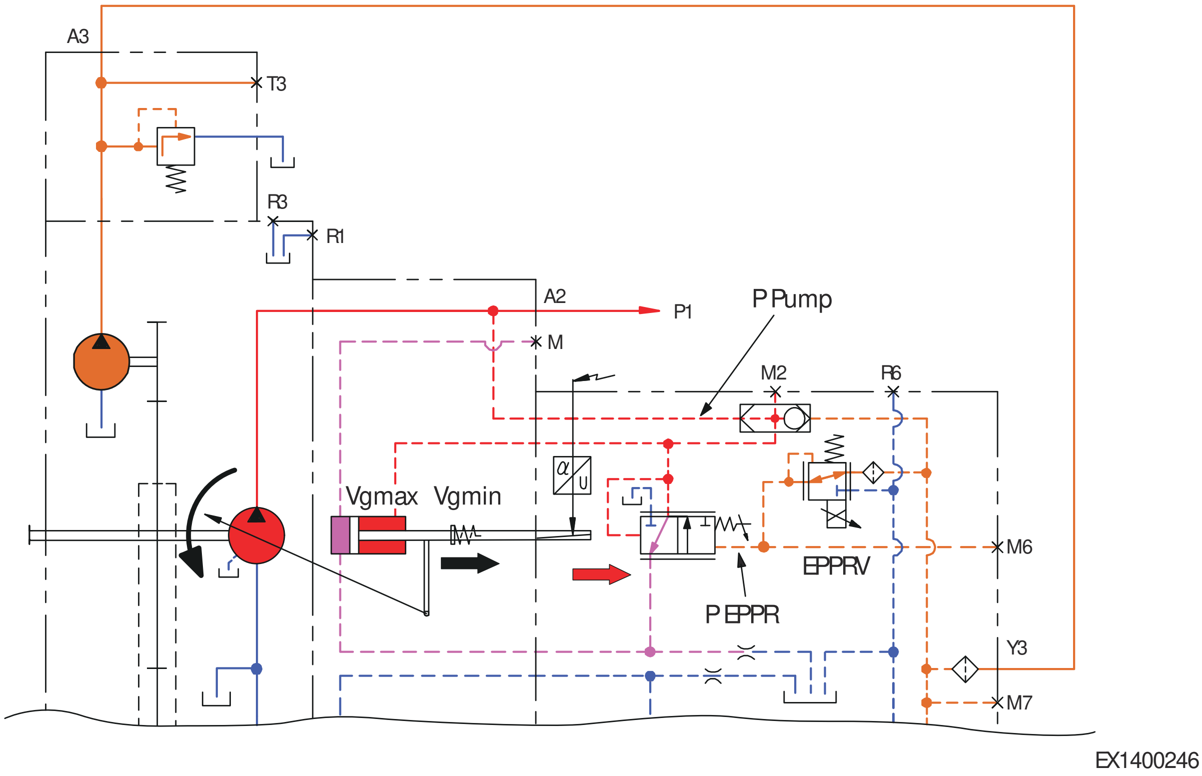
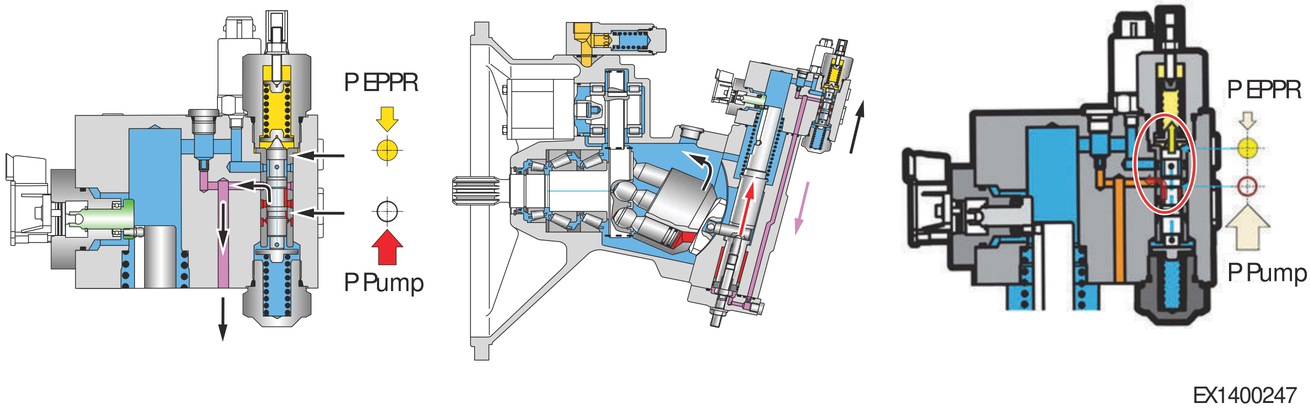


Figure 183



Increase of Pump Pressure (Flow)

Increase input pressure signal to EPPR valve from EPOS, 2ndly pressure after EPPR valve is increased on regulator spool. And regulator spool moves left side by 2ndly pressure from EPPR valve and head side of piston oil is connected to the tank.

Control piston moves the left side and increases the angle between shaft and cylinder (move to maximum displacement position).

Increasing flow rate increases pump pressure.

Figure 184

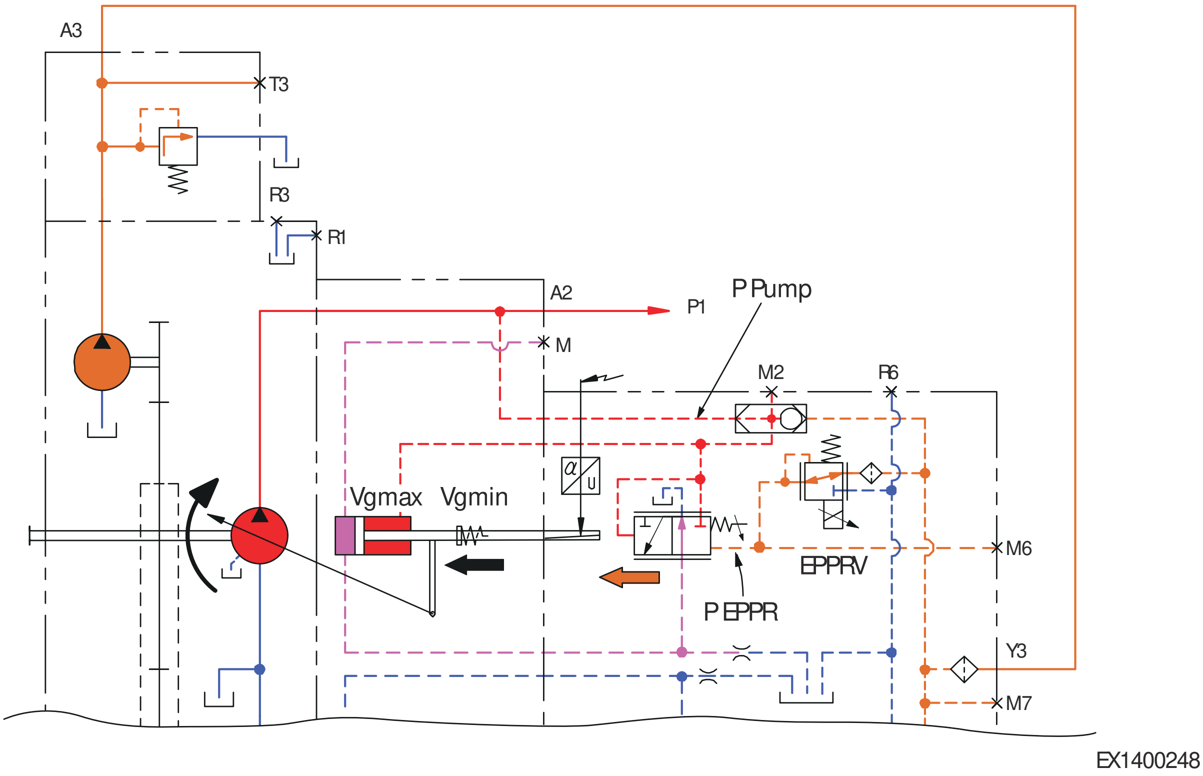
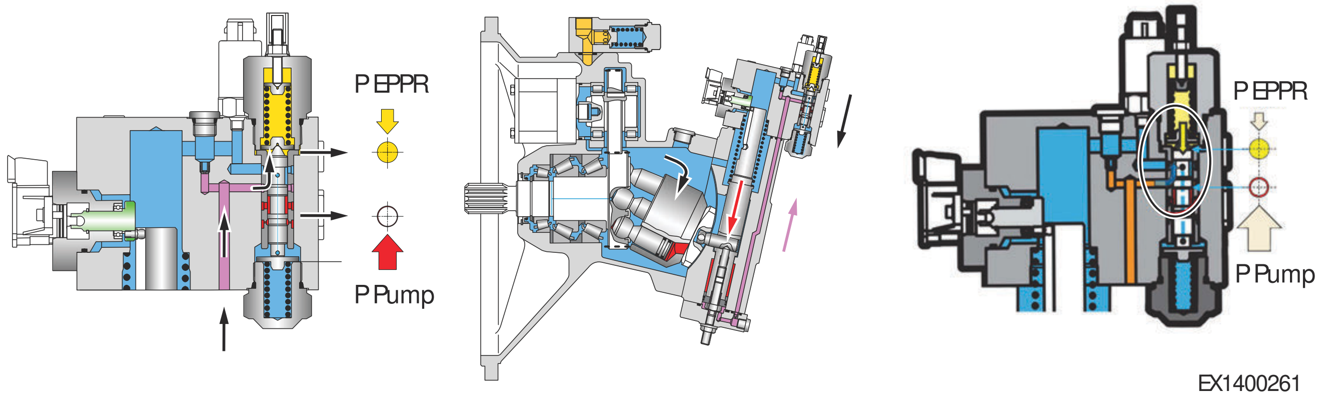


Figure 185



- Control spool area ratio = 1: 12.25

Pump Setting

Max. Flowrate at Each Operations

Max. Flowrate at Each Operations		L/min @ 1,800 rpm	
	Idle	Drive	Total
Boom Up	360	210	570
Boom Down	85		85
Arm Crowd	259	360	619
Arm Dump	100	360	460
Bucket Crowd	360		360
Bucket Dump	360		360

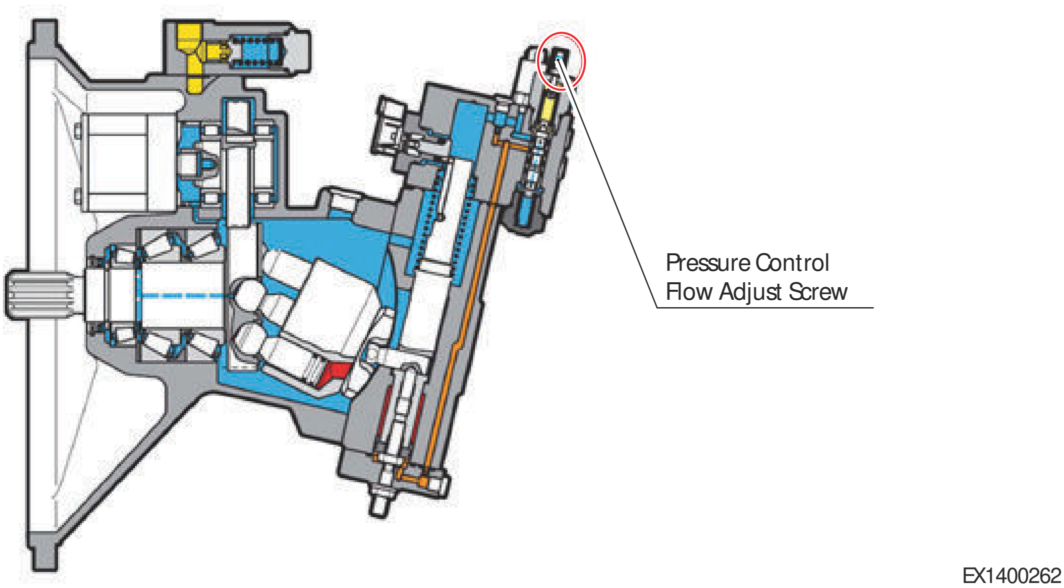
Max. Flowrate at Each Operations		L/min @ 1,800 rpm	
	Idle	Drive	Total
Swing		350	350
Travel	325	325	325

Power Configuration

Power Configuration			
Working Mode	rpm	Torque Ratio (%)	Power Ratio (%)
Power+	1,800		100
Power	1,700		92
Standard	1,600		84.4
Economy	1,500		79.7

Pump Adjustment

Figure 186



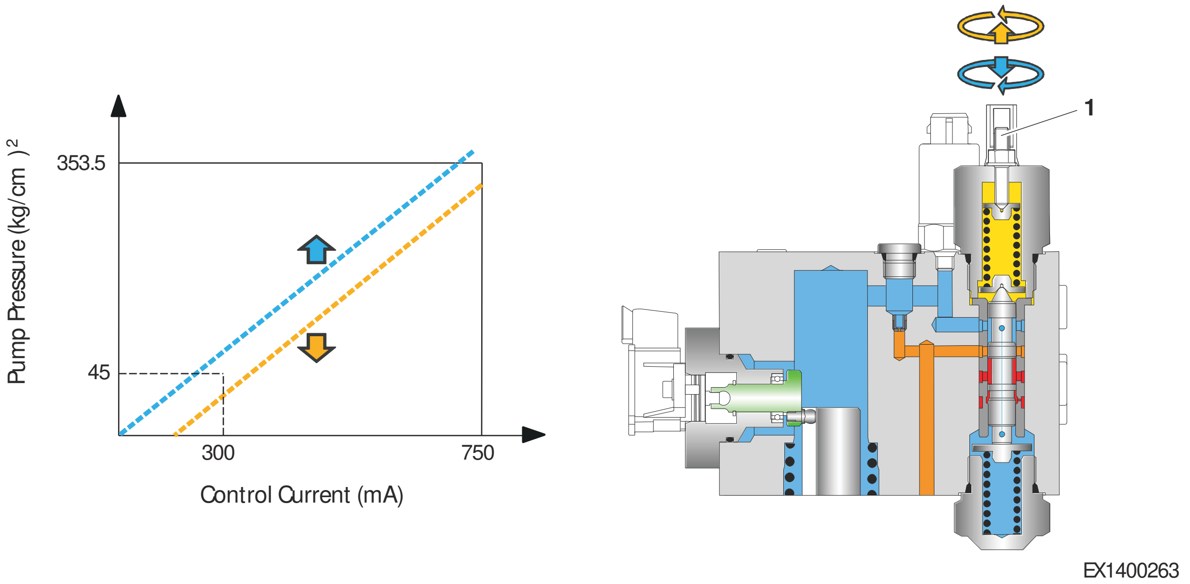
As describe in the picture, fastening the bolts will lead to the increase of initial spring force and increase of pump pressure with respect to input current signal.

Pump pressure initial tuning

1. Turn on the engine, set the excavator at power mode, high idle (750 mA)

2. Tighten the screw (1, Figure 10) at the top until pump pressure reaches 353.5 kg/cm^2 (347 bar).

Figure 187

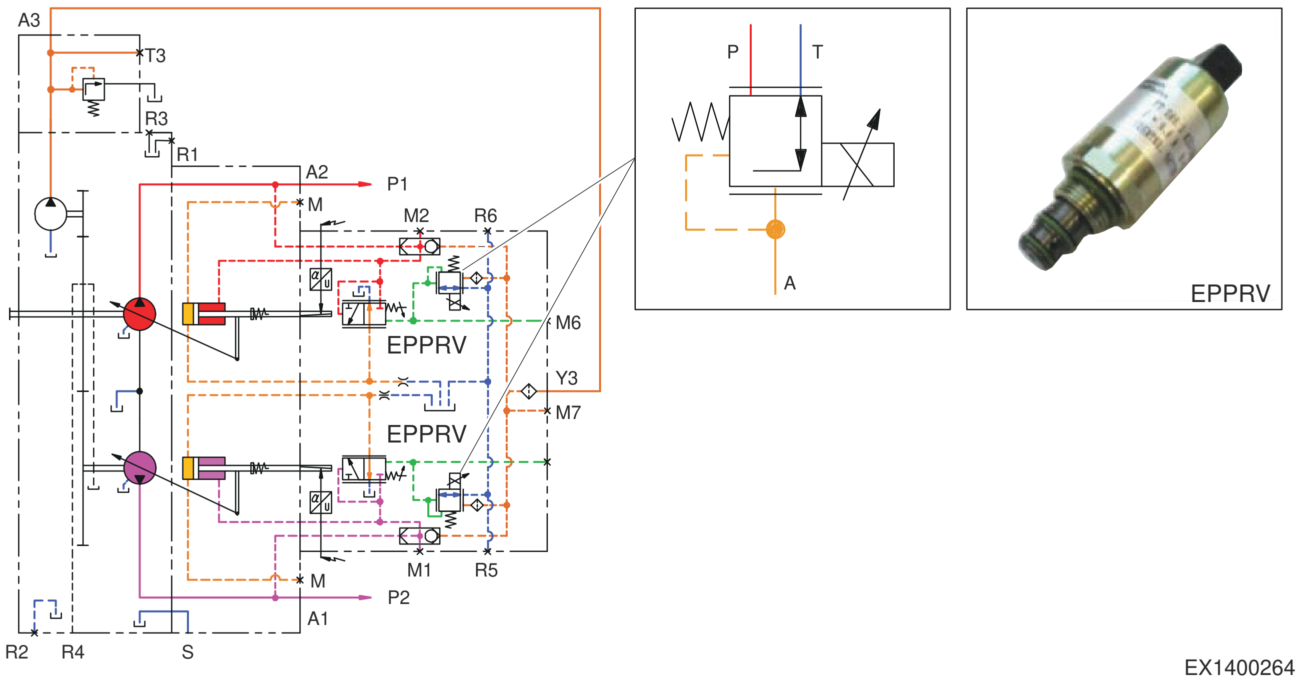


- Secondary pressure of EPPR valve - 3.94 kg/cm^2 (3.86 bar) and pump pressure - 45 kg/cm^2 (44 bar) at current 300 mA.
- Secondary pressure of EPPR valve - 28.4 kg/cm^2 (27.9 bar) and pump pressure - 353.5 kg/cm^2 (347 bar) at current 750 mA.

EPPR Valve (Electronic Proportional Pressure Reduce)

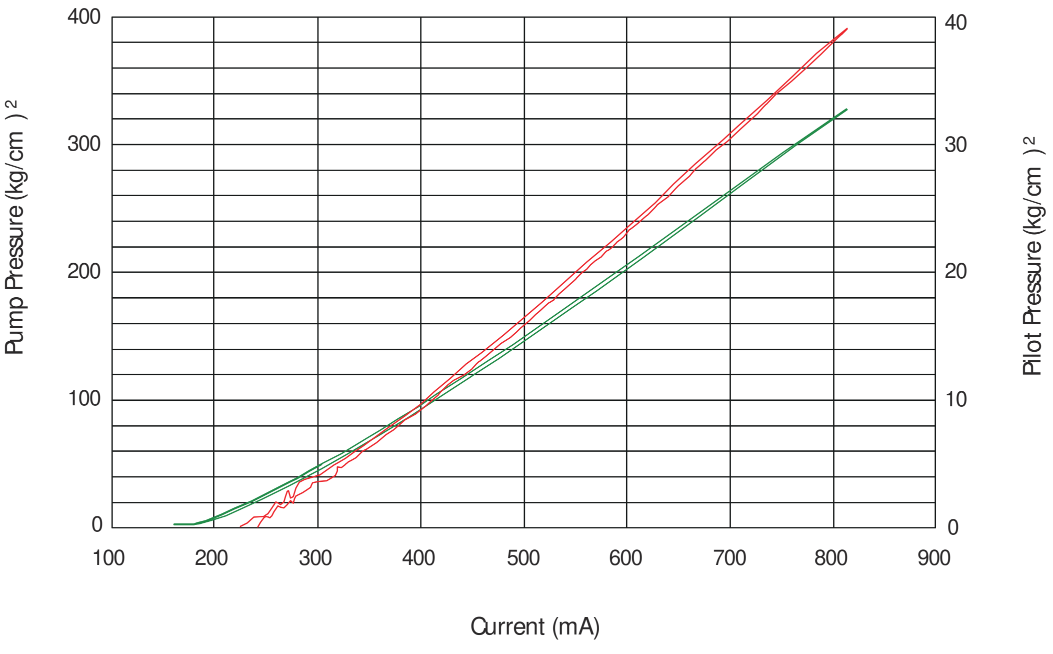
Symbol

Figure 188



Pressure - Current Curve

Figure 189



I (mA)	300	350	400	500	600	650	700	750	785
P (bar)	47	75	104	169	238	275	309	347	362
Pi (bar)	3.86	6.53	9.19	14.52	19.85	22.51	25.18	27.8	29.7
Allowance ± (bar)	8	7.4	7	6	5	4.5	4	3.4	3.19

Emergency Operate

- High load (using 1 pump): 294 bar (650 mA)
- Low load: 196 bar (470 mA)

Manual Override

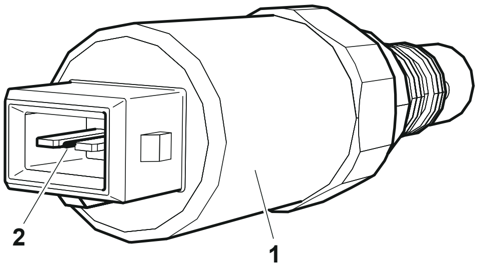
When power supply to the machine is interrupted, maximum operating pressure can be established using a manual override so the machine can be driven under its own power and relocated to another work area.

NOTICE

Before actuating the manual override device of the system the safety lever near the operator's seat must be activated.

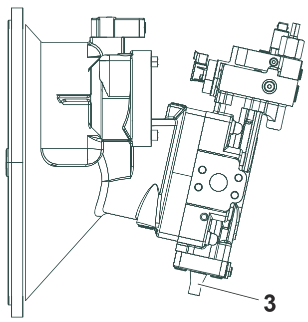
Activate Manual Override

Figure 190



To activate the manual override:

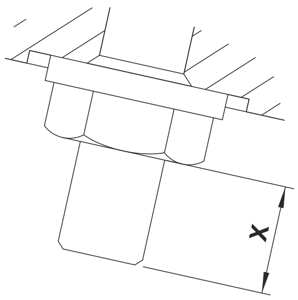
1. Unplug the electrical connectors from both pressure reducing valves (1, Figure 13).
2. Press the pin (2, Figure 13) between other pins up to the stop. Manual override is activated while the pin (2) is pressed.
3. Remove both protective caps (3, Figure 14) on the covers with a suitable tool (e.g. gripper).
   Figure 191



NOTICE

The protective caps will be destroyed by the removal process. When you require replacement protective caps, contact your responsible Service partner or the service department of the manufacturer's plant for the axial piston unit.

4. On both $V_{g\ max}$-limiting threaded pins measure and record the extension X to the SEAL LOCK®-nut.
   Figure 192



5. Fix both $V_{g\ max}$-limiting threaded pins with hexagonal socket wrench (size M6). Loosen the SEAL LOCK® nuts (wrench size M12).

6. Screw the $V_{g\ max}$-limiting threaded pins into the cover with a hexagonal socket wrench (size M6).

NOTICE

Do not screw the $V_{g\ max}$ limiting threaded pins completely into the cover but rather leave the $V_{g\ max}$limiting threaded pins overhanging the SEAL LOCK®nuts with an extension of X = 8 mm because otherwise the $V_{g\ max}$ limiting threaded pins will be less stable.

7. Tighten the SEAL LOCK® nuts with a torque of 69 N.m (wrench size M12).
8. Move the safety lever, located next to the operator's seat, to the “LOCK” position to prevent unintentional machine movement.
9. Apply the manual override only briefly, e.g. to drive the machine and relocate it to another area. If the power supply to components of the main pump is defective, contact your responsible Service partner or the service department of the manufacturer's plant for the axial piston unit.

Deactivate Manual Override

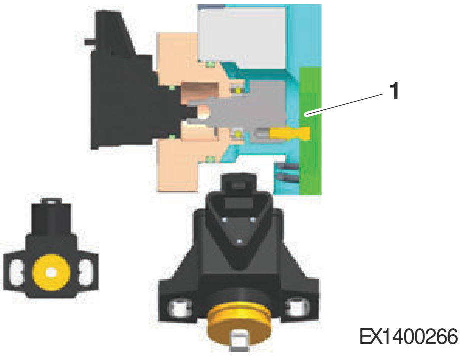
When the PINs are no longer depressed, manual override is deactivated. To return the $V_{g\ max}$-limiting threaded pins to the original setting, perform the operations 4-6 above in the reverse order. Check the organization X to the SEAL LOCK® nuts against your records.

Angle Sensor

The discharge flow from the pump is measured with an angle sensor. Its 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.

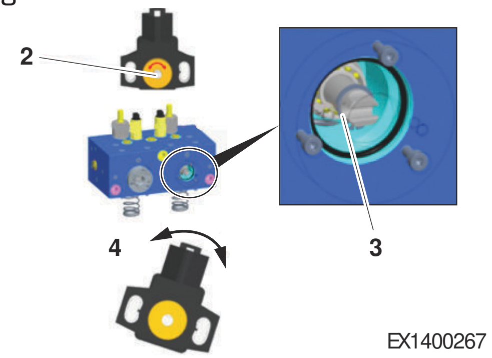
Installation of Angle Sensor

1. Ensure that ball pin is guided in the nut of the spring collar in spring position. (Install the angle sensor with the electrical connection to the top.)
   Figure 193



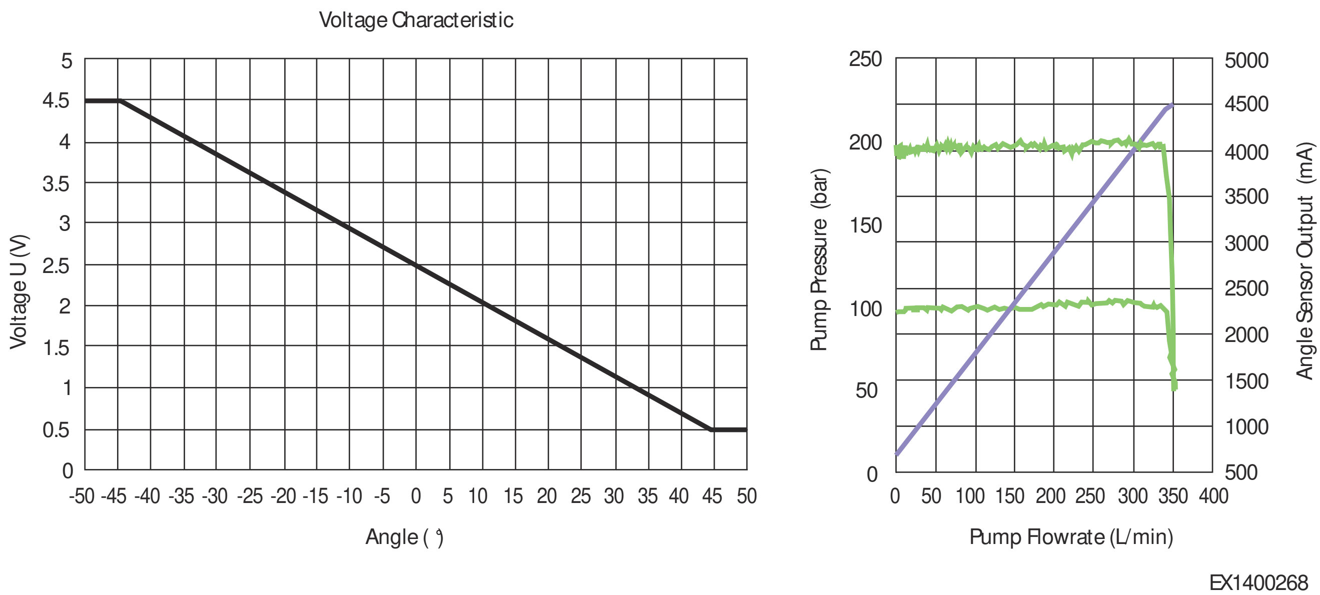
2. Center (rotate) the shaft of the swivel angle sensor between the stoppers like the position on the Figure 17.

   Figure 194



3. Check the groove/slot position of the sensor shaft in the controller (must not be horizontal) and set (rotate) and install the swivel angle sensor to groove/slot position.
4. Turn the angle sensor to adjust the signal of +4.5 V at the Q max position of the rotary group and install the screw with the correct torque.

Figure 195



Main Control Valve

Overview

The control block is an enhancement of the standard open circuit control, with improved functionality and reduced energy consumption, under normal operation condition, the bypass oil line is clogged by bypass cut valve.

The pumps receive the highest pilot pressure signal from the EPOS by a hydraulic logic; they then prepare the oil flow for the system according to the pump characteristics.

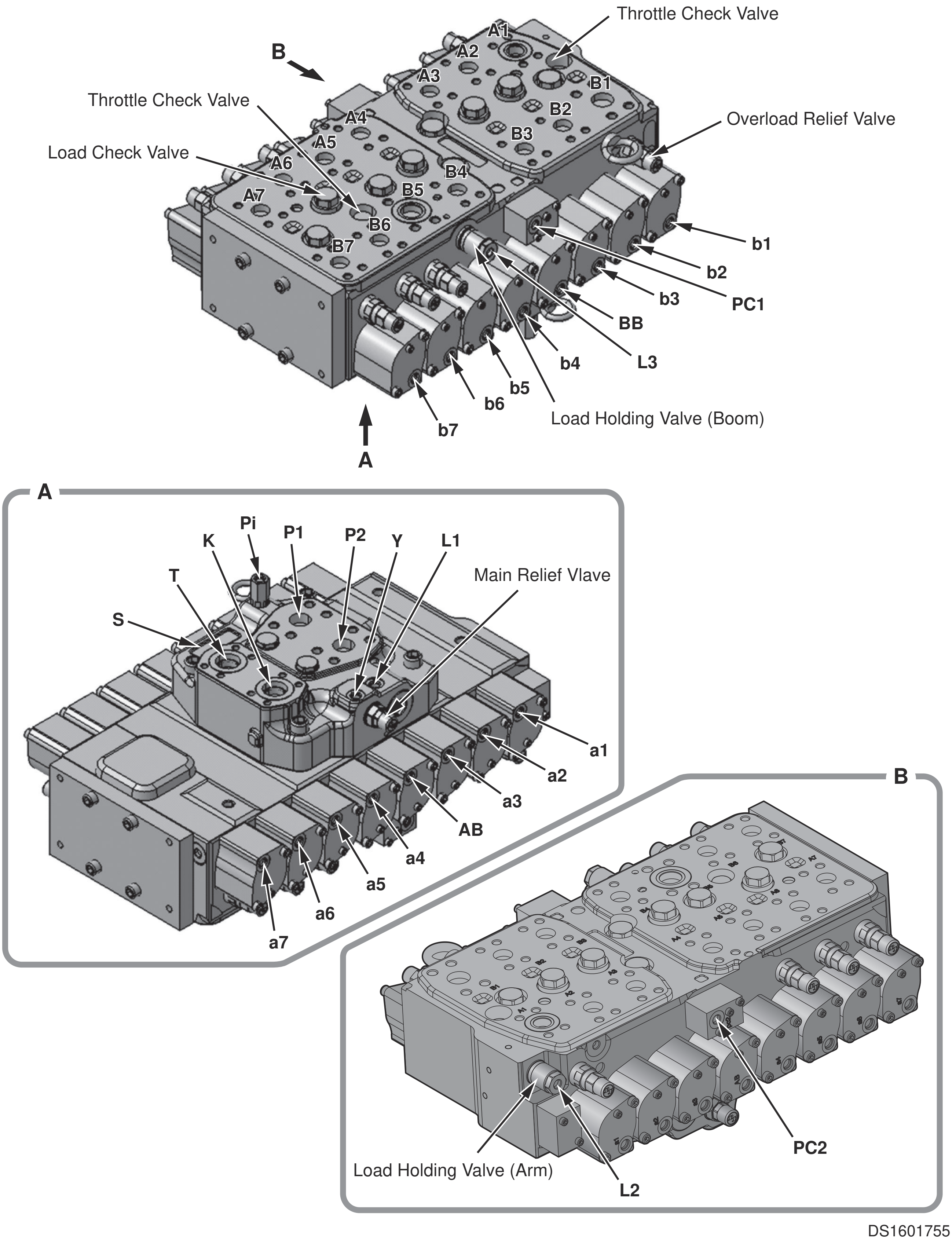
The main control valve with seven spools, summation valves, bypass cut valves, and a shuttle valve block.

The remote control signals are connected to each spool chamber for shifting spools.

Pilot controls signals are connected to control pistons on the shuttle valve block, bypass cut valve, and main relief valve.

The shuttle valve chain is also used to control pumps P1 and P2 and to control other functions including summation, straight travel and system operation pressure up, etc.

Figure 196



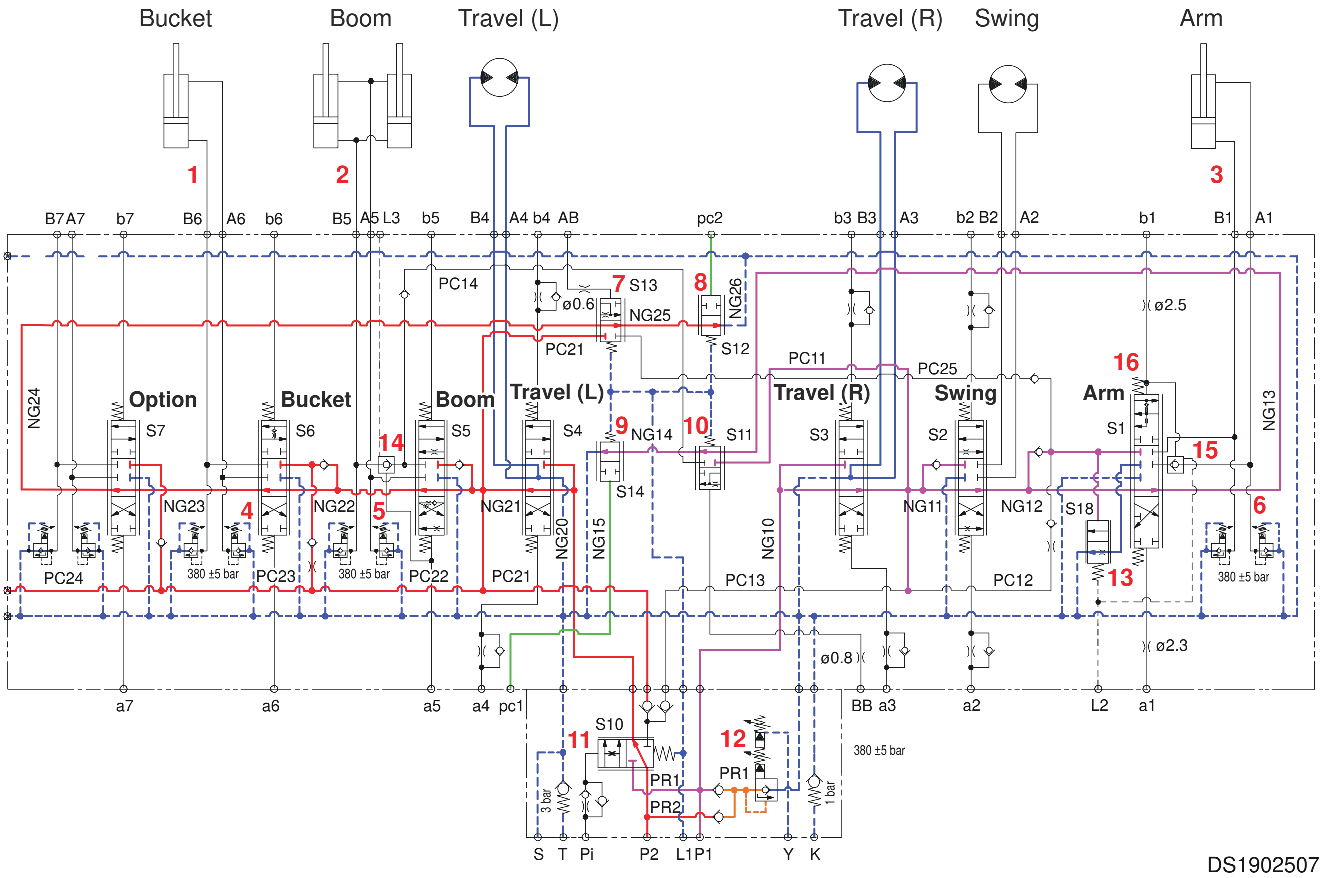
DS1601755

Port	Name	Size
P1	Drive Pump (1) High-pressure Port	SAE 1 1/4", 6,000 psi
P2	Idle Pump (2) High-pressure Port	
B1	Arm Cylinder Tube Side Port	
B5	Boom Cylinder Tube Port	
T	Return Port (to Tank)	
K	Return Port (to Oil Cooler)	
A1	Arm Cylinder Rod Side Port	SAE 1", 6,000 psi
A2	Swing Motor Right Port	
A3	Travel Forward (RH)	
A4	Travel Forward (LH)	
A5	Boom Cylinder Rod Side Port	
A6	Bucket Cylinder Rod Side Port	
A7	Two-way Option (LH) Port	
B2	Swing Motor Left Port	
B3	Travel Backward (RH)	
B4	Travel Backward (LH)	
B6	Bucket Cylinder Tube Port	
B7	Two-way Option (RH) Port	
L2	Drain Port (Arm)	PF 1/4"
L3	Drain Port (Boom)	
PC1	Bypass Cut Valve Port	
PC2	Bypass Cut Valve Port	
AB	Arm Summation Valve Port	UNF 9/16"-18
BB	Boom Summation Valve Port	
a1	Arm Dump Pilot Port	
a2	Swing Right Pilot Port	
a3	Travel Forward Pilot Port (RH)	
a4	Travel Forward Pilot Port (LH)	
a5	Boom Down Pilot Port	
a6	Bucket Dump Pilot Port	
a7	Two-way Pilot (LH) Port	
b1	Arm Crowd Pilot Port	
b2	Swing Left Pilot Port	
b3	Travel Backward Pilot Port (RH)	
b4	Travel Backward Pilot Port (LH)	
b5	Boom Up Pilot Port	

Port	Name	Size
b6	Bucket Crowd Pilot Port	
b7	Two-way Pilot (RH) Port	
Pi	Travel Straight Pilot Port	
L1	Drain Port (to Tank)	
Y	Drain Port (to Tank)	
S	Swing Motor Make Up	UNF 1 1/16"-12

Hydraulic Circuit

Figure 197



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	Arm Summation Valve
8, 9	Bypass Cut Valves

Reference Number	Description
10	Boom Summation Valve
11	Travel Straight Valve
12	Main Relief Valve
13	Arm Brake Valve
14, 15	Holding Valves
16	Arm Regeneration Valve
S1 - S7	Main Spools

Theory of Operation

General Description

Oil of (P1) supplies the travel right (S3), swing (S2) and arm (S1)

sections. Oil of (P2) supplies the travel left (S4), boom (S5) bucket (S6) and option (S7) sections.

Under normal operation condition, the neutral gallery (NG) is clogged by bypass cut valve.

Since the downstream consumer sections can no longer be supplied by the neutral gallery (NG) during simultaneous control of several sections, parallel channels (PC) are integrated into the control valve.

The boom (S5) is operated to full output, the bucket section (S6) is supplied by the PC23 parallel channel. The same applies to the swing (S2) and arm (S1) sections.

To ensure the loaded upstream and downstream sections are supplied with enough oil even at different load pressures, orifices are assigned to the parallel channels (PC).

The travel sections (S3) and (S4) boasts a special feature. The spools are assigned in tandem to the downstream S2 and S1 respectively S5 and S6 to ensure the oil supply is provided consistently (as a priority) for the travel section under different working conditions.

If the travel section (S3) is operated to full output thus interrupting the P1 supply to sections S2 and S1, the supply comes from pump 2 (P2) by the parallel channels PC13 and PC 12 over the straight travel valve (S10).

If the travel section (S4) is operated to full output thus interrupting the P2 supply to sections S5, S6, and S7 by NG21, the supply comes from the pump (P2) by the straight travel valve (S10) and the parallel channels PC21, PC22, PC23, and PC24. At the same time, the travel section will be supplied by pump1 (P1) by the straight travel valve.

Neutral Passage

When the spool is at the neutral position, the minimum discharge flow from the pump and no oil is returned to the tank by the center bypass line.

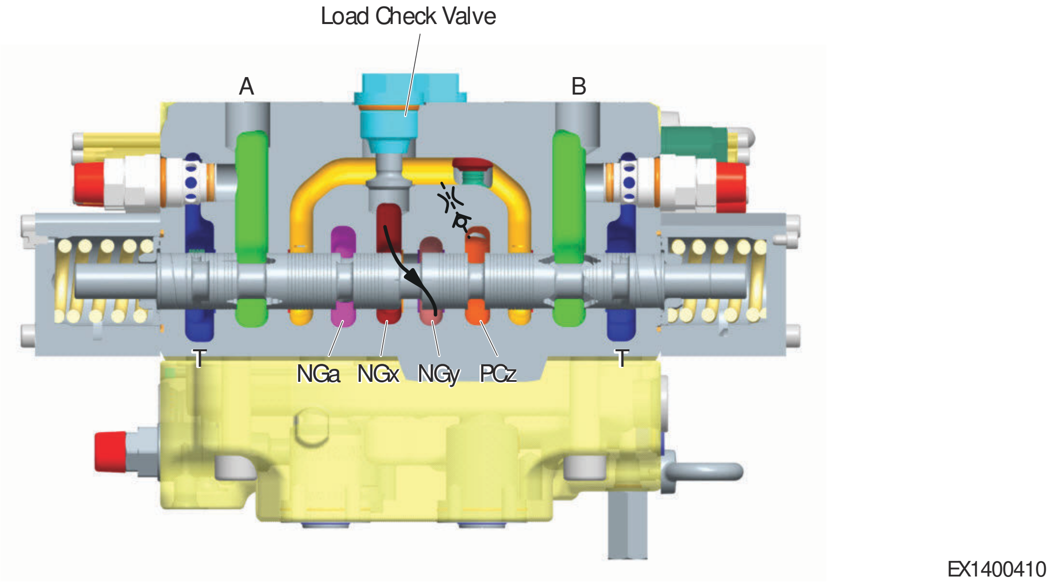
When the spool is switched, the oil discharged from the pump flows to the operator port by the load check valve and the parallel channel, since the center bypass line is closed.

(The oil flows: NGx →NGy is cut off by the spool switching)

The oil returning after operating the actuator (cylinder and motor) returns to the tank by the spool.

- NG: Neutral Gallery
- PC: Parallel Channel

Figure 198Neutral Spool Position



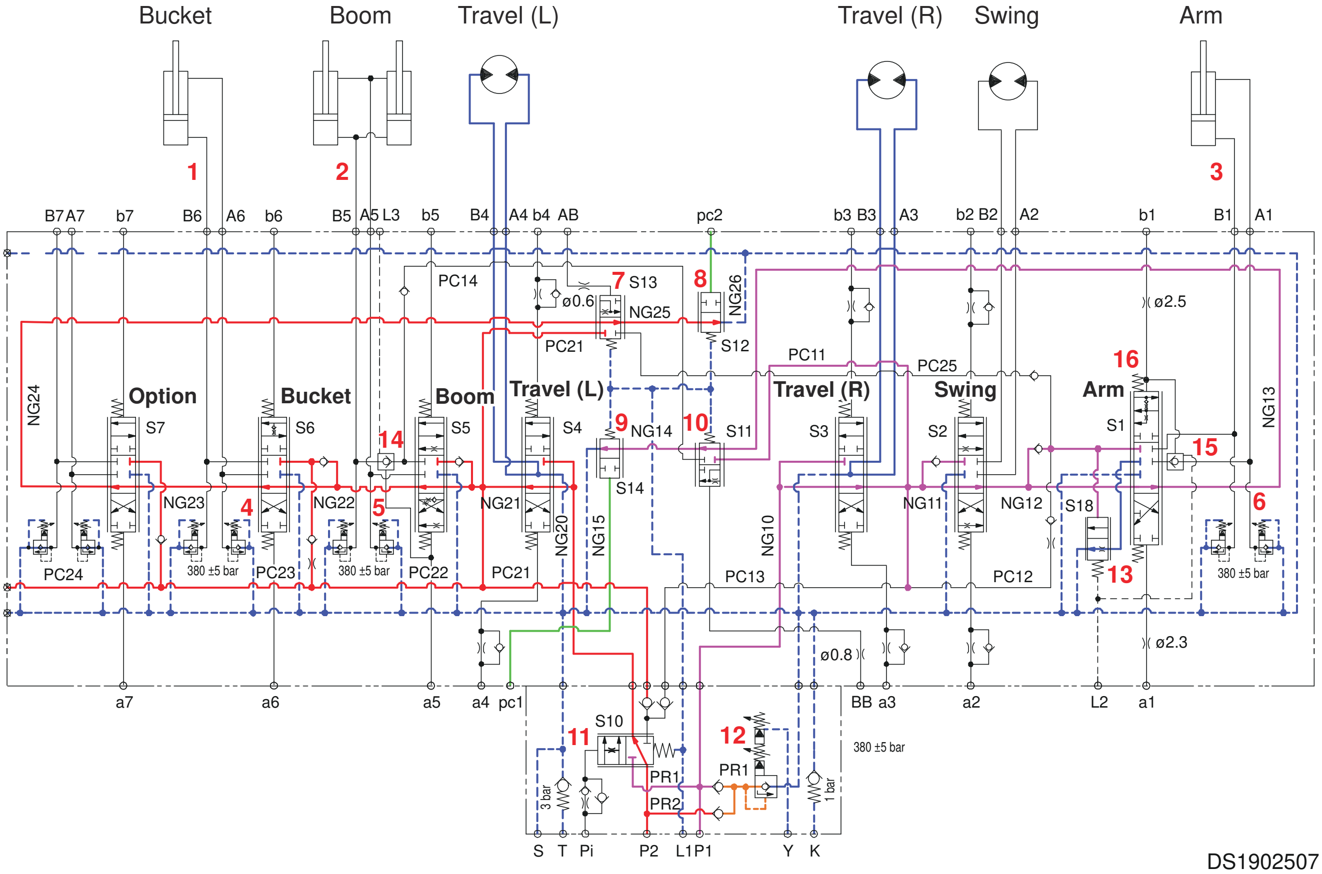
PC (Parallel Channel)

If no volumetric flow is needed, both pumps are the minimum volumetric flow set (Q min). The Q min quantity now flows through the “Neutral Gallery” (NG) of the main control valve back to the tank. P1 flows for Q min through the control block by P1 → S3 → NG11 → S2 → NG12 → S1 → NG13 → S11 → NG14 → NG15 into the tank channel. Q min of P2 flows through the control block by P2 → S10 → NG20 → S4 → NG21 → S5 → NG22 → S6 → NG23 → S7 → NG24 → S13 → NG25 → S12 → NG26 into the tank channel.

D-Eco Power

If no volumetric flow is needed, cut spools S12 and S14 are switched by pilot pressure in PC1 and PC2 →NG15 and NG26 are closed, no connection to tank channel.

Figure 199

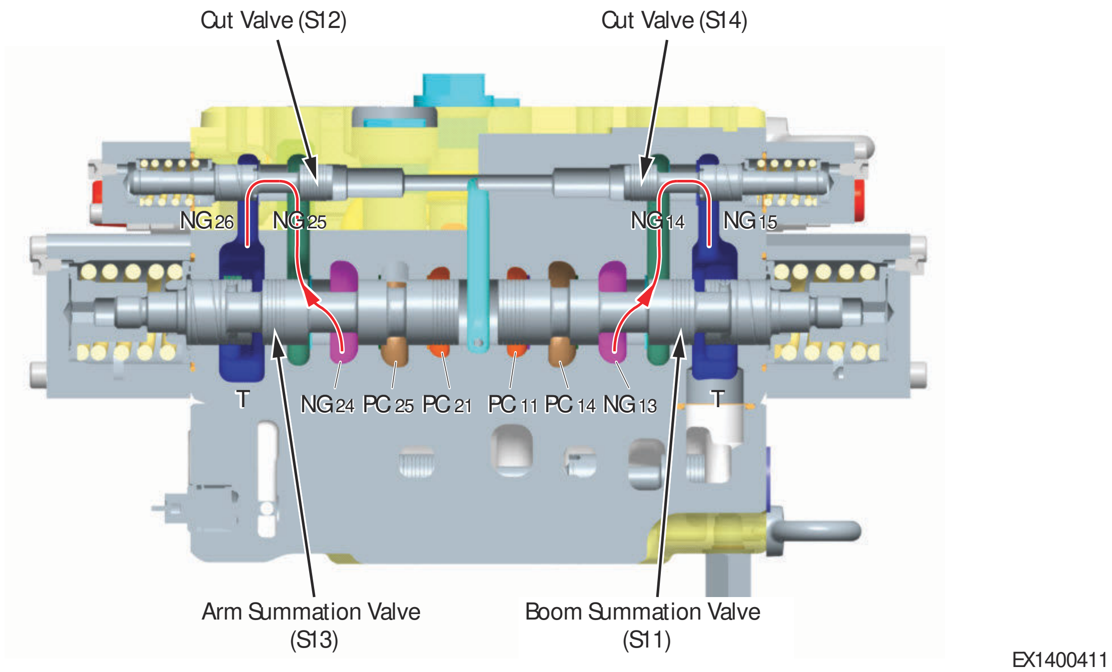


Summing and Cut Valves

The oil flow path from the A2 pump is as follows.

- P1 Pump → Travel (Right) Spool → Swing Spool → Arm Spool → S11 (Boom Summation Valve) → S14 (Cut Valve) → Tank

  Figure 200

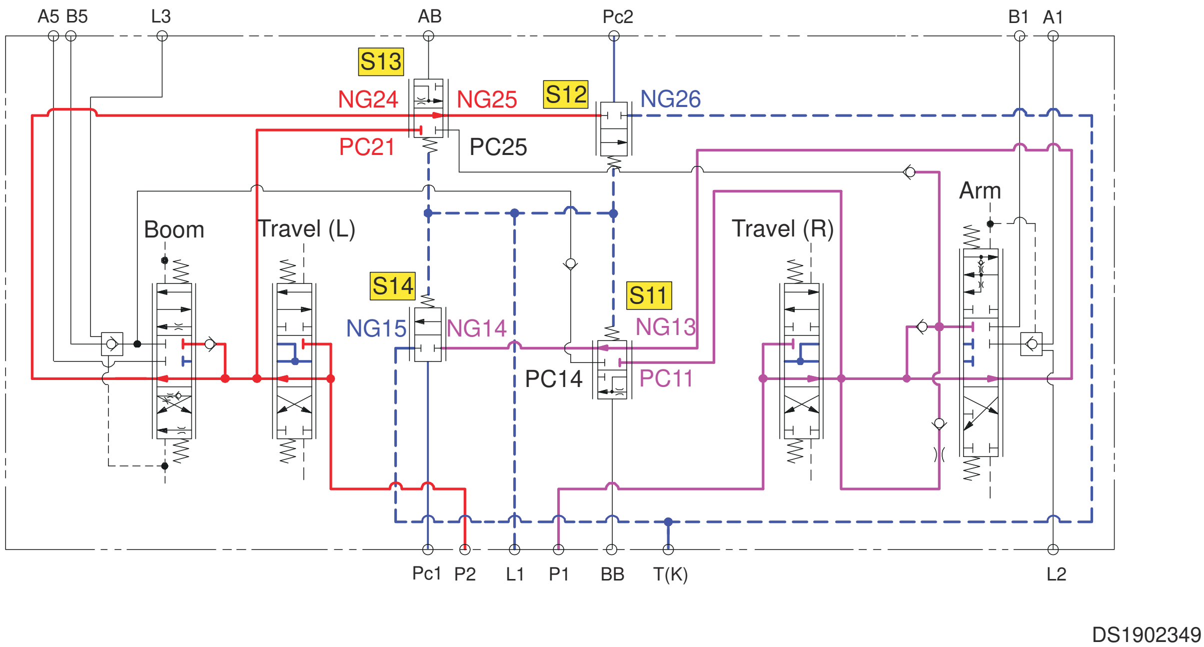


Two summing valves and two cut valves are integrated.

The summing valves enable summation of the pump volumes when the boom is raised and the arm crowd or dump. If the function of raising the boom is activated, also the boom boost valve S11 (connection BB) must also be activated. When P1 is in neutral, the connection between NG13 and NG14 on the S11 axis is open and the pump line is connected through the S14 cut valve into the tank channel. (D-Eco Power: Cut spools S12 and S14 are switched by pilot pressure in PC1 and PC2 → NG15 and NG26 are closed, no connection to tank channel.)

So that pump A2 (P1) can flow directly into the boom cylinder supply when the boom is being raised, the neutral gallery on S11 is closed (connection between NG13 and NG14), and the connection between NG13 and PC14 and the parallel connection between PC11 and PC14 is opened.

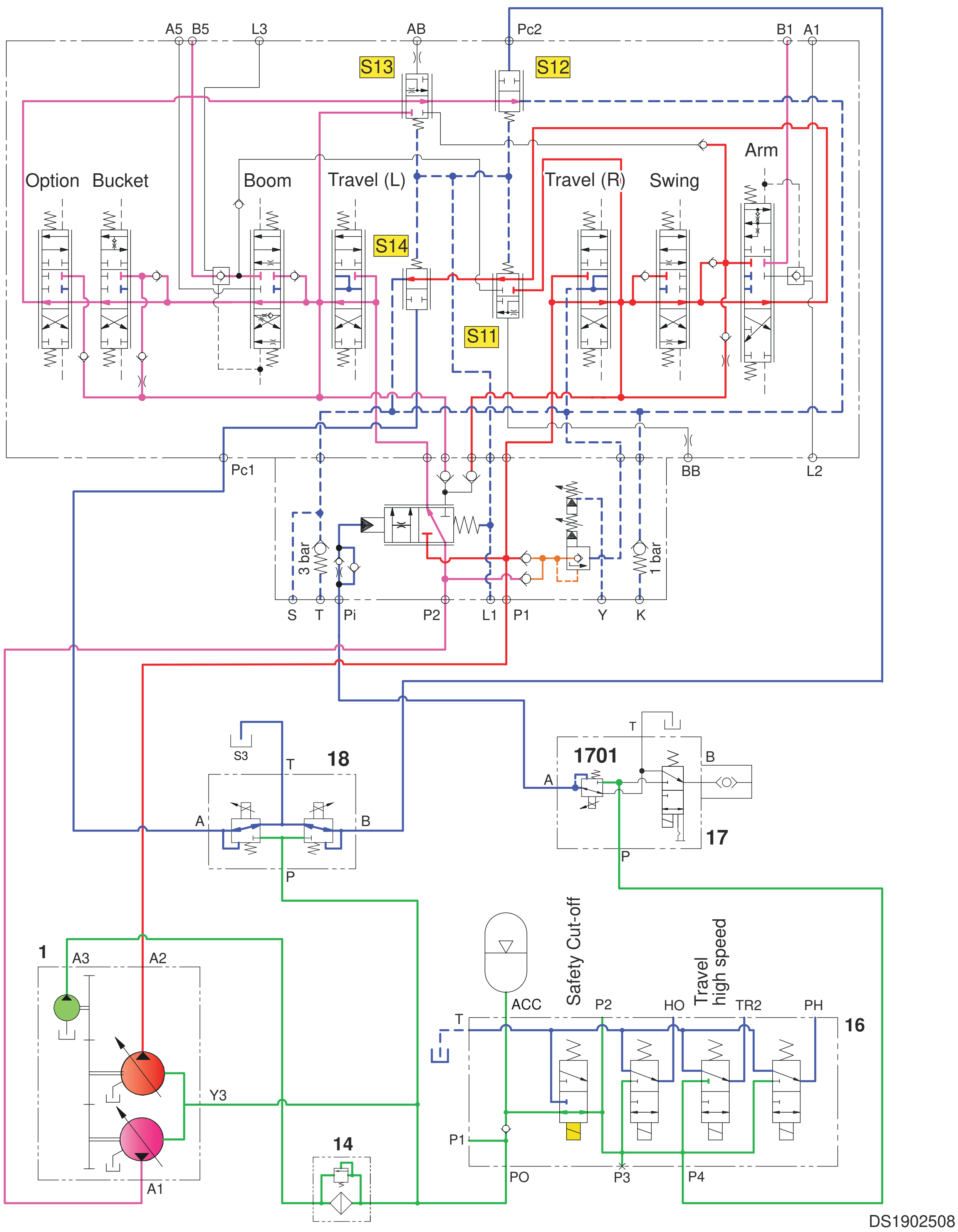
The supply orifices NG13 → NG14, NG13 → PC14 and PC11 → PC14 are integrated into the S11 summing piston for optimal control of the boom. If the function of arm crowd or dump is activated, also the arm boost valve S13(connection AB) must be activated. When pump A1 (P2) is in neutral, the connection between NG24 and NG25 on the S13 axis is open and the pump volume flows through the S12 cut valve into the tank channel. (D-Eco Power: cut spools S12 and S14 are switched by pilot pressure in PC1 and PC2 → NG15 and NG26 are closed, no connection to tank channel). So that pump volume A1 (P2) can flow directly into the arm clip when the arm is operated, the neutral gallery on S13 is closed (connection between NG24 and NG25), and the connection between NG24 and PC25 and the parallel connection between PC21 and PC25 is opened. The supply orifices NG24 → NG25, NG24 → PC25 and PC21 → PC25 are integrated into the S13 summing piston for optimal control of the arm.
Figure 201



- AB: Arm Signal
- BB: Boom Up Signal
- Pc1, Pc2: Center Bypass Cut Off Signal

Schematics (Summing and Cut Valve Related)

Figure 202



Straight Travel Spool

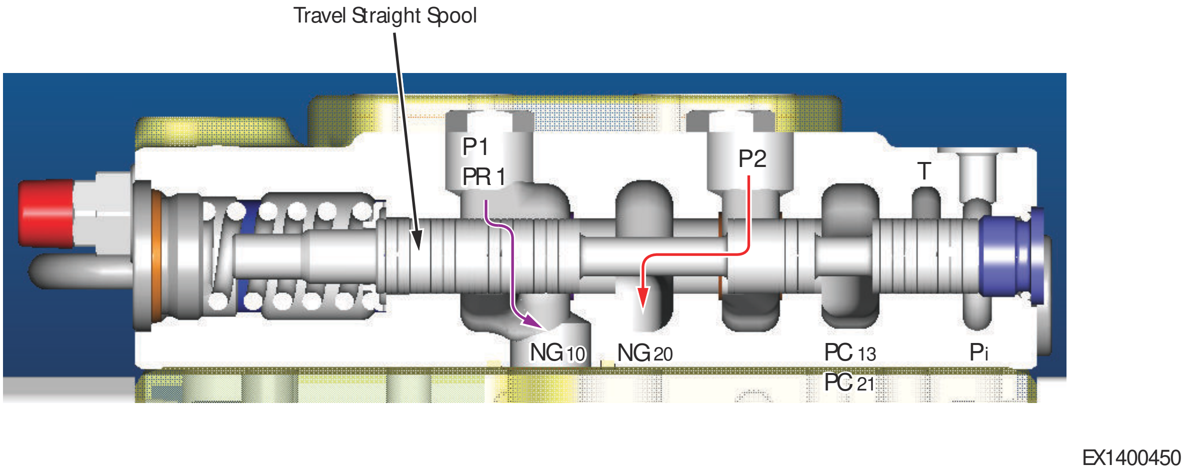
Travel Straight Operation

The straight travel spool (S10), which is integrated in the in-and outlet valve ensures the separation of the pump circuits to minimize the mutual interaction when the travel function is operated at the same time as any working function. (arm, boom, bucket and option).

During separation of the pump circuits P1 oil supplies the travel section S3 and S4 and P2 oil supplies all other functions.

The S3 spool (travel right) is assigned in tandem to the next S2 and S1 to ensure the oil supply through P1 oil is provided consistently as a priority for the travel under the different working conditions. In this way, the travel S3 is not affected by the actuation of others.

Figure 203

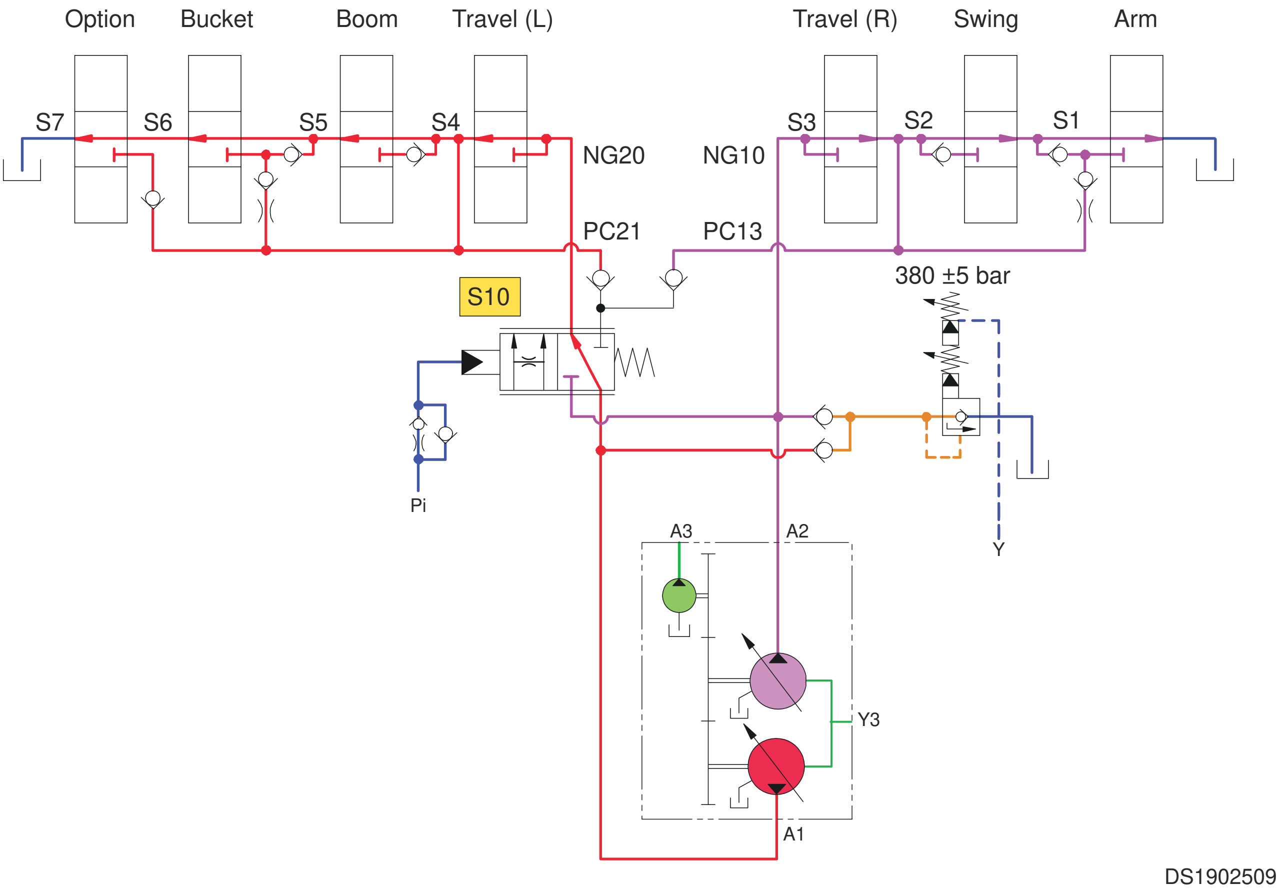


Travel Straight Spool - OFF

When the straight travel spool (S10) is in neutral, the connection between P2 and NG20 is opened. The connection or feed by the P2 pump for the parallel channel between PC13 and PC21 is closed. If the travel S3 section is not actuated, the S1 and S2 sections are supplied by the neutral circulation of the S3 spool.

As soon as the S1 and/or S2 spool are actuated at the same time as the S3 spool, the straight travel spool has to be switched on by the Pi port.

Figure 204



Travel Straight Spool - ON

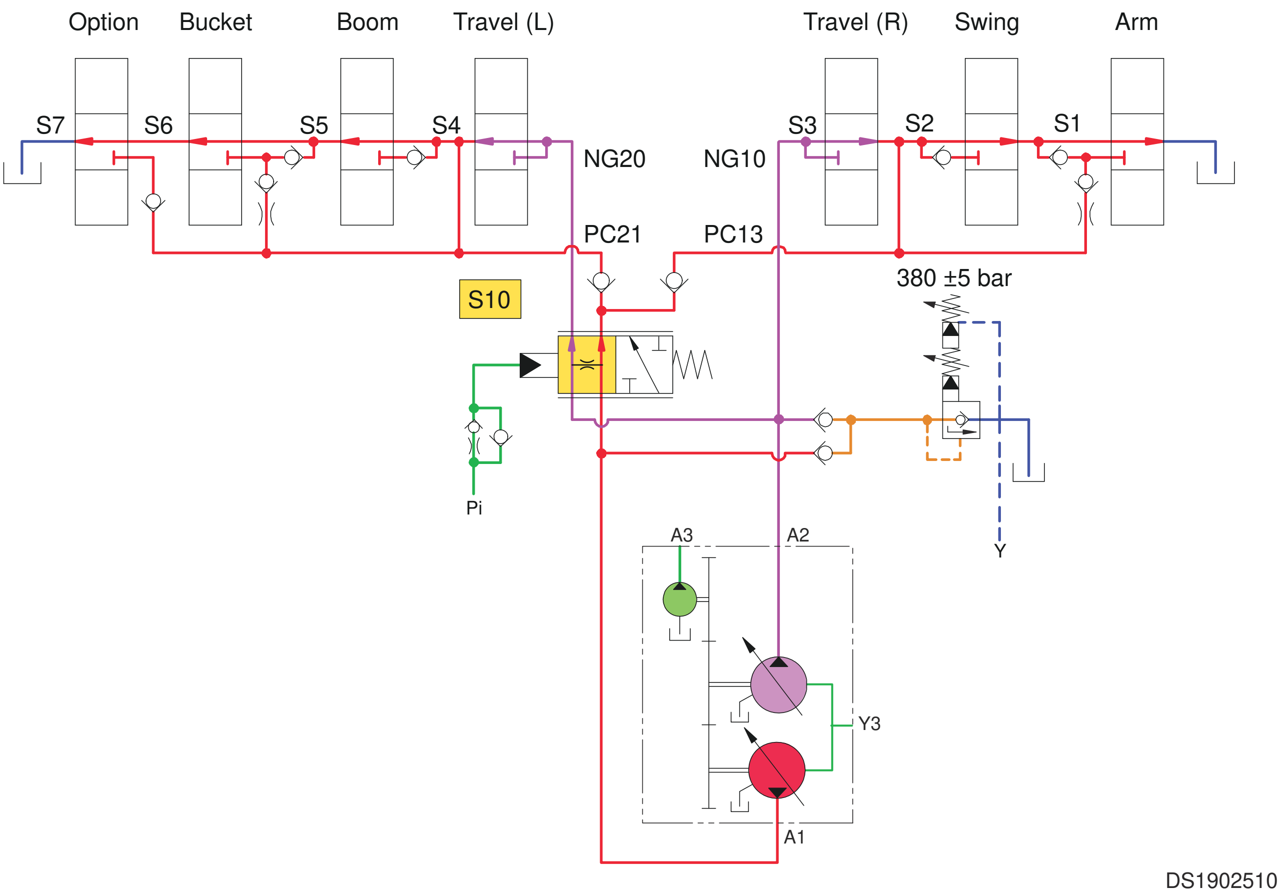
The S1 and S2 axis are then supplied by the P2 pump by the PC13 channel during operation, so full pump volume from P1 is available for driving the machine. The cut valve (S12) "Summing and Cut Valves" is switched on in parallel so necessary pressure is applied to pump 2 (P2).

The S4 spool (travel left) is assigned in tandem to the next S5, S6 and S7 to ensure the oil supply through pump 2 (P2) is provided consistently as a priority for the travel under the different working conditions. In this way, the travel S4 is not affected by the actuation of others. When the straight travel spool (S10) is in neutral, the connection between P2 and NG20 is opened.

The connection or feed by the P2 pump for the parallel channel between PC13 and PC21 is closed. If the travel S4 spool is not actuated, the S5, S6 and S7 sections are supplied by the neutral circulation of the S4 spool. As soon as the S5, S6 and/or S7 spool are actuated at the same time as the S4 spool, the straight travel valve has to be switched on by the Pi port.

The S5, S6 and S7 spools are then supplied by the P2 pump by the PC21 channel during operation, so full pump volume from P1 is available for driving the machine. The S14 cut valve "Summing and Cut Valves" is switched on in parallel so necessary pressure is applied to pump A1 (P2).

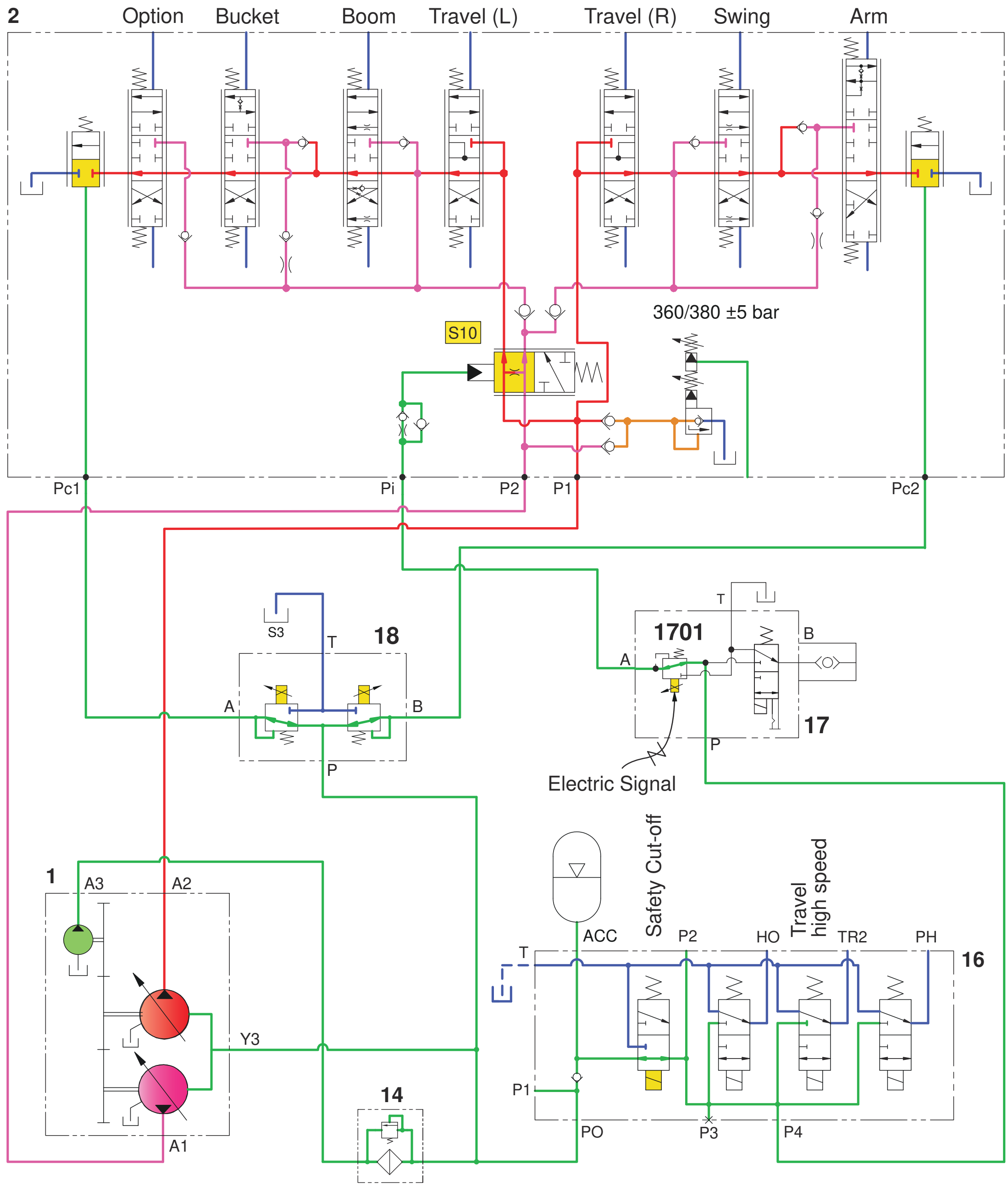
Figure 205



The Straight Traveling Spool Operating Conditions

- At the operation of the pilot EPPR valve (electric current supplied)
  - Traveling straight (left and right traveling simultaneously)→ Less than 12 kg/cm^2: 150 mA, 12 kg/cm^2 or higher: 150 - 600 mA
  - Traveling straight (left and right traveling simultaneously) + Front operation → 150 - 600 mA
  - Simultaneous traveling condition is judged by the condition that less value of the left and right traveling exceeds 1/2 of the larger value.

- EPPR output is proportional to the front lever summation
  Figure 206



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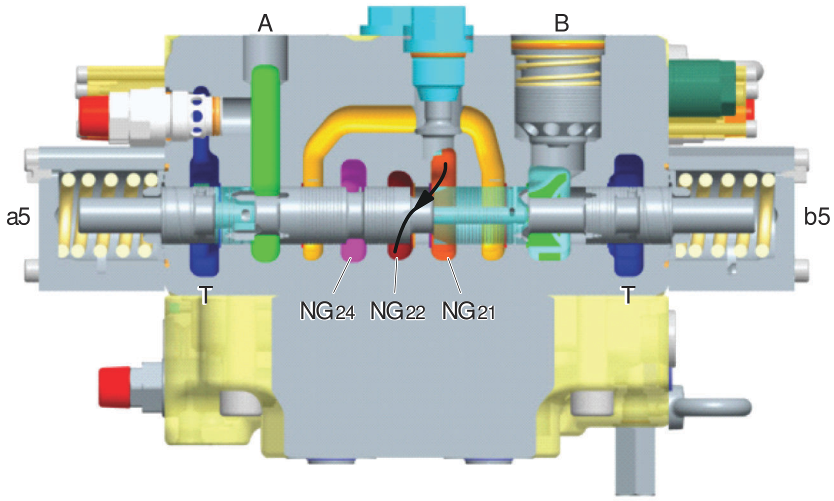
Boom Spool Shift

Load holding valve and regeneration valve (boom down) is installed on boom line.

Figure 207



Boom Up (2-pump Summation)

In single operation, the supply for raising the boom (S5) (B5 port) is provided by (P2) by the NG20 and NG21 neutral circulation. For the summation of both pump flows P1 and P2 form boom raising it is necessary to activate the boom summation spool (S11) by the BB port (Summing and Cut Valves) in parallel to the spool S5.

The oil from pump 1 (P1) is then added directly into the boom bottom side by the NG10/NG11/NG12/NG13 neutral circulation and the PC14 parallel channel.

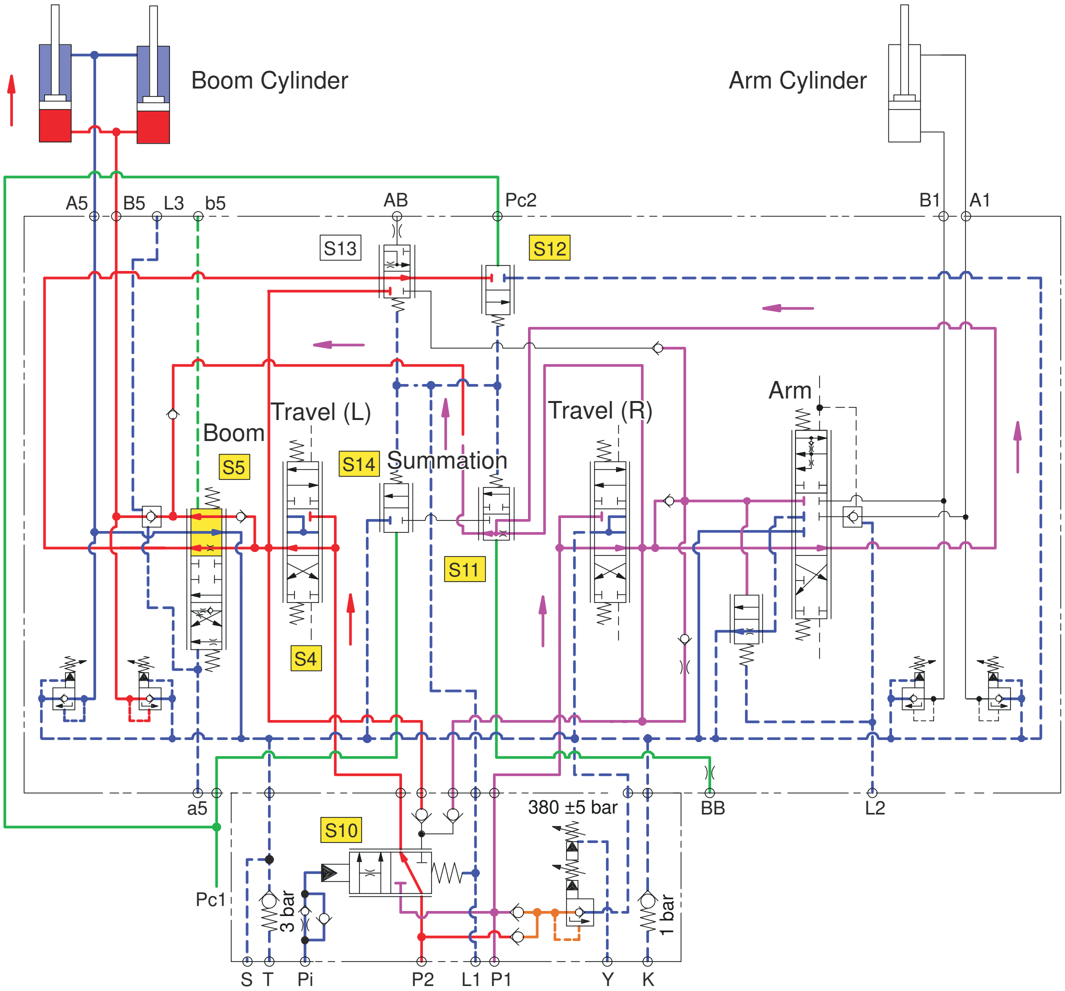
If other spools are actuated, which are supplied by pump 1 (P1), at the same time as raising the boom, the supply from NG13 to PC14 by the summing piston (S11) is interrupted.

The parallel passage from PC11 to PC14 in the summing piston (S11) can also be used to provide the boom raising function for corresponding load pressures with an additional supply through a partial flow from (P1) by NG10/NG11/PC11 and the PC14 parallel channel. If the travel spool (S4) is proportionally operated to full output at the same time as the boom section (S5), the supply by the neutral gallery NG21 is reduced for boom spool (S5).

In the opposite direction, the supply for S5 by the parallel channel PC21 by (P2) increases because the connection between P2 and PC21 opens in proportion by the straight travel spool (S10). At the same time the supply of travel spool S4 will be taken over by (P1) through the connection of P1 and NG20 which is opened by the straight travel valve (S10). Also the necessary pressure in the pump circuit (P1) is established by closing the cut valve (S14).

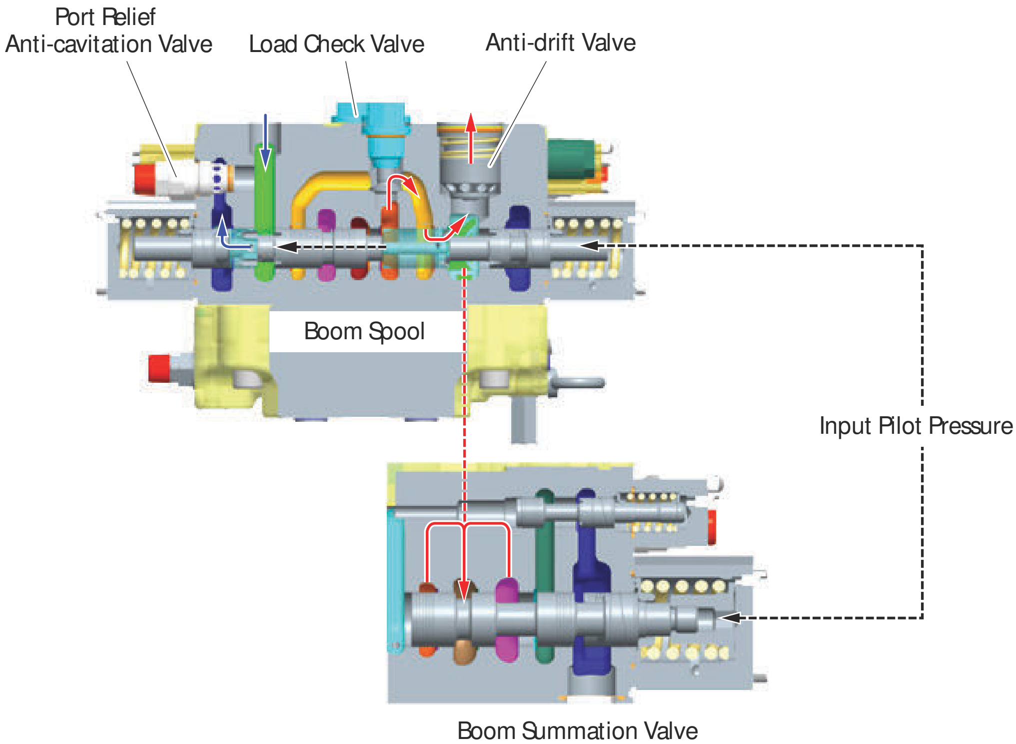
The pilot-controlled check valve (10) "Pilot-controlled Check Valve (Anti drift Valve)" which is integrated into the boom supply, ensures a leak-free boom shut-off against undesirable lowering while the S5 piston is in neutral. Both the rod side (A) and the head side (B) are protected by a combined pressure anti cavitation valve.

Figure 208



DS1902511

Figure 209



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Boom Down (Regeneration)

In single operation, the supply for lowering the boom (S5) is provided by (P2) by the NG20 and NG21. Parallel to this, the pilot controlled check valve (10) “Pilot-controlled Check Valve (Anti drift Valve)” is activated so return oil can drain from the cylinder (B5 port) to the tank. The regeneration function integrated into the boom piston enables high lowering speeds on the boom without cavitation on the rod also for overlapped movements, since some of the oil draining away from the base, in addition to the available pump oil, is fed into the rod side of the boom cylinder. If the travel section (S4) is proportionally operated to full output at the same time as the boom spool (S5), the supply by the NG21 is reduced for boom spool S5. In the opposite direction, the supply for S5 by the parallel channel PC21 by (P2) increases because the connection between P2 and PC21 opens in proportion by the straight travel spool (S10). At the same time the supply of section S4 will be taken over by (P1) through the connection of P1 and NG20 which is opened by the straight travel spool (S10). Also the necessary pressure in the pump circuit (P1) is established by closing the cut valve (S14).

Figure 210

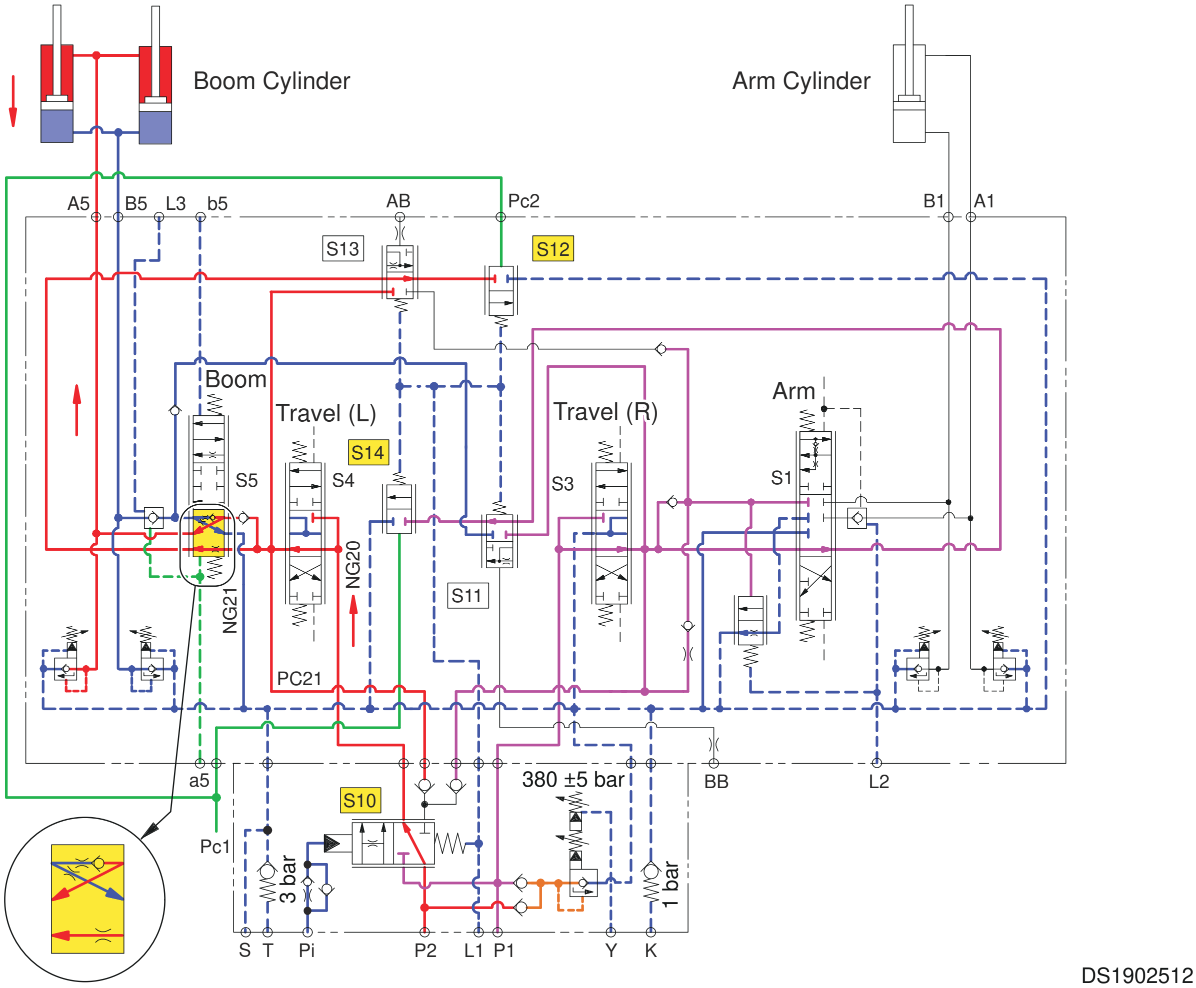
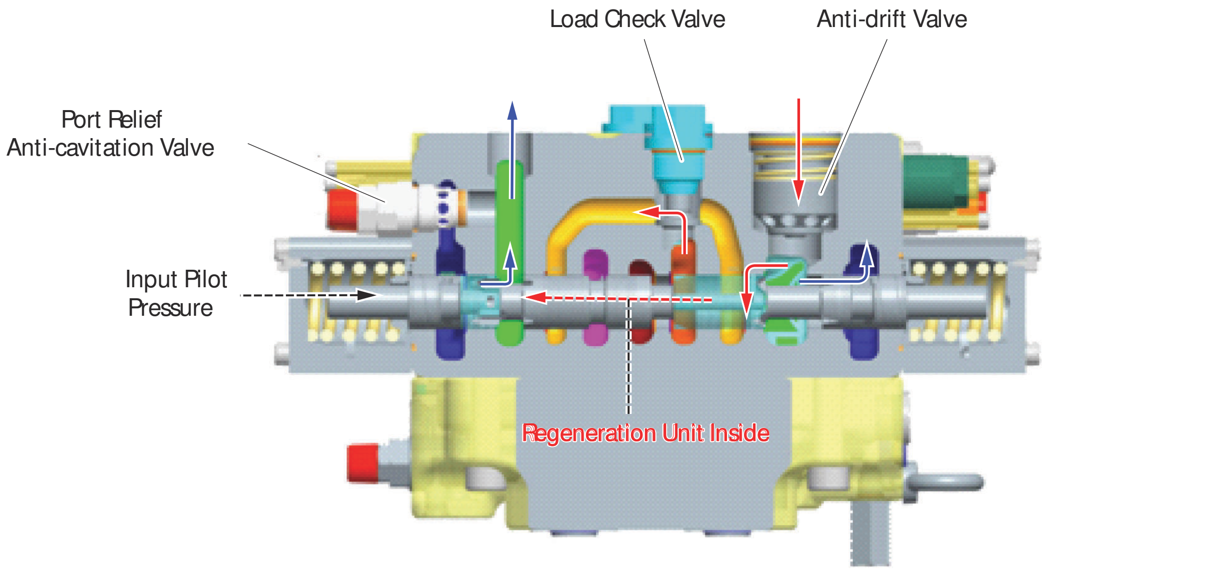


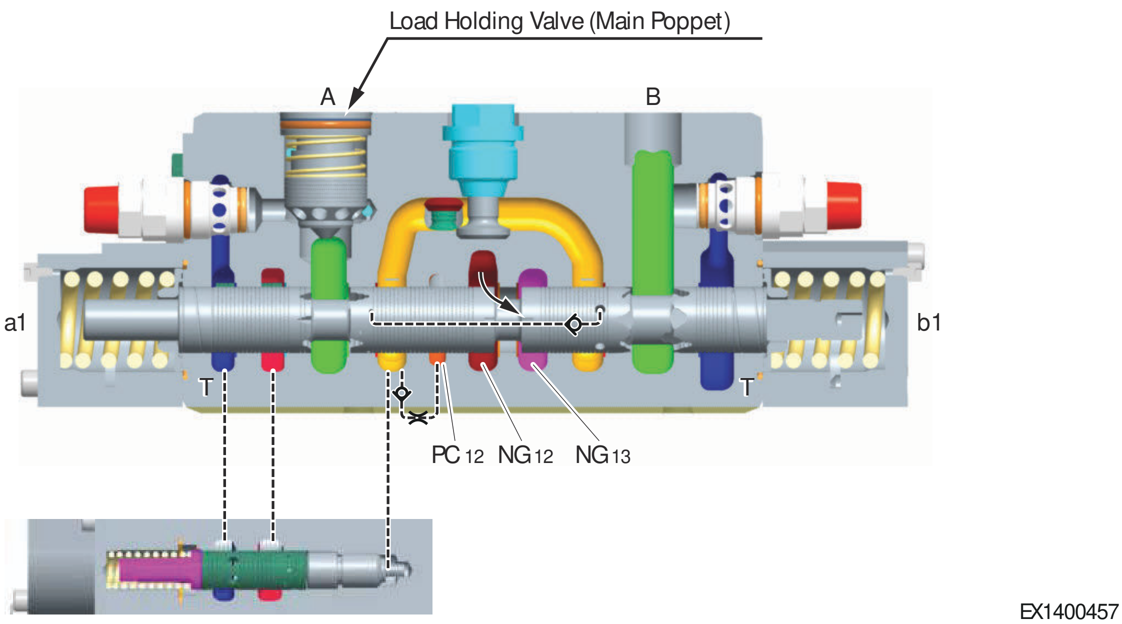
Figure 211



Arm Spool Shift

Load holding valve and regeneration valve (arm crowd) is installed on arm line.

Figure 212



Arm Crowd (Retraction)

In single operation, the arm extension function (S1) is supplied by the NG10, NG11 and NG12 neutral gallery by (P1). For the summation of both pump flows P1 and P2 form arm out it is necessary to activate the arm summation spool (S13) by the AB port in parallel to the spool S1.

The oil from pump 2 (P2) is supplied into the arm spool by the NG20/NG21/NG22/NG23/NG24 neutral gallery and the PC25 parallel channel.

If the boom and/or bucket are activated at the same time as the arm, the supply from NG24 to PC25 by the summing piston (S13) is interrupted.

The parallel passage from PC21 to PC25 in the summation spool (S13) can also be used to provide the arm function for corresponding load pressures with an additional supply through a partial flow from (P2) by NG20/NG21/PC21 and the PC25 parallel channel. If the travel spool (S4) is at maximum control, no oil can flow to the arm by the parallel nut in the summing piston (S13).

Both the head side (A) and the rod side (B) can be secured by a combined pressure anti cavitation valve. The check valve “Pilot-controlled Check Valve (Anti drift Valve)”, which is integrated into the head side feed from the arm ensures a leak-free shut-off and prevents the arm being retracted at the neutral position of the arm spool (S1).

When the arm spool (S1) being activated by b1, the Arm is retracted. The Pilot-controlled Check Valve (Anti drift Valve) is controlled at the same time so return oil can flow from the cylinder head side to the tank.

Figure 213

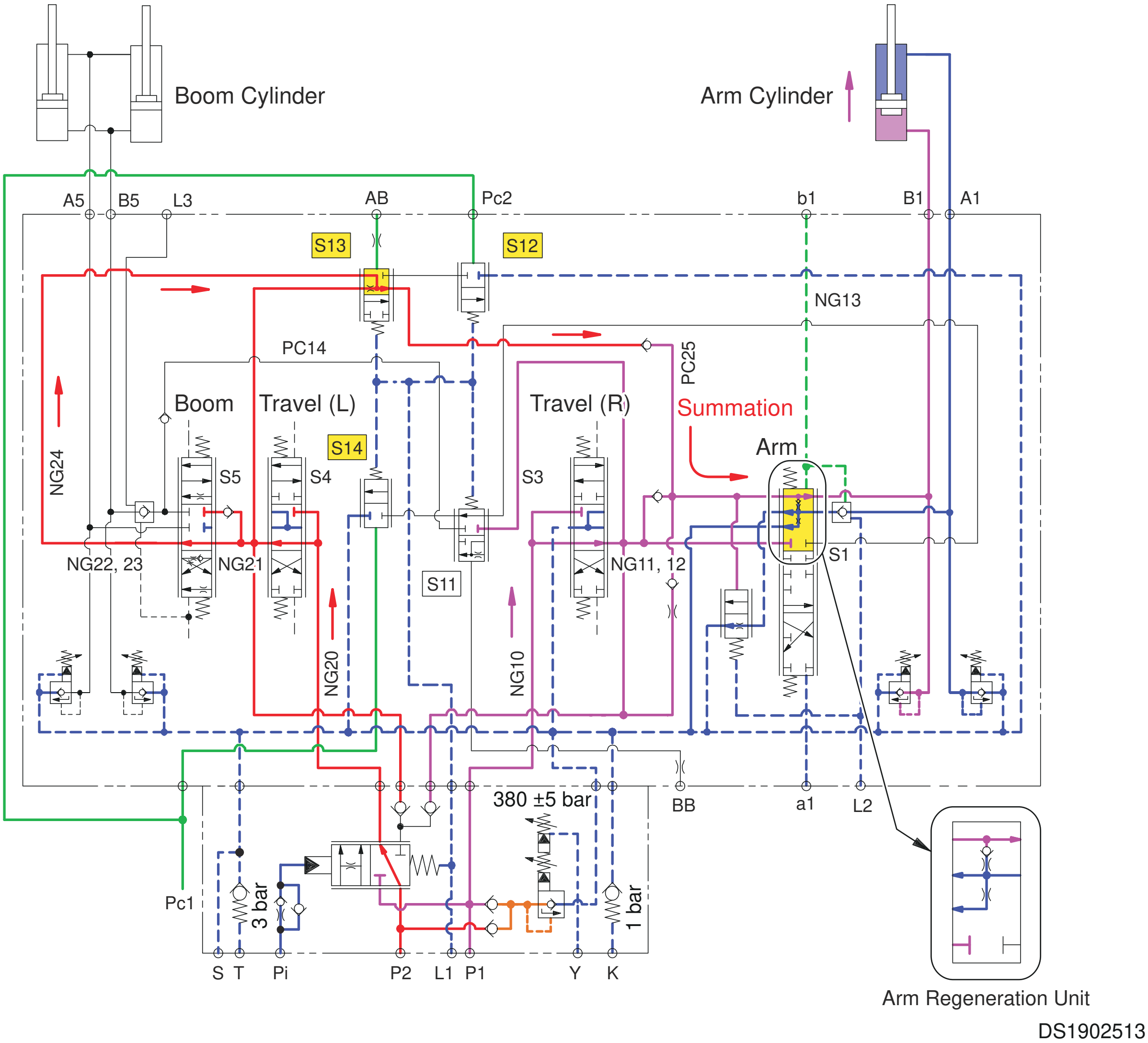
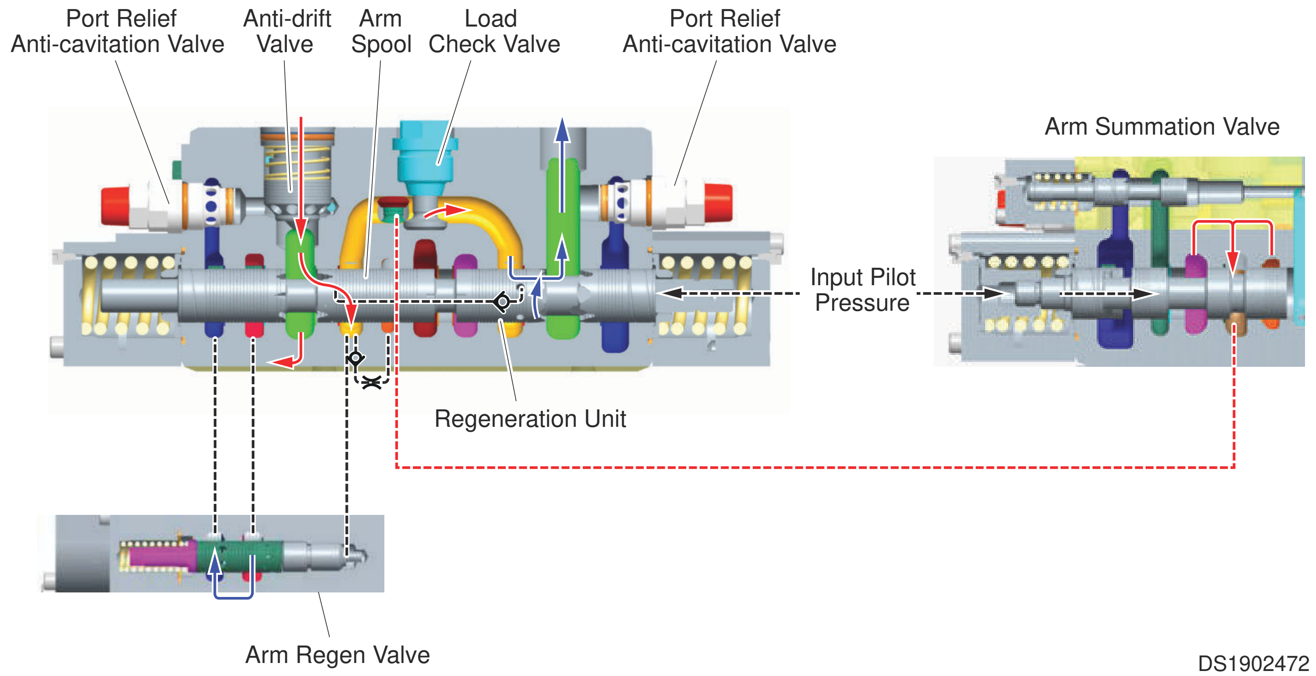


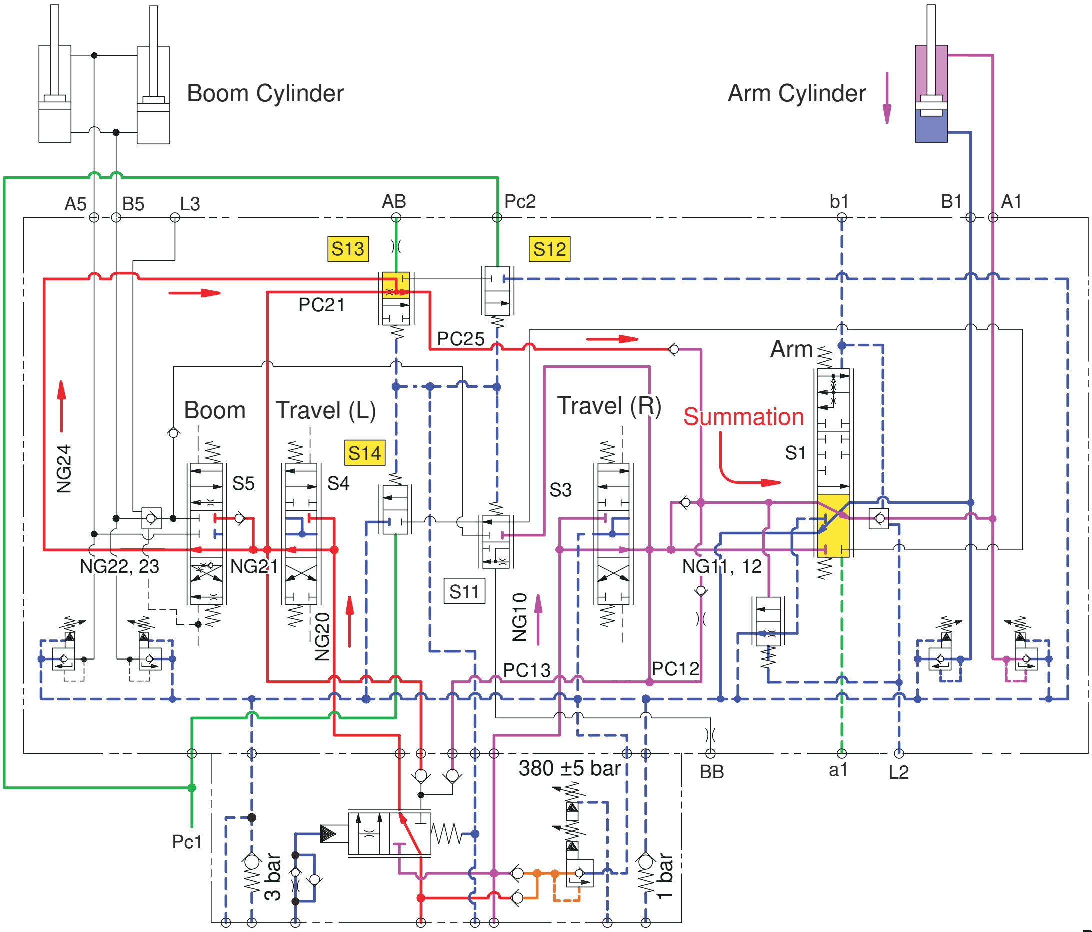
Figure 214



Arm Dump (Extension)

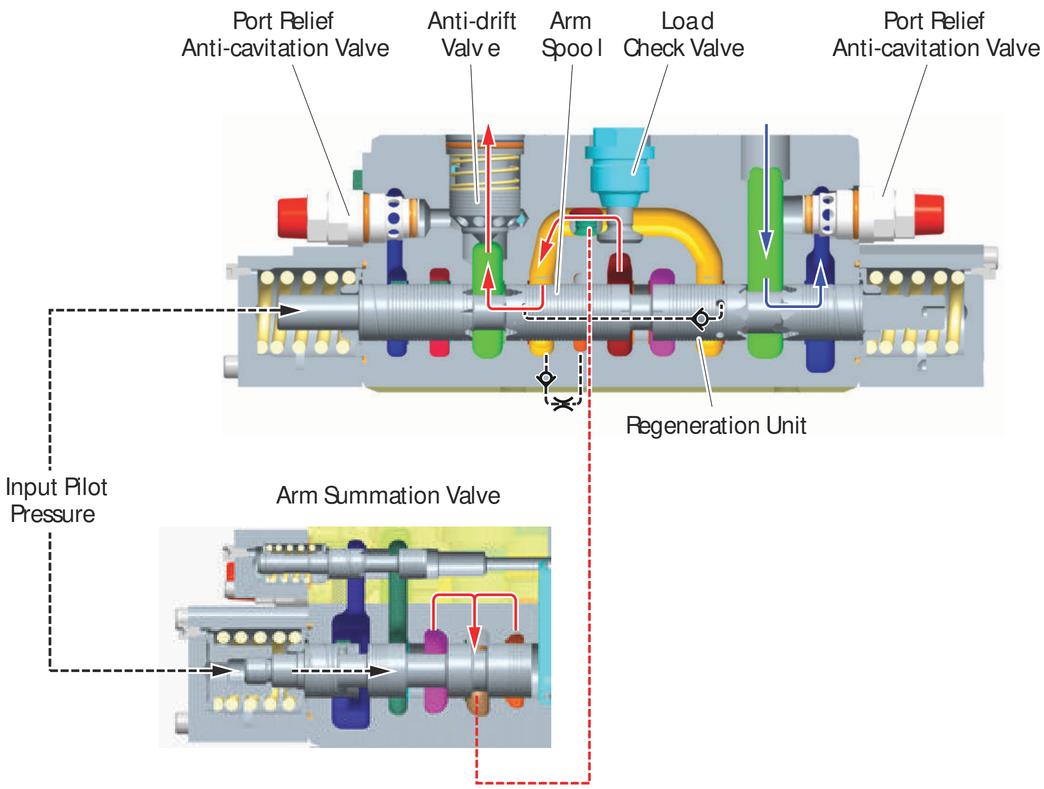
In single operation, the arm extension function (S1) is supplied by the NG10, NG11 and NG12 neutral gallery by (P1). For the summation of both pump flows P1 and P2 form arm dump it is necessary to activate the arm summation spool (S13) by the AB port "Summing and Cut Valves" in parallel to the spool S1. The oil from (P2) is then added into the arm spool by the NG20/NG21/NG22/NG23/NG24 neutral gallery and the PC25 parallel channel. The arm spool (S1) can also be supplied by an orifice within the parallel channel PC12. If the boom and/or bucket are activated at the same time as the arm, the supply from NG24 to PC25 by the summing piston (S13) is interrupted. The parallel groove from PC21 to PC25 in the sum piston (S13) can also be used to provide the arm function for corresponding load pressures with an additional supply through a partial flow from (P2) by NG20/NG21/PC21 and the PC25 channel. If the travel spool (S4) is at maximum control, no oil can flow to the arm by the parallel nut in the summing piston (S13).

Figure 215



DS1902514

Figure 216

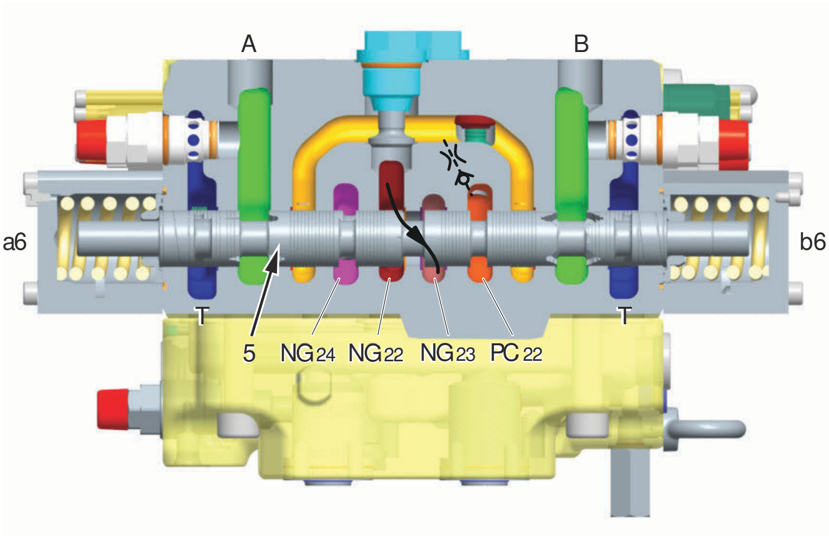


EX1400467

Bucket Compound Operation

The regeneration valve (bucket crowd) is installed on bucket section.

Figure 217



In single operation, the bucket section (S6) is supplied by pump A1 (P2) by the neutral gallery NG20, NG21 and NG22, the clip channel (5) and parallel channel (PC22). The PC22 parallel channel is fed by the NG21 neutral circulation as soon as the necessary load pressure is established in the NG21/NG22 circulation by controlling the bucket piston (S6).

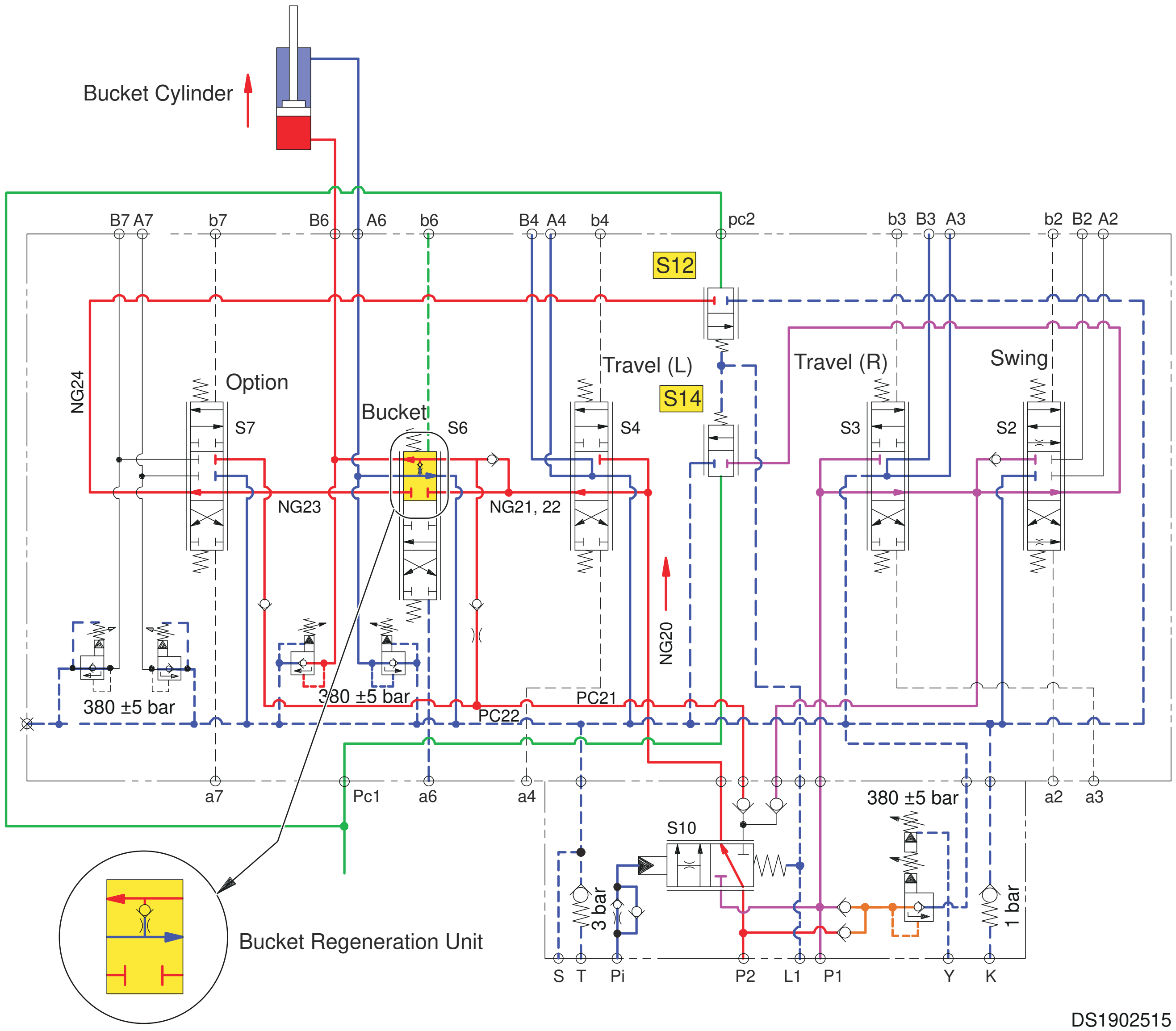
In single operation, the bucket section (S6) is supplied by pump 2 (P2) by the NG20, NG21 and NG22 neutral circulation, the clip channel (5) and parallel channel (PC22).

The PC22 parallel channel is fed by the NG21 neutral circulation as soon as the necessary load pressure is established in the NG21/NG22 circulation by controlling the bucket piston (S6).

If the travel section (S4) is proportionally operated to full output at the same time as the bucket section (S6), the supply from pump 2 (P2) by NG21 is reduced for the (S6) spool. In the opposite direction, the supply from pump A1 (P2) into the PC21/PC22 by the straight travel spool (S10) increases. The connection between P1 and NG20 opens in proportion by the straight travel spool (S10) to supply the travel section (S4).

The necessary pressure in the P2 pump circuit is established by closing the cut valve (S14).

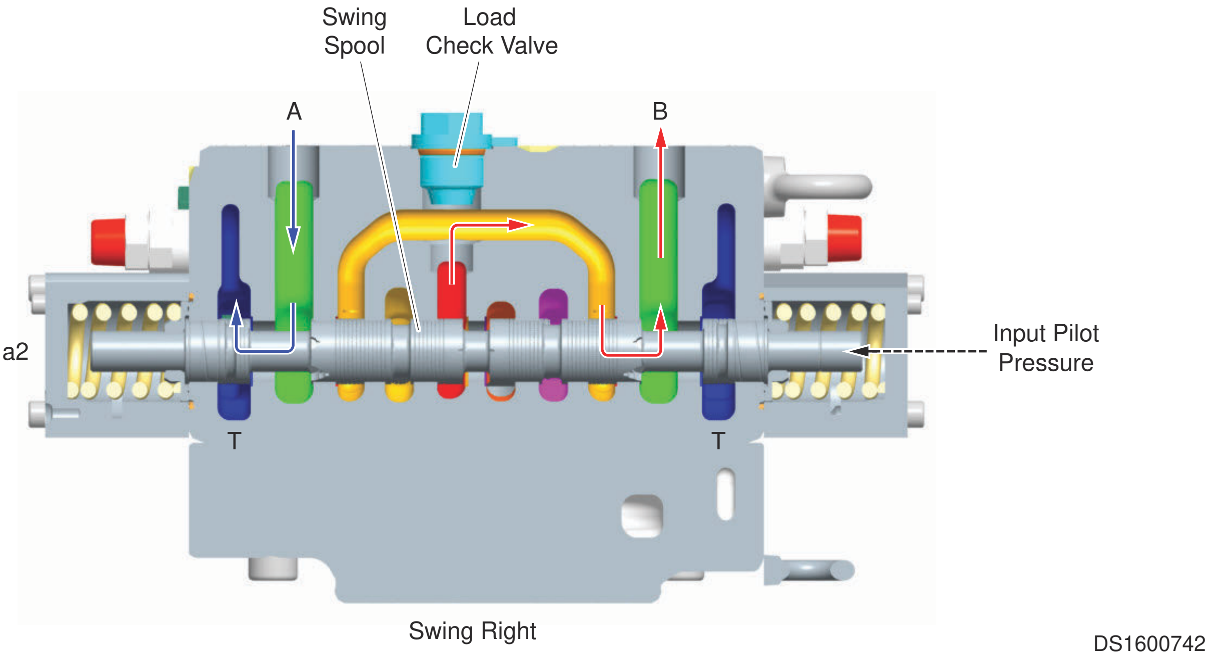
Figure 218



Swing Compound Operation

In single operation, the swing section (S2) is supplied by (P1). The swing spool (S2) and arm spool (S1) are connected in parallel to the pump (P1) by PC12. With an appropriately set restrict or in PC12, the slewing gear retains the necessary priority for acceleration in relation to the arm spool (S1).

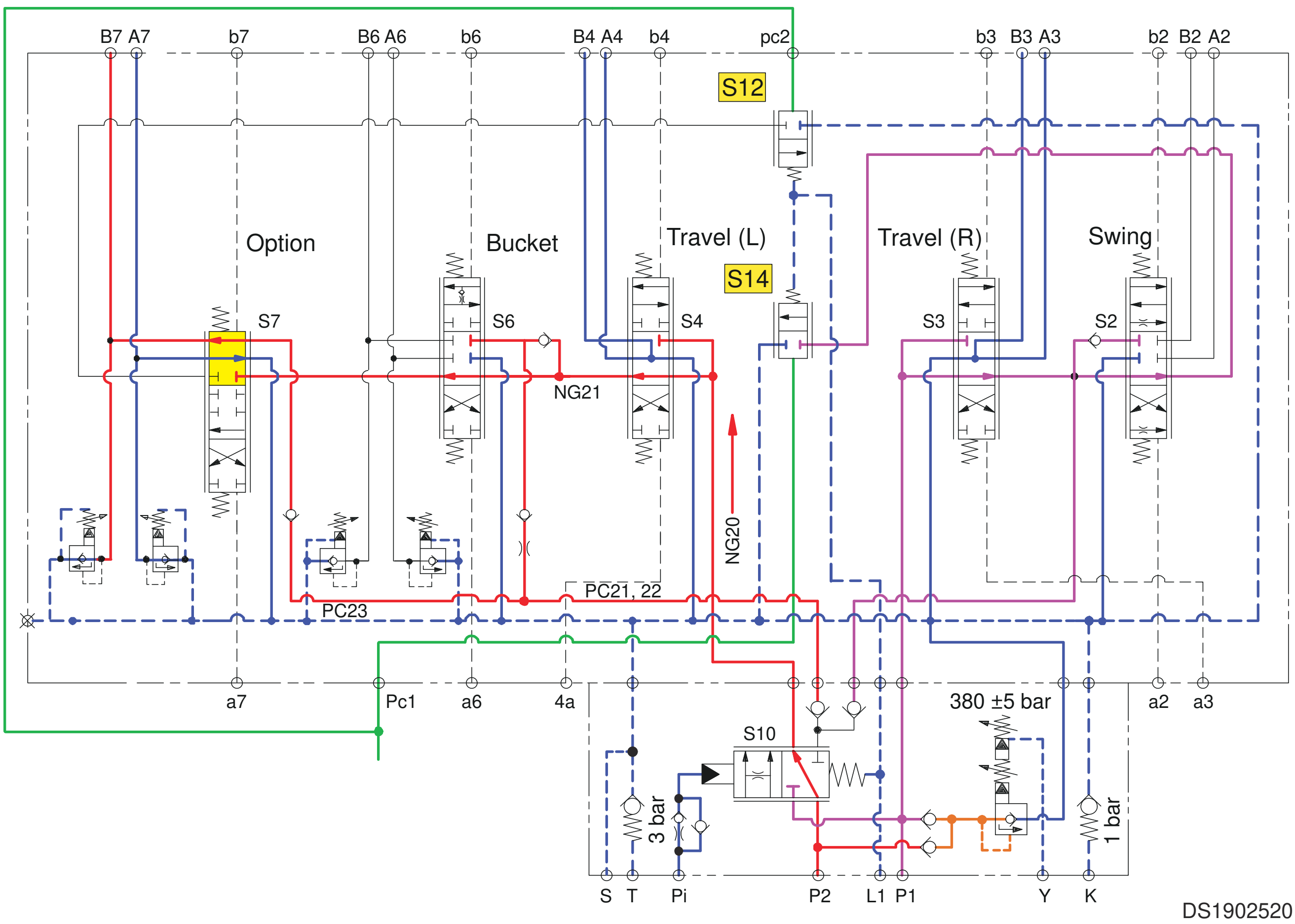
Figure 219



Swing Right/Left

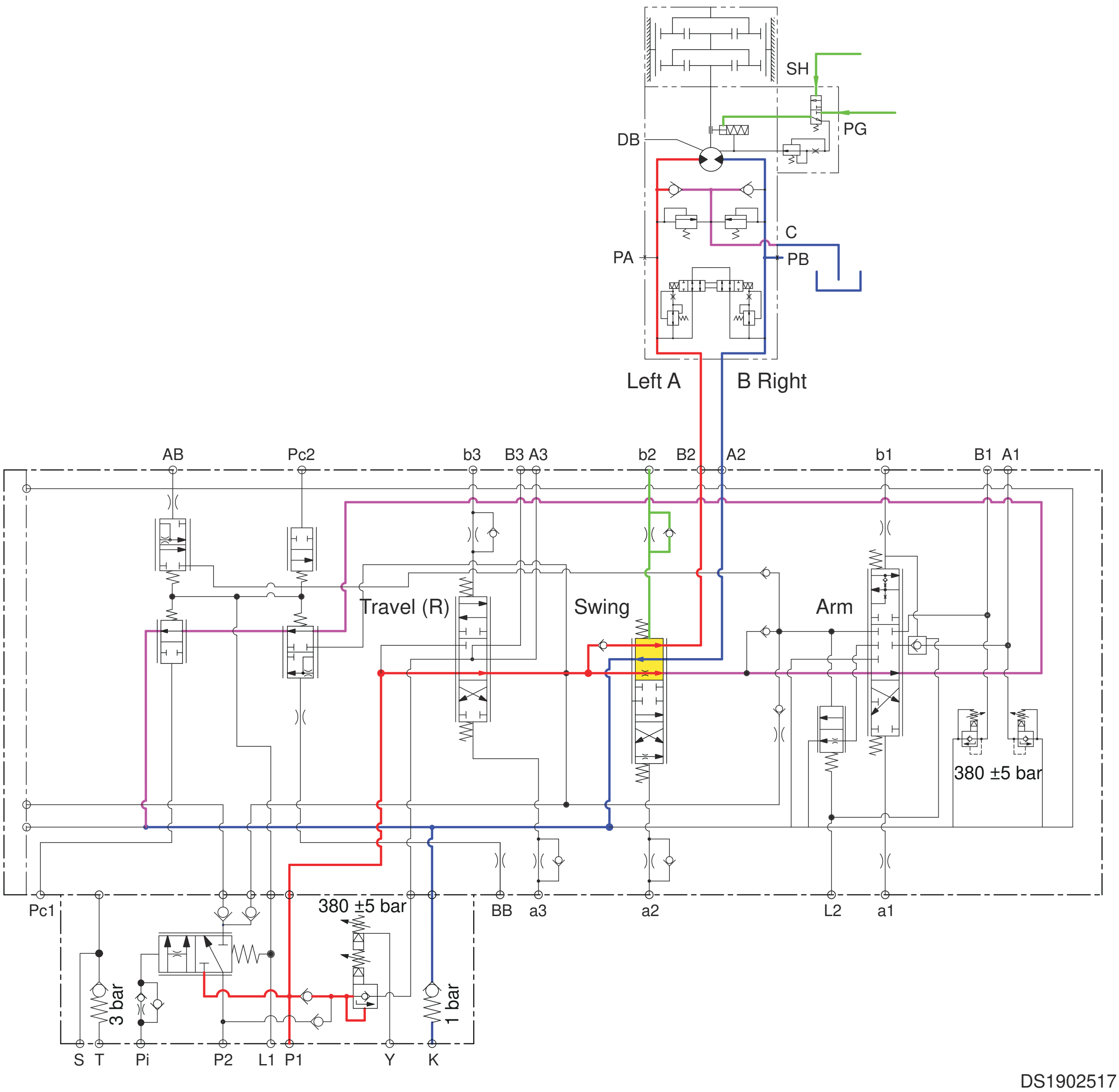
Flow rate discharged from P1 is supplied to swing motor through swing spool, whose opening area dependent on the swing pilot signal. The direction of the swing motor rotation is dependent on the pilot signal, right or left.

Figure 220



No Swing Signal with Swing Operation

1. Sudden fall of “Swing Signal Input” will lead to the upper carriage keep moving because of the inertia of huge mass.
2. The bypass-cut valve must remain opened during this operation to supply oil required for the makeup function.
3. Oil from tank reaches to the swing motor, actually working as a swing pump, through makeup valve to avoid cavitation.
   Figure 221

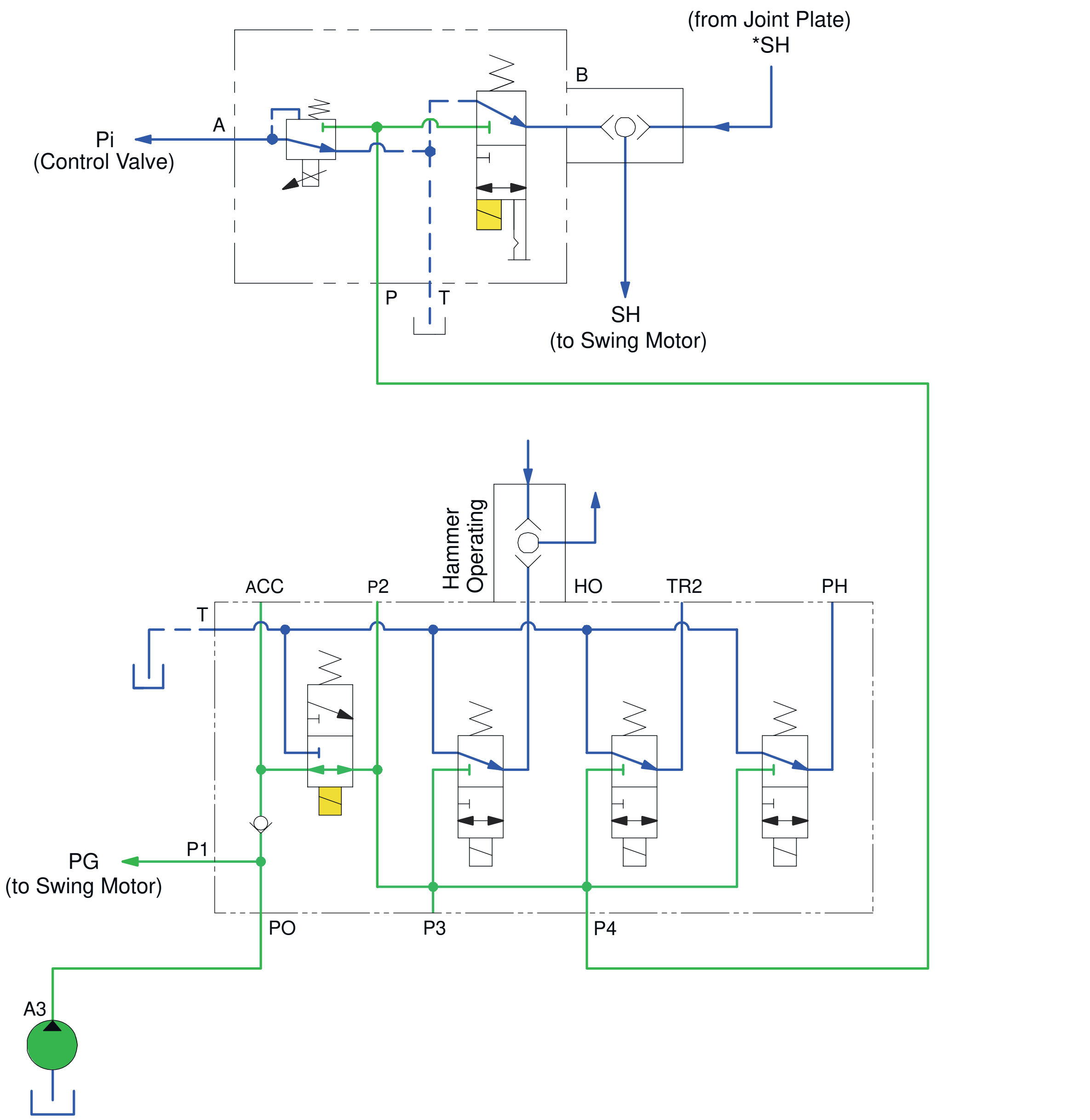


Swing Brake Release Operation Condition

At swing parking brake solenoid valve ON (Any one or more of the boom, arm, bucket, and swing sensor is 1.5 V or higher)

- During swing operation (released by pilot pressure in swing operation, shuttle valve SH signal pressure)

- Left and right simultaneous traveling (travel sensor value is 1.5 V or higher)
  Figure 222



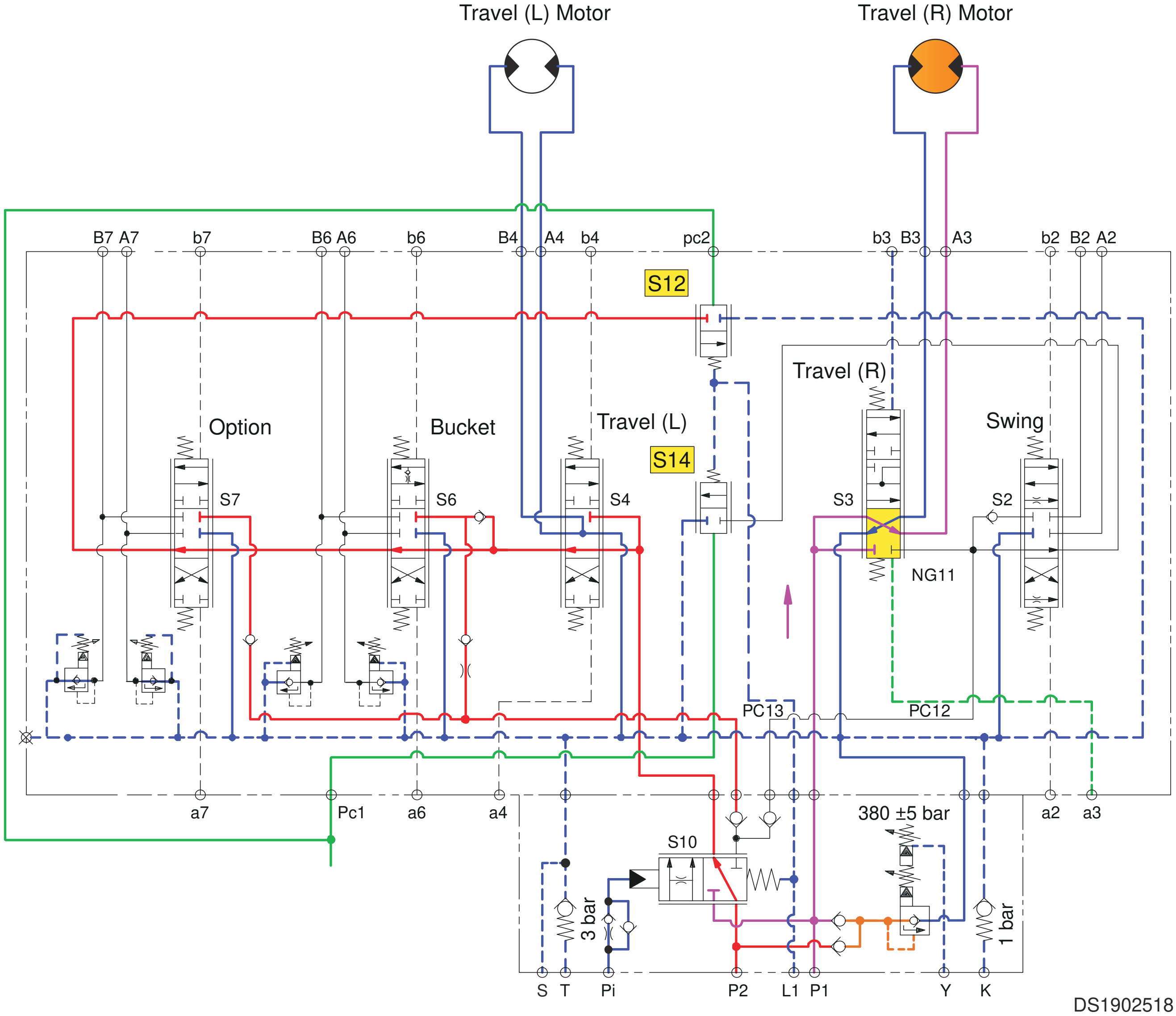
Travel Operation

Travel Right

In single operation, the travel spool (S3) supply is provided directly by (P1). To ensure operation with maximum volumetric flow is not affected by other spools, (P1) is available exclusively for travel function when the travel spool (S3) is operated to full output. The travel spool (S3) therefore takes priority over the swing spool (S2) and arm spool (S1), which are supplied by the straight travel spool (S10) and the channels PC13 and PC12 by pump 2 (P2) in this case.

This priority is established by closing the NG11 neutral circulation of the travel spool (S3).

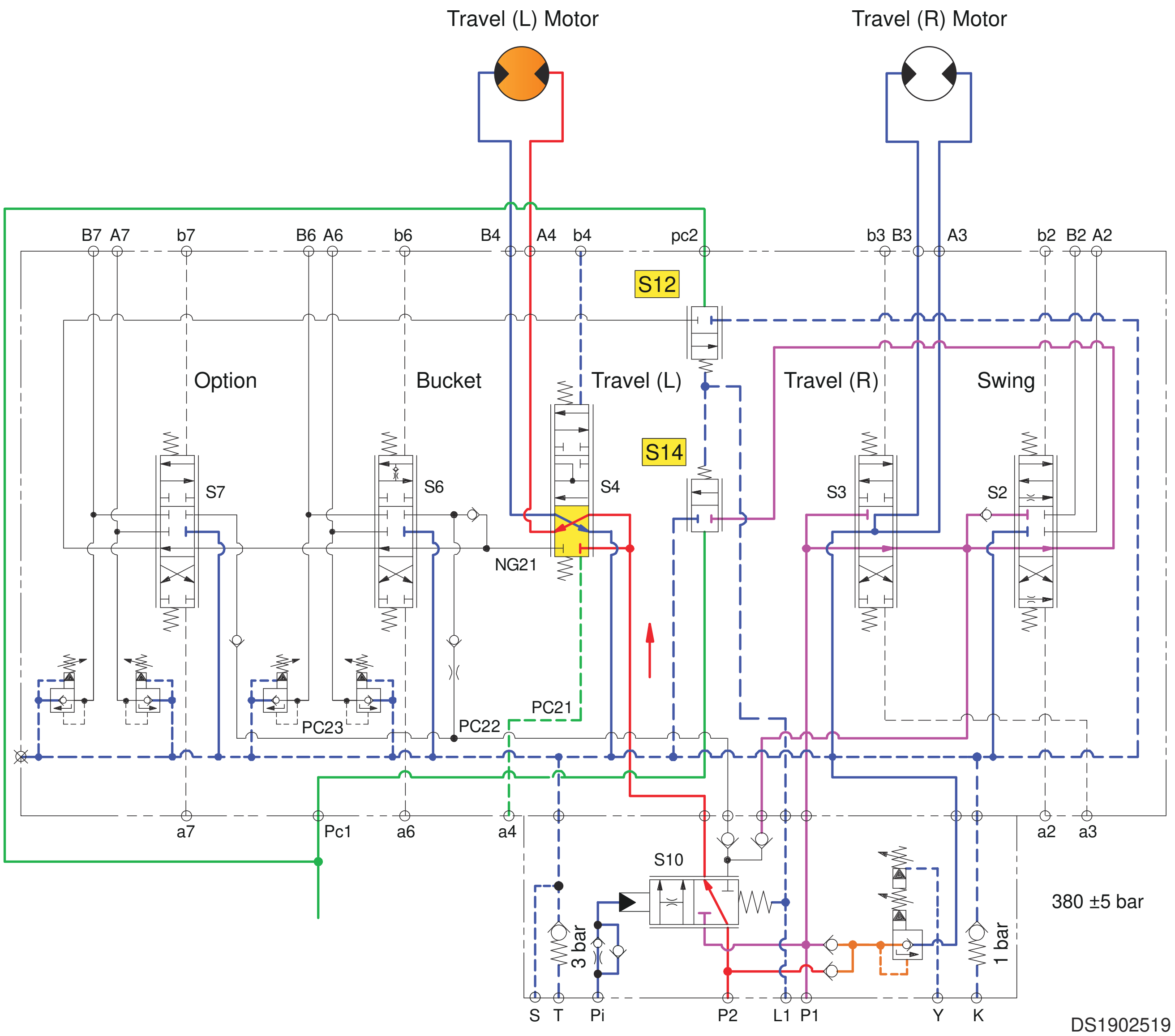
Figure 223



Travel Left

In single operation, the travel spool (S4) supply is provided directly by (P2). To ensure operation with maximum volumetric flow is not affected by other spools, (P2) is available exclusively for travel function when the travel spool (S4) is operated to full output. The travel spool (S4) therefore takes priority over the boom spool (S5), bucket spool (S6) and option spool (S7). This priority is established by closing the NG21 neutral gallery of the travel spool (S4). As soon as the boom, bucket or option section is operated in parallel with the travel spool S4 the travel spool will be supplied by (P1) and the following sections will be supplied by PC21, PC22 and PC23 by (P2) by the straight travel spool.

Figure 224



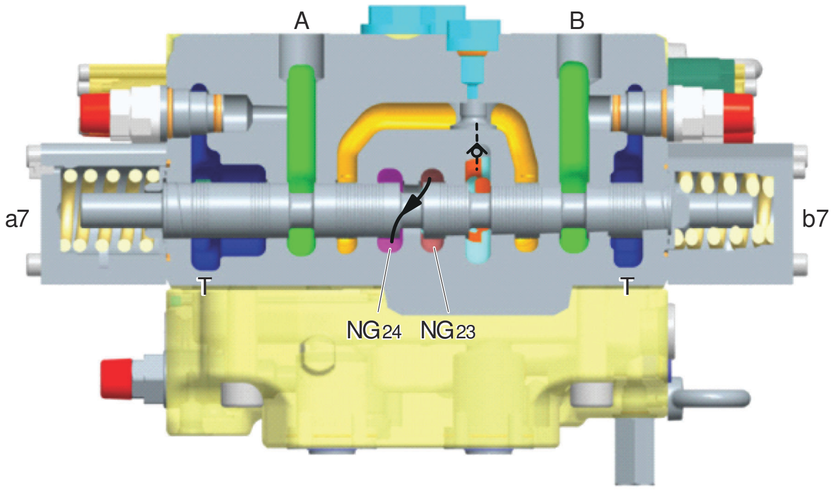
Option Spool Shift

Breaker and shear can be installed on option line.

The brake is one way and the shear is two-way.

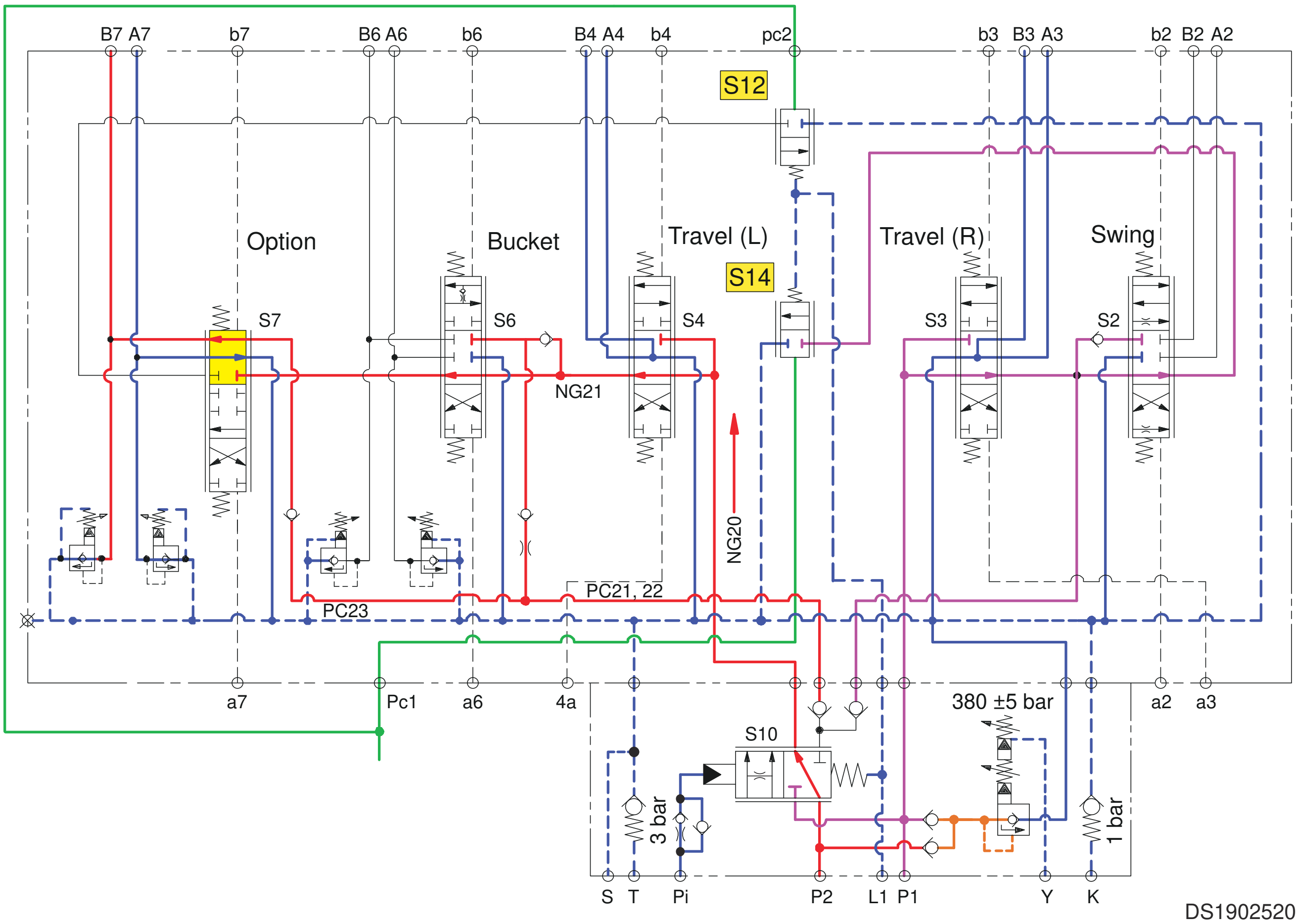
The pump discharge rate related to option (spool) is set up at the instrument panel.

Figure 225



In single operation, the option spool (S7) is supplied by (P2) by the neutral gallery NG20, NG21 and the parallel channel PC22, PC23. If the travel spool (S4) is proportionally operated to full output at the same time as the option spool (S7), the supply from (P2) by NG21 is reduced for the S7. In the opposite direction, the supply from (P2) into the PC21/PC22/PC23 by the straight travel spool (S10) increases. The connection between P1 and NG20 opens in proportion by the straight travel spool (S10) to supply the travel spool (S4). The necessary pressure in the P1 and P2 pump circuit is established by closing the cut valve (S14).

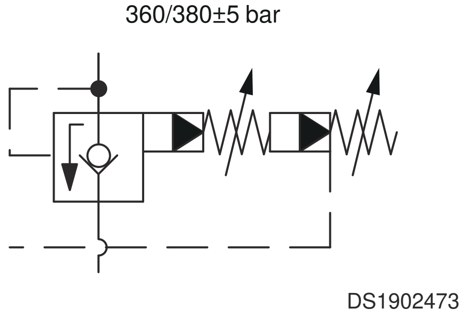
Figure 226



Main Relief Valve and Port Relief Valve

Main Relief Valve

Figure 227



The pilot-operated primary pressure relief valve is screwed into the side of the control block, and limits the maximum pump (system) pressure to the set value as a safety valve. Pressure peaks in the pump line can occur if the volume flow requested by the orifices is used up more quickly than the volume flow requested by the pump or if an error occurs in the system.

When the system is delivered, the pressure setting is set according to the project, and must not be changed.

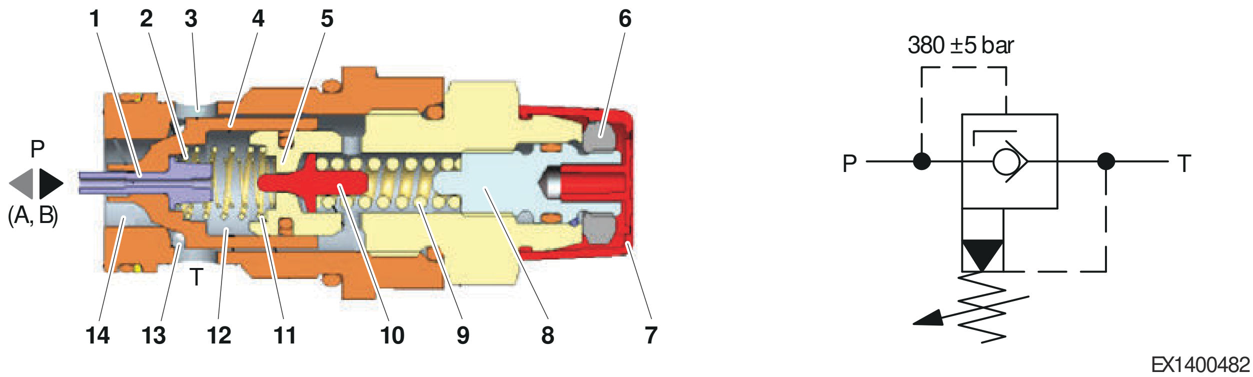
Operation

The primary pressure relief valve and the secondary pressure relief valves are identical in design and function. The system pressure p is available by the restrict or D1 (1) in chamber C (12) (Figure 32,Figure 33). Since the A2 surface (4) is larger than A1 (14), the main poppet remains closed. The spring 1 (2) in chamber C (12) ensures a stable installation position. The valve remains closed as long as the system pressure p is less than the value set by the spindle (7) and compression spring (9). If the pressure p exceeds the set value, the pilot poppet (10) opens and the oil volume from chamber C (12) flows to the tank by the D2 restrict or (5). The pressure in chamber C (12) drops because the supply by the smaller section of the D1 restrict or (1) is less than the outflow by the opened pilot poppet (10). The higher pressure p on the surface A1 (14) opens the main poppet against the spring 1 (2), and connects the pump line/demand line to the tank. The anti cavitation (feed) function is not used on the primary side.

Port Relief Valve

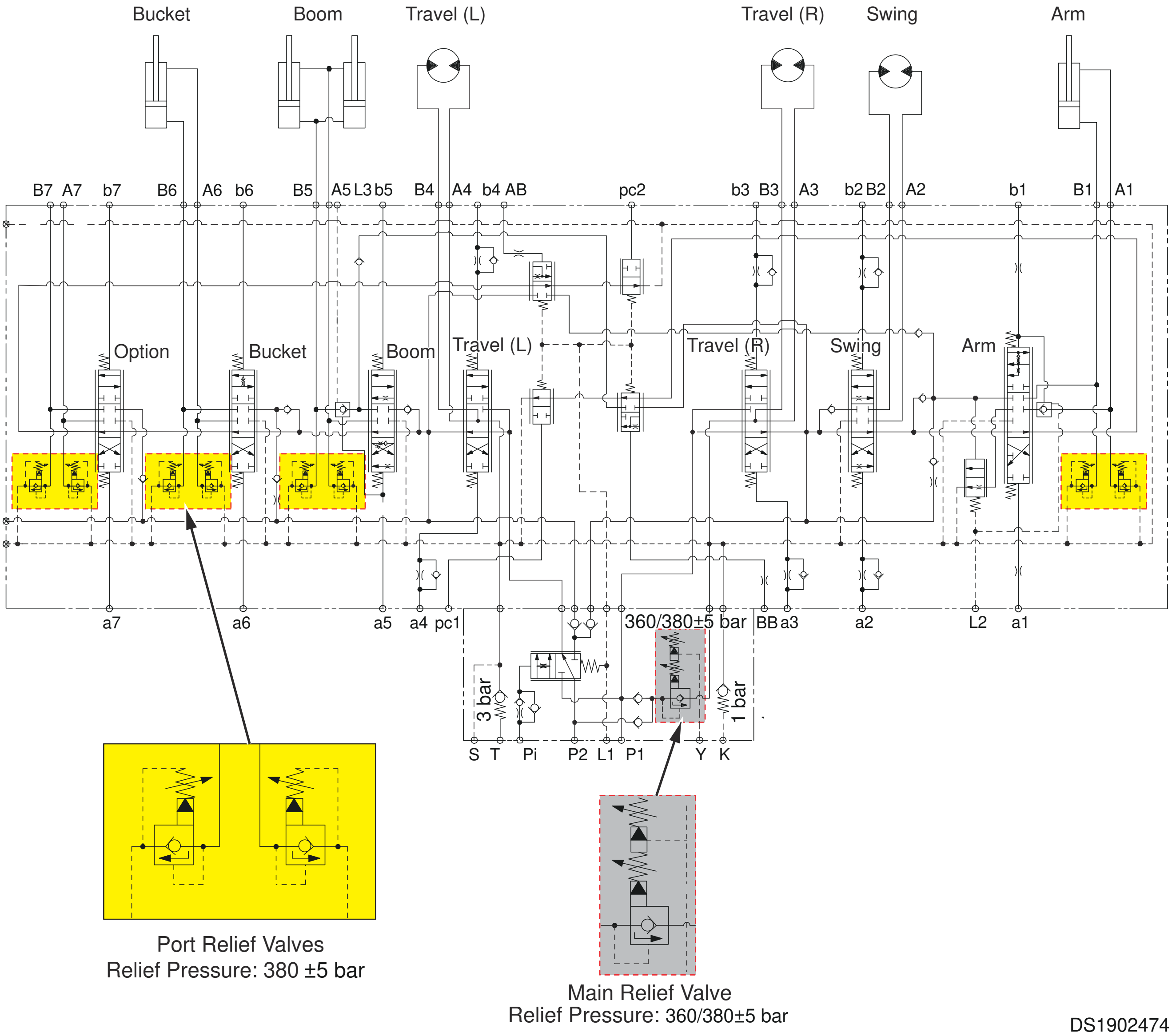
The pilot-controlled pressure anti cavitation valves of the individual consumer connections A and B are screwed into the individual sections as valves in cartridge form above the control piston. The valve protects the consumer circuit from overloading or damage, e.g. from external forces or abrupt delays (control piston in neutral position) by removing the pressure peak to the tank. It limits the maximum pressure in the consumer as a safety valve and sets the connection to the directional control valve to the individually set value. When the system is delivered, the pressure setting is set according to the project, and must not be changed.

Figure 228



Reference Number	Description
1	D1 Restrict or
2	Spring 1
3	Main Poppet
4	A2 Surface
5	D2 Restrict or
6	Counter nut
7	Setting Spindle
8	pst Supply
9	Pressure Setting Spring
10	Pilot Poppet
11	Spring 2
12	Chamber C
13	A3 Surface
14	A1 Surface

Figure 229

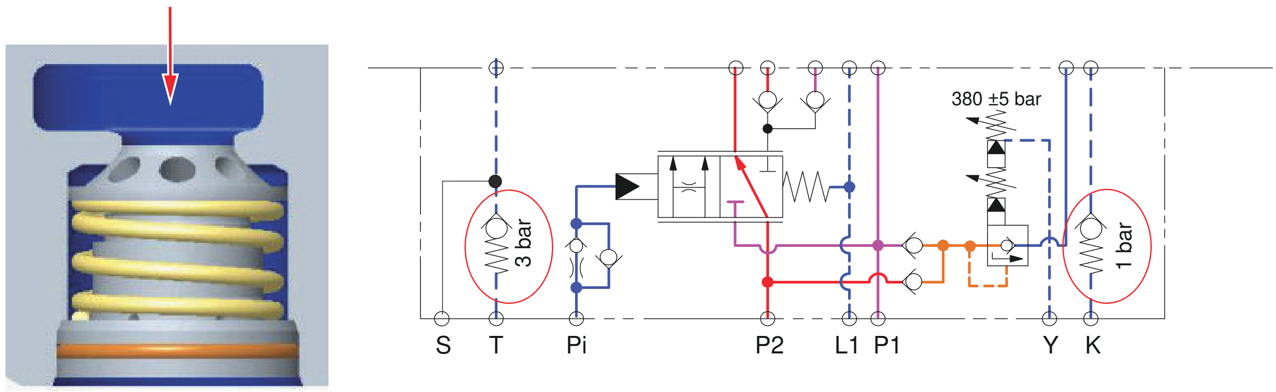


Retraction Valve (1 bar, 3 bar Check Valve)

The mono block has central cooling and tank connections K and T which are integrated in the in- and outlet valve. These are check valves and pre-tensioned by springs. The resulting backlog in the outflow ensures oil feeds in the event of negative external loads (e.g. lowering the boom, downhill travel or similar movements creating extra demand) and avoids filling problems/cavitation in the system.

The volume required for the post-feeds is fed from the demand volume during consumer movements. If a consumer is delayed abruptly, and the mass moment of inertia does not stop immediately, e.g. swing motor, the Q min volume of pumps 1 (P1) and 2 (P2) ensure the required tank line volume in the block. The lower pre-tensioning of the check valve on the K-connection creates the priority of the non-return valve of the oil by the cooler. With increasing volume flow, the resistance increases in the cooler line, and a partial flow is fed in the bypass by the T-connection to the tank.

Figure 230



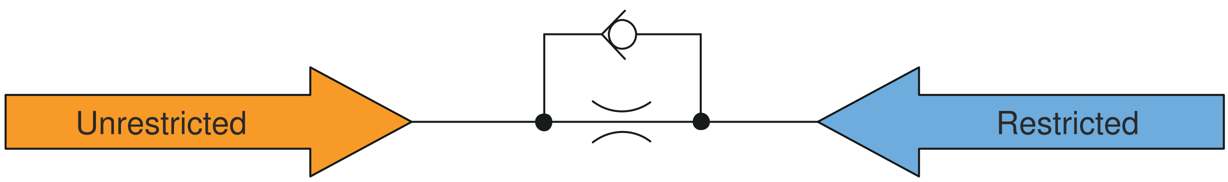
DS1902521

Shockless Valve

The shockless valve (orifice, check valve) in the control valve pilot line enables smooth control of the spool. (Initial control of the spool)

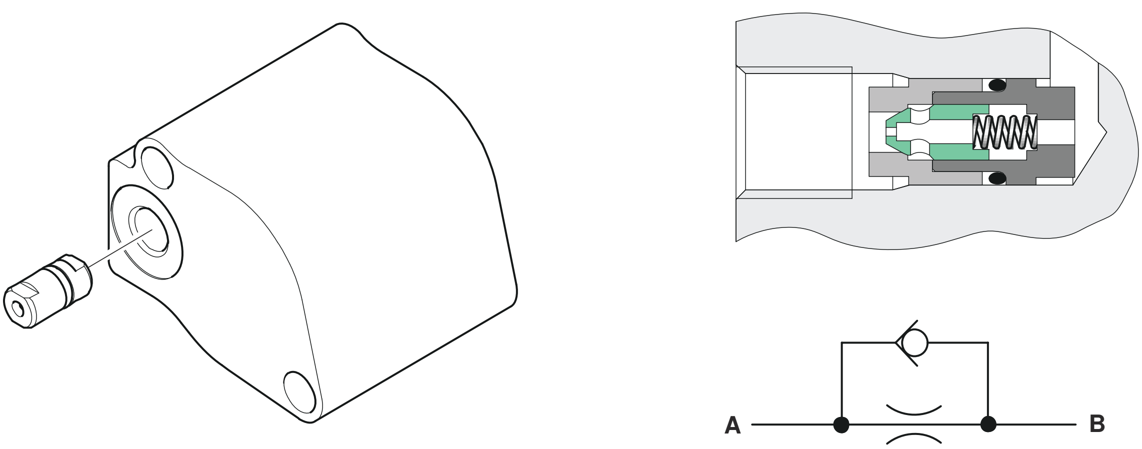
- Total six valves are provided: swing and traveling (left, right).

1. Circuit diagram
   Figure 231



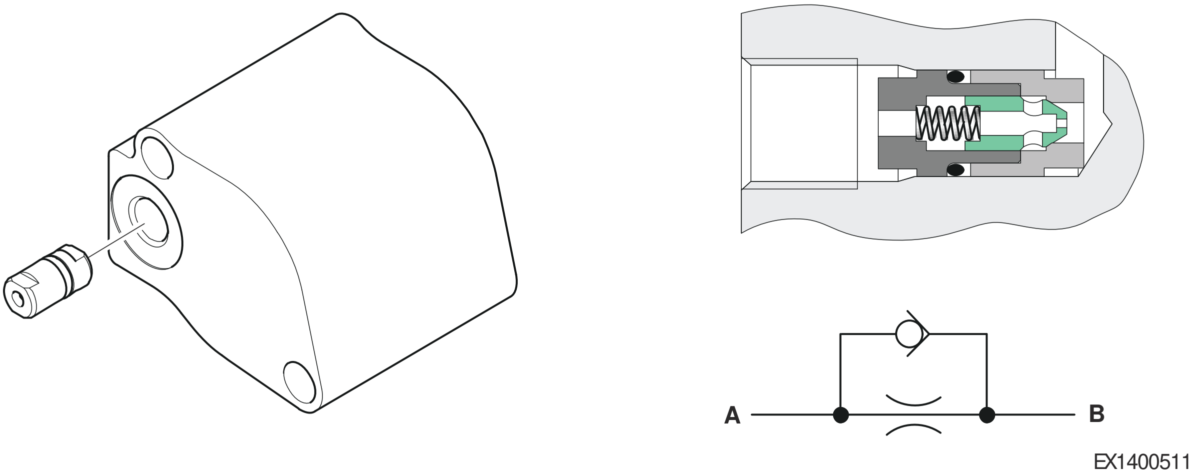
DS1601016

2. Normal assembly
   Figure 232



EX1400510

3. Abnormal (wrong) assembly
   Figure 233

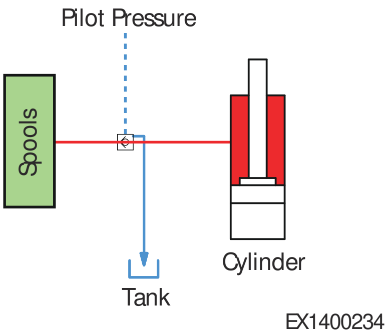


Load Holding (Anti drift) Valve

In the boom lowering and arm dump line, load holding valves (lock valve) are installed to cut off cylinder oil flow when the spool is at the neutral position. (Maintain the intrinsic settlement of the cylinder at minimum value)

Holding Valve Operation - Cylinder Locking

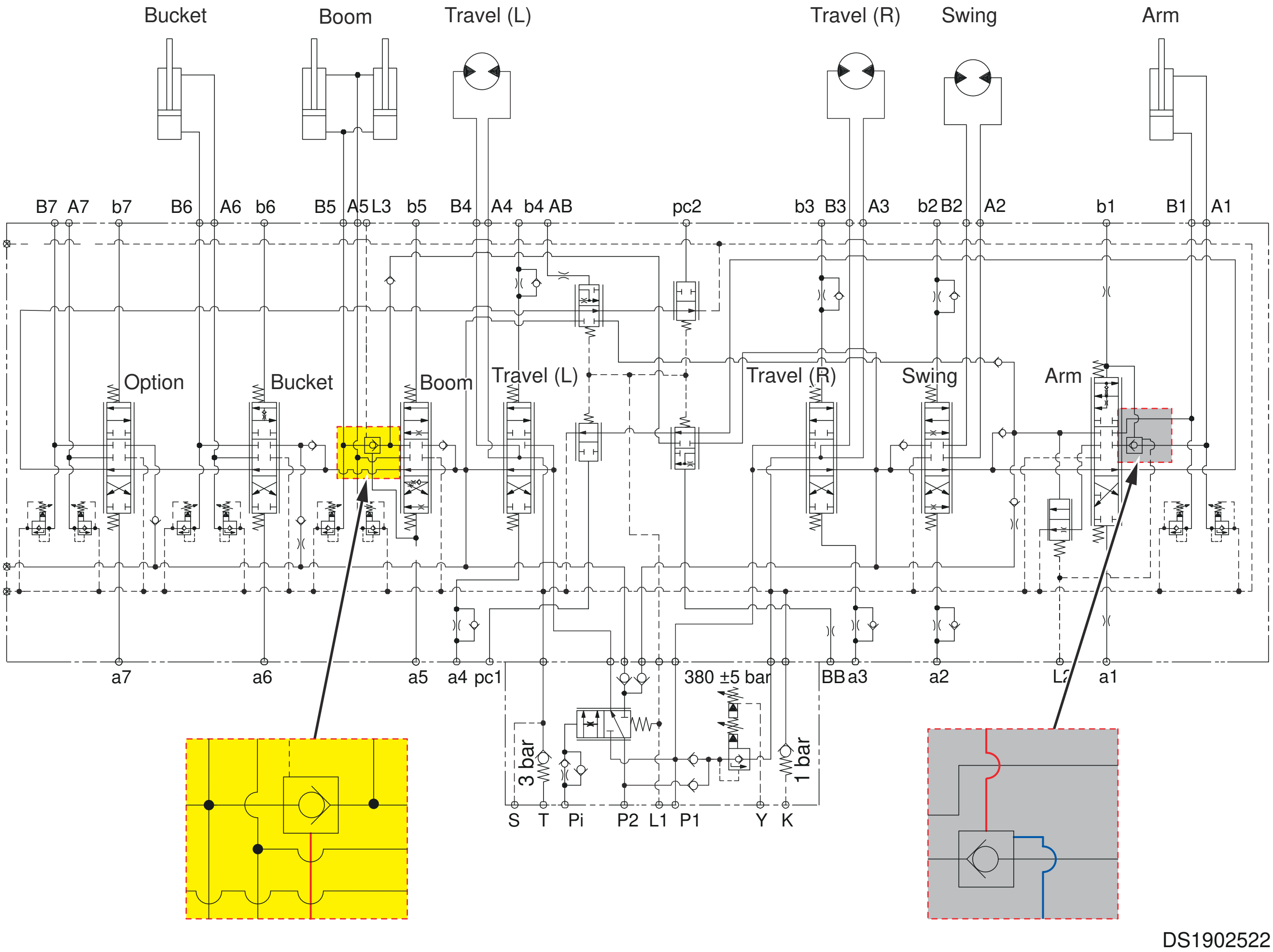
Figure 234



Pilot pressure is 0 bar

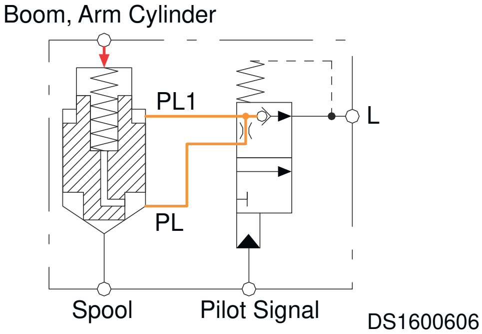
Cylinder pressure is restricted behind holding valve with high-pressure. The check valve prevents the fluid from leaking.

Figure 235



Neutral

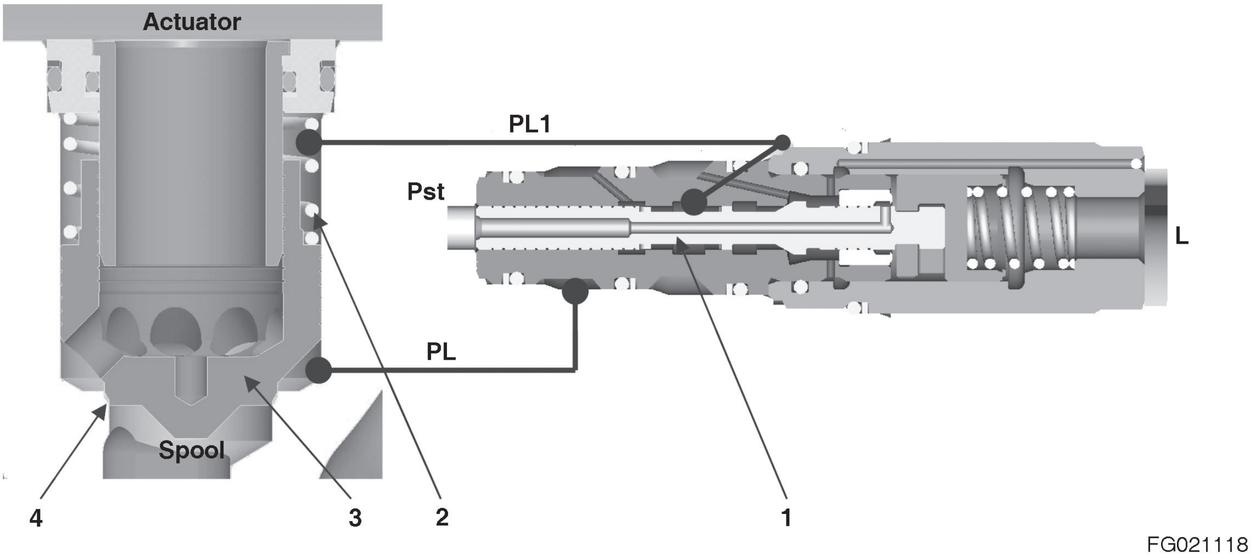
Figure 236



Boom and arm spools (S2 and S5) in lock position (no pump pressure on the pilot-controlled check valve) and any load pressure from the consumer.

The load-holding pressure of the consumer (actuator) is held in the PL chamber, and is reported to the PL1 chamber by the piston (1) of the pilot cartridge. This means the same pressure is available in the PL and PL1 chambers. The surface conditions are selected so primary poppet (3) is held in a closed state by the spring force (2). The oil flow is avoided by seat of the (4) of the main poppet (3).

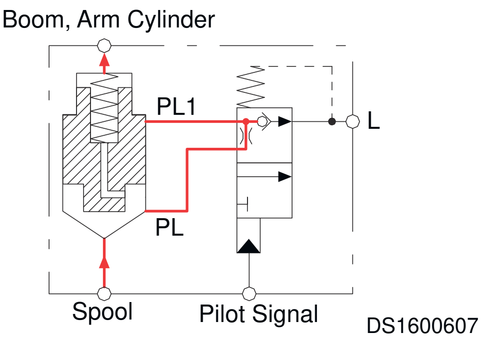
Figure 237



Reference Number	Description
1	Pistons of the Pilot Cartridge
2	Spring
3	Main (Primary) Poppet
4	Seat

Boom Raise, Arm Dump

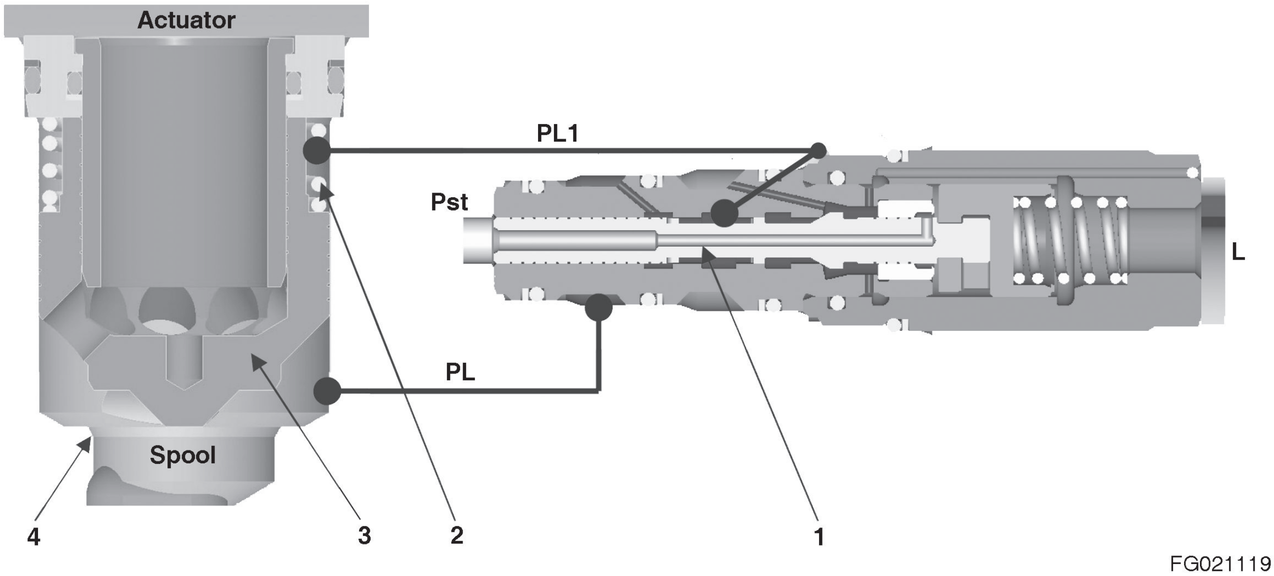
Figure 238



Pump pressure on the pilot-controlled check valve and any load pressure from the consumer.

As soon as the pump pressure (PL) is greater than the load pressure (PL1) plus the spring force (2), the primary poppet (3) of the pilot-controlled check valve (anti drift valve) opens, and the required volume flow can flow to the consumer. This balances out the pressure in the PL and PL1 chambers by the pistons of the pilot cartridge (1).

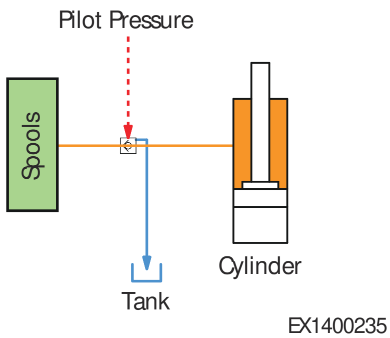
Figure 239



Reference Number	Description
1	Pistons of the Pilot Cartridge
2	Spring
3	Primary Poppet
4	Seat

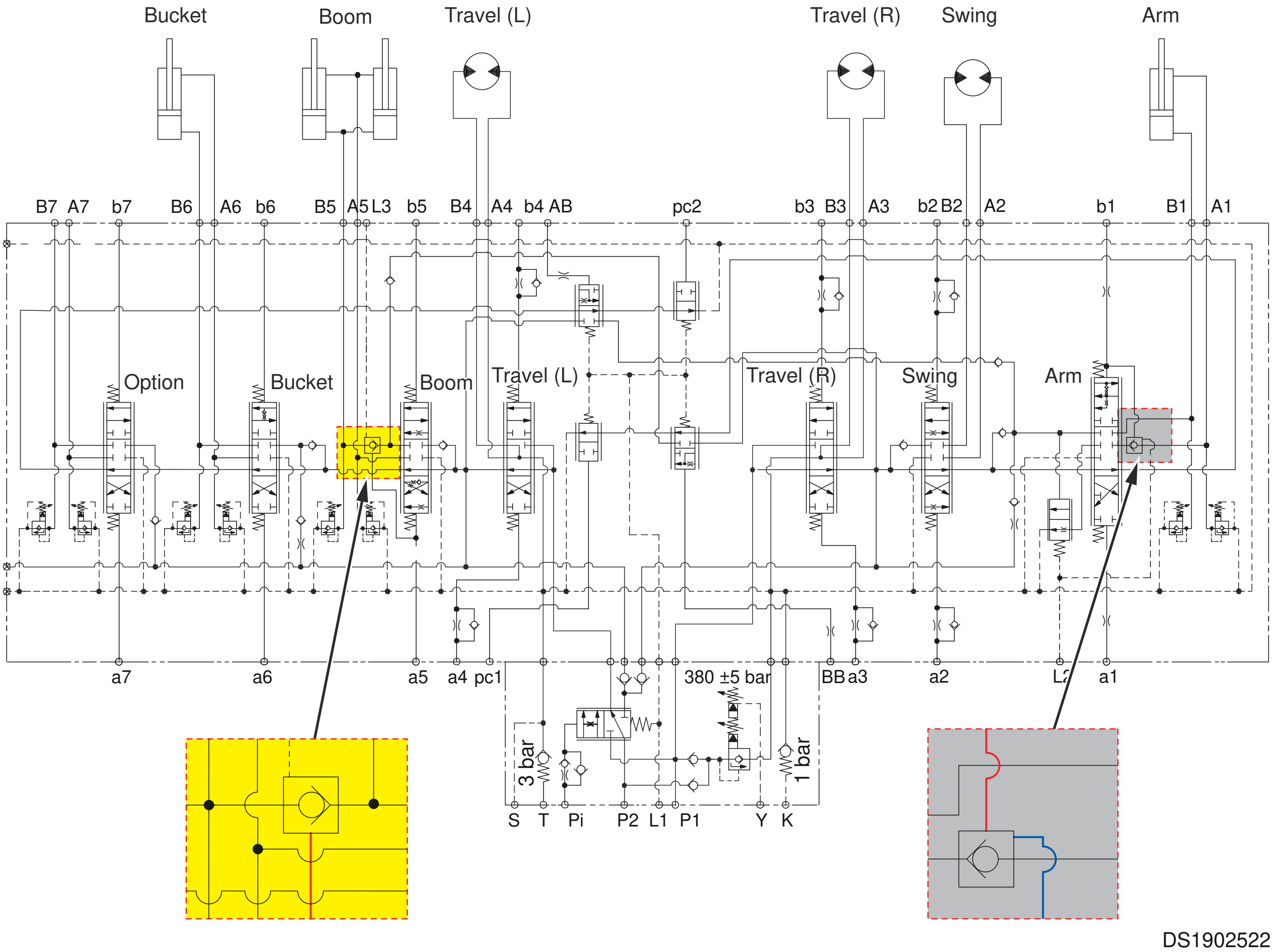
Holding Valve Operation - Cylinder Released

Figure 240



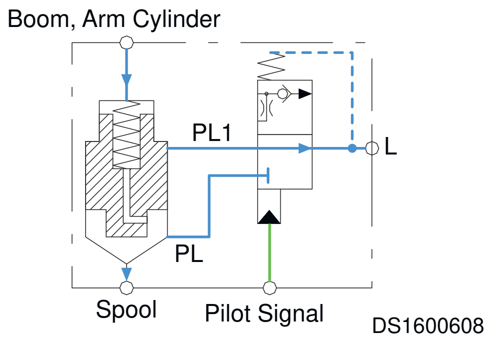
Pilot pressure is given. When the pilot pressure rises, the position of lock valve is changed, making the fluid inside of cylinder rod released through the spool holding valve operation.

Figure 241



Pilot-controlled Check Valve (Return Flow)

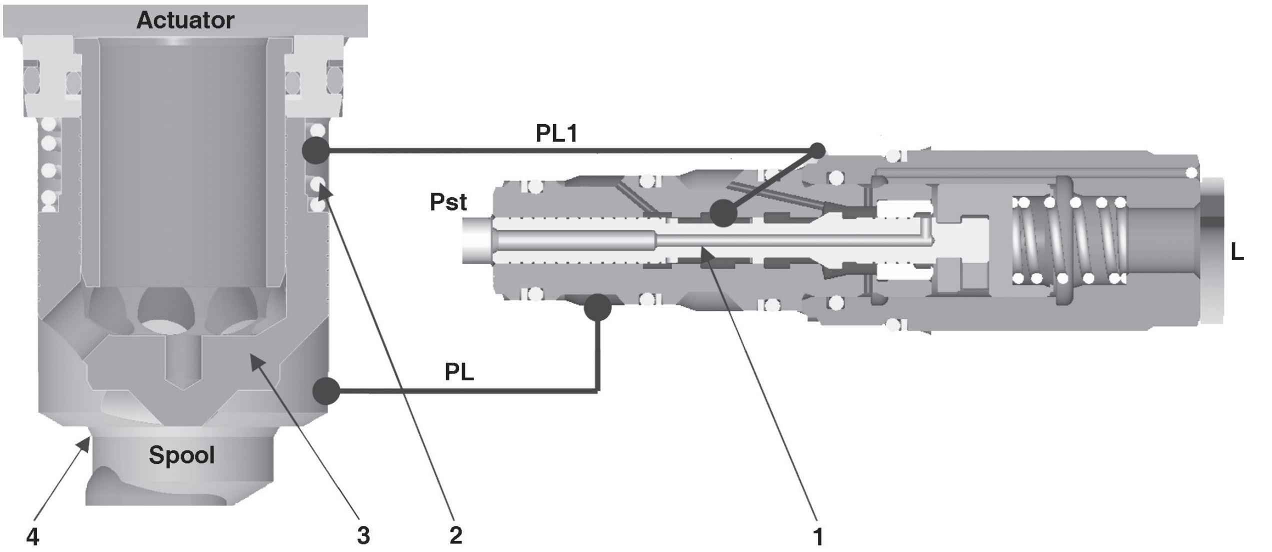
Figure 242



The return pressure on the pilot-controlled check valve and control of the pilot cartridge by pst.

When the piston of the pilot cartridge (1) is controlled by the pst pressure, the connection of the PL1 and PL chambers is separated, and the PL1 chamber to the drain connection L is released. The main piston (3) can now be opened against the spring (3) by the surface of the PL chamber with the pressure of the return oil, and the return oil from the consumer can flow into the tank by the boom and arm spools (S1 or S5).

Figure 243



Reference Number	Description
1	Pistons of the Pilot Cartridge
2	Spring
3	Primary Poppet
4	Seat

Bypass Cut Off Solenoid Valve

Bypass cut valve and bypass cut solenoid valve, which is controlled by the signal from the electric controller, determine the flow rate discharged from the main pump.

Bypass cut off solenoid valve always operates in the normal operation of the equipment. (Solenoid valve: power on - center bypass line cut off)

The cases (conditions) when the bypass cut solenoid valve does not operate (solenoid valve power cut off) are as follows:

- Engine speed is 500 rpm or below (not applicable to most equipment)
- At engine starting-up (temporarily) (At engine off, the pump swivel angle becomes maximum →At engine start up, open the by pass line to reduce loss.)
- Coolant temperature is 20°C or below (prevent pump vibration)
- Stop during swing (Swinging for 0.6 second or longer = Normal swing operation) →prevent swing cavitation
- During left and right simultaneous traveling (straight traveling valve operating) →prevent cavitation with travel spool (traveling make up)

- Stop operation suddenly →prevent pick pressure while stopping operation.
Figure 244

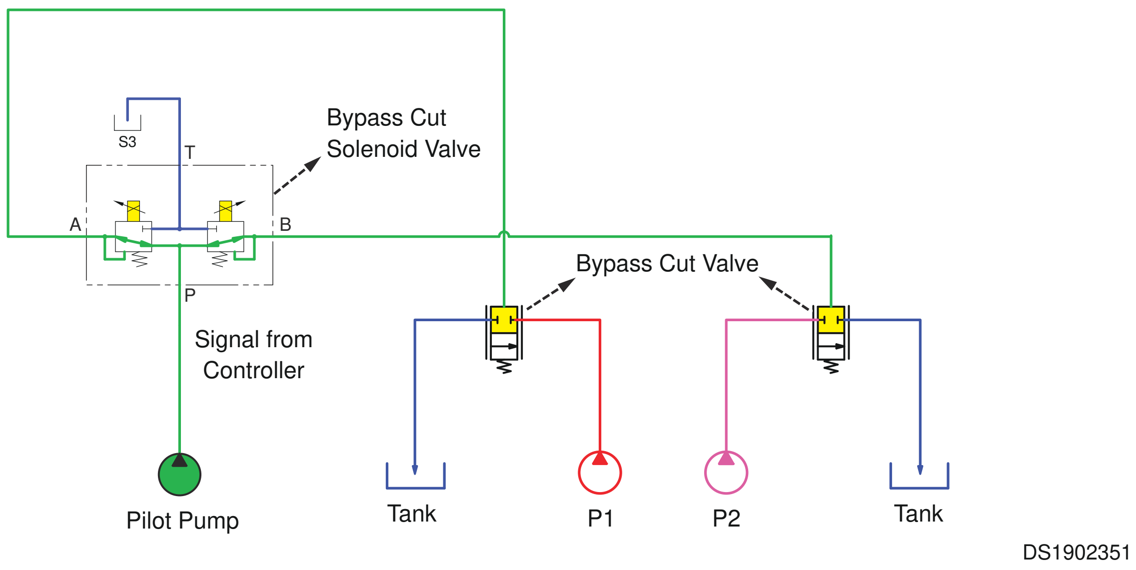
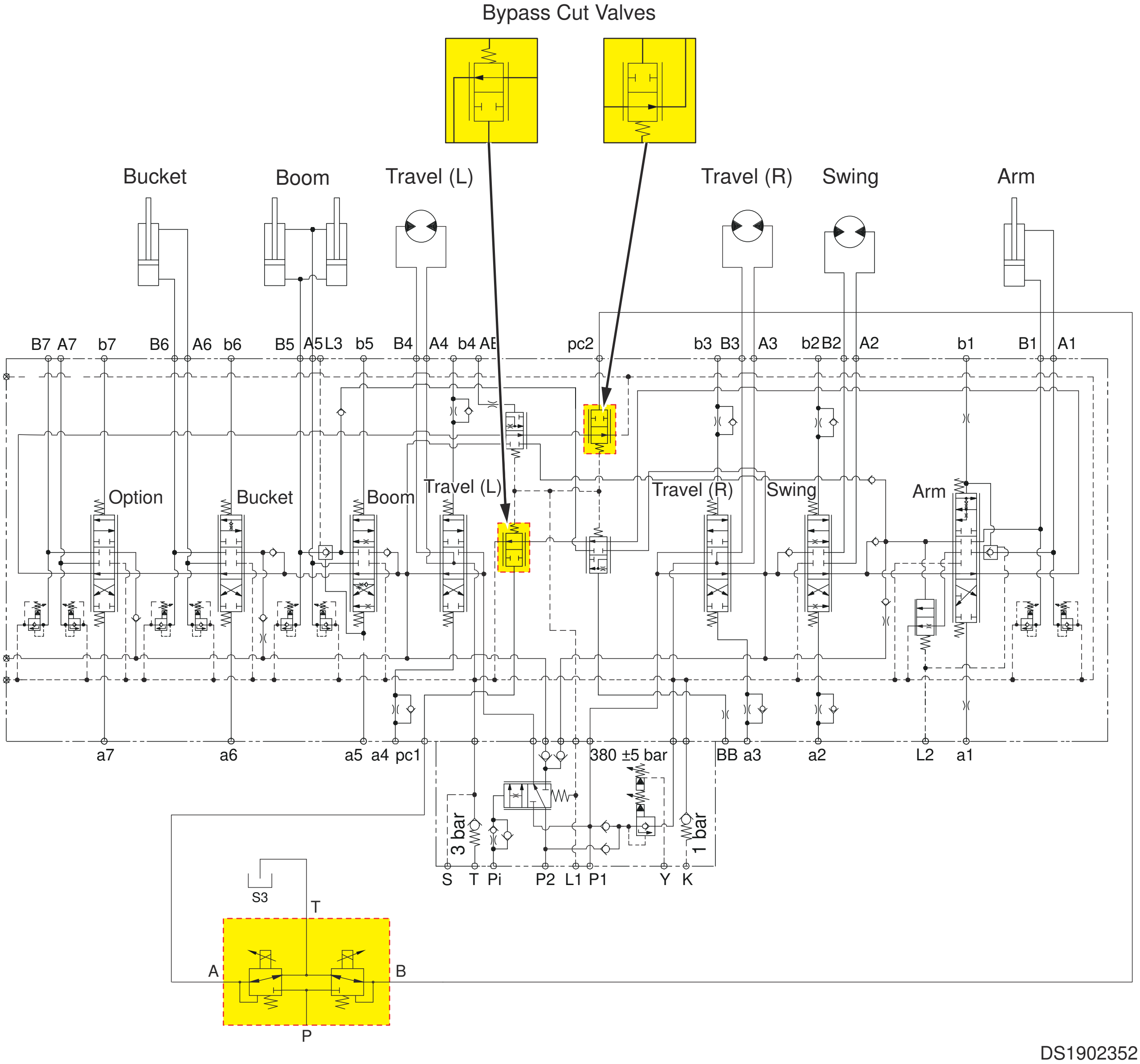


Figure 245



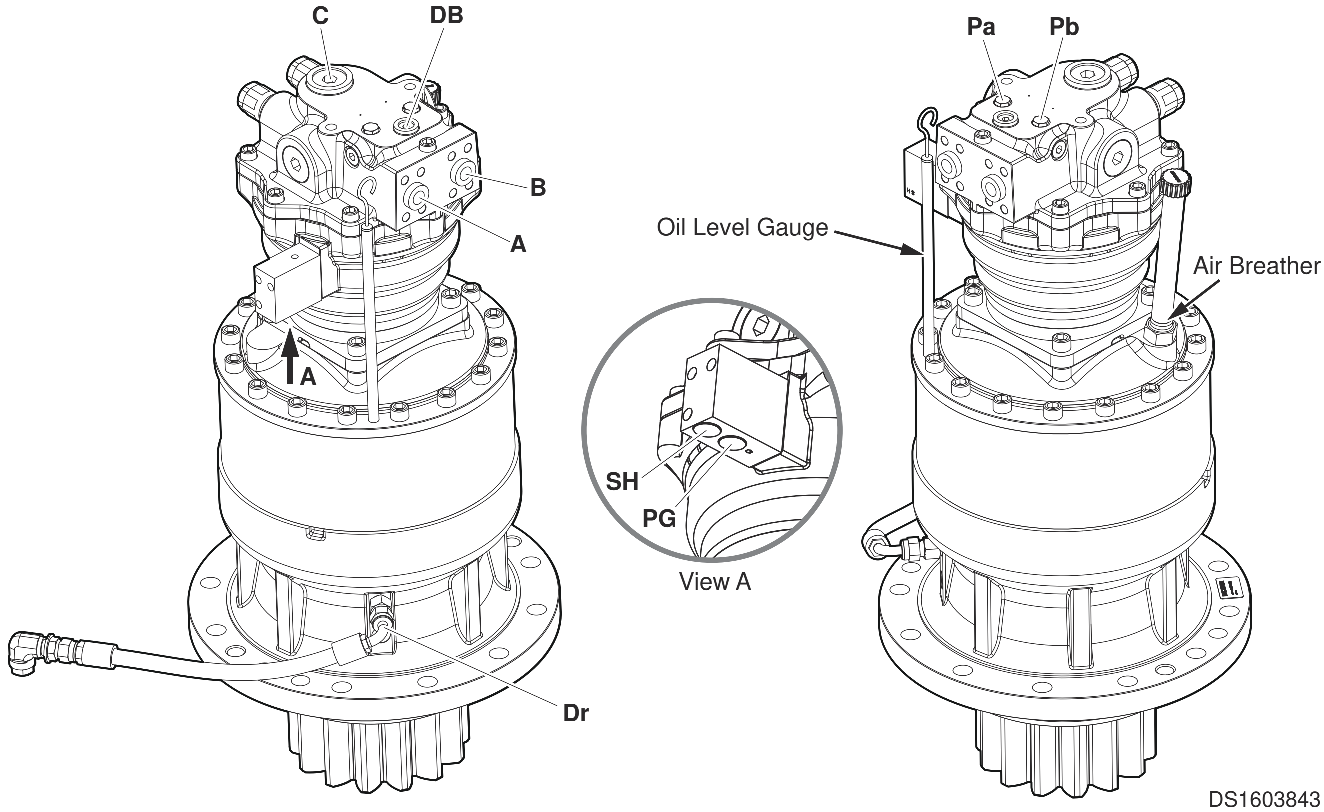
DS1902352

Swing Device

Overview

Swing device consists of the swing motor, swing reduction gear. Swing motor includes piston motor, mechanical parking valve, relief valve, makeup valve, swing reaction less valve and time delay valve. The swing motor has two rotation direction and one rotation speed 2 main, 1 return, 1 drain port and 2 pilot port on the motor. Swing reduction gear includes 2 stage planetary gear and pinion gear 2 main, 1 return, 1 drain and 2 pilot port on the motor.

Figure 246



Port	Name	Size
A	High-pressure (Right)	SAE 1"-6,000 psi
B	High-pressure (Left)	SAE 1"-6,000 psi
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	PF 1/4", O-ring
Pa	Pressure Gauge	PF 1/4", O-ring
Pb	Pressure Gauge	PF 1/4", O-ring
	Air Breather	PT 3/4"
	Oil Level Gauge	PT 3/4"
Dr	Oil Drain	PT 3/8"

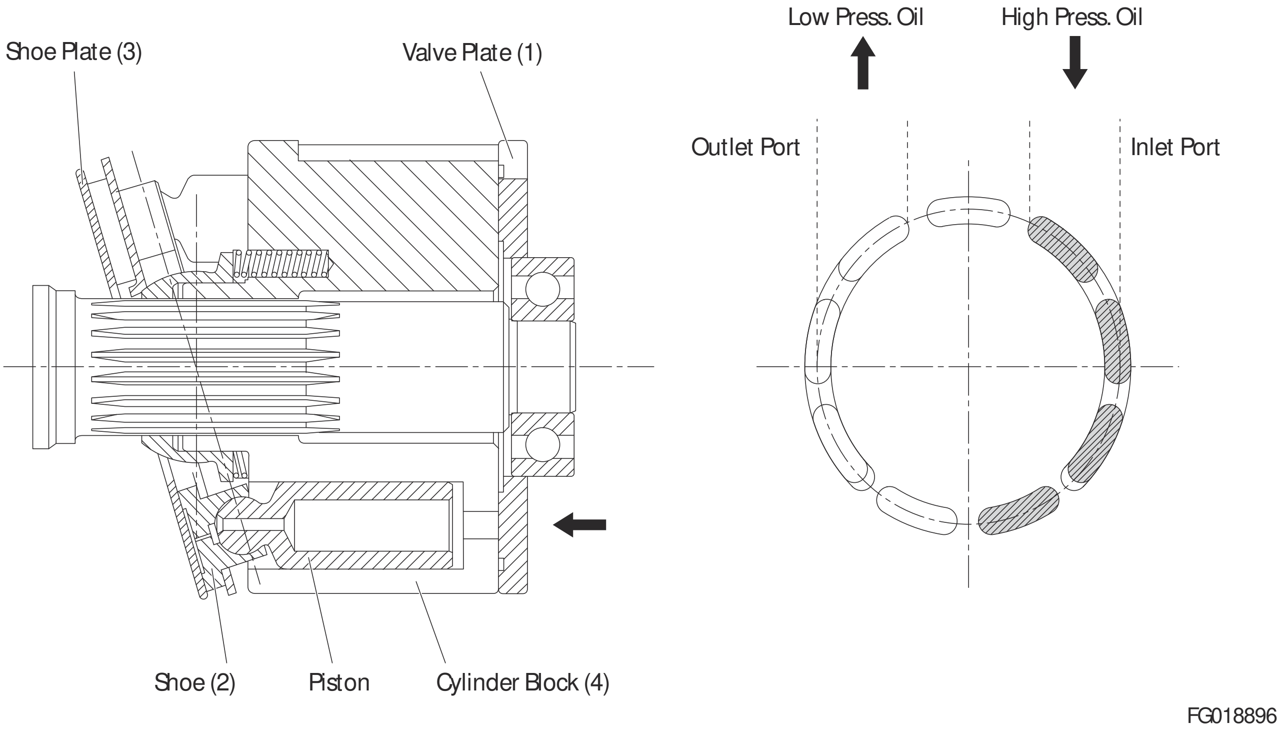
Theory of Operation

Hydraulic Motor

As shown in the figure below, the high-pressure oil entering the cylinder block through valve plate (1) inlet side port exerts pressure on the piston, generating axial force. The force is divided into the two vectors of force F' which is perpendicular to the swash plate (3) and the other F' which is horizontal to the shaft, with the shoe (2) as the medium. With the piston and the medium, the force F' is transmitted to the cylinder block (4) and generates rotational torque to the output shaft. On the cylinder block, 9 pistons are arranged equidistantly, and rotational torque is transmitted to the output shaft by the multiple pistons connected to the inlet side of the high-pressure oil in consequences.

Reversing the direction of oil flow will reverse the direction of rotation of the output shaft.

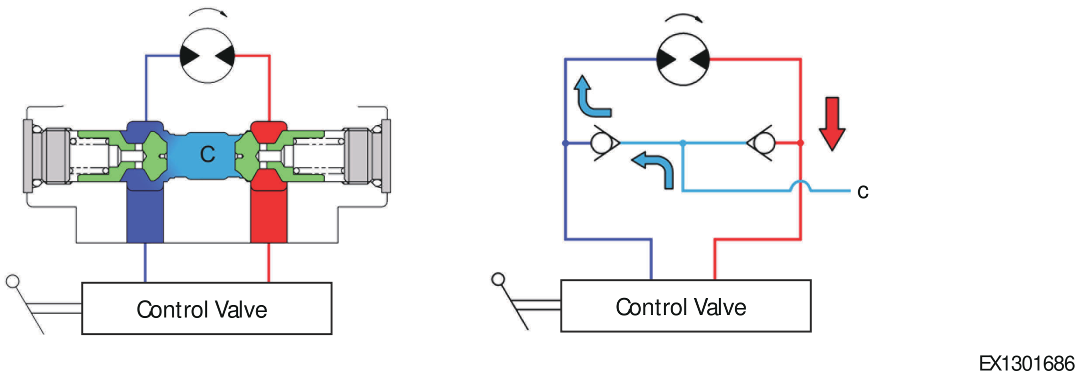
Figure 247



Valve Casing

1. Anti cavitation check valve

   Since the system using this type of motor has no valve which has counter balance function, the motor may rotate exceeding the feed oil flow while swing stop by inertia force of swing operation. In case of swing stop to prevent cavitation, suck in deficient oil through the makeup check valve.
   Figure 248



2. Relief valve

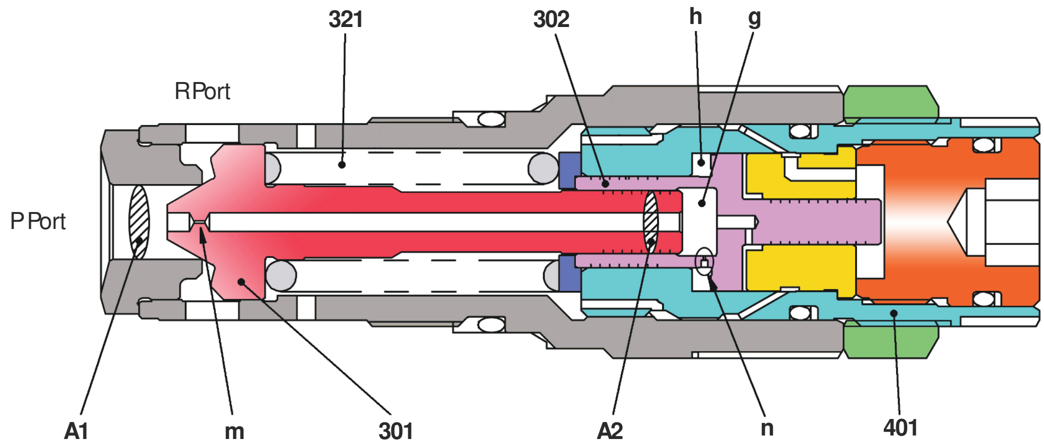
   When swing start, the high-pressure oil flow is into the P port on swing motor, the motor may not rotate fast in a short time due to inertia force of the stop condition for starting swing operation.

   The high-pressure oil flow flows to the tank through relief valve when swing starting after swing starting the relief valve is clogged for normal swing operation when swing stop, the motor may rotate exceeding by inertia force of swing operation.

   The relief valve is open and the oil flow in motor flows to the tank (swing speed is reduced by hydraulic brake function).

Let's assume that port P is pressurized from the tank pressure. Initially, ports P and R are at tank pressure.

Figure 249



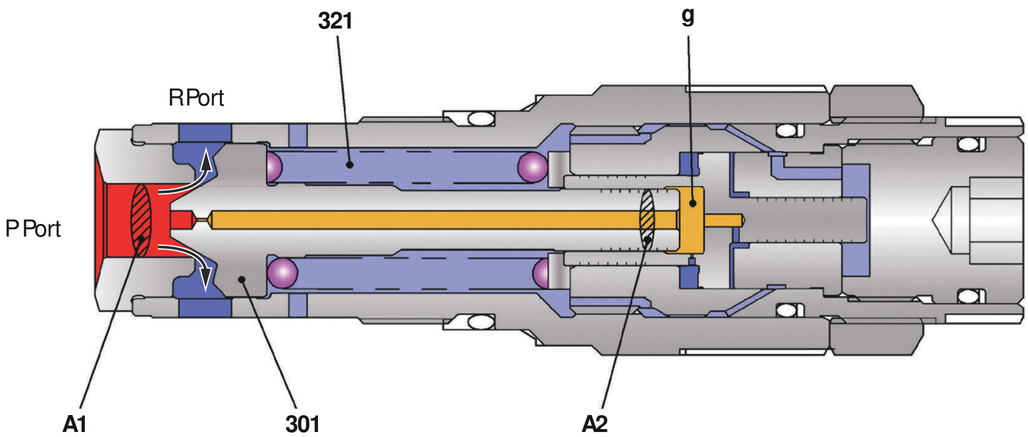
When the two forces; the force defined by the product of the area (A1) of plunger (301) receiving pressure and pressure P1; and the force defined by the product of spring (321) force (Fsp) and pressure-receiving area (A2) of plunger (301) by the pressure Pg in the chamber g; become the same, the relief valve starts to function.

Here, the Pg is the pressure in the chamber g which is pressurized by the oil through the orifice m, and when it reaches the pressure defined by the spring (321) pressing the piston (302), the piston starts to move to the left.

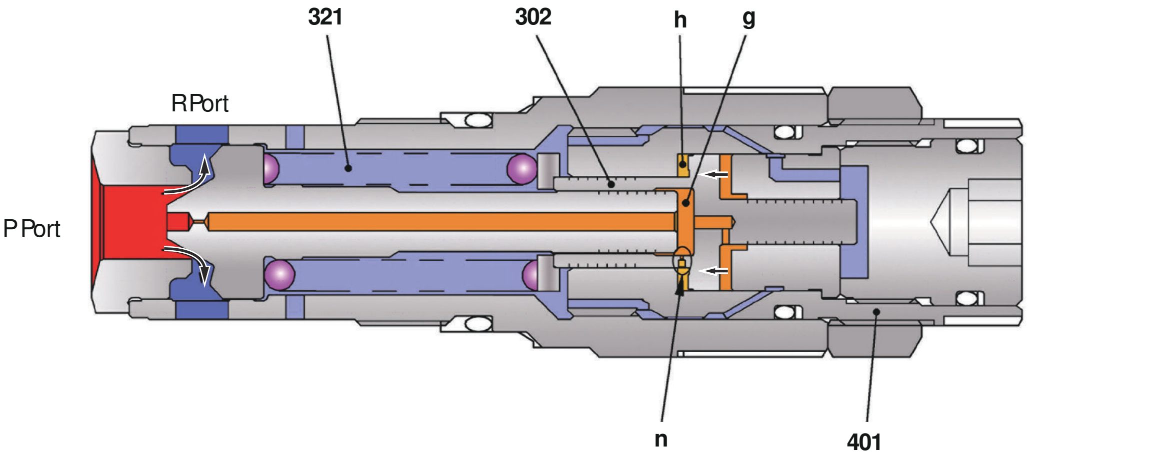
P1 x A1 = F_{sp} +P_gx A2

P1 =	F_{sp}+P_gx A2
	A1

Figure 250



3. Chamber h acts as a damping chamber by the orifice (n) formed on the side of the piston (302). By this, the pressure in the chamber g increases smoothly until piston (302) reaches the end of the adjustment plug (401).
   Figure 251



When the piston (302) reaches the end of the adjustment plug (401), it cannot move further to the left, thus, the pressure in chamber g becomes equal to Ps and the force of the spring (321) becomes Fsp' (Figure 7).

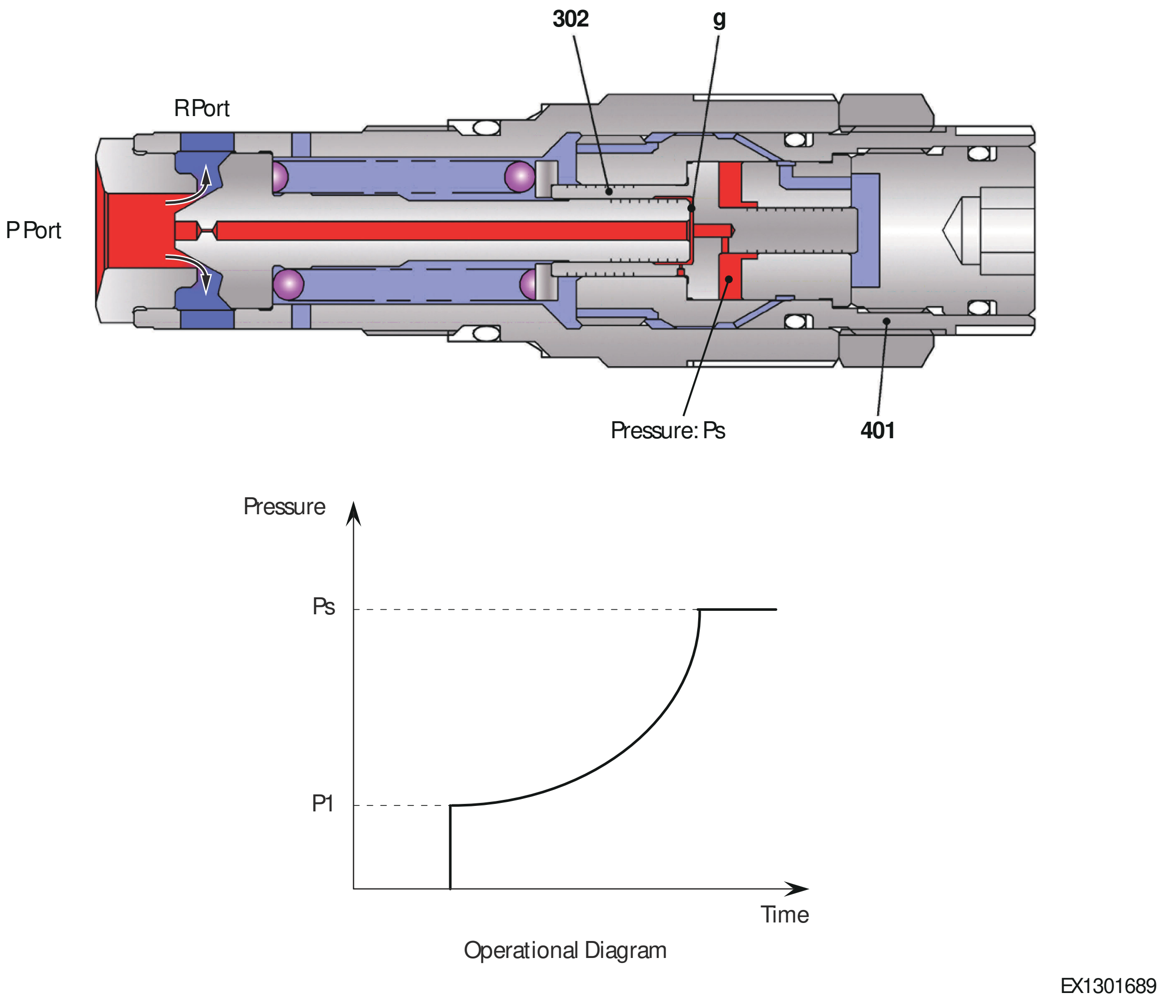
Consequently, the pressure P varies as illustrated in (Figure 7).

The pressure Ps at the final stage is expressed with the equation below;

$P_s \times A1 = F_{sp'} + P_s \times A2$

<table>
<tr><td rowspan="2">P_s</td><td>$F_{sp'}$</td></tr>
<tr><td>A1 - A2</td></tr>
</table>

Figure 252



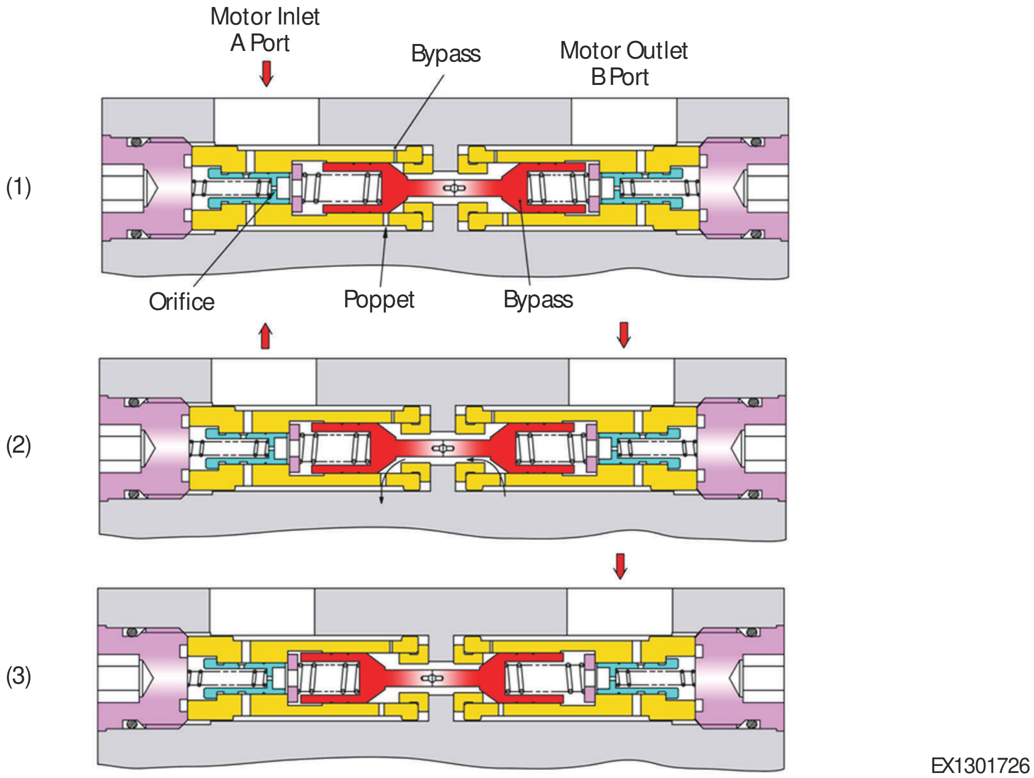
4. Reaction less valve

   When the direction switching valve of swing motor I switched, high-pressure oil is supplied to the port A (or port B) of the hydraulic motor. Then, the poppet of the reaction less valve moves to the right, blocks the bypass route and drives the rotating body (1, Figure 8).

   Then, when the direction switching valve returns to neutral position, the ports at both sides of the hydraulic motor are blocked, but the rotating body would maintain its rotation because of inertia and the momentum of inertia is transmitted to the hydraulic motor through the reduction gear, generating brake pressure at the port B (or port A) which stops the rotating body and tries to reverse the direction of rotation.

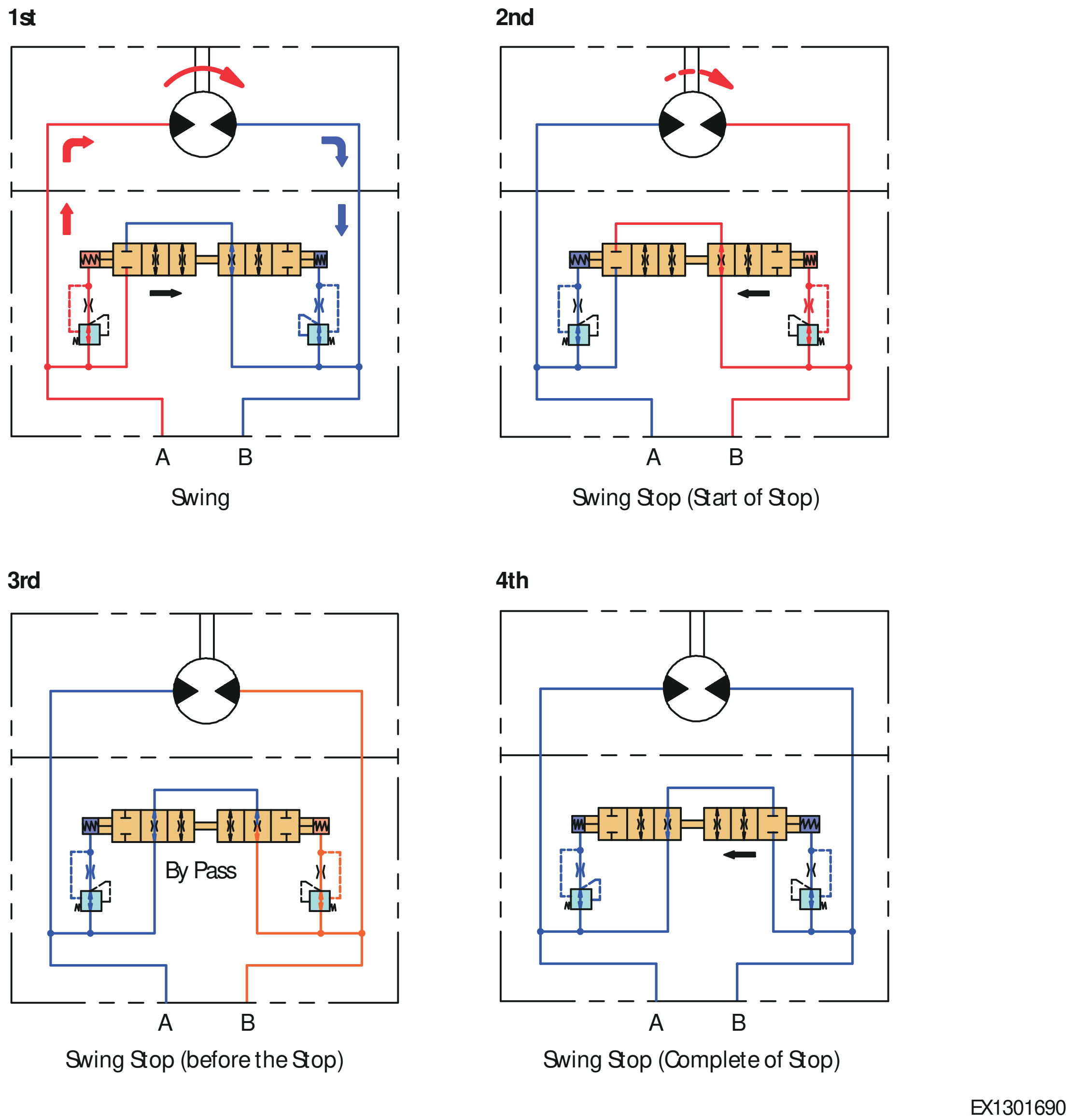
   By this brake pressure, the swing motor first stops and then tries to reverse its direction of rotation and the pressure at the port B tries to switch the poppet to the left, but the action is delayed by the orifice at the port A. Now, a bypass route is formed connecting the ports A and B through which the high-pressure oil flows from port B to the port A (2, Figure 8).

And, the poppet on the port B side moves to the left until it blocks the bypass route (3, Figure 8).
Figure 253



Schematic of Operation of Reaction less Valve

Figure 254

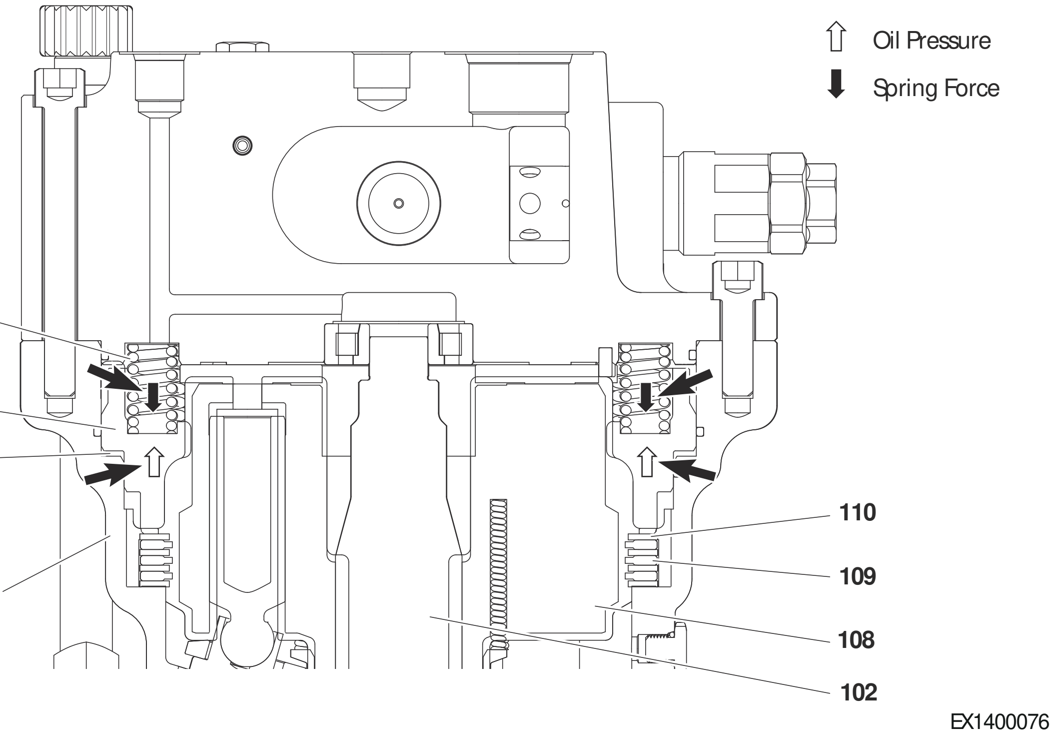


Brake Part

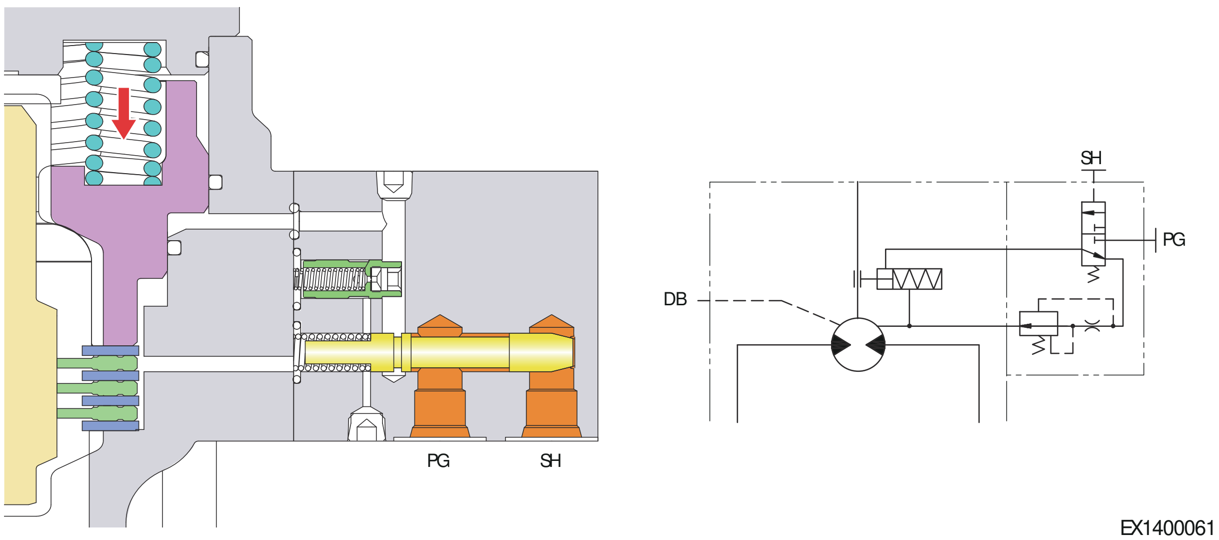
The cylinder block (108) is connected with the driveshaft (102) by spline joint, and rotation of the separation plate (110) in circumferential direction is restricted by the circular arc grooved on the casing (115). When the friction plate (109), engaged with the outer circumference of the cylinder with gears, is pressed to the casing (115) by the brake spring (118) with the separation plate (110) and brake piston (119) as the media. Friction force is generated between the friction plate and casing, separation plate and brake piston. This friction force restricts and brakes the driveshaft.

When brake release pressure is applied to the oil chamber formed between the brake piston and casing and this pressure overcomes the spring force, the brake piston moves and the friction plate is separated from the casing, and the brake is released.

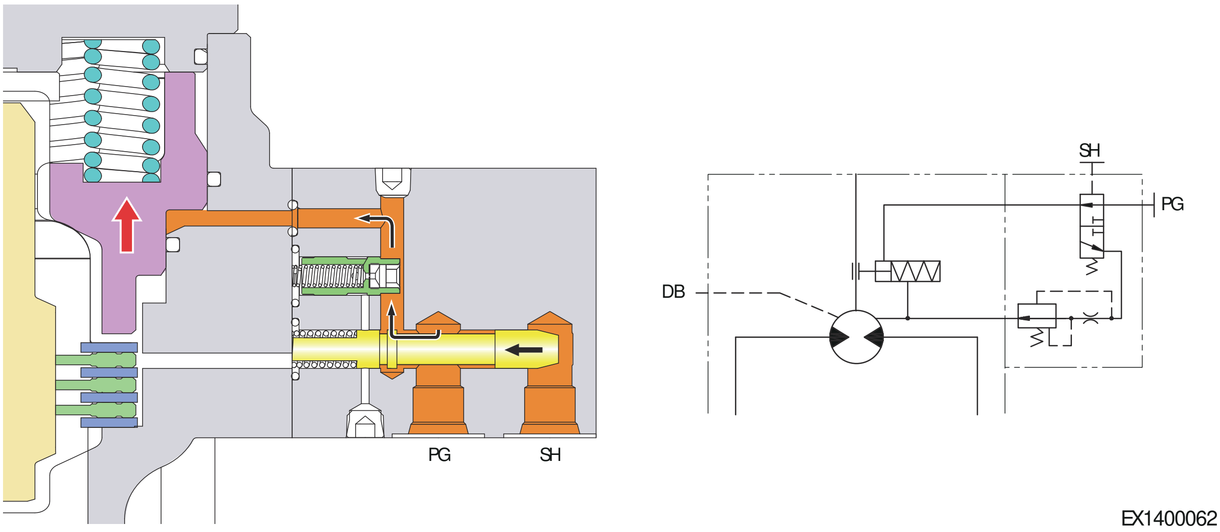
Figure 255operation Diagram of Bake



1. Parking brake operating
   Figure 256



2. Parking brake release
   Figure 257



Fan Pump

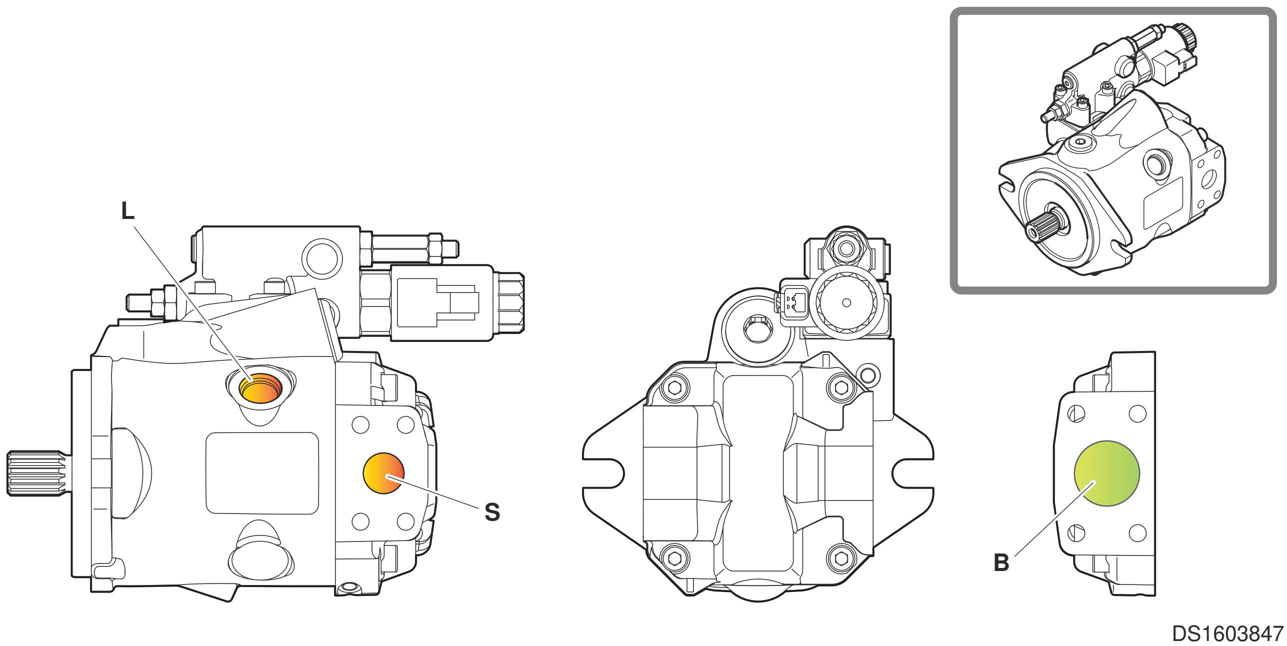
Overview

Fan pump is a piston type pump of variable displacement, discharging flow is controlled by EPPR current value with EPOS.

The low temperature of the cooling system the discharging flow is decreasing to low flow amount, and high temperature of the cooling system the discharging flow is increased to high flow amount.

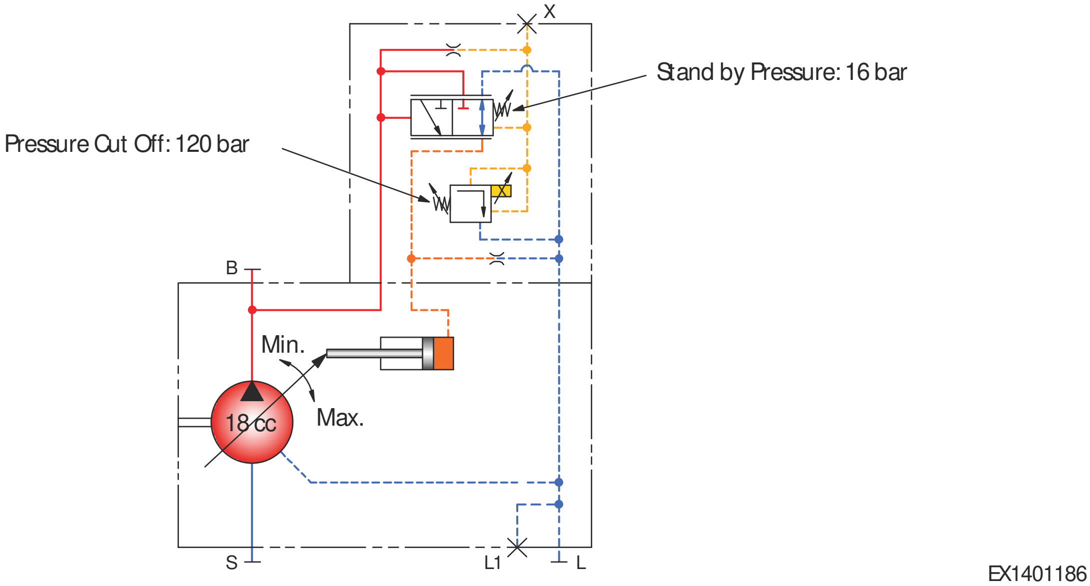
Discharging flow depends on the angle of the swash plate even the pump shaft rotating speed is low or high.

Figure 258



Port and Hydraulic Circuit

Figure 259



Port	Name	Size
B	Pressure	SAE 3/4"
S	Suction	SAE 1 1/4"
L	Case Drain	UNF 3/4"-16-2B

Theory of Operation

The (1, Figure 3) and (2) valves adjust the pump swivel angle in order to maintain the electrically set pressure level.

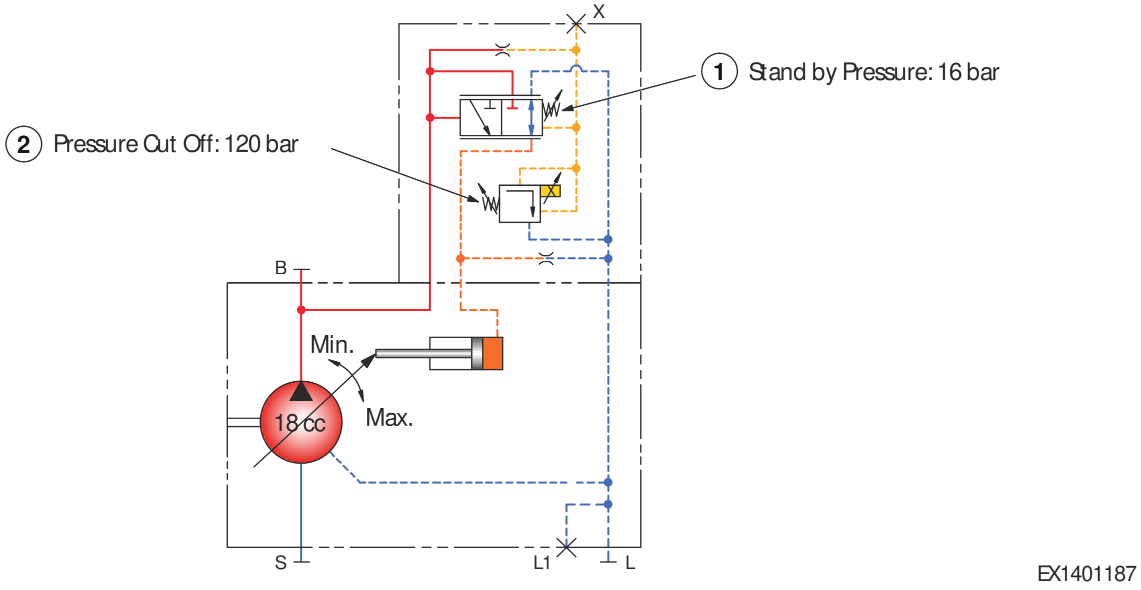
When the cutoff pressure is controlled, the P-I curve also shifts in response to the cutoff pressure (pressure measurement: X).

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: 16 bar (16.3 kg/cm^2, 232 psi)
- Pressure cut off: 120 bar (122.4 kg/cm^2, 1,740 psi) (at 0 mA)

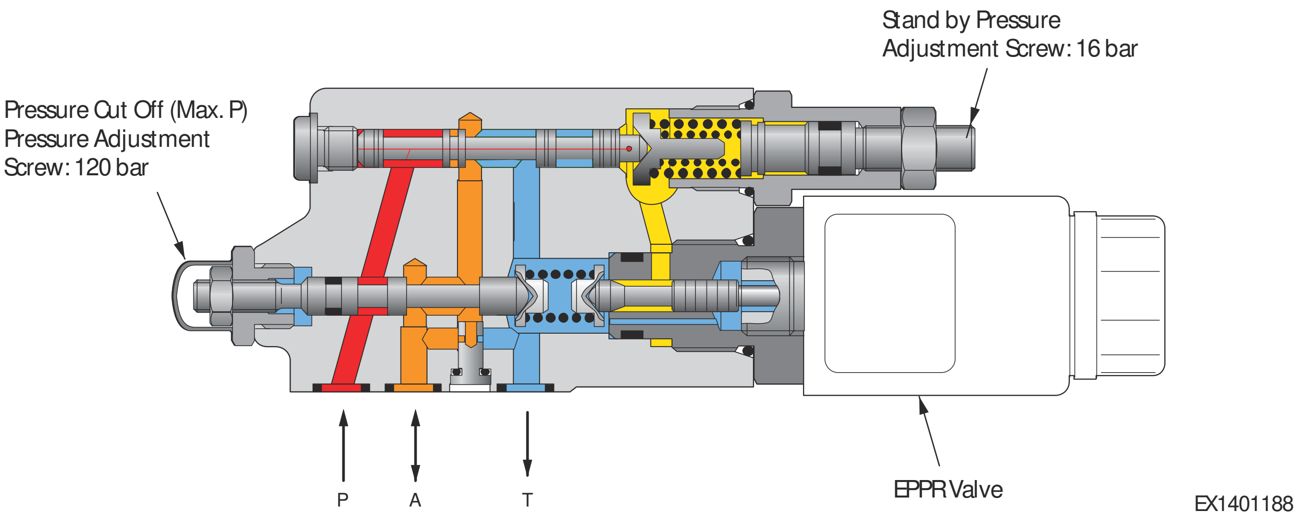
Circuit

Figure 260



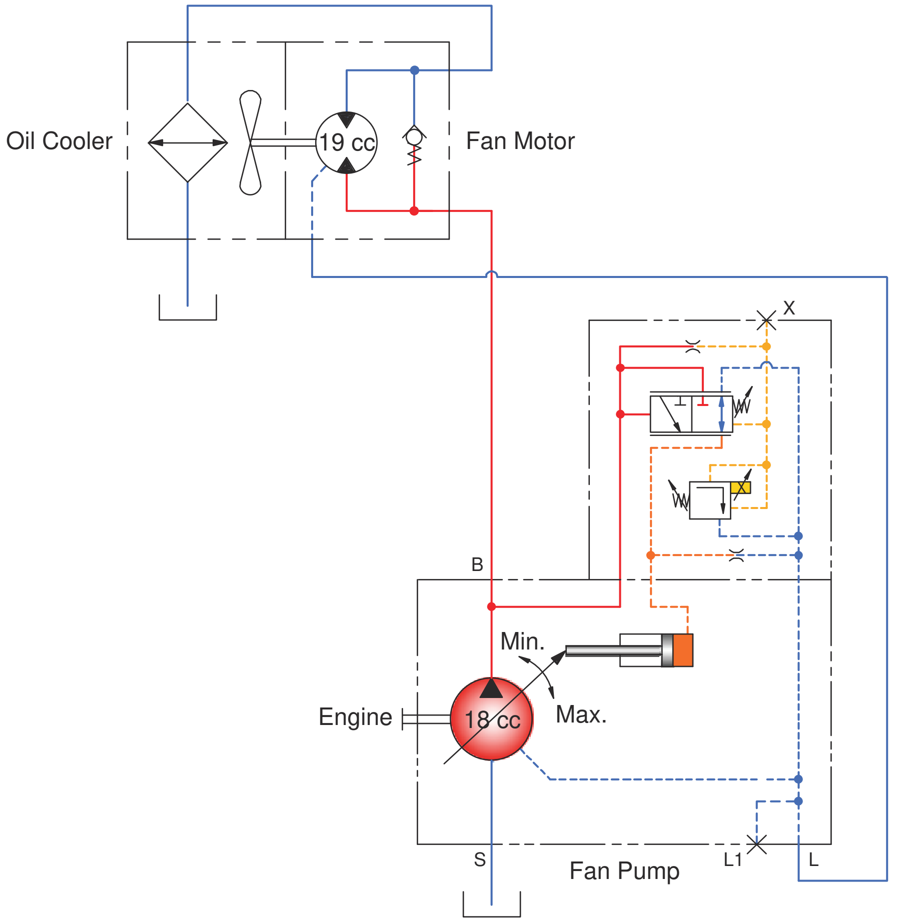
Control Section

Figure 261



Circuit Diagram Related to Fan Drive

Figure 262



Pump EPPR Valve

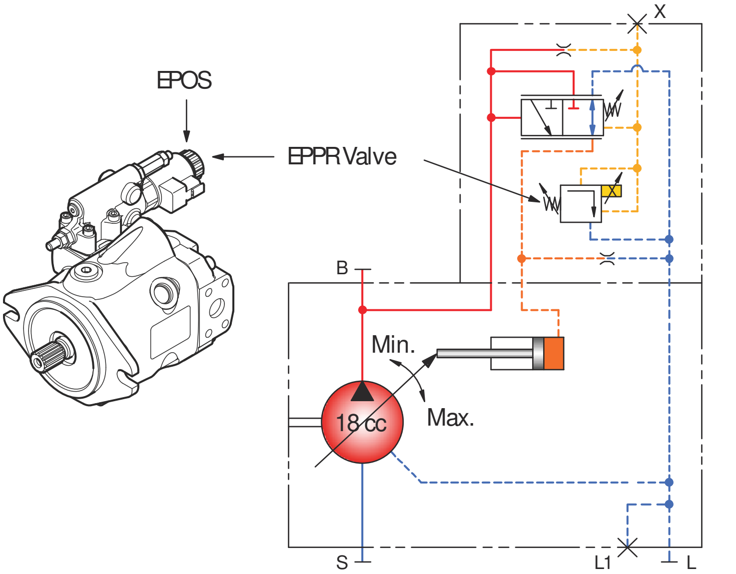
With the EPOS, the speed of the cooling fan can be controlled according to the temperatures of the hydraulic oil and the engine coolant.

The speed of the fan can be controlled by controlling the value of current supplied to the EPPR valve (by changing the pressure).

Revolutions	1,250 ±50 rpm	Maximum Value (Standard)
Pressure	106 ±10 bar (108 ±10 kg/cm^2, 1,537 ±145 psi)	
Electric current	80 ±25 mA	

EPPR Valve

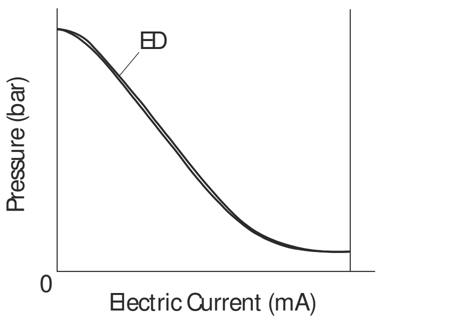
Figure 263



EX1301363

Control Curve (Pressure Compared to the Current Value)

Figure 264

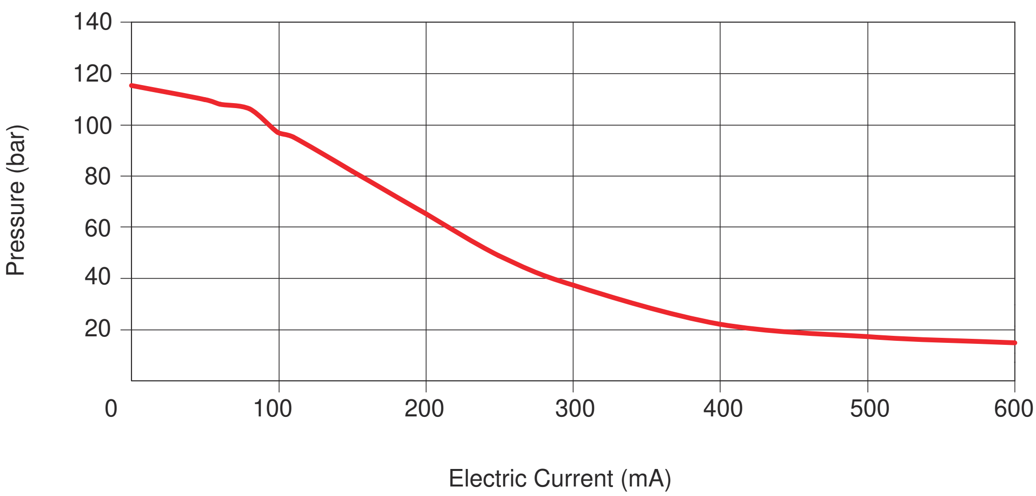


EX1401295

- ED: Pressure compared to the current value

Control Curve (Pressure Compared to the Current Value)

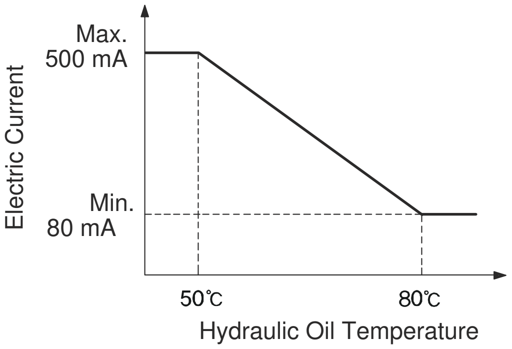
Figure 265



DS1603849

Current Curve (Current Value According to the Temperature)

- Hydraulic oil temperature less than 50°C: 500 mA (17.5 bar)
  Figure 266

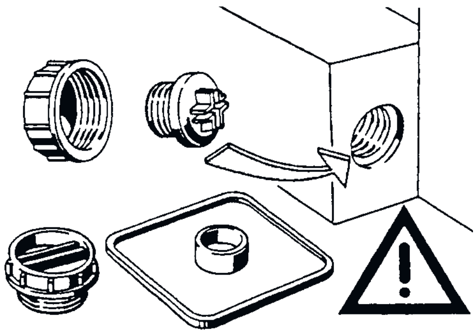


DS1603850

- Hydraulic oil temperature at 80°C: or more: 80 mA (106 bar at Motor Inlet)

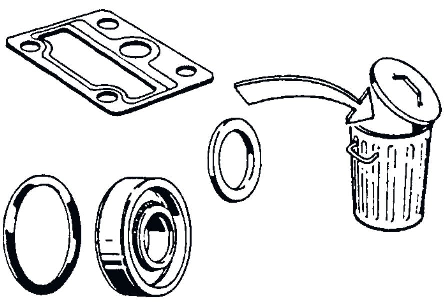
Maintenance Guidelines

1. Close off all openings of hydraulic unit.
   Figure 267



ASS0030L

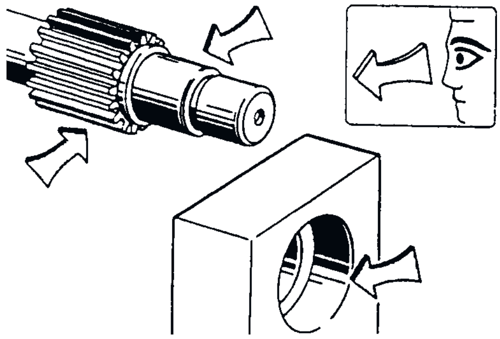
2. Replace all seals.
   Figure 268



ASS0040L

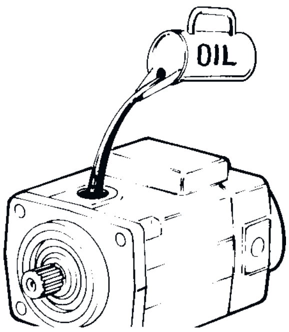
   Use only original replacement parts

3. Check all sealing and sliding surfaces for wear.
Figure 269


ASS0050L

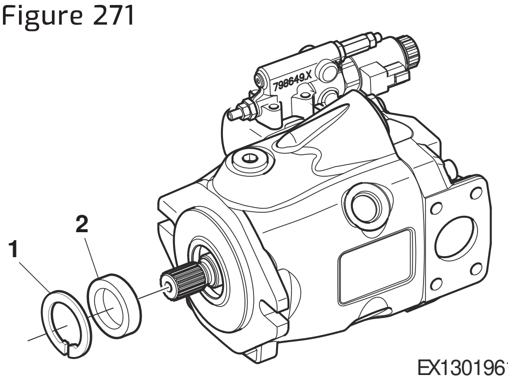
NOTE: *Do not rework sliding surfaces using crocus cloth or other similar materials. It can damage the surface.*

4. Fill hydraulic unit with clean hydraulic oil before putting into operation.
Figure 270



ASS0060L

Figure 271

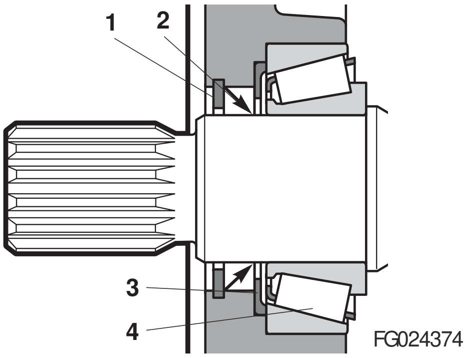


EX1301961

Sealing Driveshaft

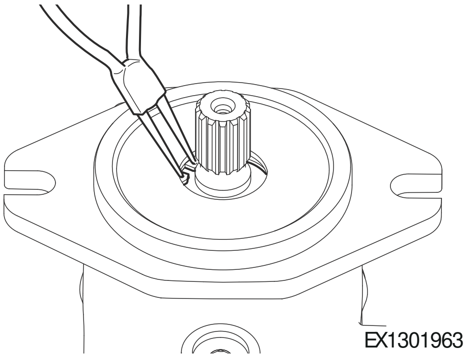
Reference Number	Description
1	Retaining Ring
2	Shaft Seal
3	Ring
4	Bearing

Figure 272



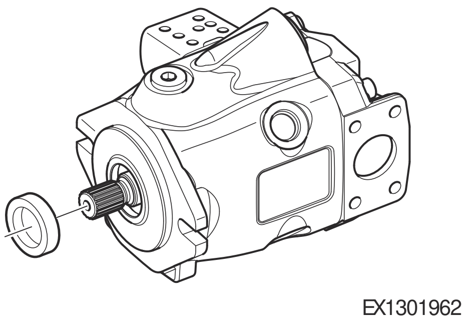
1. Protect driveshaft.

   Figure 273



2. Remove retaining ring from pump body.
3. Remove shaft seal from front of pump body.

   Figure 274

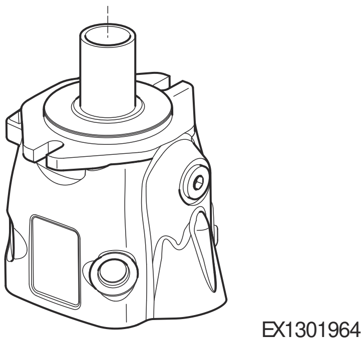


NOTE: *Change shaft seal and check its sliding surface (driveshaft) and housing. Grease sealing ring.*

NOTE: *Check that shaft seal is properly seated in housing.*

4. Press sealing ring carefully down just below retaining ring groove.

   Figure 275



5. Install retaining ring in retaining ring groove.

   Figure 276

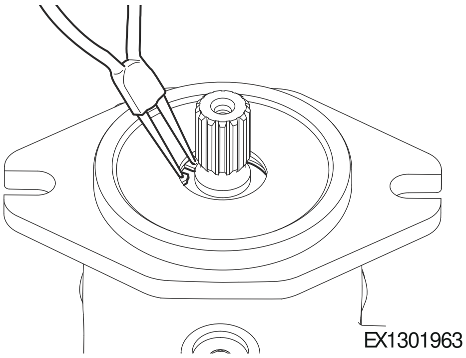
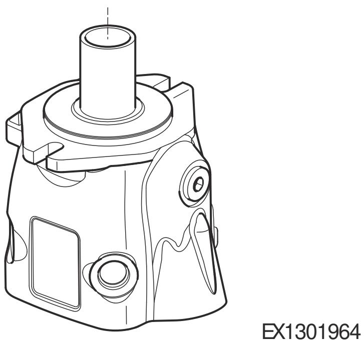


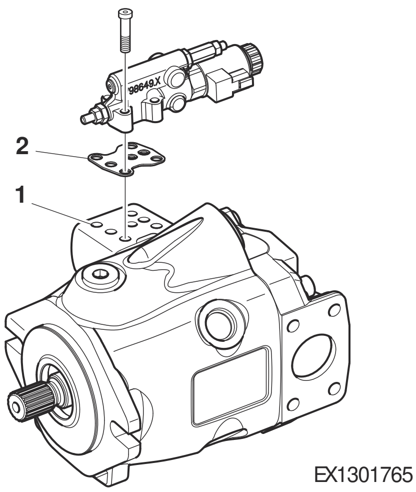
   Figure 277



NOTE: *Make sure that retaining ring is properly seated in groove.*

Sealing Control Valve

Figure 278

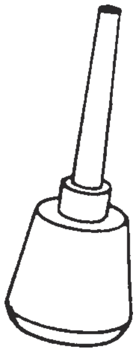


NOTE: *Remove control valve. Measure dimension and write down.*

1. Check sealing surface (1).
2. Check O-rings (2).

Tools

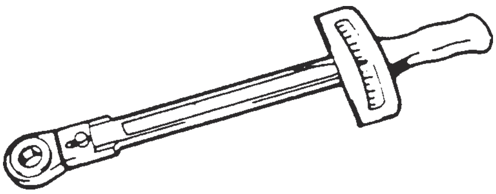
Figure 279



FG024423

Loctite Types

- For all break-off plugs: #601
- For all other parts: #242
- Bolt tensile strength grade: 8.8, 10.9, 12.9
  Figure 280



FG024424

Electrical System

Systems Operation and Description

Safety Instructions

⚠ WARNING

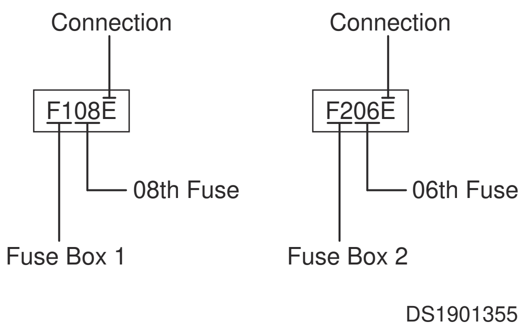
AVOID DEATH OR SERIOUS INJURY

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.

General Schematics

Fuse Box

Figure 281

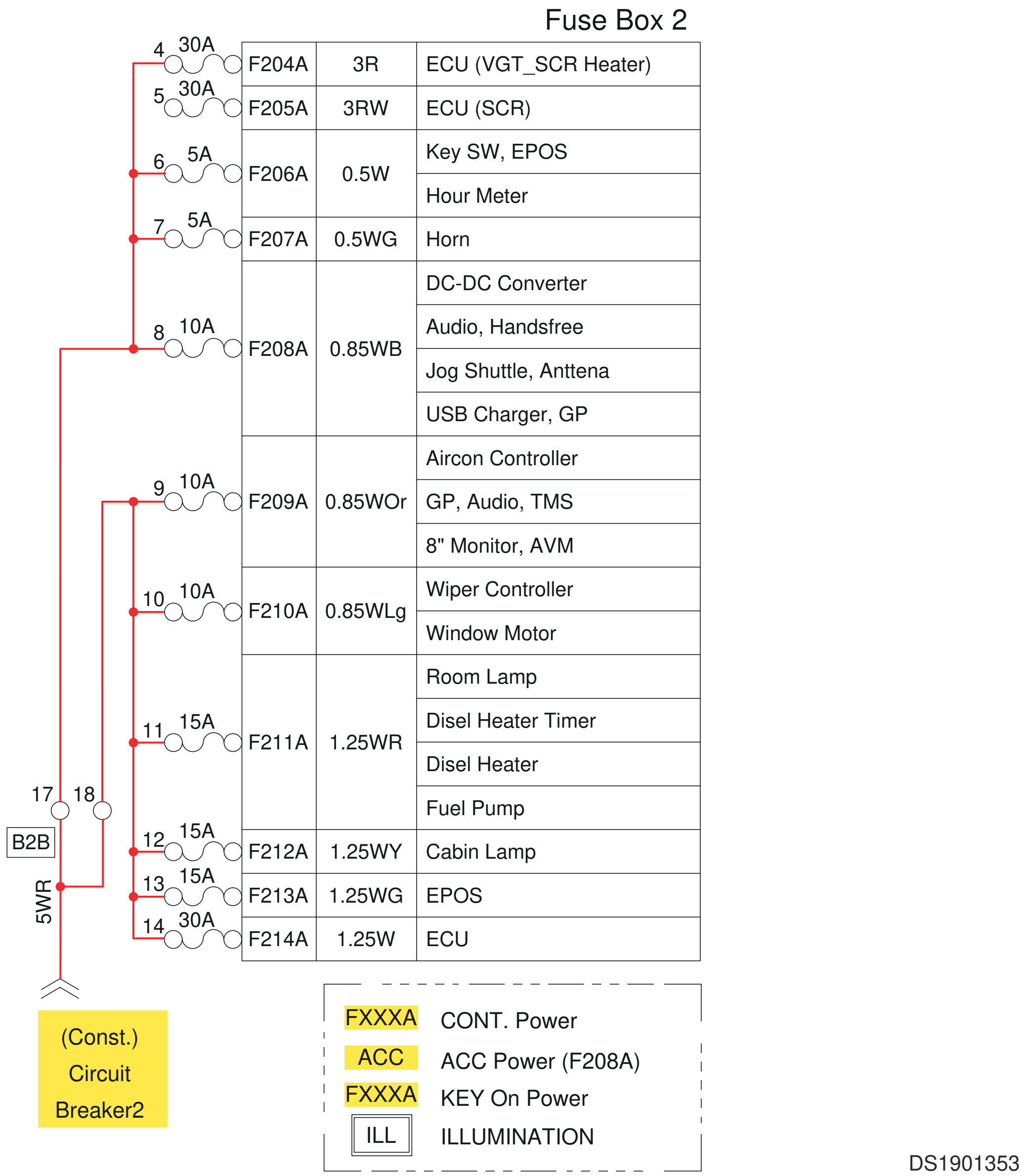


The new common standard for the electric schematics has a new position and layout for the fuse box in the top right hand corner.

The fuses that are supplied by a constant supply from circuit breaker 2, are in this case fuses 4, 6-14 of fuse box 2 and all supply out along wires with a base color of white (W).

The fuses that have a key controlled supplied from circuit breaker 1, are fuses 2-14 of fuse box 1 plus fuses 1-3 and 5 of fuse box 2 and all supply out along wires with a base color of orange (Or) or red (R).

Figure 282

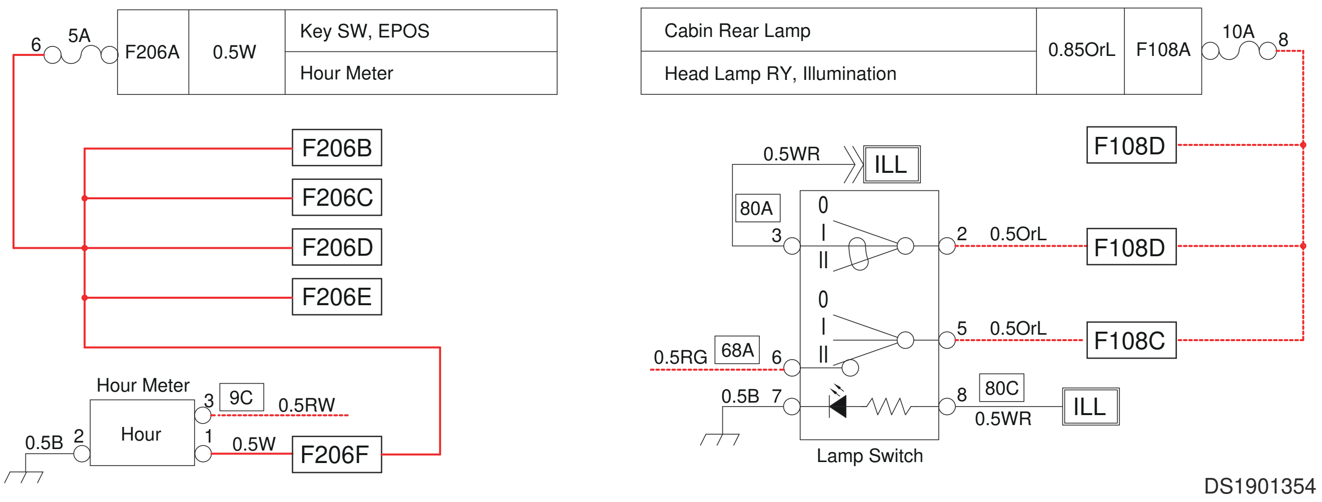


Wiring Connection

Instead of drawing each wire from the fuse box to where it is supplying on the circuit diagram, the details of what each fuse supplies have been made complete. And the supply point is marked with the fuse details.

Fuse No. 6 of fuse box 2 is supplying electric current to F206A-F206E.

Figure 283

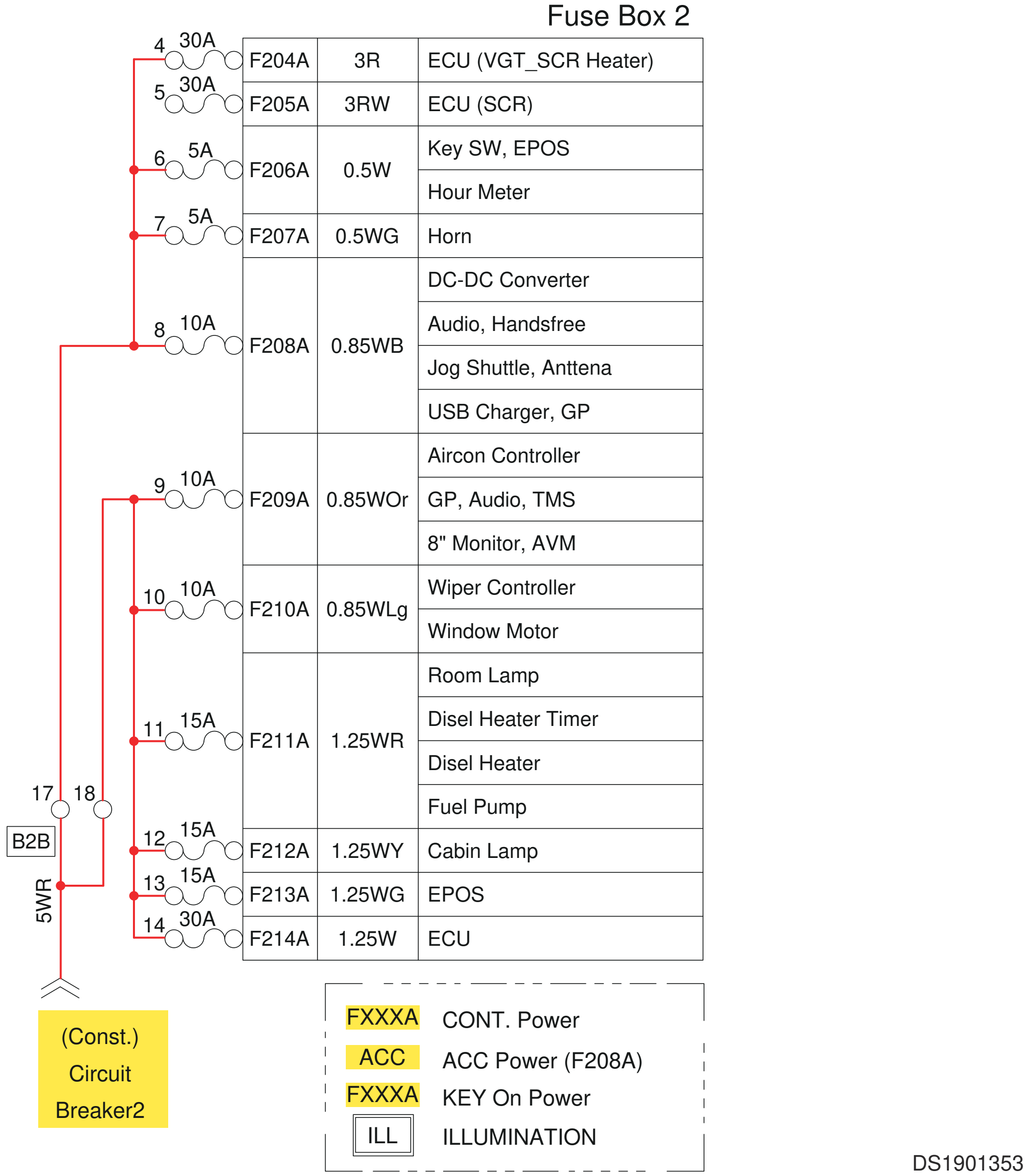


6
5A
F206A
0.5W
Key SW, EPOS
Hour Meter
F206B
F206C
F206D
F206E
Hour Meter
Hour
3
9C
0.5RW
0.5B
2
1
0.5W
F206F
Cabin Rear Lamp
Head Lamp RY, Illumination
0.85OrL
F108A
10A
8
0.5WR
ILL
F108D
80A
0
I
II
3
2
0.5OrL
F108D
0
I
II
5
0.5OrL
F108C
0.5RG
68A
6
0.5B
7
8
80C
0.5WR
ILL
Lamp Switch
DS1901354

Power Supply

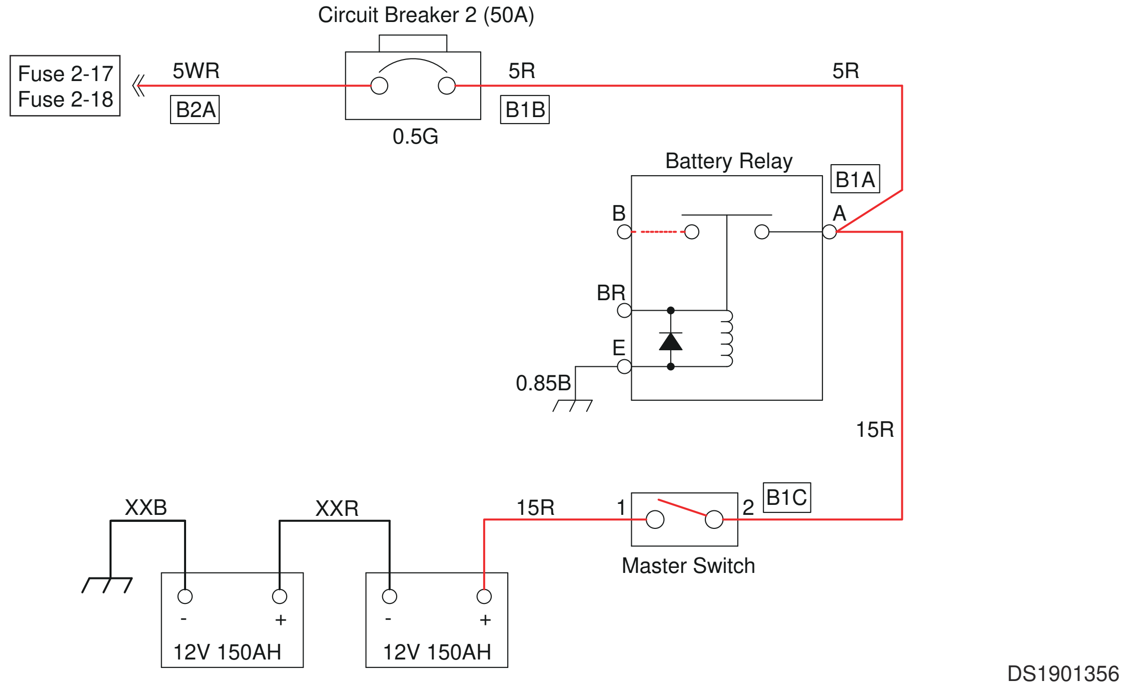
OFF / Constant Power Flow

Figure 284



Electric current flows from battery + to circuit breaker 2 through master switch and battery relay A. Then current goes to #17 and #18 pin of fuse box 2 and is supplied to specific parts continuously.

Figure 285

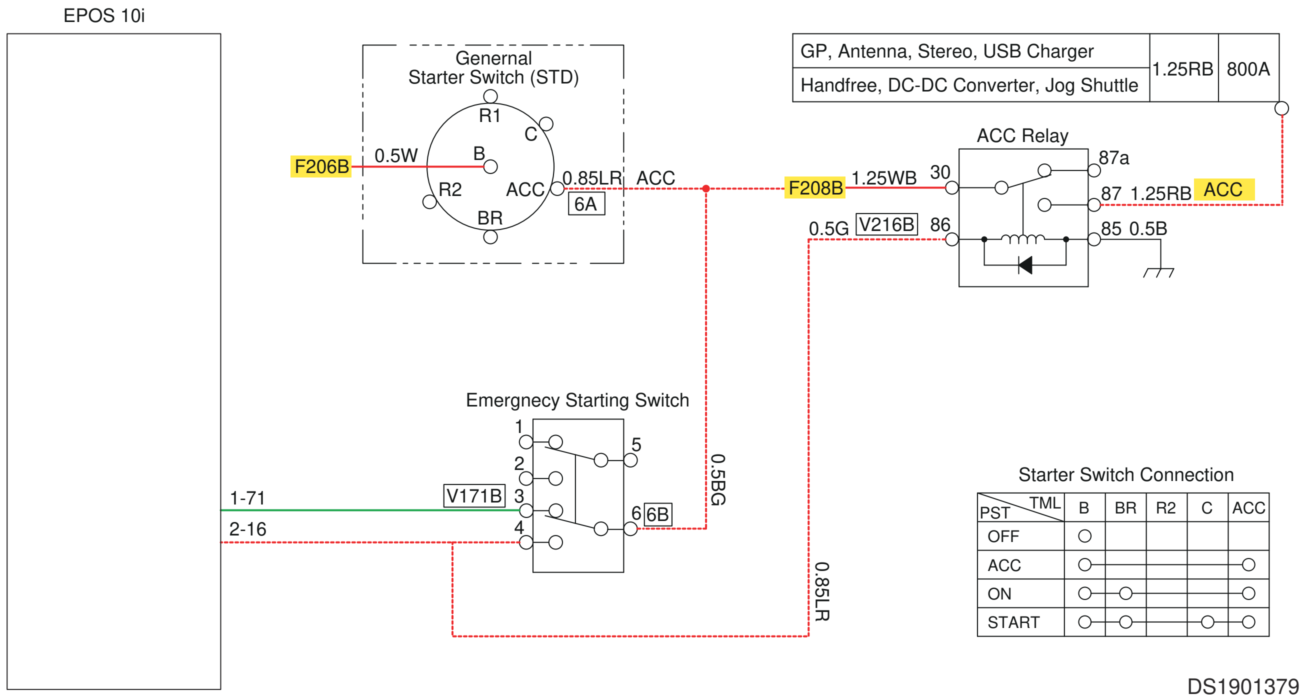


Current from fuse box 2 is distributed to each fuse and components are listed in the circuit diagram.

Key ACC

With the standard key in the ACC position, the standard key supplies 24V signal to EPOS terminal 1-71. EPOS then powers the ACC relay to activate the ACC powered devices (gauge panel, USB charger, DC-DC converter..) on 2-16.

Figure 286



Key ON

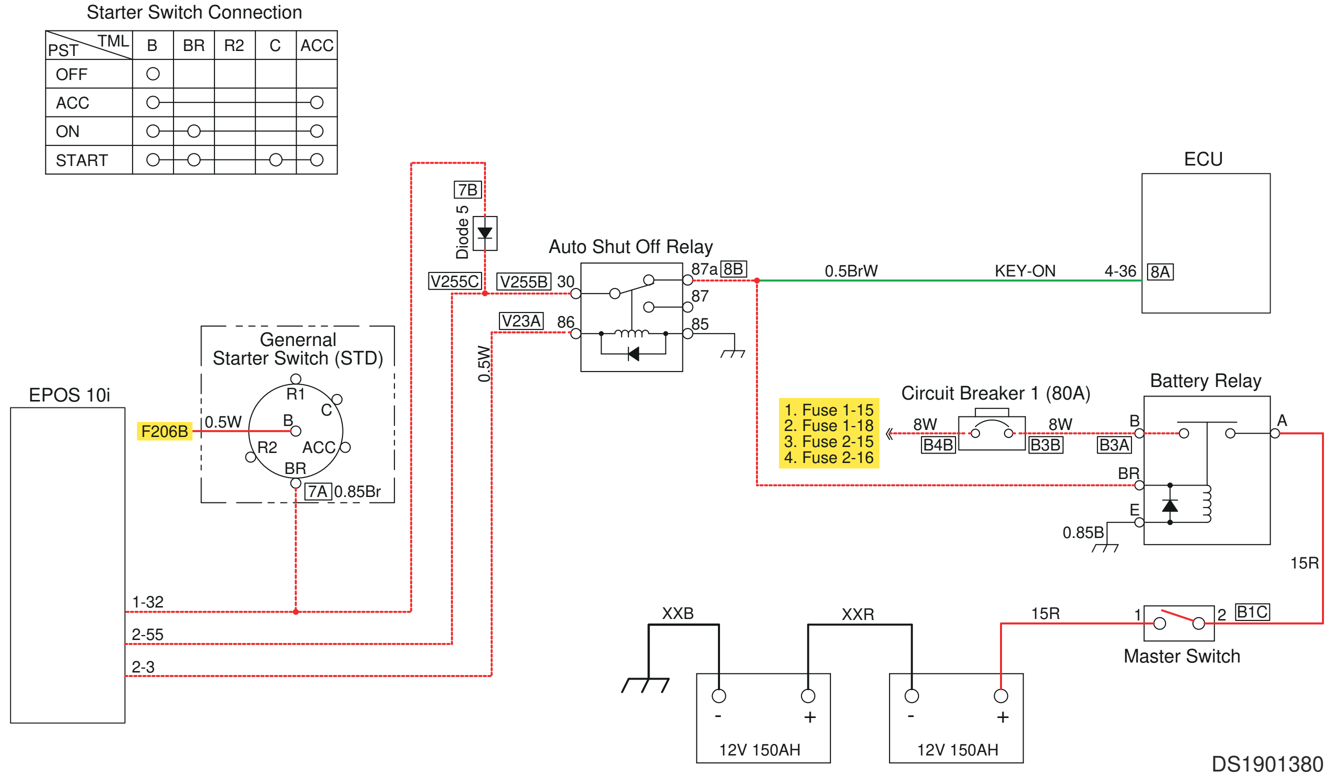
With the standard key in the ON position, it supplies 24V signal to EPOS terminal 1-32 and 2-55.

The signal also goes via the diode 5 to:

- The EPOS terminal 2-55
- The ECU terminal 4-36 via the auto shut off relay
- To the battery relay, to energize it & so power the rest of the fuses

The signal also goes to the starter relay 1 terminal 87

Figure 287

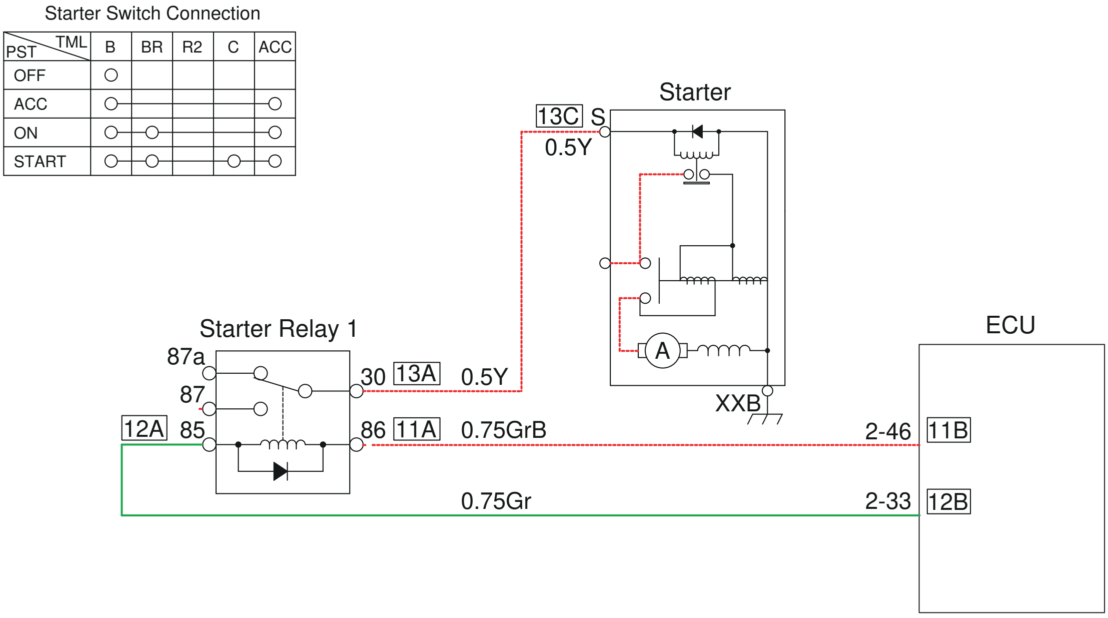


Starting System

In case of turning the standard key to the start position, it sends 24V signal to the EPOS terminal 2-55 and the emergency starting switch.

At the same time, the same signal is sent to the ECU terminal 4-31, which then energizes the starter relay 1 by signalling the relay from ECU terminal 2-46 & earthing it through terminal 2-33, so the starter motor becomes energised.

Figure 288

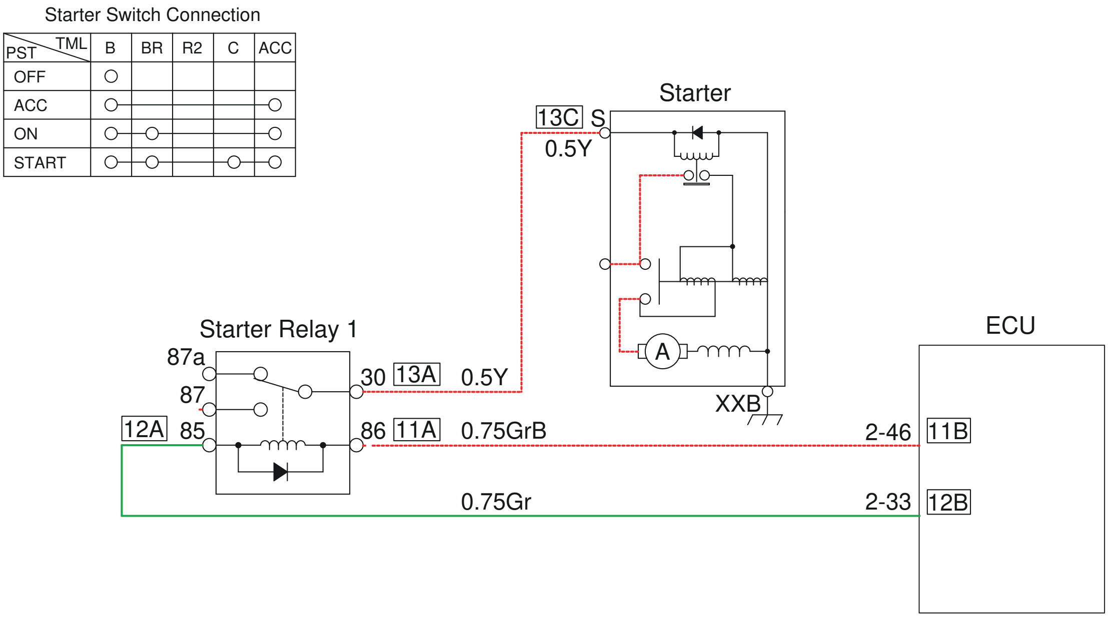


DS1901381

Start

In order to prevent restarting the starter or machine immobilization function, EPOS communicates with ECU and ECU controls starter relay 1 to keep no more starter motor running. (from ECU 2-33/2-46 to starter relay 1 by CAN communication)

Figure 289



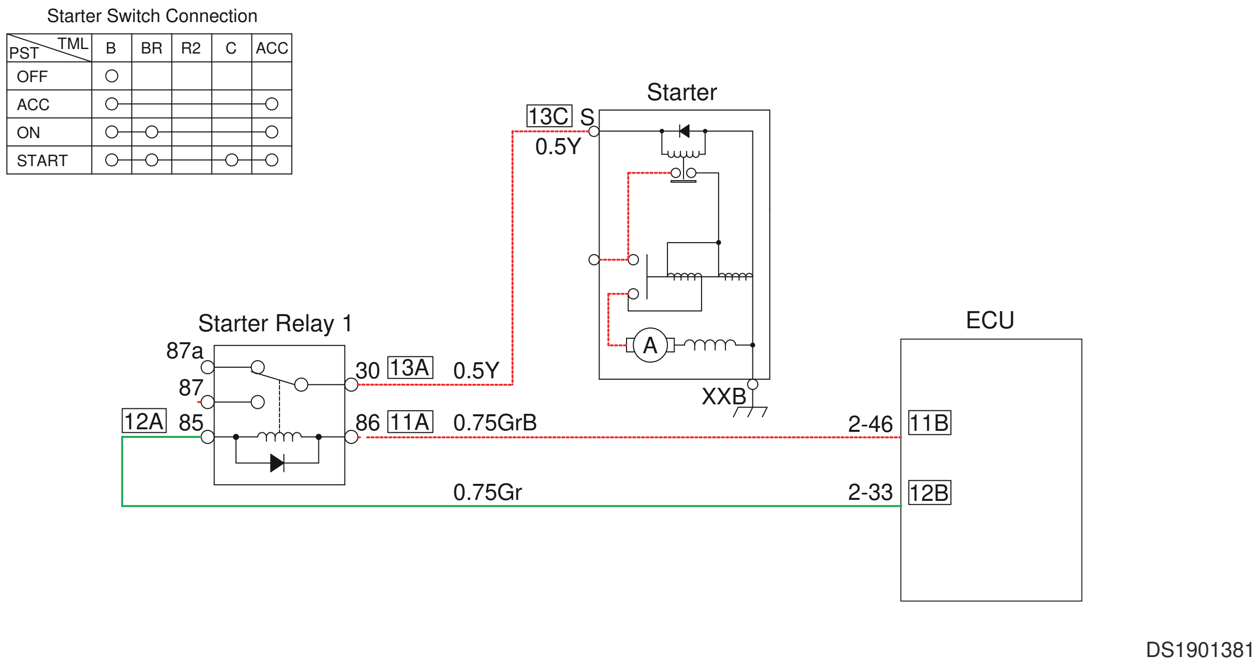
DS1901381

Restarting Protection (After Starting)

- Basically, the startup control is managed by the ECU.
- There is no restarting protection logic by the EPOS no more.

Once the engine speed exceeds around 500 rpm the ECU cuts the supply to the starter 1 relay so ECU stops the starter motor

Figure 290

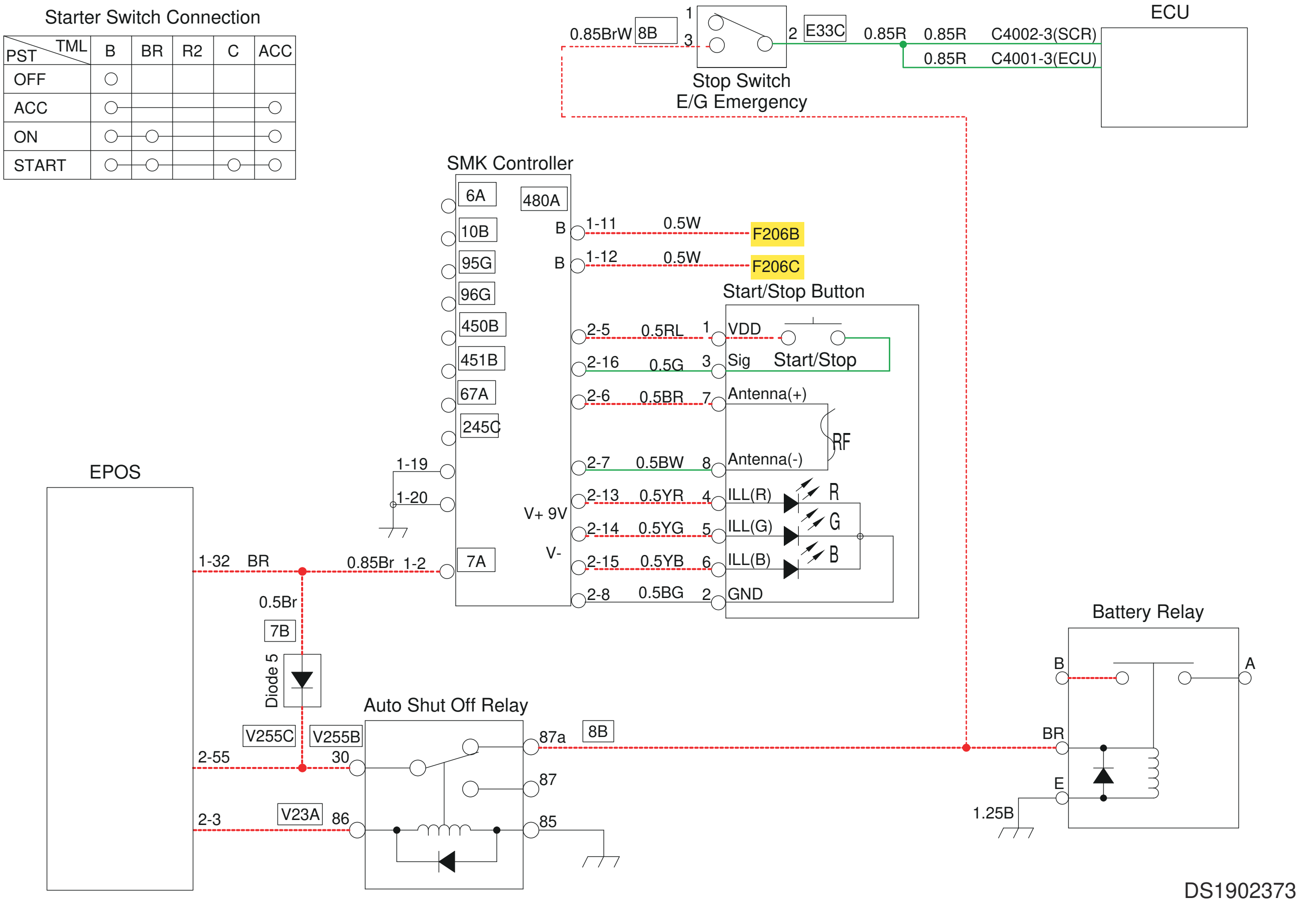


Auto Shut Off (After Starting)

If the machine is idling without the controls being operated, EPOS 2-3 pin will activate the auto shut off relay. Then the power supply to battery relay, stop switch E/G emergency and ECU are disconnected. The instrument panel works normally.

NOTE: *The auto shut off will not activate if the coolant temperature is too low.*

Figure 291



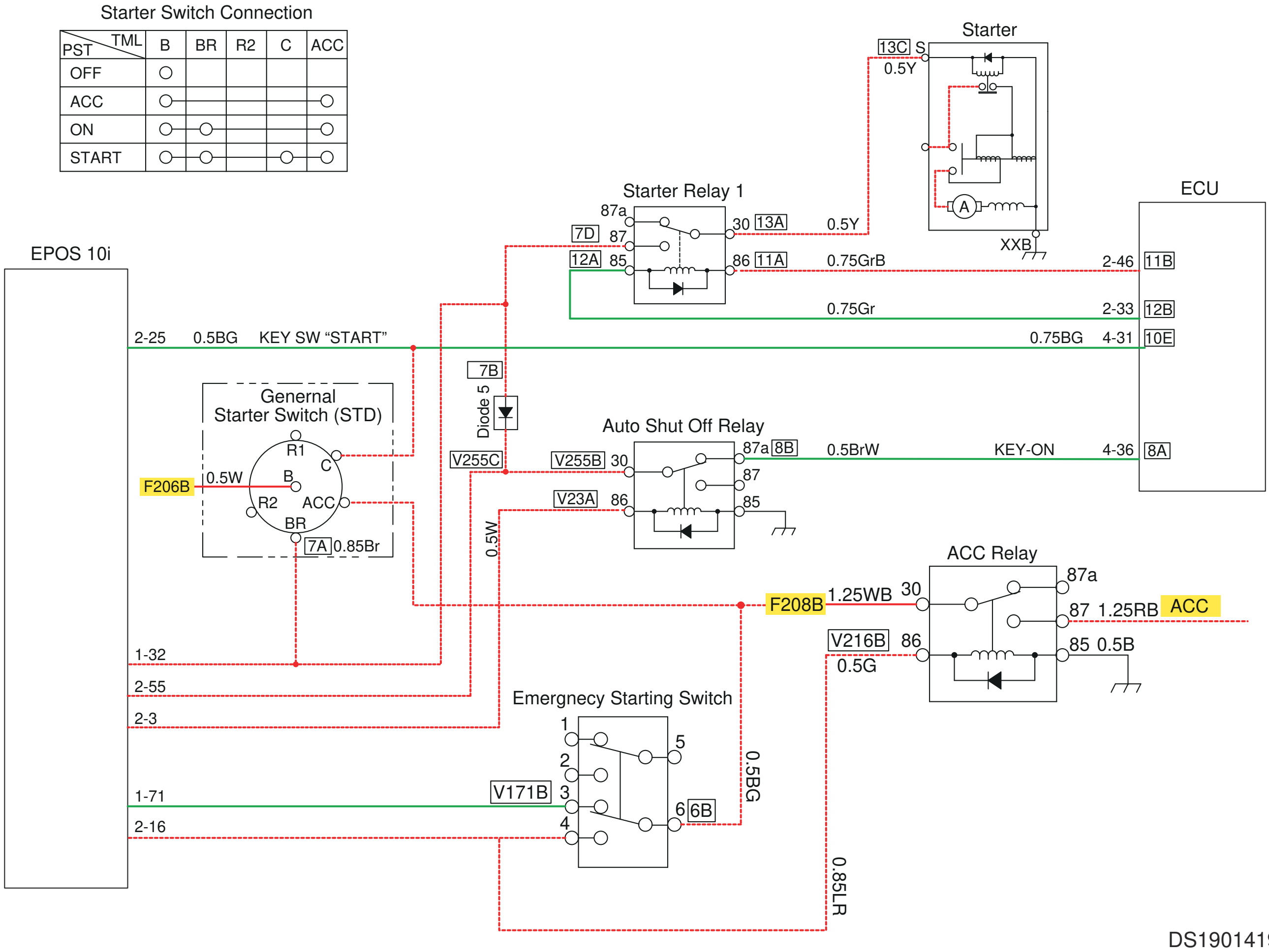
Once auto shut off activated and the required conditions are met, auto shut off relay cuts the power supply to the battery relay to removes the power supply to all of the key controlled fuses.

At the same time, EPOS removes the power supply to the ACC relay, which cuts the power supply to everything else except the items that are supplied by none key controlled supply.

This is only for the none key controlled power supply to the EPOS, which can keep the auto shut off relay energized.

The system is reset by turning the key off, which removes the power supplies to EPOS from the ACC & BR terminals of the starter switch.

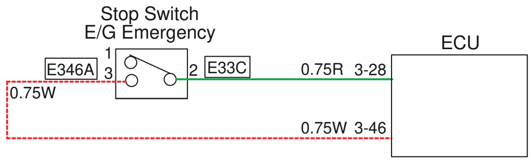
Figure 292



DS1901419

Emergency Start and Stop

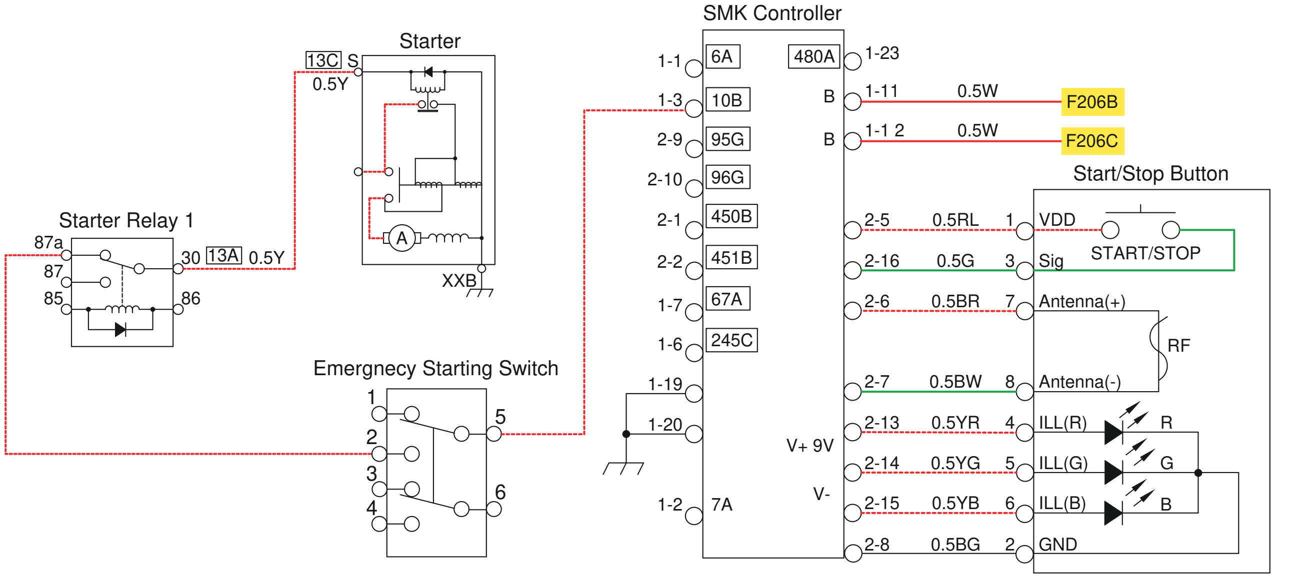
Figure 293



DS1901421

In case of EPOS failure, the emergency starting switch is used to redirect the starting signal from the standard key terminal C 1-3, directly to the starter relay on the starter motor via starter relay 1.

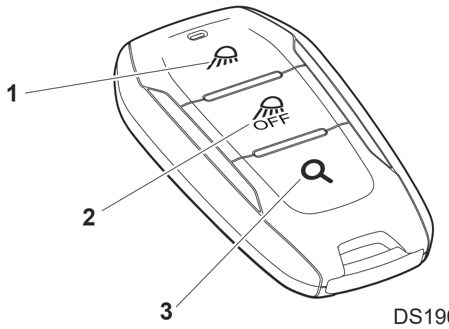
Figure 294



DS1901420

Smart Key (Option)

Figure 295

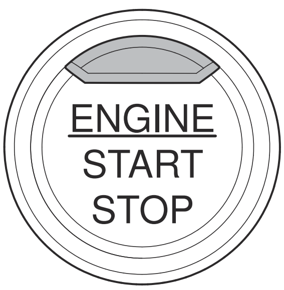


DS1900266

RF antenna - for horn, lamp

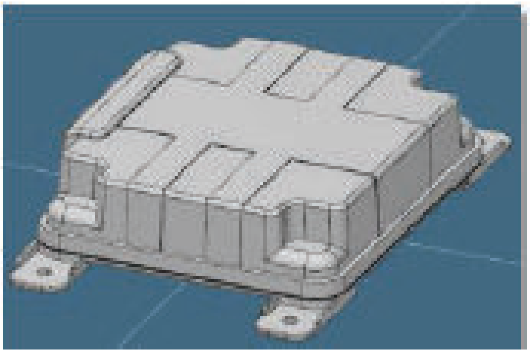
LF antenna (0.7 ~ 1.0 m) - for FOB

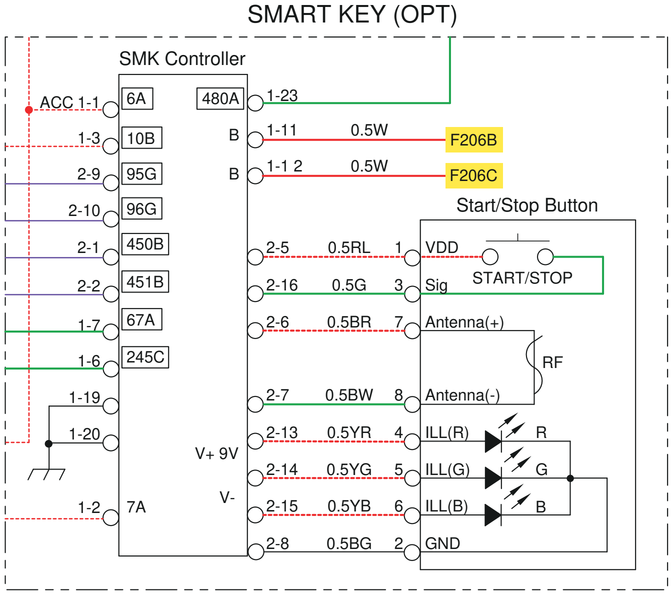
Figure 296



DS1901193

Figure 297

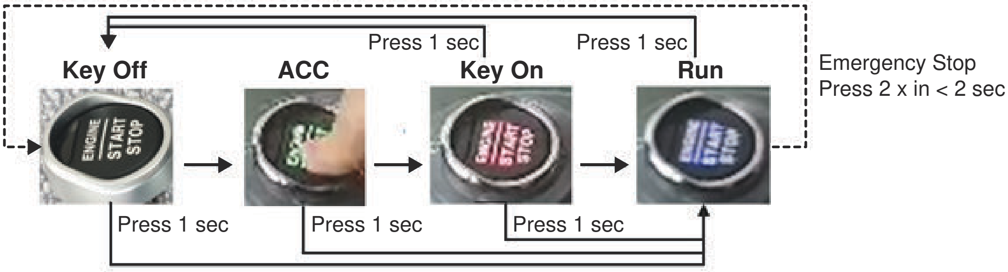




DS1901386

Starting System

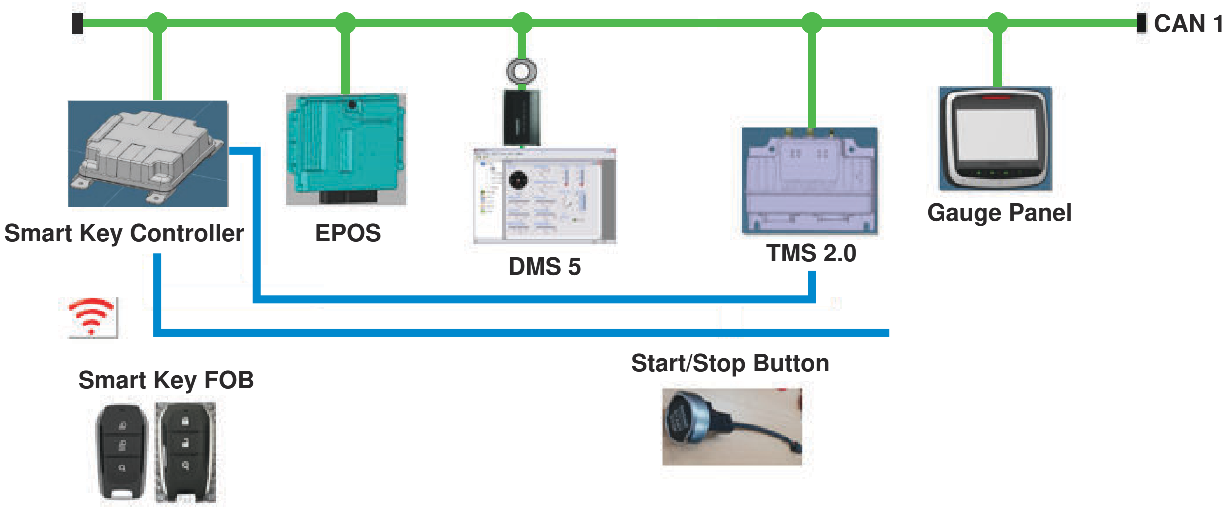
Figure 298



DS1901387

Smart Key System

Figure 299



DS1901388

Figure 300

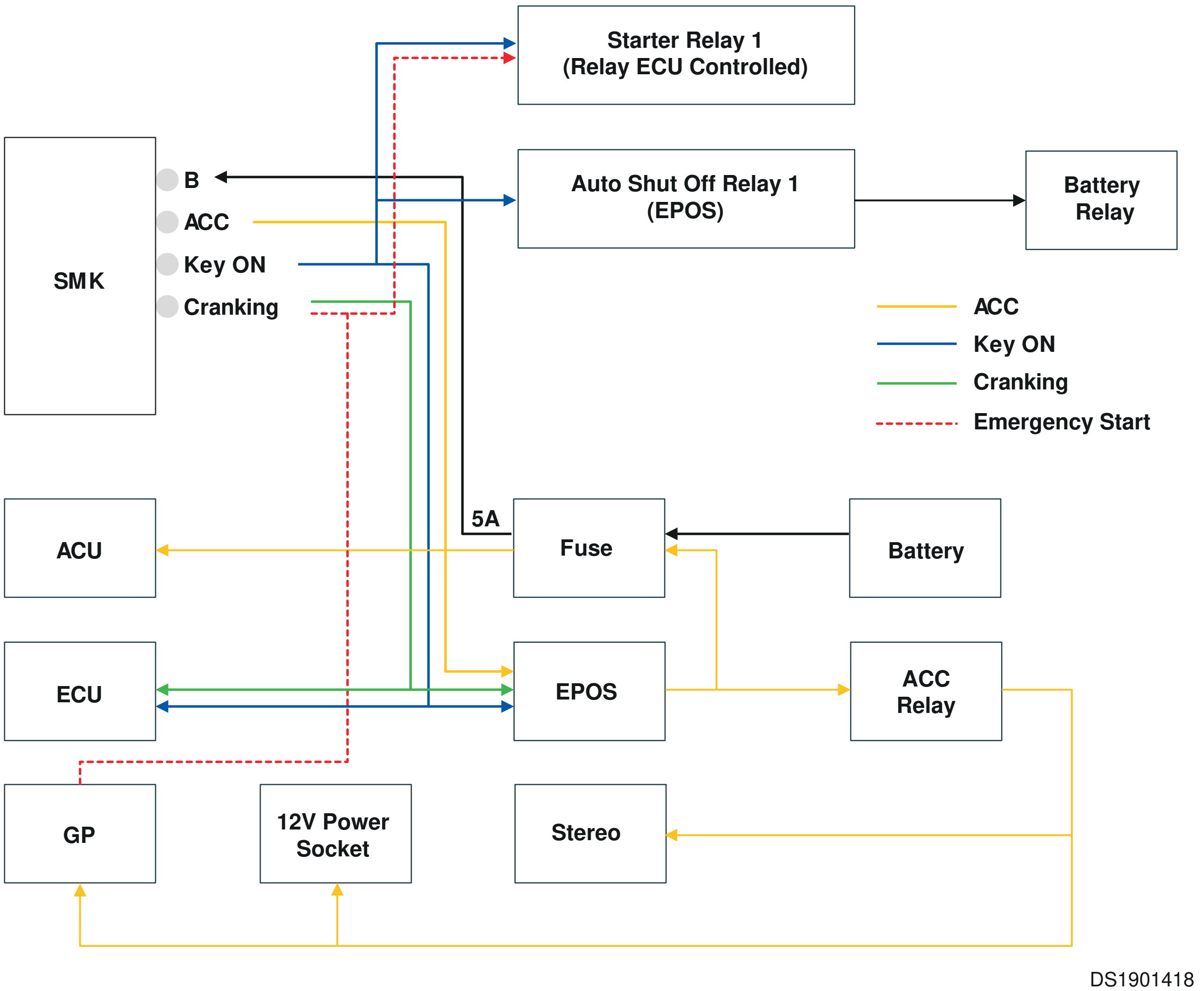
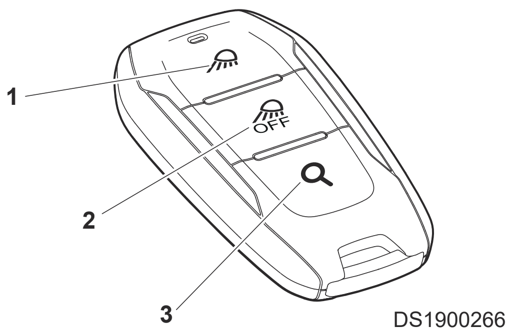


Figure 301



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.*

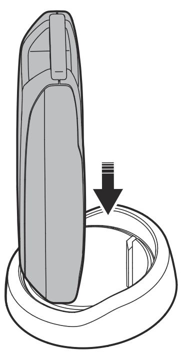
When the machine is put into the ACC condition, the smart key controller starts searching for 10 seconds for the smart key. If the smart controller fails to locate the smart key, the machine will display the smart key not present warning message on the gauge panel.

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 302


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.

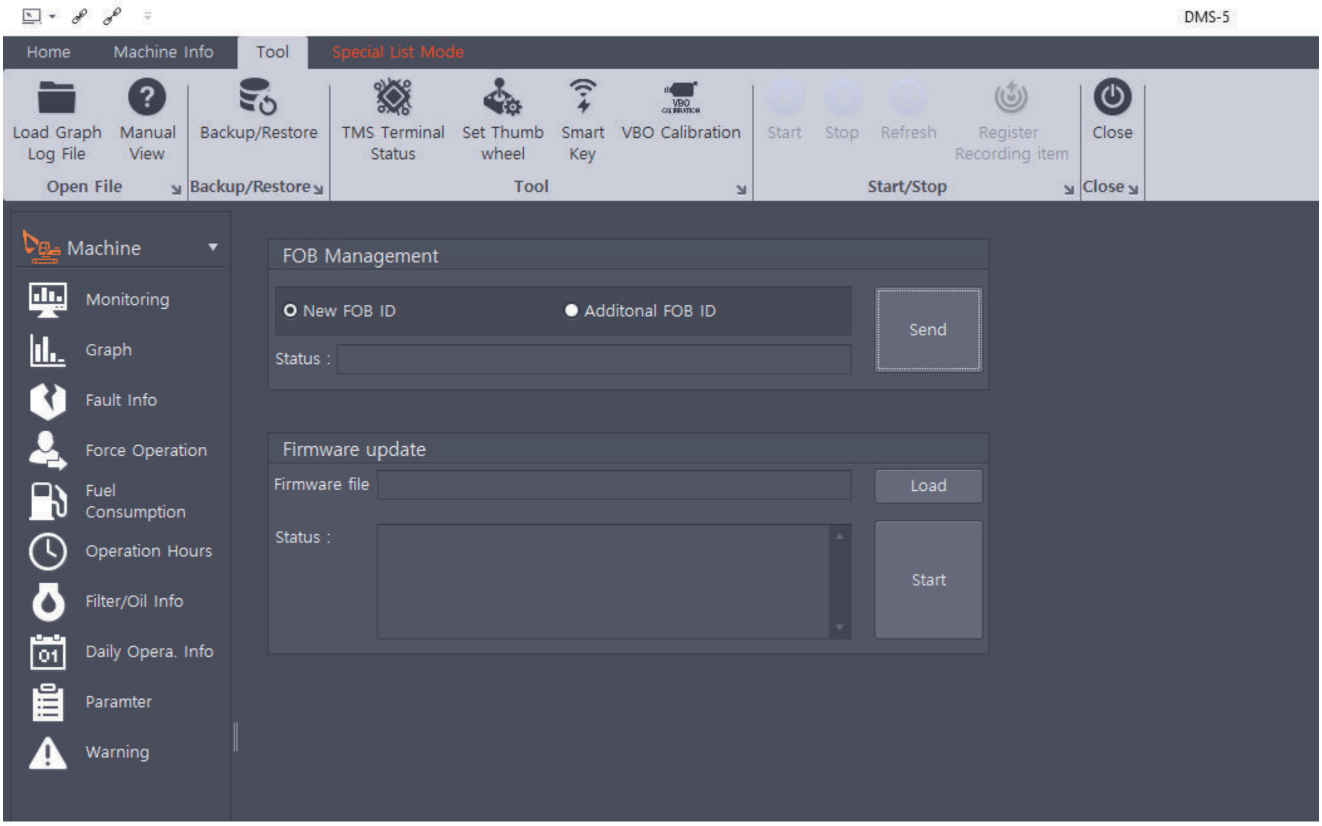
It will be possible to register a smart key to a machine by 2 methods:

- With DMS 5
- Through HD HYUNDAI CONSTRUCTION EQUIPMENT Fleet Management

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 303

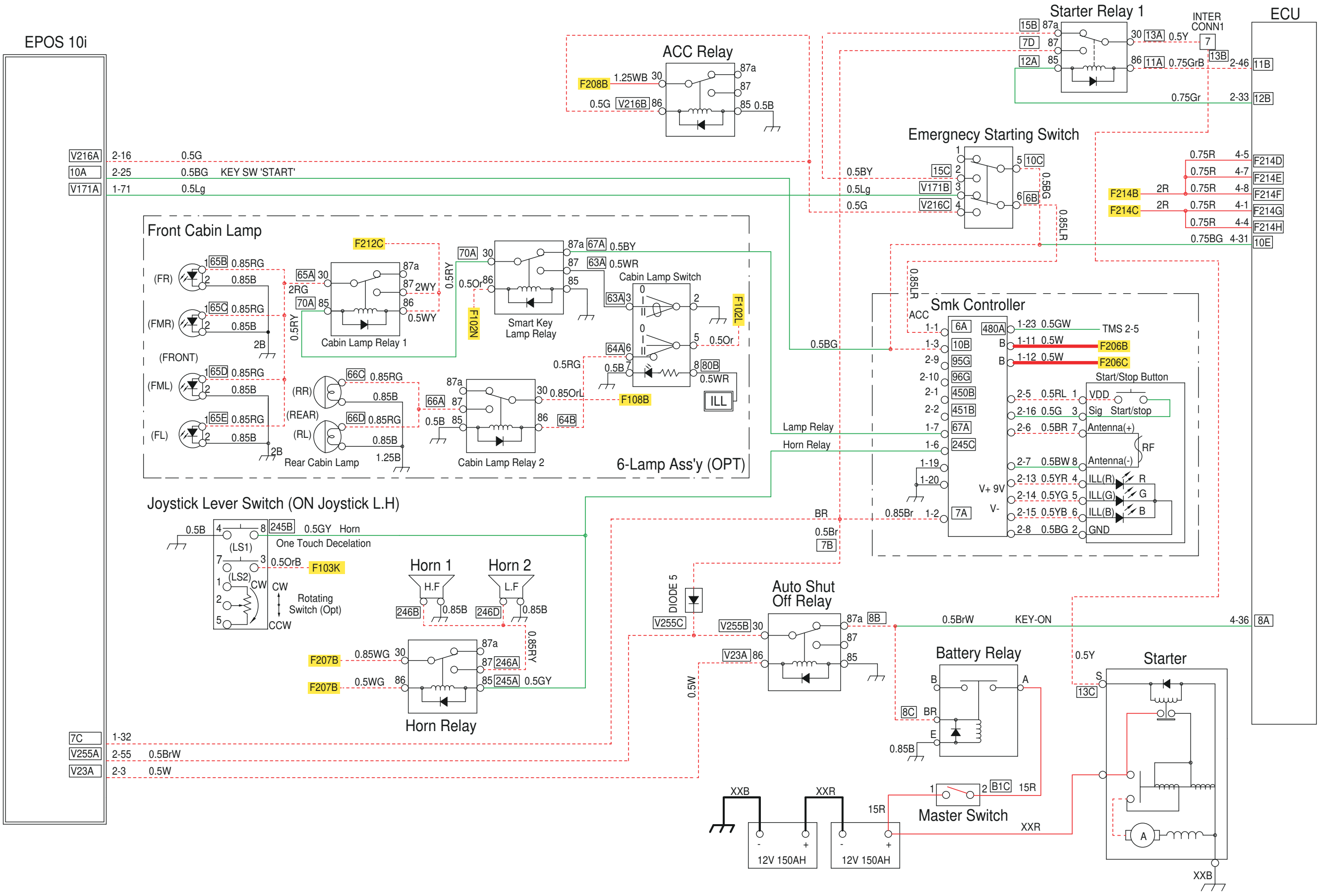


DS1901417

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 304

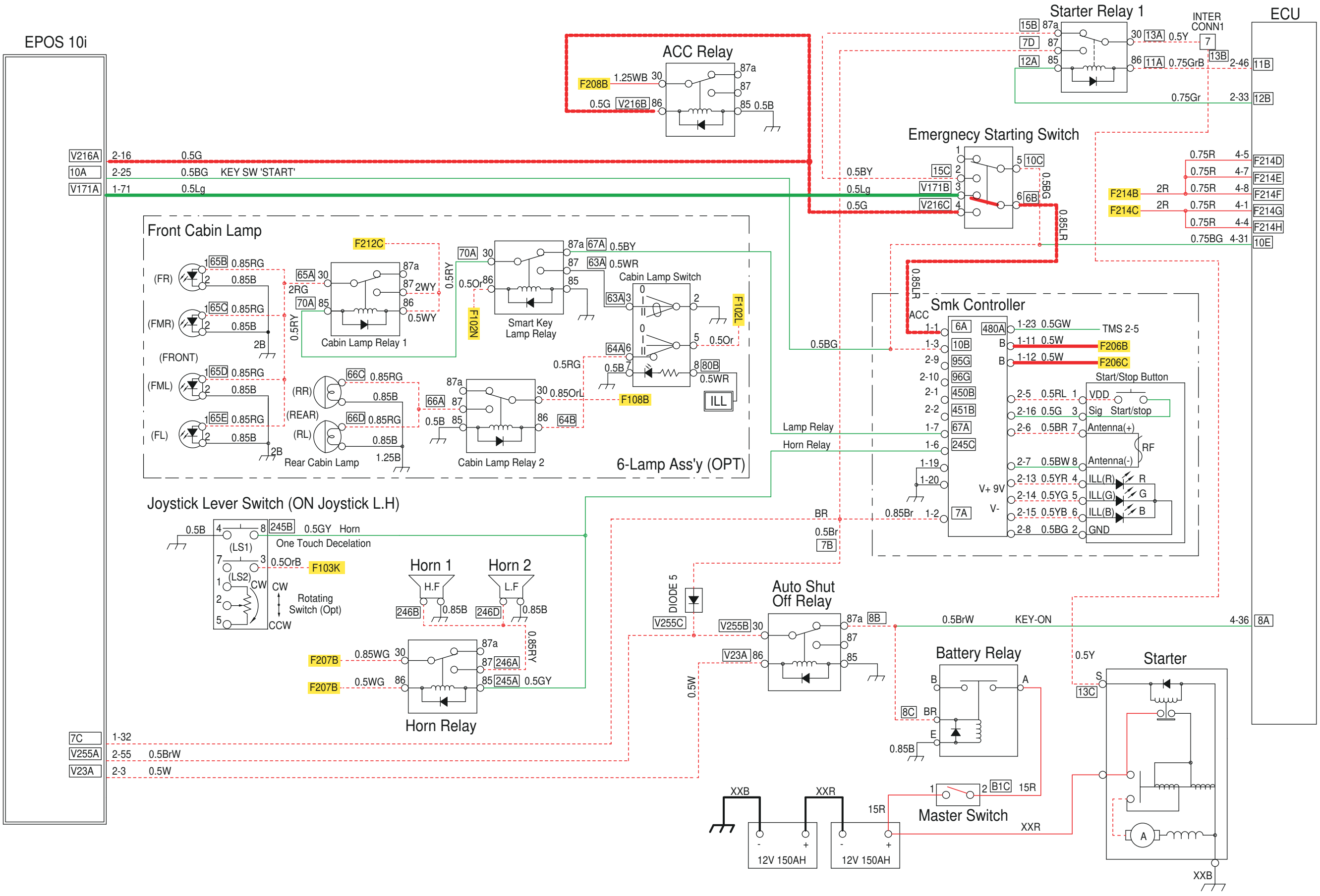


DS1901647

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 305



DS1901648

Smart Key (ON Condition)

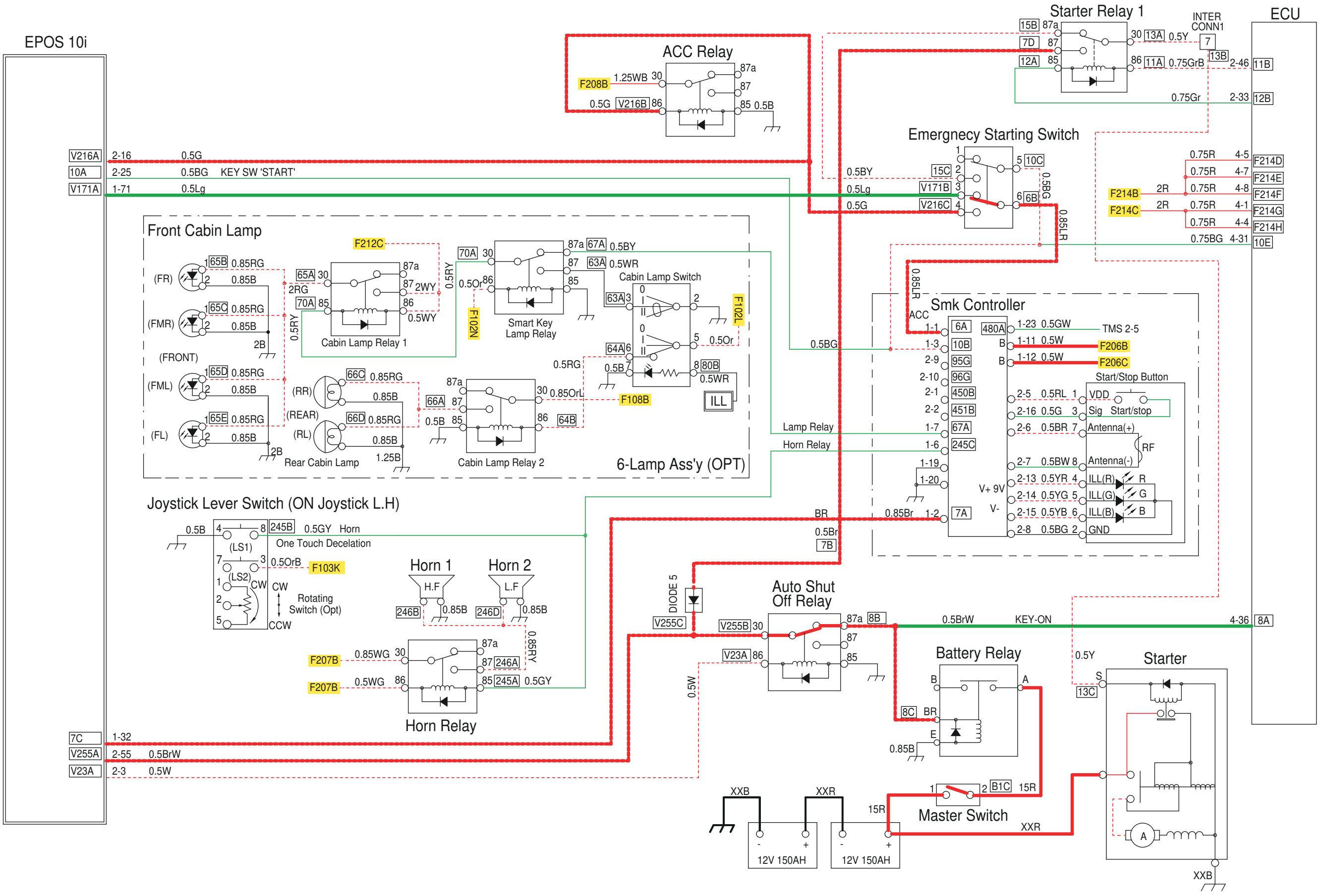
On the second press of the start / stop button, the button illumination changes to red and the SMK controller sends a signal to EPOS terminal 1-32.

The signal also goes via the diode 5 to:

- The EPOS terminal 2-55
- The ECU terminal 4-36 via the auto shut off relay
- To the battery relay, to energize it & so power the rest of the fuses

The signal also goes to the starter relay 1 terminal 87

Figure 306



DS1901649

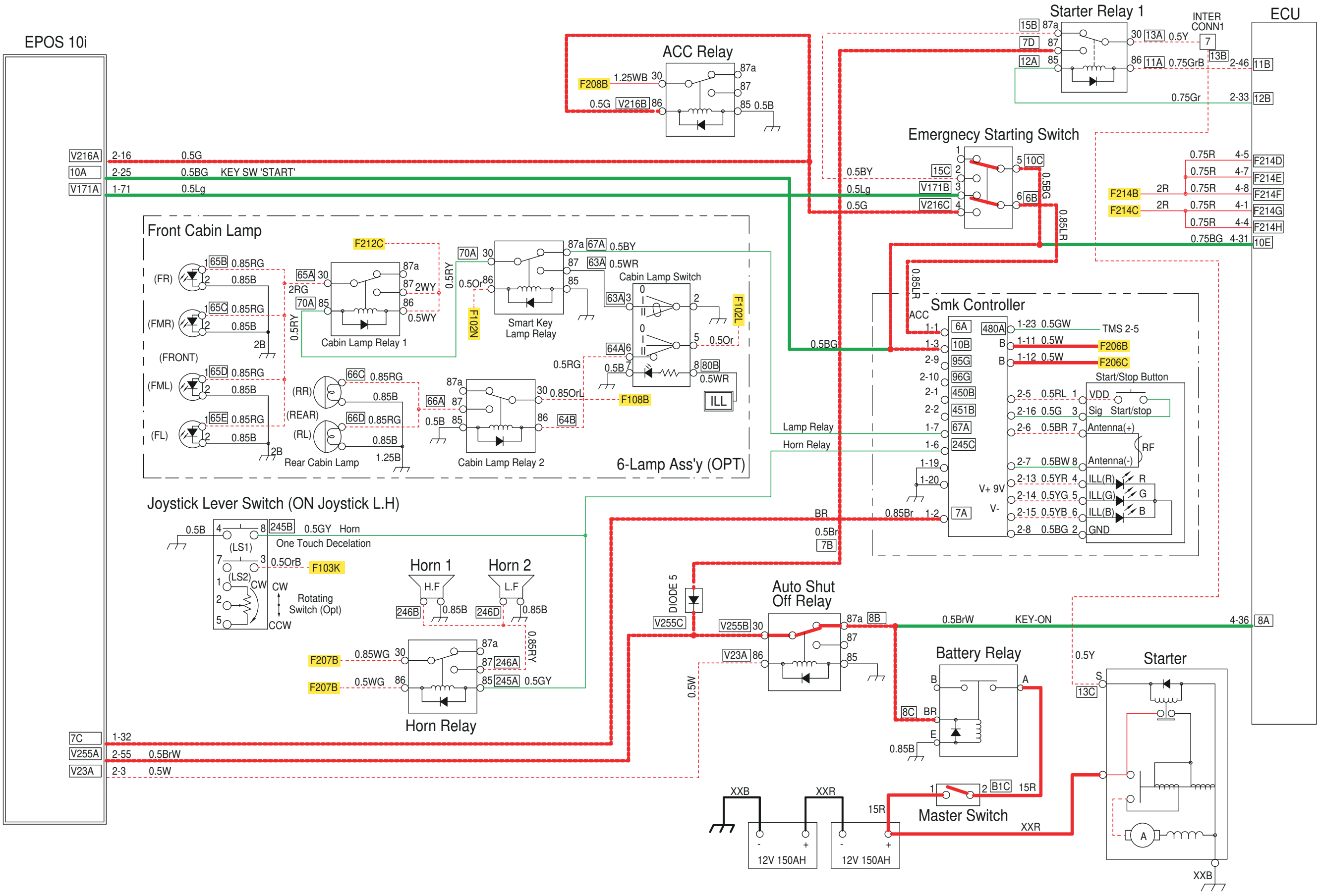
Smart Key (Start Condition)

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 same signal is sent to the ECU terminal 4-31, which then energizes the starter relay 1 by signalling the relay from ECU terminal 2-46 & earthing it through terminal 2-33, so the starter motor becomes energized.

During starting the button illumination turns blue.

Figure 307

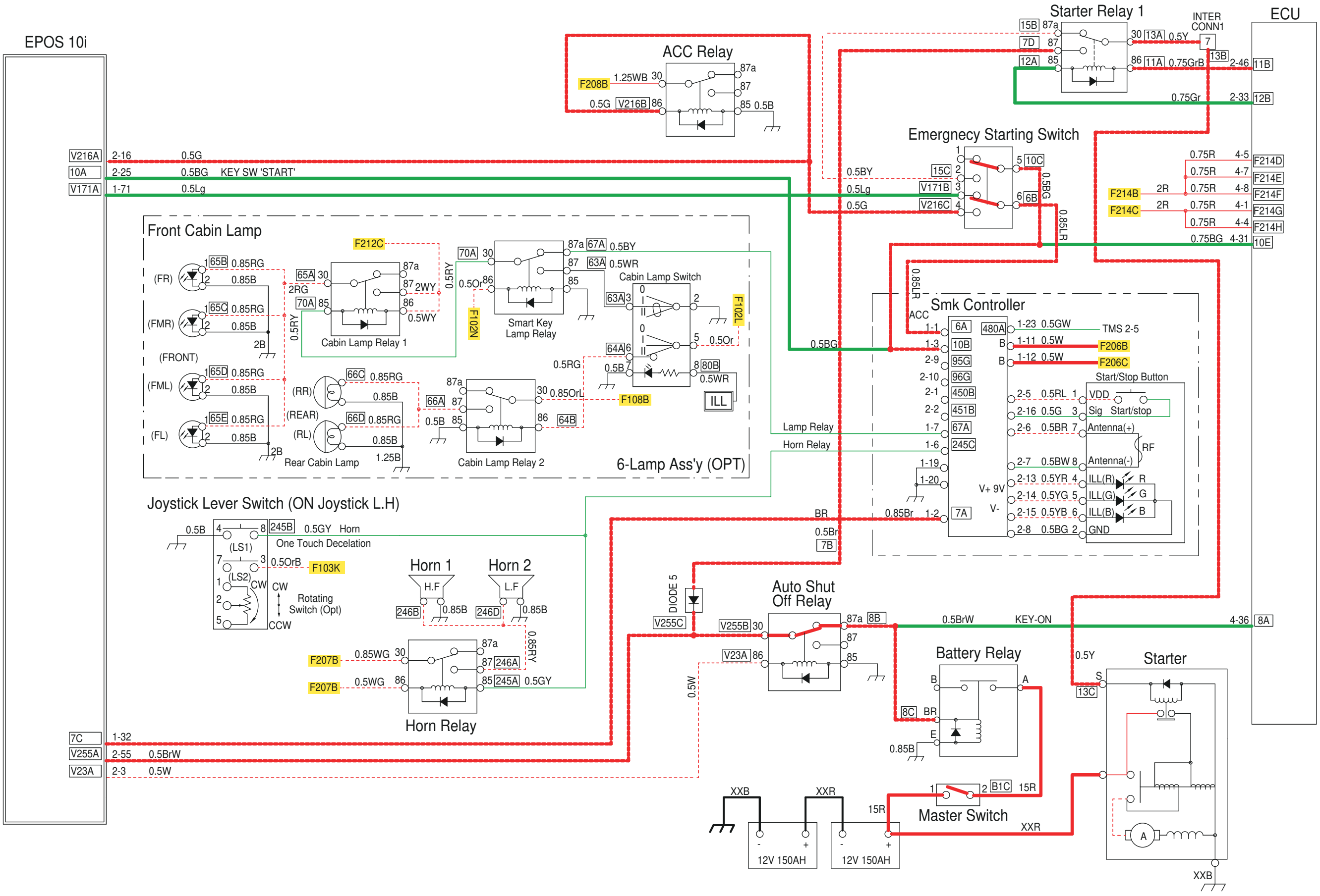


DS1901650

Once the engine speed exceeds 500 rpm the ECU cuts the supply to the starter 1 relay and stops the starter motor.

The ECU controls the starter relay 1, also acts to prevent the starter motor being re-engaged while the engine is running, as there is no longer a starter controller.

Figure 308

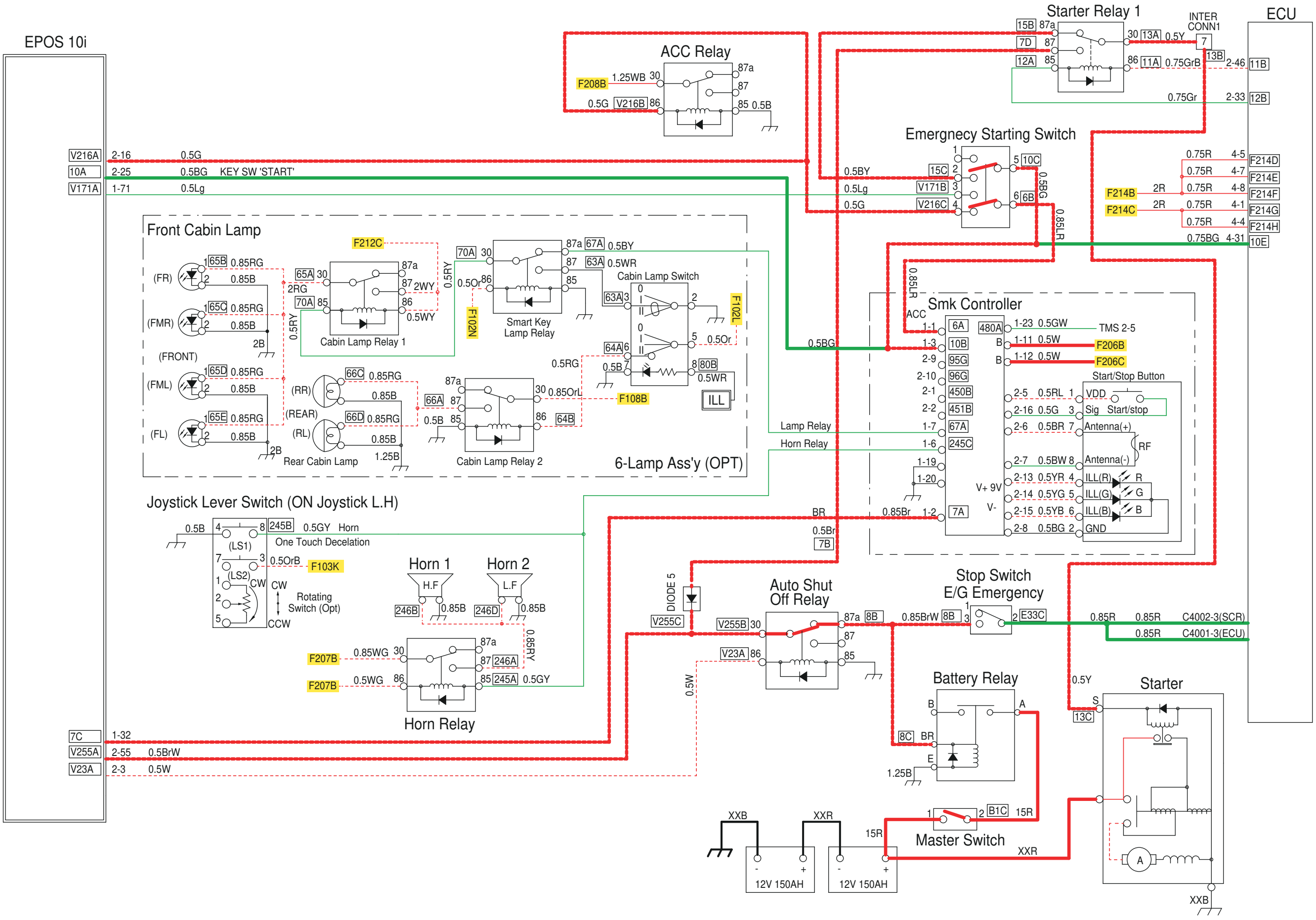


DS1901651

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 309



DS1902376

Preheating / After Heating System

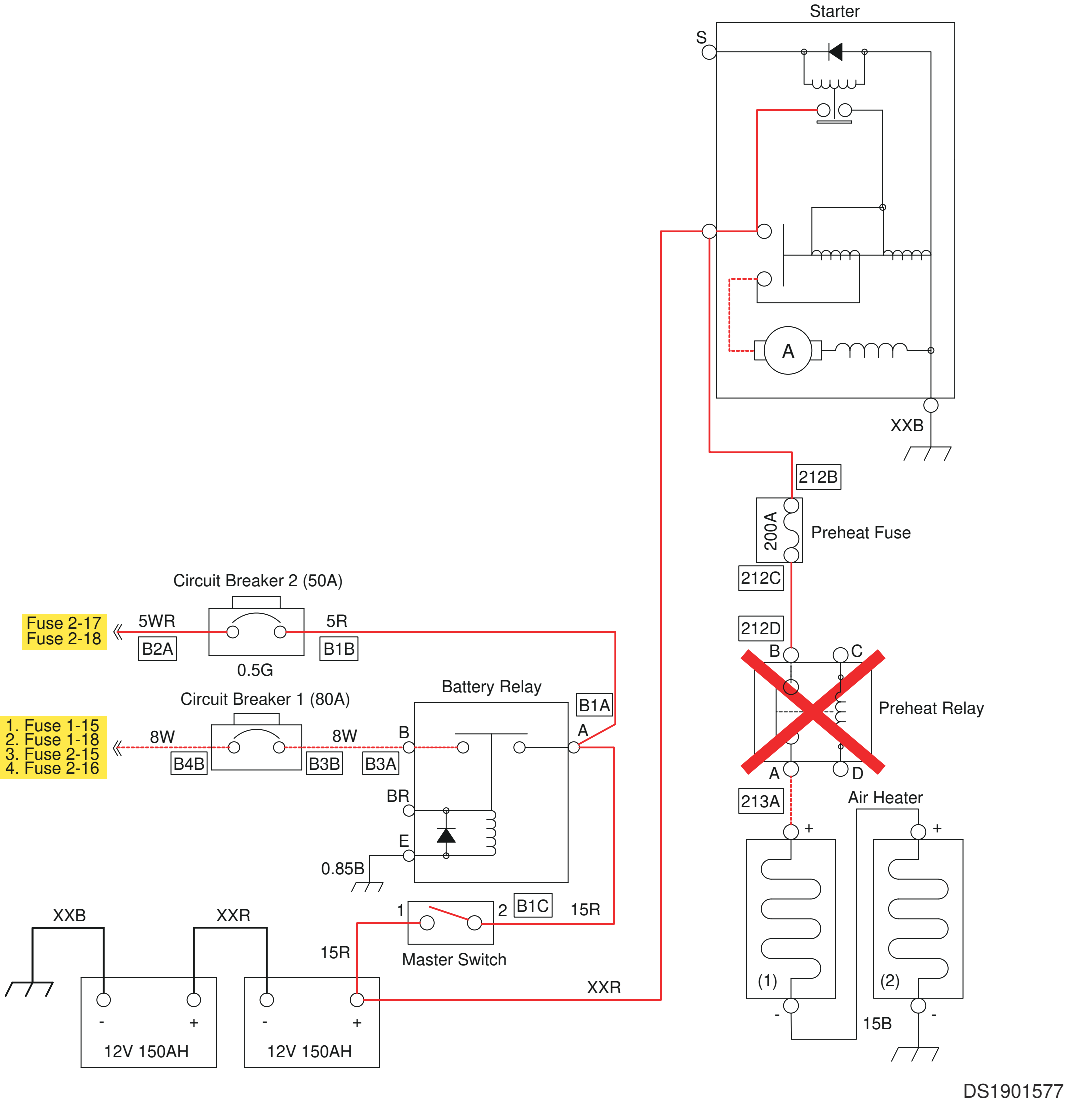
Preheating Control is Managed by the ECU

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

Figure 310

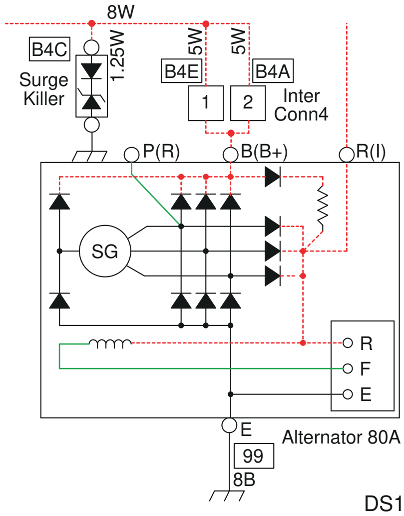


Starter
S
A
XXB
212B
200A
Preheat Fuse
212C
212D
B
C
Preheat Relay
A
D
213A
Air Heater
+
+
(1)
(2)
-
-
15B
Circuit Breaker 2 (50A)
Fuse 2-17
Fuse 2-18
5WR
B2A
0.5G
5R
B1B
Circuit Breaker 1 (80A)
Battery Relay
B1A
1. Fuse 1-15
2. Fuse 1-18
3. Fuse 2-15
4. Fuse 2-16
8W
B4B
8W
B3B
B3A
B
A
BR
E
0.85B
1
2
B1C
15R
Master Switch
15R
XXB
XXR
XXR
12V 150AH
12V 150AH
DS1901577

Charging System

Alternator

Figure 311



DS1901578

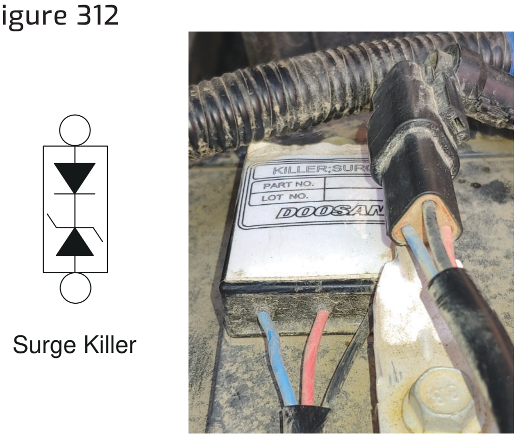
P: Do not use

B: Power for electric load

R: Alternator operating check when it is 12V or less

Surge Killer

Figure 312



DS1901579

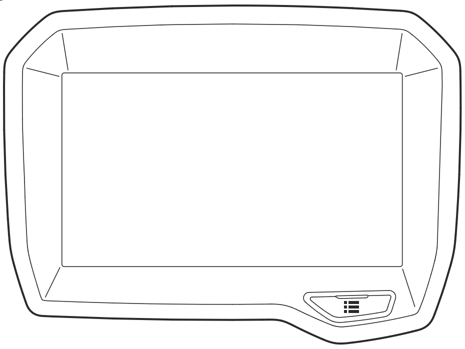
In order to protect the electronic components in the machine against damage caused by sudden electrical surges, a surge killer has been installed.

The surge killer removes the need for the zener diode on the alternator to battery relay line.

AVM System

AVM

Figure 313

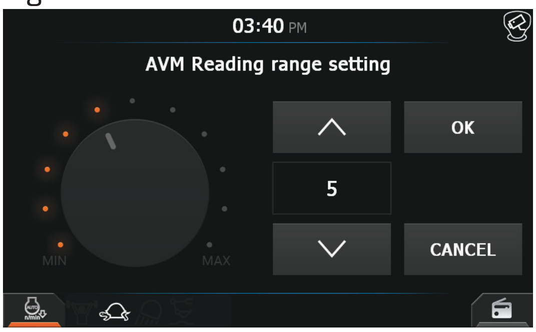


DS1901279

Length sensitivity of the ultrasonic sensor

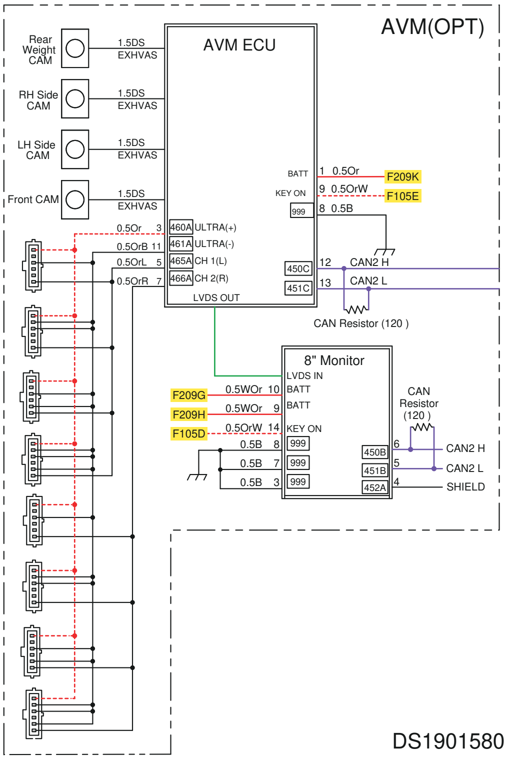
1. Step 1: Approx. 0.5 ~ 0.9 m
2. Step 5: Approx. 0.9 ~ 1.8 m
3. Step 10: Approx. 1.8 ~ 2.7 m

   Figure 314



DS1900339

Figure 315

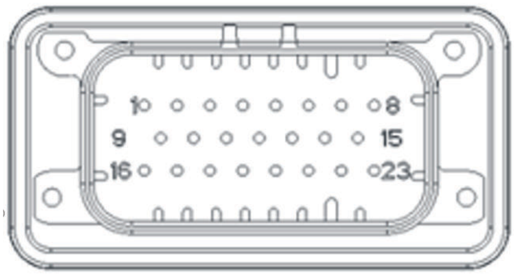


DS1901580

Gauge Panel System

Gauge Panel

Figure 316



DS1901576

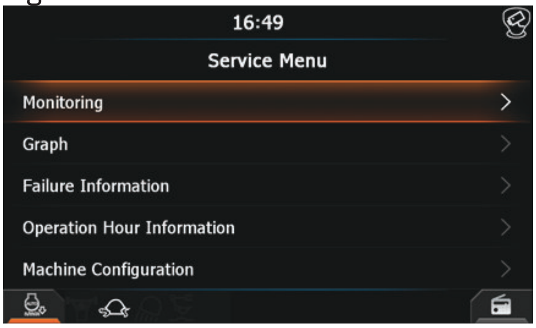
Connection Pin Detail
Main Connector

#	Description	Function	I/o	#	Description	Function	I/O
1	RS232_Rxd	Signal	O	13	Camera_PWR	Power	Power
2	RS232_Rxd	Signal	I	14	EXT_VIN0A	Signal	I
3	RS232_Gnd	Power	GND	15	EXT_VIN1A	Signal	I
4	CAN1_H	Signal	Bi	16	Main_GND	Power	GND
5	CAN1_L	Signal	Bi	17	Main_GND	Power	GND
6	CAN2_H	Signal	Bi	18	Spare1	Signal	I
7	CAN2_L	Signal	Bi	19	Ext_Buzzer	Signal	O
8	Ext. Lamp	Signal	I	20	Spare2	Signal	I

#	Description	Function	I/o	#	Description	Function	I/O
9	BAT+	Power	Power	21	Camera_GND	Power	GND
10	BAT+	Power	Power	22	Ext_V_GND	Power	GND
11	Key_Switch_ACC	Signal	I	23	Ext_V_GND	Power	GND
12	Key_Switch_Br	Signal	I				

Service Menu

Figure 317



DS1901969

Overview

In this menu, many types of operating conditions and functions can be accessed and displayed.

This menu is mainly used for machine testing and fault diagnostics.

Various submenus can be selected by turning the jog switch and clicking on the jog switch to select the menu.

Press the ESC button to return to the previous screen.

NOTE: *The information, illustrations, and menu can change at any time without prior notice.*

Menu Description				
1st	2nd	3rd	4th	5th
Service Menu	Monitoring	Vehicle Analog Input		
		Vehicle Analog Output		
		Vehicle Digital Input		
		Vehicle Digital Output		
		Engine Signal		
		User Selection Signal		
		TMS Information	GPS Information	
			Network Information	
			Terminal Information	

	Graph	Graph Data Monitoring		
		Set Graph Data		
	Failure Information	Real Time Failure Information		
		Failure Log Information		
		AVM Real Time Failure Information		
	Operation Hour Information			
	Machine Configuration	Option Configuration	Set Attachment Option	One Way
				Two Way
				Attachment Operating Option
				Option Pedal Type
				Rotating
				Ripper
				Tiltrotatator
				Dozer
			Set Function Option	2D Machine Guidance
				3D Machine Guidance
				Machine Control
				Weighing
			Set Machine Option	Two-Pump
				Highland
				Intelligent Boom Float
				OWD
				Travel/Swing Alarm
				Quick Coupler
				RCW
				Mirror Heater
				Reverse Fan
				Arti-Boom
				Fuel Sensor (CAN Type)

				Joystick
			Set Machine Option (Wheeled machine only)	
			Set General Option	AVM
				Ultrasonic Sensor
				Outside Voice Alarm
				Boom Camera
				TMS
				Gateway
				Smart Key
				DAB
				OTA
				Keyless
		Set Camera	Set Camera1	
			Set Camera2	
		Version Information		
		Program Update		
		Enter Vehicle Name		
		Enter Serial Number		
		Reset	Failure Log Reset	
			Operation Hour Reset	
			Gauge Panel Configuration Reset	
		Calibration	Front Weight Calibration (if equipped)	
			Set AVM Tolerance Calibration	
			Tilt Sensor Calibration (if equipped)	
			Machine Guidance	Set Model Option
				Work Part Sensor
				Body Sensor
				Tilt Rotator Body

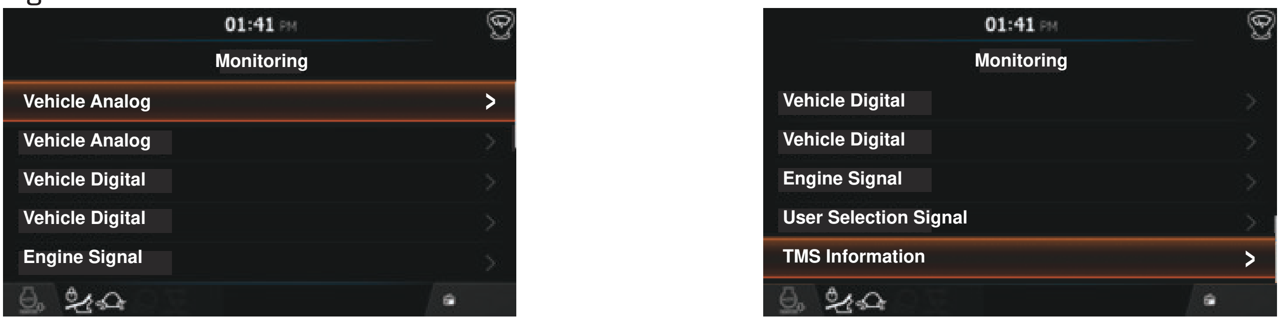
				Monitoring
			Machine Control	
			Weighing	
		Permanent Security Unlock		
		Gauge Panel Monitoring		

Monitoring

1. Entering submenus: When cursor is located on "Monitoring" of special menu screen, press the jog switch and the "Monitoring" will be displayed.

2. The following menus can be accessed: Vehicle Analog, Vehicle Digital, Engine Signal, User Selection Signal and TMS Information.

Figure 318



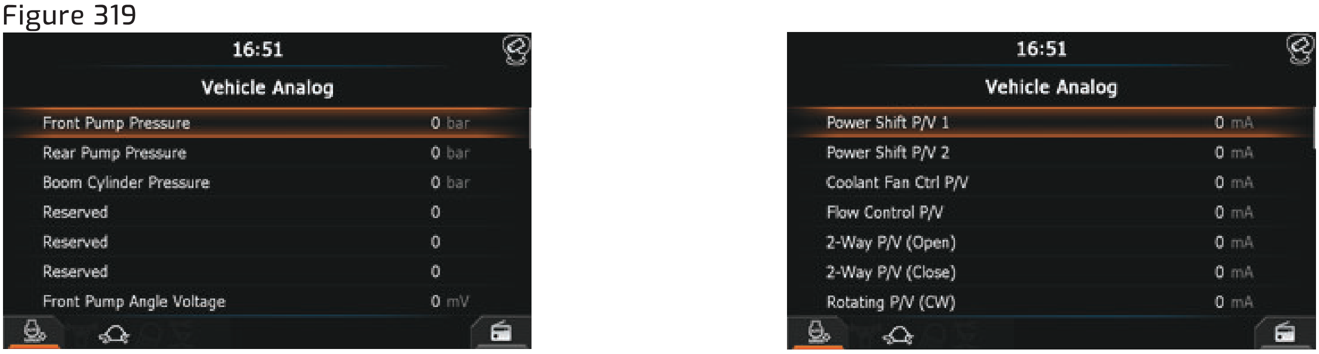
DS1901970

* TMS Information is displayed only when TMS is activated in the option.

Vehicle Analog

The following menus can be accessed: Front Pump Pressure, Rear Pump Pressure, Boom Cylinder Pressure, Reserved, Front Pump Angle Voltage, Power Shift P/V 1, Power Shift P/V 2, Coolant Fan Ctrl P/V, Flow Control P/V, 2-Way P/V (Open), 2-Way P/V (Close) and Rotating P/V(CW).

Figure 319

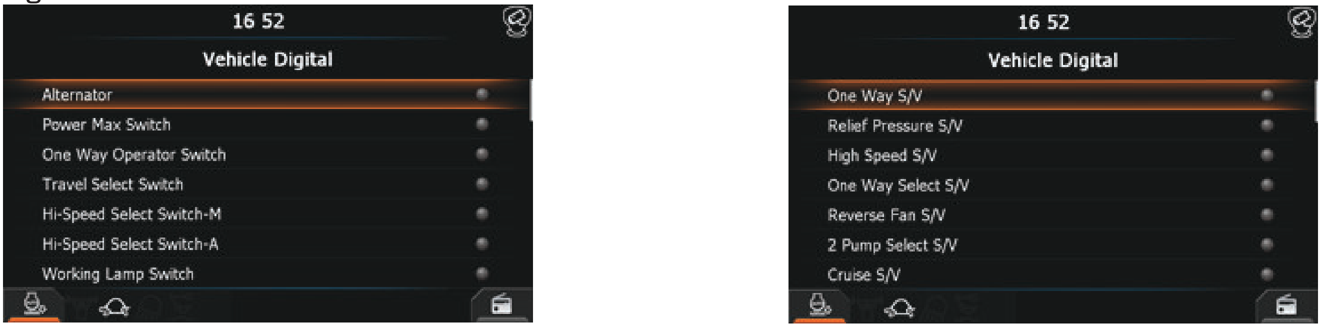


DS1901971

Vehicle Digital

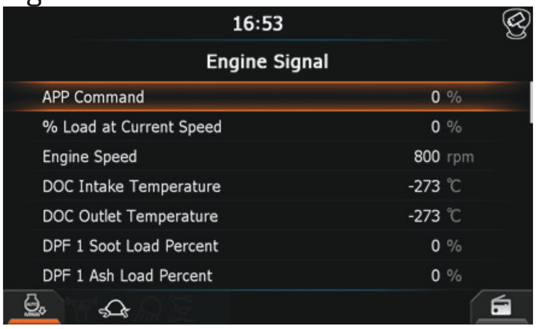
The following menus can be accessed: Alternator, Power Max Switch, One Way Operator Switch, Travel Select Switch, Hi-Speed Select Switch-M, Hi-Speed Select Switch-A, Working Lamp Switch, One Way S/V, Relief Pressure S/V, High Speed S/V, One Way Select S/V, Reverse Fan S/V, 2 Pump Select S/V and Cruise S/V.

Figure 320



DS1901972

Figure 321

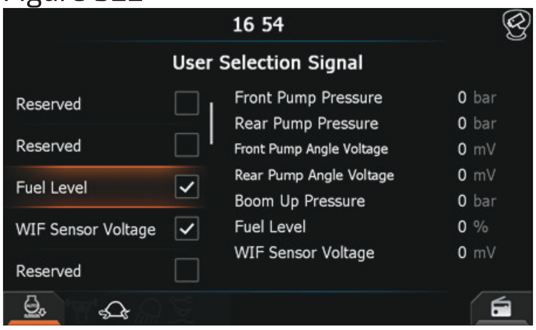


DS1901973

Engine Signal

The following menus can be accessed: App Command, % Load at Current Speed, Engine Speed, ... and DPF 1 Ash Load Percent.

Figure 322



DS1901974

User Selection Signal

The following menus can be accessed: Front Pump Pressure, Rear Pump Pressure, Boom Cylinder Pressure, Fuel Level, WIF Sensor Voltage and etc.

1. Left side represents the monitoring item name and selection.
   A. Monitoring item
      - Vehicle analog input / output, vehicle digital input / output, and engine signal.
   B. Selection
      - The monitor displays the selected item status.
2. Right display unit is to display data in accordance with the monitoring unit selected in the left list.
   A. Items that display monitoring item, data units are as follows:

- Vehicle analog input / output, engine signal

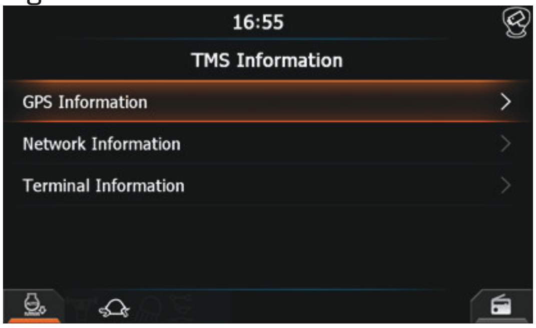
B. Items that display monitoring item, the activation is as follows:

- Vehicle digital input / output

3. Number where you can select the monitor is up to 8.

- If the current selection number is 8, adding another data will cause a popup.

Figure 323



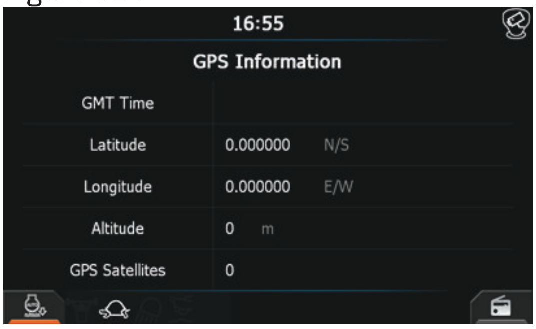
DS1901975

TMS Information

Overview

The following menus can be accessed: GPS Information, Network Information and Terminal Information.

Figure 324



DS1902017

GPS Information

Overview

In this screen, GPS Information can be monitored.

1. Items to display GPS Information are as follows.

A. Greenwich standard time

- 'dd/mm/yyyy hh:mm:ss +hh' formatted.

B. Latitude

- '0.000000 N/S' formatted.

C. Longitude

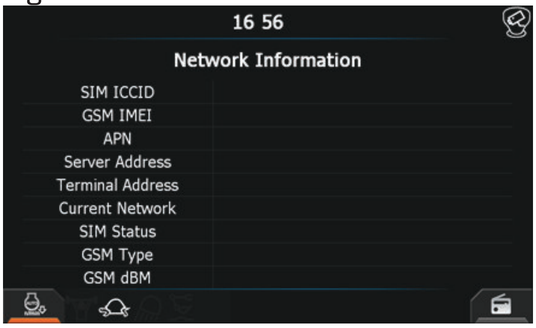
- '0.000000 E/W' formatted.

D. Altitude

- '00 m' formatted.

E. GPS Satellite number
 - Displays the number of satellites used.

Figure 325



DS1901976

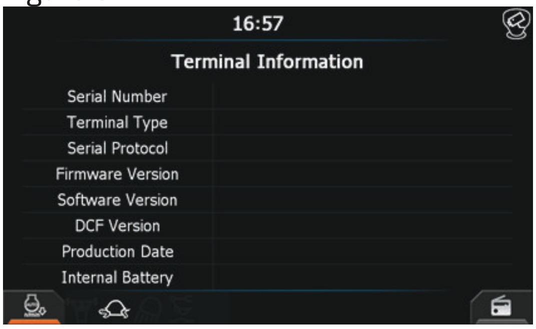
Network Information

Overview

In this screen, Network Information can be monitored.

1. The items to display the Network Information are as follows.
   A. SIM ICCID: Displays SIM ICCID
   B. GSM IMEI: Displays GSM IMEI
   C. APN: Displays APN
   D. Server Address: Displays server
   E. Terminal Address: Displays terminal
   F. Current Network: Displays current network
   G. SIM Status: Displays SIM status "Connected" or "Not Connected"
   H. GSM Type: Displays GSM type
   I. GSM dBM: Displays GSM dBM

Figure 326



DS1901977

Terminal Information

Overview

In this screen, Terminal Information can be monitored.

1. The items to display the terminal information are as follows.
   A. Serial Number: Displays serial number

B. Terminal Type: Displays terminal type
C. Serial Protocol: Displays serial protocol
D. Firmware Version: Displays firmware version
E. Software Version: Displays software version
F. DCF Version: Displays DCF version
G. Production Date: Displays production date
H. Internal Battery: Displays battery information

Figure 327

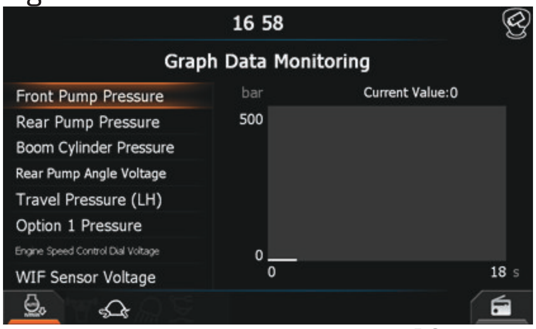
DS1901978

Graph

Overview

The following menus can be accessed: Graph Data Monitoring and Graph Data Setting.

Figure 328



DS1901979

Graph Data Monitoring

Overview

In this screen, the items selected in the graph data setting can be confirmed by a graph.

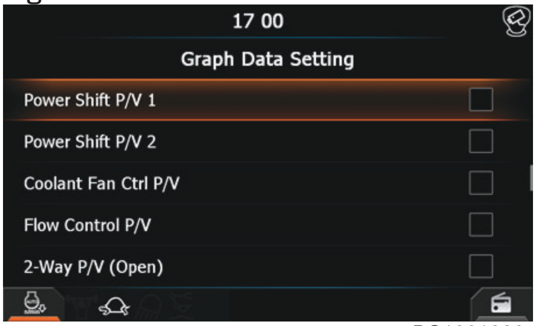
1. Left list unit is to display the monitored item name in the graph data set.
2. The right display shows the entire graph selected from the left, and the currently selected graph is displayed in bolder than the other graph. The graph display method is as follows.
   A. X axis
      - On the time axis, display the time on the left and right for 18 seconds.
      - After 18 seconds, the minimum and maximum values of the x-axis are increased by 1 second, showing only 18 seconds.
   B. Y axis

- Data axis displays data for 18 seconds.
- The y-axis maximum value indicates a specially determined value.

C. Current Value

- Display the value of the corresponding data in real time.

Figure 329



DS1901980

Graph Data Setting

Overview

In this screen, it is possible to select data to check the graph in Graph Data Setting.

1. Items to select graph data are as follows.
   - Vehicle analog input / output, engine signal
2. Indicate whether to select graph data for each item.
3. Up to 8 graph data monitoring options can be selected.
   - If the current selection number is 8, adding other data causes a popup.

Figure 330

DS1901981

Failure Information

Overview

The following menus can be accessed: Real Time Failure Information, Failure Log Information and AVM Real Time Failure Information.

1. AVM Real Time Failure Information menu is displayed only when the AVM option is enabled.

Figure 331

DS1901982

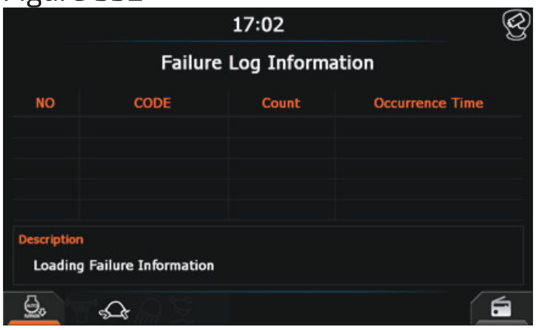
Real Time Failure Information

Overview

In this screen, Real Time Failure Information can be monitored.

1. In the central list section, the fault sequence, fault code, and fault details are indicated as follows.
   A. NO: Displays the order according to the error code priority.
   B. CODE: Displays the error code.
      - Equipment error code: VXX (Prefix) + nnn (Priority) - nn (FMI)
      - Engine error code: E + nnnnnn (SPN) - nn (FMI)
   C. Description: Displays detailed fault information.

Figure 332



DS1901983

Failure Log Information

Overview

In this screen, Failure Log Information can be monitored.

1. In the central list section, the fault sequence, fault code, and fault details are indicated as follows.
   A. NO: Displays the order according to the error code priority.
   B. CODE: Displays the error code.
      - Equipment error code: VXX (Prefix) + nnn (Priority) - nn (FMI)
      - Engine error code: E + nnnnnn (SPN) - nn (FMI)
   C. Number of occurrences: Displays the total number of times the corresponding fault occurred.
   D. Occurrence Time: Indicates the operating time of the latest point where the corresponding fault occurred.

Figure 333

DS1901984

AVM Real Time Failure Information

Overview

In this screen, AVM Real Time Failure Information can be monitored.

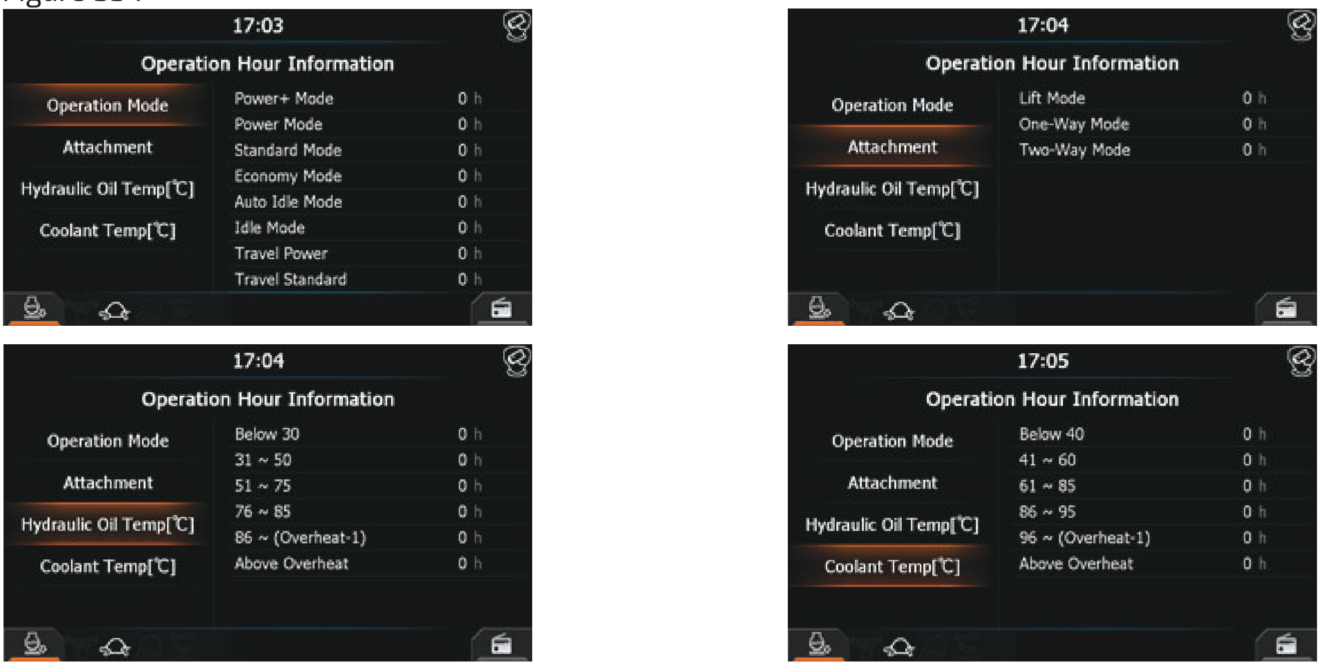
1. In the central list section, the fault sequence, fault code, and fault details are indicated as follows.
   A. NO: Displays the order according to the error code priority.
   B. CODE: Displays the error code.
      - AVM error code: A + nnnnnn (SPN) - nn (FMI)
   C. Description: Displays detailed fault information.

Operation Hour Information

Overview

In this screen, Operation Mode, Attachment, Hydraulic Oil Temp and Coolant Temp can be monitored.

Figure 334



DS1901985

1. The left list shows the Operating Mode, Attachment, Operating Oil Temperature and Coolant Temperature.
2. The right side display shows the following items according to the left side list.
   A. Operation Mode

- Power + Mode, Power Mode, Standard Mode, Economy Mode, Auto Idle Mode, Idle Mode, Driving Power, Travel Standard

B. Attachment Mode

- Lift Mode, Breaker Mode, Two Way Mode

C. Operating Oil Temperature

- 30 or less, 31 ~ 50, 51 ~ 75, 76 ~ 85, 86 ~ (Overheat Temperature -1)

D. Cooling Water Temperature

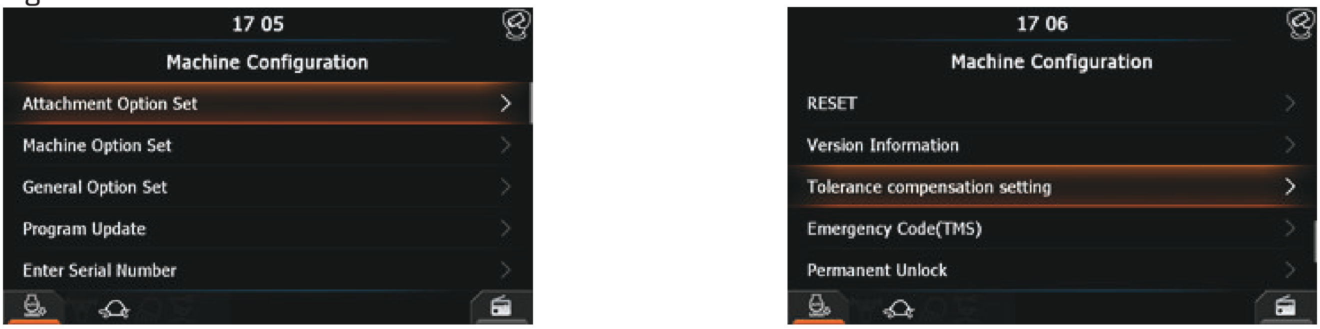
- 40 or less, 41 ~ 60, 61 ~ 85, 86 ~ 95, 96 ~ (Overheat Temperature -1)

Machine Configuration

Overview

The following menus can be accessed: Attachment Option Set, Machine Option Set, General Option Set, Program Update, Enter Serial Number, RESET, Version Information, Tolerance compensation setting, Emergency Code (TMS) and Permanent Unlock.

Figure 335



DS1901986

1. The following menu is displayed only in the case of the following right.

   A. Camera setting, camera guideline tuning: AVM option setting disabled

   B. Tolerance correction setting: Activate AVM option

   C. Tilt sensor calibration: Wheel excavator

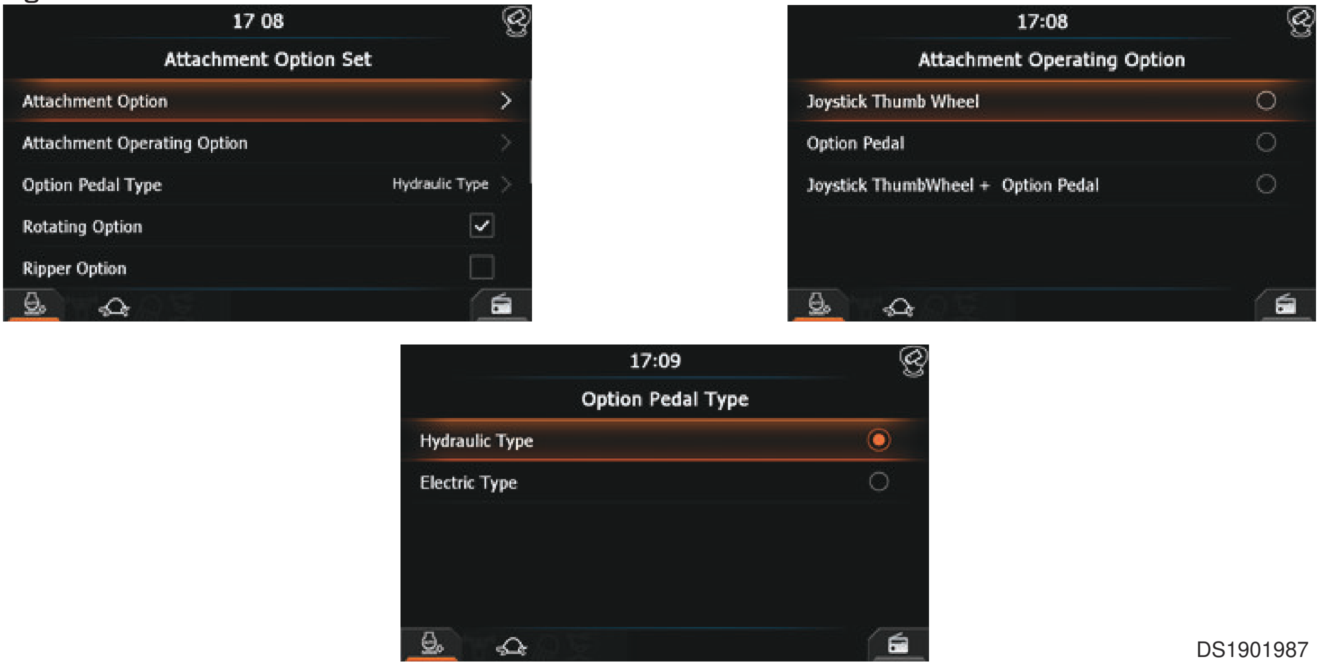
   D. Disable temporary security, disable permanent security: Activate TMS option

Attachment Option Set

Overview

The following menus can be accessed: Attachment Option, Attachment Operating Option, Option Pedal Type, Rotating Option, Ripper Option, Joystick Thumb wheel, Option Pedal and Joystick Thumbwheel + Option Pedal.

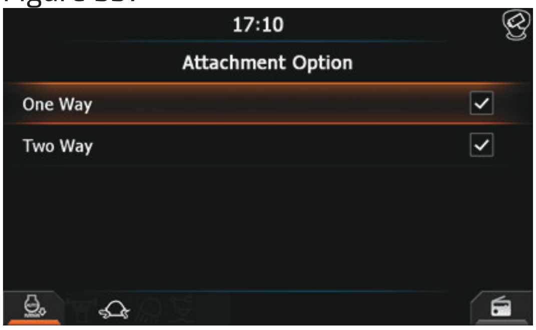
Figure 336



DS1901987

1. This screen is structured as shown above.
2. Indicates which option is used.
3. The following menu is displayed only in the case of the following right.
   A. Attachment manipulation option: Two-way activation of attachment option
   B. Optional pedal type: Activate pedal of attachment operation option
   C. External voice warning option: Enable AVM option of option setting

Figure 337



DS1901988

Attachment Option

Overview

In this screen, attachment options can be set.

1. Indicates which attachment option is used. Attachment options are:
   - One Way (Breaker), Two Way

Figure 338

DS1901999

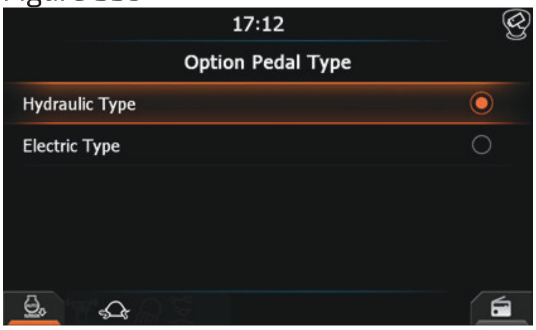
Attachment Operating Option

Overview

In this screen, the Attachment Operation Options can be set.

1. This screen is structured as shown above.
2. Indicates which attachment manipulation option is used. Attachment manipulation options are:
   - Joystick Thumbwheel, Optional Pedal, Joystick Thumbwheel + Optional Pedal

Figure 339



DS1902000

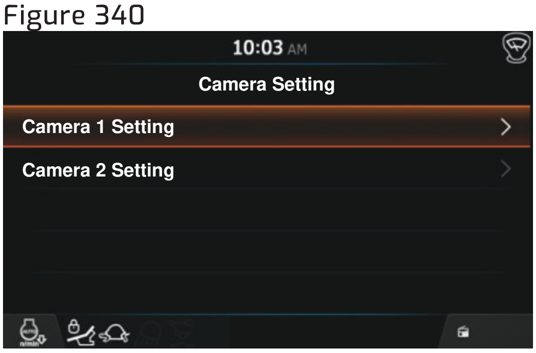
Option Pedal Type

Overview

In this screen, Option Pedal Type can be set.

1. Displays the current option setting.
2. The types of option pedals that can be set are as follows.
   - Hydraulic, Electric

Figure 340



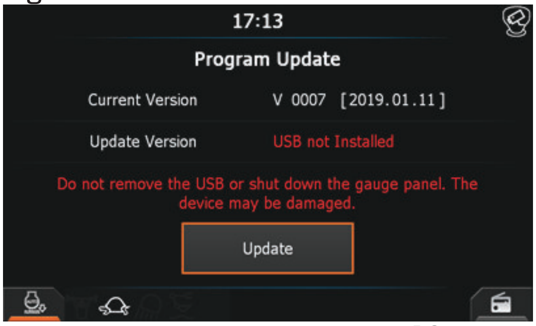
DS1902001

Camera Setting

Overview

In this screen, it is possible to select the camera to set and then enter the Camera Setting screen.

Figure 341



DS1902003

SW Update

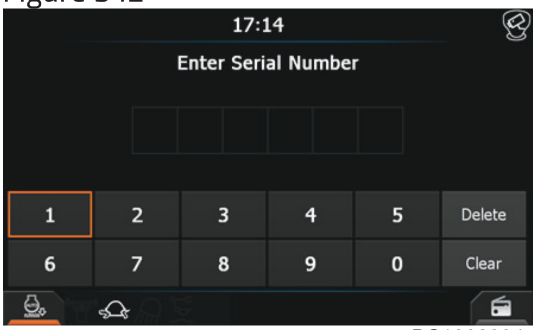
Overview

In this screen, the instrument cluster SW can be upgraded.

1. The current version and the updated version are indicated as follows.
   A. Current Version
      - Displays the SW version currently installed in the instrument cluster
      - Display in the format "V XXXX (yyyy.mm.dd)"

   B. Update Version
      - If the USB is connected and the instrument update file exists on the USB, the SW version on the connected USB is displayed in the format "V XXXX (yyyy.mm.dd)"
      - If USB is connected and there is no instrument panel update file in USB, "No update file!" is displayed
      - If there is no USB connection, "No USB storage device!" is displayed
2. The guidance text shall be marked as follows.
   - "Please be careful when unplugging the USB or power off"

Figure 342



DS1902004

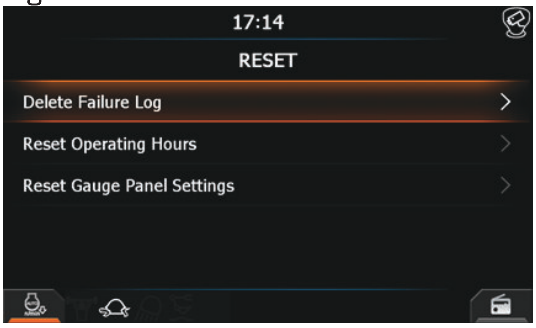
Enter Serial Number

Overview

On this screen, it is possible to enter the equipment serial number.

1. Display the serial number of the device being input.

Figure 343



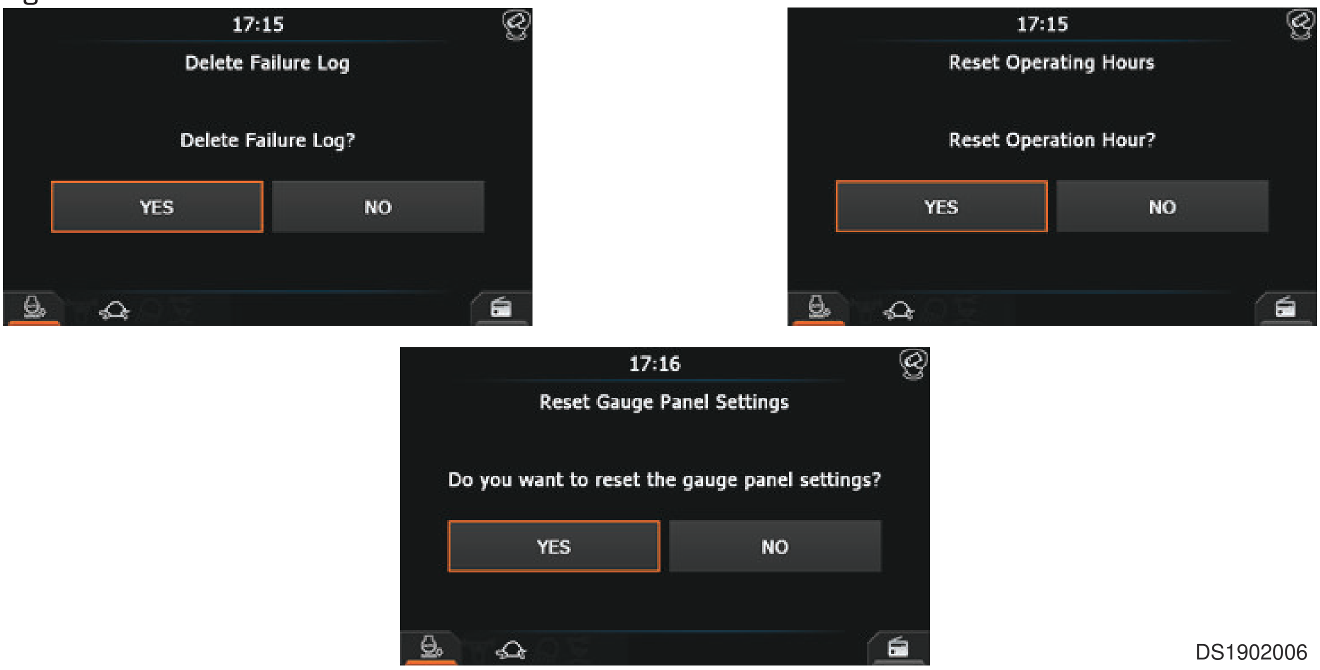
DS1902005

RESET

Overview

In this screen, it is possible to enter Delete Failure Log, Reset Operating Hours and Reset Gauge Panel Settings.

Figure 344



DS1902006

Figure 345

DS1902007

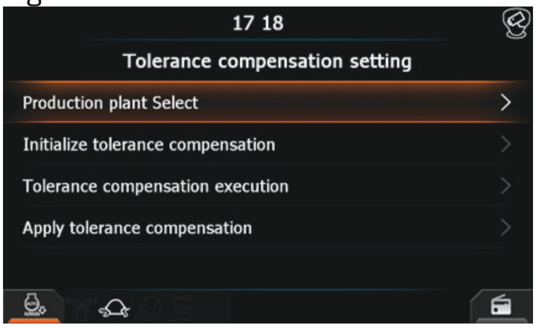
Version Information

Overview

In this screen, it is possible to check EPOS S/W Version, Gauge Panel S/W Version, Gauge Panel OS Version, ECU S/W Version and AVM S/W Version.

1. The version currently installed on the instrument panel is displayed. The display format is as follows.
   - Display in the format "V XXXX (yyyy.mm.dd)" (XXXX: 4 digits of the version number, yyyy.mm.dd: year of release, month, day)
2. AVM version display: Displayed when the AVM option is activated.

Figure 346



DS1902008

Tolerance Compensation Setting

Overview

In this screen, it is possible to enter Production plant Select, Initialize tolerance compensation, Tolerance compensation execution and Apply tolerance compensation.

Figure 347

DS1902009

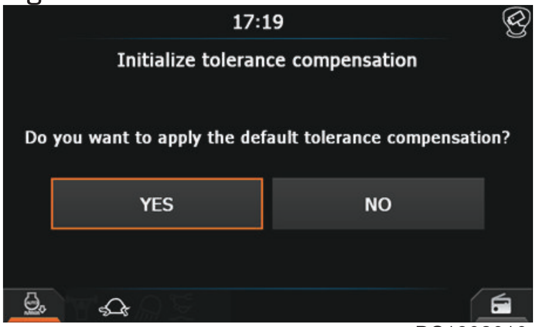
Production Plant Select

Overview

In this screen, the producer can be selected.

1. It displays the currently set producer.
2. The producers to choose from are as follows.
   - Factory 1, Factory 2, Factory 3, Factory 4

Figure 348



DS1902010

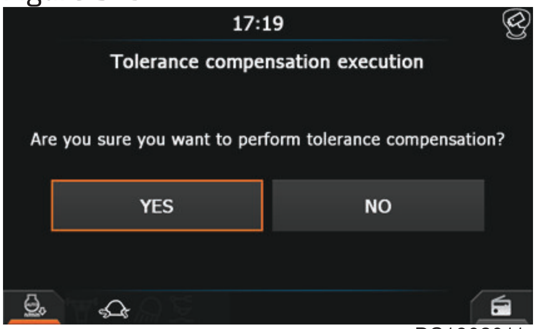
Initialize Tolerance Compensation

Overview

In this screen, it is possible to initialize the tolerance compensation.

1. This screen is composed of a button for selecting to initialize the tolerance correction setting.

Figure 349



DS1902011

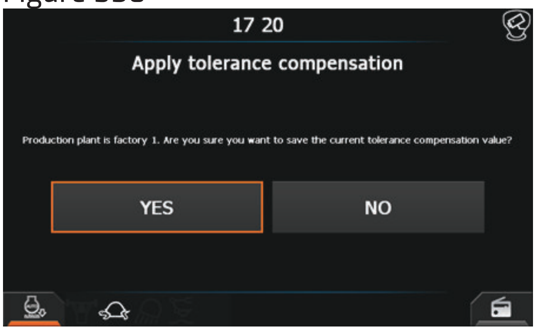
Tolerance Compensation Execution

Overview

This screen is for performing tolerance correction.

1. This screen is composed of the tolerance correction execution selection button as shown in the right figure.

Figure 350



DS1902012

Apply Tolerance Compensation

Overview

This screen is for applying tolerance correction.

Figure 351

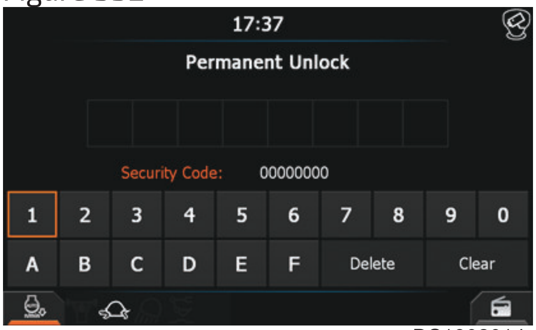
DS1902013

Emergency Code (TMS)

Overview

This screen is for unlocking the authorized personnel by inputting the code through the instrument panel (Ignition Lock or RPM Limitation) locked by the TMS server and the TMS terminal is in the shaded area and cannot receive the release command.

Figure 352



DS1902014

Permanent Unlock

Overview

This screen is unlocking the authorized personnel by inputting the code through the instrument panel (Ignition Lock or RPM Limitation) locked by the TMS server and the TMS terminal is in the shaded area and cannot receive the release command.

1. This screen is composed of a display part and an input keypad as shown in the right figure.
2. Display
   - Current password: Displays the current password.
   - Security Code: Displays the 8-digit release code received from EPOS.

You can get your password off with the security code.

Figure 353

DS1902015

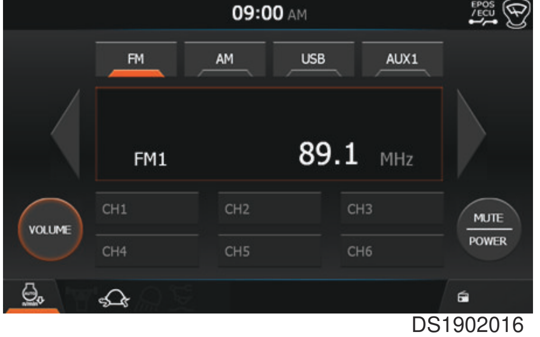
Enter The Equipment Name

Overview

In this screen, the device name can be set by inputting with English keypad.

1. On the left side, the name of the currently input equipment is displayed.
2. On the right side, the name of the device being input is displayed.

Figure 354



DS1902016

Miscellaneous

Audio Display

Overview

In this screen, audio can be set.

EPOS system

Figure 355

DS1901575

No.	Controller	
1	Supply Voltage	10 ~ 32V
	Normal Operation Voltage	24V
	Standby, in the 24V	300 ±10 (mA)
	Loaded, in the 24V	max. ±30 (A)
2	Digital Inputs for Switch (Active High)	0 ~ 32V
	Voltage Range	H: >10
3	DIH / DIL Inputs (ADC Read)	0 ~ 32V
	Voltage Range: Digital Signal	L: < 1, H: > 5
	Voltage Range: Analog Signal	0 ~ 5V
4	Analog Voltage Inputs	
	Voltage Range (Low Speed Sensor: 10)	0 ~ 5V
	Voltage Range (High Speed Sensor: 3)	0 ~ 5V
5	PWM / Frequency Input	
	Voltage Range	1 ~ 32V
6	EPPR: High Side	
	Current Range	0 ~ 1.65A
7	Solenoid / Relay: High Side	
	Current Range	0 ~ 1.65A
8	Relay: Low Side	
	Current Range	0 ~ 0.5A
9	Power Output	5Vdc, 200mA

Mode Control - Engine

- Power mode control (Power +, Power, Standard, ECO)
- Work mode control (Dig, Lift, Breaker)

Item		Unit	
4.	Engine RPM Control		
4-1.	Engine Min / Max Rated RPM		
	Engine Rated RPM	rpm	1,800
	Low Idle RPM	rpm	800
4-2.	Engine RPM by Control Mode		
	Working P+ Mode Engine Rated RPM	rpm	1,800
	Working P Mode Engine Rated RPM	rpm	1,700

Item		Unit	
	Working S Mode Engine Rated RPM	rpm	1,650
	Working E Mode Engine Rated RPM	rpm	1,600
	Travel P Mode Engine Rated RPM	rpm	1,800
	Travel S Mode Engine Rated RPM	rpm	1,800
	Working Lift Mode Engine Rated RPM	rpm	1,500
	Auto Idle Mode Engine Rated RPM	rpm	900
	Limp Home Engine Rated RPM - Dial Fault	rpm	1,500
4-3.	Engine RPM Request by Control Logic		
	One Touch Deceleration Engine RPM	rpm	800
	Safety Mode Engine RPM (Crawler)	rpm	1,000
	Engine RPM at Overheat	rpm	800
4-4.	Engine RPM Command at Dial Min / Max		
	Dial Position Voltage at Rated RPM	rpm	1.15
	Dial Position Voltage at Low Idle	rpm	3.85
	RPM Command at Rated RPM	rpm	1,800
	RPM Command at Low Idle	rpm	800

Mode Control - Pump

- Power mode control (Power +, Power, Standard., ECO)
- Work mode control (Dig, Lift, Breaker, Two Way)

Item		Unit	
5.	Pump Torque Control		
5-3.	Pump Torque Setting By Control Mode		
	Pump % Torque at Working Lift Mode	%	100.0
	Pump % Torque at Working P+ Mode	%	100.0

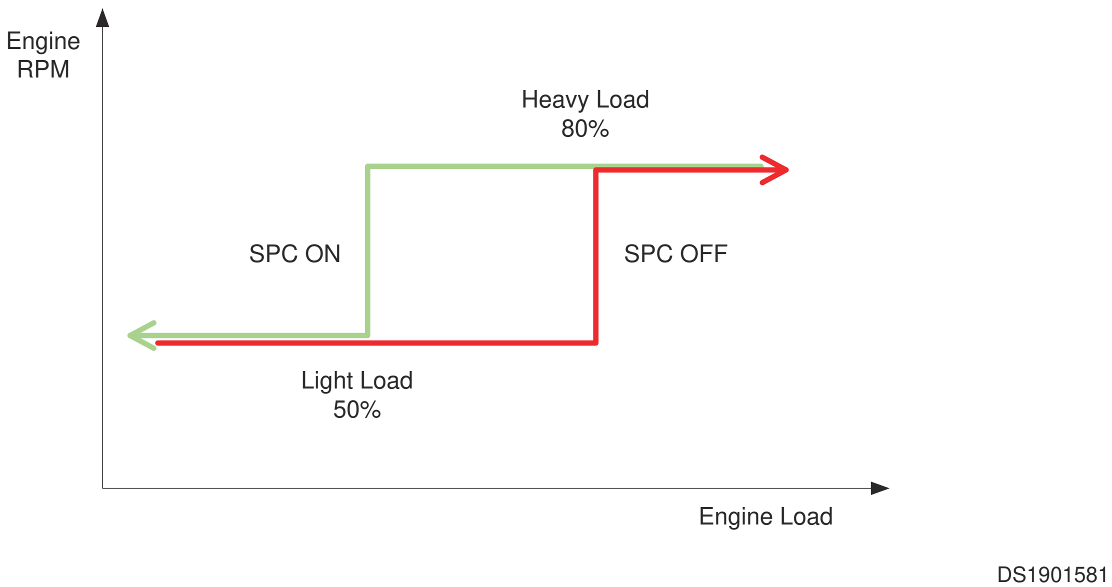
Item		Unit	
	Pump % Torque at Working P Mode	%	97.0
	Pump % Torque at Working S Mode	%	92.6
	Pump % Torque at Working E Mode	%	89.2
	Pump % Torque at Travel P Mode	%	100.0
	Pump % Torque at Travel S Mode	%	100.0
	Pump % Torque at Travel E Mode	%	100.0
	Pump % Torque at Autoidle	%	55.2
	Pump % Torque at Lowidle	%	55.2
	Dial or Accel Pedal Fall Back Mode % Torque	%	81.0
	Item	Unit	
37.	EPPR V/V Current By Control Mode		
	EPPR V/V Current at Working P+ Mode	mA	200
	EPPR V/V Current at Working P Mode	mA	230
	EPPR V/V Current at Working S Mode	mA	275
	EPPR V/V Current at Working E Mode	mA	310
	EPPR V/V Current at Working Lift Mode	mA	200
	EPPR V/V Current at Travel P Mode	mA	200
	EPPR V/V Current at Travel S Mode	mA	200
	EPPR V/V Current at Travel E Mode	mA	200
	EPPR V/V Current at Autoidle	mA	650
	EPPR V/V Current at Lowidle	mA	700
	Pump Current X5	mA	200.0

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 dropped 100 rpm.

Item		Unit	
29-5	Pilot Pressure		
	Boom Up Pressure Criteria	bar	20
	Arm In Pressure Criteria	bar	15

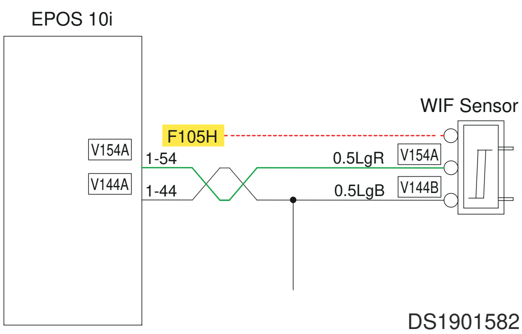
Figure 356



Engine RPM Control

WIF

Figure 357



Out put signal voltage

No water: 3.5 ~ 3.8 DCV (resister value: 27.0 KΩ)

Water in filter: 0.9 ~ 1.2 DCV (resister value: 2.7 KΩ)

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.*

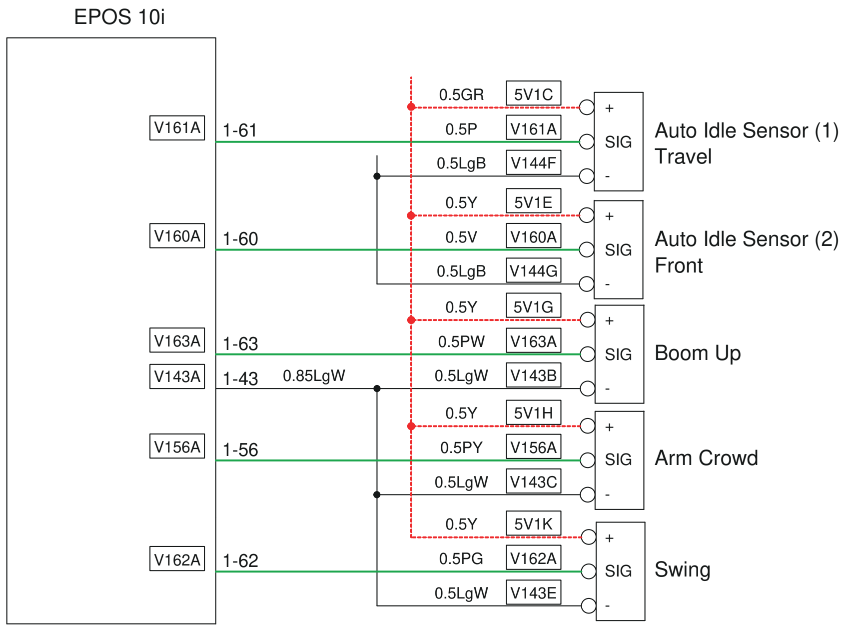
Auto Idle

With the engine running, if the auto idle function is switched "ON", then the engine speed is controlled as follows:

- If throttle dial is set lower than auto idle rpm, engine speed follows dial request according to mode selection.
- If throttle dial is set above auto idle setting and signal at 1-60 or 1-61 rises above the set value, the engine speed follows the dial request according to mode selection.
- If throttle dial is set above auto idle setting and signal at 1-60 and 1-61 drops below the lower pressure setting for more than the set auto idle time, engine speed drops to auto idle setting (unless lifting mode is selected).

Item		Unit	DX300LC-7 (S5)	DX340LC-7 (S5)	DX380LC-7 (S5)
10.	Autoidle Pa, Pt Sensor ON/OFF Reference Point				
	Pa Sensor Working ON Pressure	bar	5.5	8.0	8.0
	Pa Sensor Working OFF Pressure	bar	3.5	4.0	4.0
	Pt Sensor Working ON Pressure	bar	5.5	8.0	8.0
	Pt Sensor Working OFF Pressure	bar	3.5	4.0	4.0

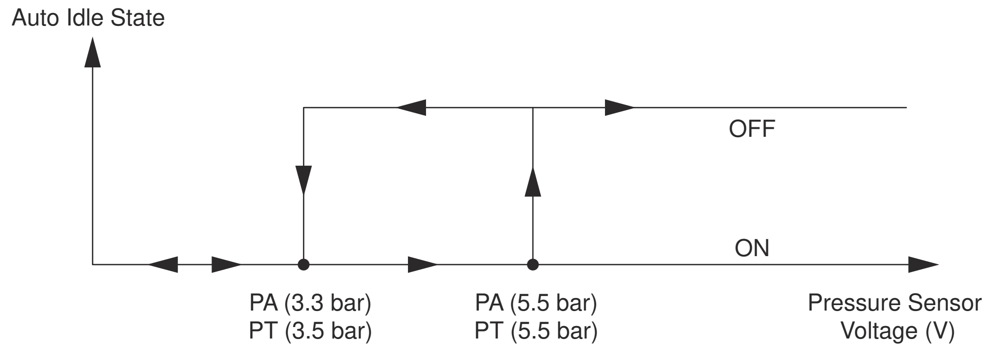
Figure 358



DS1901583

Figure 359

• Example : DX300LC-7

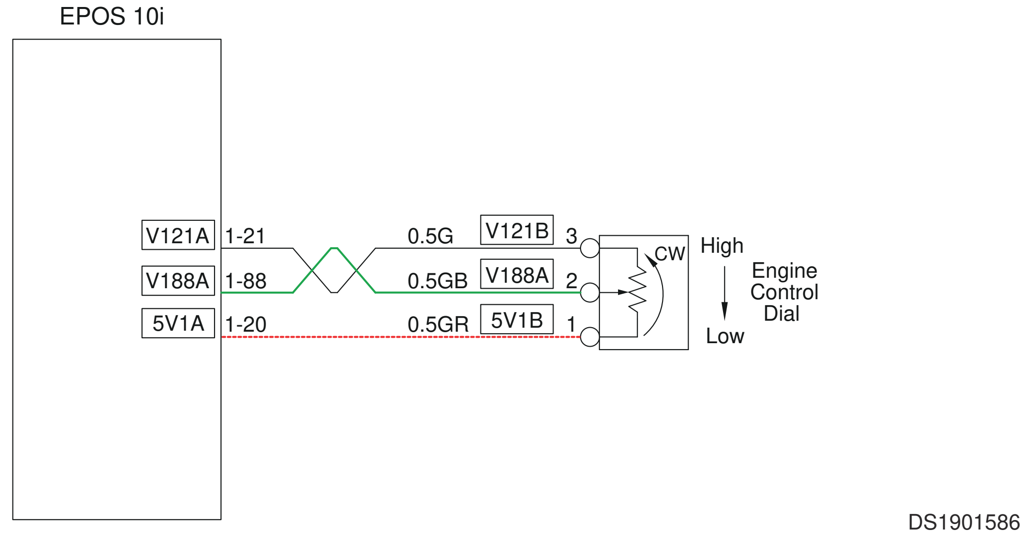


DS1901584

Fuel Pressure

Fuel pressure between pre filter and main filter < 50 Kpa (0.5 bar)	→	GP Symbol ON
Coolant Temp. > 50°C		 Fuel Filter
Fuel Temp. > 10°C		
For more than 600 sec under symbol ON condition	→	RPM derating: 1,400 rpm

Figure 360



Coolant Overheating (Engine rpm will be fixed as 800)

	Pump (%)	100	95	90	85	80	70
DX350LC-7	Coolant Temp (°C)	105	106	107	108	109	110
	HYD Temp (°C)	94	95	96	97	98	99

Fixed Engine RPM with Specific Error or Faulty

- 800 RPM: Over heating
- 1,000 RPM: EPOS malfunction/no communication with ECU
- 1,200 RPM: WIF
- 1,400 RPM: Fuel pressure sensor detect
- 1,500 RPM: Engine RPM control dial faulty

Coolant Level Warning

	Coolant Level	

1. Coolant level switch ON and over 1hr → Symbol (amber color) and pop-up, every 15 min
2. Coolant level switch ON for 2 days → Symbol (red color) and pop-up, buzzer, every 30 min

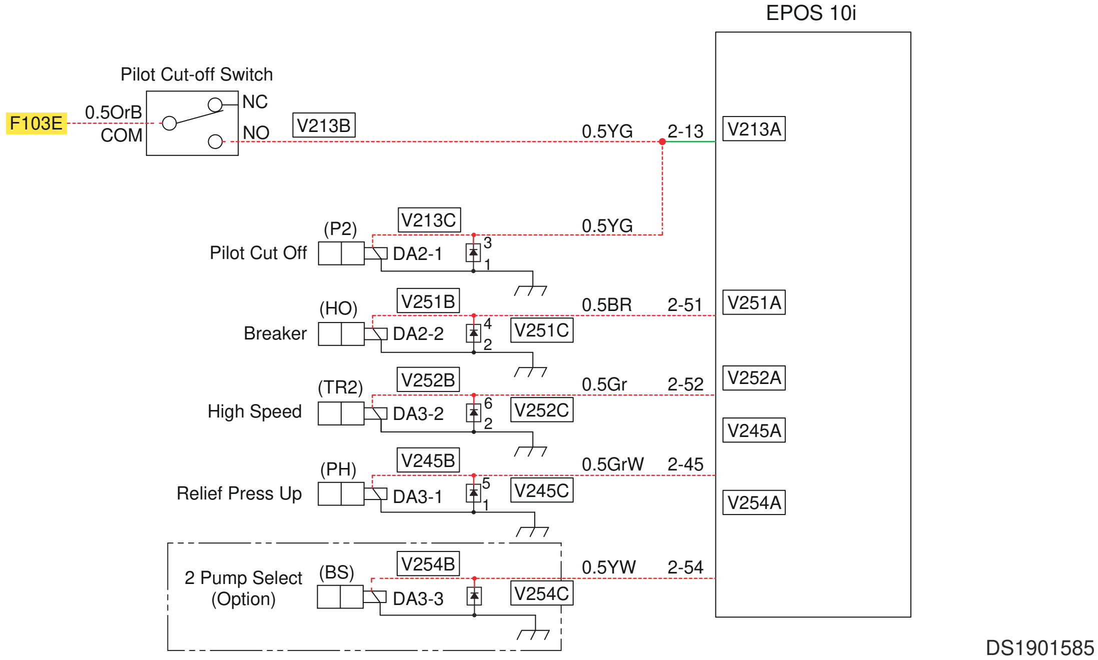
Pilot Control

Auto Traveling

1. When the high-speed select switch is in the "O" position, the high-speed solenoid valve is OFF
2. When the high-speed select switch is in the "I" position, the high-speed solenoid valve is ON
3. When the high-speed select switch is in the "II" position, the high-speed solenoid will be turned ON, provided the dial voltage is below the set criteria, both pump output pressures are below the set pressure and the EPOS sees the PT signal.
4. While traveling with all other criteria met and either one or both pump output pressure exceeds the high-pressure criteria for more than 0.5 sec, the EPOS will deactivate the High-speed solenoid until both pump pressures drop back below the low-pressure limit for more than 1 second.

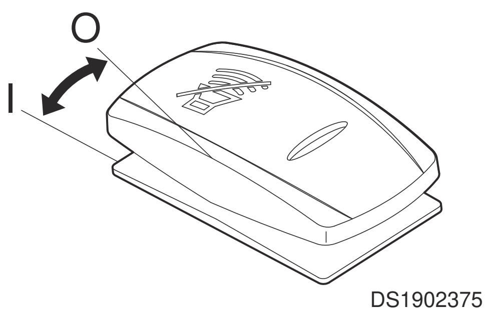
Item	Unit	DX300LC-7 (S5)	DX340LC-7 (S5)	DX380LC-7 (S5)
Auto Travel Mode Pressure (High)	kg/cm^2	294	294	294
Auto Travel Mode Pressure (Low)	kg/cm^2	157	157	157
Delay Time	sec	0.5	0.5	0.5
Auto Travel Mode Dial Voltage	V	2.5	2.5	2.5

Figure 361



Travel Alarm

Figure 362

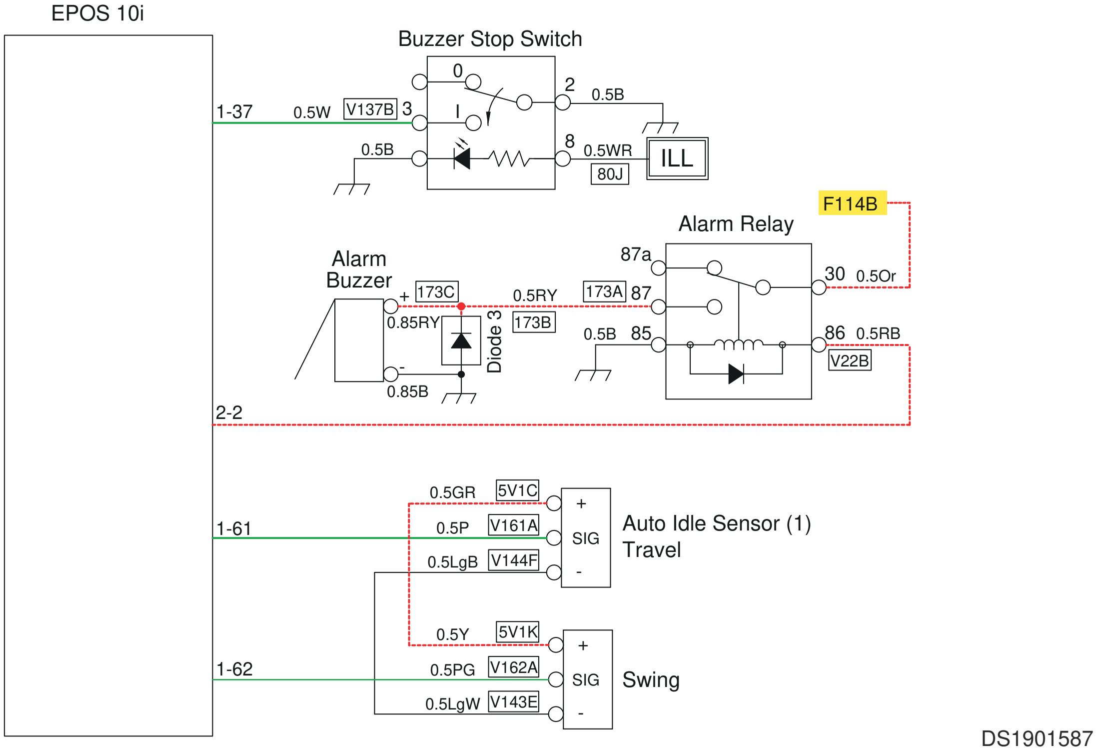


If the machine is equipped with the swing and travel alarm, the function is activated through the gauge panel.

If installed and activated, the swing and travel alarm will be set to operate every time the machine is started.

Pressing the swing/travel alarm switch will cancel the function, until either the switch is pressed again, or the machine is turned off and restarted.

Figure 363



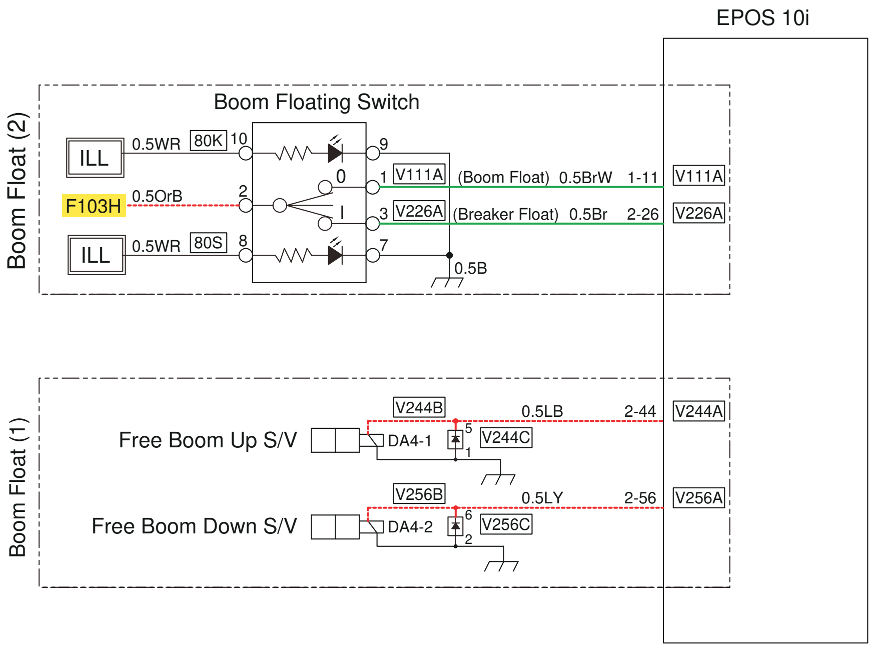
Alarm	State	DX300LC-7	DX340LC-7	DX380LC-7
Swing Alarm	ON	PA > 5.5 bar	PA > 8.0 bar	PA > 8.0 bar
	OFF	PA > 3.5 bar	PA > 4.0 bar	PA > 4.0 bar
Travel Alarm	ON	PA > 5.5 bar	PA > 8.0 bar	PA > 8.0 bar
	OFF	PA > 3.5 bar	PA > 4.0 bar	PA > 4.0 bar

Intelligent Boom Floating System

The boom floating switch is connected to EPOS, so that EPOS can control the intelligent floating boom solenoid valves as required.

EPOS can detect faults and notify faults on gauge panel regarding the Intelligent floating boom solenoid valves or their wiring.

Figure 364



DS1901588

Seat Belt Alarm

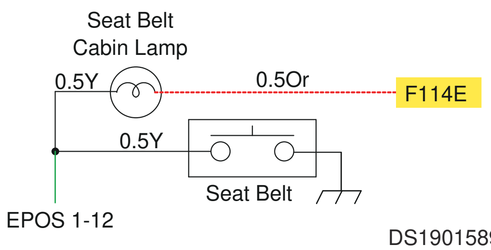
Figure 365

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 366



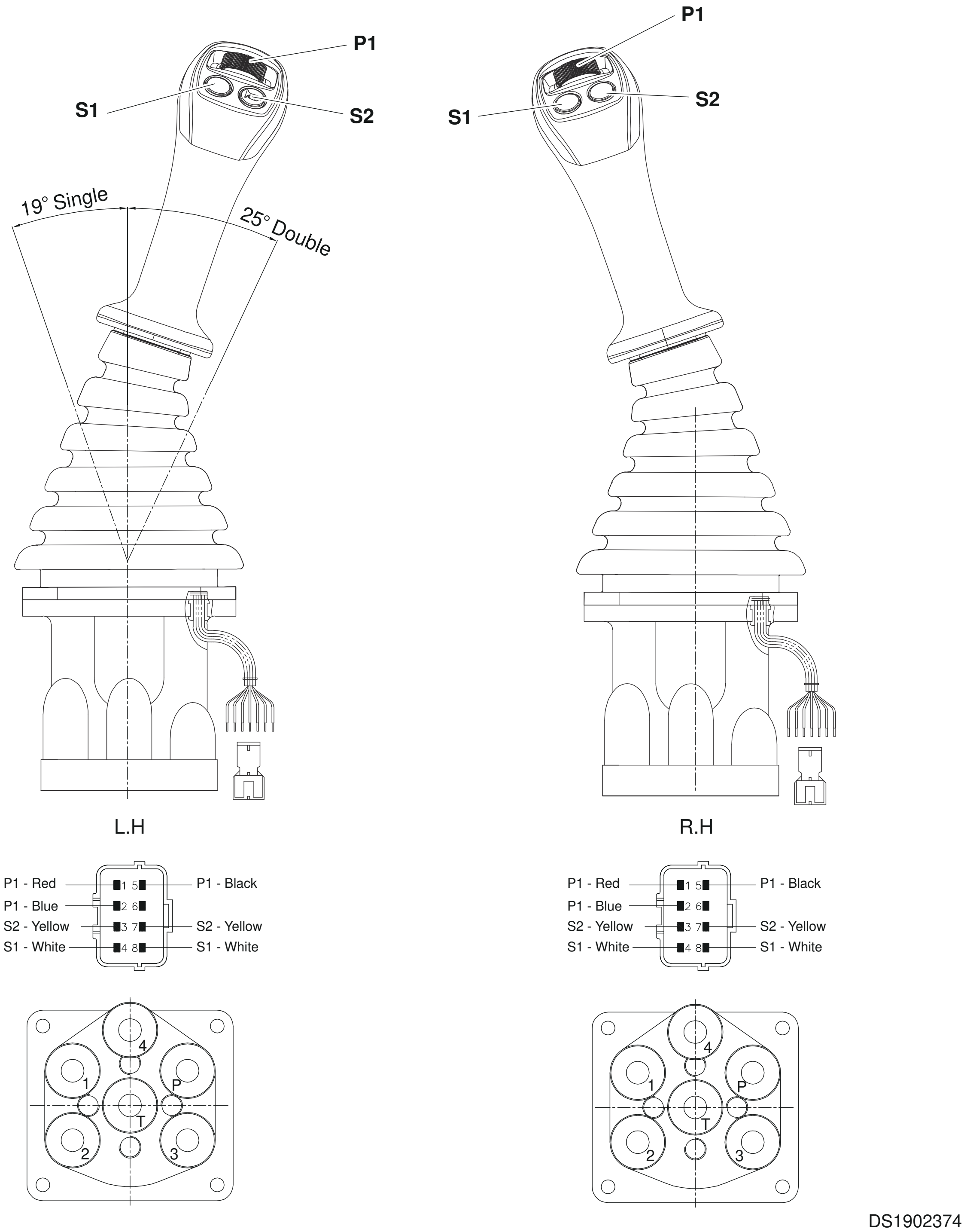
DS1901589

Quick Coupler

Control Workflow

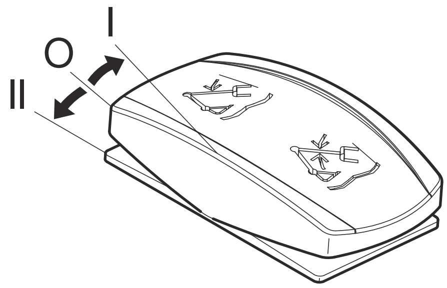
1. Toggle switch ON: quick hitch mode start.
   A. EPOS turns QH warn audible alarm and display ON.
   B. Button allocation: S1 button of both joystick assigned to quick hitch operation button.
2. Dual button: two S1 button on joystick pushed and held, then EPOS turn quick hitch hydraulic solenoid valve.
   A. As solenoid valve opens, QH starts opens. Move joystick with button pushed, hydraulic pressure increased and QH accelerated.
   B. any button released, QH returned to lock state (hold-to-run). Warnings still on.

3. Toggle switch OFF: QH keep locked position and warnings OFF.
   Figure 367



Intelligent Floating Boom Switch (If Equipped)

Figure 368



FG018272

This switch is used to control the Intelligent Floating Boom function.

O. In this position, "NORMAL MODE" is selected.

I. In this position, "INTELLIGENT FLOATING BOOM MODE" is selected. The boom can move freely "UP" and "DOWN".

II. In this position, "BREAKER MODE" is selected.

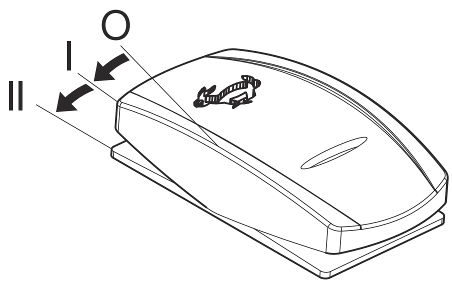
NOTE: *See Operation and Maintenance Manual for further information.*

Travel Auto

1. When high-speed select SW is "O" position, high-speed S/V is OFF.
2. When high-speed select SW is "I" position, high-speed S/V is ON.
3. When high-speed select SW is "II" position and dial voltage is higher than the criterion, high-speed S/V is OFF.
4. When high-speed select SW is "II" position and dial voltage is lower than the criterion and pressure is lower than the criterion working on the condition, high-speed S/V is ON.

Travel Speed Selector Switch

Figure 369



FG016016

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

Do not operate the travel speed selector switch whenmachine is in motion. Temporary loss of control couldresult

This switch activates the automatic speed range for travel.

O. In this position, "LOW" travel speed is selected.

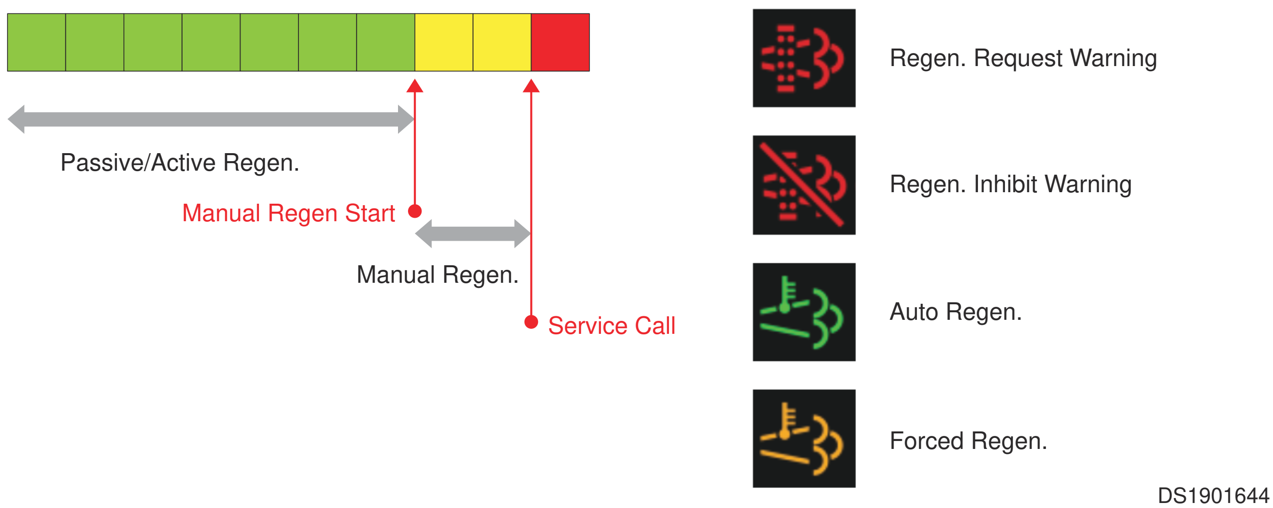
I. In this position, "HIGH" travel speed is selected.

II. In this position, "AUTOMATIC" travel speed is selected. The travel speed automatically changes between "LOW" or "HIGH" range, depending on engine speed and travel motor loads.

Item		Unit	DX300LC-7 (S5)	DX340LC-7 (S5)	DX380LC-7 (S5)
10.	Crawler Auto Travel Mode Reference Point				
	Auto Travel Mode Pressure (high)	kg/cm^2	294	294	294
	Auto Travel Mode Pressure (low)	kg/cm^2	157	157	157
	Delay Time	sec	0.5	0.5	0.5
	Auto Travel Mode Dial Voltage	V	2.5	2.5	2.5

ATS Soot % Indicating

Figure 370



Zone	Regen Status	HD HYUNDAI CONSTRUCTION EQUIPMENT DL06/DL08 (%)	HD HYUNDAI CONSTRUCTION EQUIPMENT G2 (%)
Green	Passive Regen.	0 ~ 80	0 ~ 99
	Active Regen.	81 ~ 100	100 ~ 105
Yellow	Manual Regen.	101 ~ 120	106 ~ 120
Red	Service Regen.	121 ~	121 ~

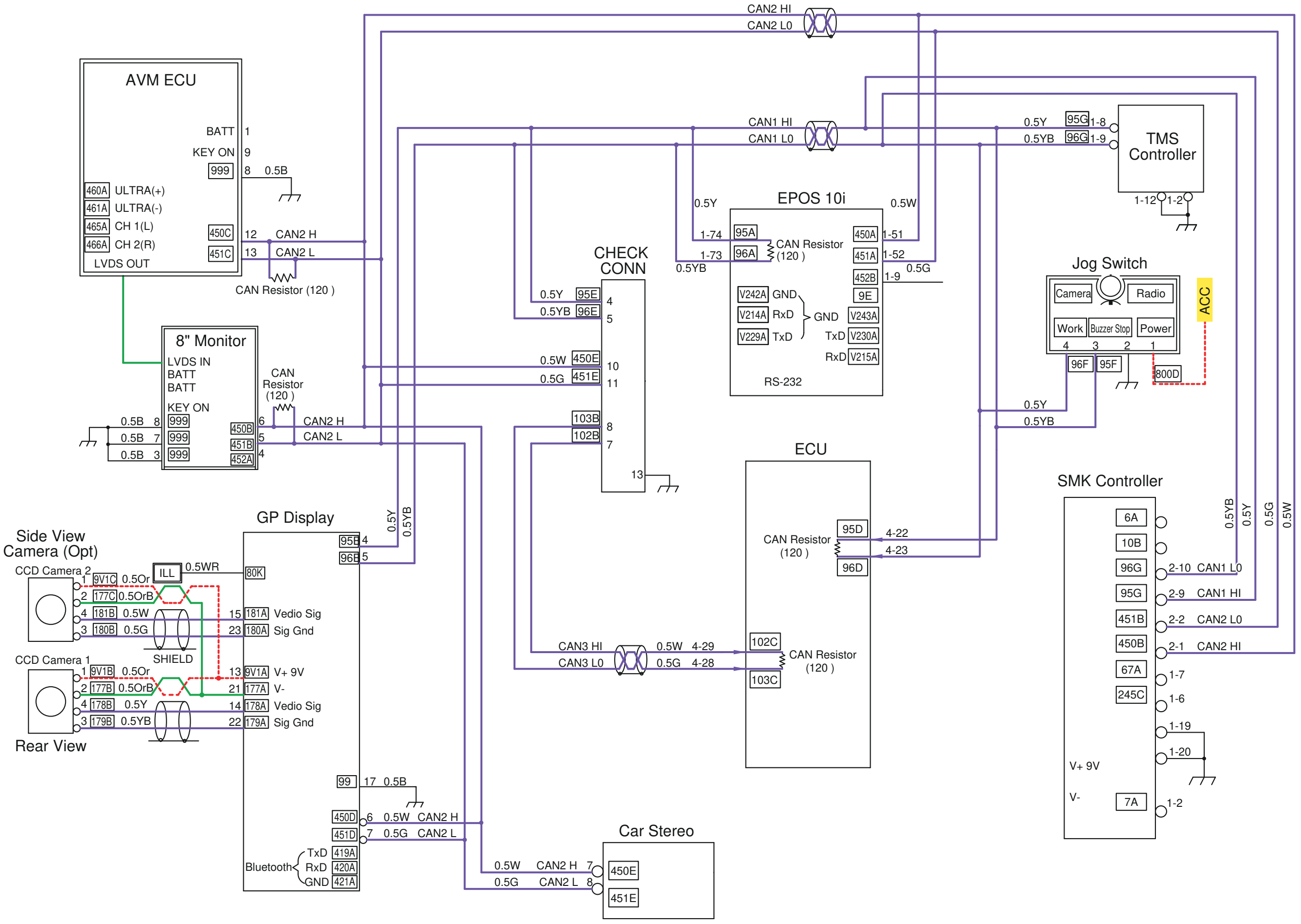
Zone	Bar Step	HD HYUNDAI CONSTRUCTION EQUIPMENT DL06/DL08 (%)	HD HYUNDAI CONSTRUCTION EQUIPMENT G2 (%)
Green	1	~ 40	~ 40
	2	41 ~ 100	41 ~ 105
	3		

Zone	Bar Step	HD HYUNDAI CONSTRUCTION EQUIPMENT DL06/DL08 (%)	HD HYUNDAI CONSTRUCTION EQUIPMENT G2 (%)
	4		
	5		
	6		
	7		
Yellow	8	101 ~ 120	106 ~ 110
	9		111 ~ 120
Red	10	121 ~	121 ~

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.

Figure 371

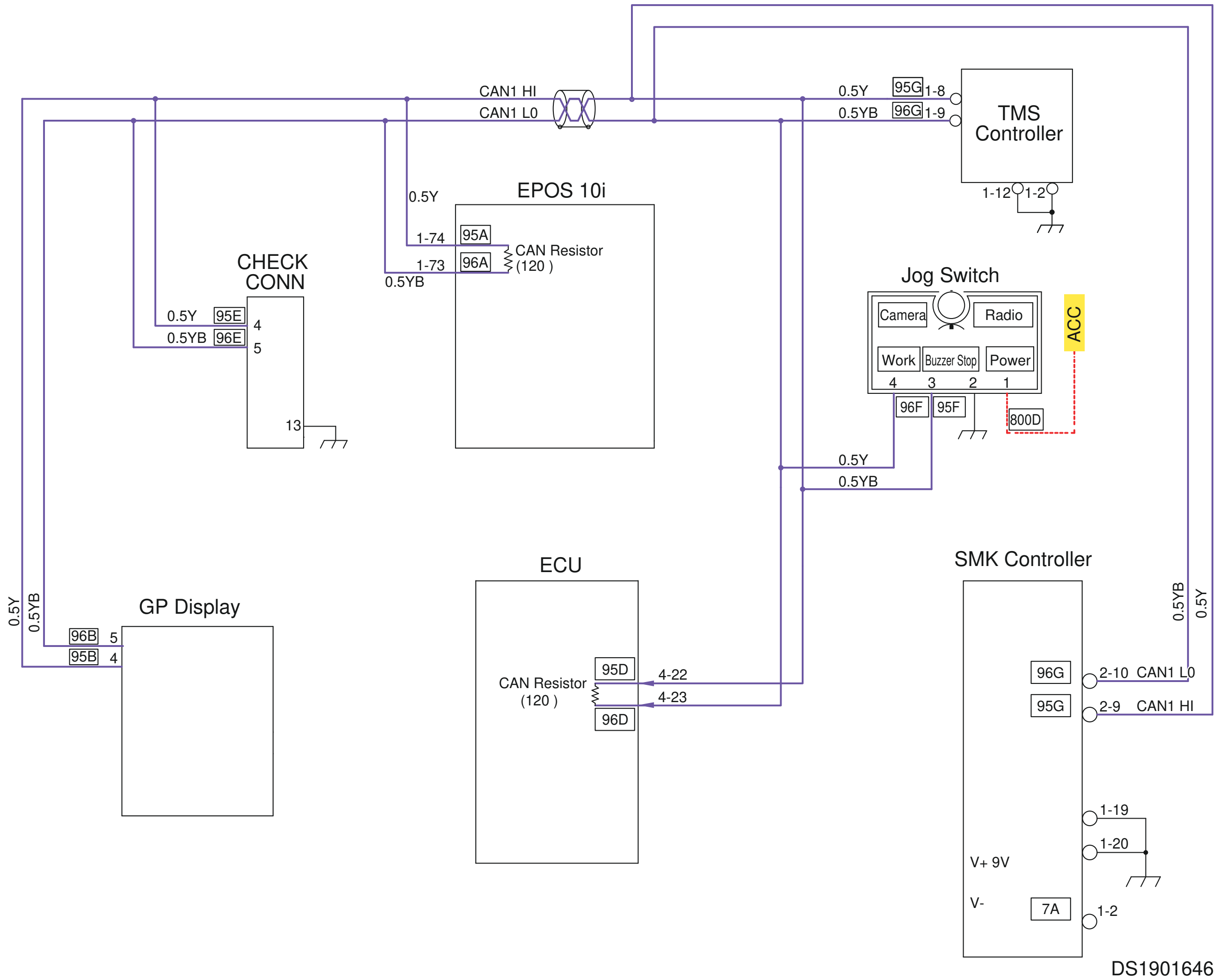


TMS (2.0)

EPOS collects key information of the equipment or controls the equipment through commands transmitted from the communication server.

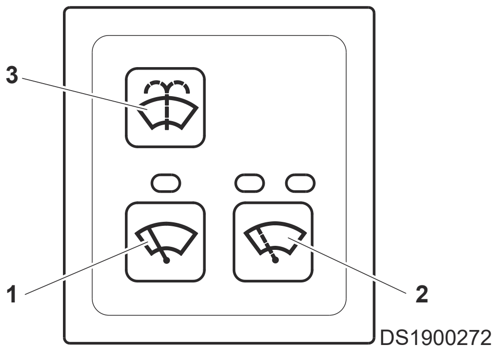
Main collection information: location of equipment, total running time of engine, working time, fuel status, equipment warning / fault information, etc.

- Equipment control: RPM limit, engine restart limit
- Terminal H/W is divided into GSM only and dual mode
  Figure 372



Wiper System

Figure 373



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

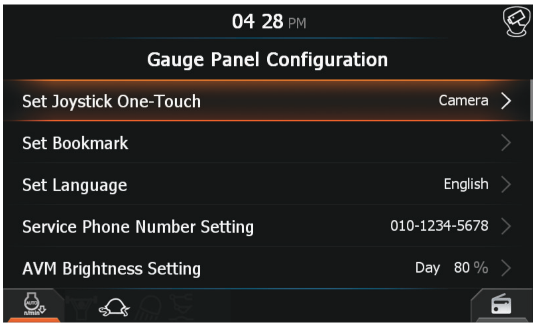
   Pressing the washer button will spray windshield washer fluid onto the windshield. Use only the proper windshield washer fluid in the system.

   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: SSK703*

Joystick Multi-function

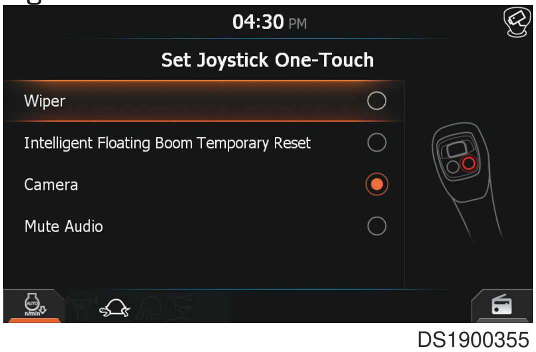
Figure 374



DS1901272

This page is to set joystick one touch.

Figure 375



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.

Removal and Installation

Removal And Installation

Engine

Safety Instructions

⚠ WARNING

AVOID DEATH OR SERIOUS INJURY

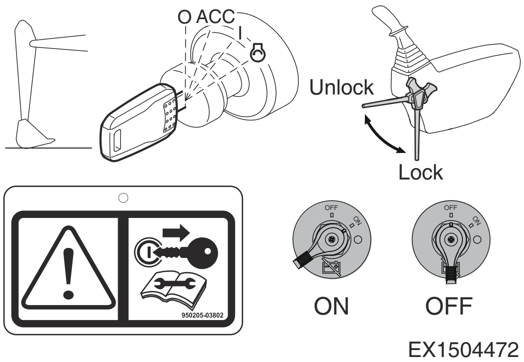
Instructions are necessary before operating or servicing machine. Read and understand the Operation & Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or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

Before Removing and Installing

Preparatory Work

1. Park the machine on level ground. And lower front attachment to the ground.

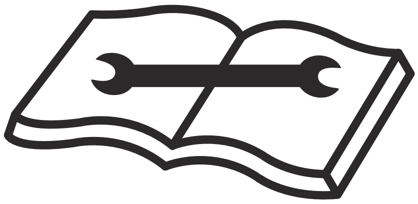
   Figure 1



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

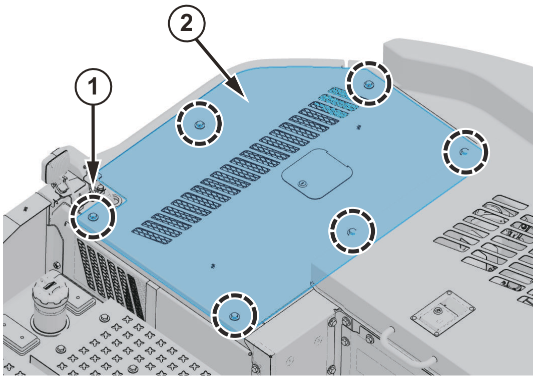
Step-A. Remove radiator cover
Step-B. Disconnect wiring harness
Step-C. Remove ECU assembly

Removal

1. Turn OFF the battery disconnect switch.

Radiator Cover

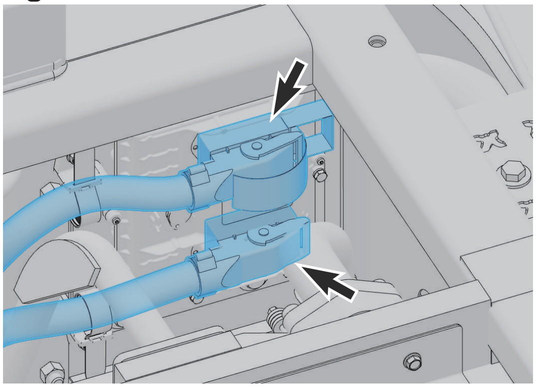
1. Remove bolts and washers (1) (6 ea) with cover (2).
   Figure 3



- Tool: 19 mm ( )
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Radiator cover weight: about 25 kg (55.1 lb)

Wiring Harness

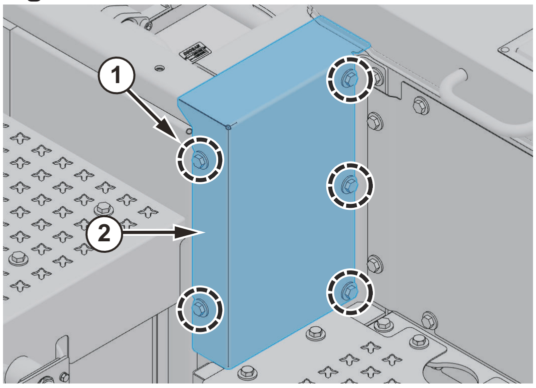
1. Disconnect harnesses from ECU.
   Figure 4



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.*

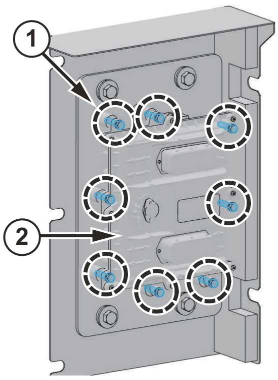
ECU Assembly

1. Remove bolts (1) and ECU cover (2) from support.
Figure 5



DS2201590

2. Remove mounting bolts (1) and ECU assembly (2) from cover.
Figure 6



DS2201591

NOTE: *Do not tighten the fasteners too hard when installing.*

Installation

1. Perform installation in the reverse order to removal.

V-Belt

Repair Procedure Quick Guide

Step-A. Remove radiator cover

Step-B. Remove fan guard assembly

Step-C. Remove engine side cover

Step-D. Remove V-belt

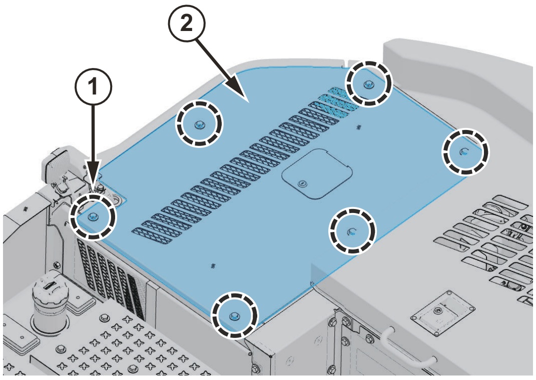
Removal

1. Turn OFF the battery disconnect switch.

Radiator Cover

1. Remove bolts and washers (1) (6 ea) with cover (2).

   Figure 7



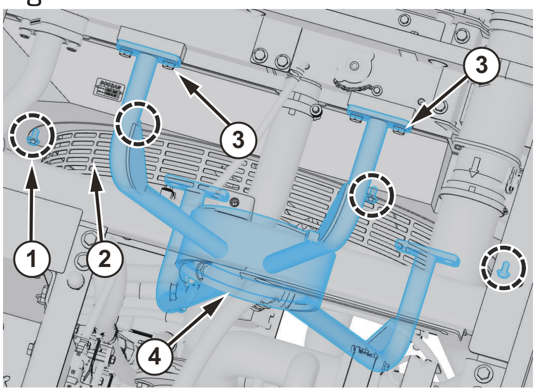
DS2201579

- Tool: 19 mm ()
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Radiator cover weight: about 25 kg (55.1 lb)

Fan Guard

1. Remove bolts (1) (5 ea) with fan guard (2) from oil cooler.

   Figure 8



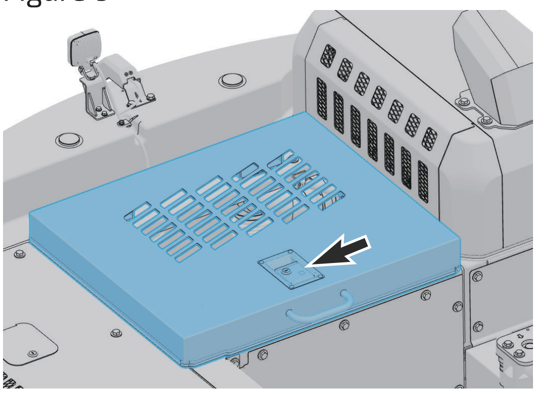
DS2201580

- Tool: 13 mm ()
- Torque: 29.4 N.m (3 kg.m, 21.7 ft lb)

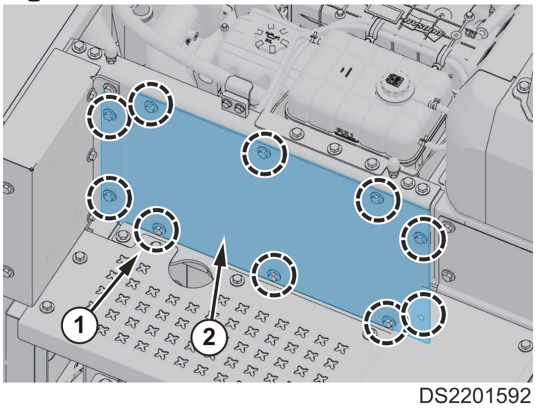
Engine Side Cover

1. Open engine cover.

   Figure 9

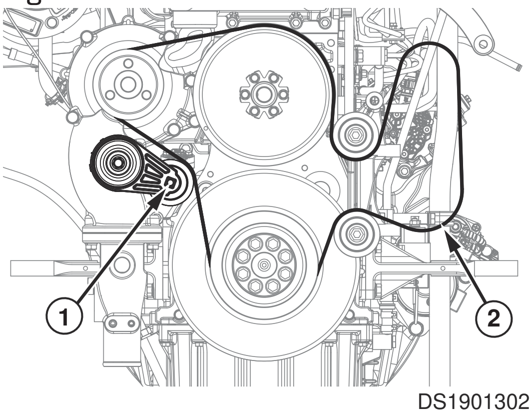


DS2201573

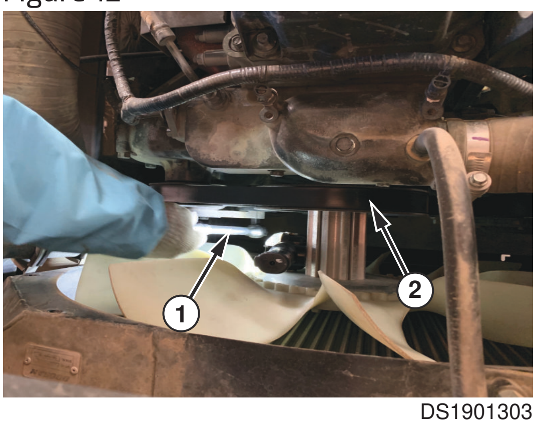
2. Remove mounting bolts (1) and cover (2) from support.
   Figure 10
   

   - Tool: 19 mm ( )
   - Torque: 107.8 N.m (11 kg.m, 79.5 ft lb)
   - Cover weight: about 6 kg (13.2 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.*

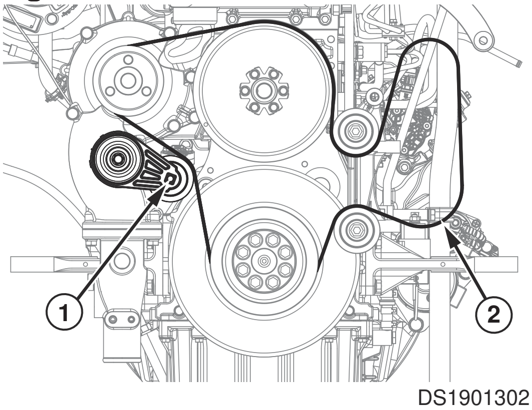
2. Turn the auto tensioner with tool (1) clockwise to loosen and put away the V-belt (2).
   Figure 12
   

   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.
   Figure 13



2. Check that v-belt (2) is installed to the all pulley grooves.
3. Start engine.

Alternator

Repair Procedure Quick Guide

Step-A. Remove radiator cover

Step-B. Remove fan guard assembly

Step-C. Remove engine side cover

Step-D. Remove V-belt

Step-E. Disconnect wiring harness

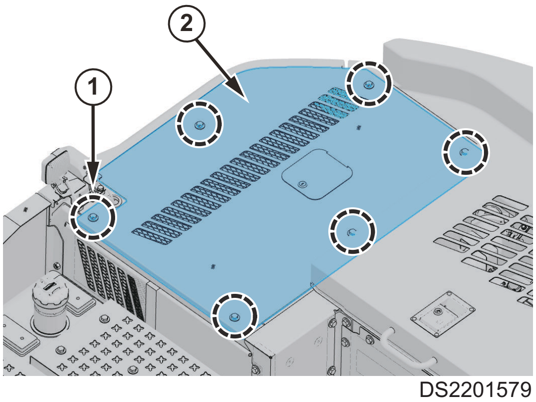
Step-F. Remove alternator assembly

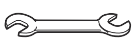
Removal

1. Turn OFF the battery disconnect switch.

Radiator Cover

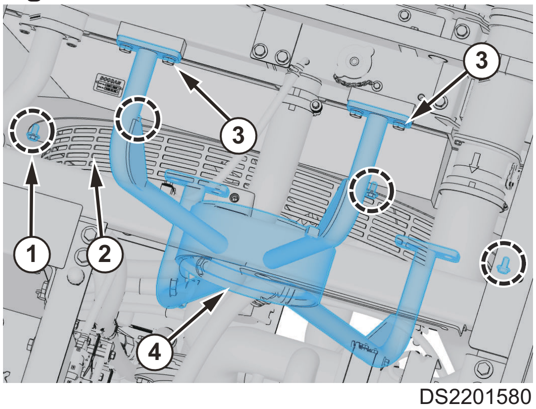
1. Remove bolts and washers (1) (6 ea) with cover (2).
   Figure 14



- Tool: 19 mm ()
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Radiator cover weight: about 25 kg (55.1 lb)

Fan Guard

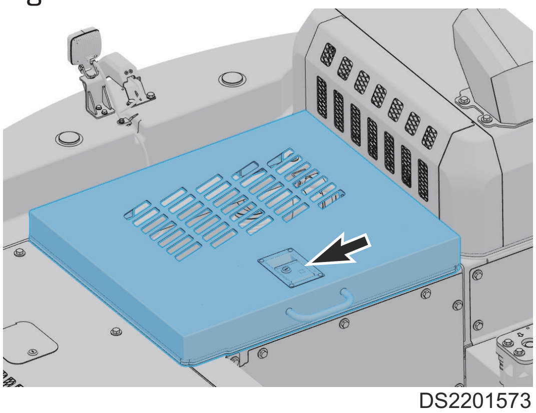
1. Remove bolts (1) (5 ea) with fan guard (2) from oil cooler.
   Figure 15



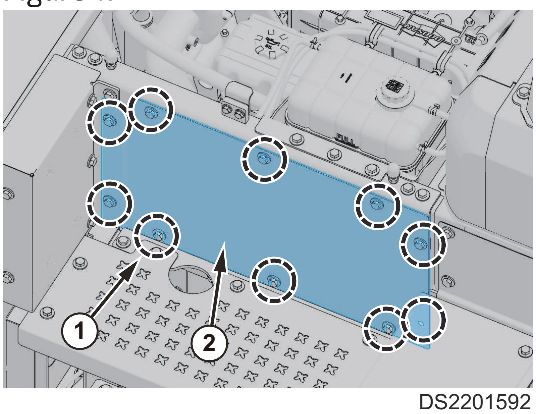
- Tool: 13 mm ( )
- Torque: 29.4 N.m (3 kg.m, 21.7 ft lb)

Engine Side Cover

1. Open engine cover.
   Figure 16



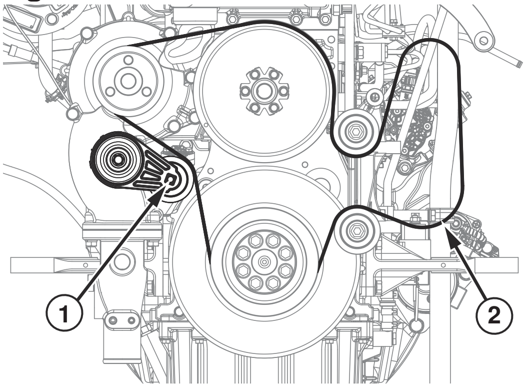
2. Remove mounting bolts (1) and cover (2) from support.
   Figure 17



- Tool: 19 mm ( )
- Torque: 107.8 N.m (11 kg.m, 79.5 ft lb)
- Cover weight: about 6 kg (13.2 lb)

V-belt

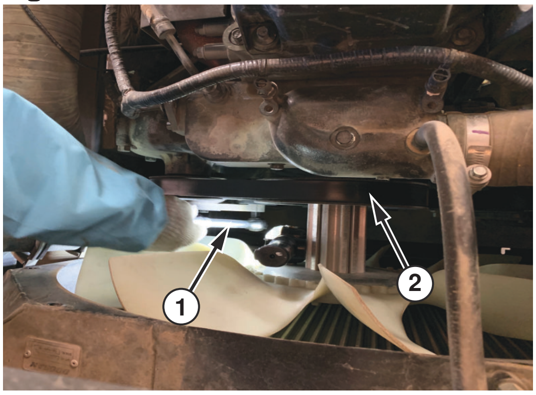
1. Insert the tool into the auto tensioner service hole (1).
   Figure 18



DS1901302

NOTE: *Before removing the belt, check the belt layout.*

2. Turn the auto tensioner with tool (1) clockwise to loosen and put away the V-belt (2).
   Figure 19



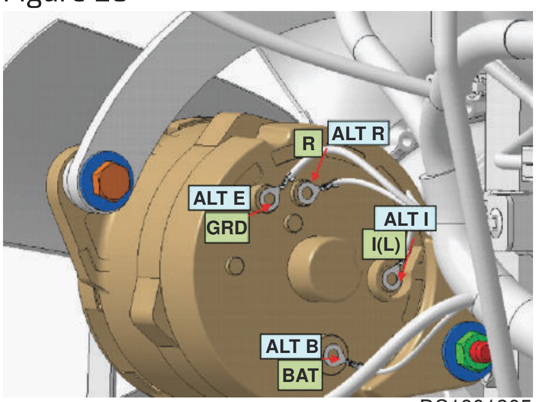
DS1901303

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.

Wiring Harness

1. Disconnect wire harness (R).
   Figure 20



DS1901305

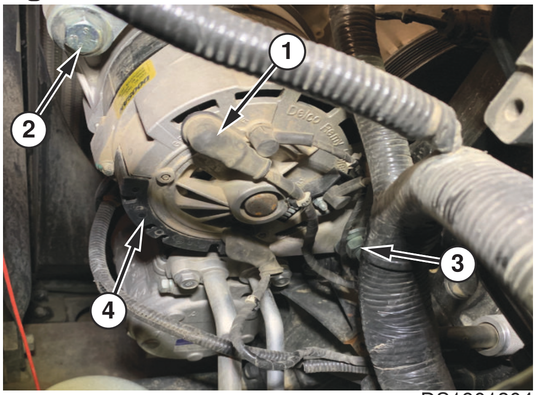
- Tool: 8 mm ( )
- Torque: 5 N.m (0.5 kg.m, 3.7 ft lb)

2. Disconnect wire harness (GRD).
    - Tool: 10 mm ( )
    - Torque: 6 N.m (0.6 kg.m, 4.4 ft lb)
3. Disconnect wire harness (I).
    - Tool: 8 mm ( )
    - Torque: 5 N.m (0.5 kg.m, 3.7 ft lb)
4. Disconnect wire harness (BAT).
    - Tool: 10 mm ( )
    - Torque: 6 N.m (0.6 kg.m, 4.4 ft lb)

Alternator Assembly

1. Remove the mounting bolt (2) from brace.

Figure 21



DS1901304

    - Tool: 19 mm ( )
    - Torque: 88 N.m (9 kg.m, 65 ft lb)
2. Remove the nut (3) from alternator.
    - Tool: 19 mm ( )
    - Torque: 88 N.m (9 kg.m, 65 ft lb)
3. Remove the alternator (4) from engine.

Installation

1. Perform installation in the reverse order to removal.
2. Start engine.

Starter Motor

Repair Procedure Quick Guide

Step-A. Remove engine cover and support

Step-B. Disconnect cable

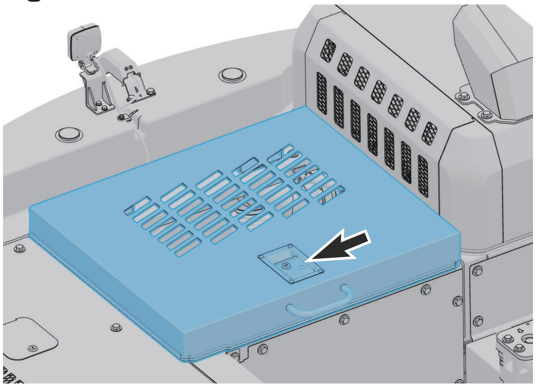
Step-C. Remove starter motor

Removal

1. Turn OFF the battery disconnect switch.

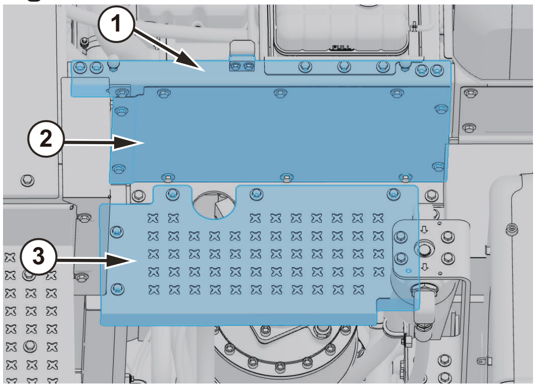
Engine Cover and Support

1. Open engine hood (1).
   Figure 22



DS2201573

2. Remove mounting bolts and baffle cover (1).
   Figure 23

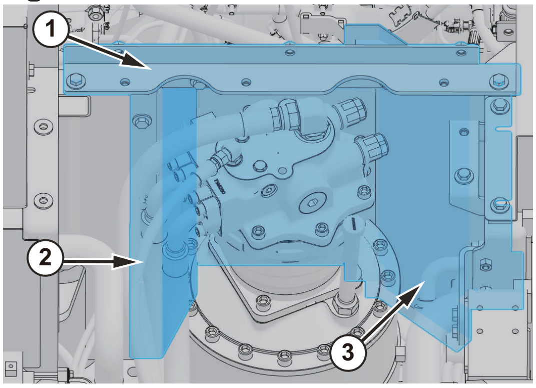


DS2201610

- Tool: 19 mm ( )
- Torque: 107.8 N.m (11 kg.m, 79.5 ft lb)
- Baffle Cover (1) weight: about 6 kg (13.2 lb)

3. Remove mounting bolts and support (2).
   - Tool: 19 mm ( )
   - Torque: 107.8 N.m (11 kg.m, 79.5 ft lb)
   - Support (2) weight: about 6 kg (13.2 lb)
4. Remove mounting bolts and upper cover (3).
   - Tool: 19 mm ( )
   - Torque: 107.8 N.m (11 kg.m, 79.5 ft lb)
   - Upper cover (3) weight: about 15 kg (33.1 lb)

5. Remove mounting bolts and support (1).
   Figure 24



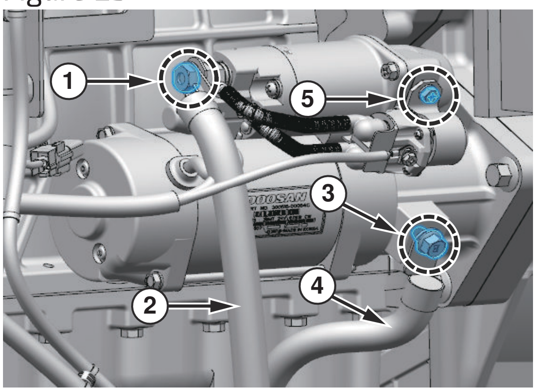
DS2201611

- Tool: 19 mm ( )
- Torque: 107.8 N.m (11 kg.m, 79.5 ft lb)
- Support (1) weight: about 6 kg (13.2 lb)

6. Remove mounting bolts and baffle cover (2, 3).
   - Tool: 19 mm ( )
   - Torque: 107.8 N.m (11 kg.m, 79.5 ft lb)
   - Baffle Cover (2) weight: about 6 kg (13.2 lb)
   - Baffle Cover (3) weight: about 3 kg (6.6 lb)

Cable

1. Remove nut (1) from starter motor.
   Figure 25

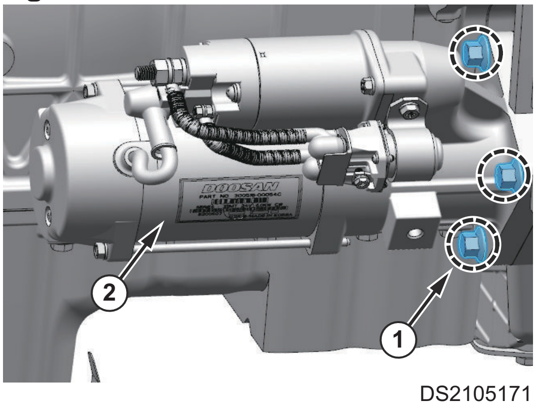


DS2105170

2. Disconnect the positive cable (2) from starter motor.
3. Remove mounting bolt (3) and ground cable (4).
4. Remove mounting screw (5) and cable.

Starter Motor

1. Remove upper mounting bolts (1) from starter motor.
   Figure 26



2. Remove lower mounting bolts (1) from starter motor.
3. Remove starter motor (2).

Installation

1. Perform installation in the reverse order to removal.
2. Start engine.

DEF (adblue®) Quality Sensor

Repair Procedure Quick Guide

Step-A. Drain of DEF (AdBlue®)

Step-B. Open the DEF (AdBlue®) tank cover

Step-C. Disconnect wiring harness and quick connector

Step-D. Remove engine sensors - DEF (AdBlue®) quality sensor

Removal

1. Open the left side door.
2. Turn OFF the battery disconnect switch.

Draining of DEF (AdBlue®)

1. Suitable container under the DEF (AdBlue®) tank.
2. Loosen drain plug and drain DEF (AdBlue®).
   - DEF (AdBlue®) Tank: 62 L

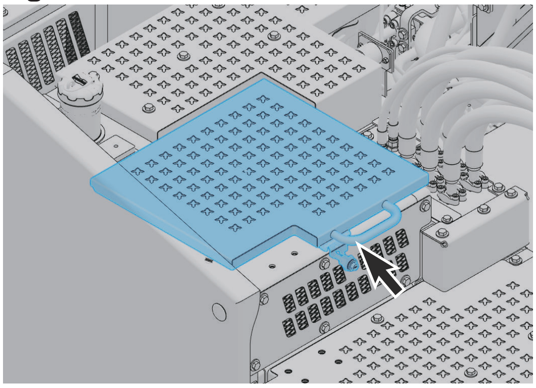
     NOTE: *The drain plug is located under the tank.*

     NOTE: *Be sure to use vinyl gloves.*

Cover

1. Open the DEF tank cover.

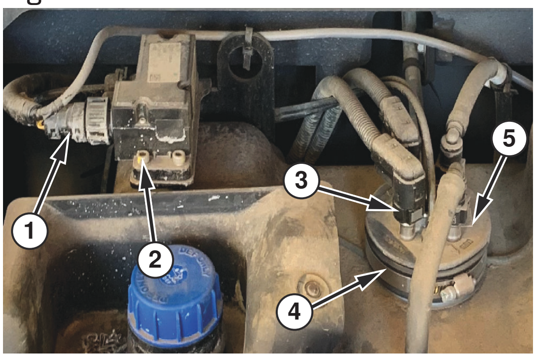
Figure 27



DEF (AdBlue®) Quality Sensor

1. Disconnect wire harness connectors (1) from DEF (AdBlue®) quality sensor.

Figure 28



2. Remove the bolts (2).
3. Disconnect quick connectors (3).

   NOTE: *Check the location of the connectors before disconnecting.*
4. Remove clamp (4) and DEF (AdBlue®) quality sensor (5).

   NOTE: *Quality sensor includes Level, concentration, and temperature.*

   NOTE: *Be sure to use vinyl gloves.*

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 muffler assembly

Step-F. Remove cover and support - main pump room

Step-G. Disconnect wiring harness

Step-H. Disconnect hydraulic hose

Step-I. Remove main pump assembly

Step-J. Remove fan gaurd

Step-K. Remove engine side cover

Step-L. Remove V-belt

Step-M. Separate air conditioner compressor

Step-N. Disconnect air hose and tube - engine

Step-O. Disconnect wiring harness and cable - engine

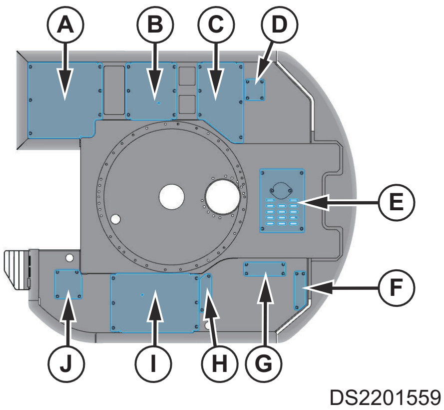
Step-P. Remove engine mount

Step-Q. Remove engine assembly

Removal

Undercover

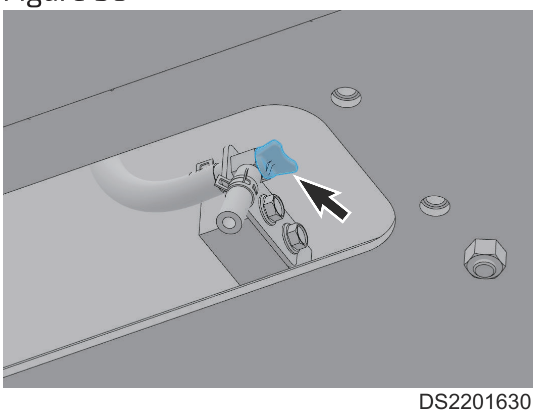
1. Remove the undercover (C, E, G).
   Figure 29



For details, refer to Undercovers - Removal and Installation.

Coolant

1. Slowly open the radiator cap.
   Figure 30



2. Open the drain cock from radiator.
3. Drain the coolant.
   - Coolant volume: 47.5 L (12.5 U.S. gal)

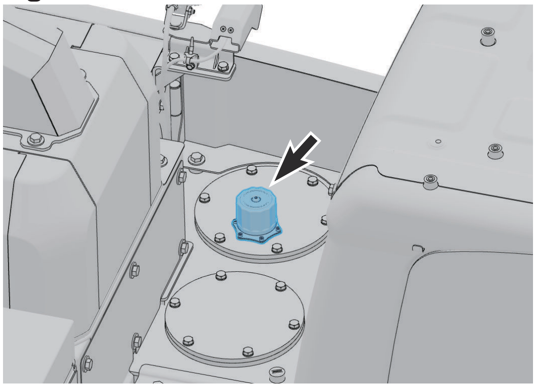
NOTE: *Dispose of drained fluids according to local applicable environmental laws and regulations.*

For details, refer to Coolant - Change of Operation Manual

Hydraulic Oil

1. 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.

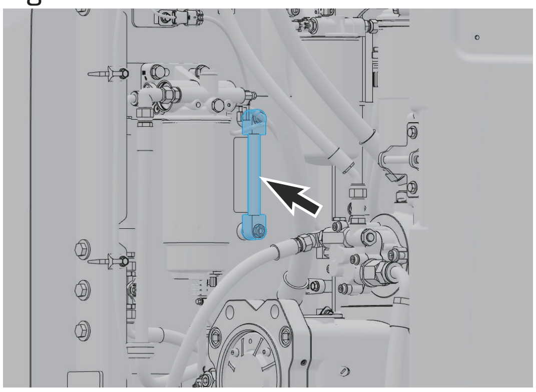
   Figure 31

   DS2201562

2. Oil drain method.

   Figure 32

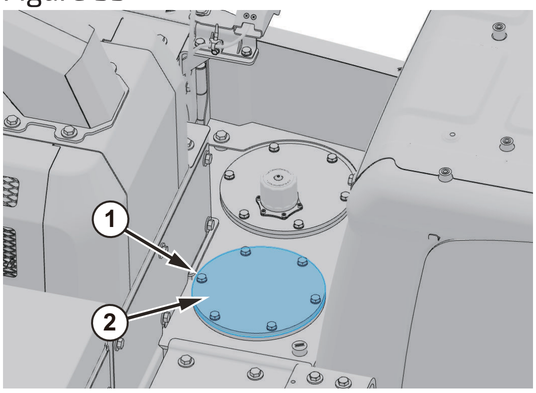
   

   DS2201616

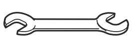
   NOTE: *Check the flow on the oil level gauge before draining the oil.*

   A. If using the suction oil pump, remove cover on oil tank bolts. drain hydraulic oil using suction oil pump.

      Figure 33

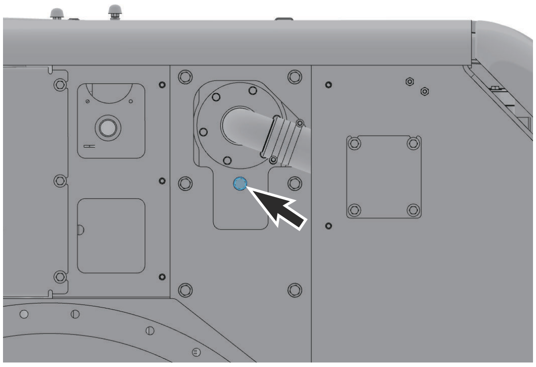
      

      DS2201604

      • Tool: 17 mm ()

- Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)
- Hydraulic oil tank volume: 175 L (46.2 U.S. gal)

B. Loosen drain plug at the bottom of the hydraulic tank. drain hydraulic oil.
Figure 34

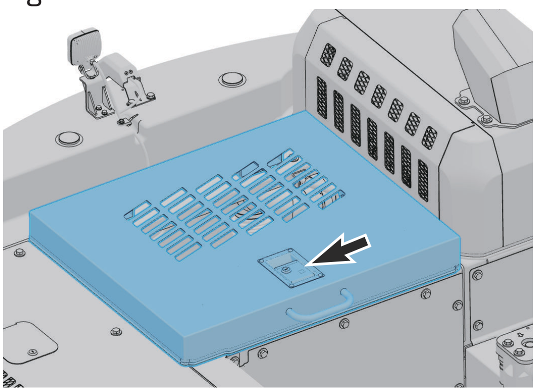


DS2201605

- Tool: 27 mm ( )
- Torque: 93.2 N.m (9.5 kg.m, 68.7 ft lb)
- Hydraulic oil tank volume: 130 L (34.3 U.S. gal)

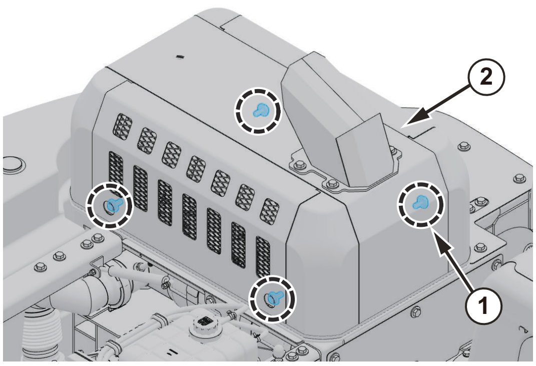
Engine Hood Assembly

1. Open the engine hood.
Figure 35



DS2201573

2. Remove the bolts (1) and muffler cover (2).
Figure 36



DS2201617

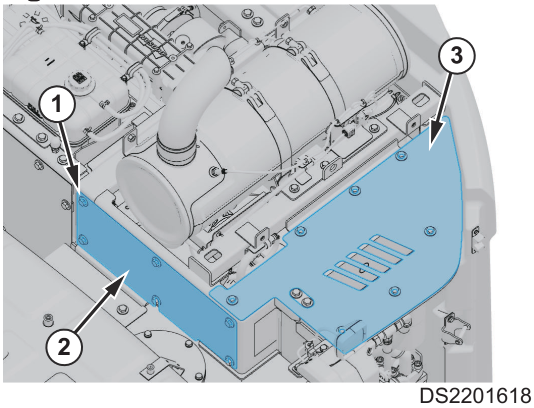
- Tool: 19 mm ( )
- Torque: 88.2 N.m (9 kg.m, 65 ft lb)

- Muffler with Tail Pipe Weight: about 35 kg (77.2 lb)

Muffler Assembly

1. Remove bolts (1, 13ea) and covers (2, 3).

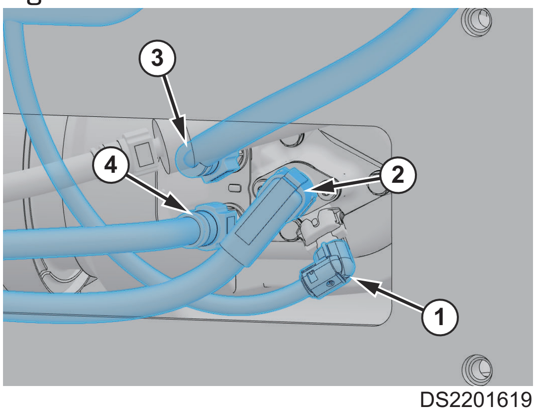
Figure 37



- Tool: 19 mm ( )
- Torque: 88.2 N.m (9 kg.m, 65 ft lb)
- Cover (2) Weight: about 2 kg (4.4 lb)
- Cover (3) Weight: about 5 kg (11.0 lb)

2. Disconnect DEF (AdBlue®) hose quick connector (1).

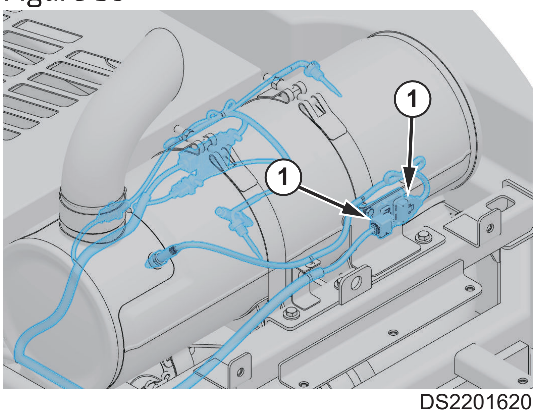
Figure 38



NOTE: *Be sure to use vinyl gloves disconnect DEF (AdBlue®) hose.*

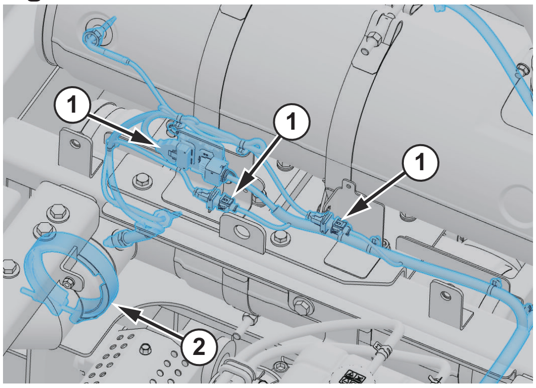
3. Disconnect clamp and water hoses (2, 3, 4).
4. Disconnect wiring harness connectors (1).

Figure 39



5. Disconnect wiring harness connectors (1) V-clamp (2) and exhaust hose.

Figure 40



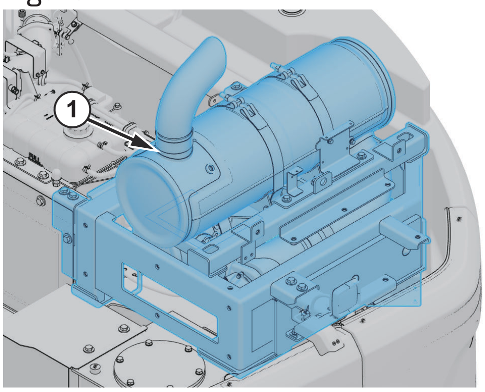
DS2201621

- Tool: 11 mm ( )
- Torque: 10.7 N.m (1.1 kg.m, 7.9 ft lb)

NOTE: *Be careful not to let water get into electrical components (sensor, connectors). If water gets into electrical system, this will cause an electrical short circuit and result in improper machine operation.*

6. Attach a lifting device at lifting point.

Figure 41

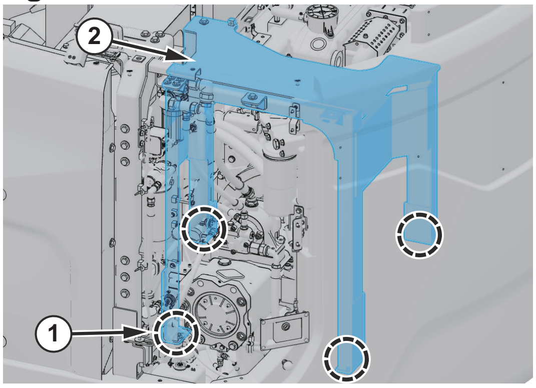


DS2201622

7. Remove support and muffler assembly (1).
   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
   - Muffler assembly weight: about 100 kg (220.5 lb)
   - Support weight: about 50 kg (110.2 lb)

Cover and Support - Main Pump Room

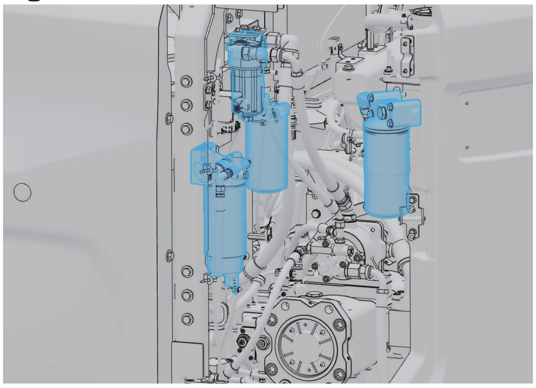
1. Remove mounting bolts (1) and support (2).
   Figure 42



DS2201623

   - Tool: 19 mm ()
   - Torque: 107.8 N.m (11 kg.m, 79.5 ft lb)
   - Support weight: about 72 kg (158.7 lb)

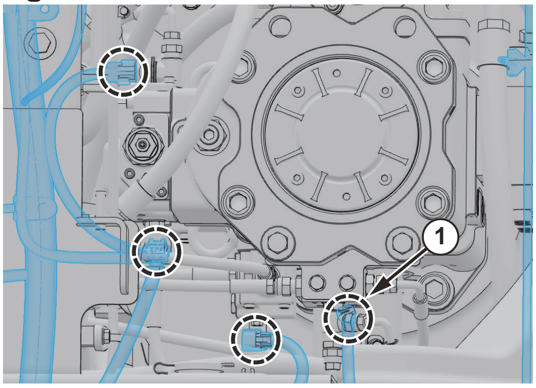
2. Separate the filters and mounting bracket at the support assembly.
   Figure 43



DS2201624

Wiring Harness

1. Disconnect wiring harness connectors (1) from main pump assembly.
   Figure 44



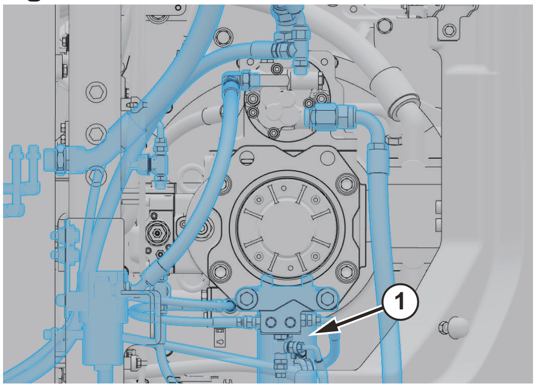
DS2201625

2. Disconnect any additional electrical connections as necessary.

Hydraulic hose

1. Disconnect hydraulic hoses (1) at the main pump assembly.

   Figure 45



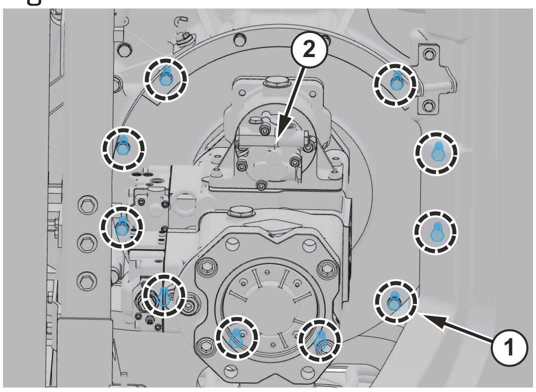
DS2201626

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.*

Main Pump Assembly

1. Remove bolts (1) (10 ea) of pump (2) without top bolts (2 ea).

   Figure 46



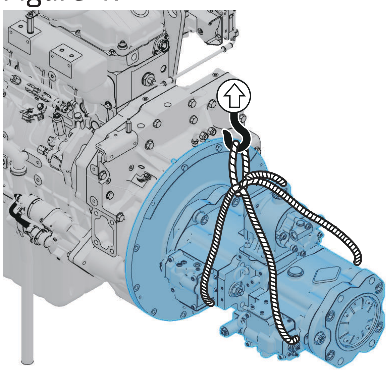
DS2201627

- Tool: 17 mm ( )
- Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)

  NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*

2. Attach a lifting device around pump. Raise the lifting device until the pump is supported prior to removing remaining bolts (2 ea).

   Figure 47

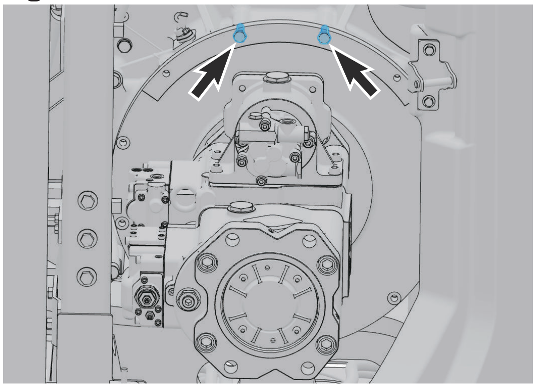


DS2201629

- Pump with Cover Weight: about 230 kg (507.1 lb)

3. Remove remaining bolts (2 ea).

Figure 48



DS2201628

- Tool: 17 mm ( )
- Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)

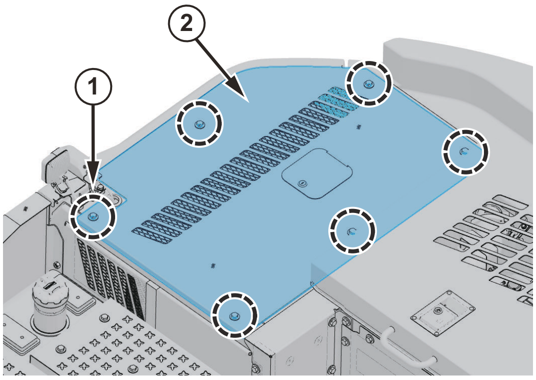
NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*

4. Lift the pump from engine slowly and carefully.

Radiator Cover

1. Remove bolts and washers (1) (6 ea) with cover (2).

Figure 49

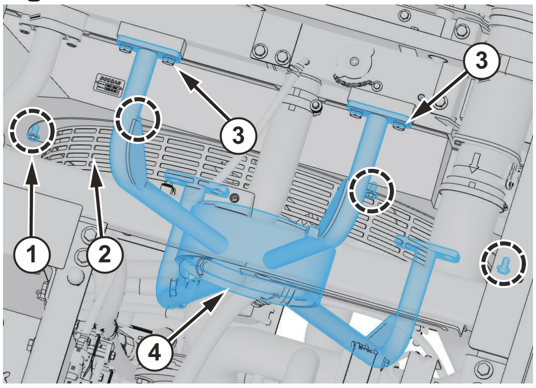


DS2201579

- Tool: 19 mm ( )
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Radiator cover weight: about 25 kg (55.1 lb)

Fan Guard

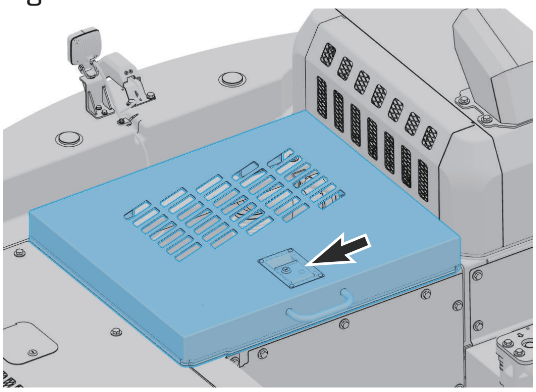
1. Remove bolts (1) (5 ea) with fan guard (2) from oil cooler.
   Figure 50



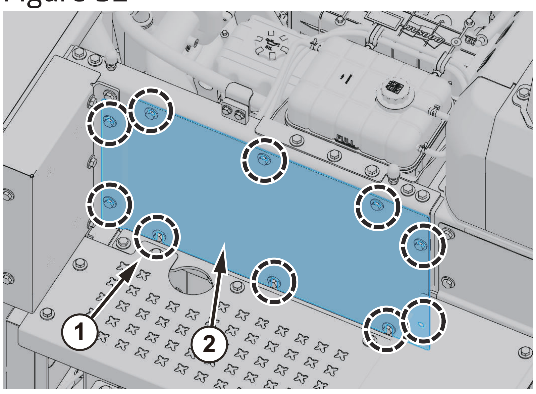
- Tool: 13 mm ()
- Torque: 29.4 N.m (3 kg.m, 21.7 ft lb)

Engine Side Cover

1. Open engine cover.
   Figure 51



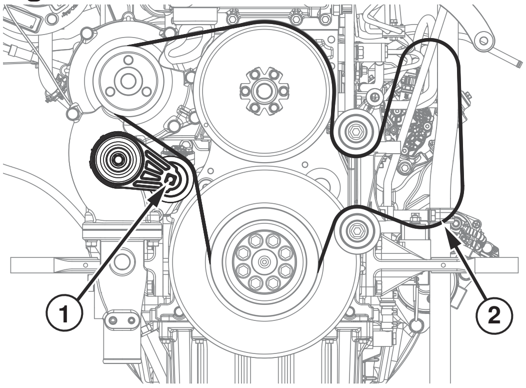
2. Remove mounting bolts (1) and cover (2) from support.
   Figure 52



- Tool: 19 mm ()
- Torque: 107.8 N.m (11 kg.m, 79.5 ft lb)
- Cover weight: about 6 kg (13.2 lb)

V-belt

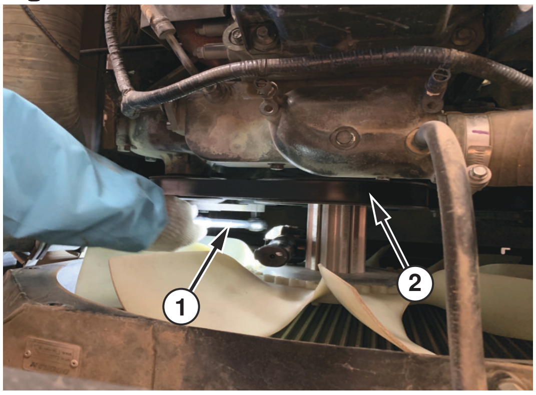
1. Insert the tool into the auto tensioner service hole (1).
   Figure 53



DS1901302

NOTE: *Before removing the belt, check the belt layout.*

2. Turn the auto tensioner with tool (1) clockwise to loosen and put away the V-belt (2).
   Figure 54



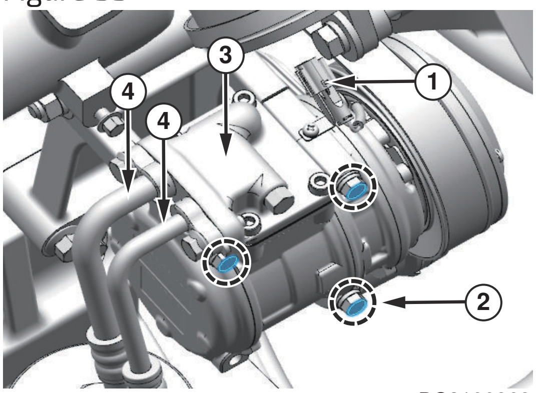
DS1901303

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 harnesses (1) from air conditioner compressor.
   Figure 55



DS2100969

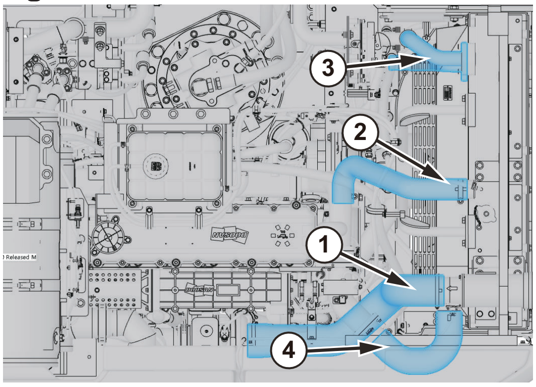
2. Remove the mounting bolts (2).
3. Separate air conditioner compressor (3) from engine.

NOTE: *Do not disconnect air conditioner hoses (4) from compressor.*

Air Hose, Tube - Engine

1. Loosen the clamp bolt and disconnect air hose (1).

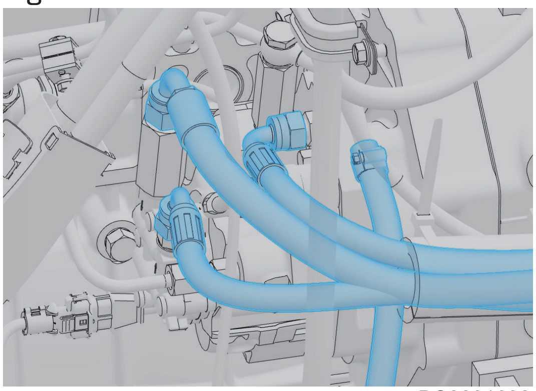
Figure 56



DS2201631

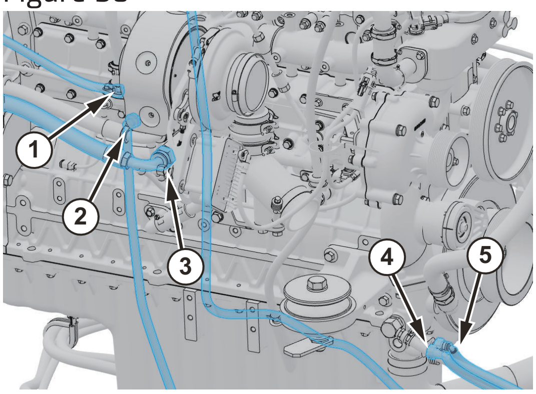
2. Disconnect water hose (2) from engine.
3. Disconnect CAC hoses (3, 4).
4. Disconnect fuel hoses from engine.

Figure 57


DS2201632

5. Disconnect engine oil filter hoses (1) from engine.

Figure 58



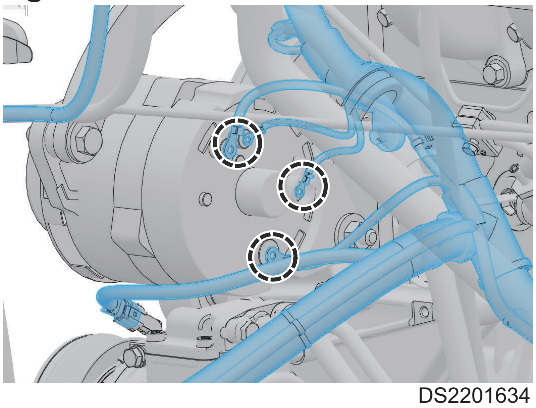
DS2201633

6. Disconnect water hose (2, 3, 4, 5) from engine.

Wiring Connectors and Cables - Engine

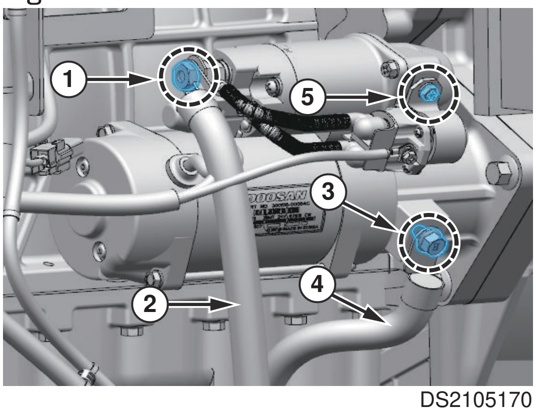
1. Disconnect wire harnesses from alternator.

   Figure 59

2. Remove nut (1) from starter motor.

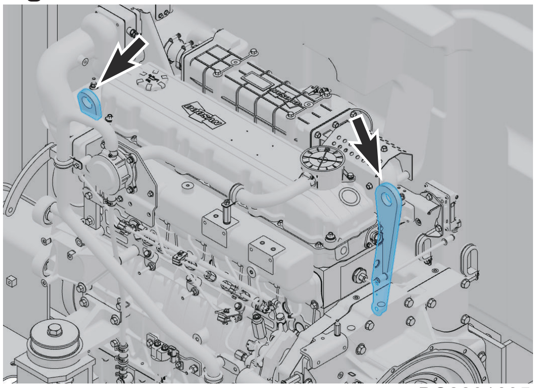
   Figure 60

3. Disconnect the positive cable (2) from starter motor.
4. Remove mounting bolt (3) and ground cable (4).
5. Remove mounting screw (5) and cable.
6. Disconnect engine wiring harness from main harness and ECU.

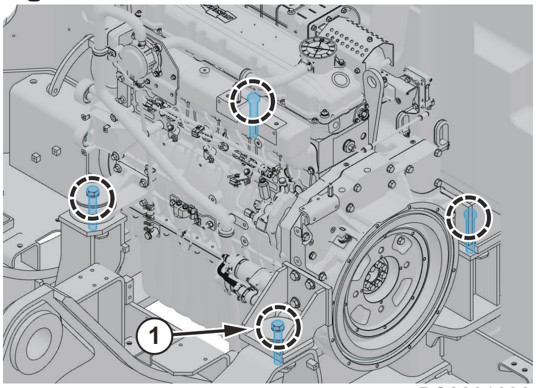
   NOTE: *Be careful not to let water get into electrical components (sensor, connectors). If water gets into electrical system, this will cause an electrical short circuit and result in improper machine operation.*

Engine Mount

1. Fit the lifting eyes in the flywheel housing.
   Figure 61
   
   DS2201635

2. Fasten the lifting chain to the rear lifting eyes.

3. Fasten the ratchet lever hoist to the front lifting eye.

4. Remove the engine mounting bolts (1).
   Figure 62
   

   DS2201636

   - Tool: 30 mm ( )
   - Torque: 451 N.m (46 kg.m, 332.7 ft lb)
   - Engine assembly weight: about 855 kg (1885 lb)

   NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*

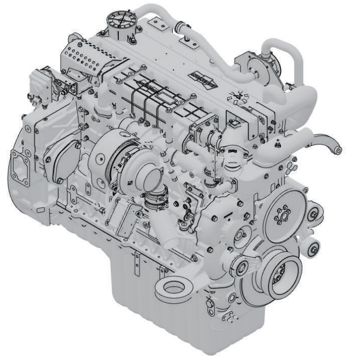
   NOTE: *Mark the location of the bolts before removing.*

   NOTE: *Check the location of the engine mounting rubbers and supports before removing.*

5. Lift the engine assembly from machine slowly and carefully.

Engine Assembly

1. Disconnect engine wire harness from engine.
   Figure 63



DS2201637

2. Install the engine to the engine stand.
3. Transfer parts as needed.

Installation

1. Perform installation in the reverse order to removal.

Hydraulic Systems and Structure

Safety Instructions

WARNING

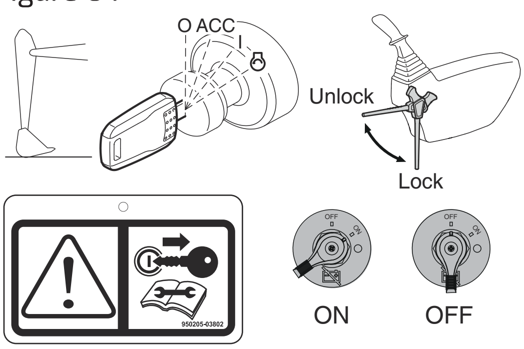
AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or 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.

Before Removing and Installing

Preparatory Work

1. Park the machine on level ground. And lower front attachment to the ground.
   Figure 64

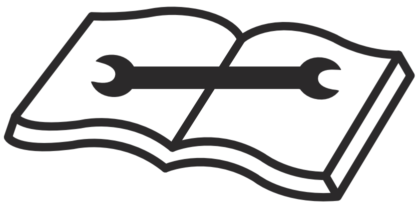


EX1504472

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 65



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.

Drive Coupling

Repair Procedure Quick Guide

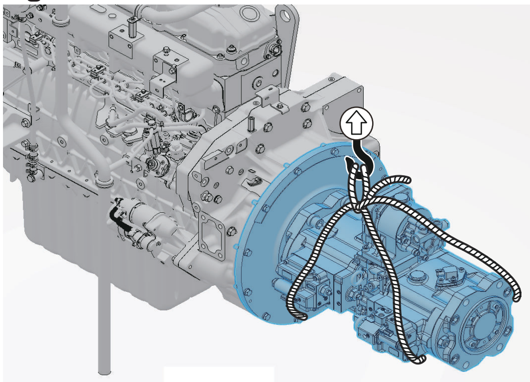
Step-A. Remove main pump assembly

Step-B. Remove drive coupling

Removal

Main Pump Assembly

1. Remove the main pump assembly.
   Figure 66



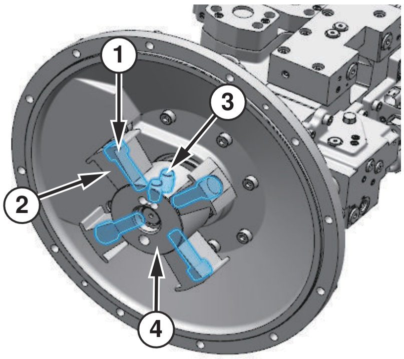
DS2200507

   For details, refer to Main pump - Removal and Installation.

   When the pump is removed from an engine, the hub and insert would be attached on the pump.

Drive Coupling Assembly

Figure 67



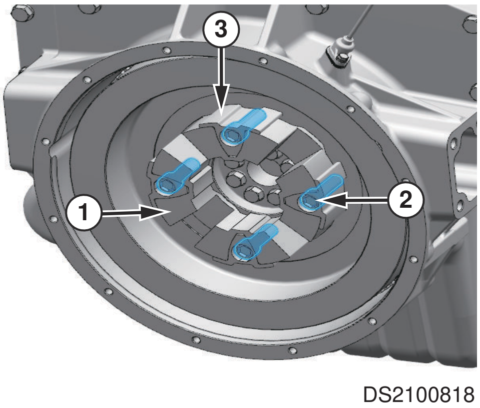
DS2100816

Main Pump Side

1. Remove bolts (1) and inserts (2) from the hub (4).
   - Torque: 215.7 N.m (22 kg.m, 159.1 ft lb)
2. Remove clamp screws (3) and hub (4) from the main pump shaft.
   - Torque: 107.8 N.m (11 kg.m, 79.5 ft lb)

Engine Side

1. Remove element (1) and bolts (2) with inserts (3) and spring pins from flywheel.
   Figure 68

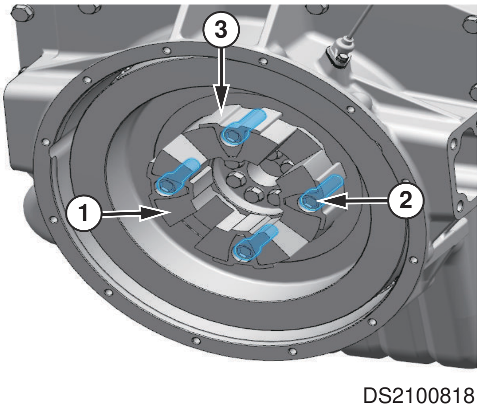


   - Tool: 14 mm ( )
   - Torque: 215.7 N.m (22 kg.m, 159.1 ft lb)

Installation

Drive Coupling

Figure 69

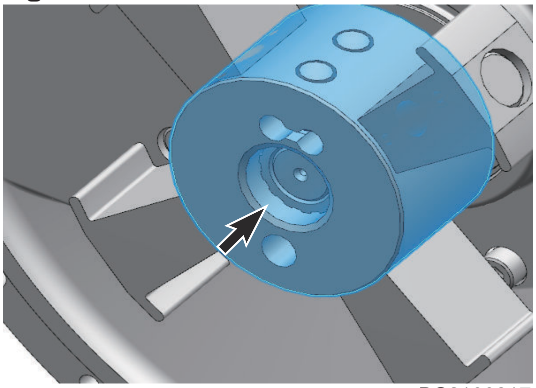


Engine Side

1. Install bolts (2) and inserts (3) with element (1) to flywheel.
   - Tool: 14 mm ( )
   - Torque: 215.7 N.m (22 kg.m, 159.1 ft lb)

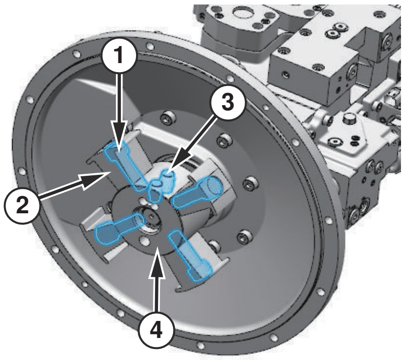
Main Pump Side

1. Check the "E" mark on the hub, it is must install toward engine side.
   Figure 70



DS2100817

2. Clearance between from pump shaft to coupling hub must be 10.5 mm.
3. Install clamp screws (3) and hub (4) to the main pump shaft.
   Figure 71

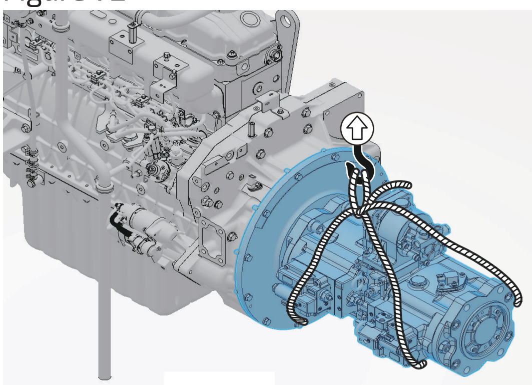


DS2100816

   - Torque: 107.8 N.m (11 kg.m, 79.5 ft lb)
4. Install bolts (1) and inserts (2) to the hub (4).
   - Torque: 215.7 N.m (22 kg.m, 159.1 ft lb)

Main Pump Assembly

1. Install the main pump assembly.
   Figure 72



DS2200507

For details, refer to Main Pump - Removal and Installation.

NOTICE
Element is not resistant to bonding compounds, oil or grease. Be careful not to expose them to it.

Remove oil or dirt from flywheel cover and pump shaft before assembly.

Undercovers

Repair Procedure Quick Guide

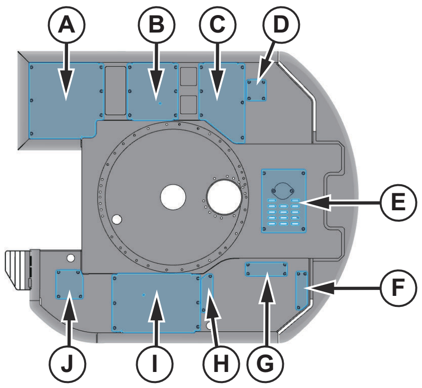
Step-A. Place the machine in the suitable service position

Step-B. Removel Undercovers

Removal

Undercovers

Figure 73



DS2201559

1. Position the machine on even, firm and level ground.
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 15 kg (33.1 lb)
   - Undercover (B)
     - Tool: 19 mm ( )
     - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
     - Weight: about 8 kg (17.6 lb)
   - Undercover (C)
     - Tool: 19 mm ( )
     - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

- Weight: about 8 kg (17.6 lb)
- Undercover (D)
  - Tool: 19 mm ( )
  - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
  - Weight: about 1 kg (2.2 lb)
- Undercover (E)
  - Tool: 19 mm ( )
  - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
  - Weight: about 6 kg (13.2 lb)
- Undercover (F)
  - Tool: 19 mm ( )
  - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
  - Weight: 1 kg (2.2 lb)
- Undercover (G)
  - Tool: 19 mm ( )
  - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
  - Weight: about 1.5 kg (3.3 lb)
- Undercover (H)
  - Tool: 19 mm ( )
  - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
  - Weight: about 1 kg (2.2 lb)
- Undercover (I)
  - Tool: 19 mm ( )
  - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
  - Weight: about 14 kg (30.9 lb)
- Undercover (J)
  - Tool: 19 mm ( )
  - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
  - Weight: about 2 kg (4.4 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

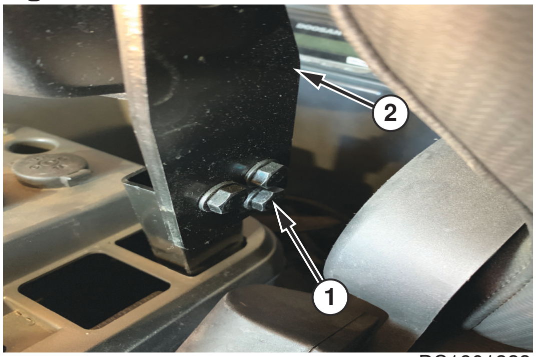
Step-D. Disconnect hydraulic hoses and fittings

Step-E. Remove joystick valve

Removal

Armrest

1. Remove mounting bolts (1) and armrest (2).
   Figure 74

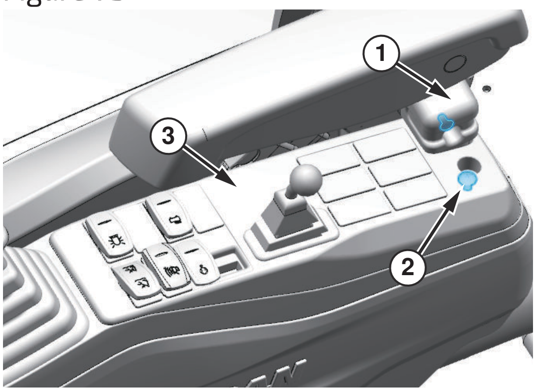


DS1901323

- 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 75

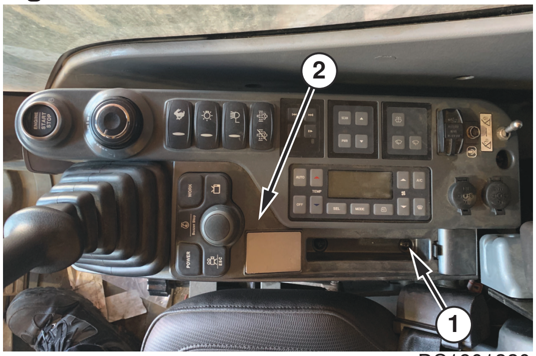


DS2100467

2. Remove the rubber pad, and screws (2).
3. Lift off the stand cover LH (3).

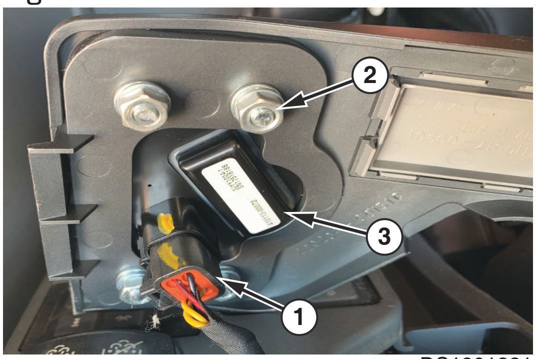
Stand Cover - Right Side

1. Remove the rubber pad, and screws (1).
   Figure 76



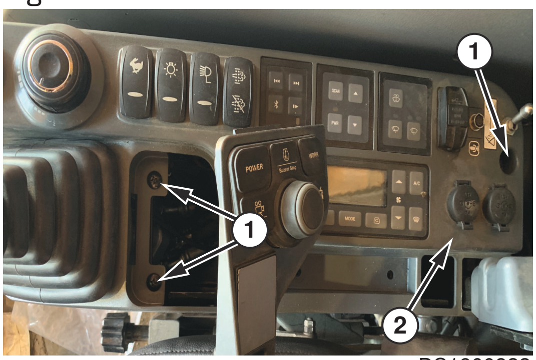
DS1901320

2. Lift off the stand upper cover (2).
3. Disconnect wiring harness connector (1) from jog switch.
   Figure 77



DS1901321

4. Remove the stand upper cover.
5. Remove the screws (1).
   Figure 78

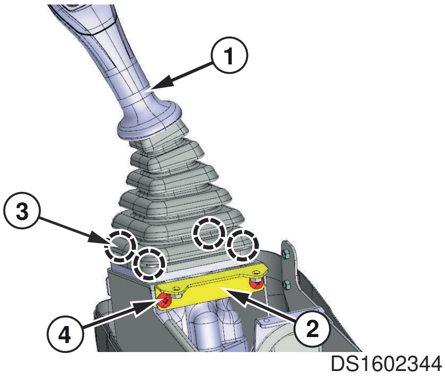


DS1900822

6. Remove the mounting screw and cover (2) from armrest bracket.

Control Stand Bracket

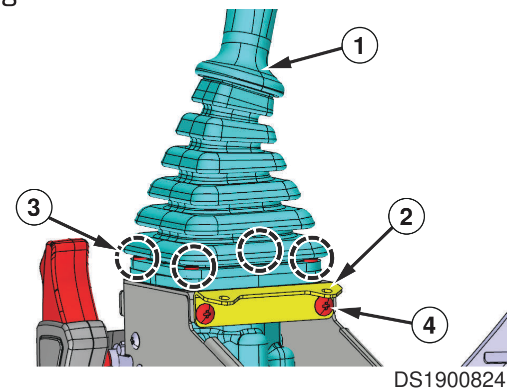
1. Remove screws (4) (2 ea), socket bolts and washers (3) (4 ea) of joystick valve (1).
   Figure 79



2. Remove bracket (2) from control stand bracket.
3. Separate joystick valve from control stand.

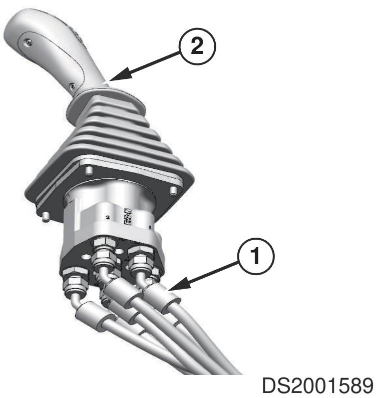
   Left side is same.

   - Tool: 5 mm ( ), Phillips screwdriver
     Figure 80



Hydraulic Hoses and Fittings

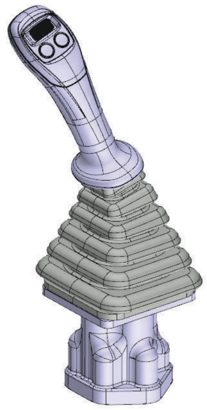
1. Disconnect hydraulic hoses (1) and from joystick valve (2).
   Figure 81



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.*

Joystick Valve

1. Remove joystick valve from control stand.
   Figure 82



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 undercovers

Step-B. Disconnect hydraulic hoses and fittings

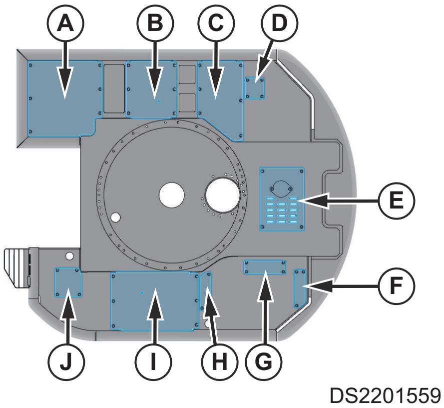
Step-C. Remove foot rest and travel pedal

Step-D. Remove travel control valve

Removal

Undercovers

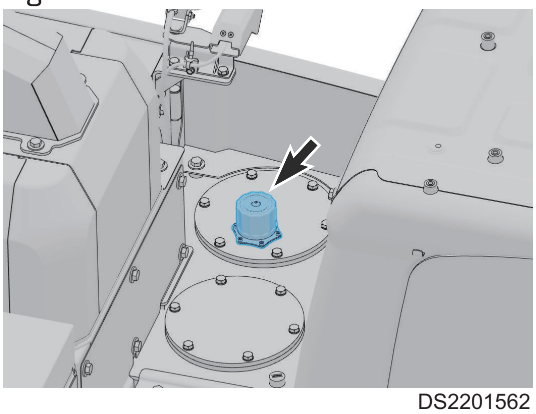
1. Remove undercover (A).
   Figure 83



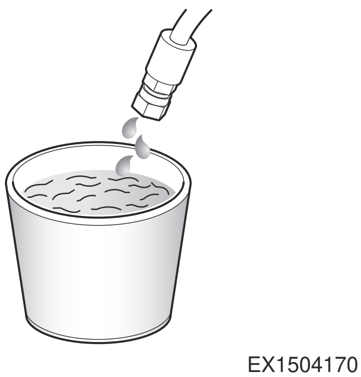
For details, refer to Undercovers - Removal and Installation.

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 84

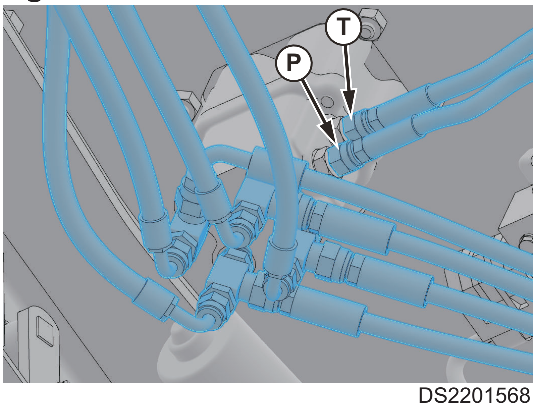


2. When disconnecting the hose, oil left in the hose may flow out. Therefore, place the end of the hose into a suitable container to prevent contamination of the ground and environment.
   Figure 85



3. Remove hoses and adapters from travel control valve.

Figure 86

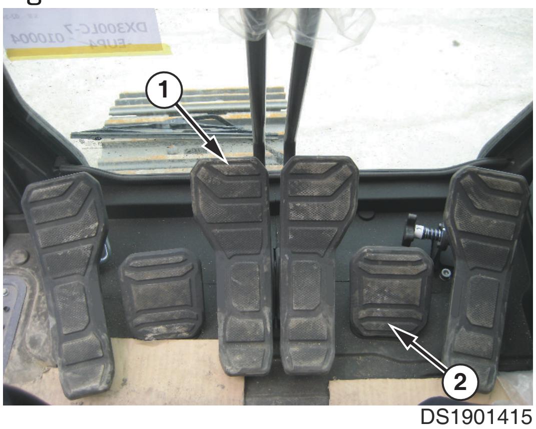


NOTE: *Attach identification tags to the removed hoses for reassembling. After disconnecting hoses from travel control valve, plug them to prevent dirt or dust from entering. Disconnect the hoses from the bottom to top of travel control valve.*

Foot Rest and Travel Pedal

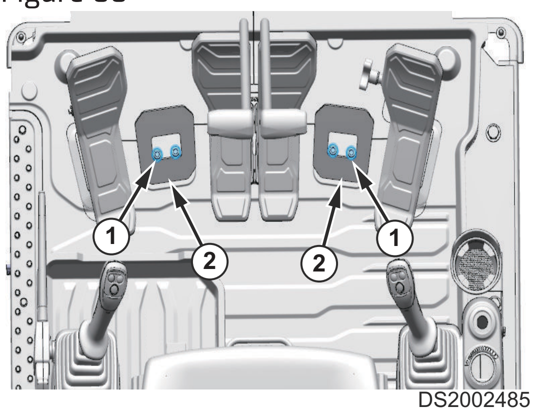
1. Remove floor mat from the cabin.

Figure 87



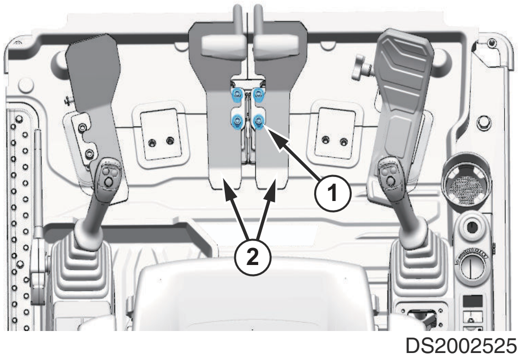
2. Remove rubber pads (1, 2) from foot rests and travel control pedal.
3. Remove bolts (1) and foot rests (2) from cabin.

Figure 88



- Tool: 8 mm ( )
- Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)

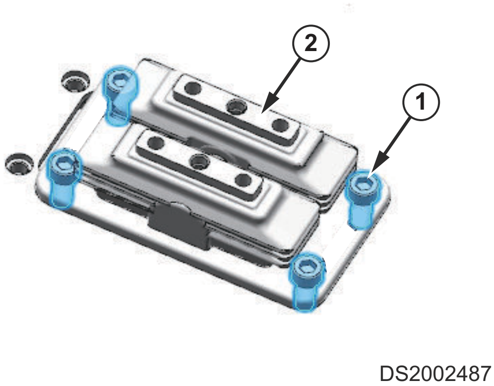
4. Remove bolts (1) and travel control pedal (2) travel control valve.
   Figure 89



- 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 90



- 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.

Main Control Valve

Repair Procedure Quick Guide

Step-A. Remove MCV covers and support

Step-B. Disconnect wiring harness

Step-C. Disconnect hydraulic hoses and fittings

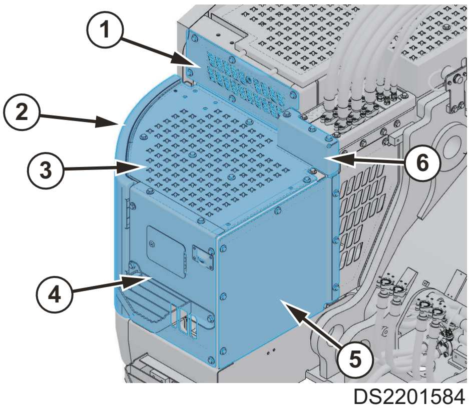
Step-D. Remove main control valve

Removal

1. Turn OFF the battery disconnect switch.

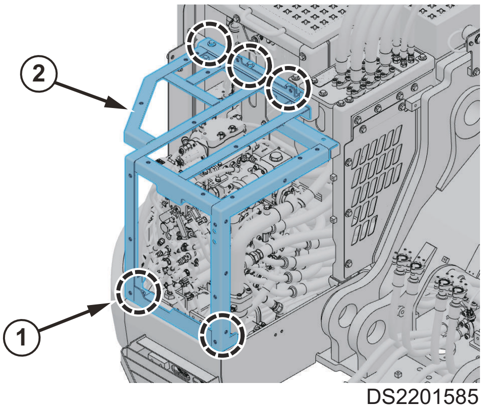
MCV Covers and Support

1. Remove mounting bolts and MCV covers (1, 2, 3, 4, 5).
   Figure 91



- Tool: 19 mm ( )
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Cover (1) weight: about 3 kg (6.6 lb)
- Cover (2) weight: about 13 kg (28.7 lb)
- Cover (3) weight: about 15 kg (33.1 lb)
- Cover (4) weight: about 7 kg (15.4 lb)
- Cover (5) weight: about 8 kg (17.6 lb)
- Cover (6) weight: about 3 kg (6.6 lb)

2. Remove mounting bolts (1, 5ea) and support (2).
   Figure 92

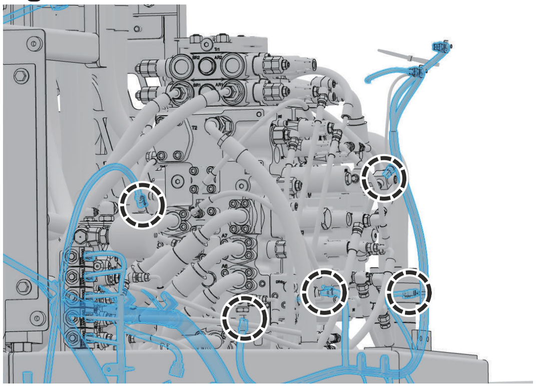


- Tool: 19 mm ( )
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Support weight: about 22 kg (48.5 lb)

Wiring Harness

1. Disconnect wiring harnesses from MCV assembly.

   Figure 93

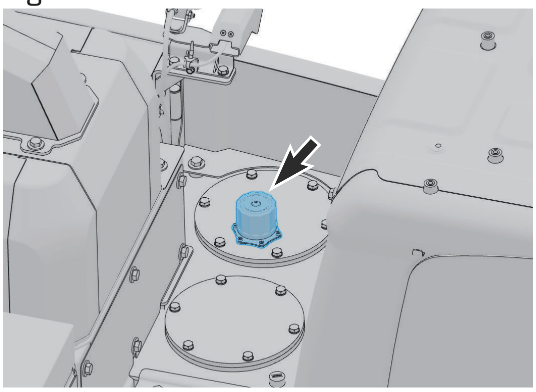
   

   DS2201586

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.

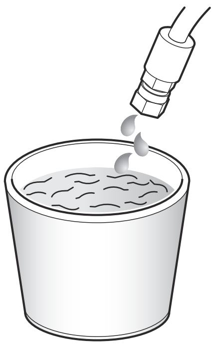
   Figure 94

   DS2201562

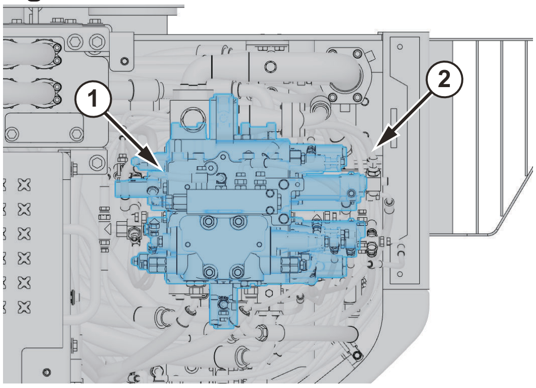
2. When disconnecting the hose, oil left in the hose may flow out. Therefore, place the end of the hose into a suitable container to prevent contamination of the ground and environment.

   Figure 95

   EX1504170

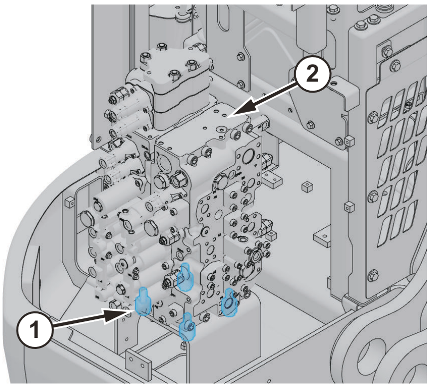
3. Remove hose and adapters (1) from main control valve (2).
   Figure 96



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.*

Main Control Valve

1. Tie with rope to the eyebolts to lift it and remove mounting bolts (1) from frame.
   Figure 97



- Tool: 24 mm ( )
- Torque: 264.7 N.m (27 kg.m, 195.2 ft lb)
- Main control valve weight: about 270 kg (595.2 lb)

NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*

2. Lift the main control valve (2) by crane from machine 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.

Main Pump

Repair Procedure Quick Guide

Step-A. Drain hydraulic oil

Step-B. Remove engine hood assembly

Step-C. Remove muffler assembly

Step-D. Remove cover and support - main pump room

Step-E. Disconnect wiring harness

Step-F. Disconnect hydraulic hose

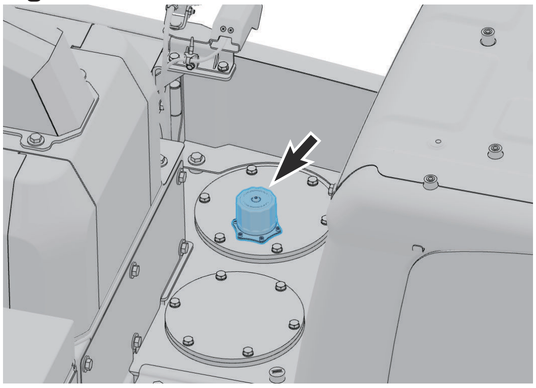
Step-G. Remove main pump assembly

Removal

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.

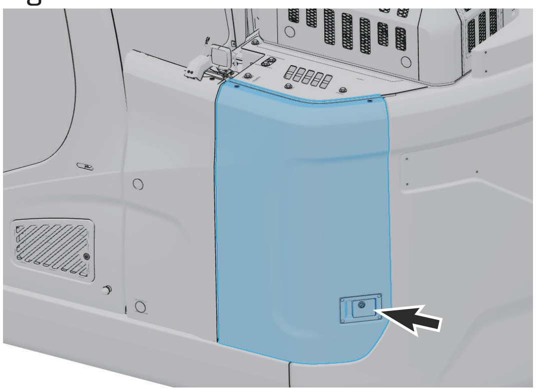
   Figure 98

   DS2201562

2. Open the left side door.

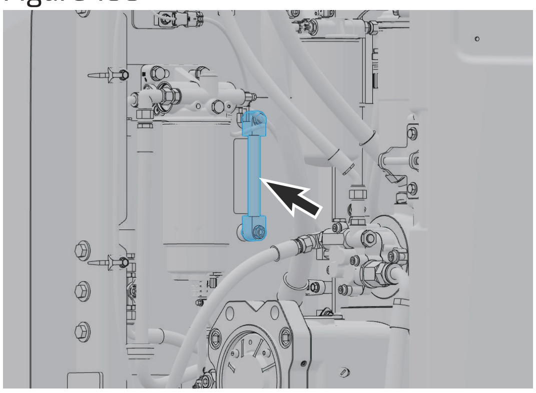
   Figure 99

   DS2201603

3. Oil drain method.

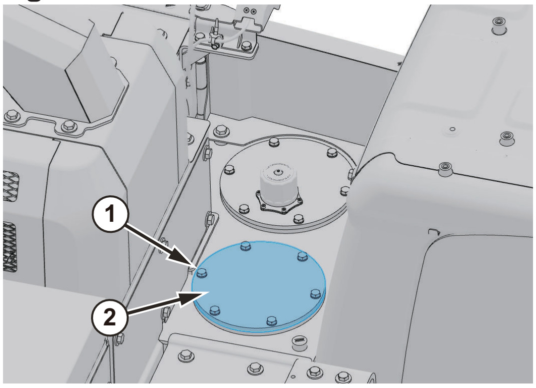
   Figure 100

   DS2201616

NOTE: *Check the flow on the oil level gauge before draining the oil.*

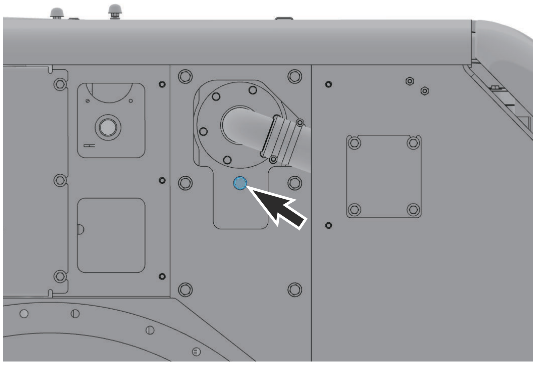
A. If using the suction oil pump, remove cover on oil tank bolts. drain hydraulic oil using suction oil pump.
Figure 101



DS2201604

- Tool: 17 mm ( )
- Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)

B. Loosen drain plug at the bottom of the hydraulic tank. drain hydraulic oil.
Figure 102

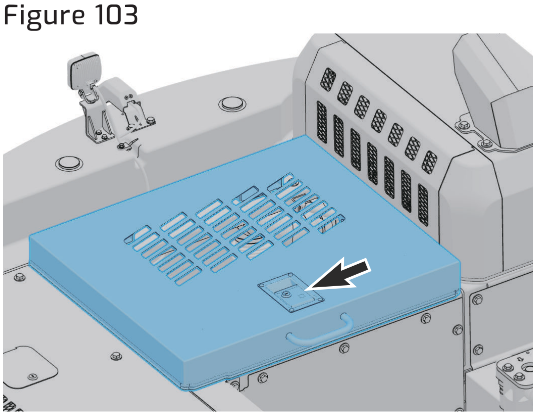


DS2201605

- Tool: 27 mm ( )
- Torque: 93.2 N.m (9.5 kg.m, 68.7 ft lb)
- Hydraulic oil tank volume: 175 L (46.2 U.S. gal)

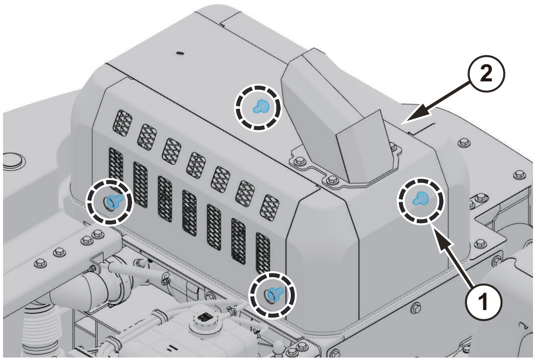
Engine Hood Assembly

1. Open the engine hood.
Figure 103



DS2201573

2. Remove the bolts (1) and muffler cover (2).
Figure 104

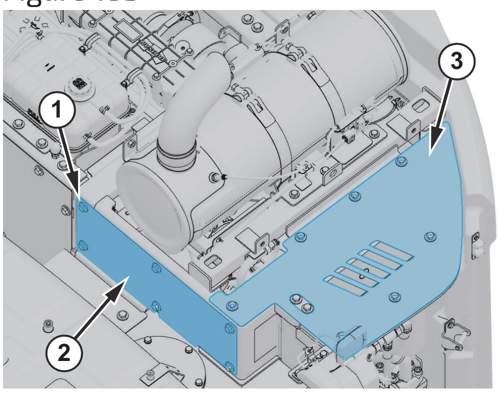


DS2201617

- Tool: 19 mm ( )
- Torque: 88.2 N.m (9 kg.m, 65 ft lb)
- Muffler with Tail Pipe Weight: about 35 kg (77.2 lb)

Muffler Assembly

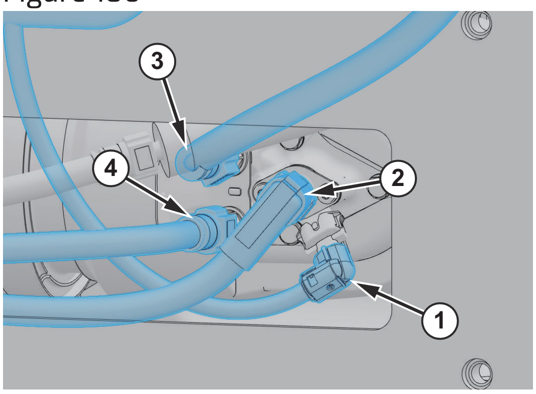
1. Remove bolts (1, 13ea) and covers (2, 3).
Figure 105



DS2201618

- Tool: 19 mm ( )
- Torque: 88.2 N.m (9 kg.m, 65 ft lb)
- Cover (2) Weight: about 2 kg (4.4 lb)
- Cover (3) Weight: about 5 kg (11.0 lb)

2. Disconnect DEF (AdBlue®) hose quick connector (1).
Figure 106

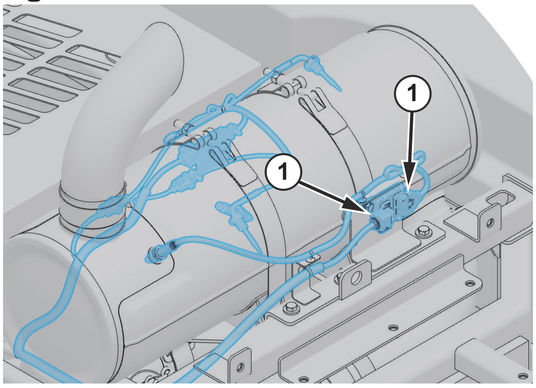


DS2201619

NOTE: *Be sure to use vinyl gloves disconnect DEF (AdBlue®) hose.*

3. Disconnect clamp and water hoses (2, 3, 4).
4. Disconnect wiring harness connectors (1).

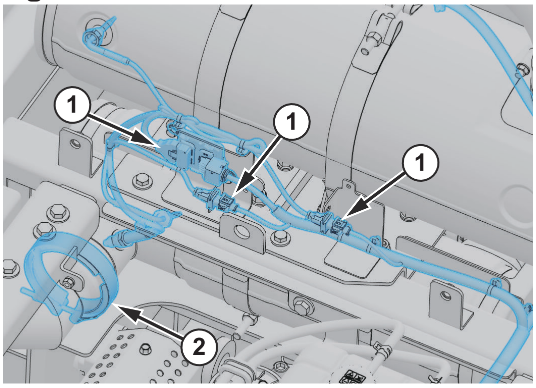
Figure 107



DS2201620

5. Disconnect wiring harness connectors (1) V-clamp (2) and exhaust hose.

Figure 108



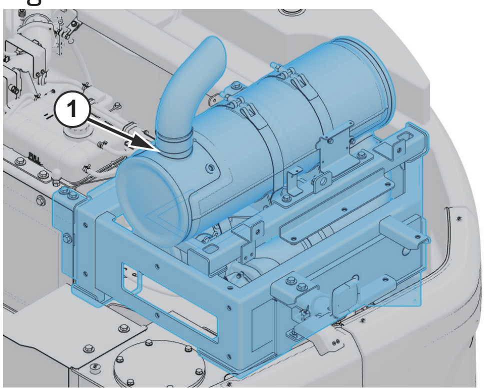
DS2201621

- Tool: 11 mm ( )
- Torque: 10.7 N.m (1.1 kg.m, 7.9 ft lb)

NOTE: *Be careful not to let water get into electrical components (sensor, connectors). If water gets into electrical system, this will cause an electrical short circuit and result in improper machine operation.*

6. Attach a lifting device at lifting point.

Figure 109



DS2201622

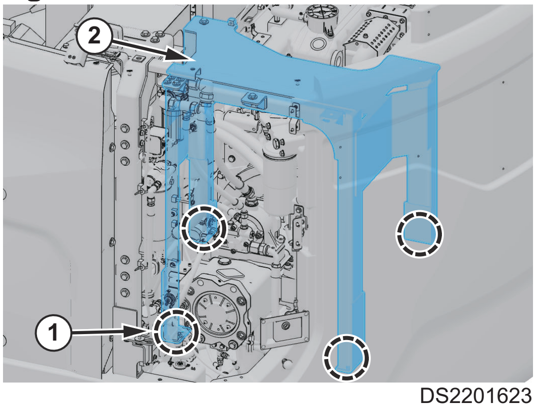
7. Remove support and muffler assembly (1).

- Tool: 19 mm ( )
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Muffler assembly weight: about 100 kg (220.5 lb)
- Support weight: about 50 kg (110.2 lb)

Cover and Support - Main Pump Room

1. Remove mounting bolts (1) and support (2).

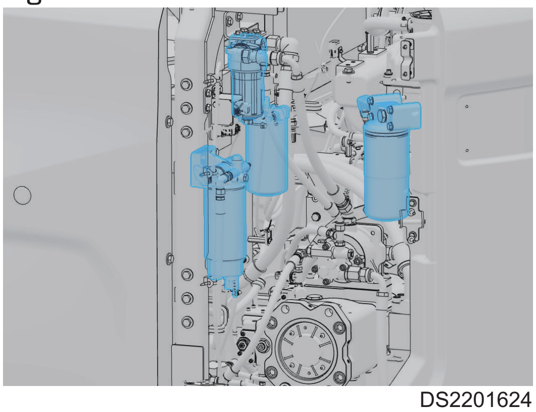
Figure 110



- Tool: 19 mm ( )
- Torque: 107.8 N.m (11 kg.m, 79.5 ft lb)
- Support weight: about 72 kg (158.7 lb)

2. Separate the filters and mounting bracket at the support assembly.

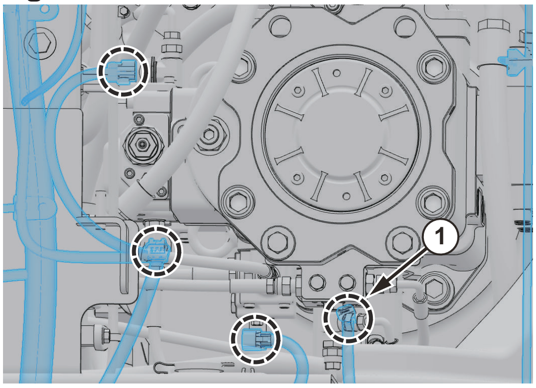
Figure 111



Wiring Harness

1. Disconnect wiring harness connectors (1) from main pump assembly.

   Figure 112

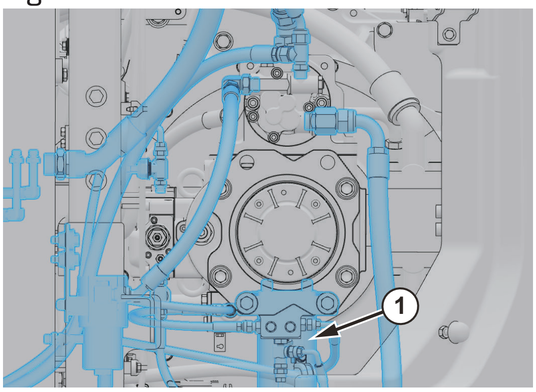
   DS2201625

2. Disconnect any additional electrical connections as necessary.

Hydraulic hose

1. Disconnect hydraulic hoses (1) at the main pump assembly.

   Figure 113

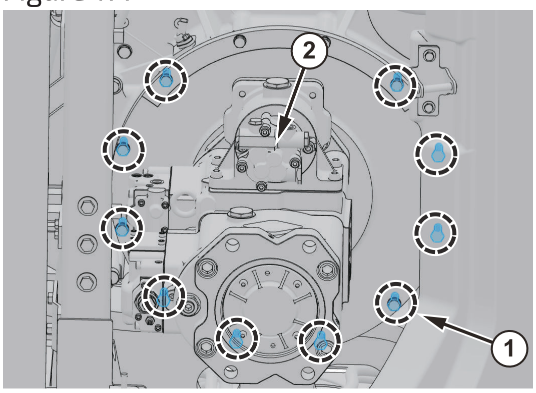
   DS2201626

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.*

Main Pump Assembly

1. Remove bolts (1) (10 ea) of pump (2) without top bolts (2 ea).

   Figure 114

   DS2201627

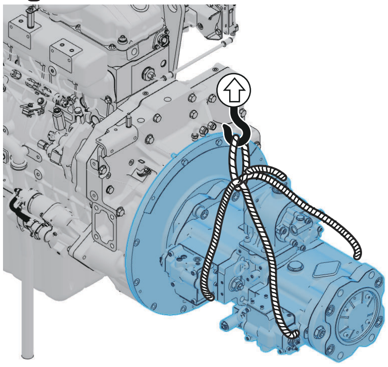
   - Tool: 17 mm ( )

- Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)

  NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*

2. Attach a lifting device around pump. Raise the lifting device until the pump is supported prior to removing remaining bolts (2 ea).

   Figure 115

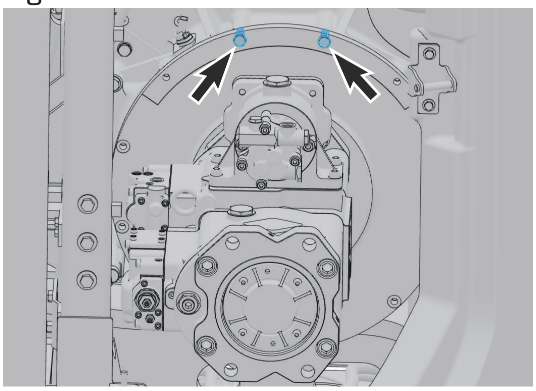


DS2201629

- Pump with Cover Weight: about 230 kg (507.1 lb)

3. Remove remaining bolts (2 ea).

   Figure 116



DS2201628

- Tool: 17 mm ( )
- Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)

  NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*

4. 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.

Hydraulic Oil Tank

Repair Procedure Quick Guide

Step-A. Drain hydraulic oil

Step-B. Remove hydraulic tank covers

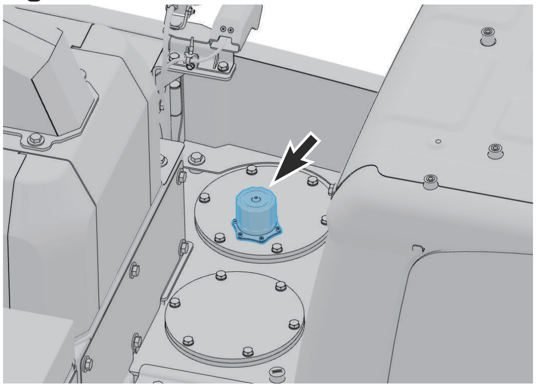
Step-D. Disconnect hydraulic hoses and fittings

Step-E. Remove hydraulic tank assembly

Removal

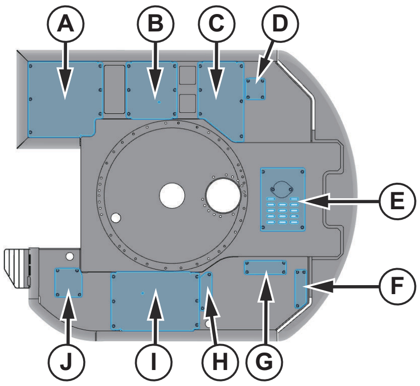
Hydraulic Oil

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 117

   DS2201562

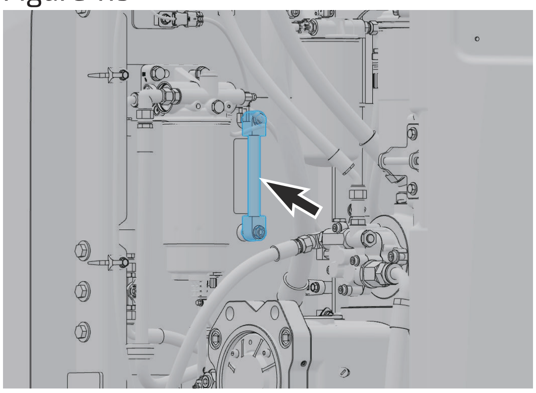
2. Remove undercover (C).
   Figure 118

   DS2201559

   For details, refer to Undercovers - Removal and Installation.

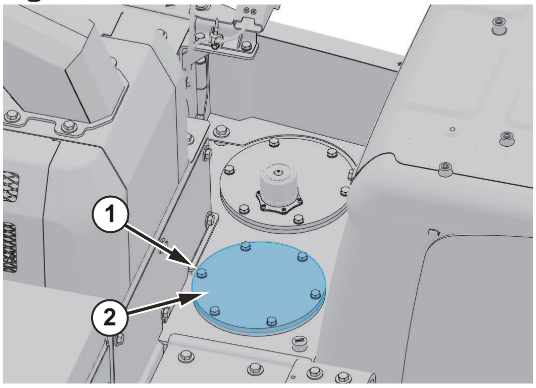
3. Oil drain method.
   Figure 119

   DS2201616

   NOTE: *Check the flow on the oil level gauge before draining the oil.*

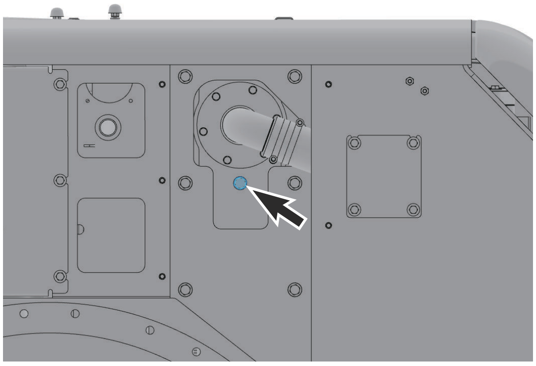
A. If using the suction oil pump, remove cover on oil tank bolts. drain hydraulic oil using suction oil pump.
Figure 120



DS2201604

- Tool: 17 mm ( )
- Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)
- Hydraulic oil tank volume: 175 L (46.2 U.S. gal)

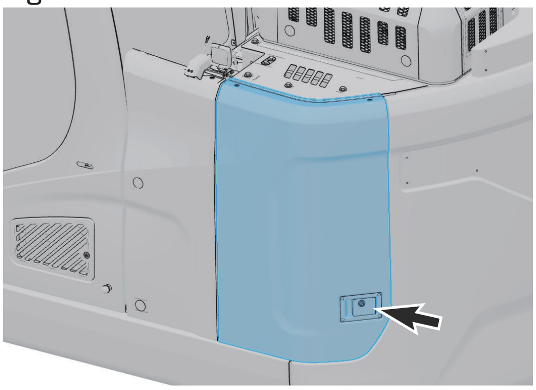
B. Loosen drain plug at the bottom of the hydraulic tank. drain hydraulic oil.
Figure 121

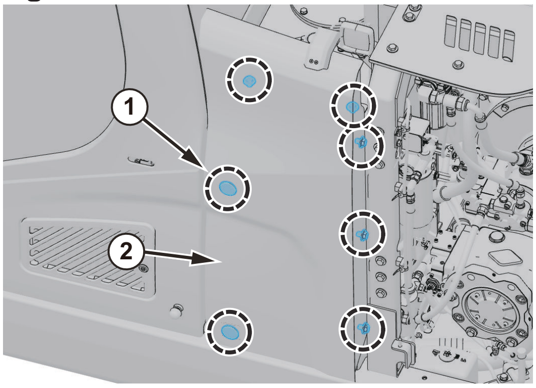

DS2201605

- Tool: 27 mm ( )
- Torque: 93.2 N.m (9.5 kg.m, 68.7 ft lb)
- Hydraulic oil tank volume: 131 L (34.6 U.S. gal)

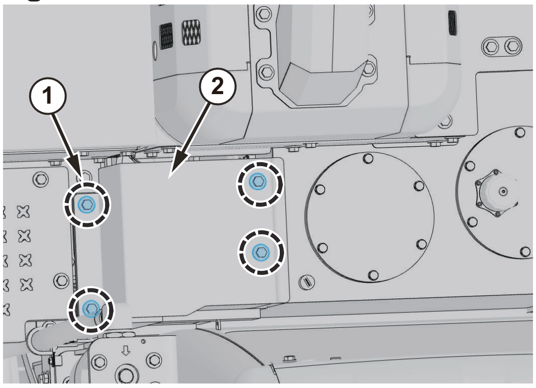
Hydraulic Tank Covers

1. Open the left side door.
Figure 122


DS2201603

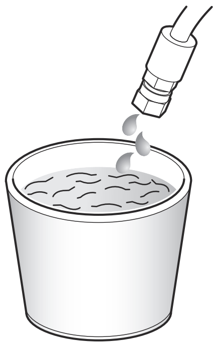
2. Remove cap and bolts (1) and left side cover (2).
Figure 123


DS2201607

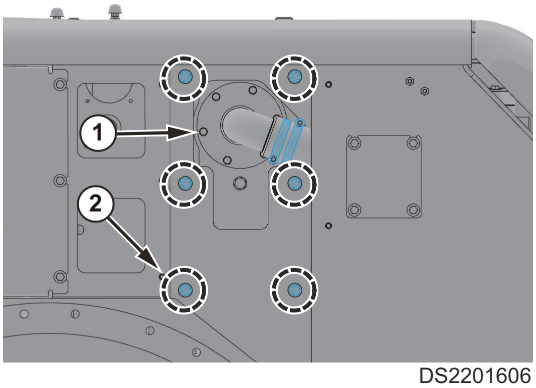
3. Remove bolts (1) and cover (2).
Figure 124


DS2201608

Hydraulic Hoses and Fittings

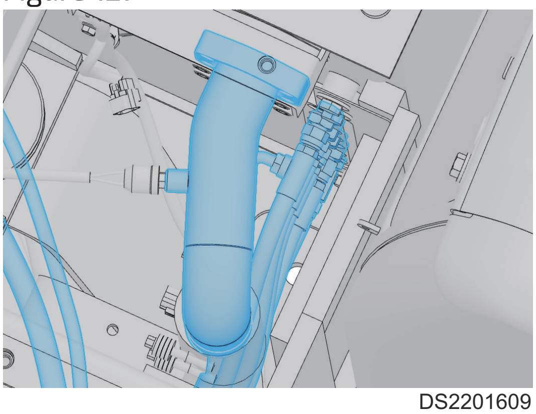
1. When disconnecting the hose, oil left in the hose may flow out. Therefore, place the end of the hose into a suitable container to prevent contamination of the ground and environment.
Figure 125

EX1504170

2. Remove bolts (1) (6 ea) with suction pipe from the oil tank.
   Figure 126



   - Tool: 17 mm ( )
   - Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)
3. Remove mounting bolts (2) from hydraulic tank.
   - Tool: 24 mm ( )
   - Torque: 264.7 N.m (27 kg.m, 195.2 ft lb)

   NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*
4. Remove hoses and adapters from the oil tank.
   Figure 127



   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.*
5. Disconnect wire harness.

Hydraulic Tank Assembly

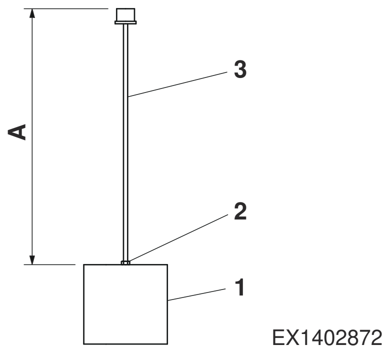
1. Install eyebolts (2 ea) on the oil tank.

   And tie the rope to the bolts to lift oil tank.
2. Lift the oil tank by crane from frame slowly and carefully.
   - Oil tank weight: about 240 kg (529.1 lb)

Installation

1. Perform installation in the reverse order of removal.

2. When assembling rod to suction filter, adjust the assembling length as Figure 12.
Figure 128



Reference Number	Description
1	Suction Filter
2	Nut
3	Rod

- Length (A): 792 mm
- Torque (2 nut): 34.3 N.m (3.5 kg.m, 25.3 ft lb)

Fuel Tank

Repair Procedure Quick Guide

Step-A. Remove undercover

Step-B. Drain fuel

Step-C. Remove guardrail assembly and covers

Step-D. Disconnect wiring harness connector

Step-E. Disconnect fuel hoses and fittings

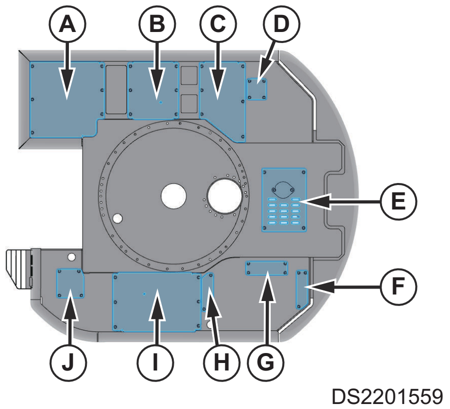
Step-F. Remove fuel tank assembly

Removal

1. Turn OFF the battery disconnect switch.

Undercover

1. Remove the undercover (I).
Figure 129

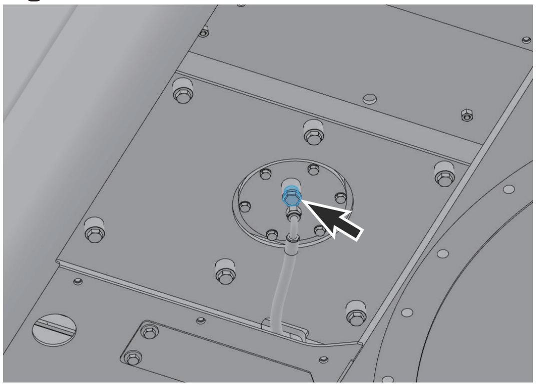


For details, refer to Undercovers - Removal and Installation.

Fuel

1. Remove drain plug from fuel tank.

Figure 130

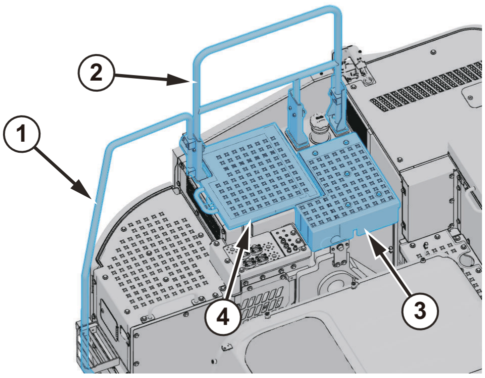

DS2201594

- Fuel tank capacity: 490 L (129.4 U.S. gal)

Guardrail Assembly and Covers

1. Remove mounting bolts and handrail (1), guardrail (2), upper cover (3) and DEF cover (4) from fuel tank and frame.

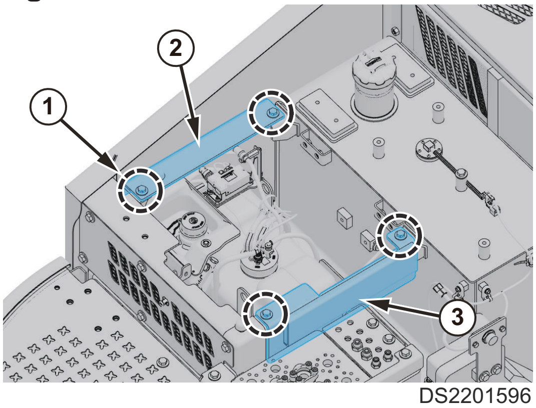
Figure 131



DS2201595

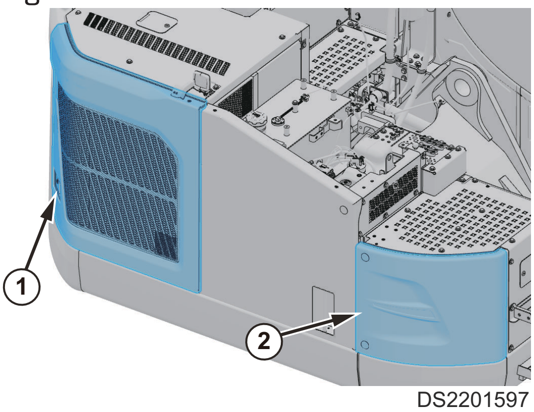
- Tool: 19 mm ( )
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Handrail (1) weight: about 10 kg (22.0 lb)
- Guardrail (2) weight: about 27 kg (59.5 lb)
- Upper cover (3) weight: about 12 kg (26.5 lb)
- DEF cover (4) weight: about 18 kg (39.7 lb)

2. Remove bolts (1) and support (2, 3) from fuel tank.
Figure 132

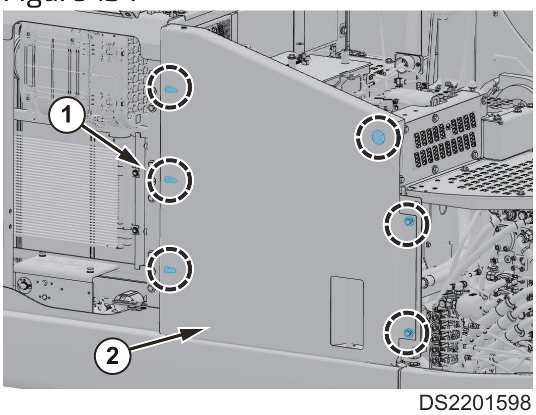


- Tool: 19 mm ( )
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Support (2) weight: about 3 kg (6.6 lb)
- Support (3) weight: about 6 kg (13.2 lb)

3. Clean area around fuel tank fill cap. Open fuel cap.
4. Open the side doors (1, 2).
Figure 133



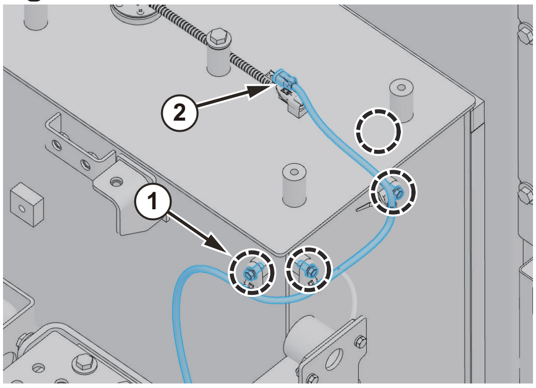
5. Remove cap and mounting bolts (1) and side cover (2).
Figure 134



- Tool: 19 mm ( )
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Cover (2) weight: about 35 kg (77.2 lb)

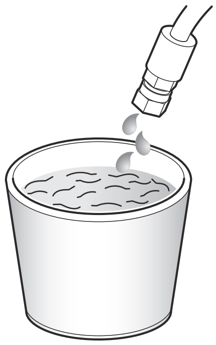
Harness Connector

1. Remove mounting bolts (1) and disconnect wire harness (2).
   Figure 135

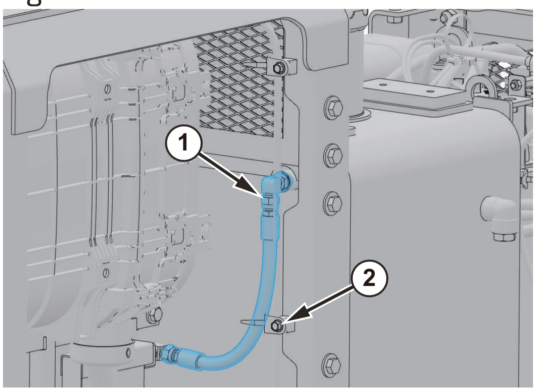


Hydraulic Hoses and Fittings

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 136



2. Remove hose (1) from fuel tank.
   Figure 137

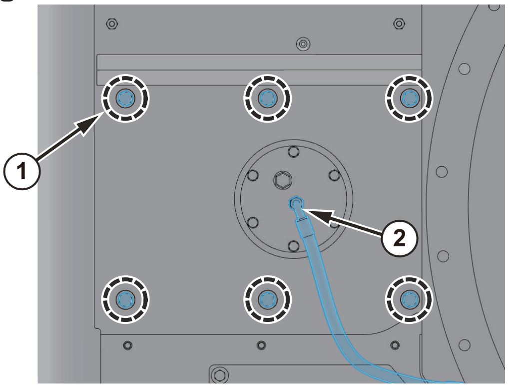


NOTE: *Cap the open ends of hose with plug.*

3. Remove mounting bolt (2) from fuel tank.

Fuel Tank Assembly

1. Remove hose (2) from fuel tank.
   Figure 138



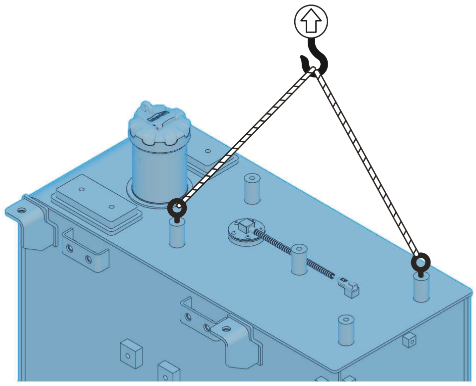
DS2201601

NOTE: *Cap the open ends of hose with plug.*

2. Remove fuel tank mounting bolts (1) from the main frame.
   - Tool: 24 mm ( )
   - Torque: 264.6 N.m (27 kg.m, 195.2 ft lb)

   NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*

3. Install eyebolts (2 ea) on the fuel tank.
   Figure 139



DS2201602

And tie the rope to the bolts to lift tank.

4. Completely remove tank after inspection.
   - Fuel tank weight: about 302 kg (665.8 lb)

Installation

1. Perform installation in the reverse order to remove.
2. Fill fuel tank and check for signs of leaks. Correct any problems found.

Swing Device

Repair Procedure Quick Guide

Step-A. Remove engine cover and support

Step-B. Remove step cover

Step-C. Remove baffle

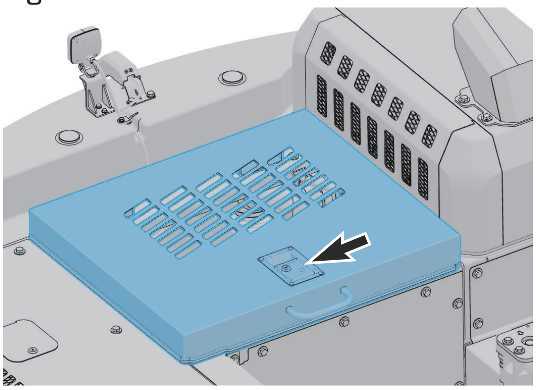
Step-D. Disconnect hydraulic hoses and fittings

Step-E. Remove swing device

Removal

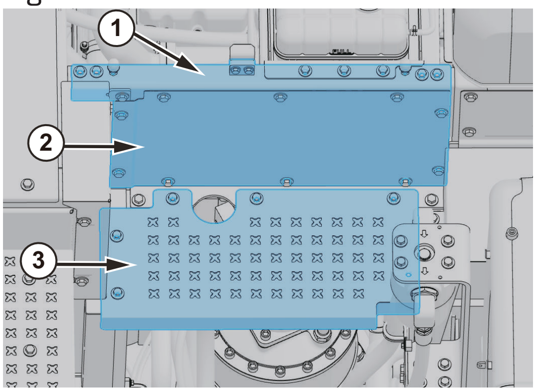
Engine Cover and Support

1. Open engine hood (1).
   Figure 140



DS2201573

2. Remove mounting bolts and baffle cover (1).
   Figure 141



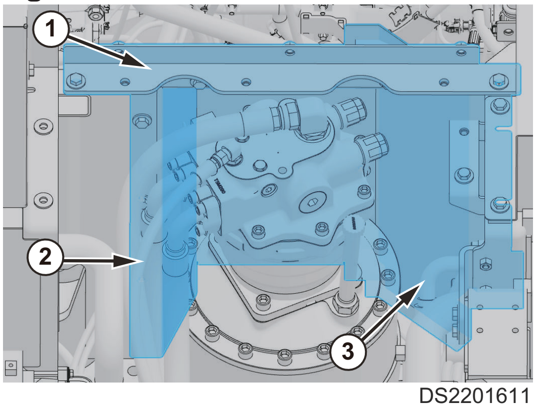
DS2201610

   - Tool: 19 mm ( )
   - Torque: 107.8 N.m (11 kg.m, 79.5 ft lb)
   - Baffle Cover (1) weight: about 6 kg (13.2 lb)

3. Remove mounting bolts and support (2).
   - Tool: 19 mm ( )
   - Torque: 107.8 N.m (11 kg.m, 79.5 ft lb)
   - Support (2) weight: about 6 kg (13.2 lb)

4. Remove mounting bolts and upper cover (3).
   - Tool: 19 mm ( )
   - Torque: 107.8 N.m (11 kg.m, 79.5 ft lb)
   - Upper cover (3) weight: about 15 kg (33.1 lb)

5. Remove mounting bolts and support (1).
   Figure 142

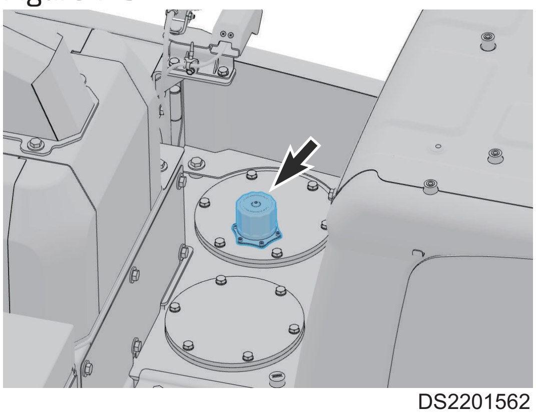


   - Tool: 19 mm ( )
   - Torque: 107.8 N.m (11 kg.m, 79.5 ft lb)
   - Support (1) weight: about 6 kg (13.2 lb)

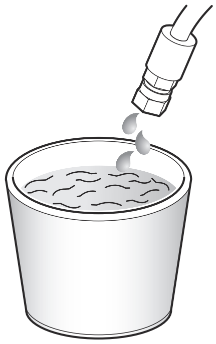
6. Remove mounting bolts and baffle cover (2).
   - Tool: 19 mm ( )
   - Torque: 107.8 N.m (11 kg.m, 79.5 ft lb)
   - Baffle Cover (2) weight: about 6 kg (13.2 lb)

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 143

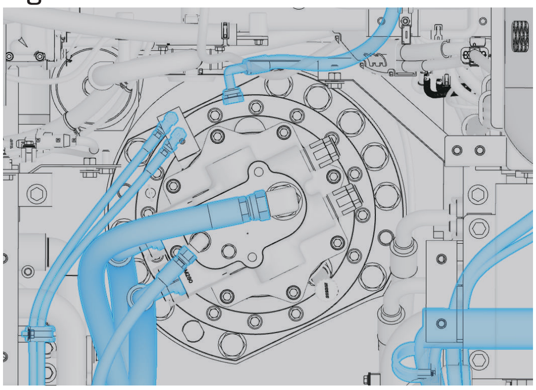


2. When disconnecting the hose, oil left in the hose may flow out. Therefore, place the end of the hose into a suitable container to prevent contamination of the ground and environment.
   Figure 144



EX1504170

3. Remove hoses and adapters from the swing device.
   Figure 145



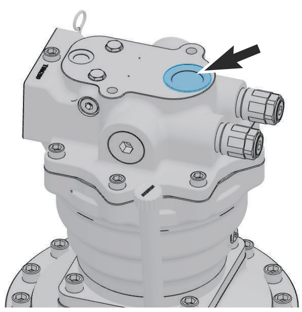
DS2201612

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.*

4. Disconnect wiring harness connector from swing device.
5. Remove the bolt from swing device oil filler.

Swing Device

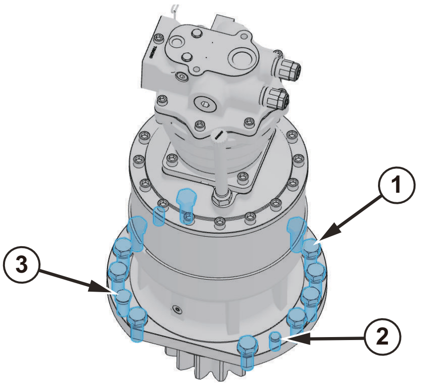
1. Install the eyebolts.
   Figure 146



DS2201613

2. Attach a lifting device onto the eyebolts.

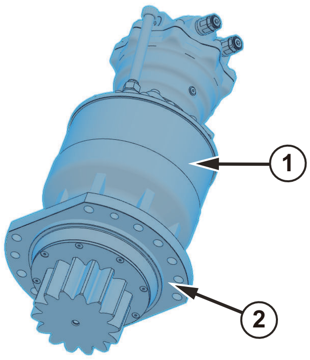
3. Remove bolts and washers (1) (11 ea).
   Figure 147



   - 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 (2).
5. Remove lock pin (3) from swing device.
6. Install the back bolt to the plug position to ensure that frame and swing device can be separated.
   Figure 148



7. Hoist and remove swing device (1) from the frame.
   - Weight: about 450 kg (992.1 lb)

   NOTE: *Apply adhesive (Loctite #30515) to the surface (2).*

   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.*

8. Wind wire rope around the swing device, lift it up with a crane and wash with flushing oil.

   After washing, dry with compressed air.

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. 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.

Fan Pump

Repair Procedure Quick Guide

Step-A. Remove engine cover and support

Step-B. Remove exhaust pipe

Step-C. Disconnect the wiring harness connector

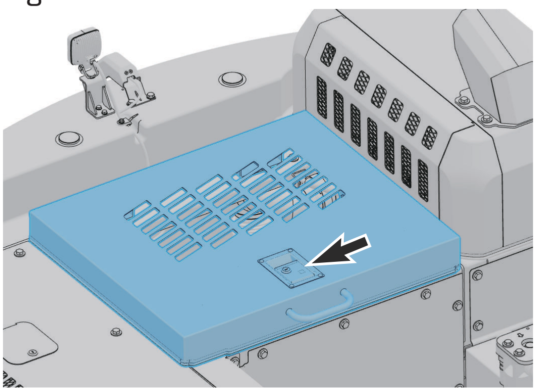
Step-D. Disconnect hydraulic hoses and fittings

Step-E. Remove fan pump

Removal

Engine Cover and Support

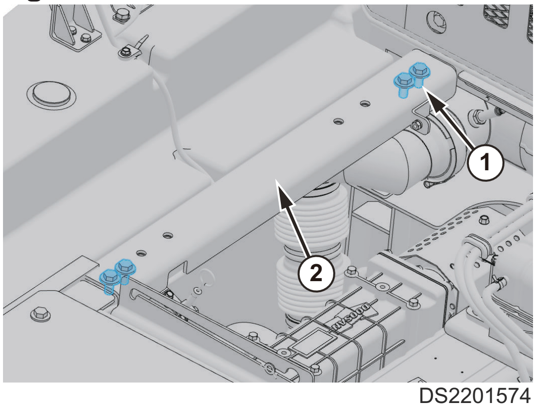
1. Open the engine cover.
   Figure 149



DS2201573

2. Remove bolts (4ea) from cover support.
   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
   - Engine cover weight: about 28 kg (61.7 lb)
3. Remove engine cover.

4. Remove bolts (1) and support (2).
   Figure 150

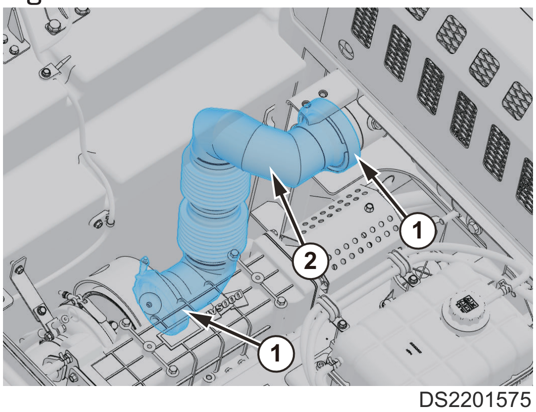


- Tool: 19 mm ( )
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Engine cover weight: about 7 kg (15.4 lb)

5. Remove support (2).

Exhaust Pipe

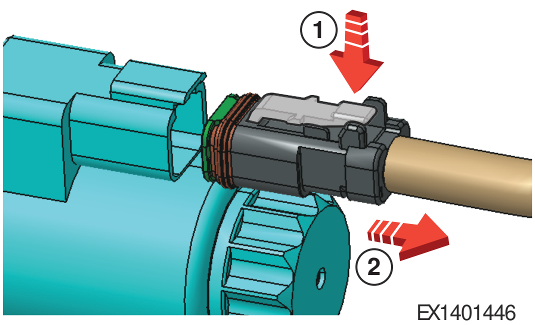
1. Remove clamp (1) and exhaust pipe (2).
   Figure 151



- Tool: 11 mm ( )

Wiring Harness Connector

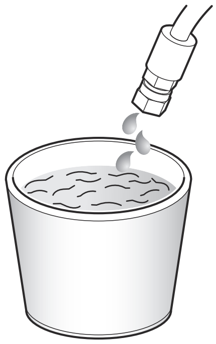
1. Disconnect the harness connector (1) from EPPR Valve of fan pump.
   Figure 152



NOTE: *Be careful not to let water get into electrical components (sensor, connectors). If water gets into electrical system, this will cause an electrical short circuit and result in improper machine operation.*

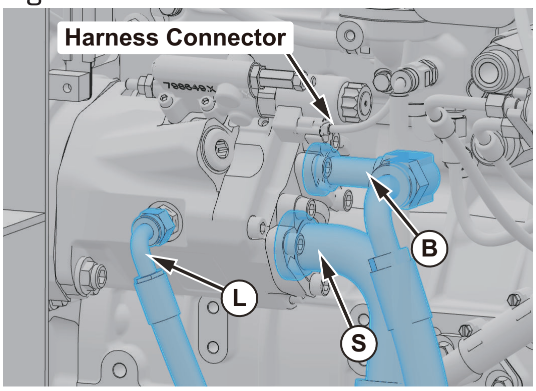
Hydraulic Hoses and Fittings

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 153



EX1504170

2. Disconnect the hoses and adapters from fan pump.
   Figure 154



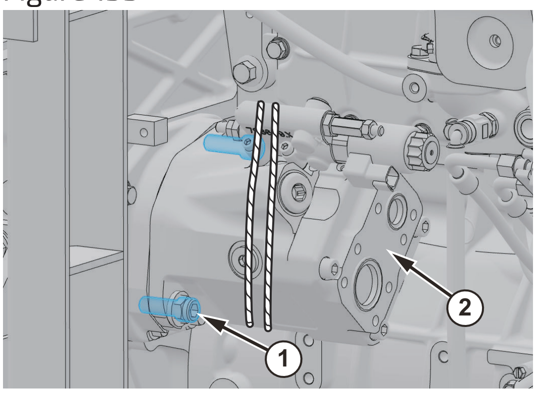
DS2201576

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.*

- Hoses and plugs ports

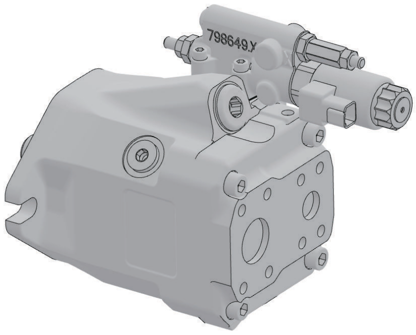
Fan Pump

1. Tie pump with rope to lift it.
   Figure 155



DS2201577

2. Remove mounting bolts (1) with fan pump (2) from engine.
   - Tool: 10 mm ( )
   - Fan pump weight: about 16 kg (35.3 lb)
3. Lift the pump from engine slowly and carefully.
   Figure 156



DS2201578

Installation

1. Perform installation in the reverse order to remove.

Fan Motor

Repair Procedure Quick Guide

Step-A. Remove radiator cover

Step-B. Remove fan guard

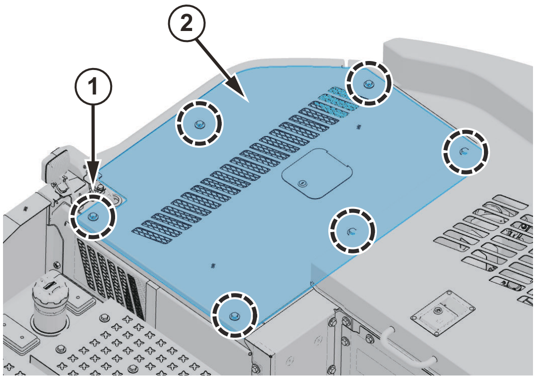
Step-C. Disconnect hydraulic hoses and fittings

Step-D. Remove fan motor

Removal

Radiator Cover

1. Remove bolts and washers (1) (6 ea) with cover (2).
   Figure 157

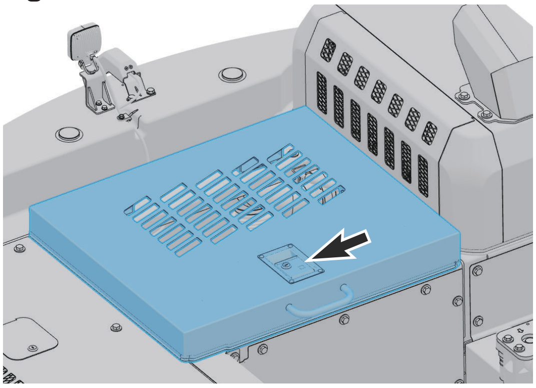


DS2201579

   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
   - Radiator cover weight: about 25 kg (55.1 lb)

2. Open the engine cover.

Figure 158

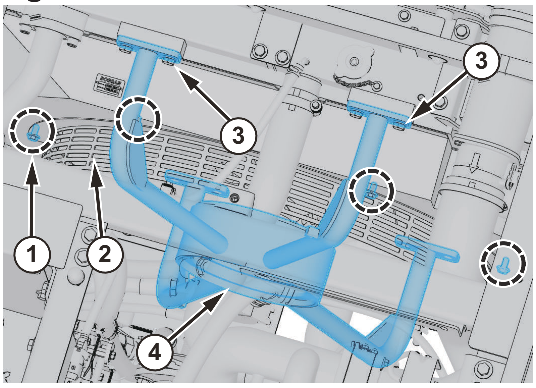


DS2201573

Fan Guard

1. Remove bolts (1) (5 ea) with fan guard (2) from oil cooler.

Figure 159



DS2201580

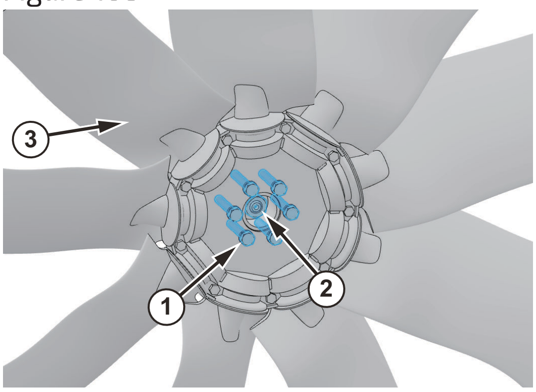
- Tool: 13 mm ( )
- Torque: 29.4 N.m (3 kg.m, 21.7 ft lb)

2. Remove bolts (3) (8 ea) and bracket (4) with fan and motor.

- Tool: 19 mm ( )
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

3. Remove the bolts (1) (6 ea) and nut (2) with fan (3) from fan motor. (Input the hand into the fan)

Figure 160



DS2201581

4. Removed fan put in oil cooler shroud.

⚠ CAUTION

AVOID SERIOUS INJURY

Don’t damage the core of oil cooler by fan.

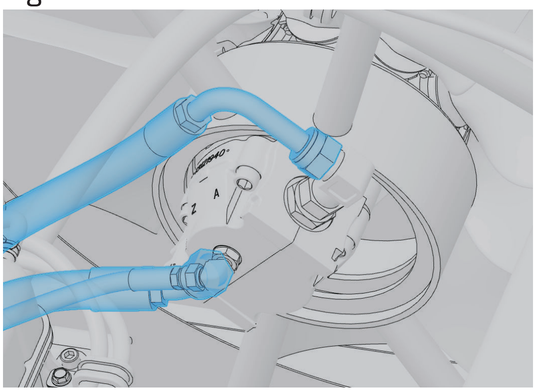
- Tool (Bolt): 13 mm ( )
- Torque: 29.4 N.m (3 kg.m, 21.7 ft lb)
- Tool (Nut): 22 mm ( )
- Torque: 40 N.m (4.1 kg.m, 29.5 ft lb)

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 161

EX1504170

2. Remove hoses and adapters from the fan motor.
   Figure 162

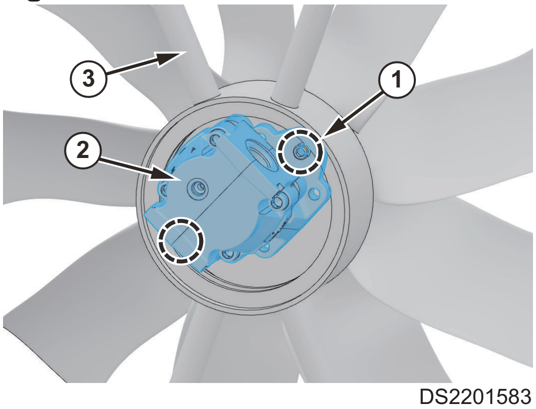


DS2201582

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.*

Fan Motor

1. Remove mounting bolts (1) with fan motor (2) from bracket (3).
   Figure 163



- Tool: 10 mm ( )
- Motor weight: about 16 kg (35.3 lb)

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 normally.
2. The direction of plane of hub must be assembled towards fan motor direction.

Center Joint

Repair Procedure Quick Guide

Step-A. Remove undercarriage cover

Step-B. Disconnect hydraulic hoses and fittings

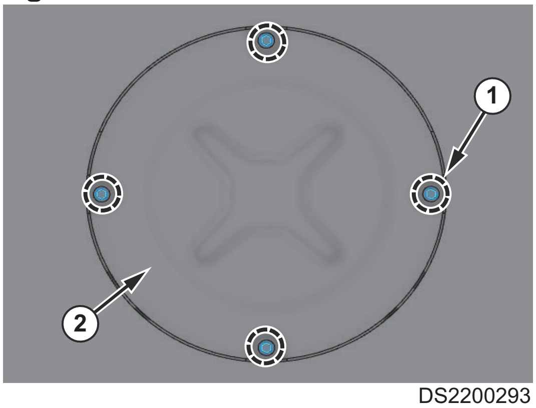
Step-C. Remove center joint

Removal

1. Turn OFF the battery disconnect switch.

Undercarriage Cover

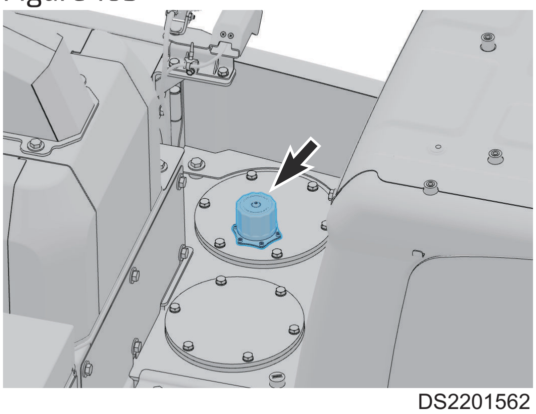
1. Remove bolts (1) and under cover (2) from frame.
   Figure 164



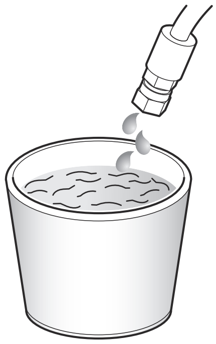
- Tool: 19 mm ( )
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Undercover Weight: about 14 kg (30.9 lb)

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 165

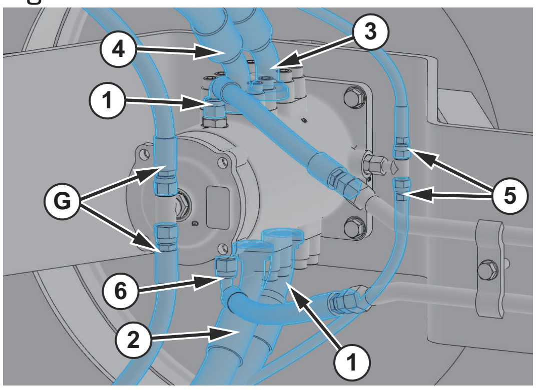


2. When disconnecting the hose, oil left in the hose may flow out. Therefore, place the end of the hose into a suitable container to prevent contamination of the ground and environment.
Figure 166



EX1504170

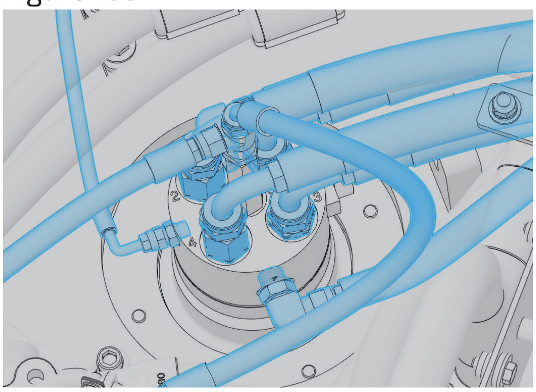
3. Remove under hoses and adapters from center joint.
Figure 167



DS2201569

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.*

4. Remove upper hoses and adapters from center joint.
Figure 168



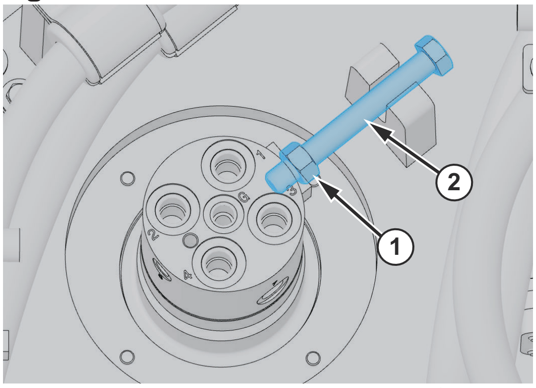
DS2201570

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.*

Center Joint

1. Loosen lock nut (1) and remove bolt (2).

   Figure 169

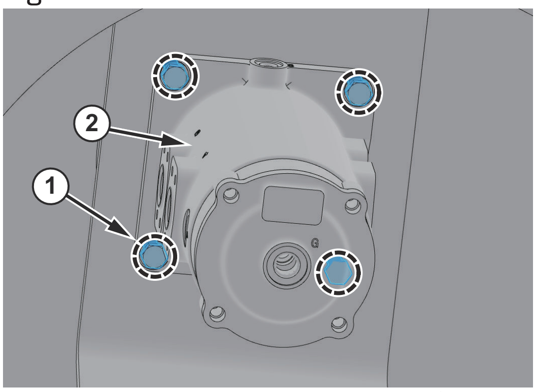


DS2201572

   - Tool: 30 mm ( )

2. Position suitable pallet jack under center joint.
3. Place blocks of wood can be used between the center joint and the pallet jack.
4. Remove mounting bolts (1) from frame.

   Figure 170



DS2201571

   - Tool: 19 mm ( )
   - Torque: 107.8 N.m (11 kg.m, 79.6 ft lb)

   NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*

5. Remove center joint (2) from frame.
   - Center joint weight: about 37 kg (81.6 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 track guard

Step-D. Remove sprocket and track frame cover

Step-E. Disconnect hydraulic hoses and fittings

Step-F. Remove travel device

Removal

1. Turn OFF the battery disconnect switch.

Tension of Track

1. Position machine on a smooth level surface with adequate space.

   Figure 171

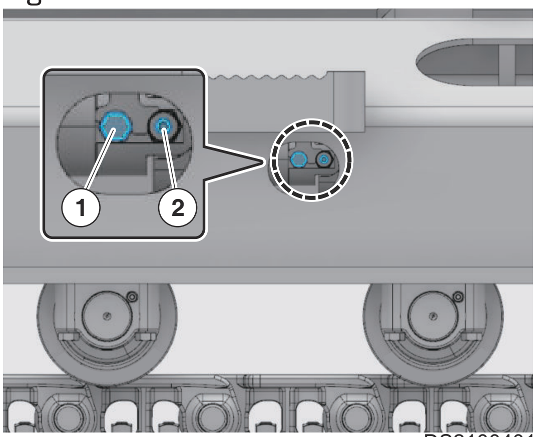
   

   DS2002649

2. Move the track until the master pin is positioned as figure.

3. Loosen grease valve, and then slacken the tension of track.

   Figure 172

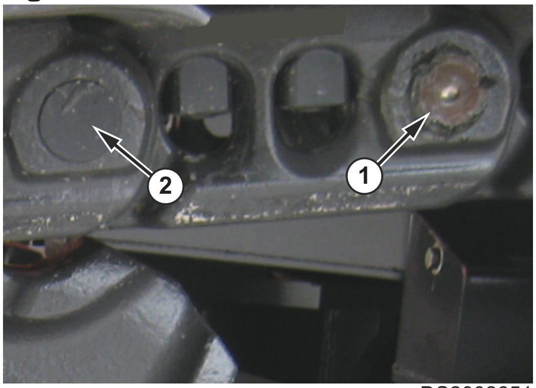
   DS2100401

   For details, refer to Track tension - Operation Manual.

Master Pin

1. Locate the master pin (1) position.

Figure 173

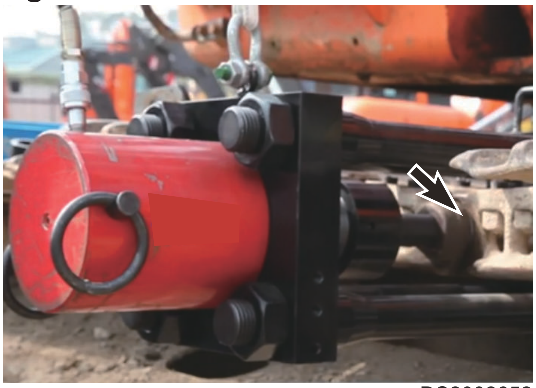


DS2002651

NOTE: *Do not remove regular pin (2).*

2. Remove master pin using jig or tool.

Figure 174

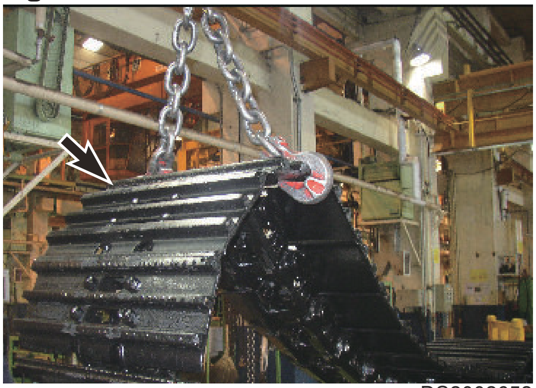


DS2002652

Upper Track

1. Remove upper track slowly and carefully.

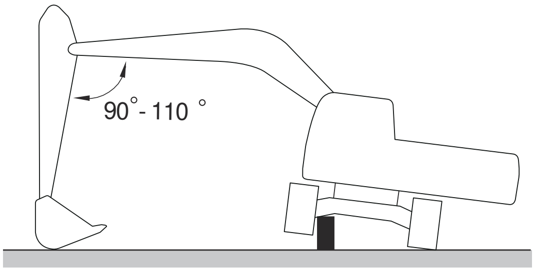
Figure 175



DS2002653

Sprocket and Track Frame Cover

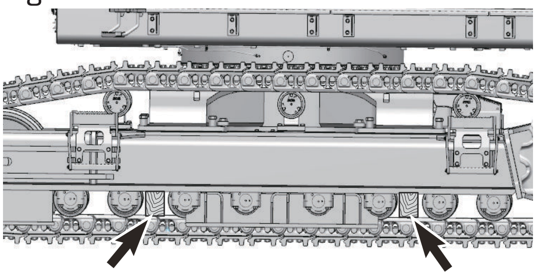
1. Turn the upper structure 90° and jack up the machine.
   Figure 176



EX1300534

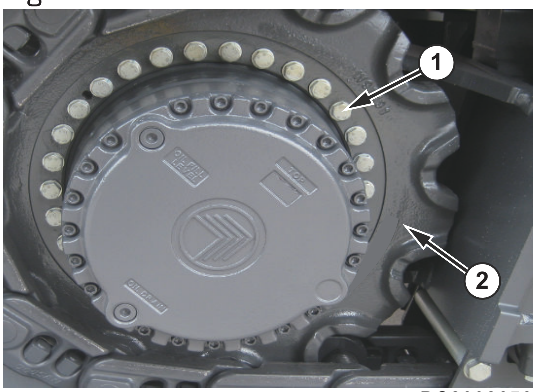
   NOTE: *Jack up the machine until the track is slightly off the ground.*

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 177



DS2002655

4. Remove bolt (1)(30 ea) with sprocket (2) from travel device.
   Figure 178

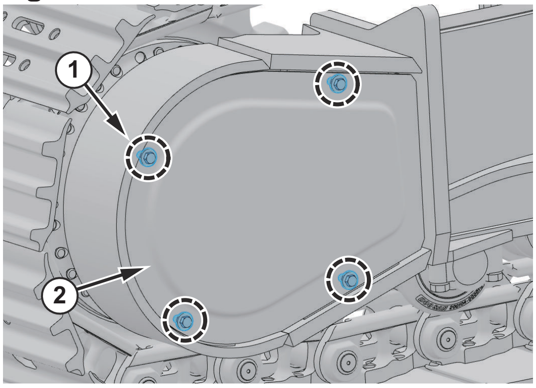


DS2002656

   - Tool: 30 mm ( )
   - Torque: 539.4 N.m (55 kg.m, 397.8 ft lb)
   - Sprocket weight: about 83 kg (183.0 lb)

   NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*

5. Remove mounting bolts (1) and cover (2) from track frame.
   Figure 179

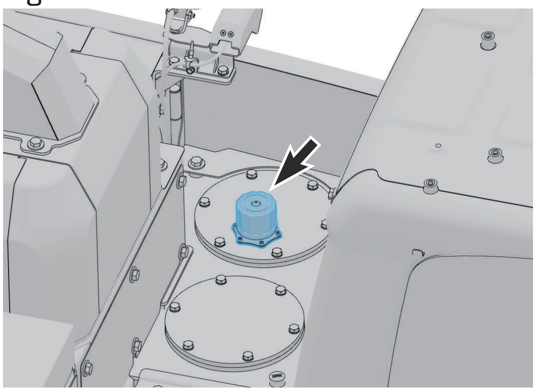


DS2201560

- Tool: 19 mm ( )
- Torque: 107.8 N.m (11 kg.m, 79.5 ft lb)
- Cover weight: about 10 kg (22 lb)

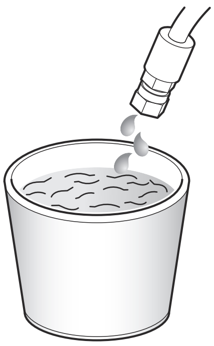
Hydraulic Hoses and Fittings

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 180



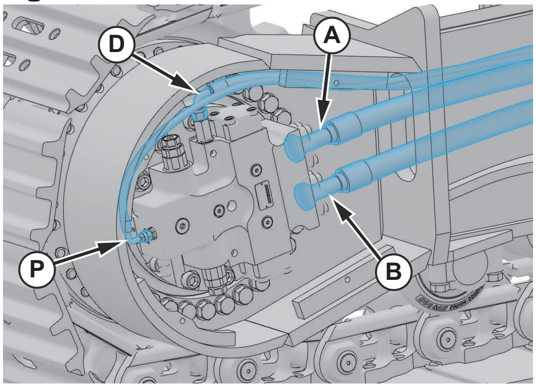
DS2201562

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 181



EX1504170

3. Remove hoses and adapters from travel device.
   Figure 182

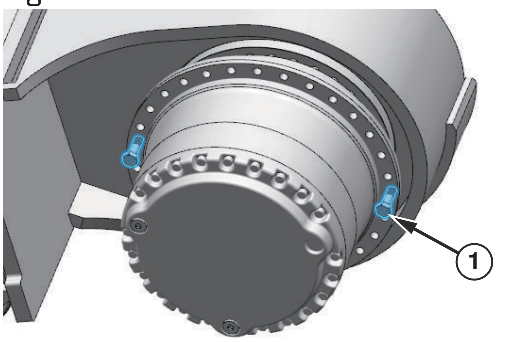


DS2201561

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.*

Travel Device

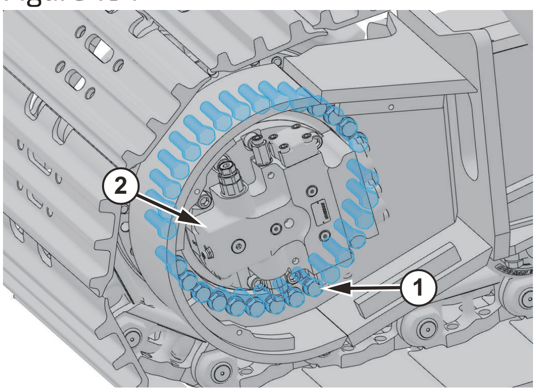
1. Install the sprocket bolts (1) to travel device, and tie the rope to the bolts to lift it.
   Figure 183



DS2002658

- Tool: 22 mm ( )

2. Remove mounting bolts (1) from track frame (2).
   Figure 184



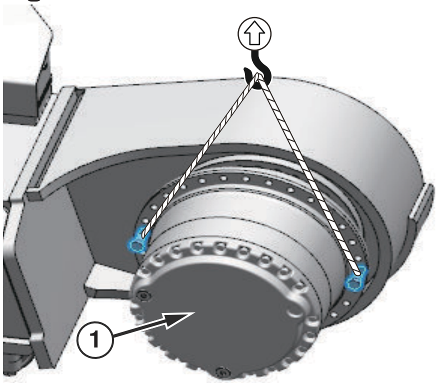
DS2201563

- Tool: 30 mm ( )
- Torque: 539.4 N.m (55 kg.m, 397.8 ft lb)

  NOTE: *Apply adhesive (Loctite #262) to the mounting bolt.*

3. Hoist and remove travel device (1) from track frame very slowly.

Figure 185



- Weight: about 360 kg (793.7 lb)
- Travel device oil specification and quantity
- Replace oil: genuine oil
- Travel device oil quantity: 7 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.

Cabin

Repair Procedure Quick Guide

Step-A. Remove undercover

Step-B. Removal 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

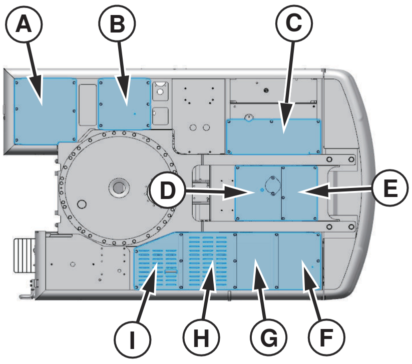
Step-J. Remove cabin

Removal

1. Turn OFF the battery disconnect switch.
2. Open the cabin door.

Undercover

1. Remove undercovers (A).
   Figure 186

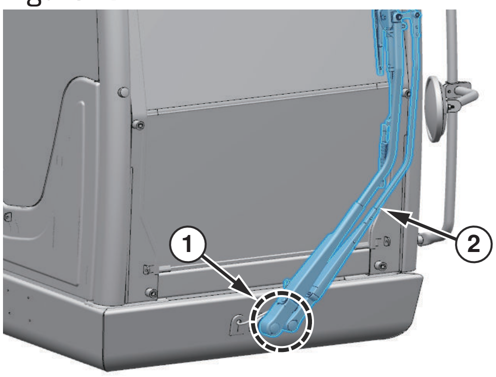


DS2100468

For details, refer to Undercovers - Removal and Installation.

Lower Wiper Arm and Blade

1. Disconnect washer hose from lower wiper arm and blade.
   Figure 187

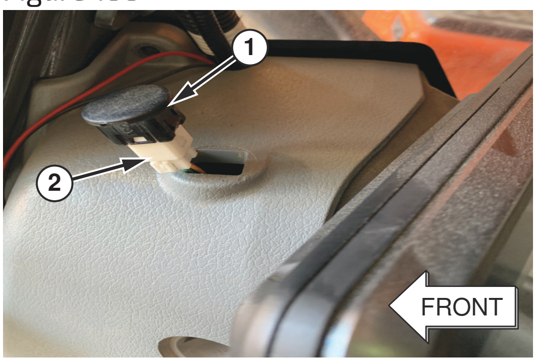


DS2100472

2. Remove wiper arm and blade from the cabin.

Cabin Photo Sensor

1. Pull up cabin photo sensor (1) by using a flat-head screwdriver.
   Figure 188



DS1901316

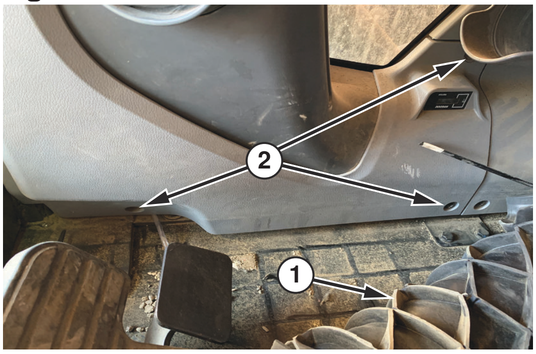
NOTE: *The cabin photo sensor is located behind the display monitor.*

NOTE: *Please find the service groove.*

2. Disconnect wiring harness (2) from cabin photo sensor.
3. Remove cabin photo sensor (1).

Cabin Side Cover

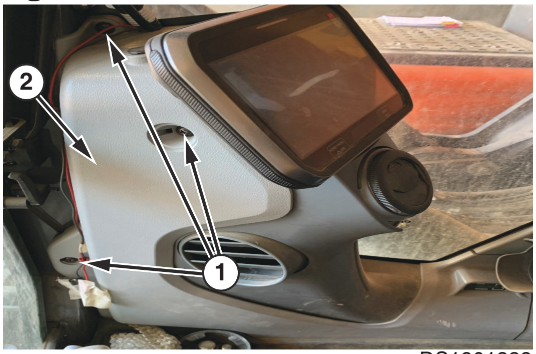
1. Put away the floor rubber mat (1).
   Figure 189



2. Remove the plug cap and screws (2) from cabin side cover.

   NOTE: *Please find the service groove.*

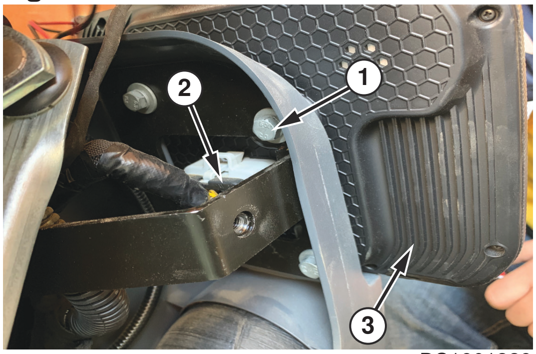
3. Remove the plug cap and screws (1) from cabin side cover.
   Figure 190



4. Remove the cabin side cover (2).

Display Monitor

1. Remove the bolts (1) from display monitor.
   Figure 191

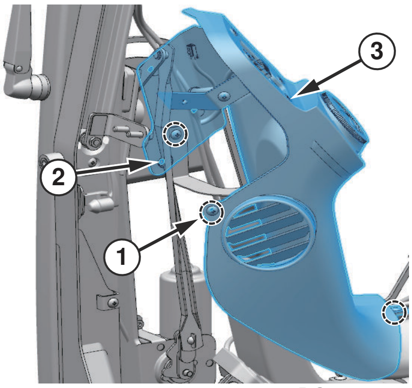


   - Refer to torque values for standard.

2. Disconnect wire harness (2) from display monitor (3).
3. Remove the display monitor from bracket.

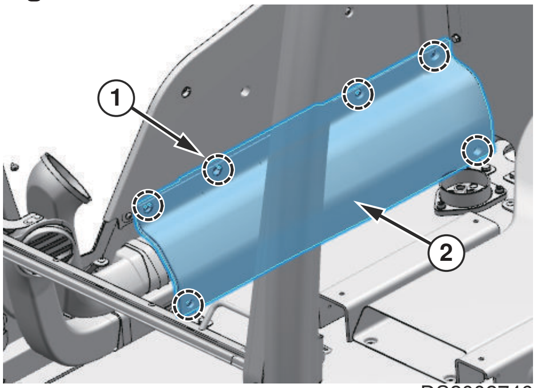
Cabin Side Cover - Upper, Lower

1. Remove screws (1) from cabin side cover.
   Figure 192



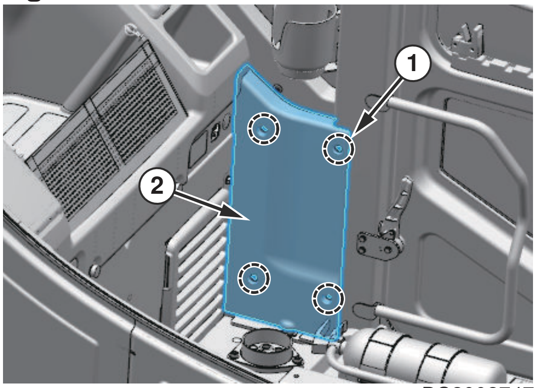
DS2002510

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 193



DS2002746

5. Remove cabin side cover (2) from cabin.
6. Remove screws (1) from cabin side cover.
   Figure 194

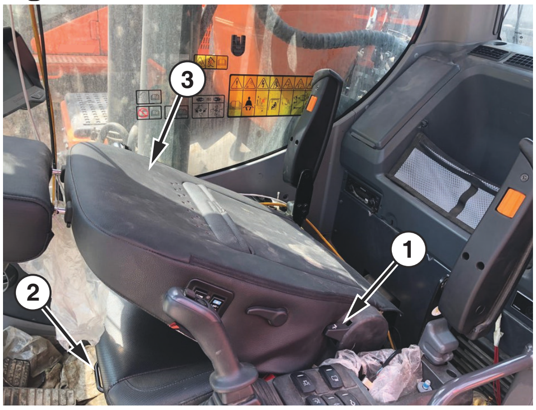


DS2002747

7. Remove cabin side cover (2) from cabin.

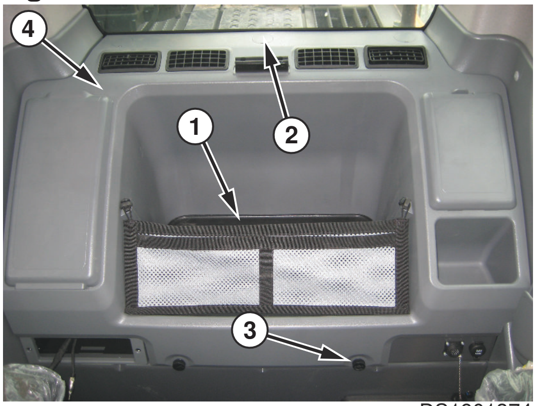
Cabin Center Cover

1. Pulling up left lever (1), fold the seat backrest (3) forward.
   Figure 195



DS1901309

2. Move the seat assembly forward using a lever (2).
3. Remove the pad (1) and two bolts under pad.
   Figure 196

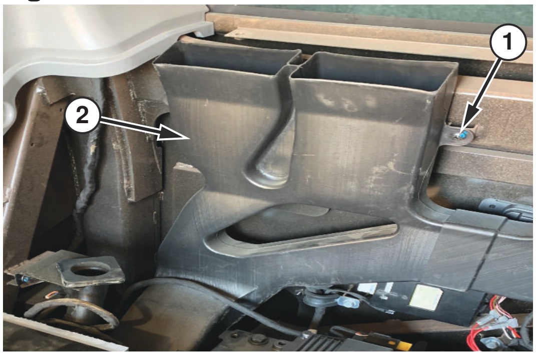


DS1901374

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

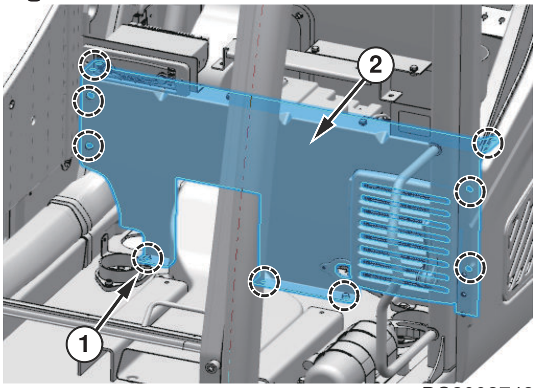
1. Remove screws (1) and air duct (2) from cabin.
   Figure 197



DS1901311

2. Remove mounting bolts (1) and under cover (2) from cabin.

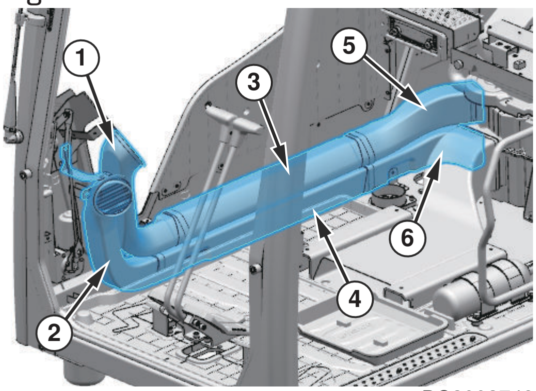
Figure 198



- 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.

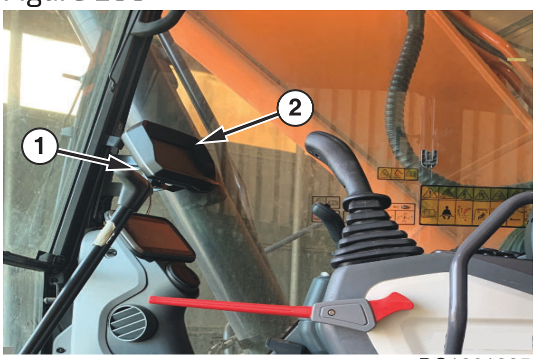
Figure 199



Electrical Component

1. Remove bolts (1) from around view monitor.

Figure 200



- 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. For details, refer to Smart Key Controller - Removal and Installation.

   Separate smart key controller from cabin.

7. Separate TMS controller from cabin.

   For details, refer to TMS Controller - Removal and Installation.

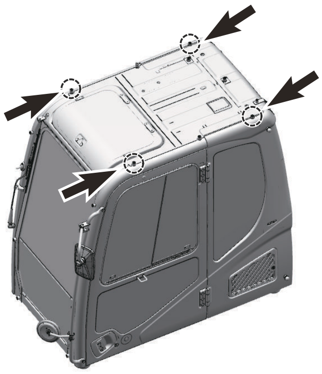
   NOTE: *Do not disconnect the wiring connector when removing the all controller.*

8. Remove TMS antenna cable from cabin.

9. Remove lamps from cabin.

Cabin

1. Remove cabin handle from top of cabin.
   Figure 201

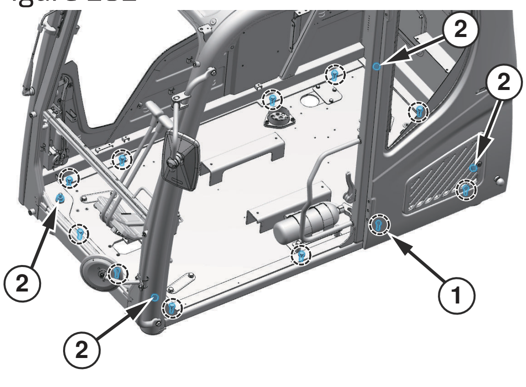


DS2002750

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 202



DS2002751

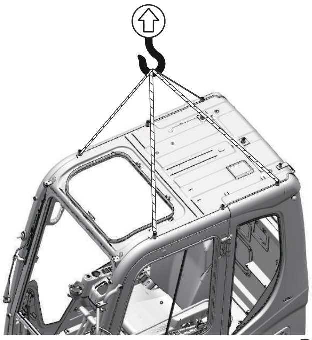
   - Tool: 19 mm ( )
   - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

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)

NOTE: *Apply adhesive (Loctite #262) to the mounting nut.*

5. Lift cabin approximately 25 - 50 mm (1" - 2") above deck.
   Figure 203



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.

Air Condenser Filter

Repair Procedure Quick Guide

Step-A. Open the door.

Step-B. Recover the refrigerant.

Step-C. Remove air condenser filter

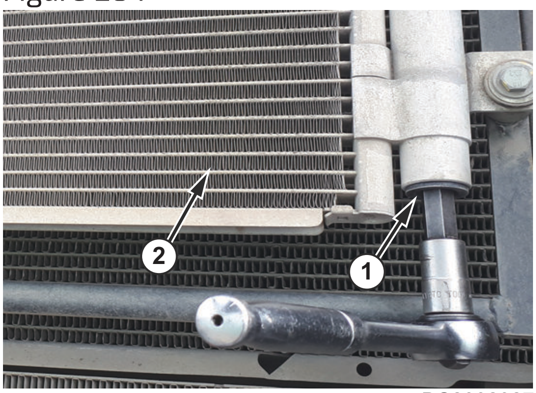
Step-D. Remove zeolite

Removal

1. Open the door.
2. Turn OFF the battery disconnect switch.
3. Recover the refrigerant. Refer to Refrigerant Recovery.

Air Condenser Filter

1. Remove plug with filter (1) from air condenser (2).
   Figure 204

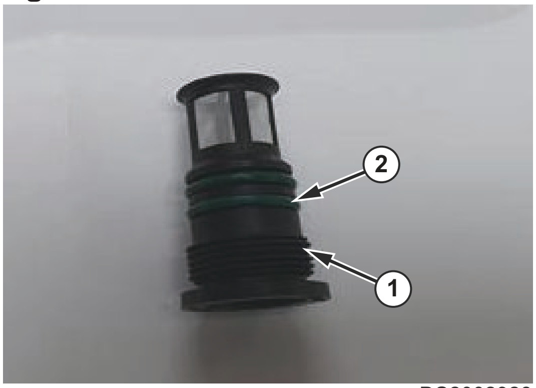


DS2002927

- Tool: 14 mm ( )
- Torque: 3.23 N.m (33 kg.m, 2.39ft lb)

2. Remove air condenser filter (1).

   Figure 205



DS2002928

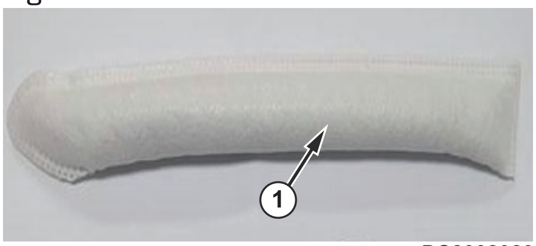
NOTE: *Do not reuse air condenser filter.*

NOTE: *Check that the O-ring (2) are fitted to filter when installing*

NOTE: *Plug at the air condenser to prevent dirt or dust from entering.*

3. Remove zeolite (1) from air condenser.

   Figure 206



DS2002929

NOTE: *Be careful not to let water get into zeolite.*

Installation

1. Perform installation in the reverse order to removal.

Electric and Electronic

Safety Instructions

WARNING

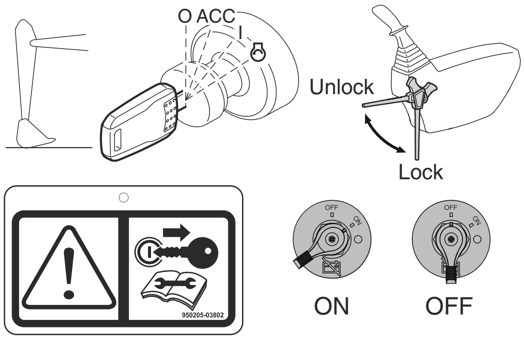
AVOID DEATH OR SERIOUS INJURY

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.

Before Removing and Installing

Preparatory Work

1. Park the machine on level ground. And lower front attachment to the ground.
   Figure 207

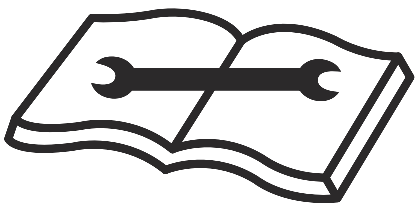


EX1504472

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 208



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 right side cover

Step-B. Remove upper cover

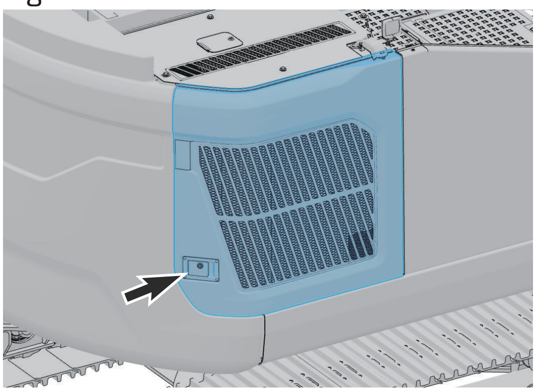
Step-C. Disconnect wiring harness

Step-D. Remove battery assembly

Removal

1. Open right side cover.

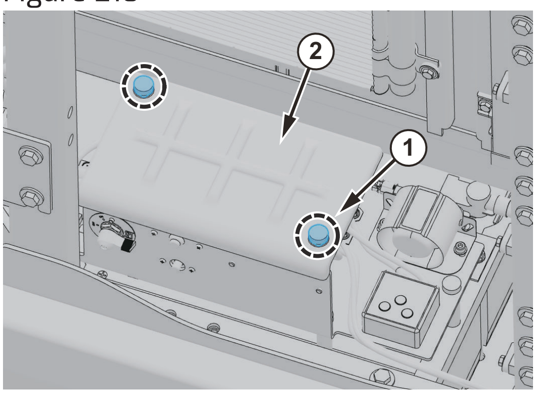
   Figure 209



DS2201564

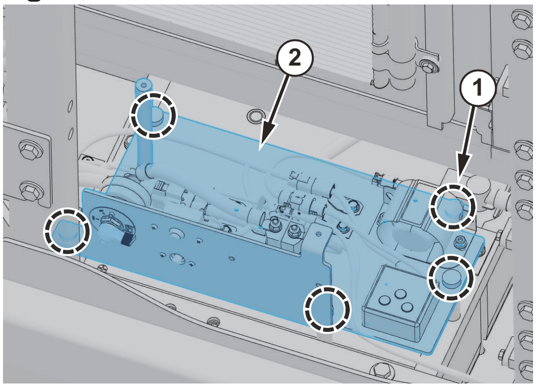
2. Turn OFF the battery disconnect switch.
3. Remove plug (1) and battery upper cover (2).

   Figure 210



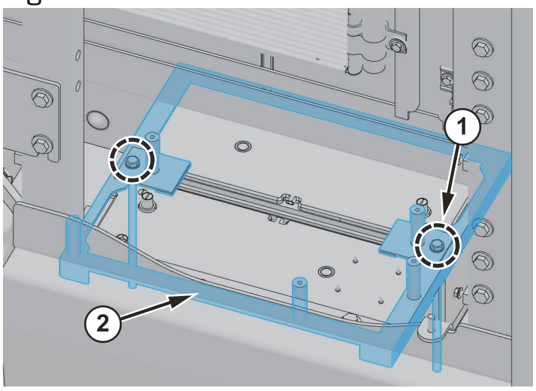
DS2201565

4. Disconnect the negative cable and positive cable from the batteries.
5. Disconnect any additional electrical connections as necessary.
6. Remove the plug (1) and bracket (2).
   Figure 211



DS2201566

7. Remove the hold down bracket (2) and bolts (1).
   Figure 212



DS2201567

   - Tool: 17 mm ( )
8. Remove batteries 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 the cabin door

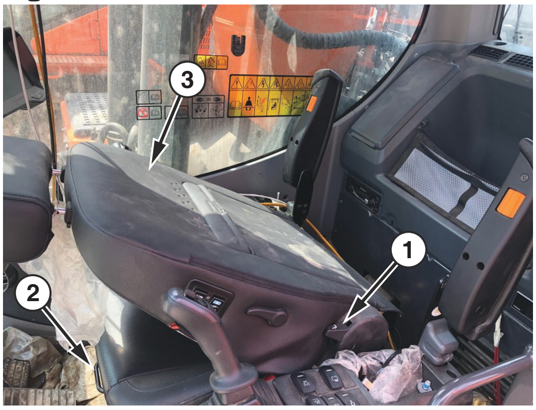
Step-B. Remove cabin center cover

Step-C. Disconnect wiring harness

Step-D. Remove EPOS controller

Removal

1. Turn OFF the battery disconnect switch.
   Figure 213

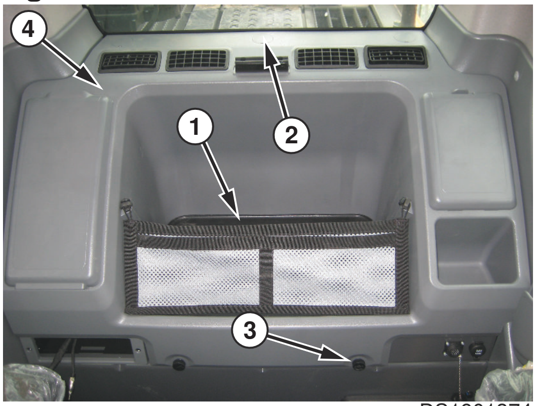


DS1901309

2. Open the cabin door.
3. Pulling up left lever (1), fold the seat backrest (3) forward.
4. Move the seat assembly forward using a lever (2).

Cabin Center Cover

1. Remove the pad (1) and two bolts under pad.
   Figure 214

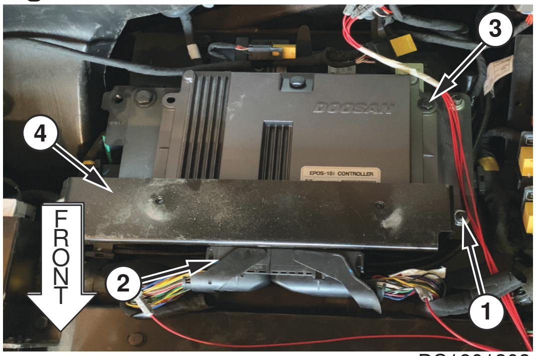


DS1901374

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).

EPOS Controller

1. Remove nut (1) and bracket (4).
   Figure 215



DS1901308

   - Tool: 13 mm ( )
   - Torque: 19.6 N.m (2 kg.m, 14.5 ft lb)
2. Disconnect wiring harness connectors (2) from EPOS controller.

   NOTE: *Move up connector levers when disconnect.*
3. Remove mounting bolts (3) from EPOS controller.
   - Tool: 13 mm ( )
   - Torque: 29.4 N.m (3 kg.m, 21.7 ft lb)
4. Remove EPOS controller.

Installation

1. Perform installation in the reverse order to removal.

TMS Controller

Repair Procedure Quick Guide

Step-A. Open the cabin door

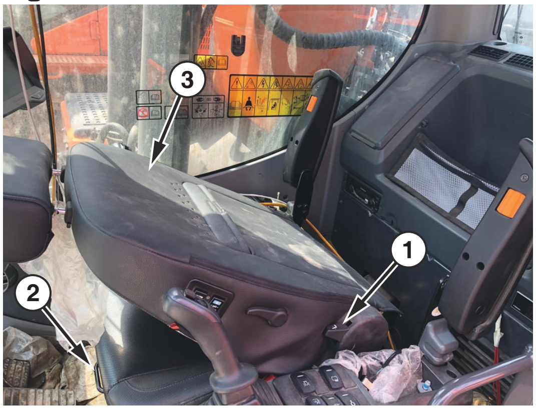
Step-B. Remove cabin center cover

Step-C. Disconnect wiring harness

Step-D. Remove TMS controller

Removal

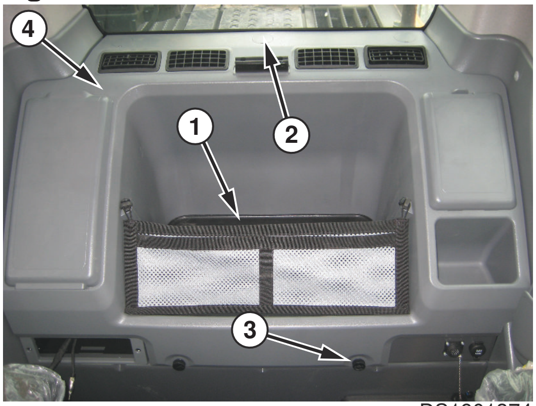
1. Open the left side door.
   Figure 216



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 217

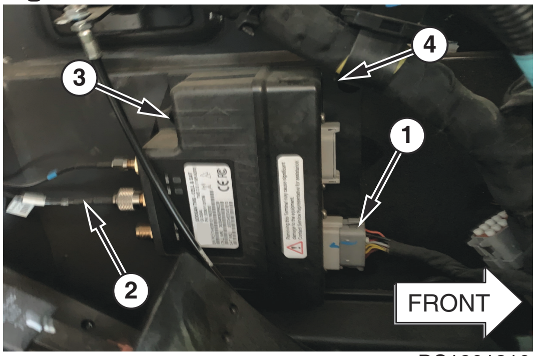


2. Remove the caps and bolt (2) from cabin center cover.
3. Remove bolts (3) from cabin center cover.
4. Remove cabin center cover (4).

TMS Controller

1. Disconnect wiring harness (1) and cables (2) from TMS controller.

   Figure 218

   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

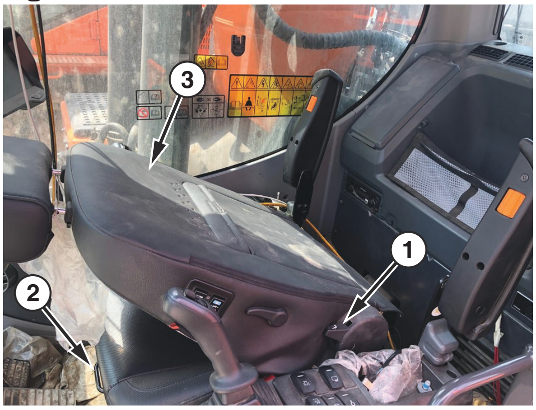
Step-C. Remove air duct

Step-D. Disconnect wiring harness

Step-E. Remove AVM controller

Removal

1. Turn OFF the battery disconnect switch.
   Figure 219

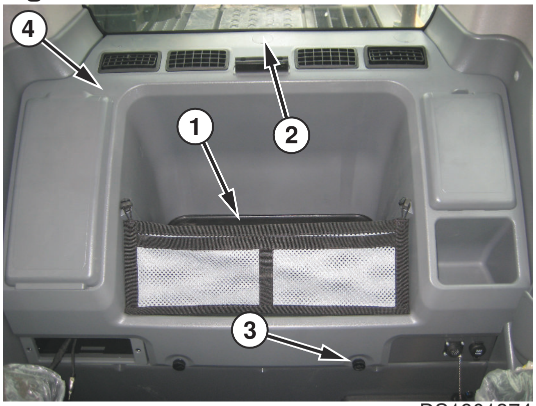


DS1901309

2. Open the cabin door.
3. Pulling up left lever (1), fold the seat backrest (3) forward.
4. Move the seat assembly forward using a lever (2).

Cabin Center Cover

1. Remove the pad (1) and two bolts under pad.
   Figure 220

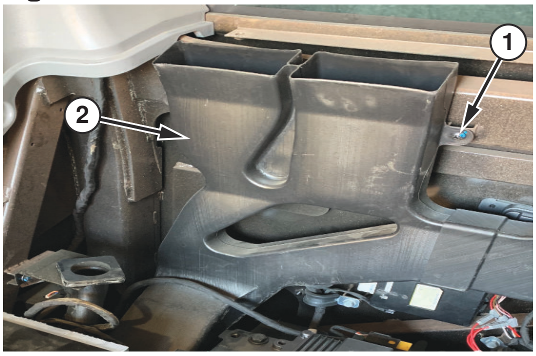


DS1901374

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

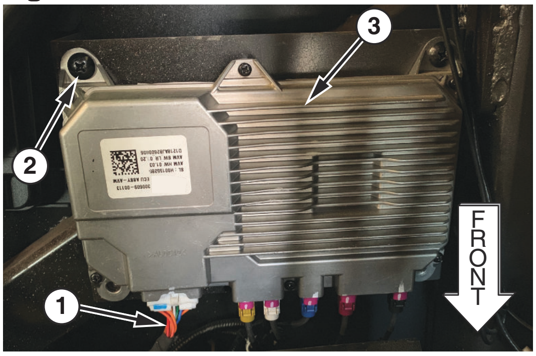
1. Remove screws (1) and air duct (2) from cabin.
   Figure 221



DS1901311

AVM Controller

1. Disconnect wiring harness connector (1) and all connectors from AVM controller.
   Figure 222



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

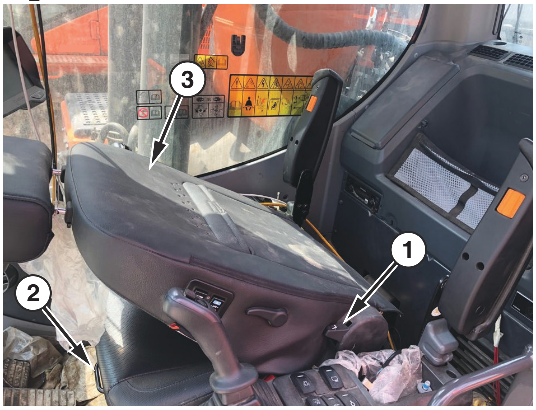
Step-C. Remove air duct

Step-D. Disconnect wiring harness

Step-E. Remove microphone controller

Removal

1. Turn OFF the battery disconnect switch.
   Figure 223

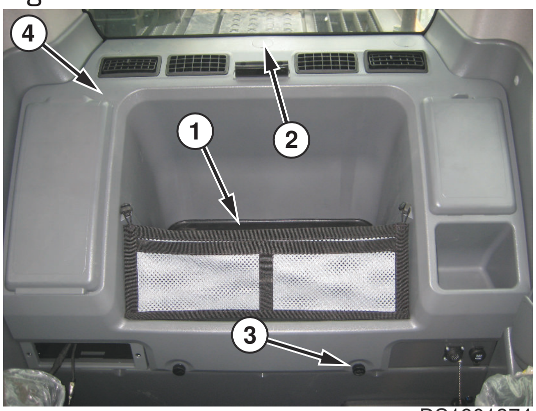


DS1901309

2. Open the cabin door.
3. Pulling up left lever (1), fold the seat backrest (3) forward.
4. Move the seat assembly forward using a lever (2).

Cabin Center Cover

1. Remove the pad (1) and two bolts under pad.
   Figure 224



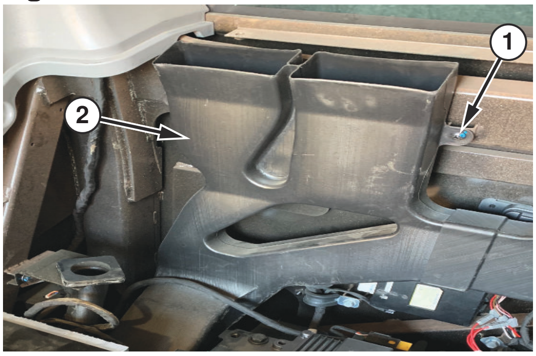
DS1901374

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

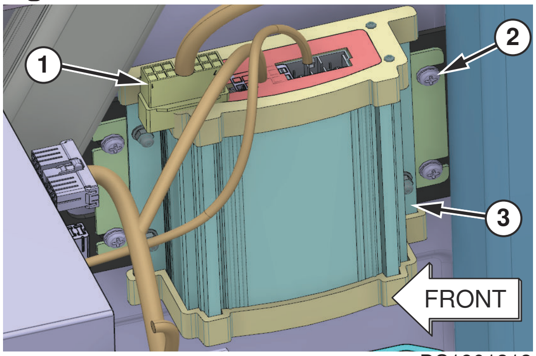
1. Remove screws (1) and air duct (2) from cabin.
   Figure 225



DS1901311

Microphone Controller

1. Disconnect wiring harness connector (1) and all connectors from microphone controller.
   Figure 226



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

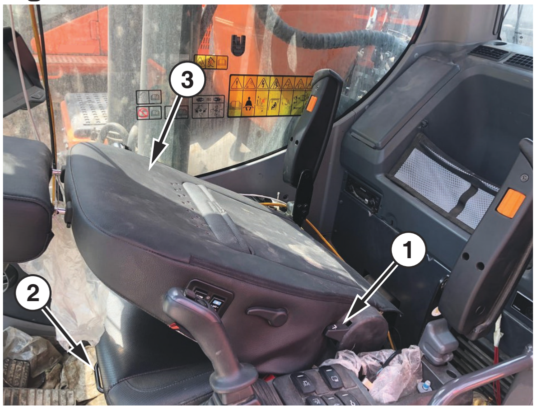
Step-B. Remove cabin center cover

Step-C. Disconnect wiring harness

Step-D. Remove smart key controller

Removal

1. Turn OFF the battery disconnect switch.
   Figure 227

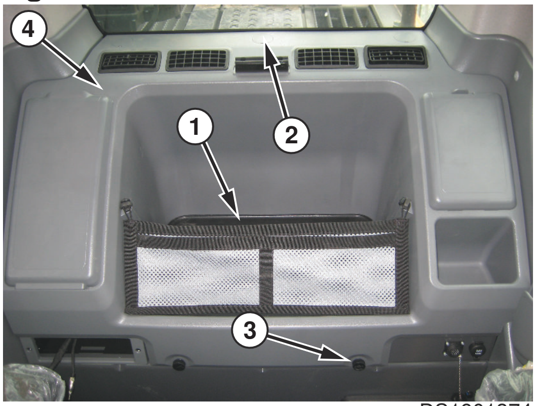


DS1901309

2. Open the cabin door.
3. Pulling up left lever (1), fold the seat backrest (3) forward.
4. Move the seat assembly forward using a lever (2).

Cabin Center Cover

1. Remove the pad (1) and two bolts under pad.
   Figure 228

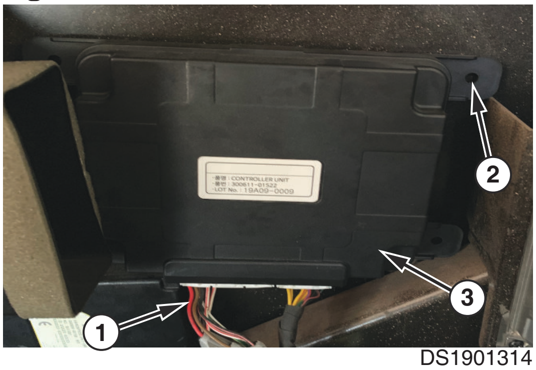


DS1901374

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 229



DS1901314

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.

DC-DC Controller

Repair Procedure Quick Guide

Step-A. Open the cabin door

Step-B. Remove cabin center cover

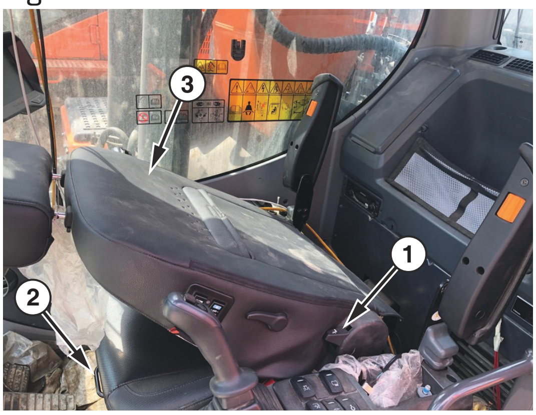
Step-C. Remove EPOS controller

Step-D. Disconnect wiring harness

Step-E. Remove DC-DC controller

Removal

1. Turn OFF the battery disconnect switch.
   Figure 230



DS1901309

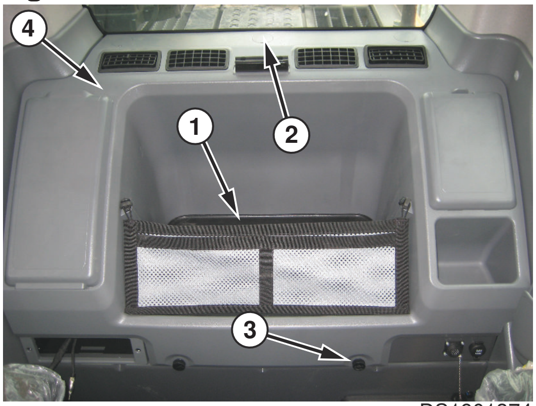
2. Open the cabin door.
3. Pulling up left lever (1), fold the seat backrest (3) forward.

4. Move the seat assembly forward using a lever (2).

Cabin Center Cover

1. Remove the pad (1) and two bolts under pad.

Figure 231



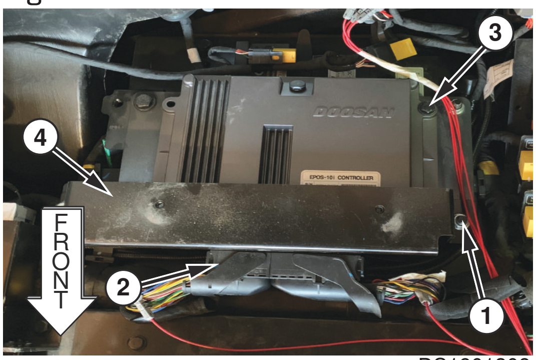
DS1901374

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).

EPOS Controller

1. Remove nut (1) and bracket (4).

Figure 232



DS1901308

- Tool: 13 mm ( )
- Torque:19.6 N.m (2 kg.m, 14.5 ft lb)

2. Disconnect wiring harness (2) from EPOS controller.

NOTE: *Move up connector levers when disconnect.*

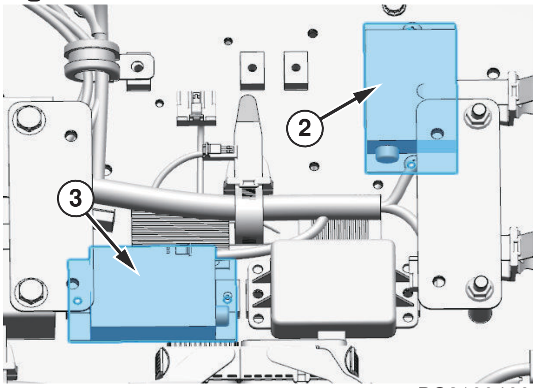
3. Remove mounting bolts (3) from EPOS controller.

- Tool: 13 mm ( )
- Torque: 29.4 N.m (3 kg.m, 21.7 ft lb)

4. Remove EPOS controller.

DC-DC Controller

1. Disconnect wiring harness from DC-DC Controller.
   Figure 233



DS2100466

NOTE: *Check the location of the connectors before disconnecting.*

2. Remove mounting screws from DC-DC Controller.
3. Remove DC-DC controller (2 and 3).

Installation

1. Perform installation in the reverse order to removal.

Cabin Photo Sensor

Repair Procedure Quick Guide

Step-A. Open the cabin door

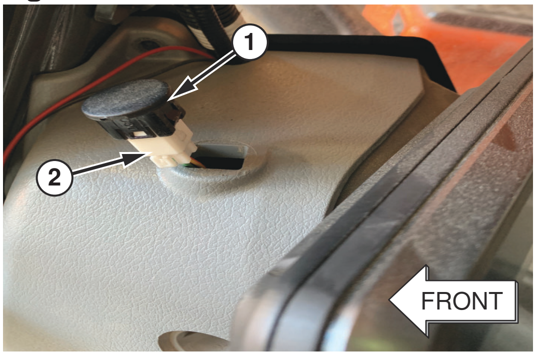
Step-B. Remove cabin photo sensor

Removal

1. Turn OFF the battery disconnect switch.
2. Open the cabin door.

Cabin Photo Sensor

1. Pull up cabin photo sensor (1) by using a flat-head screwdriver.
   Figure 234



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

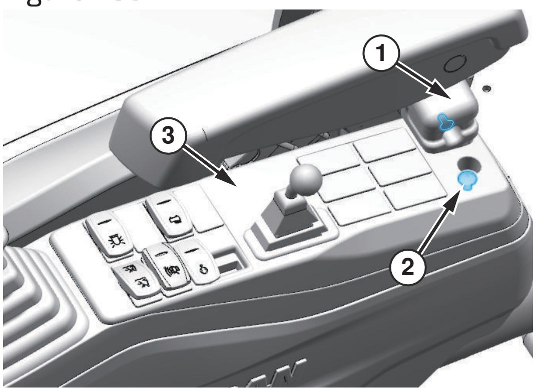
Step-E. Remove cabin switches

Removal

1. Turn OFF the battery disconnect switch.
2. Open the cabin door.

Stand Cover - Left Side

1. Remove the mounting screw and cover (1) from armrest bracket.
   Figure 235



2. Remove mounting screws (2).
3. Lift off the stand cover LH (3).

Wiring Harness - Left Side

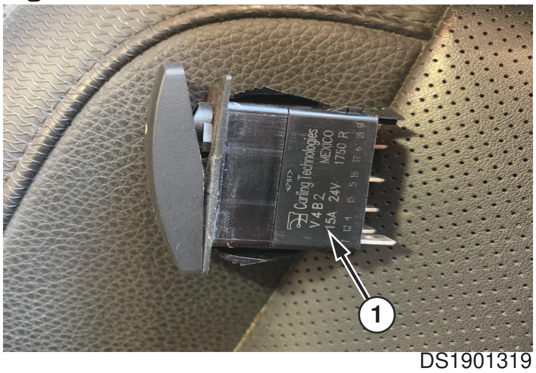
1. Disconnect wiring harness connector (1) and all connector from switches.
   Figure 236

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 237

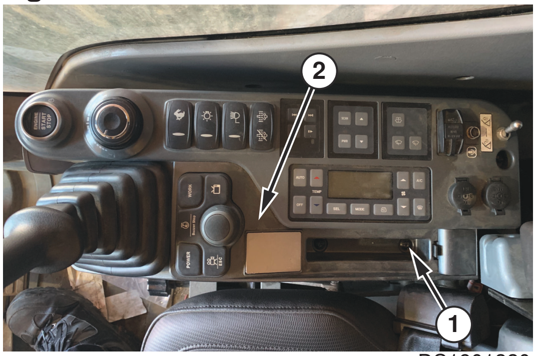


DS1901319

NOTE: *Be careful not to break the switch assembly.*

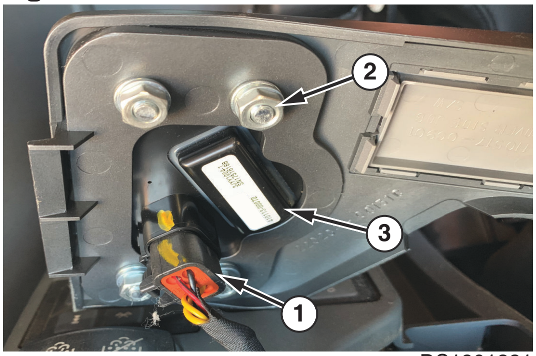
Stand Cover - Right Side

1. Remove the rubber pad and screws (1).
   Figure 238



DS1901320

2. Lift off the stand upper cover (2).

3. Disconnect wiring harness connector (1) from jog switch.
   Figure 239
   

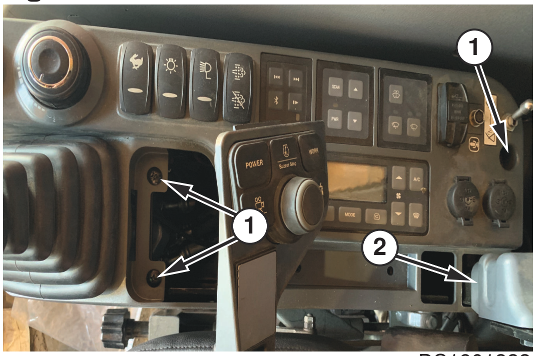
   DS1901321

4. Remove the stand upper cover.

   If you need to remove jog switch, please next following procedure.

   A. Remove the nuts (2).

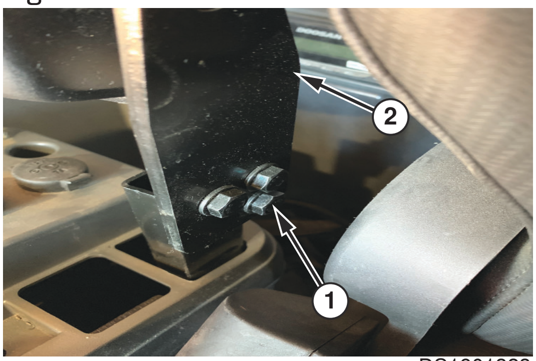
   B. Remove the jog switch (3) from stand upper cover.

5. Remove the screws (1).
   Figure 240
   

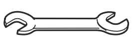
   DS1901322

6. Remove the mounting screw and cover (2) from armrest bracket.

Armrest

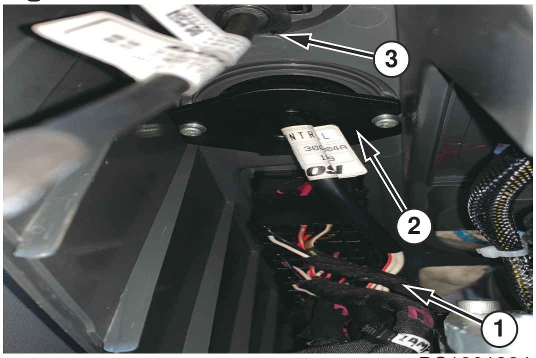
1. Remove mounting bolts (1) and armrest (2).
   Figure 241
   

   DS1901323

   - 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.

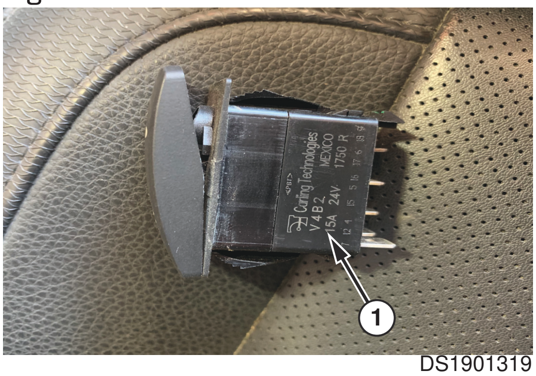
Wiring Harness - Right Side

1. Lift off the stand upper cover.
   Figure 242
   

   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 243
   

   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

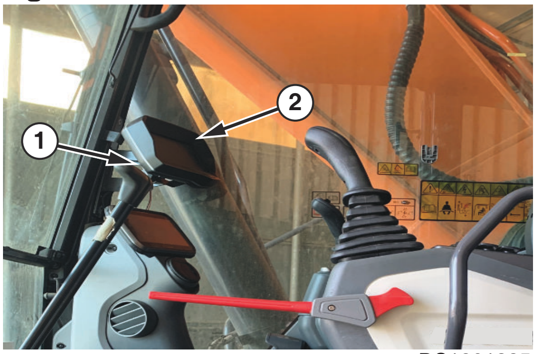
Step-B. Remove around view monitor

Removal

1. Turn OFF the battery disconnect switch.
2. Open the cabin door.

Around View Monitor

1. Remove bolts (1) from around view monitor.
   Figure 244



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 side cover

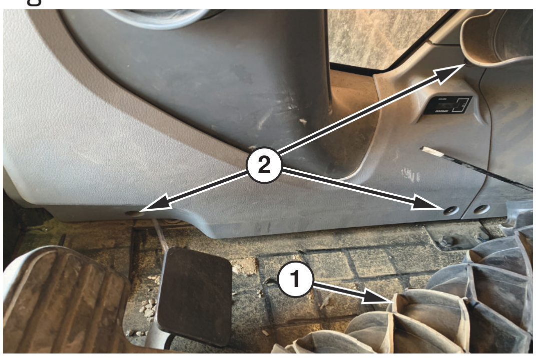
Step-C. Remove display monitor

Removal

1. Turn OFF the battery disconnect switch.
2. Open the cabin door.

Cabin Side Cover

1. Put away the floor rubber mat (1).
   Figure 245

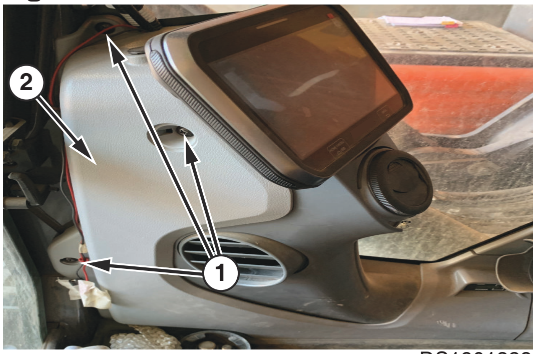


DS1901327

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 246

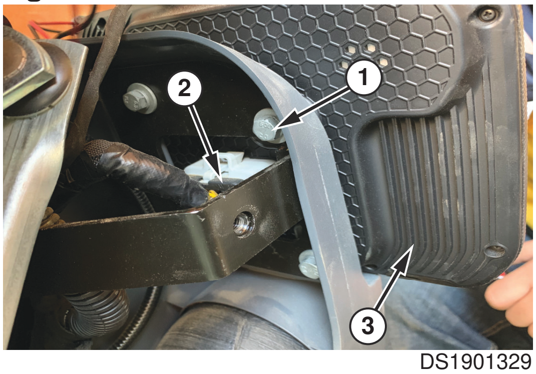


DS1901328

4. Remove the cabin side cover (2).

Display Monitor

1. Remove the bolts (1) from display monitor.
   Figure 247



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

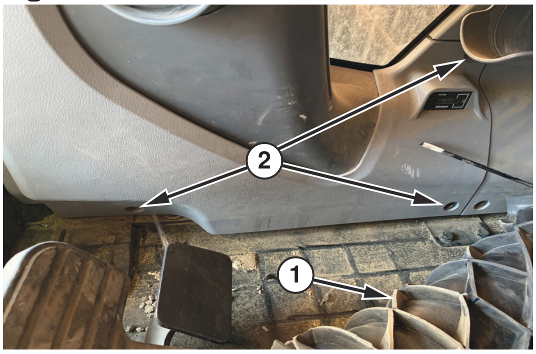
Step-C. Remove hour meter

Removal

1. Turn OFF the battery disconnect switch.
2. Open the cabin door.

Cabin Side Cover

1. Put away the floor rubber mat (1).
   Figure 248

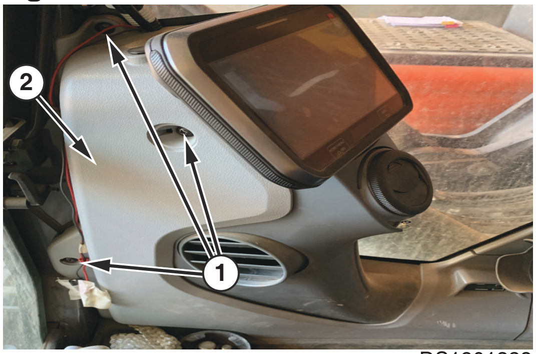


DS1901327

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 249

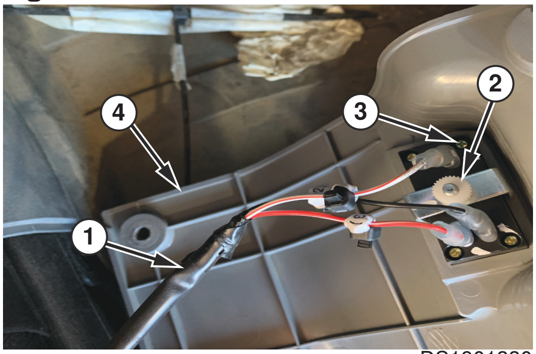


DS1901328

4. Remove the cabin side cover (2).

Hour Meter

1. Disconnect wire harnesses (1).
   Figure 250



DS1901330

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. Remove wiper arm and blade.

Step-B. Remove undercover

Step-C. Remove wiper motor

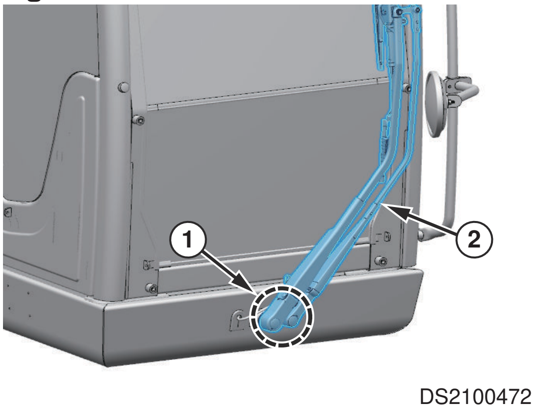
Removal

1. Turn OFF the battery disconnect switch.

Wiper Arm and Blade

1. Remove mounting nuts (1) and wiper arm and blade.

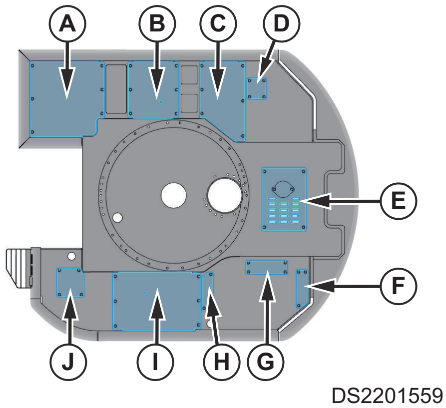
   Figure 251



Undercover

1. Remove undercover (A).

   Figure 252

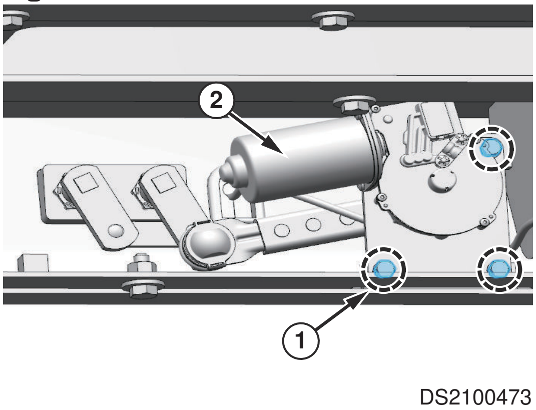


   For details, refer to Undercovers - Removal and Installation.

Wiper Motor

1. Disconnect wire harness connector from wiper motor.

Figure 253



2. Remove mounting bolts (1) and wiper motor (2) frame.

Installation

1. Perform installation in the reverse order to removal.

Troubleshooting Guide

Troubleshooting

Wiring Harness Layout

Safety Instructions

⚠ WARNING

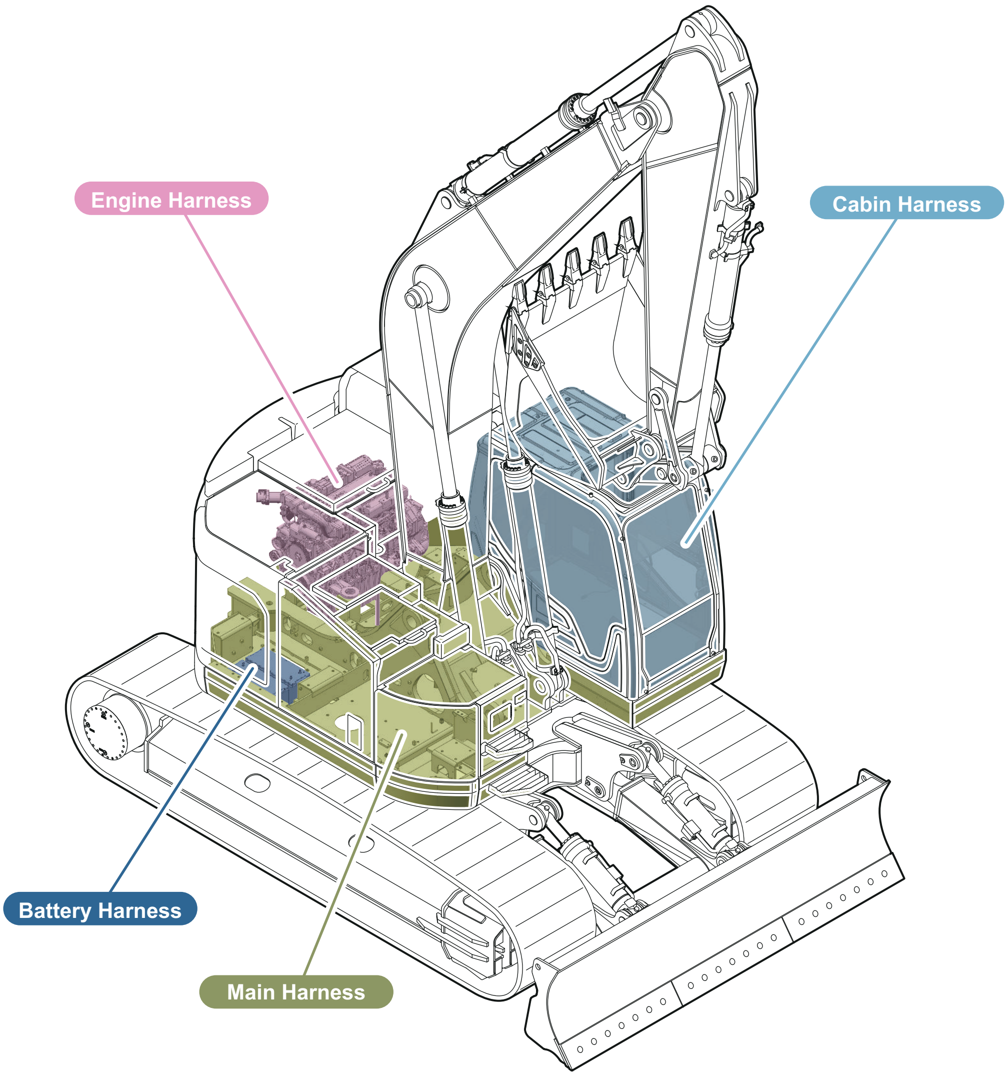
AVOID DEATH OR SERIOUS INJURY

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.

Wiring Device

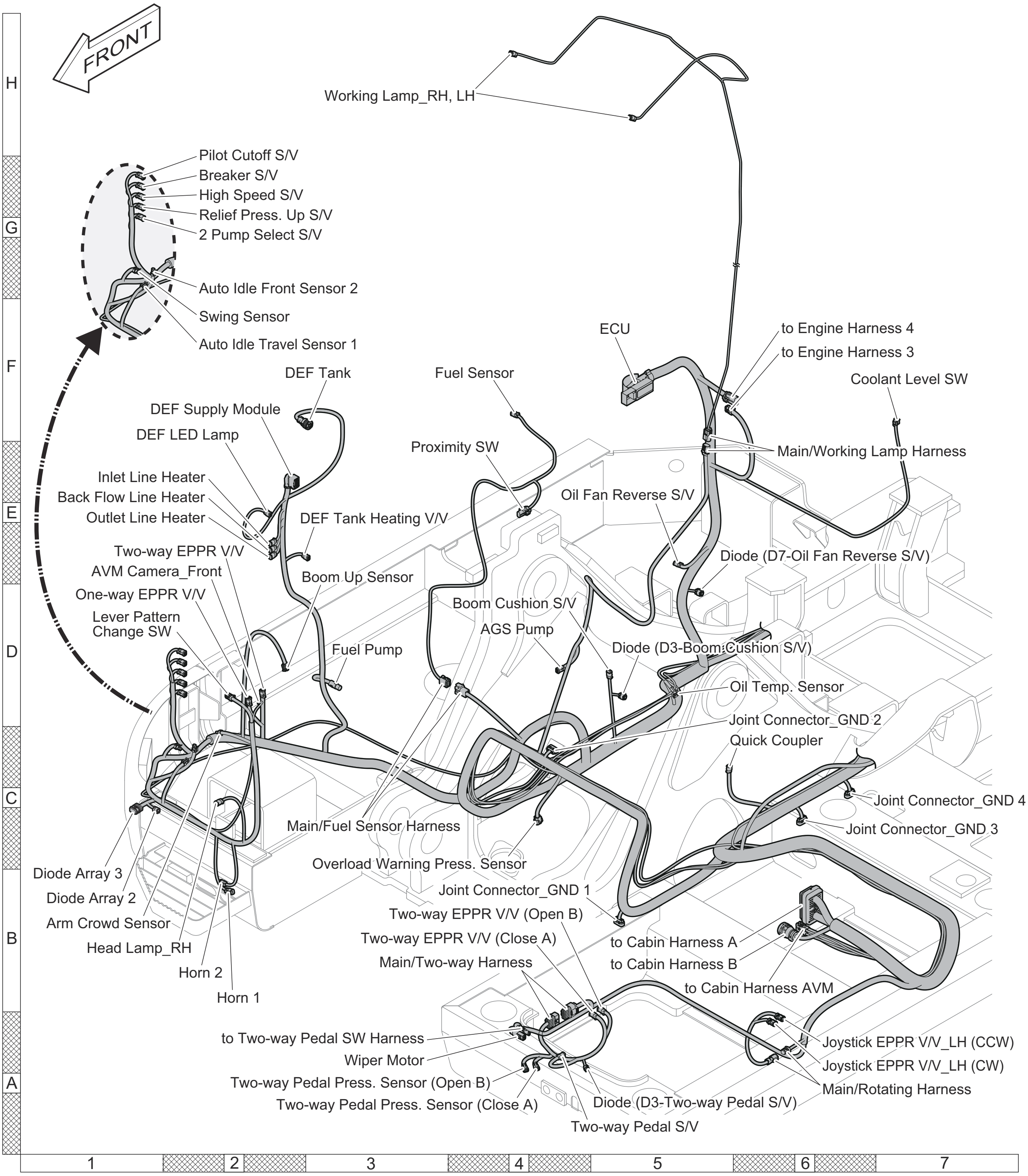
Wiring Harness Layout

Figure 1



Main Harness (1/2)

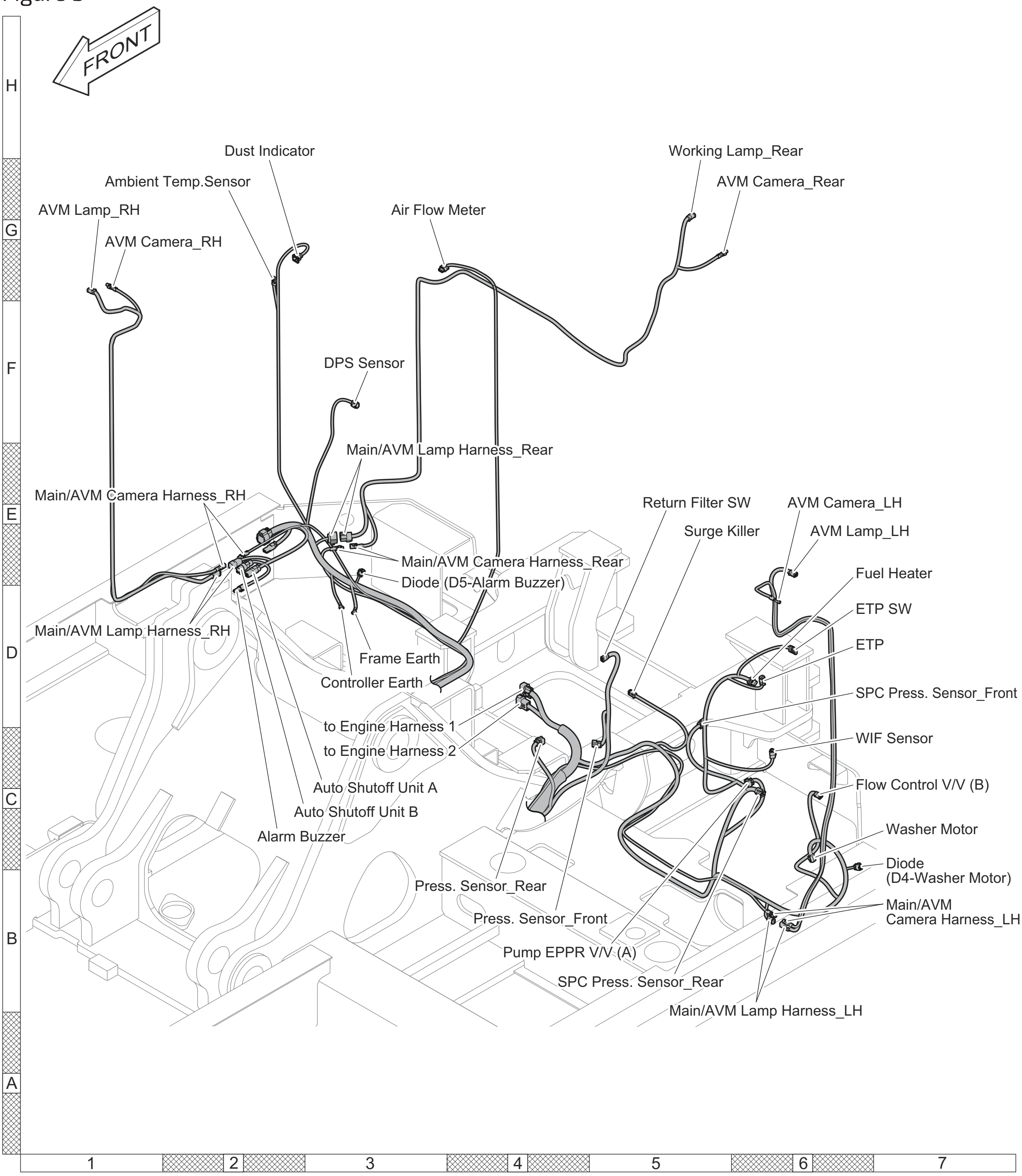
Figure 2



DS2201916

Main Harness (2/2)

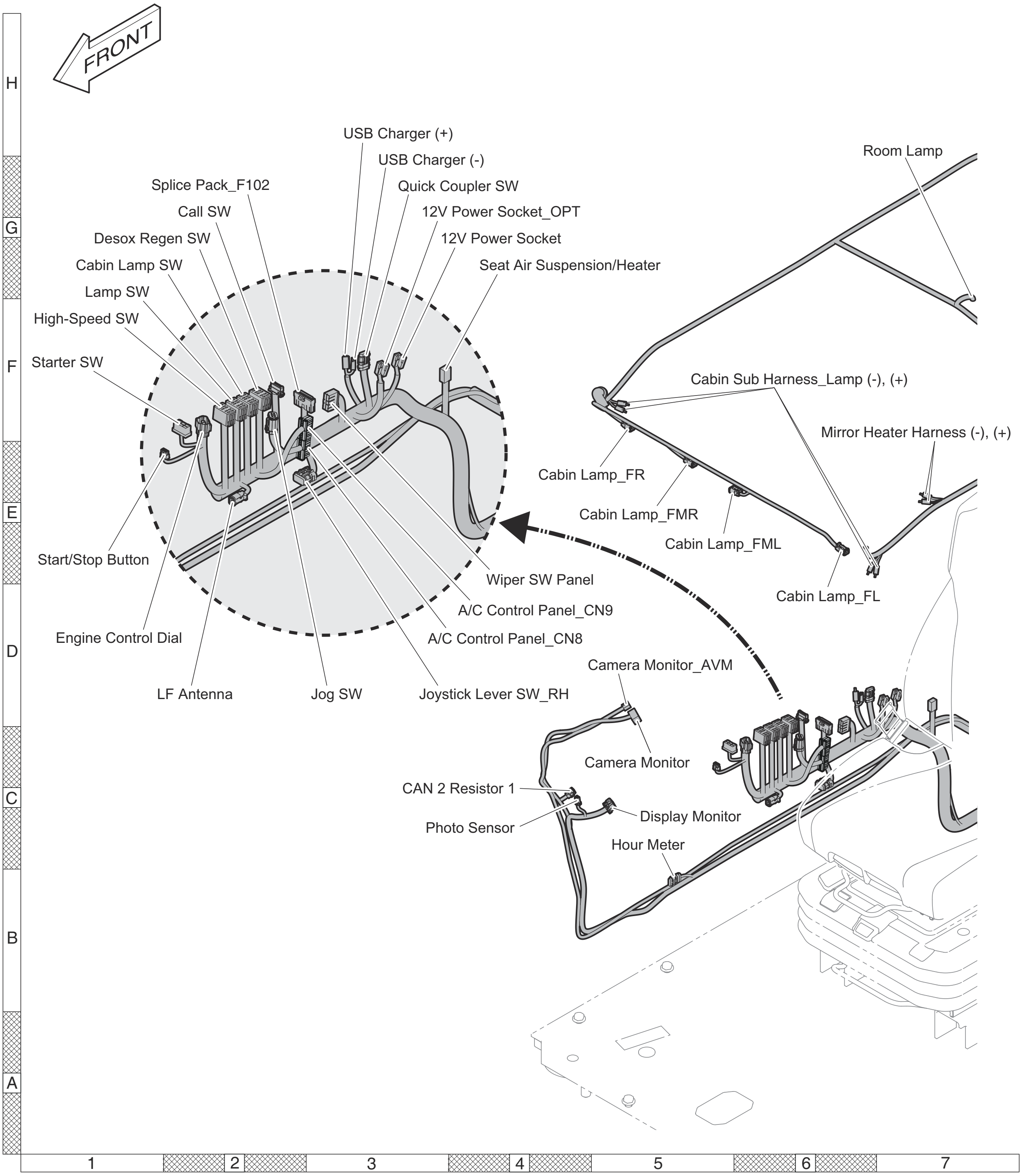
Figure 3



DS2201917

Cabin Harness (1/2)

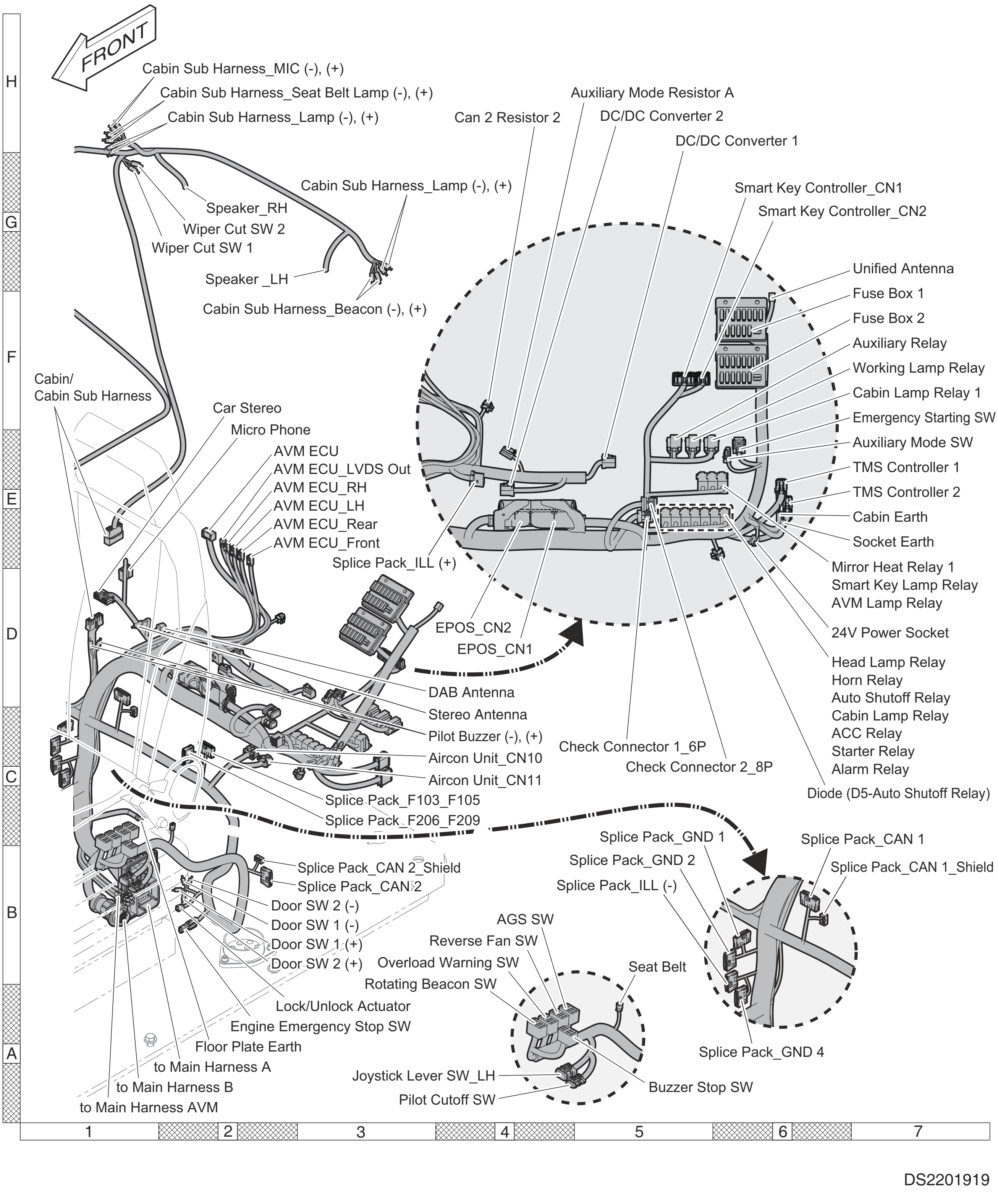
Figure 4



DS2201918

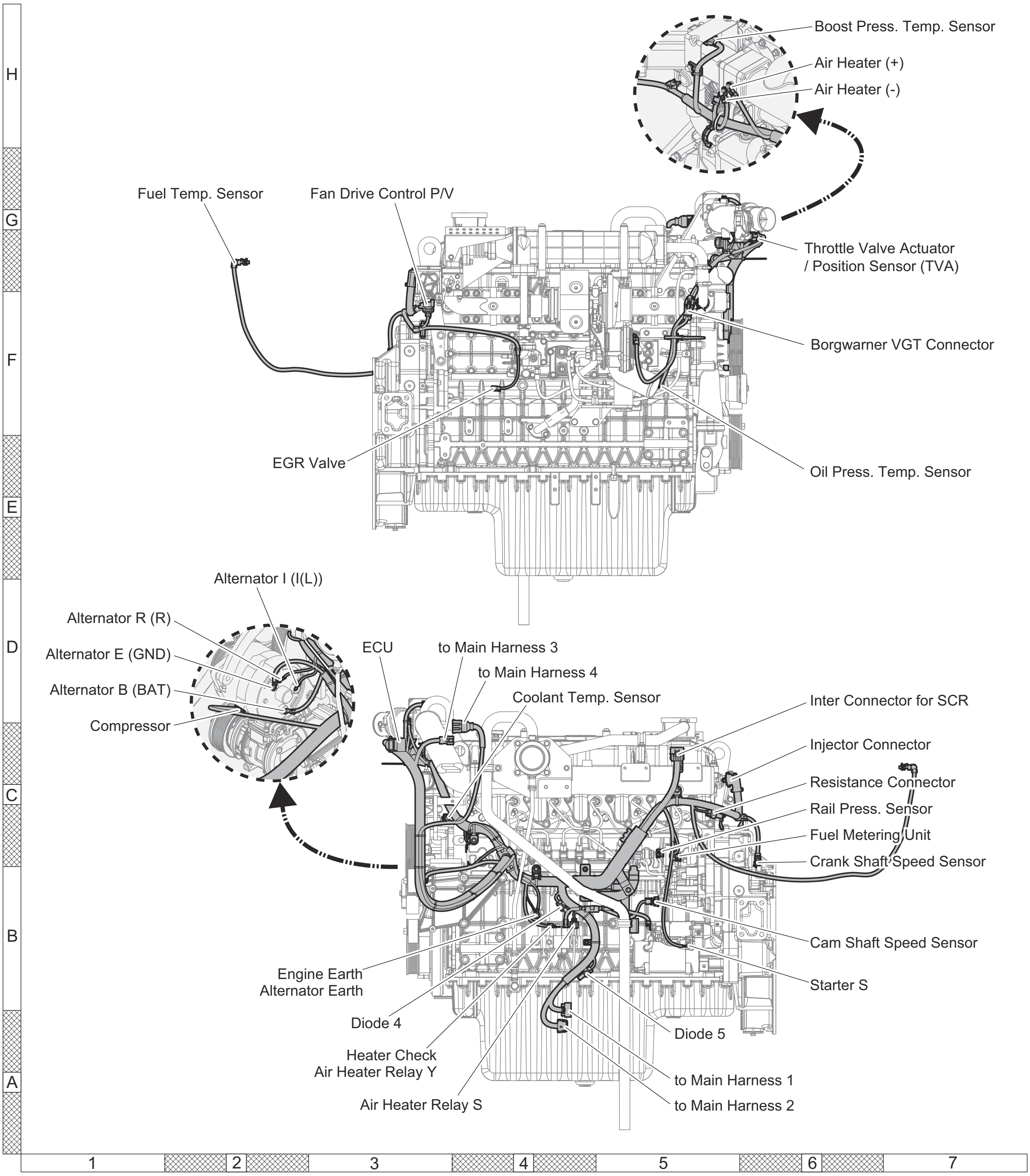
Cabin Harness (2/2)

Figure 5



Engine Harness

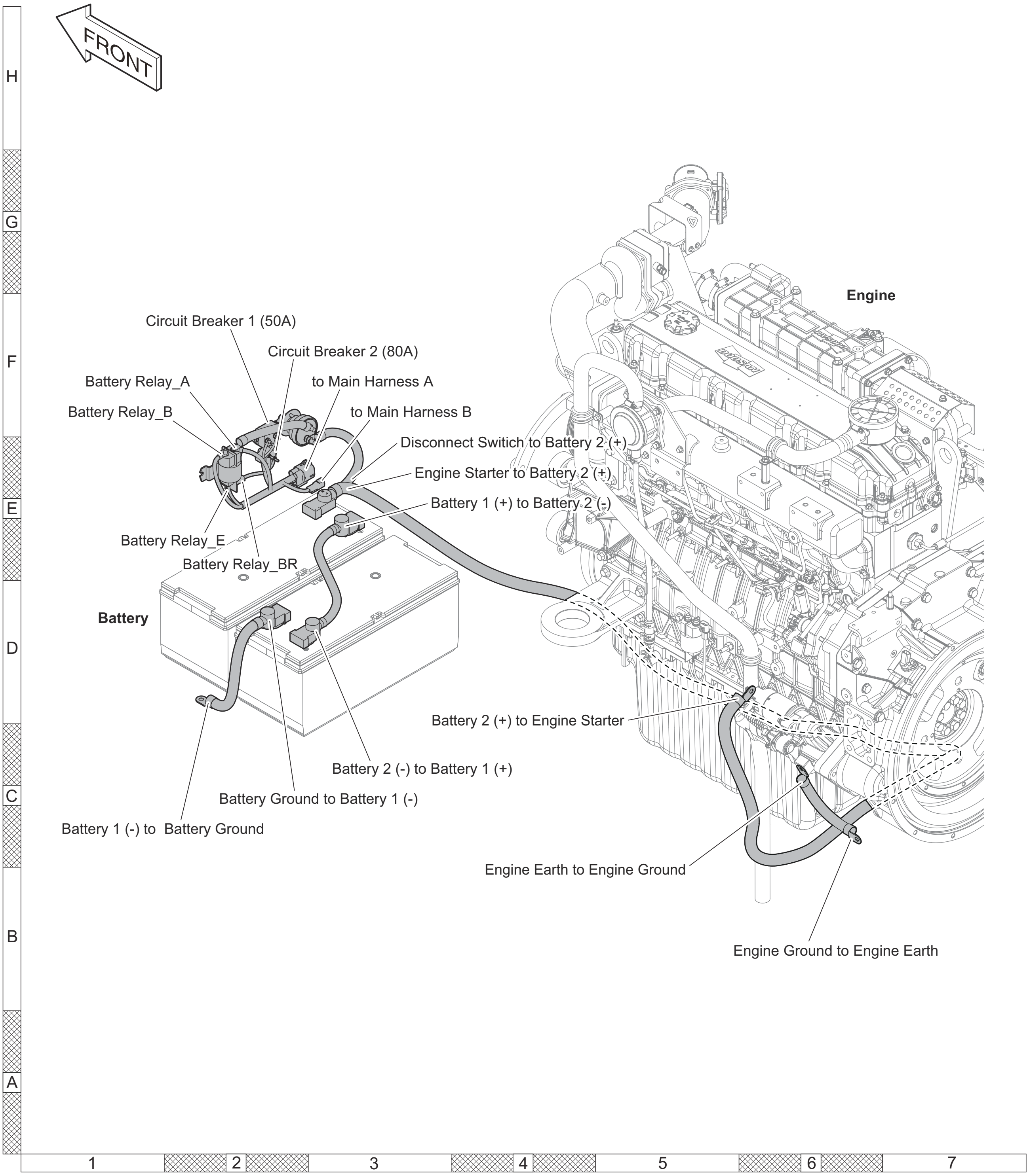
Figure 6



DS2201920

Battery Harness

Figure 7



DS2201921

Error Code

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.

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. VPV005	Pressure Control 1 Proportional Valve (H)
6. VPV006	Pressure Control 2 Proportional Valve (I)
7. VPV007	Flow Control Proportional Valve (C) 2-way RH-Open
8. VPV008	Flow Control Proportional Valve (D) 2-way RH-Close
9. VPV009	Flow Control Proportional Valve (E) Rotating CW
10. VPV010	Flow Control Proportional Valve (F) Rotating CCW
11. VPV025	Bypass Cut-off (A) Proportional Valve
12. VPV026	Bypass Cut-off (B) Proportional Valve
13. VSP032	Swing Priority Proportional Valve
14. VSV001	Breaker Operating Solenoid Valve
15. VSV003	High-speed Solenoid Valve (C)
16. VSV007	Option Safety Solenoid Valve
17. VSV035	Free Boom Up Solenoid Valve
18. VSV036	Free Boom Down Solenoid Valve
19. VSV037	Quick Coupler Solenoid Valve
20. VRY002	Back Buzzer Relay
21. VRY016	Auto Shut Off Relay
22. VRY018	ACC Relay
23. VRY026	Mirror Heater Relay

No.	Description of the Problems
24. VGC003	External Voice Warning Signal
25. VGC004	Wiper Operating Signal
26. VSP001	Front Pump Pressure Sensor
27. VSP002	Rear Pump Pressure Sensor
28. VSP003	Overload Warning Pressure Sensor
29. VSP006	Boom Up Pressure Sensor
30. VSP007	Bucket Crowd Pressure Sensor
31. VSP008	Boom Down Pressure Sensor
32. VSP009	Bucket Dump Pressure Sensor
33. VSP010	Arm In Pressure Sensor
34. VSP011	Arm Out Pressure Sensor
35. VSP012	Travel Pressure Sensor (LH)
36. VSP013	Travel Pressure Sensor (RH)
37. VSP014	Swing Pressure Sensor
38. VSP015	ATT (Option) Pressure Sensor
39. VSP016	Attachment 2 Pressure Sensor
40. VSP017	Option Pedal 1 Pressure Sensor
41. VSP018	Option Pedal 2 Pressure Sensor
42. VSP049	Dozer Pressure Sensor
43. VSE001	Oil Temperature Sensor
44. VSE002	Fuel Sensor
45. VSE004	WIF Sensor
46. VSE007	Angle Sensor (A)
47. VSE008	Angle Sensor (B)
48. VS5001	Thumb Wheel (RH)
49. VS5002	Thumb Wheel (LH)
50. VS5005	Dial
51. VS5006	Machine Controller +5 V Output 1
52. VS5007	Machine Controller +5 V Output 2
53. VAL001	Alternator Potential

1. VCO001 Gauge Panel

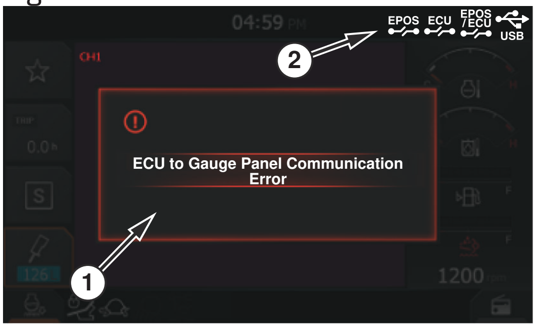
Action Level	Failure Code	Failure	Gauge Panel Communication
Gauge Panel	VCO001		
Detail of Failure	The EPOS has not received CAN data from the gauge panel for more than 10 seconds.		

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	1. Vehicle data received from the EPOS cannot be checked on the gauge panel. 2. 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. 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.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		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.

Figure 8



DS1901654

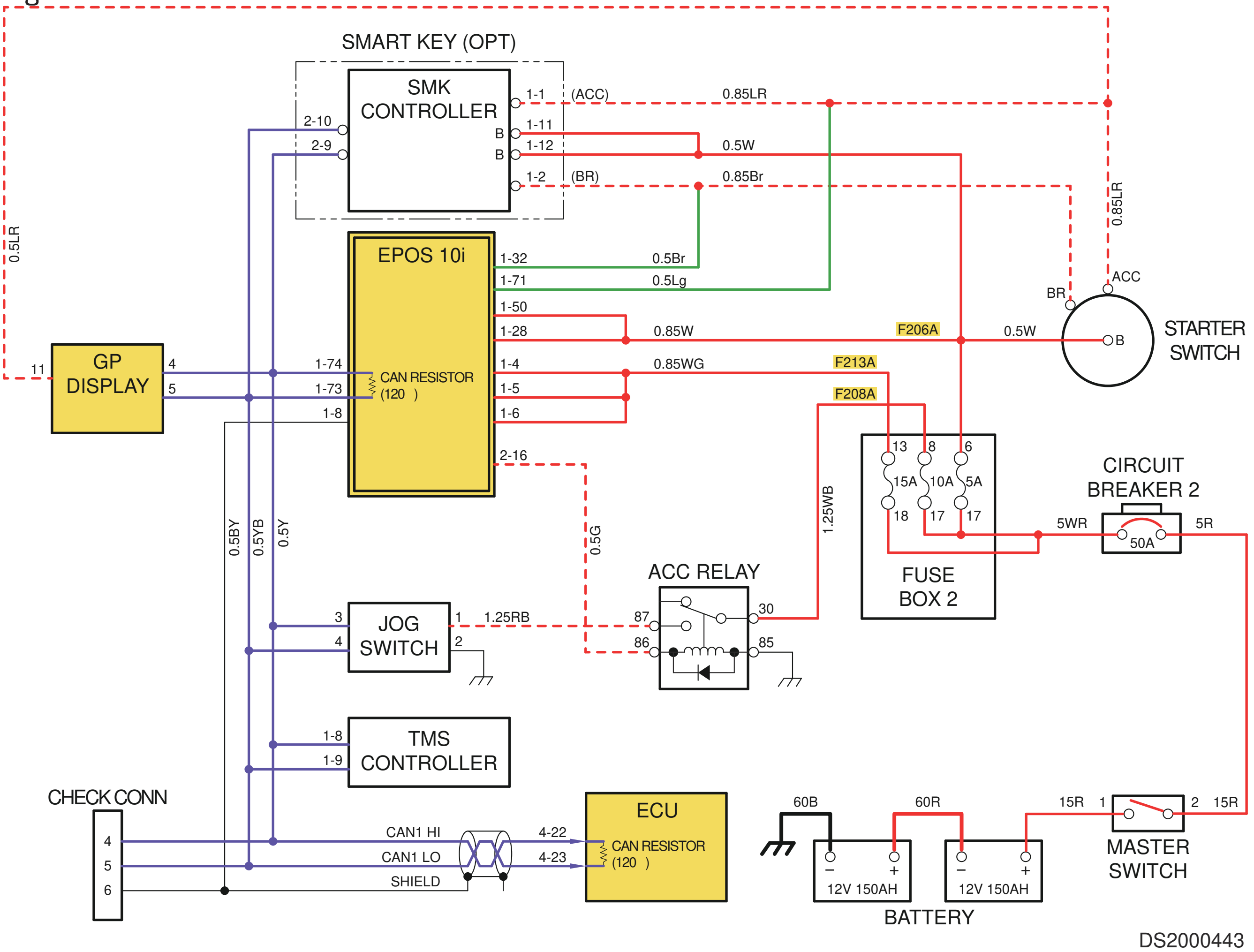
Pop-ups, Warning Symbols and Indicators

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 9



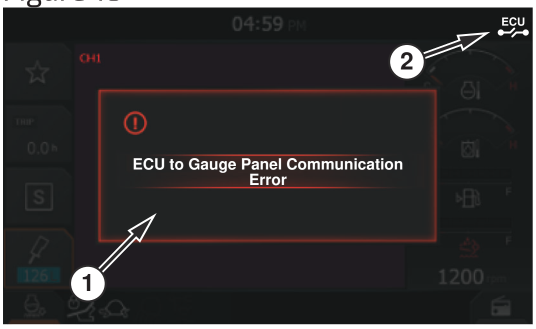
2. VC0002 E-ECU

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	1. Engine data received from the ECU cannot be checked on the gauge panel. 2. The rpm is not changed as the engine dial 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 1 or 2 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 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.

Figure 10



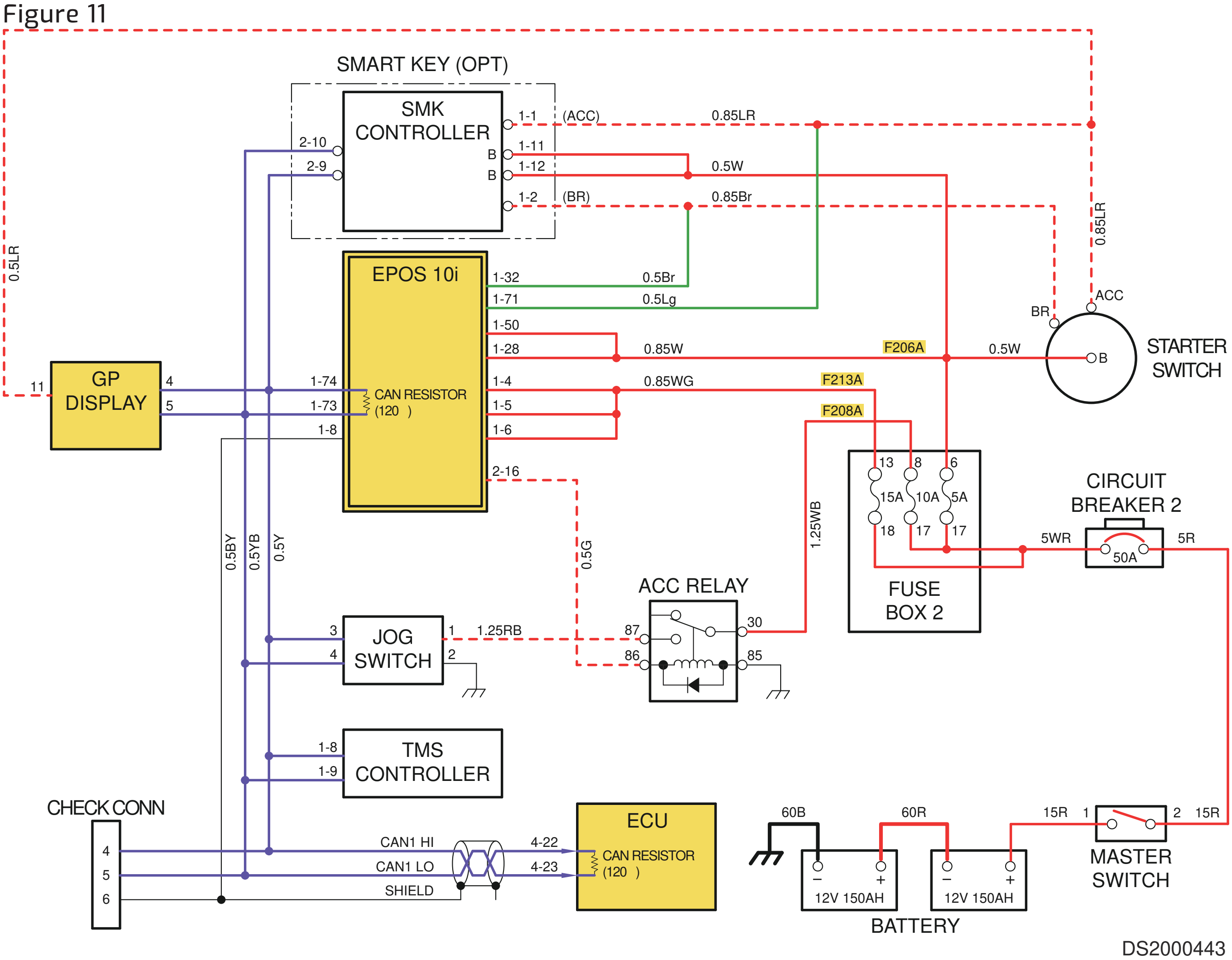
DS1901655

Pop-ups, Warning Symbols and Indicators

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 11



3. VPV001 Pump Proportional Valve (A)

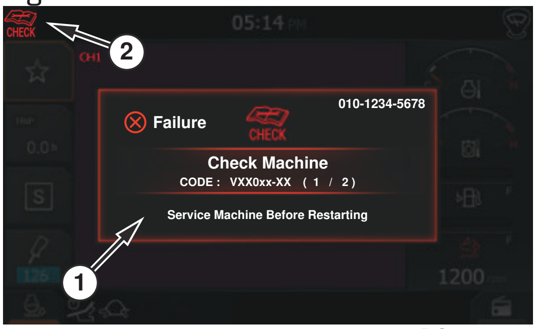
Action Level	Failure Code	Failure	Pump Proportional Valve (A)
Gauge Panel	VPV001		
Detail of Failure	FMI 5: Pump proportional valve (A), current below normal (open circuit). FMI 6: Pump proportional valve (A), current above normal (short circuit).		
Action of Machine Monitor or Controller	• If the pump 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	1. The speed of the boom up, arm in and arm out operations is decreased. 2. The speed of the boom up, arm in and arm out operations is decreased. 3. Arti boom does not work when Arti boom is operated in a machine equipped with the Arti boom option. 4. The relief pressure up function is disabled.		

	5. The machine cannot be driven straight ahead during travel.(it moves in a diagonal direction unintentionally.) 6. 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 "|" 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: 280 ±30 mA (@45bar) 2) Pilot operation: up to 730 ±30 mA(@350bar) 3) Relief pressure up operation: 750 ±30 mA(@368bar)

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 "|" position. 2. If the switch is in the "|" 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 pump Proportional 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.

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: 21±5% Ω

Figure 12



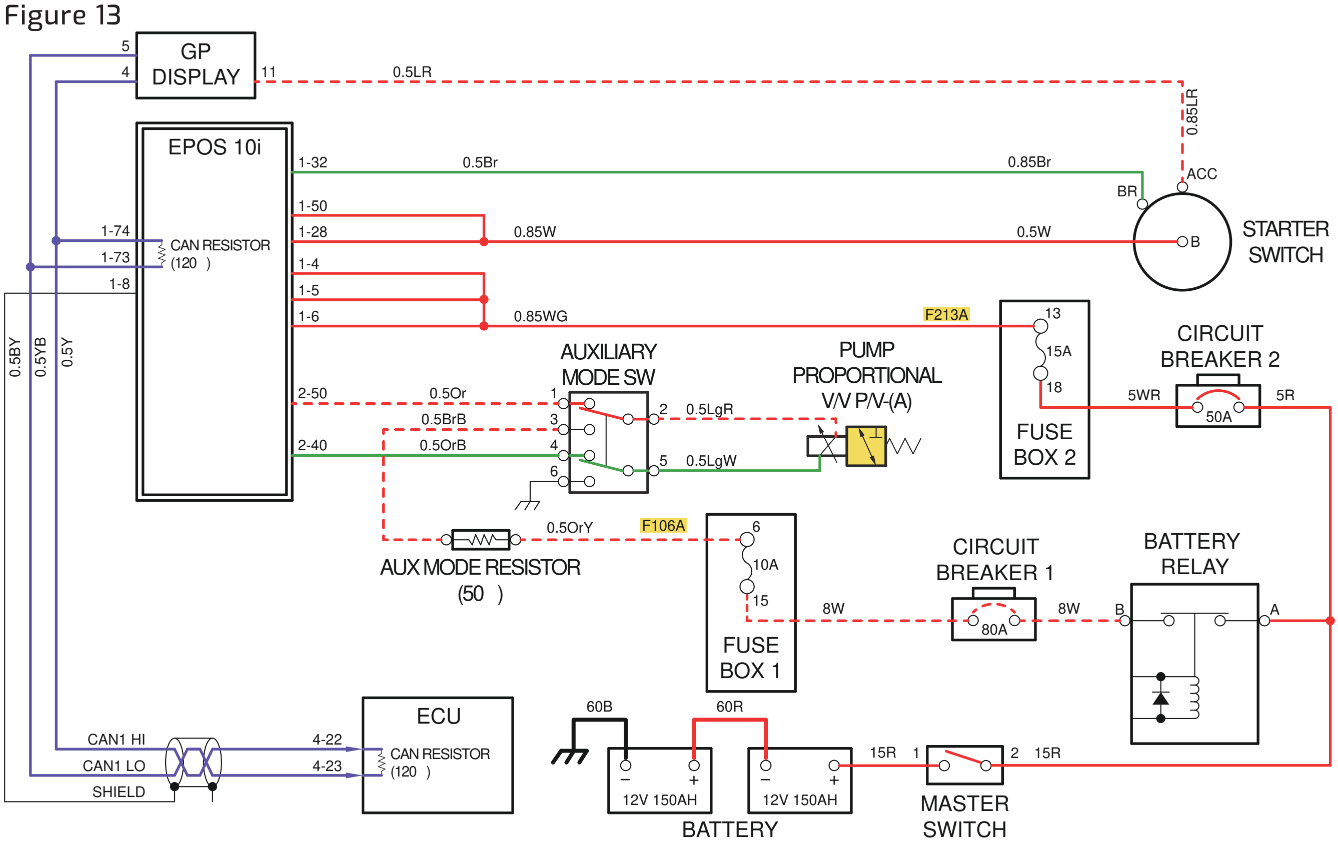
DS2102170

Pop-ups, Warning Symbols and Indicators

If the pump proportional valve (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.

Block Diagram

Figure 13



DS2000444

4. VPV002 Pump Proportional Valve (B)

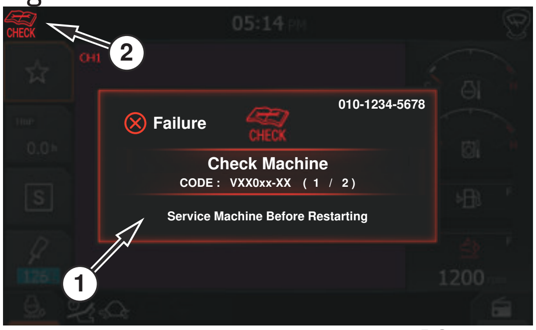
Action Level	Failure Code	Failure	Pump Proportional Valve (B)

Gauge Panel	VPV002		
Detail of Failure	FMI 5: Pump proportional valve (B), current below normal (open circuit). FMI 6: Pump proportional valve (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. • If the pump proportional valve is malfunctioning, the "activation of emergency mode" pop-up and warning symbol will be displayed on the main screen of the gauge panel.		
Problem on Machine	1. The speed of the boom up, arm in and arm out operations is decreased. 2. Swing, travel (LH) and option operation (breaker/two way) does not work when swing, travel (LH) and option operation (breaker/two way) operations. 3. The relief pressure up function is disabled. 4. The machine cannot be driven straight ahead during travel.(it moves in a diagonal direction unintentionally.) 5. 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: 280 ±30 mA (@ 45 bar) 2) Pilot operation: up to 730 ±30 mA (@ 350 bar) 3) Relief pressure up operation: 750 ±30 mA (@ 368 bar)		

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.

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 measurement is 0 Ω, this indicates a normal connection. 3. Check that the connectors of the pump proportional 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: 21±5% Ω

Figure 14



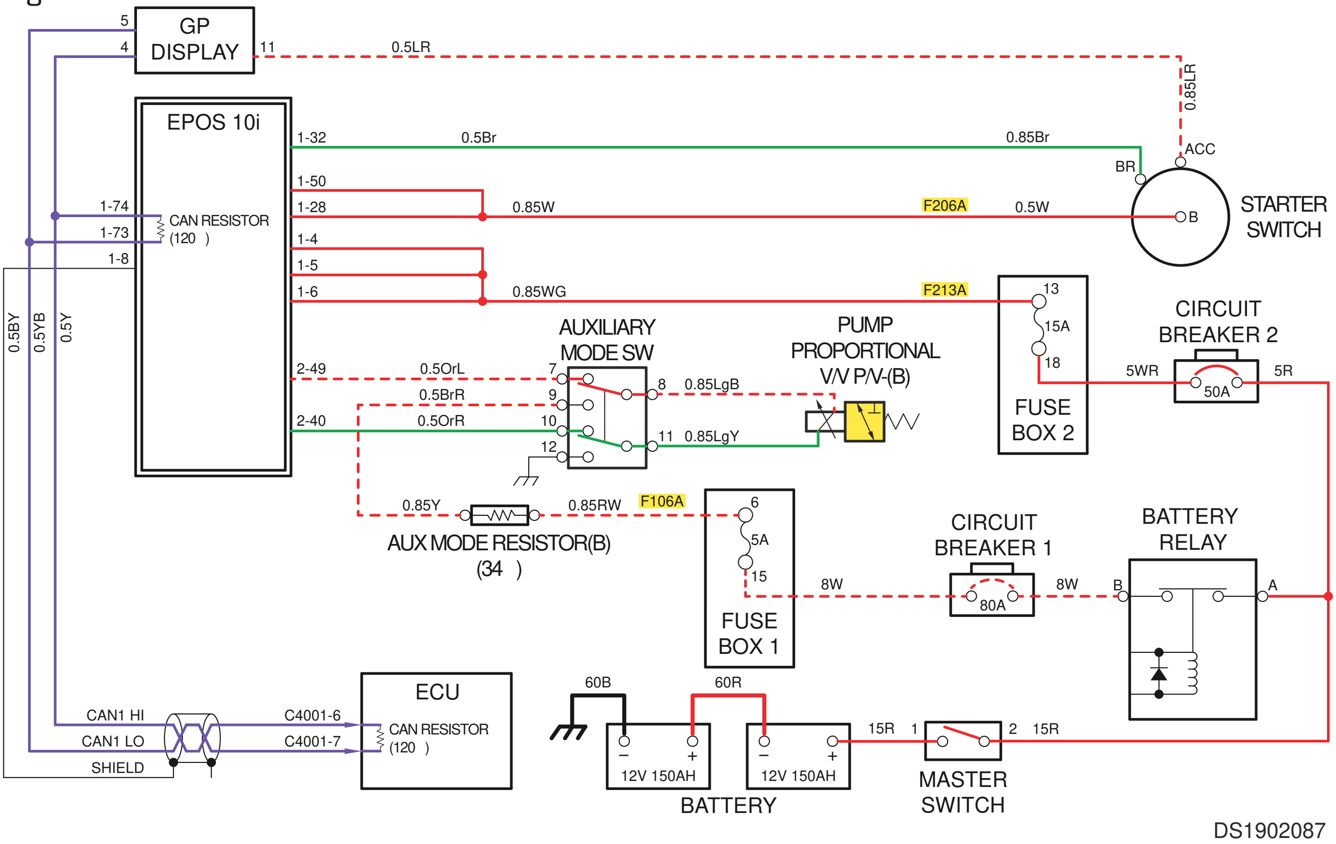
DS2102170

Pop-ups, Warning Symbols and Indicators

If the pump proportional valve (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.

Block Diagram

Figure 15



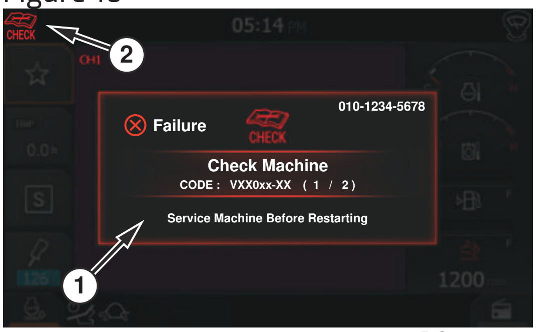
5. VPV005 Pressure Control 1 Proportional Valve (H)

Action Level	Failure Code	Failure	Pressure Control Proportional Reducing 1 Valve (H)
Gauge Panel	VPV005		
Detail of Failure	Only occurs in a machine with the two-way option where the use of the option (one-way/two-way) is set enabled on the gauge panel. FMI 5: Pressure control proportional reducing valve (H), current above normal (open circuit). FMI 6: Pressure control proportional reducing valve (H), current below normal (short circuit).		
Actions of Machine Monitor or Controller	• If the pressure control proportional reducing valve (H) is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the pressure control proportional reducing valve (H) is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	1. The attachment pressure set on the gauge panel is not built in the one-way or two-way operation.		
Related Information	1. An error code is generated when the EPPR valve's connector is disconnected. 2. The attachment cannot be operated unless the attachment operation setting on the gauge panel is set as Enabled. A. Normal output status of pressure control proportional reducing valve (H)		

	1) 0 bar: 650 ±15 mA output 2) 140 bar : 457±15mA output 3) 290 bar : 225±15mA output 4) 345 bar : 0mA output

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 pressure control EPPR 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: 28.5 Ω (@ 20°C)

Figure 16



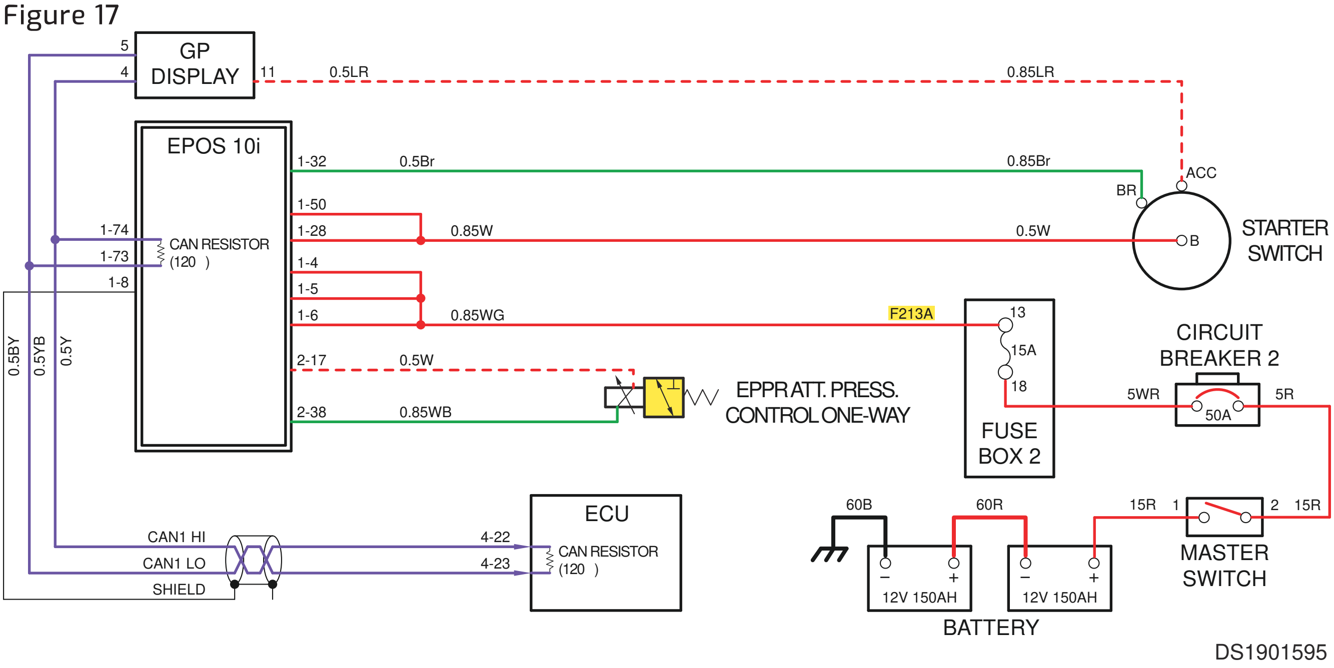
DS2102170

Pop-ups, Warning Symbols and Indicators

If the pressure control proportional reducing 1 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 17

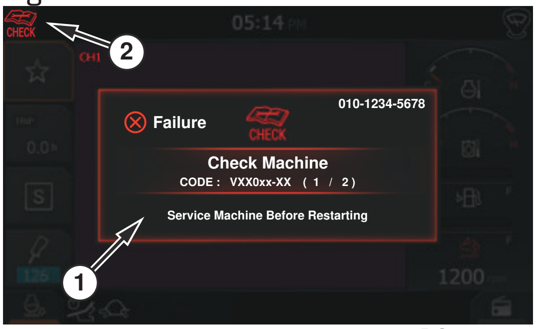


6. VPV006 Pressure Control 2 Proportional Valve (I)

Action Level	Failure Code	Failure	Pressure Control Proportional Reducing 2 Valve (I)
Gauge Panel	VPV006		
Detail of Failure	Only occurs when the use of the option (two-way) is set enabled on the gauge panel. FMI 5: Pressure control proportional reducing valve (I), current above normal (open circuit). FMI 6: Pressure control proportional reducing valve (I), current below normal (short circuit).		
Actions of Machine Monitor or Controller	• If the pressure control proportional reducing valve (I) is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the pressure control proportional reducing valve (I) is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	1. The attachment pressure set on the gauge panel does not form during two way operation.		
Related Information	1. An error code is generated when the EPPR valve's connector is disconnected. 2. The attachment cannot be operated unless the attachment operation setting on the gauge panel is set as Enabled. A. Normal output status of pressure control proportional reducing valve (I) 1) 0 bar: 650 ±15 mA output 2) 140 bar : 457±15 mA output 3) 290 bar : 225±15 mA output 4) 345 bar : 0 mA output		

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 pressure control EPPR 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: 28.5 Ω (@ 20°C)

Figure 18



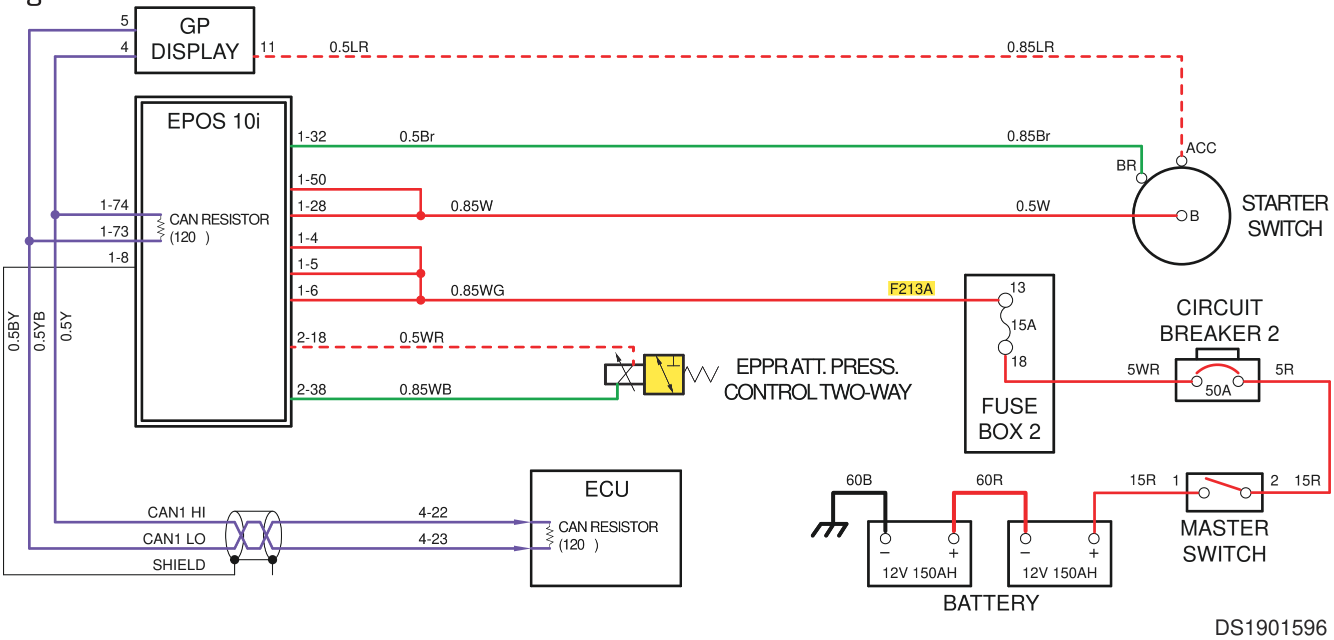
DS2102170

Pop-ups, Warning Symbols and Indicators

If the pressure control proportional reducing 2 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 19

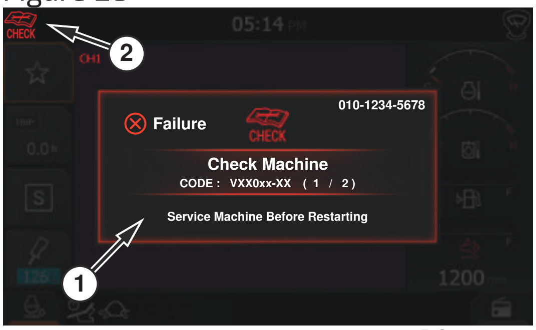


7. VPV007 Flow Control Proportional Valve (C) 2-way RH-Open

Action Level	Failure Code	Failure	Flow Control Proportional Reducing Valve (C) 2-way RH-Open
Gauge Panel	VPV007		
Detail of Failure	Only occurs when the use of the option (two-way) is set enabled on the gauge panel. FMI 5: Flow control proportional reducing valve (C), current below normal (open circuit). FMI 6: Flow control proportional reducing valve (C), current above normal (short circuit).		
Actions of Machine Monitor or Controller	• If the flow control proportional reducing valve (C) is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the flow control proportional reducing valve (C) is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	1. The attachment is not operated at all or operated abnormally not according to the setting of the thumb wheel switch.		
Related Information	1. An error code is generated when the EPPR valve's connector is disconnected. 2. The attachment cannot be operated unless the attachment operation setting on the gauge panel is set as Enabled. 3. Normal output of flow control proportional reducing valve (C)(2-way RH-open) A. Current control by thumb wheel switch voltage. 1) 1.1 V or less, or 3.9 V or more: 660 mA output 2) 2.18 V or 2.82 V: 320 mA output 3) 2.275 V to 2.725 V: 0 mA output		

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 flow control EPPR 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±3% (@ 20°C)

Figure 20



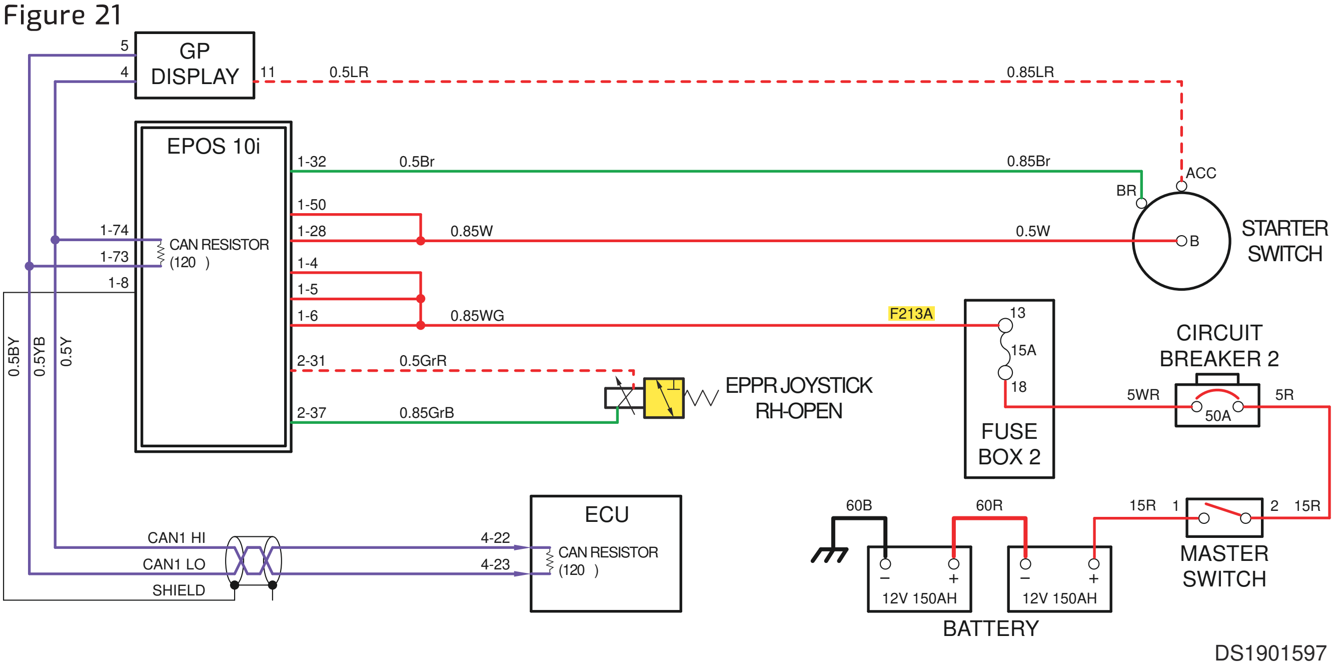
DS2102170

Pop-ups, Warning Symbols and Indicators

If the flow control proportional reducing valve (C) (2-way RH-open) 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 21

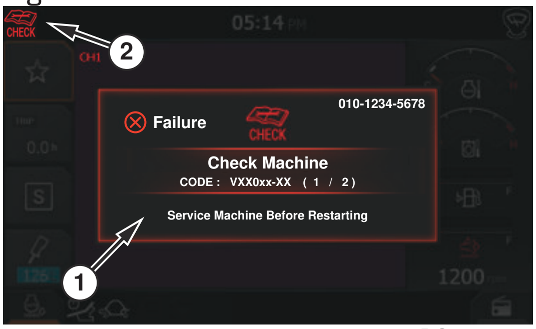


8. VPV008 Flow Control Proportional Valve (D) 2-way RH-Close

Action Level	Failure Code	Failure	Flow Control Proportional Valve (D) 2-way RH-Close
Gauge Panel	VPV008		
Detail of Failure	Only occurs when the use of the option (two-way) is set enabled on the gauge panel. FMI 5: Flow control proportional reducing valve (D), current below normal (open circuit). FMI 6: Flow control proportional reducing valve (D), current above normal (short circuit).		
Actions of Machine Monitor or Controller	• If the flow control proportional reducing valve (D) is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the flow control proportional reducing valve (D) is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	1. The attachment is not operated at all or operated abnormally not according to the setting of the thumb wheel switch.		
Related Information	1. An error code is generated when the EPPR valve's connector is disconnected. 2. The attachment cannot be operated unless the attachment operation setting on the gauge panel is set as Enabled. 3. Normal output of flow control proportional reducing valve (D) (2-way RH high-pressure) A. Current control by thumb wheel switch voltage. 1) 1.1 V or less, or 3.9 V or more: 660 mA output 2) 2.18 V or 2.82 V: 320 mA output 3) 2.275 V to 2.625 V: 0 mA output		

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 flow control EPPR 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±3% (@ 20°C)

Figure 22



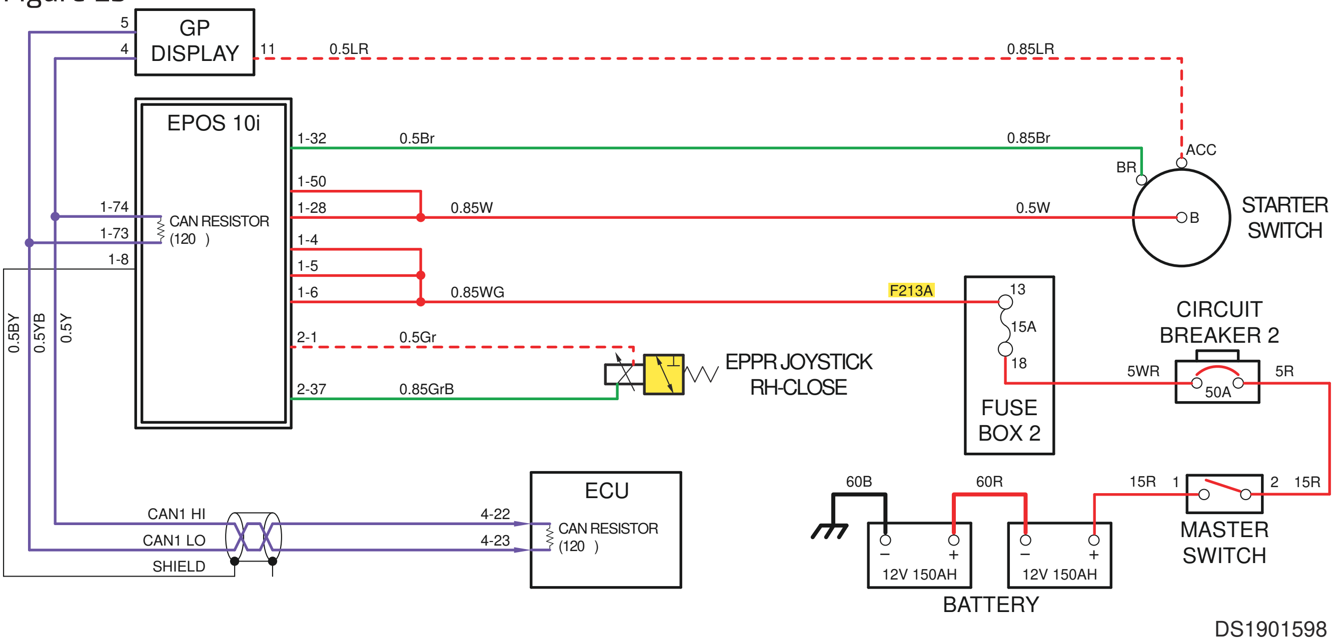
DS2102170

Pop-ups, Warning Symbols and Indicators

If the flow control proportional reducing valve (D) (2-way RH-close) 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 23

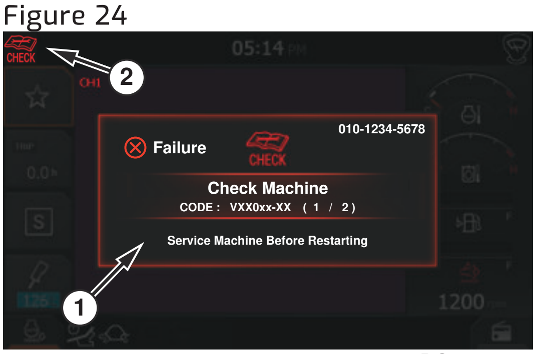


9. VPV009 Flow Control Proportional Valve (E) Rotating CW

Action Level	Failure Code	Failure	Flow Control Proportional Reducing Valve (E) Rotating CW
Gauge Panel	VPV009		
Detail of Failure	The failure occurs only when the rotating option is mounted. FMI 5: Flow control proportional reducing valve (E), current below normal (open circuit). FMI 6: Flow control proportional reducing valve (E), current above normal (short circuit).		
Actions of Machine Monitor or Controller	• If the flow control proportional reducing valve (E) is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the flow control proportional reducing valve (E) is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	1. The attachment is not operated at all or operated abnormally not according to the setting of the thumb wheel switch.		
Related Information	1. An error code is generated when the EPPR valve's connector is disconnected. 2. Normal output of flow control proportional reducing valve (E) (rotating clockwise) A. Current control by thumb wheel switch voltage. 1) 1.1 V or less, or 3.9 V or more: 660 mA output 2) 2.18 V or 2.82 V: 320 mA output 3) 2.275 V to 2.675 V: 0 mA output		

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±3% (@ 20°C)

Figure 24



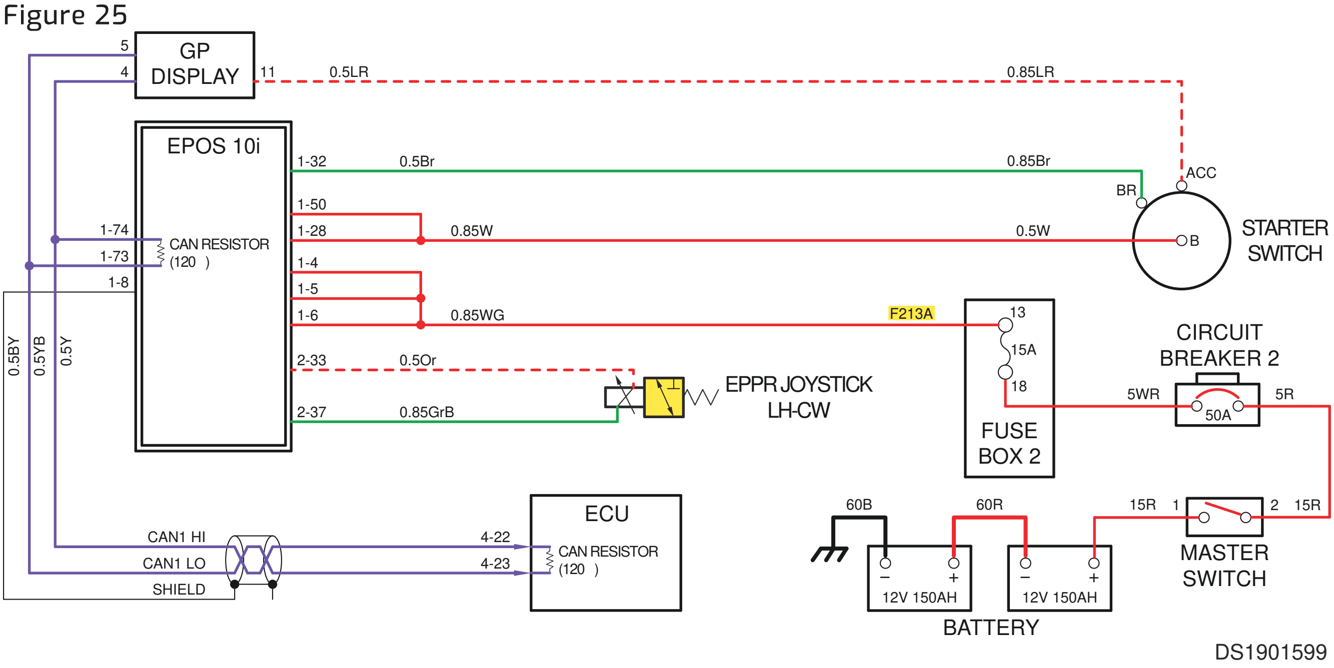
DS2102170

Pop-ups, Warning Symbols and Indicators

If the flow control proportional reducing valve (E) (rotating CW) 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 25

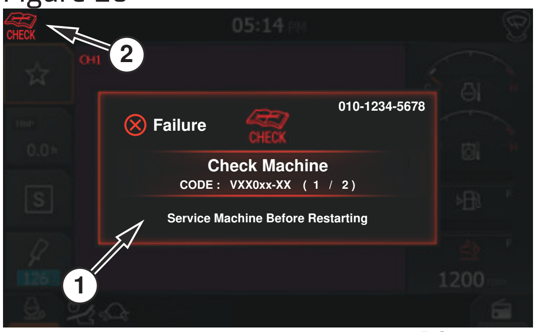


10. VPV010 Flow Control Proportional Valve (F) Rotating CCW

Action Level	Failure Code	Failure	Flow Control Proportional Reducing Valve (F) Rotating CCW
Gauge Panel	VPV010		
Detail of Failure	The failure occurs only when the rotating option is mounted. FMI 5: Flow control proportional reducing valve (F), current below normal (open circuit). FMI 6: Flow control proportional reducing valve (F), current above normal (short circuit).		
Actions of Machine Monitor or Controller	• If the flow control proportional reducing valve (F) is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the flow control proportional reducing valve (F) is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	1. The attachment does not operate at all or operates abnormally, not according to the setting of the thumb wheel switch.		
Related Information	1. An error code is generated when the EPPR valve's connector is disconnected. 2. Normal output of flow control proportional reducing valve (F) (rotating counterclockwise) A. Current control by thumb wheel switch voltage. 1) 1.1 V or less, or 3.9 V or more: 660 mA output 2) 2.18 V or 2.82 V: 320 mA output 3) 2.275 V to 2.675 V: 0 mA output		

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±3% (@ 20°C)

Figure 26



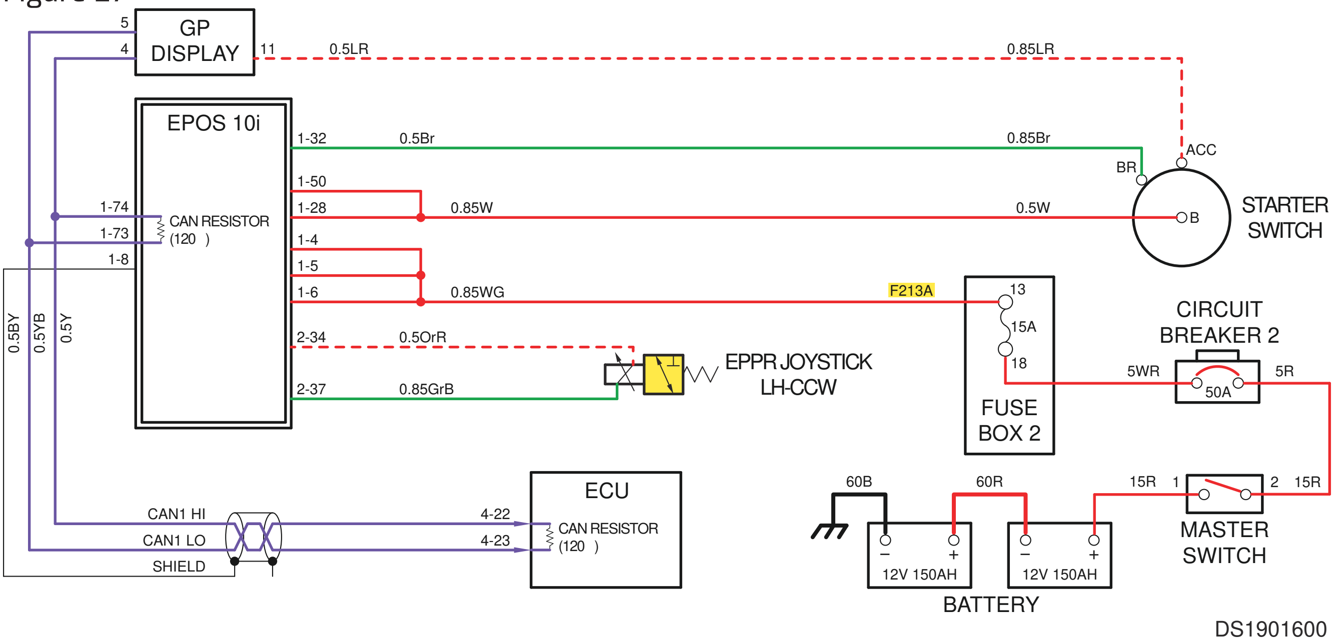
DS2102170

Pop-ups, Warning Symbols and Indicators

If the flow control proportional reducing valve (F) (rotating CCW) 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 27



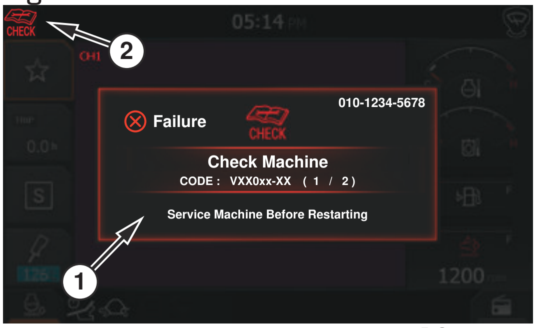
11. VPV025 Bypass Cut-off (A) Proportional Valve

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	1. Arm, swing, travel (LH) and option (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 (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. 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±3% (@ 20°C)

Figure 28



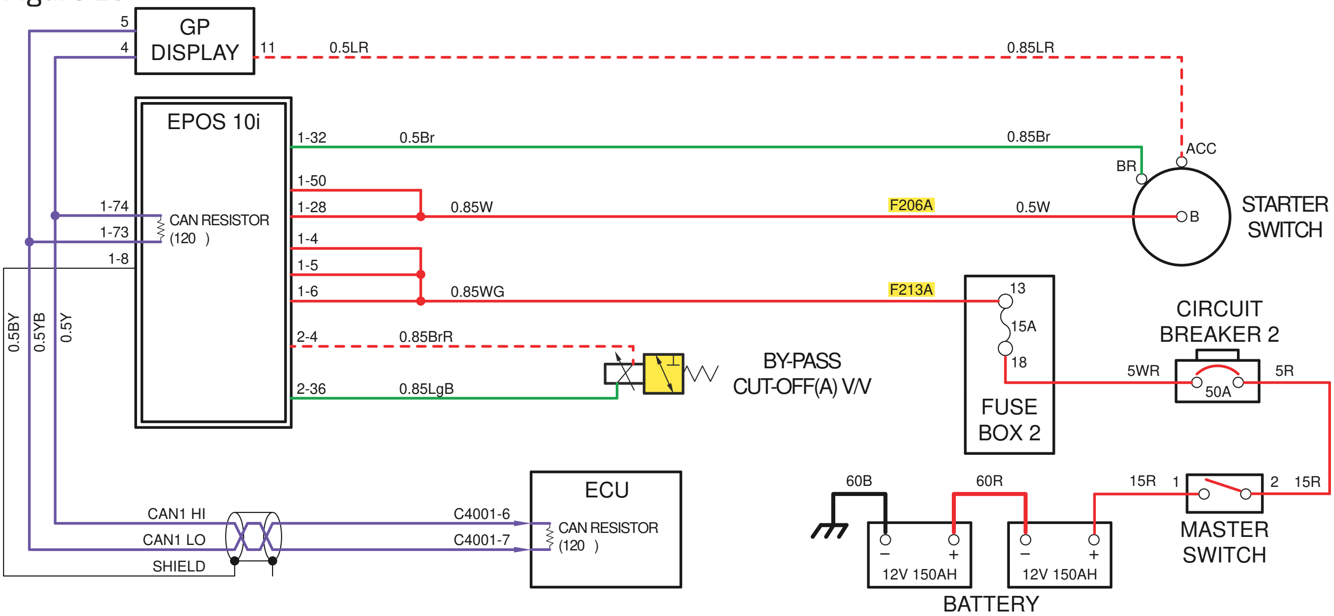
DS2102170

Pop-ups, Warning Symbols and Indicators

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 29



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12. VPV026 Bypass Cut-off (B) Proportional Valve

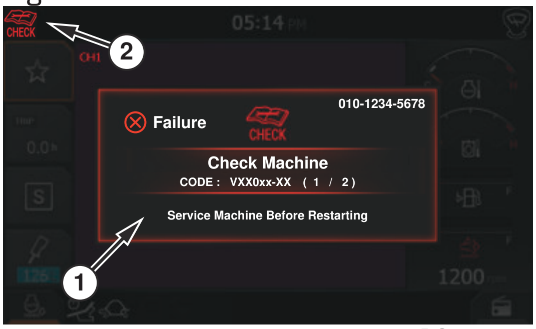
Action Level	Failure Code	Failure	Bypass Cut-off (B) Proportional Reducing Valve
Gauge Panel	VPV026		
Detail of Failure	FMI 5: Bypass cut-off (B) proportional reducing valve, current below normal (open circuit). FMI 6: Bypass cut-off (B) proportional reducing valve, current above normal (short circuit).		
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	1. Boom, bucket and travel (RH) 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. 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.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		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±3% (@ 20℃)

Figure 30



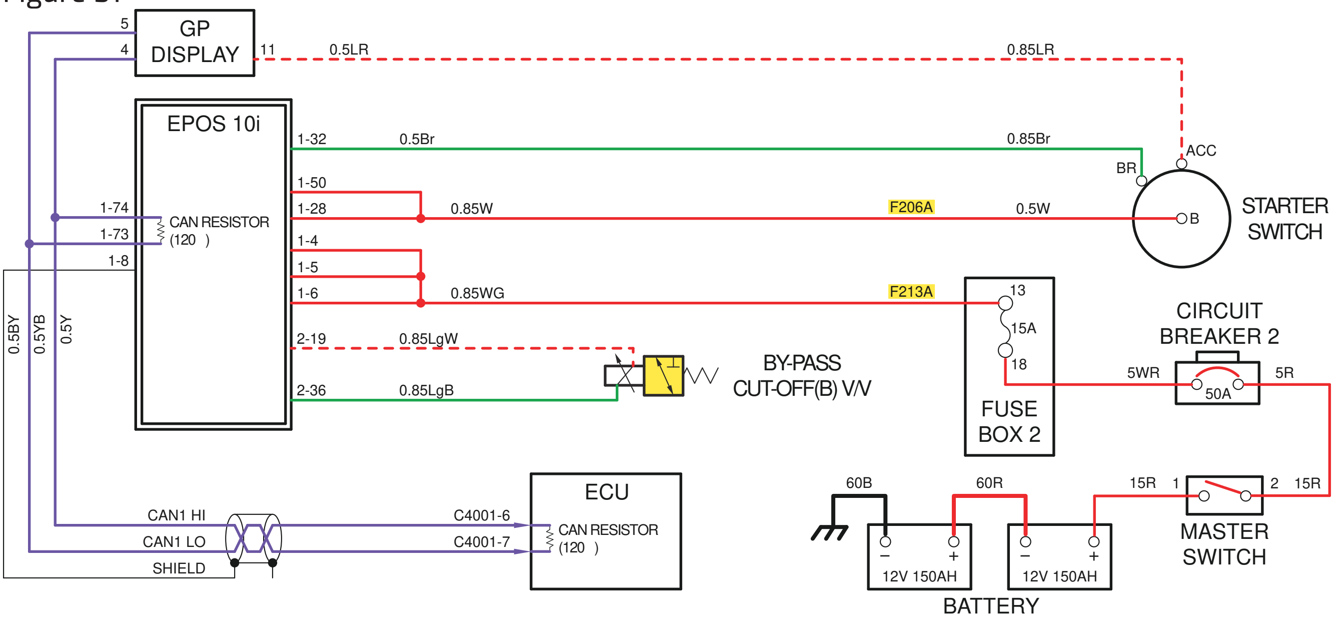
DS2102170

Pop-ups, Warning Symbols and Indicators

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 31



DS1902090

13. VPV032 Swing Priority Proportional Valve

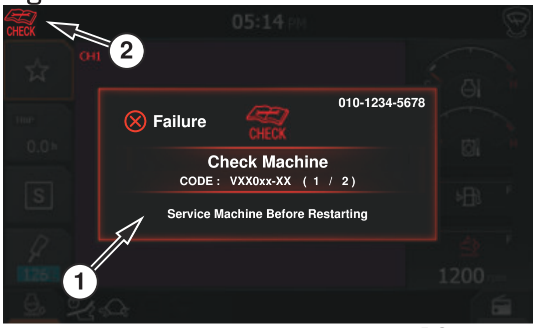
Action Level	Failure Code	Failure	Swing Priority Proportional Valve
Gauge Panel	VPV032		

Detail of Failure	FMI 5: Swing priority proportional valve, current below normal (open circuit). FMI 6: Swing priority proportional valve, current above normal (short circuit).
Actions of Machine Monitor or Controller	• If the swing priority proportional 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 priority 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	• Swing priority function does not work or malfunction.
Related Information	1. An error code occurs when the EPPR valve’s connector is disconnected. 2. Normal output of the swing priority proportional valve. A. Swing priority proportional valve: 1) When the pilot pressure of each operation is more than 5 bar during both driving, bucket dump, and arm crowd combined operation : 800mA output 2) When the pilot pressure of each operation is more than 5 bar during both driving, boom up, and arm crowd combined operation : 800mA output

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: 18.35Ω

Figure 32



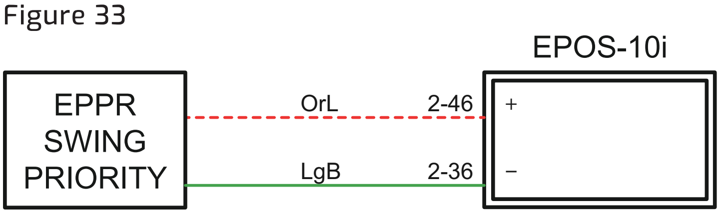
DS2102170

Pop-ups, Warning Symbols and Indicators

If the swing priority 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 33



DS2100954

14. VSV001 Breaker Operating Solenoid Valve

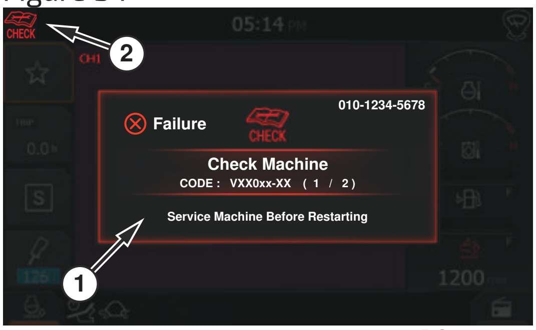
Action Level	Failure Code	Failure	Breaker Operating Solenoid Valve
Gauge Panel	VSV001		
Detail of Failure	The failure occurs only when the one-way is mounted. FMI 5: Breaker operating solenoid valve, current below normal (open circuit). FMI 6: Breaker operating solenoid valve, current above normal (short 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	1. 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% 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 breaker 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 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.

Figure 34



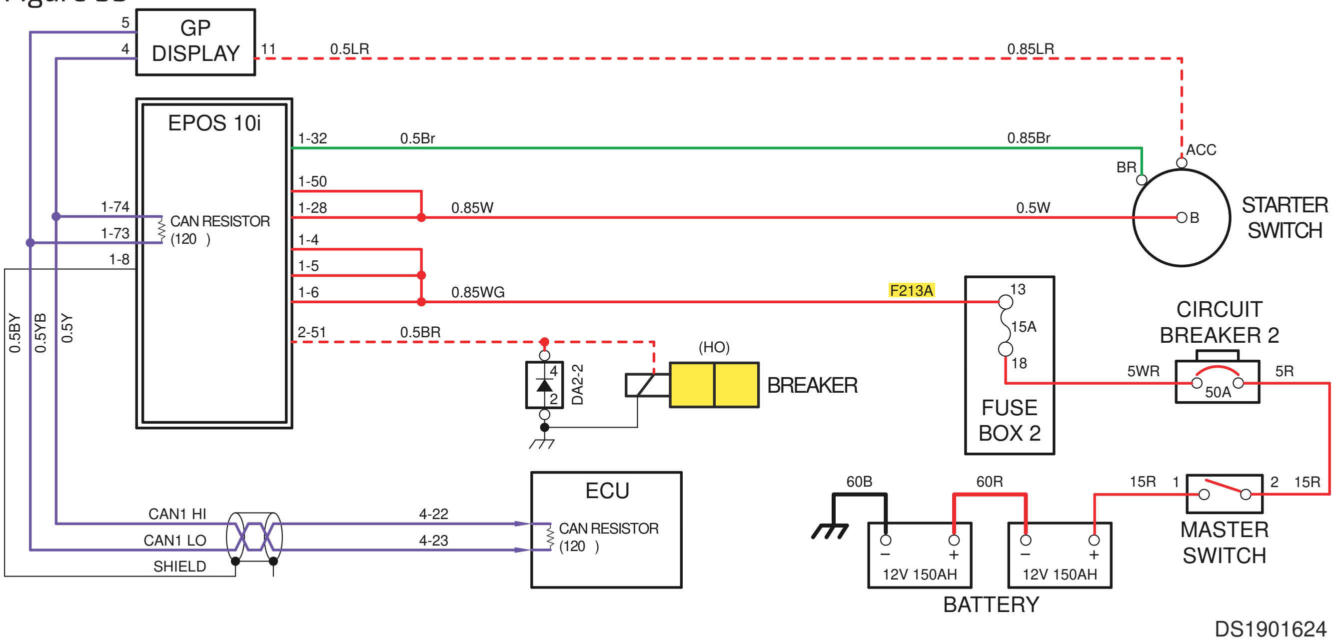
DS2102170

Pop-ups, Warning Symbols and Indicators

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 35



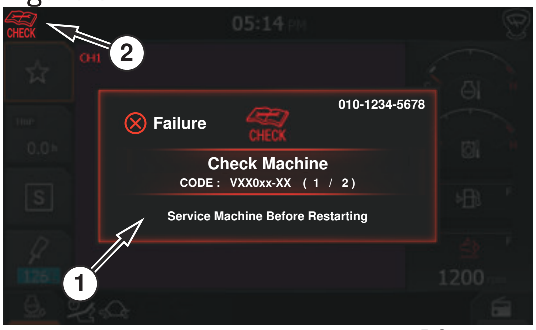
15. VSV003 High-speed Solenoid Valve (C)

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.		
Problem on Machine	1. 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.
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.

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.

Figure 36



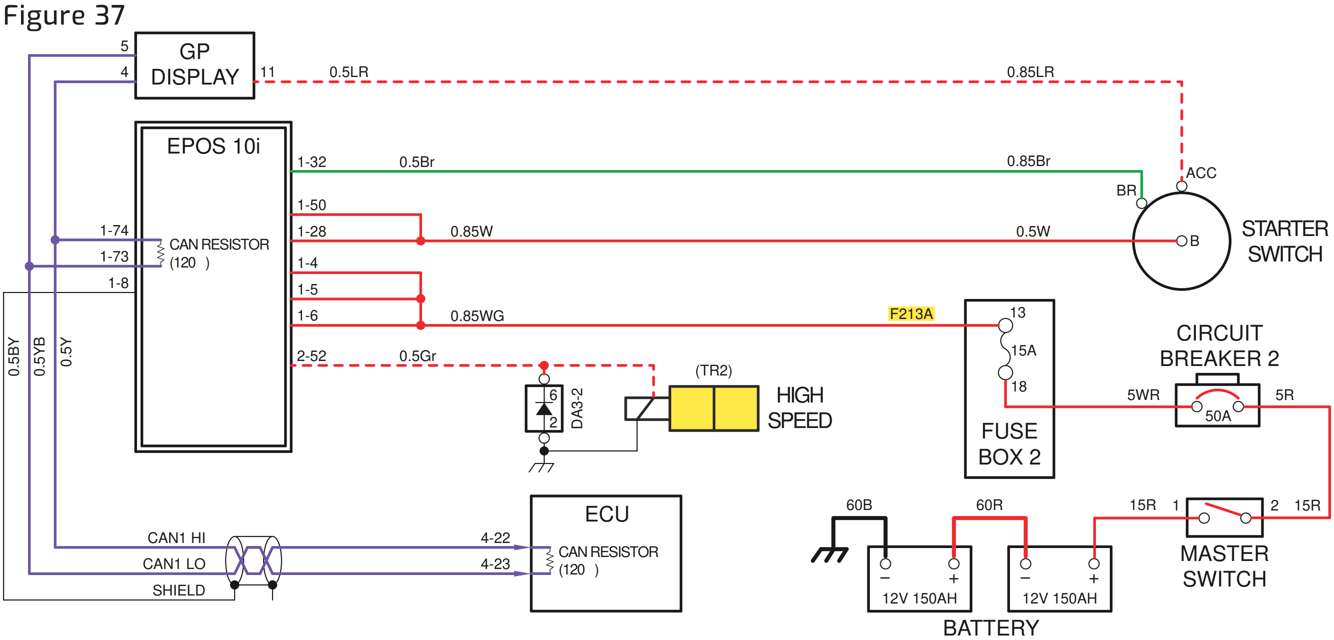
DS2102170

Pop-ups, Warning Symbols and Indicators

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 37



DS1901626

16. VSV007 Option Safety Solenoid Valve

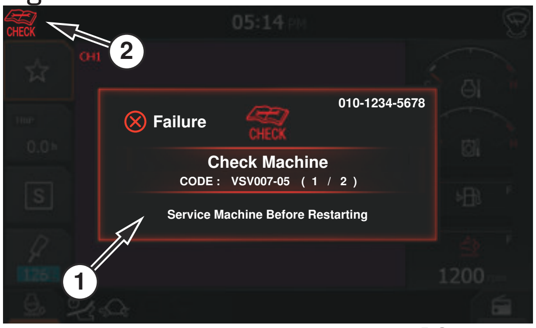
Action Level	Failure Code	Failure	Option Safety Solenoid Valve
Gauge Panel	VSV007		
Detail of Failure	The failure occurs only when the two-way and hydraulic pedal are mounted. FMI 5: Option safety solenoid valve, current below normal (open circuit). FMI 6: Option safety solenoid valve, current above 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 valve is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.
Problem on Machine	1. The attachment function may be operated abnormally or may not be operated at all if the option pedal safety solenoid valve is defective. 2. 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. 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 ±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 option safety 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.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		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 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.

Figure 38



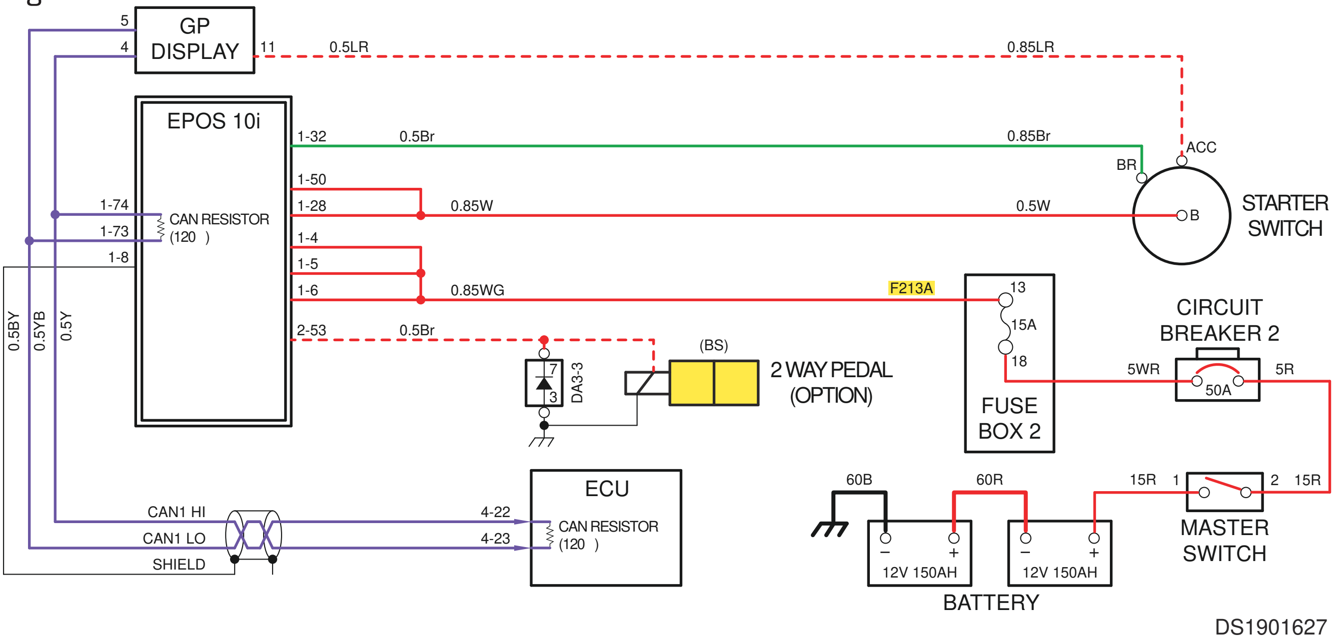
DS1901668

Pop-ups, Warning Symbols and Indicators

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 39



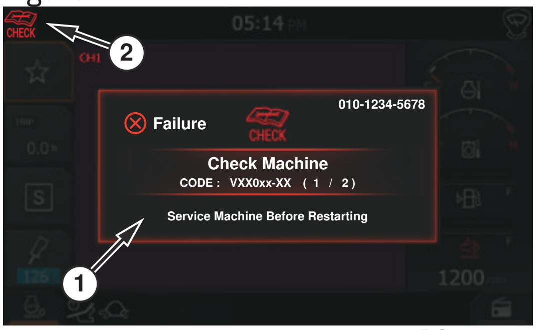
17. VSV035 Free Boom Up Solenoid Valve

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.		
Problem on Machine	1. 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) Resistance: a) C1: 27.5 Ω ±3% (@20°C) b) C2: 29.8 Ω ±3% (@20°C)		

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: a) C1: 27.5 Ω ±3% (@20°C) b) C2: 29.8 Ω ±3% (@20°C)
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.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		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.

Figure 40



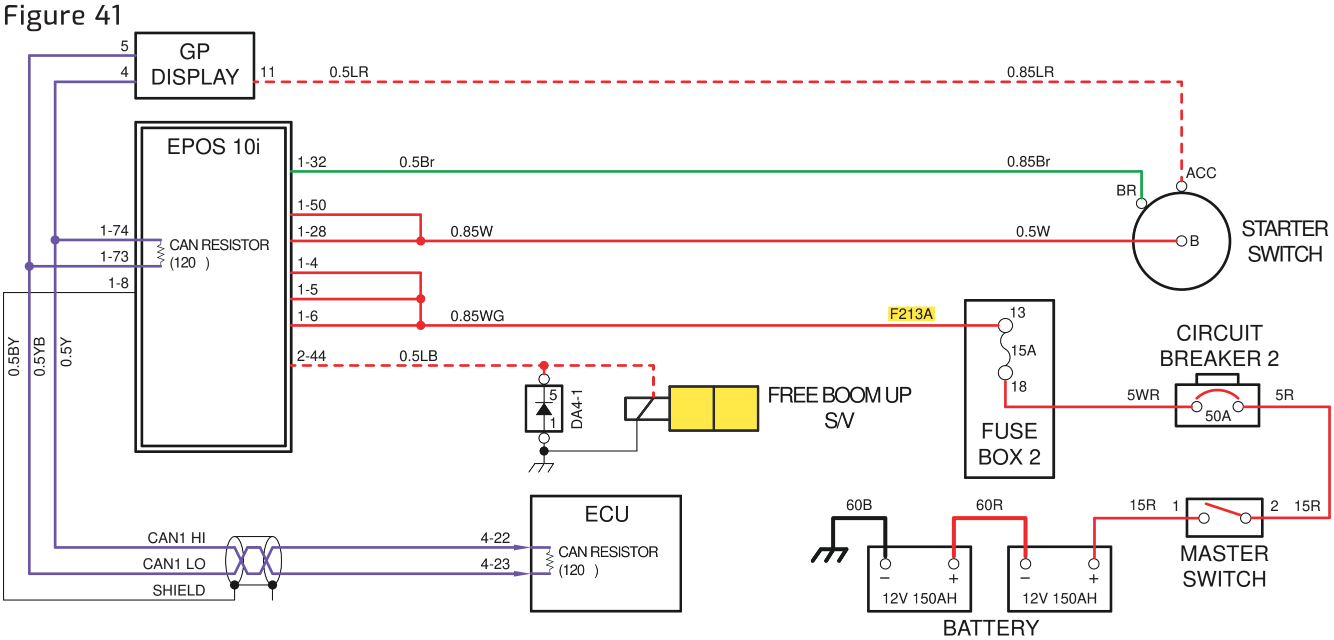
DS2102170

Pop-ups, Warning Symbols and Indicators

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 41



DS1901629

18. VSV036 Free Boom Down Solenoid Valve

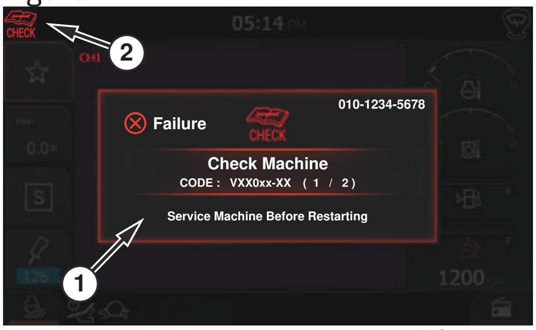
Action Level	Failure Code	Failure	Free Boom Down Solenoid Valve
Gauge Panel	VSV036		
Detail of Failure	FMI 5: Free boom down solenoid valve, current below normal (open circuit).		

	FMI 6: Free boom down solenoid valve, current above normal (short circuit).
Actions of Machine Monitor or Controller	• If the free boom down 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 down 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	1. The breaker floating boom function may be operated abnormally or may not be operated at all if the free boom down 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) Resistance: a) C1: 27.5 Ω ±3% (@20°C) b) C2: 29.8 Ω ±3% (@20°C)

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.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		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: a) C1: 27.5 Ω ±3% (@20°C) b) C2: 29.8 Ω ±3% (@20°C)
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 down function is not operating. 3. Check if the voltage of the (+) terminal of its solenoid valve measures 24 V when free boom down 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.

Figure 42



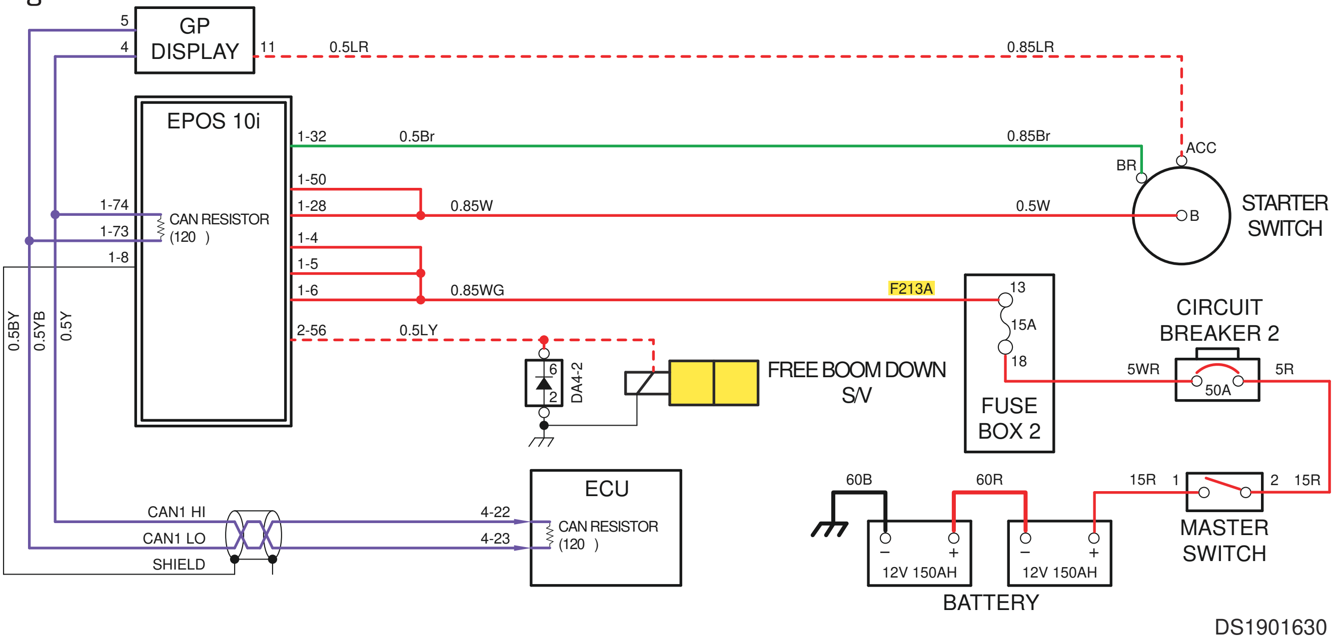
DS2102170

Pop-ups, Warning Symbols and Indicators

If the free boom down 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 43



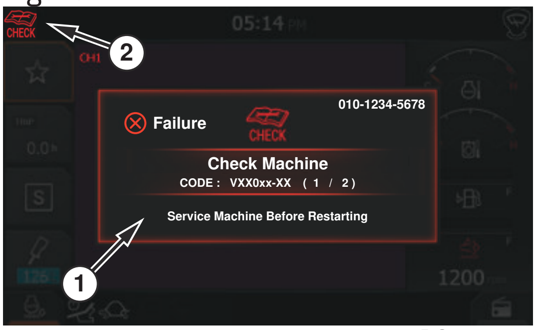
19. VSV037 Quick Coupler Solenoid Valve

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	1. 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 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 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. 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, 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.

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.

Figure 44



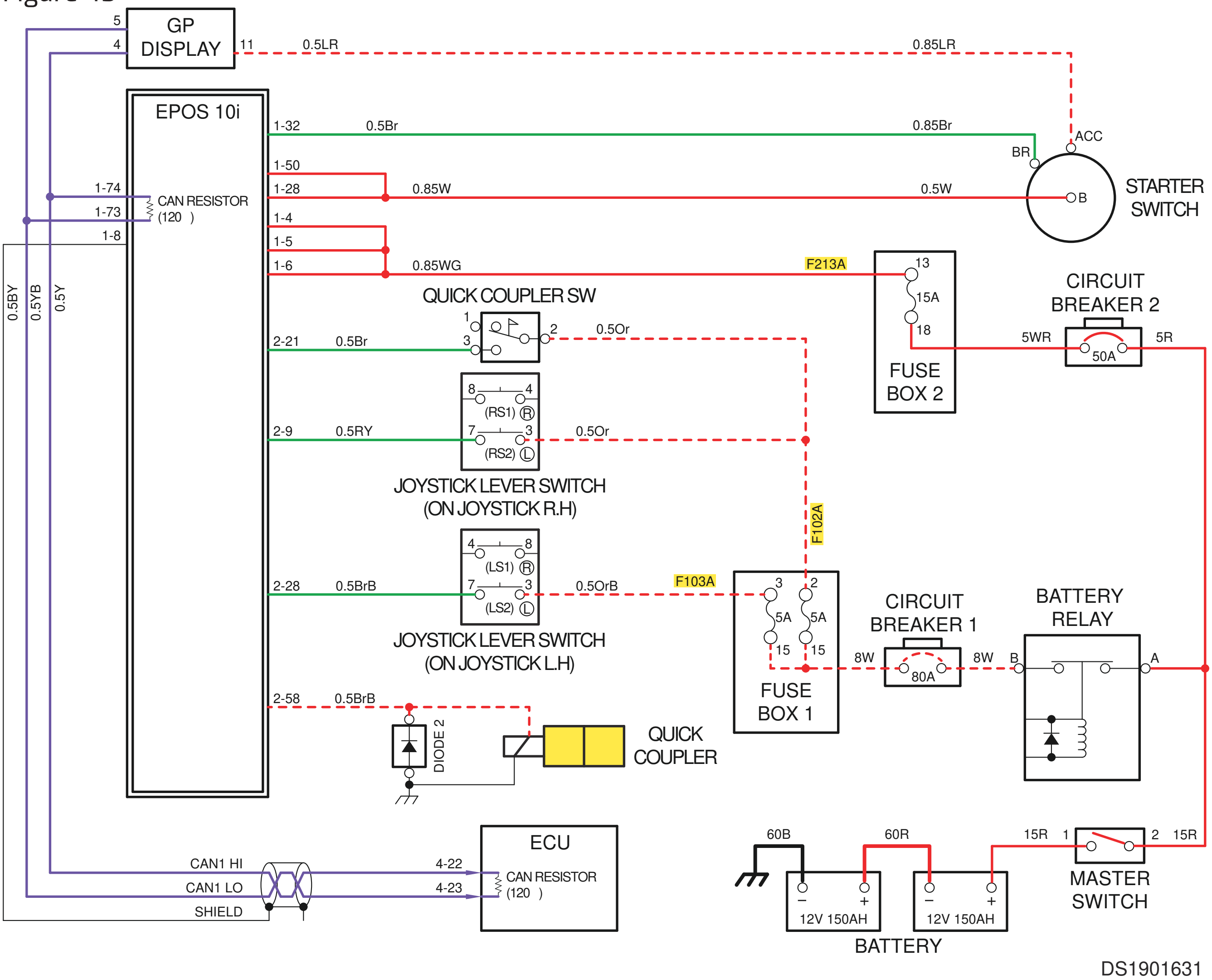
DS2102170

Pop-ups, Warning Symbols and Indicators

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 45



20. VRY002 Back Buzzer Relay

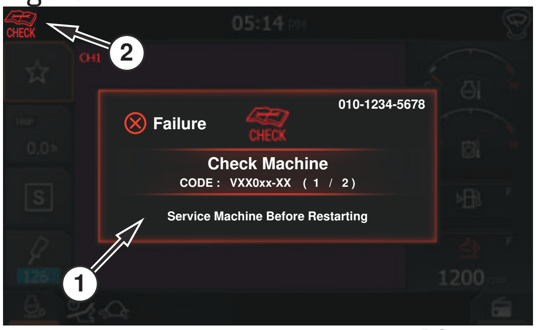
Action Level	Failure Code	Failure	Back Buzzer Relay
Gauge Panel	VRY002		
Detail of Failure	FMI 5: Back buzzer relay, current below normal (open circuit). FMI 6: Back buzzer relay, current above normal (short circuit).		
Actions of Machine Monitor or Controller	• If the backup buzzer relay is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • 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	1. 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 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 relay. 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 relay. 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 backup buzzer not in operation to check if the measurement is 0 V.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		3. Measure the voltage at the relay terminal No. 86 during a travel 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.

Figure 46



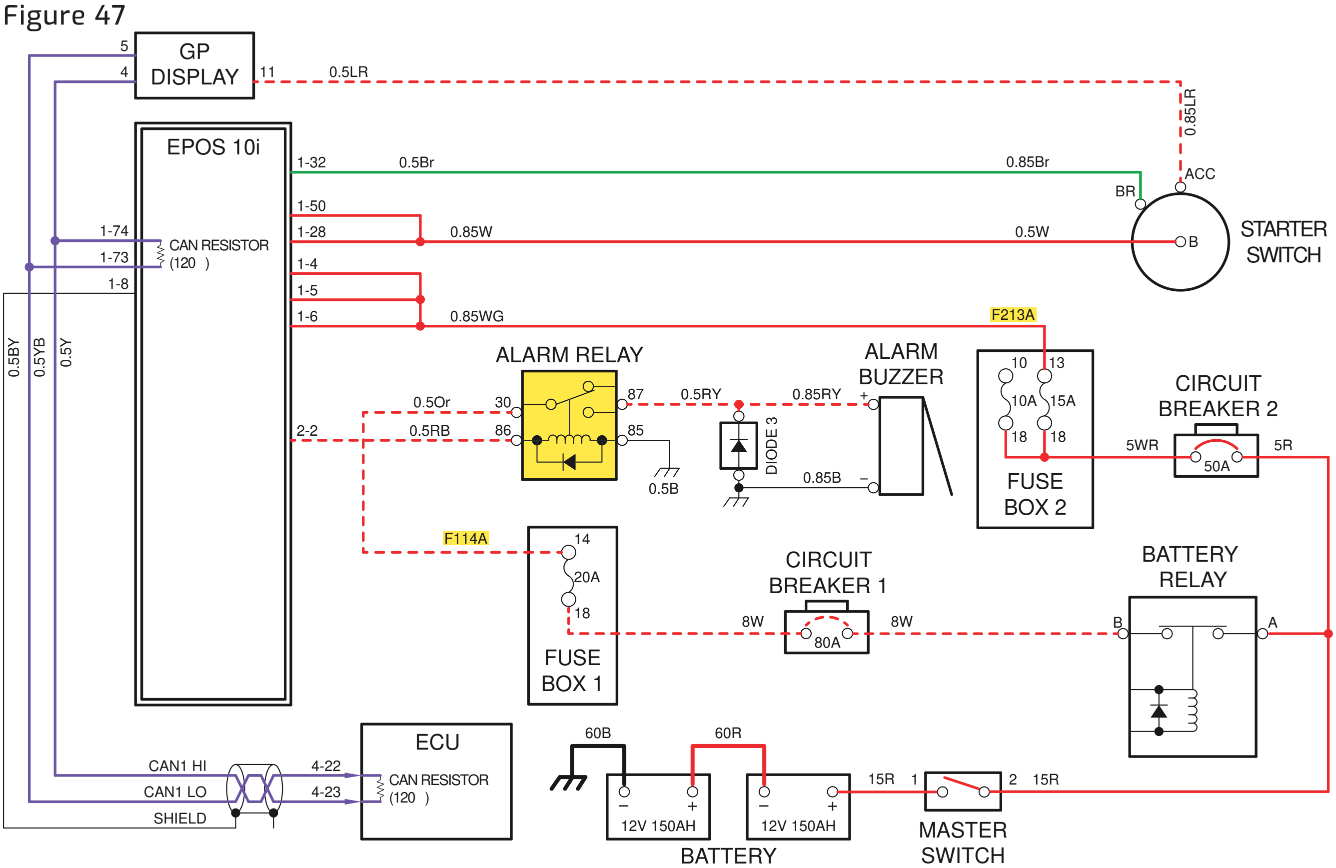
DS2102170

Pop-ups, Warning Symbols and Indicators

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 47



DS1901601

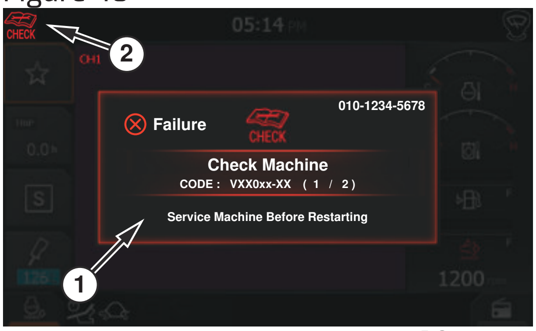
21. VRY016 Auto Shut Off Relay

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	1. 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 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 relay. 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 relay. 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.

Figure 48



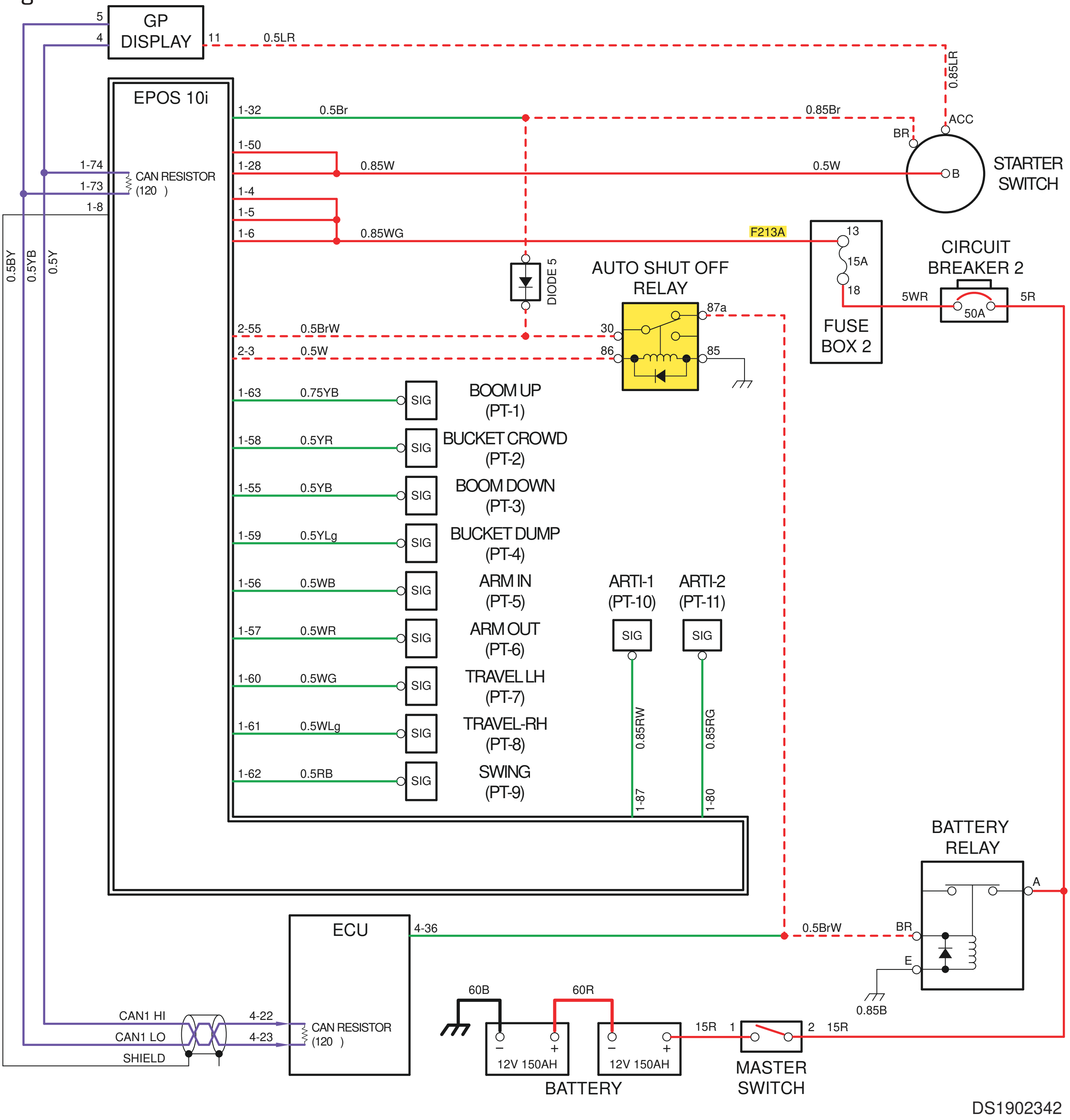
DS2102170

Pop-ups, Warning Symbols and Indicators

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 49



22. VRY018 ACC Relay

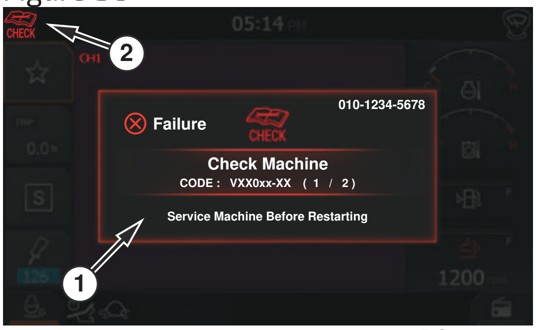
Action Level	Failure Code	Failure	ACC Relay
Gauge Panel	VRY018		
Detail of Failure	FMI 5: ACC Relay, current below normal (open circuit). FMI 6: ACC Relay, current above normal (short circuit).		
Actions of Machine Monitor or Controller	• If the ACC relay is malfunctioning, the "Check the machine" pop-up 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	1. Although the key switch is in "OFF" position, Audio, USB charger, hands free, 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 ACC 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 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 relay. 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 relay.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		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.

Figure 50



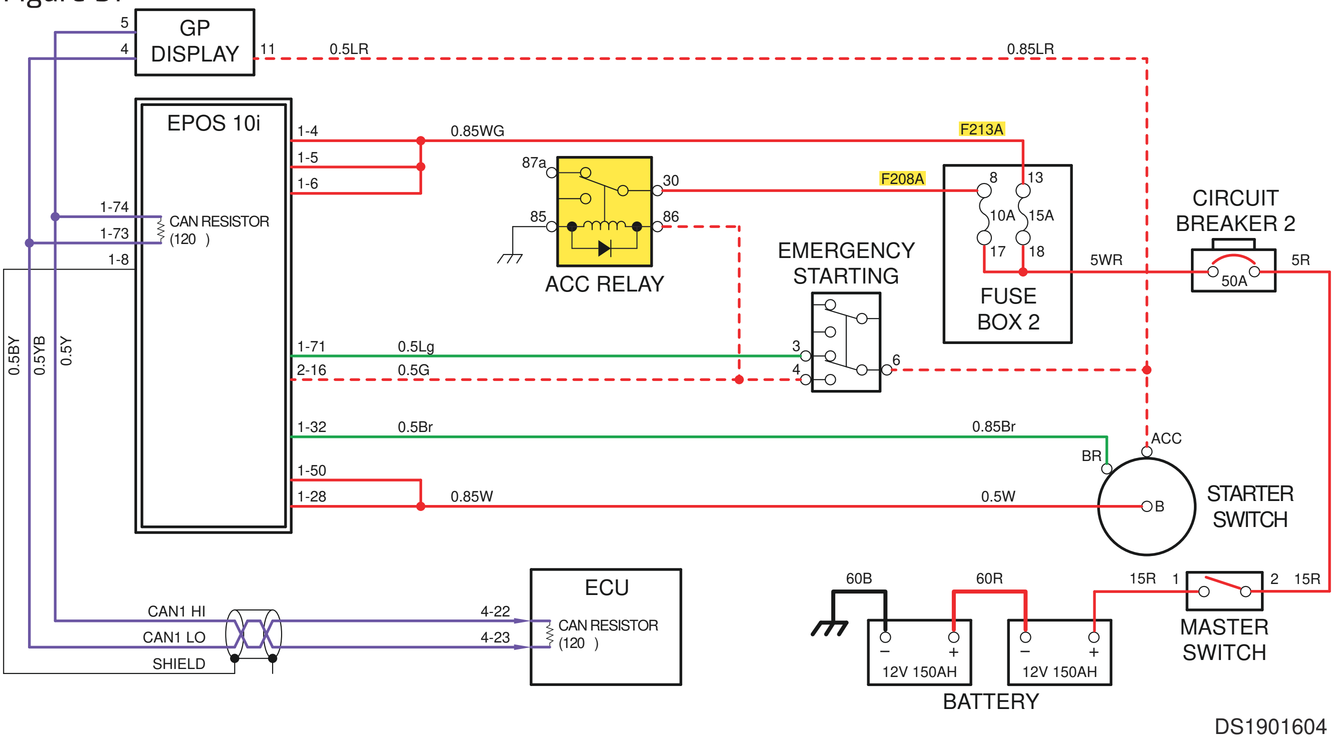
DS2102170

Pop-ups, Warning Symbols and Indicators

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 51



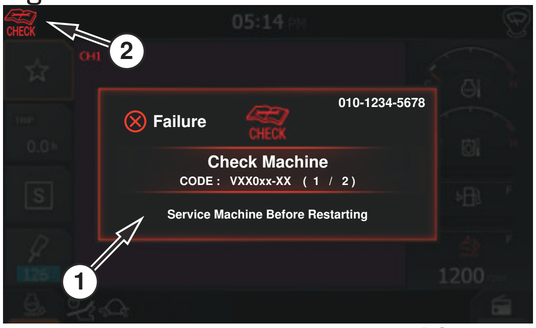
23. VRY026 Mirror Heater Relay

Action Level	Failure Code	Failure	Mirror Heater Relay
Gauge Panel	VRY026		
Detail of Failure	FMI 5: Mirror heater Relay, current below normal (open circuit). FMI 6: Mirror heater Relay, current above normal (short circuit).		
Actions of Machine Monitor or Controller	• If the Mirror heater 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 Mirror heater relay is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	1. Mirror heater function does not work or malfunction.		
Related Information	1. The failure code is generated when the Mirror heater relay is not connected to the correct position. 2. The function may operate abnormally unless the Mirror heater 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 Mirror heater relay is connected to the correct position.
2	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 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 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 relay. 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 relay. 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 / ACC and check if the voltage output from the relay at terminal 86 measures 0 V. 3. Measure the voltage at the relay terminal 86 during a mirror heater operation to check if the measurement is 24V. 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.

Figure 52



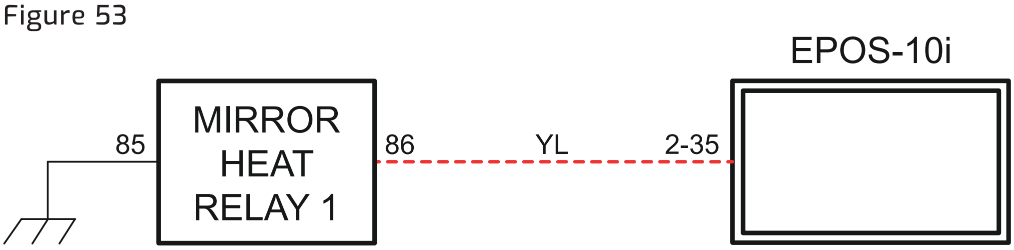
DS2102170

Pop-ups, Warning Symbols and Indicators

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 53



DS2100955

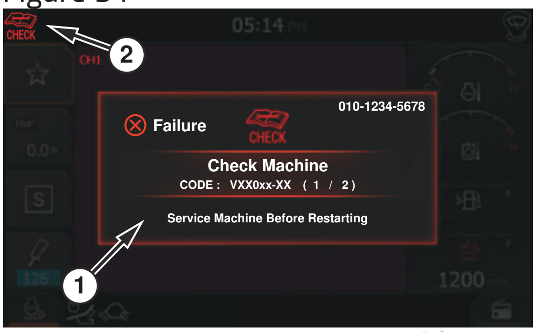
24. VGC003 External Voice Warning Signal

Action Level	Failure Code	Failure	External Voice Warning Signal
Gauge Panel	VGC003		
Detail of Failure	FMI 5: External voice warning signal, current below normal (open circuit). FMI 6: External voice warning signal, current above normal (short circuit).		
Actions of Machine Monitor or Controller	• This occurs only in a machine equipped with the AVM ultrasonic system and microphone option. - Defects regarding the outside voice alarm signal line can be checked in the Real Time Failure Information menu on the gauge panel.		
Problem on Machine	1. Despite the detection of an object by the ultrasonic sensor, the outside voice alarm for having people stay away is not set off or malfunctions.		
Related Information	1. The AVM ultrasonic system and microphone option work only when they are installed together. 2. To activate the outside voice alarm option, it should be set enabled on the gauge panel.		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	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 continuous operating signal terminal of wiper controller. 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 Micro phone External voice warning signal terminal. A. Check the power source, ground, and signal line for any short circuit.
3	Faulty EPOS	If the harness is correctly connected: 1. Check if the outside voice alarm signal is normally sent from the EPOS. → Microphone terminal 9. 2. Have the ultrasonic sensor detect an object and check if the voltage output from the microphone at terminal 9 measures 0 V. 3. If the voltage at the microphone terminal 9 measures constant at 24 V or 0 V, the EPOS is faulty and needs to be replaced.

Figure 54



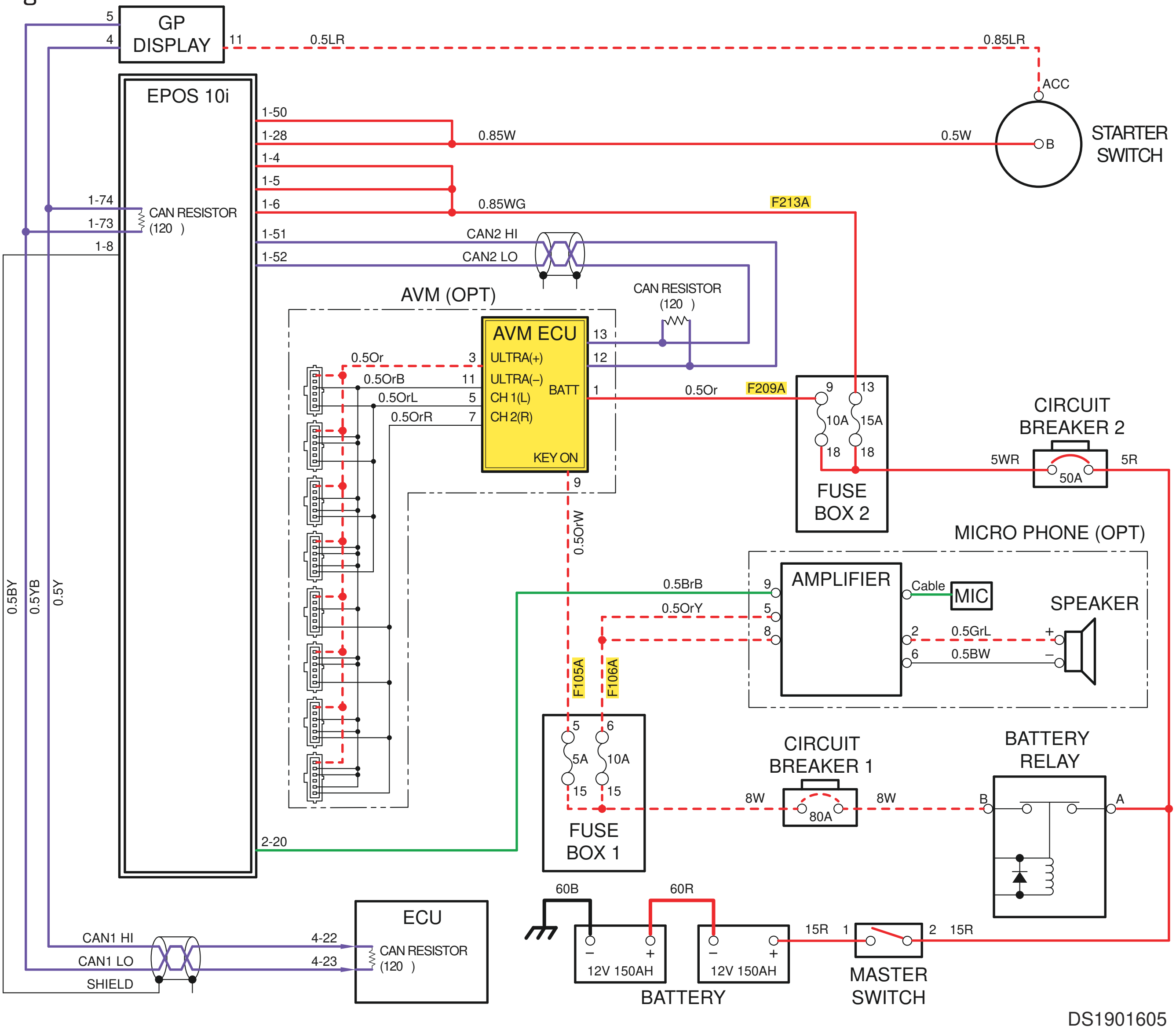
DS2102170

Pop-ups, Warning Symbols and Indicators

If the microphone 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 55

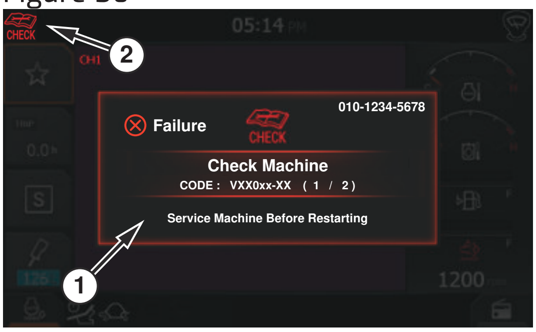


25. VGC004 Wiper Operating Signal

Action Level	Failure Code	Failure	Wiper Operating Signal
Gauge Panel	VGC004		
Detail of Failure	FMI 5: Wiper operating signal, current below normal (open circuit). FMI 6: Wiper operating signal, current above normal (short circuit).		
Actions of Machine Monitor or Controller	• If the joystick's multi-function is set to Wiper but the wiper operation signal cannot be normally delivered through its line, details of the defect can be checked in the real time failure Information menu on the gauge panel.		
Problem on Machine	• Although the joystick's multi-function is set to Wiper, the wiper may fail to operate or malfunction with the multi-function button pressed.		
Related Information	1. If the joystick's multi-function button is malfunctioning or its circuit is defective, the wiper may malfunction.		

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 ground and continuous operating signal terminal of wiper controller. 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 Micro phone External voice warning signal terminal. A. Check the power source, ground, and signal line for any short circuit.
3	Faulty EPOS	If the harness is correctly connected: 1. Check if the outside voice alarm signal is normally sent from the EPOS. → Microphone terminal 5. 2. Have the ultrasonic sensor detect an object and check if the voltage output from the microphone at terminal 5measures 0 V. 3. If the voltage at the microphone terminal 5 measures constant at 24 V or 0 V, the EPOS is faulty and needs to be replaced.

Figure 56



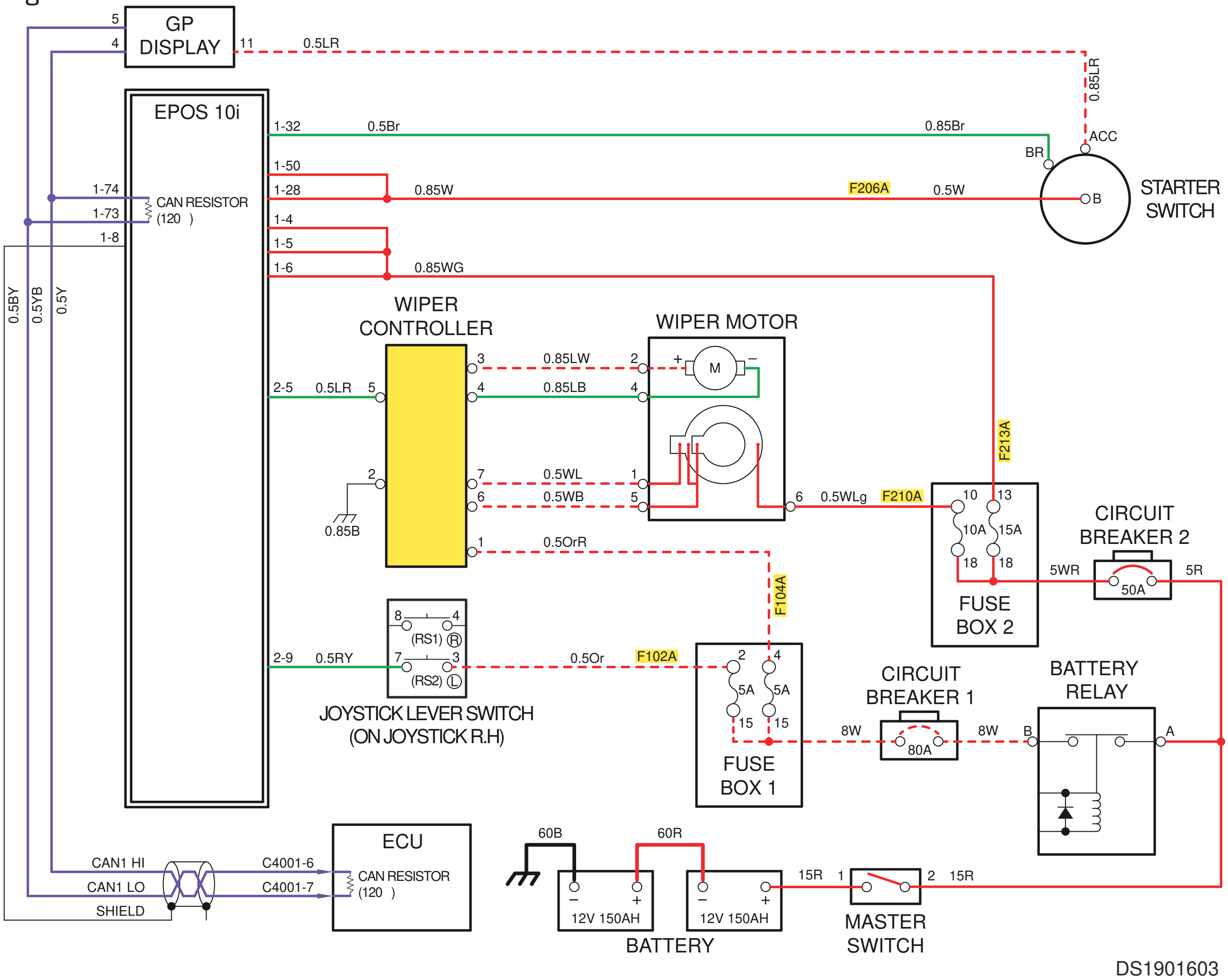
DS2102170

Pop-ups, Warning Symbols and Indicators

If the microphone 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 57



26. 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	1. The relief cutoff function won't operate if the front pump pressure sensor is malfunctioning. 2. Automatic travel mode is not operative. 3. 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.		

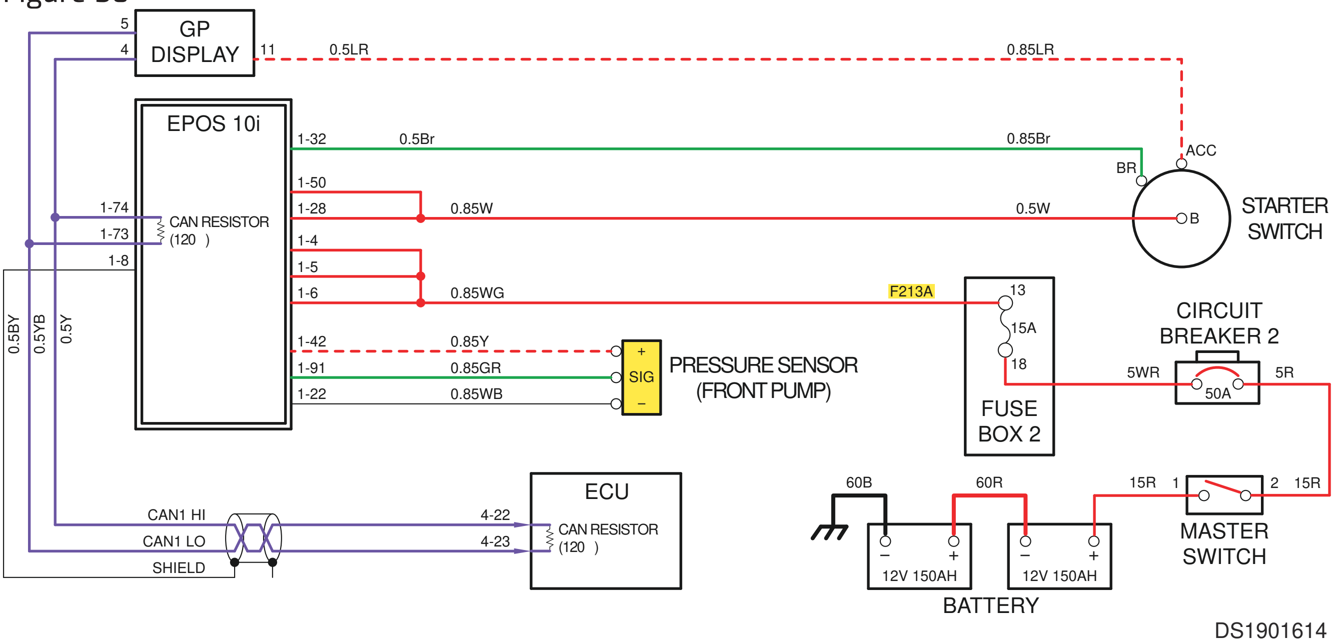
	3. The pressure value measured by the pressure sensor can be checked on the monitoring menu screen of the gauge panel. A. Features of pressure sensor 1) Operating voltage: 5 V ±5% 2) Operating current: max. 10 mA 3) Output voltage: 1 to 5 V 4) Measuring pressure: 0 to 500 bar 5) Measurement tolerance: ± 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.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
4	Faulty 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 58



27. VSP002 Rear Pump Pressure Sensor

Action Level	Failure Code	Failure	Rear Pump Pressure Sensor

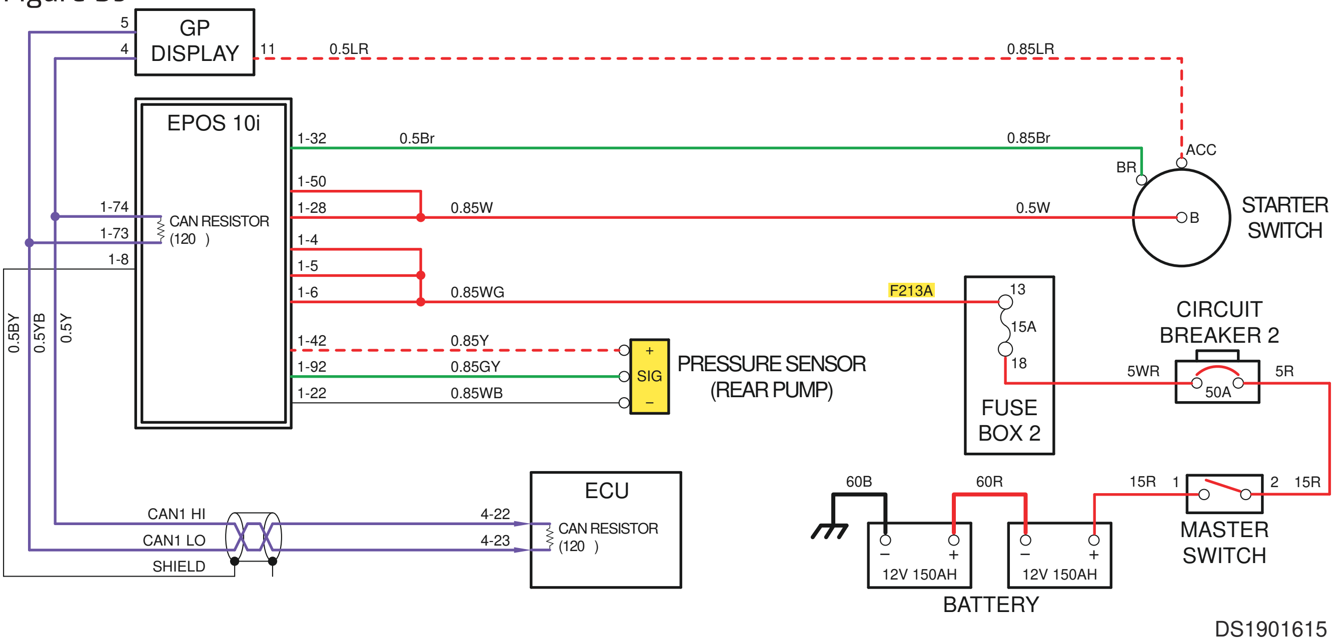
Gauge Panel	VSP002		
Detail of Failure	FMI 2: The rear pump pressure sensor, incorrect signal. FMI 3: The rear pump pressure sensor, voltage above normal. FMI 4: The rear pump pressure sensor, voltage below normal.		
Actions of Machine Monitor or Controller	• If the rear pump pressure sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	1. The relief cutoff function won't operate if the rear pump pressure sensor is malfunctioning. 2. Automatic travel mode is not operative. 3. 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 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.

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. 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 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 59



28. 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.		
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	1. 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: ± 2%		

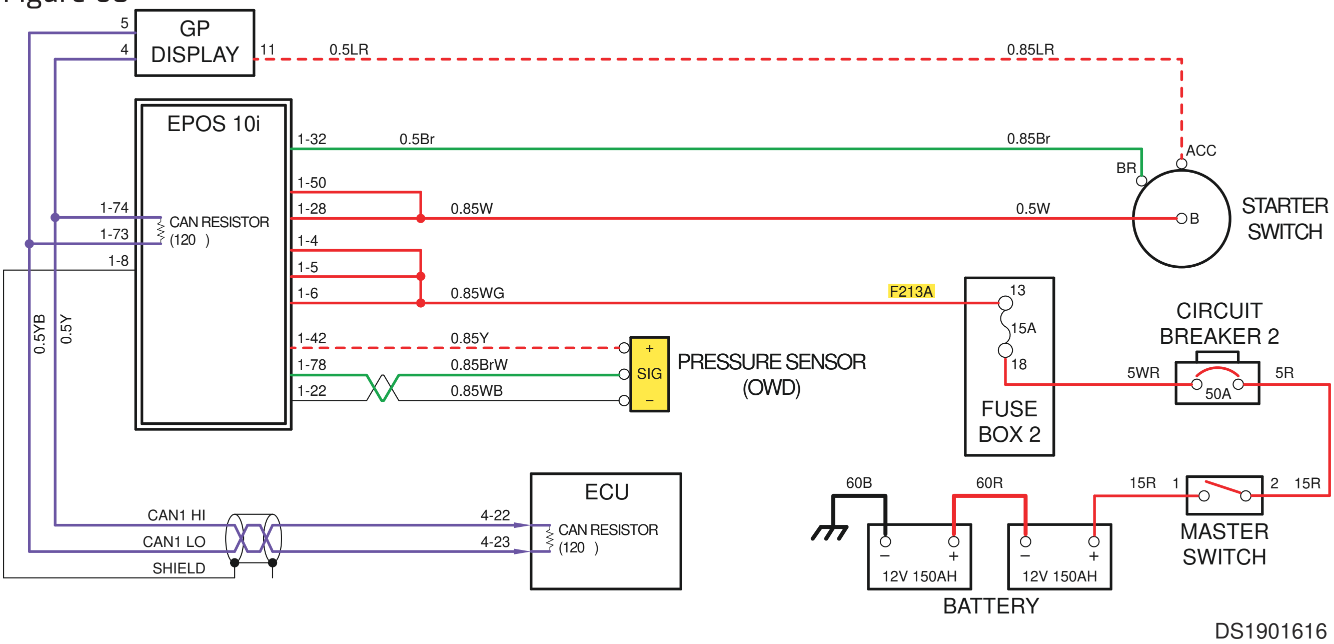
No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the pressure sensor is correctly connected.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		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 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

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		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 60



29. 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	1. 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.		

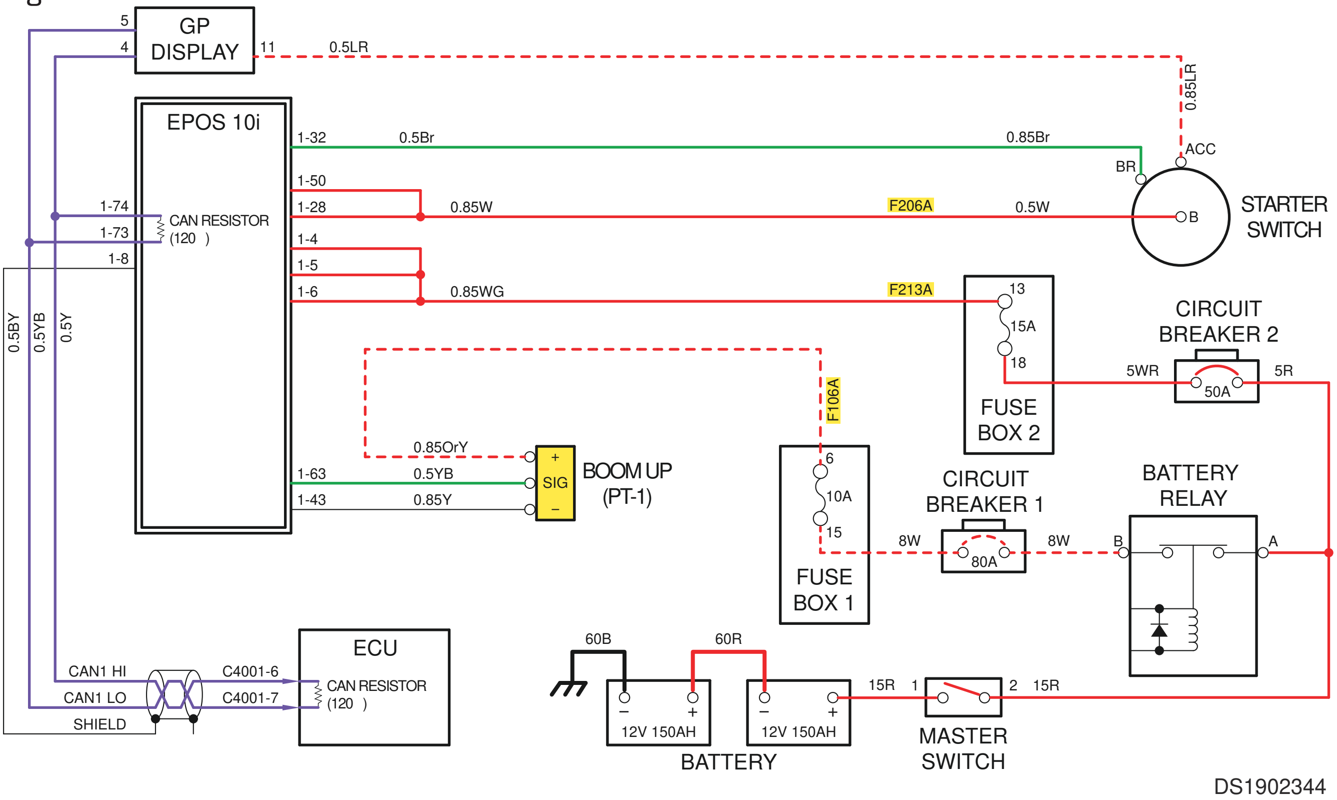
	2. The pressure sensor can be severely damaged if its power line and ground line are swapped. 3. The pressure value measured by the pressure sensor can be checked on the monitoring menu screen of the gauge panel. A. Features of pressure sensor 1) Operating voltage: 24 V ±10% 2) Operating current: max. 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. 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.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		A. Check the power source, ground, and signal line for any short circuit.
4	Faulty 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 61



30. VSP007 Bucket Crowd Pressure Sensor

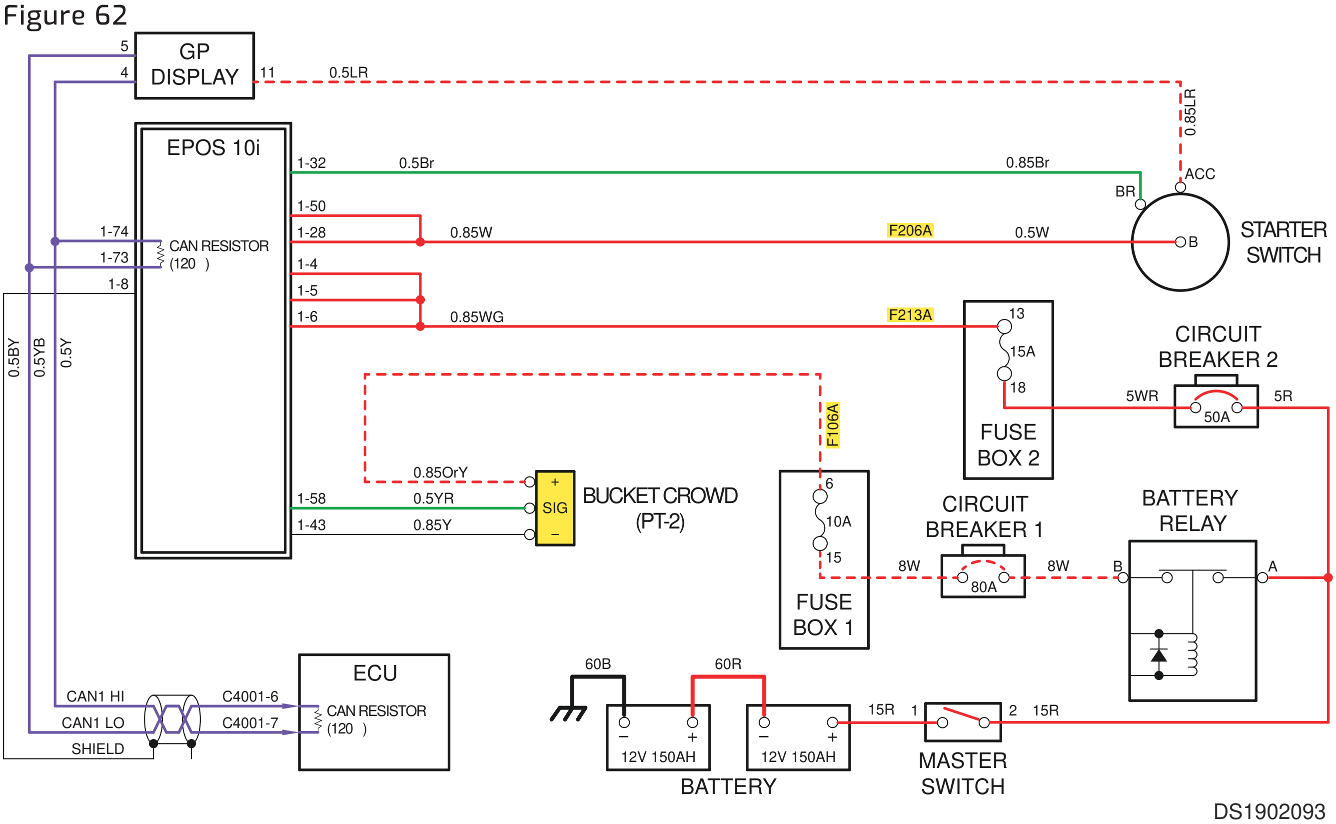
Action Level	Failure Code	Failure	Bucket Crowd Press. Sensor
Gauge Panel	VSP007		
Detail of Failure	FMI 3: The bucket crowd pressure sensor, voltage above normal. FMI 4: The bucket crowd pressure sensor, voltage below normal.		
Actions of Machine Monitor or Controller	• If the bucket crowd pressure sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	1. 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 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 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.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		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 62



31. 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.		

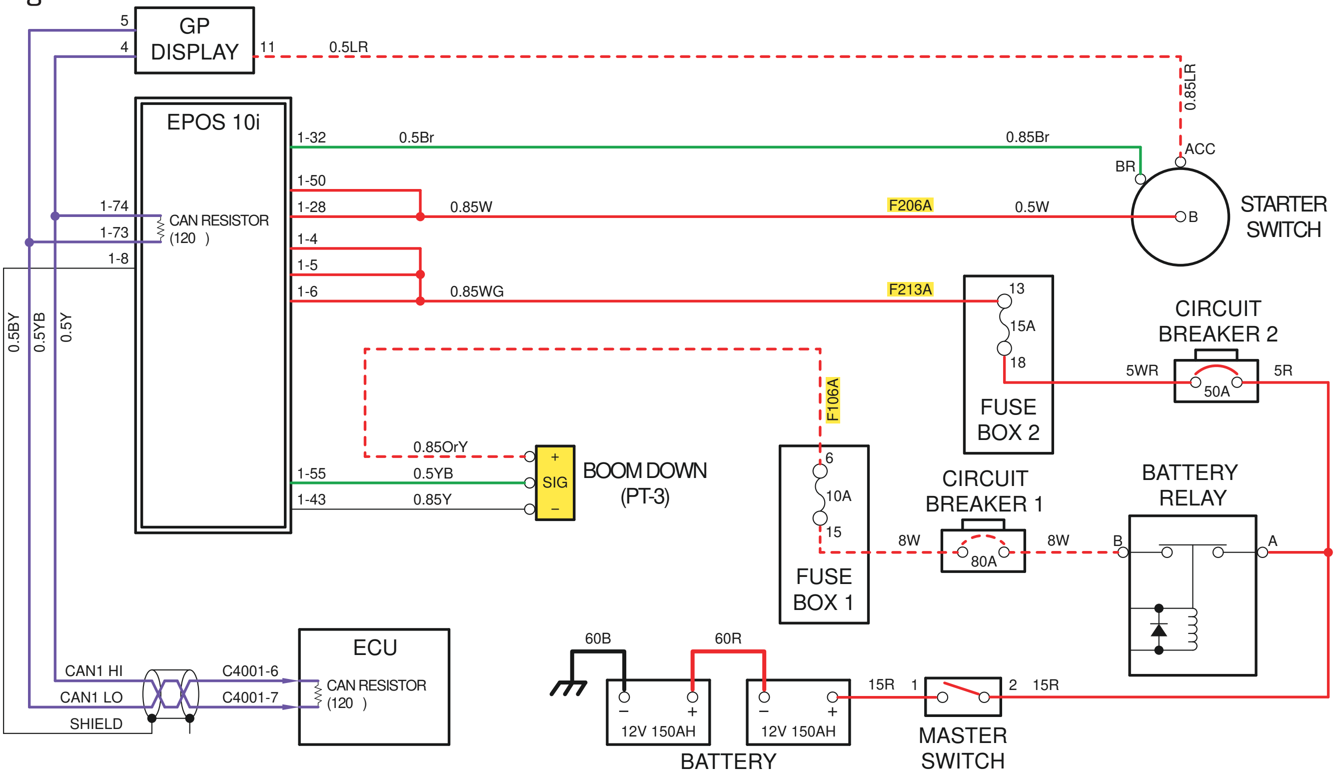
Actions of Machine Monitor or Controller	• If the boom down pressure sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.
Problem on Machine	1. When the boom-down pressure sensor is malfunctioning, the boom-down 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. 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.

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	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 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 63



32. VSP009 Bucket Dump Pressure Sensor

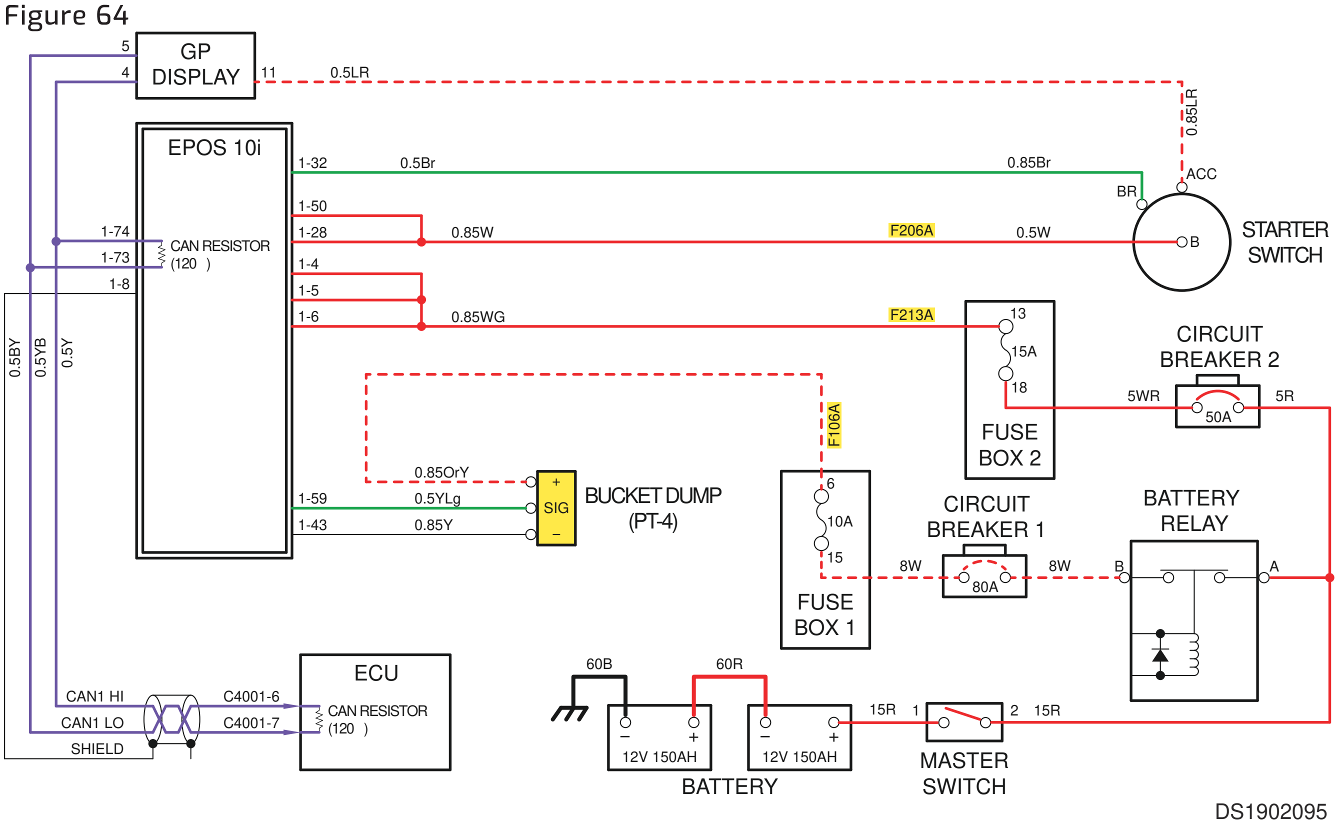
Action Level	Failure Code	Failure	Bucket Dump Press. Sensor
Gauge Panel	VSP009		
Detail of Failure	FMI 3: The bucket dump pressure sensor, voltage above normal. FMI 4: The bucket dump pressure sensor, voltage below normal.		
Actions of Machine Monitor or Controller	• If the bucket dump pressure sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	1. 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 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 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.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		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 64



33. VSP010 Arm in Pressure Sensor

Action Level	Failure Code	Failure	Arm in Pressure Sensor
Gauge Panel	VSP010		
Detail of Failure	FMI 3: The arm in pressure sensor, voltage above normal. FMI 4: The arm in pressure sensor, voltage below normal.		

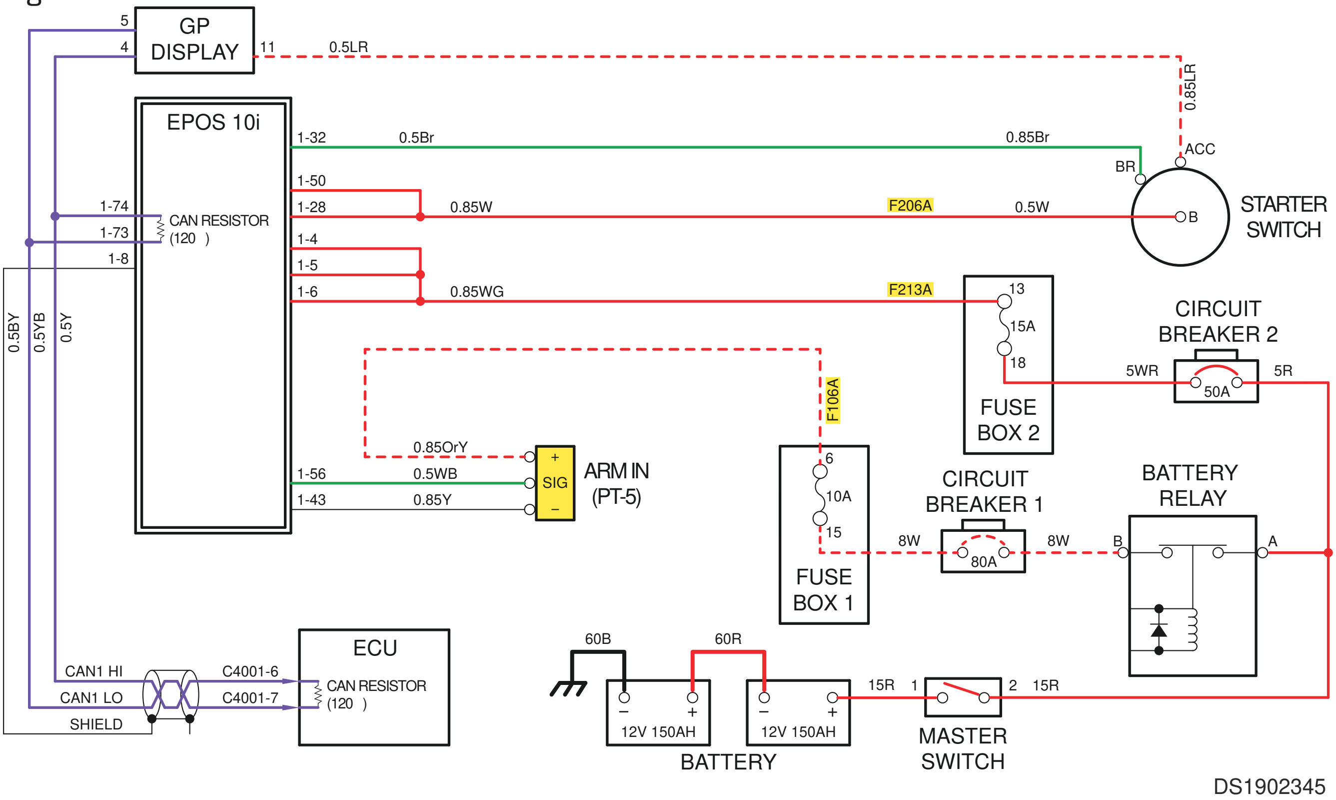
Actions of Machine Monitor or Controller	• If the arm in pressure sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.
Problem on Machine	1. When the arm-in pressure sensor is malfunctioning, the arm-in operation may slow down or malfunction as the arm-in pressure cannot be detected.
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.

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	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 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 65



34. VSP011 Arm Out Pressure Sensor

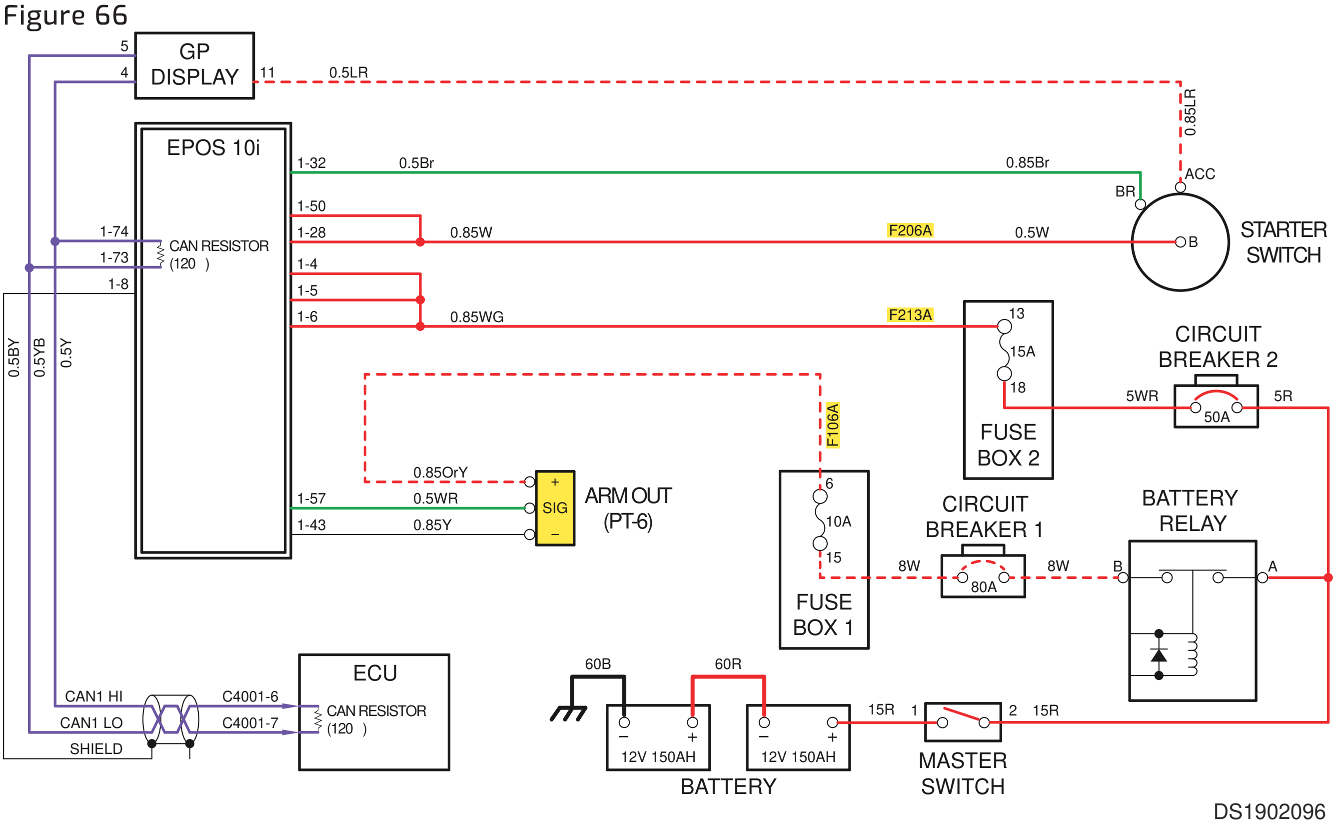
Action Level	Failure Code	Failure	Arm Out Pressure Sensor
Gauge Panel	VSP011		
Detail of Failure	FMI 3: The arm out pressure sensor, voltage above normal. FMI 4: The arm out pressure sensor, voltage below normal.		
Actions of Machine Monitor or Controller	• If the arm in pressure sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	1. 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 5) Measurement tolerance: ± 3%		

<table>
<tr><th>No.</th><th>Cause</th><th>Procedure, Measuring Location, Criteria and Remarks</th></tr>
<tr><td>1</td><td>Faulty Power Supply</td><td>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.</td></tr>
<tr><td>2</td><td>Open Circuit in Harness</td><td>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.</td></tr>
<tr><td>3</td><td>Short Circuit in Harness</td><td>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.</td></tr>
<tr><td>4</td><td>Faulty Sensor</td><td>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.</td></tr>
</table>

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		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 66



35. 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.		

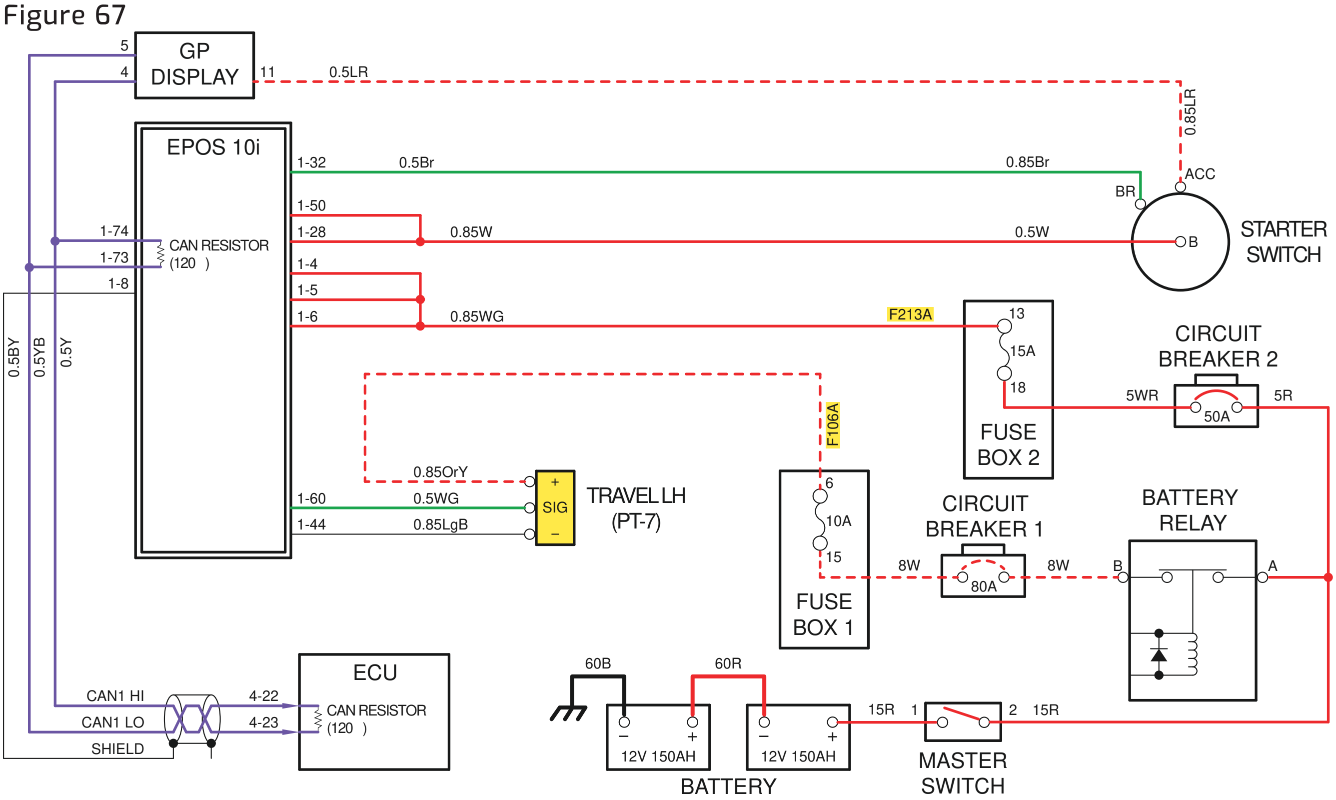
Actions of Machine Monitor or Controller	• If the travel pressure sensor (LH) is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.
Problem on Machine	• If an exclusive left travel or forward/reverse travel is performed 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. 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.

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	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 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 67



36. 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	1. 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 4) Measuring pressure: 0 to 50 bar		

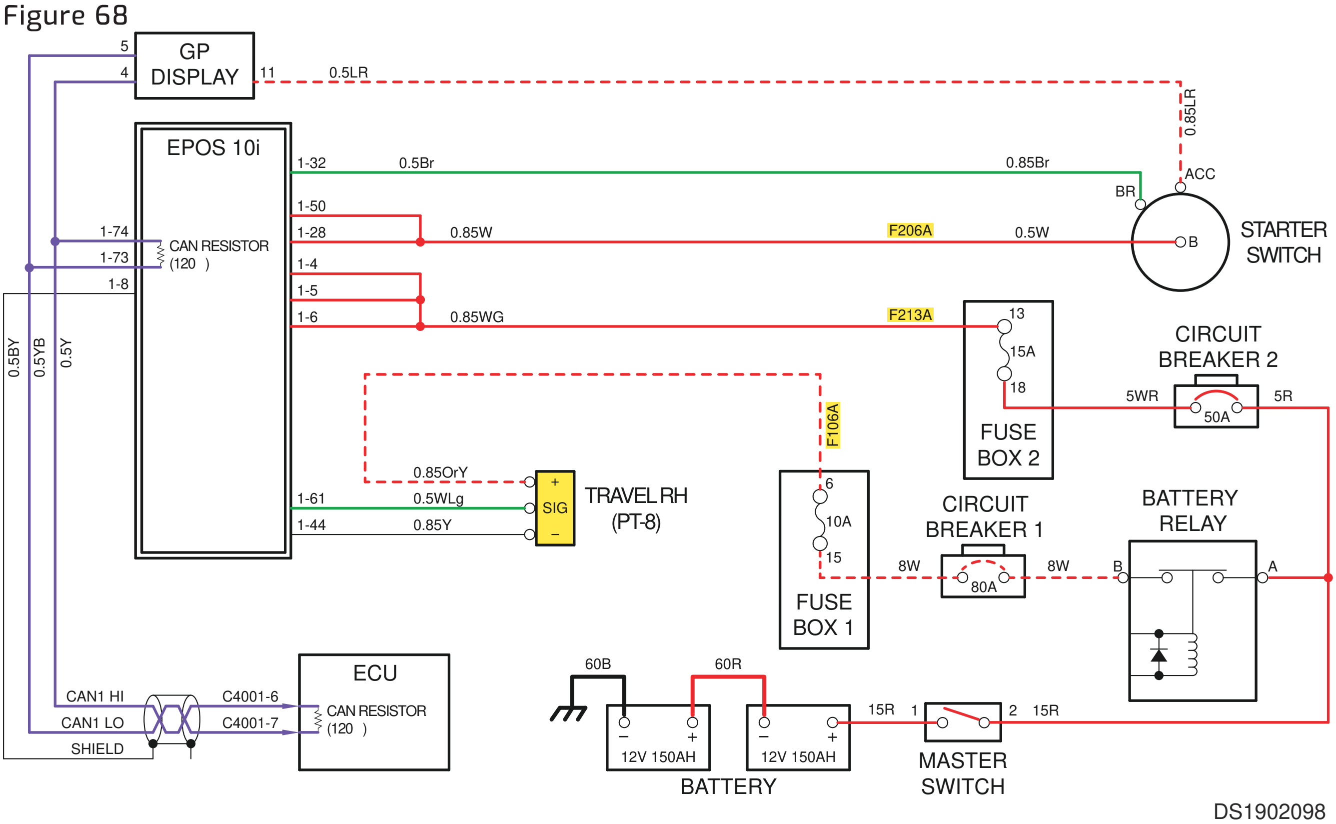
	5) Measurement tolerance: ± 3%

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 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.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		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 68



37. 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.		

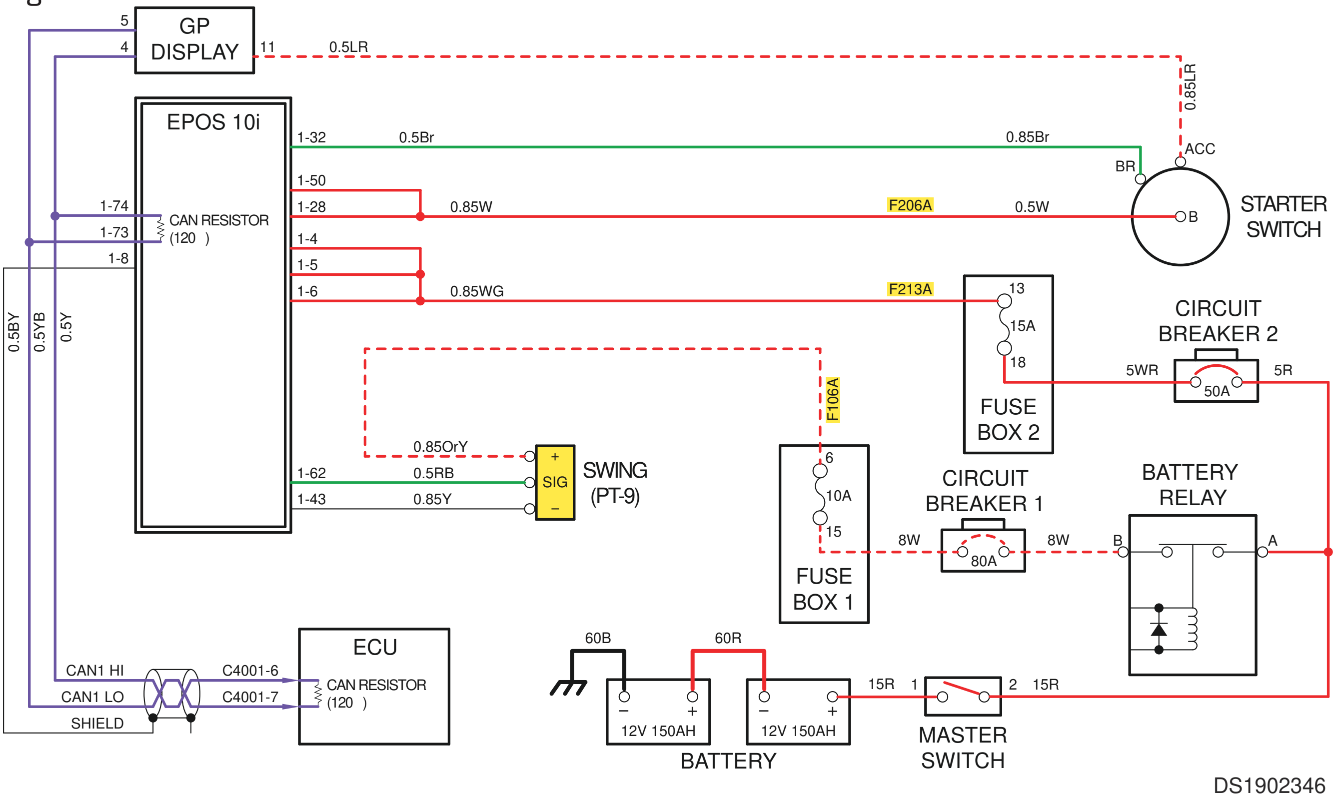
	FMI 4: The swing pressure sensor, voltage below normal.
Actions of Machine Monitor or Controller	• If the swing pressure sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.
Problem on Machine	1. When the swing 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. 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.

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	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 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 69



38. VSP015 ATT(Option) Pressure Sensor

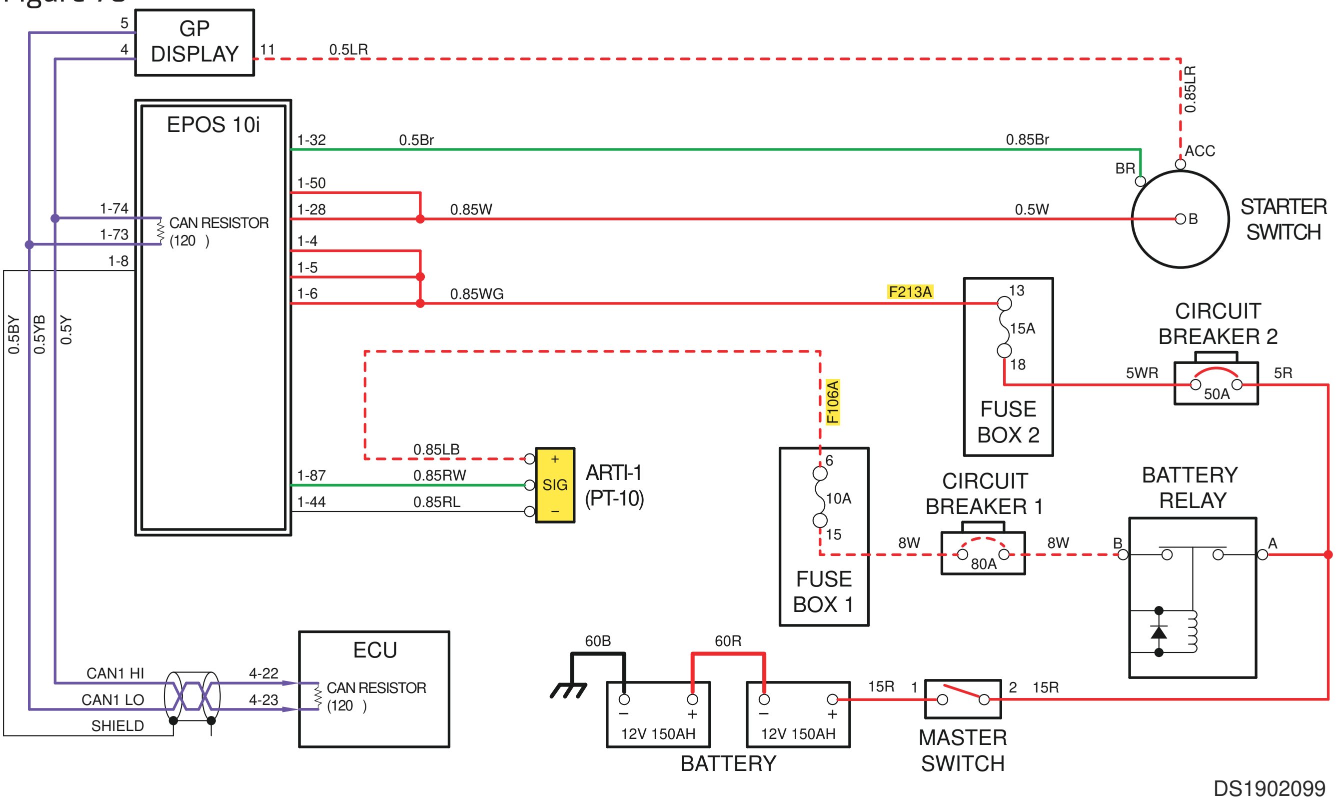
Action Level	Failure Code	Failure	ATT (Option) Pressure Sensor
Gauge Panel	VSP015		
Detail of Failure	FMI 3: The ATT (option) pressure sensor, voltage above normal. FMI 4: The ATT (option) pressure sensor, voltage below normal.		
Actions of Machine Monitor or Controller	• If the ATT (option) pressure sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	1. When the attachment (option) 1 pressure sensor is malfunctioning, the attachment (option) operation may slow down or malfunction as the attachment (option) 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. 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 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.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		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 70



39. VSP016 Attachment 2 Pressure Sensor

Action Level	Failure Code	Failure	Attachment 2 Pressure Sensor
Gauge Panel	VSP016		
Detail of Failure	FMI 3: The attachment 2 pressure sensor, voltage above normal. FMI 4: The attachment 2 pressure sensor, voltage below normal.		

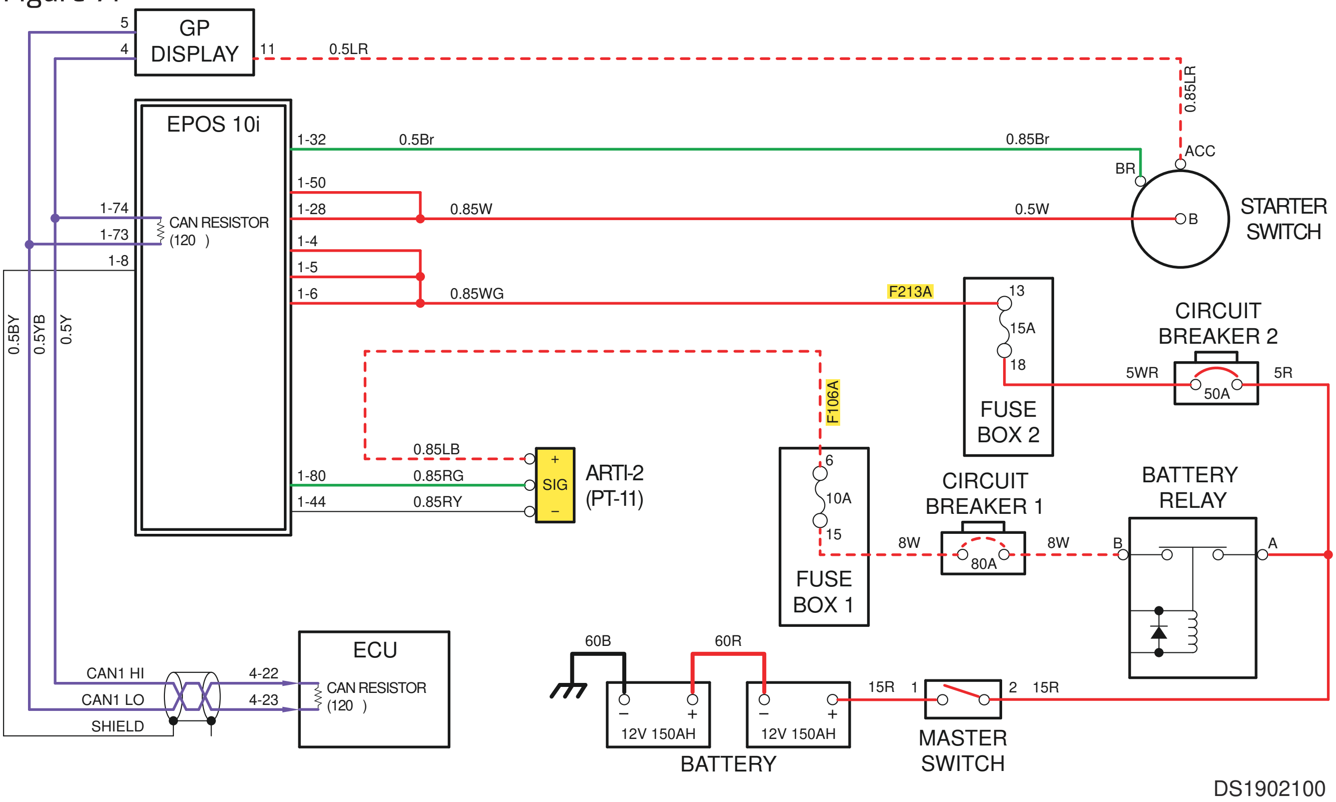
Actions of Machine Monitor or Controller	• If the attachment 2 pressure sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.
Problem on Machine	• When the attachment (option) 2pressure sensor is malfunctioning, the attachment (option) operation may slow down or malfunction as the attachment (option) 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. 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.

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	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 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 71



40. 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	1. If the option pedal 1 pressure sensor is malfunctioning, the option may function abnormally. 2. 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		

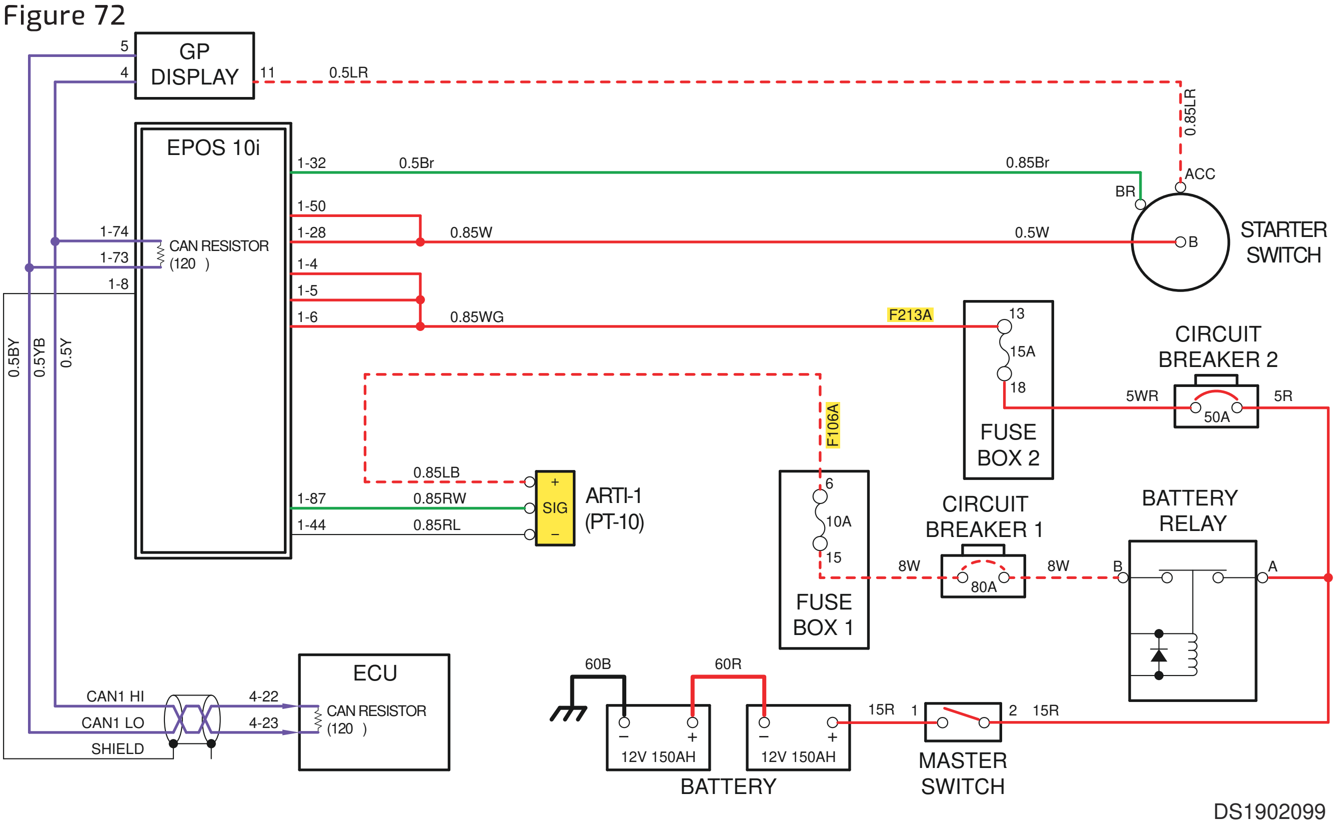
	5) Measurement tolerance: ± 3%

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 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.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		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 72



41. 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.		

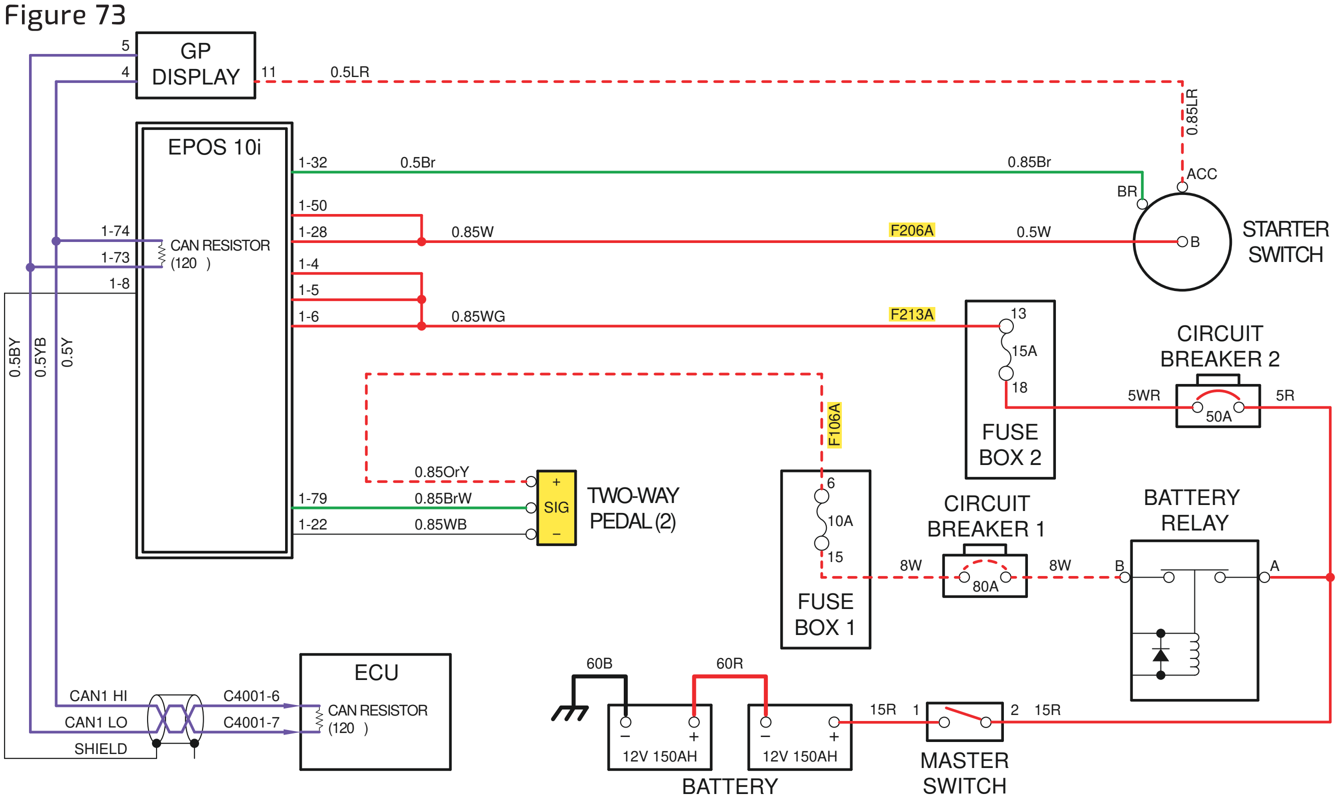
	FMI 4: The option pedal 2 pressure sensor, voltage below normal.
Actions of Machine Monitor or Controller	• If the option pedal 2 pressure sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.
Problem on Machine	1. If the option pedal 2 pressure sensor is malfunctioning, the option may function abnormally 2. 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 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.

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. 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 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 73



42. VSP049 Dozer Pressure Sensor

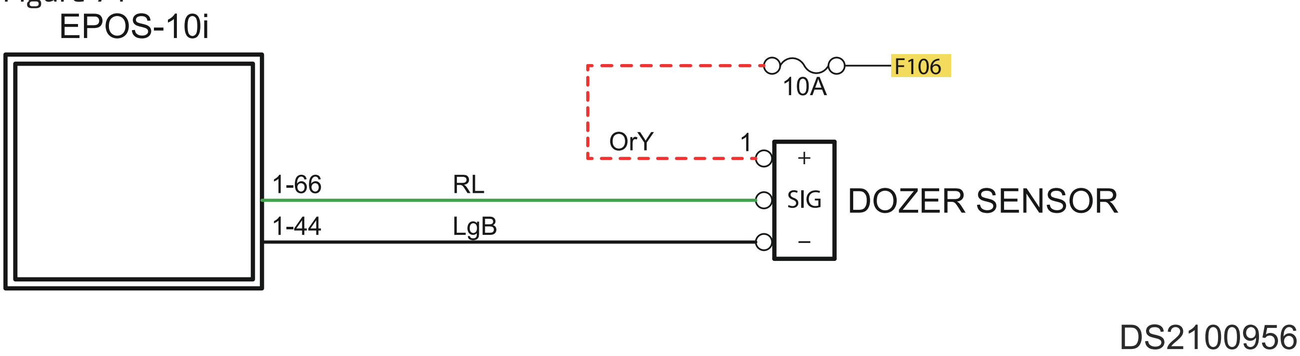
Action Level	Failure Code	Failure	Option Pedal 2 Pressure Sensor
Gauge Panel	VSP049		
Detail of Failure	FMI 3: The Dozer pressure sensor, voltage above normal. FMI 4: The Dozer pressure sensor, voltage below normal.		
Actions of Machine Monitor or Controller	• If the Dozer pressure sensor is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel..		
Problem on Machine	1. When the dozer pressure sensor is malfunctioning, the dozer operation may slow down or malfunction as the dozer 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. 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 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.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		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 74



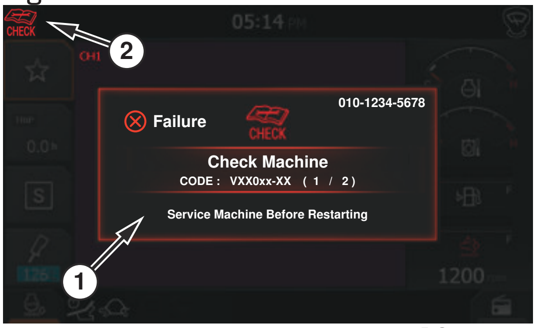
43. VSE001 Oil Temperature Sensor

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	1. The operating oil gauge may operate abnormally or may not operate at all if the oil temperature sensor is defective. 2. 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 temperature sensor is correctly connected. 3. Check connection of the temperature 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 temperature 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 temperature sensor. A. Check the power source, ground, and signal line for any short circuit.
3	Faulty Sensor	Measure the resistance of the temperature 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. If the proper sensor voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced.

Figure 75



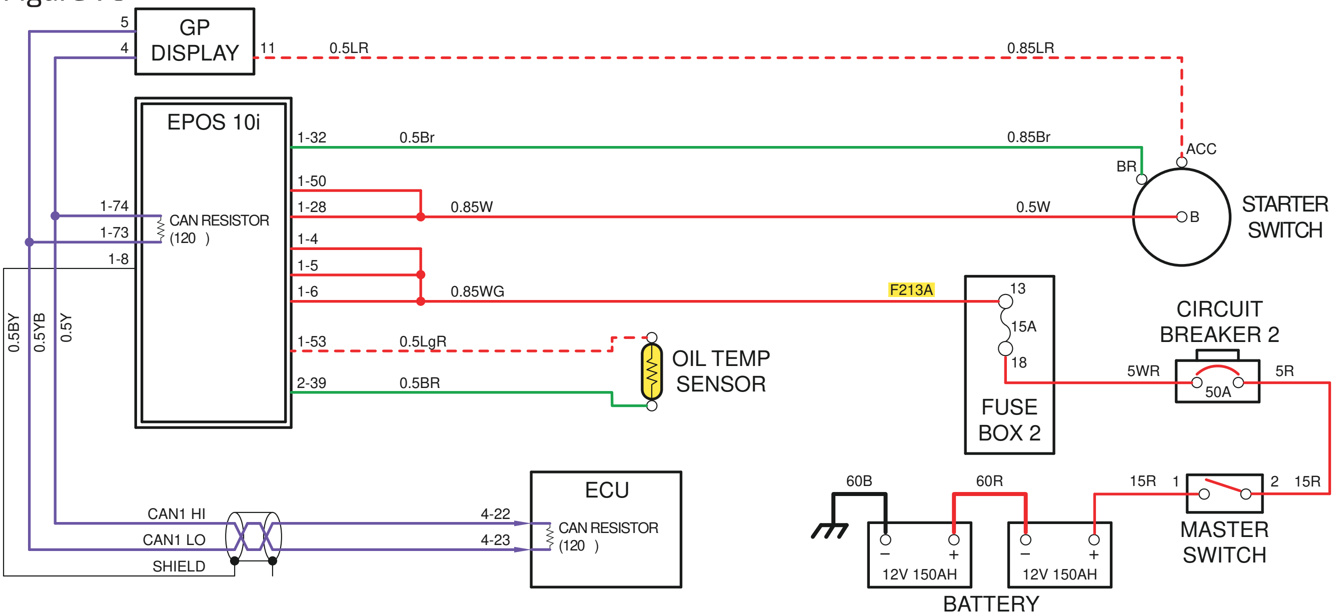
DS2102170

Pop-ups, Warning Symbols and Indicators

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 76



DS1901611

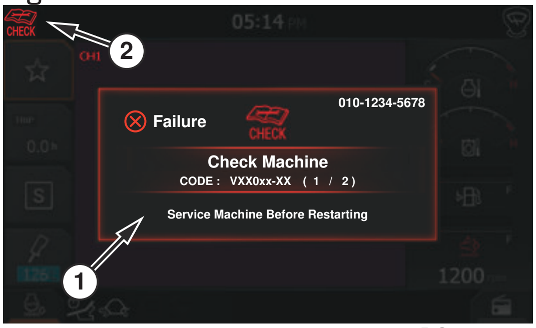
44. VSE002 Fuel Sensor

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	1. The fuel gauge may operate abnormally or may not operate at all if the fuel sensor is defective.		

	2. 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% 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 fuel sensor is correctly connected. 3. Check connection of the fuel 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 fuel 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 fuel sensor. A. Check the power source, ground, and signal line for any short circuit.
3	Faulty Sensor	Measure the resistance of the fuel 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.

Figure 77



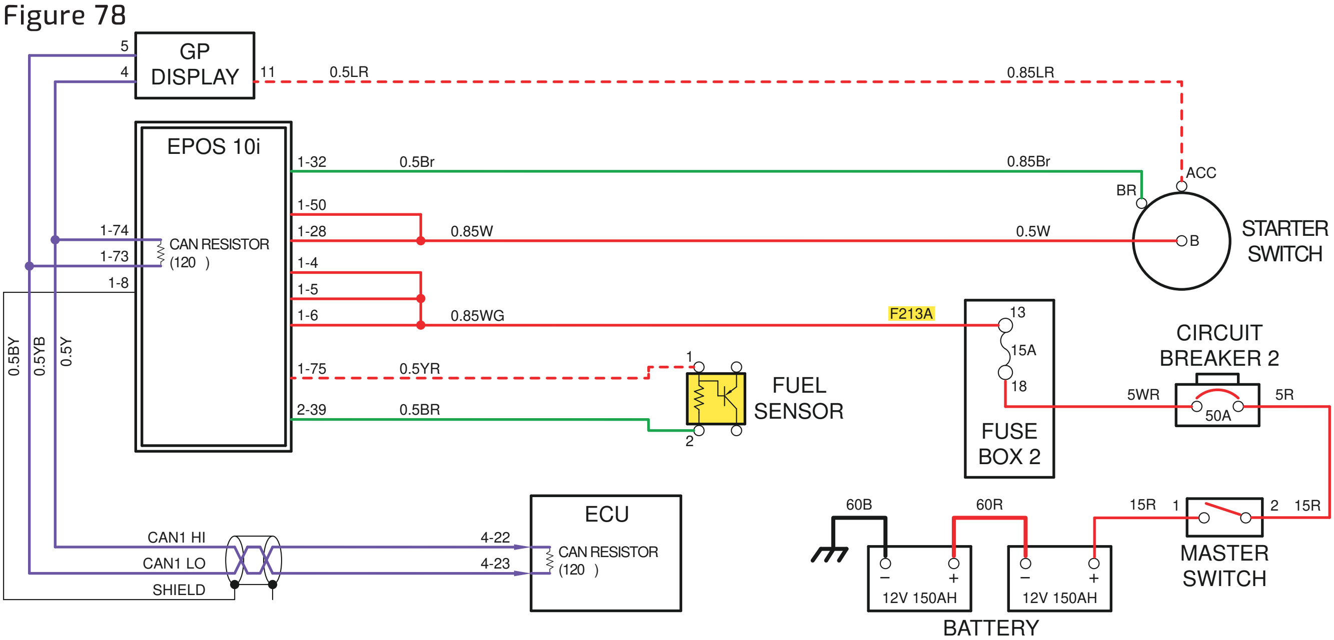
DS2102170

Pop-ups, Warning Symbols and Indicators

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 78



DS1901612

45. VSE004 WIF Sensor

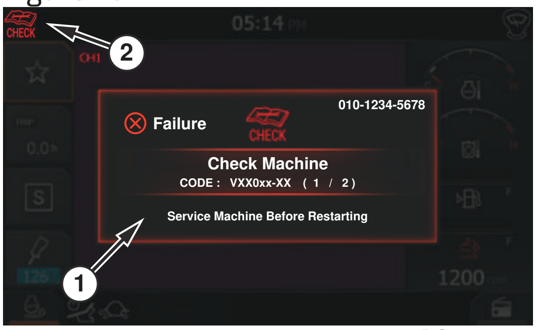
Action Level	Failure Code	Failure	WIF Sensor
Gauge Panel	VSE004		
Detail of Failure	FMI 1: Water in fuel detected. FMI 3: The WIF sensor, voltage above normal. FMI 4: The WIF sensor, voltage below normal.		
Actions of Machine Monitor or Controller	• If the WIF sensor is malfunctioning, the "Check the 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	1. The WIF warning symbol may appear on the gauge panel if the WIF sensor is defective.		

	2. The buzzer may sound if the WIF sensor is defective. 3. 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. Features of WIF sensor: 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

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the WIF sensor is correctly connected. 2. Check that the terminal No. 1 of the WIF sensor connector is correctly supplied with 24V. 3. Check the fuse box condition for power supply of the WIF 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 WIF 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 WIF 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 WIF 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 WIF sensor. A. Check the power source, ground, and signal line for any short circuit.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
4	Faulty Sensor	Measure the output voltage of the WIF 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. 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 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.
6	Failure to Remove Water	1. Check if water inside the fuel of the WIF sensor is removed.

Figure 79



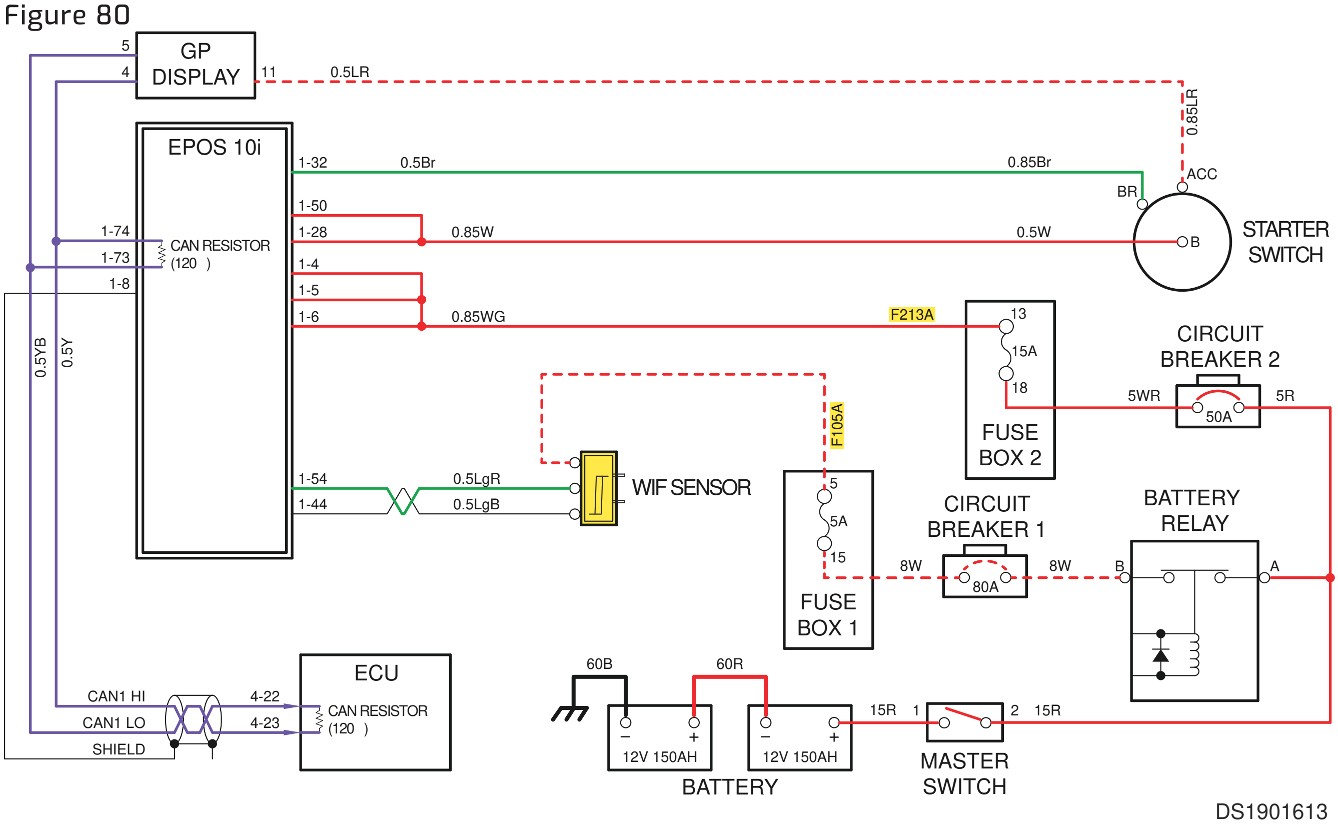
DS2102170

Pop-ups, Warning Symbols and Indicators

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 80



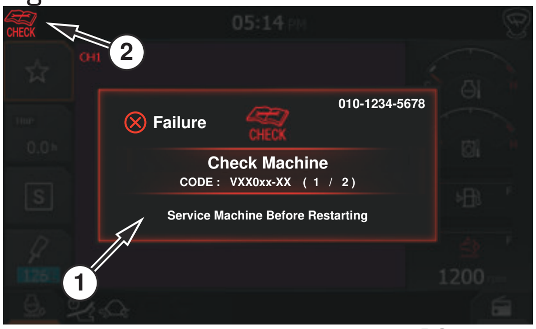
46. VSE007 Angle Sensor (A)

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	1. The machine may operate abnormally or may not operate at all if the angle sensor (A) defective.		
Related Information	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 a) -45°: 0.5 V ±0.025 V b) 0° : 2.5 V ±0.05 V c) 45° : 4.5 V ±0.025 V		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the angle sensor is correctly connected. 2. Check that the terminal No. 1 of the angle sensor connector is correctly supplied with 24 V. 3. Check the fuse box condition for power supply of the angle 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 WIF 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 WIF 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 WIF 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 angle 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.

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.

Figure 81



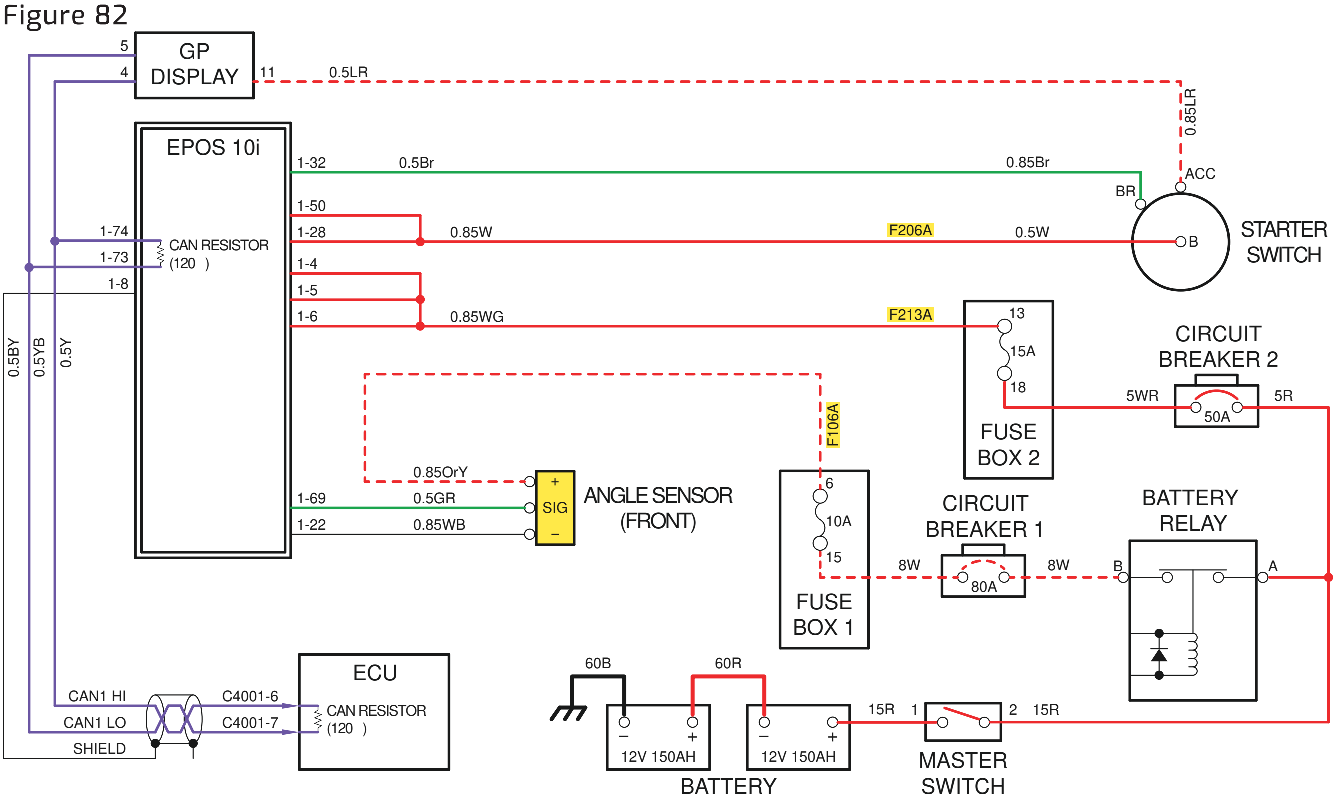
DS2102170

Pop-ups, Warning Symbols and Indicators

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.

Block Diagram

Figure 82



DS1902091

47. VSE008 Angle Sensor (B)

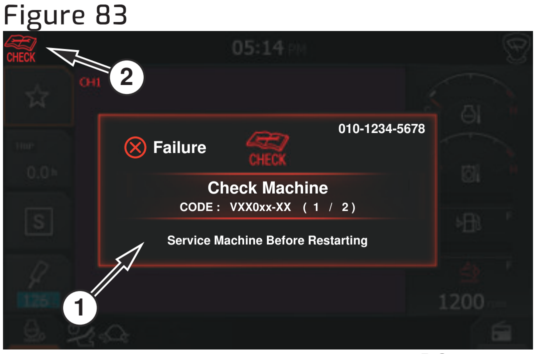
Action Level	Failure Code	Failure	Angle Sensor (B)
Gauge Panel	VSE008		
Detail of Failure	FMI 3: The angle sensor (B), voltage above normal. FMI 4: The angle sensor (B), voltage below normal.		

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	1. The machine may operate abnormally or may not operate at all if the angle sensor (B) defective.
Related Information	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 a) -45°: 0.5 V ±0.025 V b) 0° : 2.5 V ±0.05 V c) 45° : 4.5 V ±0.025 V

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the angle sensor is correctly connected. 2. Check that the terminal No. 1 of the angle sensor connector is correctly supplied with 24 V. 3. Check the fuse box condition for power supply of the angle 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 WIF 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 WIF 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 WIF sensor connector terminal No. 2.

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	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 angle 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.

Figure 83



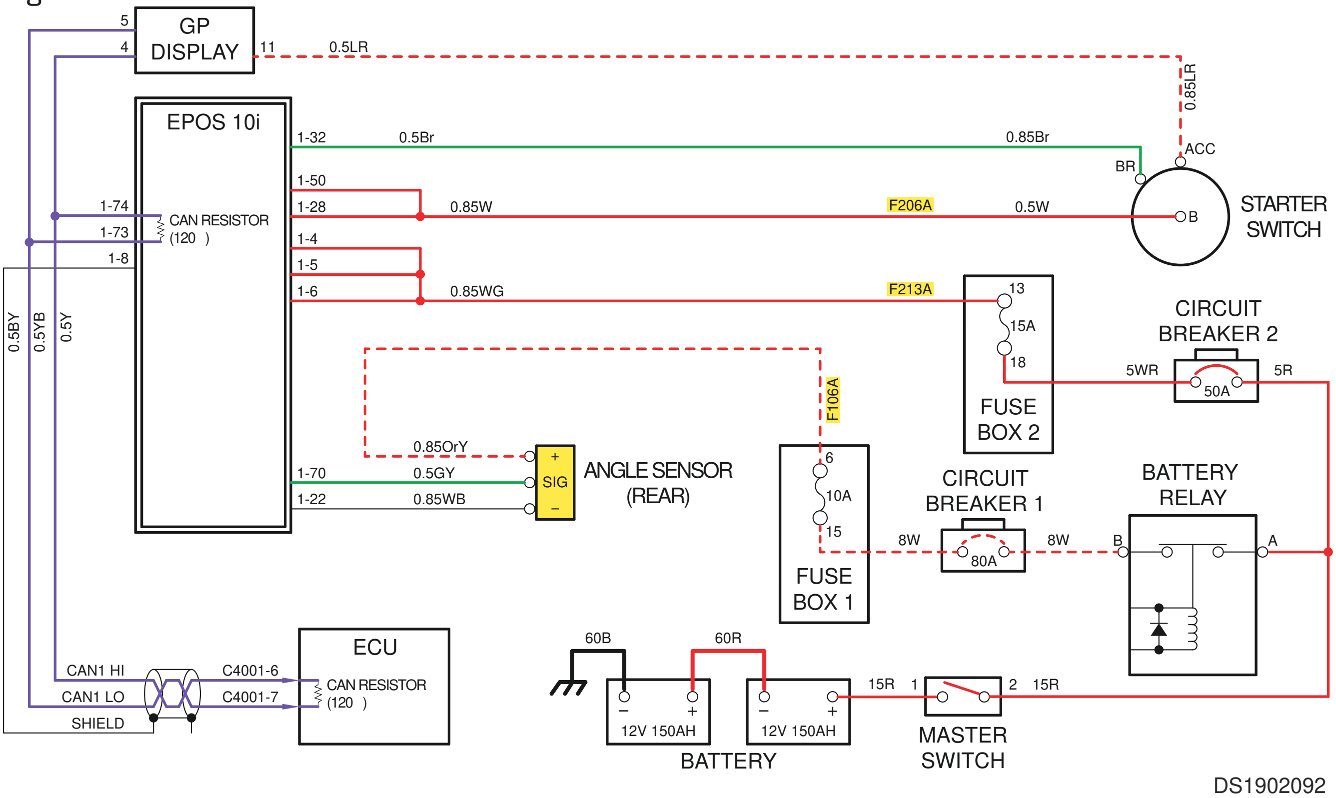
DS2102170

Pop-ups, Warning Symbols and Indicators

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.

Block Diagram

Figure 84



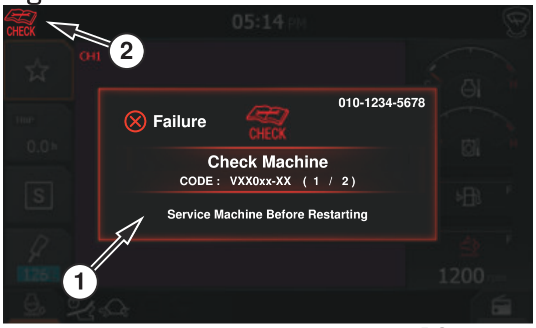
48. VS5001 Thumb Wheel (RH)

Action Level	Failure Code	Failure	Thumb Wheel (RH)
Gauge Panel	VS5001		
Detail of Failure	FMI 2: The thumb wheel (RH), incorrect signal. FMI 3: The thumb wheel (RH), voltage above normal. FMI 4: The thumb wheel (RH), voltage below normal.		
Actions of Machine Monitor or Controller	• If the thumb wheel (RH) is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the thumb wheel (RH) is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	1. The machine's performance may be degraded if the thumb wheel (RH) is defective. 2. The attachment may be operated abnormally or may not be operated at all if the thumb wheel (RH) is defective.		
Related Information	1. The switch won't operate if it is not supplied with 5 V. 2. The switch can be severely damaged if its power line and ground line are mixed up. A. Thumb wheel specification: 1) 1.1 V or less, or 3.9 V or more: 660 mA output 2) 2.18 V or 2.82 V: 296 mA output 3) 2.275 V to 2.725 V: 0 mA output		

	4) Below 0.5 V or over 4.5 V: Triggers an error.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the switch is correctly connected. 2. Check that the terminal No. 1 of the switch 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 switch 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 switch 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 switch 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 switch. A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Switch	Measure the output voltage of the sensor. 1. Check that the output range of the sensor is 1V to 4V.
5	Faulty EPOS	If the harness and switch are correctly connected. 1. Check if the switch 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 switch voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced.

Figure 85



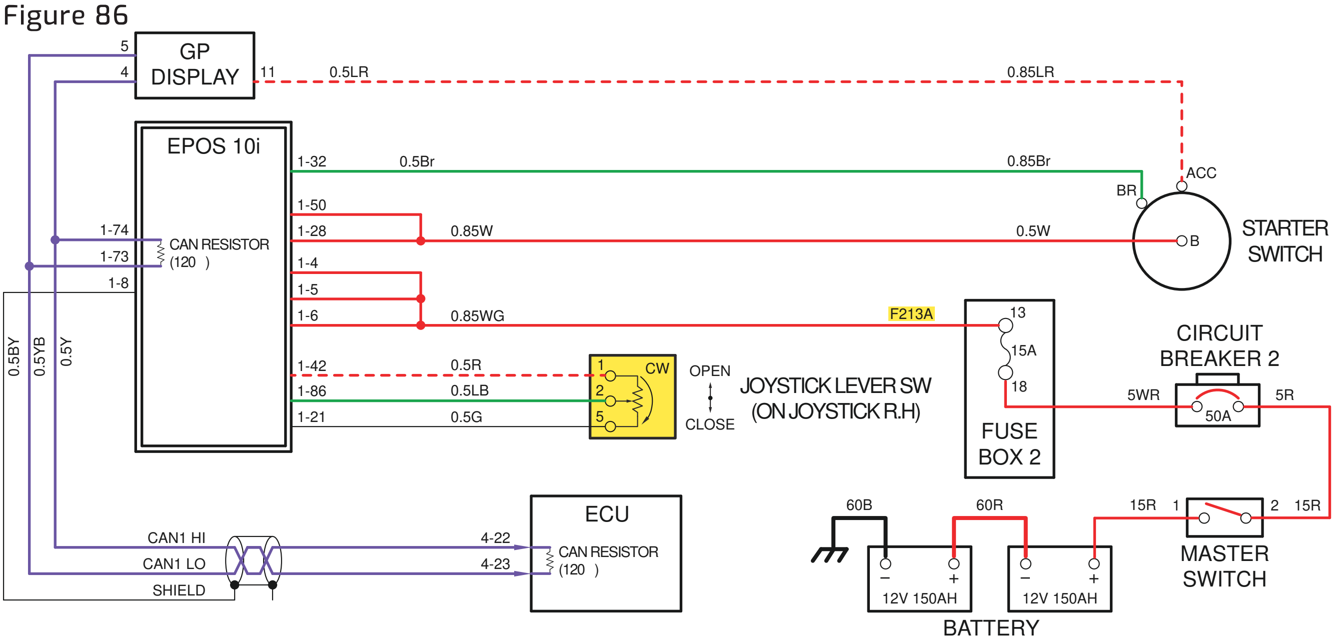
DS2102170

Pop-ups, Warning Symbols and Indicators

If the thumb wheel (RH) malfunctions or a connection error occurs, an error message (1) pops up and the relevant or a connection error occurs, an error message (1) pops up and the relevant

Block Diagram

Figure 86



DS1901606

49. VS5002 Thumb Wheel (LH)

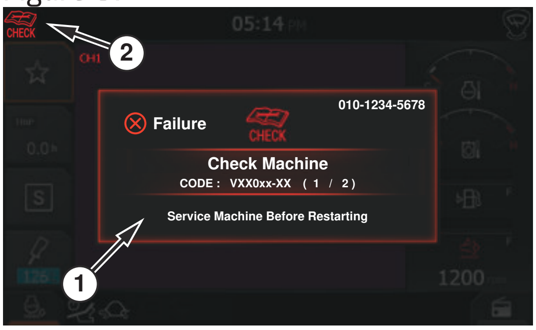
Action Level	Failure Code	Failure	Thumb Wheel (LH)
Gauge Panel	VS5002		
Detail of Failure	FMI 2: The thumb wheel (LH), incorrect signal. FMI 3: The thumb wheel (LH), voltage above normal. FMI 4: The thumb wheel (LH), voltage below normal.		
Actions of Machine Monitor or Controller	• If the thumb wheel (LH) is malfunctioning, the "Check the machine" pop-up and warning symbol will be displayed on the main screen of the gauge panel. • If the thumb wheel (LH) is malfunctioning, the corresponding malfunction details can be checked in the "Real time failure information" menu on the gauge panel.		
Problem on Machine	1. The machine's performance may be degraded if the thumb wheel (LH) is defective.		

	2. The attachment may be operated abnormally or may not be operated at all if the thumb wheel (LH) is defective.
Related Information	1. The switch won't operate if it is not supplied with 5 V. 2. The switch can be severely damaged if its power line and ground line are mixed up. A. Thumb wheel specification: 1) 1.1 V or less, or 3.9 V or more: 660 mA output 2) 2.18 V or 2.82 V: 296mA output 3) 2.275 V to 2.725 V: 0 mA output 4) Below 0.5 V or over 4.5 V: Triggers an error.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Faulty Power Supply	1. Check that the connector of the switch is correctly connected. 2. Check that the terminal No. 1 of the switch 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 switch 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 switch 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 switch 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 switch. A. Check the power source, ground, and signal line for any short circuit.
4	Faulty Switch	Measure the output voltage of the sensor.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		1. Check that the output range of the sensor is 1 V to 4 V.
5	Faulty EPOS	If the harness and switch are correctly connected. 1. Check if the switch 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 switch voltage is measured at the front of the EPOS connector, the EPOS is defective and needs to be replaced.

Figure 87



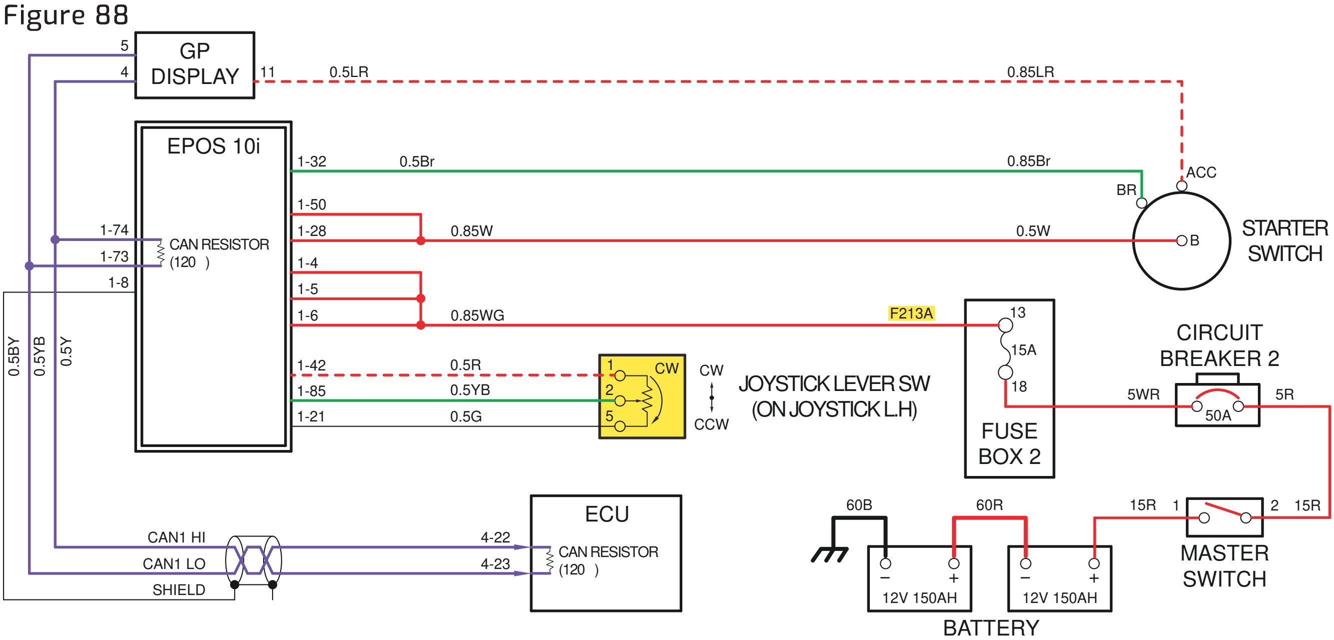
DS2102170

Pop-ups, Warning Symbols and Indicators

If the thumb wheel (LH) 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 88



DS1901607

50. VS5005 Dial

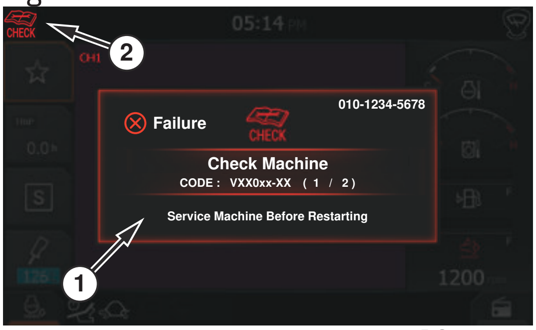
Action Level	Failure Code	Failure	Dial

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	1. The machine's performance may be degraded if the dial is defective. 2. 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. 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.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		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 Dial	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 89



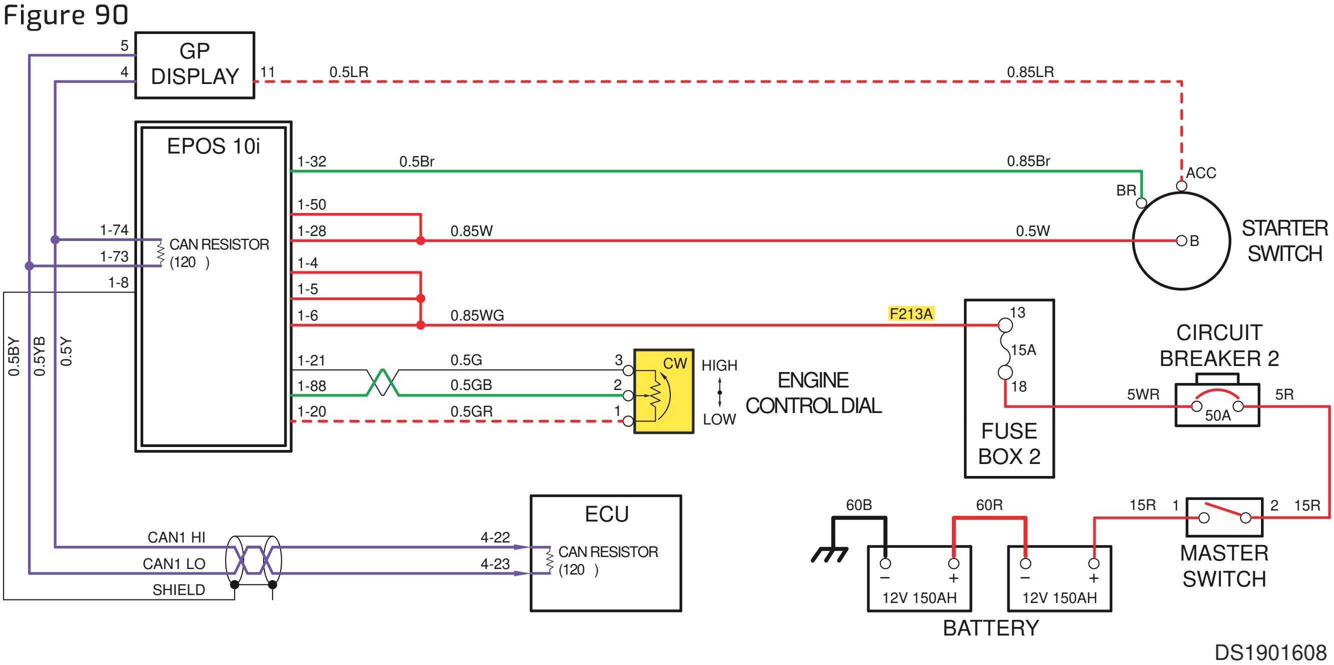
DS2102170

Pop-ups, Warning Symbols and Indicators

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 90



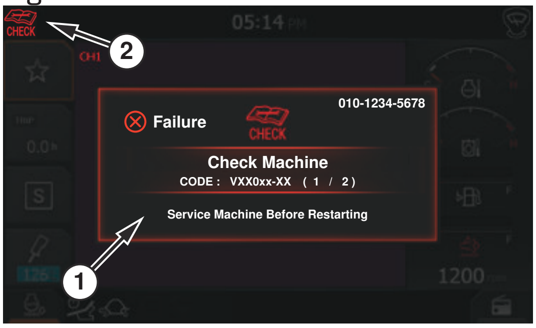
51. VS5006 Machine Controller +5 V Output 1

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	1. If the 5 V power output 1 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 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) Oil temperature sensor 5) Fuel sensor		

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
1	Connector Failure	1. Check that the EPOS connector is correctly connected.

No.	Cause	Procedure, Measuring Location, Criteria and Remarks
		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.

Figure 91



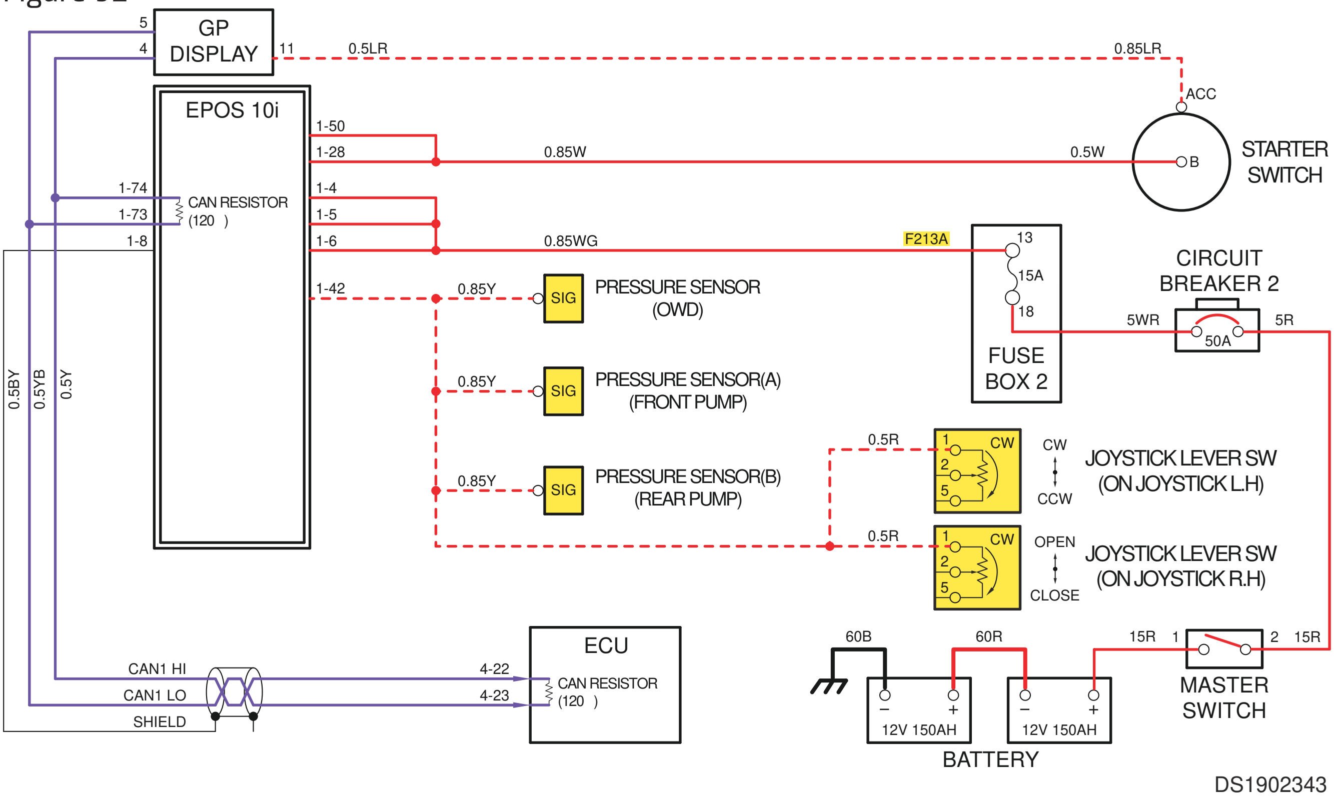
DS2102170

Pop-ups, Warning Symbols and Indicators

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 92



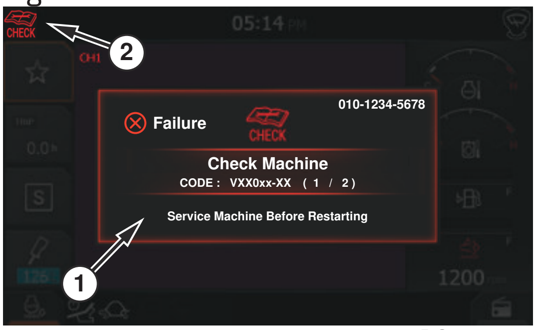
52. VS5007 Machine Controller +5 V Output 2

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	1. If the 5 V power output 2 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 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.

Figure 93



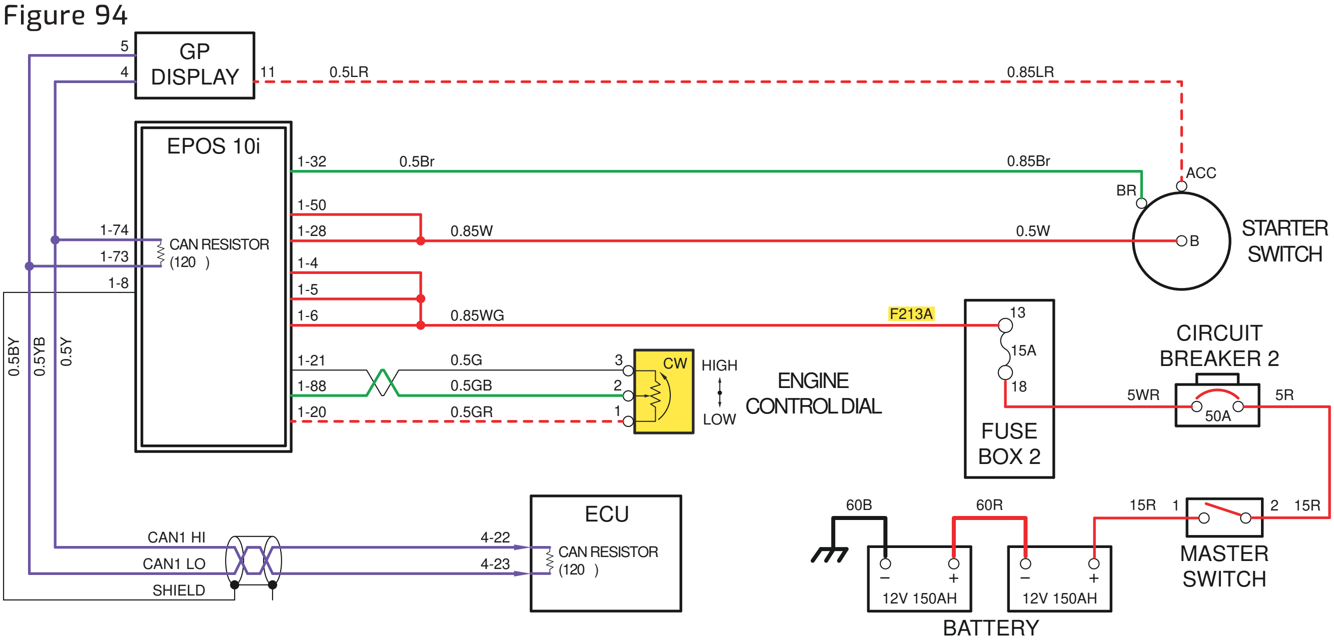
DS2102170

Pop-ups, Warning Symbols and Indicators

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 94



DS1901608

53. 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. • 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	1. The hour meter may operate abnormally if the alternator is defective. 2. The engine starting status detection logic may function abnormally if the alternator is defective. 3. 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.

Figure 95

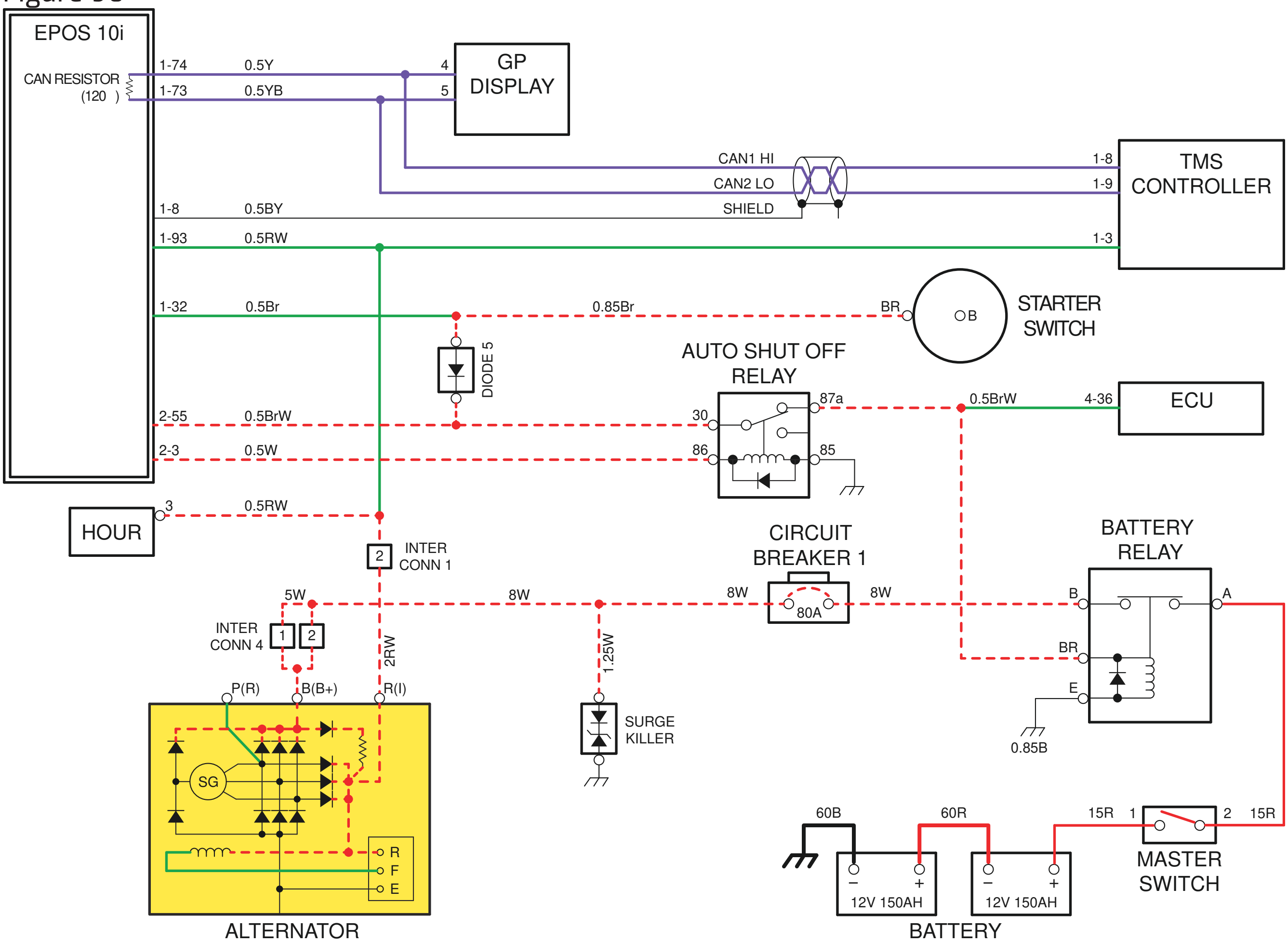
DS1901686

Pop-ups, Warning Symbols and Indicators

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 96



DS1901590

1. Engine Fault Code List

Gauge Panel Fault Code	P Code	Description
E000029-03	P0223	Short circuit to plus error of accelerator pedal signal 2 - (P0223)

Gauge Panel Fault Code	P Code	Description
E000029-04	P0222	Short circuit to ground error of accelerator pedal signal 2 - (P0222)
E000035-04	P1608	Short circuit to ground error at sensor supply 3 (throttle valve/rail pressure sensor) - (P1608)
E000051-03	P02E9	Short circuit to battery error for throttle valve - (P02E9)
E000051-04	P02E8	Short circuit to ground error for throttle valve - (P02E8)
E000091-03	P0123	Short circuit to plus error of accelerator pedal signal 1 - (P0123)
E000091-04	P0122	Short circuit to ground error of accelerator pedal signal 1 - (P0122)
E000091-12	P2135	Synchronization error for pedal signals - (P2135)
E000100-00	P0521	High oil pressure error - (P0521)
E000100-01	P1521	Low oil pressure error - (P1521)
E000100-03	P1522	High voltage error for oil pressure sensor - (P1522)
E000100-04	P1523	Low voltage error for oil pressure sensor - (P1523)
E000102-00	P0236	High boost pressure error - (P0236)
E000102-03	P0238	High voltage error for boost pressure sensor - (P0238)
E000102-04	P0237	Low voltage error for boost pressure sensor - (P0237)
E000105-00	P0110	High boost temperature error - (P0110)
E000105-03	P0113	High voltage error for boost temperature sensor - (P0113)
E000105-04	P0112	Low voltage error for boost temperature sensor - (P0112)
E000108-00	P2227	High atmospheric pressure error - (P2227)
E000108-01	P1227	Low atmospheric pressure error - (P1227)
E000108-03	P2229	High voltage atmospheric pressure sensor - (P2229)
E000108-04	P2228	Low voltage atmospheric pressure sensor - (P2228)
E000108-12	P006D	Atmospheric pressure sensor plausibility error - (P006D)
E000110-00	P0116	High coolant temperature error - (P0116)
E000110-03	P0118	High voltage error for coolant temperature sensor - (P0118)
E000110-04	P1119	Low voltage error for coolant temperature sensor - (P1119)
E000129-00	P0191	Maximum offset excess error of the rail pressure sensor - (P0191)
E000129-01	P1191	Minimum offset of the rail pressure excess error - (P1191)
E000129-03	P0193	High voltage error of the rail pressure sensor - (P0193)
E000129-04	P0192	Low voltage error of the rail pressure sensor - (P0192)
E000157-02	P125A	No information error of the metering unit power stage - (P125A)
E000158-00	P0563	High battery voltage error - (P0563)
E000158-01	P0562	Low battery voltage error - (P0562)
E000158-03	P1563	Short circuit to battery error for battery sensor - (P1563)
E000158-04	P1562	Short circuit to ground error for battery sensor - (P1562)
E000171-00	P0071	High environment temperature error - (P0071)

Gauge Panel Fault Code	P Code	Description
E000171-03	P0073	High voltage error for environment temperature sensor - (P0073)
E000171-04	P0072	Low voltage error for environment temperature sensor - (P0072)
E000174-00	P0181	High fuel temperature error - (P0181)
E000174-03	P0183	High voltage error for fuel temperature sensor - (P0183)
E000174-04	P0182	Low voltage error for fuel temperature sensor - (P0182)
E000175-00	P0196	High oil temperature error - (P0196)
E000175-03	P0198	High voltage error for oil temperature sensor - (P0198)
E000175-04	P0197	Low voltage error for oil temperature sensor - (P0197)
E000606-00	P0219	Engine over-speed detection error - (P0219)
E000734-04	P0262	Short circuit to ground error for injector 1 low side powerstage - (P0262)
E000734-05	P0201	Open circuit error of injector 1 powerstage - (P0201)
E000734-12	P086A	Short circuit error between highside and low side of the power stage 0(cylinder 1) - (P086A)
E000735-04	P0265	Short circuit to ground error for injector 5 low side powerstage - (P0265)
E000735-05	P0202	Open circuit error of injector 5 powerstage - (P0202)
E000735-12	P086B	Short circuit error between high side and low side of the power stage1(cylinder 5) - (P086B)
E000736-04	P0268	Short circuit to ground error for injector 3 low side powerstage - (P0268)
E000736-05	P0203	Open circuit error of injector 3 powerstage - (P0203)
E000736-12	P086C	Short circuit error between high side and low side of the power stage2 (cylinder 3) - (P086C)
E000737-04	P0271	Short circuit to ground error for injector 6 low side powerstage - (P0271)
E000737-05	P0204	Open circuit error of injector 6 powerstage - (P0204)
E000737-12	P086D	Short circuit error between high side and low side of the power stage3 (cylinder 6) - (P086D)
E000738-04	P0274	Short circuit to ground error for injector 2 low side powerstage - (P0274)
E000738-05	P0205	Open circuit error of injector 2 powerstage - (P0205)
E000738-12	P086E	Short circuit error between high side and low side of the power stage4 (cylinder 2) - (P086E)
E000739-04	P1277	Short circuit to ground error for injector 4 low side powerstage - (P1277)
E000739-05	P120B	Open circuit error of injector 4 powerstage - (P120B)
E000739-12	P086F	Short circuit error between high side and low side of the power stage5 (cylinder 4) - (P086F)
E000970-12	P1102	Emergency stop switch stuck error - (P1102)

Gauge Panel Fault Code	P Code	Description
E001207-00	P0669	High ECU internal temperature error (1) - (P0669)
E001207-01	P0668	Low ECU internal temperature error (1) - (P0668)
E001207-03	P1669	High voltage error for ECU temperature sensor - (P1669)
E001207-04	P1668	Low voltage error for ECU temperature sensor - (P1668)
E001208-00	P166A	High ECU internal temperature error (2) - (P166A)
E001208-01	P166B	Low ECU internal temperature error (2) - (P166B)
E001208-02	P1670	Short circuit to battery or CRC error for ECU temperature sensor - (P1670)
E001208-03	P1671	Short circuit to ground or CRC error for ECU temperature sensor - (P1671)
E001208-12	P1672	Plausibility error for internal ECU temperature sensor - (P1672)
E001639-03	P0527	High voltage error for fan speed sensor - (P0527)
E001639-04	P0528	Low voltage error for fan speed sensor - (P0528)
E001639-05	P0529	Open circuit error for fan speed sensor - (P0529)
E001639-07	P1526	Loose contact error for fan speed sensor - (P1526)
E001639-12	P0526	CAN signal error for fan speed sensor - (P0526)
E001675-12	P101D	function monitoring: fault of ECU power train active - (P101D)
E001761-00	P203E	Short circuit to battery error for DEF tank overflow lamp - (P203E)
E001761-01	P203F	Short circuit to ground error for DEF tank overflow lamp - (P203F)
E001761-05	P104E	Open circuit error for DEF tank overflow lamp - (P104E)
E001761-07	P103C	Low DEF tank level error - (P103C)
E001761-12	P103E	Over temperature error in ECU internal chip for DEF tank overflow lamp - (P103E)
E003031-00	P205B	High DEF temperature error - (P205B)
E003031-31	P115C	Overheating error of DEF tank temperature - (P115C)
E003242-00	P2084	High DPF upstream temperature error - (P2084)
E003242-03	P242D	High voltage error for DPF upstream temperature sensor - (P242D)
E003242-04	P242C	Low voltage error for DPF upstream temperature sensor - (P242C)
E003363-03	P20B4	Short circuit to battery error for coolant valve - (P20B4)
E003363-04	P20B3	Short circuit to ground error for coolant valve - (P20B3)
E003363-05	P20B1	Open circuit error for coolant valve - (P20B1)
E003363-12	P10B1	Over temperature error in ECU internal chip for Coolant valve - (P10B1)
E003511-00	P06B2	Over voltage error at sensor supply 1 (DEF pump pressure/fan speed sensor) - (P06B2)
E003511-01	P06B5	Under voltage error at sensor supply 1 (DEF pump pressure/fan speed sensor) - (P06B5)

Gauge Panel Fault Code	P Code	Description
E003511-04	P06B4	Short circuit to ground error at sensor supply 1 (DEF pump pressure/fan speed sensor) - (P06B4)
E003511-07	P0643	Collective error at sensor supply 1 (DEF pressure/fan speed sensor) - (P0643)
E003511-12	P06B1	Over temperature error in ECU internal chip at sensor supply 1 (DEF pump pressure/fan speed sensor) - (P06B1)
E003512-00	P16B5	Over voltage error at sensor Supply 2 (DPF differential pressure/ camshaft sensor) - (P16B5)
E003512-01	P1610	Under voltage error at sensor supply 2 (DPF differential pressure/ camshaft sensor) - (P1610)
E003512-04	P1606	Short circuit to ground error at sensor Supply 2 (DPF differential pressure/camshaft sensor) - (P1606)
E003512-07	P0653	Collective error for sensor supply 2 (DPF differential pressure/ camshaft sensor) - (P0653)
E003512-12	P06B3	Over temperature error in ECU internal chip at sensor supply 2 (DPF differential pressure/camshaft sensor) - (P06B3)
E003513-00	P16B2	Over voltage error at sensor supply 3 (throttle valve/rail pressure sensor) - (P16B2)
E003513-07	P0699	Collective error at sensor supply 3 (throttle valve/rail pressure sensor) - (P0699)
E003513-12	P1607	Over temperature Error in ECU internal chip at sensor supply 3 (throttle valve/rail pressure sensor) - (P1607)
E003514-00	P16B4	Over voltage error at sensor supply 4 (boost pressure/oil pressure/VGT speed sensor) - (P16B4)
E003514-01	P1701	Under voltage error at sensor supply 4 (boost pressure/oil pressure/VGT speed sensor) - (P1701)
E003514-04	P1700	Short circuit to ground error at sensor supply 4 (boost pressure/oil pressure/VGT speed sensor) - (P1700)
E003514-07	P1609	Over temperature error in ECU internal chip at sensor supply 4 (boost pressure/oil pressure/VGT speed sensor) - (P1609)
E003514-12	P16B3	Collective error at sensor supply 4 (boost pressure/oil pressure/VGT speed sensor) - (P16B3)
E003514-18	P16B1	Under voltage error at sensor supply 3 (throttle valve/rail pressure sensor) - (P16B1)
E003520-12	P1122	Open circuit error for DEF quality sensor - (P1122)
E003719-00	P2463	Maximum soot mass excess error in DPF (> 110%) - (P2463)
E003719-01	P248A	Maximum soot mass excess error in DPF (> 120%) - (P248A)
E004331-12	P1725	Leakage detection error during no dosing - (P1725)
E004334-03	P204D	High voltage error of DEF pump pressure sensor - (P204D)
E004334-04	P204C	Low voltage error of DEF pump pressure sensor - (P204C)
E004354-03	P20BC	Short circuit to battery error for DEF back flow line heater - (P20BC)
E004354-04	P20BB	Short circuit to ground error for DEF back flow line heater - (P20BB)

Gauge Panel Fault Code	P Code	Description
E004354-05	P20B9	Open circuit error for DEF back flow line heater - (P20B9)
E004354-12	P10B9	Over temperature in ECU internal chip error for DEF back flow line heater - (P10B9)
E004355-03	P20C0	Short circuit to battery error for DEF pressure line heater - (P20C0)
E004355-04	P20BF	Short circuit to ground error for DEF pressure line heater - (P20BF)
E004355-05	P20BD	Open circuit error for DEF pressure line heater - (P20BD)
E004355-12	P10BD	Over temperature error in ECU internal chip for pressure line heater - (P10BD)
E004356-03	P20C4	Short circuit to battery error for DEF suction line heater - (P20C4)
E004356-04	P20C3	Short circuit to ground error for DEF suction line heater - (P20C3)
E004356-05	P20C1	Open circuit error for DEF suction line heater - (P20C1)
E004356-12	P10C1	Over temperature error in ECU internal chip for DEF suction line heater - (P10C1)
E004357-03	P20C8	Short circuit to battery error for DEF supply module heater - (P20C8)
E004357-04	P20C7	Short circuit to ground error for DEF supply module heater - (P20C7)
E004357-05	P20C5	Open circuit error for DEF supply module heater - (P20C5)
E004357-12	P10C5	Over temperature error in ECU internal chip for supply module heater - (P10C5)
E004358-03	P202C	Short circuit to battery error for DEF tank heating relay - (P202C)
E004358-04	P202B	Short circuit to ground error for DEF tank heating relay - (P202B)
E004358-05	P202A	Open circuit error for DEF tank heating relay - (P202A)
E004358-12	P202F	Over temperature error in ECU internal chip for DEF tank heating relay - (P202F)
E004360-00	P0436	High SCR upstream temperature error - (P0436)
E004360-03	P0438	High voltage error for SCR upstream temperature - (P0438)
E004360-04	P0437	Low voltage error for SCR upstream temperature - (P0437)
E004363-00	P043B	High SCR downstream temperature error - (P043B)
E004363-03	P043D	High voltage error for SCR downstream temperature sensor - (P043D)
E004363-04	P043C	Low voltage error for SCR downstream temperature sensor - (P043C)
E004375-12	P1721	DEF pump motor speed deviation error - (P1721)
E004375-31	P1722	DEF pump motor speed deviation permanent error - (P1722)
E004376-03	P20A3	Short circuit to battery error for DEF reverting valve - (P20A3)
E004376-04	P20A2	Short circuit to ground error for DEF reverting valve - (P20A2)
E004376-05	P20A0	Open circuit error for DEF reverting valve - (P20A0)
E004765-00	P2080	High DOC upstream temperature error - (P2080)

Gauge Panel Fault Code	P Code	Description
E004765-03	P0546	High voltage error for DOC upstream temperature - (P0546)
E004765-04	P0545	Low voltage error for DOC upstream temperature - (P0545)
E004767-03	P2465	High voltage error for DPF differential pressure sensor - (P2465)
E004767-04	P2464	Low voltage error for DPF differential pressure sensor - (P2464)
E005266-04	P1420	DOC HC conversion efficiency low - (P1420)
E005465-00	P2263	Under boost pressure error(air leakage) - (P2263)
E005465-01	P1263	Over boost pressure error (blocked) - (P1263)
E520110-00	P045A	Over temperature error in ECU internal chip for ECU on lamp - (P045A)
E520111-00	P1123	Keep Alive error during runtime at an external device - (P1123)
E520111-01	P1124	Keep Alive error during initialization phase at an external device - (P1124)
E520112-02	P1125	Stop Counter counts slower/faster than allowed or no communication with counter possible - (P1125)
E520113-00	P1126	Read diagnosis for ECU non volatile memory - (P1126)
E520113-01	P1127	Write diagnosis for ECU non volatile memory - (P1127)
E520114-00	P1128	Sticky Main - ECU relay error - (P1128)
E520115-00	P1129	ECU stack memory threshold overrun - (P1129)
E520116-00	P1130	ECU observation counter irregular switch off counter triggered by engine running - (P1130)
E520196-12	P0251	Maximum positive deviation excess error of rail pressure(Fuel leakage) - (P0251)
E520199-00	P0336	Disturbed crankshaft signal error - (P0336)
E520199-02	P0335	No crankshaft signal error - (P0335)
E520200-00	P0341	Disturbed camshaft signal error - (P0341)
E520200-02	P0340	No camshaft signal error - (P0340)
E520201-12	U0110	CAN communication timeout error of AT1T1I - (U0110)
E520203-12	P0089	Maximum opening counter excess error of pressure relief valve - (P0089)
E520205-03	P1484	Short circuit to battery error for fan clutch - (P1484)
E520205-04	P0485	Short circuit to ground error for fan clutch - (P0485)
E520205-05	P0480	Open circuit error for fan clutch - (P0480)
E520205-12	P0484	Over temperature error in ECU internal chip for fan clutch - (P0484)
E520207-07	P1021	Air heater relay signal stuck error (always on) - (P1021)
E520209-12	P1106	Abnormal DEF pressure build-up error - (P1106)
E520214-00	U0130	CAN communication check sum error of TSC1TE (TCU) - (U0130)
E520214-01	U0139	CAN data length error of TSC1TE(TCU) - (U0139)
E520214-02	U0131	CAN communication rolling counter error of TSC1TE(TCU) - (U0131)

Gauge Panel Fault Code	P Code	Description
E520214-12	U0132	CAN communication timeout error of TSC1TE(TCU) - (U0132)
E520214-15	U0133	CAN communication active timeout error of TSC1TE(TCU) - (U0133)
E520214-16	U0134	CAN communication passive timeout error of TSC1TE(TCU) - (U0134)
E520215-03	P1194	Short circuit to battery error on power stage of ECU for intake air heater lamp - (P1194)
E520215-04	P1195	Short circuit to ground error on power stage of ECU for intake air heater lamp - (P1195)
E520215-05	P1196	Open circuit error on power stage of ECU for intake air heater lamp - (P1196)
E520215-12	P1193	Over temperature error in ECU internal chip on power stage for intake air heater lamp - (P1193)
E520219-12	U0135	CAN communication timeout error of AUXIO1 - (U0135)
E520220-12	U0136	CAN communication timeout error of DEC1 (VCU) - (U0136)
E520221-12	U0137	CAN communication timeout error of EBC1(VCU) - (U0137)
E520224-12	P1212	Camshaft signal offset error - (P1212)
E520225-02	P1022	Fuel quantity limitation error by level2 torque integral overshoot information - (P1022)
E520225-12	P1023	Fuel quantity limitation error by exceeding threshold of the level2 torque integral - (P1023)
E520226-12	P1024	ECU safety management unit group 0 failure error - (P1024)
E520227-12	P1025	ECU safety management unit group 1 failure error - (P1025)
E520228-12	P1026	ECU safety management unit group 2 failure error - (P1026)
E520229-12	P1027	ECU safety management unit group 3 failure error - (P1027)
E520230-12	P1028	ECU safety management unit group 4 failure error - (P1028)
E520231-12	P1029	ECU safety management unit group 6 failure error - (P1029)
E520232-12	P161B	Diagnostic fault check to report ABE active state - (P161B)
E520233-01	P161D	Function monitoring: fault of ECU, Error pin active suspicion of HW fault - (P161D)
E520336-12	P1000	Environment temperature drift error - (P1000)
E520337-12	P1001	DOC upstream temperature drift error - (P1001)
E520338-12	P1002	DPF upstream temperature drift error - (P1002)
E520339-12	P1003	Coolant temperature drift error - (P1003)
E520340-12	P1004	Boost temperature drift error - (P1004)
E520515-02	P1478	DOC upstream temperature plausibility error - (P1478)
E520516-02	P1479	DPF upstream temperature plausibility error - (P1479)
E520517-02	P147A	SCR upstream temperature plausibility error - (P147A)
E520518-02	P147B	SCR downstream temperature plausibility error - (P147B)
E520522-03	P1617	Short circuit to battery error at starter high side powerstage - (P1617)

Gauge Panel Fault Code	P Code	Description
E520522-04	P1616	Short circuit to ground error at starter high side powerstage - (P1616)
E520523-03	P0617	Short circuit to battery error at starter low side powerstage - (P0617)
E520523-04	P0616	Short circuit to ground error at starter low side powerstage - (P0616)
E520523-05	P0615	Open load error at starter low side powerstage - (P0615)
E520523-12	P0618	Over temperature error in ECU internal chip at starter low side powerstage - (P0618)
E520610-03	P0542	Short circuit to battery error on power stage of ECU for intake air heater relay - (P0542)
E520610-04	P0541	Short circuit to ground error on power stage of ECU for intake air heater relay - (P0541)
E520610-05	P0543	Open circuit error on power stage of ECU for intake air heaters relay - (P0543)
E520610-12	P0540	Over temperature error in ECU internal chip on power stage for intake air heater relay - (P0540)
E520611-04	P2607	Circuit to ground, over current, over temperature error in the Intake air heater feedback diagnosis line - (P2607)
E520611-05	P2605	Open circuit error in the Intake air heater feedback diagnosis line - (P2605)
E520612-01	U0126	CAN communication check sum error of DEC1 (VCU) - (U0126)
E520612-02	U0127	CAN data length error of DEC1(VCU) - (U0127)
E520616-03	P1564	Disabled powerstage diagnostic error due to high battery voltage - (P1564)
E520616-04	P1565	Disabled powerstage diagnostic error due to low battery voltage - (P1565)
E520618-12	P060B	Function monitoring: fault of ECU ADC . Null Load Test Pulse - (P060B)
E520621-00	P1457	Maximum DPF differential pressure error - (P1457)
E520621-01	P1456	Minimum DPF differential pressure error - (P1456)
E520626-03	P162E	Short circuit to battery error for injection bank1 power stage - (P162E)
E520632-00	P1767	Invalid supply module PWM signal error - (P1767)
E520632-01	P1769	Supply module temperature duty cycle error in failure range - (P1769)
E520632-02	P1768	Supply module temperature PWM signal error - (P1768)
E520632-07	P1764	Supply module heater temperature duty cycle error in failure range - (P1764)
E520632-12	P1765	Supply module heater temperature duty cycle error in invalid range - (P1765)

Gauge Panel Fault Code	P Code	Description
E520632-15	P176A	Invalid signal range error of supply module temperature duty - (P176A)
E520632-31	P1766	No information error for supply module temperature measurement - (P1766)
E520633-02	P161A	Function monitoring: fault of ECU, WDA active by inquiry/response communication - (P161A)
E520633-03	P161C	Function monitoring: fault of ECU, WDA active by over-voltage detection - (P161C)
E520643-12	P101A	Error to demand for an ICO due to an error in change of EOM - (P101A)
E520644-00	P1600	Error in the post build selectable monitoring - (P1600)
E520650-12	P1079	Active regeneration failed error during working, request forced regeneration - (P1079)
E520656-12	U029D	CAN communication timeout error of upstream NOx sensor - (U029D)
E520657-12	U029E	CAN communication timeout error of downstream NOx sensor - (U029E)
E520662-00	P2201	Upstream NOx sensor upper plausibility error - (P2201)
E520662-01	P1201	Upstream NOx sensor lower plausibility error - (P1201)
E520664-01	P10EE	Low NOx conversion efficiency error - (P10EE)
E520669-12	P1712	Blocked DEF dosing valve detection error - (P1712)
E520670-12	P1713	Response error of DEF dosing valve at low voltage - (P1713)
E520673-12	P170E	Stuck error in range check of DEF tank temperature sensor - (P170E)
E520691-03	P1209	Short circuit to battery error for injection bank2 power stage - (P1209)
E520693-00	P062B	Low Injector booster voltage error - (P062B)
E520694-03	P0254	Short circuit to battery error on high side of the metering unit - (P0254)
E520694-04	P0253	Short circuit to ground error on high side of the metering unit - (P0253)
E520694-05	P0255	Open circuit error of the metering unit - (P0255)
E520694-12	P0256	Short circuit error between high side and low side of the metering unit - (P0256)
E520695-03	P1254	Short circuit to battery error on low side of the metering unit - (P1254)
E520695-04	P1253	Short circuit to ground error on low side of the metering unit - (P1253)
E520696-12	P160C	Function monitoring: fault of ECU ADC – test voltage - (P160C)
E520707-01	P1614	Indicate ICO request from MoCSOP module - (P1614)
E520708-12	P1008	Injection cut off demand (ICO) error for shut off coordinator - (P1008)

Gauge Panel Fault Code	P Code	Description
E520709-12	P108C	Forced opening error of pressure relief valve by pressure increase - (P108C)
E520710-12	P108D	Forced opening error of pressure relief valve by pressure shock - (P108D)
E520711-07	P108E	Open error of pressure relief valve - (P108E)
E520712-12	P1036	Quantity balance check if a successful pressure relief valve opening is ensured - (P1036)
E520713-12	P1037	Out of tolerance rage error of averaged rail pressure - (P1037)
E520714-12	P108F	Maximum allowed opening time excess error of pressure relief valve - (P108F)
E520715-12	P1251	Leakage detection error of balancing the fuel volumes flows (leakage) - (P1251)
E520716-12	P1252	Maximum negative rail pressure deviation excess error(blocked) - (P1252)
E520717-12	P0087	Monitoring error for rail pressure - (P0087)
E520719-12	P1090	Maximum rail pressure excess error - (P1090)
E520720-12	P1050	Rail pressure set point plausibility error in overrun mode - (P1050)
E520721-12	P1257	Plausibility error of the volume flow of the metering unit at low idle - (P1257)
E520722-12	P1192	Monitoring error for maximum rail pressure in limp home mode - (P1192)
E520727-12	P12E9	SCR Inducement Level 1 (Interruption of dosing) - (P12E9)
E520729-12	P12EB	SCR Inducement Level 2 (Interruption of dosing) - (P12EB)
E520730-12	P12EC	SCR Inducement Warning (Interruption of dosing) - (P12EC)
E520731-12	P12ED	SCR Inducement Warning (DEF level empty) - (P12ED)
E520736-12	P12F2	SCR Inducement Level 1 (DEF quality) - (P12F2)
E520738-12	P12F4	SCR Inducement Level 2 (DEF quality) - (P12F4)
E520739-12	P12F5	SCR Inducement Warning (DEF quality) - (P12F5)
E520740-12	P12F6	SCR Inducement Level 1 (Tampering) - (P12F6)
E520742-12	P12F8	SCR Inducement Level 2 (Tampering) - (P12F8)
E520743-12	P12F9	SCR Inducement Warning (Tampering) - (P12F9)
E520744-05	P02E0	Open load error for throttle valve H-bridge - (P02E0)
E520744-06	P02E7	Over current error for throttle valve H-bridge - (P02E7)
E520744-12	P02EB	Over temperature error in ECU internal chip for throttle valve H-bridge - (P02EB)
E520745-03	P02E3	Short circuit to battery error for throttle valve H-bridge - (P02E3)
E520745-04	P02E2	Short circuit to ground error for throttle valve H-bridge - (P02E2)
E520746-01	P12E7	Under voltage error for throttle valve H-bridge - (P12E7)
E520746-03	P12E3	Short circuit to battery 2 error for throttle valve H-bridge - (P12E3)

Gauge Panel Fault Code	P Code	Description
E520746-04	P12E4	Short circuit to ground 2 error for throttle valve H-bridge - (P12E4)
E520746-05	P12E5	Short circuit to over load error for throttle valve H-bridge - (P12E5)
E520746-06	P12E6	Over current error for throttle valve H-bridge by high temperature active - (P12E6)
E520747-07	P02E4	Throttle valve position open jammed error - (P02E4)
E520747-12	P02E5	Throttle valve position closed jammed error - (P02E5)
E520750-12	P12FC	Error to demand for an ICO due to an error in total torque relevant quantity - (P12FC)
E520751-12	P1703	DEF back flow line plausibility error - (P1703)
E520752-12	P1105	Abnormal DEF pressure drop error - (P1105)
E520753-12	P1702	DEF pressure stabilization error - (P1702)
E520755-12	P20E9	Overpressure error during DEF dosing mode - (P20E9)
E520757-12	P20E8	Under pressure error during DEF dosing mode - (P20E8)
E520758-12	P1706	DEF over pressure error - (P1706)
E520765-03	P1718	Short circuit to battery error for DEF dosing valve actuator - (P1718)
E520765-04	P1716	Short circuit to ground error for DEF dosing valve actuator - (P1716)
E520766-04	P1717	Short circuit to ground error for DEF dosing valve high side - (P1717)
E520767-12	P1719	Supply module heater plausibility error - (P1719)
E520769-12	P171C	Plausibility error of supply module temperature sensor - (P171C)
E520769-31	P171D	Plausibility error of supply module temperature sensor at cold start (Insufficient temperature increment) - (P171D)
E520771-12	P1723	DEF pump motor no activation error - (P1723)
E520772-03	P208D	Short circuit to battery error for DEF pump motor - (P208D)
E520772-04	P208C	Short circuit to ground error for DEF pump motor - (P208C)
E520772-05	P208A	Open circuit error for DEF pump motor - (P208A)
E520772-12	P1724	Over temperature error in ECU internal chip for DEF pump motor powerstage - (P1724)
E520773-04	P1732	Low supply voltage error for VGT - (P1732)
E520774-12	P1733	No reference data error for VGT - (P1733)
E520775-07	P1731	Jammed valve error for VGT - (P1731)
E520776-12	P173C	Initialization error for VGT - (P173C)
E520777-12	P1729	CAN communication timeout error of VGT Status Rx - (P1729)
E520778-12	P174E	Internal actuator error for VGT - (P174E)
E520779-03	P1734	High voltage error for VGT speed sensor - (P1734)
E520779-04	P1735	Low voltage error for VGT speed sensor - (P1735)
E520779-12	P174F	Command source timeout error for VGT - (P174F)
E520780-12	P173B	No command source error for VGT - (P173B)

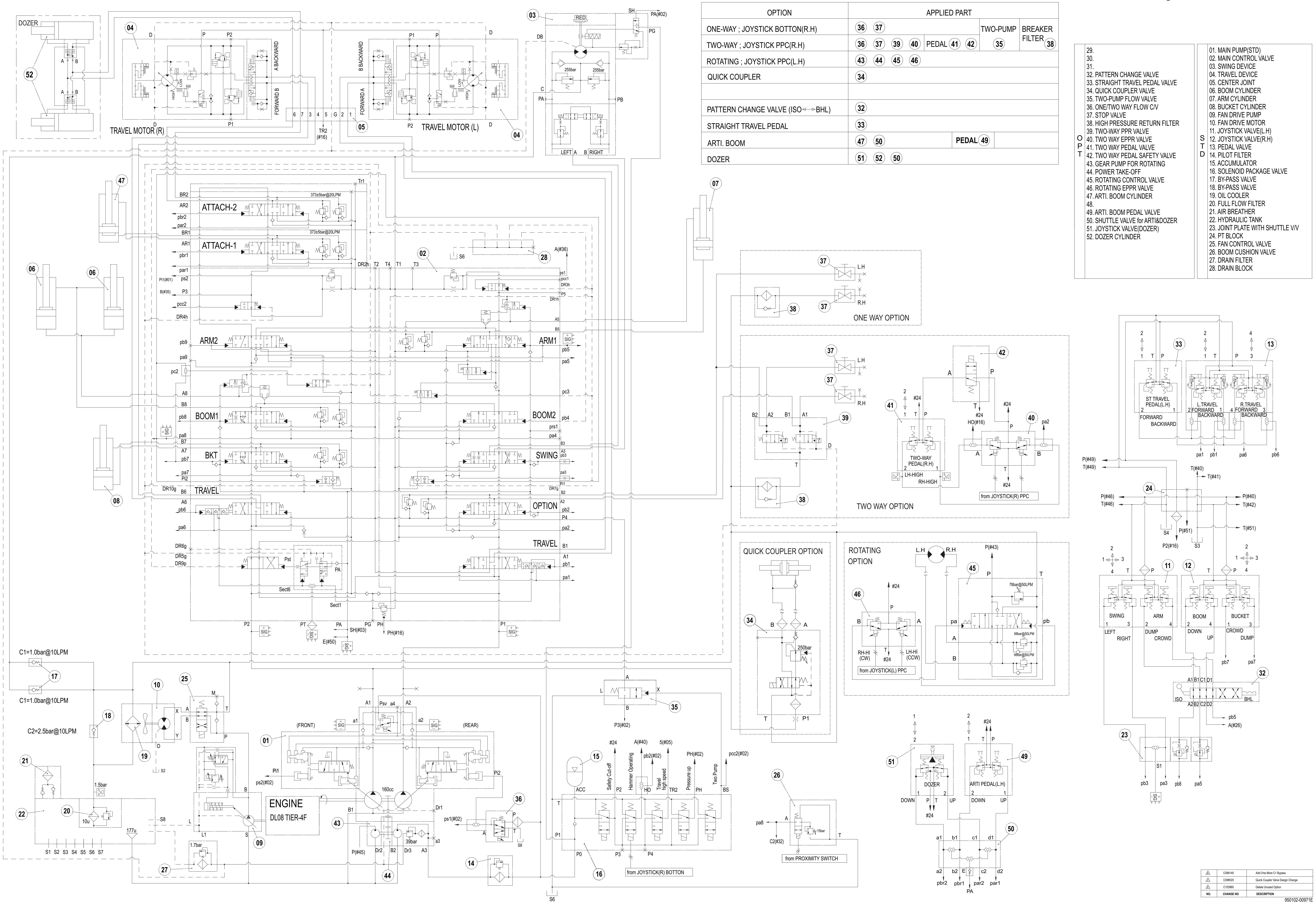
Gauge Panel Fault Code	P Code	Description
E520793-12	P173A	High temperature error for VGT - (P173A)
E520794-12	P1205	Detection error of not correctly mounted upstream NOx sensor - (P1205)
E520795-12	P1206	Detection error of not correctly mounted downstream NOx sensor - (P1206)
E520796-12	P1012	Monitoring of accelerator pedal position - (P1012)
E520797-12	P1013	Fault of engine speed check - (P1013)
E520798-12	P1014	Report the plausibility error between level 1 energizing time and level 2 information - (P1014)
E520799-12	P1015	Report the error due to plausibility between the injection begin v/s injection type - (P1015)
E520800-12	P1016	Report the error due to non plausibility in ZFC - (P1016)
E520802-12	P1018	Error to demand for an ICO due to an error in the PoI2 shut off - (P1018)
E520803-12	P1019	Error to demand for an ICO due to an error in the PoI3 efficiency factor - (P1019)
E520804-12	P101B	Error due to injection quantity correction - (P101B)
E520805-12	P101C	Plausibility error in rail pressure monitoring - (P101C)
E520807-07	P1020	Torque comparison error - (P1020)
E520807-12	P101F	Energizing time comparison error during overheat protection injections are active. - (P101F)
E520807-31	P101E	Energizing time comparison error - (P101E)
E520810-12	P1736	Time out error to enter metering control state - (P1736)
E520811-01	P206C	Low DEF quality error - (P206C)
E520813-02	P268C	Injector 1 adjustment value error - (P268C)
E520814-02	P2690	Injector 5 adjustment value error - (P2690)
E520815-02	P268E	Injector 3 adjustment value error - (P268E)
E520816-02	P2691	Injector 6 adjustment value error - (P2691)
E520817-02	P268D	Injector 2 adjustment value error - (P268D)
E520818-02	P268F	Injector 4 adjustment value error - (P268F)
E520822-12	P1730	DEF pressure line heater error (Perform after-run) - (P1730)
E520823-00	U0100	CAN communication check sum error of SMVCU(VCU) - (U0100)
E520823-12	U0107	CAN communication timeout error of SMVCU(VCU) - (U0107)
E520824-12	U0105	CAN communication timeout error of A1DEFI (DEF Tank) - (U0105)
E520826-00	U0101	CAN communication check sum error of TSC1VE(VCU) - (U0101)
E520826-01	U005A	CAN data length error of TSC1VE(VCU) - (U005A)
E520826-02	U0103	CAN communication rolling counter error of TSC1VE (VCU) - (U0103)
E520826-12	U0108	CAN communication timeout error of TSC1VE(VCU) - (U0108)

Gauge Panel Fault Code	P Code	Description
E520826-15	U006A	CAN communication active timeout error of TSC1VE(VCU) - (U006A)
E520826-16	U006B	CAN communication passive timeout error of TSC1VE(VCU) - (U006B)
E520827-00	U1100	Inhibition of engine starting by No input of EPOS password(VCU) - (U1100)
E520828-05	P1739	Open circuit error for dosing valve actuator - (P1739)
E520900-12	P107A	DPF regeneration request switch stuck error - (P107A)
E520901-03	P270A	Short circuit to battery error at ECU internal relay 1 (Fan) - (P270A)
E520901-12	P107B	DPF regeneration inhibit switch stuck error - (P107B)
E520902-04	P271A	Short circuit to ground error at ECU internal relay 1 (Fan) - (P271A)
E520903-03	P270C	Short circuit to battery error at ECU internal relay 6 (DEF tank coolant valve/DEF hos line heater) - (P270C)
E520904-03	P270D	Short circuit to battery error at ECU internal relay 7 (Engine stop switch/DEF overflow lamp/ECU on lamp) - (P270D)
E520905-03	P270E	Short circuit to battery error at ECU internal relay 8 (Supply module/reverting valve) - (P270E)
E520906-03	P270B	Short circuit to battery error at ECU internal relay 5 (Air heater) - (P270B)
E520907-04	P271B	Short circuit to ground error at ECU internal relay 5 (Air heater) - (P271B)
E520908-04	P271C	Short circuit to ground error at ECU internal relay 6 (DEF tank coolant valve/DEF hos line heater) - (P271C)
E520909-04	P271D	Short circuit to ground error at ECU internal relay 7 (Engine stop switch/DEF overflow lamp/ECU on lamp) - (P271D)
E520910-04	P271E	Short circuit to ground error at ECU internal relay 8 (Supply module/reverting valve) - (P271E)
E520911-02	U0102	CAN communication rolling counter error of SMVCU (VCU) - (U0102)
E520920-00	P1714	Upper tolerable DEF pressure limit excess error - (P1714)
E520921-01	P1715	Lower tolerable DEF pressure limit excess error - (P1715)
E520923-05	P1161	Open circuit error for ECU on lamp - (P1161)
E520924-03	P1162	Short circuit to battery error for ECU on lamp - (P1162)
E520925-04	P1163	Short circuit to ground error for ECU on lamp - (P1163)

Hydraulic Schematic

OPTION	APPLIED PART			
ONE-WAY ; JOYSTICK BOTTON(R.H)	36 37		TWO-PUMP 35	BREAKER FILTER 38
TWO-WAY ; JOYSTICK PPC(R.H)	36 37 39 40	PEDAL 41 42		
ROTATING ; JOYSTICK PPC(L.H)	43 44 45 46			
QUICK COUPLER	34			
PATTERN CHANGE VALVE (ISO↔BHL)	32			
STRAIGHT TRAVEL PEDAL	33			
ARTI. BOOM	47 50	**PEDAL** 49		
DOZER	51 52 50			

	OPT		STD
	29. 30. 31. 32. PATTERN CHANGE VALVE 33. STRAIGHT TRAVEL PEDAL VALVE 34. QUICK COUPLER VALVE 35. TWO-PUMP FLOW VALVE 36. ONE/TWO WAY FLOW C/V 37. STOP VALVE 38. HIGH PRESSURE RETURN FILTER 39. TWO-WAY PPR VALVE 40. TWO WAY EPPR VALVE 41. TWO WAY PEDAL VALVE 42. TWO WAY PEDAL SAFETY VALVE 43. GEAR PUMP FOR ROTATING 44. POWER TAKE-OFF 45. ROTATING CONTROL VALVE 46. ROTATING EPPR VALVE 47. ARTI. BOOM CYLINDER 48. 49. ARTI. BOOM PEDAL VALVE 50. SHUTTLE VALVE for ARTI&DOZER 51. JOYSTICK VALVE(DOZER) 52. DOZER CYLINDER		01. MAIN PUMP(STD) 02. MAIN CONTROL VALVE 03. SWING DEVICE 04. TRAVEL DEVICE 05. CENTER JOINT 06. BOOM CYLINDER 07. ARM CYLINDER 08. BUCKET CYLINDER 09. FAN DRIVE PUMP 10. FAN DRIVE MOTOR 11. JOYSTICK VALVE(L.H) 12. JOYSTICK VALVE(R.H) 13. PEDAL VALVE 14. PILOT FILTER 15. ACCUMULATOR 16. SOLENOID PACKAGE VALVE 17. BY-PASS VALVE 18. BY-PASS VALVE 19. OIL COOLER 20. FULL FLOW FILTER 21. AIR BREATHER 22. HYDRAULIC TANK 23. JOINT PLATE WITH SHUTTLE V/V 24. PT BLOCK 25. FAN CONTROL VALVE 26. BOOM CUSHION VALVE 27. DRAIN FILTER 28. DRAIN BLOCK

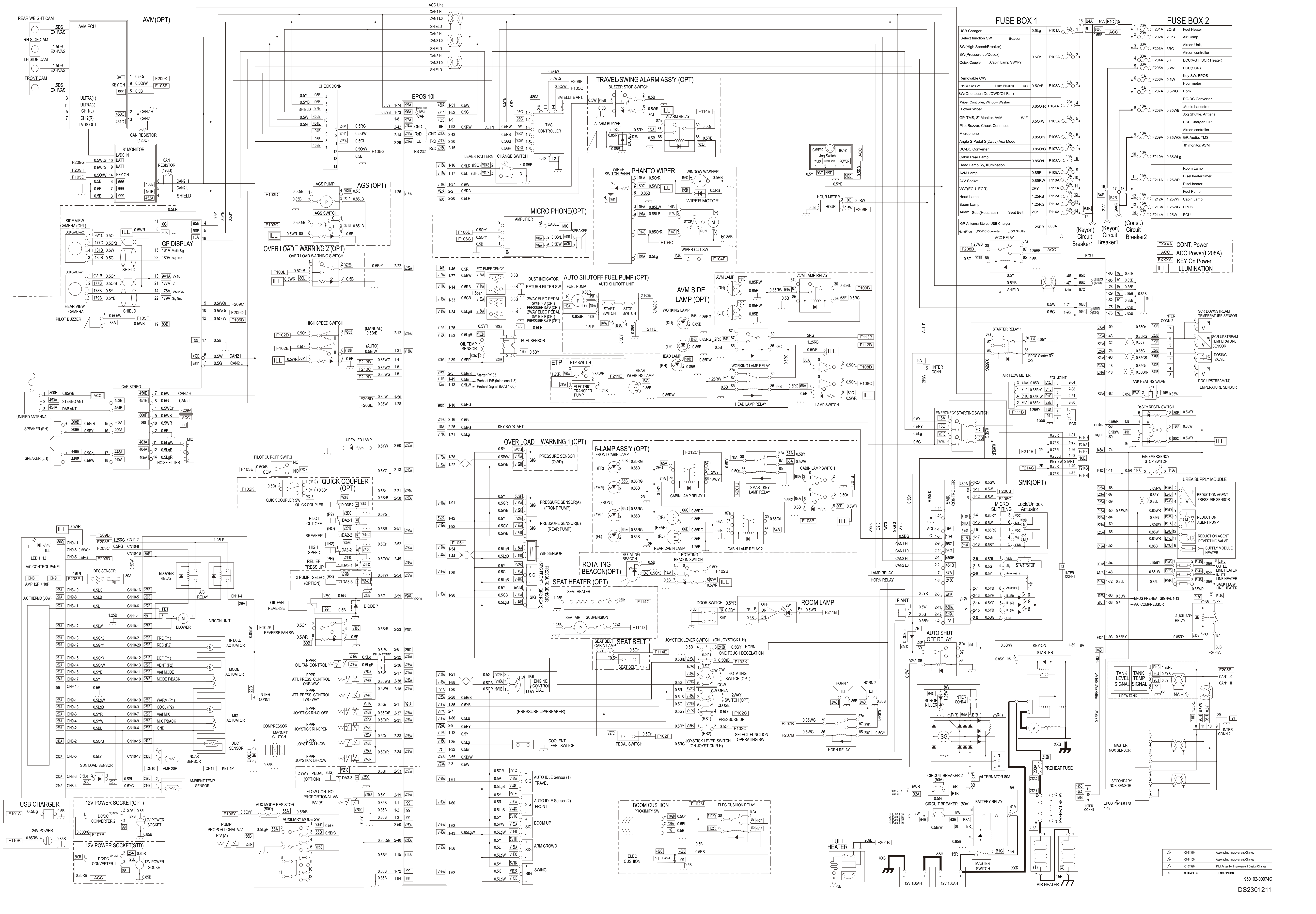


NO.	CHANGE NO	DESCRIPTION
B	C096140	Add One More C1 Bypass
C	C098020	Quick Coupler Valve Design Change
E	C103860	Delete Unused Option

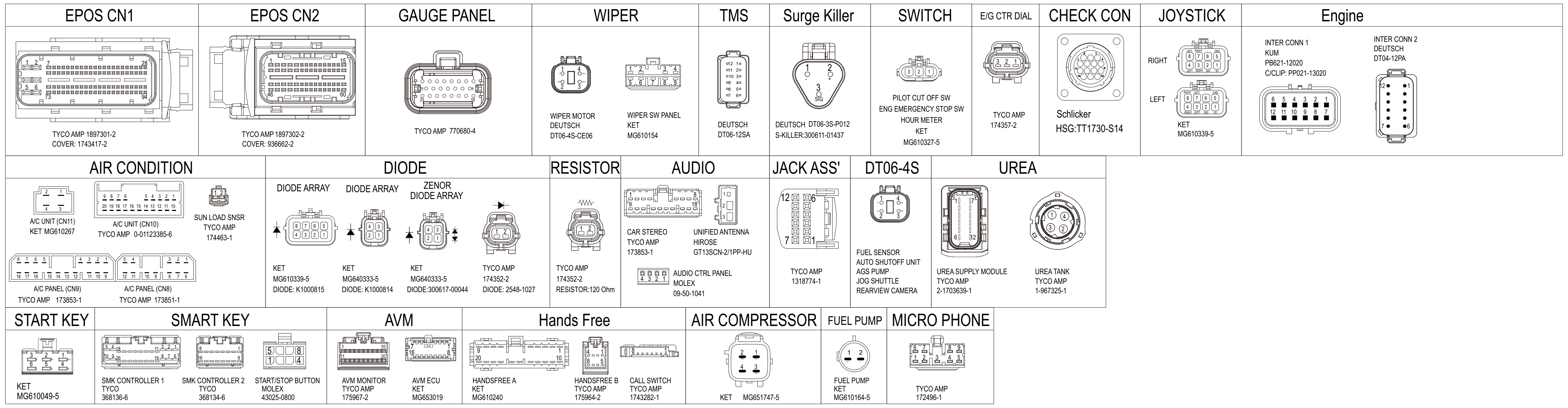
950102-00971E

DS2301255

Electrical Schematic(1/2)



Electrical Schematic(2/2)



NO.	CHANGE NO	DESCRIPTION
A	C091310	Assembling Improvement Change
B	C094100	Assembling Improvement Change
C	C101320	Pilot Assembly Improvement Design Change

950102-00974C

DS2301212