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# Safety, Specification and Systems Operation



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# Safety, Specification and Systems Operation

# **Track Excavator Maintenance Safety**

# **Safety Instructions**

# 

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.

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

### **Pressurized Fluids**

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, the 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.





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# Flying or Falling Objects

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

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

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



HAOATIOL

HAOA100L

Figure 3

#### Personal Protective Equipment (PPE)

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. 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.

Figure 4



### **Crushing and Cutting**

Figure 5

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 motor 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.

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

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.



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HDO1009L





#### **Electrical System and Electrical Shock**

Never short across starter terminals or across batteries. Shorting could damage electrical system.

**NOTE:** If it is necessary to touch injector terminal or controllers, Contact your HD HYUNDAI CONSTRUCTION EQUIP-MENT 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

Thiexcavator 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 EQUIP-MENT distributor for parts.

ROPS - Roll-over Protective Structure complies with

ISO 12117-2:2008, EN13531:2001.

#### Figure 8



# 

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)

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

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

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

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

#### Figure 9



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

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

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

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

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

#### **Emergency Exit from Operator's Station**

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.



AVOID DEATH OR SERIOUS INJURY Protect your eyes when breaking the glass.







# Long Term Storage

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, battery, 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 motor stopped, perform the following operations:

#### **Before Storage**

Keep the excavator in the position shown in Figure 12 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.
- Seal all external openings (i.e. hydraulic breather, 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.

Figure 12



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### **During Storage**

- Once a month, start the motor 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".

### 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 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 motor 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.

# 

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.
- Stop and allow motor to cool and clean motor of flammable materials before checking fluids.
- Never service or adjust machine with motor running unless instructed to do so in this manual.
- Avoid contact with leaking hydraulic fluid under pressure. It can penetrate skin or eyes.
- Keep body, jewelry and clothing away from moving parts, electrical contact, and hot parts.
- Wear eye protection to guard from battery acid, compressed springs, fluids under pressure and flying debris when motor is 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 parts.
- Only authorized personnel should service and repair the machine. Do not allow unauthorized personnel into work area.
- Lower work equipment and stop motor 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.
- Put blocks under track to prevent the machine from moving.
- To prevent injury, do not perform maintenance with motor running. If maintenance must be done with motor 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 motor 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.
- 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

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 motor, 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

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

#### Figure 13



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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 oil, battery electrolyte, window washer fluid, 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**

Most lubricants 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 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 oil caps.

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 motor compartment, battery system components and hydraulic lines.

### **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 hydraulic motor and pump) may be made from rubber that contains fluorides, which, when exposed to high heat



Figure 16

H D O 1 C



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(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

# 

When disconnecting or connecting connectors always disconnect the battery to prevent damage to any Electric parts.

If you do not follow this procedure, the parts will be damaged and/or the motor will not operate properly.

# NOTE: Disconnect battery only when LED light is OFF after motor 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 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 17

OFF

OF

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

- 1. Turn battery disconnect switch to "OFF" position.
- 2. Disconnect the negative (-) cable of battery.
- 3. Proceed with welding.
- 4. After welding, connect the negative (-) cable of battery.
- 5. Clean battery compartment.
- 6. Turn battery disconnect switch to "ON" position.
- 7. Close battery compartment door.

# Warning for Counterweight and Front Attachment Figu Removal



ON

OFF



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# 

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

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

The pilot control system is equipped with an accumulator. For a short period of time after motor 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.



#### Figure 20

Figure 19



Safety, Specification and Systems Operation 1-28

 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 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**

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

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.







HDO1042L

#### High-pressure Lines, Tubes and Hoses

Figure 23

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.

Oil 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.



EX1400129

#### Battery

#### **Battery Hazard Prevention**

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 motor 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 motor 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 motor starter switch key "OFF". Then disconnect negative (-) terminal of battery to stop flow of electricity.



Figure 24

EX1400136

# **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**

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

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

#### Figure 26



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

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

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

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

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



EX1300688







### Safety, Specification and Systems Operation 1-35

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 motor 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.

 Keep batteries fully charged to prevent freezing. If distilled water is added to batteries, run motor 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.

## 

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 motor in good mechanical condition for easy starting and good performance during adverse weather.
- 3. 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.

### 

### 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.

- 4. Lubricate entire machine according to Operation and Maintenance Manual or lubrication chart on machine.
- 5. Start motor 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.
- 6. 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 motor and hydraulic system temperatures and stop machine to let it cool, when necessary.

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

## 

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

- 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 motor 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.

### 

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.
- 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 motor 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.

- 1. Check motor 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 motor with a different power source. There is a potential hazard that could cause a battery explosion or fire.
  - Before charging or starting motor 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.

### **Asbestos Information**

# 

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

# 

#### 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 30

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.

### 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  $2.5 \text{ m/s}^2$ .

### Whole Body Vibration Level

The highest root mean square value of weighted acceleration to which the whole body is subjected, is more than  $0.5 \text{ m/s}^2$  (less than 1.15 m/s<sup>2</sup>).

### 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;
  - 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.

# **General Specifications**

# **Safety Instructions**

### 

### 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.

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# 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**

IT	EMS	UNIT	KR10	EU10	Note
OPERATING WEIG	HT (with operator 75kg)	ka	1962	1941	KR10 with Quick Coupler 26kg
	(whit operator rong)	Ng	1002	1041	EU10 w/o Quick Coupler
BUCKET C	APACITY (ISO)	m <sup>3</sup>	0.05	0.05	
	MOTOR POWER (Gross)	kWh	20.5	20.5	
EPS	MOTOR POWER (Continuous)	kW	6.1	6.1	
	BATTERY CAPACITY	kWh	20.4	20.4	
	MAX. PUMP FLOW	L/min	17.6x2+13. 2	17.6x2+13. 2	At rated rpm
HYDRAULICS	MAX. AUX FLOW	L/min	30.8	30.8	At rated rpm
	SYSTEM PRESSURE (P1&P2/P3)	bar	206 / 163	206 / 163	210 / 167 kg/cm <sup>2</sup>
SWIN	G SPEED	rpm	9.6	9.6	
TRAVEL SPI	EED (High/Low)	km/h	3.7 / 2.0	3.7 / 2.0	
GRAD	GRADEABILITY		58 (30deg)	58 (30deg)	
SHOE	E WIDTH	mm	230	230	
GROUND	PRESSURE	kg/cm <sup>2</sup>	309	309	
	BUCKET (ISO)	ton	1.53	1.53	
DIGGING FORCE	ARM (ISO)	ton	0.868	0.785	
	MAX. DIGGING REACH	mm	3,830 (3,960)	3,975	( ): with Quick Coupler
	MAX. DIGGING DEPTH	mm	2,200 (2,325)	2,350	(): with Quick Coupler
	MAX. DIGGING HEIGHT	mm	3,680 (3,835)	3,650	( ): with Quick Coupler
	MAX. DUMP HEIGHT	mm	2,625 (2,505)	26,525	( ): with Quick Coupler
	MIN. DUMP HEIGHT	mm	1.020 (900)	810	( ): with Quick Coupler
	MIN. SWING RADIUS	mm	1,490 (1,490)	1,535	(): Boom swing
	TAIL SWING RADIUS	mm	720	720	
	BOOM SWING ANGLE (L/R)	deg	45/70	45/70	
	BOOM OFFSET (L/R)	mm	513/553	513/553	

	WIDTH x HEIGHT	mm	950 (1,360) x 265	950 (1,360) x 265	(): Track extended
	MAX. LIFTING HEIGHT	mm	251	251	
DOZER BLADE	MAX. LOWERING DEPTH	mm	234	234	
	DOZER LIFTING ANGLE	deg	33	33	From track
	OVERALL LENGTH	mm	3,435	3,460	
	OVERALL WIDTH	mm	950 (1,360)	950 (1,360)	(): Track extended
TRANSPORTATION	OVERALL HEIGHT	mm	2,360	2,345	
DIMENSION	GROUND CLEARANCE	mm	155	155	
	TUMBLER DISTANCE	mm	1,258	1,258	
	TRACK GAUGE	mm	720 (1,130)	720 (1,130)	(): Track extended
	· RUBBER TRACK	SHOE	· 0.95m Arm	· 1.1m Arm	· QUICK COUPLER & PIPING
STANDARD FEATURES	STANDARD · VARIABLE TRACK FEATURES		· 2P Canopy	· 4P Canopy	· ONE/TWO WAY PIPING WITH PEDAL
	· BOOM SWING WITH PEDAL		· Quick	Non-Quick	· LED BOOM LAMP & GUARD
	· BUCKET/ARM/BOOM CYLINDER GUARD				

# **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 motor, 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 **Figure 31** for communication among coworkers.

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.
- 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.

EX1302009

# Operational Performance Standard Table

ltem	Model		Unit	Measuring Conditions	Performan ce Standard	Toleranc e	
		Pow	er Mode	rpm	SPC Off	2,300	±25
		Fower mode		rpm	SPC Off + A/I On	-	-
	Standa		ard Mode	rpm	SPC Off	1,800	±25
		Econo	my Mode	rpm	SPC Off	1,500	±25
	Working Mode	Low Idle	Above Air Temp. 15°c	rpm	Dial Min	1,200	±25
	- Unload		Above Air Temp. 15°c	rpm		1,200	±25
		Auto Idle	Above Air Temp. 10°c	rpm	A/I On	0	±25
			Below Air Temp. 10°c	rpm	An On	0	±25
Motor			1 Pump	rpm		2,280	Above
		Relief	2 Pump	rpm	*Standard	2,280	Above
		3 Pump	rpm		2,280	Above	
			Power Mode	rpm	Dial Max., Sudden Command.	2,280	Above
	Working Mode Boom Up - Load or Arm Dump	Boom Up	Standard Mode	rpm		1,780	±25
		Dump Operation	Economy Mode	rpm		1,480	±25
		Load	1300 rpm	rpm	Max. Power Mode, Adjust Dial, Sudden Command	-	±25
			Low Idle	rpm	Dial Min., Sudden Command	Not Stop Motor	
	F	an Revoluti	on	rpm	*Standard	-	-
		Pump 1 &	Normal	bar		206	0~+5
	Main	2	2 Boost bar *Stand		*Standard	-	-
		Pump 3	Normal	bar		164	0~+5
Pressure	Swing	Relief (at Motor)		bar	*Standard	143	0~+10
Set	Cwilly	Relief	(at Pump)	bar	*Standard	164	0~+10
		1 Wa	ay Relief	bar	*Standard, 150 lpm, 220	-	-
	Option	2 Wa	ay Relief	bar	bar.	-	-
		Rotating Relief		bar	*Standard	-	-

ltem		Model	Unit	Measuring Conditions	Performan ce Standard	Toleranc e
		Up	sec		2.2	±0.2
	Boom	Down	sec	-	1.6	-
		Down (with Lock Valve)	sec	-	-	-
		Crowd	sec	-	2.1	±0.2
	Arm	Crowd (with Lock Valve)	sec	-	-	-
		Dump	sec	-	2.6	±0.3
	Bucket	Crowd	sec	*Standard, Sudden	1.9	±0.2
Front Speed	*Crawler Type	Dump	sec	- Commanu.	2.2	±0.2
	Arti.	Up (With Lock Valve)	sec		-	-
		Down (With Lock Valve)	sec	-	-	-
	Boom	Left to Right	sec	-	3.1	±0.3
	Swing	Right to Left	sec		3.2	±0.3
	Dozor	Up	sec	*Standard, Actuator Speed	1.6	±0.2
	Dozei	Down	sec	at Machine Jack-up	2.0	±0.2
Swing	(F	Swing Speed (Fine Swing Off)		*Standard, Max. Reach Position, Empty Bucket, 3	19.2	±1.9
Speed	S	wing Coasting	mm	Rotations Time & Swing Coasting After Max. Swing Speed	59	±12
	Track Sag	Steel Shoe	mm	Pofor to The Track Sea	-	-
	Hack Say	Rubber Shoe	mm	Refer to the flack Say	70	±7
	Travel	1st Gear	sec	*Standard 20 m	35.6	±3.6
	Speed	2nd Gear	sec	Stanuaru, 20 m.	19.4	±1.9
Travel	Track	1st Gear	sec		18.7	±1.9
	Speed With Jack-up	2nd Gear	sec	*Standard, 3 Turns.	10.0	±1.0
	_	1st Gear	mm	*Standard,	500	Below
	Crawl Meandering	2nd Gear	mm	Forward/Reverse Each, Meandering After 20 M Crawling	500	Below

ltem		Model	Unit	Measuring Conditions	Performan ce Standard	Toleranc e
		Boom Down	mm/5 min	Max. Reach, Bucket Crowd posture, (50 mm cylinder lift	5	Below
	Cylinder reeping Front Front Arm Crowd n Arm Crowd n Bucket Dump n Arti. Boom Down n	mm/5 min	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	20	Below	
Cylinder		mm/5 min		20	Below	
Creeping		mm/5 min		-	-	
Vertical Displacement of Bucket End (*S.korea Only)	mm/1 0 min	Max. Reach, Bucket Dump Posture, Empty Bucket.	332	Below		
	Lower	Dozer Down	mm/5 min	*Standard	20	Below

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

• Standard: STD. Boom, STD. Arm, STD. Bucket

# **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  $^\circ\text{F}).$ 

Power Mode Switch	Work Mode	Auto-idle Switch
Power 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
    - 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
  - 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.

 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

### Figure 32



EX1301781



EX1301782

extended (crowded) to the point at which the arm cylinder is fully folded (dumped).

- C. Bucket cylinder
  - 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.
- 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.

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	Power Mode Switch	Work Mode	Auto-idle Switch
Low Mode	Power Mode	Digging Mode	OFF
High Mode	Power 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.

### **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 36



EX1300534

### 

#### 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	Power Mode Switch	Work Mode	Auto-idle Switch
Low Mode	Power Mode	Digging Mode	OFF
High Mode	Power 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 OBC

**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.

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

### 

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	Power Mode Switch	Work Mode	Auto-idle Switch
Low Mode	Power Mode	Digging Mode	OFF
High Mode	Power 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 OBC

### Swing Speed

### Summary

Measure the time required to swing three complete turns.



- 1. Check the lubrication of the swing gear and swing bearing.
- 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).

# Figure 38



The height as the / boom foot pin height.

EX1301770

### 

### 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.

Power Mode Switch	Work Mode	Auto-idle Switch
Power 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 OBC

### **Swing Function Drift Check**

### Summary

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

- 1. Check the lubrication of the swing gear and swing bearing.
- 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°.
- 6. Maintain the hydraulic oil temperature at 50 ±5 °C (122 ±41 °F).

### 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.

Power Mode Switch	Work Mode	Auto-idle Switch
Power 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.

### **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.

Figure 39



EX1301772





Mark on Swing Bearing

EX1301774

- 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  $\pm$ 5°C (122  $\pm$ 41°F).
- 6. Prepare a tapeline.
- 7. The machine's posture (Figure 42)
  - 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 42Excavation Posture with the Maximum Reach



Measurement

- 1. Stop the motor.
- 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.

DS1605186
- 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 43How to Measure a Cylinder's Displacement





<Arm Cylinder Extension "B-A">

DS1605187

**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.

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

#### Evaluation

Refer to OBC

### Approximate Weight of Workload Materials

### 

Weights are approximations of estimated average volume and mass. Exposure to rain, snow or groundwater; settling or compaction because of overhead weight and chemical or industrial processing or changes because of thermal or chemical transformations could all increase value of weights listed in table.

#### **Material Weight**

The data below describes weight of a cubic meter (cubic yard) of many types of workload materials.

Material	Density 1,200 kg/m <sup>3</sup> (2,000 lb/yd <sup>3</sup> ), or less	Density 1,500 kg/m <sup>3</sup> (2,500 lb/yd <sup>3</sup> ), or less	Density 1,800 kg/m <sup>3</sup> (3,000 lb/yd <sup>3</sup> ), or less	Density 2,100 kg/m <sup>3</sup> (3,500 lb/yd <sup>3</sup> ), or less
Charcoal	401 kg/m <sup>3</sup> (695 lb/yd <sup>3</sup> )	-	-	-
Coke, blast furnace size	433 kg/m <sup>3</sup> (729 lb/yd <sup>3</sup> )	-	-	-
Coke, foundry size	449 kg/m <sup>3</sup> (756 lb/yd <sup>3</sup> )	-	-	-
Coal, bituminous slack, piled	801 kg/m <sup>3</sup> (1,350 lb/yd <sup>3</sup> )	-	-	-
Coal, bituminous r. of m., piled	881 kg/m <sup>3</sup> (1,485 lb/yd <sup>3</sup> )	-	-	-
Coal, anthracite	897 kg/m <sup>3</sup> (1,512 lb/yd <sup>3</sup> )	-	-	-
Clay, DRY, in broken lumps	1,009 kg/m <sup>3</sup> (1,701 lb/yd <sup>3</sup> )	-	-	-
Clay, DAMP, natural bed	-	-	1,746 kg/m <sup>3</sup> (2,943 lb/yd <sup>3</sup> )	-
Cement, portland, DRY granular	-	-	1,506 kg/m <sup>3</sup> (2,583 lb/yd <sup>3</sup> )	-
Cement, portland, DRY clinkers	-	1,362 kg/m <sup>3</sup> (2,295 lb/yd <sup>3</sup> )	-	-
Dolomite, crushed	-	-	1,522 kg/m <sup>3</sup> (2,565 lb/yd <sup>3</sup> )	-

Material	Density 1,200 kg/m <sup>3</sup> (2,000 lb/yd <sup>3</sup> ), or less	DensityDensity200 kg/m³1,500 kg/m³000 lb/yd³),(2,500 lb/yd³),or lessor less		Density 2,100 kg/m <sup>3</sup> (3,500 lb/yd <sup>3</sup> ), or less
Earth, loamy, DRY, loose	-	1,202 kg/m <sup>3</sup> (2,025 lb/yd <sup>3</sup> )	-	-
Earth, DRY, packed	-	-	1,522 kg/m <sup>3</sup> (2,565 lb/yd <sup>3</sup> )	-
Earth, WET, muddy	-	-	1,762 kg/m <sup>3</sup> (2,970 lb/yd <sup>3</sup> )	-
Gypsum, calcined, (heated, powder)	961 kg/m <sup>3</sup> (1,620 lb/yd <sup>3</sup> )	-	-	-
Gypsum, crushed to 3 inch size	-	-	1,522 kg/m <sup>3</sup> (2,565 lb/yd <sup>3</sup> )	-
Gravel, DRY, packed fragments	-	-	-	1,810 kg/m <sup>3</sup> (3,051 lb/yd <sup>3</sup> )
Gravel, WET, packed fragments	-	-	-	1,922 kg/m <sup>3</sup> (3,240 lb/yd <sup>3</sup> )
Limestone, graded above 2	-	1,282 kg/m <sup>3</sup> (2,160 lb/yd <sup>3</sup> )	-	-
Limestone, graded 1-1/2 or 2	-	1,362 kg/m <sup>3</sup> (2,295 lb/yd <sup>3</sup> )	-	-
Limestone, crushed	-	-	1,522 kg/m <sup>3</sup> (2,565 lb/yd <sup>3</sup> )	-
Limestone, fine	-	-	1,602 kg/m <sup>3</sup> (2,705 lb/yd <sup>3</sup> )	-
Phosphate, rock	-	1,282 kg/m <sup>3</sup> (2,160 lb/yd <sup>3</sup> )	-	-
Salt	929 kg/m <sup>3</sup> (1,566 lb/yd <sup>3</sup> )	-	-	-
Snow, light density	529 kg/m <sup>3</sup> (891 lb/yd <sup>3</sup> )	-	-	-
Sand, DRY, loose	-	-	1,522 kg/m <sup>3</sup> (2,565 lb/yd <sup>3</sup> )	-
Sand, WET, packed	-	-	1,922 (3,240	
Shale, broken	-	1,362 kg/m <sup>3</sup> (2,295 lb/yd <sup>3</sup> )		
Sulfur, broken	529 kg/m <sup>3</sup> (891 lb/yd <sup>3</sup> )	-	-	-

## Main System

### **Electric Power System**

### Powerpack

Nominal voltage	51 V
Energy	20.4 kWh
Max Charging Current	268 A
Max Discharging Current	500 A
Cell type	Cylindrical, NR 21700 M50L
Cell configuration	14S-20P
Dimension (L x W x H)	644 x 362 x 441 mm
Weight	app. 150kg
IP grade	IP 65
eTMS	None

#### Figure 44



DS2300593

#### CONNECTOR

	LV CONNECTOR	HV CONNECTOR		HV CONNECTOR HV CONNECTOR	
PIN ID	Description	PIN ID	Description	PIN ID	Description
1	AUX IN 12(V+)	1	POS (+)	1	NEG (-)
2	IGNITION (BMS ignition)	MATE CONN	-	MATE CONN	-
3	CHARGER (Charge Wake up)				
4	CAN 1 - High (j1939)				
5	CAN 2 - GND (Q/C)				
6	CAN 2 - High (Q/C)				
7	CAN 2 - Low (Q/C)				
8	CAN 1 - GND (J1939)				
9	CAN 1 - Low (J1939)				
10	-				
11	LSD (GPIO)				

	LV CONNECTOR	HV CONNECTOR		HV CONNECTOR	
PIN ID	Description	PIN ID	Description	PIN ID	Description
12	AUX IN (12V-)				
MATE CONN	-				

#### Motor

Rated Power	9 kW
Phase Current	200 Arms
Insulation Class	Class H
IP Grade	IP 65
Speed	3,000 rpm
Weight	app. 20 kg
Operating Temperature	-40 to 50 degrees in Celsius

Figure 45



DS2300455

|--|

PIN1	V IN (5V)
PIN2	TEMP +
PIN3	SINE
PIN4	COSINE
PIN5	0 V
PIN6	SHIELD



Figure 46

#### Inverter

Nominal Voltage	60 - 84 V (12V)
Peak Current	550 Arms (2 min.)
IP grade	IP 65
Weight	app. 6.8 kg
Dimension (L x W x H)	275 x 232 x 85
Operating Ambient Temperature	-40 to 50 degrees in Celsius

#### **Typical Wiring**

#### Figure 47





### OBC

Nominal Output Power	3.3 kW
Input Voltage	82 - 265 Vac
AC Input Current	< 16 A
DC Output Voltage	58.8 Vmax - 65A
Dimension (L x W x H)	300 x 204 x 110 mm
Weight	app. 7 kg
Operating Ambient Temperature	-35 to 65 (possilbe derating above 40) degrees in Celsius
IP grade	IP 67

### LDC

Nominal Output Power	300 W
Output Current	M22 A
Output Voltage	13.7 V (13.5 - 13.9 V)
Dimension (L x W x H)	190 x 76 x 44 mm
Weight	app. 1 kg
Operating Ambient Temperature	-40 to 75 degrees in Celsius
IP grade	IP 67

Figure 49



### Oil Cooler (E-Fan)

Туре	E-Fan Blower, 9 Blades, Plastic
RPM @ Max. RPM	3,000 rpm



### **Performance Curve**

#### Motor Performance Curve

Figure 51



# OBC Performance Curve Figure 52



## **General Maintenance Instructions**

### **Safety Instructions**

### 

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.

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### Welding Precautions and Instructions

### 

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.

### 

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

### 

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.

### 

#### 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 motor 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 motor (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 motor 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.

### 

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.

### 

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 55



0565A

**NOTE:** Grease lip seals before assembly.

### **Cleaning and Inspection**

### **General Instructions**

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

### 

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 airstream across bearing to avoid spinning bearings that are not lubricated. DO NOT SPIN BEARINGS WHEN DRYING; bearings may be rotated slowly by hand to facilitate drying process.
- 3. Carefully inspect all bearing rollers, cages and cups for wear, chipping or nicks to determine condition. Do not replace a bearing cone or cup individually without replacing mating cup or cone at the same time. After inspection, dip bearings in lightweight oil and wrap in clean lintless cloth or paper to protect them until installation.
- 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.
- 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.

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**

Smooth even surfaces with no discoloration or marks.







HASA620S

Bent Cage

Cage damage because of improper handling or tool usage. Replace bearing.

Metal smears on roller ends because of overheat, lubricant

Replace bearing - check seals and check for proper lubrication.







HASA460S





HASA470S

#### Galling

failure or overload.

Figure 59



HASA480S

#### Abrasive Step Wear

Figure 60

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.





HASA490S

#### Etching

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

Outer race misalignment because of foreign object.

Clean related parts and replace bearing. Make sure races are

Surface depressions on race and rollers caused by hard particles

Clean all parts and housings, check seals and replace bearings

Replace bearings - check seals and check for proper lubrication.







HASA500S

#### Misalignment

properly seated.

Figure 62





HASA510S

#### Indentations

of foreign materials.

if rough or noisy.

Figure 63





HASA520S



Safety, Specification and Systems Operation 1-122


### **Fatigue Spalling**

Flaking of surface metal resulting from fatigue. Replace bearing - clean all related parts.





HASA530S

#### Brinelling

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.







HASA540S

### Cage Wear

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

Replace bearings - check seals.







HASA550S

#### **Abrasive Roller Wear**

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.

Figure 67





HASA560S

### **Cracked Inner Race**

Figure 68

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

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



HASA570S

#### Smears

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.

### Figure 69



HASA580S

### Frettage

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.





HASA590S

### Heat Discoloration

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.







HASA600S

#### **Stain Discoloration**

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.

Figure 72



HASA610S

# **Standard Torques**

# **Safety Instructions**

# 

### 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.

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# **Torque Values for Standard Metric Fasteners**

Dia. x						Grade					
Pitch (mm)	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	0.15	0.16	0.25	0.22	0.31	0.28	0.43	0.48	0.50	0.75	0.90
Std.	(1.08)	(1.15)	(1.80)	(1.59)	(2.24)	(2.02)	(3.11)	(3.47)	(3.61)	(5.42)	(6.50)
M6 x	0.28	0.30	0.45	0.40	0.55	0.47	0.77	0.85	0.90	1.25	1.50
Std.	(2.02)	(2.16)	(3.25)	(2.89)	(3.97)	(3.39)	(5.56)	(6.14)	(6.50)	(9.04)	(10.84)
M7 x	0.43	0.46	0.70	0.63	0.83	0.78	1.20	1.30	1.40	1.95	2.35
Std.	(3.11)	(3.32)	(5.06)	(4.55)	(6.00)	(5.64)	(8.67)	(9.40)	(10.12)	(14.10)	(16.99)
M8 x	0.70	0.75	1.10	1.00	1.40	1.25	1.90	2.10	2.20	3.10	3.80
Std.	(5.06)	(5.42)	(7.95)	(7.23)	(10.12)	(9.04)	(13.74)	(15.18)	(15.91)	(22.42)	(27.48)
M8 x 1	0.73	0.80	1.20	1.00	1.50	1.35	2.10	2.30	2.40	3.35	4.10
	(5.28)	(5.78)	(8.67)	(7.23)	(10.84)	(9.76)	(15.18)	(16.63)	(17.35)	(24.23)	(29.65)
M10 x	1.35	1.40	2.20	1.90	2.70	2.35	3.70	4.20	4.40	6.20	7.20
Std.	(9.76)	(10.12)	(15.91)	(13.74)	(19.52)	(19.99)	(26.76)	(30.37)	(31.18)	(44.84)	(52.07)
M10 x	1.50	1.60	2.50	2.10	3.10	2.80	4.30	4.90	5.00	7.00	8.40
1.25	(10.84)	(11.57)	(18.08)	(15.18)	(22.42)	(20.25)	(31.10)	(35.44)	(36.16)	(50.63)	(60.75)
M12 x	2.40	2.50	3.70	3.30	4.70	4.20	6.30	7.20	7.50	10.50	12.50
Std.	(17.35)	(18.08)	(26.76)	(23.86)	(33.99)	(30.37)	(45.56)	(52.07)	(54.24)	(75.94)	(90.41)
M12 x	2.55	2.70	4.00	3.50	5.00	4.50	6.80	7.70	8.00	11.20	13.40
1.25	(18.44)	(19.52)	(28.93)	(25.31)	(36.16)	(32.54)	(49.18)	(55.69)	(57.86)	(81.00)	(96.92)
M14 x	3.70	3.90	6.00	5.20	7.50	7.00	10.00	11.50	12.00	17.00	20.00
Std.	(26.76)	(28.20)	(13.23)	(37.61)	(54.24)	(50.63)	(72.33)	(83.17)	(86.79)	(122.96)	(144.66)
M14 x	4.10	4.30	6.60	5.70	8.30	7.50	11.10	12.50	13.00	18.50	22.00
1.5	(29.65)	(31.10)	(47.73)	(41.22)	(60.03)	(54.24)	(80.28)	(90.41)	(94.02)	(11.26)	(158.12)
M16 x	5.60	6.00	9.00	8.00	11.50	10.50	15.50	17.90	18.50	26.00	31.00
Std.	(40.50)	(43.39)	(65.09)	(57.86)	(83.17)	(75.94)	(112.11)	(129.47)	(133.81)	(188.05)	(224.22)
M16 x	6.20	6.50	9.70	8.60	12.50	11.30	17.00	19.50	20.00	28.00	35.50
1.5	(44.84)	(47.01)	(70.16)	(62.20)	(90.41)	(81.73)	(122.96)	(141.04)	(144.66)	(202.52)	(256.77)
M18 x	7.80	8.30	12.50	11.00	16.00	14.50	21.00	27.50	28.50	41.00	43.00
Std.	(56.41)	(60.03)	(90.41)	(79.56)	(115.72)	(104.87)	(151.89)	(198.90)	(206.14)	(296.55)	(311.01)
M18 x	9.10	9.50	14.40	12.50	18.50	16.70	24.50	27.50	28.50	41.00	49.00
1.5	(65.82)	(68.71)	(104.15)	(90.41)	(133.81)	(120.79)	(177.20)	(198.90)	(206.14)	(296.55)	(354.41)
M20 x	11.50	12.00	18.00	16.00	22.00	19.00	31.50	35.00	36.00	51.00	60.00
Std.	(83.17)	(86.79)	(130.19)	(115.72)	(159.12)	(137.42)	(227.83)	(253.15)	(260.38)	(368.88)	(433.98)
M20 x	12.80	13.50	20.50	18.00	25.00	22.50	35.00	39.50	41.00	58.00	68.00
1.5	(92.58)	(97.64)	(148.27)	(130.19)	(180.82)	(162.74)	(253.15)	(285.70)	(296.55)	(419.51)	(491.84)
M22 x	15.50	16.00	24.50	21.00	30.00	26.00	42.00	46.00	49.00	67.00	75.00
Std.	(112.11)	(115.72)	(177.20)	(151.89)	(216.99)	(188.05)	(303.78)	(332.71)	(354.41)	(484.61)	(542.47)
M22 x	17.00	18.50	28.00	24.00	34.00	29.00	47.00	52.00	56.00	75.00	85.00
1.5	(122.96)	(133.81)	(202.52)	(173.59)	(245.92)	(209.75)	(339.95)	(44.76)	(405.04)	(542.47)	(614.80)
M24 x	20.50	21.50	33.00	27.00	40.00	34.00	55.00	58.00	63.00	82.00	92.00
Std.	(148.27)	(155.50)	(238.68)	(195.29)	(289.32)	(245.92)	(397.81)	(419.51)	(455.67)	(593.10)	(655.43)
M24 x	23.00	35.00	37.00	31.00	45.00	38.00	61.00	67.00	74.00	93.00	103.00
2.0	(166.35)	(253.15)	(267.62)	(224.22)	(325.48)	(202.52)	(441.21)	(484.61)	(535.24)	(672.66)	(744.99)

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

# **Torque Values for Standard U.S.** Fasteners

Туре	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.	$\bigcirc$
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.

- **NOTE:** 0.70 When Molykote, white lead or similar mixtures are used as lubricants.
- NOTE: 0.75 When Parkerized bolts or nuts are used.
- **NOTE:** 0.85 When cadmium plated bolts or nuts and zinc bolts w/waxed zinc nuts are used.
- **NOTE:** 0.9 When hardened surfaces are used under the nut or bolt head.
- **NOTE:** When reusing bolts and nuts in service, use minimum torque values.

The following General Torque Values must be used where SPECIAL TORQUE VALUES

are not given.

**NOTE:** Torque values listed throughout this manual are lubricated (wet) threads; values must be increased 1/3 for non lubricated (dry) threads.

	Heat-treated Material Grade 5 and Grade 8					
Thread Size	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		

**NOTE:** Torque values listed throughout this manual are lubricated (wet) threads; values must be increased 1/3 for non lubricated (dry) threads.

	Heat-treated Material Grade 5 and Grade 8						
Thread Size	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" - 28	7	9	11	15			
5/16" - 18	13	18	18	24			
5/16" - 24	15	20	21	28			
3/8" - 16	24	33	34	46			
3/8" - 24	27	37	38	52			
7/16" - 14	38	52	54	73			
7/16" - 20	42	57	60	81			
1/2" - 13	58	79	82	111			
1/2" - 20	65	88	90	122			
9/16" - 12	84	114	120	163			
9/16" - 18	93	126	132	179			
5/8" - 11	115	156	165	224			
5/8" - 18	130	176	185	251			
3/4" - 10	205	278	290	393			
3/4" - 16	240	312	320	434			
7/8" - 9	305	414	455	617			
7/8" - 14	334	454	515	698			
1" - 8	455	617	695	942			
1" - 14	510	691	785	1064			
1 1/8" - 7	610	827	990	1342			
1 1/8" - 12	685	929	1110	1505			
1 1/4" - 7	860	1166	1400	1898			
1 1/4" - 12	955	1295	1550	2102			
1 3/8" - 6	1130	1532	1830	2481			
1 3/8" - 12	1290	1749	2085	2827			
1 1/2" - 6	1400	2034	2430	3295			
1 1/2" - 12	1690	2291	2730	3701			
1 3/4" - 5	2370	3213	3810	5166			
2" - 4 1/2	3550	4813	5760	7810			

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

# Type 8 Phosphate Coated Hardware

This chart provides tightening torque for general purpose applications using original equipment standard hardware as listed in the Parts Manual for the machine involved. DO NOT SUBSTI-TUTE. 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%				
Nominal Thread Diameter	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.).

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

# ORFS Swivel Nut Recommended Torque

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

# **Torque Values for Split Flanges**

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

Elongo Sizo (*)	Bolt Size	Bolt To	orque
Fidlige Size ( )		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

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

 $(\ensuremath{^*})$  - 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 73

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:

 $I = A \times T/A + B$  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:

1 =	AxT	12 x 300	3600	=	150
. –	A + B	12 + 12	24	_	150

- **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.



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• 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.

# Main System

# 

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.

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# **Overview**

### **General information**

#### The main system of machine consists of Electric power system and Hydraulic system.

The electric power system consists of 4 major parts which are Energy storage part, Charging part, Power distribution part, and Drive part.

- Energy storage part: Cell, BMS
- Charging part: OBC, Quick charger, Charging inlet, Charging cable
- Power distribution part: LDC, PDU
- Drive part: Motor, Inverter

#### Figure 74



BMS: Battery Management System

OBC: On Board Charger

LDC: Low voltage DC/DC Converter

PDU: Power Distribution Unit

# Layout

# Figure 75



# DS2300448

Reference Number	Description	Reference Number	Description
1	Power Distribution Unit (PDU)	5	Fast Charging Socket
2	Inverter	6	Fast Charging Switch
3	Vehicle Control Unit (VCU)	7	On Board Charger (OBC)
4	Battery Pack	-	-





# DS2300449

Reference Number	Description	Reference Number	Description
1	Slow Charging Socket	6	Inverter
2	Main Pump	7	Vehicle Control Unit (VCU)
3	Motor	8	Power Distribution Unit (PDU)
4	Low voltage DC/DC Converter (LDC)	9	Cooler
5	Battery 12V	10	-

# **Battery Pack**

### **General Information**

For general information, refer to the drawings and specifications of the battery pack.

- Generally, the battery can be charged at a temperature of 0°C or higher. For the module equipped with a PTC heater, the battery can even be charged at a temperature of -20°C 0°C.
- When a charger is connected to the module for charging under this condition, the heater is first activated to raise the battery temperature over 0°C, which is a rechargeable temperature, and then the charging is started.
- The following label, which contains information such as the product specifications and warnings, is attached to the top of the battery pack.

#### **General Guidelines**

- 1. In order to maintain optimum long-term performance and safety, please read and familiarize yourself with this manual and perform routine inspections and regular inspections.
- 2. The content of this manual is divided into causes of bodily injury and damage to assets and causes of pollution.

# 

There is a risk of injuries or electrocution resulting from an accident, e.g. fires or explosions. In case of an accident, seek medical attention immediately.

#### Cautions for Starting the e-Powerpack

- 1. Before starting the e-Powerpack, please read this manual carefully and familiarize yourself with the 'Danger', 'Warning', and 'Caution' items. If you cannot fully understand something or have any questions, please contact us.
- 2. For safety reasons, attach "Warning" signs around the e-Powerpack in service to keep people other than workers away from the e-Powerpack. Let e-Powerpack operators know that they are responsible for the safety of the e-Powerpack room.
- 3. Only authorized personnel may start and operate the e-Powerpack. Unauthorized personnel should not be allowed to handle the e-Powerpack.
- 4. Do not touch wire and electric parts while the e-Powerpack is in operation.
- 5. Be careful not to make contact with the e-Powerpack while it is running since it becomes hot during operation.

#### **Cautions for Inspection and Repair**

1. Inspections and repairs of the e-Powerpack should be performed only when the module is stopped. Otherwise, burns or safety accidents may occur, so do not perform inspections or repairs while the e-Powerpack is running.

# 

Make sure to wear protective equipment, e.g. insulated gloves. Workers are not allowed to wear metal accessories, e.g. watches and rings, which can cause a short. Make sure to remove all such items before operation.

2. Only certified professional technicians should perform repairs and maintenance on the e-Powerpack.

- 3. Only appropriate tools should be used. If the jaws of a wrench are worn out, the wrench might slip during use, causing safety accidents.
- 4. Do not allow other people to stand or pass under the e-Powerpack when lifting the e-Powerpack with a crane. Before lifting the e-Powerpack, ensure that there is no one around the e-Powerpack and secure enough safe space.
- 5. Before inspecting or replacing electrical equipment, disconnect the battery ground wire first. Connect the battery ground wire after completing all required work for checking or replacing the electrical equipment in order to prevent a short circuit.
- 6. Workers should wear protective equipment and use insulated tools. Cover the irrelevant area with an insulated cover. Organize and store the removed parts on an insulated mat to avoid causing a short circuit.
- 7. Confirm that the voltage between the power terminals is 0 V. When disconnecting any cable or bus bar or removing any part related to the battery, make sure to avoid contact between the positive (+) and negative (-) terminals. When disconnecting any cable or bus bar, insulate the corresponding part with insulating tape immediately.

#### **General Maintenance**

Turn off the MDS (Manual Disconnect Switch) on top of the battery pack before the long-term storage of the vehicle or the installation, removal, or disassembly of the battery pack.

#### Figure 77



Reference Number	Description	Reference Number	Description
1	Disconnect switch	2	Connector
3	Connector (high voltage, +/-)	4	Vent
## Layout

Figure 78



Reference Number	Reference NumberDescriptionReference Number		Description
1	Power Distribution Unit (PDU)	5	Fast Charging Socket
2	Inverter	6	Fast Charging Switch
3	Vehicle Control Unit (VCU)	7	On Board Charger (OBC)
4	Battery Pack	-	-





Reference Number	Description	Reference Number	Description
1	Slow Charging Socket	6	Inverter
2	Main Pump	7	Vehicle Control Unit (VCU)
3	Motor	8	Power Distribution Unit (PDU)
4	Low voltage DC/DC Converter (LDC)	9	Cooler
5	Battery 12V	10	-

# Inverter

### Overview

### OBC (On Board Charger): A device that charges a DC battery using commercial AC power

LDC (Low Voltage DC-DC Converter): A device that steps down a high voltage (DC voltage) into a low voltage Inverter: A device that drives an electric motor by converting AC or DC voltage

### Figure 80

## **51V System Power Line**



### Introduction

The Inverter delivers smooth power and flexibility in a true dual-voltage package.A 12 V chassis-grounded system can be used for low-power circuits, while the high power, high voltage system is isolated to ensure a high level of protection against electrical shock. These AC controllers contain two microprocessors, which provide the enhanced diagnostic functions required to meet modern safety standards.

The primary microprocessor runs an advanced field-oriented AC motor control while simultaneously running VCL software in an embedded logic controller. The second microprocessor continuously monitors the operation of the system, redundantly measuring inputs, crosschecking results, and verifying critical timing and operations.

#### Figure 81



Terminal	Description	Terminal	Description
B+	Positive battery to controller	V	Motor phase V
B-	Negative battery to controller	W	Motor phase W
U	Motor phase U	-	-

### Diagnostics

Types of LED display				
DISPLAY	STATUS			
Neither LED illuminated	Controller is not powered on; or vehicle has dead battery; or severe damage.			
Yellow LED flashing	Controller is operating normally.			
Yellow and red LEDs both on solid	Controller is in Flash program mode.			
Red LED on solid	No software loaded, or an internal hardware fault detected by the Supervisor or Primary microprocessor. Cycle KSI to clear. Reload software or replace controller if necessary.			
Red LED and yellow LED flashing alternately	Controller has detected a fault. 2-digit code flashed by yellow LED identifies the specific fault; one or two flashes by red LED indicate whether first or second code digit will follow.			

### OVERVIEW

The OBC includes additional built-in features not previously seen in an industrial battery charger:

- 12V BMS wake-up output
- Adjustable 13.5V/27.0V DC-DC output
- Full EVSE support: SAE J1772, IEC61851 Mode 2 and Mode 3
- Stackable-ready

Figure 82



## AC Voltage vs Power

DS2300603

### DC-DC (LVDC Output)

The patented XV-series DC-DC converter shares components from the HVDC charging output to run the LVDC output.

- 500W continuous with no AC connection
- 70W from separate circuit when AC connected
- Voltage is software configurable and controllable: 12-15V (12V version) or 24-29V (24V version)

Min/Max HVDC voltages to run DC-DC:

- 12V output:
  - \* 32-65VDC; or
  - \* 60-120VDC

#### **In-Rush Current**

If no AC is detected and all safety checks pass, the charger will pre-charge the bus to match the voltage of the traction pack, close the relay and start producing LV output. This process will take a few seconds (the 120V variants take a few seconds longer than 65V models). However, the circuit is very effective and there is essentially no inrush when switching to DCI mode now simplifying system integration.

### **ELECTRICAL CONNECTIONS**

## 

Mechanical loads applied to the AC, HVDC, and LVDC connectors must be controlled by appropriate strain relief of the cable. No bend/twist/flex is allowed on the cable prior to securement. Cable must be fixed to a point structurally contiguous with the receptacle connector within 75mm from the mating interface of the plug and receptacle. No relative movement between receptacle and first cable-securing device is permissible. Strain relief distance should be minimized for all applications.

Caution: When not mated, connector housings are not water-proof. Moisture could enter the charger and cause damage if exposed to water when connectors are not mated!

#### Figure 83



#### DS2300604

Connection Label	Brand	Series	Receptacle Part/model #	Plug Part/model #
DC (Traction)	Amphenol DTI	PowerLok 4.0	PL082X-60-10 (orange)	PL182X-60-10 (orange)
AUX DC (Output)	Amphenol DTI	PowerLok 4.0	PL082Y-60-6 (black)	PL182Y-60-6 (black)
SIG1	TE DEUTSCH	DTM Series	DTM15-12PA	DTM06-12SA
SIG2	TE DEUTSCH	DTM Series	DTM15-12PB	DTM06-12SB
AC (Input)	Amphenol DTI	PowerLok 4.0	PL083X-40-2.5 (orange)	PL183.X-40-2.5 (orange)

Contact Material (All Connectors): Tin



Pin	Function
1	Neutral
2	Earth Ground
3	Line

Aux DC Output Figure 85



Pin	Function
1	Positive
2	Negative

Traction DC Connection Figure 86



Pin	Function
1	Negative
2	Positive

SIG1: Signals Connector 1 (Battery) Figure 87



# DS2300607

Pin	PREMIER Model	BASE Model	Notes
1	CAN LO 2*	12V 5A (AC Powered only)	aka LV AC-DC
2	CAN HI 2*	LVDC GND	
3	CAN HI 1*	CAN HI 1	
4	CAN LO 1*	CAN LO 1	
5	HVDC GND Reference		
6	BMS Wakeup 12V		2W max
7	Temperature Sense +		Also used for Charger Control
8	Key Start In		For charger wake
9	LVDC GND Reference		
10	Interlock normally Closed		Signal contacts only. Max current TBD
11	Interlock Common		
12	Interlock Normally Open		

CAN1 and CAN2 are on the same bus so that two sets of contacts are available for wiring the bus. Install terminator on CAN2 if needed.

### SIG2: Signals Connector 2 (EVSE)

DT13-12PB - Blank if EVSE option not installed **Figure 88** 



# DS2300608

1	LED-OUT-0/Actuator Release Button	Vehicle Inlet LEDs/Actuator Release Button
2	LED-OUT-1	
3	LED-OUT-4	
4	LED-OUT-2	
5	LED-OUT-5	
6	LED-OUT-3	
7	LV GND	Low Voltage Bus Ground
8	PP PROXIMITY-IN	Proximity Pilot
9	CP CONTROL-IN	Control Pilot
10	ACTUATOR-FB	Lock actuator feedback
11	ACTUATOR-FWD	Lock actuator forward drive
12	ACTUATOR-REV	Lock actuator reverse drive

## 

Signals Connector 2 is inverted when compared to Signals Connector 1 on the panel installation.



# DS2300609

### Display / UI

Status	LED Operation	
No AC	OFF	
DC-DC active	Sold Amber	
Charging: battery at low state of charge	Slow GREEN breathing (1s on; 0.2s off)	
Charging: battery at high state of charge	Fast GREEN breathing (0.4s on; 0.1s off)	
Charge Complete	Solid GREEN	
Error	Rapid AMBER flashing (0.5s on; 0.5s off)	
Fault	Solid RED	

# **PDU (Power Distribution Unit)**







Figure 91



	SUPPLIER	MAX CURRENT	COLOR	KEY CODE
DC Charging Connector (+)	AMPHENOL	350 A	RED	90 °
DC Charging Connector (-)	AMPHENOL	350 A	BLACK	180 °
BATTERY CONNECTOR (+)	AMPHENOL	350 A	ORANGE	120 °
BATTERY CONNECTOR (-)	AMPHENOL	350 A	BLACK	150 °
INVERTER CONNECTOR (+)	AMPHENOL	350 A	ORANGE	90 °
INVERTER CONNECTOR (+)	AMPHENOL	350 A	BLACK	60 °
OBC CONNECTOR (+)	AMPHENOL	350 A	ORANGE	90 °
OBC CONNECTOR (-)	AMPHENOL	350 A	BLACK	180 °
LDC CONNECTOR	TE	40 A	ORANGE	-
LV SIGNAL CONNECTOR	AMPHENOL	13 A	BLACK	-



#### **GENERAL SPECIFICATION**

System Voltage (HV Side)DC 34 V - 58 VSystem Voltage (LV Side)DC 9 V - 16 VRating VoltageDC 51 VOperating Temperature-30 °C ~ +60 °CStorage Temperature-40 °C ~ +85 °COperating CurrentMAX 275 A

# **Inverter Troubleshooting**

CODE	PROGRAMMER LCD DISPLAY EFFECT OF FAULT	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
12	Controller Over current Shutdown Motor; Shut down Main Contactor; Shutdown EM Brake; Shutdown Throttle; Full Brake; Shutdown Pump.	<ol> <li>External short of phase U,V, or W motor connections. 2. Motor parameters are mis-tuned. 3. Controller defective. 4. Speed encoder noise problems.</li> </ol>	Set: Phase current exceeded the current measurement limit. Clear: Cycle KSI.
13	Current Sensor Fault Shutdown Motor; Shutdown Main Contactor; Shutdown EM Brake; Shutdown throttle; Full Brake; Shutdown Pump.	1. Leakage to vehicle frame from phase U, V, or W (short in motor stator). 2. Controller defective.	Set: Controller current sensors have invalid offset reading. Clear: Cycle KSI.
14	Precharge Failed Shutdown Motor; Shutdown Main Contactor; Shutdown EM Brake; Shutdown Throttle; Full Brake; Shutdown Pump.	<ol> <li>See Monitor menu » Battery: Capacitor Voltage. 2. Open circuit in external precharge relay, external precharge resistor, or associated wiring. 3. External load on capacitor bank (B+ connection terminal) that prevents the capacitor bank from charging.</li> </ol>	Set: Precharge failed to charge the capacitor bank from the external precharge resistor. Clear: Cycle Interlock input or use VCL function Enable_Precharge().
15	Controller Severe Undertemp Shutdown Motor; Shutdown Main Contactor; Shutdown EM Brake; Shutdown Throttle; Full Brake; Shutdown Pump.	1. See Monitor menu » Controller: Temperature. 2. Controller is operating in an extreme environment.	Set: Heatsink temperature below -40°C. Clear: Bring heatsink temperature above -40°C, and cycle interlock or KSI.
16	Controller Severe Overtemp Shutdown Motor; Shutdown Main Contactor; Shutdown EM Brake; Shutdown Throttle; Full Brake; Shutdown Pump.	1. See Monitor menu » Controller: Temperature. 2. Controller is operating in an extreme environment. 3. Excessive load on vehicle. 4. Improper mounting of controller.	Set: Heatsink temperature above +95°C. Clear: Bring heatsink temperature below +95°C, and cycle interlock or KSI
17	Severe B+ Undervoltage Reduced drive torque.	1. Battery parameters are misadjusted. 2. Non-controller system drain on battery. 3. Battery resistance too high. 4. Battery disconnected while driving. 5. See Monitor menu » Battery: Capacitor Voltage. 6. Blown B+ fuse or main contactor did not close.	Set: Capacitor bank voltage dropped below the Severe Undervoltage limit (see pages 25 and 61) with FET bridge enabled. Clear: Bring capacitor voltage above Severe Undervoltage limit.
17	Severe KSI Undervoltage If below brownout voltage, motor current is switched off and reset may occur (see Voltage Limits overview on page 25).	<ol> <li>See Monitor menu » Battery: Keyswitch Voltage. 2.</li> <li>Non-controller system drain on low power circuit voltage. 3.</li> <li>Resistance in low power circuit too high. 4. Low power circuit power source disconnected while driving. 5. Blown fuse.</li> </ol>	Set: KSI voltage dropped below 8.4 V (Brownout occurs at 8.0 V.) Clear: Bring KSI voltage above 8.4 V.

CODE	PROGRAMMER LCD DISPLAY EFFECT OF FAULT	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
18	Severe B+ Overvoltage Shutdown Motor; Shutdown Main Contactor; Shutdown EM Brake; Shutdown Throttle; Full Brake;	<ol> <li>See Monitor menu » Battery: Capacitor Voltage. 2. Battery parameters are misadjusted. 3. Battery resistance too high for given regen current. 4. Battery disconnected while regen braking.</li> </ol>	Set: Capacitor bank voltage exceeded the Severe Overvoltage limit (see pages 25 and 61) with FET bridge enabled. Clear: Bring capacitor voltage below Severe Overvoltage limit, and then cycle KSI.
18	Severe KSI Overvoltage Shutdown Motor; Shutdown Main Contactor; Shutdown EM Brake; Shutdown Throttle; Full Brake; Shutdown Pump.	<ol> <li>See Monitor menu » Battery: Keyswitch Voltage. 2. Incorrect low power circuit voltage applied.</li> <li>Low power circuit voltage spike caused by inductive load switching, etc.</li> </ol>	Set: KSI voltage exceeded 20 V. Clear: Bring KSI voltage below 20 V, and then cycle KSI.
22	Controller Overtemp Cutback Reduced drive and brake torque.	1. See Monitor menu » Controller: Temperature. 2. Controller is performance-limited at this temperature. 3. Controller is operating in an extreme environment. 4. Excessive load on vehicle. 5. Improper mounting of controller.	Set: Heatsink temperature exceeded 85°C. Clear: Bring heatsink temperature below 85°C.
23	B+ Undervoltage Cutback Reduced drive torque.	1. Normal operation. Fault indicates the batteries need recharging. Controller is performance limited at this voltage. 2. Battery parameters are misadjusted. 3. Non-controller system drain on battery. 4. Battery resistance too high. 5. Battery disconnected while driving. 6. See Monitor menu » Battery: Capacitor Voltage. 7. Blown B+ fuse or main contactor did not close.	Set: Capacitor bank voltage dropped below the Undervoltage limit (see pages 25 and 61) with the FET bridge enabled. Clear: Bring capacitor voltage above the Undervoltage limit.
24	B+ Overvoltage Cutback Reduced brake torque. Note: This fault is declared only when the controller is running in regen.	<ol> <li>Normal operation. Fault shows that regen braking currents elevated the battery voltage during regen braking. Controller is performance limited at this voltage. 2. Battery parameters are misadjusted. 3. Battery resistance too high for given regen current. 4. Battery disconnected while regen braking. 5. See Monitor menu » Battery: Capacitor Voltage.</li> </ol>	Set: Capacitor bank voltage exceeded the Overvoltage limit (see pages 25 and 61) with the FET bridge enabled. Clear: Bring capacitor voltage below the Overvoltage limit.
25	+5V Supply Failure None, unless a fault action is programmed in VCL.	1. External load impedance on the +5V supply (pin 26) is too low. 2. See Monitor menu » outputs: 5 Volts and Ext Supply Current.	Set: +5V supply (pin 26) outside the 5 V± 10% range. Clear: Bring voltage within range.

CODE	PROGRAMMER LCD DISPLAY EFFECT OF FAULT	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
26	Digital Out 6 Open/Short Digital Output 6 driver will not turn on.	1. External load impedance on Digital Output 6 driver (pin 19) is too low.	Set: Digital Output 6 (pin 19) current exceeded 15 mA. Clear: Remedy the overcurrent cause and use the VCL function Set_DigOut() to turn the driver on again.
27	Digital Out 7 Open/Short Digital Output 7 driver will not turn on.	1. External load impedance on Digital Output 7 driver (pin 20) is too low.	Set: Digital Output 7 (pin 20) current exceeded 15 mA. Clear: Remedy the overcurrent cause and use the VCL function Set_DigOut() to turn the driver on again.
28	Motor Temp Hot Cutback Reduced drive torque.	<ol> <li>Motor temperature is at or above the programmed setting, and the current is being cut back.</li> <li>Motor Temperature Control Menu parameters are mis-tuned.</li> <li>See Monitor menu » Motor: Temperature and » Inputs: Analog2. 4. If the application doesn't use a motor thermistor, Temp Compensation and Temp Cutback should be programmed Off.</li> </ol>	Set: Motor temperature is at or above the Temperature Hot parameter setting. Clear: Bring the motor temperature within range.
29	Motor Temp Sensor Fault Max Speed reduced (LOS, Limited Operating Strategy), and motor temperature cutback disabled.	<ol> <li>Motor thermistor is not connected properly. 2. If the application doesn't use a motor thermistor, Motor Temp Sensor Enable should be programmed Off. 3. See Monitor menu » Motor: Temperature and » Inputs: Analog2.</li> </ol>	Set: Motor thermistor input (pin 8) is at the voltage rail (0 V or 10 V). Clear: Bring the motor thermistor input voltage within range.
31	Coil1 Driver Open/Short ShutdownDriver1.	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	Set: Driver 1 (pin 6) is either open or shorted. This fault can be set only when Main Enable = Off. Clear: Correct open or short, and cycle driver.
31	Main Open/Short Shutdown Motor; Shutdown Main Contactor; Shutdown EM Brake; Shutdown Throttle; Full Brake; Shutdown Pump.	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	Set: Main contactor driver (pin 6) is either open or shorted. This fault can be set only when Main Enable = On. Clear: Correct open or short, and cycle driver
32	Coil2 Driver Open/Short ShutdownDriver2.	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	Set: Driver 2 (pin 5) is either open or shorted. This fault can be set only when EM Brake Type = 0. Clear: Correct open or short, and cycle driver.

CODE	PROGRAMMER LCD DISPLAY EFFECT OF FAULT	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
32	EM Brake Open/Short Shutdown EM Brake; Shutdown Throttle; Full Brake.	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	Set: Electromagnetic brake driver (pin 5) is either open or shorted. This fault can be set only when EM Brake Type > 0. Clear: Correct open or short, and cycle driver.
33	Coil3 Driver Open/Short ShutdownDriver3.	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	Set: Driver 3 (pin 4) is either open or shorted. Clear: Correct open or short, and cycle driver.
34	Coil4 Driver Open/Short ShutdownDriver4.	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	Set: Driver 4 (pin 3) is either open or shorted. Clear: Correct open or short, and cycle driver.
35	PD Open/Short Shutdown PD.	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	Set: Proportional driver (pin 2) is either open or shorted. Clear: Correct open or short, and cycle driver.
36	Encoder Fault Shutdown EM Brake; Shutdown Throttle.	1. Motor encoder failure. 2. Bad crimps or faulty wiring. 3. See Monitor menu » Motor: Motor RPM.	Set: Motor encoder phase failure detected. Clear: Cycle KSI.
37	Motor Open Shutdown Motor; Shutdown Main Contactor; Shutdown EM Brake; Shutdown Throttle; Full Brake; Shutdown Pump.	1. Motor phase is open. 2. Bad crimps or faulty wiring.	Set: Motor phase U, V, or W detected open. Clear: Cycle KSI.
38	Main Contactor Welded Shutdown Motor; Shutdown Main Contactor; Shutdown EM Brake; Shutdown Throttle; Full Brake; Shutdown Pump.	<ol> <li>Main contactor tips are welded closed. 2. Motor phase U or V is disconnected or open. 3. An alternate voltage path (such as an external precharge resistor) is providing a current to the capacitor bank (B+ connection terminal).</li> </ol>	Set: Just prior to the main contactor closing, the capacitor bank voltage (B+ connection terminal) was loaded for a short time and the voltage did not discharge. Clear: Cycle KSI
39	Main Contactor Did Not Close Shutdown Motor; Shutdown Main Contactor; Shutdown EM Brake; Shutdown Throttle; Full Brake; Shutdown Pump.	<ol> <li>Main contactor did not close. 2.</li> <li>Main contactor tips are oxidized, burned, or not making good contact. 3. External load on capacitor bank (B+ connection terminal) that pre-vents capacitor bank from charging.4. Blown B+ fuse.</li> </ol>	Set: With the main contactor commanded closed, the capacitor bank voltage (B+ connection terminal) did not charge to B+. Clear: Cycle KSI.
41	Throttle Wiper High Shutdown Throttle.	1. See Monitor menu » Inputs: Throttle Pot. 2. Throttle pot wiper voltage too high.	Set: Throttle pot wiper (pin 16) voltage is higher than the high fault threshold (can be changed with the VCL function Setup_Pot_Faults()). Clear: Bring throttle pot wiper voltage below the fault threshold.

CODE	PROGRAMMER LCD DISPLAY EFFECT OF FAULT	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
42	Throttle Wiper Low Shutdown Throttle.	1. See Monitor menu » Inputs: Throttle Pot. 2. Throttle pot wiper voltage too low.	Set: Throttle pot wiper (pin 16) voltage is lower than the low fault threshold (can be changed with the VCL function Setup_Pot_Faults()).Clear: Bring throttle pot wiper voltage above the fault threshold.
43	Pot2 Wiper High Full Brake.	1. See Monitor menu » Inputs: Pot2 Raw. 2. Pot2 wiper voltage too high.	Set: Pot2 wiper (pin 17) voltage is higher than the high fault threshold (can be changed with the VCL function Setup_Pot_Faults()).Clear: Bring Pot2 wiper voltage below the fault threshold.
44	Pot2 Wiper Low Full Brake.	1. See Monitor menu » Inputs: Pot2 Raw. 2. Pot2 wiper voltage too low.	Set: Pot2 wiper (pin 17) voltage is lower than the low fault threshold (can be changed with the VCL function Setup_Pot_Faults()).Clear: Bring Pot2 wiper voltage above the fault threshold.
45	Pot Low Overcurrent Shutdown Throttle; Full Brake.	1. See Monitor menu » Outputs: Pot Low.2. Combined pot resistance connected to pot low is too low.	Set: Pot low (pin 18) current exceeds 10 mA. Clear: Clear pot low overcurrent condition and cycle KSI.
46	EEPROM Failure Shutdown Motor; Shutdown Main Contactor; Shutdown EM Brake; Shutdown Throttle; Shutdown Interlock; Shutdown Driver1; Shutdown Driver2; Shutdown Driver3; Shutdown Driver4; Shutdown PD; Full Brake; Shutdown Pump.	1. Failure to write to EEPROM memory. This can be caused by EEPROM memory writes initiated by VCL, by the CAN bus, by adjusting parameters with the programmer, or by loading new software into the controller.	Set: Controller operating system tried to write to EEPROM memory and failed. Clear: Download the correct software (OS) and matching parameter default settings into the controller and cycle KSI.
47	HPD/Sequencing Fault Shutdown Throttle.	1. KSI, interlock, direction, and throttle inputs applied in incorrect sequence. 2. Faulty wiring, crimps, or switches at KSI, interlock, direction, or throttle inputs. 3. See Monitor menu » Inputs.	Set: HPD (High Pedal Disable) or sequencing fault caused by incorrect sequence of KSI, interlock, direction, and throttle inputs. Clear: Reapply inputs in correct sequence.
49	Parameter Change Fault Shutdown Motor; Shutdown Main Contactor; Shutdown EM Brake; Shutdown Throttle; Full Brake; Shutdown Pump.	1. This is a safety fault caused by a change in certain parameter settings so that the vehicle will not operate until KSI is cycled.For example, if a user changes the Throttle Type this fault will appear and require cycling KSI before the vehicle can operate.	Set: Adjustment of a parameter setting that requires cycling of KSI. Clear: Cycle KSI.

CODE	PROGRAMMER LCD DISPLAY EFFECT OF FAULT	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
51–67	OEM Faults (See OEM documentation.)	1. These faults can be defined by the OEM and are implemented in the application-specific VCL code. See OEM documentation.	Set: See OEM documentation. Clear: See OEM documentation.
68	VCL Run Time Error Shutdown Motor; Shutdown Main Contactor; Shutdown EM Brake; Shutdown Throttle; Shutdown Interlock; Shutdown Driver1; Shutdown Driver2; Shutdown Driver3; Shutdown Driver4; Shutdown PD; Full Brake; Shutdown Pump.	1. VCL code encountered a runtime VCL error. 2. See Monitor menu » Controller: VCL Error Module and VCL Error. This error can then be compared to the runtime VCL module ID and error code definitions found in the specific OS system information file.	Set: Runtime VCL code error condition. Clear: Edit VCL application software to fix this error condition; flash the new compiled software and matching parameter defaults; cycle KSI.
69	External Supply Out of Range None, unless a fault action is programmed in VCL.	1. External load on the 5V and 12V supplies draws either too much or too little current. 2. Fault Checking Menu parameters Ext Supply Max and Ext Supply Min are mis-tuned. 3. See Monitor menu » Outputs: Ext Supply Current.	Set: The external supply current (combined current used by the 5V supply [pin 26] and 12V supply [pin 25]) is either greater than the upper current threshold or lower than the lower current threshold. The two thresholds are defined by the External Supply Max and External Supply Max and External Supply Min parameter settings (page 56). Clear: Bring the external supply current within range.
71	OS General Shutdown Motor; Shutdown Main Contactor; Shutdown EM Brake; Shutdown Throttle; Shutdown Interlock; Shutdown Driver1; Shutdown Driver2; Shutdown Driver3; Shutdown Driver4; Shutdown PD; Full Brake; Shutdown Pump.	1. Internal controller fault.	Set: Internal controller fault detected. Clear: Cycle KSI.
72	PDO Timeout Shutdown Throttle; CAN NMT State set to Pre-operational.	1. Time between CAN PDO messages received exceeded the PDO Timeout Period.	Set: Time between CAN PDO messages received exceeded the PDO Timeout Period. Clear: Cycle KSI or receive CAN NMT message.
73	Stall Detected Shutdown EM Brake; Shutdown Throttle; Control Mode changed to LOS (Limited Operating Strategy).	<ol> <li>Stalled motor. 2. Motor encoder failure. 3. Bad crimps or faulty wiring. 4. Problems with power supply for the motor encoder. 5.</li> <li>See Monitor menu » Motor: Motor RPM.</li> </ol>	Set: No motor encoder movement detected. Clear: Either cycle KSI, or detect valid motor encoder signals while operating in LOS mode and return Throttle Command = 0 and Motor RPM = 0.
74	Fault On Other Traction Controller	Dual Drive fault: see Dual Drive manual.	
75	Dual Severe Fault	Dual Drive fault: see Dual Drive manual.	

CODE	PROGRAMMER LCD DISPLAY EFFECT OF FAULT	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
76	Insulation Resistance Low Isolation monitor will open circuit its connection between the high power circuit and the vehicle chassis. Driving is still allowed.	1. See Monitor menu » Battery: Insulation Resistance. 2. Insulation Resistance Fault threshold set too high. 3. Electrical fault path between high power battery terminals and chassis. 4. Insulation breakdown in motor. 5. Short circuit to chassis fault in high power system wiring. 6. Internal 1239E controller failure.	Set: Insulation Resistance dropped below Insulation Resistance Fault threshold. Clear: Remove insulation fault; cycle KSI.
77	Supervisor Fault Shutdown Motor; Shutdown Main Contactor; Shutdown EM Brake; Shutdown Throttle; Shutdown Interlock; Shutdown Driver1; Shutdown Driver2; Shutdown Driver3; Shutdown Driver4; Shutdown PD; Full Brake; Shutdown Pump.	<ol> <li>The Supervisor has detected a mismatch in redundant readings.</li> <li>Internal damage to Supervisor microprocessor.</li> <li>Switch inputs allowed to be within upper and lower thresholds for over over 100 ms.</li> </ol>	Set: Mismatched redundant readings; damaged Supervisor; illegal switch inputs. Clear: Check for noise or voltage drift in all switch inputs; check connections; cycle KSI.
78	Supervisor Incompatible Shutdown Motor; Shutdown Main Contactor; Shutdown EM Brake; Shutdown Throttle; Shutdown Interlock; Shutdown Driver1; Shutdown Driver2; Shutdown Driver3; Shutdown Driver4; Shutdown PD; Full Brake; Shutdown Pump.	1. The main OS is not compatible with the Supervisor OS.	Set: Incompatible software. Clear: Load properly matched OS code or update the Supervisor code; cycle KSI.
87	Motor Characterization Fault Shutdown Motor; Shutdown Main Contactor; Shutdown EM Brake; Shutdown Throttle; Full Brake; Shutdown Pump.	<ol> <li>Motor characterization failed during characterization process. See Monitor menu » Controller: Motor Characterization Error for cause: 0=none 1=encoder signal seen, but step size not determined; set Encoder Step Size manually 2=motor temp sensor fault 3=motor temp hot cutback fault 4= controller overtemp cutback fault 5=controller undertemp cutback fault 6=undervoltage cutback fault 7=severe overvoltage fault 8=encoder signal not seen, or one or both channels missing 9=motor parameters out of characterization range.</li> </ol>	Set: Motor characterization failed during the motor characterization process. Clear: Correct fault; cycle KSI.

CODE	PROGRAMMER LCD DISPLAY EFFECT OF FAULT	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
88	Encoder Pulse Count Fault Shutdown Motor; Shutdown Main Contactor; Shutdown EM Brake; Shutdown Throttle; Shutdown Interlock; Shutdown Driver1; Shutdown Driver2; Shutdown Driver3; Shutdown Driver4; Shutdown PD; Full Brake; Shutdown Pump.	1. Encoder Steps parameter does not match the actual motor encoder.	Set: Motor lost IFO control and accelerated without throttle command. Clear: Ensure the Encoder Steps parameter matches the actual encoder; cycle KSI.
89	Motor Type Fault Shutdown Motor; Shutdown Main Contactor; Shutdown EM Brake; Shutdown Throttle; Full Brake; Shutdown Pump.	1. The Motor_Type parameter value is out of range.	Set: Motor_Type parameter is set to an illegal value. Clear: Set Motor_Type to correct value and cycle KSI.
91	VCL/OS Mismatch Shutdown Motor; Shutdown Main Contactor; Shutdown EM Brake; Shutdown Throttle; Shutdown Interlock; Shutdown Driver1; Shutdown Driver2; Shutdown Driver3; Shutdown Driver4; Shutdown PD; Full Brake; Shutdown Pump.	1. The VCL software in the controller does not match the OS software in the controller.	Set: VCL and OS software do not match; when KSI cycles, a check is made to verify that they match and a fault is issued when they do not. Clear: Download the correct VCL and OS software into the controller.
92	EM Brake Failed to Set Shutdown EM Brake; Shutdown Throttle. Position Hold is engaged when Interlock=On.	1. Vehicle movement sensed after the EM Brake has been commanded to set. 2. EM Brake will not hold the motor from rotating.	Set: After the EM Brake was commanded to set and time has elapsed to allow the brake to fully engage, vehicle movement has been sensed. Clear: Activate the throttle.
93	Encoder LOS (Limited Operating Strategy) Enter LOS control mode.	1. Limited Operating Strategy (LOS) control mode has been activated, as a result of either an Encoder Fault (Code 36) or a Stall Detect Fault (Code 73). 2. Motor encoder failure. 3. Bad crimps or faulty wiring. 4. Vehicle is stalled.	Set: Encoder Fault (Code 36) or Stall Detect Fault (Code 73) was activated, and Brake or Interlock has been applied to activate LOS control mode, allowing limited motor control. Clear: Cycle KSI or, if LOS mode was acti-vated by the Stall Fault, clear by ensuring encoder senses proper operation, Motor RPM = 0, and Throttle Command = 0.
98	Illegal Model Number Shutdown Motor; Shutdown Main Contactor; Shutdown EM Brake; Shutdown Throttle; Full Brake; Shutdown Pump.	<ol> <li>Model_Number variable contains illegal value. Any value other than 1239 is illegal. 2. Software and hardware do not match. 3. Controller defective.</li> </ol>	Set: Illegal Model_Number variable; when KSI cycles, a check is made to confirm a legal Model_Number, and a fault is issued if one is not found. Clear: Download appropriate software for your controller model.
99	Dualmotor Parameter Mismatch	Dual Drive fault: see Dual Drive manual.	

# Hydraulic System

## **Safety Instructions**

## 

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.

# **Table of Contents**

Main System
# **Main Control Valve**

### Overview

Open Center System with adjustable displacement

#### Figure 105







DS2200271

#### **Hydraulic Circuit**

Figure 107



DS2200272

The pump flow is delivered into each element of the MCV and it has an individual main relief valve for controlling each side system. P3 inlet block has a con flux spool for supporting boom up and travel straight operation. It is an open center circuit system and a discharged oil from the pump goes to the tank all the time when an idling condition, when the spool is shifted by the operator, the oil from the pump goes to the actuator for the machine operation.

#### Figure 108



DS2200273

- 1. Main relief valve (P1, P2, P3)
- 2. Main spool
- 3. Pilot signal spool on main spool
- 4. Port (overload) relief valve
- 5. Holding valve (boom)

- 6. Conflux valve (for boom up, travel straight)
- 7. Orifice for pilot signal (auto idle)
- 8. Load check valve

#### Working principle

Neutral position (Main) Figure 109



The main relief of P1 is in charge of Travel, Boom, and bucket, P2 is in charger of travel and Arm and Option (Two way). The main relief of P3 is in charge of swing, Boom swing, dozer, and option (Rotating).Each main relief valve controls related machine front attachment operation individually. P1, P2, P3 pump oil goes to the tank.

#### **Neutral position (Pilot)**

Figure 110



DS2200275

The pilot pressure line is connected to the tank patching through each spool, the pressure is not built up. When the spool is shifted, the pressure of the pilot line is built up.



DS2200276

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т

In the neutral position of the spool, discharged oil from pump oil goes to tank path through the spool centerline. But spool is shifted for working, the pump oil goes to the actuator and returns oil from actuator goes to the tank. And Oil path of the pilot signal on the spool is clogged and the pressure is built up. It is used for auto idle signals.

#### Main spool operation (Conflux spool)

Figure 112





DS2200277

The neutral position of con flux spool, P3 oil does not mix with P1 and P2 side of oil path in MCV, P3 oil is in charge of P3 side of oil path when P3 side of spool is switched. When the spool is shifted by both track traveling or boom up operation, P3 oil supports to P1 or P2 side for better front attachment operation. (P1 and P2 in charge of both travel only)

Figure 113



If under NO swing operation condition and arm crowd operation, P3 oil provides both of P1 and P2 line. When boom up operation, P3 oil provides P1 and P2 line but more oil goes to Boom and bucket side, and delivery oil amount is depended on boom up pilot pressure. When both traveling, P3 oil provide P1 line only for better boom up (Bucket) operation.

# **Systems Operation and Description**

# **Safety Instructions**

## 

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# **Table of Contents**

**Safety Instructions** 

# Introduction

The electrical system for this equipment is DC 12 volts. The rated voltage for all electric components is 12 volts. The system contains one 12 volts battery and a three phase AC generator with a rectifier. The electrical wiring used in the system is easily identifiable by the insulator color. The color symbols used in the electrical system are listed in the following chart.

#### **Electrical Wire Color**

Symbol	Color
W	White
G	Green
Or	Orange
В	Black
L	Blue
Lg	Light green
R	Red
Gr	Gray
Р	Pink
Y	Yellow
Br	Brown
V	Violet

**NOTE:** *RW: Red wire with White stripeR - Base Color, W - Stripe Color* 

**NOTE:** 0.85G: Nominal sectional area of wire core less insulator =  $0.85 \text{ mm}^2$ 

# **Vehicle Control Unit**

## System Interface

Figure 114



## Input & Output list

#### Figure 115

	-							
Pin	INFORMATION	Source	Pin	INFORMATION	Source	Pin	INFORMATION	Source
1-1	F108B	Power	2-1	FAST Charging Relay	Active Low	3-1	OBC Charging Indicator	Active Low
1-2	GND	GND	2-2	Quick Charging Ind.	Active Low	3-2	RESERVED	Pulse_S
1-3	GND	GND	2-3	RESERVED	Low Input	3-3	RESERVED	Sensor
1-4	CAN1_H	CAN1_H	2-4	RESERVED	Low Input	3-4	RESERVED	sensor
1-5	CAN1_L	CAN1_L	2-5	Hyd. Wake Up SW	Low Input	3-5	HYD. TEMP_GND	S_GND
1-6	CAN1_Shield	Shield	2-6	RESERVED	Low Input	3-6	Autoidle Pressure SIG	Sensor
1-7	DMS	TxD	2-7	RESERVED	Low Input	3-7	Autoidle Pressure GND	S_GND
1-8	DMS	RxD	2-8	Pilot Buzzer	Active Low	3–8	RESERVED	Sensor
1-9	DMS	GND	2-9	HV Precharge Relay	Active Low	3-9	RESERVED	S_GND
1-10	Pilot Cutoff	High Input	2-10	HV Main Relay	Active Low	3-10	BMS Wake-up +	EPPR V/V
1-11	High Speed Switch	High Input	2-11	Track Expansion Sol	Active Low	3-11	BMS Wake-up -	EPPR V/V
1-12	🛝 LV Main Relay +	EPPR V/V	2-12	Working Lamp Relay	Active Low	3-12	RESERVED	Active Low
1-13	LV Main Relay -	EPPR V/V	2-13	RÉSERVÉD	Resistance	3-13	Auto Idle/Engine Dial	5V PWR
1-14	🛦 HOUR METÉR	Active Low	2-14	RESERVED	Resistance	3-14	Engine Control Dial SIG	Sensor
1-15	Quick Coupler Sol.	Active Low	2-15	HYD. TEMP	Sensor	3-15	Engine Control Dial GND	S_GND
1-16	A RESERVED	Active Low	2-16	DC-DC Converter	Alternator	3-16	RESERVED	Sensor
1-17	Fast Charge SW	High Input				3-17	RESERVED	S_GND
1-18	Quick Coupler Switch	High Input				3-18	RESERVED	Sensor
1-19	Key On Signal	High Input				3-19	RESERVED	S_GND
1-20	RESERVED	High Input				3-20	RESERVED	Sensor
1-21	Emergency Stop SW	High Input				3-21	RESERVED	EPPR V/V
1-22	▲ RS232 for TMS	TxD				3-22	RESERVED	EPPR V/V
1-23	▲ RS232 for TMS	RxD						
1-24	SCI-BOOT	SCI-BOOT						
1-25	▲ RESERVED	EPPR V/V						
1-26	в FAN PWM Signal	EPPR V/V						

DS2300361

# **VCU Controller**

Figure 116



DS2300594

Terminal	Connector Pin		Туре	Min	Max	Res.	Unit
1	1-1	Power					
2	1-2	GND	Power				
3	1-3	GND					
55	3-13	Sensor 5V	5V PWR				
4	1-4	CAN-H					
5	1-5	CAN-L	COMM. CAN				
6	1-6	Shield	-				
7	1-7	TxD					
8	1-8	RxD	COMM. RS232 for DMS				
9	1-9	GND					
24	1-24	SCI-BOOT					
22	1-22	TxD	RS232 for				
23	1-23	RxD	TMS				

Terminal	Connector Pin		Туре	Min	Max	Res.	Unit
10	1-10	Pilot Cutoff					ON/OFF
11	1-11	High Speed Switch	-				ON/OFF
17	1-17	Charge SW	-				ON/OFF
18	1-18	Quick Coupler Switch	-				ON/OFF
19	1-19	Key Switch (Key On Signal)	-				ON/OFF
20	1-20	RESERVED	Digital Input				ON/OFF
21	1-21	Emergency Stop SW	Digital Input				ON/OFF
29	2-3	RESERVED	-				ON/OFF
30	2-4	RESERVED	-				ON/OFF
31	2-5	Hyd. Wake Up SW	-				ON/OFF
32	2-6	RESERVED	-				ON/OFF
33	2-7	RESERVED	-				ON/OFF
39	2-13	RESERVED		0	300k	10	Ω
40	2-14	RESERVED	-	0	6k	1	Ω
41	2-15	HYD. Oil Temp. Sensor	-	0	40k	1	Ω
42	2-16	DC-DC Converter	-	0	32	0.1	V
46	3-4	RESERVED	-	0	12	0.1	V
47	3-5	Common GND	-				
48	3-6	Autoidle Pressure SIG		0	12	0.1	V
49	3-7	autoidle Pressure GND					
50	3-8	RESERVED		0	12	0.1	V
51	3-9	RESERVED	-				
56	3-14	Control Dial SIG		0	12	0.1	V
57	3-15	Control Dial GND					
58	3-16	RESERVED		0	12	0.1	V
59	3-17	RESERVED					
60	3-18	RESERVED		0	12	0.1	V
61	3-19	RESERVED					
44	3-2	RESERVED		0	6500	0.1	Hz
45	3-3	RESERVED	Pulse Input				
62	3-20	RESERVED		0	6500	0.1	Hz
14	1-14	Hour Meter		0	3		А
15	1-15	Quick Coupler Sol.		0	3		А
16	1-16	RESERVED		0	3		А
43	3-1	OBC Charging Indicator		0	3		А
54	3-12	RESERVED		0	3		А
27	2-1	FAST Charging Relay		0	3		A
28	2-2	FAST Charging Indicator		0	3		А
34	2-8	Pilot Buzzer		0	3		А
35	2-9	Pre-Charging Relay		0	3		А

Terminal	Connector Pin		Туре	Min	Max	Res.	Unit
36	2-10	HV_Main Relay		0	3		А
37	2-11	Track Expansion Sol V/V		0	3		А
38	2-12	Working Lamp Relay		0	3		А
25	1-25	RESERVED (Remove Diode)		0	3		А
26	1-26	FAN PWM Signal		0	3		А
12	1-12	LV Main Relay +		0	3		А
13	1-13	LV Main Relay -		0	3		А
52	3-10	BMS Wake Up +		0	3		А
53	3-11	BMS Wake Up -		0	3		А
63	3-21	RESERVED		0	3		А
64	3-22	RESERVED		0	3		А

# Service Menu tree

Service Menu tree, Depth						
1st	2nd	3rd				
Monitoring						
	Analog Input					
	Analog Output					
	Digital Input					
	Digital Output					
	BMS Signal					
	PMI Signal					
	TMS Information					
		GPS Information				
		Network Information				
		Terminal Information				
Graph						
	Graph Data Monitoring					
	Graph Data Configuration					
Failure Information						
	Real Time Failure Information					
	Failure Log Information					
Operation Hour Information						
	Operation Mode					
		Power Mode				
		Standard Mode				
		Economy Mode				
		Auto Idle Mode				
		Idle Mode				
	Hydraulic Oil Temp					
Machine Configuration						
	Set Machine Option					
		Quick Coupler				
	Set General Option					
		TMS				
	SW Update					
	Enter Serial Number					
	Reset					
		Reset Failure Log				
		Reset Operating Hours				
		Reset Gauge Panel Settings				
	Version Information					
	Permanent Security Unlock					

# **Removal and Installation**

# Hydraulic Systems and Structure

# **Safety Instructions**

## 

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**

- 1. If maintenance is performed by unskilled technicians, or without the specified tools and facilities, serious bodily injury or critical faults in e-Powerpack performance may occur.
- 2. Regular inspections and maintenance are required to maintain long-term optimal e-Powerpack conditions and top performance.
- 3. In the event that a part must be replaced, only genuine parts as defined by the parts on the list (PARTS BOOK) should be used.
- HD HYUNDAI CONSTRUCTION EQUIPMENT shall not be held accountable for any critical damage or faults which have been caused by the use of unauthorized or remanufactured part.

### **Cautions for Inspection and Repair**

1. Inspections and repairs of the e-Powerpack should be performed only when the module is stopped. Otherwise, burns or safety accidents may occur, so do not perform inspections or repairs while the e-Powerpack is running.

# 

AVOID DEATH OR SERIOUS INJURY Make sure to wear protective equipment, e.g. insulated gloves. Workers are not allowed to wear metal accessories, e.g. watches and rings, which can cause a short. Make sure to remove all such items before operation.

- 2. Only certified professional technicians should perform repairs and maintenance on the e-Powerpack.
- 3. Only appropriate tools should be used. If the jaws of a wrench are worn out, the wrench might slip during use, causing safety accidents.

- 4. Do not allow other people to stand or pass under the e-Powerpack when lifting the e-Powerpack with a crane. Before lifting the e-Powerpack, ensure that there is no one around the e-Powerpack and secure enough safe space.
- 5. Before inspecting or replacing electrical equipment, disconnect the battery ground wire first. Connect the battery ground wire after completing all required work for checking or replacing the electrical equipment in order to prevent a short circuit.
- 6. Workers should wear protective equipment and use insulated tools. Cover the irrelevant area with an insulated cover. Organize and store the removed parts on an insulated mat to avoid causing a short circuit.
- 7. Confirm that the voltage between the power terminals is 0 V. When disconnecting any cable or busbar or removing any part related to the battery, make sure to avoid contact between the positive (+) and negative (-) terminals. When disconnectingany cable or busbar, insulate the corresponding part with insulating tape immediately.

### **General Repair Work**

- 1. Wait until the e-Powerpack is properly cooled down before starting work, since you may get burned if the e-Powerpack is overheated.
- 2. Use a diagnostic device to check whether the e-Powerpack is functioning properly.
- 3. Disconnect the battery ground wire to prevent damage to wires and sensors caused by a short circuit.
- 4. Store disassembled parts in a designated space to avoid damage or contamination.
- 5. If parts need to be replaced, use only genuine parts. Using unauthorized or remanufactured parts may cause critical damage and faults in e-Powerpack performance.
- 6. Group and store disassembled parts in the order that they were disassembled. The strength, shape, and tightening torque of bolts and nuts differ according to their assembly positions. Group and store them accordingly to these characteristics.
- 7. Clean disassembled parts to remove foreign matter before inspecting or reassembling parts.
- 8. When replacing a gasket, remove the old gasket, clean the surface, and then install a new gasket. However, it is not always required to replace the gasket for every repair or service. If any physical damage, e.g. a crack or burr, is found on the gasket, replace it with a new one to avoid the degradation of its waterproof/dustproof performance.
- 9. Assemble bolts and nuts at the specified tightening torque.
- 10.After repair, operate the battery pack to confirm its normal operation.

# Other Safety Instructions and Environmental Pollution

- 1. Good ventilation and low humidity should be maintained in the workspace.
- 2. The workspace should be clean, organized, and not have any flammable substances nearby.
- 3. Smoking is strictly forbidden in the workshop.
- 4. Workers must wear insulated gloves, insulation shoes, work clothes, and insulated safety helmets.
- 5. Workers are not allowed to wear metal accessories, such as watches and rings that can cause a short. Make sure to remove them before operation.
- 6. Wait until the e-Powerpack is properly cooled down before starting work, since you may get burned if the e-Powerpack is overheated.
- 7. Do NOT work on rotating or running parts once the e-Powerpack has been operated.
- 8. Discard polluting substances according to the regulations set forth by the relevant authorities.

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Failure to comply with the regulations of the relevant authorities violates environmental pollution regulations and may be subject to legal penalties.

### Use of Genuine Parts

- 1. The e-Powerpack consists of many parts which form a mechanically harmonized unit.
- 2. To prevent e-Powerpack faults in advance and maintain the best e-Powerpack performance for a long period of time, maintenance and replacement of consumable parts should be conducted regularly.
- 3. Only genuine parts should be used for repair. Using unauthorized or remanufactured parts may cause critical damage and faults in the e-Powerpack for which HD HYUNDAI CONSTRUCTION EQUIPMENT shall not be held accountable.

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# **Before Removing and Installing**

### **Preparatory Work**

- 1. Park the machine on level ground. And lower front attachment **F** to the ground.
- 2. Move safety lever to "LOCK" position and then stop the motor.
- 3. Turn battery disconnect switch to "OFF" position.
- 4. Release the remaining pressure in the hydraulic circuit.
- 5. Cool down the hydraulic system and motor.
- 6. Attach a maintenance warning tag on controls.

# Figure 1

DS2300158

### **General Precaution**

- 1. Always read the safety section before removing and Installing. Figure 2
- 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 leak from the machine.
- 2. Check all oil level and if necessary, add oil.
- 3. Apply grease to all lubrication points.
- 4. When hydraulic component has been disconnected, air must be bled from circuit.
  - For details, see the Operation and Maintenance Manual.
- 5. Start the motor and run at low idle for about 5 minutes.
- 6. Perform the machine performance test.



# Undercovers

### **Repair Procedure Quick Guide**

Step-A. Place the machine in the suitable service position

Step-B. Remove undercovers

### Removal

### Undercovers

- 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
    - Tool: 13 mm (@\_\_\_\_\_\_)
    - Torque: 29.4 N.m (3 kg.m, 21.7 ft lb)
    - Weight: about 1 kg (2.2 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

1. Turn OFF the battery disconnect switch.

### Arm Rest

- 1. Remove the mounting bolts (1) from arm rest.
  - Tool: 13 mm (~\_\_\_\_\_)
  - Torque: 29.4 N.m (3 kg.m, 21.7 ft lb)
- 2. Remove arm rest (2) from stand.



### Stand Cover - Left Side

- 1. Remove mounting screws (1) and cover (2) from upper cover. Figure 5
- 2. Remove mounting screws (3).
- 3. Lift off the stand left side cover (4).



### Stand Cover - Right Side

- 1. Remove the mounting screws and covers from upper cover.
- 2. Lift off the stand right side cover.

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Figure 6

### **Control Stand Bracket**

- 1. Remove mounting bolts (1) and bracket (2) from stand.
- Figure 7 2 DS2300129 Figure 8
- 2. Remove mounting bolts (1, 2) from the joystick valve.
- 3. Separate the joystick valves from control stand.





### **Hydraulic Hoses and Fittings**

1. Disconnect hydraulic hoses (1) and from joystick valve (2).

**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.

Figure 9



**Joystick Valve** 

1. Remove joystick valve from control stand.

### Figure 10



DS2300132

Installation

## 

INCORRECT INSTALLATION CAN CAUSE DEATH OR SERIOUS INJURY Any change in the connections will lead to malfunctions.

- When connecting hydraulic components, observe the specified mining conording to the hydraulic cohometic diagram of
- ified 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.

# **Main Control Valve**

### **Repair Procedure Quick Guide**

- Step-A. Remove right side frame cover
- Step-B. Drain hydraulic oil
- Step-C. Remove wiring harness
- Step-D. Disconnect hydraulic hoses
- Step-E. Remove main control valve

### Removal

1. Turn OFF the battery disconnect switch.

### Right Side Frame Cover

- 1. Remove right side frame cover caps and bolts (1) from chassis frame.
- 2. Remove right side frame cover (2) from chassis frame.
  - Right side frame cover weight: about 10 kg (22.0 lb)

# 

DS2300148

### Hydraulic Oil

- 1. Loosen drain plug at the bottom of the hydraulic tank. Drain hydraulic oil.
  - Tool: 22 mm (~\_\_\_\_\_)
  - Hydraulic oil tank volume: 16 L (4.2 U.S. gal)

# Figure 12

### Wiring Harness

1. Open the left side frame cover.



2. Disconnect the harness from main control valve.





### **Hydraulic Hoses**

- 1. Remove hydraulic hoses from main control valve.
  - **NOTE:** Attach identification tags to the removed hoses for reassembling. After disconnecting hoses from main control valve, plug them to prevent dirt or dust from entering. Disconnect the hoses from the bottom to top of control valve.

### Figure 15



### Main Control Valve

1. Separate joint balls from main control valve.

DS2300163



- Tool: 17 mm (
- Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)
- Main control valve weight: 28 kg (61.7 lb)

**NOTE:** Apply adhesive (Loctite #262) to the mounting bolt.



### Installation

1. Perform installation in the reverse order to removal.







DS2300165

# Main Pump

### Repair Procedure Quick Guide

- Step-A. Remove right side cover
- Step-B. Drain hydraulic oil
- Step-C. Remove oil cooler
- Step-D. Disconnect wiring harness
- Step-E. Disconnect hydraulic hoses
- Step-F. Remove main pump

### Removal

1. Turn OFF the battery disconnect switch.

### **Right Side Cover**

- 1. Open the rear cover.
- 2. Remove right side cover caps and bolts (1) from chassis frame.
- 3. Remove right side cover (2) from chassis frame.
  - Right side cover weight: about 5 kg (11.0 lb)





- 4. Remove right side frame cover caps and bolts (1) from chassis frame.
- 5. Remove right side frame cover (2) from chassis frame.
  - Right side frame cover weight: about 10 kg (22.0 lb)

### Figure 20



### Hydraulic Oil

- 1. Loosen drain plug at the bottom of the hydraulic tank. Drain hydraulic oil.
  - Tool: 22 mm (
  - Hydraulic oil tank volume: 16 L (4.2 U.S. gal)



DS2300149

### **Oil Cooler**

1. Disconnect wiring harness (1) and hoses (2) from oil cooler.



2. Remove mounting bolts (1) and oil cooler (2).

Figure 23



### Wiring Harness

1. Disconnect wiring harness from main pump.

Figure 24



### **Hydraulic Hoses**

- 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.
- 2. Remove hoses and adapters from the main pump.
  - **NOTE:** Attach an 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 main pump.



DS2300169

### Main Pump

- 1. Remove mounting bolts (1) from main pump (2).
  - Tool: 19 mm (2)
  - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
  - Main pump weight: about 23 kg (50.7 lb)
- 2. Lift the pump from motor slowly and carefully.

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Make sure there are no other electrical wires or hoses connected to main pump.

### Installation

- 1. Perform installation in the reverse order to removal.
- 2. After completing the work, check the oil level.
- 3. Start the motor and check for any oil leaks.



# Hydraulic Oil Tank

### **Repair Procedure Quick Guide**

- Step-A. Remove undercovers
- Step-B. Drain hydraulic oil
- Step-C. Remove front cover
- Step-D. Disconnect wiring harness
- Step-E. Remove hydraulic oil tank

### Removal

- 1. Open the battery box cover.
- 2. Turn OFF the battery disconnect switch.



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Figure 28

### Undercovers

1. Remove the undercover (H).

For details, refer to Undercovers.

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### **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.
- 2. Oil drain method.



- Tool: 17 mm ()
- Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)



- Tool: 36 mm (~\_\_\_\_\_)
- Hydraulic oil tank volume: 94L (24.8 U.S. gal)



Figure 30







1

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2

### Front Cover

- 1. Remove mounting cap and bolts (1) from front cover.
  - Tool: 19 mm (\_\_\_\_\_\_)
  - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
  - (2) Cover weight: about 6.5 kg (14.3 lb)
  - (3) Cover weight: about 11 kg (24.3 lb)
- 2. Remove front cover (2, 3) from frame.



DS2200992

### Wiring Harness

- 1. Disconnect wiring harness (1) and clip bolts (2) from oil tank.
  - Tool: 13 mm (
  - Torque: 19.6 N.m (2 kg.m, 14.5 ft lb)











- 3. Remove bolts (1) from bracket.
- 4. Disconnect wiring harness (2) and ECU bracket bolts (3) from oil tank.
- 5. Remove clip bolts (4) from hydraulic tank.
- 6. Remove hydraulic hose (5) from hydraulic tank.

Figure 35



DS2201533

### Hydraulic Tank Assembly

- 1. Remove bolts (1) (6 ea) with suction pipe from the oil tank.
  - Tool: 17 mm (\_\_\_\_\_\_)
  - Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)
- 2. Remove mounting bolts (2) (4 ea) 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.

• Install eyebolts (2 ea) on the oil tank.

And tie the rope to the bolts to lift oil tank.

- Lift the oil tank by crane from frame slowly and carefully.
  - Oil tank weight: about 120 kg (264.6 lb)

### Installation

- 1. Perform installation in the reverse order of removal.
- 2. When assembling rod to suction filter, adjust the assembling length .

Reference Number	Description
1	Suction Filter
2	Nut
3	Rod

• Length (A): 563.5 mm





# **Swing Device**

### **Repair Procedure Quick Guide**

Step-A. Remove floor plate

Step-B. Disconnect hydraulic hoses and fittings - swing device

Step-C. Remove swing device

### Removal

1. Turn OFF the battery disconnect switch.

### Floor Plate

1. Remove mat from floor.



Figure 39

- 2. Remove mounting bolts (1) and floor plate (2).
  - Tool: 17 mm (\_\_\_\_\_\_)
  - Torque: 49 N.m (5 kg.m, 36.1 ft lb)



### Hydraulic Hoses and Fittings

- 1. Remove hoses and adapters from the swing device.
  - **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.

### Figure 40



DS2300146

### **Swing Device**

- 1. Attach a lifting device around swing device.
- 2. Remove mounting bolts and washers (1).

### Figure 41

- Tool: 10 mm (
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- 3. Install the back bolt to the plug position to ensure that frame and swing device can be separated.
- 4. Hoist and remove swing device (2) from the frame.
  - Weight: about 25 kg (55.1 lb)
  - **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.
- 5. 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

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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.

# **Center Joint**

### **Repair Procedure Quick Guide**

- Step-A. Remove floor plate
- Step-B. Remove undercarriage cover
- Step-C. Disconnect hydraulic hoses and fittings center joint
- Step-D. Remove center joint

### Removal

1. Turn OFF the battery disconnect switch.

### Floor Plate

1. Remove mat from floor.





- Tool: 17 mm (@\_\_\_\_\_\_)
- Torque: 49 N.m (5 kg.m, 36.1 ft lb)



### **Undercarriage Cover**

- 1. Remove bolts (1) and under cover (2) from frame.
  - Tool: 17 mm ()
  - Torque: 63.7 N.m (6.5 kg.m, 47.0 ft lb)
  - Undercover Weight: about 2 kg (4.4 lb)





DS2300142

### Hydraulic Hoses and Fittings - Center Joint

- 1. Remove under hoses and adapters from center joint.
  - **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.

### Figure 45



- 2. Remove upper hoses and adapters from center joint.
  - **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.

Figure 46



### **Center Joint**

- 1. Position suitable pallet jack under center joint.
- 2. Place blocks of wood can be used between the center joint and the pallet jack.

- 3. Remove mounting bolts (1) from frame.
  - Tool: 17 mm (2)
  - Torque: 63.7 N.m (6.5 kg.m, 47.0 ft lb)

**NOTE:** Apply adhesive (Loctite #262) to the mounting bolt.

- 4. Remove center joint (2) from frame.
  - Center joint weight: about 14 kg (30.9 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-D. Remove rubber shoe and sprocket
- 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.
- 2. Loosen grease valve, and then slacken the tension of track. For details, refer to Track tension - Operation Manual.

# Figure 48

DS2300133

### **Rubber Shoe and Sprocket**

1. Turn the upper structure 90° and jack up the machine.

**NOTE:** Jack up the machine until the track is slightly off the ground.

2. Set the angle between boom and arm in 90  $\sim$  100° and support the machine by using a block.

### Figure 49



3. Slide in the idler all the way, and remove the rubber crawler from the idler using a steel bar.

- 4. Remove bolt (1) with sprocket (2) from travel device.
  - Tool: 8 mm (
  - Torque: 63.7 N.m (6.5 kg.m, 47.0 ft lb)
  - Sprocket weight: about 4 kg (8.8 lb)

**NOTE:** Apply adhesive (Loctite #262) to the mounting bolt.





DS2200040



DS2300134

### **Hydraulic Hoses and Fittings**

- 1. Remove mounting bolts (1) and cover (2) from track frame.
  - Tool: 17 mm ()
  - Torque: 63.7 N.m (6.5 kg.m, 47.0 ft lb)
  - Cover weight: about 1 kg (2.2 lb)



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.

- 3. Remove hoses and adapters from travel device.
  - 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.
  - Tool: 8 mm (



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DS2300136





Figure 54

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2. Remove mounting bolts (1) from track frame (2).

### • Tool: 8 mm (

Torque: 63.7 N.m (6.5 kg.m, 47.0 ft lb)
NOTE: Apply adhesive (Loctite #262) to the mounting bolt.



DS2300137

- 3. Hoist and remove travel device (1) from track frame very slowly.
  - Weight: about 21 kg (46.3 lb)
  - Travel device oil specification and quantity
  - Replace oil: Genuine oil
  - Travel device oil quantity: 0.35 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.



# Counterweight

### **Repair Procedure Quick Guide**

- Step-A. Remove the motor cover and bracket
- Step-B. Remove right side cover and bracket
- Step-C. Remove counterweight

### Removal

- 1. Turn OFF the battery disconnect switch.
- 2. Position the machine on even, firm and level ground.
- 3. Put attachment on ground.

**NOTE:** *Place the machine in the suitable service position.* 

### Motor Cover and Bracket

- 1. Remove bolts from chassis frame.
- 2. Remove motor cover from chassis frame.
  - Motor cover weight: about 6 kg (13.2 lb)



Figure 58

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### **Right Side Cover and Bracket**

- 1. Remove right side cover caps and bolts (1) from chassis frame.
- 2. Remove right side cover (2) from chassis frame.
  - Right side cover weight: about 5 kg (11.0 lb)



3. Remove bolts (1) and bracket (2) from counterweight support.



DS2300114

### Counterweight

- 1. Remove mounting bolts (1) and counterweight (2) from frame.
  - Tool: 30 mm (~\_\_\_\_\_)
  - Torque: 539.4 N.m (55 kgf.m, 397.8 ft lb)
  - Weight: about 120 kg (265.0 lb)

**NOTE:** Apply adhesive (Loctite #262) to the mounting bolt.



### Installation

1. Perform installation in the reverse order to removal.

# **Electric and Electronic**
# **Safety Instructions**

## 

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**

- 1. If maintenance is performed by unskilled technicians, or without the specified tools and facilities, serious bodily injury or critical faults in e-Powerpack performance may occur.
- 2. Regular inspections and maintenance are required to maintain long-term optimal e-Powerpack conditions and top performance.
- 3. In the event that a part must be replaced, only genuine parts as defined by the parts on the list (PARTS BOOK) should be used.
- HD HYUNDAI CONSTRUCTION EQUIPMENT shall not be held accountable for any critical damage or faults which have been caused by the use of unauthorized or remanufactured part.

### **Cautions for Inspection and Repair**

1. Inspections and repairs of the e-Powerpack should be performed only when the module is stopped. Otherwise, burns or safety accidents may occur, so do not perform inspections or repairs while the e-Powerpack is running.

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AVOID DEATH OR SERIOUS INJURY Make sure to wear protective equipment, e.g. insulated gloves. Workers are not allowed to wear metal accessories, e.g. watches and rings, which can cause a short. Make sure to remove all such items before operation.

- 2. Only certified professional technicians should perform repairs and maintenance on the e-Powerpack.
- 3. Only appropriate tools should be used. If the jaws of a wrench are worn out, the wrench might slip during use, causing safety accidents.

- 4. Do not allow other people to stand or pass under the e-Powerpack when lifting the e-Powerpack with a crane. Before lifting the e-Powerpack, ensure that there is no one around the e-Powerpack and secure enough safe space.
- 5. Before inspecting or replacing electrical equipment, disconnect the battery ground wire first. Connect the battery ground wire after completing all required work for checking or replacing the electrical equipment in order to prevent a short circuit.
- 6. Workers should wear protective equipment and use insulated tools. Cover the irrelevant area with an insulated cover. Organize and store the removed parts on an insulated mat to avoid causing a short circuit.
- 7. Confirm that the voltage between the power terminals is 0 V. When disconnecting any cable or busbar or removing any part related to the battery, make sure to avoid contact between the positive (+) and negative (-) terminals. When disconnectingany cable or busbar, insulate the corresponding part with insulating tape immediately.

### **General Repair Work**

- 1. Wait until the e-Powerpack is properly cooled down before starting work, since you may get burned if the e-Powerpack is overheated.
- 2. Use a diagnostic device to check whether the e-Powerpack is functioning properly.
- 3. Disconnect the battery ground wire to prevent damage to wires and sensors caused by a short circuit.
- 4. Store disassembled parts in a designated space to avoid damage or contamination.
- 5. If parts need to be replaced, use only genuine parts. Using unauthorized or remanufactured parts may cause critical damage and faults in e-Powerpack performance.
- 6. Group and store disassembled parts in the order that they were disassembled. The strength, shape, and tightening torque of bolts and nuts differ according to their assembly positions. Group and store them accordingly to these characteristics.
- 7. Clean disassembled parts to remove foreign matter before inspecting or reassembling parts.
- 8. When replacing a gasket, remove the old gasket, clean the surface, and then install a new gasket. However, it is not always required to replace the gasket for every repair or service. If any physical damage, e.g. a crack or burr, is found on the gasket, replace it with a new one to avoid the degradation of its waterproof/dustproof performance.
- 9. Assemble bolts and nuts at the specified tightening torque.
- 10.After repair, operate the battery pack to confirm its normal operation.

# Other Safety Instructions and Environmental Pollution

- 1. Good ventilation and low humidity should be maintained in the workspace.
- 2. The workspace should be clean, organized, and not have any flammable substances nearby.
- 3. Smoking is strictly forbidden in the workshop.
- 4. Workers must wear insulated gloves, insulation shoes, work clothes, and insulated safety helmets.
- 5. Workers are not allowed to wear metal accessories, such as watches and rings that can cause a short. Make sure to remove them before operation.
- 6. Wait until the e-Powerpack is properly cooled down before starting work, since you may get burned if the e-Powerpack is overheated.
- 7. Do NOT work on rotating or running parts once the e-Powerpack has been operated.
- 8. Discard polluting substances according to the regulations set forth by the relevant authorities.

# 

Failure to comply with the regulations of the relevant authorities violates environmental pollution regulations and may be subject to legal penalties.

### Use of Genuine Parts

- 1. The e-Powerpack consists of many parts which form a mechanically harmonized unit.
- 2. To prevent e-Powerpack faults in advance and maintain the best e-Powerpack performance for a long period of time, maintenance and replacement of consumable parts should be conducted regularly.
- 3. Only genuine parts should be used for repair. Using unauthorized or remanufactured parts may cause critical damage and faults in the e-Powerpack for which HD HYUNDAI CONSTRUCTION EQUIPMENT shall not be held accountable.

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# **Before Removing and Installing**

### **Preparatory Work**

- 1. Park the machine on level ground. And lower front attachment to the ground.
- 2. Move safety lever to "LOCK" position and then stop the motor.
- 3. Turn battery disconnect switch to "OFF" position.
- 4. Release the remaining pressure in the hydraulic circuit.
- 5. Cool down the hydraulic system and motor.
- 6. Attach a maintenance warning tag on controls.

### Figure 63



DS2300158

### **General Precaution**

- 1. Always read the safety section before removing and Installing. Figure 64
- 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 leak from the machine.
- 2. Check all oil level and if necessary, add oil.
- 3. Apply grease to all lubrication points.
- 4. When hydraulic component has been disconnected, air must be bled from circuit.
  - For details, see the Operation and Maintenance Manual.
- 5. Start the motor and run at low idle for about 5 minutes.
- 6. Perform the machine performance test.



DS2300159

# **Battery Assembly**

### **Repair Procedure Quick Guide**

Step-A. Open the rear cover

Step-B. Remove terminal on the battery

Step-C. Remove battery assembly

### Removal

- 1. Turn OFF the battery disconnect switch.
- 2. Position the machine on even, firm and level ground.
- 3. Put attachment on ground.

**NOTE:** *Place the machine in the suitable service position.* 

### **Rear Cover**

1. Open the rear cover.



### Terminal on the battery

- 1. Disconnect the negative cable and positive cable from the batteries.
- 2. Disconnect any additional electrical connections as necessary.

# Figure 66

### **Battery Assembly**

- 1. Remove the hold down bracket (2) and bolts (1).
  - Tool: 17 mm (\_\_\_\_\_\_)
- 2. Remove batteries from frame.

### Installation

1. Perform installation in the reverse order to removal.



# **TMS** Controller

### **Repair Procedure Quick Guide**

Step-A. Remove TMS cover

Step-B. Disconnect wiring harness

Step-C. Remove TMS controller

### Removal

1. Turn OFF the battery disconnect switch.

### TMS Cover

1. Remove bolts (1) and TMS cover (2).



### **TMS Controller**

- Disconnect wiring harness (1) and cables from TMS controller.
  NOTE: Check the location of the connectors before disconnecting.
- 2. Remove mounting bolts (2) from TMS controller.
- 3. Loosen mounting bolts (3).

**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 to the right when TMS controller is mounted to the machine.

### Installation

1. Perform installation in the reverse order to removal.

### Figure 69



# **VCU** Controller

### **Repair Procedure Quick Guide**

Step-A. Remove canopy

- Step-B. Remove display monitor cover
- Step-C. Remove display monitor
- Step-D. Remove armrest
- Step-E. Remove LH/RHstand covers
- Step-F. Remove control stand bracket
- Step-G. Disconnect hydraulic hoses and fittings
- Step-H. Remove joystick valve
- Step-I. Remove right side cover
- Step-J. Remove right side stand
- Step-K. Remove seat and seat base
- Step-L. Disconnect wiring harness
- Step-M. Remove the VCU controller

### Removal

1. Turn OFF the battery disconnect switch.

### Canopy

- 1. Remove bolts (1, 4ea) and upper canopy body (2).
  - Tool: 19 mm (@\_\_\_\_\_\_\_)
  - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
  - Upper canopy body weight: 24 kg (52.9 lb)

If TMS installed, refer to <u>TMS Controller- Removal and Instal-</u> lation.

- 2. Remove bolts (3, 5ea) and lower canopy body (4).
  - Tool: 19 mm (~\_\_\_\_\_)
  - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
  - Lower canopy body weight: 10 kg (22.0 lb)



### **Display Monitor Cover**

1. Remove display monitor cover (1) from display monitor bracket.

### Figure 71



### **Display Monitor**

- 1. Disconnect wire harness connector (1) from display monitor.
- 2. Remove mounting bolts (2) from display monitor bracket.
- 3. Remove display monitor (3) from bracket.





Arm Rest

- 1. Remove the mounting bolts (1) from arm rest.
  - Tool: 13 mm (~\_\_\_\_)
  - Torque: 29.4 N.m (3 kg.m, 21.7 ft lb)
- 2. Remove arm rest (2) from stand.



### Upper Stand Cover - Left Side

- 1. Remove mounting screws (1) and cover (2) from upper cover. Figure 74
- 2. Remove mounting screws (3).
- 3. Lift off the stand left side cover (4).



### **Upper Stand Cover - Right Side**

- 1. Remove the mounting screws and covers from upper cover.
- 2. Lift off the stand right side cover.

Figure 75



### Switches

- 1. Disconnect wire harness and screws from starter switch
- 2. Remove the rock nut and quick coupler switch (1) from cover.
- 3. Remove the screws and motor speed control dial (2) from cover.
- 4. Remove the nuts and key pad (3) from cover.
- 5. Remove the cap and key switch (4) from cover.
- 6. Remove the 12V power socket (5) from cover.

Figure 76



DS2300118

- Pull up switches (1) by using a flat-head screwdriver.
  NOTE: Be careful not to break the switch assembly.
- Figure 77

2

DS1901319

### **Control Stand Bracket**

1. Remove mounting bolts (1) and bracket (2) from stand.

- 2. Remove mounting bolts (1, 2) from the joystick valve.
- 3. Separate the joystick valves from control stand.
- Figure 79

Figure 78

### **Hydraulic Hoses and Fittings**

1. Disconnect hydraulic hoses (1) and from joystick valve (2).

**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 81



DS2300132

### **Right Side Cover**

- 1. Open the rear cover.
- 2. Remove right side cover caps and bolts (1) from chassis frame.
- 3. Remove right side cover (2) from chassis frame.
  - Right side cover weight: about 5 kg (11.0 lb)



- 4. Remove oil tank cover caps and bolts (1).
  - Tool: 13 mm (~\_\_\_\_\_)
- 5. Remove oil tank cover (2).
  - Oil tank cover weight: about 2 kg (4.4 lb)



**Right Side Stand** 

1. Remove mounting bolts and screw (1) and right side cover (2). Figure 84



### Seat and Seat Base

- 1. Remove mounting bolts (1, 2) and seat (3).
  - (1) Tool: 13 mm (
  - (1) Torque: 29.4 N.m (3 kg.m, 21.7 ft lb)
  - (2) Tool: 17 mm (
  - (2) Torque: 63.7 N.m (6.5 kg.m, 47.0 ft lb)
  - Seat weight: about 22 kg (48.5 lb)



- 2. Remove left side cover caps and bolts (1) from chassis frame.
- 3. Remove left side cover (2) from chassis frame.
  - Left side cover weight: about 4 kg (8.8 lb)

Figure 86



DS2300122

- 4. Remove mounting bolts (1, 2) and seat base (3).
  - (1) Tool: 13 mm (
  - (1) Torque: 29.4 N.m (3 kg.m, 21.7 ft lb)
  - (2) Tool: 17 mm (2)
  - (2) Torque: 63.7 N.m (6.5 kg.m, 47.0 ft lb)
  - Seat base weight: about 19 kg (41.9 lb)







DS2300179

### Wiring Harness

1. Disconnect wiring harness.

### **VCU Controller**

- 1. Remove mounting bolt (1, 4ea) and VCU controller (2) from support.
  - VCU controller weight: about 2 kg (4.4 lb)

### Figure 89



### Installation

1. Perform installation in the reverse order to removal.

# **Cabin Switches**

### **Repair Procedure Quick Guide**

- Step-B. Remove armrest
- Step-C. Remove stand cover
- Step-D. Disconnect wiring harness
- Step-E. Remove switches

### Removal

- 1. Open the rear cover.
- 2. Turn OFF the battery disconnect switch.

### Arm Rest

- 1. Remove the mounting bolts (1) from arm rest.
  - Tool: 13 mm (~\_\_\_\_\_)
  - Torque: 29.4 N.m (3 kg.m, 21.7 ft lb)
- 2. Remove arm rest (2) from stand.



### Stand Cover

- 1. Remove the mounting screws and covers from upper cover.
- 2. Lift off the upper cover.

Figure 91



### Switches

- 1. Disconnect wire harness and screws from starter switch
- 2. Remove the rock nut and quick coupler switch (1) from cover.
- 3. Remove the screws and motor speed control dial (2) from cover.
- 4. Remove the nuts and key pad (3) from cover.
- 5. Remove the cap and key switch (4) from cover.
- 6. Remove the 12V power socket (5) from cover.



### Installation

1. Perform installation in the reverse order to removal.









DS1901319

# **Display Monitor**

### **Repair Procedure Quick Guide**

Step-A. Remove display monitor cover

Step-B. Remove display monitor

### Removal

1. Turn OFF the battery disconnect switch.

### **Display Monitor Cover**

1. Remove display monitor cover (1) from display monitor bracket.



### **Display Monitor**

- 1. Disconnect wire harness connector (1) from display monitor.
- 2. Remove mounting bolts (2) from display monitor bracket.
- 3. Remove display monitor (3) from bracket.

### Installation

1. Perform installation in the reverse order to removal.





# **Hour Meter**

### **Repair Procedure Quick Guide**

Step-A. Remove left side cover

Step-B. Remove hour meter

### Removal

1. Turn OFF the battery disconnect switch.

### Left Side Cover

1. Open the rear cover (1).



- 2. Remove left side cover caps and bolts (1) from chassis frame.
- 3. Remove left side cover (2) from chassis frame.
  - Left side cover weight: about 4 kg (8.8 lb)

### Figure 97



### Hour Meter

- 1. Disconnect wire harnesses.
- 2. Remove the fastener from hour meter.
- 3. Remove the hour meter from support.

### Installation

1. Perform installation in the reverse order to removal.

# Figure 98

DS2300123

# **Troubleshooting Guide**

# Wiring Harness Layout

# **Safety Instructions**

# 

### 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.

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Wiring Harness Layout	. 9
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Main Harness (2/2)	11
Cabin Harness	12
E-Power Harness	13
Battery Harness	14

# Wiring Device

### Wiring Harness Layout

Figure 1



DS2300595
#### Main Harness (1/2)

#### Figure 2



#### Main Harness (2/2) Figure 3 FRON Н to Cabin Harness\_LH 1 to Cabin Harness\_LH 3 to Cabin Harness\_LH 2 Resistor 1 G PDU Inverter Battery Pack F VIEW A VCU 1 VCU 2 VCU 3 Resistor 2 E Battery (-) AC Motor Master SW D Hour Meter Engine Emergency Stop SW Check Connector Joint A Check Connector Joint B С to Fast Charger Harness Frame Earth 2 Frame Earth 1 Diode A (Fast Charger SW) В Fast Charger Indicator Fast Charger SW A 2 3 5 4 6 1

#### **Cabin Harness**

Figure 4



#### **E-Power Harness**

Figure 5



#### **Battery Harness**

Figure 6



## **Error Code**

### **Safety Instructions**

### 

AVOID DEATH OR SERIOUS INJURYInstructions 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.

### **Table of Contents**

#### Error Code

Safety Instructions17 EPOS Error Code21

## **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.	Failure Code	Description of the Problems
1	VCO001-11	GAUGE PANEL ERROR
2	VSP004-03	Px(FRONT) PRESS. SENSOR, Voltage above normal
3	VSP004-04	Px(FRONT) PRESS. SENSOR, Voltage below normal
4	VSE001-03	OIL TEMP. SENSOR, Voltage above normal
5	VSE001-04	OIL TEMP. SENSOR, Voltage below normal
6	VS5006-03	Machine Controller +5V Output 1, Voltage above normal
7	VS5006-04	Machine Controller +5V Output 1, Voltage below normal
8	VS5005-03	DIAL, Voltage above normal
9	VS5005-04	DIAL, Voltage below normal
10	VAL003-03	LDC, Voltage above normal
11	VAL003-04	LDC, Voltage below normal
12	VSV037-05	QUICK COUPLER S/V, Current below normal
13	VSV037-06	QUICK COUPLER S/V, Current above normal
14	VRY021-05	WORKING LAMP RELAY, Current below normal
15	VRY021-06	WORKING LAMP RELAY, Current above normal
16	VGC007-05	PILOT BUZZER, Current below normal
17	VGC007-06	PILOT BUZZER, Current above normal
18	VRY030-05	BATTERY RELAY, Current below normal
19	VRY030-06	BATTERY RELAY, Current above normal
20	VGC009-05	NORMAL CHARGING INDICATOR, Current below normal
21	VGC009-06	NORMAL CHARGING INDICATOR, Current above normal
22	VRY031-05	QUICK CHARGING RELAY, Current below normal
23	VRY031-06	QUICK CHARGING RELAY, Current above normal
24	VGC010-05	QUICK CHARGING INDICATOR, Current below normal
25	VGC010-06	QUICK CHARGING INDICATOR, Current above normal
26	VRY032-05	HIGH VOLTAGE PRECHARGING RELAY, Current below normal
27	VRY032-06	HIGH VOLTAGE PRECHARGING RELAY, Current above normal
28	VRY033-05	HIGH VOLTAGE MAIN RELAY, Current below normal
29	VRY033-06	HIGH VOLTAGE MAIN RELAY, Current above normal
30	VSV064-05	TRACK EXPANSION S/V, Current below normal
31	VSV064-06	TRACK EXPANSION S/V, Current above normal

# I ydraulic Schematic



## Hydraulic Schematic



### 01. MAIN PUMP 02. MAIN CONTROL VALVE 03. SWING DEVICE 04. BOOM CYLINDER 05. ARM CYLINDER 06. BUCKET CYLINDER 07. CENTER JOINT 08. TRAVEL DEVICE 09. JOYSTICK VALVE(L.H) 10. JOYSTICK VALVE(L.H) 11. OIL COOLER 12. RETURN FILTER 13. HYDRAULIC TANK S 14. DOZER CYLINDER T 15. EXTENTION CYLINDER T 15. EXTENTION CYLINDER D 16. DZ/EXT. CYL SELECT VALVE 17. BOOM SWING CYLINDER 18. ONE/TWO WAY SELECT VALVE 19. PT BLOCK 20. QUICK COUPLER VALVE 21. ACCUMULATOR 8 TRAVEL DEVICE(L) R/G -ò--6 SWING DEVICE T2 \* P2(BACKWARD) P1(FORWARD) $\leq 2$ (3) (7) BAIJCE GGHFD $\geq$ 142Bar 142Bar (16) A1 A2 DZ/EXT. CYL Z<sup>8</sup>/ <sup>8</sup> <sup>M</sup> SELECT VALVE <u>ትሱ--ሱ</u>ላ $\triangleleft$ ΒI -(18) ONE/TWO WAY SELECT VALVE JOINT PLATE (Blade) GHJ 2 4 BOOM 9 LEFT JOYSTICK 2 P 1 <del>4</del> 3 4 $1 \stackrel{\overline{4}}{\triangleleft \psi} 3$ ——— Main - Pilot ---- Option box Drain — Text Return — Suction \_\_\_\_ NO. CHANGE NO DESCRIPTION 950102-01079 DS2301371

## **Hydraulic Schematic**

# **Electric Schematic**

Pin	INFORMATION	Source	Pin	INFORMATION	Source	Pin	INFORMATION	Source
1-1	F108B	Power	2-1	FAST Charging Relay	Active Low	3-1	OBC Charging Indicator	Active Low
1-2	GND	GND	2-2	Quick Charging Ind.	Active Low	3-2	RESERVED	Pulse_S
1-3	GND	GND	2-3	RESERVED	Low Input	3-3	RESERVED	Sensor
1-4	CAN1_H	CAN1_H	2-4	RESERVED	Low Input	3-4	RESERVED	sensor
1-5	CAN1_L	CAN1_L	2-5	Hyd. Wake Up SW	Low Input	3-5	HYD. TEMP_GND	S_GND
1-6	CAN1_Shield	Shield	2-6	RESERVED	Low Input	3-6	Autoidle Pressure SIG	Sensor
1-7	DMS	TxD	2-7	RESERVED	Low Input	3-7	Autoidle Pressure GND	S_GND
1-8	DMS	RxD	2-8	Pilot Buzzer	Active Low	3-8	RESERVED	Sensor
1-9	DMS	GND	2-9	HV Precharge Relay	Active Low	3-9	RESERVED	S_GND
1-10	Pilot Cutoff	High Input	2-10	HV Main Relay	Active Low	3-10	BMS Wake-up +	EPPR V/V
1-11	High Speed Switch	High Input	2-11	Track Expansion Sol.	Active Low	3-11	BMS Wake-up -	EPPR V/V
1-12	LV Main Relay +	EPPR V/V	2-12	Working Lamp Relay	Active Low	3-12	RESERVED	Active Low
1-13	LV Main Relay -	EPPR V/V	2-13	RESERVED	Resistance	3-13	Auto Idle/Engine Dial	5V PWR
1-14	HOUR METER	Active Low	2-14	RESERVED	Resistance	3-14	Engine Control Dial SIG	Sensor
1-15	Quick Coupler Sol.	Active Low	2-15	HYD. TEMP	Sensor	3-15	Engine Control Dial GND	S_GND
1-16	A RESERVED	Active Low	2-16	DC-DC Converter	Alternator	3-16	RESERVED	Sensor
1-17	Fast Charge SW	High Input				3-17	RESERVED	S_GND
1-18	Quick Coupler Switch	High Input	]			3-18	RESERVED	Sensor
1-19	Key On Signal	High Input	]			3-19	RESERVED	S_GND
1-20	RESERVED	High Input	]			3-20	RESERVED	Sensor
1-21	Emergency Stop SW	High Input	]			3-21	RESERVED	EPPR V/V
1-22	A RS232 for TMS	TxD	1			3-22	RESERVED	EPPR V/V
1-23	A RS232 for TMS	RxD	]					
1-24	SCI-BOOT	SCI-BOOT	]					
1-25	RESERVED	EPPR V/V	]					
1-26	A FAN PWM Signal	EPPR V/V	]					





## **Electrical Schematic**



\land X01	C109080	Pilot Change
🛆 X11	C104250	Pilot Change
NO.	CHANGE NO	DESCRIPTION
		B00000400



Pin	INFORMATION	Source	Pin	
1-1	F108B	Power	2-1	FA
1-2	GND	GND	2-2	C
1-3	GND	GND	2-3	
1-4	CAN1 H	CAN1 H	2-4	
1-5	CAN1_L	CAN1_L	2-5	
1-6	CAN1_Shield	Shield	2-6	
1-7	DMS	TxD	2-7	
1-8	DMS	RxD	2-8	
1-9	DMS	GND	2-9	H
1-10	Pilot Cutoff	High Input	2-10	
1-11	High Speed Switch	High Input	2-11	٦
1-12	LV Main Relay +	EPPR V/V	2-12	W
1-13	LV Main Relay -	EPPR V/V	2-13	
1-14	HOUR METER	Active Low	2-14	
1-15	Quick Coupler Sol.	Active Low	2-15	
1-16	RESERVED	Active Low	2-16	
1-17	Fast Charge SW	High Input		
1-18	Quick Coupler Switch	High Input	]	
1-19	Key On Signal	High Input	]	
1-20	RESERVED	High Input	]	
1-21	Emergency Stop SW	High Input	]	
1-22	RS232 for TMS	TxD	]	
1-23	RS232 for TMS	RxD	]	
1-24	SCI-BOOT	SCI-BOOT		
1-25	RESERVED	EPPR V/V		
1-26	FAN PWM Signal	EPPR V/V	]	

INFORMATION     Source     Pin     INFORMATION       -1     FAST Charging Relay     Active Low     3-1     OBC Charging Indicat       -2     Quick Charging Ind.     Active Low     3-2     RESERVED       -3     RESERVED     Low Input     3-3     RESERVED       -4     RESERVED     Low Input     3-4     RESERVED       -5     Hyd. Wake Up SW     Low Input     3-5     HYD. TEMP GND       -6     RESERVED     Low Input     3-6     Autoidle Pressure SIC       -7     RESERVED     Low Input     3-7     Autoidle Pressure GN       -8     Pilot Buzzer     Active Low     3-8     RESERVED       -9     HV Precharge Relay     Active Low     3-9     RESERVED	Source Active Low Pulse_S Sensor Sensor S GND
-1 FAST Charging Relay Active Low 3-1 OBC Charging Indicat   -2 Quick Charging Ind. Active Low 3-2 RESERVED   -3 RESERVED Low Input 3-3 RESERVED   -4 RESERVED Low Input 3-4 RESERVED   -5 Hyd. Wake Up SW Low Input 3-5 HYD. TEMP GND   -6 RESERVED Low Input 3-6 Autoidle Pressure SIG   -7 RESERVED Low Input 3-7 Autoidle Pressure GN   -8 Pilot Buzzer Active Low 3-8 RESERVED   -9 HV Precharge Relay Active Low 3-9 RESERVED	tor Active Low Pulse_S Sensor sensor S GND
-2 Quick Charging Ind. Active Low 3-2 RESERVED   -3 RESERVED Low Input 3-3 RESERVED   -4 RESERVED Low Input 3-4 RESERVED   -5 Hyd. Wake Up SW Low Input 3-5 HYD. TEMP GND   -6 RESERVED Low Input 3-6 Autoidle Pressure SIG   -7 RESERVED Low Input 3-7 Autoidle Pressure GN   -8 Pilot Buzzer Active Low 3-8 RESERVED   -9 HV Precharge Belay Active Low 3-9 RESERVED	Pulse_S Sensor sensor S_GND
3     RESERVED     Low Input     3-3     RESERVED       4     RESERVED     Low Input     3-4     RESERVED       5     Hyd. Wake Up SW     Low Input     3-5     HYD. TEMP_GND       6     RESERVED     Low Input     3-6     Autoidle Pressure SIG       7     RESERVED     Low Input     3-7     Autoidle Pressure GN       8     Pilot Buzzer     Active Low     3-8     RESERVED       9     HV Precharge Belay     Active Low     3-9     RESERVED	Sensor sensor SGND
4     RESERVED     Low Input     3-4     RESERVED       -5     Hyd. Wake Up SW     Low Input     3-5     HYD. TEMP_GND       -6     RESERVED     Low Input     3-6     Autoidle Pressure SIG       -7     RESERVED     Low Input     3-7     Autoidle Pressure GN       -8     Pilot Buzzer     Active Low     3-8     RESERVED       -9     HV Precharge Belay     Active Low     3-9     RESERVED	sensor S_GND
-5     Hyd. Wake Up SW     Low Input     3-5     HYD. TEMP_GND       -6     RESERVED     Low Input     3-6     Autoidle Pressure SIC       -7     RESERVED     Low Input     3-7     Autoidle Pressure GN       -8     Pilot Buzzer     Active Low     3-8     RESERVED       -9     HV Precharge Relay     Active Low     3-9     RESERVED	S_GND
-6     RESERVED     Low Input     3-6     Autoidle Pressure SI(       7     RESERVED     Low Input     3-7     Autoidle Pressure GN       -8     Pilot Buzzer     Active Low     3-8     RESERVED       -9     HV Precharge Relay     Active Low     3-9     RESERVED	
-7     RESERVED     Low Input     3-7     Autoidle Pressure GN       -8     Pilot Buzzer     Active Low     3-8     RESERVED       -9     HV Precharge Relay     Active Low     3-9     RESERVED	Sensor
-8 Pilot Buzzer Active Low 3-8 RESERVED	D S_GND
-9 HV Precharge Relay Active Low 3-9 RESERVED	Sensor
	S_GND
10 HV Main Relay Active Low 3-10 BMS Wake-up +	EPPR V/V
11 Track Expansion Sol. Active Low 3-11 BMS Wake-up -	EPPR V/V
12 Working Lamp Relay Active Low 3-12 RESERVED	Active Low
13 RESERVED Resistance 3-13 Auto Idle/Engine Dia	I 5V PWR
14 RESERVED Resistance 3-14 Engine Control Dial SI	IG Sensor
15 HYD. TEMP Sensor 3-15 Engine Control Dial GN	ND S_GND
16 DC-DC Converter Alternator 3-16 RESERVED	Sensor
3-17 RESERVED	S_GND
3-18 RESERVED	Sensor
3-19 RESERVED	S_GND
3-20 RESERVED	Sensor
3-21 RESERVED	EPPR V/V
3-22 RESERVED	EPPR V/V



### **Electrical Schematic**

A	C109080	Quick Charger Option
A	C111830	ENE Pilot Design Change
A	C117010	Piilot Change
NO.	CHANGE NO	DESCRIPTION
		950102-010650
		DS2301125