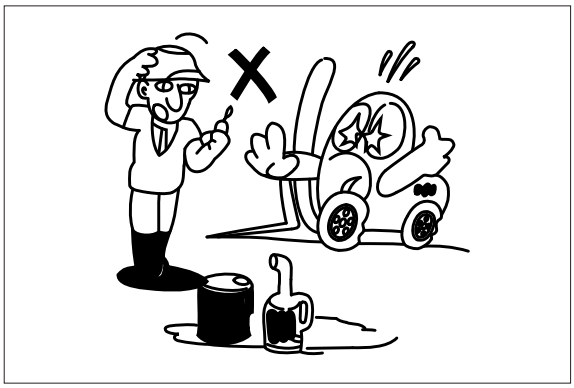
CONTENTS

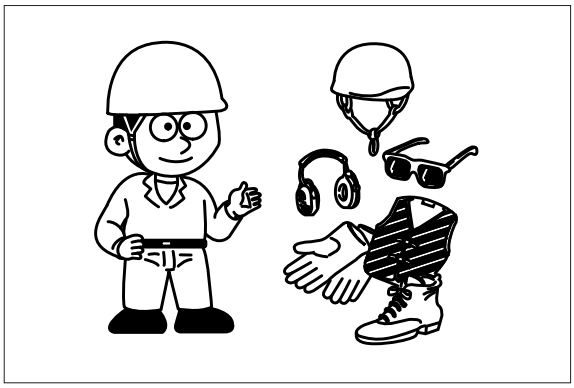
GROUP 1 SAFETY HINTS

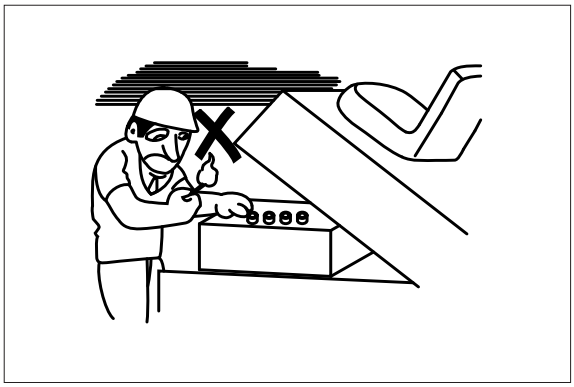
Careless performing of the easy work may cause injuries. Take care to always perform work safely, at least observing the following.

- Oil is a dangerous substance. Never handle oil, grease or oily clothes in places where there is any fire of flame.
  As preparation in case of fire, always know the location and directions for use of fire extinguishers and other fire fighting equipment.

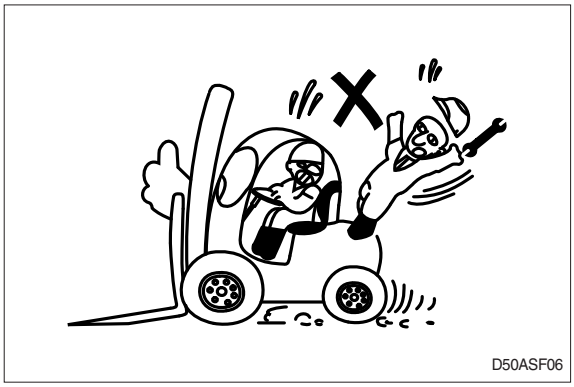


- Wear well-fitting helmet, safety shoes and working clothes. When drilling, grinding or hammering, always wear protective goggles. Always do up safety clothes properly so that they do not catch on protruding parts of machines. Do not wear oily clothes.
  When checking, always release battery plug.





- When working on top of the machine, be careful not to lose your balance and fall.



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6. RECOMMENDED LUBRICANTS

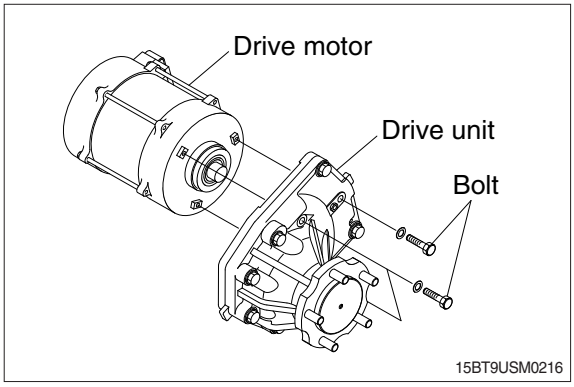
Use only oils listed below or equivalent. Do not mix different brand oil.

Service point	Kind of fluid	Capacity ℓ (U.S. gal)	Ambient temperature °C (°F)
			-50 (-58) / -30 (-22) / -20 (-4) / -10 (14) / 0 (32) / 10 (50) / 20 (68) / 30 (86) / 40 (104)
Axle	Gear oil	0.35 (0.1)	ATF Dexron Ⅲ
Hydraulic oil tank	Hydraulic oil	20 (5.2)	★ISO VG 15 / ISO VG 46 / ISO VG 68
Brake system	Brake oil	0.5 (0.13)	DOT 3
Fitting (Grease nipple)	Grease	0.1 (0.03)	★NLGI No.1 / NLGI No.2

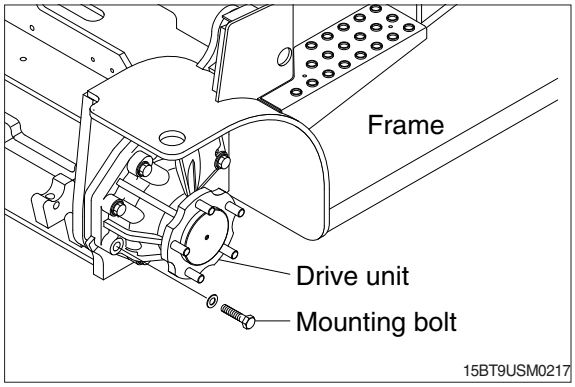
·ATF : Automatic Transmission Fluid
·API : American Petroleum Institute
·SAE : Society of Automotive Engineers
·ISO : International Organization for Standardization
·NLGI : National Lubricating Grease Institute

★ : Cold region
Russia, CIS, Mongolia

② Remove three hexagon bolts holding the drive motor in place.
③ Carefully remove the drive motor from the drive unit.
USE pm 4010 page DWG



④ Loosen seven mounting bolts on the truck frame and carefully take out the drive unit.

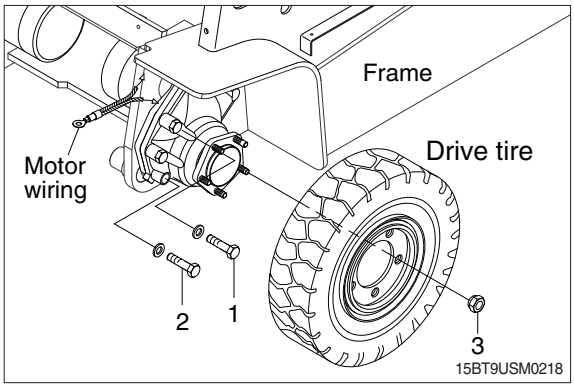


2) INSTALLATION

Installation is the reverse order of removal, but be careful of the following tightening torque.

· Tightening torque

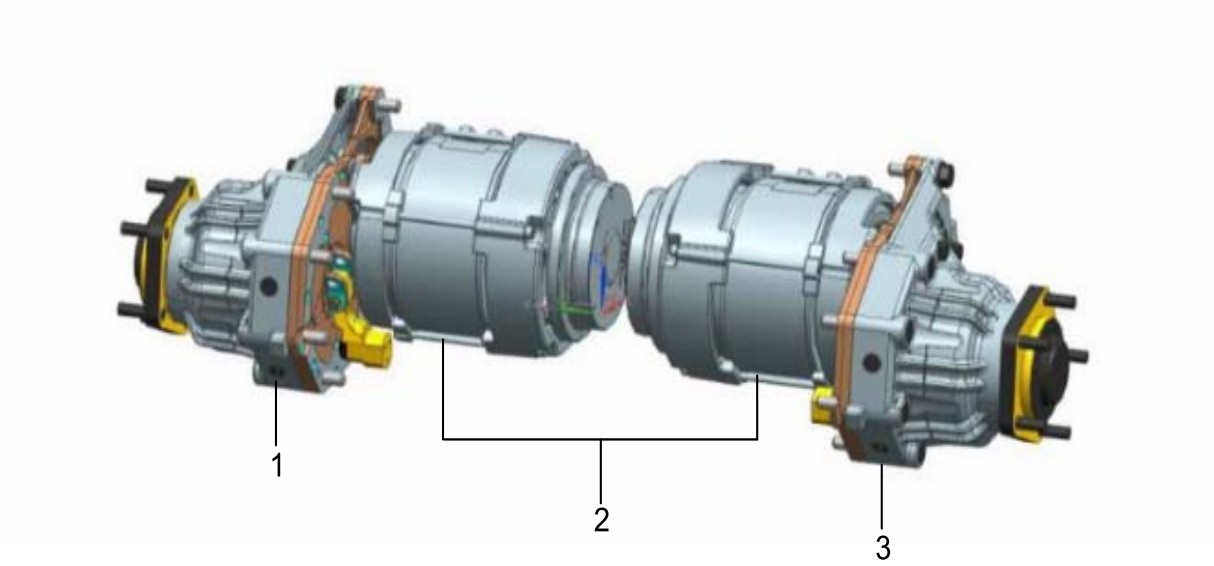
Item	kgf · m	lbf · ft
Drive motor (1)	5.6 ~ 8.2	40.5 ~ 59.3
Drive unit (2)	12.5 ~ 15	90.4 ~ 109
Wheel nut (3)	12.5 ~ 15.5	90.4 ~ 112



3) PRINCLPLE OF OPERATION

(1) Outline of the power transmission system

The drive units are composed of the drive unit (LH) and the drive unit (RH) which are connected with the motor as a power transmission system to assemble the drive wheel for the battery type fork lift.



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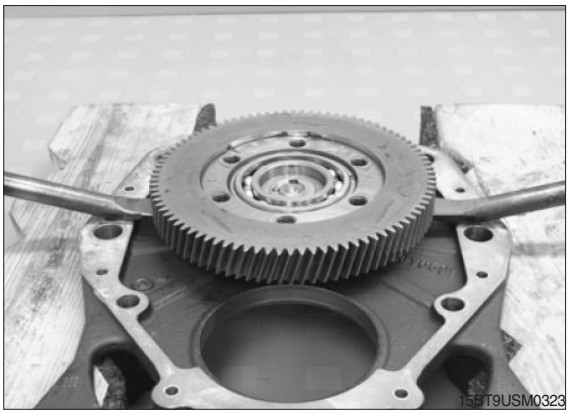
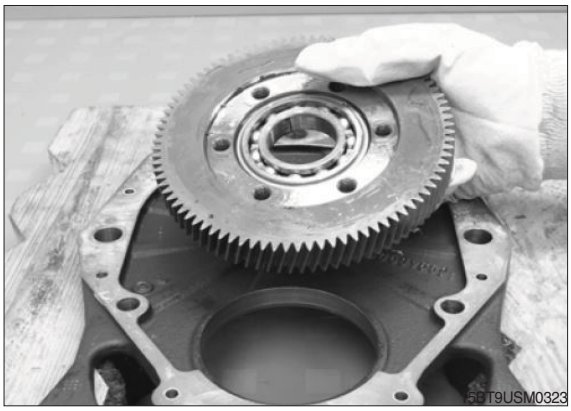
1 Drive unit (LH) 2 Motor 3 Drive unit (RH)

The power of the drive motor which is received from signal of the controller transmits to the dirve gear and the power transfered from the drive gear transmits to the drive wheel via the planetary gear and wheel hub. As a result, it is able to drive to forward and reverse of the fork lift.

(11) By levering the spur gear alternately on both sides, manually remove it from the housing cover.

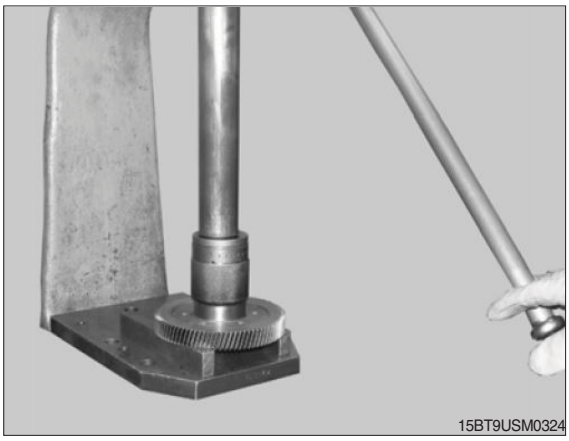
※ Be careful not to damage the toothing when levering.





(12) Remove the grooved ball roller bearing from the spur gear using tool and the hand lever press.

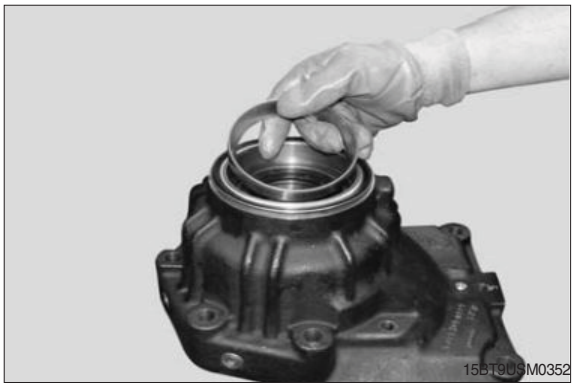
※ Risk of accident and injury from crushing. When pressing out the grooved ball roller bearing, do not place hands between the punch and the tool.

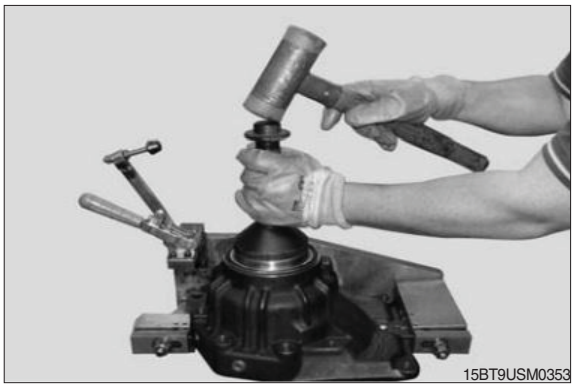


Wheel shaft side bearing seat

(5) Clean the wheel shaft side bearing seat of the taper roller bearing in the housing .

(6) Drive the wheel shaft side bearing cup of the taper roller bearing into the bearing seat.
The inside of the bearing cup shall narrow to a taper towards the bearing seat and the wide edge of the bearing cup shall be positioned at the bottom.

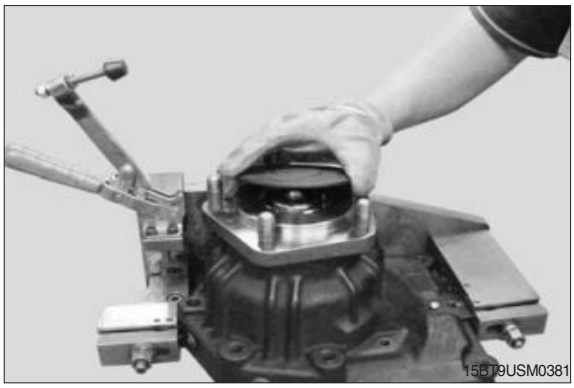




(7) Coat the inner lip of the shaft sealing ring with multipurpose

Protective cap

(33) Fit the protective cap to the wheel shaft and tap it lightly until it snaps into place.

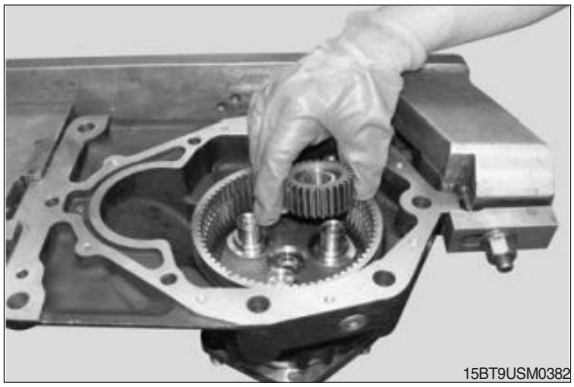


Planetary gears

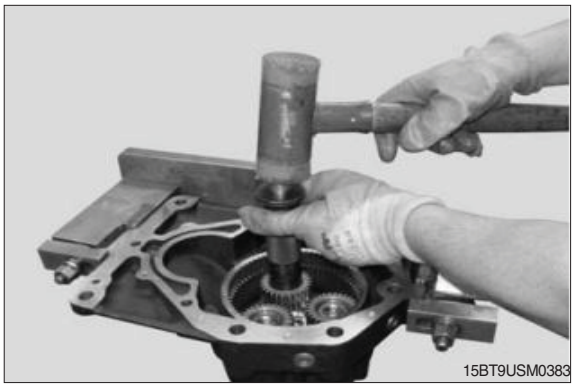
(34) Version with 3 planet gears

Place a planet gear with pre-assembled cylindrical roller bearing straight onto one of the pins of the planet carrier.

Do not tilt the planet gear. Face upwards the identification mark of the planet gear.

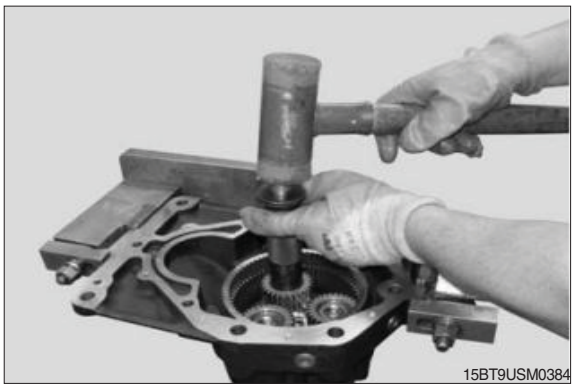


(35) Drive in the planet gear including the cylindrical roller bearing until reaching the limit stop. Use a hammer and a striking mandrel. Drive in the remaining two pre-assembled planet gears by using the same method. Note the correct meshing of the teeth of both planet gears and ring gear.



(36) Apply a pining by using tool to lock the planet gears.

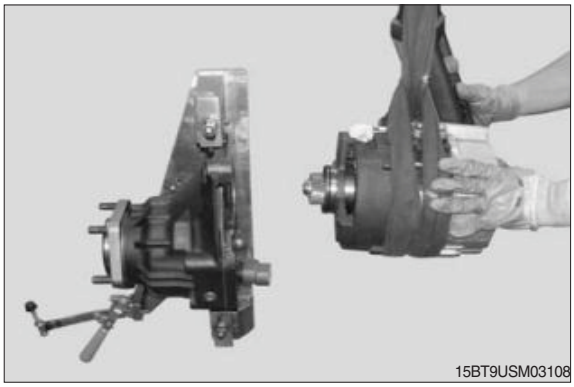
The pining is done correcly as soon as the axial play of the planet gear's cylindrical roller bearings on the bolts has dissappeared completely.



3) Motor reassembly

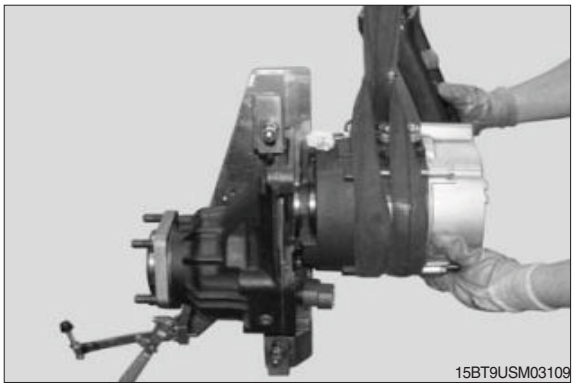
Motor

(1) Fasten the motor to suitable lifting gear using approved attachment equipment.



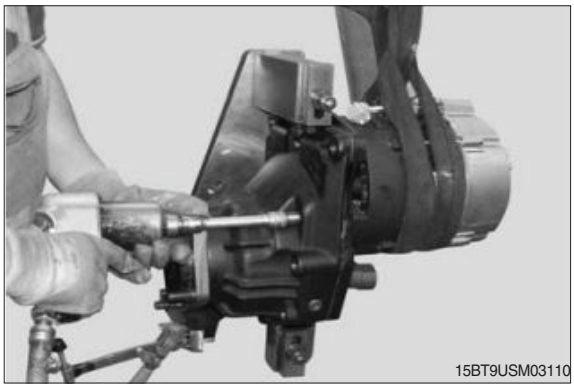
(2) Position the motor in front of the drive unit and manually mesh the motor pinion with the spur gear pinion.

When meshing the motor pinion with the spur gear, make sure that both sets of teeth are not tilted or damaged.
The motor connections shall be at the top in the installation position.

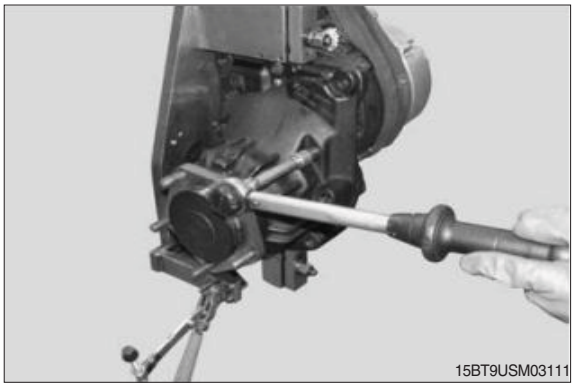


(3) Fasten the motor to the drive unit with the 3 Allen bolts.

Screw in the shorter Allen bolt at the top of the drive unit and each of the two other bolts into the right hand and left-hand side of the drive unit.

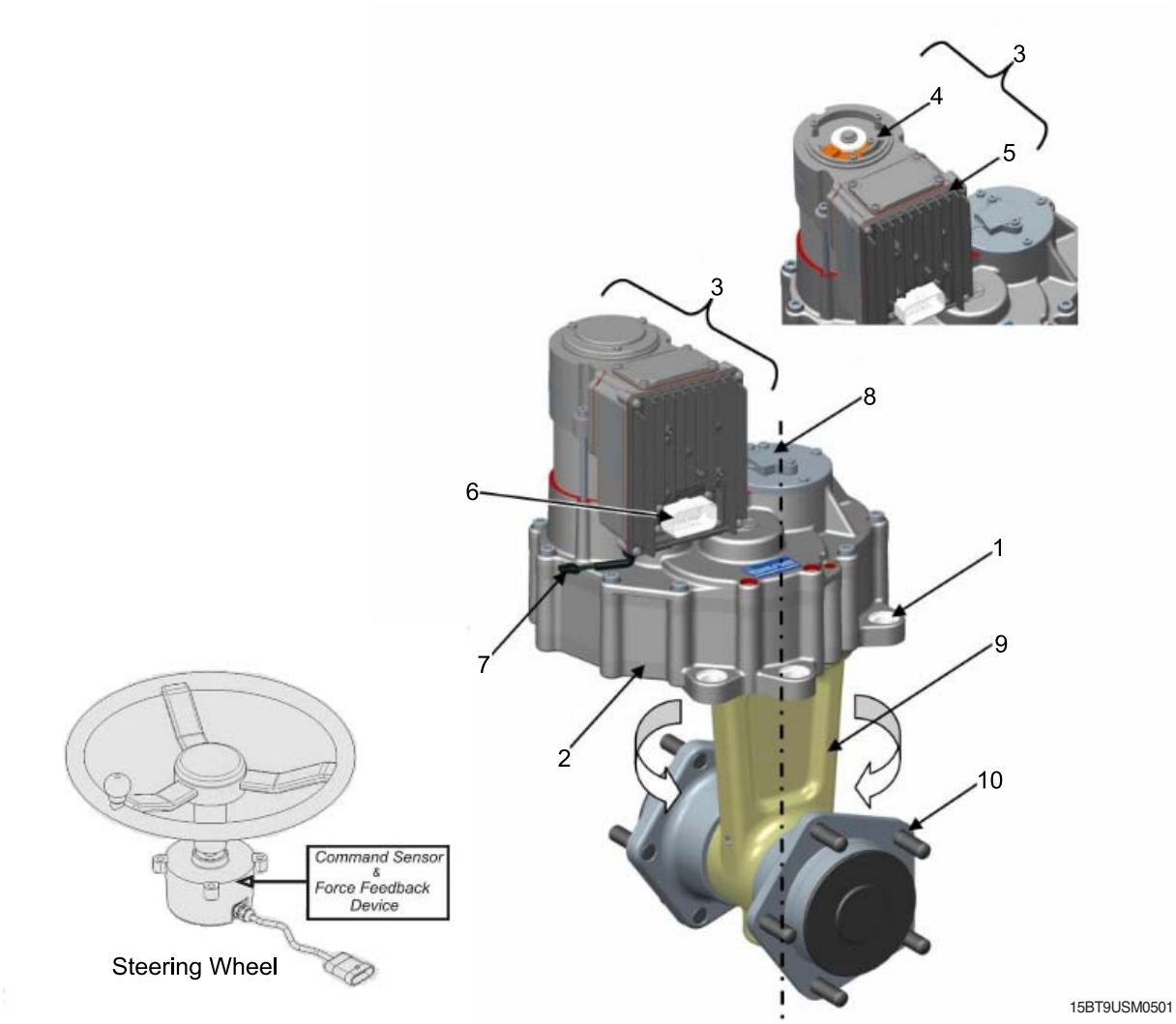


(4) Firmly tighten the 3 Allen bolts to a tightening torque of 23Nm.



GROUP 1 STRUCTURE AND FUNCTION

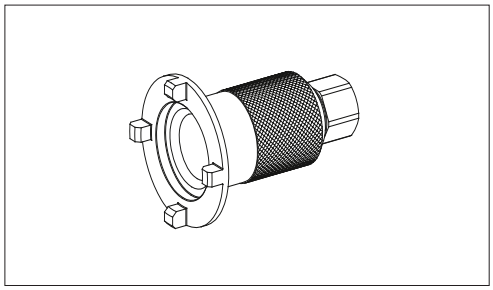
1. LAYOUT



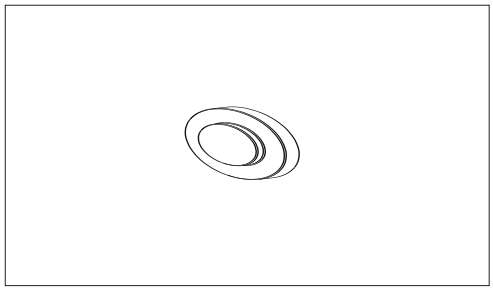
1	Hole (connection to Forklift chassis)	5	Steering controller	8	Angle sensor
2	Helical gear (3 stage)	6	Steering controller connection	9	Axle carrier
3	Motor controller unit	7	Connection for angles-of-rotation sensor	10	Output flange
4	AC Steering motor				

The steering operation by rotating the electric motor using the signal values from the steering sensor installed under the steering handle. EPS(Electronic Power Steering) system uses the electric motor for steering to achieve advanced functions such as operating force, lock to lock rev adjustment, and the correct system. Unlike traditional HPS(Hydraulic Power Steering) system, The electric motor only operates when the steering wheel is turned. And eliminating unnecessary energy consumption and noise. Without any hydraulic equipment, oil maintenance is unnecessary and environmentally friendly.

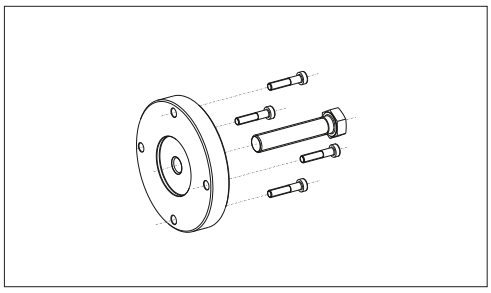
(6) Slotted nut wrench



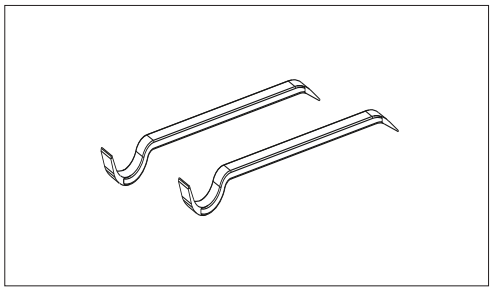
(7) Pressure piece



(8) Forcing device

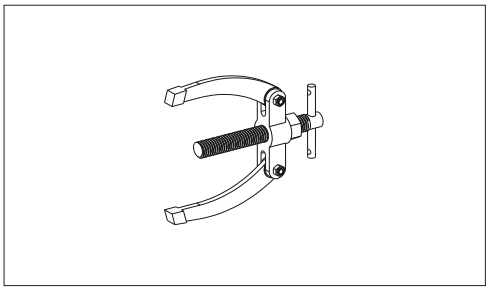


(9) Assembly lever set



(10) Extrator

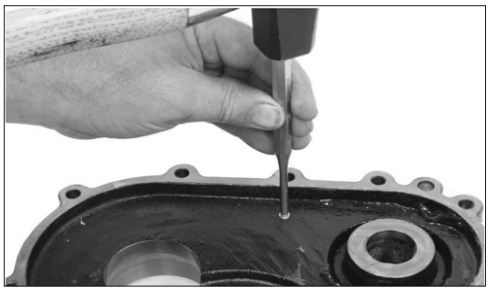
(11) Counter support



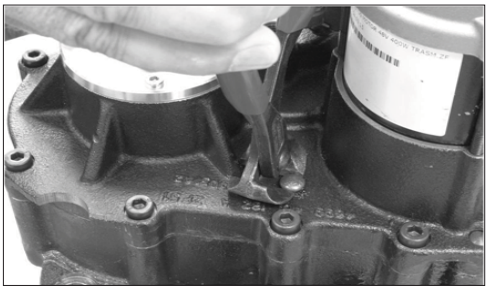
⑧ If required, remove fitting key.

Breather

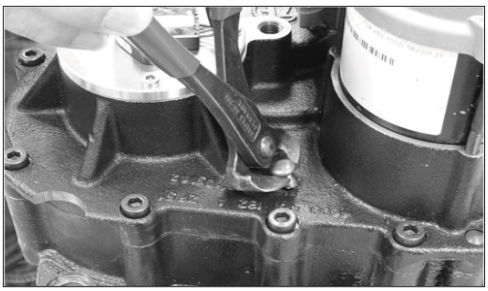
① For removal on detached housing cover, drive the breather out of the hole on the inner side of the housing cover using a pin punch and remove it.



② For removal on mounted unit, locate pincer head of the end-cutting pliers beneath the breather cap.

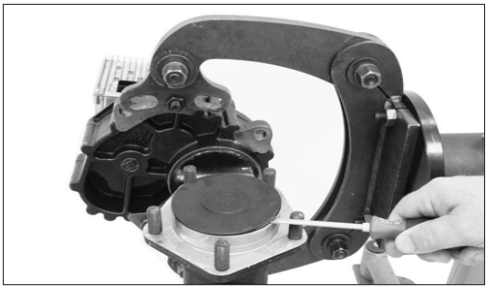


③ Pull the breather out of the housing cover.

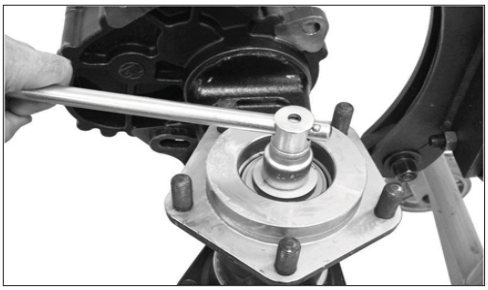


Wheel hub bearing

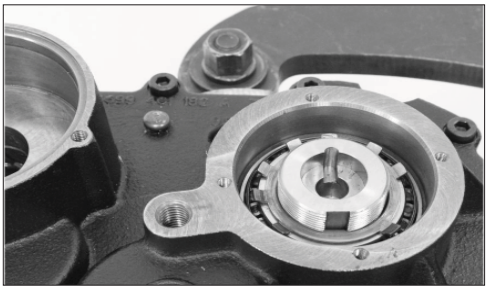
① Rotate transmission on the assembly truck (horizontal position).
Use screw driver to lever out protective cap and remove it from the output flange.



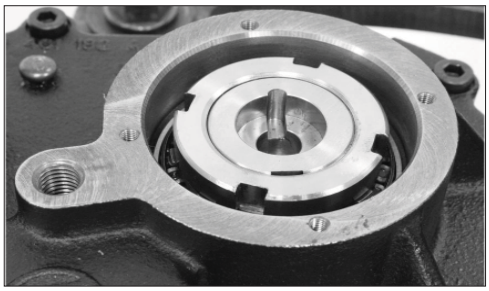
② Loosen hexagon screw.



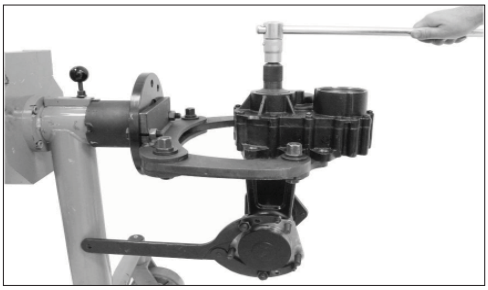
⑥ Insert locking plate.



⑦ Hand-tighten slotted nut.
Remove lashing strap.

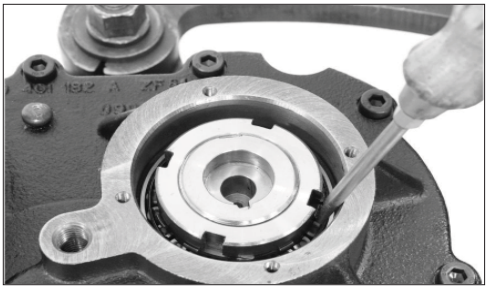


⑧ Position the holding device on the gear shaft and fix it on the wheel bolt using two wheel nuts. Tighten slotted nut until the required rolling torque is obtained. Then force out bearing by means of slight hits and roll it in.



⑨ Check rolling torque of axle carrier bearing 10~15 Nm.

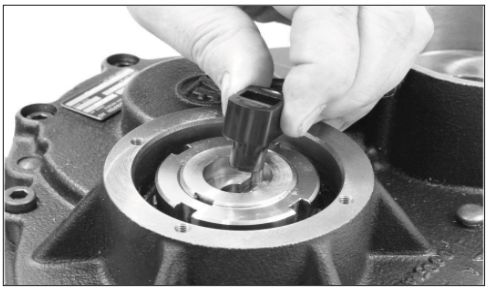
⑩ Secure slotted nut with locking plate.



(2) Housing

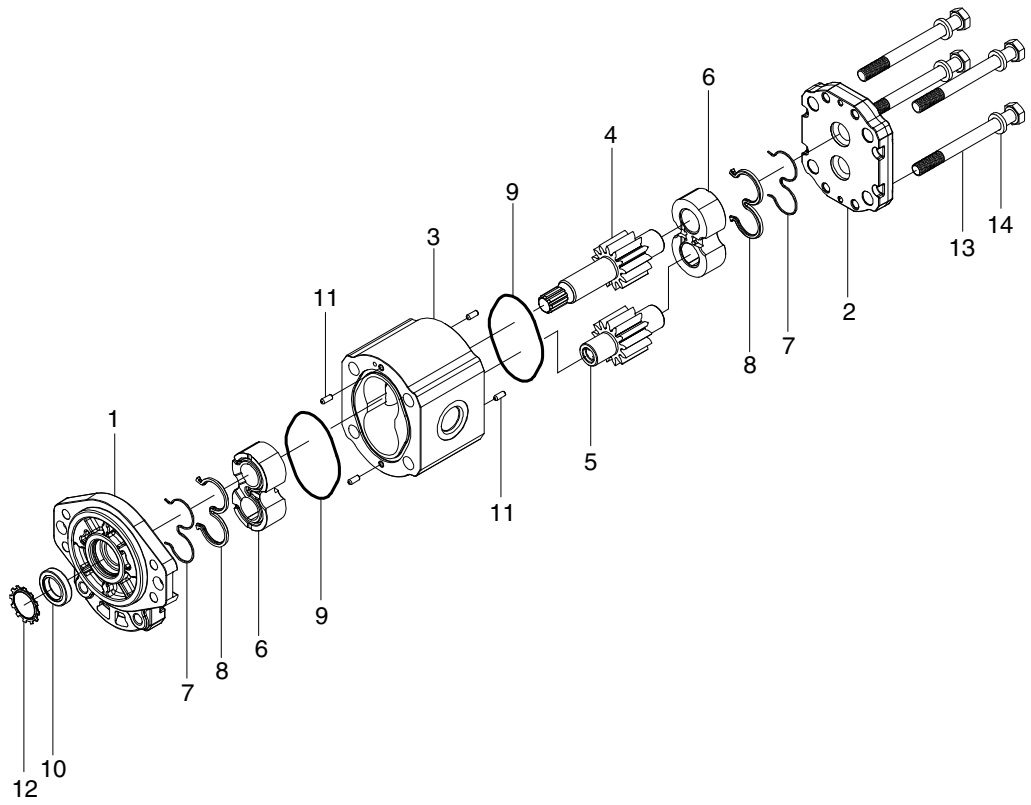
Angles of rotation sensor

① Insert solenoid into the groove of the axle carrier.



2. HYDRAULIC GEAR PUMP

1) STRUCTURE



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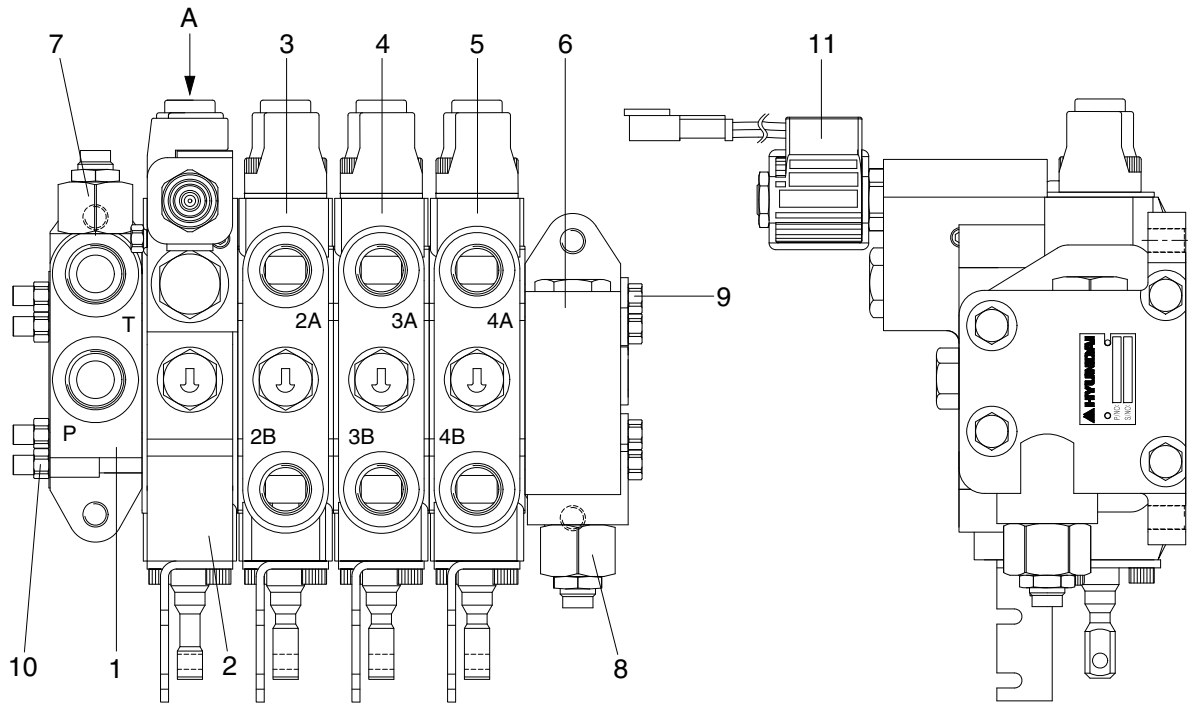
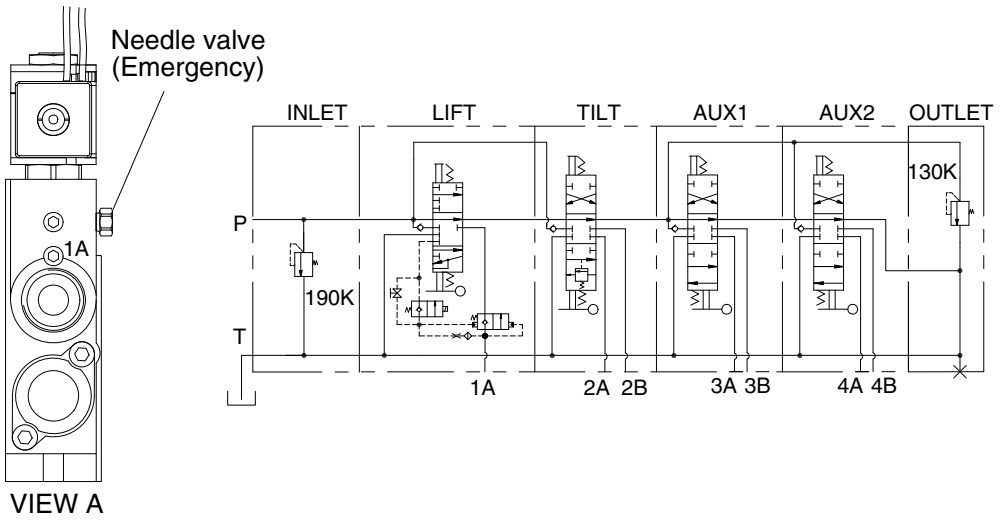
1	Mounting flange	6	Bearing block	11	Dowel pin
2	End cover	7	Backup ring	12	Start ring
3	Gear housing	8	Seal	13	Socket head bolt
4	Drive gear	9	O-ring	14	Spring washer
5	Idler shaft	10	Shaft seal		

2) OPERATION

This pump comprises of an rear cover, a body, bushings and a housing bolted together with bolts. The gear journals are supported in side plate within pressure balanced bushings to give high volumetric and mechanical efficiencies.

2) STRUCTURE (4 Spool)





Port name	Size	Port
Inlet port	7/8-14UNF	P
Outlet port	7/8-14UNF	T
Work port	7/8-14UNF	1A
Work port	3/4-16UNF	2A, 2B, 3A, 3B, 4A, 4B

15BT9USM0622

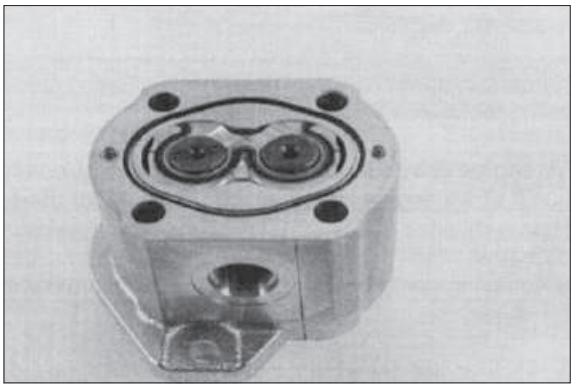
1 Inlet block assy
2 Lift block assy
3 Tilt block assy
4 Aux 1 block assy
5 Aux 2 block assy
6 Outlet block assy
7 Main relief valve assy
8 Auxiliary relief valve assy
9 Long bolt
10 Nut
11 Solenoid valve

2. TROUBLE SHOOTING

1) SYSTEM

Problem	Cause	Remedy
Large fork lowering speed	· Seal inside control valve defective. · Oil leaks from joint or hose. · Seal inside cylinder defective.	· Replace spool or valve body. · Replace. · Replace packing.
Large spontaneous tilt of mast	· Tilting backward : Check valve defective. · Tilting forward : tilt lock valve defective. · Oil leaks from joint or hose. · Seal inside cylinder defective.	· Clean or replace. · Clean or replace. · Replace. · Replace seal.
Slow fork lifting or slow mast tilting	· Lack of hydraulic oil. · Hydraulic oil mixed with air. · Oil leaks from joint or hose. · Excessive restriction of oil flow on pump suction side. · Relief valve fails to keep specified pressure. · Poor sealing inside cylinder. · High hydraulic oil viscosity. · Mast fails to move smoothly. · Oil leaks from lift control valve spool. · Oil leaks from tilt control valve spool.	· Add oil. · Bleed air. · Replace. · Clean filter. · Adjust relief valve. · Replace packing. · Change to ISO VG46. · Adjust roll to rail clearance. · Replace spool or valve body. · Replace spool or valve body.
Hydraulic system makes abnormal sounds	· Excessive restriction of oil flow pump suction side. · Gear or bearing in hydraulic pump defective.	· Clean filter. · Replace gear or bearing.
Control valve lever is locked	· Foreign matter jammed between spool and valve body. · Valve body defective.	· Clean. · Tighten body mounting bolts uniformly.
High oil temperature	· Lack of hydraulic oil. · High oil viscosity. · Oil filter clogged.	· Add oil. · Change to ISO VG46. · Clean filter.

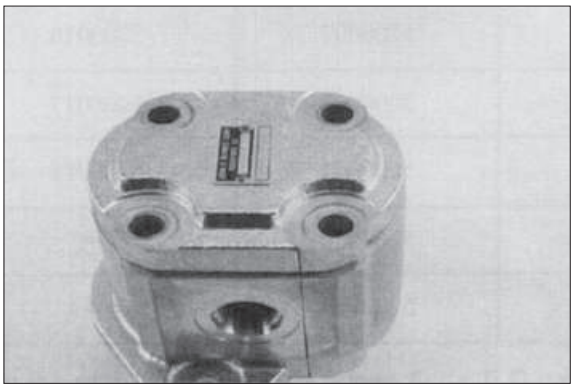
(13) Gently slide the gear housing over the rear bearing block assembly, slide housing down until the housing engages the dowel pins. Press firmly in place with hands, do not force or use any tool.
Check to make sure the intake port in the housing in on the same side as the open end of the E-seal and that the marked lines on the mounting flange and gear housing are in alignment.



PUMP 23

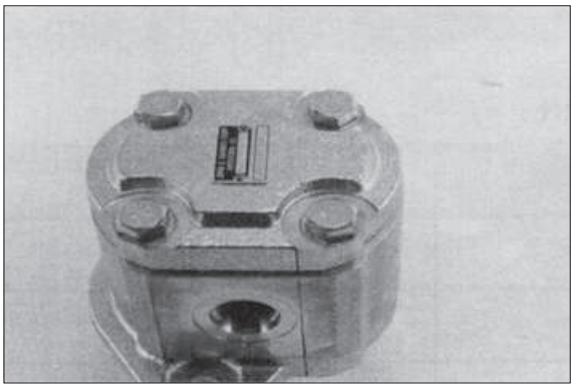
(14) The surface of the rear bearing block should be slightly below the face of the gear housing. If the bearing block sits higher then the rear face of the gear housing then the E-seal or O-ring have shifted out of the groove. If this is the case, remove the gear housing and check for proper seal installation.

(15) Install the two remaining dowel pins in the rear of the gear housing and place the end cover over the back of the pump.



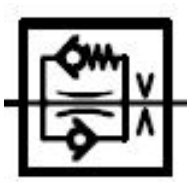
PUMP 24

(16) Install the four spacers and hexagon head bolts through the bolt holes in the end cover, hand tighten.



PUMP 25

(3) S damping screw

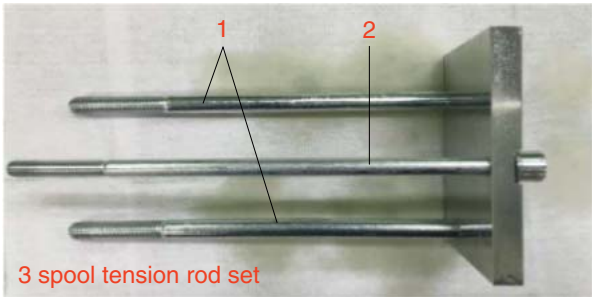


※ S damping
Integrated combination of orifice, check valve, pre-load valve (approx. 25 bar).

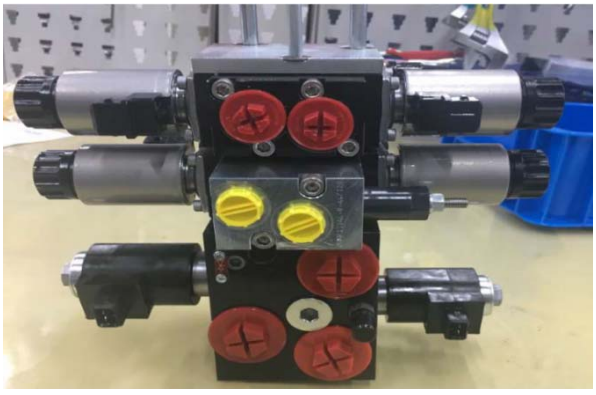
※ Tightening torque
1.02 kgf·m (7.4 lbf·ft)

5) ADD SECTION PART

(1) Disassembly



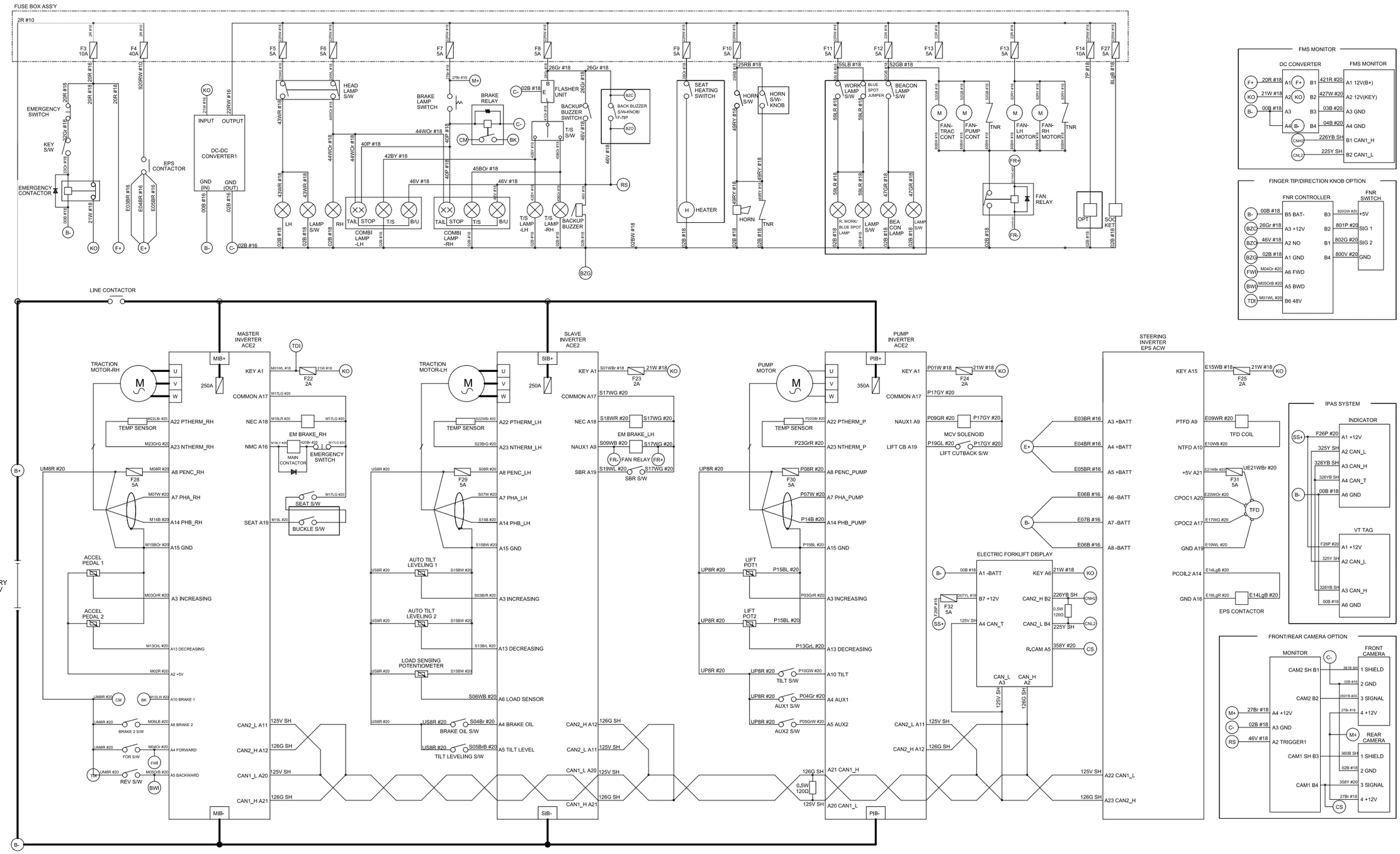
※ Tightening torque
- Item 1 (2 EA) : 2.3 kgf·m (17.0 lbf·ft)
- Item 2 (1 EA) : 0.97 kgf·m (7.0 lbf·ft)



※ From 4 spool to 3 spool.

※ When it needs to disassemble section valve, it's possible to release tension rod sets.

·UL MANUAL TYPE (15BT-9U : ~#89, 18BT-9 : ~#145, 20BT-9U : ~#179)



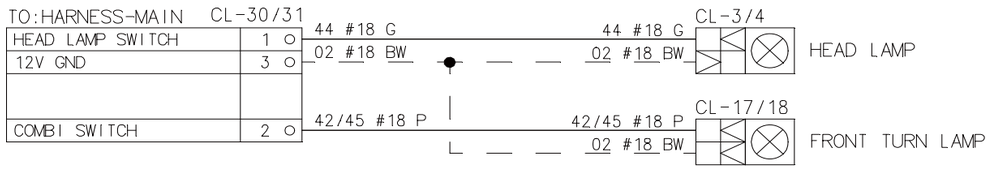
NOTE

1.B+ : BATTERY POSITIVE
B- : BATTERY NEGATIVE
C- : CONVERTER1 OUTPUT NEGATIVE
E+ : EPS CONTROLLER POSITIVE
KO : KEY SWITCH OUT
FR+: FAN RELAY POSITIVE
FR- : FAN RELAY NEGATIVE
M+ : MONITOR POSITIVE
F+ : FMS POSITIVE
CNH2: CAN HIGH_2
CNL2: CAN LOW_2
RS : REVERSE SIGNAL
BZC: BACK BUZZER COMMON
BZO: BACK BUZZER OUT
BZG: BACK BUZZER GROUND
FWI: FORWARD INPUT
BWI: BACKWARD INPUT
TDI: TRACTION DIGITAL INPUT COMMON
CS : CAMERA SIGNAL
SS+ ; FINGERTIP SUB CONTROLLER POSITIVE
CM : CONTROLLER COMMON
BK : BRAKE SIGNAL
2. ⋯ is optional item.
3. ⬭ is shield wire.

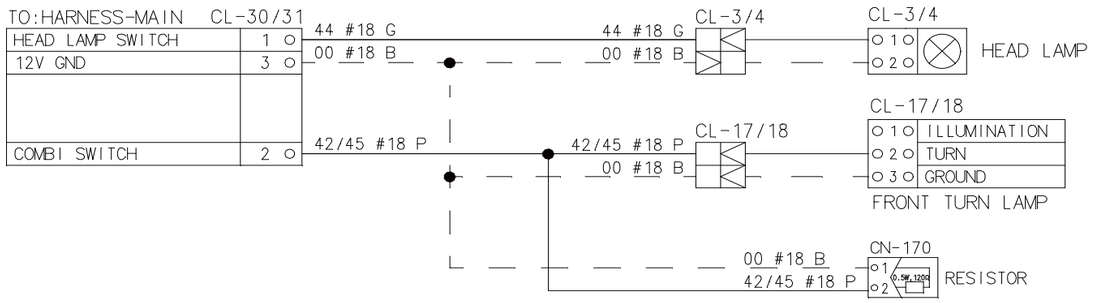
21FY-90611

·OHG (15BT-9U : #278~, 18BT-9U : #397~, 20BT-9U : #661~)

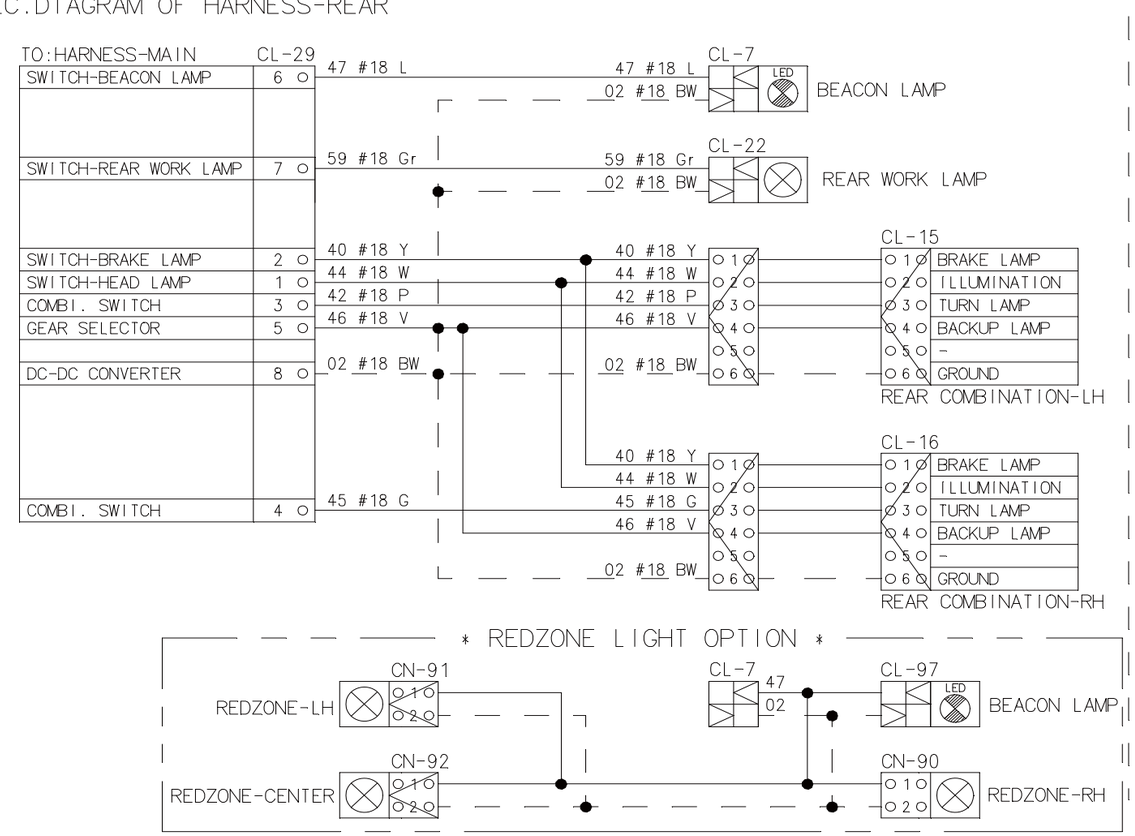
*ELEC.DIAGRAM OF HARNESS-FRONT LH/RH(HALLOGEN LAMP)



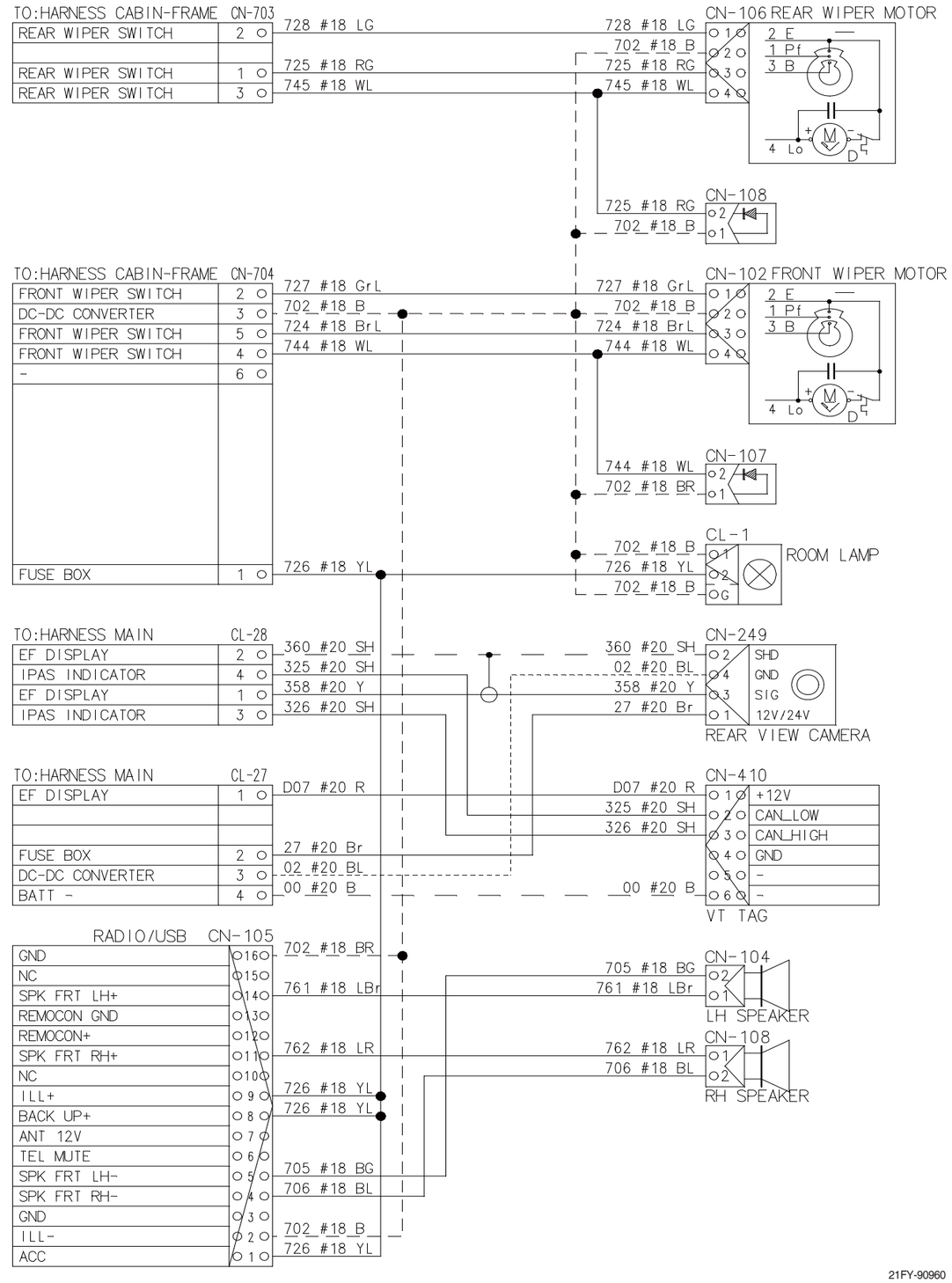
*ELEC.DIAGRAM OF HARNESS-FRONT LH/RH(LED LAMP)



*ELEC.DIAGRAM OF HARNESS-REAR



*ELEC.DIAGRAM OF HARNESS CABIN-OHG



21FY-90960

(2) Performance and maintenance of batteries

① Initial charge

Wet-charged battery gradually decreases its capacity during storage. In order to provide sufficient discharge capacity in the first discharge, the good initial charge is required. The conditions of initial charging are seen as below at room temperature.

a. By modified constant voltage charger

Connect the battery to the charger and turn on the equalizing charge "ON." The battery will be fully charged and terminated automatically.

b. By constant voltage constant current charger (standard)

Connect the battery to the charger and turn on the equalizing charge "ON." The battery will be fully charged and terminated automatically.

c. By constant current charger

Connect the charger to the battery and charge the battery by 0.1C×5 hour rate nominal capacity current for 24 hours or more. The charge shall be terminated when one of the following conditions is identified.

- When a constant value is indicated for more than 1 hour after the battery voltage has reached the maximum value.
- When more than 1 hour of charge is continued after the electrolyte specific gravity has risen fully and becomes constant.

② Discharge and capacity

The capacity of batteries is indicated at 5 hour rate capacity which means the battery can be discharged for 5 hours with the discharge current calculated by dividing the capacity value by 5 until the unit cell mean voltage reaches down to 1.7V at the electrolyte temperature of 30°C.

That is, the capacity is indicated by AH (ampere hour) being calculated as the product of ampere (A) and time (H). However, even if it is the same type of batteries, the capacity varies with the discharge conditions (discharge current, battery temperature and specific gravity of electrolyte).

Even if the batteries discharged its full capacity, if immediately charged to full, there will be no harmful effects remained. Ideal charging amount (AH) is 110-125% of the amount of previous discharge.

③ Specific gravity of electrolyte

Specific gravity of electrolyte drops at discharge and rises at charge. When the batteries are fully charged, it becomes almost constant and shows no further rise. The specific gravity value varies with the change in temperature. Therefore specific gravity measurement should be made with temperature of electrolyte at the same so the measured specific gravity value could be corrected to that at the standard temperature of 25°C by the following formula.

$$S_{25} = S_t + 0.0007\ (t-25)$$

Where, S_{25} : Specific gravity at 25°C

S_t : Actually measured specific gravity at t°C

t : Electrolyte temperature (°C)

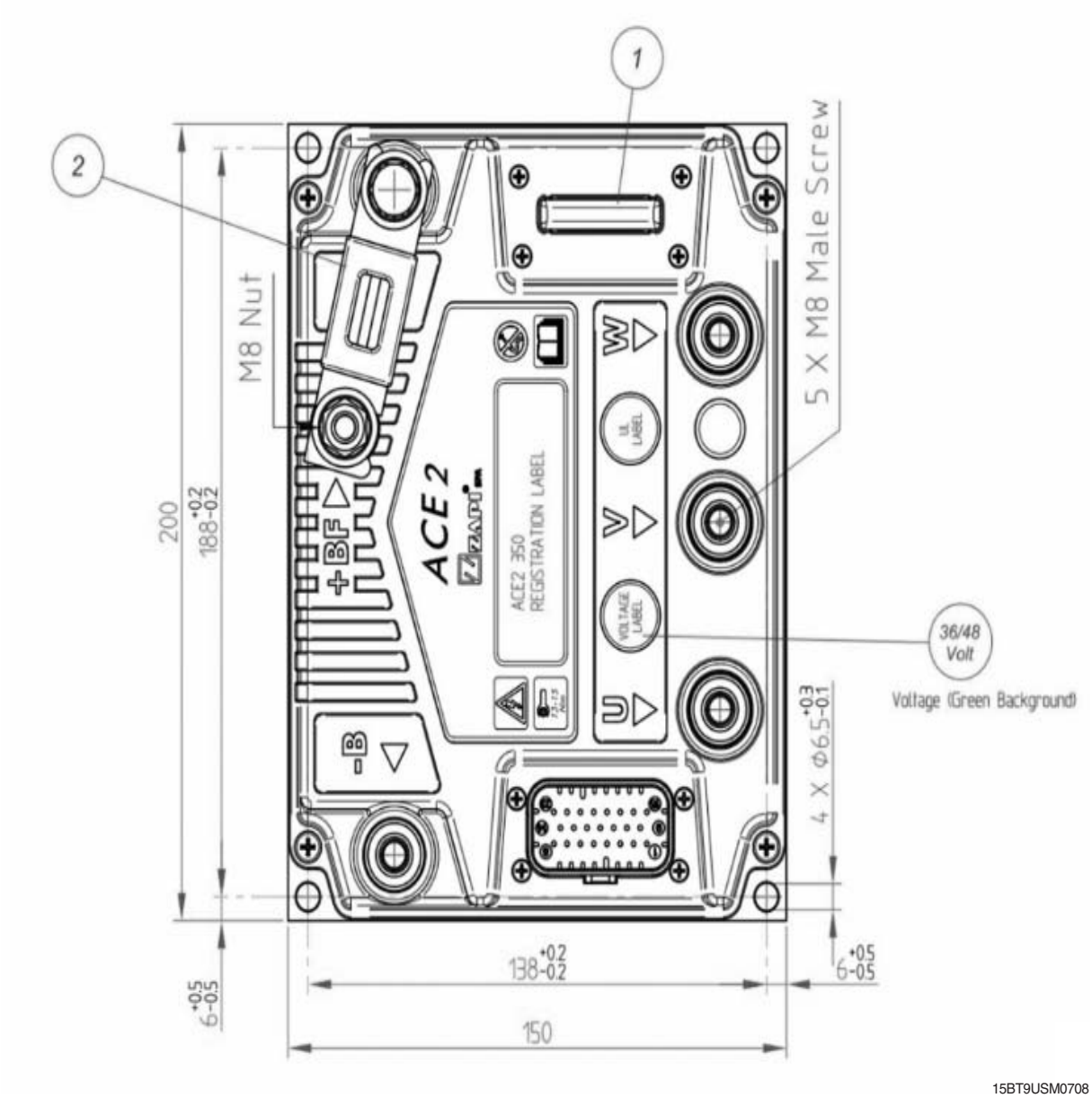
The standard specific gravity for this type of battery is 1.280±0.01(25°C) at full charge condition. If the electrolyte is decreased naturally while using, distilled water shall be replenished up to the specified level. (Never refill sulfuric acid).

Only when large quantity of electrolyte is lost due to spillage, etc., dilute sulfuric acid specified in gravity shall be added.

5. CONTROLLER SYSTEM

1) STRUCTURE

(1) Traction and Pump controller

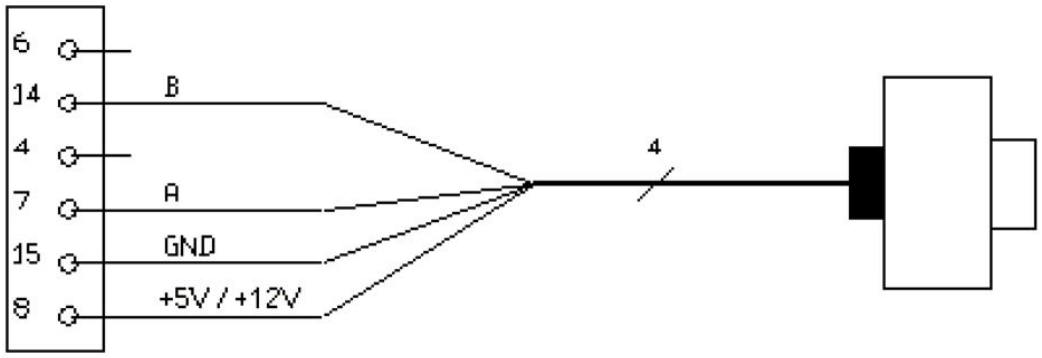


15BT9USM0708

(3) Connection of encoder(Traction and Pump)

ACE2 can handle different types of encoder. To control AC motor, it is necessary to install an incremental encoder with 2 phases shifted by 90°. The encoder supply can be 5 V or 12 V. For special applications it is possible to install incremental encoder with zero-position signal.

- A 8 : +5V/+12V : encoder positive power supply.
- A15 : GND : encoder negative supply.
- A 7 : ENC A : encoder phase A.
- A14 : ENC B : encoder phase B.



15BT9USM0713

4) Function configuration

Using the CONFIG MENU of the programming smart console, or using a display, the user can configure the following functions.

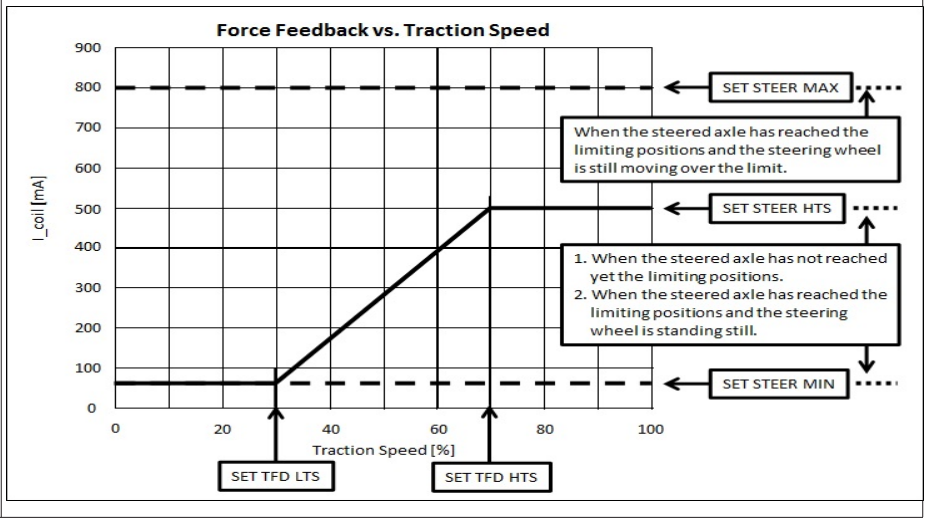
(1) Right traction inverter

① Set option

SET OPTIONS	DESCRIPTION
HOUR COUNTER	This option specifies the hour counter mode. It can be set one of two: - RUNNING: The counter registers travel time only - KEY ON: The counter registers when the "key" switch is closed
BATTERY CHECK	This option specifies the management of the low battery charge situation. There are four levels of intervention: - 0 : nothing happens; the battery charge level is evaluated but ignored, meaning that no action is taken when the battery runs out. - 1 : The BATTERY LOW alarm occurs when the battery level is evaluated to be lower or equal to 10% of the full charge. With the BATTERY LOW alarm, the control reduces the maximum speed down and it also reduces the maximum current down to 50% of the full current. - 2 : The BATTERY LOW alarm occurs when the battery level is evaluated to be lower or equal to 10% of the full charge. - 3 : The BATTERY LOW alarm occurs when the battery level is evaluated to be lower or equal to 10% of the full charge. With the BATTERY LOW alarm, the control reduces the maximum speed down.

(4) EPS inverter

① Parameter

Parameter	DESCRIPTION
POTI REVOLUTIONS	From 30 to 90. This setting specifies the number of revolutions of the steering wheel for a side to side rotation of the steered axle.
SET STEER MIN.	0 to 1000mA. The minimum Force Feedback value is set via SET STEER MIN. (Please refer to the Force Feedback vs. Traction Speed in the description of SET TFD HTS)
SET STEER MAN.	0 to 1000mA. The maximum Force Feedback value is set via SET STEER MAX. (Please refer to the Force Feedback vs. Traction Speed in the description of SET TFD HTS)
SET STEER HTS	0 to 1000mA. This parameter is used to handle the minimum Force Feedback value at HTS (High Traction Speed). (Please refer to the Force Feedback vs. Traction Speed in the description of SET TFD HTS)
PERCUSSION DUTY	The time delay before switching off the Force Feedback when the steered axle has reached the limiting position and the steering wheel has been released is set by this parameter. - LEVEL 0: 16 msec delay. - LEVEL 1: 32 msec delay. - LEVEL 2: 48 msec delay. - LEVEL 9: 160 msec delay.
1ST ANGLE GAIN	From 30 to 180 degrees. This parameter sets the maximum steered axle angle in the steering direction with FEEDBACK POT 1 value higher than 2.5V.
2ND ANGLE GAIN	From 30 to 180 degrees. This parameter sets the maximum steered axle angle in the steering direction with FEEDBACK POT 1 value lower than 2.5V.
SET TFD LTS	This parameter is used to handle the minimum Force Feedback value at LTS(Low Traction Speed). (Please refer to the Force Feedback vs. Traction Speed in the description of SET TFD HTS)
SET TFD HTS	This parameter is used to handle the minimum Force Feedback value at HTS(High Transation Speed). 

④ Left traction slave

Monitoring	Description
MEASURED SPEED	Motor speed measured through the encoder and expressed in the same unit of FREQUENCY (Hz).
CNA4	Status of the Brake oil SW Input on A4.
CNA5	Status of the Tilt leveling SW input A5.
CNA6	Status of the Load sensor potentiometer (analog signal) input A6.
CNA19	Status of the SBR SW Input on A19.
A13 TILT LEV 1	Status of the Auto tilt leveling 1 (Decreasing analog signal) input A13.

(5) Truck speed

The truck speed is shown in number. The unit can be km/h or mph according to the display setting (see 7-66 page).

(6) Hour meter

The number shows the hours worked. The letter present beside the hour meter number shows which hour meter is displayed.

– hK : the Key Hour shows the truck Key ON time;

– hT : the Traction Hour shows the Gate ON (driven) time of the traction motor.

– hP : the Pump Hour shows the Gate ON (driven) time of the pump motor.

(7) Wheel position and running direction

The arrow point is up when the truck is forward running and points down when the truck is reverse running. The arrow points the direction of the steering angle.

(8) Power mode

The letter H, N, or E, shows the power mode which is being used in the controller. The mode can be scrolled by pressing the  button sequentially. When a mode is selected, the related information will be sent via CAN-BUS to traction and pump controllers that will manage this data.

H (High) – corresponds to the highest performance

N (Normal) – corresponds to normal performance

E (Economic) – corresponds to economic performance

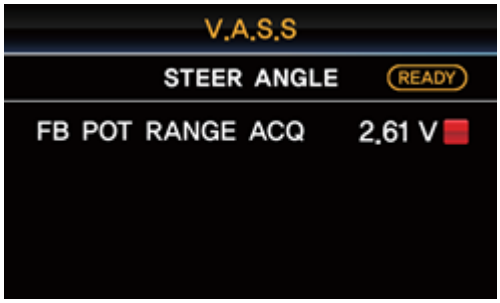
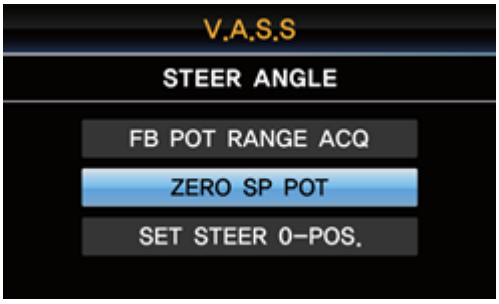
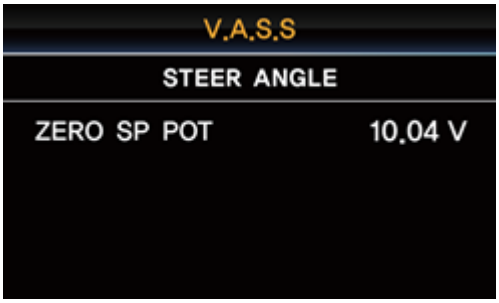
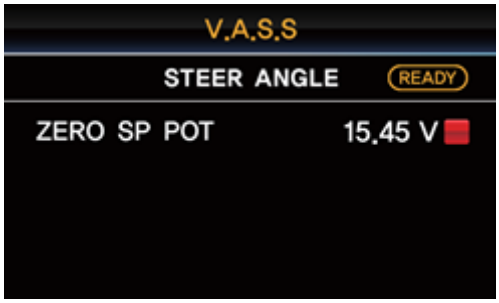
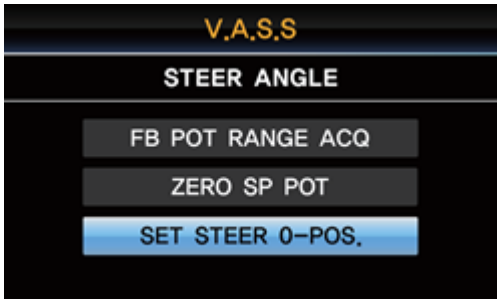
(9) BDI (battery's state of charge)

The battery's state of charge is shown by ten bars. Each bar represents the 10% of the battery charge. As the battery becomes discharged, the bars turn off progressively, one after another, in proportion to the value of the residual battery charge. When the residual battery charge is 20% or under, the bars displayed become red.

(10) Load weight (option)

The indicator shows the weight the machine carrying at load.

- Indicator range : 0~6375 kg

Step	Display	Description
4		1. If the voltage change no longer appears, press "ENTER" to save.
5		1. Access the lift sensor setting screen via "TRUCK M ENU → SETTING → V.A.S.S. → STEER ANGLE". 2. Enter the "ZERO SP POT" menu.
6		1. Press the "ENTER" button on the left screen to start the setting.
7		1. Position the steering wheel in the forward direction (steering knob at 8 o'clock) and press "ENTER" to save. 
8		1. Access the lift sensor setting screen via "TRUCK M ENU → S ETTING → V.A.S.S. → STEER ANGLE". 2. Enter the "SET STEER 0-POS." menu.

4) LCD FUNCTION

1	Current time	6	BDI (Battery Discharge Indicator)
2	Turtle mode	7	Hour meter
3	Truck speed pointer	8	Load weight (option)
4	Speed level	9	Wheel position and running direction
5	Truck speed	10	Power mode

(1) Current time

The number shows the current time according to the setting, which can be changed by display setting at page 7-58.

(2) Turtle mode

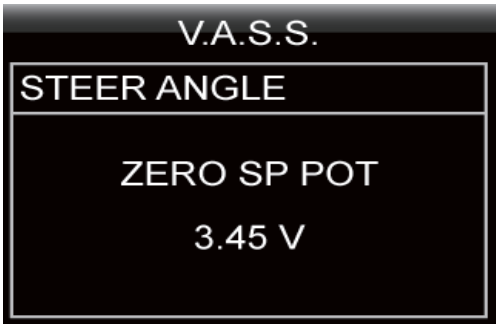
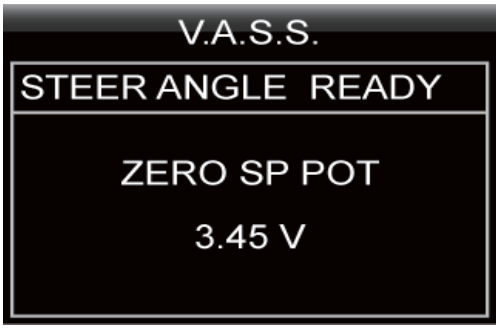
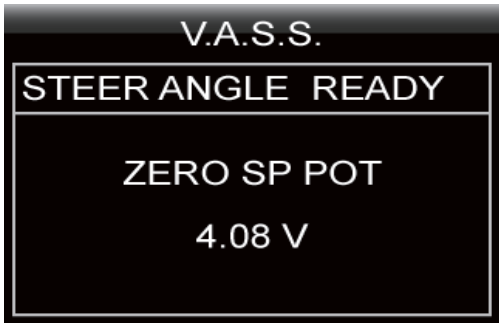
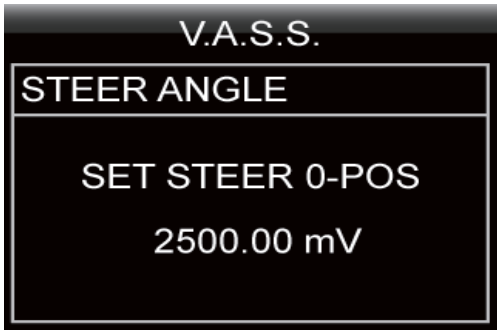
The turtle symbol is normally off. When this symbol appears, the turtle mode is activated regardless of the power mode of the truck to reduce the maximum speed to the set-point. This mode can be activated by pressing the button.

(3) Truck speed pointer

The speed of the truck is indicated with a pointer.

(4) Speed level

It indicates the speed level by 2 km.

Step	Display	Description
4		1. If the voltage change no longer appears, press "ENTER" to save. 2. You have to key-off and key-on the forklift after the save.
5		1. Access the steer angle sensor setting screen via "TRUCK M ENU → SETTING → V.A.S.S. → STEER ANGLE". 2. Press the "▼" DOWN button. 3. You can see the "ZERO SP POT" screen.
6		1. Press the "ENTER" button on the left screen to start the setting.
7		1. Position the steering wheel in the forward direction (steering knob at 8 o'clock) and press "ENTER" to save.  2. You have to key-off and key-on the forklift after the save.
8		1. Access the lsteer angle sensor setting screen via "TRUCK M ENU → S ETTING → V.A.S.S. → STEER ANGLE". 2. Press the "▼" DOWN button twice. 3. You can see the "SET STEER 0-POS" screen.

Code	Alarm	Master	Slave	Description
52	PUMP I=0 EVER	O		Cause: While truck is running, current value is 0 for more than 1 sec. Remedy: - Check the Main contactor - Check the controller
53	STBY I HIGH	O		Cause: In standby, the sensor detects a current value different from zero. Troubleshooting: The current sensor or the current feedback circuit is damaged. Replace the controller.
60	CAPACITOR CHARGE	O		Cause: When the key is switched on, the inverter tries to charge the power capacitors through the series of a PTC and a power resistance, checking if the capacitors are charged within a certain timeout. If the capacitor voltage results less than a certain percentage of the nominal battery voltage, the alarm is raised and the main contactor is not closed. Troubleshooting: - Check if an external load in parallel to the capacitor bank, which sinks current from the capacitors-charging circuit, thus preventing the caps from charging well. Check if a lamp or a dc/dc converter or an auxiliary load is placed in parallel to the capacitor bank. - The charging resistance or PTC may be broken. Insert a power resistance across line-contactor power terminals; if the alarm disappears, it means that the charging resistance is damaged. - The charging circuit has a failure or there is a problem in the power section. Replace the controller.
62	TH. PROTECTION	O		Cause: The temperature of the controller base plate is above 85 °C. The maximum current is proportionally decreased with the temperature excess from 85 °C up to 105 °C. At 105 °C the current is limited to 0 A. Troubleshooting: It is necessary to improve the controller cooling. To realize an adequate cooling in case of finned heat sink important factors are the air flux and the cooling-air temperature. If the thermal dissipation is realized by applying the controller base plate onto the truck frame, the important factors are the thickness of the frame and the planarity and roughness of its surface. If the alarm occurs when the controller is cold, the possible reasons are a thermal-sensor failure or a failure in the logic board. In the last case, it is necessary to replace the controller.

Code	Alarm	Master	Slave	Description
194	FORK SENS LOCK		O	Cause: TILT LEVELING sensor is frozen (stuck) more than 1.5sec at the correct direction movement. Troubleshooting: - Release the tilt leveling command. - Check if the tilt function is working correctly or if it is mechanically locked. - Check wirings and TILT LEVELING sensor.
195	FINGERTIPS ACQ		O	Cause: Fingertip calibration is not correct. Troubleshooting: - Acquire the correct value of parameters LIFT MAX, LIFT MIN, LOWER MAX, LOWER MIN, TILT UP MAX, TILT UP MIN, TILT DOWN MAX, TILT DOWN MIN, AUX1 UP MAX, AUX1 UP MIN, AUX1 DOWN MAX, AUX1 DOWN MIN, AUX2 UP MAX, AUX2 UP MIN, AUX2 DOWN MAX, AUX2 DOWN MIN
196	MOT.PHASE SH.	O		Cause: Short circuit between two motor phases. The hexadecimal value "XX" identifies the shorted phases: 36: U – V short circuit 37: U – W short circuit 38: V – W short circuit Troubleshooting: - Verify the motor phases connection on the motor side. - Verify the motor phases connection on the inverter side. - Check the motor power cables. - Replace the controller. - If the alarm does not disappear, the problem is in the motor. Replace it.
	LOAD SENS. ERROR		O	Cause: The signal of LOAD SENSOR input is not valid. Troubleshooting: - Acquire the correct value of parameters ADJ MIN LOAD, ADJ REF LOAD - Check the wirings.

Code	Alarm	Master	Slave	Description
229	HW FAULT EB.	O		Cause: At start-up, the hardware circuit dedicated to enable and disable the EB driver (output A18) is found to be faulty. The hexadecimal value “XX” facilitates Hyundai dealer debugging the problem. Troubleshooting: This type of fault is not related to external components. Replace the logic board.
	NO CAN WR MSG. XX		O	Cause CANbus communication does not work properly. The hexadecimal value “XX” identifies the faulty node. Troubleshooting - Verify the CANbus network (external issue). - Replace the logic board (internal issue).
230	LC COIL OPEN	O		Cause: This fault appears when no load is connected between the NLC output A16 and the positive voltage (for example +KEY). Troubleshooting: - Check the wiring, in order to verify if LC coil is connected to the right connector pin and if it is not interrupted. - If the alarm is still present, than the problem is inside the logic board; replace it.
	SOFTWARE ERROR		O	Cause: A software issue has been detected. This alarm code is reserved for factory tests during the development of the application.
232	CONT. DRV. EV	O		Cause: AUX valve driver is not able to drive the load. Troubleshooting: The device or its driving circuit is damaged. Replace the controller.
233	POWERMOS SHORTED	O		Cause: The DC-link voltage drops to zero when a high-side or low-side MOSFET is turned on. Troubleshooting: - Check that motor phases are correctly connected. - Check that there is no dispersion to ground for every motor phases. - In case the problem is not solved, replace the controller.
234	DRV. SHOR. EV	O		Cause: AUX valve driver is shorted. Troubleshooting: Check if there is a short circuit or a low impedance path between the negative terminal of the coils and -B.

Code	Alarm	Master	Slave	Description
98	INPUT ERROR #2	O	O	Cause: The revolution of the sensor at the steering wheel is split in 4 quadrants: 1ST: 0 to 90 degrees 2ND: 90 to 180 degrees 3RD: 180 to 270 degrees 4TH: 270 to 360 degrees This alarm occurs in case the configuration of the two outputs jumps to a NOT ADIACENT quadrant. In practice, when the configuration of the two outputs: - Is in the 1ST quadrant, shift to 3RD quadrant is not admitted - Is in the 2ND quadrant, shift to 4TH quadrant is not admitted - Is in the 3RD quadrant, shift to 1ST quadrant is not admitted - Is in the 4TH quadrant, shift to 2ND quadrant is not admitted Single event raises the alarm. Troubleshooting: Check the connections of the analog sensor at the steering wheel (CNA #20 and CNA #17). Disturb or interference on the sensor.
205	SELF CHECK #2	O	O	Cause: This warning occurs when the SELFCHECKING routine #2 is in progress and the check result has not been determined yet. This selfchecking routine carries out an embedded monitoring of the encoder and of the current in the motor when commanded to move at a fixed speed of 25Hz. We suggest to launch SELFCHECK #2 with the steered wheel lifted up. The goal of this selftest is to check the functionality of encoder and mechanical components (transmission, sensor bearings, gears, pinion). After the gathered data have been processed and an unexpected result occurred, this warning message will turn in an alarm information. Troubleshooting: Recycle the key to exit the SELFCHECK #2 warning.
206	SELF CHECK #1	O	O	Cause: This warning occurs when the SELFCHECKING routine #1 is in progress and the check result has not been determined yet. This selfchecking routine carries out a voltammeter measure of the motor resistances between phase V and W (Rvw) and between phase W and U (Rwu) by injecting a fixed 14.7Adc current (sqrt(3/2) * ID RMS MAX). The goal of this selftest is to check the functionality of motor and three phase power bridge. After the gathered data have been processed and an unexpected result occurred, this warning message will turn in an alarm information. Troubleshooting: Recycle the key to exit the SELFCHECK #1 warning.

Code	Alarm	Master	Slave	Description
254	NO SP REFRESH	O	O	Cause: This alarm is alive only when the sensor at the steering wheel is of PWM type (not analog). Then, in case at least one output between CPOC 1 and CPOC 2 (CNA #20 and CNA #17) has a PWM period shorter than 4msec or longer than 6msec confirmed for 92msec long, this alarm occurs (NO SP REFRES 02 and NO SP REFRES 04). It occurs also when at least one between CPOC 1 and CPOC 2 does not switch longer than 12msec (2 period lost) with alarm NO SP REFRES20 (i.e. 20h=32dec). Troubleshooting: Check the sensor at the steering wheel and the wiring from the steering wheel to the controller.

8. BATTERY CHARGER

This explains basic information related to charger to help you easily understand and use it. This includes the contents from the way to install a charger to tips for emergency situations. This is focused on practices aiming to be usefully utilized in the field.

1) BASIC INFORMATION

(1) What is charger

Charger is a device which makes a battery accept D.C electricity under optimal condition as it transforms A.C provided from external source of electricity.

The charger is a constant-current and constant-voltage way, SCR type charger that it has advantages as follows

① Even though A.C input voltage fluctuates within 10% of rated voltage (220/380/410/440V), the current and voltage provided to the battery are stable.

② As minimizing the increase of temperature while charging a battery, it minimizes the stress on the battery.

③ The noisy of charger is minimal but the charging efficiency is very high.

④ It prevents from under charging and overcharging.

Therefore, it helps the battery to maintain its performance for longer time and to prolong the life of the battery.

(2) Notice on caring chargers

① If any abnormal status is found while using a charger, immediately stop using and check the charger. If it is impossible to take an appropriate measure for yourself, please apply for A/S.

② While charging, hydrogen and oxygen gas is produced. Use or approach of fire should be strictly prohibited.

③ Keep clean to prevent from sneak current and attack on the interface and surroundings of the battery.

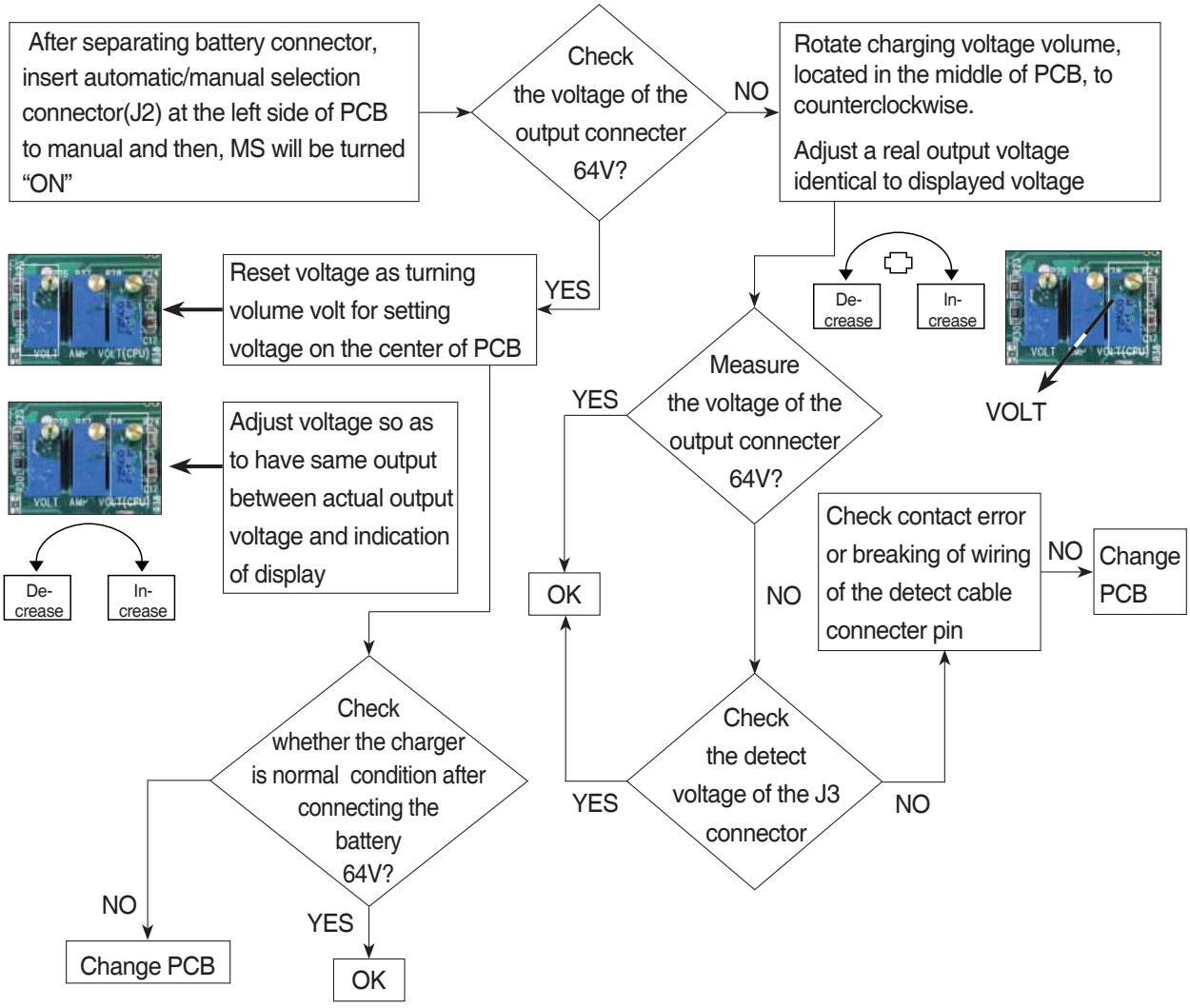
④ Check the electrolyte of the battery every week and provide distilled water immediately if it is required. (Electrolyte has to be provided between 10~12 ㎜ level on the positive plate inside storage battery)

⑤ If battery liquid temperature becomes over 55°C, charging should be stopped.
If it is continued,
- the appearance is transformed
- and metal area can be attacked as electrolyte overflows

⑥ Electric forklift truck using battery should be charged as soon as the charging lamp is on while driving. As batteries are internally discharged naturally if they are deposed for a long time, charge them once or twice a month to prevent from reducing the lives of batteries.

⑦ When a green sign is on among charging status indication lamps, please notify that it is not converted as equalized charge for stabilization of charging status.

③ Charger TRIP is occurred after abnormality lamp is on.
In case error code is "O.V" → Over-voltage output / Set at 66V (In case of BATT 48V)
34V (In case of BATT 24V)
108V (In case of BATT 80V)



③ Ensure that the actual battery type matches the specified battery in the forklift.
If the unsuitable battery is used, it can cause poor performance or damage to the truck during operation.

④ The battery pack is shipped with a charge of 30% to 50%, so charge it fully before use.

⑤ Do not install or connect except for professional technicians who have been sufficiently trained in handling methods and risks.

⑥ Please contact your dealer for battery module replacement. Incorrect replacement operation may cause battery damage.

⑦ Do not reverse or drop the battery pack.

⑸ **Maintenance (◆ Warning - Discharge, Charge)**

① Do not use the battery current that exceeds twice the rated capacity.
The battery Internal damage caused by abnormal use may cause an explosion.

② Charge the battery pack with a charger dedicated to the lithium-ion battery. If use different type charger will not charge enough, Battery may leak, short circuit.

③ Make sure that the lithium battery pack temperature is not above 55℃during charging. A rise in temperature causes fire and explosion. Take extra care when charging during the summer and under the direct sunlight.

④ Do not change the maximum voltage of the charger without consulting the battery manufacturer. An excessive high input voltage will overcharge the battery, increasing the temperature and shortening battery life.

⑤ Don't charge in areas with poor ventilation, high temperature and high humidity, rainy areas, and corrosive gases.

⑥ Do not use firearm (lighter, cigarette, grinder, welding flame, etc.) during charging. It causes an explosion.

⑦ Do not overcharge. The battery can overheat. It can be dangerous and shorten its life.

⑧ Keep the battery below 55℃. It will shorten the life cycle when used at high temperatures. If the battery exceeds 55℃ during charging, the charge must be stopped.

⑨ Make sure that there is sufficient ventilation when charging indoors. Even if Battery is stored indoors, enough ventilation is needed.

⑩ Do not charge the battery below -25℃. Because it can be increased battery internal resistance at low temperature. Low temperature will reduce the efficiency of the charge and require adjustment of the charge volume. Therefore, a charging room with a temperature of 5 to 10℃ required at low temperatures.

⑹ **Environment of use (◇ Caution - Cleaning, ◆ Warning - Organic solvent)**

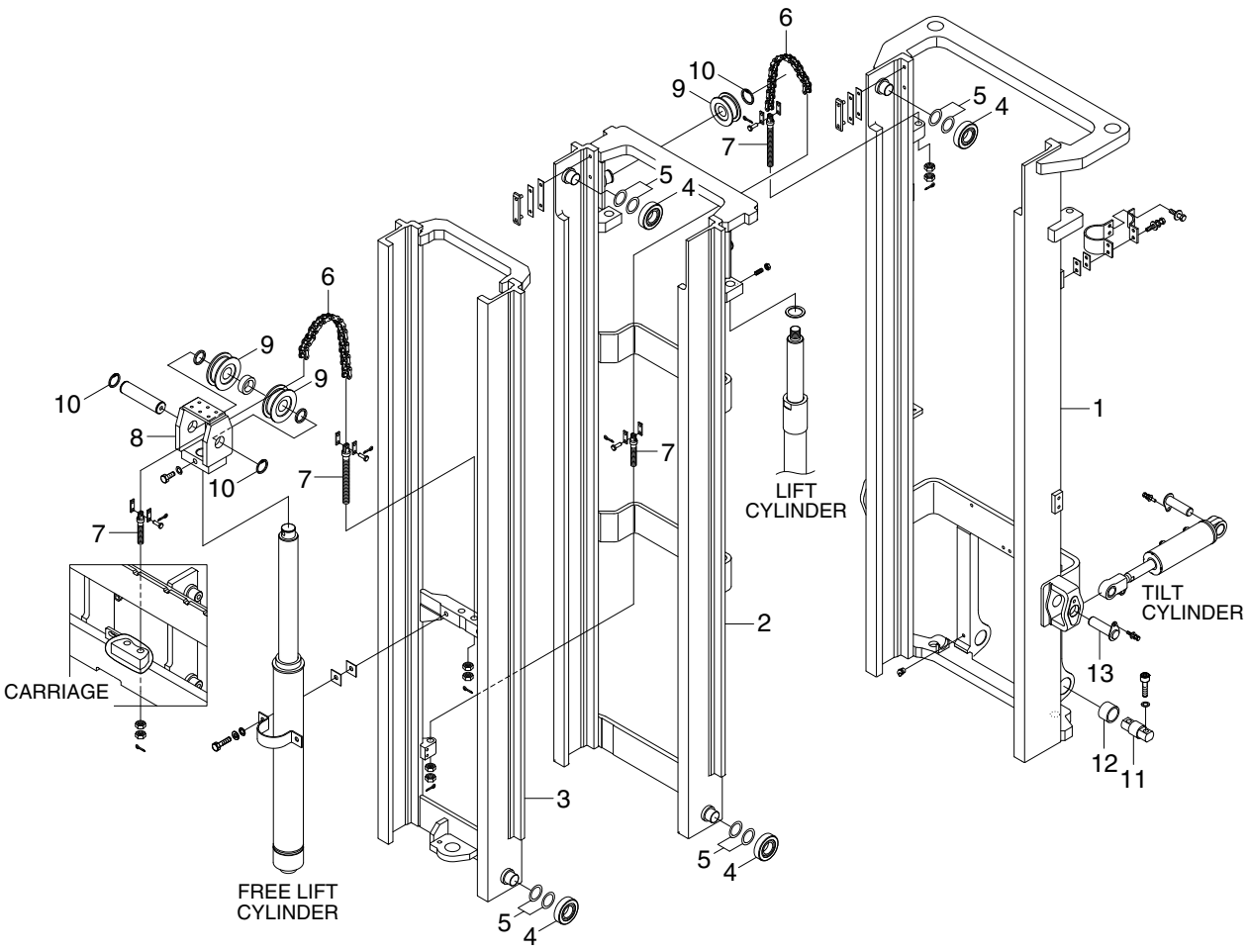
① Contaminants and debris on the top or connections of the battery may cause a short circuit and fire. Clean with a wet cloth and keep the area clean and dry.

② Do not use organic solvents or chemicals such as benzene, thinner and gasoline for battery cleaning. It may cause damage to the battery.

③ Do not flush the battery. It may causes damage.

④ If it is not used for a long time, keep it in a well ventilated and fire-free place to prevent explosion.

2. 3 STAGE MAST(TF MAST)



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1	Outer mast	6	Lift chain	11	Mast mounting pin
2	Middle mast	7	Anchor bolt	12	Bushing
3	Inner mast	8	Sheave bracket	13	Pin
4	Roller	9	Sheave		
5	Shim (0.5, 1.0t)	10	Retaining ring		