SECTION 7 ELECTRICAL SYSTEM

GROUP 1 COMPONENT LOCATION
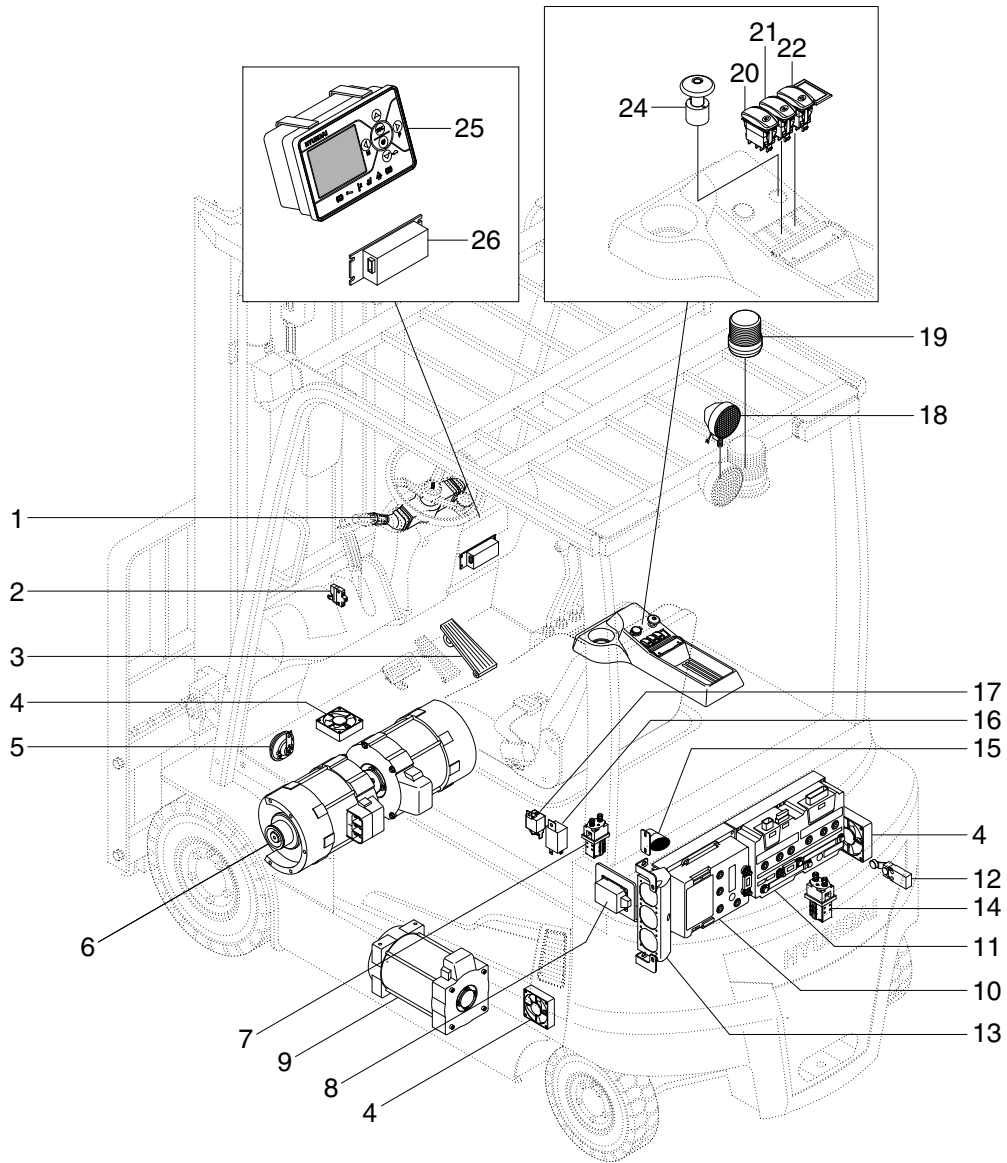
22B9FEL02

1 Combination switch	10 Pump controller	19 Beacon lamp (opt)
2 Parking switch	11 Traction controller	20 Head lamp switch (opt)
3 Accelerator assy	12 SBR switch assy (opt)	21 Rear work lamp switch (opt)
4 Fan assy	13 Fan assy	22 Beacon switch (opt)
5 High horn	14 Contactor-SW200B	24 Emergency switch assy
6 Drive motor	15 Back up alarm	25 Display
7 Contactor-SW80B	16 Flasher unit assy	26 DC-DC converter
8 Fuse box assy	17 Relay	
9 Pump motor	18 Rear work lamp (opt)	
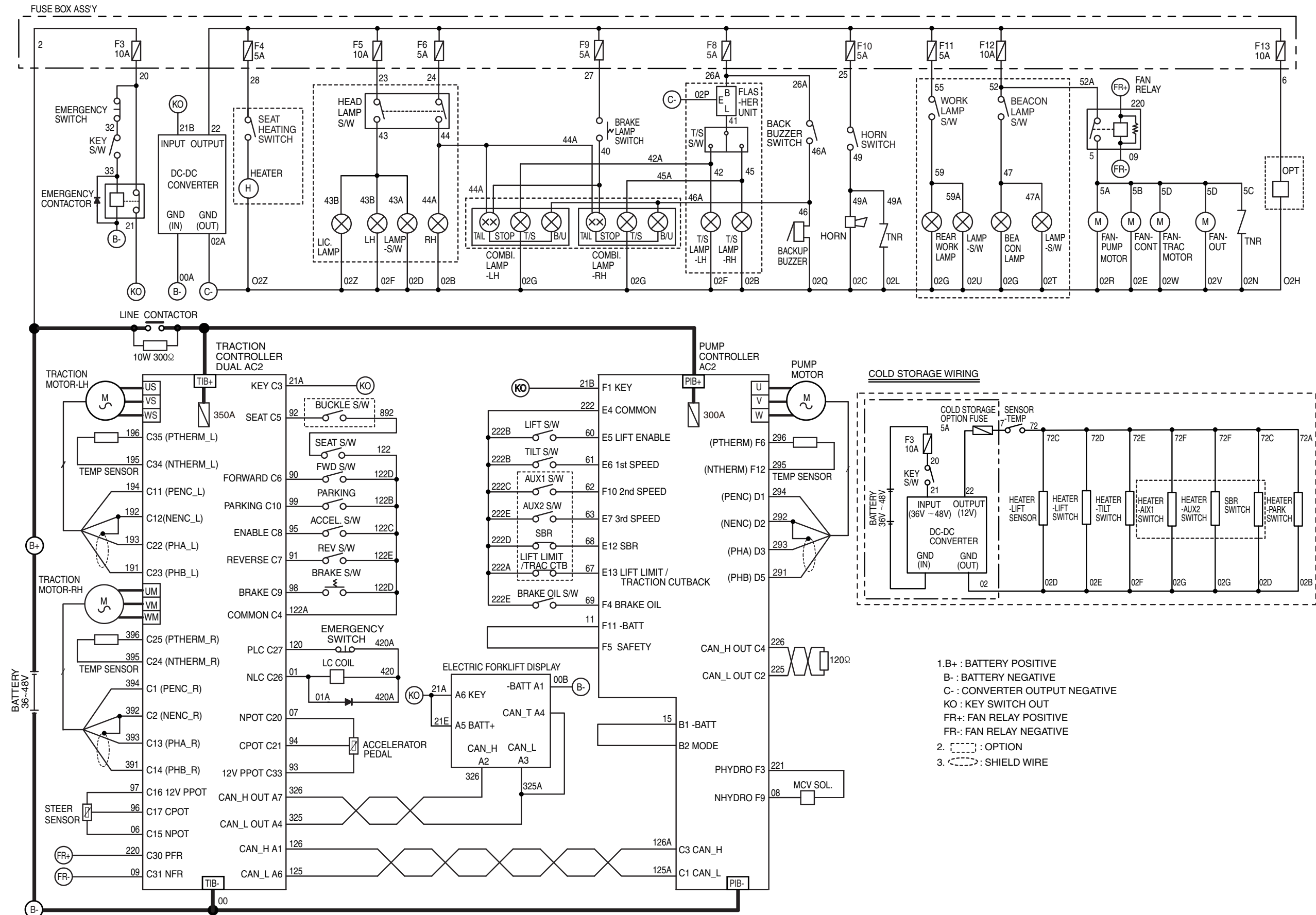
GROUP 3 ELECTRIC COMPONENTS

1. FUNCTIONS OF BATTERY FORKLIFT TRUCK AND ELECTRIC COMPONENTS

The major functions of forklift truck can be divided into DRIVING FUNCTION and LOADING and UNLOADING FUNCTION.

All the components that work DRIVING and LOADING & UNLOADING functions are driven by AC motors. And as the BATTERY works as power source of these motors, a charging device is needed.

To drive the fork lift truck, a DRIVING CONTROL SYSTEM and some electric components such as direction change lever (forward/reverse section switch) and accelerator are required to select the driving direction and to control the speed of driving motor.

The CONTROL SYSTEM includes some protective circuits that protect the equipment and components from malfunctioning.

A MONITORING SYSTEM is installed in the monitor panel, which monitors the equipment and working condition, and let the operator take proper action. For the monitoring system, there are many sensors such as current sensors, potentiometer sensors, and temperature sensors. The HYUNDAI Battery forklift trucks are equipped with the most advanced DRIVING CONTROL SYSTEM currently available world-widely. The operator friendliness features enable him to set the truck conditions properly according to each working circumstance easily on his seat, and the SELF-DIAGNOSTIC function displays current status of truck in working.

2. BATTERY

1) STRUCTURE
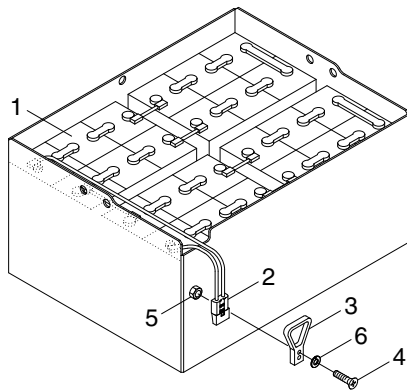
22/25B-9F
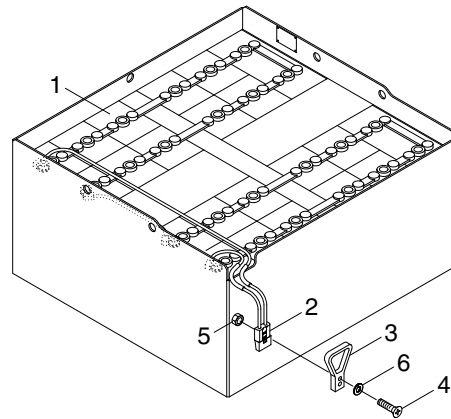
30B-9F

22B9FEL03

|			
1	Cell	4	Round head screw
2	Battery connector	5	Weld nut
3	Handle	6	Spring washer

2) GENERAL

As in the battery forklift, the battery is an energy source, the handling of the battery is very important.

The life and performance of the battery greatly depend on the ordinary handling and maintenance. Therefore, be sure to check and maintain the battery so that it may be kept best.

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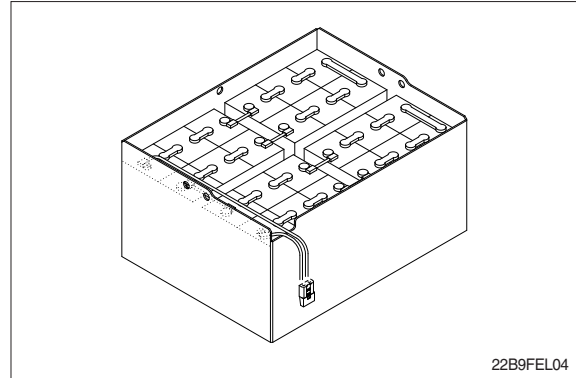
3) SPECIFICATION AND SERVICE DATA

Item	Unit	22/25B-9F	30B-9F
Type	–	Lead Acid	←
Rated voltage	V	48	←
Capacity	AH/hr	600/5	660/5
Electrolyte	–	WET	←
Dimension (L×W×H) (opt)	mm	1030×796×533 (1066×796×537)	1030×990×533 (1066×990×537)
Connector	–	SB 350 or SR 350	
Weight (Min / Max)	kg	970/1300	1040/1495

Fully charged specific gravity	1.280 (25°C)
End of discharge specific gravity	1.120 (25°C)
Discharge end voltage	48V
Electrolyte	Refined dilute sulfuric
Replenishment fluid	Refined (pure) water
Insulation resistance	1MΩ

4) SAFETY PRECAUTIONS

(1) When sulfuric acid contact with skin

For acid contact with skin, eye or clothing, flush with water immediately. If swallowed, drink a large amount of water or milk. Seek medical attention immediately. When handling acid, always wear eye goggles or a face shield and rubber gloves.

(2) Strict prohibition of fire and ventilation

Since batteries generate explosive hydrogen gas, no fire should be drawn near. Before the battery charging, keep the battery cover open and check the ventilation status. Charging in an enclosed space can cause an explosion.

(3) Never place metallic articles on the batteries

If done so, it may cause "short circuit" accidents (dangerous especially while charging) (Especially dangerous while charging).
Sparks will be generated which is equally dangerous as open fires.

(4) Handling of charger

When connecting or disconnecting a battery from a charger or attempting maintenance, make sure switches are all off. Ensure that the charger and the battery are matched. If a 300Ah battery is used with a charger designed to charge a 500Ah battery, it will severely overcharge the battery.

5) OPERATION PRECAUTIONS

(1) Avoid over-discharge

If over-discharged, it will be difficult to restore the batteries to the original state by recharge. In order to maintain the batteries in use for long period of time, it is recommended to use the batteries with discharge amount not exceeding 80% of the rated capacity. Further care should be taken for preventing the unit cell voltage from falling below 1.5V.

(2) Avoid over-charge

If overcharged, the rise in battery temperature will become excessive, resulting in deterioration of plates and other parts and markedly shortening of battery life.

(3) Avoid excessive elevation of temperature

Be sure to open the cover of battery housing tray before charging. If there is a possibility of temperature to exceed 55°C, discontinue the charge operation temporarily, or reduce the charge current.

6) CHECKING

(1) Unpacking

Electric traction storage batteries (herein after refer to as "batteries") are delivered to customers in dry-charged condition. At unpacking, check whether the batteries and accessories have been damaged. If there are observed defects, you should notify the condition to our branch office or agent. Never remove the sealing plug until the battery is put into service.

(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 $0.1C \times 5$ 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 $1.280 \pm 0.01(25°C)$ 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.

④ **Normal charge**

Charge the discharged batteries as quickly as possible. The temperature of electrolyte before starting the charging operation shall preferably be below 45°C, and the temperature during the charge should be maintained at no higher than 55°C. (Under any unavoidable situations, it should never be above 55°C). Methods of charging vary in precise meaning with the types of chargers used. A standard charging method is described hereunder. (If a special method is mentioned to be adopted, follow that instruction).

a. **Charging by modified constant voltage automatic charger**

There is almost automatic charger today which completes the charging just only connecting the plug between battery and charger without outer operating timer. But if your charger has it, after setting the timer for 3-4 hours and turn on the charger and the charger is left as it is, then the charge will be made automatically. In principle, regardless of the amount of previous discharge, it is not required to alter the setting of timer time. The recommendable current value of this type of charger is "5 hour rate current $\times 1.0 \sim 1.5$" at the start of charging, and at the final stage it is "5 hour rate current $\times 0.15 \sim 0.25$". Normally the charge is terminated within 8~12 hours automatically.

b. **Charging by constant current constant voltage automatic charger**

After a lapse of specified charging time after the switch is turned on, the charge will be completed by turning off the switch. The charging time can be calculated by the following formula.

$$\text{Charging time} = \frac{\text{Amount of previous discharge(AH)}}{\text{Capacity of charger(A)}} + 2 \sim 3(H)$$

When the amount of previous discharge is not known, use the 5 hour rate rated capacity of the batteries. At immediately after charging, the charge current is allowed up to 3 times 5 hour rate current. For charger provided with a timer, the charge will terminate automatically if the timer is set at the specified time according to the operation manual.

c. **Charging by constant current charger**

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

⑤ **Equalizing charge**

When large number of cells are used in a set of battery, the voltage and specific gravity of respective cells tend to become unequal, resulting in necessity of charging all the cells at an appropriate time in order to equalize them. This is called equalizing charge. Normally the equalizing charge should be carried out once every month. The methods are in normal type charger, extend the charge for 5 more hours after full charge at the final stage current, and in automatic charger which is in most cases provided with timer, extend the time setting for 3-6 more hours.

⑥ **Replenishment of distilled water**

Only the water content of electrolyte is decreased due to electrolysis of distilled water during charge and natural evaporation. If a battery used with the electrolyte decreased excessively, plates will deteriorate resulting in markedly shortening of battery life. Be sure to check the electrolyte level once every week. If the electrolyte level is lowered, replenish distilled water up to the specified level. In this case, never attempt to replenish sulfuric acid or tap water. Use only distilled water for battery replenishment. If the amount of water required for weekly addition to a unit cell for 100AH of battery capacity is in excess of 45 cc, it is assumed that the cell is receiving overcharge. Accordingly, be sure to reduce slightly the daily charge amount. Under the normal conditions, the addition of water per week is 45 cc or less. Incidentally, distilled water replenishment should be made before charging to the content of minimum level. (For the purpose of uniform stirring of electrolyte by charging).

If the electrolyte level is improper after completion of charging, you may topping up the electrolyte level to the maximum level.

a. **Determination of replenishment time and methods (cell with ONE TOUCH CAP)**

Confirm the electrolyte level by looking at the float in the ONE TOUCH CAP. If too low as shown in figure, replenish distilled water. Replenishment shall be performed after opening the cover of the plug using syringe and jug. When refilling is completed, close each cover completely until "click" sound is heard.

Minimum Level

Cell cover

Float

B153EL041

Maximum Level

Cell cover

Float

B153EL042
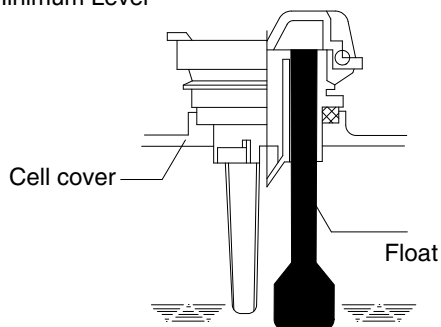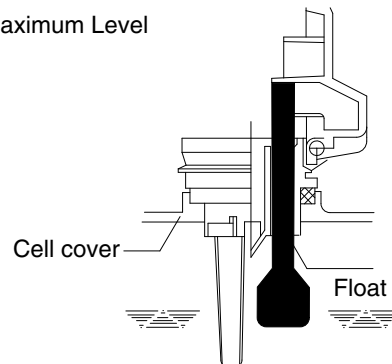
⑦ **Cleaning**

If electrolyte spills or the cells are polluted with dust or stains, it will cause generation of leak current. Wipe off dust and stains with moist cloth and clean in such a manner that the cells are kept in dry condition. In the case of plastic containers or covers, never use such organic solvents as paint thinner and gasoline. If used, the plastic containers or covers may suffer cracking. If you are forced to use them, be sure to use white kerosene.

⑧ **Notice on charging**

The charging area must be well ventilated to facilitate exhaust of gas generated from the battery during charging. Charge the battery in an area free from iron working, welding, etc. Further the battery generates hydrogen, oxygen, acid mist and on rare occasions, hydrogen sulfide during charging depending on the case. Special care may be required in the case of equipment and objects near the battery that may contaminated or damaged. Do not pull out the charging plug during charging, as it will cause sparks. Since hydrogen gas generated during charging may remain in the area surrounding the battery after charging, never bring fire or flame close to this area. In case of counter-balance type vehicles, open the battery cover before charging.

⑨ **Repair of failure cell**

a. To remove a cell from the circuit or battery from steel tray, it is first necessary that the intercell connector be removed.

b. Before performing any repairs, you must open one-touch caps for gas purging of all cells. After you have finished that, must remove connector covers and on-touch caps from failure cell including surrounding cells. All vent holes of cells removed of one-touch caps must cover by four layers of water dampened cloth and then proceed with repairs. Using an acid syringe withdraw sufficient electrolyte from failure cell to reduce the liquid levels until minimum level indicating of one touch caps.

c. The safe and most efficient method of removing a connector from failure cell as well as all surrounding cells is with hand or electric drill (25 mm).

⚠ **You must make sure to clear of explosive hydrogen gas in the cells before repairs. Be careful not to drill to far into the cell and damage the unit. During drilling operation make sure lead curls produced do not contact opposite cell poles and cause a spark.**

d. Upon completion of drilling the intercell connectors, can be lifted off.

e. Lifted off the failure cell from circuit after removing of intercell connector.

f. Installing new cell and connector.

g. With surfaces properly cleaned and neutralized, position the connectors.

h. Place damp rags around each lead head. Hold tip of the welder in center of post move welder completely around top of post and out to the area where the post meets the connector. Move welder back to center of post and add molten lead until area is filled to top of connector. Again, move welder completely around area, with tip on molten lead. If you have jig for welding connector, have easier and better welding work.

i. When replacing electrolyte in a repaired cell, use sulphuric acid of the same specific gravity that is found in the balance of the battery.

j. Finally, rejoin connector covers and one-touch caps to the cells.

⑩ Summary of daily maintenance

  a. Avoid overcharge. After discharge, charge the batteries immediately. The standard frequency of equalizing charge is more than once every month.
  b. Be sure to check the electrolyte level once every week. If found decreased, replenish distilled water up to the specified level.
  c. The top surface of battery cells should be kept clean and dry.
  d. Be sure to keep open the cover of battery housing tray during charge.
  e. Never draw near open fires such as lighted cigarettes or burning matches during charge.

(3) Others

① Storage of batteries

When batteries are stored, keep them away from room heaters or other heat generating sources. Clean, cool and dry place where no direct sunlight is suited for battery storage. Before putting into storage, it is important to charge the batteries and keep the electrolyte level at the specified level.

When the temperature in storage location is higher than 20°C, check the specific gravity once a month, and when lower than 0°C, check it once every two months. If the measurements show values lower than 1.230 (20°C), it is required to charge the battery in accordance with the method described in NORMAL CHARGE.

② Maintenance record

It is recommended to keep maintenance record in order to know the operational conditions of batteries. Daily charge and discharge, equalizing charge requirements, and distilled water replenishment requirements can be clarified at a glance. Measurements of specific gravity and temperatures once every two to four months after equalizing charge and maintenance thereof will serve for battery health diagnosis.

③ Electrolyte temperature

The operating temperature range of batteries is -10~45°C (temperature of electrolyte). If the batteries are exposed to cold atmosphere in discharged condition, the electrolyte may freeze, and in extreme cases, the capacity will be decreased, but, if not frozen, no adverse effects will be exerted.

Contrarily if the temperature is high, especially if used at above 55°C, the battery life will be considerably shortened. Care must be taken so that the temperature during charge will be maintained at 55°C or lower. Even under unavoidable circumstances it should not exceed 55°C.

7) TROUBLESHOOTING

Nature of trouble	Symptoms	Causes	Corrective Action
Deformation	· Deformation of container. Lid or one touch cap	· Excessive temperature rising or external impact	· Replace
Breakage	· Electrolyte leakage according to breakage of container, lid or one touch cap · Termination of connector or pole post etc.	· External impact, improper handling, excessive vibration · Excessive temperature rising or external impact	· Replace or install a new one · Replace
Sulfate	· Specific gravity drops and capacity is decreased. · Charge voltage rises rapidly with immature gassing in earlier stage but specific gravity does not rise and charge can't be carried out.	· When left in state of discharge or left long without equalizing charge. · Insufficient charge. · When electrolyte is so decreased that plate is deposed. · When concentration of electrolyte rises. · When impurities are mixed in electrolyte.	· Need equalizing charge · Need equalizing charge · Need equalizing charge · Adjust specific gravity · Replace electrolyte
Decrease and falling of specific gravity	· May be easily detected by measurement of the specific gravity.	· Rise of temperature due to such trouble. · When left long period without refilling of water. · Short circuit.	· Replace · Refill water in regular period · Replace
Rise of specific gravity	· May be easily detected by measurement of the specific gravity.	· Diluted sulfuric acid is used in refilling. · When the electrolyte level excessively drops.	· Adjust specific gravity after full charge. · Refill distilled water.
Mixing of impurities	· Decrease of capacity. · Drop of charge and discharge voltage. · Odor of generated gas and coloring of the electrolyte.	· Metals such as iron, copper nickel and manganese. · Impurities such as sea water, chloric acid, nitric acid etc. · Filling of impure water.	· Under a fully discharged condition, pour out the electrolyte. Then pour in an acid of the specific gravity higher by 0.03~0.05 than that of the drained acid. Charge fully and adjust the specific gravity to the specified value.

3. DRIVE MOTOR

1) STRUCTURE
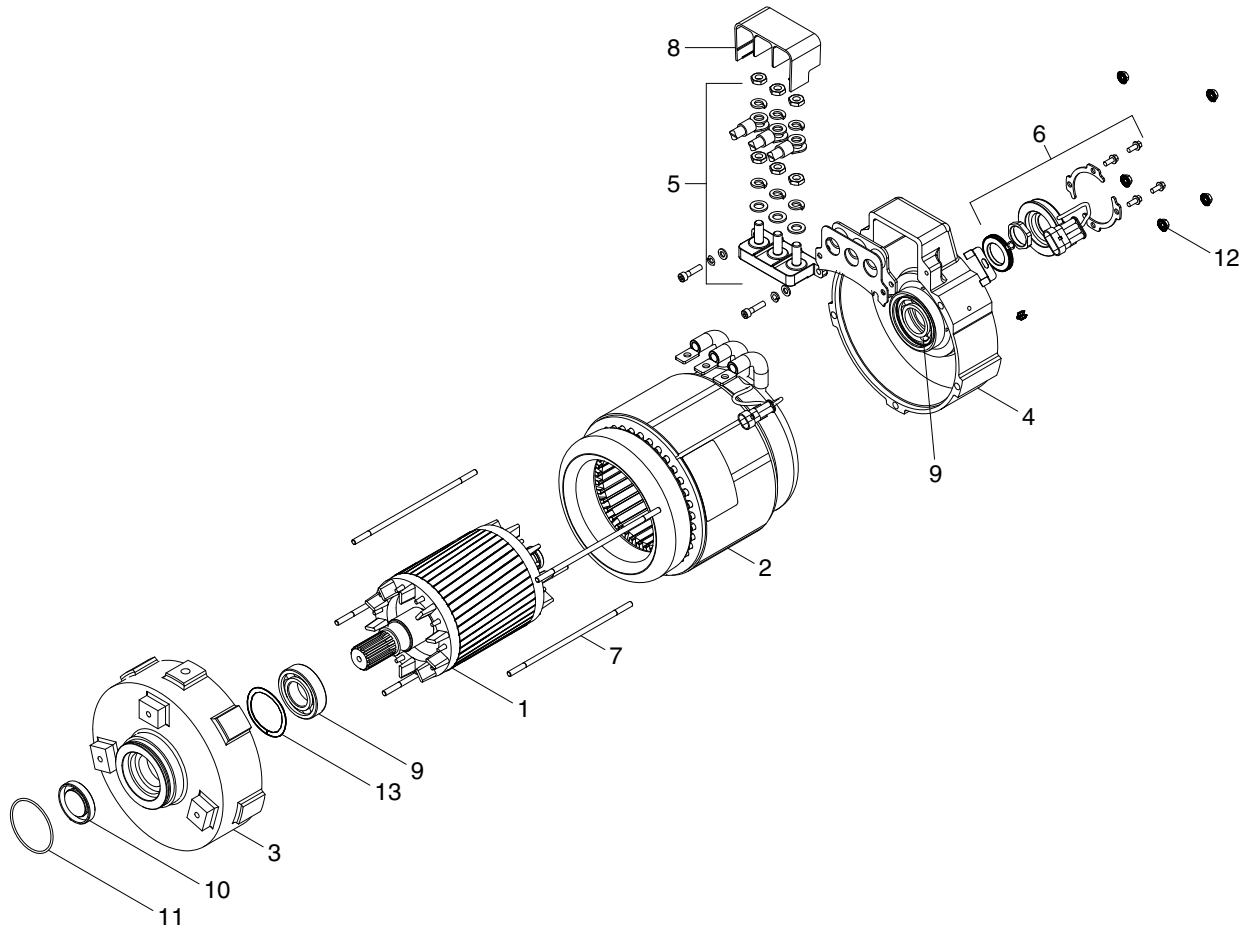
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1	Rotor assy	6	Speed sensor kit	11	O-ring
2	Stator assy	7	Stud bolt	12	Flange nut
3	Endbell De	8	Terminal protector	13	Wave washer
4	Endbell	9	Bearing		
5	Terminal A block	10	Oil seal		

2) SPECIFICATION

Item	Unit	Specification
Type	-	AMDN4002
Rated voltage	Vac	32
Rated output	kW	4.7×2
Insulation	-	Class F

3) INTERNAL INVOLUTE SPLINE DATA

Item	Unit	Specification
No of teeth	EA	16
Pressure angle	mm	30
Pitch diameter	Degree	ø 28
Major diameter	mm	ø 29.5
Minor diameter	mm	ø 26.3
Over pin diameter (min)	mm	ø 32.683 (pin dia 3)
Over pin diameter (max)	mm	ø 32. 728 (pin dia 3)
Thickness of tooth	mm	3.127

4) MAINTENANCE INSTRUCTION

※ Before starting the maintenance please disconnect the power supply.

(1) Ball bearing

Both ball bearing are maintenance free. Should it be necessary to remove the bearings in case of repair, they should be replaced. In any case the sealing parts (shaft sealing ring etc.) have to be replaced.

If a bearing which is to be replaced has only one sealing lip, this should be greased with quality bearing grease.

After approximately 10,000 operating hours the bearings have to be replaced.

5) INSPECTION

(1) Rotor assembly inspection

Rotor should always be cleaned with compressed air.

If the dirt will not come off lightly wipe off with piece of cotton or soft cloth wetted with gasoline.

Rotor out diameter : ⌀123.1± 0.05

Tool : Vernier calipers and standard tool

18BR9EL41

(2) Stator assembly inspection

Stator should always be cleaned with compressed air.

If the dirt will not come off lightly wipe off with piece of cotton or soft cloth wetted with gasoline, using care not to damage the coil insulation.

Use mmΩ tester and check for two power line of stator repeatedly (U-V, V-W, W-U).

At that time resistance is around 3.3 mmΩ.
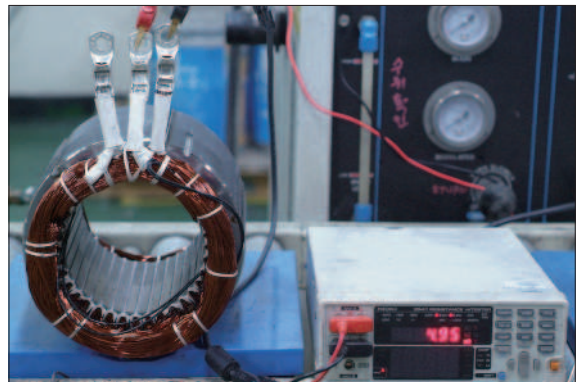
18BR9EL42

Insulation test

Use insulation tester (1000 Vac, Min. 10 MΩ) and measure as a picture.

If the insulation is defective, replace with new parts.
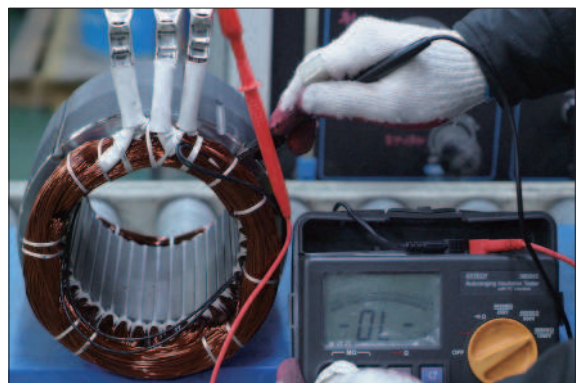
18BR9EL43

6) DISASSEMBLY FOR AC MOTOR

(1) Before disassembling motor, remove terminal protector from the motor and separate thermistor and speed sensor connectors from hanger.

18BR9EL44

18BR9EL45

(2) Remove 3 nuts from terminal block of the motor to disassemble terminal block from the motor.

18BR9EL46

(3) Remove 4 screw fixing speed sensor on the enbell side and then disassemble speed sensor, fixed nut and toothed wheel of the motor.

18BR9EL47

(4) Remove 4 flange nuts with available general tool on the endbell drive side.

18BR9EL48

(5) Remove endbell de and wave washer.

18BR9EL49

(6) Remove stator assembly by hand or suitable tool.
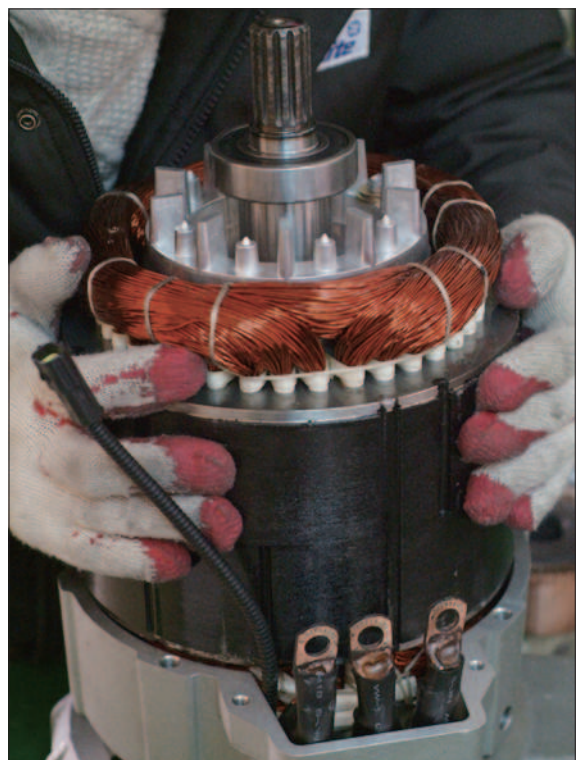
18BR9EL50

(7) Remove endbell from rotor assembly by hand-puller as a right picture.

18BR9EL51

(8) The motor are composed of 5-parts (rotor assembly, stator assembly, enbell de, endbell, etc).
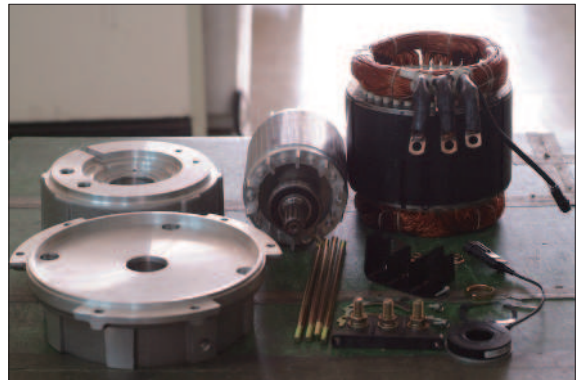
18BR9EL52

7) ASSEMBLY AND INSTALLATION

Perform assembly in the reverse order of disassembling.
After assembling, check for speed sensor. Normal signal is as right.

Clockwise rotation

Phase A

Phase B
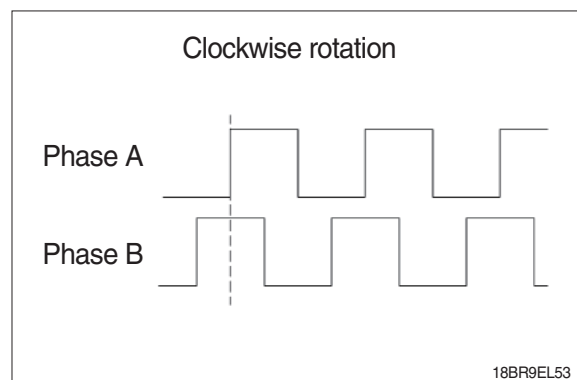
18BR9EL53

4. PUMP MOTOR

1) STRUCTURE
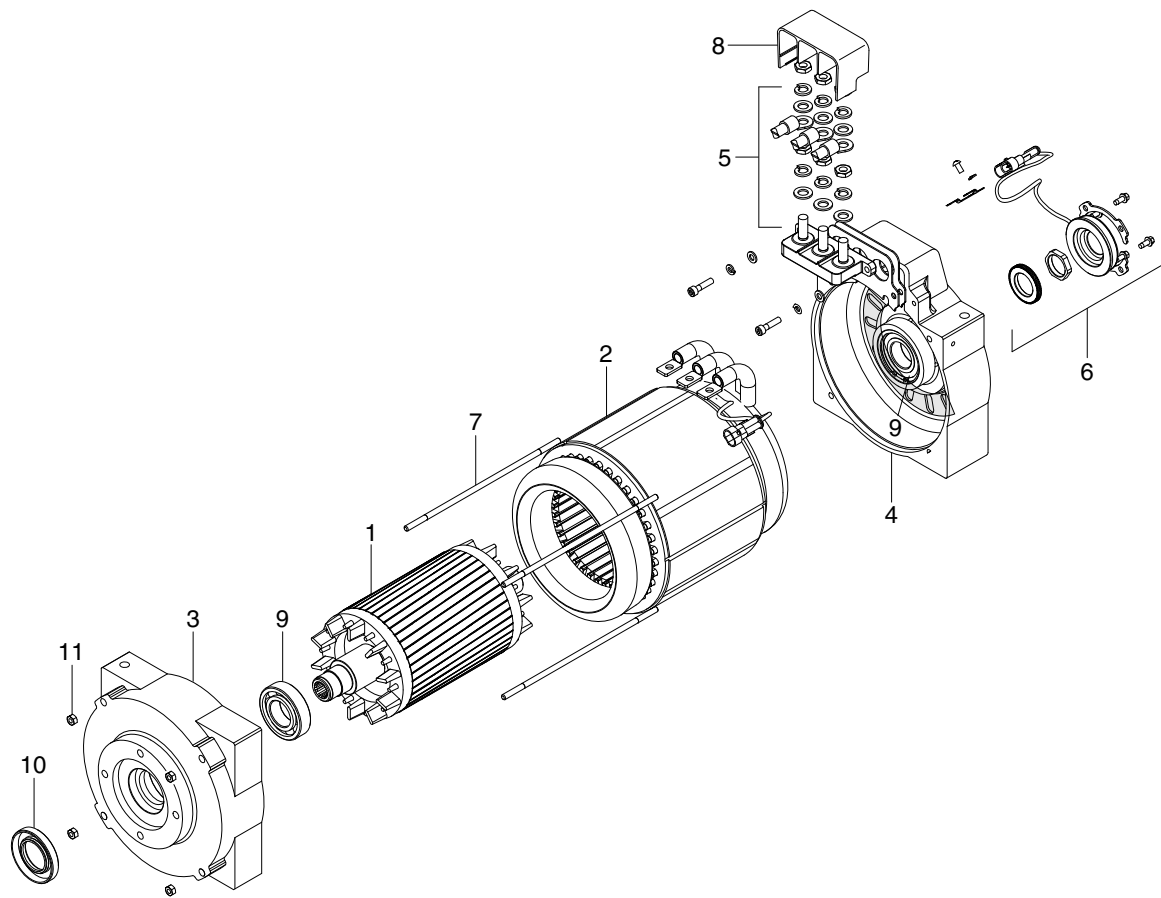
22B9FEL08

1	Rotor assy	5	Terminal A block	9	Bearing
2	Stator assy	6	Speed sensor kit	10	Oil seal
3	Endbell De	7	Stud bolt	11	Flange nut
4	Endbell	8	Terminal protector		

2) SPECIFICATION

Item	Unit	Specification
Type	-	AMDL4001
Rated voltage	Vac	30
Rated output	kW	17
Insulation	-	Class F

3) INTERNAL INVOLUTE SPLINE DATA

Item	Unit	Specification
Flat root side fit	-	Class 7
No of teeth	EA	11
Spline pitch	mm	16/32
Pressure angle	Degree	30
Major diameter	mm	ø 19.7104
Form diameter	mm	ø 19.1516
Minor diameter	mm	ø 16.0274
Pin diameter	mm	2.7432

4) MAINTENANCE INSTRUCTION

※ Before starting the maintenance please disconnect the power supply.

(1) Ball bearing

Both ball bearing are maintenance free. Should it be necessary to remove the bearings in case of repair, they should be replaced. In any case the sealing parts (shaft sealing ring etc.) have to be replaced.

If a bearing which is to be replaced has only one sealing lip, this should be greased with quality bearing grease.

After approximately 10,000 operating hours the bearings have to be replaced.

5) INSPECTION

(1) Rotor assembly inspection

Rotor should always be cleaned with compressed air.

If the dirt will not come off lightly wipe off with piece of cotton or soft cloth wetted with gasoline.

Rotor out diameter : ⌀ 123.1 ± 0.05

Tool : Vernier calipers and standard tool

18BR9EL54

(2) Stator assembly inspection

Stator should always be cleaned with compressed air.

If the dirt will not come off lightly wipe off with piece of cotton or soft cloth wetted with gasoline, using care not to damage the coil insulation.

Use mmΩ tester and check for two power line of stator repeatedly (U-V, V-W, W-U).

At that time resistance is around 3.1 mmΩ.
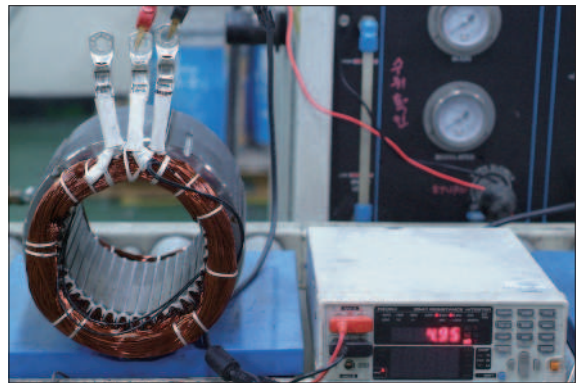
18BR9EL42

Insulation test

Use insulation tester (1000 Vac, Min. 10 MΩ) and measure as a picture.

If the insulation is defective, replace with new parts.
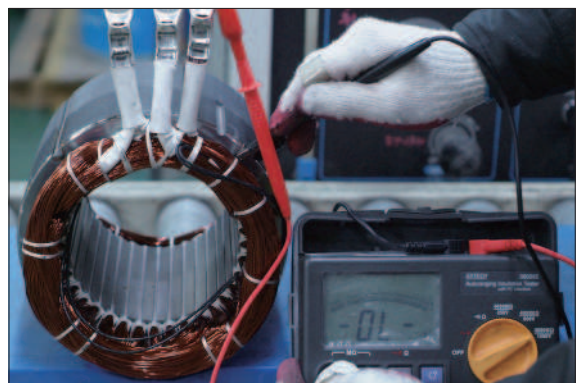
18BR9EL43

6) DISASSEMBLY FOR AC MOTOR

(1) Before disassembling motor, remove terminal protector from the motor and separate thermistor and speed sensor connectors from hanger.

18BR9EL44

18BR9EL45

(2) Remove 3 nuts from terminal block of the motor to disassemble terminal block from the motor.

18BR9EL46

(3) Remove 4 screw fixing speed sensor on the endbell side and then disassemble speed sensor, fixed nut and toothed wheel of the motor.
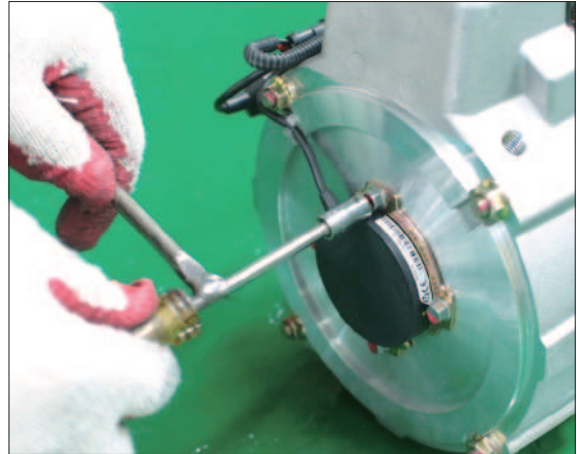
18BR9EL55

(4) Remove 4 flange nuts with available general tool on the endbell drive side.

18BR9EL56

(5) Remove endbell de and wave washer.
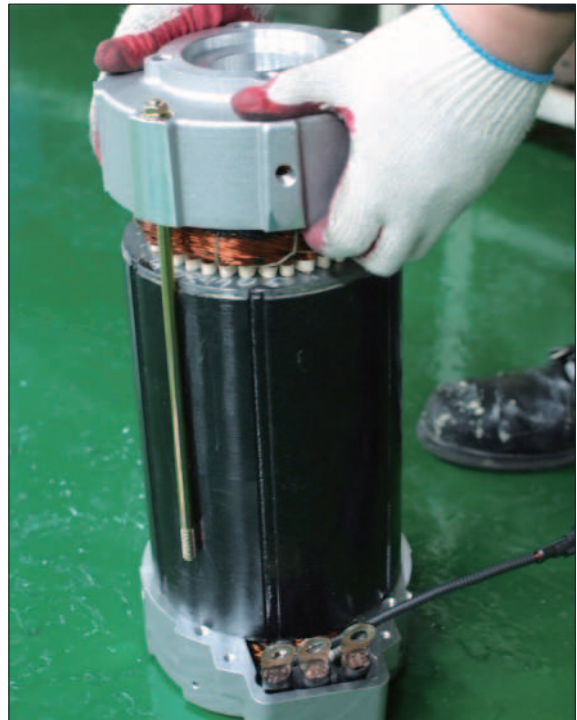
18BR9EL57

(6) Remove stator assembly by hand or suitable tool.

18BR9EL58

(7) Remove endbell from rotor assembly by hand-puller as a right picture.

18BR9EL51

(8) The motor are composed of 5-parts (rotor assembly, stator assembly, enbell de, endbell, etc).

18BR9EL59

7) ASSEMBLY AND INSTALLATION

Perform assembly in the reverse order of disassembling.
After assembling, check for speed sensor.
Normal signal is as right.

Clockwise rotation

Phase A

Phase B

18BR9EL53

5. CONTROLLER SYSTEM
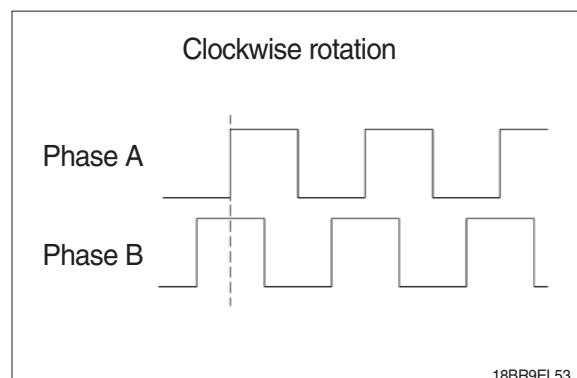
1) STRUCTURE
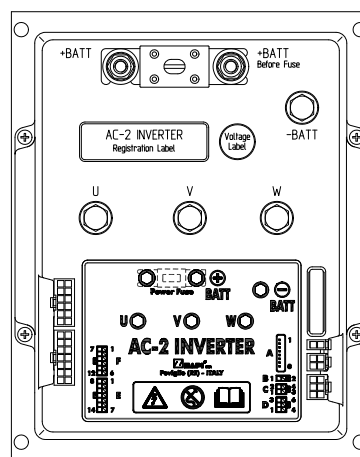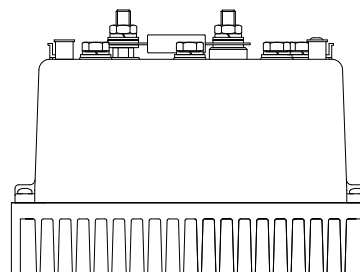
Traction controller   Pump controller

22B9FEL10

(1) Specifications

Model	Model	Application	Type	Power	Current limit
22/25/30B-9F	DUAL AC2	Traction	MOSFET	48V, 330A+330A	330A/3min
	AC2	Pump	MOSFET	48V, 450A	450A/3min

2) OPERATIONAL FEATURES

(1) Features

① Speed control.

② Optimum behavior an a slope due to the speed feedback:
  · The motors speed follows the accelerator, starting a regenerative braking if the speed overtakes the speed set-point.
  · The system can perform an electrical stop on a ramp (the machine is electrically hold on a slope) for a programmable time.

③ Electronic differential feature with torque balance between external and internal wheel.

④ Regenerative release braking based upon deceleration ramps.

⑤ Regenerative braking when the accelerator pedal is partially released (deceleration).

⑥ Direction inversion with regenerative braking based upon deceleration ramp.

⑦ Regenerative braking and direction inversion without contactors: only the main contactor is present.

⑧ Optimum sensitivity at low speeds.

⑨ Voltage boost at the start and with overload to obtain more torque (with current control).

⑩ Hydraulic steering function:
  · The traction inverter sends a "hydraulic steering function" request to the pump inverter on the can-bus line.

⑪ Backing forward and reverse options are available, with the tune and the speed of the function programmable with Zapi console or buttons on a display.

⑫ High efficiency of motor and battery due to high frequency commutations.

⑬ Modification of parameters through the programming console or buttons on a display.

⑭ Internal hour-meter with values that can be displayed on the console.

⑮ Memory of the last five alarms with relative hour-meter and temperature displayed on the console.

⑯ Diagnostic function with Zapi console for checking main parameters.

⑰ Built in BDI feature.

⑱ Flash memory, software downloadable via serial link and via CANBUS.

(2) Diagnosis

The microcontrollers continually monitor the inverter and carry out a diagnostic procedure on the main functions. The diagnosis is made in 4 points.

① Diagnosis on key switch closing that checks: watchdog circuit, current sensor, capacitor charging, phase's voltages, contactor drivers, can-bus interface, if the switch sequence for operation is correct and if the output of accelerator unit is correct, correct synchronization of the two μ CS, integrity of safety related inputs hardware.

② Standby diagnosis in standby that checks: Watchdog circuit, phase's voltages, contactor driver, current sensor, can-bus interface.

③ Diagnosis during operation that checks: Watchdog circuits, contactor driver, current sensors, can-bus interface.

④ Continuous diagnosis that checks: Temperature of the inverter, motor temperature.

Diagnosis is provided in two ways. The digital console can be used, which gives a detailed information about the failure; the failure code is also sent on the Can-Bus.

3) DESCRIPTION OF THE CONNECTORS

(1) Traction controller
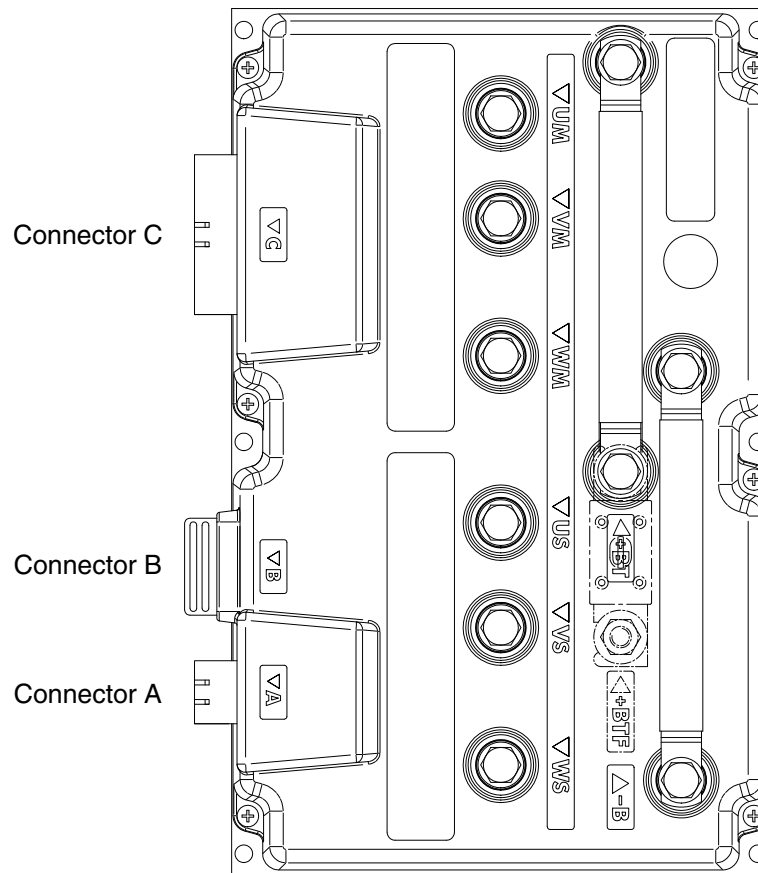
Traction controller

16B9FEL13

No. of pin	Function	Description
A1	CAN_H	High level CAN-BUS voltage I/O.
A2	NA	-
A3	NA	-
A4	CAN_L_OUT	Low level CAN-BUS voltage I/O.
A5	NA	-
A6	CAN_L	Low level CAN-BUS voltage I/O.
A7	CAN_H_OUT	High level CAN-BUS voltage I/O.
A8	NA	-
B1	PCLRXD	Positive serial reception.
B2	NCLRXD	Negative serial reception.
B3	PCLTXD	Positive serial transmission.
B4	NCLTXD	Negative serial transmission.
B5	GND	Negative console power supply.
B6	+12	Positive console power supply.

No. of pin	Function	Description
B7	FLASH	Must be connected to A8 for the flash memory programming (if used).
B8	FLASH	Must be connected to A7 for the flash memory programming (if used).
C1	PENC_R	Positive of right motor encoder power supply (+12 V).
C2	NENC_R	Negative of right motor encoder power supply.
C3	KEY	Connected to + batt trough a key switch and a 10 A fuse in series.
C4	CM	Common of FW / REV / HB / PB / SEAT / ENABLE switches.
C5	SEAT & BUCKLE	Seat and buckle (opt) request signal; active high.
C6	FORWARD	Forward direction request input; active high.
C7	REVERSE	Reverse direction request input; active high.
C8	ENABLE	Traction request input; active high.
C9	PB	Pedal brake request input; active high.
C10	HB	Hand brake request input.
C11	PENC_L	Positive of left motor encoder power supply (+12 V).
C12	NENC_L	Negative of left motor encoder power supply.
C13	PHA_R	Right motor encoder phase A.
C14	PHB_R	Right motor encoder phase B.
C15	NPOTST	Negative of steering potentiometer.
C16	PPOTST	Positive of steering potentiometer (+12 V).
C17	CPOTST	Steering potentiometer wiper signal.
C18	NA	-
C19	NA	-
C20	NPOT	Negative of accel pedal potentiometer.
C21	CPOT	Accel pedal potentiometer wiper signal.
C22	PHA_L	Left motor encoder phase A.
C23	PHB_L	Left motor encoder phase B.
C24	NTHERM_R	Negative of right traction motor temperature sensor.
C25	PTHERM_R	Input for right traction motor temperature sensor.
C26	NLC	Output of main contactor coil driver (drives to -BATT).
C27	PLC	Positive of main contactor coil.
C28	NA	-
C29	NA	-
C30	PAUX	Positive of fan relay.
C31	NAUX	Negative of fan relay.
C32	-BATT	Negative power supply.
C33	PPOT	Negative of accel pedal potentiometer.
C34	NTHERM_L	Negative of left traction motor temperature sensor.
C35	PTHERM_L	Input for left traction motor temperature sensor.

(1) Encoder installation

① Traction controller card is fit for different types of encoder. To control AC motor with Zapi inverter, it is necessary to install an incremental encoder with 2 phases shifted of 90°. The encoder power supply can be +12V. It can have different electronic output.

C11/C1 :   +12V : Positive of encoder power supply.

C12/C2 :   GND   : Negative of encoder power supply.
C22/C13 :   A   : Phase A of encoder.
C23/C14 :   B   : Phase B of encoder.

② Connection of encoder with open collector output; +12V power supply.
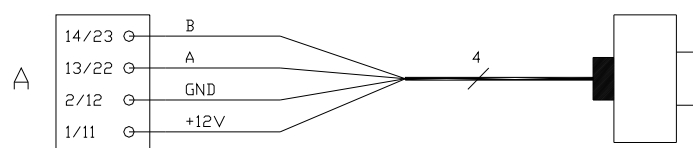
20B7EL26

③ The encoder power supply voltage and output electronic has to be communicated to ZAPI in order to correctly set the selection jumpers in the logic card.

(2) Pump controller
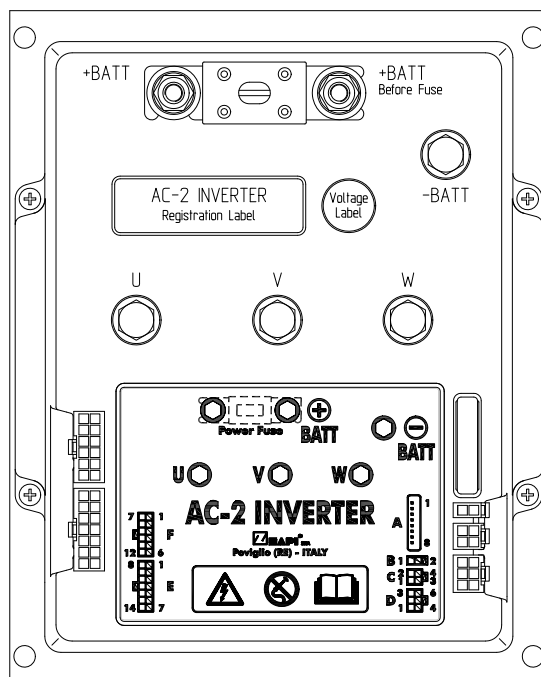
Pump controller

22B9FEL14

No. of pin	Function	Description
A1	PCLRXD	Positive serial reception.
A2	NCLRXD	Negative serial reception.
A3	PCLTXD	Positive serial transmission.
A4	NCLTXD	Negative serial transmission.
A5	GND	Negative console power supply.
A6	+12	Positive console power supply.
A7	FLASH	Must be connected to A8 for the flash memory programming (if used).
A8	FLASH	Must be connected to A7 for the flash memory programming (if used).
B1	- BATT	Negative power supply.
B2	MODE	This input allows the customer to select the software in case of double version.
C1	CAN L	Low level CAN-BUS voltage I/O.
C2	CAN L-OUT	Low level CAN-BUS voltage I/O.
C3	CAN H	High level CAN-BUS voltage I/O.
C4	CAN H-OUT	High level CAN-BUS voltage I/O.
D1÷D6	-	Incremental ENCODER connector.

No. of pin	Function	Description
E1	NA	-
E2	NA	-
E3	NA	-
E4	COMMON	Common of LIFT ENABLE/1ST SPEED/2ND SPEED/3RD SPEED/ SBR/SR/BRAKE OIL microswitches.
E5	LIFT ENABLE	Input for lifting enable request.
E6	1ST SPEED	Input for 1st speed request (TILT).
E7	3RD SPEED	Input for 3rd speed request (AUX2).
E8	NA	-
E9	NA	-
E10	NA	-
E11	NA	-
E12	SBR	Input for SBR (Side Battery Removal) request.
E13	SR	Input for SR (Speed Reduction) request.
E14	NA	-
F1	KEY	Input of the key switch signal.
F2	PMC	Positive of AUX coil.
F3	PHYDRO	Positive of MCV solenoid coil.
F4	BRAKE OIL	Input for brake oil digita input.
F5	SAFETY	If not connected to -batt the MC coil power output will be disabled. Can also be used as a general purpose input.
F6	PTHERM	Input for pump motor temperature sensor.
F7	NA	-
F8	NMC	AUX coil driver (drives to -Batt).
F9	NHYDRO	MCV solenoid coil driver (drives to -Batt).
F10	2ND SPEED	Input for 2nd speed request (AUX1).
F11	- BATT	Negative power supply.
F12	NTHERM	Negative of pump motor temperature sensor.

4) FUNCTION CONFIGURATION

■ TRACTION CONTROLLER-MASTER

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

(1) Submenu "SET OPTIONS"

① **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.

② **Battery check**
- ON : The battery discharge level check is carried out; when the battery level reaches 10%, an alarm is signalled and the maximum current is reduced to the half of the programmed value.
- OFF : The battery discharge level check is carried out but no alarm is signalled.

③ **Traction cutout**

When the alarm "BATTERY LOW" appears, if this option is programmed to ON the traction maximum speed is reduced to 60Hz.

④ **Lift cutout**

When the alarm "BATTERY LOW" appears, if this option is programmed to ON the lift function is disabled.

⑤ **S.R.O.**

If this option is set to ON the static return to OFF is requested for starting truck. The required sequence is :
· Seat-direction lever-accelerator pedal or
· Seat-accelerator pedal-direction lever within the seq. delay time.
If this option is set to OFF the required sequence to start the truck is :
· Direction lever-accelerator pedal or
· Accelerator pedal-direction lever within the seq. delay time.

⑥ **Hydro key on**
- ON / OFF : If this option is programmed ON the traction inverter manages an hydraulic steering function when the "key" is switched ON.

⑦ **Stop on ramp**

Only when the encoder is present, it is possible to electrically hold the truck on a slope when the accelerator is released but the tiller is not released.
- ON : The stop on ramp feature (truck electrically hold on a ramp) is managed for a time established by AUXILIARY TIME parameter.
- OFF: The stop on ramp feature is not performed. That means the truck comes down slowly during the AUXILIARY TIME.

⑧ **Aux input #1**
- EXCLUSIVE HYDRO : Not available.
- OPTION #1 : Input C10 is the input for an handbrake device, active low (open switch).
- OPTION #2 : Input C10 is the input for a speed reduction device, active low (open switch).

⑨ **Set temperature**

　　- DIGITAL : A digital (ON/OFF) motor thermal sensor is connected to C25 (C35) input.

　　- ANALOG : An analog motor thermal sensor is connected to C25 (C35).

　　- NONE : No motor thermal sensor switch is connected.

⑩ **Steer table**

　　- OPTION #1 : The steering table is the 22/25/30B-9F.

　　- OPTION #2 : Not available.

⑪ **Display**

　　- OFF : When display is not connected to the CAN bus.

　　- ON : When display is connected to the CAN bus.

⑫ **Pedal type**

　　- OPTION #1/OPTION #2 : The speed set-position is sent to the display for graphic indication.

⑬ **Pedal brk stop**

　　- ON : The truck is stopped when the pedal brake is pressed.

　　- OFF : The traction current is reduced to the half of the maximum current.

(2) Submenu "ADJUSTMENTS"

① **Set battery type**

　It selects the nominal battery voltage.

② **Adjust battery**

　Fine adjustment of the battery voltage measured by the controller. Please increase or decrease the value 1 by 1 and check the voltage.

③ **Max steer right** (only available on console)

　This is the function to record in the controller EEPROM the steering potentiometer output voltage when the wheels are fully turned right (maximum of the steering potentiometer range).

④ **Max steer left** (only available on console)

　This is the function to record in the controller EEPROM the steering potentiometer output voltage when the wheels are fully turned left (minimum of the steering potentiometer range).

⑤ **Set steer 0-pos.** (only available on console)

　This is the function to record in the controller EEPROM the steering potentiometer output voltage when the wheels are straight.

⑥ **Set steer right**

　This parameter sets the max steering angle in right direction.

⑦ **Set steer left**

　This parameter sets the max steering angle in left direction.

⑧ **Throttle 0 zone**

It establishes a deadband in the accelerator input curve.

⑨ **Throttle X point**

This parameter, together with the THROTTLE Y POINT, changes the characteristic of the accelerator input curve : when the accelerator is de-pressed to X point percent, the corresponding truck speed is Y point percent of the maximum truck speed. The relationship between the accelerator position and the truck speed is linear between the THROTTLE 0 ZONE and the X point and also between the X point and the maximum accelerator position but with two different slopes.

⑩ **Throttle Y point**

This parameter, together with the THROTTLE X POINT, changes the characteristic of the accelerator input curve : when the accelerator is de-pressed to X point percent, the corresponding truck speed is Y point percent of the maximum truck speed. The relationship between the accelerator position and the truck speed is linear between the THROTTLE 0 ZONE and the X point and also between the X point and the maximum accelerator position but with two different slope.

⑪ **Cooling fan work**

Cooling fans installed on nearby motors and controllers will work as follows;

Option #1 : fans work always.

Option #2 : fans work in case a temperature of controller or motor exceeds a temperature set on START TEMP. FAN menu.

Option #3 : fans work when motors work.

⑫ **Start temp. fan**

If COOLING FAN WORK menu is set as option #2, this menu is used to set a temperature limitation which allows fans to work when a temperature of controller or motor exceeds the limitation.

⑬ **Adjustment #2 bdi**

It adjusts the lower level of the battery discharge table. Higher level means higher voltage.

⑭ **Adjustment #1 bdi**

It adjusts the upper level of the battery discharge table. Higher level means higher voltage.

⑮ **Adjustment #03 :**

Set an increment of battery charge above actual value. If battery voltage exceed this total value the software recognize charging, and battery charge percentage increase to correct value also if battery isn't fully charged.

⑯ **Main cont. voltage**

It specifies the percentage of battery voltage supplied to MC coil to close the contactor.

⑰ **Aux output voltage**

It specifies the percentage of battery voltage supplied to AUX coil to close the AUXILIARY electro valve.

⑱ **Adjustment #04 :**

This parameter determines the motor temperature level at which the "MOTOR TEMPERATURE" alarm is signalled. This parameter must be adjusted only if the "SET TEMPERATURE" (menu "SET OPTION") parameter is programmed "ANALOG".

⑲ Speed factor

It adjusts the speed coefficient to have the correct speed indication on the display. This coefficient has to be regulated depending on truck mechanic characteristics. It results from the following formula :

Speed factor = 88 $*$ rr $*$ p $/$ ∅

where :

rr = total gearbox ratio

∅ = traction wheel diameter (m)

P = number of pair poles of the motor

(3) Parameter change

① Acceler. delay

It determines the acceleration ramp.

Less value means better acceleration performance.

② Release braking

It controls the deceleration ramp when the travel request is released.

Less value means better braking performance.

③ Invers. braking

It controls the deceleration ramp when the direction switch is inverted during travel.

Less value means better braking performance.

④ Pedal braking

It determines the deceleration ramp when the travel request is released and the brake pedal switch is closed.

⑤ Speed limit brk.

Deceleration ramp when the pedal position is changed but not completely released.

Less value means better braking performance.

⑥ Brake cutback

It determines the deceleration ramp when the speed reduction input becomes active and the motor slow down.

⑦ Max speed forw

It determines the maximum speed in forward direction.

⑧ Max speed back

It determines the maximum speed in backward direction.

⑨ Cutback speed 1

Speed reduction when the cutback switch is active.

⑩ Turtle speed

Hz. It determines the truck maximum speed when the turtle mode is activated.

⑪ Curve cutback

Speed reduction when the truck is doing a curve. The parameter sets the speed setpoint when the maximum steering angle is reached (4 wheels truck, the internal wheel is stopped). In intermediate steering angles, the speed setpoint will be within a range between the straight wheel speed and the CURVE CUTBACK SPEED.

⑫ **Frequency creep**

Minimum speed when the forward or reverse switch is closed, but the accelerator is on a minimum position.

⑬ **Maximum current**

Maximum level of the current (percentage of the maximum current of the controller).

⑭ **Acc. smooth**

It gives a parabolic shape to the acceleration ramp.

⑮ **Inv. smooth**

It gives a parabolic shape to the acceleration ramp after a direction inversion.

⑯ **Stop smooth**

Hz. It sets the frequency where the smooth effect of the parabolic acceleration ends.

⑰ **Seat delay time**

It determines the delay time between the opening of the seat switch and the start of the truck electrical braking.

⑱ **Sequence de. time**

It sets the maximum delay time between the accelerator is pressed and the direction lever is moved out of the neutral position.

If this time is expired the truck stops with warning : "SEQUENCE FAULT".

⑲ **Chat time**

After no travel or pump request is active for the chat time the line contactor is automatically opened. To restart, the the operator needs to press the accelerator pedal or activate the hydraulic levers.

■ TRACTION CONTROLLER-SLAVE

Using the config menu of the programming console, or using a display, the user can configure the following functions.

(1) Submenu "SET OPTIONS"

Not available.

(2) Submenu "ADJUSTMENTS"

① **Set battery type**

It selects the nominal battery voltage.

② **Adjust battery**

Fine adjustment of the battery voltage measured by the controller. Please increase or decrease the value 1 by 1 and check the voltage.

③ **Aux output volt**

It specifies the percentage of battery voltage supplied to AUX coil to close the AUXILIARY electro valve.

(3) Parameter change

① **Acceler. delay**

It determines the acceleration ramp. Less value means better acceleration performance.

② **Release braking**

It controls the deceleration ramp when the travel request is released.
Less value means better braking performance.

③ **Seat delay time**

It determines the delay time between the opening of the seat switch and the start of the truck electrical braking.

■ PUMP CONTROLLER

Using the config menu of the programming console, the user can configure the following functions.

(1) Submenu "SET OPTIONS"

① **Cutback mode**
- NONE : This truck doesn't apply the cutback mode.
- OPTION #1 : When the cutback switch is activated, the truck is reduced the travel and lift speed.
- OPTION #2 : When the cutback switch is activated, the truck is reduced the travel speed.
- OPTION #3 : When the cutback switch is activated, the truck is reduced the lift speed.

② **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.

③ **Set temperature**

It can be set :
- ANALOG : An analogue sensor for the control of the motor temperature is connected to CNA#22. Typically the temperature sensor is a PTC (positive thermal coefficient resistance), providing the sensor characteristic to Zapi the correct table can be loaded in the controller software.
- DIGITAL : A digital (ON/OFF) sensor for the motor temperature monitoring is connected to CNA#22 input.
- NONE : No temperature sensor is connected.

④ **Digital lift**
   - OFF : The lift sensor includes a lift switch and an analogue lift sensor. Lift speed can be controlled proportionally with lever position.
   - ON : The lift sensor includes a lift switch only. Lift speed cannot be controlled proportionally.

(2) Submenu "ADJUSTMENTS"

① **Set battery type** : Selects the nominal battery voltage.
② **Adjust battery** : Fine adjustment of the battery voltage measured by the controller. Please increase or decrease the value 1 by 1 and check the voltage.
③ **Throttle 0 zone** : It establishes a deadband in the lift potentiometer input curve.
④ **Throttle X zone** : This parameter, together with the THROTTLE Y POINT, changes the characteristic of the lift potentiometer input curve : when the potentiometer is depressed to X point per cent, the corresponding pump speed is Y point percent of the maximum pump speed. The relationship between the lift potentiometer position and the pump speed is linear between the THROTTLE 0 ZONE and the X point and also between the X point and the maximum potentiometer position but with two different slopes.
⑤ **Throttle Y zone** : This parameter, together with the THROTTLE X POINT, changes the characteristic of the lift potentiometer input curve : when the potentiometer is de-pressed to X point per cent, the corresponding pump speed is Y point per cent of the maximum pump speed. The relationship between the potentiometer position and the pump speed is linear between the THROTTLE 0 ZONE and the X point and also between the X point and the maximum accelerator position but with two different slope.

⑥ **Adjustment #04** : This parameter determines the motor temperature level at which the "MOTOR TEMPERATURE" alarm is signalled. This parameter must be adjusted only if the "SET MOT. TEMPERAT" (menu "SET OPTION") parameter is programmed "ANALOG".
⑦ **PWM on main contactor**
   - OFF: The inverter applies the battery voltage to the coil F8 output. (AUX coil)
   - ON: The PWM reduces the voltage to the set value.
⑧ **PWM on aux output**
   - OFF: The inverter applies the battery voltage to the coil on F9 output. (MCV coil)
   - ON: The PWM reduces the voltage to the set value.
⑨ **MC/AUX PWM**: It sets the PWM level in % in the outputs F8 and F9. Here is used to drive a main contact for pump.

(3) Parameter change

① Acceler. delay
It determines the acceleration ramp.
Less value means better acceleration performance.

② Deceler. delay
It determines the deceleration ramp.
Less value means better braking performance.

③ Max speed up
It determines the maximum lifting speed.

④ Min speed up
It determines the minimum lifting speed with a potentiometer control when the lifting enable switch is closed.

⑤ Cutback speed
It determines the lift speed reduction in percentage when the speed reduction switch is activated.

⑥ Tilt speed
Tilt speed, fine regulation.

⑦ Shift speed
Shift speed, fine regulation.

⑧ Aux speed
Auxiliary function speed, fine regulation.

⑨ Hydro speed fine
Hydro speed, fine regulation (steering speed).

⑩ Maximum current
This parameter changes the maximum current of the inverter.

⑪ Idle time
It is the remaining time after that the hydro request goes down.

■ DISPLAY
Operators can have below functions through display.

(1) Password
If determines to set the function of user password when key on.
- OFF : No use.
- ON : Activate the user password (Default password is "00000" and it can be re-set at user-menu)

(2) Maintenance
If determines to set the function of maintenance alarm when if come to service interval.
- OFF : No use.
- ON : Activate the maintenance alarm function.

(3) Hour counter
It indicates the machine operating hours.
- Key ON : Key on time.
- Pump : Pump motor operating time.
- Traction : Traction motor operating time.

5) PROGRAMMING & ADJUSTMENTS

There are two ways to adjust parameter via a console or buttons on a display.

※ Adjustments via buttons on a display, please refer to the display section. (page 7-57)

ADJUSTMENTS VIA CONSOLE (Option)

Adjustment of parameters and changes to the inverter's configuration are made using the digital console. The console is connected to the "B" connector of the inverter.

(1) Descriptions of console
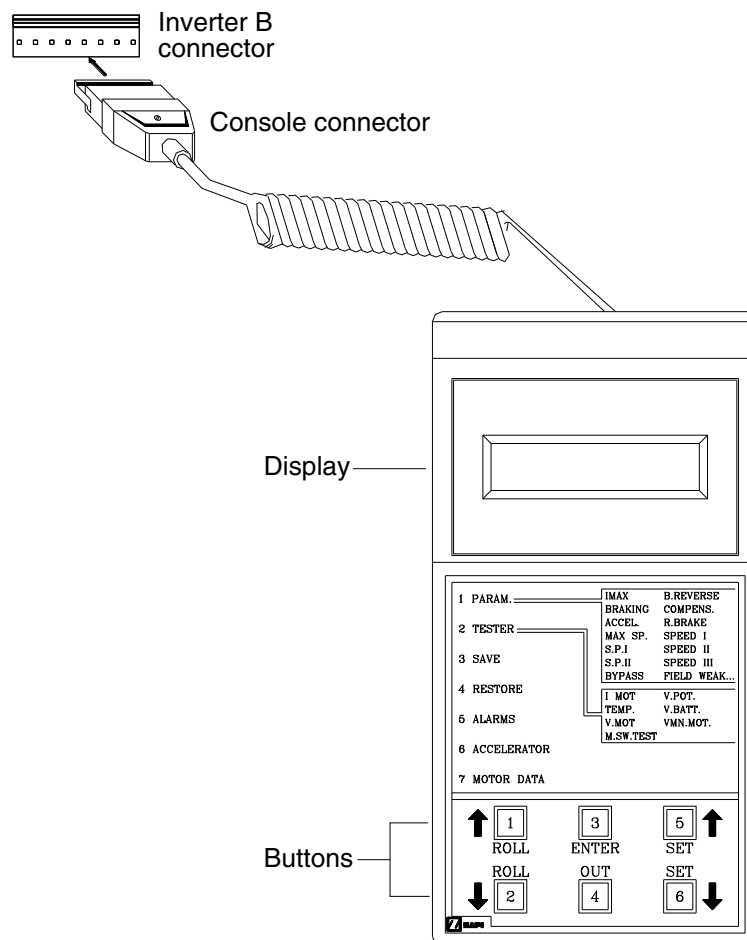
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※ Please connect and disconnect it from the inverter after a key switch off.

(2) Description of standard console menu

① Traction controller-Master

```
                                          HEADING

                  MAIN MENU

  PARAMETER          ACCELERATION DELAY    0÷9         SET MODEL      CONNECTED TO 3
  CHANGE             RELEASE BRAKING       0÷9
                     INVERS. BRAKING       0÷9
                     PEDAL BRAKING         0÷9
                     SPEED LIMIT BRAKING   0÷9         SET OPTIONS    HOUR COUNTER      RUNNING/KEY ON
                     BRAKE CUTBACK         0÷9                        BATTERY CHECK     ON/OFF
                     MAX SPEED FORW        Hz                         TRACTION CUTOUT   ON/OFF
                     MAX SPEED BACK        Hz                         LIFT CUTOUT       ON/OFF
                     CUTBACK SPEED 1       %                          S. R. O.          ON/OFF
                     TURTLE SPEED          Hz                         HYDRO KEY ON      ON/OFF
                     CURVE CUTBACK         %                          STOP ON RAMP      ON/OFF
                     FREQUENCY CREEP       Hz                         AUX INPUT #1      EXCLUSIVE HYDRO/OPTION #1
                     MAXIMUM CURRENT       0÷9                                          / OPTION #2
                     ACC. SMOOTH           Hz                         SET TEMPERATURE   DIGITAL/ANALOG/NONE
                     INV. SMOOTH           Hz                         STEER TABLE       OPTION #1/OPTION #2
                     STOP SMOOTH           Hz                         DISPLAY           ON/OFF
                     SEAT DELAY TIME       Sec                        PEDAL TYPE        OPTION #1/OPTION #2
                     SEQ. DELAY TIME       Sec                        PEDAL BRAKE STOP  ON/OFF
                     CHAT TIME             Min


  TESTER             MOTOR VOLTAGE         %
                     FREQUENCY             Hz
                     ENCODER               Hz
                     SLIP VALUE            Hz
                     CURRENT RMS           A
                     TEMPERATURE           °C
                     TEMPERATURE #1        °C
                     TEMPERATURE #2        °C
                     ACCELERATOR           V
                     STEER ANGLE           °
                     INT WHEEL CUTB        %
                     FORW. SWITCH          ON/OFF
                     BACK SWITCH           ON/OFF      ADJUSTMENTS    SET BATTERY TYPE   24/36/48/72/80/96
                     ENABLE SWITCH         ON/OFF                     ADJUST BATTERY     ...V
                     SEAT SWITCH           ON/OFF                     MAX STEER RIGHT    ...V
                     CUTBACK SWITCH        ON/OFF                     MAX STEER LEFT     ...V
                     BRAKE SWITCH          ON/OFF                     SET STEER 0-POS    ...V
                     EXCLUSIVE HYDRO       ON/OFF                     SET STEER RIGHT    ...°
                     BRAKE PEDAL POTI      %                          SET STEER LEFT     ...°
                     HAND BRAKE            ON/OFF                     THROTTLE 0 ZONE    ...%
                     VOLTAGE BOOSTER       %                          THROTTLE X ZONE    ...%
                     BATTERY VOLTAGE       V                          THROTTLE Y ZONE    ...%
                     BATTERY CHARGE        %                          COOLING FAN WORK   OPTION #1/ OPTION #2
  SAVE                                                                START TEMP. FAN    OPTION #2
  PARAMETER                                                           ADJUSTMENT #2 BDI  0÷9
                                                                      ADJUSTMENT #1 BDI  0÷9
  RESTORE                                                             ADJUSTMENT #3      ...%
  PARAMETER                                                           MAIN CONT VOLT     ...V
                                                                      AUX OUTPUT VOLT    ...V
  ALARMS             CODE,                                            ADJUSTMENT #4      ...°C
                     h, N°, °C                                        SPEED FACTOR

  PROGRAM            VACC SETTING    MIN/MAX
  VACC

  MOTOR DATA         NOT
                     AVAILABLE
```

22B9FEL18

7-42

② Traction controller-Slave

```
                                                ┌─────────────────┐
                                                │     HEADING     │
                           ┌───────────┐        └─────────────────┘
                           │ MAIN MENU │                 │
                           └───────────┘
         ┌──────────────┐                        ┌─────────────┐
         │  PARAMETER   │   ┌──────────────────────────┐      │  SET MODEL  │   ┌──────────────┐
         │   CHANGE     │   │ ACCELERATION DELEY  0÷9   │      └─────────────┘   │ CONNECT TO 4 │
         └──────────────┘   │ RELEASE  BRAKING    0÷9   │                        └──────────────┘
                            │ SEAT DELAY TIME     Sec.  │
                            └──────────────────────────┘
                                                        ┌─────────────┐
                                                        │ SET OPTIONS │   ┌───────────────┐
                                                        └─────────────┘   │ NOT AVAILABLE │
                                                                          └───────────────┘
         ┌──────────┐   ┌────────────────────────────────┐
         │  TESTER  │   │ MOTOR  VOLTAGE      %          │  ┌─────────────┐   ┌──────────────────────────────────────────┐
         └──────────┘   │ FREQUENCY           Hz         │  │ ADJUSTMENTS │   │ SET BATTERY TYPE  24/36/48/72/80/96       │
                        │ ENCODER             Hz         │  └─────────────┘   │ ADJUST  BATTERY      ...V                 │
                        │ SLIP  VALUE         Hz         │                    │ AUX  OUTPUT VOLT     ...V                 │
                        │ CURRENT  RMS        A          │                    └──────────────────────────────────────────┘
                        │ TEMPERATURE         °C         │
                        │ VOLTAGE  BOOSTER    %          │
                        │ BATTERY  VOLTAGE    V          │
                        │ SEAT  SWITCH        ON/OFF     │
                        │ FORW.  SWITCH       ON/OFF     │
                        │ BACK.  SWITCH       ON/OFF     │
                        └────────────────────────────────┘

         ┌──────────────┐
         │    SAVE      │
         │  PARAMETER   │
         └──────────────┘
         ┌──────────────┐
         │   RESTORE    │
         │  PARAMETER   │
         └──────────────┘
         ┌──────────┐   ┌────────────────┐
         │  ALARMS  │   │     CODE,       │
         └──────────┘   │  h,  N°,  °C    │
                        └────────────────┘
         ┌──────────────┐   ┌──────────────────────────┐
         │   PROGRAM    │   │ VACC SETTING    MIN/MAX  │
         │    VACC      │   └──────────────────────────┘
         └──────────────┘
         ┌──────────────┐   ┌────────────────┐
         │ MOTOR  DATA  │   │      NOT        │
         └──────────────┘   │   AVAILABLE     │
                            └────────────────┘
```

22B9FEL19

③ Pump controller

```
                                    ┌─────────────────┐
                                    │     HEADING     │
                                    └─────────────────┘
                    ┌─────────────┐
                    │  MAIN MENU  │
                    └─────────────┘

┌──────────────┐   ┌──────────────────────────────────┐     ┌─────────────┐   ┌──────────────────┐
│  PARAMETER   │   │ ACCELERATION DELAY   0÷9          │     │  SET MODEL  │   │  CONNECT TO 5    │
│   CHANGE     │   │ DECELERATION DELAY   0÷9          │     └─────────────┘   └──────────────────┘
└──────────────┘   │ MAX  SPEED  UP       Hz          │
                   │ MIN  SPEED  UP       Hz          │
                   │ CUTBACK  SPEED       Hz          │
                   │ TILT  SPEED          Hz          │
                   │ SHIFT  SPEED         Hz          │
                   │ AUX  SPEED           Hz          │     ┌─────────────┐   ┌──────────────────────────────────────────┐
                   │ HYD  SPEED  FINE     Hz          │     │ SET OPTIONS │   │ CUTBACK MODE     NONE/OPTION #1/#2/#3     │
                   │ MAXIMUM  CURRENT     0÷9         │     └─────────────┘   │ HOUR  COUNTER    RUNNING/KEY ON          │
                   │ IDLE  TIME           Sec         │                      │ SET TEMPERATURE  DIGITAL/ANALOG/NONE      │
                   └──────────────────────────────────┘                      │ DIGITAL  LIFT    ON/OFF                   │
                                                                             └──────────────────────────────────────────┘

┌──────────────┐   ┌──────────────────────────────────┐     ┌─────────────┐   ┌──────────────────────────────────────────┐
│   TESTER     │   │ MOTOR  VOLTAGE       %           │     │ ADJUSTMENTS │   │ SET BATTERY TYPE   24/36/48/72/80/96      │
└──────────────┘   │ FREQUENCY            Hz          │     └─────────────┘   │ ADJUST  BATTERY    V                     │
                   │ ENCODER              Hz          │                      │ THROTTLE 0 ZONE    %                     │
                   │ SLIP  VALUE          Hz          │                      │ THROTTLE X POINT   %                     │
                   │ CURRENT  RMS         A           │                      │ THROTTLE Y POINT   %                     │
                   │ TEMPERATURE          ˚C          │                      │ ADJUSTMENT  #4     ˚C                    │
                   │ ACCELERATOR          V           │                      │ PWM  ON MAIN CONT  ON/OFF               │
                   │ MOTOR  TEMPERATURE   ˚C          │                      │ PWM  ON AUX  OUT   ON/OFF               │
                   │ LIFTING  SWITCH      ON/OFF      │                      │ MC/AUX/PWM         %                    │
                   │ SECURITY  SWITCH     ON/OFF      │                      │ FORK  LEVELING     ON/OFF               │
                   │ HYDRO  SPEED  REQ    ON/OFF      │                      └──────────────────────────────────────────┘
                   │ LIFT/LOWER  REQ      V           │
                   │ TILT  REQUEST        V           │
                   │ SHIFT  REQUEST       V           │
                   │ AUX  REQUEST         V           │
                   │ CUTBACK  SWITCH                  │
                   │ VOLTAGE  BOOSTER     V           │
                   │ BATTERY  VOLTAGE     V           │
                   └──────────────────────────────────┘

┌──────────────┐
│    SAVE      │
│  PARAMETER   │
└──────────────┘

┌──────────────┐
│   RESTORE    │
│  PARAMETER   │
└──────────────┘

┌──────────────┐   ┌──────────────────┐
│   ALARMS     │   │     CODE,        │
└──────────────┘   │   h,  N˚,  ˚C    │
                   └──────────────────┘

┌──────────────┐   ┌──────────────────────────────┐
│ PROGRAM VACC │   │ VACC  SETTING     MIN/MAX    │
└──────────────┘   └──────────────────────────────┘

┌──────────────┐   ┌──────────────────┐
│  MOTOR DATA  │   │  NOT  AVAILABLE  │
└──────────────┘   └──────────────────┘
```

22B9FEL20

6) MORNITORING MENU

In Console, This menu appears as "TESTER" MENU

(1) Traction controller-Master

① **Motor voltage**

Percentage value. It is the voltage generated by the inverter expressed in percent of the actual battery voltage. 100% means the sine wave width is close to the actual battery voltage; 0% means the sine wave width is null.

② **Frequency**

Hz value. This is the frequency of the sine waves the inverter is supplying.

③ **Encoder**

Hz value. This is the speed of the motor measured with the encoder and expressed in the same unit of the FREQUENCY reading.

④ **Slip value**

Hz value. This is the slip between the frequency and the speed of the motor (SLIP VALUE = FREQUENCY-ENCODER).

⑤ **Current rms**

Ampere value. Root Mean Square value of the line current in the motor.

⑥ **Temperature**

°C value. This is the temperature of the master inverter heatsink. This temperature is used for the HIGH TEMPERATURE alarm detection.

⑦ **Temperature #1**

°C value. This is the temperature of the right motor windings picked up with an analog sensor inside the motor. Normally this sensor is a PTC Philips KTY84-130. This temperature is used only to raise a warning, when the motor temperature overtakes the MOTOR OVERTEMP setting.

⑧ **Temperature #2**

°C value. This is the temperature of the left motor windings picked up with an analog sensor inside the motor. Normally this sensor is a PTC Philips KTY84-130. This temperature is used only to raise a warning, when the motor temperature overtakes the MOTOR OVERTEMP setting.

⑨ **Accelerator**

From 0.0V to 5.0V. ACCELERATOR reading is in the range 0.0 to 5.0Vdc.

⑩ **Steer angle**

° value. This is the angle of steering wheel.

⑪ **Int. wheel cutback**

This is the indication of the speed reduction applied to the internal wheel; in other words, it shows the ratio of the two speeds.

⑫ **Forward switch**

ON/OFF. This is the status of forward signal.

⑬ **Backward switch**

ON/OFF. This is the status of backward signal.

⑭ **Enable switch**

ON/OFF. This is the status of enable switch.

⑮ Seat switch

ON/OFF. This is the status of seat switch.

⑯ Cutback switch

ON/OFF. This is the status of cutback switch.

⑰ Brake switch

ON/OFF. This is the status of pedal brake switch.

⑱ Exclusive hydro

ON/OFF. This is the status of exclusive hydro switch.

⑲ Brake pedal pot.

Voltage of the brake potentiometer's wiper.

⑳ Hand brake

ON/OFF. This is the status of pedal handbrake switch from display.

㉑ Voltage booster

Percentage value. It is the booster contribute to the voltage really supplied to the motor expressed in percent of the actual battery voltage.

㉒ Battery voltage

Voltage value with 1 decimal digit. Battery voltage value measured at the key ON.

㉓ Battery charge

Percentage value. It supplies the residual charge of the battery as a percentage of the full charge level.

(2) Traction controller-Slave

① Motor voltage

Percentage value. It is the voltage generated by the inverter expressed in percent of the actual battery voltage. 100% means the sine wave width is close to the actual battery voltage; 0% means the sine wave width is null.

② Frequency

Hz value. This is the frequency of the sine waves the inverter is supplying.

③ Encoder

Hz value. This is the speed of the motor measured with the encoder and expressed in the same unit of the FREQUENCY reading.

④ Slip value

Hz value. This is the slip between the frequency and the speed of the motor (SLIP VALUE = FREQUENCY-ENCODER).

⑤ Current rms

Ampere value. Root Mean Square value of the line current in the motor.

⑥ **Temperature**

°C value. This is the temperature of the slave inverter heatsink. This temperature is used for the HIGH TEMPERATURE alarm detection.

⑦ **Voltage booster**

Percentage value. It is the booster contribute to the voltage really supplied to the motor expressed in percent of the actual battery voltage.

⑧ **Battery voltage**

Voltage value with 1 decimal digit. Battery voltage value measured at the key ON.

⑨ **Seat switch**

ON/OFF. This is the status of seat switch.

⑩ **Forward switch**

ON/OFF. This is the status of forward signal.

⑪ **Backward switch**

ON/OFF. This is the status of backward signal.

(3) Pump controller

① **Motor voltage**

Percentage value. It is the voltage generated by the inverter expressed in percent of the actual battery voltage. 100% means the sine wave width is close to the actual battery voltage; 0% means the sine wave width is null.

② **Frequency**

Hz value. This is the frequency of the sine waves the inverter is supplying.

③ **Encoder**

Hz value. This is the speed of the motor measured with the encoder and expressed in the same unit of the FREQUENCY reading.

④ **Slip value**

Hz value. This is the slip between the frequency and the speed of the motor (SLIP VALUE = FREQUENCY-ENCODER).

⑤ **Current rms**

Ampere value. Root Mean Square value of the line current in the motor.

⑥ **Temperature**

˚C value. This is the temperature of the inverter base plate. This temperature is used for the HIGH TEMPERATURE alarm detection.

⑦ **Accerator**

From 0.0V to 5.0V. ACCELERATOR reading is in the range 0.0 to 5.0Vdc.

⑧ **Motor temperat.**

˚C value. This is the temperature of the motor windings picked up with an analog sensor inside the motor. Normally this sensor is a PTC Philips KTY84-130. This temperature is used only to raise a warning, when the motor temperature overtakes the MOTOR OVERTEMP setting.

⑨ **Lifting switch**

ON/OFF. This is the status of the lift switch.

⑩ **Security switch**

ON/OFF. This is the status of the SBR switch.

⑪ **Hydro speed req**

ON/OFF. This is the status of hydro speed request.

⑫ **Lift/lower req**

Level of the lift and lower analogue signal.

⑬ **Tilt request**

Voltage of the tilt analogue signal.

⑭ **Shift request**

Voltage of the shift analogue signal.

⑮ **Aux request**

Voltage of the auxiliary analogue signal.

⑯ **Cutback switch**

ON/OFF. This is the status of cutback switch.

⑰ **Voltage booster**

Percentage value. It is the booster contribute to the voltage really supplied to the motor expressed in percent of the actual battery voltage.

⑱ **Battery voltage**

Voltage value with 1 decimal digit. Battery voltage value measured at the key on.

7) GENERAL SUGGESTION FOR SAFETY

For a proper installation take care of the following recommendations:

⚠ After operation, even with the key switch open, the internal capacitors may remain charged for some time. For safe operation, we recommend that the battery is disconnected, and a short circuit is made between battery positive and battery negative power terminals of the inverter using a resister between 10 ohm and 100 ohm.

⚠ During battery charge, disconnect the controller from the battery.

⚠ Do not connect the controller to a battery with a nominal voltage different than the value indicated on the controller label. A higher battery voltage may cause power section failure. A lower voltage may prevent the logic operating.

⚠ Before doing any operation, ensure that the battery is disconnected and when all the installation is completed start the machine with the drive wheels raised from the floor to ensure that any installation error do not compromise safety.

⚠ Take care all the inductive devices in the truck (horn, solenoid valves, coils, contactors) have a proper transient suppression device.

※ **The method of discharging internal capacitor**

Bofore checking controllers, motors, cables and etc., discharge the internal capacitor in controllers by following below steps ;

① Disconnect the battery cable.
② Emergency contactor on and key on.
③ Wait untill all warning lamps (red LED) on display become off.
④ Discharging process is finished.

6. INSTRUMENT PANEL : DISPLAY

1) STRUCTURE

The DISPLAY has 6 red LEDs indicating the status information of the lift truck to the driver.

Spare #1

Spare #2

Brake oil level

Park brake

Wrench

Seat belt

Thermometer

Seat

22BH9OM65

2) WARNING LAMP

(1) Brake oil level warning lamp
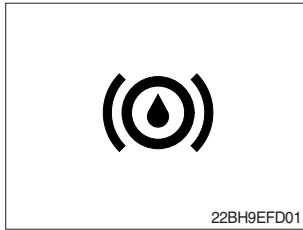
This LED lights when measured level of brake oil stored in reservoir tank is below the minimum acceptable mark.

22BH9EFD01

(2) Wrench warning lamp
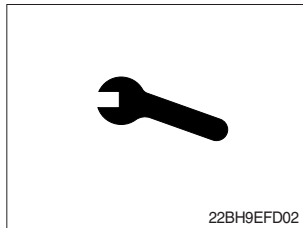
This LED lights when an electric device (controller, motor, cable, etc.) is in alarm condition.

22BH9EFD02

(3) Thermometer warning lamp
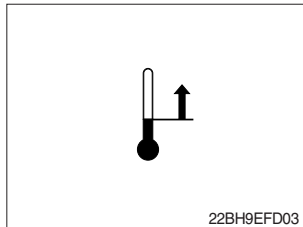
This LED lights when the controller or motor temperature is high.

22BH9EFD03

(4) Seat warning lamp

This LED lights when the operator is not on the seat.

22BH9EFD04

(5) Seat belt warning lamp
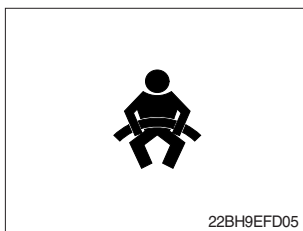
(1) This LED blinks in following 2 cases.
　① When operator starts the truck, LED blinks for 5 seconds, which means initial diagnosis is on going, and buttons on display will work properly just after the diagnosis is completed.
　② LED blinks when the seat belt is not correctly fastened.

22BH9EFD05

(6) Handbrake warning lamp
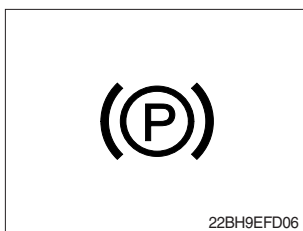
(1) This LED lights when the parking brake is activated.

22BH9EFD06

3) BUTTONS

These buttons are used to select or change the menu and input value of the LCD function and display menu.

(1) UP button

22BH9EFD07

Press to select upward move

(2) DOWN button (DOWN/TURTLE button)

22BH9EFD08

Press to select downward move
TURTLE MODE ON/OFF

(3) LEFT/MENU button

22BH9EFD09
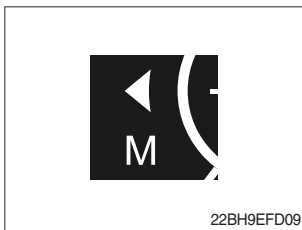
Press to select leftward move
Go into the menu

(4) RIGHT/PERFORMANCE button

22BH9EFD10

Press to select rightward move
POWER MODE H/N/E

(5) Cancel (ESC) button

22BH9EFD11
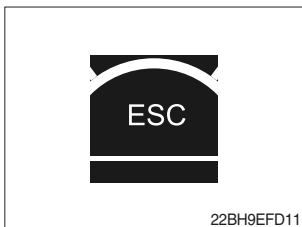
Press to select cancel
Keep pressing this button shows PASSWORD entry field.

(6) ENTER button

22BH9EFD12

Press to select Enter

4) LCD FUNCTION (MAIN SCREEN)

MAIN SCREEN

16B9FFD13

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

(1) Current time

The number shows the current time according to the setting, which can be changed by DISPLAY Setting [6. 5), Page 7-55].

(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 setpoint. 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.

(5) Truck speed

The truck speed is shown in number. According to the DISPLAY setting km/h or mph unit is available.

(6) Hour meter

The number shows the hours worked. The letter present near the hour meter 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 point is moved to the leftward or the rightward according as 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 Discharge Indicator)

The battery 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.

※ **How to adjust BDI**

If necessary, service man can a adjust BDI with adjustment #1, #2 BDI menu.

① Adjustment #1 BDI

It adjusts the upper level of the battery discharge table. Higher level means higher voltage.

② Adjustment #2 BDI

It adjusts the lower level of the battery discharge table. Higher level means higher voltage. (for detail menu, please refer to page 7-34)

5) HOW TO USE DISPLAY MENU
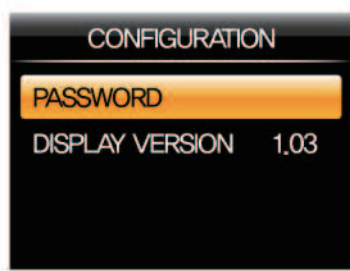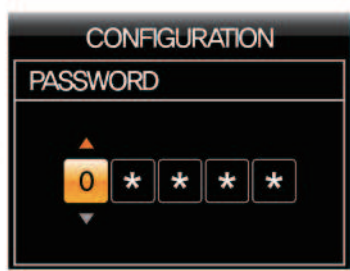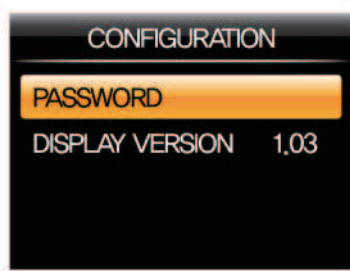
22BH9EFD14

22BH9EFD15

6) DESCRIPTION OF THE TRUCK MENU

(1) Access to truck menu

ESC If this button is pressed long, the PASSWORD dialog appears.

Enter correct PASSWORD, then on MAIN SCREEN, Press ◄| button to access the controller "TRUCK MENU"

(2) How to change detail menus

The detail items of menu can be changed as follows ;
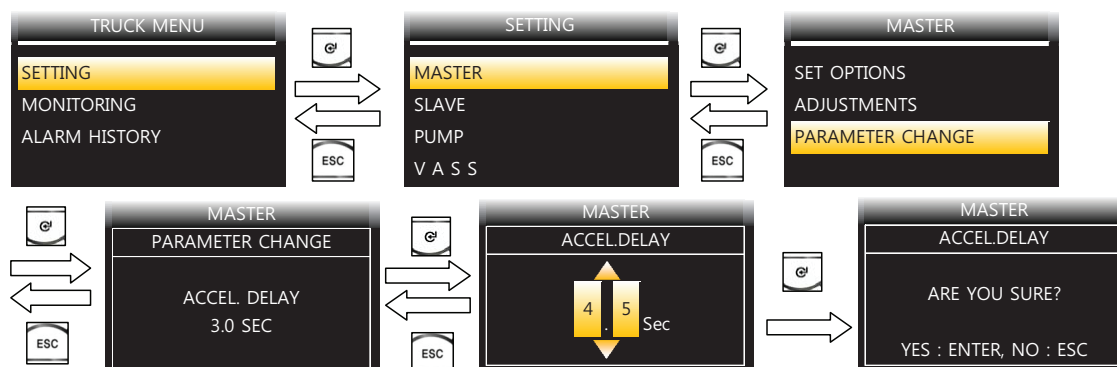
22B9EL24

Selection can be made in 4 methods as follows ;

- ON/OFF Selection
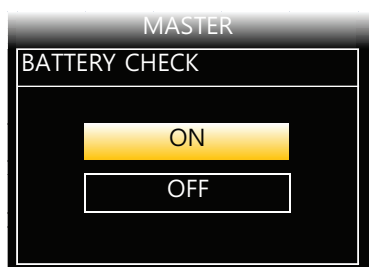
22B9EL25

Select a desired value with ▲ , ▼ button, then save with ↵ button or press ESC button to escape without saving.

- Type Selection
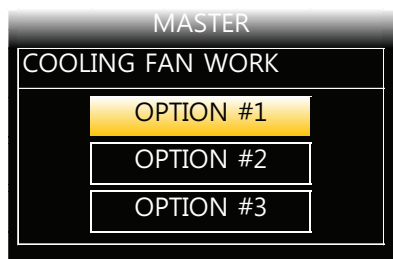
22B9EL30

Select a desired value with ▲ , ▼ button, then save with ↵ button or press ESC button to escape without saving.

- Figure input
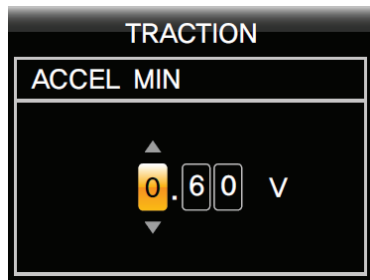
22B9EL31

Select a desired value with [▲] , [▼] , [◀|M] , [▶|P] button, then save with [↵] button or press [ESC] button to escape without saving.

- Level Selection
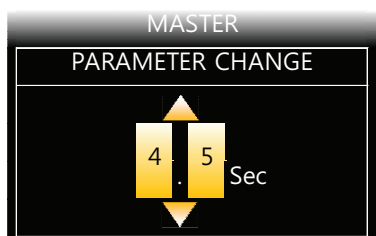
22B9EL30

Select a desired value with [▲] , [▼] button, then save with [↵] button or press [ESC] button to escape without saving.
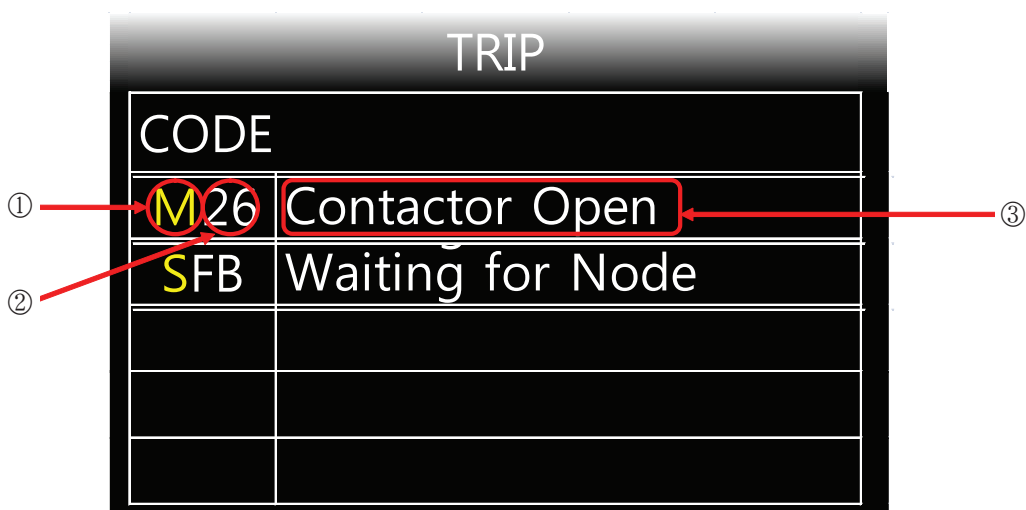
7) ALARM & ALARM HISTORY

(1) How to check alarms

Normally, ALARM SCREEN pops up if any kind of a alarm happens, but service man can switch between a MAIN SCREEN and ALARM SCREEN with [ESC] , [↵] buttons as follows :

(Press more than 1 sec)

CODE	NAME
M26	Contactor Open
SFB	Waiting for Node

16B9FEL35

(2) Detail description of ALARM SCREEN

22B9EL36

① First yellow capital letter shows in which controller the alarm happens as below;

   M : Traction-Master

   S : Traction-Slave

   P : Pump

   V : Mhyrio CB

② Following two letters or digits show alarm code. Please refer to 7. ALARM CODE (Page 7-67).

③ This shows a name of ALARM. Please refer to 7. ALARM CODE (page 7-67).

(3) Alatm history

Alarm History can be looked up as follows ;
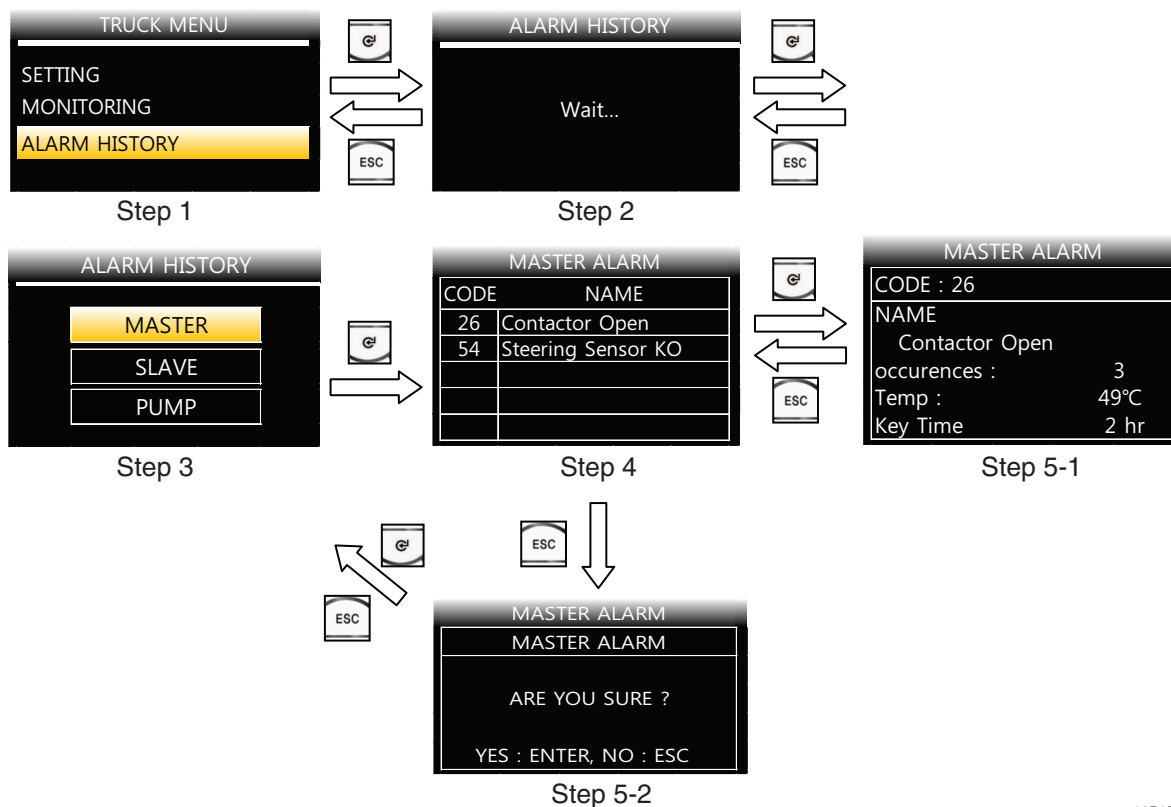
22B9EL37

① Step 1 : Service man can check the alarm history on ALARM HISTORY menu
② Step 2 : When service man enter the ALARM HISTORY menu, display read entire alarm records of all controller. So it takes 9~15 seconds to read.
③ Step 3 : When display finish to read alarm records, service man can choose each controller to read the alarm history.
④ Step 4 : When service man enters each controller's alarm history, service man can check simply up to 5 alarms and choose a specific alarm to read detail alarm information.
⑤ Step 5-1 : When service man press [↵] button at Step 4, operator can see a detail alarm information of chosen alarm. Please refer to 6-7)-(4) DETAIL ALARM INFORMATION (as below).
⑥ Step 5-2 : When service man press [ESC] button at Step 4, service man can see a alarm clear menu. If service man press [↵] button, Recorded alarms of selected controller will be erased.
(to verify cleaned alarm records, service man should be back to Step 1 & 2 to refresh.)
If operator press [ESC] button, just escape to step 3 without clearing

(4) Detail alarm information
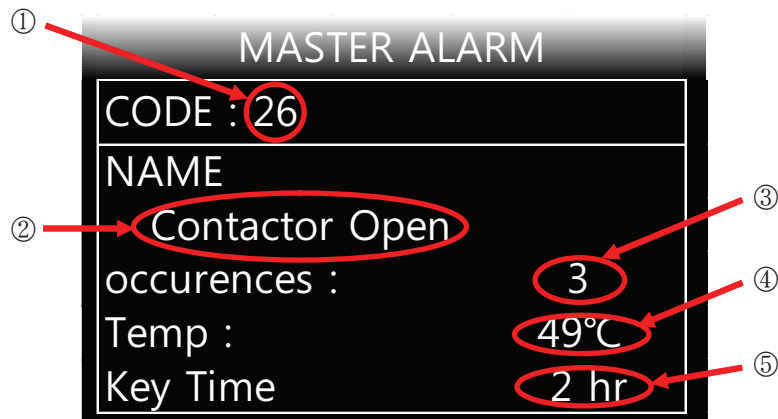
22B9EL38

① Code of alarm
② Name of alarm
③ Count of alarm
④ Temperature of controller as alarm occurs.
⑤ Hourmeter of controller as alarm occurs.

8) VASS SETUP USING DISPLAY MENU

This function searches and memorizes the minimum and maximum potentiometer wiper voltage of the accelerator pedal, lift lever, and steering sensor which use potentiometer sensors. The belows show how to use the VASS function of DISPLAY.
(All figures in belows are just example.)

※ While even a motor is running, VASS can not be configured properly, so please be sure that all motors are not running before entering configuration process & saving.

(1) ACCEL VASS setting method

V.A.S.S	
ACCEL	
MIN FORWARD	0.76V
MAX FORWARD	1.76V
MIN REVERSE	0.76V
MAX REVERSE	1.76V

Please make sure that all motors are not running & direction lever is in NEUTRAL position.

V.A.S.S	
ACCEL	READY
MIN FORWARD	0.76V
MAX FORWARD	1.76V
MIN REVERSE	0.76V
MAX REVERSE	1.76V

If "READY" appears beside ACCEL, you are in configuration process.
Set direction lever in FORWARD position.

V.A.S.S	
ACCEL	READY
MIN FORWARD	0.90V
MAX FORWARD	0.90V
MIN REVERSE	0.76V
MAX REVERSE	1.76V

Now, you can see that voltage value of MIN FORWARD and MAX FORWARD are changed.
Step on accel pedal fully, then Take foot off accel pedal.

V.A.S.S	
ACCEL	READY
MIN FORWARD	0.90V
MAX FORWARD	4.47V
MIN REVERSE	0.76V
MAX REVERSE	1.76V

Now, you can see that voltage value of MAX FORWARD are changed.
Set direction lever in REVERSE position. (Sometimes, depending on controller model, MIN FORWARD value looks like that it is fixed as 0.0V, which is normal.)

V.A.S.S	
ACCEL	READY
MIN FORWARD	0.90V
MAX FORWARD	4.47V
MIN REVERSE	0.90V
MAX REVERSE	0.90V

Now, you can see that voltage value of MIN REVERSE and MAX REVERSE are changed.
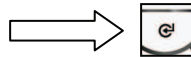Step on accel pedal fully, then Take foot off accel pedal

22B9EL39-1

```
         V.A.S.S
ACCEL              READY
MIN FORWARD        0.90V
MAX FORWARD        4.47V
MIN REVERSE        0.90V
MAX REVERSE        4.47V
```

Now, you can see that voltage value of
MAX REVERSE are changed.
Please make sure that all motors are not
running & direction lever is in NEUTRAL
position.

```
         V.A.S.S
ACCEL              FINISH


      ARE YOU SURE ?


   YES : ENTER, NO : ESC
```

22B9EL39-2

(2) LIFT VASS setting method

```
         V.A.S.S
LIFT

  MIN LIFT         0.10V

  MAX LIFT         1.25V
```

Please make sure that all
motors are not running &
direction lever is in NEUTRAL
position.

```
         V.A.S.S
LIFT               READY

  MIN LIFT         0.25V

  MAX LIFT         0.25V
```

If "READY" appears beside LIFT, you are
in configuration process.
Now, operator can see that voltage value
of MIN LIFT and MAX LIFT are
changed.
Full the lift lever toward operator fully
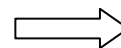
```
         V.A.S.S
LIFT               READY

  MIN LIFT         0.25V

  MAX LIFT         6.20V
```

Now, you can see that voltage value of
MAX LIFT are changed.
Please make sure that all motors are not
running & direction lever is in NEUTRAL
position.

```
         V.A.S.S
LIFT               READY

      ARE YOU SURE ?


   YES : ENTER, NO : ESC
```

22B9EL40

(3) STEER ANGLE VASS setting method

```
         V.A.S.S
STEER ANGLE
STEER RIGHT      2.45V
STEER LEFT       4.24V
STEER 0-POS      3.64V
```

Please make sure that all motors are not running & direction lever is in NEUTRAL position.

```
         V.A.S.S
STEER ANGLE      READY
STEER RIGHT      2.94V
STEER LEFT       4.24V
STEER 0-POS      3.64V
```

If "READY" appears beside STEER ANGLE, you are in configuration process. Now, operator can see that voltage value of STEER RIGHT is changed.
Turn steer handle to right-end fully, the value will be changed.

```
         V.A.S.S
STEER ANGLE      READY
STEER RIGHT      1.20V
STEER LEFT       1.20V
STEER 0-POS      3.64V
```

Now, you can see that voltage value of STEER RIGHT is saved.
Turn steer handle to left-end fully, the voltage value will be changed.

```
         V.A.S.S
STEER ANGLE      READY
STEER RIGHT      1.20V
STEER LEFT       7.84V
STEER 0-POS      7.84V
```

Now, you can see that voltage value of STEER LEFT is saved.
Turn steer handle to center position, the voltage value will be changed.
Please make sure that all traction motors are not running

```
         V.A.S.S
STEER ANGLE      READY

      ARE YOU SURE ?

   YES : ENTER, NO : ESC
```
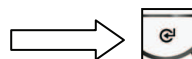
22B9EL41

9) STRUCTURE OF TRUCK MENU

TRUCK MENU is in order to make configuration of truck easily, and consists of 3 major categorys : SETTING, MONITORING, ALARM HISTORY.

[To know how to get in to TRUCK MENU, refer to 6-6)-(1) "ACCESS TO TRUCK MENU" page 7-57]

(1) Settings
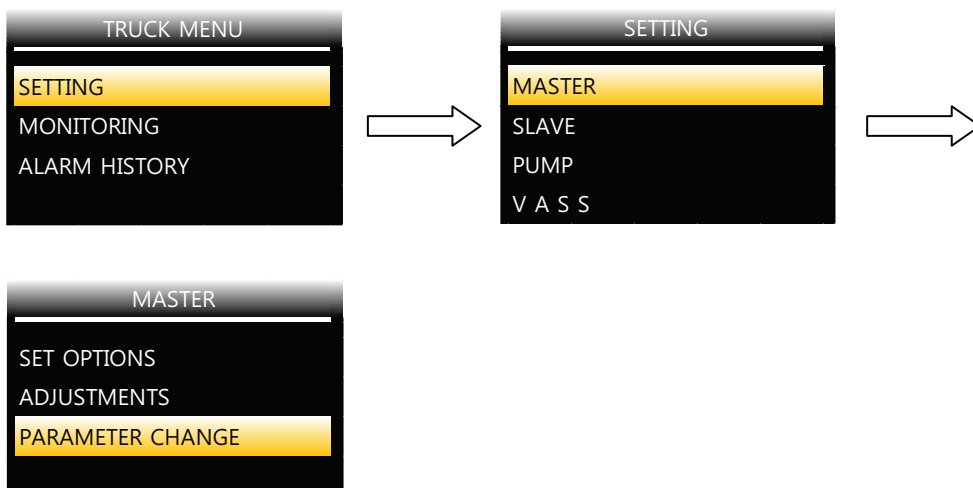
22B9EL42

In SETTINGS, service man can choose a specific controller's submenu or VASS menu.

① MASTER->SET OPTIONS

Refer to 5-4)- ■ "TRACTION-MASTER CONTROLLER"-(1) "SET OPTIONS" (page 7-32)

② MASTER->ADJUSTMENTS

Refer to 5-4)- ■ "TRACTION-MASTER CONTROLLER"-(2) "ADJUSTMENTS" (page 7-33)

③ MASTER->PARAMETER CHANGE

Refer to 5-4)- ■ "TRACTION-MASTER CONTROLLER"-(3) "PARAMETER CHANGE" (page 7-36)

④ SLAVE->SET OPTIONS

Not available

⑤ SLAVE->ADJUSTMENTS

Refer to 5-4)- ■ "TRACTION-SLAVE CONTROLLER"-(2) "ADJUSTMENTS" (page 7-38)

⑥ SLAVE->PARAMETER CHANGE

Refer to 5-4)- ■ "TRACTION-SLAVE CONTROLLER"-(3) "PARAMETER CHANGE" (page 7-38)

⑦ PUMP->SET OPTIONS

Refer to 5-4)- ■ "PUMP CONTROLLER"-(1) "SET OPTIONS" (page 7-38)

⑧ PUMP->ADJUSTMENTS

Refer to 5-4)- ■ "PUMP CONTROLLER"-(2) "ADJUSTMENTS" (page 7-39)

⑨ PUMP->PARAMETER CHANGE

Refer to 5-4)- ■ "PUMP CONTROLLER"-(3) "PARAMETER CHANGE" (page 7-40)

⑩ V.A.S.S

Refer to 6-8) "VASS SETUP USING DISPLAY MENU" (page 7-62)

(2) Monitoring

TRUCK MENU
SETTING
MONITORING
ALARM HISTORY

MONITORING
MASTER
SLAVE
PUMP

MONITORING	
MASTER	
Voltage booster	0%
Battery voltage	47.9V
Battery charge	50V
Device Name	HY
H/W VER	DA2M
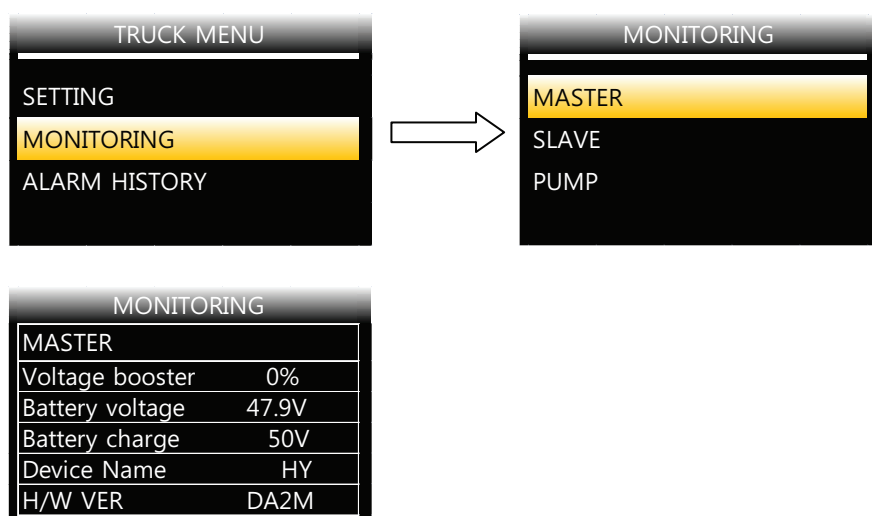
22B9EL43

In MONITORING MENU, service man can check various stats of trucks.

① MASTER

    Refer to 5-6)-(1) "Traction controller-master" (page 7-45)

② SLAVE

    Refer to 5-6)-(2) "Traction controller-Slave" (page 7-46)

③ PUMP

    Refer to 5-6)-(3) "Pump controller" (page 7-48)

(3) Alarm history

    Refer to 6-7) "ALARM & ALARM HISTORY" (page 7-59)

7. ALARM CODE

1) TRACTION-MASTER & SLAVE CONTROLLER

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
08	WATCHDOG	Alarm: the watchdog circuit has been triggered	- If the alarm is present in Init status, remove the alarm condition - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a traction request
0D	EEPROM KO	Warning: EEPROM fault, controller will use default parameters	- To remove warning cause
11	LOGIC FAILURE #3	Alarm: failure in over-load protection hw circuit	- To remove alarm condition + activation of traction request - Check the controller
12	LOGIC FAILURE #2	Alarm: failure in U, V, W voltage feedback circuit	- To remove alarm condition + activation of traction request
13	LOGIC FAILURE #1	Alarm: an overvoltage or undervolt. condition has been detected	- To recycle the key switch - Sometimes if battery voltage is too low, it can be happens - Check the controller
1E	VMN LOW	Alarm: wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor	- If the alarm is present in Init status, remove the alarm condition - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a traction request - Check the U,V,W cable and motor and if there is any shorted circuit with frame or any other parts of truck - Check the controller
1F	VMN HIGH	Alarm: wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor	- If the alarm is present in Init status, remove the alarm condition - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a traction request - Check the U,V,W cable and motor and if there is any shorted circuit with frame or any other parts of truck - Check the controller
25	CONTACTOR CLOSED	Alarm: line contactor power contact is stuck	- To remove alarm cause within a timeout; if the timeout is elapsed, it is necessary to re-cycle the key - Check the contactor & cables attached to the contactor
26	CONTACTOR OPEN	Alarm: line contactor power contact does not pull-in	- To remove alarm cause within a timeout; if the timeout is elapsed, it is necessary to re-cycle the key - Check the contactor & cables attached to the contactor
31	I = 0 EVER	Alarm: while truck is running, current value is 0 for more than 1 sec	- Check the main contactor - Check the controller

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
35	STBY I HIGH	Alarm: wrong voltage in the current sensor feedback circuit	- If the alarm is present in Init status, remove the alarm condition - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a traction request
3C	CAPACITOR CHARGE	Alarm: power capacitor voltage does not increase when the key is turned ON; failure in the power section, or in the logic PCB, or in the driver PCB, or in the motor	- To remove alarm condition - Check the contactor resistance (300Ω, 10W) - Check the controller
3D	HIGH TEMPERATURE	Warning: master or slave temperature higher than 75°C	- To remove warning cause
41	MOTOR TEMPERAT.	Warning: traction motor temperature high	- To remove warning cause - Check the motor temp-sensor
42	BATTERY LOW	Warning: battery charge level below 10%	- To remove warning cause
4A	DRIVER SHORTED	Alarm: line contactor coil driver is shorted	- If the alarm is present in Init status, remove the alarm cause - If the alarm has occurred in stby or running mode, it is necessary to remove alarm cause and to activate traction request
4B	CONTACTOR DRIVER	Alarm: line contactor coil driver is open (not able to drive the coil to the correct voltage)	- To remove alarm cause and to activate traction request
4C	COIL SHORTED	Alarm: - Init: the LC and EB coil driver protection circuit is damaged - Stby or running: short on LC coil or EB coil	- If the alarm is present in Init status, remove the alarm cause - If the alarm has occurred in stby or running mode, it is necessary to remove alarm cause and to activate traction request
4E	VACC NOT OK	Warning: acc. signal (CPOT) voltage higher than VACC MIN +1V while the traction enable switch is open	- To remove warning cause - Re-configure VASS ACCEL
4F	INCORRECT START	Warning: wrong traction request sequence	- To remove warning cause
50	FORW + BACK	Warning: forward and reverse inputs are both active	- To remove warning cause
52	ENCODER ERROR	Alarm: motor speed sensor (encoder) does not work properly	- To recycle the key - Check the motor encoder
54	STEER SENSOR KO	Alarm: steering sensor signal out of range	- To remove alarm cause
56 (Slave only)	PEDAL WIRE KO	Alarm: fault in accelerator negative (NPOT) input circuit	- To remove alarm cause and activate a traction request

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
F0	MOTOR STALL	Warning: the encoder signal is constantly zero when the maximum torque is applied to the motor	- To recycle the key - Check the motor and encoder
F1	DATA ACQUISITION	Alarm: data communication is now processing.	- If this alarm occurs, when sensor setting procedure, recycle the key.
F2	PUMP WARNING	Warning: a warning is active on the pump module	- To remove warning cause
F3	SEQUENCE FAULT	Warning: an incorrect start sequence has been detected on the seat, pedal and levers commands	- To remove warning cause
F4	SLAVE WARNING	Warning: a warning is active on the SLAVE module	- To remove warning cause
F5	WRONG SET BAT.	Alarm: the battery voltage does not correspond to SET BATTERY programming	- To remove alarm cause
F6 (master only)	SLAVE KO	Alarm: master µC detects a slave µC malfunctioning	- To recycle the key - Check if any other alarm happens (Some alarms such as CHAT TIME or PEDAL WIRE KO, alarms related to CONTACTOR, DISPLAY ENABLE, alarms related to CAN-BUS can make this alarm sometimes.) - Check the communication with all controllers (display TRUCK MENU->MONITORING-> choose controller->H/W ver, S/W ver. If CAN communication is not available, H/W ver, S/W ver will be blank.)
F6 (slave only)	MASTER KO	Alarm: slave µC detects a master µC malfunctioning or a mismatch between inputs status and master commands (via CAN-BUS)	- To recycle the key - Check If any other alarm happens (Some alarms such as CHAT TIME or PEDAL WIRE KO, alarms related to CONTACTOR, DISPLAY ENABLE, alarms related to CAN-BUS can make this alarm sometimes.) - Check the communication with all controllers (display TRUCK MENU->MONITORING-> choose controller->H/W ver, S/W ver. If CAN communication is not available, H/W ver, S/W ver will be blank.)

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
F7	NO CAN MSG N.	Alarm: traction has lost CAN communication with #X	- To remove alarm cause - Check if any other alarm happens (Some alarms such as CHAT TIME or PEDAL WIRE KO, alarms related to CONTACTOR, DISPLAY ENABLE, alarms related to CAN-BUS can make this alarm sometimes.) - Check the communication with all controllers (display TRUCK MENU->MONITORING->choose controller->H/W ver, S/W ver. If CAN communication is not available, H/W ver, S/W ver will be blank.)
F8	DISPLAY ENABLE	Warning: the display enable signal has not been received to operate the truck	- To remove warning cause
F9	THERMIC SENS. KO	Warning: traction temp. sensor is out of range	- To remove warning cause
FA (slave only)	INPUT MISMATCH	Alarm: slave µC has detected a mismatch between inputs status and the input status transmitted via CAN-BUS by master µC	- To recycle the key
FA (master only)	HANDBRAKE	Warning: handbrake microswitch is open and a travel request is active	- To remove warning cause
FB	WAITING FOR NODE	Warning: master controller signals that other controllers are in alarm status	- To remove warning cause - Check if any other alarm happens (Some alarms such as CHAT TIME or PEDAL WIRE KO, alarms related to CONTACTOR, DISPLAY ENABLE, alarms related to CAN-BUS can make this alarm sometimes.) - Check the communication with all controllers (display TRUCK MENU-> MONITORING->choose controller->H/W ver, S/W ver. If CAN communication is not available, H/W ver, S/W ver will be blank.) - Check other controllers
FC	CHAT MODE	Warning: the chat time has expired	- To activate traction or pump request
FD	AUX OUTPUT KO	Alarm: fan relay driver shorted or open	- If the alarm is present in Init status, remove the alarm cause - If the alarm has occurred in stby or running mode, it is necessary to remove alarm cause and to activate traction request
FE	CANBUS KO DISPL.	Alarm: master has lost can communication with the display	- To remove warning cause

2) PUMP CONTROLLER

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
08	WATCHDOG	Alarm: the watchdog circuit has been triggered	- If the alarm is present in Init status, remove the alarm condition - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a pump request
0D	EEPROM KO	Warning: EEPROM fault, controller will use default parameters	- To remove warning cause
12	LOGIC FAILURE #2	Alarm: failure in U, V, W voltage feedback circuit	- To remove alarm condition + activation of pump request
13	LOGIC FAILURE #1	Alarm: an overvoltage or undervolt. condition has been detected	- To recycle the key switch - Sometimes if battery voltage is too low, it can be happens - Check the controller
1E	VMN LOW	Alarm: wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor	- If the alarm is present in Init status, remove the alarm condition - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a pump request - Check the U, V, W cable and motor and if there is any shorted circuit with frame or any other parts of truck - Check the controller
1F	VMN HIGH	Alarm: wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor	- If the alarm is present in Init status, remove the alarm condition - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a pump request - Check the U, V, W cable and motor and if there is any shorted circuit with frame or any other parts of truck - Check the controller
25	CONTACTOR CLOSED	Alarm: line contactor power contact is stuck	- To remove alarm cause within a timeout; if the timeout is elapsed, it is necessary to re-cycle the key - Check the contactor & cables attached to the contactor
26	CONTACTOR OPEN	Alarm: line contactor power contact does not pull-in	- To remove alarm cause within a timeout; if the timeout is elapsed, it is necessary to re-cycle the key - Check the contactor & cables attached to the contactor
31	I = 0 EVER	Alarm: while truck is running, current value is 0 for more than 1 sec	- Check the main contactor - Check the controller

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
35	STBY I HIGH	Alarm: wrong voltage in the current sensor feedback circuit	- If the alarm is present in Init status, remove the alarm condition - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a pump request
3C	CAPACITOR CHARGE	Alarm: power capacitor voltage does not increase when the key is turned ON; failure in the power section, or in the Logic PCB, or in the driver PCB, or in the motor	- To remove alarm condition - Check the contactor resistance (300Ω, 10W) - Check the controller
3D	TH. PROTECTION	Warning: pump temperature higher than 75°C	- To remove warning cause
41	MOTOR TEMPERAT.	Warning: pump motor temperature high	- To remove warning cause - Check the motor temp-sensor
42	BATTERY LOW	Warning: battery charge level below 10%	- To remove warning cause
4A	DRIVER SHORTED	Alarm: line contactor coil driver is shorted	- If the alarm is present in Init status, remove the alarm cause - If the alarm has occurred in stby or running mode, it is necessary to remove alarm cause and to activate pump request
4B	CONTACTOR DRIVER	Alarm: line contactor coil driver is open (not able to drive the coil to the correct voltage)	- To remove alarm cause and to activate pump request
4C	COIL SHORTED	Alarm : - Init: the LC and EB coil driver protection circuit is damaged - Stby or running: short on LC coil or EB coil	- If the alarm is present in Init status, remove the alarm cause - If the alarm has occurred in stby or running mode, it is necessary to remove alarm cause and to activate pump request
4E	VACC NOT OK	Warning: lift signal (CPOT) voltage higher than VACC MIN +1V while the lift enable switch is open	- To remove warning cause - Re-configure VASS ACCEL
4F	INCORRECT START	Warning: wrong pump request sequence	- To remove warning cause
50	FORW + BACK	Warning: forward and reverse inputs are both active	- To remove warning cause
52	ENCODER ERROR	Alarm: motor speed sensor (encoder) does not work properly	- To recycle the key - Check the motor encoder
DF	SBR SWITCH OPEN	Warning: side battery removal sensor is open	- To remove warning cause - Check the sensor
E0	AUX COIL SHORT	Alarm: short circuit on EB/AUX coil	- To remove alarm cause
E3	WATCHDOG #2	Alarm: the watchdog signal #2 is not in the correct status	- To remove alarm cause

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
E4	CHAT TIME	Warning: the chat time has expired	- To activate traction or pump request
E5	SAFETY INPUT	Alarm: the safety input is open (it is not connected to –Batt)	- To remove alarm cause
E6	MC COIL SHORT	Alarm: shortcircuit on MC coil	- To remove alarm cause
E7	COIL SHORT HW KO	Alarm: the harware to check a MC or EB/AUX coil shorted is damaged	- Check the controller
E8	KEY OFF SHORT	Alarm: at start-up the keyoff logic signal is low	- Check the connection. - Check the key input signal.
E9	POWER MOS SHORT	Alarm: short circuit on the power mosfets	- Check the controller
EA	DISPLAY ENABLE	Warning: the display enable signal has not been received to operate the truck	- To remove warning cause
EB	HANDBRAKE	Warning: handbrake microswitch is open and a travel request is active	- To remove warning cause
EC	CURRENT GAIN	Warning: the maximum current gain parameters are the default values, which means the maximum current adjustment procedure has not been carried out yet	- Ask the assistance of an engineer at the development department to do the correct adjustment procedure of the current gain parameters.
ED	ANALOG INPUT	Alarm: the analog channel ready is not updated	- Check the controller
EE	WRONG 0 VOLTAGE	Alarm: the motor phases voltage feedback are out of permitted range	- To remove alarm cause
EF	SAFETY OUTPUT	Alarm: the safety-out driver is damaged (shorted or open)	- To remove alarm cause
F0	HARDWARE FAULT	Alarm: the mosfets driver are not switched off with watch-dog signal in alarm status	- Check the controller
F1	FLASH CHECKSUM	Alarm: the program verify is not OK	- Try to program the controller again. Check the controller logic board
F2	MOTOR STALL	Warning: the encoder signal is constantly zero when the maximum torque is applied to the motor	- To recycle the key - Check the motor and encoder
F4	SOFTWARE ERROR	Alarm: CAN-BUS line of ACE2 is in CAN-BUS line OFF condition	- Check CAN-BUS connection. If CAN-BUS connection is OK, replace the logic of ACE2.

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
F5	WRONG RAM MEMORY	Alarm: the algorithm implemented to check the main RAM registers finds a wrong contents: the register is "dirty". This alarm inhibit the machine operations.	- Try to switch the key off and then on. If the alarm is still present, replace the ACE2 logic board.
F6	AUX DRIV.OPEN	Alarm: the AUX coil driver is not able to drive the load. The device itself or its driving circuit is damaged.	- This type of fault is not related to external components, replace the ACE2 logic board.
F7	DATA ACQUISITION	Alarm: data communication is now processing.	- If this alarm occurs, when sensor setting procedure, recycle the key.
F8	BRAKE OIL	Warning: lack of brake oil	- Check the brake oil tank & sensor
F9	CHECK UP NEEDED	Warning: truck reached the hour time for maintenance.	- Reset the checkup hour time
FB	WRONG SET BAT.	Alarm: the battery voltage does not correspond to SET BATTERY programming	- To remove alarm cause
FD	SLIP_PROFILE	Warning: error on the parameters of the slip profile setting.	- Check in the hardware settings menu the value of those parameters

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 mm 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) Names of each part (independent items)
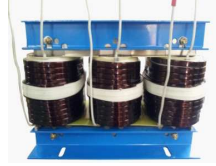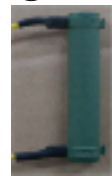
22B9BAT30

1	Main PCB board	5	Monitor PCB	9	Resistance (RD)
2	Main trans (Class H)	6	Overload	10	Resistance (DR)
3	Cooling fan	7	MG S/W		
4	SCR module	8	Assistant trans		

2) CHARGER INSTALLATION METHOD

(1) Location for charger installation
① Dry and well ventilated place.
② No inflammable and B7 fire are near by.
③ Safe place where no collision possibility with people or equipment is.

(2) Check points before installing charger
① Enough capacity of AC input power source to operate charger.
② Standard electric wire for power source by capacity.

(3) Table for capacity of charger input cable

48 V battery	Capacity of cable	Input voltage	Remarks
200-365 AH	4P - 2.5 mm²		
400-580 AH	4P - 4 mm²		
600-800 AH	4P - 6 mm²		For 3 ø 220V,
850-1000 AH	4P - 10 mm²	Based on	one step
24 V battery	-	3 ø 380 V	higher
200-600 AH	4P - 2.5 mm²	3 ø 440 V	capacity
700-1000 AH	4P - 4 mm²		cable should
80V battery	-		be used.
500-600 AH	4P - 6 mm²		(2.5 mm² →
700-800 AH	4P - 10 mm²		4mm²)

3) HOW TO USE A CHARGER

(1) General charging method (Floating charging)

① Charging by this method supplies electric power to the charger as operating external AC power switch of the charger.

② Connect battery connecter and charger connecter.

· According to charging condition

① If there is no abnormality found when the charger checks itself for 3-4 seconds after inputting AC input power source, the charger slowly increases the electric flow for charging and the charging condition lamp in the lower part of the front panel for floating charging of "input" is on.

② A charging voltage, current, amount and time are displayed in order on a monitor display window.

③ When charging is processed about 80%, yellow lamp in the middle of the front panel, which shows that the charging condition is in the middle, is on and then green lamp is on when charging is processed over 85% until charging is completed.

④ When charging is completed, "charging is completed" lamp is on in the monitor and other lamps of all monitors become off.
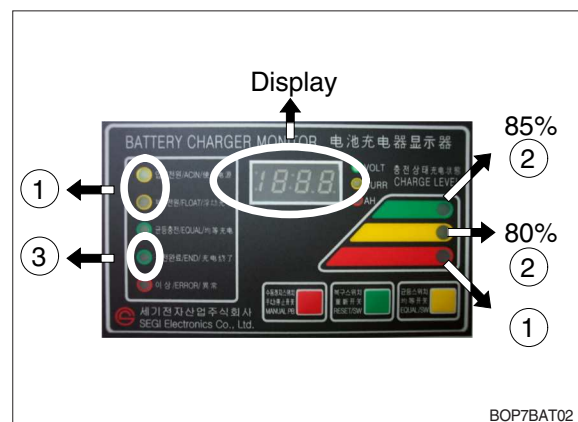
(2) Equalized charging

① Equalized charging is

Equalized charging is to correct the battery when it does not normally perform its functions as the voltage differences are too big between cells of a battery.

When equalized charging is required?

- When re-operates the battery after having left the battery for a long time.
- When a battery is over-discharged.
- When there is large deviation of voltage and specific gravity between battery cells.
- When change or supply electrolyte of battery.

22B9BAT01

Display

85%
②

80%
②

①

BOP7BAT02

② **Tips for equalized charging**

If once push the equalized charging button on the monitor in the beginning of charging, the equalized charging lamp becomes on and starts charging.

※ **When the green charging condition lamp is on (over 85% charged), the equalized charging switch is locked that it does not operate even pushing the button.**

Equalized charge indicating lamp   Equalized charge S/W

22B9BAT03
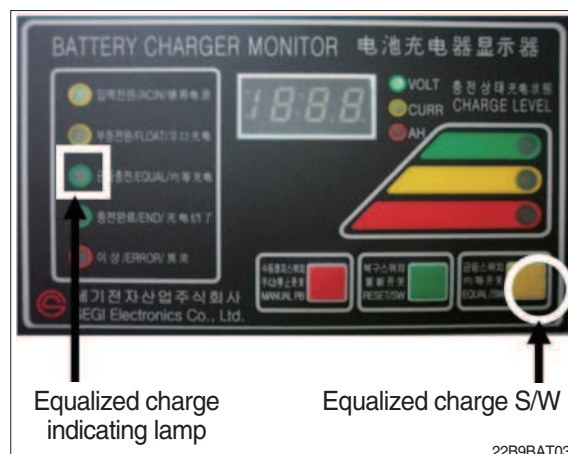
(3) Automatic/Manual switching method

Automatic connector. Manual switching connector (J2) is located on a left top corner of PCB.

※ **In case of manual switching for charger checking, make sure that the battery connector is separated beforehand.**

⊙ MG/SW operation
(Refer to the charger trouble SHEET components manual)

Manual connector connection   Automatic connector connection

J2   J2

MG/SW

22B9BAT04
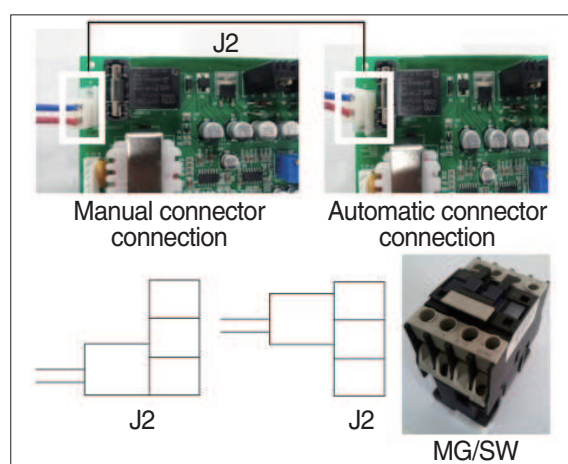
(4) Checking charging voltage soft start function (Refer to the monitor)

① Plug it into a manual connector and input after 5 sec., a floating charge, charging status red LED lights up.
② After 15 sec., charging status yellow LED lights up.
③ After a green LED lights up, if measured voltage comes out as lulua63V ~ lula64V by measuring output voltage of battery connector side with multi-meter, then it is normal.
④ After 30 sec. of switching to a manual connector, if a buzzer sound rings continuously for 10 sec. and completion LED lights up, then it is normal.
⑤ If you confirm that the charger operates in normal after checking manual switching of the charger, make sure that the charger is switched to automatic.

BOP7BAT10

⑥ If charger's out voltage is under 60 V, it is abnormal.
Please refer to the error sheet.

⑦ When the charging voltage is indicated as normal condition (64 V), convert automatic / manual switch to automatic and start charging.

※ **Display error code on the front cover as following table.**
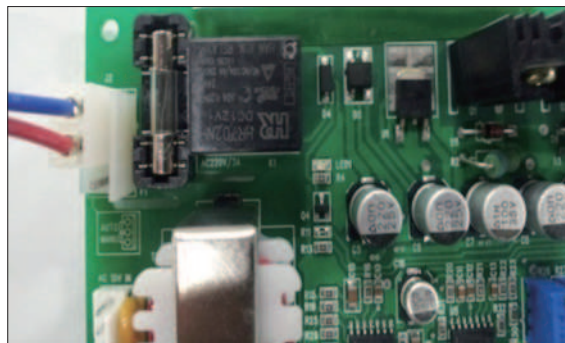
22B9BAT11

No	Code	Description of error
1	E.F	EPROM fail
2	O.V	Over voltage - Refer to page 7-85
3	O.C	Over current - Refer to page 7-84, 7-86
4	F.B	Battery error (After starting charging, the voltage doesn't go over 52V for 2 hours.) Check the battery.
5	O.T	Transformer over heat (Stop charging when it is over 160°C). - If input voltage is high, output current is over normal value and there is heat in the trans because of SCR control part fault. - Check the output current and PCB control board
6	O.H	Heatsink over heat (Stop charging when it is over 100°C). - Check the cooling fan, SCR connection cable contact point and control part.
7	A.O	Power supply error (input power 220/380V wrong wiring). - Refer to page 7-83.
8	A.F	Power supply error (absent phase) - Check if input cable is open.
9	A.C	AC fail (black out) - Check if input voltage is right.
10	L.C	Low current (If this sign is on for setting value (60 sec), charging is over).
11	F	Manual stop.

4) CHECK POINTS BEFORE APPLYING A/S

(1) AC input power source switch is input.

(2) Check if the battery connector of the order picker truck and charger's connector are connected.

(3) Check points when "Error" lamp is on in the front monitor of the charger.

(4) Check the front cover indicator.

① A.F : Input three phase power source continuity check = Check if input three phase power source is normal with AC voltage meter.

② A.O : Error on selection of input power source of 220V or 380V - Check it appropriately with full three phases.

③ A.C : Check if the input power source (220V or 380V) is normal.

④ O.C : Check the electric current, as charging current of the battery is over-standards condition.

⑤ O.V : Check the voltage, as charging voltage of the battery is over-voltage condition (66V).
Normally it is 64V±1.0V.

(5) Check other abnormalities as well. Then apply for A/S when on-site measurements are not applicable.

Error indication

BOP7BAT12
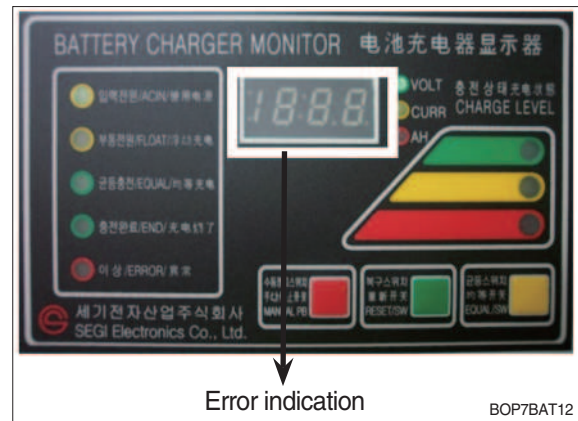
5) ERROR DETECTION

(1) Error list

① Only floating charge lamp is on in the monitor but it is not charged.

② ON and OFF is repeated with a few minutes intervals even after starting charging.

③ Charger TRIP is occurred after abnormality lamp is on.
In case error code is "O.V"

④ Charger TRIP is occurred after abnormality lamp is on.
In case error code is "O.C"

⑤ Charger TRIP is occurred after it started charging and charging completion lamp is on.

⑥ Charger has no response even the battery connector is connected.

⑦ SCR module checking method

(2) Troubleshooting

① Only floating charge lamp is on after indicating "A.O", It's not charged.

· 220/380V Model : Measure the voltage between input voltage change over tabs 2-4 2-6 4-6
· 220,380,410,440V Model : Measure the voltage in front of AC INPUT MS S/W

MS electric socket

Manual/Auto TAP (J2)

Check the rated voltage

— YES → Insert automatic/ manual connector (J2) at the upper part of PCB to manual, after separating battery connector.

→ AC INPUT MS switch ON

— YES → PCB LP lamp lights up

— YES →

NO ↓ (AC INPUT MS switch ON)

Put a black lead of multi-tester to input voltage switch No. 6 and measure voltage between tab No.8,PCB CN4,TH contact points with a red lead.

NO ↓ (PCB LP lamp lights up) → Change PCB

CN4 contact fault
PCB RY contact fault

NO (Check the rated voltage) ↓

Input power supply is not supplied.

· Check external lead cable.
· Check the connection of external input connecter
· Check external NFB TRIP

Voltage 220V

— NO → TH contact fault
CN4 contact fault
PCB RELAY fault
TH manual restoration release

YES ↓
MS COIL fault

TB.4 (380V) TB.8(220V)

70 Ω / 30W

M/S B

T.B short bar   7   8

Voltage tap

J2

PCB RY (LP lamp)

Manual / Auto S/W

TH*

M/S COIL   FAN

TB.6

M/S electrical circuit

Relay contact point   Relay

7-83

② **ON and OFF is repeated with a few minutes intervals after starting charging.**
   Indicate "O.C" on the monitor.
   - TH is operated (AC input over-current TRIP).

OUTPUT CURRENT

| DE-CREASE | IN-CREASE |

Trans noise is severe at MS ON status

— NO → Measure output current using DC current measure → Current value : 10~16A /100AH

Current value — NO → Exceed Standard current → Adjust output current AMP, VR within PCB Re-adjust to VR

Current value — YES →
· TH Setting fault
· Re-adjust TH setting value → TH. TRIP — YES → Change TH

TH. TRIP — NO → Complete

Adjust output current → Rated Current SETTING
- YES → Complete
- NO → Change PCB

* Refer to SCR Module checking method

Trans noise — YES →

Separate the battery connector and tune the charger off → Check SCR Module
- NO → Change SCR MODULE
- YES → Check MAIN TRANS VOLT
  - NO → Change PCB → Check the normal operating condition of the charger
  - YES → Check the normal operating condition of the charger

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)

After separating battery connector, insert automatic/manual selection connector(J2) at the left side of PCB to manual and then, MS will be turned "ON"

Check the voltage of the output connecter 64V?

NO → Rotate charging voltage volume, located in the middle of PCB, to counterclockwise.

Adjust a real output voltage identical to displayed voltage

De-crease   In-crease

VOLT

Reset voltage as turning volume volt for setting voltage on the center of PCB

YES

YES

Measure the voltage of the output connecter 64V?

Adjust voltage so as to have same output between actual output voltage and indication of display

De-crease   In-crease

OK

NO

Check contact error or breaking of wiring of the detect cable connecter pin

NO → Change PCB

Check whether the charger is normal condition after connecting the battery 64V?

YES

Check the detect voltage of the J3 connector

YES   NO

NO

Change PCB

YES

OK

④ Charger TRIP is occurred after abnormality lamp is on.
   After opening the cover which is located on the front bottom side of the charger.
   In case error code is "O.C" → Output over current, established as 110~120% of the rated current.

Restart the charger as pushing reset switch in the monitor.

Monitor display

Measure the output current by DC current measure 10~16A/ 100AH

NO → Check poor contact of current connector (J1), located right side of PCB; check if there is disconnection (cleaning and wiring)

YES

Re-establish charge current volume (AMP) on the center side of PCB as turning it anti clockwise rotation

Request A/S if problem persists after adjustment

De-crease   In-crease

Measure the output current by DC current measure

YES → OK

NO → Change PCB

⑤ Charger TRIP is occurred after it started charging and charging completion lamp is on.
   (In case input voltage is normal - Refer to the error detection No. 1)
   Restore the charger as pushing reset switch.

```
┌─────────────────────┐                    ┌──────────────────────┐                   ┌─────────────────────┐
│    If charging       │         NO         │ After separating     │                   │  Measure the output  │
│ current measurement  │ ─────────────────> │ battery connector,   │ ────────────────> │    voltage  64V      │
│ is normal when it is │                    │ put the automatic/   │                   │                      │
│ measured with DC     │                    │ manual S/W (J2) to   │                   └─────────────────────┘
│ ammeter              │                    │ manual               │
└─────────────────────┘                    └──────────────────────┘
         │ YES                                                                         NO │           │ YES
         ▼                                            J2                                  ▼           ▼
┌─────────────────────┐                                                       ┌─────────────────┐  ┌──────────────────────┐
│ Change PCB or       │                                              ┌────────────────┐          │ Contact fault between│
│ Request After-Service│                                             │  Check         │          │ the battery connector│
└─────────────────────┘                                             │  SCR Module    │          │ and charger connector│
                                                                     │  Normal        │          │ Battery is over-     │
                                                                     └────────────────┘          │ discharged           │
                                                                      NO │        │ YES           └──────────────────────┘
                                                                         ▼        ▼
                                                                ┌──────────┐ ┌──────────┐
                                                                │ Change   │ │ Change   │
                                                                │ SCR Module│ │ PCB     │
                                                                └──────────┘ └──────────┘
```
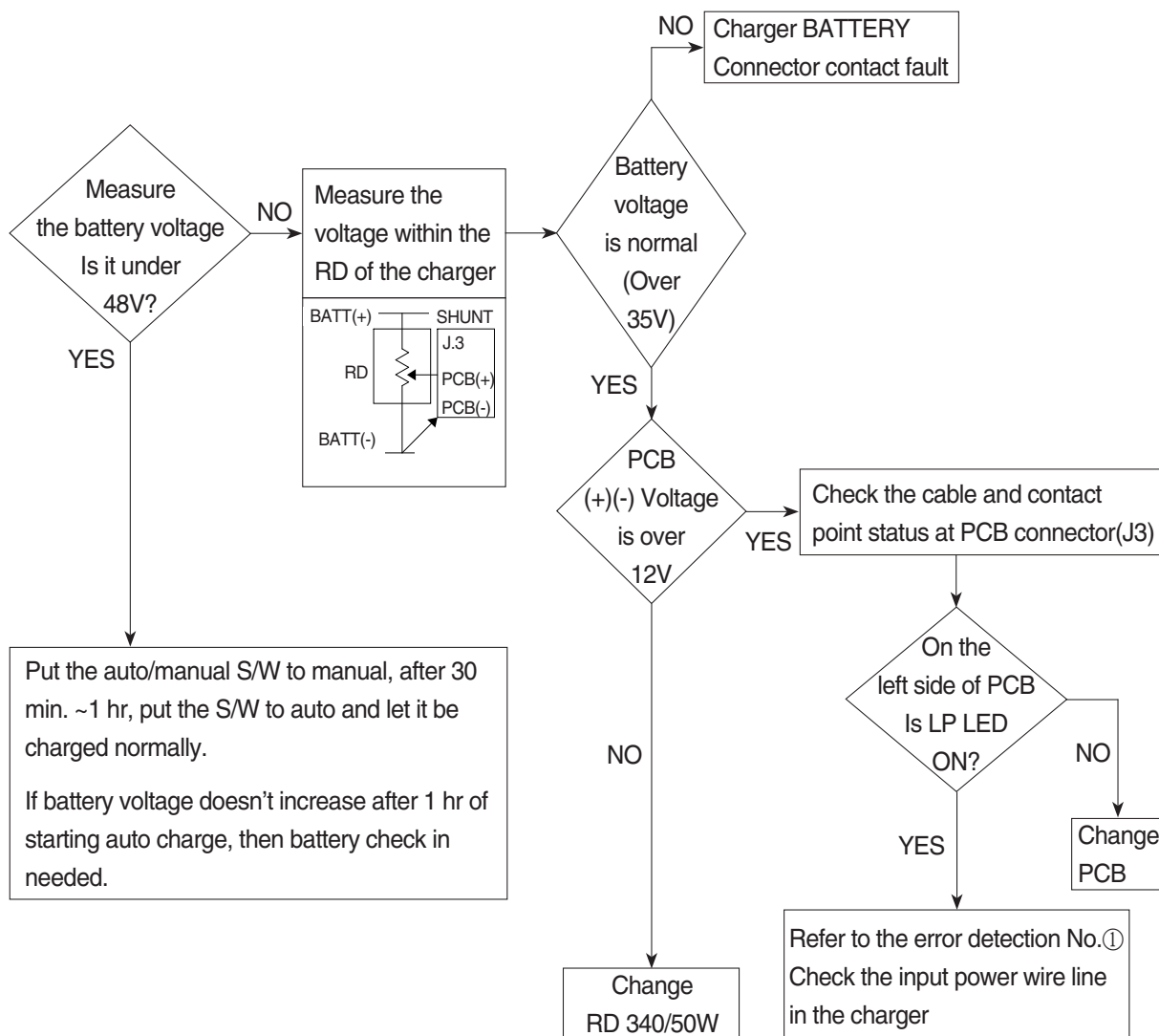
⑥ Charger has no response even if the battery connector is connected.
   - In case only floating LED is on, charger input power is cut off or doesn't connect. (In case the input voltage is normal - Refer to the error detection No. ①)
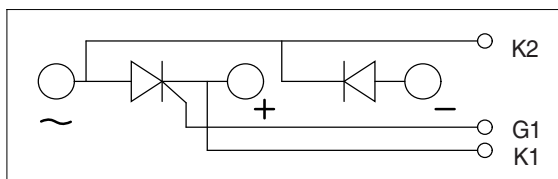
NO → **Charger BATTERY Connector contact fault**

Measure the battery voltage Is it under 48V?
— NO → **Measure the voltage within the RD of the charger**

BATT(+) ——— SHUNT
J.3
RD   PCB(+)
      PCB(-)
BATT(-)

→ **Battery voltage is normal (Over 35V)**
— NO → Charger BATTERY Connector contact fault
— YES ↓

PCB (+)(-) Voltage is over 12V
— YES → **Check the cable and contact point status at PCB connector(J3)**
— NO ↓ → **Change RD 340/50W**

On the left side of PCB Is LP LED ON?
— NO → **Change PCB**
— YES ↓

Refer to the error detection No.① Check the input power wire line in the charger

Measure the battery voltage Is it under 48V? — YES:
Put the auto/manual S/W to manual, after 30 min. ~1 hr, put the S/W to auto and let it be charged normally.

If battery voltage doesn't increase after 1 hr of starting auto charge, then battery check in needed.

RD
BATT(+)
70Ω 12V or higher
BATT(-)
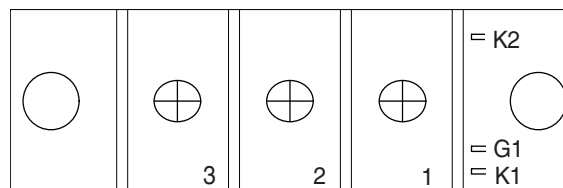(based on 48V)

LP, LED

## 7) HOW TO CHECK THE SCR MODULE

Circuit

Real diagram

* Before checking SCR MODULE, be sure to disconnect bus bar and wire on the terminal.

No.	Measuring point (Real diagram)	Measure value (Measurement of digital tester)
1	No.1 ~ No.3	Forward : Under 100 k ohm Reverse : Infinity (∞)
2	No.2 ~ No.3	Forward : Infinity (∞) Reverse : Infinity (∞)
3	G1 ~ K1	Forward : Under 100 ohm Reverse : Under 100 ohm But It depends on the module. If it is not 0 ohm, It is Ok.
4	G1 ~ K2	Forward : Infinity (∞) Reverse : Infinity (∞)

SURGE PCB
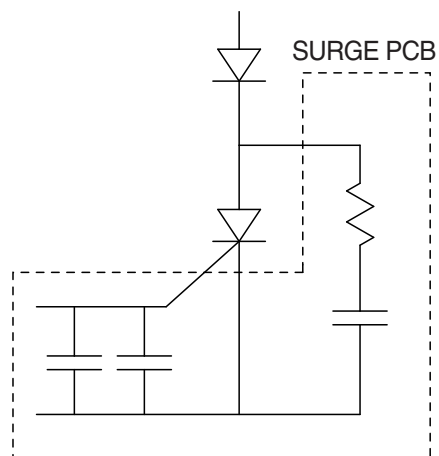
8) PCB MAJOR PARTS (NAME AND LOCATION)

22B9BAT26
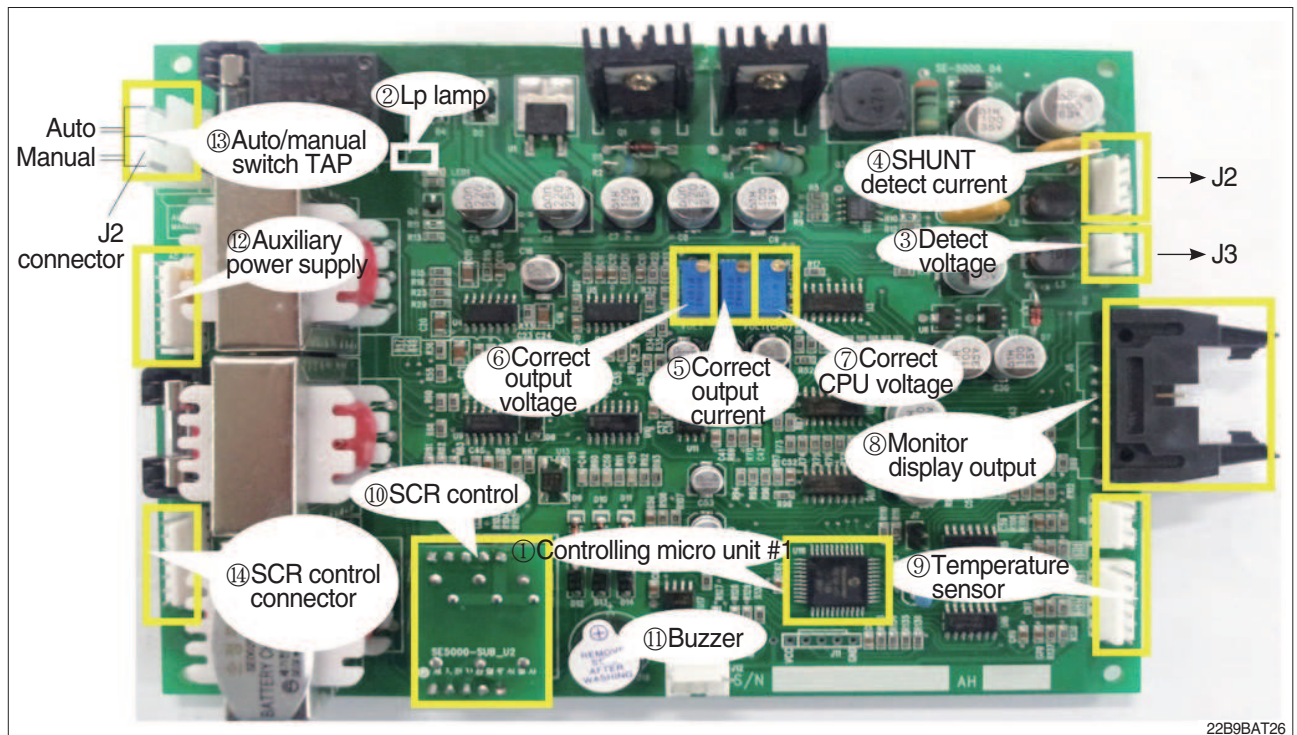
1	Controlling MICOM #1	6	Correct output voltage	11	Buzzer
2	Lp lamp	7	Correct CPU voltage	12	Auxiliary power supply
3	Detect voltage	8	Monitor display output	13	Auto/manual switch TAP
4	SHUNT detect current	9	Temperature sensor	14	SCR control connector
5	Correct output current	10	SCR control		
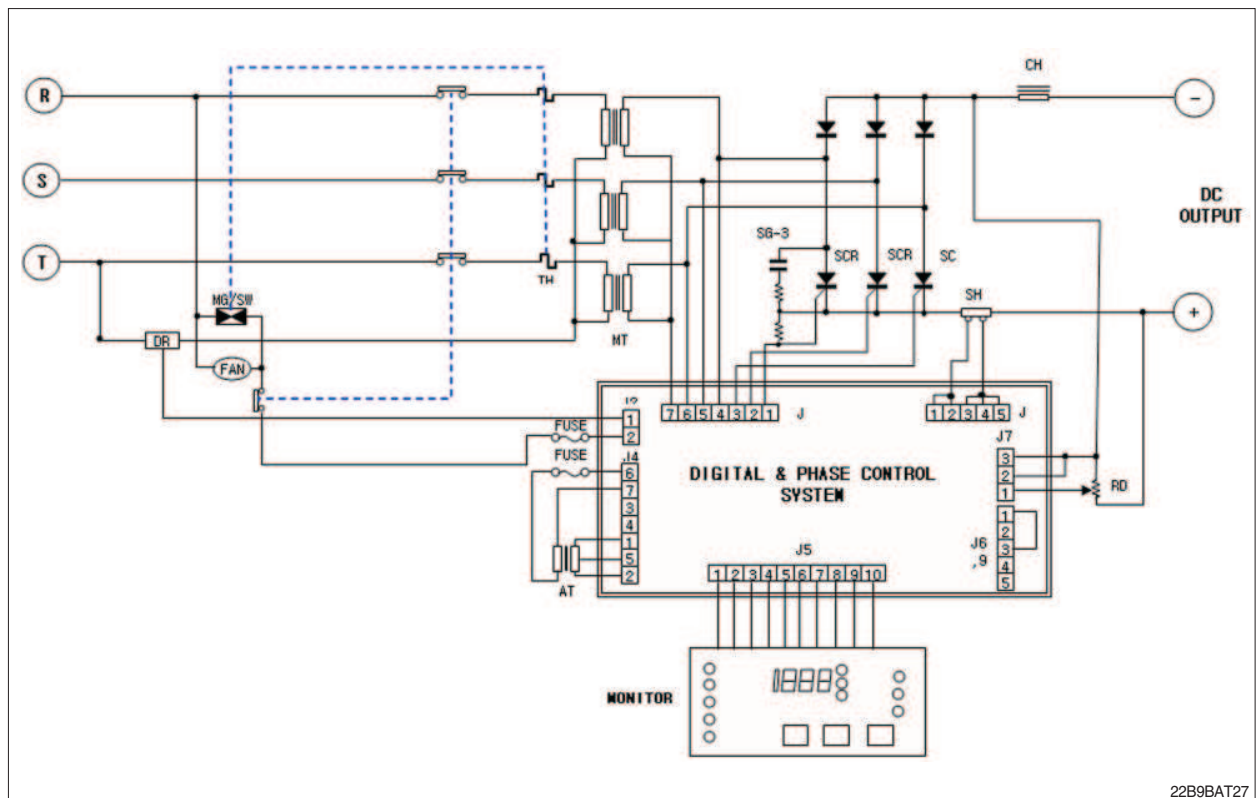
22B9BAT27

CHARGER INTERIOR PARTS
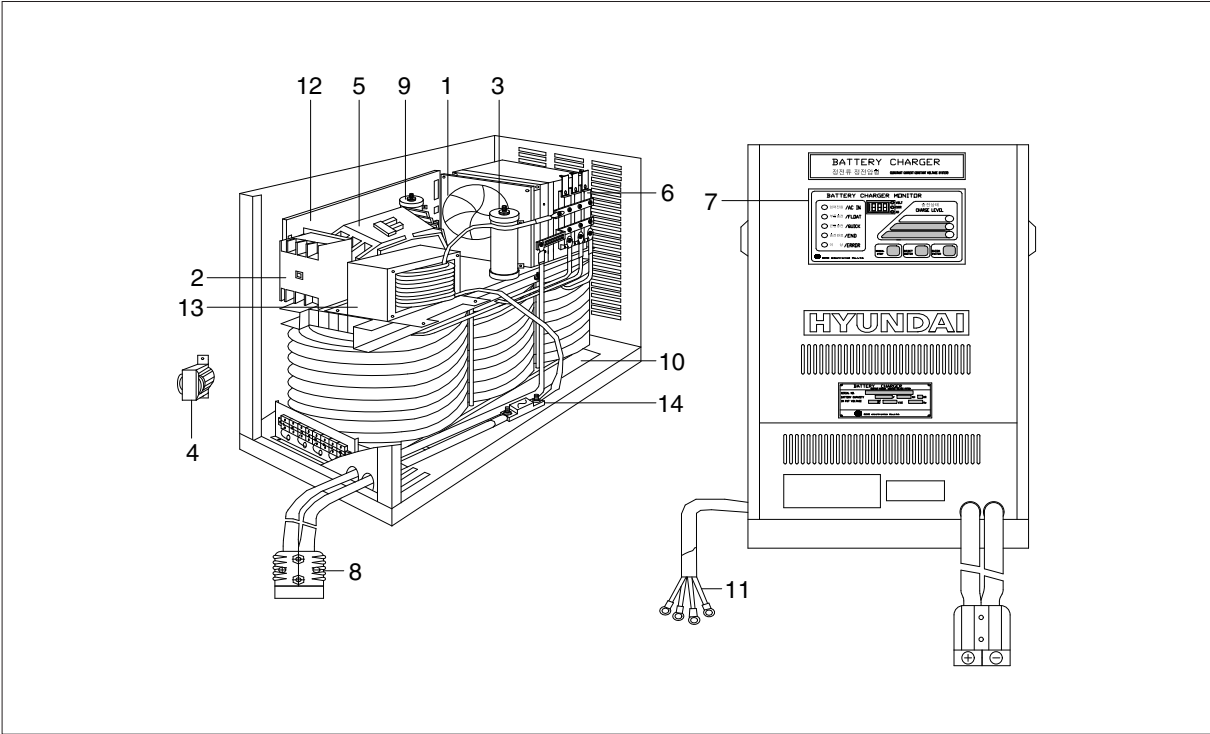
22B9BAT28

No	Part name	Remarks
1	AC fan	
2	Over load	
3	Resister RD	
4	Trans-aux	
5	Magnet switch	
6	SCR module	
7	Monitor	
8	DC out cable	
9	Resister DR	
10	Main transformer	
11	AC input cable	
12	Main control board	
13	Filter	
14	Fuse	