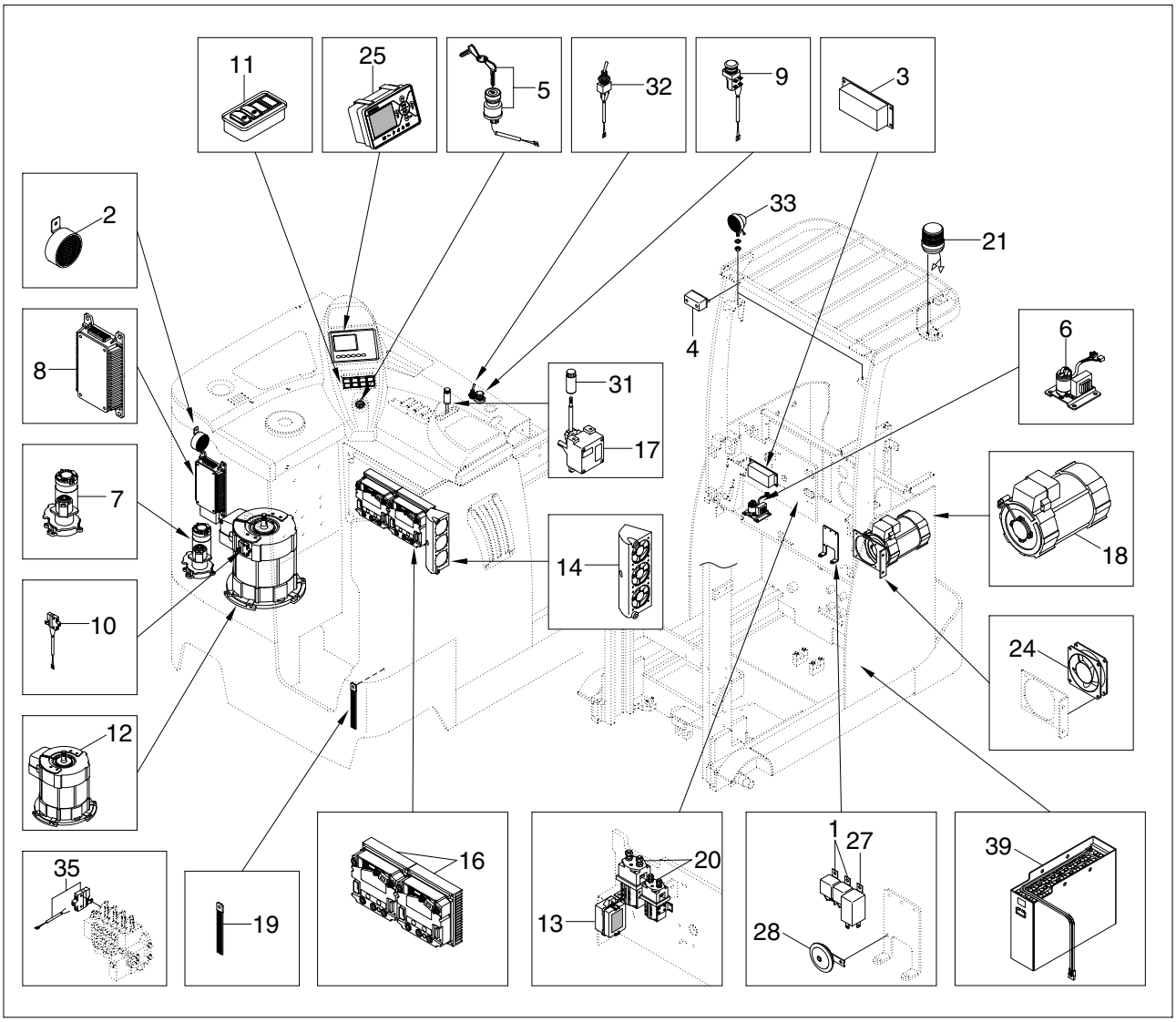
SECTION 7 ELECTRICAL SYSTEM

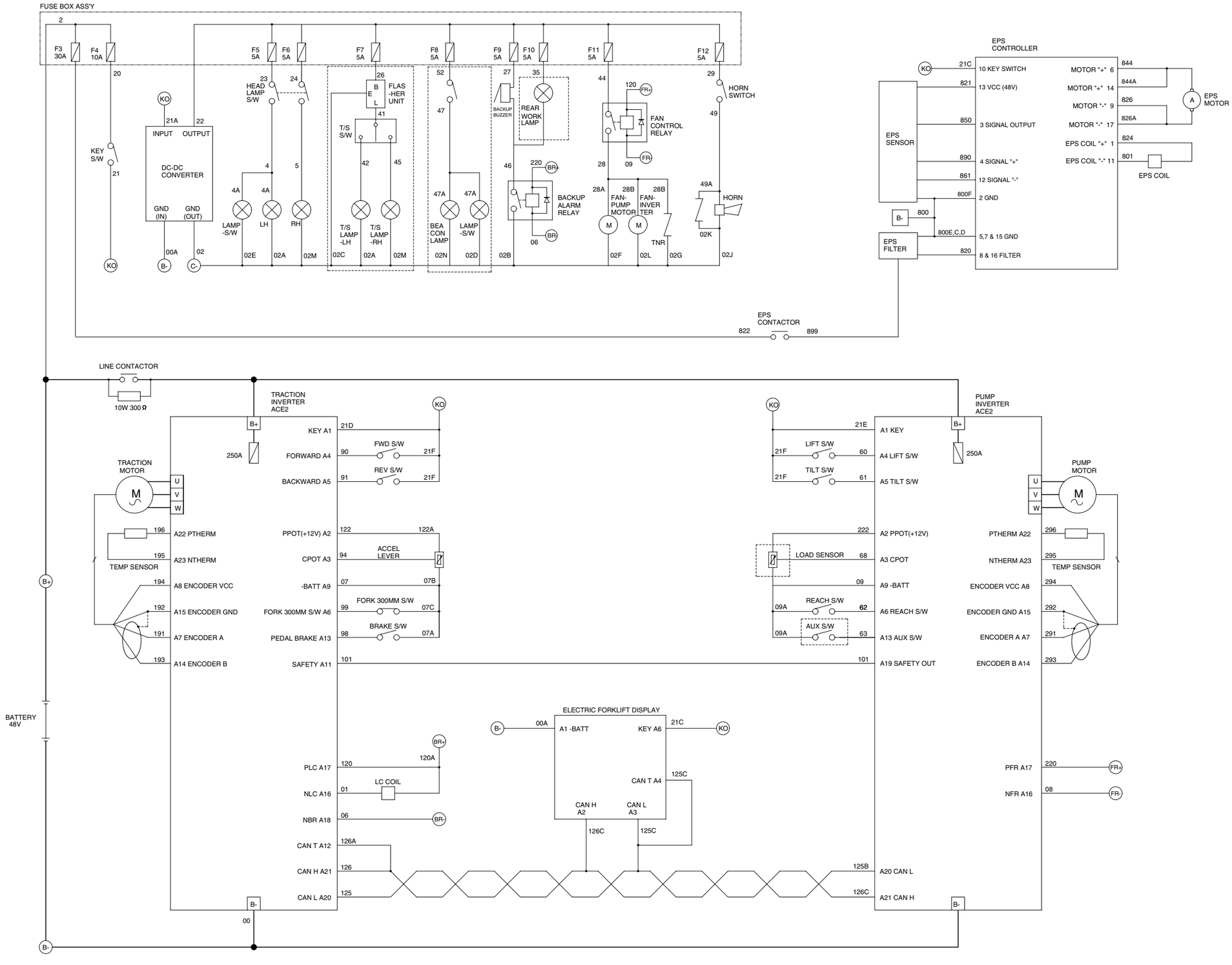
SECTION 7 ELECTRICAL SYSTEM

GROUP 1 COMPONENT LOCATION



15BR9EEL01

1	Relay	11	Switch assy	24	Fan
2	Back buzzer	12	Traction motor	25	Display
3	DC-DC converter	13	Fuse box assy	27	Flasher unit assy
4	Turn signal lamp	14	Fan assy	28	High horn
5	Key switch assy	16	ACE2-Inverter	31	Knob
6	EPS filter assy	17	Accelerator assy	32	Toggle switch
7	EPS actuator	18	Pump motor	33	Work-lamp sub assy
8	EPS controller	19	Static strap	35	Switch assy
9	Horn switch	20	Contactor	39	Battery
10	Micro switch	21	Beacon lamp		


FUSE BOX ASS'Y
F3 30A
F4 10A
F5 5A
F6 5A
F7 5A
F8 5A
F9 5A
F10 5A
F11 5A
F12 5A
KEY S/W
DC-DC CONVERTER
INPUT
OUTPUT
GND (IN)
GND (OUT)
HEAD LAMP S/W
LAMP -S/W
LH
RH
FLAS -HER UNIT
T/S S/W
T/S LAMP -LH
T/S LAMP -RH
BEA CON LAMP
BACKUP BUZZER
REAR WORK LAMP
BACKUP ALARM RELAY
FAN CONTROL RELAY
FAN-PUMP MOTOR
FAN-INVER TER
TNR
HORN SWITCH
HORN
EPS CONTROLLER
EPS SENSOR
10 KEY SWITCH
13 VCC (48V)
3 SIGNAL OUTPUT
4 SIGNAL "+"
12 SIGNAL "-"
2 GND
5,7 & 15 GND
8 & 16 FILTER
MOTOR "+" 6
MOTOR "+" 14
MOTOR "-" 9
MOTOR "-" 17
EPS COIL "+" 1
EPS COIL "-" 11
EPS MOTOR
EPS COIL
EPS FILTER
EPS CONTACTOR
LINE CONTACTOR
10W 300Ω
TRACTION INVERTER ACE2
PUMP INVERTER ACE2
TRACTION MOTOR
PUMP MOTOR
TEMP SENSOR
KEY A1
FORWARD A4
BACKWARD A5
FWD S/W
REV S/W
ACCEL LEVER
FORK 300MM S/W
BRAKE S/W
PPOT(+12V) A2
CPOT A3
-BATT A9
PEDAL BRAKE A13
SAFETY A11
A22 PTHERM
A23 NTHERM
A8 ENCODER VCC
A15 ENCODER GND
A7 ENCODER A
A14 ENCODER B
PLC A17
NLC A16
NBR A18
CAN T A12
CAN H A21
CAN L A20
LC COIL
A1 KEY
A4 LIFT S/W
A5 TILT S/W
LIFT S/W
TILT S/W
LOAD SENSOR
REACH S/W
AUX S/W
A2 PPOT(+12V)
A3 CPOT
A9 -BATT
A6 REACH S/W
A13 AUX S/W
A19 SAFETY OUT
A20 CAN L
A21 CAN H
PTHERM A22
NTHERM A23
ENCODER VCC A8
ENCODER GND A15
ENCODER A A7
ENCODER B A14
PFR A17
NFR A16
ELECTRIC FORKLIFT DISPLAY
A1 -BATT
KEY A6
CAN T A4
CAN H A2
CAN L A3
BATTERY 48V

15BR9EEL02

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 & 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.

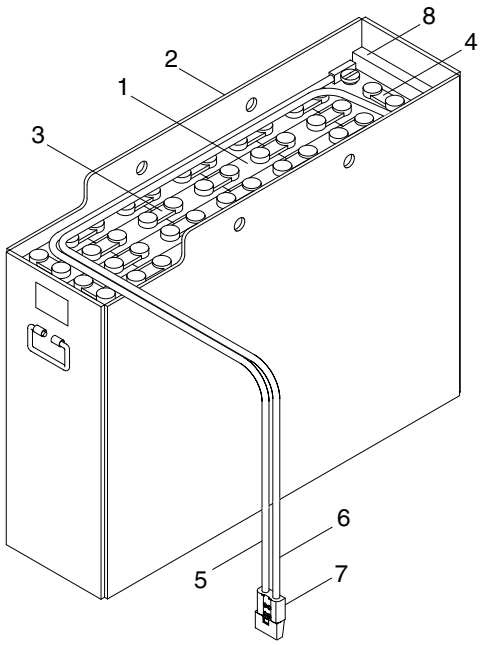
To drive the fork lift truck, a DRIVING CONTROL SYSTEM and some electric components such as direction change lever(forward/reverse section switch) and accelerator are required to select the driving direction and to control the speed of driving motor.

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, hydraulic pressure 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

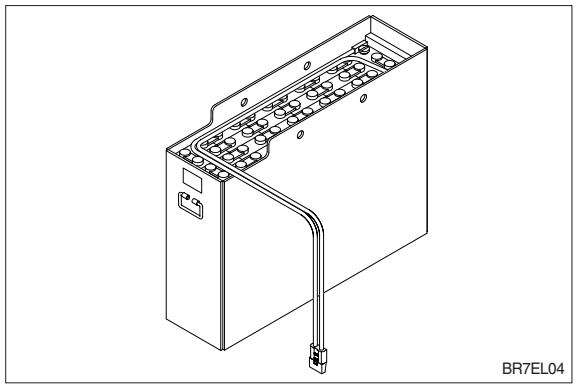


BR7EL03

1	Cells	5	Positive leading cable
2	Steel box	6	Negative leading cable
3	Cell connector	7	Plug
4	Row connector	8	Spacer

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.



3) SPECIFICATION AND SERVICE DATA

Item	Unit	15BR-9E
Type	-	VCI 230
Rated voltage	V	48
Capacity	AH/hr	230/5
Electrolyte	-	WET
Dimension (W × D × H)	mm	994 × 270 × 581.7
Connector (CE spec)	-	SB 350 (SBE 320)
Weight	kg	380

Fully charged specific gravity	1.280 (25°C)
End of discharge specific gravity	1.130 (25°C)
Discharge end voltage	48 V
Electrolyte	Refined dilute sulfuric
Replenishment fluid	Refined water (pure water)
Insulation resistance	More than 1MΩ

4) SAFETY PRECAUTIONS

(1) When a 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 a explosion.

(3) Never place metallic articles on the batteries

If done so, it may cause “short circuit” accidents(dangerous especially 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 1.5 V.

(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) INSTRUCTION

(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 decrease 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

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

c. By constant current charger

Connect the charger to the battery and charge the battery by 0.1C×5 hour rate nominal capacity current for 24 hours or more. The charge shall be terminated when one of the following condition 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 in the same type of batteries, the capacity varies with the discharge conditions (discharge current, battery temperature and specific gravity of electrolyte) Even if the batteries discharged its full capacity, if immediately charged to full, there will be no harmful effects remained. Ideal charging amount (AH) is 110-125% of the amount of previous discharge.

③ Specific gravity of electrolyte

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

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

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

S_t : Actually measured specific gravity at t °C

t : Electrolyte temperature (°C)

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

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

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$1.0~1.5" at the start of charging, and at the final stage it is "5 hour rate current $\times$0.15~0.25". 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.

$$\text{Charging time} = \frac{\text{Amount of previous discharge(AH)}}{\text{Capacity of charger(A)}} + 2\sim3\text{(H)}$$

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.

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.

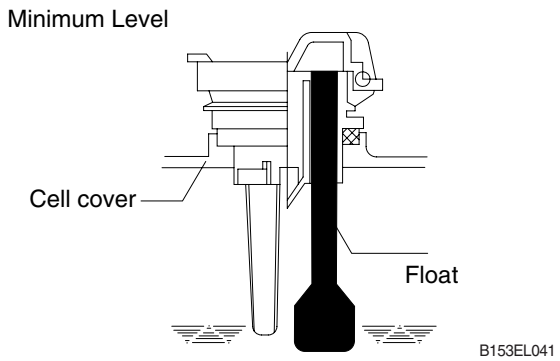
⑥ **Water replenishment**

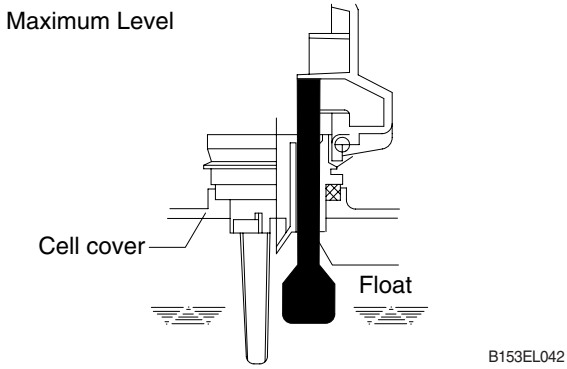
Only the water content of electrolyte is decreased due to electrolysis of water during charge and natural evaporation. If a battery used with the electrolyte decreased excessively, plates will deteriorate resulting in markedly shortening of battery life. Be sure to check the electrolyte level once every 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 45cc, 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 45cc or less. Incidentally, water replenishment should be made before charging to the contend 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 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.





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 is with hand or electric drill (ø 25 ㎜) from failure cell as well as all surrounding cells.

⚠ 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. Check the electrolyte level once a 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 distant from room heaters or other heat generating sources. Clean, cool and dry place where no direct sunlight is directed 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 20°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 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**

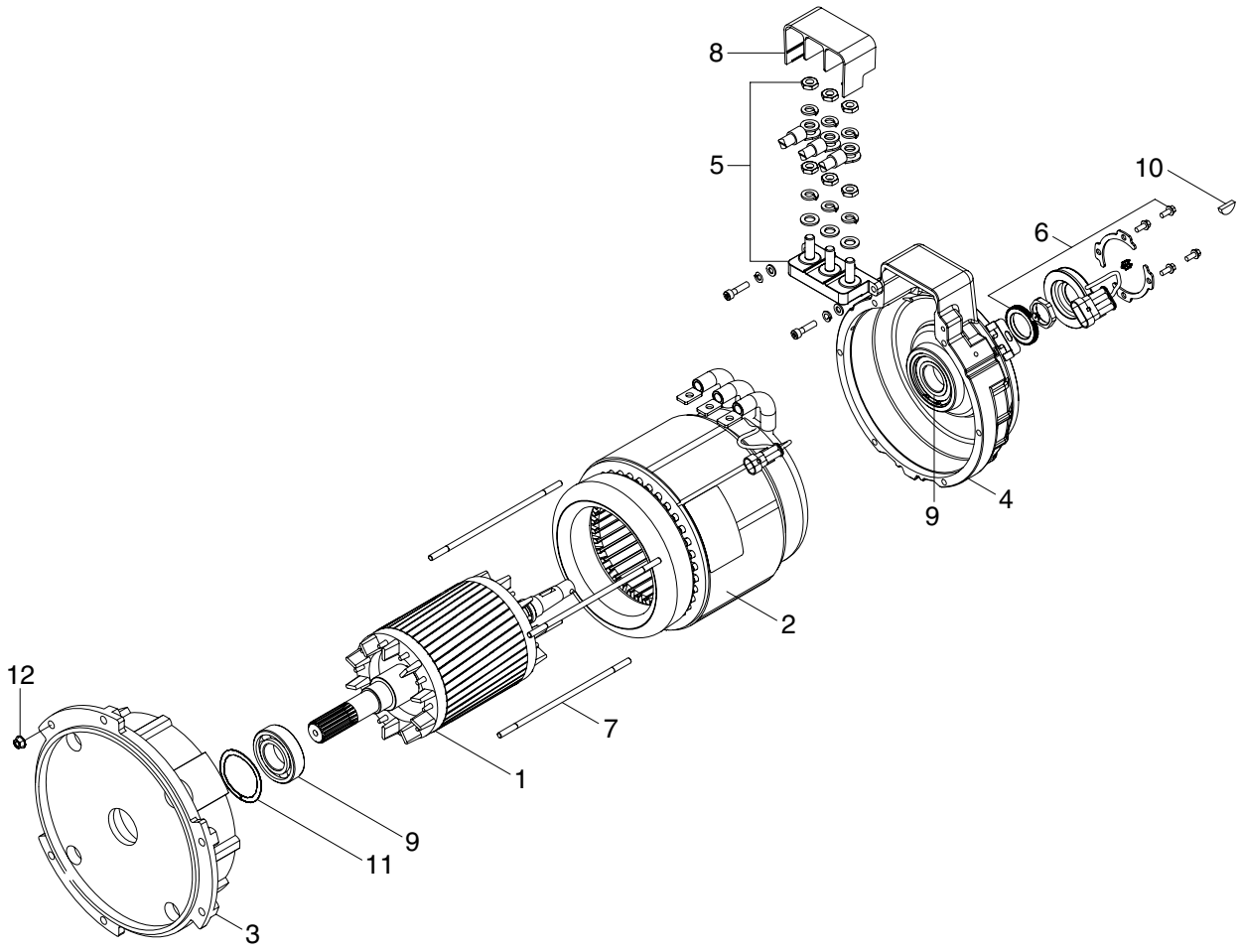
The operating temperature range of batteries is -10~45°C (temperature of electrolyte). If the batteries are exposed to cold atmosphere in discharged condition, the electrolyte may freeze, and in extreme cases, the capacity will be decreased, but, if not frozen, no adverse effects will be exerted over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



15BR9EEL06A

1	Rotor	5	Block-terminal A	9	Bearing
2	Stator	6	Speed sensor kit	10	Woodruff key
3	Endbell de	7	Stud bolt	11	Wave washer
4	Endbell	8	Protector-terminal	12	Flange nut

2) SPECIFICATION

Item	Unit	15BR-9E
Type	-	AMDU4004A
Rated voltage	Vac	30
Rated output	kW	4.5
Insulation	-	Class F

3) MAINTENANCE INSTRUCTION

(1) 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 : ø 123.1 ± 0.05

Tool : Vernier calipers and standard tool

18BR9EL41

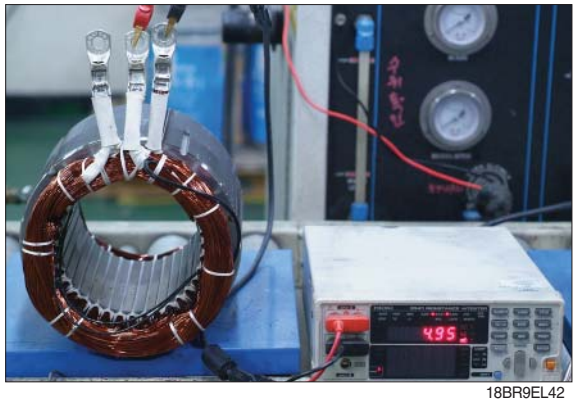
② Stator assembly inspection

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 6.3 mmΩ.

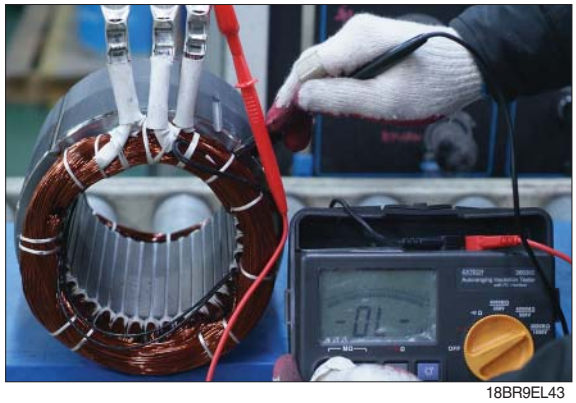


18BR9EL42

Insulation test

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

If the insulation is defective, replace with new parts.

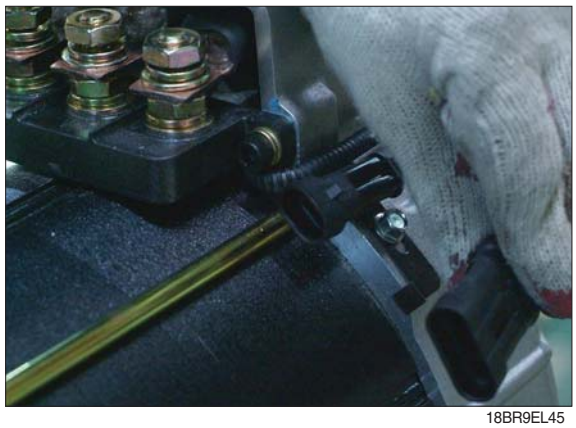


18BR9EL43

(2) 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

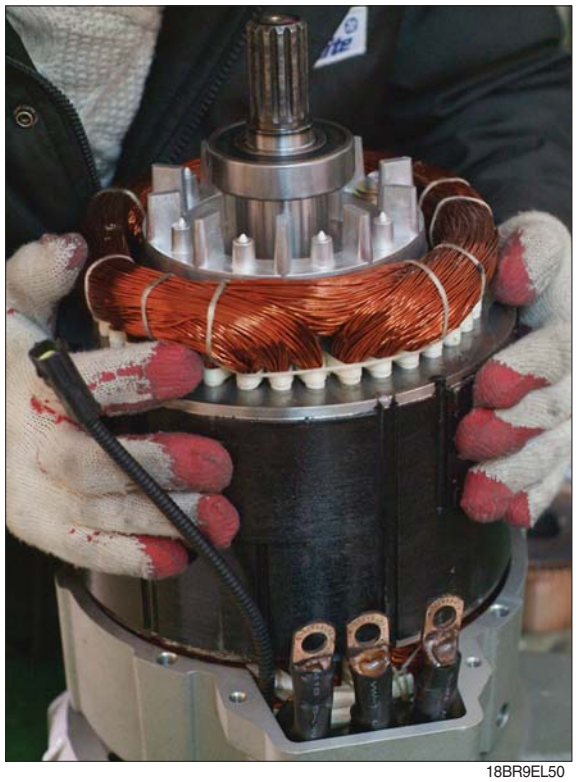
④ Remove 4 flange nuts with available general tool on the endbell drive side.

18BR9EL48

⑤ Remove endbell de and wave washer.

18BR9EL49

⑥ Remove stator assembly by hand or suitable tool.

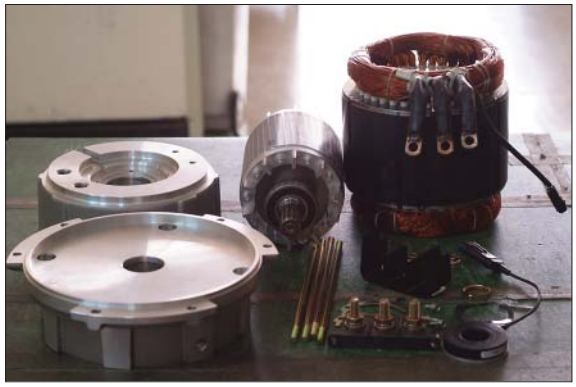


18BR9EL50

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).



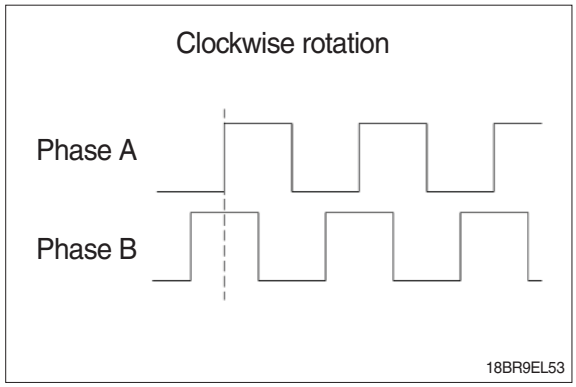
18BR9EL52

(3) Assembly and installation

Perform assembly in the reverse order of disassembling.

After assembling, check for speed sensor.

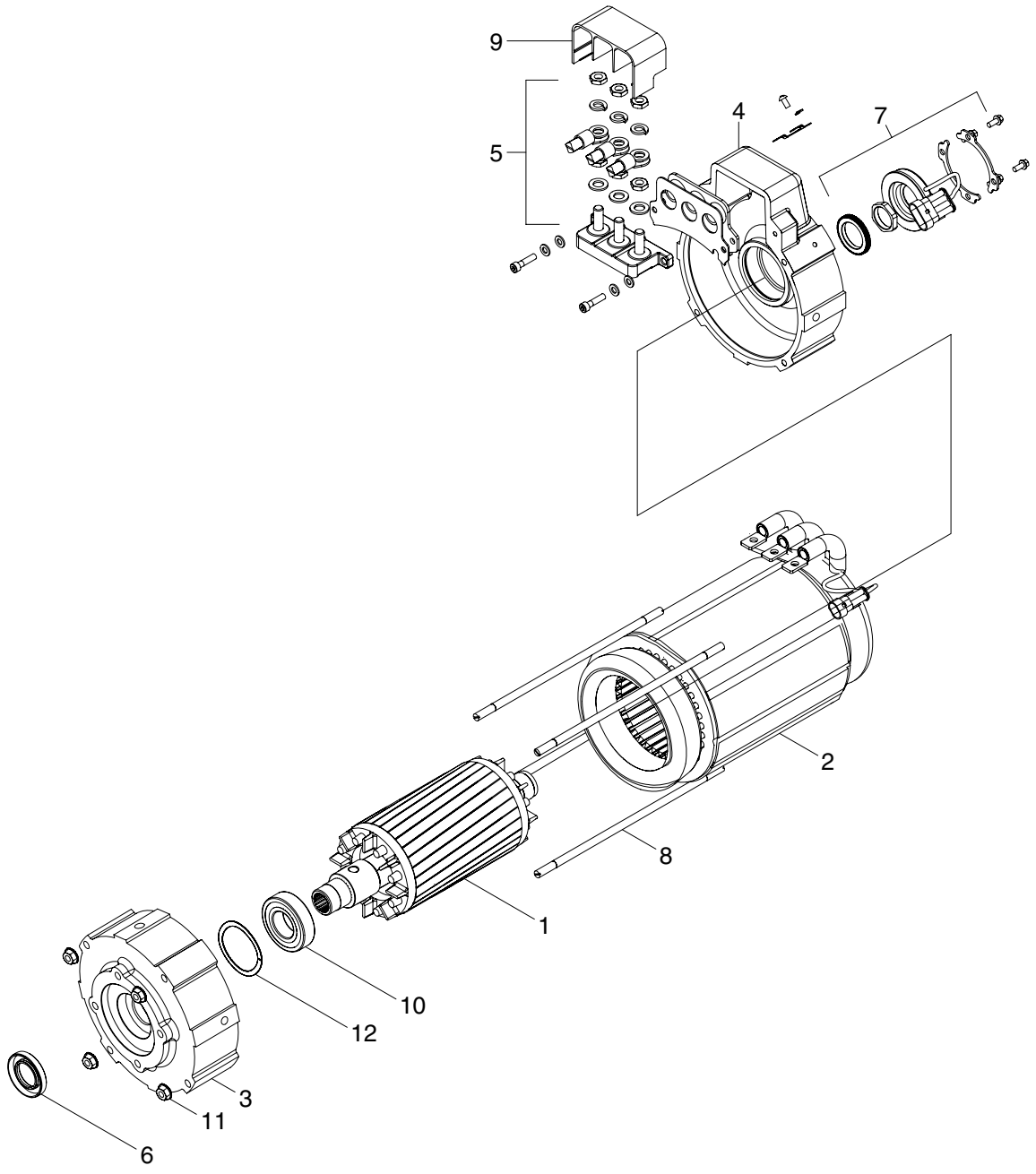
Normal signal is as right.



18BR9EL53

4. PUMP MOTOR

1) STRUCTURE



18BR9EL16

1	Rotor	5	Block-terminal A	9	Protector-terminal
2	Stator	6	Oil seal	10	Bearing
3	Endbell De	7	Speed sensor kit	11	Flange nut
4	Endbell	8	Stud bolt	12	Wave washer

2) SPECIFICATION

Item	Unit	Specification
Type	-	ADBK4001
Rated voltage	Vac	30
Rated output	kW	9.0
Insulation	-	Class F
Speed	rpm	2180
Freq.	Hz	75
P.F.	-	0.827
Duty	%	S3-15
Voltage	V	30
Current	A	237

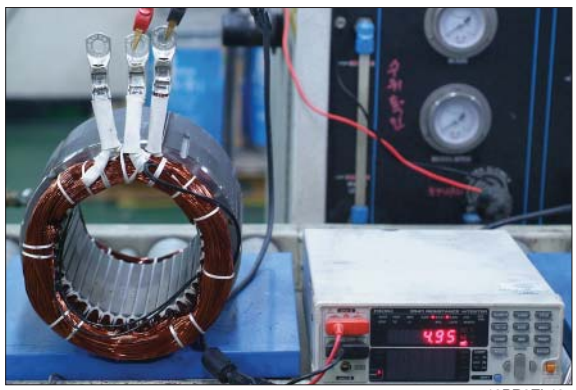
3) INSPECTION

(1) Rotor assembly inspection

① 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 : ø 104.1 ± 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 5.4 mmΩ.

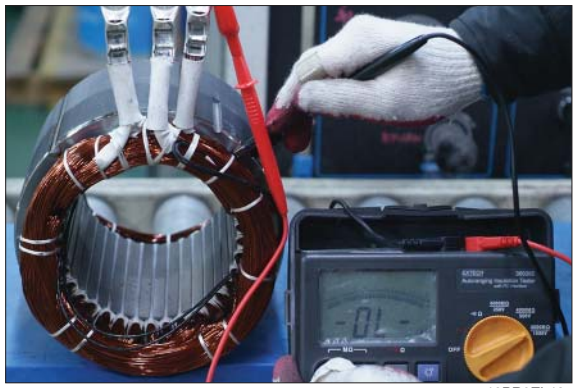


18BR9EL42

Insulation test

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

If the insulation is defective, replace with new parts.

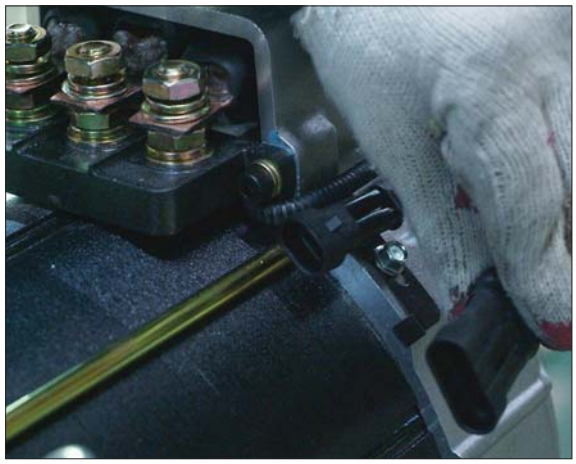


18BR9EL43

4) 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

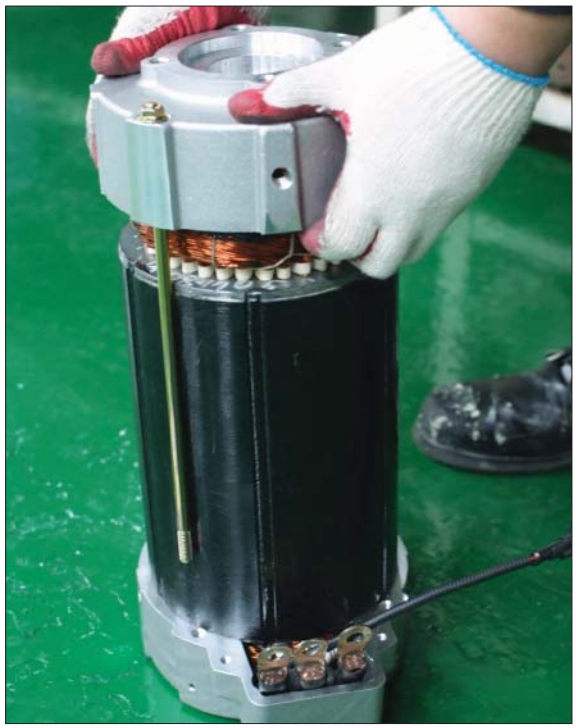
③ Remove 4 screw fixing speed sensor on the endbell side and then disassemble speed sensor, fixed nut and toothed wheel of the motor.

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).

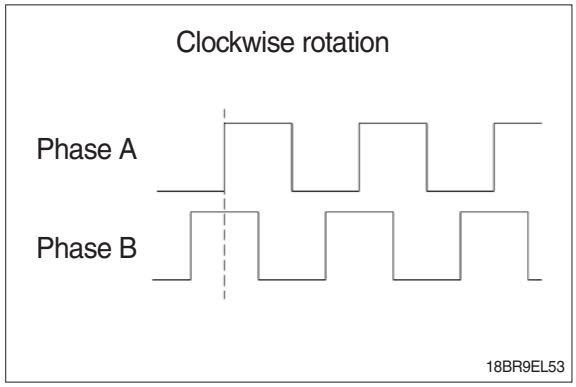
18BR9EL59

5) Assembly and installation

Perform assembly in the reverse order of disassembling.

After assembling, check for speed sensor.

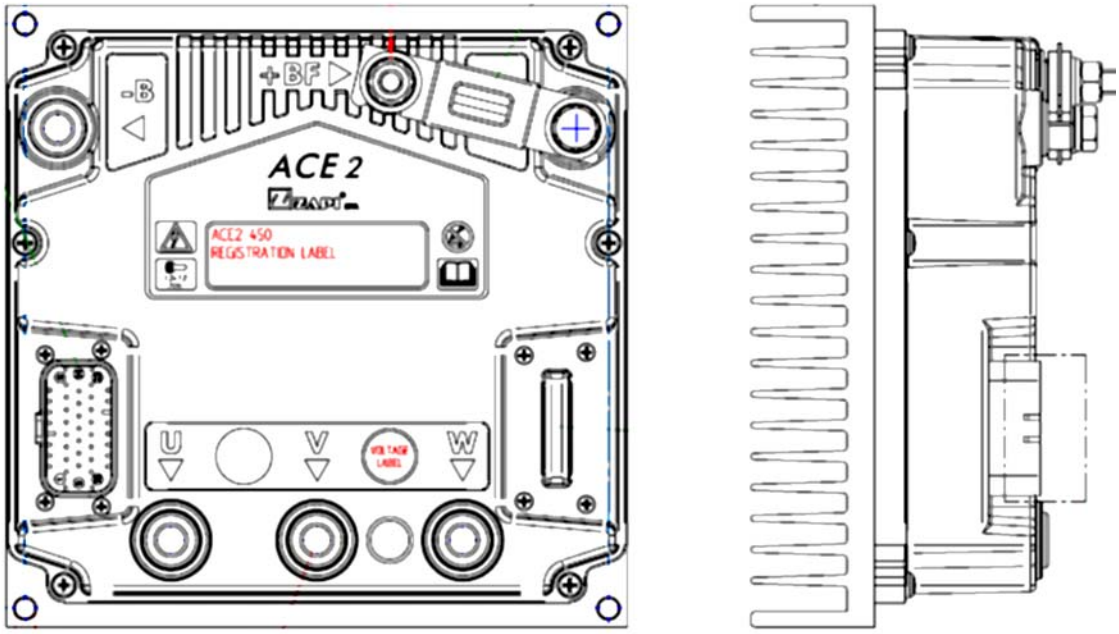
Normal signal is as right.



18BR9EL53

5. CONTROLLER SYSTEM

1) STRUCTURE



18BR9EL11

(1) Specifications

Model	Model	Application	Type	Power	Current limit
15BR-9E	ACE2	Traction	AC	36-48V, 350A	350A/3min
	ACE2	Pump	AC	36-48V, 350A	350A/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 Electronic steering function:
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

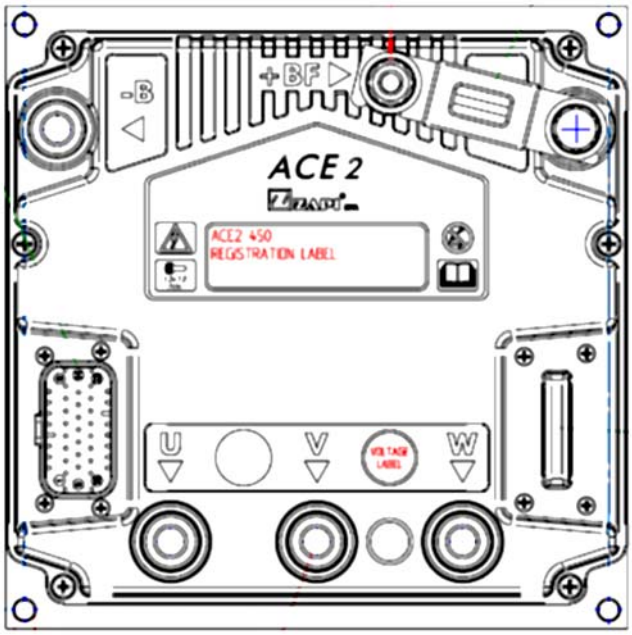
The microcontrollers continually monitor the inverter and carry out a diagnostic procedure on the main functions. The diagnosis is made in 4 points.

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



18BR9EL12

No. of pin	Function	Description
A1	KEY	Input of the key switch signal.
A2	PPOT (+12V)	Power supply (+12 V) of accel lever.
A3	CPOT	Accel lever analog signal input.
A4	FORWARD	Forward signal input.
A5	BACKWARD	Backward signal input.
A6	FORK 300MM S/W	Fork lifting height 300 mm sensing switch input.
A7	ENC A	Traction motor encoder phase A.
A8	ENC VCC	Encoder positive supply.
A9	- BATT	Negative power supply. Negative of accel lever, brake switch, fork 300 mm switch.
A10	CPOT SS	Steering analog signal input (Null).
A11	SAFETY	Connect to pump inverter A19 for the safety check.
A12	CANT	If it is connected with A21, it introduces the120 Ohm termination resistance between CAN-L and CAN-H.
A13	PEDAL BRAKE	Brake switch input.
A14	ENC B	Traction motor encoder phase B.
A15	ENC GND	Negative of encoder.
A16	NLC	Line contactor coil driver negative output.

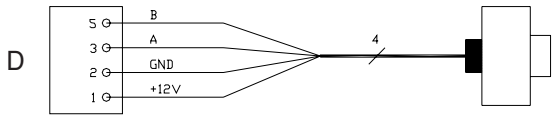
No. of pin	Function	Description
A17	PLC	Positive output of line contactor & back buzzer relay coil.
A18	NBR	Back buzzer relay coil driver negative output.
A19	EPS FAULT	EPS fault signal input (Null).
A20	CAN L	Low level CAN-BUS voltage I/O.
A21	CAN H	High level CAN-BUS voltage I/O.
A22	PTHERM	Input for motor temperature sensor.
A23	NTHERM	Negative of motor temperature sensor.

Encoder installation

① Traction controller card is fit for different types of encoder. To control AC motor with a 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.

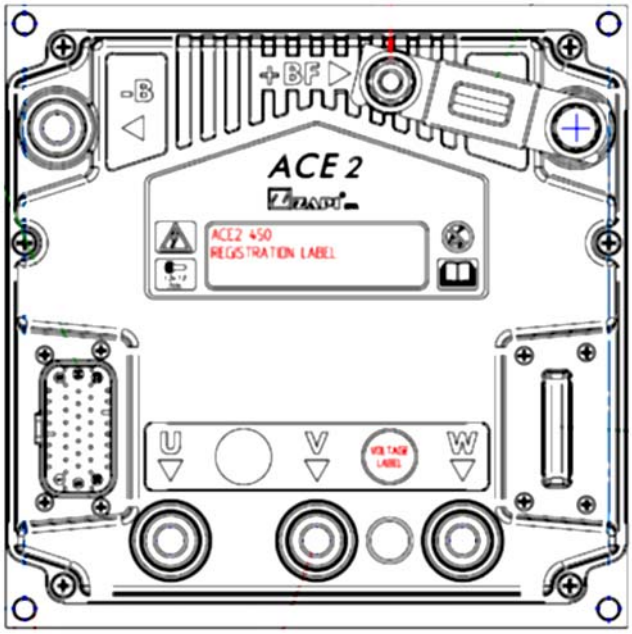
D1 : +12V - Positive of encoder power supply.
D2 : GND - Negative of encoder power supply.
D3 : A - Phase A of encoder.
D5 : B - Phase B of encoder.

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



BRJ7EL26

(2) Pump controller



18BR9EL12

No. of pin	Function	Description
A1	KEY	Input of the key switch signal.
A2	PPOT(+12V)	Power supply (+12V) of load sensor (opt).
A3	CPOT	The analog signal input of the load sensor.
A4	LIFT S/W	Lift switch input.
A5	TITL S/W	Tilt switch input.
A6	REACH S/W	Reach switch input.
A7	ENC A	Pump motor encoder phase A.
A8	ENC VCC	Encoder positive supply.
A9	- BATT	Negative power supply. Negative of reach switch, aux switch (opt), load sensor (opt).
A10	NA	-
A11	NA	-
A12	NA	-
A13	AUX S/W	Aux switch (opt) input.
A14	ENC B	Pump motor encoder phase B.
A15	ENC GND	Negative of encoder.
A16	NFR	Fan relay coil driver negative output.
A17	PFR	Positive output of fan relay coil.

No. of pin	Function	Description
A18	NA	-
A19	SAFETY OUT	Connect to traction inverter A11 for the safety check.
A20	CAN L	Low level CAN-BUS voltage I/O.
A21	CAN H	High level CAN-BUS voltage I/O.
A22	PTHERM	Input for motor temperature sensor.
A23	NTHERM	Negative of motor temperature sensor.

4) FUNCTION CONFIGURATION

■ TRACTION CONTROLLER

Using the CONFIG MENU of the programming console, 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**

This option specifies the handling of the low battery charge detection. There are three levels:

- Level 0 : Nothing happens, the battery charge level is calculated but is ignored, it means no action is taken when the battery is discharged.
- Level 1 : BATTERY LOW alarm is raised when the battery level is calculated being less than or equal to 10% of the full charge. The BATTERY LOW alarm inhibits the lifting function.
- Level 2 : BATTERY LOW alarm is raised when the battery level is calculated being less than or equal to 10% of the full charge. The BATTERY LOW alarm reduces the maximum truck speed down to 24% of the full truck speed and it inhibits the lifting function.

③ **Steer sensor**

This option set the steer sensor function.

- ON : Steering angle display on monitor and travel speed control is activated as the steer angle cutback setting (STEER DEAD ANGLE, MIDDLE ANGLE, MID. CURVE CTB. , CURVE CUTBACK). Steer sensor check function is enable.
- OFF: Steering angle doesn't display on monitor and travel speed control is not activated. Steer sensor check function is disable.

④ **Set motor temperature**

It can be set:

1. 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 (analog temperature sensor).
2. DIGITAL : A digital (on/off) sensor for the motor temperature monitoring is connected to CNA#22 input (digital temperature sensor).
3. NONE : No temperature sensor is connected.

⑤ **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.

⑥ **Display**

This option set the communication check between traction and display.

- ON : Communication check is enable. If the traction can not detect the display communication signal, CAN BUS KO DISP is occured and travel speed cutback to turtle speed.
- OFF : Communication check is disable.

⑦ **Pedal brake 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.

⑧ **EPS error check**

- ON : Traction inverter check EPS fault signal. If EPS fault signal is detected, Stop the travel function.
- OFF : Traction inverter doesn't check EPS fault signal.

⑨ **A-18 diag active**

- ON : Traction inverter check A18 port (Backbuzzer relay coil).
- OFF : Traction inverter doesn't check A18 port (Backbuzzer relay coil).

⑩ **Model truck**

This set model. Threre are 2 options.

- 10/13BR
- 15BR-9E
- This parameter must be set "15BR-9E" for 15BR-9E truck.

(2) Submenu "ADJUSTMENTS"

① **Adjust battery**

Fine adjustment of the battery voltage measured by the controller.

② **Throttle 0 zone**

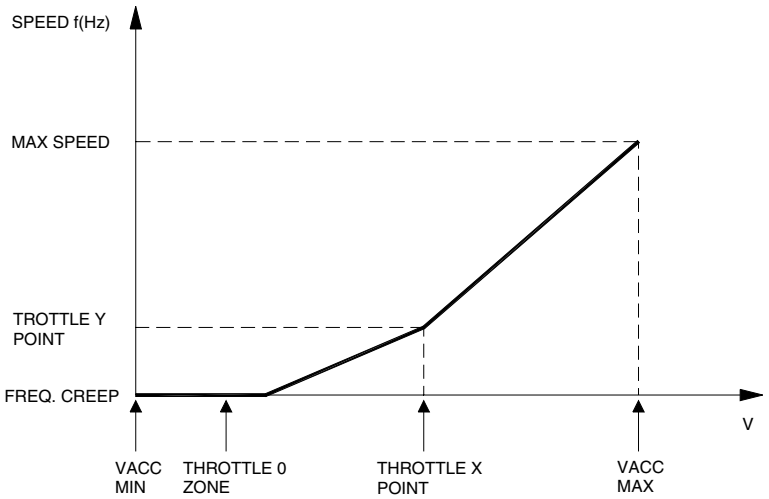
Establishes a deadband in the accelerator input curve.

③ **Throttle X point**

This parameter, together with the THROTTLE Y POINT, changes the characteristic of the accelerator input curve : when the accelerator is depressed 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 (See below figure).

④ **Throttle Y point**

This parameter, together with the THROTTLE X POINT, changes the characteristic of the accelerator input curve : when the accelerator is depressed 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 (See below figure).



20B7EL17

⑤ **BAT. MIN ADJ.**

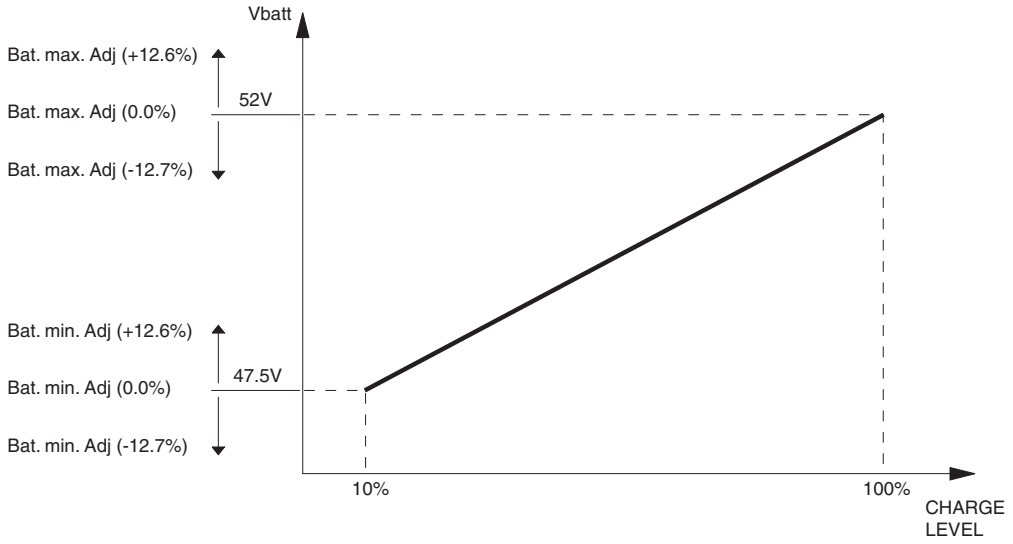
Adjust the lower level of the battery charge table (-12.7%~+12.6%).

⑥ **BAT. MAX ADJ.**

Adjust the upper level of the battery charge table (-12.7%~+12.6%).

⑦ **BDI ADJ STARTUP**

Adjust the upper level of the battery charge table (-12.7%~+12.6%).
When the key on, this setting table is applied.



⑧ **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.

⑨ **Main cont. volt**

%. This parameter stores the PWM value applied to MC coil for the first second of the output activation. It is expressed in percentage of battery voltage.

⑩ **Aux output volt**

%. This parameter stores the PWM value applied to AUX COIL for the first second of the output activation. It is expressed in percentage of battery voltage.

⑪ **Main cont. V rid**

%. This parameter stores the PWM value applied to MC coil after the first second of the output activation. It is expressed in percentage of MAIN CONT. VOLT.

⑫ **DISP SPD 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/ ø

where : rr = total gearbox ratio

ø = traction wheel diameter (cm)

P = number of pair poles of the motor

⑬ **Chat time delay**

In seconds. When truck is key on, if the operator doesn't use the truck for the time (CHAT TIME DELAY), main contactor is open to save energy.

⑭ **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”.

(3) Submenu "PARAMETER CHANGE"

① **Acceleration 0** : Seconds. It specifies the motor acceleration at 0 Hz. The parameter sets the time needed to accelerate the traction motor from 0Hz to 100Hz.

② **INV. accel 0** : Seconds. It specifies the motor acceleration at 0 Hz after an inversion of direction. The parameter sets the time needed to accelerate the traction motor from 0Hz to 100Hz.

③ **Acceleration 1** : Seconds. It specifies the motor acceleration at ACC PROF. FREQ 1 [Hz]. The parameter sets the time needed to accelerate the traction motor from 0Hz to 100Hz.

④ **Acceleration 2** : Seconds. It specifies the motor acceleration at ACC PROF. FREQ 2 [Hz]. The parameter sets the time needed to accelerate the traction motor from 0Hz to 100Hz.

⑤ **Acceleration 3** : Seconds. It specifies the motor acceleration at ACC PROF. FREQ 3 [Hz]. The parameter sets the time needed to accelerate the traction motor from 0Hz to 100Hz.

⑥ **ACC PROF. FREQ 1** : In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 1 parameter.

⑦ **ACC PROF. FREQ 2** : In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 2 parameter.

⑧ **ACC PROF. FREQ 3** : In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 3 parameter.

⑨ **Release braking** : Seconds. It controls the deceleration ramp when the travel request is released. The parameter sets the time needed to decelerate the traction motor from 100Hz to 0Hz.

⑩ **Inverse braking** : Seconds. It controls the deceleration ramp when the direction switch is inverted during travel. The parameter sets the time needed to decelerate the traction motor from 100Hz to 0Hz.

⑪ **Decel braking** : Seconds. It controls the deceleration ramp when the accelerator has turned down but not completely released. The parameter sets the time needed to decelerate the traction motor from 100Hz to 0Hz.

⑫ **Pedal braking** : Seconds. This parameter determines the deceleration ramp when the travel request is released and the brake pedal switch is closed. It sets the time needed to decelerate the traction motor from 100Hz to 0Hz.

⑬ **Speed limit BRK** : Seconds. It controls the deceleration ramp when a speed reduction has been activated. The parameter sets the time needed to decelerate the traction motor from 100Hz to 0Hz.

⑭ **Curve braking** : Seconds. It controls the deceleration ramp when a curve speed reduction has been activated. The parameter sets the time needed to decelerate the traction motor from 100Hz to 0Hz.

⑮ **Max speed forward** : Hz. It determines the maximum speed in forward direction.

⑯ **Max speed backward** : Hz. It determines the maximum speed in backward direction.

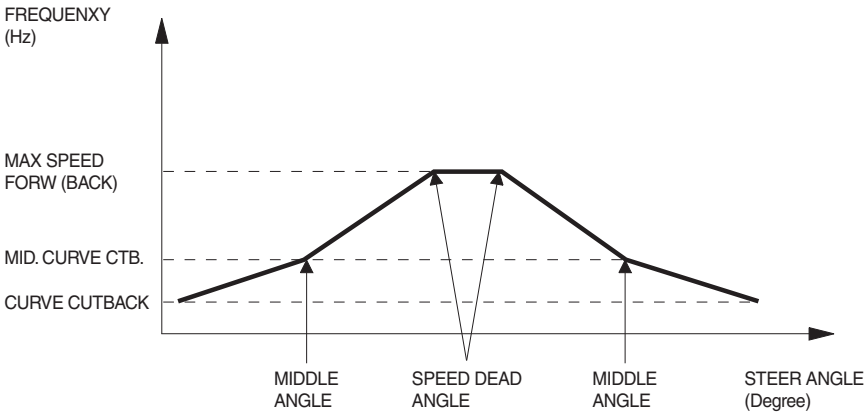
⑰ **Turtle speed** : Hz. It determines the maximum speed when turtle mode is activated.

⑱ **Steer dead angle** : %. It determines the steer tire angle range be able to get MAX SPEED FORW (BACK) speed. For example, if setting is 10% , it means truck maximun speed is same as MAX SPEED FORW (BACK) within 9˚. If steer angle is over 9˚, the maximun speed is reduced by the angle linealy.

⑲ **Middle angle** : %. It determines the steer tire angle range be able to get MID. CURVE CTB speed. This setting value is always higher than STEER DEAD ANGLE

⑳ **Mid. curve CTB** : Hz. It determines the maximum speed when truck steer angle is over MIDDLE ANGLE.

㉑ **Curve cutback** : Hz. It determines the maximum speed when truck steer angle is right turn and left turn end.



18BR9EL60

㉒ **Frequency creep** : Hz value. This is the minimum speed applied when the forward or reverse switch is closed, but the accelerator is at its minimum.

㉓ **Maximum current** : Maximum level of the current (percentage of the maximum current of the controller).

㉔ **BRK smooth** : It gives a parabolic form to the deceleration ramp.

㉕ **Stop BRK smooth** : Hz. It sets the level of frequency where the smooth effect of the deceleration parabolic form ends.

㉖ **Auxiliary time** : Time units value (seconds). For the encoder version, it determines the time duration the truck is hold on the ramp if the STOP ON RAMP option is ON.

■ PUMP CONTROLLER

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

(1) Submenu "SET OPTIONS"

① **Load sensor**

- ON : Load sensing function is activated.
- OFF : Load sensing function is disactivated.

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 motor temperature**

It can be set:

1. 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 (analog temperature sensor).
2. DIGITAL : A digital (on/off) sensor for the motor temperature monitoring is connected to CNA#22 input (digital temperature sensor).
3. NONE : No temperature sensor is connected.

④ **Cooling fan work**

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

- None : fans don't work.
- Option #1 : fans work always.
- Option #2 : fans work in case a temperature of controller or motor exceeds a temperature set in START TEMP. FAN menu
- Option #3 : fans work when motors work.

⑤ **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.

⑥ **A-16 diag active**

- ON : Pump inverter check A16 port (Fan relay coil).
- OFF : Pump inverter doesn't check A16 port (Fan relay coil).

⑦ **Model truck**

This display model setting from traction inverter . Threre are 2 models.

- 10/13BR
- 15BR-9E (Model setting is only avalible at the traction inverter side.)
- This parameter must be set "15BR-9E" for 15BR-9E truck.

(2) Submenu "ADJUSTMENTS"

① **Overload type** : This option specifies how overload alarm works in overloaded situation.
- NONE : There would'n be any kind of alarms or limitations. If re-configuration of V.A.S.S LOAD is required, please set this parameter as NONE, then proceedure-configuration.
- Option #1 : If the weight of load filed on forks exceeds the overload weight set in overload parameter, OVERLOAD alarm will be displayed and followed by traction & pump limitation except lift down & steering function.
- Option #2 : If the weight of load filed on forks exceeds the overload weight set in overload parameter, OVERLOAD alarm will be displayed.

② **REF. load weight** : This parameter is used to show and configurate the reference load weight.

③ **Overload weight** : This parameter is used to show and configurate the trigger condition for OVERLOAD alarm. If the loaded weight exceeds the weight indicated in this paramter, OVERLOAD alarm and function limitation will occur accroding to OVERLOAD TYPE paramter.

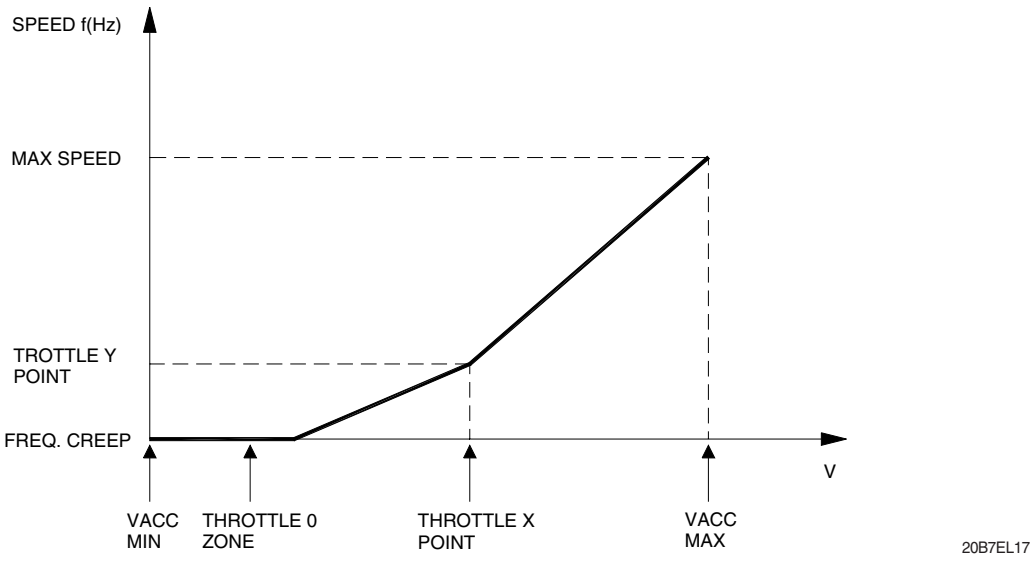
④ **Load speed UPD** : For accuracy, Load Sensor only works when the traction motor speed is lower than as set in this parameter.

⑤ **Adjust battery** : Fine adjustment of the battery voltage measured by the controller.

⑥ **Throttle 0 zone** : It establishes a dead band in the lift potentiometer input curve.

⑦ **Throttle X point** : 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 percent, 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 (See below figure).

⑧ **Throttle Y point** : This parameter, together with the THROTTLE X POINT, changes the characteristic of the lift potentiometer input curve : when the potentiometer is depressed to X point percent, the corresponding pump speed is Y point percent 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 (See below figure).



⑨ **Main cont. volt**

%. This parameter stores the PWM value applied to MC coil for the first second of the output activation. It is expressed in percentage of battery voltage.

⑩ **Aux output volt**

%. This parameter stores the PWM value applied to AUX COIL for the first second of the output activation. It is expressed in percentage of battery voltage.

⑪ **Main cont. V rid**

%. This parameter stores the PWM value applied to MC coil after the first second of the output activation. It is expressed in percentage of MAIN CONT. VOLT.

⑫ **Adjustment #04**

This parameter determines the motor temperature level at which the “Motor temperature” alarm is signalled. The range is from 70°C to 160°C with 10°C steps. This parameter must be adjusted only if the “Set motor temperature” (menu “Set option”) parameter is programmed “Analog”.

⑬ **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.

(3) Submenu "PARAMETER CHANGE"

① **Acceleration 0** : Seconds. It specifies the motor acceleration at 0 Hz. The parameter sets the time needed to accelerate the traction motor from 0Hz to 100Hz.

② **Acceleration 1** : Seconds. It specifies the motor acceleration at ACC PROF. FREQ 1 [Hz]. The parameter sets the time needed to accelerate the traction motor from 0Hz to 100Hz.

③ **Acceleration 2** : Seconds. It specifies the motor acceleration at ACC PROF. FREQ 2 [Hz]. The parameter sets the time needed to accelerate the traction motor from 0Hz to 100Hz.

④ **Acceleration 3** : Seconds. It specifies the motor acceleration at ACC PROF. FREQ 3 [Hz]. The parameter sets the time needed to accelerate the traction motor from 0Hz to 100Hz.

⑤ **ACC PROF. FREQ 1** : In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 1 parameter.

⑥ **ACC PROF. FREQ 2** : In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 2 parameter.

⑦ **ACC PROF. FREQ 3** : In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 3 parameter.

⑧ **Release braking** : Seconds. It controls the deceleration ramp when the travel request is released. The parameter sets the time needed to decelerate the traction motor from 100Hz to 0Hz.

⑨ **Max speed limit** : Hz, It determines the maximum lifting speed.

⑩ **Tilt speed** : Hz, It determines the tilt speed.

⑪ **Reach speed** : Hz, It determines the reach speed.

⑫ **Aux speed** : Hz, It determines the aux speed.

⑬ **Frequency creep** : Hz value. This is the minimum speed applied when the forward or reverse switch is closed, but the accelerator is at its minimum.

⑭ **Maximum current** : Maximum level of the current (percentage of the maximum current of the controller).

⑮ **Auxiliary time** : Time units value (seconds). For the encoder version, it determines the time duration the pump motor is hold when deceleration is activated under 2 Hz.

5) PROGRAMMING & ADJUSTMENTS

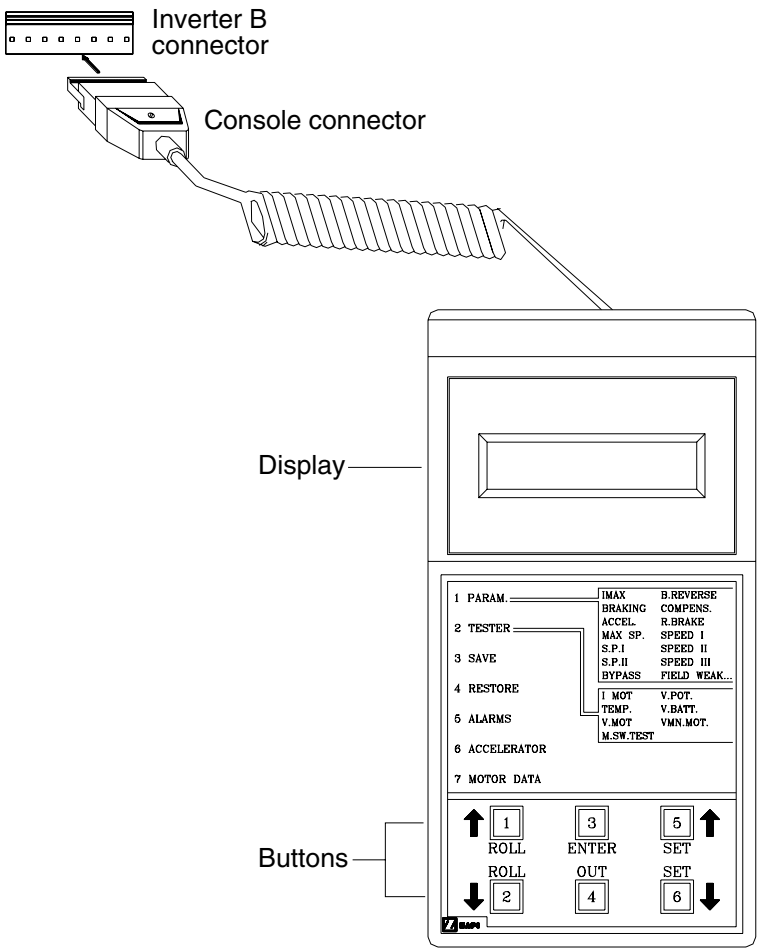
There are two ways to adjust parameter via a console or buttons on a display.

※ Adjustments via buttons on a display, please refer to the display section. (page 7-46)

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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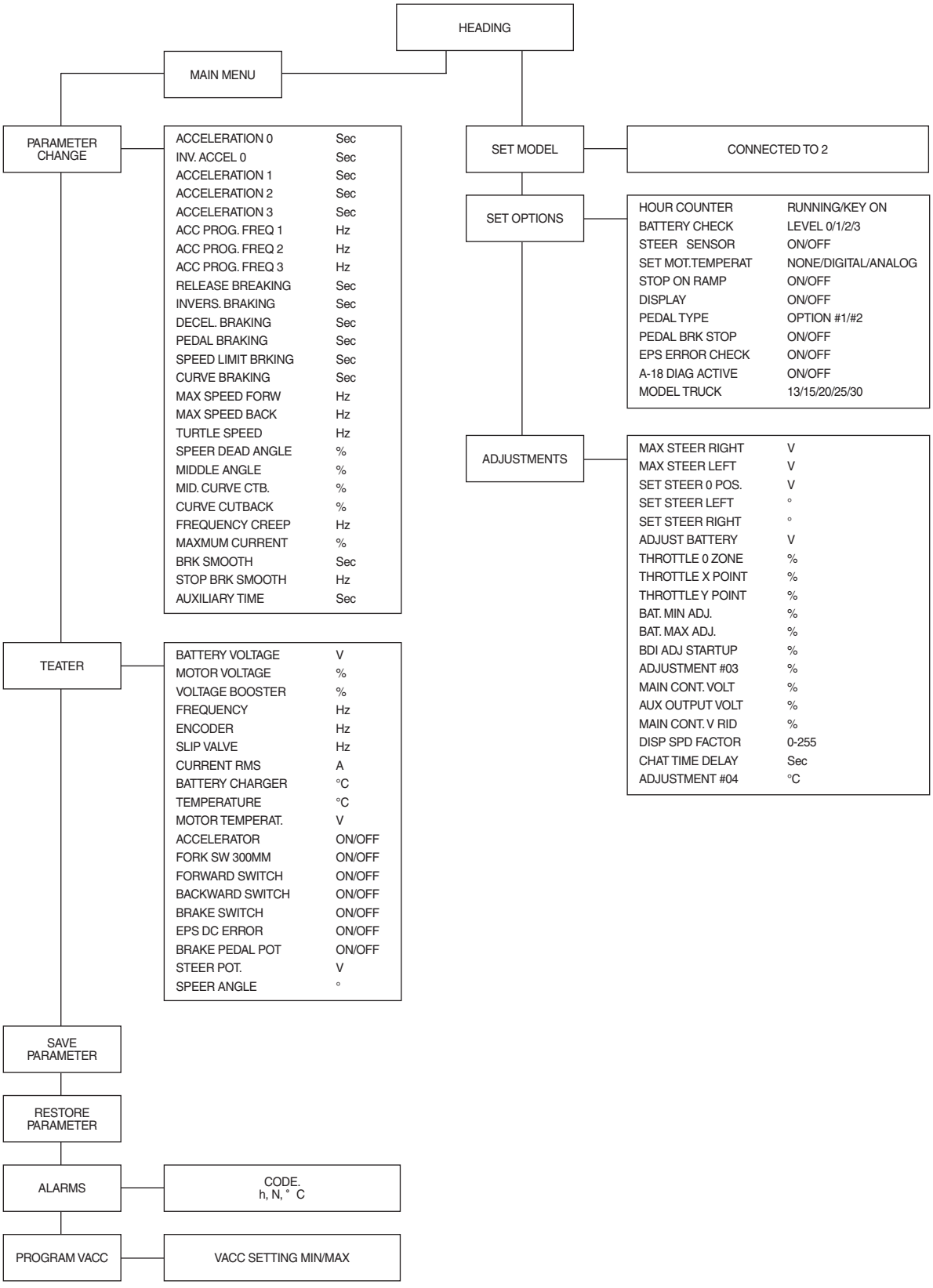
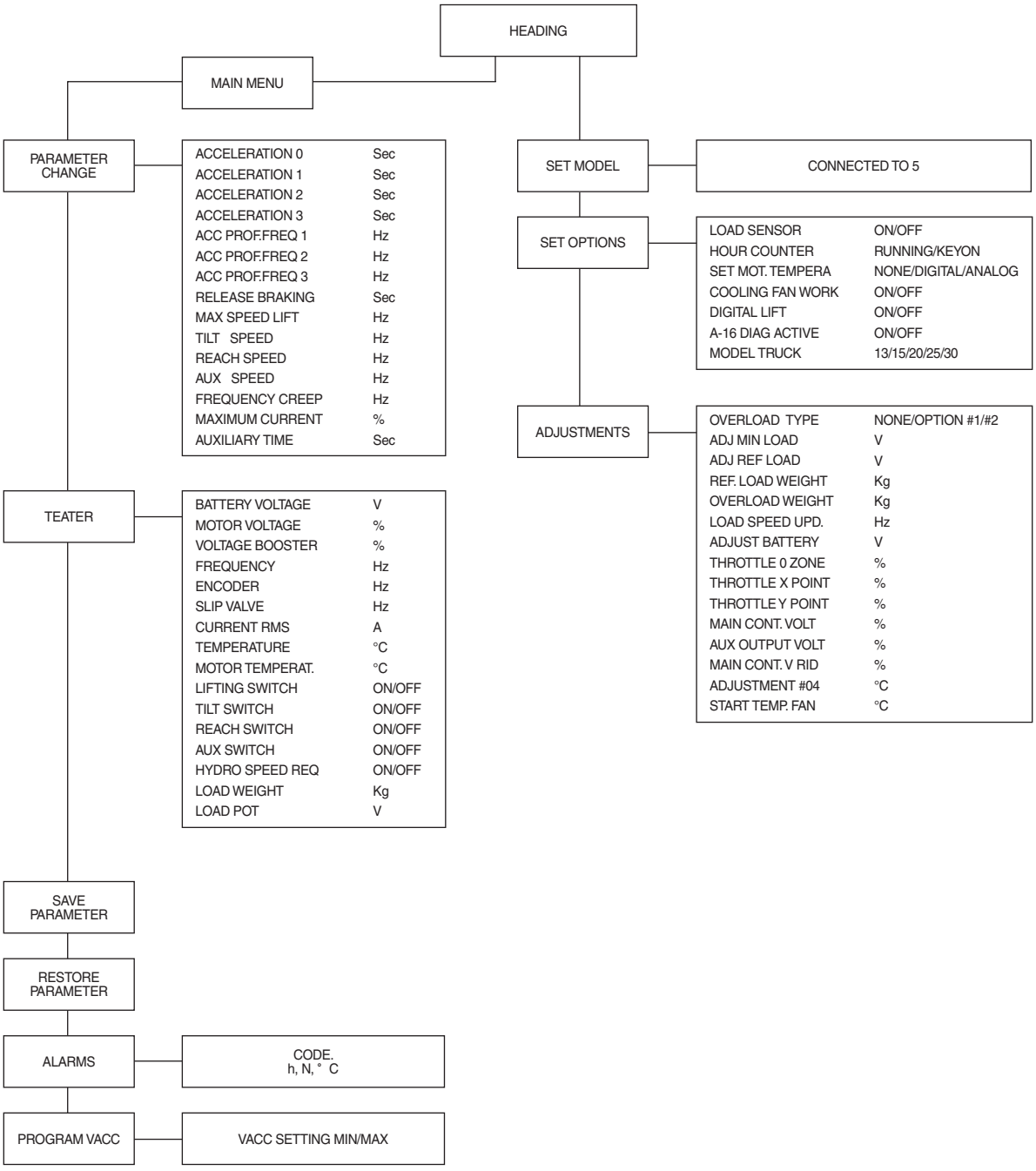
※ Digital consoles used to communicate with AC inverter controllers must be fitted with EPROM CK ULTRA, minimum "Release number 3.02".

(2) Description of standard console menu

① Traction controller



② Pump controller



(3) Description of ALARMS menu

The microprocessor in the controller records the last five alarms that have occurred. Items remembered relative to each alarm are: the code of the alarm, the number of times the particular Alarm occurred, the hour meter count, and the inverter temperature.
This function permits a deeper diagnosis of problems as the recent history can now be accessed.
Flow chart showing how to use the ALARMS function via the digital console.

① Opening Zapi display.

② Press ENTER to go into the general menu.

③ The display will show:

④ Press ROLL UP or ROLL DOWN button until PARAMETER CHANGE. appear on the display.

⑤ The display shows:

⑥ Press ENTER to go into the ALARMS function.

⑦ The display will show the most recent alarm.

⑧ Each press of the ROLL UP button brings up following alarms. Pressing ROLL DOWN returns to the most recent.

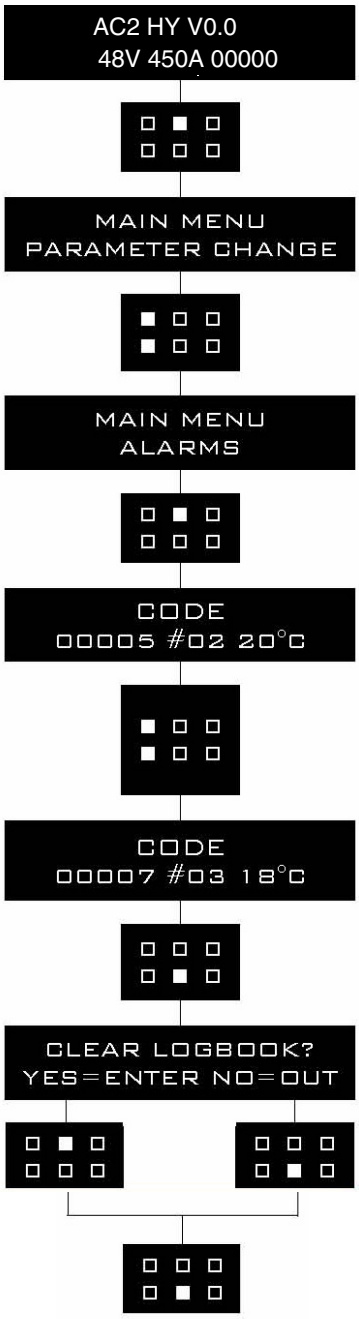
⑨ If an alarm has not occurred, the display will show: ALARM NULL.

⑩ When you have finished looking at the alarms, press OUT to exit the ALARMS menu.

⑪ The display will ask "CLEAR LOGBOOK?".

⑫ Press ENTER for yes, or OUT for NO.

⑬ Press OUT to return to the opening Zapi display.



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6) TESTER MENU

(1) Traction controller

The most important input or output signals can be measured in real time using the TESTER function of the console. The Console acts as a multimeter able to read voltage, current and temperature. In the following chapter a list of relative measurements for different configurations.

① **Battery voltage**

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

② **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.

③ **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.

④ **Frequency**

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

⑤ **Encoder**

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

⑥ **Slip value**

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

⑦ **Current RMS**

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

⑧ **Battery charge**

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

⑨ **Temperature**

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

⑩ **Motor temperature**

°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.

⑪ **Accelerator**

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

⑫ **Fork SW 300MM**

ON/OFF. This is the status of fork 300mm switch.

⑬ **Forward switch**

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

⑭ **Backward switch**

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

⑮ **Brake switch**

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

⑯ **EPS DC error**

ON/OFF. This is the status of EPS fault signal.

⑰ **Steer pot.**

From 0.0V to 5.0V. Steer angle sensor reading is in the range 0.0 to 5.0Vdc.

⑱ **Steer angle**

˚ value. This is the angle of steering wheel.

(2) Pump controller

The most important input or output signals can be measured in real time using the TESTER function of the console. The Console acts as a multimeter able to read voltage, current and temperature. In the following chapter a list of relative measurements for different configurations.

① **Battery voltage**

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

② **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.

③ **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.

④ **Frequency**

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

⑤ **Encoder**

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

⑥ **Slip value**

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

⑦ **Current rms**

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

⑧ **Temperature**

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

⑨ **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.

⑩ **Lifting switch**

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

⑪ **Tilt switch**

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

⑫ **Reach switch**

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

⑬ **Aux switch**

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

⑭ **Hydro speed req.**

Status of the hydro speed request of the pump.

- ON = an hydro speed request is received via canbus.
- OFF = no hydro speed request active.

⑮ **Load weight**

kg . This displays load weight when LOAD SENSOR option is on.

⑯ **Load pot**

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

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.

⚠ Do not connect the inverter to a battery with a nominal value different from the value indicated on the controller plate. If the battery value is greater, the MOS may fail; if it is lower, the control unit does not "power up"

⚠ 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.

8) EPS TROUBLESHOOTING

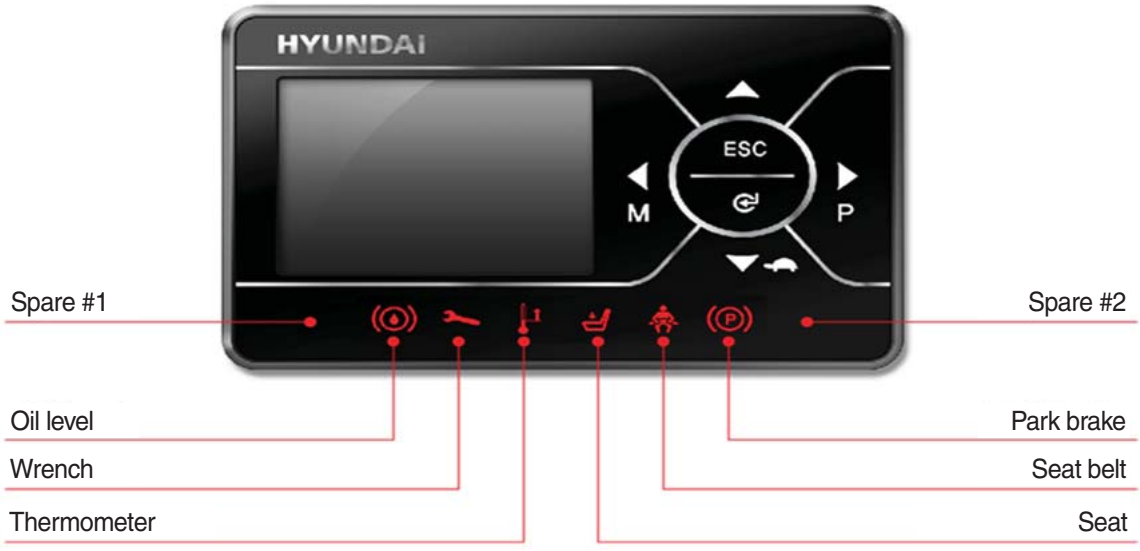
Problem	Preparable cause	Remedy
No working	※ Although the key is turned, It doesn't operate. · Check the input power. · Can you measure 20~60V in No.2 & No.10 controller? ↓ It's not power problem. · Connector contact of torque sensor is unstable. · Check the contact condition. · Although connector is equipped again, is it impossible to operate it? (At that time, check the operation with repeating key ON/OFF.) ↓ It is disrelated. · Is output power of torque sensor normal? · Check the voltage between No. 5 controller and No. 3 controller whether it is 3V~9V. ↓ It is under specification. · Check the operation of contactor. · Is the voltage between No. 1 controller and No.11 controller similar with input power. (Key on) ↓ It is similar with input power. · Check connector whether it is contacted. · Can you measure the input power between No.15 controller (-) and No. 16 controller? (Key on) ↓ It is similar with input power. · Check the motor electric wiring and burning. · Check the commutator after removing motor maintenance cover. (Key on) ↓ It's clean. · Controller failure → Replace it.	→ No power · It's not EPS problem. Power charging condition or main contactor isn't operated. The other system error. → It operate occasionally. · Replace or repair connector pin. → It is not 3V~9V. · Check the electric wiring. · Electric wiring of torque sensor failure · Torque sensor failure → Replacement → It's close to 0V. · Connector failure → Replacement · Check whether connector terminal is combined abnormally, · Check the filter wiring and terminal. → It is getting black and dug.
Weighty feeling of steering wheel	※ Steering wheel is getting weighty during driving (It differ from weighty feeling of EPS OFF condition). Is getting light when wheel is rotated other side. · If key switch is turned on after being turned off, Is steering wheel getting light? ↓ It's still weighty. · Is it similar with input power when the voltage of No. 5 terminal (-) and No. 13 terminal (+) of controller is measured. ↓ It's similar with input power. · Can you measure 3V~9V between No. 5 terminal (-) and No. 3 terminal of controller when motor connector is removed and steering wheel is rotated left and right. ↓ Voltage is less 4~8V than specification. · Torque sensor is failed. Replace it. ※ Does this problem happen occasionally?	→ Yes · It is normal. In case of long time steering to one way, controller reduce current automatically. → It is getting light. · It which operate normally now is caused by input power malfunction. → It's close to 0V. · Inner parts failure of controller. → Replace or repair it. → Yes · Check the motor whether it was burnt out. → Yes · It return to normal caused by main power. · Check the contact of torque sensor harness. · Check the motor whether it was burnt out.

Problem	Preparable cause	Remedy
Weighty feeling of steering wheel	※ Is one way of steering wheel light and is the other way weighty?	→ Yes ・ Torque sensor replacement (low wheel speed condition). ・ Controller replacement (Between low wheel speed and high wheel speed symptom is same, FET burn).
Wheel locking	※ Suddenly, wheel is locked during driving. (EPS stop) Is it normal when main power is turned off and turned on. ↓ Yes, and repeat again. ・ Check the motor whether it was burnt out. ・ Check the commutator after removing cover. ↓ It is clean. ・ Connector contact of torque sensor is unstable. ・ Check the contact. Is it impossible to operate it when connector is moved or installed again. (At that time, check whether it can be operated. ↓ It's same. ・ Check the output value of torque sensor. ・ Check whether between No. 5 controller and No.3 controller is under 3~9V.	→ No operation. ・ Refer to trouble table. → It's getting black and burnt out. ・ Replace motor. → It operate occasionally according to contact of wiring. ・ Replace or repair connector pin.
Wheel locking momentarily	※ It is getting normal when you stop to rotate steering wheel momentarily and rotate it again. ↓ Yes, and repeat again. ・ Check the motor whether it was burnt out. ・ Check the commutator after removing cover. → It was and burnt out.	→ No operation. ・ Refer to trouble table. → Replace motor.
Wheel shaking	※ Steering wheel shake during driving. Steering wheel shake in the special range. ↓ It is still shaked. ・ Controller amplifier rate is too high. (Carry out amplifier rate test with shifting down step by step.)	→ Yes ・ Is it uneven place? ・ Chain tension or chain gear ablation is strong. ・ Is spline shaft of torque sensor bent or eccentric by the external force.
Wheel rotation	※ Steering wheel rotate to one way automatically.	・ Replace torque sensor as manufacture failure. ・ Replace torque sensor as life limit.
A few wheel rotation	※ Steering wheel rotate as 0°~90° when main power is supplied or stopped.	・ In case of uneven, problem happen. ・ In case chain tension is too strong, problem happen. ・ Check disconnection. (It should be disconnected with torque sensor input power.) (Check whether it connected with the other line.)

6. INSTRUMENT PANEL : DISPLAY

1) STRUCTURE

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



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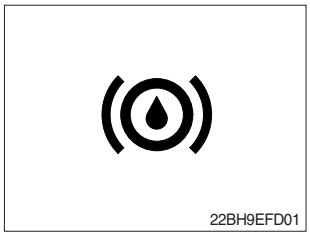
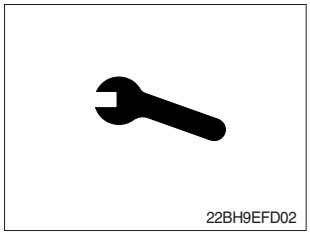
2) WARNING LAMP

(1) Brake oil level warning lamp



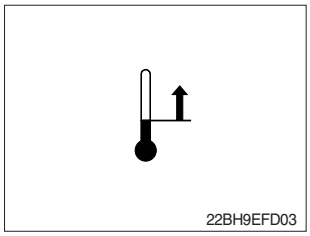
Lights when the brake oil level in the reservoir is below the lower limit.

(2) Wrench warning lamp



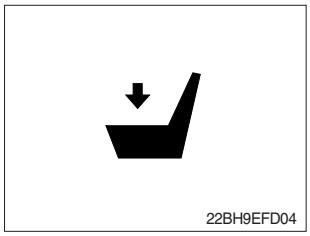
This LED lights when an electric device (controller, motor, cable, etc.) is in alarm condition.

(3) Thermometer warning lamp



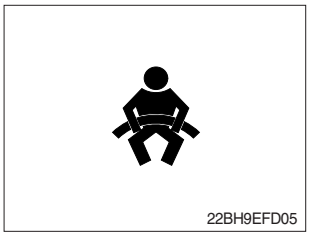
This LED lights when the controller or motor temperature is high.

(4) Seat warning lamp



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

(5) Seat belt warning lamp

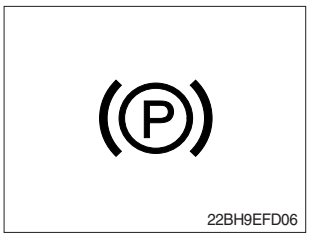


(1) This LED blinks in following 2 cases.

① When operator starts the truck, LED blinks for 5 seconds, which means initial diagnosis is on going, and buttons on display will work properely just after the diagnosis is completed.

② LED blinks when the seat belt is not correctly fastened.

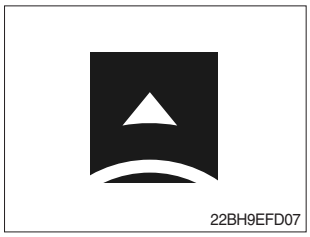
(6) Handbrake warning lamp



(1) This LED lights when the handbrake is activated.

3) BUTTONS

(1) UP button

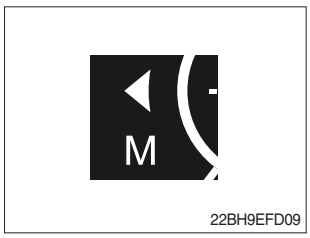


Press to select upward move

(2) DOWN button (DOWN/TURTLE button)

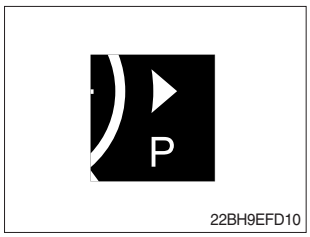
Press to select downward move
TURTLE MODE ON/OFF

(3) LEFT/MENU button



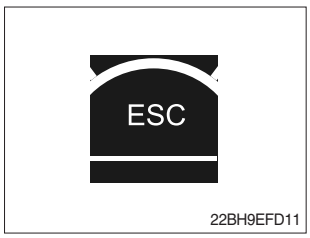
Press to select leftward move
Go into the menu

(4) RIGHT/PERFORMANCE button



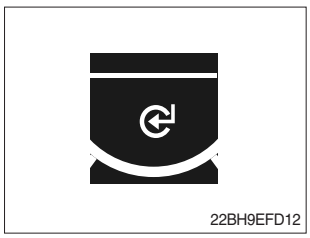
Press to select rightward move
POWER MODE H/N/E

(5) Cancel (ESC) button



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

(6) ENTER button



Press to select Enter

4) LCD FUNCTION (MAIN SCREEN)

MAIN SCREEN

22BH9EFD13

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	10	Load weight (option)

(1) Current time

The number shows the current time according to the setting, which can be changed by DISPLAY Setting [6. 5), Page 7-51].

(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

This indicator shows the truck speed same as the (3) Speed pointer.

(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.

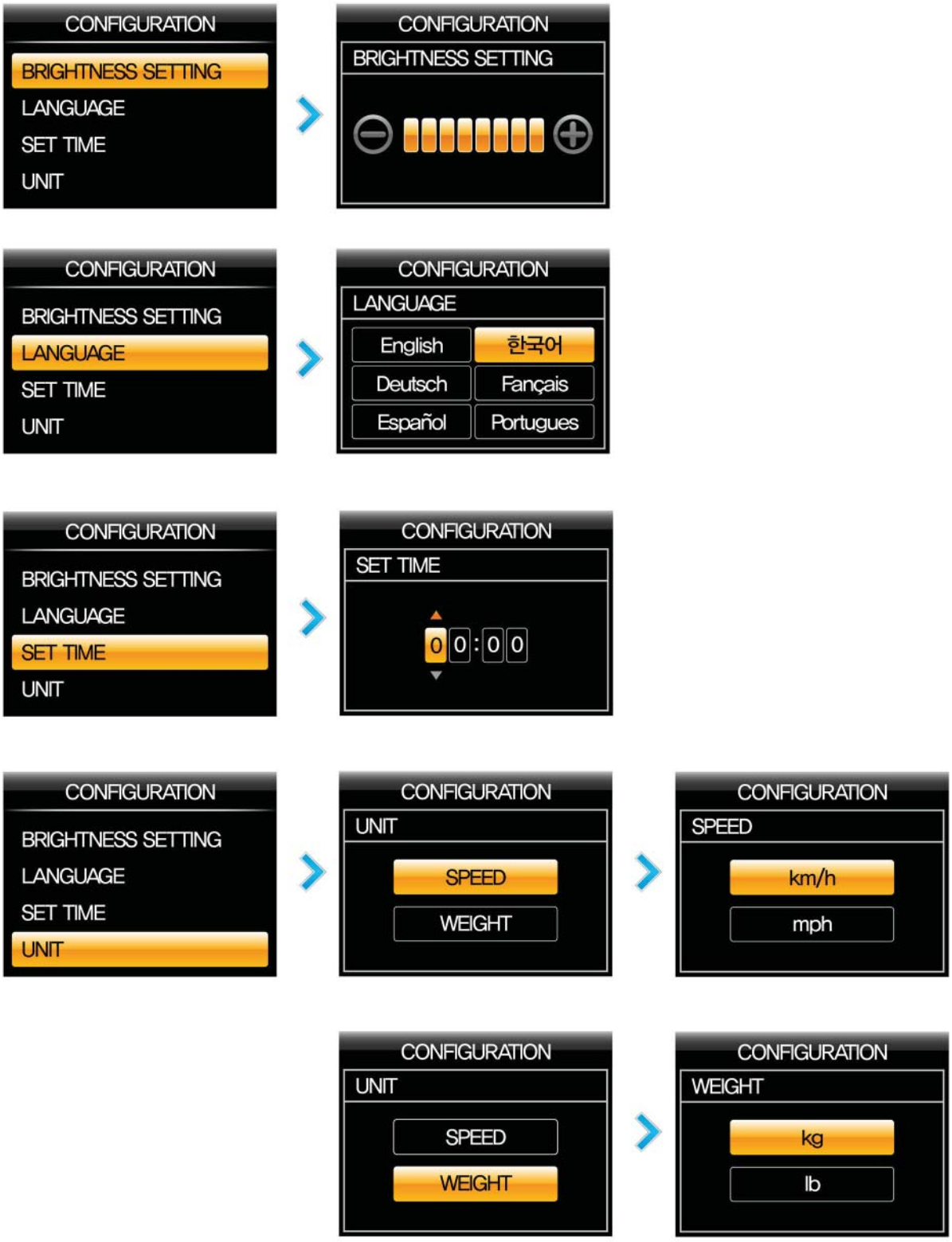
① BAT. MAX ADJ.

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

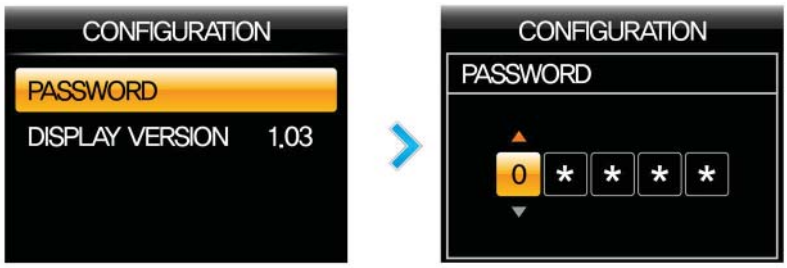
② BAT. MIN ADJ.

It adjusts the lower level of the battery discharge table. Higher value means higher voltage. (for detail menu, please refer to page 7-30)

5) HOW TO USE DISPLAY MENU



22BH9EFD14


CONFIGURATION
PASSWORD
DISPLAY VERSION 1.03
CONFIGURATION
PASSWORD
0 * * * *

20BC9EFD15

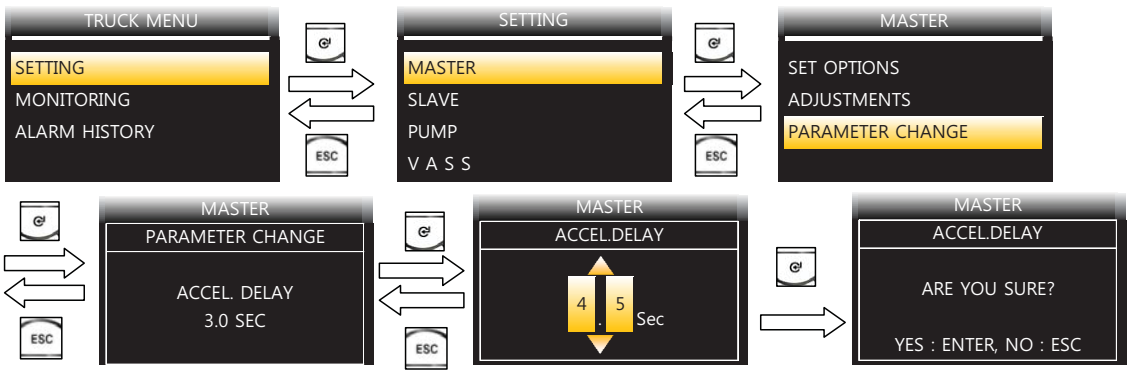
6) DESCRIPTION OF THE TRUCK MENU

(1) Access to truck menu

ESC If this button is pressed long, the PASSWORD dialog appears.
Enter correct PASSWORD, then on MAIN SCREEN, Press M button to access the controller "TRUCK MENU"

(2) How to change detail menus

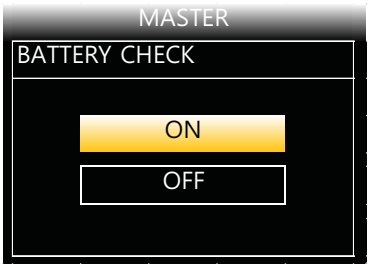
The detail items of menu can be changed as follows ;



22B9EL24

Selection can be made in 4 methods as follows ;

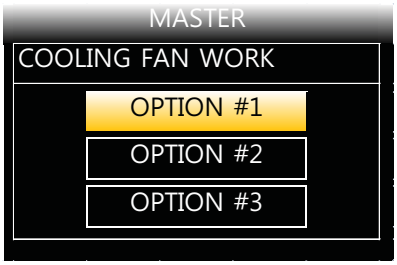
- ON/OFF Selection



22B9EL25

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

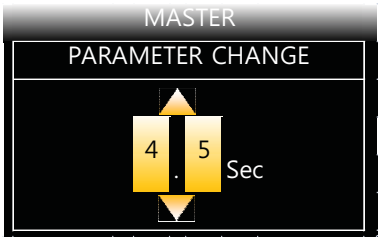
- Type Selection



22B9EL30

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

- Level Selection



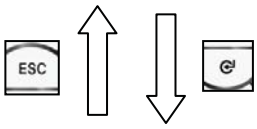
22B9EL30

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

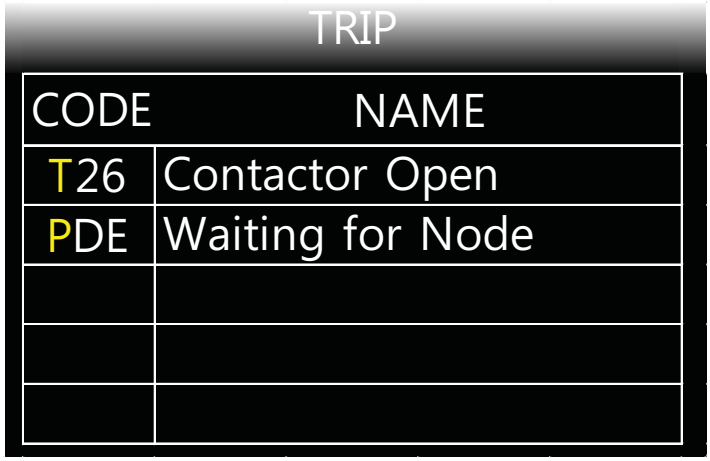
7) ALARM & ALARM HISTORY

(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 :

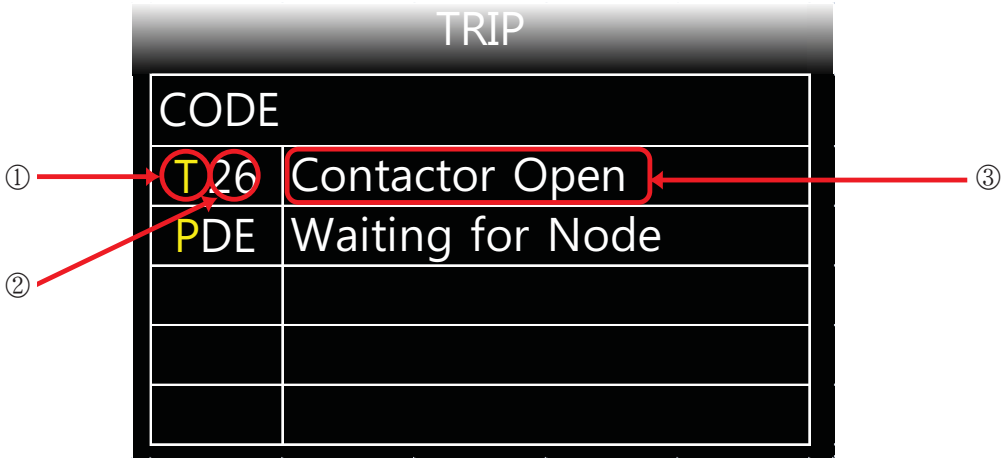


(Press more than 1 sec)



18BR9EL35

(2) Detail description of ALARM SCREEN

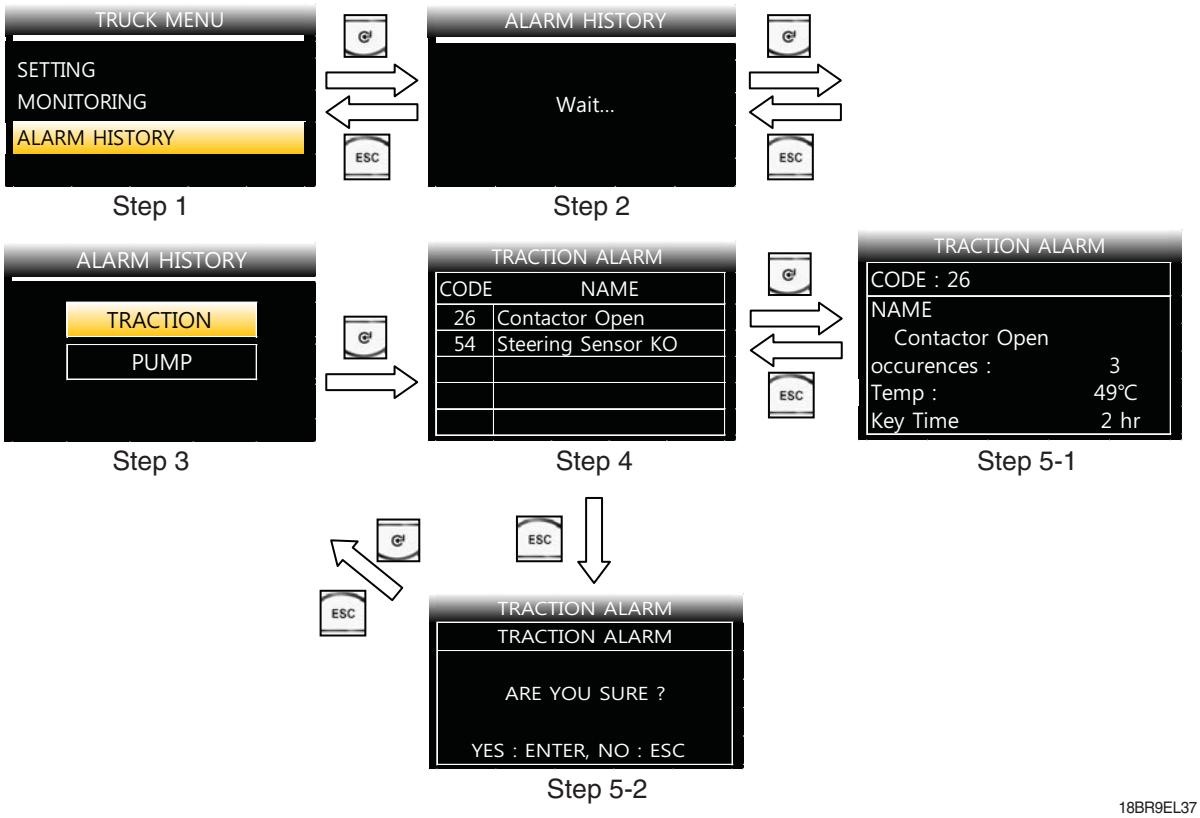


18BR9EL36

① First yellow capital letter shows in which controller the alarm happens as below;
T : Traction
P : Pump
② Following two letters or digits show alarm code. Please refer to 7. ALARM CODE (Page 7-63).
③ This shows a name of ALARM. Please refer to 7. ALARM CODE (page 7-63).

(3) Alatm history

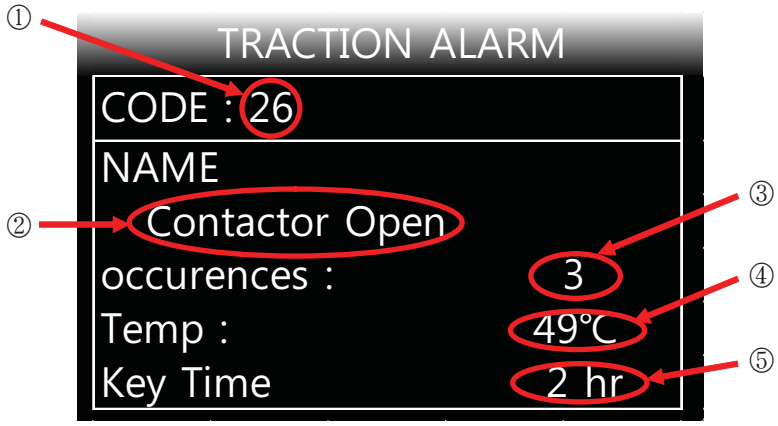
Alarm History can be looked up as follows ;



18BR9EL37

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 (page 7-57)
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.

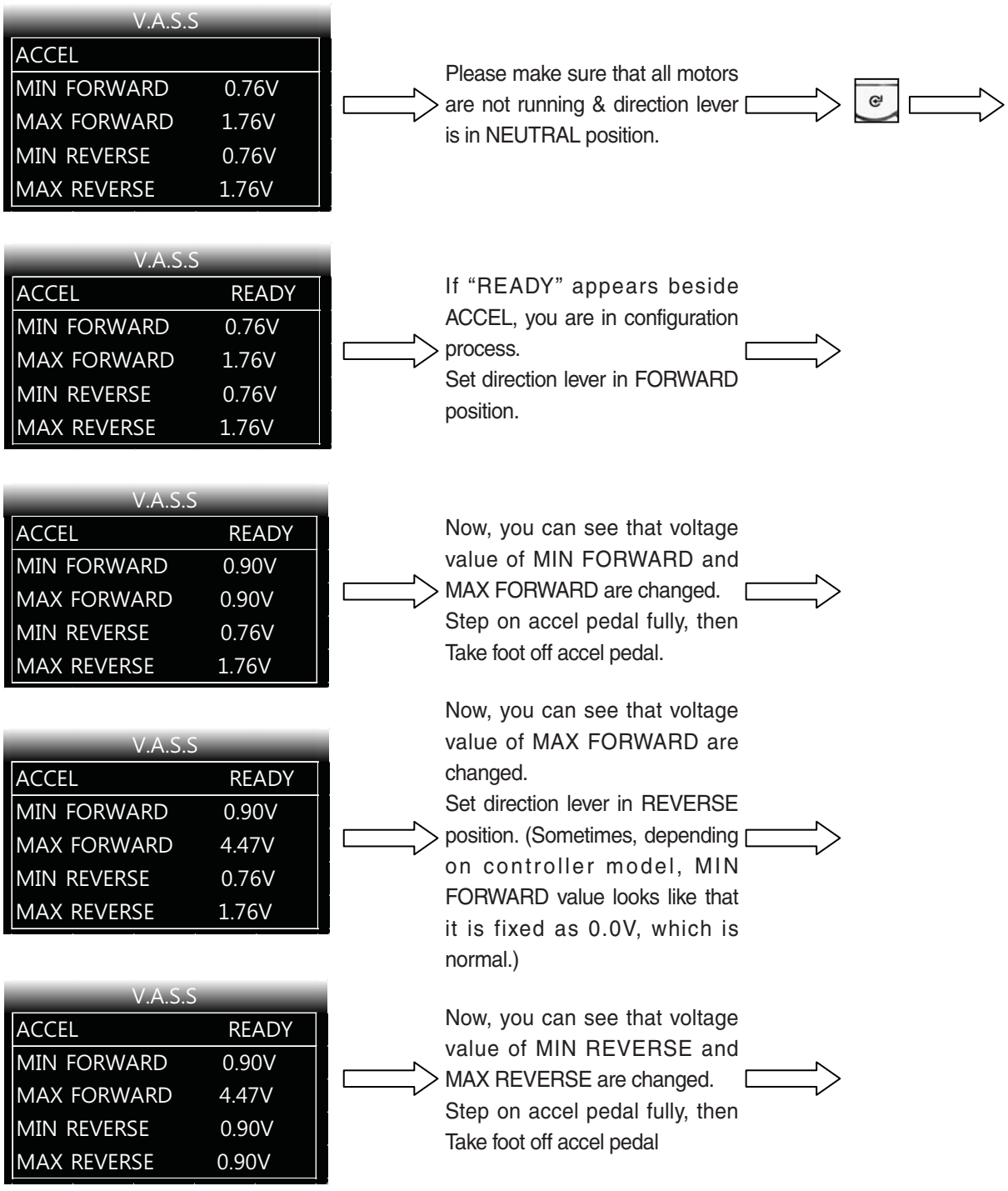
8) VASS SETUP USING DISPLAY MENU

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.

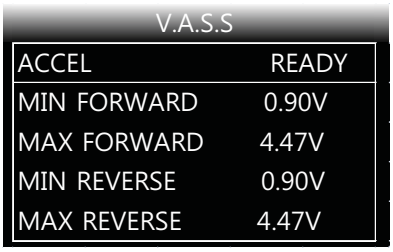
(All figures in belows are just example.)

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

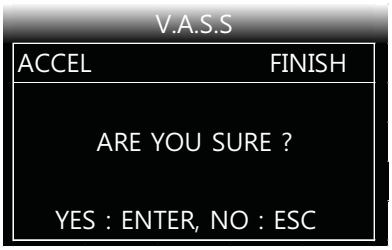
(1) ACCEL VASS setting method



22B9EL39-1

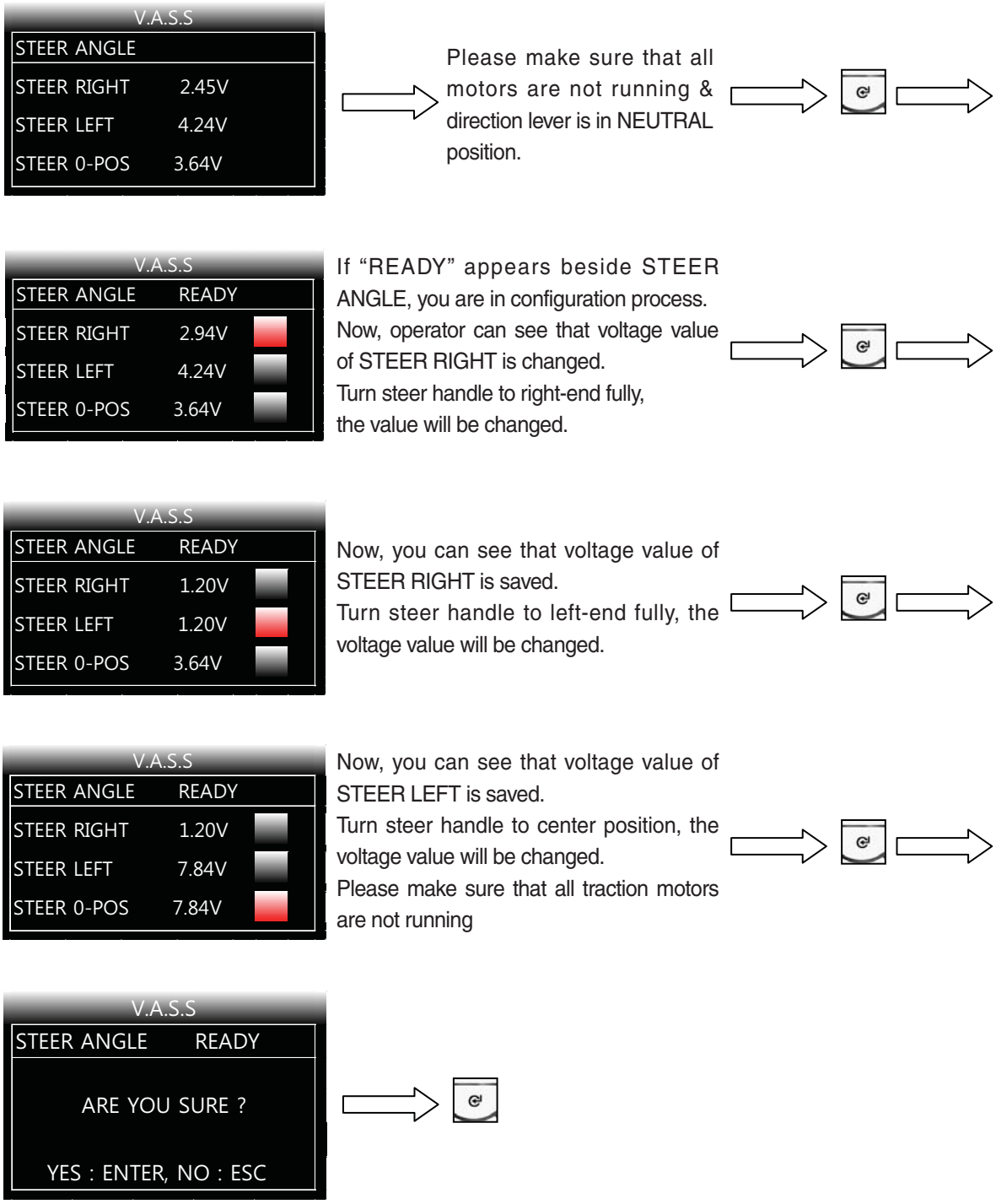


Now, you can see that voltage value of MAX REVERSE are changed.
Please make sure that all motors are not running & direction lever is in NEUTRAL position.



22B9EL39-2

(2) STEER ANGLE VASS setting method



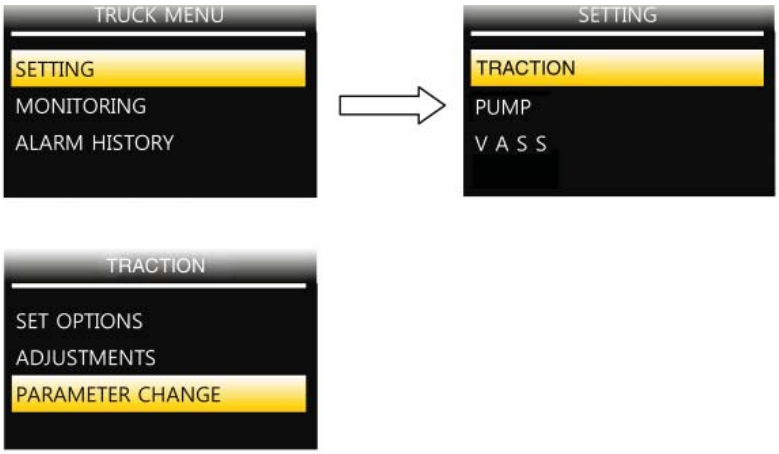
22B9EL41

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 7-53]

(1) Settings



20BC9EL42

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

① TRACTION->SET OPTIONS
Refer to 5-4)- ■ “TRACTION CONTROLLER”-(1) “SET OPTIONS” (page 7-28)

② TRACTION->ADJUSTMENTS
Refer to 5-4)- ■ ”TRACTION CONTROLLER”-(2) “ADJUSTMENTS” (page 7-29)

③ TRACTION->PARAMETER CHANGE
Refer to 5-4)- ■ ”TRACTION CONTROLLER”-(3) “PARAMETER CHANGE” (page 7-31)

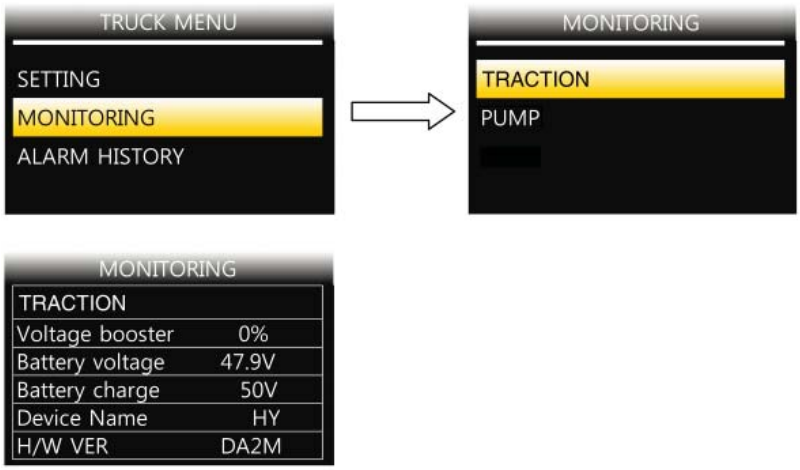
④ PUMP->SET OPTIONS
Refer to 5-4)- ■ “PUMP CONTROLLER”-(1) “SET OPTIONS” (page 7-33)

⑤ PUMP->ADJUSTMENTS
Refer to 5-4)- ■ ”PUMP CONTROLLER”-(2) “ADJUSTMENTS” (page 7-34)

⑥ PUMP->PARAMETER CHANGE
Refer to 5-4)- ■ ”PUMP CONTROLLER”-(3) “PARAMETER CHANGE” (page 7-35)

⑦ V.A.S.S
Refer to 6-8) “VASS SETUP USING DISPLAY MENU” (page 7-58)

(2) Monitoring



20BC9EL43

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

① TRACTION

Refer to 5-6)-(1) “Traction controller” (page 7-40)

② PUMP

Refer to 5-6)-(3) “Pump controller” (page 7-41)

(3) Alarm history

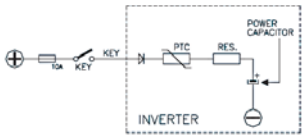
Refer to 6-7) “ALARM & ALARM HISTORY” (page 7-55)

7. ALARM CODE

1) TRACTION CONTROLLER

No	Code	Alarm name	Traction (T)	Pump (P)	Description	
					Cause	Troubleshooting
1	D	EEPROM KO	○	○	It's due to a Hardware or Software defect of the non-volatile embedded memory supporting the controller parameters. This alarm does not inhibit the machine operations, but the truck will work with the default values.	- Try to execute a CLEAR EEPROM operation (Please ask to the engineer). Switch the key off and on to check the result. If the alarm occurs permanently, it is necessary to replace the controller. If the alarm disappears, the previously stored parameters will have been replaced by the default parameters.
2	11	Logic Failure#3	○	○	Hardware problem in the logic card circuit for high current (overload) protection.	- This type of fault is not related to external components, so, when it is present it is necessary to replace the ACE logic board.
3	12	Logic Failure#2	○	○	Fault is in the hardware section of the logic board which manages the phase's voltage feedback.	- This type of fault is not related to external components, so when it happens it is necessary to replace the ACE2 logic board.
4	13	Logic Failure#1	○	○	This fault is displayed when the controller detects an over voltage or under voltage condition. In 48V controller over voltage threshold is 65V, under voltage threshold is 11V.	Troubleshooting of fault displayed at start-up or in standby; in these cases it is very likely the fault is due to an under voltage, so it is suggested to check: - Key input signal down-going pulses (below under voltage threshold) due to external loads, like DC/DC converters starting-up, relays or contactor switching, solenoids energizing / de-energizing. - Check the connection of power cables to the battery terminal, positive and negative, to MC and to controller +Batt and –Batt, which must be screwed with a torque comprised in the range 13 Nm÷15 Nm. - If no voltage transient is detected on the supply line and the alarm is present every time the key is switched ON, the failure is probably in the controller hardware, so it is necessary to replace the logic board. Troubleshooting of fault displayed during motor driving; in this case it can be an under voltage or an over voltage condition. - If the alarm happens during traction acceleration or driving hydraulic functions, it is very likely it is an under voltage condition; check battery charge condition, power cable connection. - If the alarm happens during release braking, it is very likely it is due to over voltage condition; check line contactor contact, battery power cable connection.

No	Code	Alarm name	Traction (T)	Pump (P)	Description	
					Cause	Troubleshooting
5	1E	VMN Low	○	○	Start-up test. Before switching the LC on, the software checks the power bridge: it turns on alternatingly the High side Power Mosfets and expects the phases voltage to increase toward the rail capacitor value. If the phases voltage is less than 66% of the rail capacitor voltage, this alarm occurs.	- If the problem occurs at start up (the LC does not close at all), check: - Motor internal connections (ohmic continuity) - Motor power cables connections. - Motor leakage to truck frame. - If the motor connections are OK, the problem is inside the controller, replace it.
					Motor running test. When the motor is running, power bridge is ON, the motor voltage feedback is tested; if it is lower than commanded value (a window of values are considered) fault status is entered.	- If the alarm occurs during motor running, check: - Motor connections. - If motor phases windings/cables have leakages towards truck frame. - That the LC power contact closer properly, with a good contact. - If no problem are found on the motors, the problem is inside the controller, replace it.
6	1F	VMN High	○	○	Before switching the LC on, the software checks the power bridge: it turns on alternatingly the Low side Power Mosfets and expects the phases voltage to decrease down to -BATT. If the phases voltage is higher than 10% of nominal battery voltage, this alarm occurs.	- If the problem occurs at start up (the LC does not close at all), check: - Motor internal connections (ohmic - continuity). - Motor power cables connections. If the motor connection are OK, the problem is inside the controller, replace it.
					This alarm may occur also when the start up diagnosis is overcome, and so the LC is closed. In this condition, the phases' voltages are expected to be lower than 1/2 Vbatt. If it is higher than that value, fault status is entered.	- If the problem occurs after closing the LC (the LC closed and then opens back again), check: - Motor connections. - If motor phases windings/cables have leakages towards truck frame. - If no problem are found on the motors, the problem is inside the controller, replace it.
7	25	Contector Closed	○		Before driving the MC coil, the controller checks if the contactor is stuck. The controller drives the bridge for some tens milliseconds, trying to discharge the capacitors bank. If the capacitor voltage does decrease by 20% of the key voltage the alarm is generated.	- It is suggested to verify the power contacts of LC; to replace the LC is necessary.

No	Code	Alarm name	Traction (T)	Pump (P)	Description	
					Cause	Troubleshooting
8	26	Contactor Open	○	○	The main contactor coil has been driven by the controller, but the contactor does not close.	- It could be a problem of the contacts in the MC that are not working (does not pull-in), try replacing the MC. - If the contactors of MC are working correctly than the problem is in the controller, replace it.
9	35	Stby I High	○	○	The current transducer or the current feedback circuit is damaged in the controller.	- This type of fault is not related to external components so, when it is present, it is necessary to replace the controller.
10	3C	CAPACITOR CHARGE	○	○	 When the key is switched ON, the inverter tries to charge the power capacitors through a series of a PTC and a power resistance, and check if the capacitor are charged within a timeout. If the capacitor voltage measured is less than 20% of the nominal battery voltage, an alarm is signalled; the main contactor is not closed.	- There is an external load in parallel to capacitor bank, which sinks current from the controller capacitors pre-charging circuit, thus preventing the caps from charging. Check if a lamp or a dc/dc converter or an auxiliary load is placed in parallel to - capacitor bank. The charging resistance or PTC is opened; insert a power resistance across line contactor power terminals; if the alarm disappears, it means the controller internal - charging resistance is damaged. The charging circuit has a failure, inside the - controller. There is a problem in the controller power section.
11	3E	TH. Protection	○	○	This alarm occurs when the temperature of the base plate is higher than 85°C. Then the maximum current decreases proportionally with the temperature increases from 85°C up to 105°C. At 105°C the current is limited to 0 Amps.	- It is necessary to improve the controller cooling. For realise an adequately cooling in case of finned heat sink are important factor the flux (m^3/h) and temperature (°C) of cooling air. In case of thermal dissipation realised with the controller base plate installed on truck frame it is important the thickness of frame and the planarity and roughness of its surface. If the alarm is signalled when the controller is cold, the possible reasons are a thermal sensor failure or a failure in the logic card. In this case, it is necessary to replace the controller.
12	41	Motor Temperat.	○	○	This warning occurs when the temperature sensor is opened (if digital) or has overtaken the threshold of 150°C (if analogue).	- Check the thermal sensor inside the motor (use the MOTOR TEMPERATURE reading in the MONITOR menu); check the sensor ohmic value and the sensor wiring. If the sensor is OK, improve the cooling of the motor. If the warning is present when the motor is cool, then the problem is inside the controller.

No	Code	Alarm name	Traction (T)	Pump (P)	Description	
					Cause	Troubleshooting
13	42	BATTERY LOW	○		If the "battery check" option is Level 1 or Level 2, a battery discharge algorithm is carried out. When the charge level is 10%, this alarm is signalled	- Check the battery voltage and charge the battery.
14	4A	Driver Shorted	○	○	When the key is switched ON, the µP checks that the MC coil driver is not shorted; if it is, this alarm is signalled	This type of fault is not related to external components; replace the ACE2 logic board.
15	4B	Contactor Driver	○	○	The MC 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.
16	4E	VACC Not OK	○		The test is made at key-on and immediately after that both the travel demands have been turned off. This alarm occurs if the ACCELERATOR reading in the TESTER menu' is 1.0V higher than VASS min acquisition when the accelerator is released.	Acquire the maximum and minimum potentiometer value through the VASS function. If the alarm is still present, check the mechanical calibration and the functionality of the potentiometer. If the alarm is not disappeared the failure is in the ACE logic board, replace it.
17	4F	Incorrect Start	○	○	This is a warning for an incorrect starting sequence.	The possible reasons for this alarm are (use the readings in the MONITOR menu to facilitate the troubleshooting): - A travel demand active at key on - Presence man sensor active at key on Check the wirings. Check the micro switches. It could be also an error sequence made by the operator. A failure in the logic is possible too; so when all of the above conditions were checked and nothing was found, replace the ACE logic board.
18	50	FORW + BACK	○		This alarm occurs when both the travel demands (Fwd and Bwd) are active at the same time.	Check the wiring of the Fwd and Rev travel demand inputs (use the readings in the TESTER to facilitate the troubleshooting). Check the microswitches for failures. A failure in the logic is possible too. So, when you have verified the travel demand switches are fine working and the wiring is right, it is necessary to replace the ACE-2 logic board.

No	Code	Alarm name	Traction (T)	Pump (P)	Description	
					Cause	Troubleshooting
19	52	Encoder Error	○	○	This fault is signalled in following conditions: the frequency supplied to the motor is higher than 40 Hz and the signal feedback from the encoder has a jump higher than 40 Hz in few tens mSec. This condition is related to a malfunctioning of the encoder.	Check both the electric and the mechanical encoder functionality, the wires crimping. - Check the encoder mechanical installation, if the encoder slips inside its compartment raising this alarm condition. - Also the electromagnetic noise on the sensor bearing can be a cause for the alarm. In these cases try to replace the encoder. - If the problem is still present after replacing the encoder, the failure is in the controller.
20	54	Steer Sensor KO	○		Steering sensor signal out of range	Check the steering sensor wiring connection. If wiring is ok, measure sensor output is within 5 V. If so, do the setting procedure. If problem is not clear, change the controller. If remove the steer sensor function, steer sensor set to off. In this case, travel speed cutback function is not activated and can't display the steer angle.
21	CA	CANBUS DISP. KO	○		Traction inverter can't detect the Display CAN signal.	Check display wiring. If it is ok, replace the display.
22	CB	TRUCK MISMATCH	○		Mode truck setting is different between traction inverter and pump inverter.	Recycle the key.
23	CC	EPS DC Error	○		Traction inverter detect EPS fault signal.	If EPS system is down, check EPS system. If EPS system works well, check the EPS fault signal wiring.
24	CD	Pedal Wire KO	○		Detect the fault in accelerator negative (NPOT) input circuit.	Check the wiring between accelerator and controller. If wiring is ok, check the curcuit inside the accelerator. If the accelerator is ok, replace the controller.
25	D9	Sens Mot Temp KO	○	○	The output of the motor thermal sensor is out of range.	Check the sensor ohmic value and the sensor wiring. If the sensor is OK, then the problem is inside the ACE logic board, replace it.
26	DA	Load Sens. Error		○	Load weight sensor detects that loaded weight exceeds the weight limitation, or load weight sensor is not working properly	Check the load weight sensor.
27	DB	Over Load		○	Load weight sensor detects that loaded weight exceeds the weight limited in OVERLOAD WEIGHT programming.	Remove the warning condition.

No	Code	Alarm name	Traction (T)	Pump (P)	Description	
					Cause	Troubleshooting
28	DE	Waiting for Node	○	○	Controller detects that the other Controller is malfunctioning or ALARM occurs.	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 CANBUS 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 availabel, H/W VER, S/W VER will be blank.) Check other controllers.
29	DF	Watchdog#1	○	○	At start-up the watch dog signal is already active before the software has generated it. At stby or running condition the watch dog signal is not active (in alarm status).	The WD hardware circuit or microcontroller output port are damaged. In both cases no external component are involved. Replace the logic board.
30	E0	AUX Coil Short	○	○	This alarm occurs when there is a short circuit of the AUX coils connected to CNA#18 output. After the overload condition has been removed, the alarm exits automatically by releasing and then enabling a travel demand.	- The typical root cause for this error code to be displayed is in the harness or in the load coil. So the very first check to carry out concerns connections between controller outputs and loads. - In case no failures/problems have been found externally, the problem is in the controller, which has to be replaced.
31	E2	VACC Out range	○		The CPOT input red by the microcontroller is not comprised in the range Vacc_min ÷ Vacc_max, programmed through the “VASS” function.	Acquire the maximum and minimum potentiometer value through the VASS function. If the alarm is still present, check the mechanical calibration and the functionality of the potentiometer. If the alarm is not disappeared the failure is in the ACE logic board, replace it.
32	E3	Watchdog#2	○	○	At start-up the watch dog signal is already active before the software has generated it. At stby or running condition the watch dog signal is not active (in alarm status).	The WD hardware circuit or microcontroller output port are damaged. In both cases no external component are involved. Replace the logic board.
33	E4	Chat Time	○		The chat time has expired.	To activate traction or pump request.
34	E5	Safety Input	○	○	The safety input is opened and accordingly the MC is opened an EB/AUX OUT coil is driven.	Check the CAN#11 input, if it is connected to –Batt and the alarm is generated then there is a fault in the SAFETY IN hardware circuit. Replace the logic board

No	Code	Alarm name	Traction (T)	Pump (P)	Description	
					Cause	Troubleshooting
35	E6	MC Coil Short	○	○	This alarm occurs when there is a short circuit of the MC coils connected to CNA#16 output. After the overload condition has been removed, the alarm exits automatically by releasing and then enabling a travel demand.	- The typical root cause for this error code to be displayed is in the harness or in the load coil. So the very first check to carry out concerns connections between controller outputs and loads. - In case no failures/problems have been found externally, the problem is in the controller, which has to be replaced.
36	E7	Coil Short HW KO	○	○	The hardware circuits which manages short circuits protection of LC and AUX coils has a problem.	This type of fault is not related to external components; replace the ACE logic board.
37	E8	Key Off Short	○	○	This fault is displayed when the controller detects a low logic level of Key-Off signal during Start-Up diagnosis.	It is very likely the fault is due to an under voltage, so it is suggested to check: - Key input signal down-going pulses (below under voltage threshold) due to external loads, like DC/DC converters starting-up, relays or contactor switching, solenoids energizing / de-energizing. - Check the connection of power cables to the battery terminal, positive and negative, to MC and to controller +Batt and –Batt, which must be screwed with a torque comprised in the range 13 Nm÷15 Nm. - If no voltage transient is detected on the supply line and the alarm is present every time the key is switched ON, the failure is probably in the controller hardware, so it is necessary to replace the logic board.
38	E9	Power MOS Short	○	○	Before switching the MC on, the software checks the power bridge: it turns on alternatingly the Low side and High side Power Mosfets and expects the phases voltage to decrease down to –BATT (increase up to +Batt). If the phases voltage do not follow the commands, this alarm occurs.	This type of fault is not related to external components; replace the controller.
39	EC	Curremt Gain	○	○	The Maximum current gain parameters are at the default values, which means the maximum current adjustment procedure has not been carried out yet.	Ask the assistance of an engineer at the developement department to do the correct adjustment procedure of the current gain parameters

No	Code	Alarm name	Traction (T)	Pump (P)	Description	
					Cause	Troubleshooting
40	ED	Analog Input	○	○	This alarm occurs when the A/D conversion of the analog inputs gives frozen value, on all of the converted signals, for more than 400msec. The goal of this diagnosis is to detect a failure of the A/D converter or a problem in the code flow that omits the refreshing of the analog signal conversion.	If the problem occurs permanently it is necessary to substitute ACE logic board.
41	EE	Wrong 0 Voltage	○	○	At start-up the high resolution VMN feedback is not comprised in a permitted window of values centred around 2,5V. The circuit is damaged in the controller.	It is suggested to check: - Motor internal connections. (ohmic - continuity) - Motor power cables connections. - Motor leakage to truck frame. If the motor connections are OK, the problem is inside the controller, replace the logic board.
42	EF	Safety Output	○	○	The safety out driver is shorted.	- Check if there is a short or a low impedance pull-down between SAFETY OUT (CAN#19) and –BATT. - The driver circuit is damaged in the logic board, which has to be replaced.
43	F0	Hardware Fault	○	○	The Mosfets driver are not switched off from Watch-dog signal during alarm status.	Replace the logic board.
44	F1	Flash CheckSUM	○	○	After Key-on the software verifies the integrity of program stored in the flash memory, if the verify has a negative result this alarm is generated.	The problem is in the microcontroller flash memory, which could be damaged, or in the program stored inside, which could be corrupted. Try to program the logic again, if the alarms is still signalled the problem is in the microcontroller. Replace the ACE logic board.
45	F2	Motor Stall	○	○	The encoder signal is constantly zero when the maximum torque is applied to the motor.	If motor is moving, problem is in the encoder sensor signal. Check the wire connection and encoder sensor output. If motor doesn't move, it is mechnical problem. please check whether motor stuck or not. If not, problem is inside the controller. in this case, replace the controller.
46	F3	SEQUENCE FAULT	○		The wrong operation sequence to begin traction(es. First accel lever signal activated and then forward switch activated)	Check the accel lever signal of forward and backward and accel potentiometer. If it is ok, replace the controller.

No	Code	Alarm name	Traction (T)	Pump (P)	Description	
					Cause	Troubleshooting
47	F4	Software Error	○	○	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.
48	F5	Wrong Ram memory	○	○	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.
49	F6	AUX Driv. Open	○	○	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.
50	F7	Data Acquisition	○	○	Date communication is now processing.	If this alarm occurs. When sensor setting procedure, after finishing the procedure, recycle the key.
51	F8	NO CAN MSG.	○	○	Controller doesn't receive any message from CAN line	Check the CAN line connection. If wiring is ok. Check the communication with all controllers (display TRUCK MENU→MONITORING→choose controller→H/W VER, S/W VER. If CAN communication is not availabel, H/W VER, S/W VER will be blank.)
53	FA	Thermic Sens. KO	○	○	The output of the controller thermal sensor is out of range.	This type of fault is not related to external components; replace the controller.
54	FB	Wrong Set BAT.	○	○	The battery voltage does not correspond to SET BATTERY programming	Check the battery type setting and battery status.
55	FD	Slip Profile	○	○	There is an error on the choice of the parameters of the slip profile.	Ask to the engineer at the development department.
56	FE	AUX Driv. Shrt.	○	○	The driver of the auxiliary coil is shorted.	- Check if there is a short or a low impedance pull-down between NEB/NAUX (CNA#18) and –BATT. - The driver circuit is damaged in the logic board, which has to be replaced.

8. BATTERY CHARGER

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

1) BASIC INFORMATION

(1) What is charger

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

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

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

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

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

④ It prevents from under charging and overcharging.

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

(2) Notice on caring chargers

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

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

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

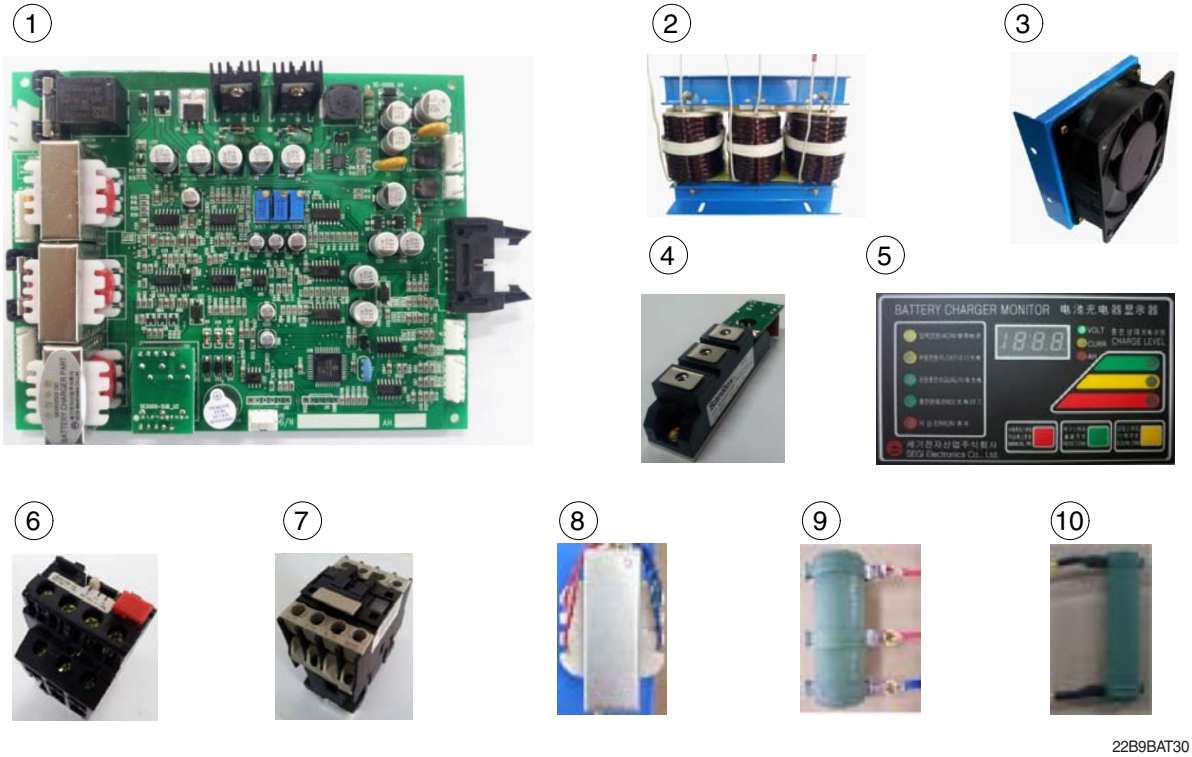
④ Check the electrolyte of the battery every week and provide distilled water immediately if it is required. (Electrolyte has to be provided between 10~12 ㎜ level on the positive plate inside storage battery)

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

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

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

(3) 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 mm^2	Based on 3 ø 380 V 3 ø 440 V	For 3 ø 220V, one step higher capacity cable should be used. (2.5 mm^2 → 4mm^2)
400-580 AH	4P - 4 mm^2		
600-800 AH	4P - 6 mm^2		
850-1000 AH	4P - 10 mm^2		
24 V battery	-		
200-600 AH	4P - 2.5 mm^2		
700-1000 AH	4P - 4 mm^2		
80V battery	-		
500-600 AH	4P - 6 mm^2		
700-800 AH	4P - 10 mm^2		

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.

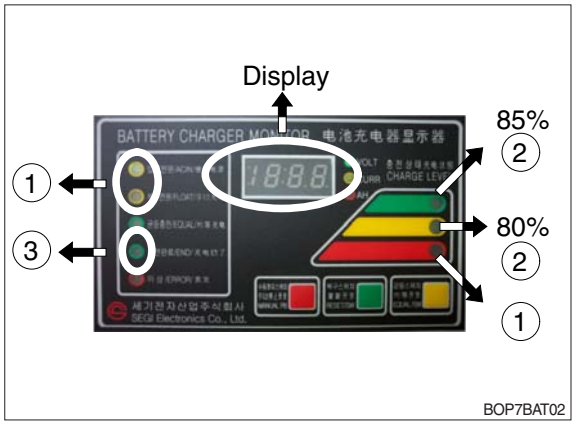
· **According to charging condition**

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.

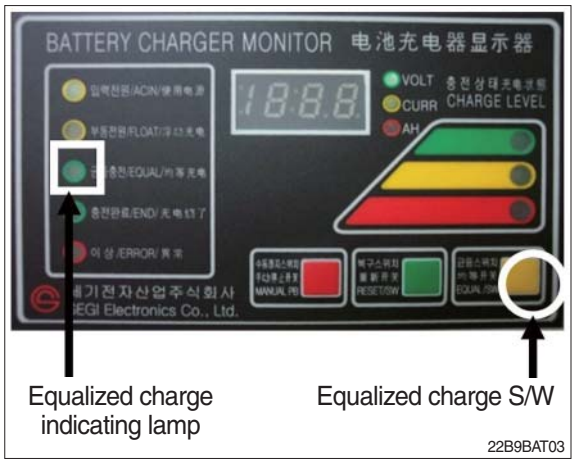
When equalized charging is required?

- 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.

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.**



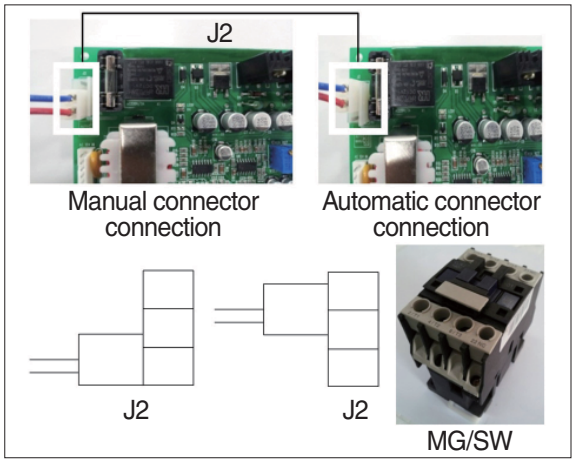
22B9BAT03

(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)



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 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 7-82
3	O.C	Over current - Refer to page 7-81, 7-83.
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 7-80.
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.

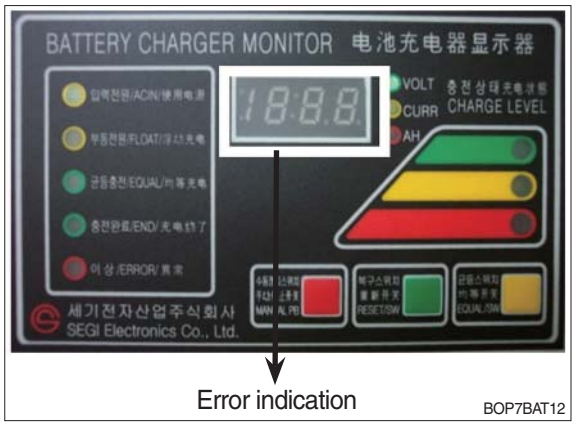
② A.O : Error on selection of input power source of 220V or 380V - Check it appropriately with full three phases.

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.



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

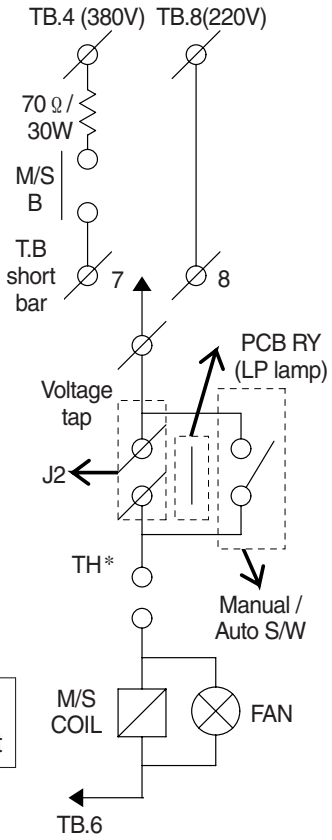
(2) Troubleshooting

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)



M/S electrical circuit

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 → CN4 contact fault / PCB RY contact fault

AC INPUT MS switch ON — NO → 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.

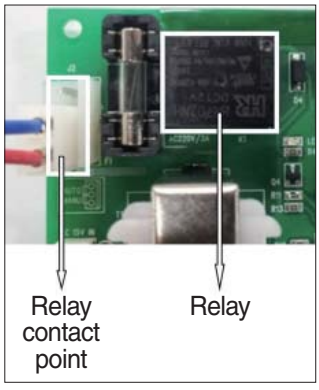
PCB LP lamp lights up — NO → Change PCB

Check the rated voltage — NO → Input power supply is not supplied.

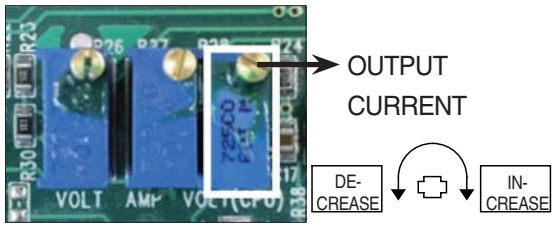
- Check external lead cable.
- Check the connection of external input connecter
- Check external NFB TRIP

Voltage 220V — NO → TH contact fault / CN4 contact fault / PCB RELAY fault / TH manual restoration release

Voltage 220V — YES → MS COIL fault



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).



Trans noise is severe at MS ON status

NO

Measure output current using DC current measure

Current value : 10~16A /100AH

NO

Exceed Standard current

Adjust output current AMP, VR within PCB Re-adjust to VR

YES

· TH Setting fault
· Re-adjust TH setting value

TH. TRIP

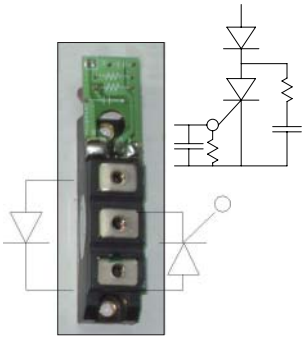
YES

Change TH

NO

Complete

* Refer to SCR Module checking method



Rated Current SETTING

YES

NO

Complete

Change PCB

YES

Separate the battery connector and tune the charger off

Check SCR Module

NO

Change SCR MODULE

YES

Check MAIN TRANS VOLT

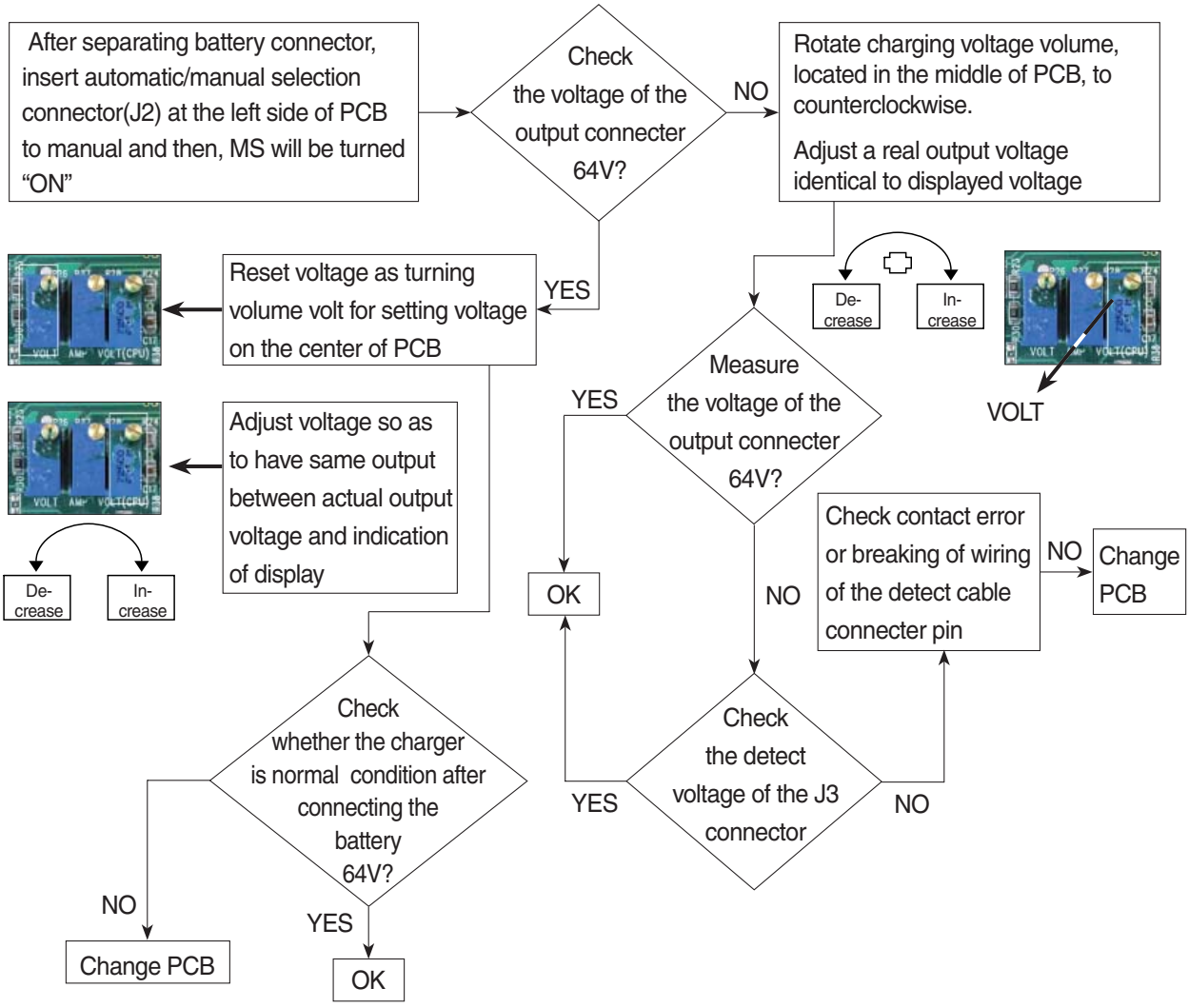
NO

Change PCB

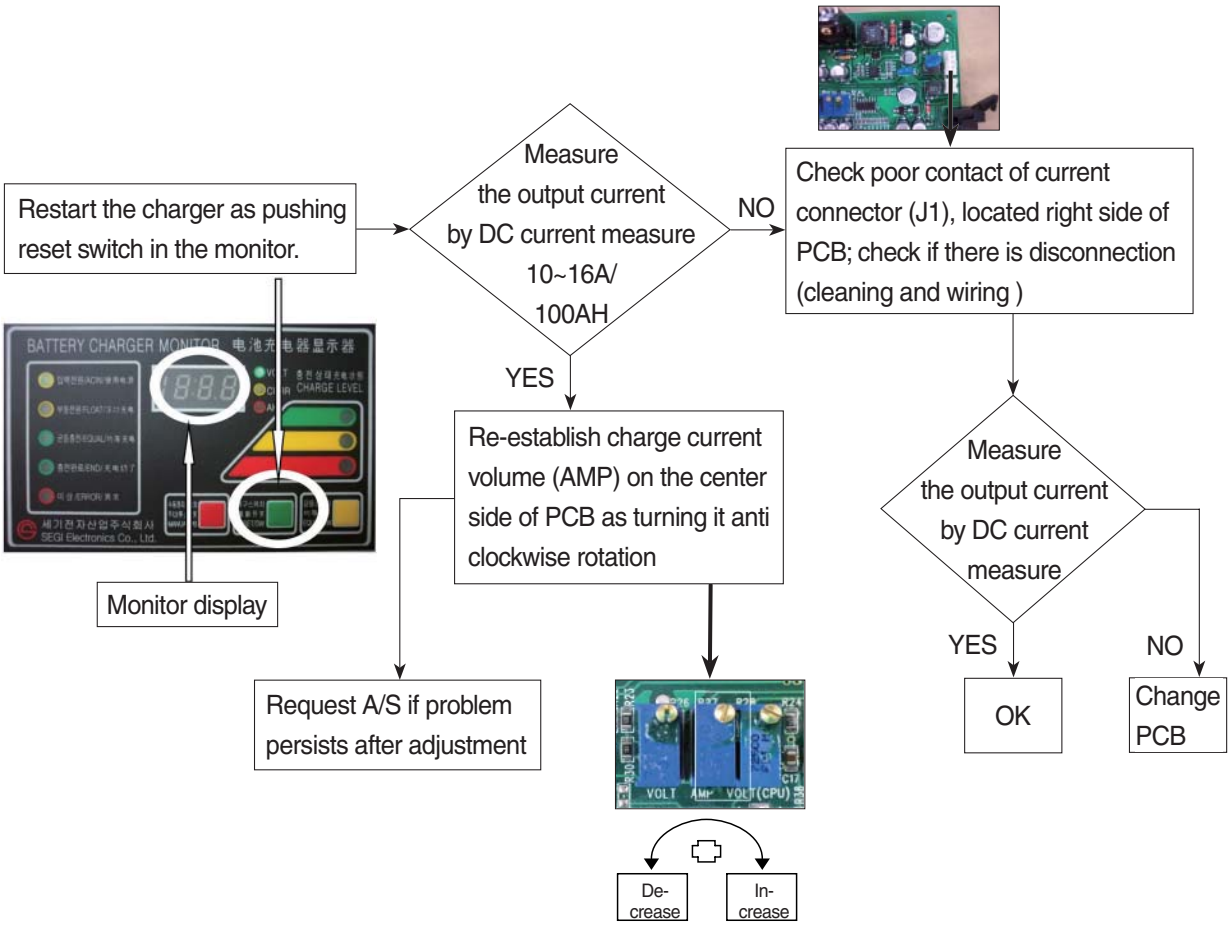
YES

Check the normal operating condition of the charger

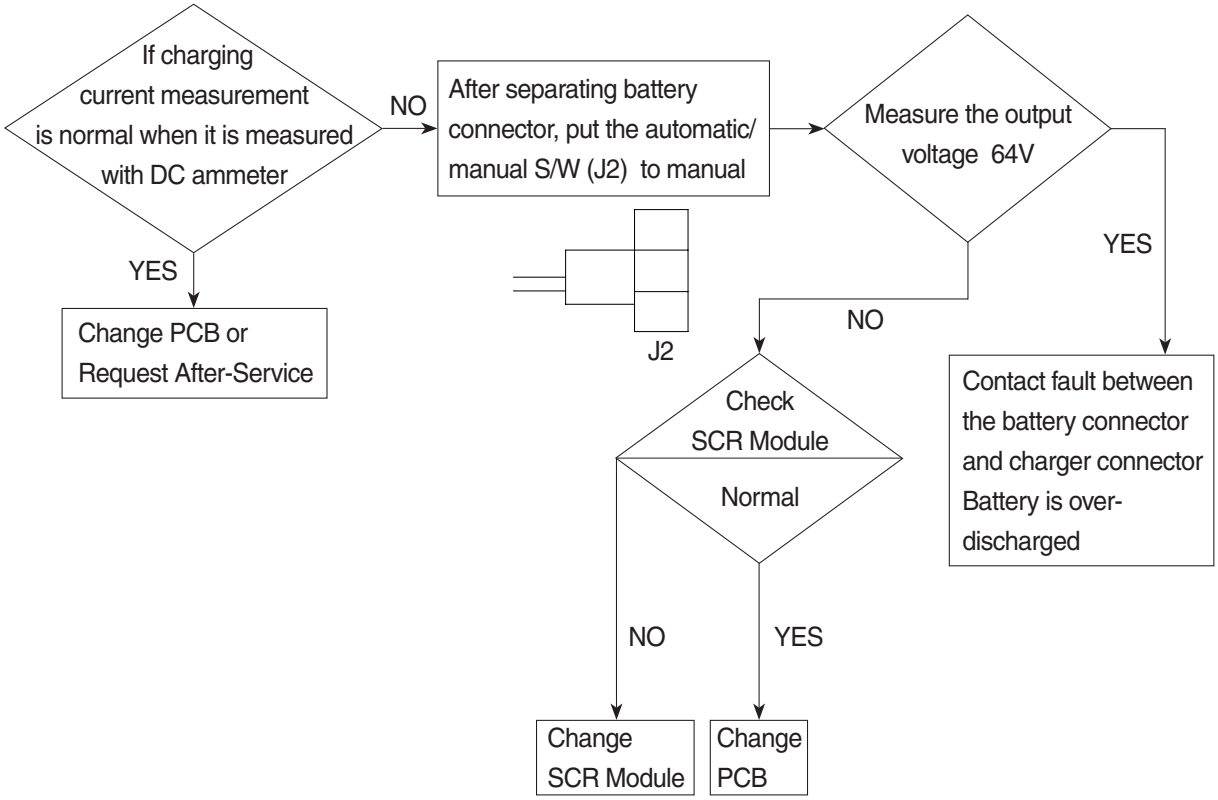
③ **Charger TRIP is occurred after abnormality lamp is on.**
In case error code is "O.V" → Over-voltage output / Set at 66V (In case of BATT 48V)
34V (In case of BATT 24V)
108V (In case of BATT 80V)



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.

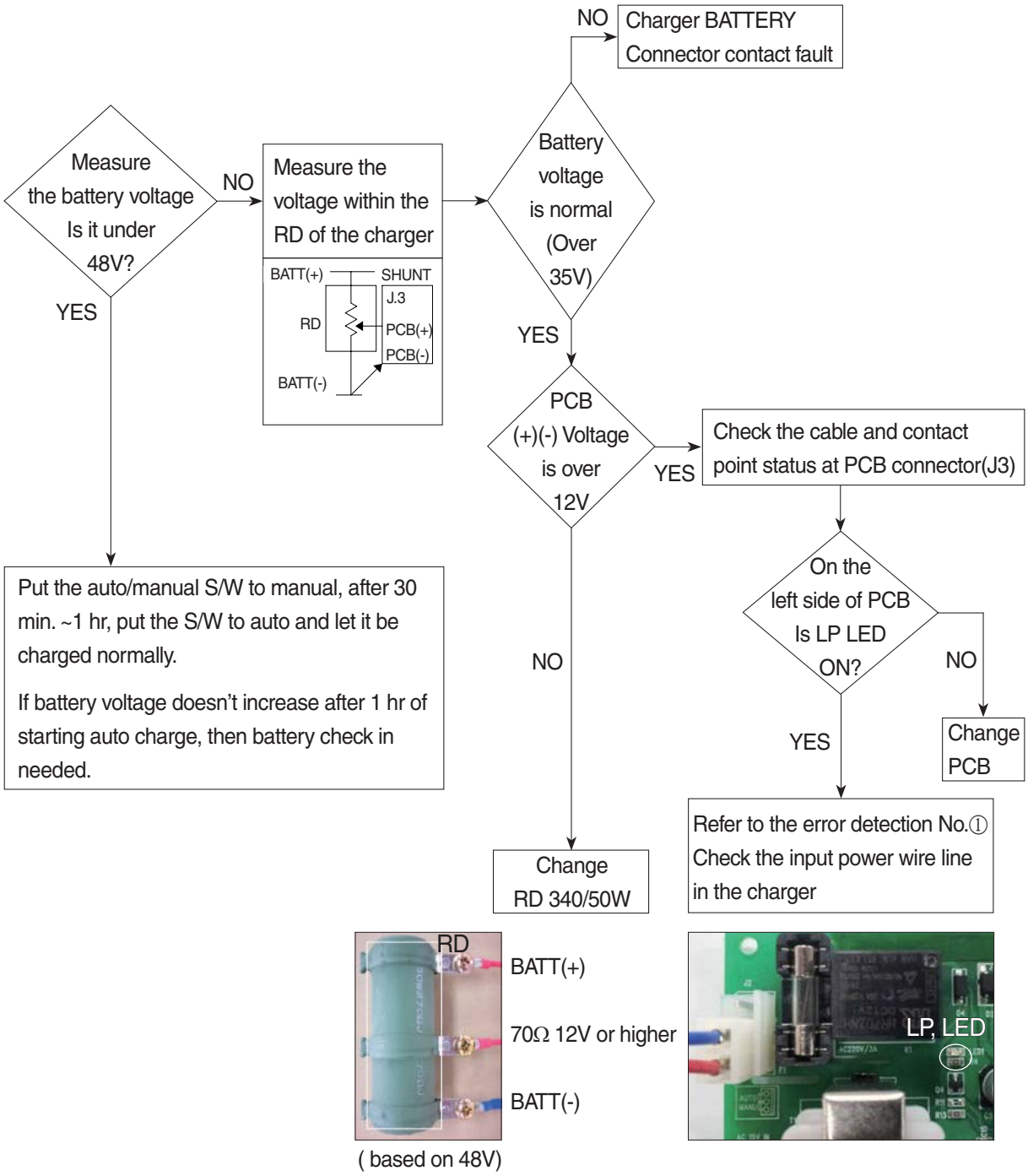


⑤ Charger TRIP is occurred after it started charging and charging completion lamp is on.
(In case input voltage is normal - Refer to the error detection No. 1)
Restore the charger as pushing reset switch.



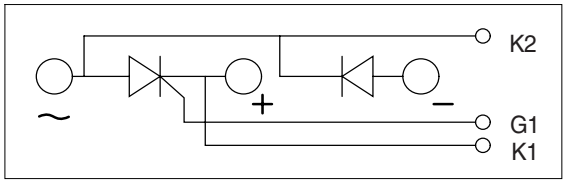
⑥ **Charger has no response even if the battery connector is connected.**

- 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)

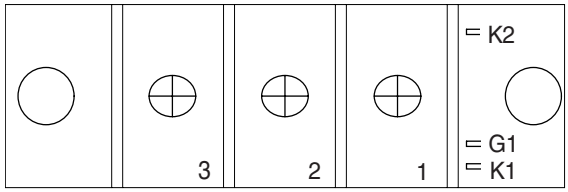


7) HOW TO CHECK THE SCR MODULE

Circuit

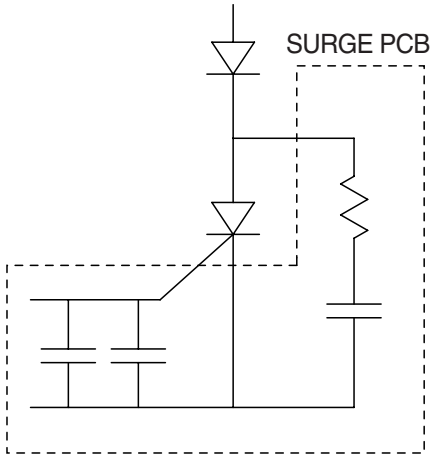


Real diagram

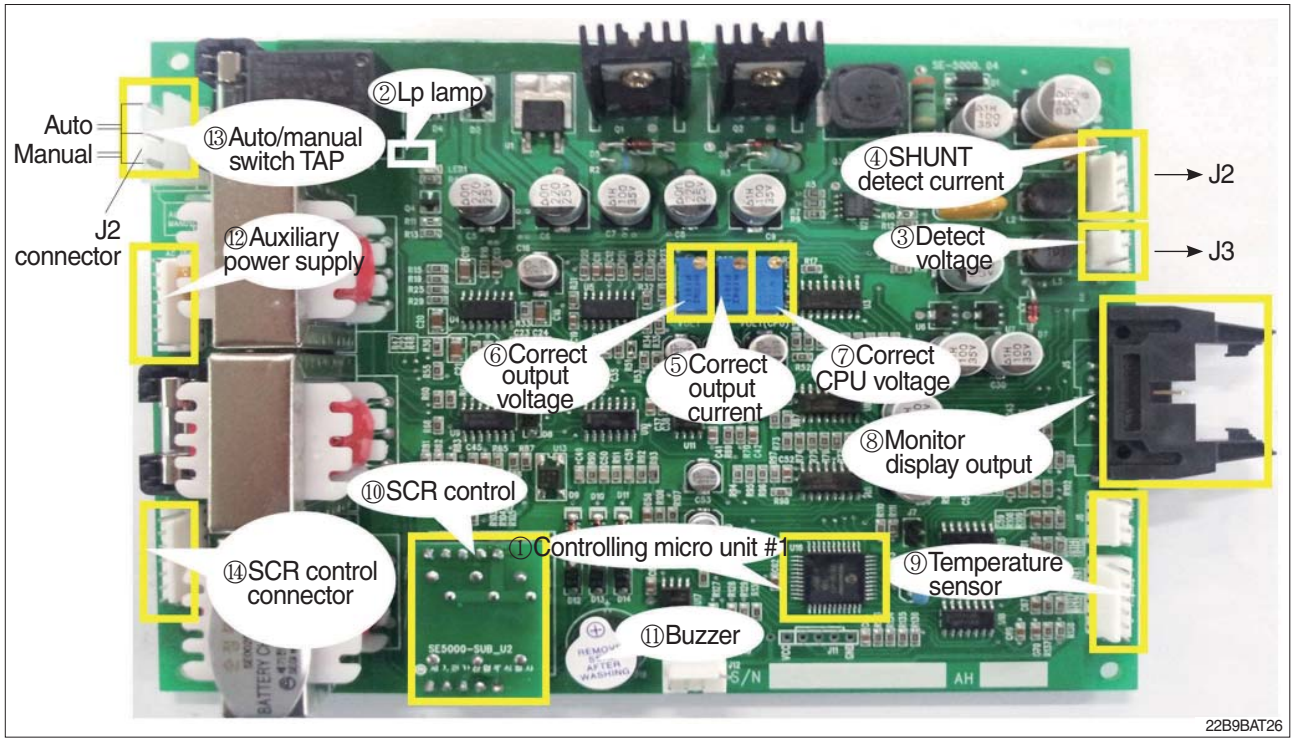


* Before checking SCR MODULE, be sure to disconnect bus bar and wire on the terminal.

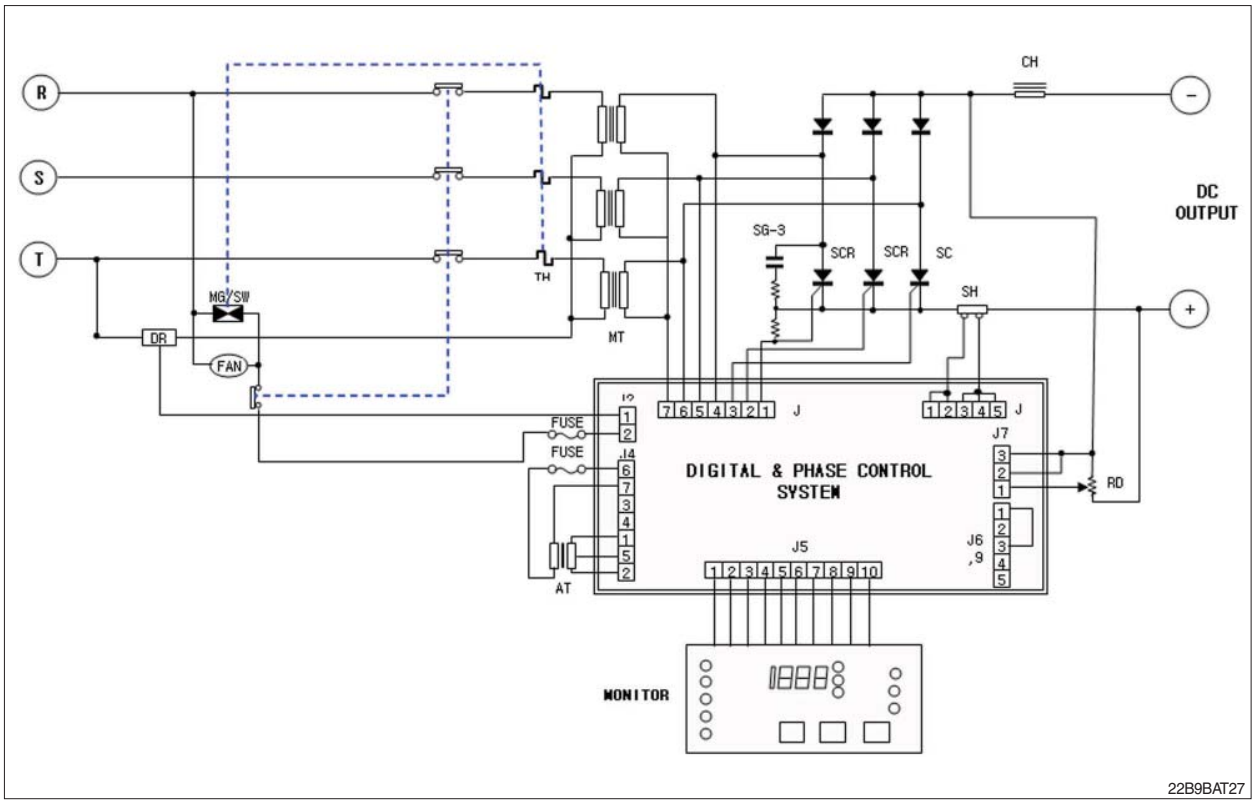
No.	Measuring point (Real diagram)	Measure value (Measurement of digital tester)
1	No.1 ~ No.3	Forward : Under 100 k ohm Reverse : Infinity (∞)
2	No.2 ~ No.3	Forward : Infinity (∞) Reverse : Infinity (∞)
3	G1 ~ K1	Forward : Under 100 ohm Reverse : Under 100 ohm But It depends on the module. If it is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



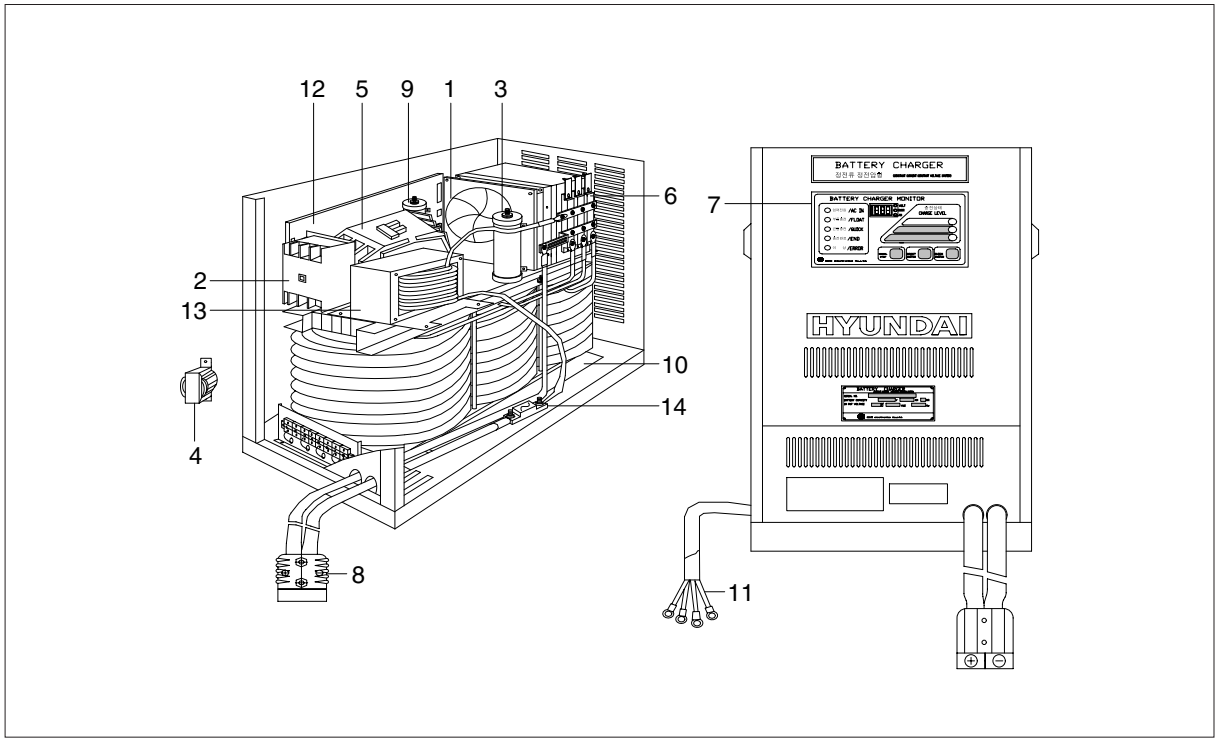
8) PCB MAJOR PARTS (NAME AND LOCATION)



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		


R
S
T
MG/SW
DR
FAN
TH
MT
CH
SG-3
SCR
SCR
SC
SH
DC
OUTPUT
FUSE
FUSE
AT
DIGITAL & PHASE CONTROL
SYSTEM
J5
J7
RD
MONITOR
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	