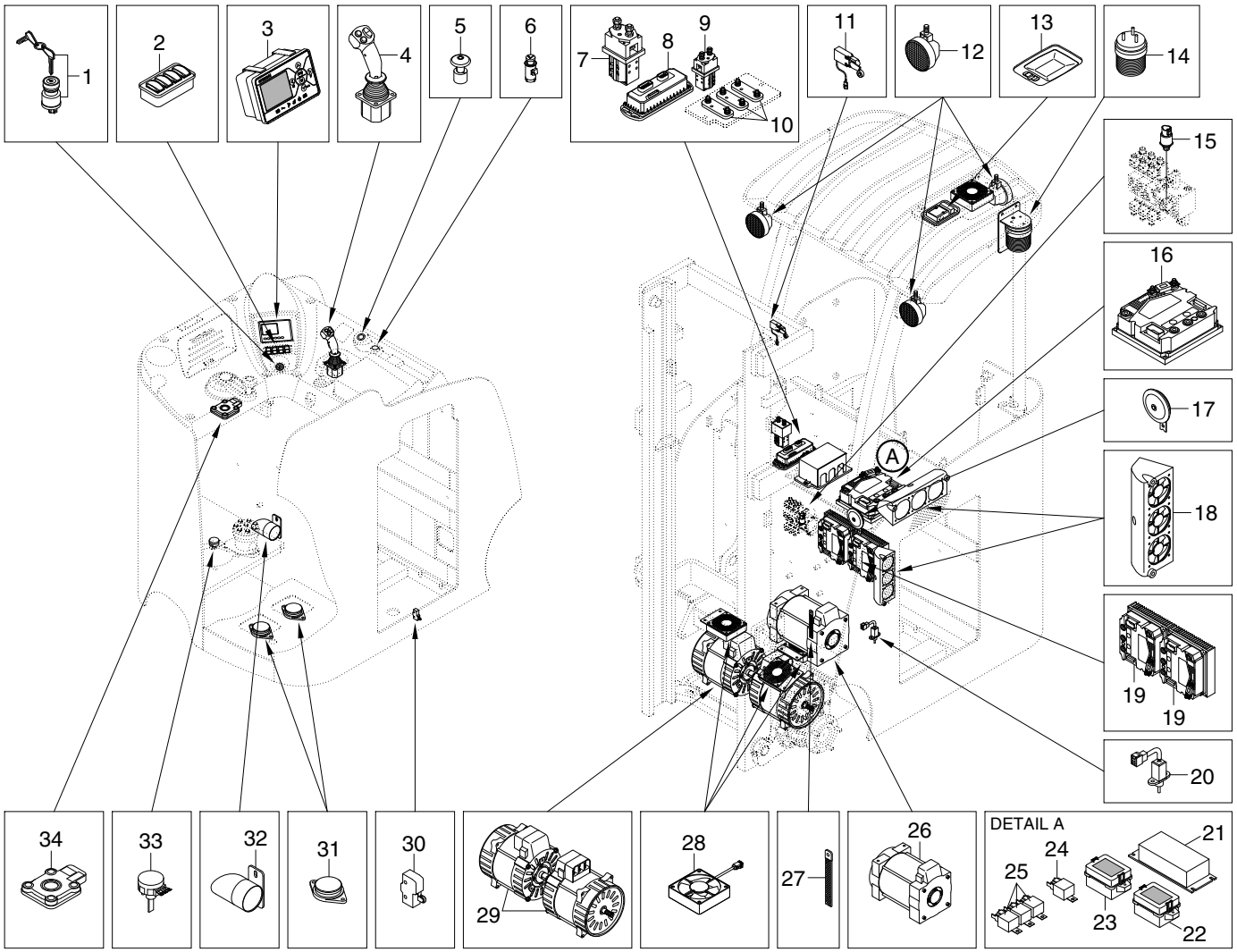
SECTION 7 ELECTRICAL SYSTEM

SECTION 7 ELECTRICAL SYSTEM

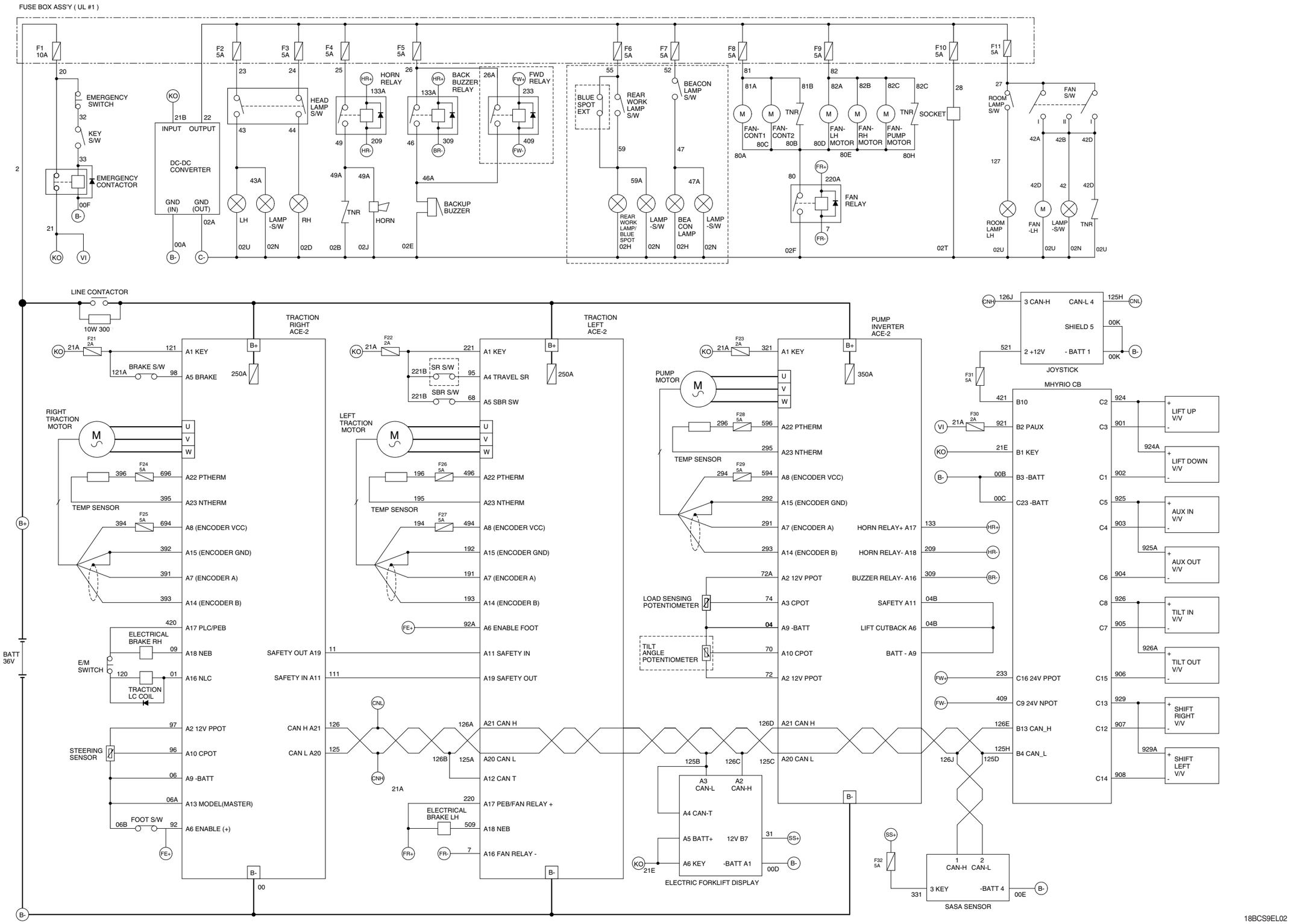
GROUP 1 COMPONENT LOCATION



18BCS9EL01

1	Start switch	13	Room lamp	25	Relay
2	Switch board	14	Beacon lamp	26	Pump motor
3	Cluster	15	Pressure sensor	27	Static strap
4	Joystick	16	Pump controller	28	Fan
5	Emergency switch	17	Horn	29	Traction motor
6	Power socket	18	Fan assy	30	Micro switch
7	Contactor	19	Traction controller	31	Seat switch
8	Fingertip controller	20	Lift sensor	32	Back buzzer
9	Contactor	21	DC-DC converter	33	Steering sensor
10	Fuse plate	22	Fuse box (UL#1)	34	Steering sensor
11	Speed limit switch	23	Fuse box (UL#2)		
12	Work lamp	24	Relay		

GROUP 2 ELECTRICAL CIRCUIT



18BCS9EL02

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.

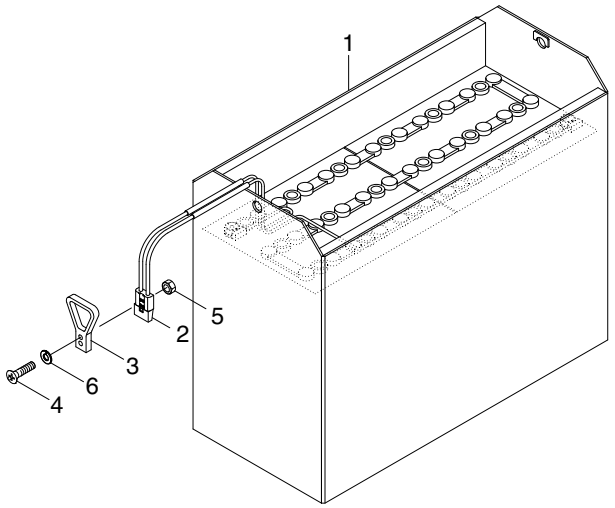
The CONTROL SYSTEM includes some protective circuits that protect the equipment and components from malfunctioning.

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.

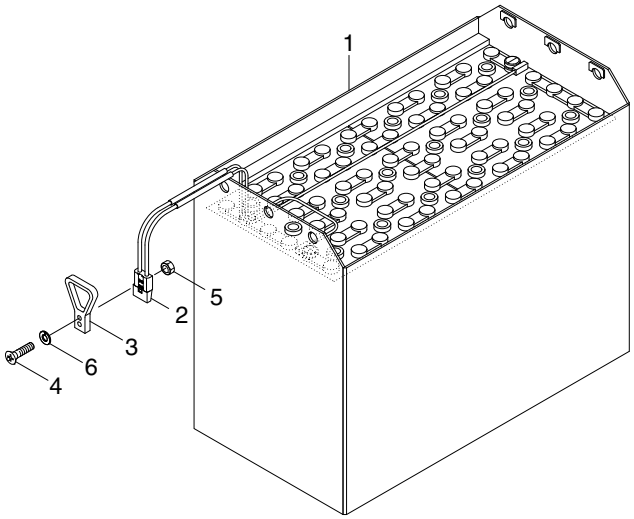
2. BATTERY

1) STRUCTURE

15/18BCS-9



20BCS-9

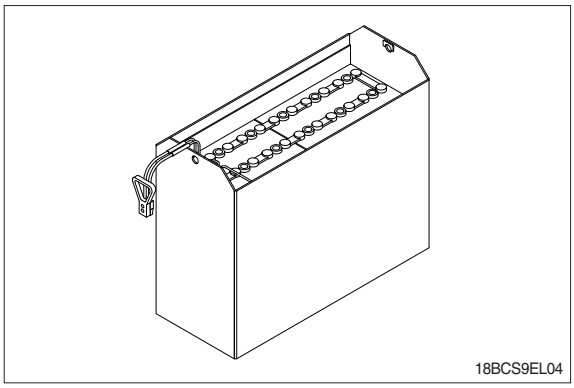


18BCS9EL03

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

2) GENERAL

As in the battery forklift, the battery is an energy source, the handling of the battery is very important. The life and performance of the battery greatly depend on the ordinary handling and maintenance.
Therefore, be sure to check and maintain the battery so that it may be kept best.



3) SPECIFICATION AND SERVICE DATA

Item	Unit	15/18BCS-9	20BCS-9
Type	-	VCJ7	VCJ8
Rated voltage	V	36	
Capacity	AH/hr	700/5	800/5
Electrolyte	-	WET	
Dimension (W × D × H)	mm	975 × 450 × 787	975 × 520 × 787
Connector	-	SB 350	
Weight	kg	1080 ± 50	1230 ± 50

Fully charged specific gravity	1.280 (25°C)
End of discharge specific gravity	1.130 (25°C)
Discharge end voltage	36 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.

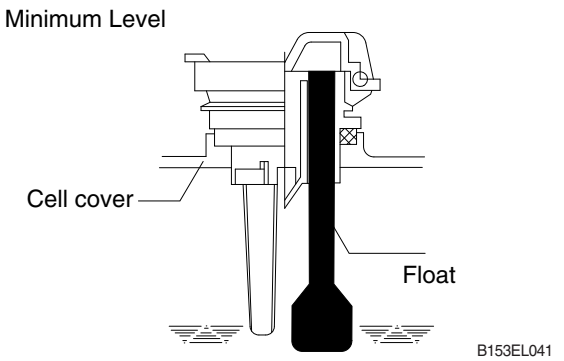
⑥ **Water replenishment**

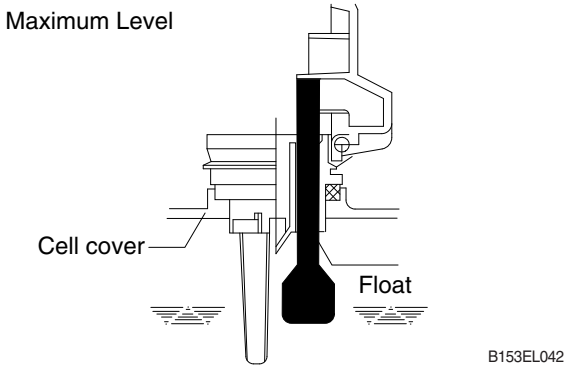
Only the water content of electrolyte is decreased due to electrolysis of water during charge and natural evaporation. If a battery used with the electrolyte decreased excessively, plates will deteriorate resulting in markedly shortening of battery life. Be sure to check the electrolyte level once every 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 (ø25 ㎜) 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**

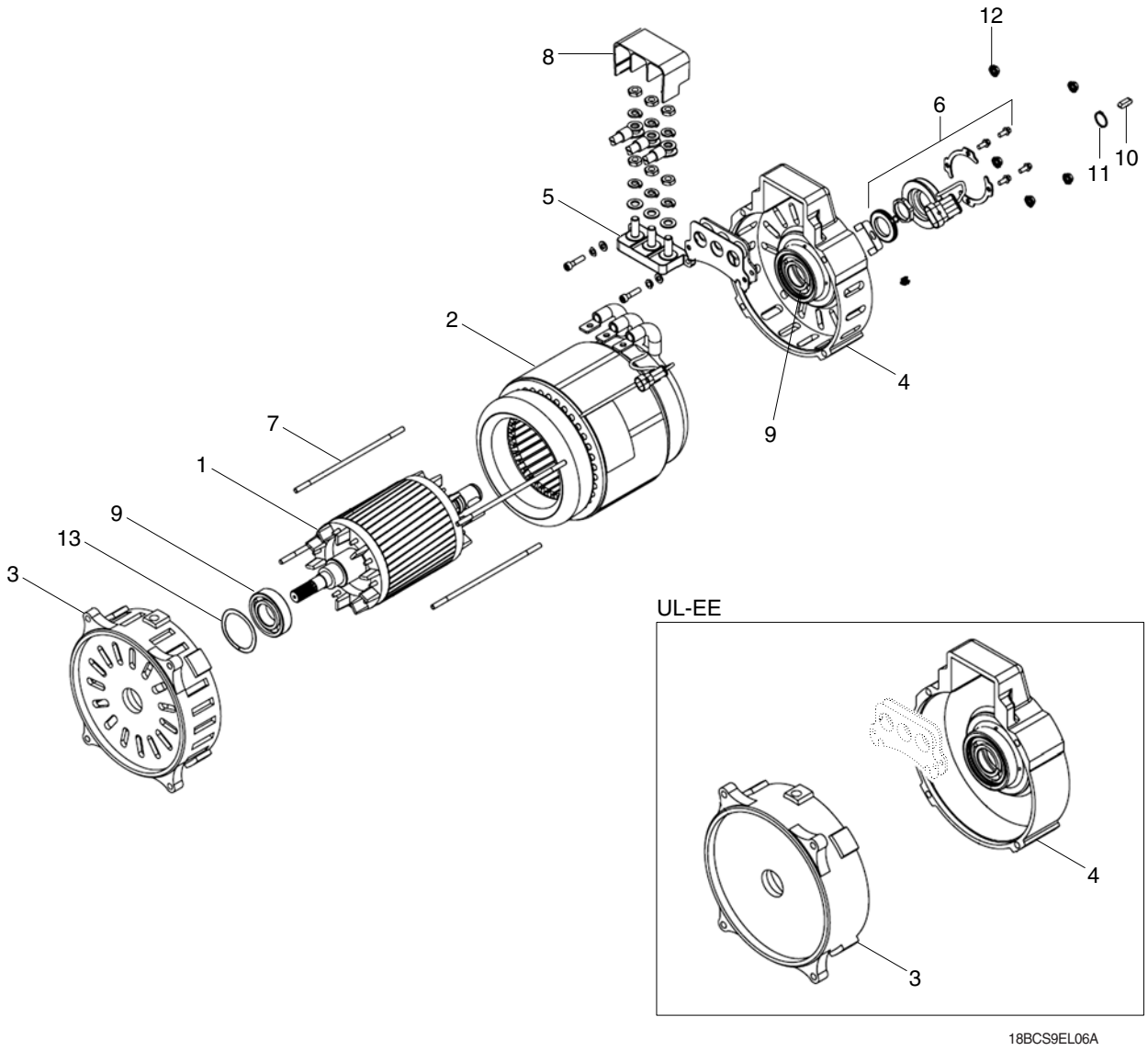
The operating temperature range of batteries is -10~45°C (temperature of electrolyte). If the batteries are exposed to cold atmosphere in discharged condition, the electrolyte may freeze, and in extreme cases, the capacity will be decreased, but, if not frozen, no adverse effects will be exerted over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



18BCS9EL06A

1	Rotor assembly	6	Speed sensor kit	11	Snap ring
2	Stator assembly	7	Stud bolt	12	Flange nut
3	Endbell de	8	Protector-terminal	13	Wave washer
4	Endbell	9	Bearing		
5	Block-terminal A	10	Sunk key		

2) SPECIFICATION

Item	Unit	15/18/20BCS-9
Type	-	AMDU6001
Rated voltage	Vac	24
Rated output	kW	4.3
Insulation	-	Class F
Speed	rpm	1750
Frequency	Hz	60

3) MAINTENANCE INSTRUCTION

(1) Inspection

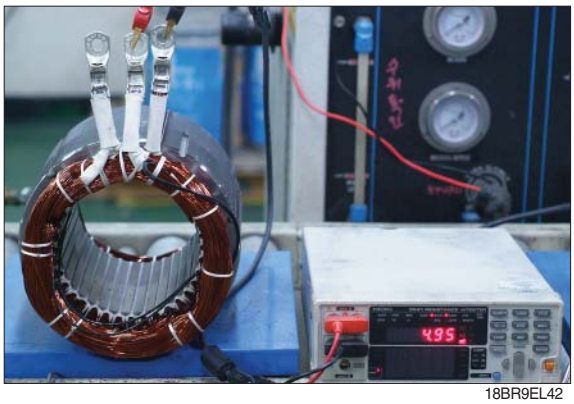
① Rotor assembly

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

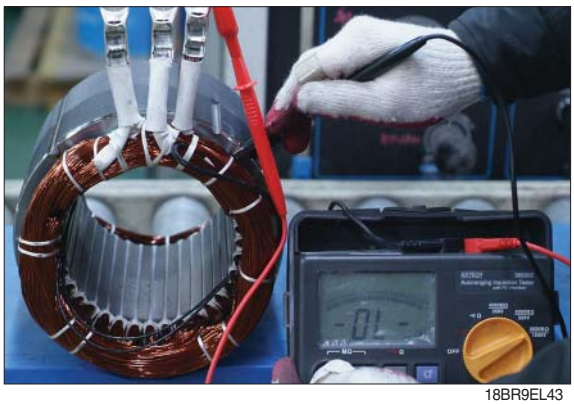

18BR9EL41

② Stator assembly

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 mΩ tester and check for two power line of stator repeatedly (U-V, V-W, W-U).
At that time resistance is around 6.3 mΩ.


18BR9EL42

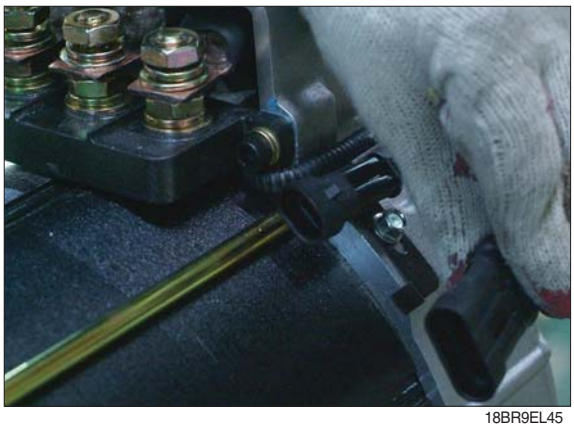
Insulation test
Use insulation tester (1000 Vac, Min. 10 MΩ) and measure as a picture.
If the insulation is defective, replace with new parts.


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

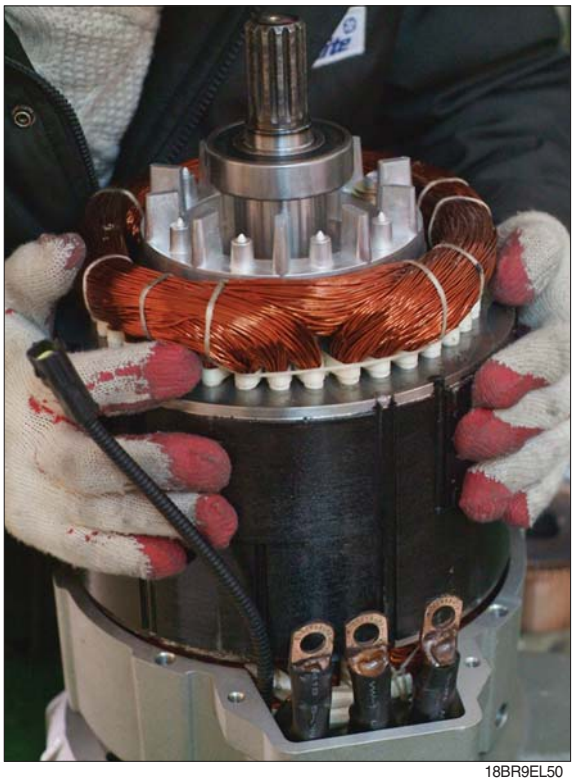
④ Remove 4 flange nuts with available general tool on the endbell drive side.

18BR9EL48

⑤ Remove endbell de and wave washer.

18BR9EL49

⑥ Remove stator assembly by hand or suitable tool.

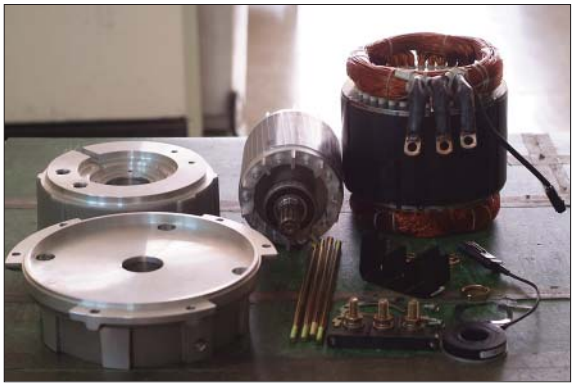


18BR9EL50

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).

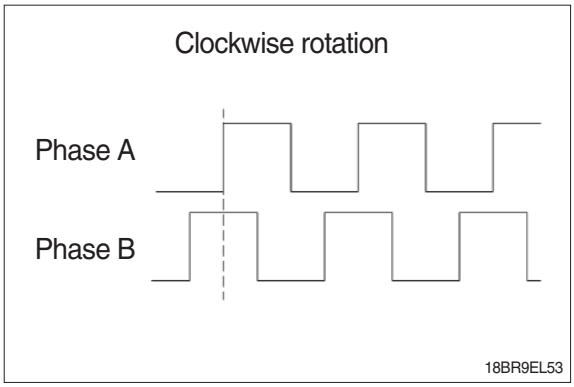


18BR9EL52

(3) Assembly and installation

① Perform assembly in the reverse order of disassembling.

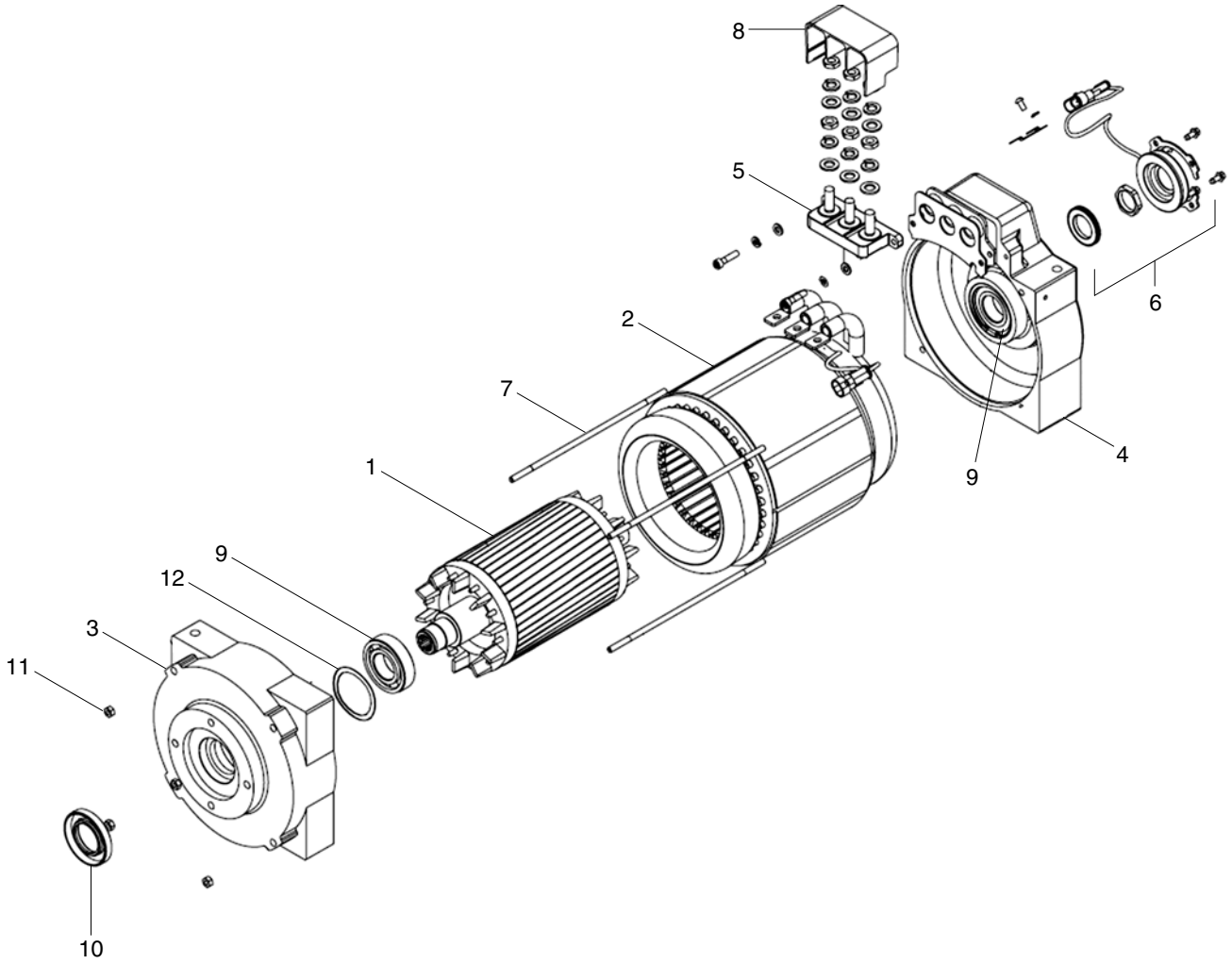
② After assembling, check for speed sensor.
Normal signal is as right.



18BR9EL53

4. PUMP MOTOR

1) STRUCTURE



18BCS9EL16

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

2) SPECIFICATION

Item	Unit	Specification
Type	-	AMBP4001
Rated voltage	Vac	24
Rated output	kW	14.0
Insulation	-	Class F
Speed	rpm	2180
Freq.	Hz	75
P.F.	-	-
Duty	%	S3-15
Voltage	V	24
Current	A	458

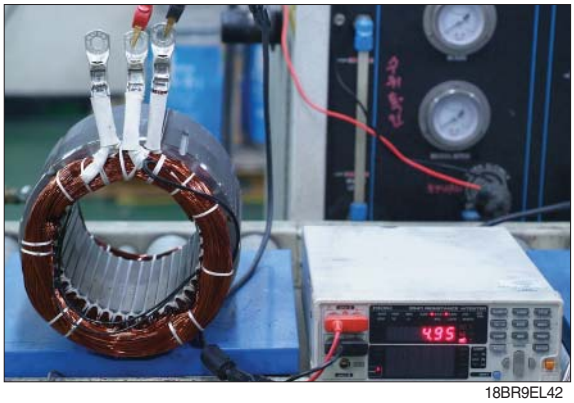
3) INSPECTION

(1) Rotor assembly

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 123.1 ± 0.05
Tool : Vernier calipers and standard tool

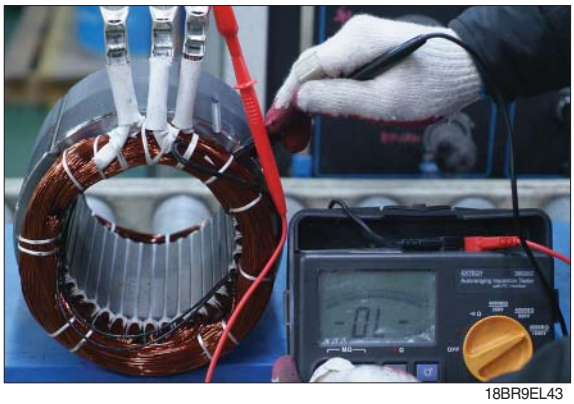
18BR9EL54

② **Stator assembly**
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 mΩ tester and check for two power line of stator repeatedly (U-V, V-W, W-U).
At that time resistance is around 1.87 mΩ.



18BR9EL42

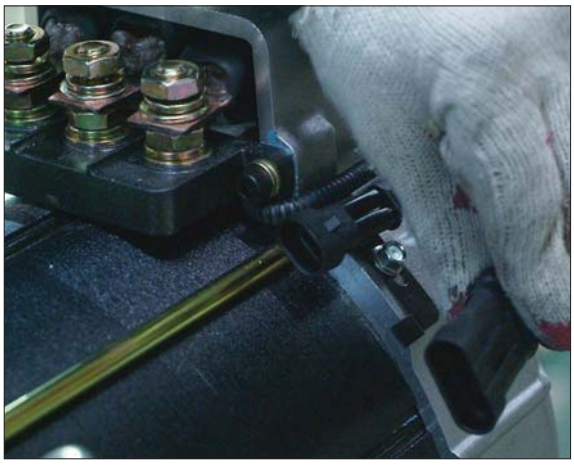
Insulation test
Use insulation tester (1000 Vac, Min. 10 MΩ) and measure as a picture.
If the insulation is defective, replace with new parts.


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

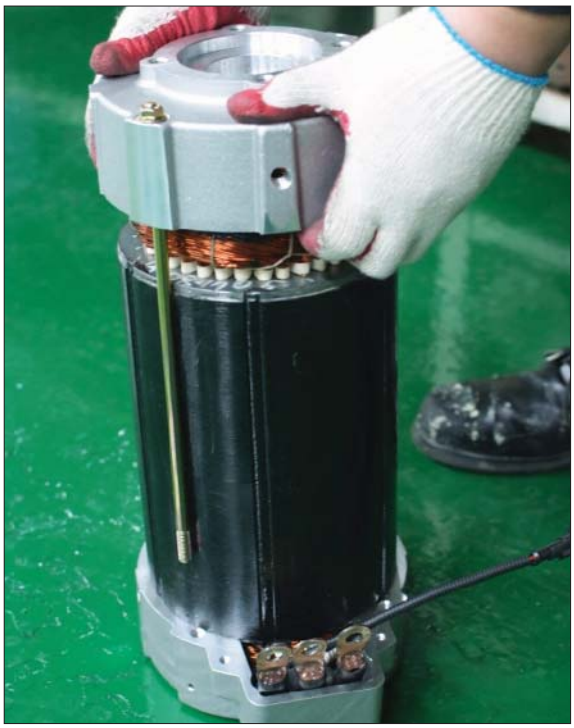
③ Remove 4 screw fixing speed sensor on the endbell side and then disassemble speed sensor, fixed nut and toothed wheel of the motor.

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

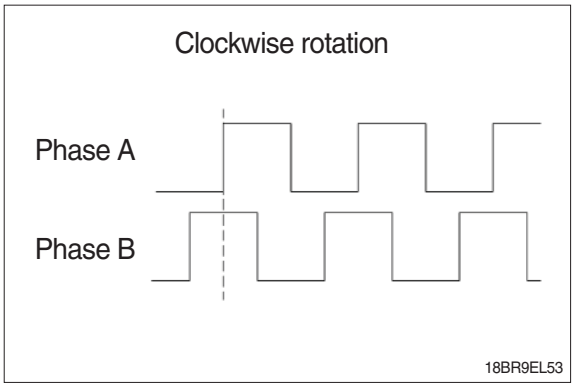
⑧ The motor are composed of 5-parts (rotor assembly, stator assembly, enbell de, endbell, etc).

18BR9EL59

5) Assembly and installation

① Perform assembly in the reverse order of disassembling.

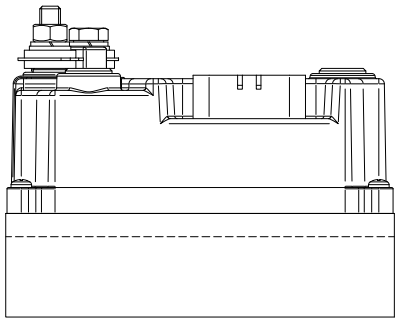
② After assembling, check for speed sensor.
Normal signal is as right.

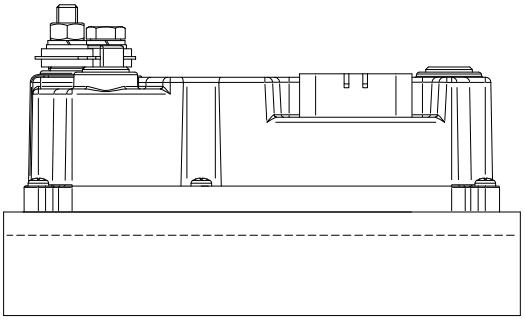


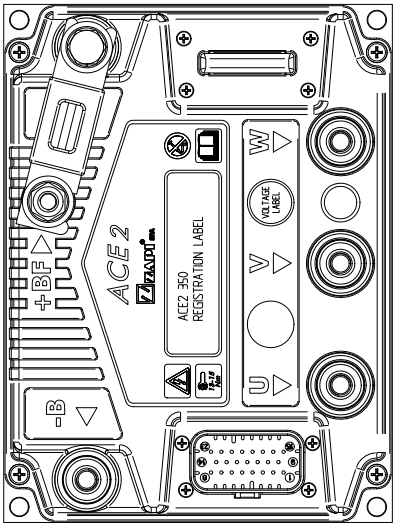
18BR9EL53

5. CONTROLLER SYSTEM

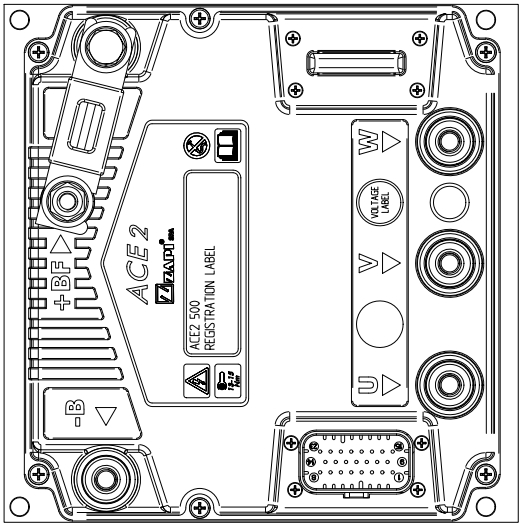
1) STRUCTURE







Traction controller



Pump controller

18BCS9EL11

(1) Specifications

Model	Model	Application	Type	Power	Current limit
15/18/20BCS-9	ACE2	Traction	AC	48V, 350A × 2	350A/3min
	ACE2	Pump	AC	48V, 500A	500A/3min

2) OPERATIONAL FEATURES

(1) Features

① Speed control.
② Optimum behavior an a slope due to the speed feedback:
- The motors speed follows the accelerator, starting a regenerative braking if the speed overtakes the speed set-point.
- The system can perform an electrical stop on a ramp (the machine is electrically hold on a slope) for a programmable time.

③ Electronic differential feature with torque balance between external and internal wheel.
④ Regenerative release braking based upon deceleration ramps.
⑤ Regenerative braking when the accelerator pedal is partially released (deceleration).
⑥ Direction inversion with regenerative braking based upon deceleration ramp.
⑦ Regenerative braking and direction inversion without contactors: only the main contactor is present.
⑧ Optimum sensitivity at low speeds.
⑨ Voltage boost at the start and with overload to obtain more torque (with current control).
⑩ Hydraulic steering function:
- The traction inverter sends a "hydraulic steering function" request to the pump inverter on the can-bus line.

⑪ Backing forward and reverse options are available, with the tune and the speed of the function programmable with Zapi console or buttons on a display.
⑫ High efficiency of motor and battery due to high frequency commutations.
⑬ Modification of parameters through the programming console or buttons on a display.
⑭ Internal hour-meter with values that can be displayed on the console.
⑮ Memory of the last five alarms with relative hour-meter and temperature displayed on the console.
⑯ Diagnostic function with Zapi console for checking main parameters.
⑰ Built in BDI feature.
⑱ Flash memory, software downloadable via serial link and via CANBUS.

(2) Diagnosis

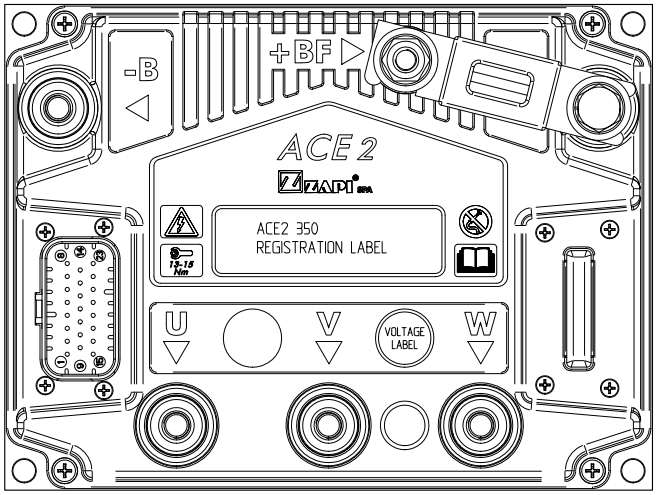
The microcontrollers continually monitor the inverter and carry out a diagnostic procedure on the main functions. The diagnosis is made in 4 points.

① Diagnosis on key switch closing that checks: watchdog circuit, current sensor, capacitor charging, phase's voltages, contactor drivers, can-bus interface, if the switch sequence for operation is correct and if the output of accelerator unit is correct, correct synchronization of the two μ CS, integrity of safety related inputs hardware.
② Standby diagnosis in standby that checks: Watchdog circuit, phase's voltages, contactor driver, current sensor, can-bus interface.
③ Diagnosis during operation that checks: Watchdog circuits, contactor driver, current sensors, can-bus interface.
④ Continuous diagnosis that checks: Temperature of the inverter, motor temperature.

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

3) DESCRIPTION OF THE CONNECTORS

(1) Traction controller



18BCS9EL11

① Master

No. of pin	Function	Description
A1	KEY	Input of the key switch signal.
A2	PPOT	Potentiometer positive for steering sensor.
A3	NA	-
A4	NA	-
A5	BRAKE	Input for brake digital input.
A6	ENABLE	Input for foot switch digital input.
A7	ENC A	Right motor encoder phase A.
A8	ENC VCC	Encoder positive power supply.
A9	- BATT	Negative power supply.
A10	CPOT	Steering sensor wiper signal.
A11	SAFETY IN	If not connected to slave A19 (safety output), the MC coil power output will be disabled.
A12	NA	-
A13	MODEL	MODE : Closed (connected with A9) - Traction master.
A14	ENC B	Right motor encoder phase B.
A15	ENC GND	Encoder negative power supply.
A16	NLC	Main contactor coil driver (drives to -Batt).

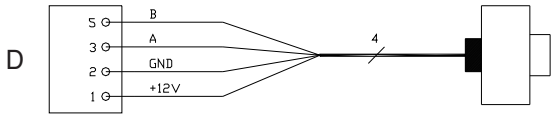
No. of pin	Function	Description
A17	PLC/PEB	Positive of main contactor coil / Electrical brake (RH).
A18	NEB	Electrical brake (RH) coil driver (drives to -Batt).
A19	SAFETY OUT	If not connected to slave A11 (safety in), the MC coil power output will be disabled.
A20	CAN L	Low level CAN-BUS voltage I/O.
A21	CAN H	High level CAN-BUS voltage I/O.
A22	PTHERM	Input for right motor temperature sensor.
A23	NTHERM	Negative of right 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.

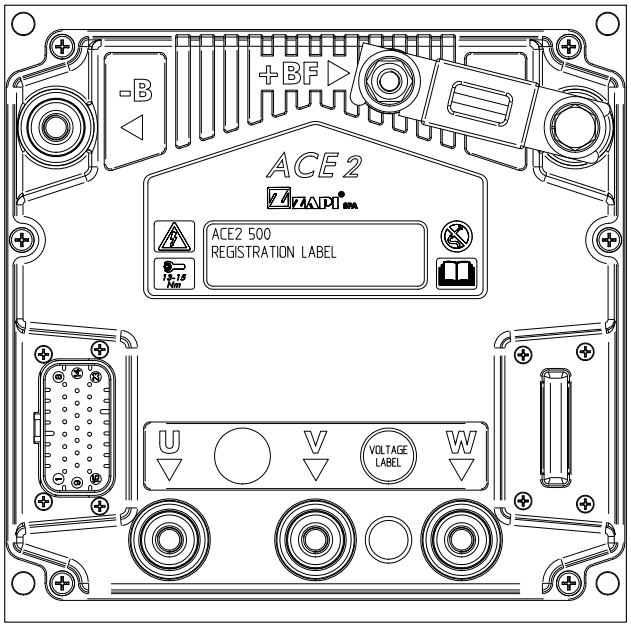


BRJ7EL26

② Slave

No. of pin	Function	Description
A1	KEY	Input of the key switch signal.
A2	NA	-
A3	NA	-
A4	TRAVEL SR	Input for travel speed reduction digital input.
A5	SBR	Input for SBR (Side Battery Removal) digital input.
A6	ENABLE FOOT	Input for foot switch digital input.
A7	ENC A	Left motor encoder phase A.
A8	ENC VCC	Encoder positive power supply.
A9	NA	-
A10	NA	-
A11	SAFETY IN	If not connected to master A19 (safety out), MC coil power output will be disabled.
A12	CAN_T	If it is connected with A21. it introduces the120 Ohm termination resistance between CAN-L and CAN-H.
A13	MODEL	MODE : open - Traction slave.
A14	ENC B	Left motor encoder phase B.
A15	ENC GND	Encoder negative power supply.
A16	NLC	Fan relay coil driver (drives to -Batt).
A17	PLC/PEB	Positive of electrical brake (LH) coil/Fan relay coil.
A18	NEB	Electrical brake (LH) coil driver (drives to -Batt).
A19	SAFETY OUT	If not connected to master A11 (safety in), MC coil power output will be disabled.
A20	CAN L	Low level CAN-BUS voltage I/O.
A21	CAN H	High level CAN-BUS voltage I/O.
A22	PTHERM	Input for left motor temperature sensor.
A23	NTHERM	Negative of left motor temperature sensor.

(2) Pump controller



18BCS9EL11

No. of pin	Function	Description
A1	KEY	Input of the key switch signal.
A2	PPOT	Potentiometer positive for tilt angle sensor and load sensor.
A3	CPOT	Load sensor wiper signal.
A4	NA	-
A5	NA	-
A6	LIFT CUTBACK	Input for lift cutback digital input.
A7	ENC A	Pump motor encoder phase A.
A8	ENC VCC	Encoder positive power supply.
A9	- BATT	Negative power supply.
A10	CPOT	Tilt angle sensor wiper signal.
A11	SAFETY	If not connected to -Batt, the MC coil power output will be disabled.
A12	NA	-
A13	NA	-
A14	ENC B	Pump motor encoder phase B.
A15	ENC GND	Encoder negative power supply.
A16	NLC	Buzzer relay coil driver (drives to -Batt).
A17	PLC/PEB	Positive of buzzer relay coil / horn relay coil.
A18	NEB	Horn relay coil driver (drives to -Batt).

No. of pin	Function	Description
A19	NA	-
A20	CAN L	Low level CAN-BUS voltage I/O.
A21	CAN H	High level CAN-BUS voltage I/O.
A22	PTHERM	Input for pump motor temperature sensor.
A23	NTHERM	Negative of pump motor temperature sensor.

4) FUNCTION CONFIGURATION

■ TRACTION CONTROLLER - MASTER

Using the CONFIG MENU of the programming console, the user can configure the following functions.

(1) Submenu "SET OPTIONS"

① **Display**

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

② **Seat switch**

- HANDLE : CNA #6 is managed as tiller input (no delay when released).
- SEAT : CNA #6 is managed as seat input (with a delay when released - debouncing function).

③ **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.

④ **Push pull**

It determines the X & Y axle's function of Joystick.

⑤ **T. speed red**

It decides an active or inactive of TRAVEL SPEEED REDUCTION function.

⑥ **Forward relay**

It decides that a forward relay is present / absent.

⑦ **Battery check**

This option specifies the handling of the low battery charge detection.

There are four 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 reduces the maximum current down to 50% of the full truck current and the maximum truck speed down to 24% of the full truck speed and it inhibits the lifting function.
- Level 2 : BATTERY LOW alarm is raised when the battery level is calculated being ess than or equal to 10% of the full charge. But is ignored, it means no action is taken when the battery is discharged.
- Level 3 : 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.

⑧ **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.

⑨ **Aux output #1**

BRAKE : Drives an electromagnetic brake coil.

⑩ **Steer table**

OPTION#1 is a steer table of 20BCS-9 Truck.

⑪ **Set mot. temperature**

It can be set :

- ANALOG : An analogue sensor for the control of the motor temperature is connected to CNA#22. Typically the temperature sensor is a PTC (positive thermal coefficient resistance), providing the sensor characteristic to Zapi the correct table can be loaded in the controller software.

1. DIGITAL : A digital (on/off) sensor for the motor temperature monitoring is connected to CNA#22 input.

2. NONE : No temperature sensor is connected.

⑫ **Truck model sel**

This display model setting from traction inverter. There are 2 models. (20BCS-9 or 23BCS-9)

(2) Submenu "ADJUSTMENTS"

① **Set battery type**

It selectes the nominal battery voltage.

② **Adjust battery**

Fine adjustment of the battery voltage measured by the controller.

③ **Max steer right**

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

④ **Max steer left**

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

⑤ **Set steer 0-pos.**

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

⑥ **Set steer right**

This parameter sets the max steering angle in left direction.

⑦ **Set steer left**

This parameter sets the max steering angle in right direction.

⑧ **Throttle 0 zone**

Establishes a deadband in the accelerator input curve.

⑨ **Throttle X1 map**

This parameter changes the characteristic of the accelerator input curve.

- Range = 0 - 100%, Resolution = 1%

⑩ **Throttle Y1 map**

This parameter changes the characteristic of the accelerator input curve.

- Range = 0 - 100%, Resolution = 1%

⑪ **Throttle X2 map**

This parameter changes the characteristic of the accelerator input curve.

- Range = 0 - 100%, Resolution = 1%

⑫ **Throttle Y2 map**

This parameter changes the characteristic of the accelerator input curve.

- Range = 0 - 100%, Resolution = 1%

⑬ **Throttle X3 map**

This parameter changes the characteristic of the accelerator input curve.

- Range = 0 - 100%, Resolution = 1%

⑭ **Throttle Y3 map**

This parameter changes the characteristic of the accelerator input curve.

- Range = 0 - 100%, Resolution = 1%

⑮ **Bat. min adj.**

Adjust the lower level of the battery charge table (-12.8% ~ 12.7%).

⑯ **Bat. max adj.**

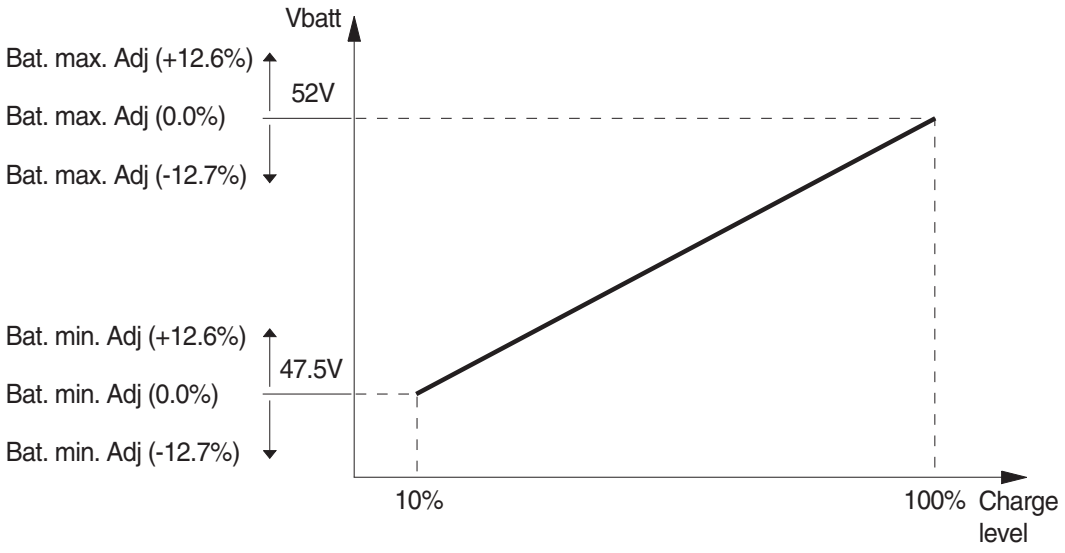
Adjust the upper level of the battery charge table (-12.8% ~ 12.7%).

⑰ **Bdi adj s.UP min**

Adjust the lower level of the battery charge table (-12.8% ~ 12.7%).
When the key on, this setting table is applied.

⑱ **Bdi adj s.up max**

Adjust the upper level of the battery charge table (-12.8% ~ 12.7%).
When the key on, this setting table is applied.



18BR9EL61

⑲ **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.

⑳ **Load HM from mdi**

Not used.

㉑ **Mainten. reset**

It determines to cancel the MAINTENANCE HOUR warning.

㉒ **Maintenance**

Setting for NONE / OPTION#1 / OPTION#2 / OPTION#3 of MAINTENANCE.

㉓ **M. pre warn time**

Time to set the maintenance pre waring time before the maintenance time.

㉔ **Maintenance time**

Time setting for the maintenance time.

㉕ **Main cont. volt**

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

㉖ **Aux output volt**

It specifies the percentage of battery voltage supplied to EB coil to apply the electro mechanic brake.

㉗ **Main cont. V rid**

It specifies the percentage of MAIN CONT VOLT parameter, supplied to MC coil to keep the contactor closed.

㉘ **Aux output V rid**

It specifies the percentage of AUX OUT VOLT parameter, supplied to EB coil to keep the electro mechanic brake applied.

㉙ **Mot high temp**

It determines the motor temperature level at which the "MOTOR HIGH TEMP" alarm is signaled.

㉚ **Motor shutdown**

It determines the motor temperature level at which the "MOTOR SHUTDOWN" alarm is signaled.

㉛ **HT mot current**

It determines the maximum current when the motor temperature is reached to the "MOTOR HIGH TEMP" setting.

㉜ **HM max speed**

It determines the maximum speed when the motor temperature is reached to the "MOTOR HIGH TEMP" setting.

㉝ **Batt. low speed**

The MAXIMUM SPEED when the battery level is calculated being less than or equal to 10% of the full charge.

㉞ **Mot. sta max curr**

It determines the maximum current when the motor is stalled.

㉟ **Batt. low current**

The MAXIMUM CURRENT when the battery level is calculated being less than or equal to 10% of the full charge.

㊱ **Speed factor**

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

It results from the following formula :

Speed factor = 88 * rr * p / ø

where:

rr = total gearbox ratio

ø = traction wheel diameter (cm)

P = number of pair poles of the motor

(3) Submenu "PARAMETER CHANGE"

① **Acceleration 0**

It specifies the motor acceleration at 0 Hz. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases.

② **INV. accel 0**

It specifies the motor acceleration at 0 Hz after an inversion of direction. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases.

③ **Acceleration 1**

It specifies the motor acceleration at ACC PROF. FREQ 1 [Hz]. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases.

④ **Acceleration 2**

It specifies the motor acceleration at ACC PROF. FREQ 2 [Hz]. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases.

⑤ **Acceleration 3**

It specifies the motor acceleration at ACC PROF. FREQ 3 [Hz]. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases.

⑥ **Acc prof. freq 1**

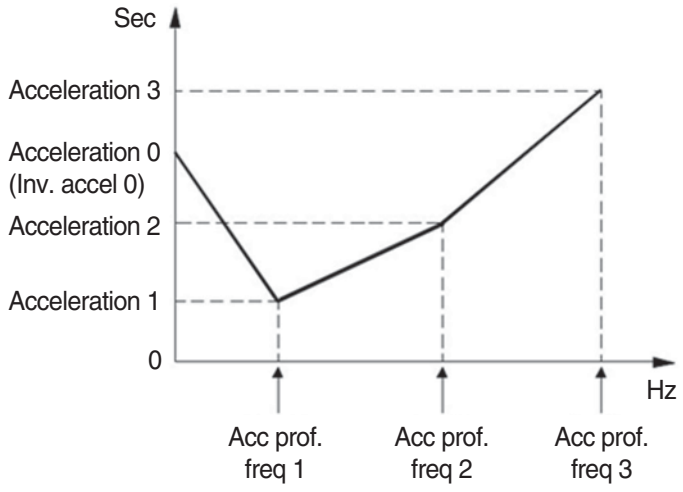
In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 1 parameter.

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.



18BCS9EL14

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 100 Hz to 0 Hz.

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 100 Hz to 0 Hz.

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 100 Hz to 0 Hz.

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 100 Hz to 0 Hz.

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 100 Hz to 0 Hz.

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 100 Hz to 0 Hz.

⑮ **Til. rel. braking**

Seconds. It controls the deceleration ramp when the tiller is released (not used).

⑯ **Enable del time**

It's a delay time for enable s/w.

⑰ **Max speed forw**

Hz. It determines the maximum speed in forward direction. When truck steer angle is in 10 degrees.

⑱ **Max speed back**

Hz. It determines the maximum speed in backward direction. When truck steer angle is in 10 degrees.

⑲ **Turtle speed**

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

⑳ **Travel speed red**

It determines the traction maximum speed when travel speed reduction switch is open.

㉑ **Cutback speed**

Speed reduction when the cutback switch is active.

㉒ **Steer dead angle**

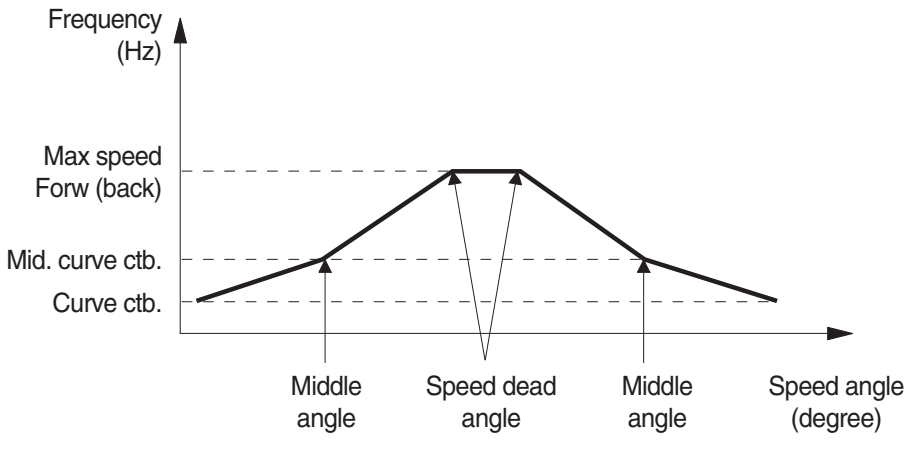
It is the angle value at the speed start to reduction.

㉓ **Mid. curve. ctb**

Hz value. It determines the maximum speed when truck steer angle is over MIDDLE ANGLE.

㉔ **Middle angle**

% value. 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.



㉕ **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.

㉖ **Maximum current**

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

㉗ **Brk smooth**

It gives a parabolic form to the deceleration ramp.

㉘ **Stop brk smooth**

Hz. It sets the level of frequency where the smooth effect of the deceleration parabolic form ends.

㉙ **Chat time**

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

㉚ **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.

㉛ **Rollback speed**

It determines the maximum speed for the rolling down on a slope.

㉜ **M.track speed red**

It determines the maximum speed when the MAINTENANCE is set to OPTOIN #2 or #3.

■ TRACTION CONTROLLER - SLAVE

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 **Fan relay coil**

It determines that the fan relay coil is present or abasent.

③ **Cooling fan**

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

- OPTION #1 : Fans work always.
- OPTION #2 : Fans work in case a temperature of controller or motor exceeds a temperature set on FAN WORKING TEMP menu.
- OPTION #3 : Fans work when motors work.

④ **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.

⑤ **Aux output #1**

Not used

⑥ **Set mot. temperat**

It can be set :

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

(2) Submenu "ADJUSTMENTS"

① **Set battery type**

It selectes the nominal battery voltage.

② **Adjustments battery**

Fine adjustment of the battery voltage measured by the controller.

③ **Load HM from mdi**

Not used

④ **Main cont. volt**

It specifies the percentage of battery voltage supplied to fan relay coil to apply the fan.

⑤ **Aux output volt**

It specifies the percentage of battery voltage supplied to EB coil to apply the electro mechanic brake.

⑥ **Main cont. v rid**

It specifies the percentage of MAIN CONT VOLT parameter, supplied to fan relay coil to keep the fan applied.

⑦ **Aux output v rid**

It specifies the percentage of AUX OUT VOLT parameter, supplied to EB coil to keep the electro mechanic brake applied.

(3) Submenu "PARAMETER CHANGE"

① **Maximum current**

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

② **Rollback speed**

It determines the maximum speed for the rolling down on a slope (decided from master controller).

③ **Fan working temp**

If COOLING FAN 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.

■ PUMP CONTROLLER

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

(1) Submenu "SET OPTIONS"

① **Seat switch**

- HANDLE : CNA #6 is managed as tiller input (no delay when released).
- SEAT : CNA #6 is managed as seat input (with a delay when released - debouncing function).

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 **Stop on ramp**

OFF : After the truck is stopped electrobrake is closed

ON : Motor is kept in torque for AUXILIARY TIME parameter than the electrobrake is closed.

④ **Aux output #1**

BRAKE : A18 used to drive electobrake.

FREE : A18 not used.

OPTION #1 : A18 used as backward indication.

⑤ **Set mot. temperat**

It can be set:

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

⑥ **Load sensor**

ON : Load sensing function is activated.

OFF : Load sensing function is disactivated.

⑦ **Overload type**

This option specifies how overload alarm works in overloaded situation.

NONE : There would'n be any kind of alarms or limitations.

OPTION #1 : If the weight of load filed on forks exceeds the overload weight set in overload parameter, OVER LOAD alarm will be displayed and followed by traction & pump limitation except lift down function.

OPTION #2 : If the weight of load filed on forks exceeds the overload weight set in overload parameter, OVER LOAD alarm will be displayed.

⑧ **Backup function**

It decides that the back-up alarm is present or absent.

⑨ **Fork leveling**

- ON : Auto fork leveling function is not activated.
- OFF : Auto fork leveling function is activated.

⑩ **Sasa sensor**

It decides that the SASA sensor is present or absent.

⑪ **Tilt sp red func**

It decides that the tilt speed reduction function is present or absent.

(2) Submenu "ADJUSTMENTS"

① **Set battery type**

It selectes the nominal battery voltage.

② **Adjust battery**

Fine adjustment of the battery voltage measured by the controller.

③ **Throttle 0 zone**

It establishes a dead band in the lift potentiometer input curve.

④ **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 per cent, the corresponding pump speed is Y point percent of the maximum pump speed. The relationship between the lift potentiometer position and the pump speed is linear between the THROTTLE 0 ZONE and the X point and also between the X point and the maximum potentiometer position but with two different slopes.

⑤ **Throttle Y point**

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

⑥ **Main cont. volt**

It specifies the percentage of battery voltage supplied to buzzer relay coil to apply the buzzer.

⑦ **Aux output volt**

It specifies the percentage of battery voltage supplied to horn relay coil to apply the horn.

⑧ **Main cont. V rid**

It specifies the percentage of MAIN CONT VOLT parameter, supplied to buzzer relay coil to keep the buzzer applied.

⑨ **Aux output V rid**

It specifies the percentage of AUX OUT VOLT parameter, supplied to horn relay coil to keep the horn applied.

⑩ **Motor high temp**

It determines the motor temperature level at which the "MOTOR HIGH TEMP" alarm is signaled.

⑪ **Mot. shutdown temp**

It determines the motor temperature level at which the "MOTOR SHUTDOWN" alarm is signaled.

⑫ **Adj min load**

This parameter is used to show and configurate the minimum voltage of load weight sensor output in case of empty weight loaded.

⑬ **Adj ref load**

This parameter is used to show and configurate the reference voltage of load weight sensor output in case of reference weight loaded.

⑭ **Ref. load weight**

This parameter is used to show and configurate the reference load weight.

⑮ **Rated load w.**

This parameter is used to show and configurate the rated load weight.

⑯ **Max load weight**

This parameter is used to show and configurate the trigger condition for LOAD SENSOR alarm. If the loaded weight exceeds the weight indicated in this parameter, The TIP OVER accident can occur, which is fatal for driver' safety, so load sensor alarm will be displayed and followed by traction and pump limitation except lift down function.

* The figures in this parameter should be higher than OVERLOAD WEIGHT parameter.

⑰ **Overload weight**

This parameter is used to show and configurate the trigger condition for OVER LOAD alarm. If the loaded weight exceeds the weight indicated in this parameter, overload alarm and function limitation will occur accroding to OVERLOAD TYPE parameter.

* The figures in this parameter should be higher than RATED LOAD W parameter and lower than MAX LOAD WEIGHT parameter.

⑱ **Load speed upd**

For accuracy, Load Sensor only works when the pump motor speed is lower than as set in this parameter.

⑲ **Fork level min.**

This parameter is used to show and configurate the minimum voltage of fork leveling sensor output in case of tilt out fully.

⑳ **Fork level max.**

This parameter is used to show and configurate the reference voltage of fork leveling sensor output in case of tilt in fully.

⑳ **Fork lvl center**

This parameter is used to show and configurate the reference voltage of fork leveling sensor output when the fork is horizontal position.

㉑ **Fork center dead**

It sets the percentage of center dead zone from the center value, when fork leveling function is doing.

㉒ **Fork appr. range**

It sets the percentage of approach range from the center value, when fork leveling function is doing.

㉓ **Fork min speed**

It sets the motor speed reduction percentage of the set tilt speed, when fork leveling function is doing.

㉔ **Fork valve min**

It sets the percentage of tilt valve current, when fork leveling function is doing.

(3) Submenu "PARAMETER CHANGE"

① **Acceleration 0**

It specifies the motor acceleration at 0 Hz. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases.

② **Acceleration 1**

It specifies the motor acceleration at ACC PROF. FREQ 1 [Hz]. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases.

③ **Acceleration 2**

It specifies the motor acceleration at ACC PROF. FREQ 2 [Hz]. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases.

④ **Acceleration 3**

It specifies the motor acceleration at ACC PROF. FREQ 3 [Hz]. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases.

⑤ **Acc prof. freq 1**

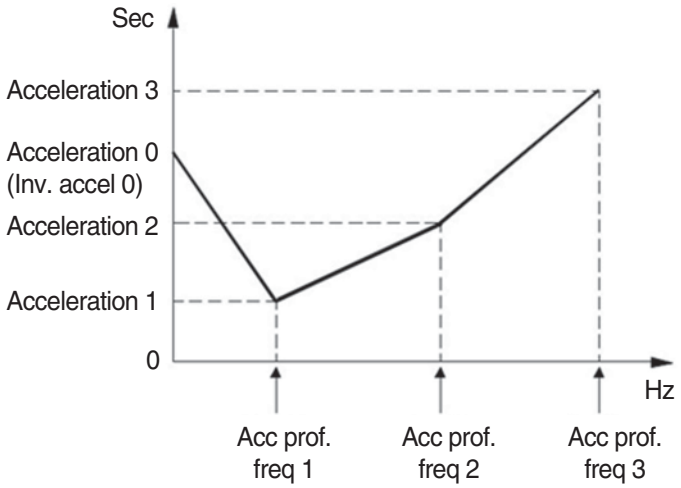
In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 1 parameter.

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.



18BCS9EL14

⑧ **Acc. torque del.**

It determines the acceleration ramp when torque control is set to ON.

⑨ **Dec. torque del.**

It determines the deceleration ramp when torque control is set to ON.

⑩ **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 100 Hz to 0 Hz.

⑪ **Max speed lift**

It determines the pump maximum speed when lift enable switch is closed.

⑫ **Lift cutb. speed**

It determines the lifting maximum speed when the lift cutback switch is open

⑬ **1st speed coarse**

It determines the pump maximum speed when speed1 switch is closed.

⑭ **Auto fork speed**

It determines the pump speed when the automatic fork leveling function is performed.

⑮ **Tilt speed red**

It determines the tilt speed when the analog sensor output is lower than "TILT DOWN RED" or higher than "TILT UP RED" setting.

⑯ **Tilt up red**

Tilt up reduction value for tilt speed reduction.

⑰ **Tilt down red**

Tilt down reduction value for tilt speed reduction.

⑱ **2nd speed coarse**

It determines the pump maximum speed when speed2 switch is closed.

⑲ **3rd speed coarse**

It determines the pump maximum speed when speed3 switch is closed.

⑳ **Idle speed**

It determines the pump idle speed.

㉑ **Hyd speed fine**

It determines the pump maximum speed when an hydraulic steering function request is received via CAN BUS.

㉒ **Hydro speed del.**

It is the delay time after the HYD SPEED FINE request is OFF.

㉓ **Sasa sensor**

It determines the steering speed (IDLE SPEED or HYD SPEED FINE) depending on this setting.

㉔ **Batt. low speed**

The MAXIMUM SPEED when the battery level is calculated being less than or equal to 10% of the full charge.

㉕ **Batt. low current**

The MAXIMUM CURRENT when the battery level is calculated being less than or equal to 10% of the full charge.

㉖ **M. pump speed red**

It determines the maximum speed when the MAINTENANCE is set to OPTOIN#2 or #3.

㉗ **Mot. ht max speed**

It determines the maximum current when the motor temperature is reached to the "MOTOR HIGH TEMP" setting.

㉘ **Mot. ht max curre**

It determines the maximum speed when the motor temperature is reached to the "MOTOR HIGH TEMP" setting.

㉙ **Frequency creep**

Minimum speed when the lift enable switch is closed, but the accelerator is on a minimum position.

㉚ **Maximum current**

This parameter changes the maximum current of the inverter.

㉚ **Auxiliary time**

Time units value (seconds). It is the time delay before close the EM brake when motor speed reach 0 rpm.

㉛ **Rollback speed**

Not used.

㉜ **Mot. sta max curr**

It determines the maximum current when the motor is stalled.

5) PROGRAMMING & ADJUSTMENTS

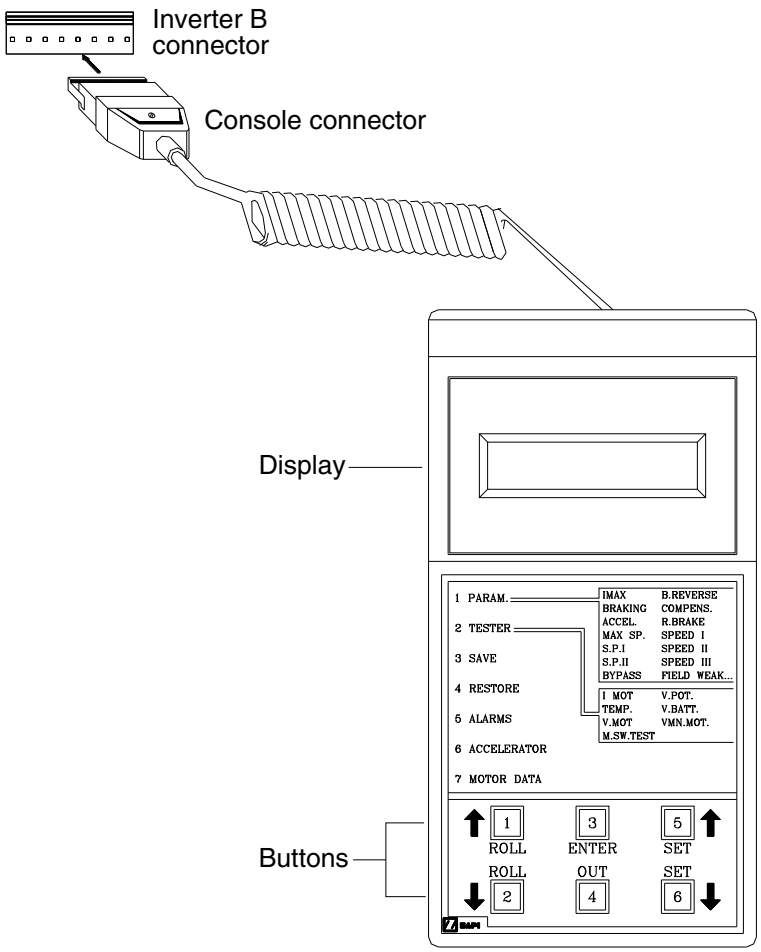
There are two ways to adjust parameter via a console or buttons on a display.

※ Adjustments via buttons on a display, please refer to the display section. (page 7-64)

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

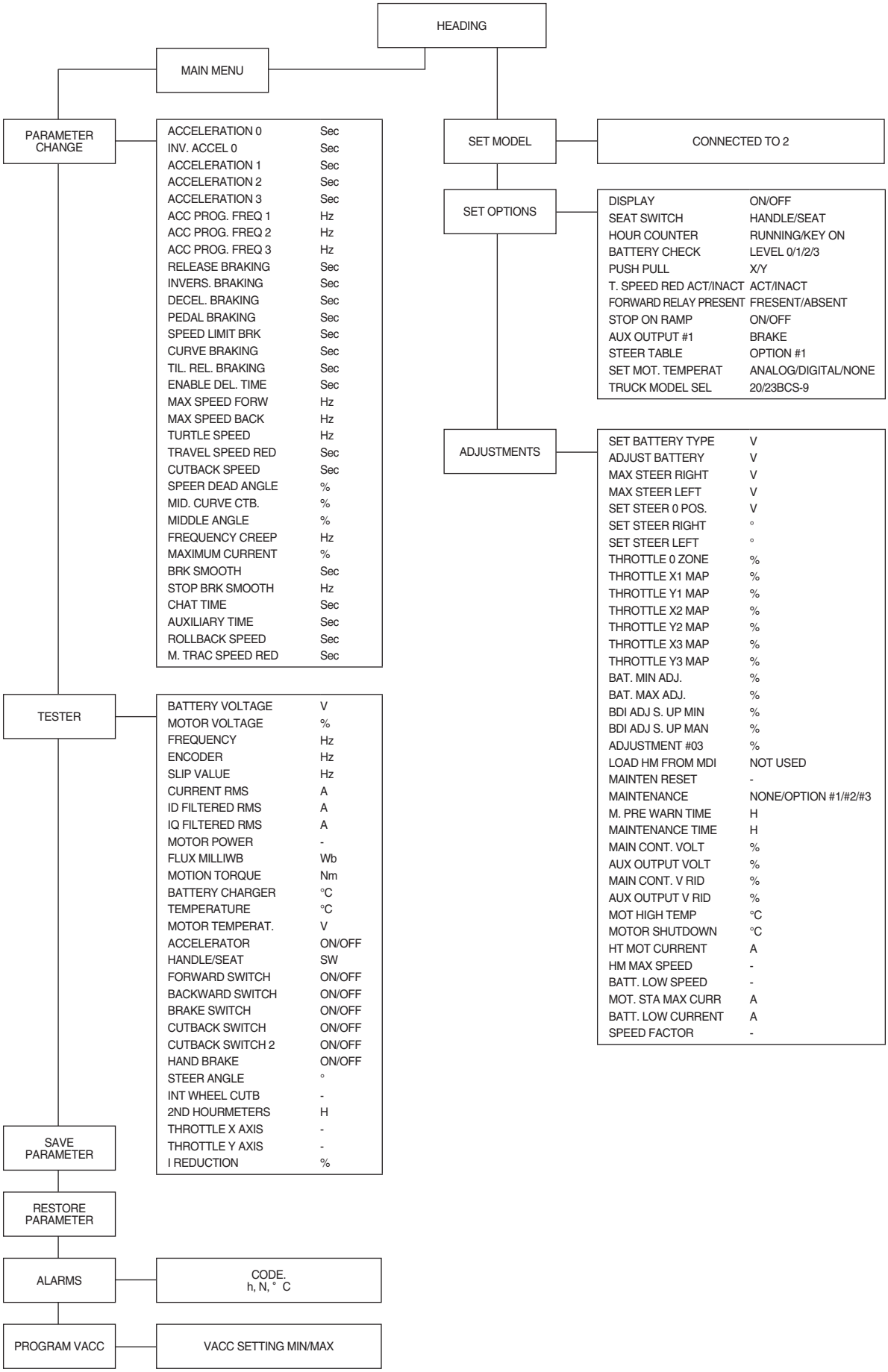


20B7EL15

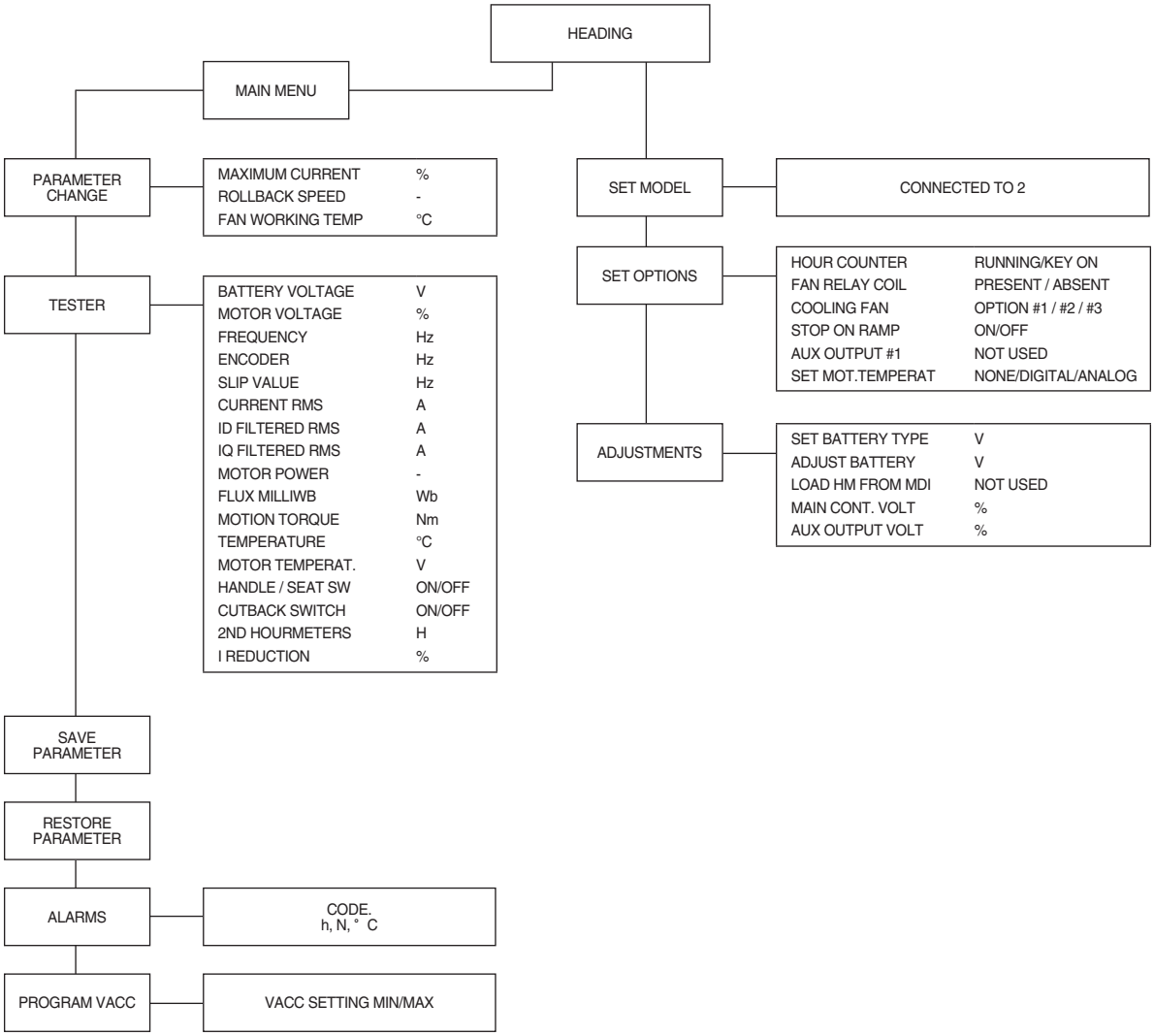
※ Digital consoles used to communicate with AC inverter controllers must be fitted with EPROM CK ULTRA, minimum "Release number 3.02".

(2) Description of standard console menu

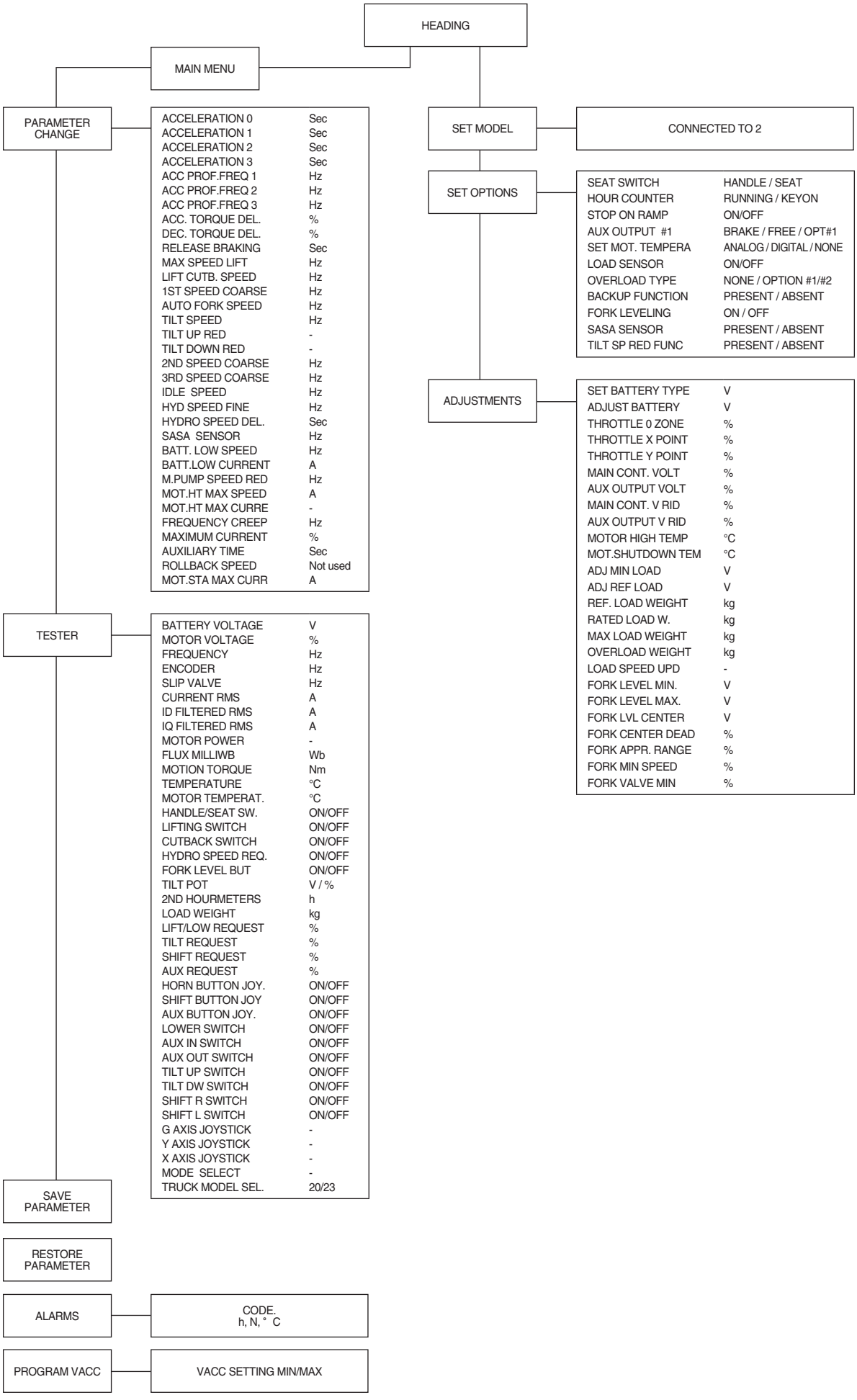
① Traction controller - master



② Traction controller - slave



③ 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.

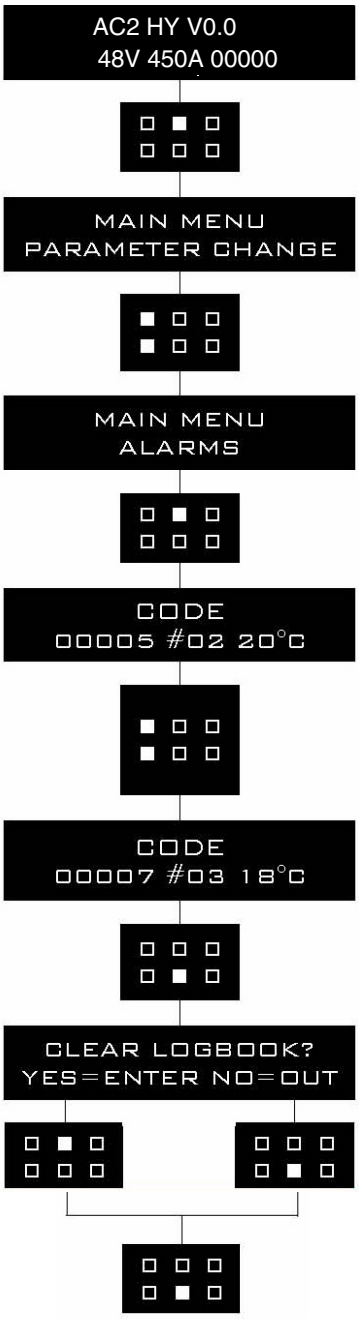
⑨ If an alarm has not occurred, the display will show: ALARM NULL.

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.



BRJ7EL23

6) TESTER MENU (IN DISPLAY, MONITORING MENU)

(1) Traction controller - master

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 **Frequency**

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

④ **Encoder**

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

⑤ **Slip value**

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

⑥ **Current RMS**

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

⑦ **ID filtered RMS**

Ampere value. Root Mean Square value of the current in d axle.

⑧ **IQ filtered RMS**

Ampere value. Root Mean Square value of the current in q axle.

⑨ **Motor power**

It is the power provided to the motor.

⑩ **Flux milliwb**

Wb value. Estimated flux into the motor.

⑪ **Motion torque**

Nm value. Estimated motion torque value.

⑫ **Battery charge**

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

⑬ **Temperature**

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

⑭ **Motor temperature**

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

⑮ **Accelerator**

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

⑯ **Handle / seat SW.**

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

⑰ **Forward switch**

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

⑱ **Backward switch**

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

⑲ **Brake switch**

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

⑳ **Cutback switch**

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

㉑ **Cutback switch 2**

ON/OFF. This is the status of cutback switch 2.

㉒ **Handbrake**

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

㉓ **Steer angle**

° value. This is the angle of the steering wheel.

㉔ **Int wheel cutb.**

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

㉕ **2nd hourmeters**

This parameter displays the working hour of master controller.

㉖ **Throttle X axis**

Value of the X axis set point sent from the joystick to zapi controller.

㉗ **Throttle Y axis**

Value of the Y axis set point sent from the joystick to zapi controller.

㉘ **I reduction**

Percentage of the maximum current that can be applied to the motor.

(2) Traction controller - slave

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.

③ **Frequency**

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

④ **Encoder**

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

⑤ **Slip value**

Hz value. This is the slip between the frequency and the speed of the motor.

⑥ **Current RMS**

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

⑦ **ID filtered RMS**

Ampere value. Root Mean Square value of the current in d axle.

⑧ **IQ filtered RMS**

Ampere value. Root Mean Square value of the current in q axle.

⑨ **Motor power**

It is the power provided to the motor.

⑩ **Flux milliwb**

Wb value. Estimated flux into the motor.

⑪ **Motion torque**

Nm value. Estimated motion torque value.

⑫ **Temperature**

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

⑬ **Motor temperature**

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

⑭ **Handle / seat SW.**

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

⑮ **Cutback switch**

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

⑯ **2nd hourmeters**

This parameter displays the working hour of slave controller.

⑰ **I reduction**

Percentage of the maximum current that can be applied to the motor

(3) 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.

③ **Frequency**

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

④ **Encoder**

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

⑤ **Slip value**

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

⑥ **Current RMS**

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

⑦ **ID filtered RMS**

Ampere value. Root Mean Square value of the current in d axle.

⑧ **IQ filtered RMS**

Ampere value. Root Mean Square value of the current in q axle.

⑨ **Motor power**

It is the power provided to the motor.

⑩ **Flux milliwb**

Wb value. Estimated flux into the motor.

⑪ **Motion torque**

Nm value. Estimated motion torque value.

⑫ **Temperature**

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

⑬ **Motor temperature**

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

⑭ **Handle / seat SW.**

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

⑮ **Lifting switch**

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

⑯ **Cutback switch**

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

⑰ **Hydro speed req.**

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

⑱ **Fork level but**

ON/OFF. This is the status of horn switch on joystick.

⑲ **Tilt pot**

Level of the tilt analogue signal. The voltage is shown on the left hand side of the display and the value in percentage on the right hand side.

⑳ **2nd hourmeters**

This parameter displays the working hour of pump controller.

㉑ **Load weight**

This shows the measured load weight.

㉒ **Lift/low request**

Shadow when you are not in JOYMODE. From 0.0V to 5.0V and from 0% and 100%. LIFT/ LOWER fingertip.

㉓ **Tilt request**

Shadow when you are not in JOYMODE. From 0.0V to 5.0V and from 0% and 100%. TILT fingertip.

㉔ **Shift request**

Shadow when you are not in JOYMODE. From 0.0V to 5.0V and from 0% and 100%. SHIFT fingertip.

㉕ **Aux request**

Shadow when you are not in JOYMODE. From 0.0V to 5.0V and from 0% and 100%. AUX fingertip.

㉖ **Horn button joy.**

ON/OFF. This is the status of horn switch on joystick.

㉗ **Shift button joy.**

ON/OFF. This is the status of shift switch on joystick.

㉘ **Aux button joy.**

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

㉙ **Lower switch**

ON/OFF. This is the status of lowering switch on joystick.

㉚ **Aux in switch**

ON/OFF. This is the status of aux in switch on joystick.

㉛ **Aux out switch**

ON/OFF. This is the status of aux out switch on joystick.

㉜ **Tilt up switch**

ON/OFF. This is the status of tilt up switch on joystick.

㉝ **Tilt dw switch**

ON/OFF. This is the status of tilt down switch on joystick.

㉞ **Shift R switch**

ON/OFF. This is the status of shift right switch on joystick.

㉟ **Shift L switch**

ON/OFF. This is the status of shift left switch on joystick.

㊱ **G axis joystick**

This is the amount of joystick G axis operation.

㊲ **Y axis joystick**

This is the amount of joystick X axis operation.

㊳ **X axis joystick**

This is the amount of joystick Y axis operation.

㊴ **Mode select**

Perfomance sent from the display to Zapi controller.

㊵ **Truck model sel.**

Type of the truck selected: 20 or 23.

8. FINGERTIP JOYSTICK CONTROLLER

1) INTRODUCTION OF FINGER TIP (JOYSTICK)

The general forklift performs lifting and tilting using the mechanical lever mounted on MCV (Main Control Valve) by an operator.

A new system is designed in order to improve operator's convenience and match up with marketing trend. The system is to apply electric joystick and proportional valve instead of mechanical levers and MCV. The attachments are operated as controlling the solenoid of a proportional valve according to the voltage of an electric lever.

2) GENERAL CHARACTERISTIC

(1) Functional characteristics

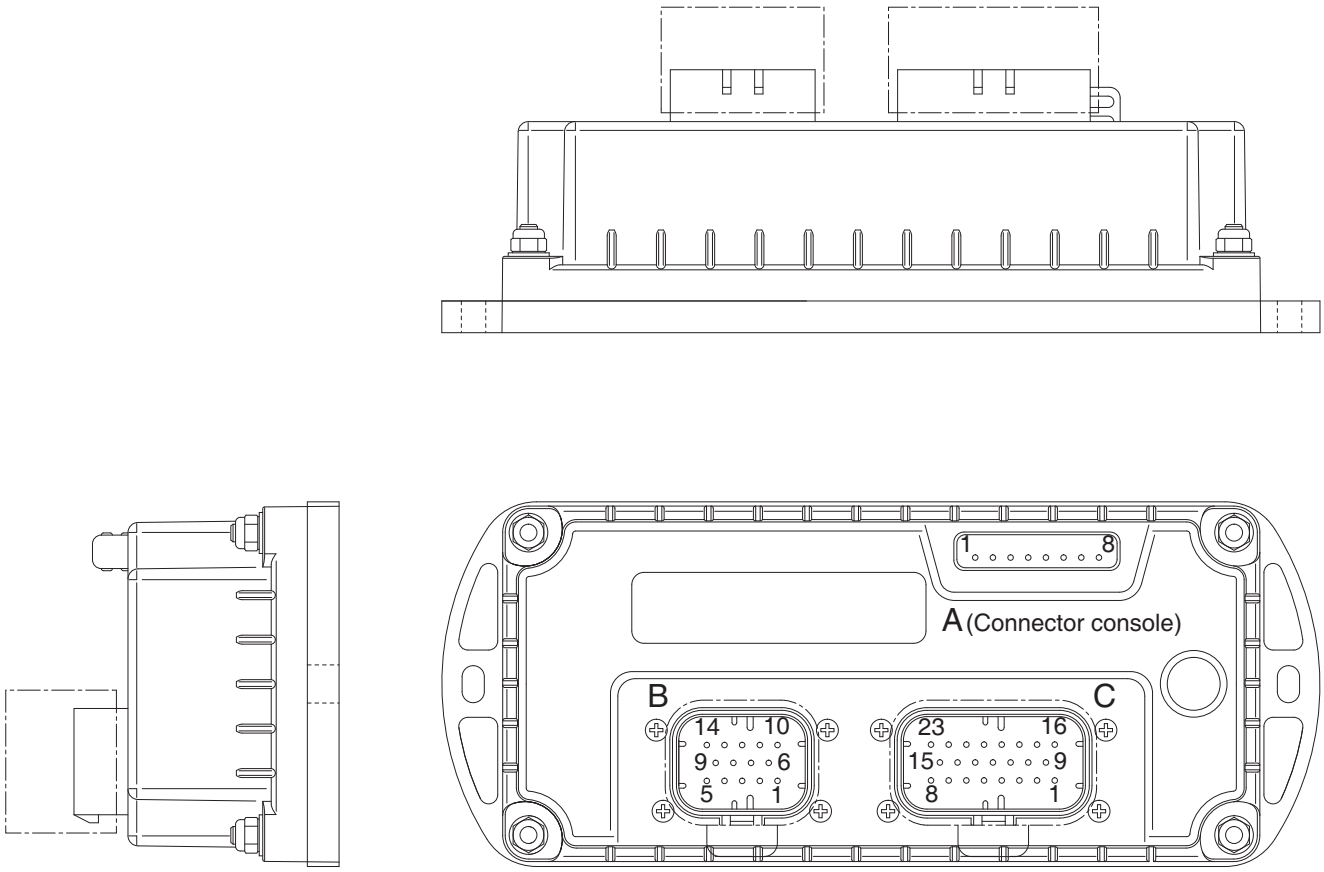
Voltage [V] ····· 24/36/48V
Output for ON-OFF valves [n˚] ····· 3
Output for proportional valves [n˚] ····· 9
Digital inputs [n˚] ····· 3
Analog inputs [n˚] ····· 1
RS-232 [n˚] ····· 1
CAN [n˚] ····· 1
Protection ····· IP65

(2) Input

Analog inputs : Mhyrio provides 1 analog input. The analog device can be supplied at +12. It is necessary to specify in the order the voltage selected. The supply output is able to deliver max 100 mA.

Proportional valves are driven in current mode with programmable frequency. The valves voltage supply is the same used for ON-OFF valves and the current range have to be defined. Via console or display it is adjustable in a big range, but the shunts can be adapted to every types of valves (minimum current 200 mA, maximum current up to 2 A).

3) STRUCTURE



Fingertip controller

18BCS9EL61

4) Description of connectors

No. of pin	Function	Description
A1	PCLRXD	Serial communication interface
A2	NCLRXD	Serial communication interface
A3	PCLTXD	Serial communication interface
A4	NCLTXD	Serial communication interface
A5	GND	Negative supply.
A6	+12	+12V supply.
A7	-	
A8	-	
B1	+KEY	Mhyrio CB positive power supply
B2	PAUX	Input of valves positive power supply
B3	-BATT	Mhyrio CB negative supply
B4	CAN_L	CAN low signal in
B9	CAN_T	CAN termination : connect to CANH_OUT (B14) to insert a 120 ohm termination resistance
B10	PPO_S	Positive supply of analog devices (+12 V) (Joystick, CAN encoder)
B13	CAN_H	Can high signal in
B14	CANH_OUT	Can high signal out (should be connected to B9)
C1	NEVP1	Negative of the proportional electro valve lift up.
C2	PEVP1/2	Positive of the proportional electro valves lowering.
C3	NEVP2	Negative of the proportional electro valve lift up.
C4	NEVP3	Negative of the proportional electro valve attach-B. (common proportional valve-B for reach out, tilt down, side shift left)
C5	PEVP3/4	Positive of the proportional electro valves attach-A, attach-B
C6	NEVP4	Negative of the proportional electro valve attach-A. (common propotional valve-A for reach in, tilt up, side shift right)
C9	NEV1	Negative of reach ON/OFF valve.
C10	NEV2	Negative of tilt ON/OFF valve.
C11	NEV3	Negative of side shift ON/OFF valve.
C12	NEVP7	Negative of the fan relay.
C13	PEVP7/8	Positive of the fan relay.
C16	PEV1	Positive of reach ON/OFF valve.
C17	PEV2	Positive of tilt ON/OFF valve.
C18	PEV3	Positive of side shift ON/OFF valve.
C23	-BATT	Mhyrio CB negative supply

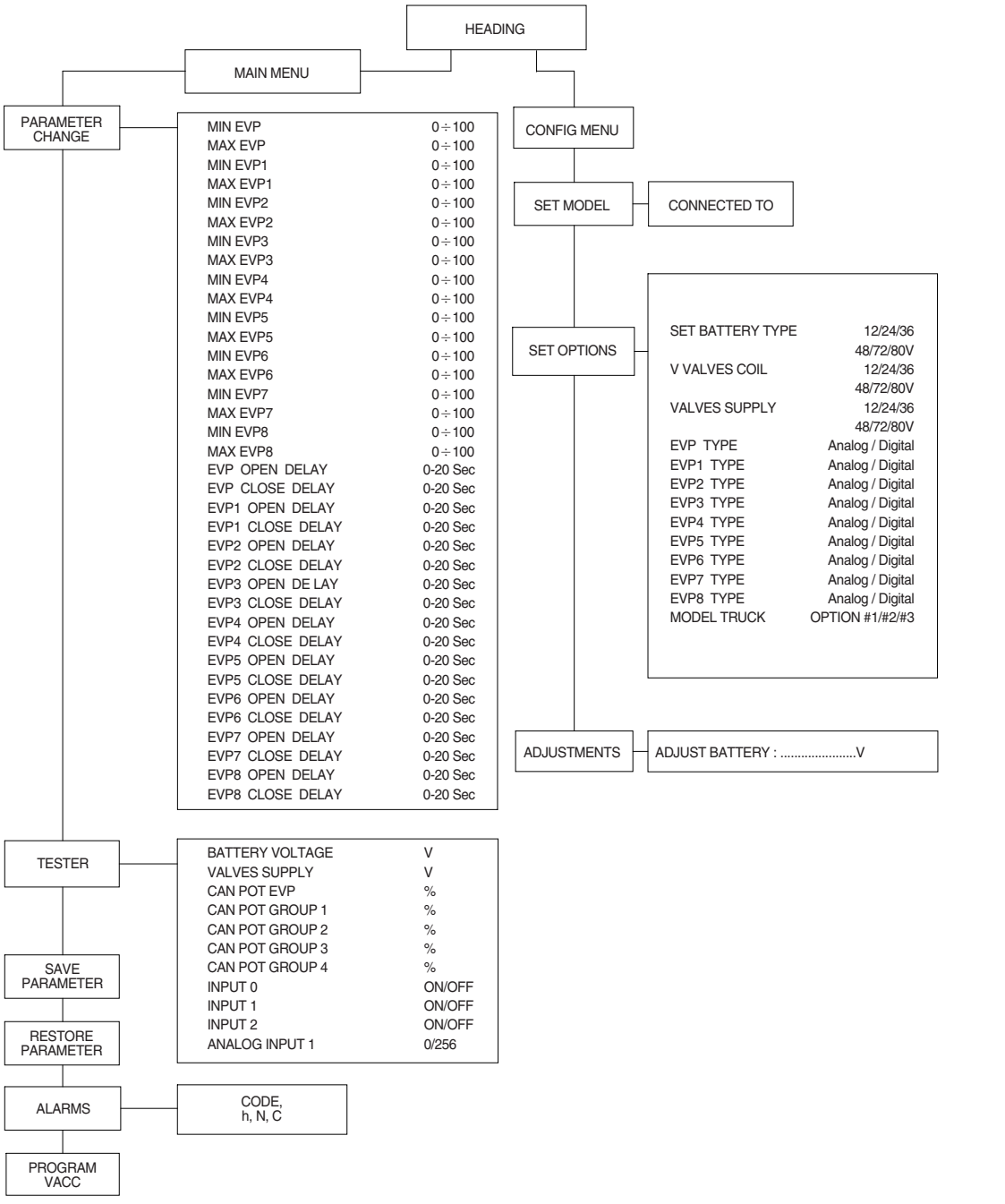
5) ADJUSTMENTS & FUNCTION

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

(1) Adjustments via console or buttons on a display

Adjustment of Parameters and changes to the controller's configuration are made using the Digital Console or buttons on a display. The console can be connected directly to Mhyrio CB (connector A), or it can be physically connected to another controller in the CANBUS net, then virtually connected to Mhyrio CB (which is node 9 of the net). If you don't have the console, you can do adjustments using the buttons on a display easily.

(2) Description of standard console menu



BRJ7EL62A

6) DESCRIPTION OF PARAMETERS THAT MAY BE PROGRAMMED (PARAMETER CHANGE)

In addition to the configuration, parameter settings can be factory set (default parameters), or the customer can make changes according to the application, using a digital console or a display. During the setting up procedure on the machine, the console can remain connected to the controller during travel. The parameters can be modified in real time, during operation. Pay attention to the polarity of the console connector. Refer to chapter 7.1 and 7.2 of this manual for connection details.

CONNECTION OF THE CONSOLE TO THE CONTROLLER MUST BE MADE WITH THE KEY SWITCH TURNED OFF.

The following parameters can be modified:

(1) Submenu "PARAMETER CHANGE"

EVP 1	Proportional valve for lift down (C2-C1)
EVP 2	Proportional valve for lift up (C2-C3)
EVP 3	Common proportional valve for reach out, tilt down, side shift left (C5-C4) (Attach-B)
EVP4	Common proportional valve for reach in, tilt up, side shift rignt (C5-C4) (Attach-A)

① **Min EVP** (not being used)
This parameter adjusts the minimum current of the SINGLE valve.

② **Max EVP** (not being used)
This parameter adjusts the MAXIMUM current of the SINGLE valve.

③ **Min EVP1** (lift down)
This parameter adjusts the minimum current of valve 1 (lift down).

④ **Max EVP1** (lift down)
This parameter adjusts the maximum current of valve 1 (lift down).

⑤ **Min EVP2** (lift up)
This parameter adjusts the minimum current of valve 2 (lift up).

⑥ **Max EVP2** (lift up)
This parameter adjusts the maximum current of valve 2 (lift up).

⑦ **Min EVP3** (attach-B)
This parameter adjusts the minimum current of valve 3 (common proportional valve for reach out, tilt down, side shift left).

⑧ **Max EVP3** (attach-B)
This parameter adjusts the maximum current of valve 3 (common proportional valve for reach out, tilt down, side shift left).

⑨ **Min EVP4** (attach-A)
This parameter adjusts the minimum current of valve 4 (common proportional valve for reach in, tilt up, side shift right).

⑩ **Max EVP4** (attach-A)
This parameter adjusts the maximum current of valve 4 (common proportional valve for reach in, tilt up, side shift right).

⑪ **Min EVP5** (not being used)
This parameter adjusts the minimum current of valve 5.

⑫ **Max EVP5** (not being used)
This parameter adjusts the maximum current of valve 5.

⑬ **Min EVP6** (not being used)
This parameter adjusts the minimum current of valve 6, if it is set as proportional (see "set option menu").
⑭ **Max EVP6** (not being used)
This parameter adjusts the maximum current of valve 6, if it is set as proportional (see "set option menu").
⑮ **Min EVP7** (not being used)
This parameter adjusts the minimum current of valve 7, if it is set as proportional (see "set option menu").
⑯ **Max EVP7** (not being used)
This parameter adjusts the maximum current of valve 7, if it is set as proportional (see "set option menu").
⑰ **Min EVP8** (not being used)
This parameter adjusts the minimum current of valve 8, if it is set as proportional (see "set option menu").
⑱ **Max EVP8** (not being used)
This parameter adjusts the maximum current of valve 8, if it is set as proportional (see "set option menu").
⑲ **EVP Open delay** (not being used)
Single proportional valve current ramping up time: this parameter sets the single valve current ramp, to change coil current from minimum EVP to maximum EVP.
⑳ **EVP Close delay** (not being used)
Single proportional valve current ramping down time: this parameter sets the single valve closing ramp, to change coil current from maximum EVP to minimum EVP.
㉑ **EVP1 Open delay** (lift down)
EVP1 proportional valve current ramping up time: this parameter sets the EVP1 valve current ramp, to change the coil current from minimum EVP1 to maximum EVP1.
㉒ **EVP1 Close delay** (lift down)
EVP1 proportional valve current ramping down time: this parameter sets the EVP1 valve closing ramp, to change the coil current from maximum EVP1 to minimum EVP1.
㉓ **EVP2 Open delay** (lift up)
EVP2 proportional valve current ramping up time: this parameter sets the EVP2 valve current ramp, to change the coil current from minimum EVP2 to maximum EVP2.
㉔ **EVP2 Close delay** (lift up)
EVP2 proportional valve current ramping down time: this parameter sets the EVP2 valve closing ramp, to change the coil current from maximum EVP2 to minimum EVP2.
㉕ **EVP3 Open delay** (attach-B)
EVP3 proportional valve current ramping up time: this parameter sets the EVP3 valve current ramp, to change the coil current from minimum EVP3 to maximum EVP3.
㉖ **EVP3 Close delay** (attach-B)
EVP3 proportional valve current ramping down time: this parameter sets the EVP3 valve closing ramp, to change the coil current from maximum EVP3 to minimum EVP3.
㉗ **EVP4 Open delay** (attach-A)
EVP4 proportional valve current ramping up time: this parameter sets the EVP4 valve current ramp, to change the coil current from minimum EVP4 to maximum EVP4.

㉘ **EVP4 Close delay** (attach-A)

EVP4 proportional valve current ramping down time: this parameter sets the EVP4 valve closing ramp, to change the coil current from maximum EVP4 to minimum EVP4.

㉙ **EVP5 Open delay** (not being used)

EVP5 proportional valve current ramping up time: this parameter sets the EVP5 valve current ramp, to change the coil current from minimum EVP5 to maximum EVP5.

㉚ **EVP5 Close delay** (not being used)

EVP5 proportional valve current ramping down time: this parameter sets the EVP5 valve closing ramp, to change the coil current from maximum EVP5 to minimum EVP5.

㉛ **EVP6 Open delay** (not being used)

EVP6 proportional valve current ramping up time: this parameter sets the EVP6 valve current ramp, to change the coil current from minimum EVP6 to maximum EVP6.

㉜ **EVP6 Close delay** (not being used)

EVP6 proportional valve current ramping down time: this parameter sets the EVP6 valve closing ramp, to change the coil current from maximum EVP6 to minimum EVP6.

㉝ **EVP7 Open delay** (not being used)

EVP7 proportional valve current ramping up time: this parameter sets the EVP7 valve current ramp, to change the coil current from minimum EVP7 to maximum EVP7.

㉞ **EVP7 Close delay** (not being used)

EVP7 proportional valve current ramping down time: this parameter sets the EVP7 valve closing ramp, to change the coil current from maximum EVP7 to minimum EVP7.

㉟ **EVP8 Open delay** (not being used)

EVP8 proportional valve current ramping up time: this parameter sets the EVP8 valve current ramp, to change the coil current from minimum EVP8 to maximum EVP8.

㊱ **EVP8 Close delay** (not being used)

EVP8 proportional valve current ramping down time: this parameter sets the EVP8 valve closing ramp, to change the coil current from maximum EVP8 to minimum EVP8.

(2) Submenu "SET OPTIONS"

① **Set Battery Type**

This parameter sets the battery nominal voltage, that is the key input voltage (Mhyrio supply). (36V in for C/B trucks)

② **V Valves Coil**

This parameter sets the ON/OFF valves coil nominal voltage. (24V for C/B trucks)

③ **Valves Supply**

This parameter sets the voltage of the valve's coil positive supply. (36V for C/B trucks)

④ **Model Truck**

This parameter changes entire parameter's value to each model's default value as below after recycle of key.

This parameter supposed to be "OPTION #1" for C/B trucks.

- Option #1 : C/B trucks
- Option #2 : BRJ-7
- Option #3 : BRP-9
- Option #4 : BRJ-9

7) TESTER MENU (IN DISPLAY, MONITORING MENU)

Following parameters can be measured in real time in the TESTER menu:

① Battery voltage

Level of battery voltage measured at the input of the key switch.

② Valves supply

Level of voltage at the positive valve supply input (B2).

③ CAN POT EVP

Single proportional valve current set point, received by canbus.

④ CAN POT group 1

Group 1 proportional valves current set point, received by canbus.

⑤ CAN POT group 2

Group 2 proportional valves current set point, received by canbus.

⑥ CAN POT group 3

Group 3 proportional valves current set point, received by canbus.

⑦ CAN POT group 4

Group 4 proportional valves current set point, received by canbus.

⑧ Input 0

Level of digital input 0:

- ON / +VB : input active, switch closed
- OFF / COND : input not active, switch open.

⑨ Input1

Level of digital input 1:

- ON / +VB : input active, switch closed
- OFF / COND : input not active, switch open.

⑩ Input 2

Level of digital input 2 :

- ON / +VB : input active, switch closed
- OFF / COND : input not active, switch open.

⑪ Analog input 1

Voltage of the analog input.

8) 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.

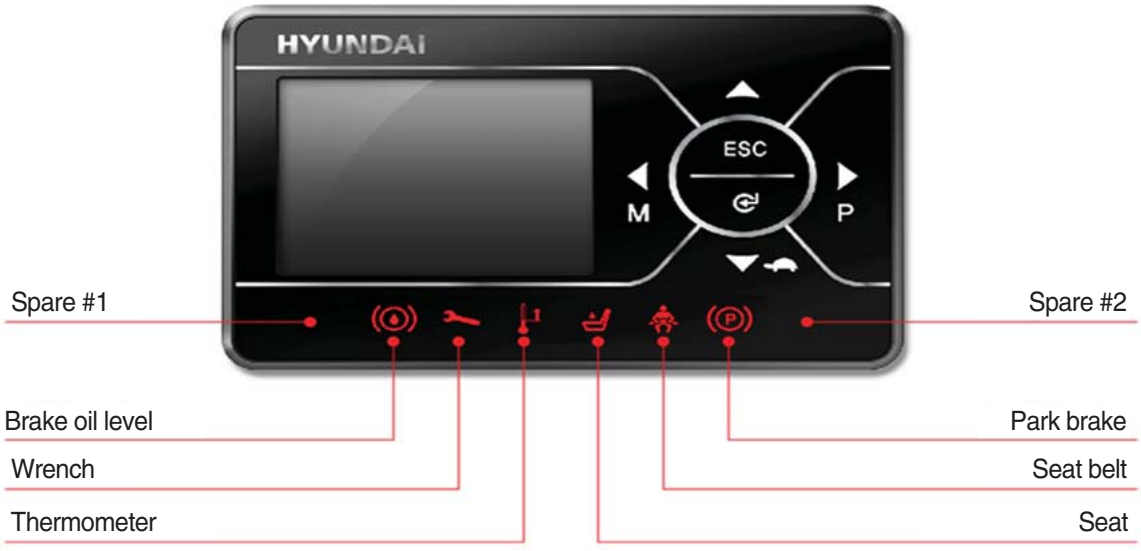
⚠ Before doing any operation, ensure that the battery is disconnected and when all the installation is completed start the machine with the drive wheels raised from the floor to ensure that any installation error do not compromise safety.

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

6. INSTRUMENT PANEL : DISPLAY

1) STRUCTURE

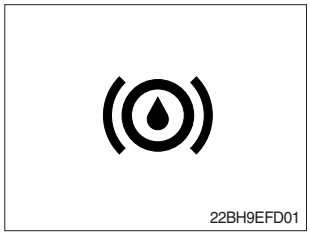
The DISPLAY has 6 red LEDs indicating the status information of the lift truck to the driver.



22BH9OM65

2) WARNING LAMP

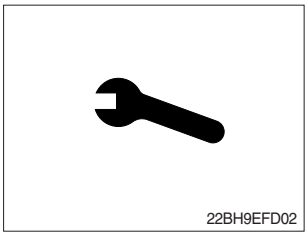
(1) Brake oil level warning lamp



This LED lights when measured level of brake oil stored in reservoir tank is below the minimum acceptable mark.

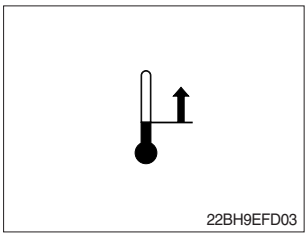
※ BCS-9 truck does not have any mechanical brake which requires brake oil, so that re-fill of brake oil is not required.

(2) Wrench warning lamp



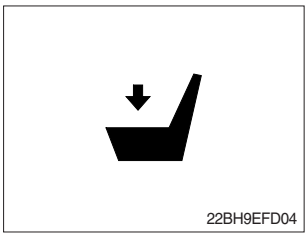
This LED lights when an electric device (controller, motor, cable, etc.) is in abnormal condition.

(3) Thermometer warning lamp



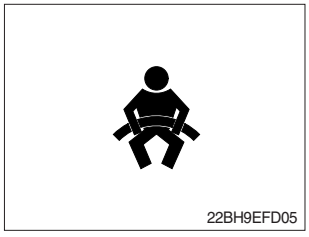
This LED lights when the controller or motor temperature is high.

(4) Seat warning lamp



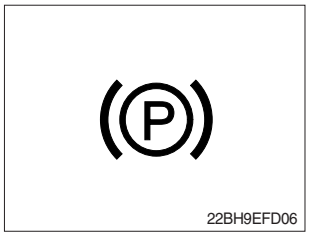
This LED lights when the operator is not on the dead man switch.

(5) Seat belt warning lamp



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.

(6) Parking brake warning lamp

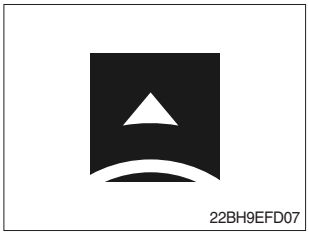


This LED lights when the parking brake is activated.

3) BUTTON

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

(1) Up button

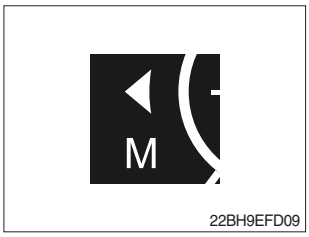


Press to select upward move.

(2) DOWN/TURTLE button

Press to select downward move.
TURTLE MODE ON/OFF

(3) LEFT/MENU button

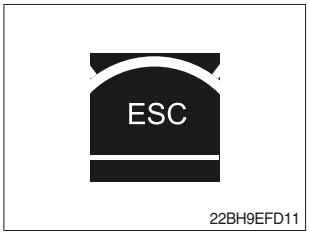


Press to select leftward move.
Go into the menu.

(4) RIGHT/PERFORMANCE button

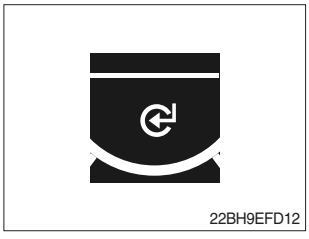
Press to select rightward move.
POWER MODE H/N/E

(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 7-69].

(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.

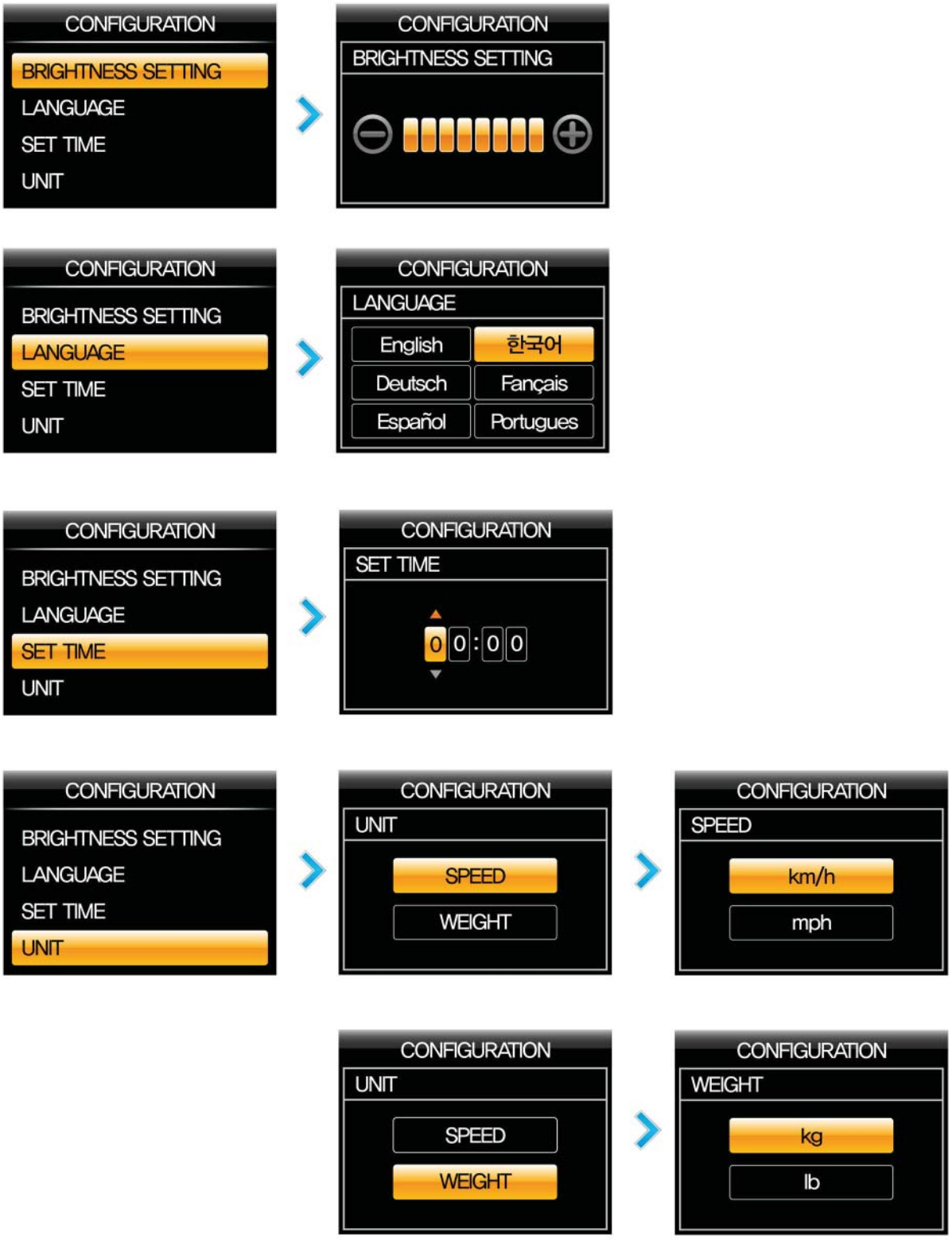
① BAT. MAX ADJ.

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

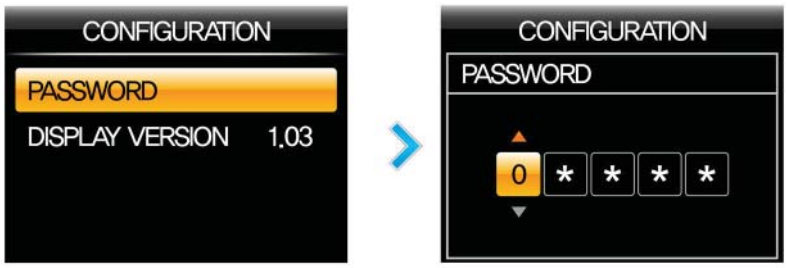
② BAT. MIN ADJ.

It adjusts the lower level of the battery discharge table. Higher value means higher voltage. (for detail menu, please refer to page 7-31)

5) HOW TO USE DISPLAY MENU



22BH9EFD14


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

20BC9EFD15

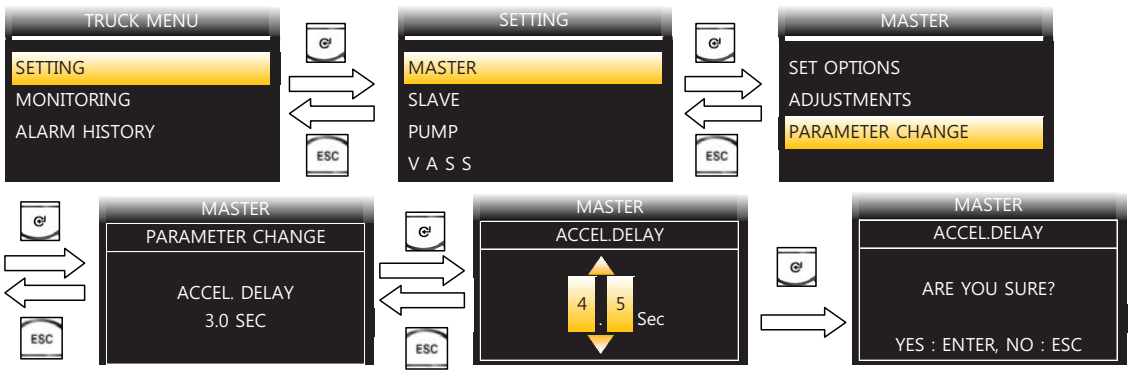
6) DESCRIPTION OF THE TRUCK MENU

(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

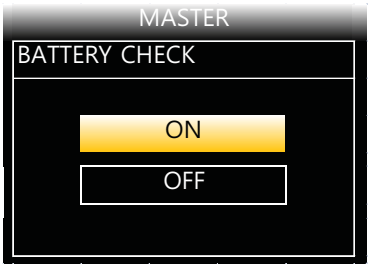
The detail items of menu can be changed as follows ;



22B9EL24

Selection can be made in 4 methods as follows ;

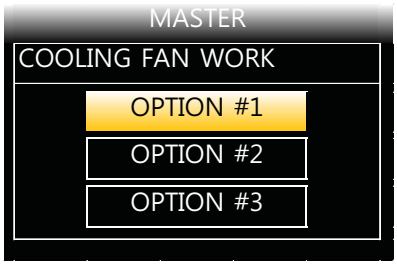
- ON/OFF Selection



22B9EL25

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

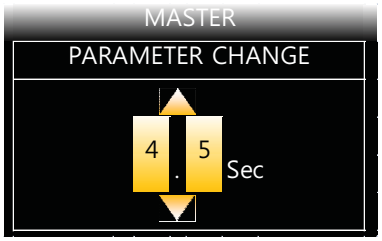
- Type Selection



22B9EL30

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

- Level Selection



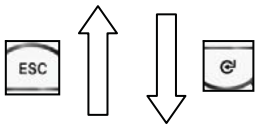
22B9EL30

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

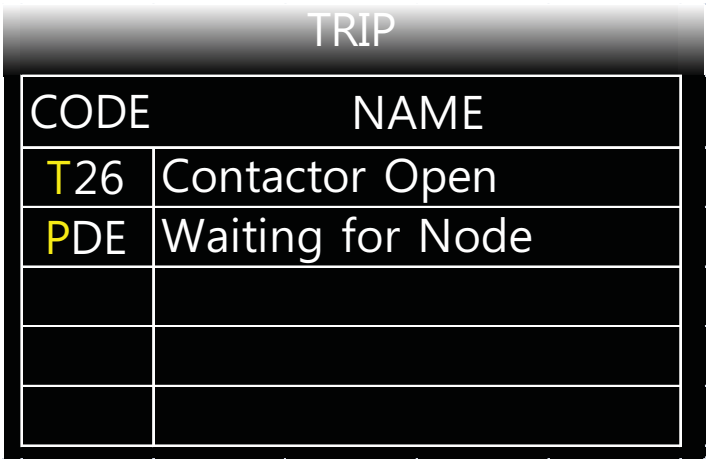
7) ALARM & ALARM HISTORY

(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 :

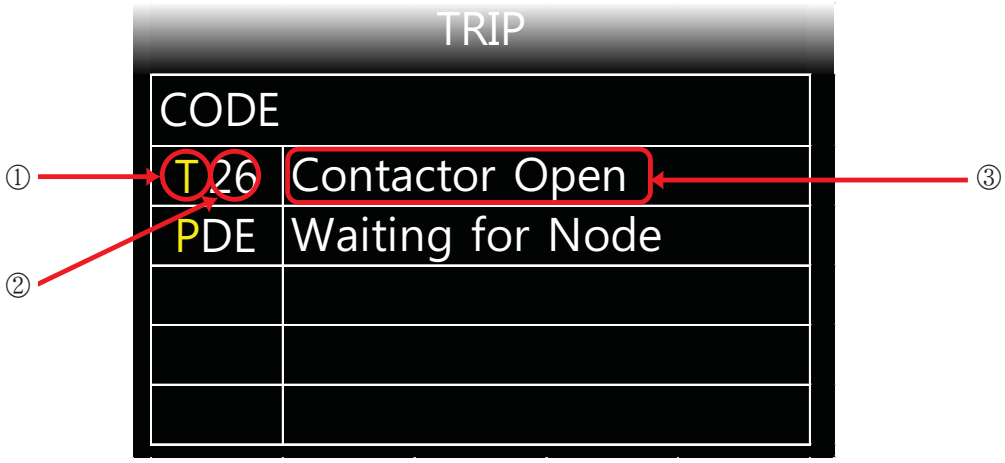


(Press more than 1 sec)



18BR9EL35

(2) Detail description of ALARM SCREEN

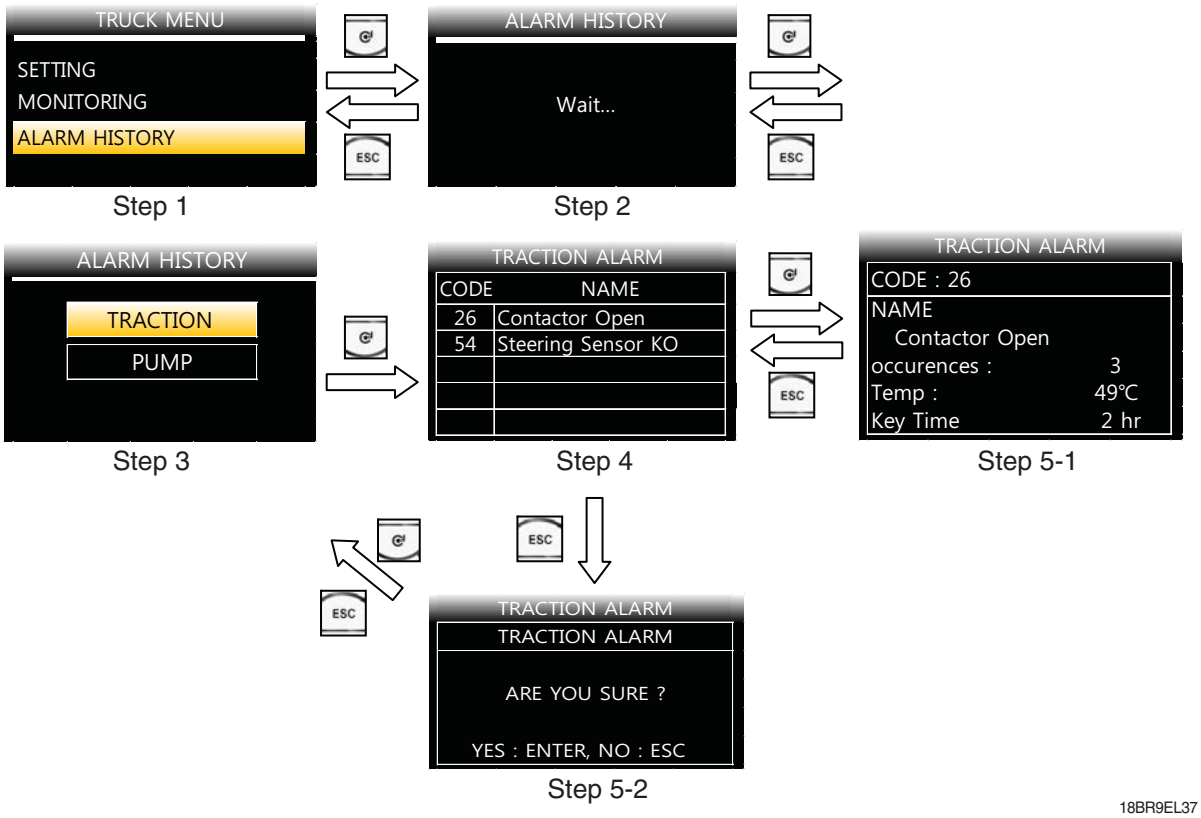


18BR9EL36

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 7-81).
③ This shows a name of ALARM. Please refer to 7. ALARM CODE (page 7-81).

(3) Alatm history

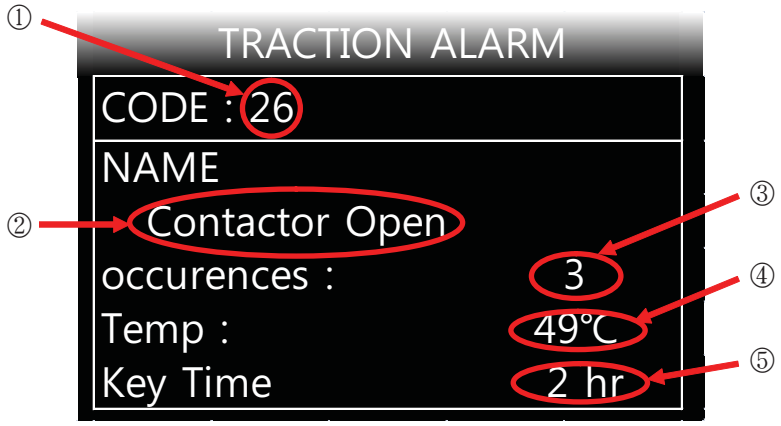
Alarm History can be looked up as follows ;



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 below.
⑥ Step 5-2 : When service man press [ESC] button at Step 4, service man can see a alarm clear menu. If service man press [↵] button, Recorded alarms of selected controller will be erased. (to verify cleaned alarm records, service man should be back to Step 1 & 2 to refresh.)
If operator press [ESC] button, just escape to step 3 without clearing

(4) Detail alarm information



22B9EL38

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

8) VASS SETUP USING DISPLAY MENU

This function searches and memorizes the minimum and maximum potentiometer wiper voltage of the accelerator pedal, lift lever, and steering sensor which use potentiometer sensors. The belows show how to use the VASS function of DISPLAY.

(All figures in belows are just example.)

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

(1) ACCEL VASS setting method

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

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

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

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

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

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

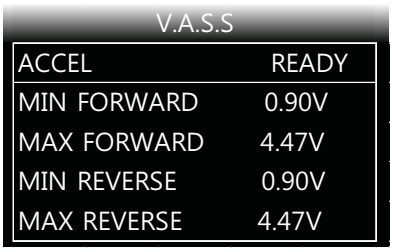
V.A.S.S	
ACCEL	READY
MIN FORWARD	0.90V
MAX FORWARD	4.47V
MIN REVERSE	0.76V
MAX REVERSE	1.76V

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

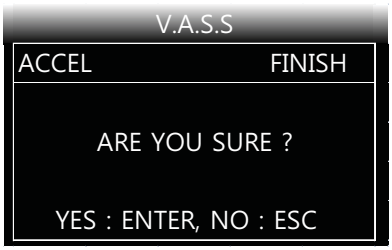
V.A.S.S	
ACCEL	READY
MIN FORWARD	0.90V
MAX FORWARD	4.47V
MIN REVERSE	0.90V
MAX REVERSE	0.90V

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

22B9EL39-1

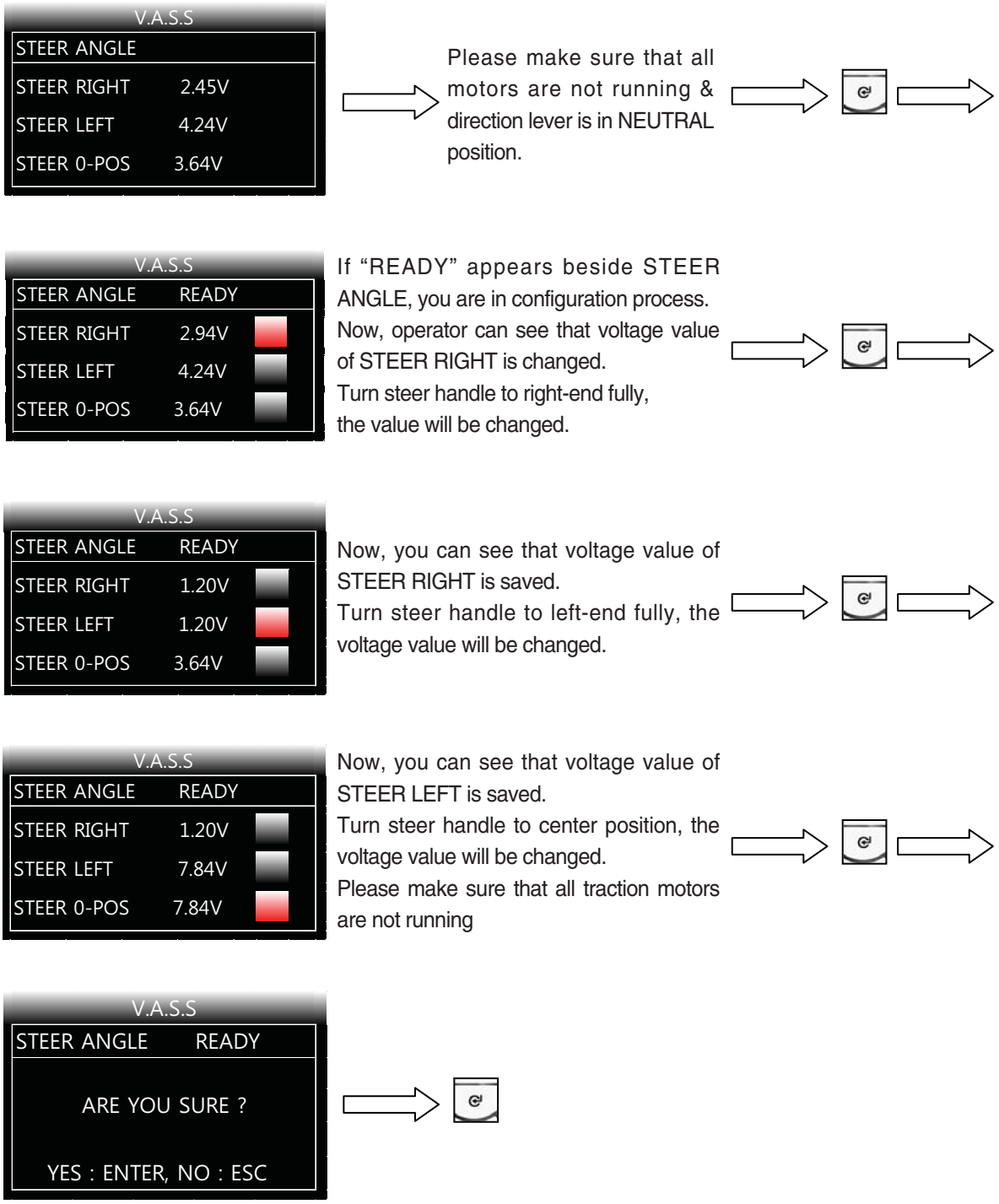


Now, you can see that voltage value of MAX REVERSE are changed.
Please make sure that all motors are not running & direction lever is in NEUTRAL position.



22B9EL39-2

(2) STEER ANGLE VASS setting method



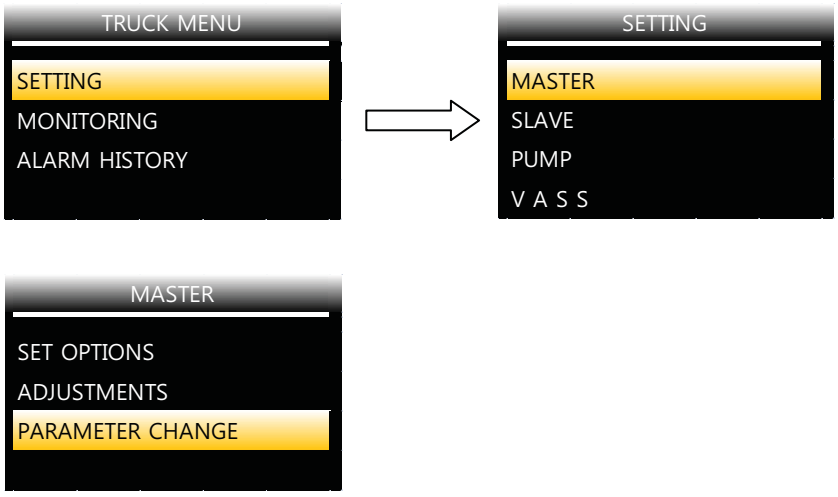
22B9EL41

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 7-71]

(1) Settings



22B9EL42

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 7-29, 7-36)

② TRACTION->ADJUSTMENTS
Refer to 5-4)- ■ ”TRACTION CONTROLLER”-(2) “ADJUSTMENTS” (page 7-30, 7-37)

③ TRACTION->PARAMETER CHANGE
Refer to 5-4)- ■ ”TRACTION CONTROLLER”-(3) “PARAMETER CHANGE” (page 7-33, 7-37)

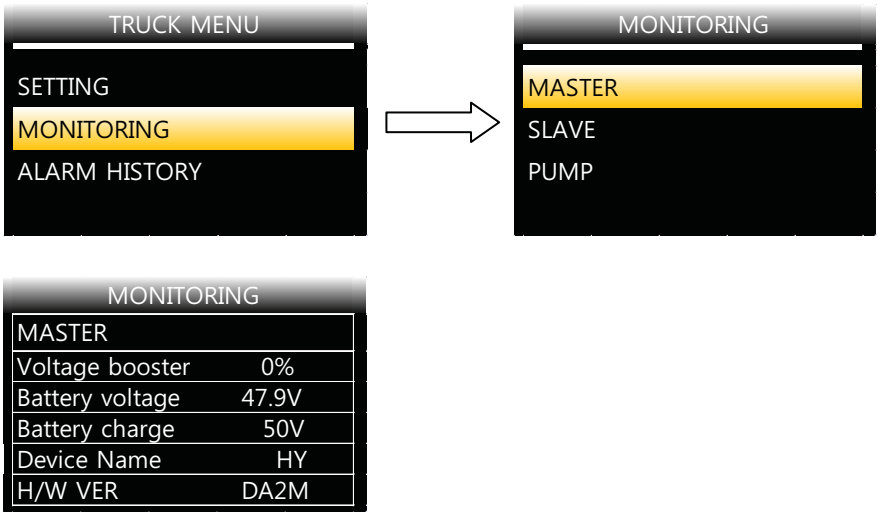
④ PUMP->SET OPTIONS
Refer to 5-4)- ■ “PUMP CONTROLLER”-(1) “SET OPTIONS” (page 7-38)

⑤ PUMP->ADJUSTMENTS
Refer to 5-4)- ■ ”PUMP CONTROLLER”-(2) “ADJUSTMENTS” (page 7-39)

⑥ PUMP->PARAMETER CHANGE
Refer to 5-4)- ■ ”PUMP CONTROLLER”-(3) “PARAMETER CHANGE” (page 7-41)

⑦ V.A.S.S
Refer to 6-8) “VASS SETUP USING DISPLAY MENU” (page 7-76)

(2) Monitoring



22B9EL43

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

① TRACTION

Refer to 5-6)-(1) “Traction controller” (page 7-49, 7-51)

② PUMP

Refer to 5-6)-(3) “Pump controller” (page 7-52)

(3) Alarm history

Refer to 6-7) “ALARM & ALARM HISTORY” (page 7-62)

7. ALARM CODE

1) TRACTION CONTROLLER

No	Code	Alarm name	Master	Slave	Description	
					Cause	Troubleshooting
1	D	EEPROM KO	○	○	Warning : EEPROM fault, controller will use default parameters.	- To remove warning cause.
2	11	Logic Failure#3	○	○	Alarm : failure in over-load protection hw circuit.	- To remove alarm condition + activation of pump request. - Check the controller.
3	12	Logic Failure#2	○	○	Alarm : failure in U, V, W voltage feedback circuit.	- To remove alarm condition + activation of pump request.
4	13	Logic Failure#1	○	○	Alarm : an overvoltage or undervolt. condition has been detected.	- To recycle the key switch. - Sometimes if battery voltage is too low, it can be happens. - Check the controller.
5	1E	VMN Low	○	○	Alarm : wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor.	- If the alarm is present in Init status, remove the alarm condition. - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a pump request. - Check the U, V, W cable and motor and if there is any shorted circuit with frame or any other parts of truck. - Check the controller.
6	1F	VMN High	○	○	Alarm : wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor.	- If the alarm is present in Init status, remove the alarm condition. - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a pump request. - Check the U, V, W cable and motor and if there is any shorted circuit with frame or any other parts of truck. - Check the controller.
7	25	Contactor Closed	○	○	Alarm : line contactor power contact is stuck.	- To remove alarm cause within a timeout; if the timeout is elapsed, it is necessary to re-cycle the key. - Check the contactor and cables attached to the contactor.
8	26	Contactor Open	○	○	Alarm : line contactor power contact does not pull-in.	- To remove alarm cause within a timeout; if the timeout is elapsed, it is necessary to re-cycle the key. - Check the contactor and cables attached to the contactor.
9	35	Stby I High	○	○	Alarm : wrong voltage in the current sensor feedback circuit.	- If the alarm is present in Init status, remove the alarm condition. - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a pump request.

No	Code	Alarm name	Master	Slave	Description	
					Cause	Troubleshooting
10	3C	Capacitor Charge	○	○	Alarm : power capacitor voltage does not increase when the key is turned ON; failure in the power section, or in the logic PCB, or in the driver PCB, or in the motor.	- To remove alarm condition. - Check the contactor resistance (300 Ω, 10 W). - Check the controller.
11	3E	TH. Protection	○	○	Warning : pump temperature higher than 75 °C.	- To remove warning cause.
12	41	Motor Temperat.	○	○	Warning : pump motor temperature high.	- To remove warning cause. - Check the motor temp-sensor.
13	42	Battery Low	○		Warning : battery charge level below 10%.	- To remove warning cause.
14	4A	Driver Shorted	○	○	Alarm : line contactor coil driver is shorted.	- If the alarm is present in Init status, remove the alarm cause. - If the alarm has occurred in stby or running mode, it is necessary to remove alarm cause and to activate pump request.
15	4B	Contactor Driver	○	○	Alarm : line contactor coil driver is open (not able to drive the coil to the correct voltage).	- To remove alarm cause and to activate pump request.
16	4E	VACC Not OK	○	○	Warning : lift signal (CPOT) voltage higher than VACC MIN+1V while the lift enable switch is open.	- To remove warning cause. - Re-configurate VASS ACCEL.
17	4F	Incorrect Start	○	○	Warning : wrong pump request sequence.	- To remove warning cause.
18	50	Forw + Back	○	○	Warning : forward and reverse inputs are both active.	- To remove warning cause.
19	52	Encoder Error	○	○	Alarm : motor speed sensor (encoder) does not work properly.	- To recycle the key. - Check the motor encoder.
20	54	Steer Sensor KO	○	○	Alarm : steering sensor signal out of range	- To remove alarm cause.
21	CF	Model Mismatch	○	○	Alarm : parameter "TRUCK MODEL SEL." is being modified.	- Key off and on controller.
22	D0	Selection Error	○	○	Alarm : A-13 input state is been modified.	- Key off and on controller.
23	D1	CANBUS DISP. KO	○	○	Alarm : master has lost can communication with the display	- To remove alarm cause.
24	D2	Display Enable	○	○	Warning : the display enable signal has not been received to operate the truck.	- To remove warning cause.

No	Code	Alarm name	Master	Slave	Description	
					Cause	Troubleshooting
25	D3	Maint pre Warn	○	○	Warning : this alarm occurs when the controller works after "M. PRE WARN TIME" hours.	- Set to ON " MAINTEN. RESET " parameter.
26	D4	Maintenance Hour	○	○	Warning : this alarm occurs when the controller works after "M. PRE WARN TIME" hours.	- Set to ON " MAINTEN. RESET " parameter.
27	D5	Motor Shutdown	○	○	Alarm : motor temperature is greater than the parameter " MOTOR SHUTDOWN ".	- Leave the truck at rest to allow the temperature to decrease.
28	D6	Side Battery Rem	○	○	Warning : side battery removal sensor is open.	- To remove warning cause. - Check the SBR sensor.
29	D7	Enable S/W Open	○	○	Warning : accelerator is activated with A-6 opened.	- Press pedal A-6 and the activate accelerator.
30	D8	CAN BUS Joystick	○	○	Controller doesn't receive joystick can message.	- Check wiring between controller and joystick.
31	D9	Left ENC Locked	○		Encoder speed from theleft motor is zero.	- Check the connection between the left motor and the left controller.
32	DA	Torque Profile	○	○	Parameter regarding the torque are not corrected.	- Perform clear EEPROM command.
33	DB	IQ Mismatched	○	○	Torque current doesn't follow the set point.	- Change the controller.
34	DD	Seat Mismatch	○	○	A-6 state of the right controller is different from A-6 of the left controller.	- Check the wiring of A-6.
35	DE	Waiting For NODE	○	○	Warning : pump controller signals that other controllers are in alarm status.	- To recycle the key. - Check if any other alarm happens (Some alarms such as CHAT TIME or PEDAL WIRE KO, alarms related to CONTACTOR, DISPALY ENABLE, alarms reated 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 available, H/W ver, S/W ver will be blank).
36	DF	Watchdog #1	○	○	Alarm : the watchdog signal #1 is not in the correct status.	- To remove alarm cause.
37	E0	AUX Coil Short	○	○	Alarm : shortcircuit on EB/ AUX coil.	- To remove alarm cause.

No	Code	Alarm name	Master	Slave	Description	
					Cause	Troubleshooting
38	E1	Safety Input KO	○	○	A-11 voltage is not correct.	- Check wiring between A-19 and A-11 of the left and right controller.
39	E2	VACC Out Range	○	○	Waring : the lift input is out of the range Vacc_ min ÷ Vacc_max, which has been acquired with "PROGRAMM VACC" function.	- Try to perform a program VACC.
40	E3	Watchdog#2	○	○	Alarm : the watchdog signal #2 is not in the correct status.	- To remove alarm cause.
41	E4	Chat Time	○		Warning : the chat time has expired.	- To activate traction or pump request.
42	E5	Safety Input	○	○	Alarm : the safety input is open (it is not connected to –Batt).	- To remove alarm cause.
43	E6	MC Coil Short	○	○	Alarm : shortcircuit on MC coil.	- To remove alarm cause.
44	E7	Coil Short HW KO	○	○	Alarm : the harware to check a MC or EB/AUX coil shorted is damaged.	- Check the controller.
45	E8	Key Off Short	○	○	Alarm : at start-up the keyoff logic signal is low.	- Check the connection. - Check the key input signal.
46	E9	Power MOS Short	○	○	Alarm : short circuit on the power Mosfets.	- Check the controller.
47	EB	Handbrake	○	○	Warning : handbrake microswitch is open and a travel request is active.	- To remove warning cause.
48	EC	Curremt Gain	○	○	Warning : the maximum current gain parameters are the default values, which means the maximum current adjustment procedure has not been carried out yet.	- Ask the assistance of an engineer at the development department to do the correct adjustment procedure of the current gain parameters..
49	ED	Analog Input	○	○	Alarm : the analog channel ready is not updated.	- Check the controller.
50	EE	Wrong 0 Voltage	○	○	Alarm : the motor phases voltage feedback are out of permitted range.	- To remove alarm cause.
51	EF	Safety Output	○	○	Alarm : the safety-out driver is damaged (shorted or open).	- To remove alarm cause.
52	F0	Hardware Fault	○	○	Alarm : the mosfets driver are not switched off with watch-dog signal in alarm status.	- Check the controller.

No	Code	Alarm name	Master	Slave	Description	
					Cause	Troubleshooting
53	F1	Flash Checksum	○	○	Alarm : the program verify is not OK.	- Try to program the controller again. - Check the controller logic board.
54	F2	Right ENC Locked	○		Encoder speed from the right motor is zero.	- Check the connection between the right motor and the left controller.
55	F3	Sens Mot Temp KO	○	○	Warning : the output of the motor thermal sensor is out of range.	- To remove warning cause.
56	F4	Software Error	○	○	Alarm : CANBUS line of ACE2 is in CANBUS line OFF condition.	- Check CANBUS connection. If CANBUS connection is OK, replace the logic of ACE2.
57	F5	Wrong RAM memory	○	○	Alarm : the algorithm implemented to check the main RAM registers finds a wrong contents: the register is "dirty". This alarm inhibit the machine operations.	- Try to switch the key off and then on. If the alarm is still present, replace the ACE2 logic board.
58	F6	AUX Driv. Open	○	○	Alarm : the AUX coil driver is not able to drive the load. The device itself or its driving circuit is damaged.	- This type of fault is not related to external components; Replace the ACE2 logic board.
59	F7	Data Acquisition	○	○	Alarm : data communication is now processing.	- If this alarm occurs, when sensor setting procedure, recycle the key.
60	F8	NO CAN MSG.	○	○	Alarm : slave has lost can communication with #X.	- To remove alarm cause. - Check if any other alarm happens (some alarms such as CHAT TIME or PEDAL WIRE KO, alarms related to CONTACTOR, DISPLAY ENABLE, alarms related to CANBUS can make this alarm sometimes.) - Check the communication with all controllers.
61	F9	Check Up Needed			Warning : truck reached the hour time for maintenance.	- Reset the checkup hour time.
62	FA	Thermic Sens. KO	○	○	Warning : pump temp. sensor is out of range.	- To remove warning cause.
63	FB	Wrong Set BAT.	○	○	Alarm : the battery voltage does not correspond to SET BATTERY programming.	- To remove alarm cause.
64	FC	Power Mismatch	○	○	The power calculated from the controller is not corrected.	- Change the controller.
65	FD	Foc Lost	○		Field current doesn't follow the set point.	- Change the controller.
66	FE	AUX Driv. Shrt.	○	○	Alarm : the EB/AUX driver is shorted so it is not able to open the contactor.	- Check the controller.

2) PUMP CONTROLLER

No	Code	Alarm name	Pump	Description	
				Cause	Troubleshooting
1	D	EEPROM KO	○	Warning : EEPROM fault, controller will use default parameters.	- To remove warning cause.
2	11	Logic Failure#3	○	Alarm : failure in over-load protection hw circuit.	- To remove alarm condition + activation of pump request. - Check the controller.
3	12	Logic Failure#2	○	Alarm : failure in U, V, W voltage feedback circuit.	- To remove alarm condition + activation of pump request.
4	13	Logic Failure#1	○	Alarm : an overvoltage or undervolt. condition has been detected.	- To recycle the key switch. - Sometimes if battery voltage is too low, it can be happens. - Check the controller.
5	1E	VMN Low	○	Alarm : wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor.	- If the alarm is present in Init status, remove the alarm condition. - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a pump request. - Check the U,V,W cable and motor and if there is any shorted circuit with frame or any other parts of truck. - Check the controller.
6	1F	VMN High	○	Alarm : wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor.	- If the alarm is present in Init status, remove the alarm condition. - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a pump request. - Check the U,V,W cable and motor and if there is any shorted circuit with frame or any other parts of truck. - Check the controller.
7	25	Contactor Closed	○	Alarm : line contactor power contact is stuck.	- To remove alarm cause within a timeout; if the timeout is elapsed, it is necessary to re-cycle the key. - Check the contactor and cables attached to the contactor.
8	26	Contactor Open	○	Alarm : line contactor power contact does not pull-in.	- To remove alarm cause within a timeout; if the timeout is elapsed, it is necessary to re-cycle the key. - Check the contactor and cables attached to the contactor.
9	35	Stby I High	○	Alarm : wrong voltage in the current sensor feedback circuit.	- If the alarm is present in Init status, remove the alarm condition. - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a pump request.

No	Code	Alarm name	Pump	Description	
				Cause	Troubleshooting
10	3C	Capacitor Charge	○	Alarm : power capacitor voltage does not increase when the key is turned ON; failure in the power section, or in the logic PCB, or in the driver PCB, or in the motor.	- To remove alarm condition. - Check the contactor resistance (300 Ω, 10 W). - Check the controller.
11	3E	TH. Protection	○	Warning : pump temperature higher than 75 °C.	- To remove warning cause.
12	41	Motor Temperat.	○	Warning : pump motor temperature high.	- To remove warning cause. - Check the motor temp-sensor.
13	42	Battery Low	○	Warning : battery charge level below 10%.	- To remove warning cause.
14	4A	Driver Shorted	○	Alarm : line contactor coil driver is shorted.	- If the alarm is present in Init status, remove the alarm cause. - If the alarm has occurred in stby or running mode, it is necessary to remove alarm cause and to activate pump request.
15	4B	Contactor Driver	○	Alarm : line contactor coil driver is open (not able to drive the coil to the correct voltage).	- To remove alarm cause and to activate pump request.
16	4E	VACC Not OK		Warning : lift signal (CPOT) voltage higher than VACC MIN+1V while the lift enable switch is open.	- To remove warning cause. - Re-configurate VASS ACCEL.
17	4F	Incorrect Start	○	Warning : wrong pump request sequence.	- To remove warning cause.
18	50	Forw + Back	○	Warning : forward and reverse inputs are both active.	- To remove warning cause.
19	52	Encoder Error	○	Alarm : motor speed sensor (encoder) does not work properly.	- To recycle the key. - Check the motor encoder.
20	B6	Fork Sens. Outrng	○	Warning : value of fork sensor (AUTO TILT LEVELING) is out of range.	- Check the fork sensor if AUTO TILT LEVELING option. - Re-configurate firk sensor of AUTO TILT LEVELING option.
21	B7	Fork Sensor Lock	○	Warning : value of fork sensor (AUTO TILT LEVELING) is fixed even tilt request is activated.	- Check the fork sensor if AUTO TILT LEVELING option. - Re-configurate firk sensor of AUTO TILT LEVELING option.
22	B8	Fork Wrong Dir.	○	Warning : direction of "AUTO TILT LEVELING" movement is not correct.	- Check if operator operates truck correctly. - Check the tilt sensor of fork leveling option. - Re-configurate tilt sensor of fork leveling option.

No	Code	Alarm name	Pump	Description	
				Cause	Troubleshooting
23	BB	Aux2 Out Of Rng.	○	Warning : voltage value of AUX2 sensor is out of range.	- Re-configurate the AUX2 lever. - Check the AUX2 lever.
24	BC	AUX1 Out Of Rng.	○	Warning : voltage value of AUX1 sensor is out of range.	- Re-configurate the AUX1 lever. - Check the AUX1 lever.
25	BD	Tilt Out Of RNG.	○	Warning : voltage value of TILT sensor is out of range.	- Re-configurate the TILT lever. - Check the TILT lever.
26	BE	Lift Out Of RNG.	○	Warning : voltage value of LIFT sensor is out of range.	- Re-configurate the LIFT lever. - Check the LIFT lever.
27	BF	Acquire Aux2	○	Warning : controller is configuration "AUX2" lever function.	- Finish the configuration process.
28	C0	Acquire Aux1	○	Warning : controller is configuration "AUX1" lever function.	- Finish the configuration process.
29	C1	Acquire Tilt	○	Warning : controller is configuration "TILT" lever function.	- Finish the configuration process.
30	D2	Load Sens. Error	○	Alarm : load weight sensor detects that loaded weight exceeds the weight limitation or load weight sensor is not wirking properly.	- To remove alarm cause. - Check the load weight sensor.
31	D3	Overload	○	Warning : load weight sensor detects that loaded weight exceeds the weight limited in OVERLOAD WEIGHT programming.	- To remove warning cause.
32	D5	Motor Shutdown	○	Alarm : motor temperature is greater than the parameter " MOTOR SHUTDOWN ".	Leave the truck at rest to allow the temperature to decrease.
33	D8	Model Mismatch	○	Alarm : parameter "TRUCK MODEL SEL." is being modified.	- Key off and on controller.
34	D9	Joystick Error	○	Joystick is in alarm.	- Check joystick alarm.
35	DA	Torque Profile	○	Parameter regarding the torque are not corrected.	- Perform clear EEPROM command.
36	DB	IQ Mismatched	○	Torque current doesn't follow the set point.	- Change the controller.

No	Code	Alarm name	Pump	Description	
				Cause	Troubleshooting
37	DE	Waiting For NODE	○	Warning : pump controller signals that other controllers are in alarm status.	- To recycle the key. - Check if any other alarm happens (Some alarms such as CHAT TIME or PEDAL WIRE KO, alarms related to CONTACTOR, DISPALY ENABLE, alarms reated 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 available, H/W ver, S/W ver will be blank.)
38	DF	Watchdog #1	○	Alarm : the watchdog signal #1 is not in the correct status.	- To remove alarm cause.
39	E0	AUX Coil Short	○	Alarm : shortcircuit on EB/ AUX coil.	- To remove alarm cause.
40	E2	CAN BUS KO SASA		sasa sensor CAN BUS data are not receive	- Check can connection between pump controller and sasa sensor.
41	E3	Watchdog#2	○	Alarm : the watchdog signal #2 is not in the correct status.	- To remove alarm cause.
42	E5	Safety Input	○	Alarm : the safety input is open (it is not connected to –Batt).	- To remove alarm cause.
43	E6	MC Coil Short	○	Alarm : shortcircuit on MC coil.	- To remove alarm cause.
44	E7	Coil Short HW KO	○	Alarm : the harware to check a MC or EB/AUX coil shorted is damaged.	- Check the controller.
45	E8	Key Off Short	○	Alarm : at start-up the keyoff logic signal is low.	- Check the connection. - Check the key input signal.
46	E9	Power MOS Short	○	Alarm : short circuit on the power Mosfets.	- Check the controller.
47	EB	Handbrake	○	Warning : handbrake microswitch is open and a travel request is active.	- To remove warning cause.
48	EC	Curremt Gain	○	Warning : the maximum current gain parameters are the default values, which means the maximum current adjustment procedure has not been carried out yet.	- Ask the assistance of an engineer at the development department to do the correct adjustment procedure of the current gain parameters.
49	ED	Analog Input	○	Alarm : the analog channel ready is not updated.	- Check the controller.

No	Code	Alarm name	Pump	Description	
				Cause	Troubleshooting
50	EE	Wrong 0 Voltage	○	Alarm : the motor phases voltage feedback are out of permitted range.	- To remove alarm cause.
51	EF	Safety Output	○	Alarm : the safety-out driver is damaged (shorted or open).	- To remove alarm cause.
52	F0	Hardware Fault	○	Alarm : the mosfets driver are not switched off with watch-dog signal in alarm status.	- Check the controller.
53	F1	Flash Checksum	○	Alarm : the program verify is not OK.	- Try to program the controller again. - Check the controller logic board.
54	F2	Encoder Locked	○	Warning : the encoder signal is constantly zero when the maximum torque is applied to the motor.	- To recycle the key. - Check the motor and encoder.
55	F3	Sens Mot Temp KO		Warning : the output of the motor thermal sensor is out of range.	- To remove warning cause.
56	F4	Software Error	○	Alarm : CANBUS line of ACE2 is in CANBUS line OFF condition.	- Check CANBUS connection. If CANBUS connection is OK, replace the logic of ACE2.
57	F5	Wrong RAM memory	○	Alarm : the algorithm implemented to check the main RAM registers finds a wrong contents: the register is "dirty". This alarm inhibit the machine operations.	- Try to switch the key off and then on. If the alarm is still present, replace the ACE2 logic board.
58	F6	AUX Driv. Open	○	Alarm : the AUX coil driver is not able to drive the load. The device itself or its driving circuit is damaged.	- This type of fault is not related to external components; replace the ACE2 logic board.
59	F7	Data Acquisition	○	Alarm : data communication is now processing.	- If this alarm occurs, when sensor setting procedure, recycle the key.
60	F8	NO CAN MSG.	○	Alarm : has lost CAN communication with #X.	- To remove alarm cause. - Check if any other alarm happens (some alarms such as CHAT TIME or PEDAL WIRE KO, alarms related to CONTACTOR, DISPLAY ENABLE, alarms related to CANBUS can make this alarm sometimes.) - Check the communication with all controllers.
61	F9	Check Up Needed	○	Warning : truck reached the hour time for maintenance.	- Reset the checkup hour time.
62	FA	Thermic Sens. KO	○	Warning : pump temp. sensor is out of range.	- To remove warning cause.

No	Code	Alarm name	Pump	Description	
				Cause	Troubleshooting
63	FB	Wrong Set BAT.	○	Alarm : the battery voltage does not correspond to SET BATTERY programming.	- To remove alarm cause.
65	FD	Foc Lost	○	Field current doesn't follow the set point.	- Change the controller.
66	FE	AUX Driv. Shrt.	○	Alarm : the EB/AUX driver is shorted so it is not able to open the contactor.	- Check the controller.

3) DIAGNOSTIC FAULT CODES OF MHYRIO

No	Code	Alarm name	Description
1	8	WATCHDOG	The test is made in both running and standby. It is a self-diagnosing test within the logic. If an alarm should occur, replace the logic.
2	13	EEPROM KO	Fault in the area of memory in which the adjustment parameters are stored; this alarm inhibits machine operation. If the defect persists when the key is switched OFF and ON again, replace the logic. If the alarm disappears, remember that the parameters stored previously have been cancelled and replaced by the default values.
3	227	SLAVE COM. ERROR	Main uC and Slave uC communicate via a local serial interface. This alarm occurs when the main uC does not receive the communication from the slave uC through this serial interface. It is necessary to replace the controller.
4	228	"EVPG1 DRIV SHORT"	One of the Group 1 valves drivers is shorted; check the external connection, if it is ok the driver is probably damaged.
5	229	"EVPG2 DRIV SHORT"	One of the Group 2 valves drivers is shorted; check the external connection, if it is ok the driver is probably damaged.
6	230	"EVPG3 DRIV SHORT"	One of the Group 3 valves drivers is shorted; check the external connection, if it is ok the driver is probably damaged.
7	231	"EVPG4 DRIV SHORT"	One of the Group 4 valves drivers is shorted; check the external connection, if it is ok the driver is probably damaged.
8	232	"EVP DRIVER SHORT"	One of the on/off valves driver is shorted; check the external connection, if it is ok the driver is probably damaged.
9	233	"EV DRIVER SHORT"	One of the on/off valves driver is shorted; check the external connection, if it is ok the driver is probably damaged.
10	239	"EVP5_ OPEN_DELAY"	EVP Coil line is interrupet
11	241	CAN BUS KO	There is a problem related to the CAN-BUS line. The error is signalled if the MHYRIO controller does not receive any message from the CAN-BUS line. First of all, check the wiring. If it is ok, the problem is on the logic board, which must be replaced.
12	242	COIL SHORTED	ON/OFF valves drivers are protected against coil short circuit; if a short is present across the coil, the flip-flop circuit is set and the alarm is signalled.
13	243	EV DRIVER KO	One of the On/Off valves drivers is open (it does not close when it is commanded by the microcontroller).
14	244	"EVPG1 DRIVER KO"	One of the Group 1 valves drivers is open (it does not close when it is commanded by the microcontroller).
15	245	"EVPG2 DRIVER KO"	One of the Group 2 valves drivers is open (it does not close when it is commanded by the microcontroller).
16	246	"EVPG3 DRIVER KO"	One of the Group 3 valves drivers is open (it does not close when it is commanded by the microcontroller).

No	Code	Alarm name	Description
17	247	"EVPG4 DRIVER KO"	One of the Group 4 valves drivers is open (it does not close when it is commanded by the microcontroller).
18	248	UNDER VOLTAGE	This fault is signalled if an undervoltage condition is detected in the MHYRIO power supply
19	249	"EVP DRIVER KO"	The single proportional valve driver is open (it does not close when it is commanded by the microcontroller).
20	250	"HI SIDE DRIVER KO"	The high side driver which supply the valves coils positive is shorted or open.
21	251	"WRONG SET BAT."	This fault is signalled if the battery voltage is non consistent with the set battery programmed in the 'set option' menu.
22	252	FF VALVES	Flip-flop circuit, that manages on/off valve drivers short-circuit protection, does not reset in the correct way. The problem is probably in the hardware circuit.

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.

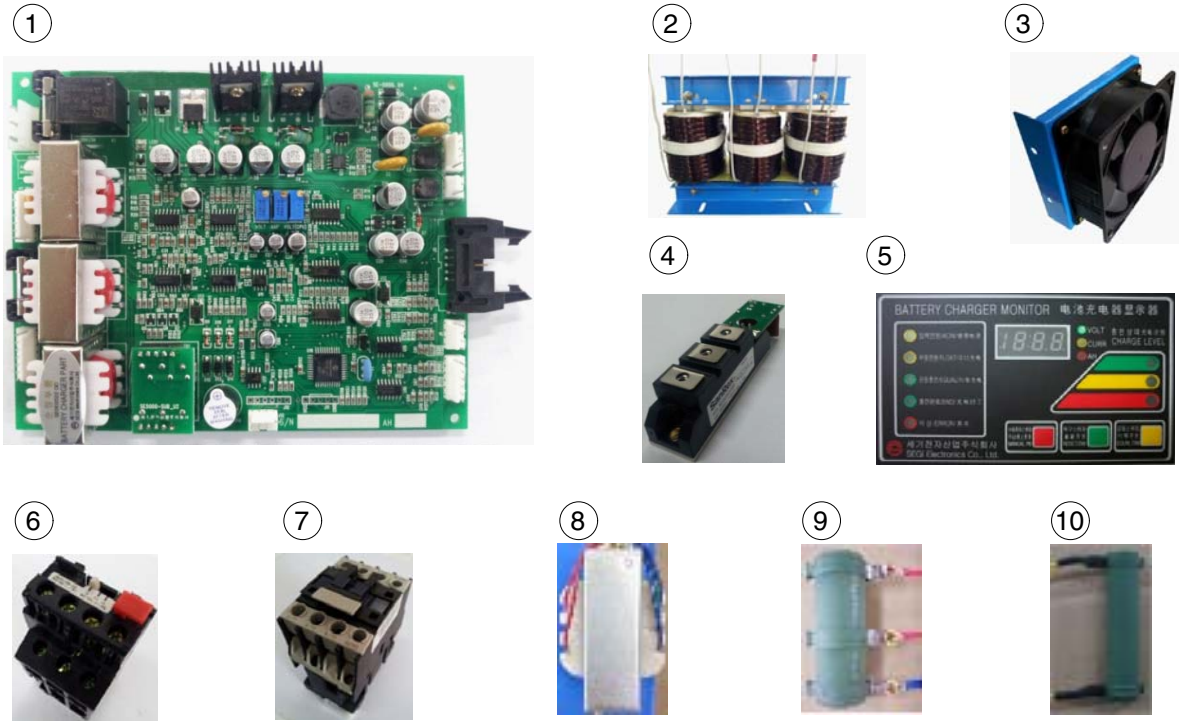
④ Check the electrolyte of the battery every week and provide distilled water immediately if it is required. (Electrolyte has to be provided between 10~12 ㎜ level on the positive plate inside storage battery)

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)
400-80 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.

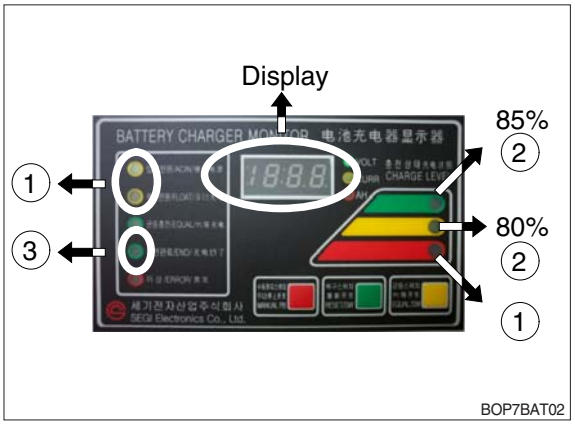
· **According to charging condition**

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.

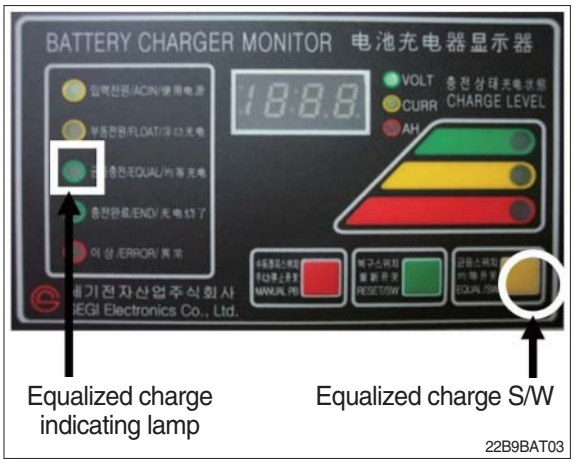
When equalized charging is required?

- 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.**



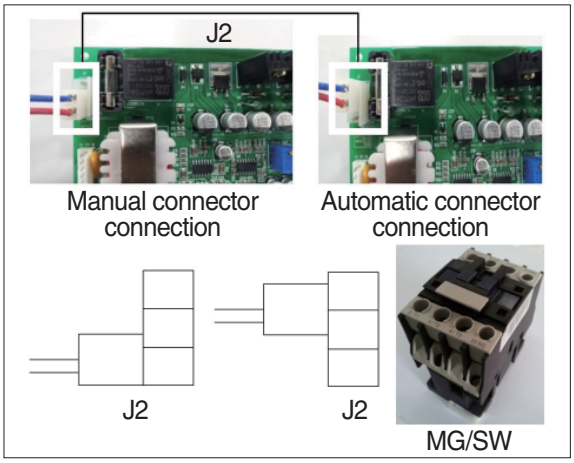
22B9BAT03

(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 7-102
3	O.C	Over current - Refer to page 7-101, 7-103.
4	F.B	Battery error (After starting charging, the voltage doesn't go over 52 V 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 220/380 V wrong wiring). - Refer to page 7-100.
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.

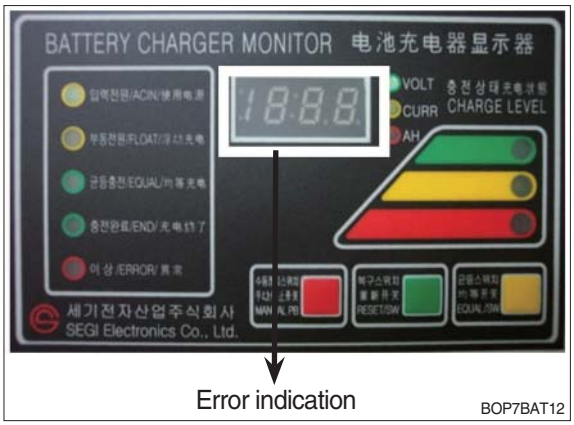
② A.O : Error on selection of input power source of 220V or 380V - Check it appropriately with full three phases.

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"

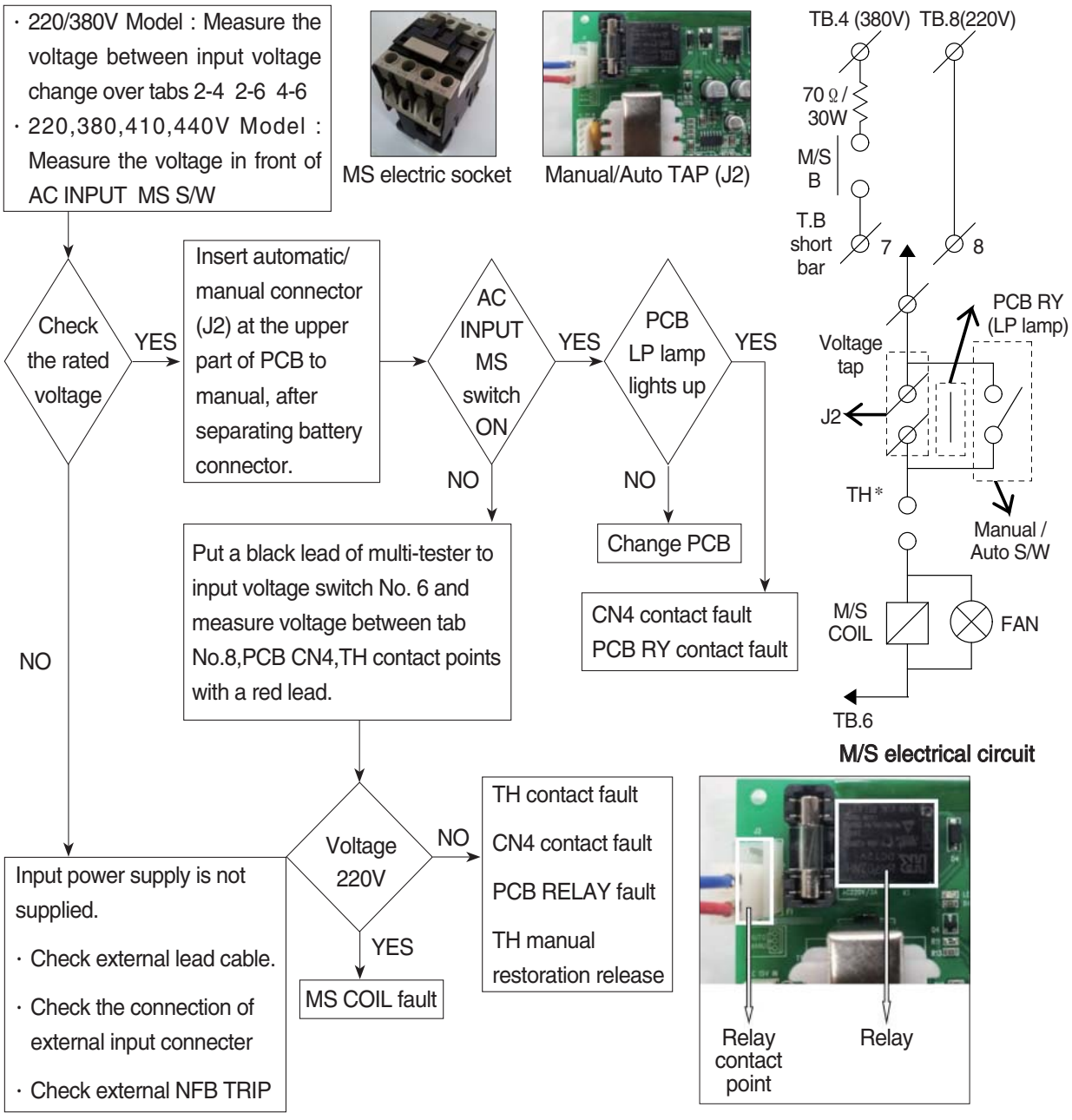
⑤ Charger TRIP is occurred after it started charging and charging completion lamp is on.

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

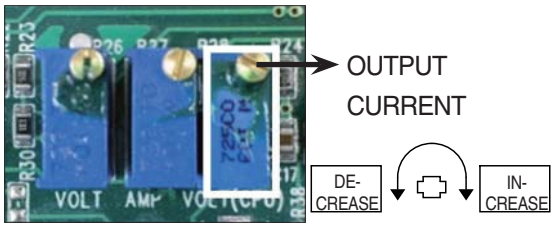
⑦ SCR module checking method

(2) Troubleshooting

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

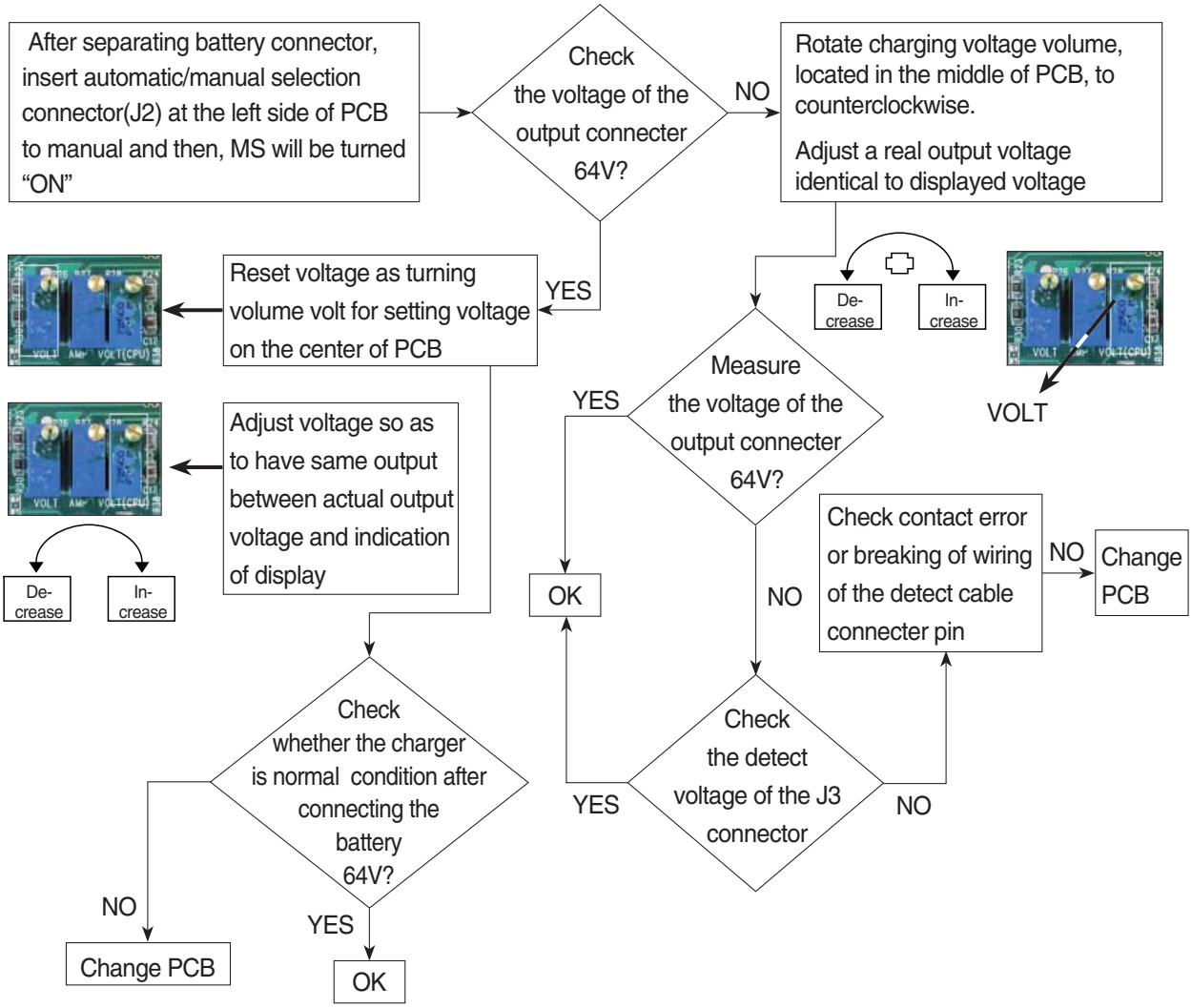


② ON and OFF is repeated with a few minutes intervals after starting charging.
Indicate "O.C" on the monitor.
- TH is operated (AC input over-current TRIP).

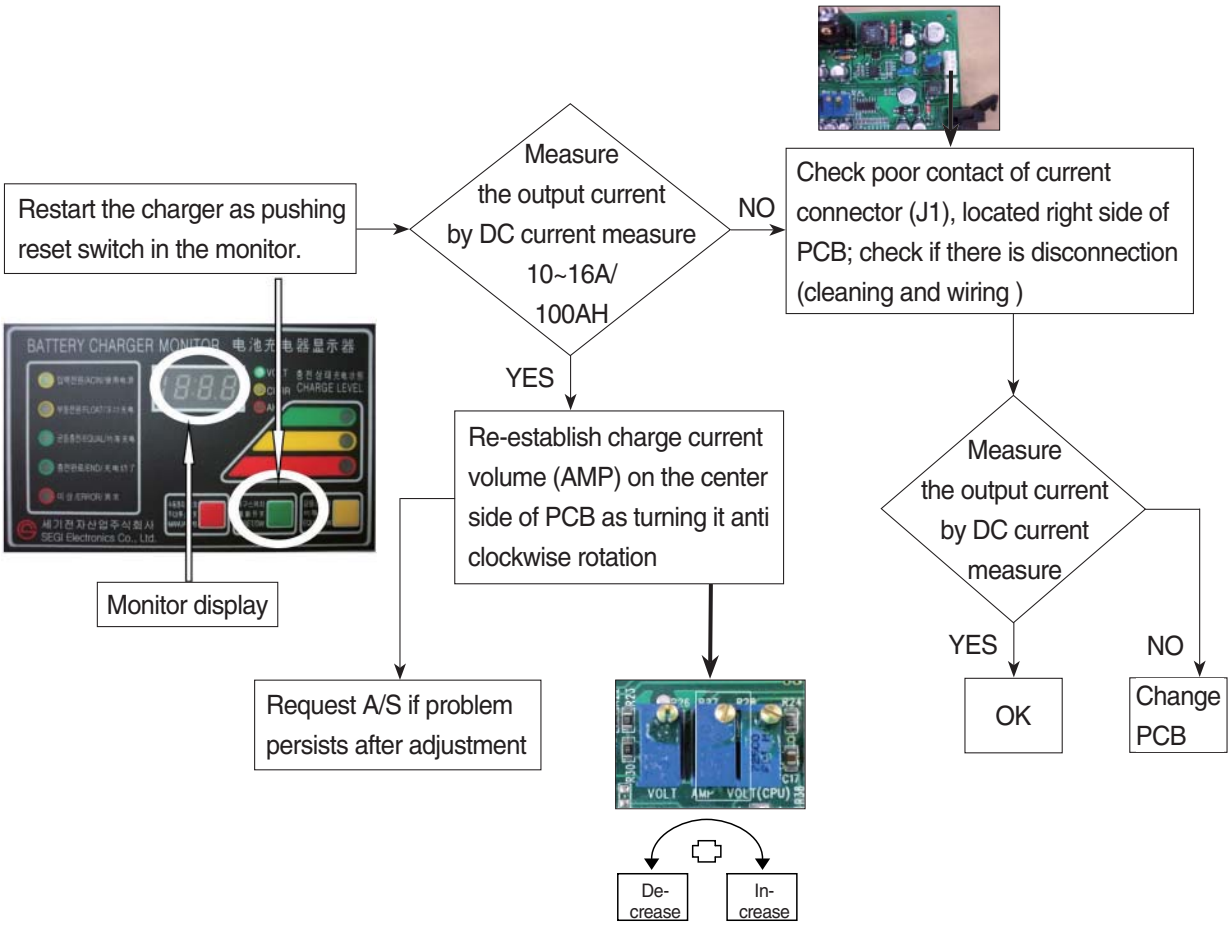


Trans noise is severe at MS ON status
NO
Measure output current using DC current measure
Current value : 10~16A /100AH
NO
Exceed Standard current
Adjust output current AMP, VR within PCB Re-adjust to VR
YES
· TH Setting fault
· Re-adjust TH setting value
TH. TRIP
YES
Change TH
NO
Complete
YES
* Refer to SCR Module checking method
Rated Current SETTING
YES
NO
Complete
Change PCB
Separate the battery connector and tune the charger off
Check SCR Module
NO
Change SCR MODULE
YES
Check MAIN TRANS VOLT
NO
Change PCB
Check the normal operating condition of the charger
YES

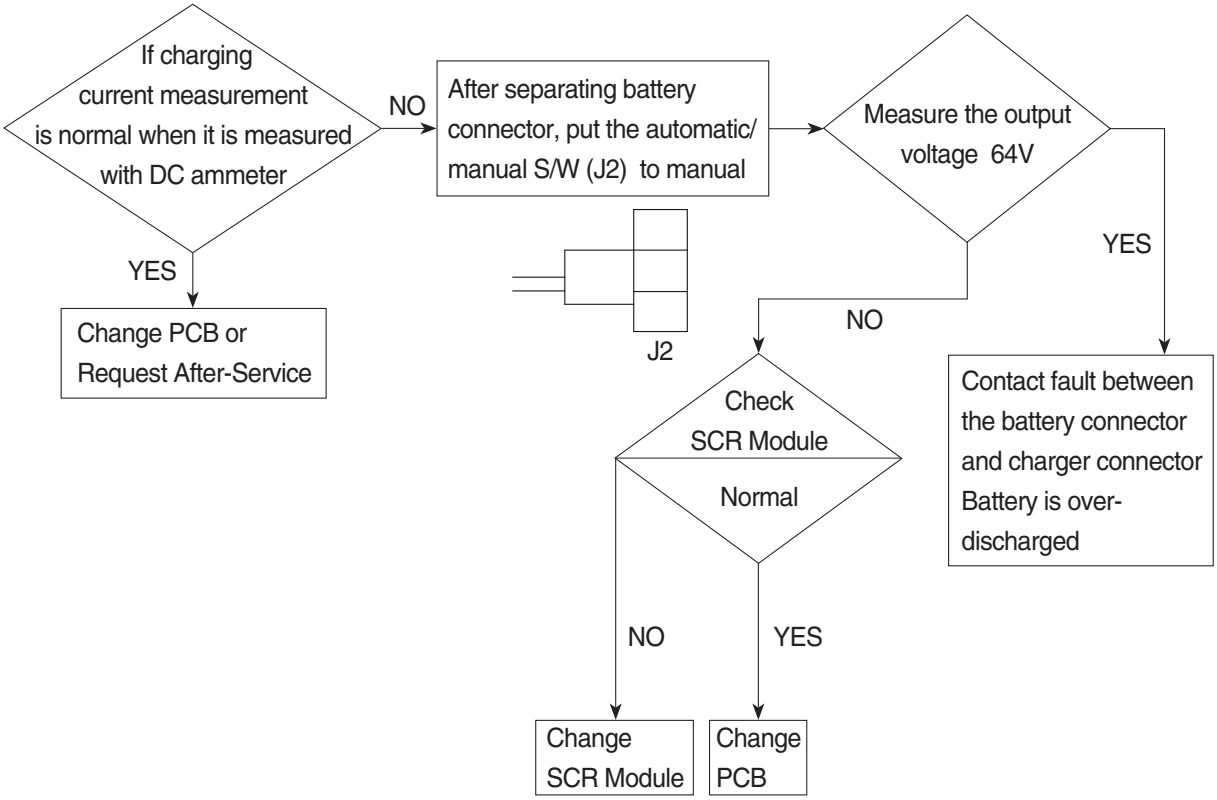
③ Charger TRIP is occurred after abnormality lamp is on.
In case error code is "O.V" → Over-voltage output / Set at 66V (In case of BATT 48V)
34V (In case of BATT 24V)
108V (In case of BATT 80V)



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.

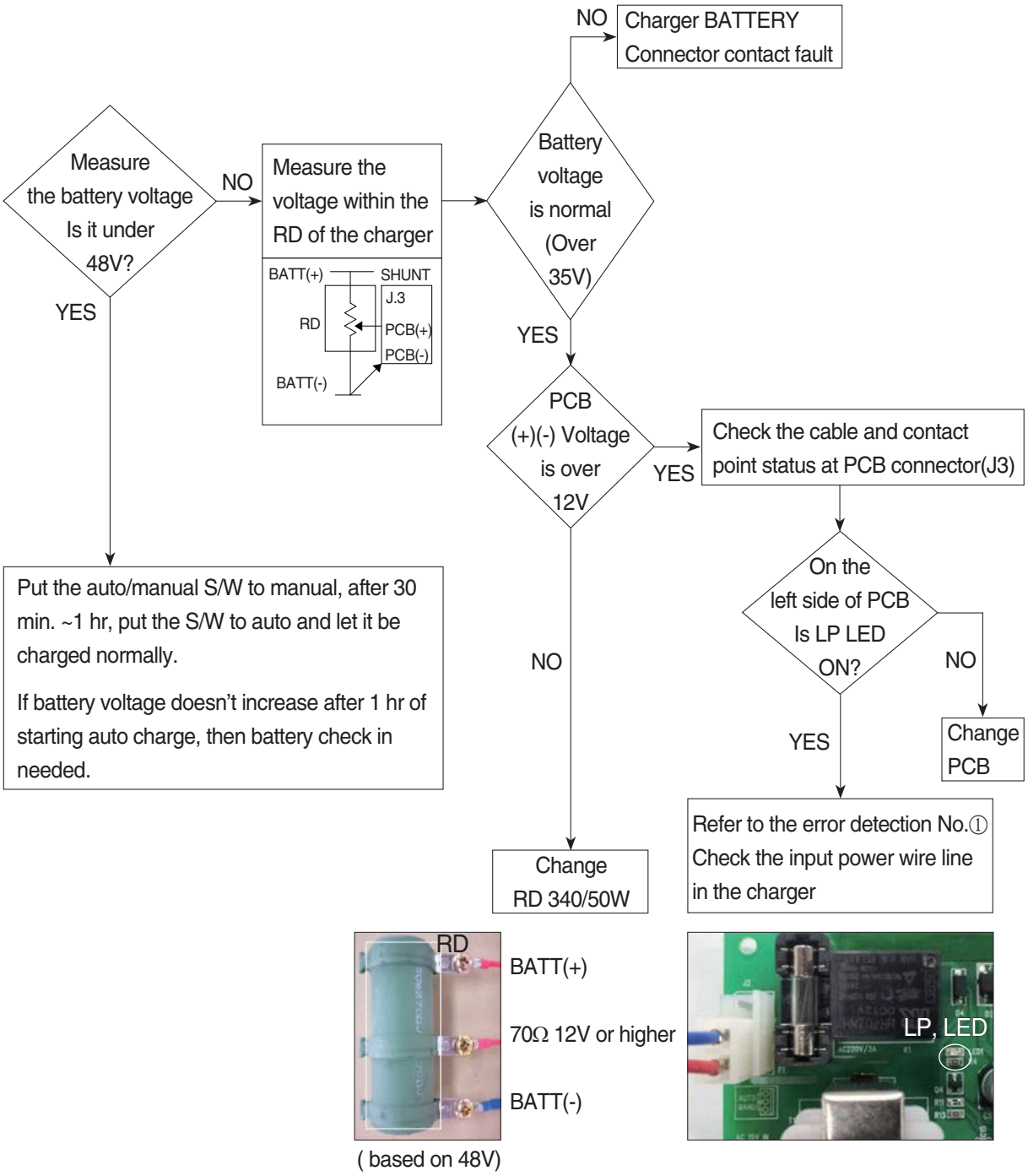


⑤ **Charger TRIP is occurred after it started charging and charging completion lamp is on.**
(In case input voltage is normal - Refer to the error detection No. 1)
Restore the charger as pushing reset switch.



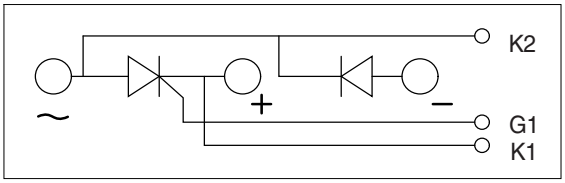
⑥ **Charger has no response even if the battery connector is connected.**

- 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)

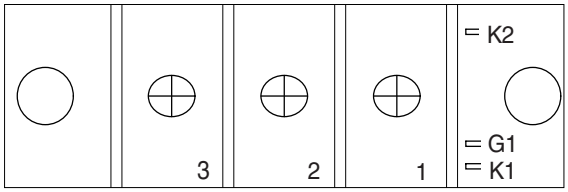


7) HOW TO CHECK THE SCR MODULE

Circuit

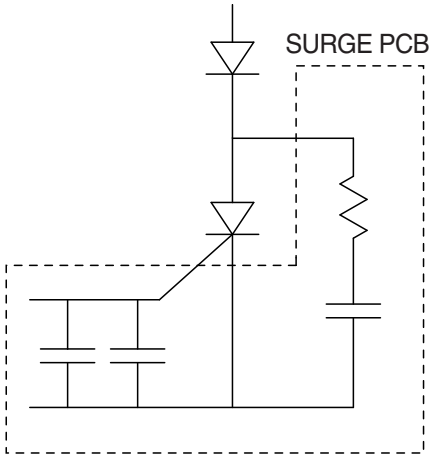


Real diagram

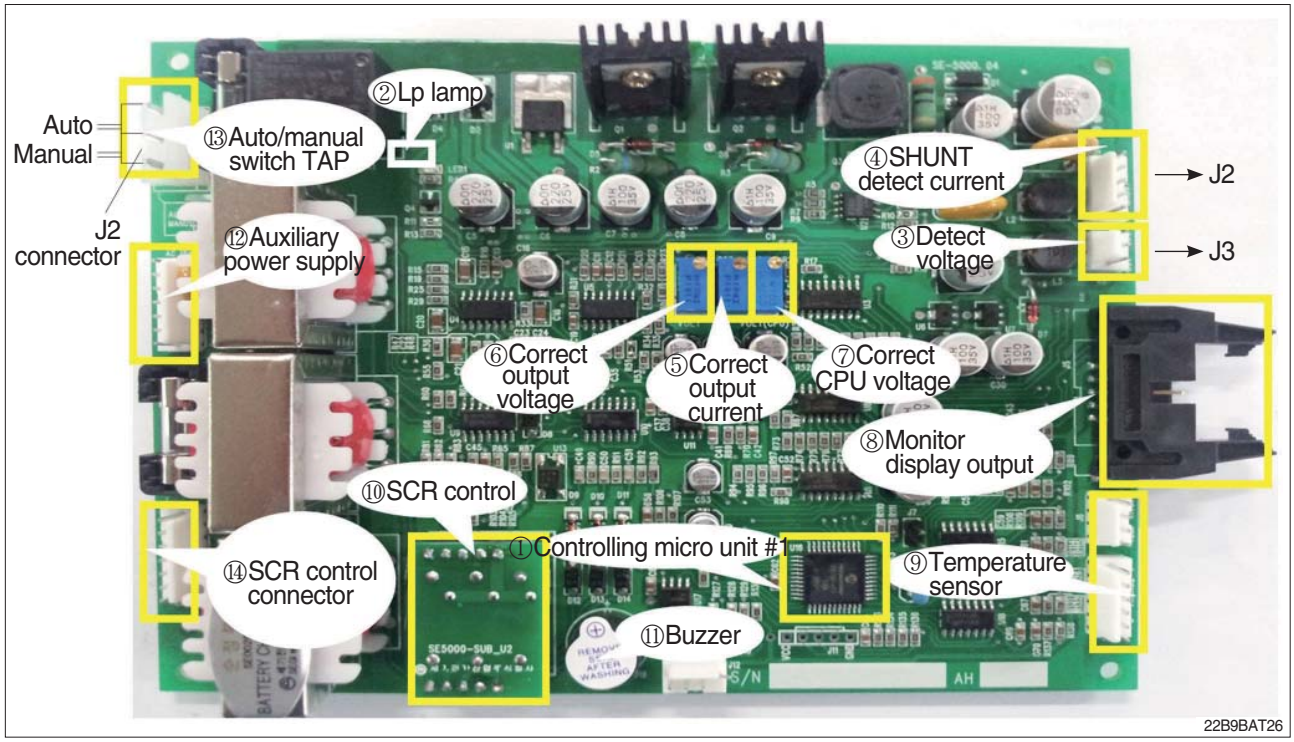


* Before checking SCR MODULE, be sure to disconnect bus bar and wire on the terminal.

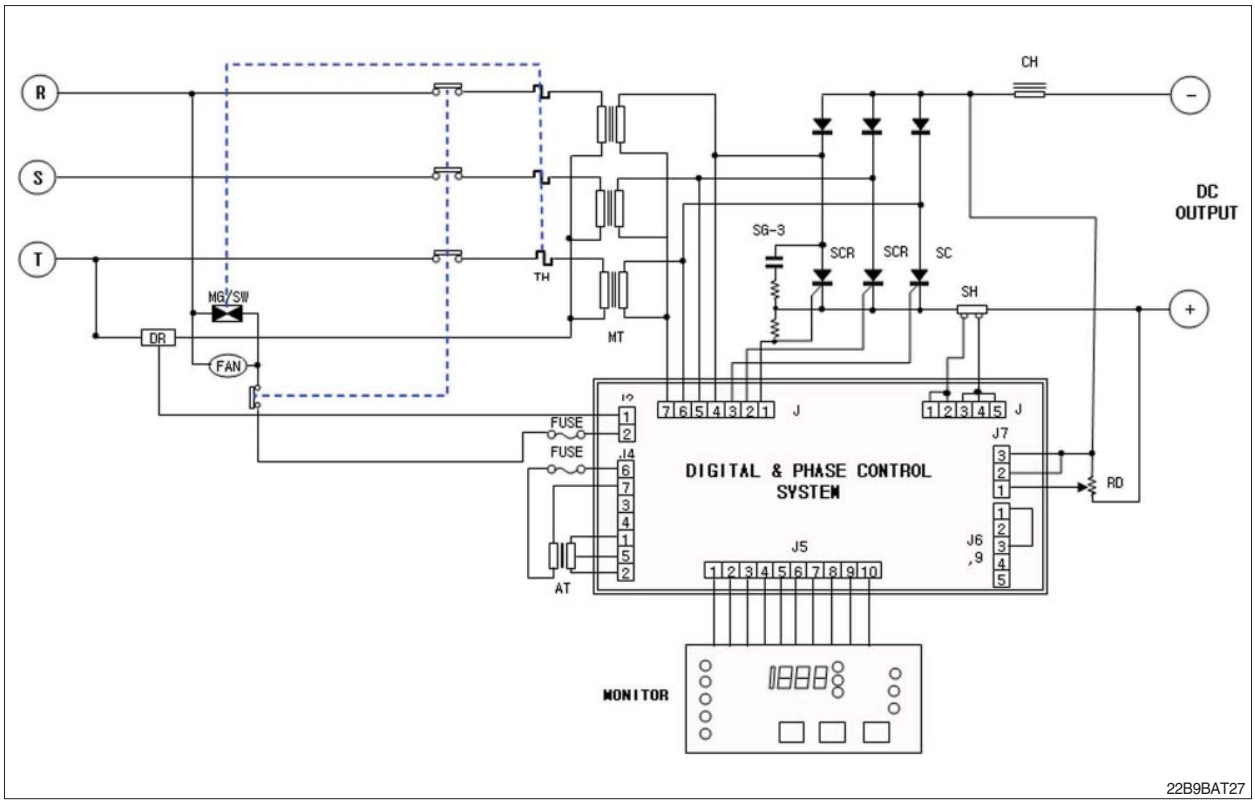
No.	Measuring point (Real diagram)	Measure value (Measurement of digital tester)
1	No.1 ~ No.3	Forward : Under 100 k ohm Reverse : Infinity (∞)
2	No.2 ~ No.3	Forward : Infinity (∞) Reverse : Infinity (∞)
3	G1 ~ K1	Forward : Under 100 ohm Reverse : Under 100 ohm But It depends on the module. If it is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



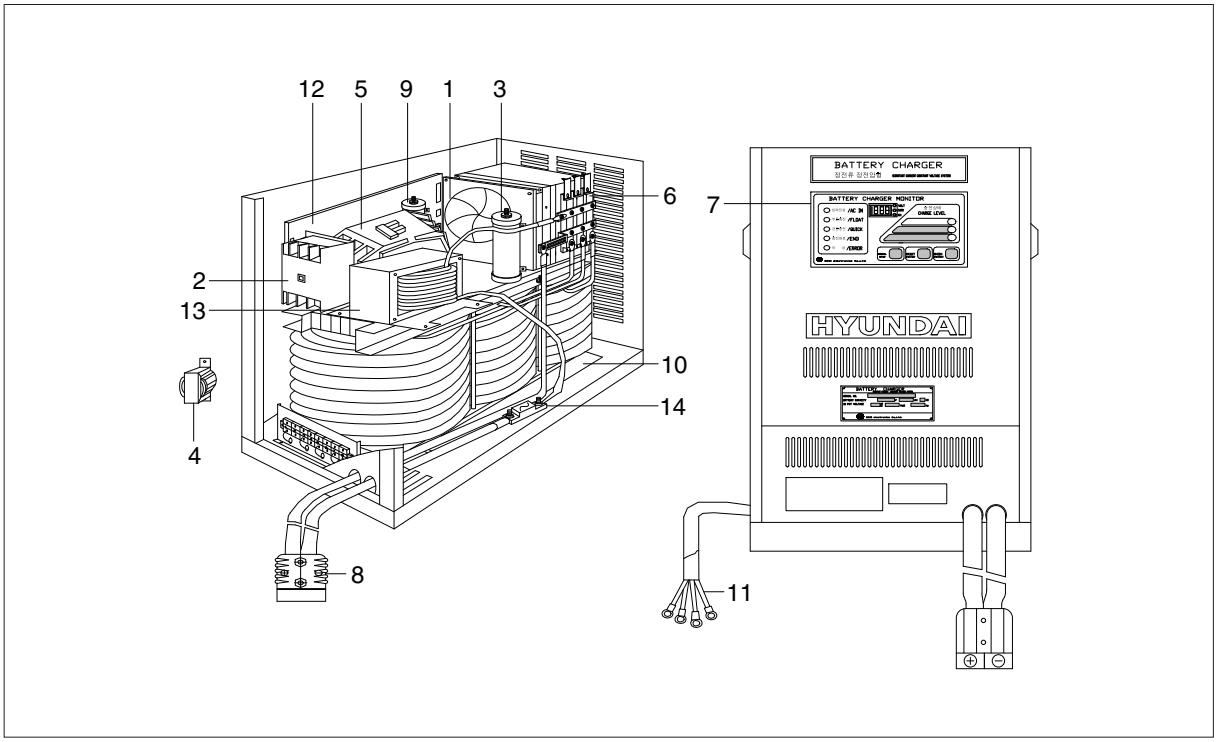
8) PCB MAJOR PARTS (NAME AND LOCATION)



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
J6
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	