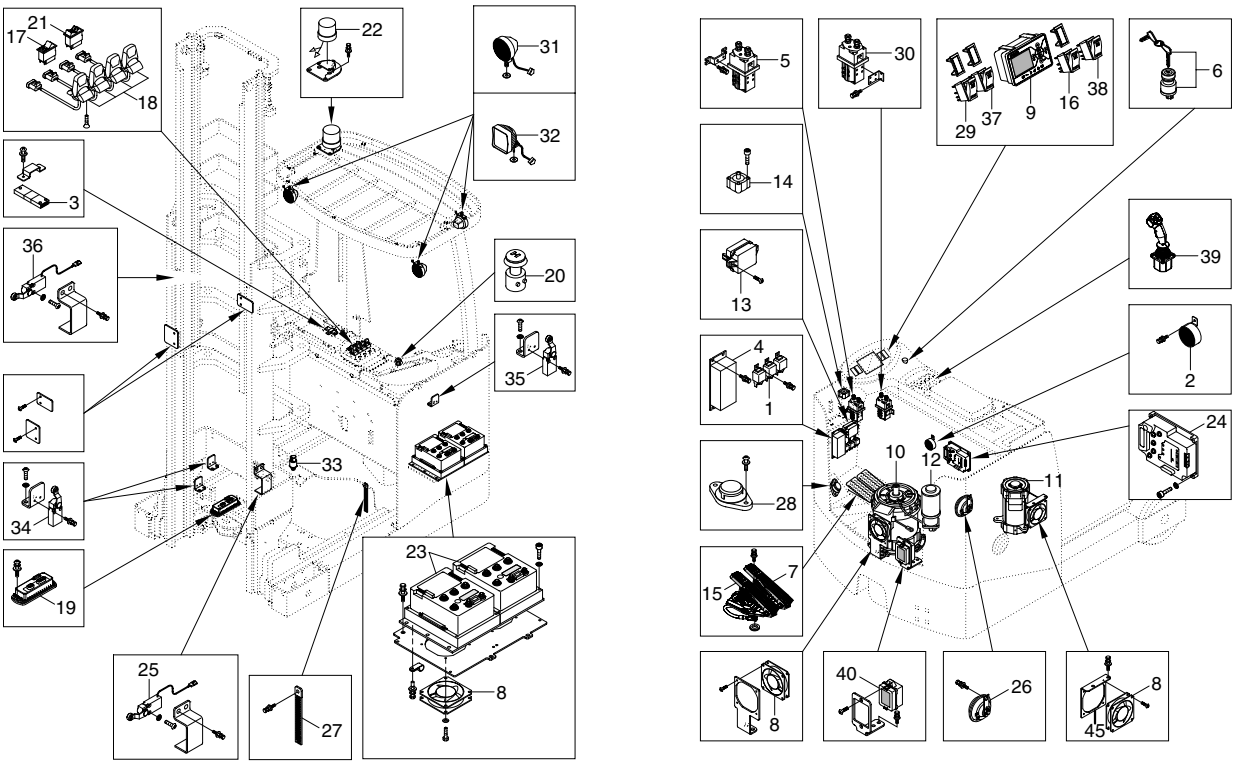
SECTION 7 ELECTRICAL SYSTEM

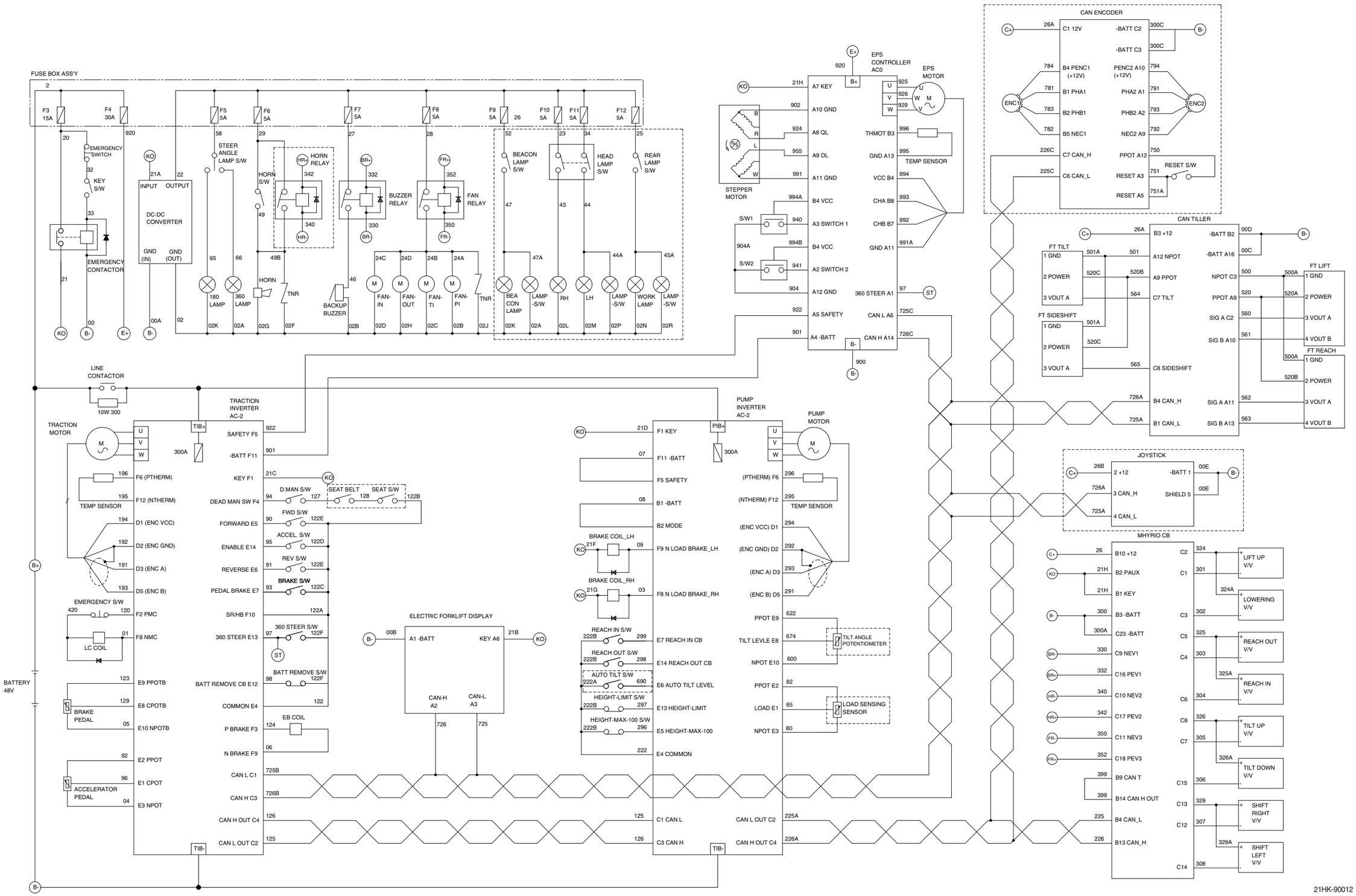
GROUP 1 COMPONENT LOCATION



14BRJ9EL01

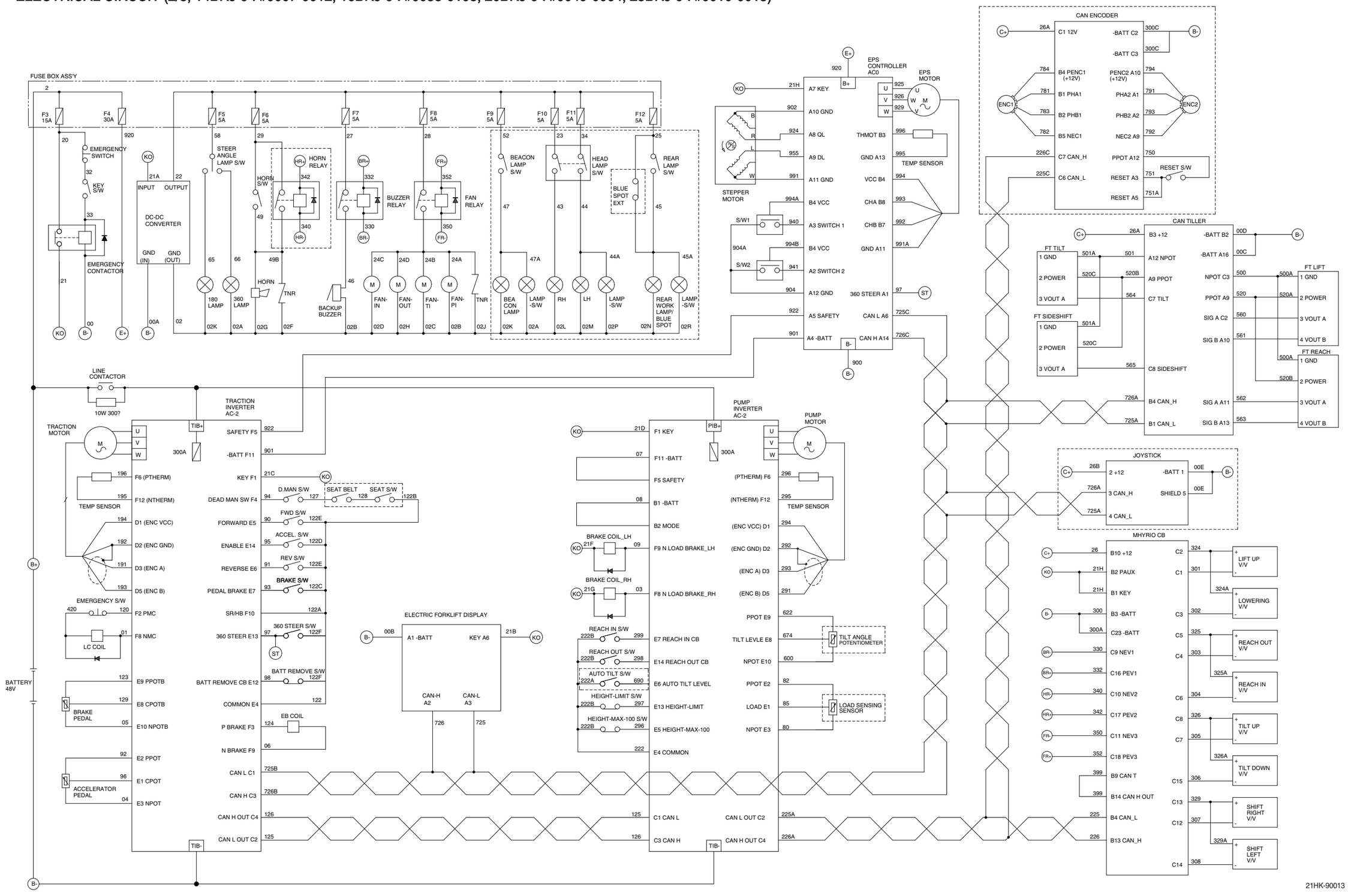
1	Relay	15	Brake pedal assy	29	Head lamp switch
2	Back buzzer	16	Beacon switch	30	Contactor
3	Can tiller card	17	Horn switch	31	Work lamp
4	DC converter	18	Fingertip lever	32	LED work lamp
5	Contactor	19	Fingertip controller	33	Pressure sensor
6	Key switch assy	20	Emergency switch	34	Reachin/reachout switch
7	Accelerator assy	21	Direction switch	35	Battery remove assy
8	Fan	22	Beacon lamp	36	Lift end switch
9	Display	23	Inverter	37	Rear work lamp switch
10	Traction motor	24	EPS control	38	Steer angle switch
11	Pump motor	25	Limit switch assy	39	Joystick
12	EPS motor	26	High horn	40	Fuse box assy
13	Fuse box assy	27	Static strap	45	Fan bracket
14	Stepping & gear motor	28	Seat switch	46	Limit switch guide bracket

· ELECTRICAL CIRCUIT (1/3, 14BRJ-9 : #0001-0006, 16BRJ-9 : #0001-0054, 20BRJ-9 : #0001-0048, 25BRJ-9 : #0001-0009)



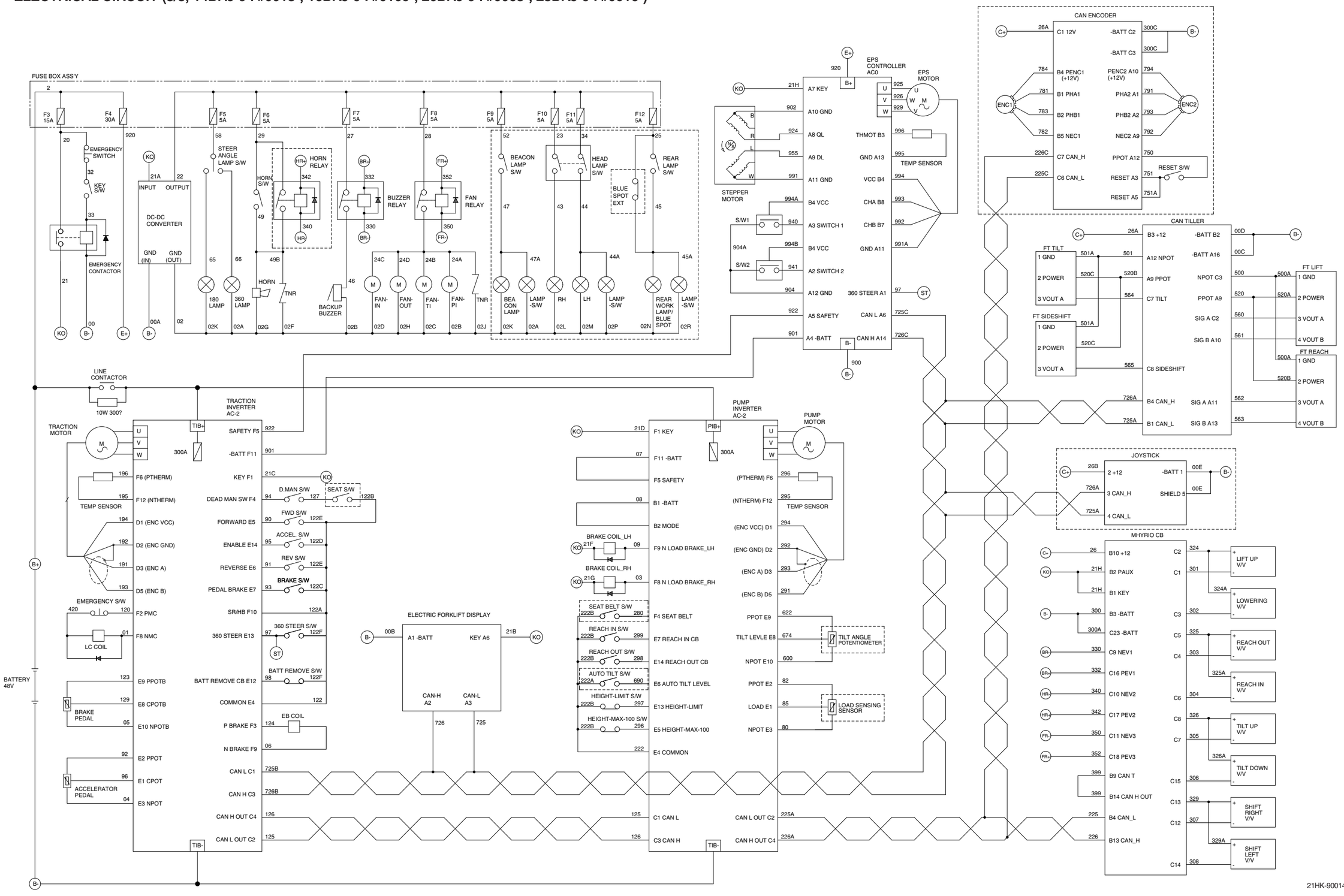
21HK-90012

· ELECTRICAL CIRCUIT (2/3, 14BRJ-9 : #0007-0012, 16BRJ-9 : #0055-0108, 20BRJ-9 : #0049-0064, 25BRJ-9 : #0010-0015)

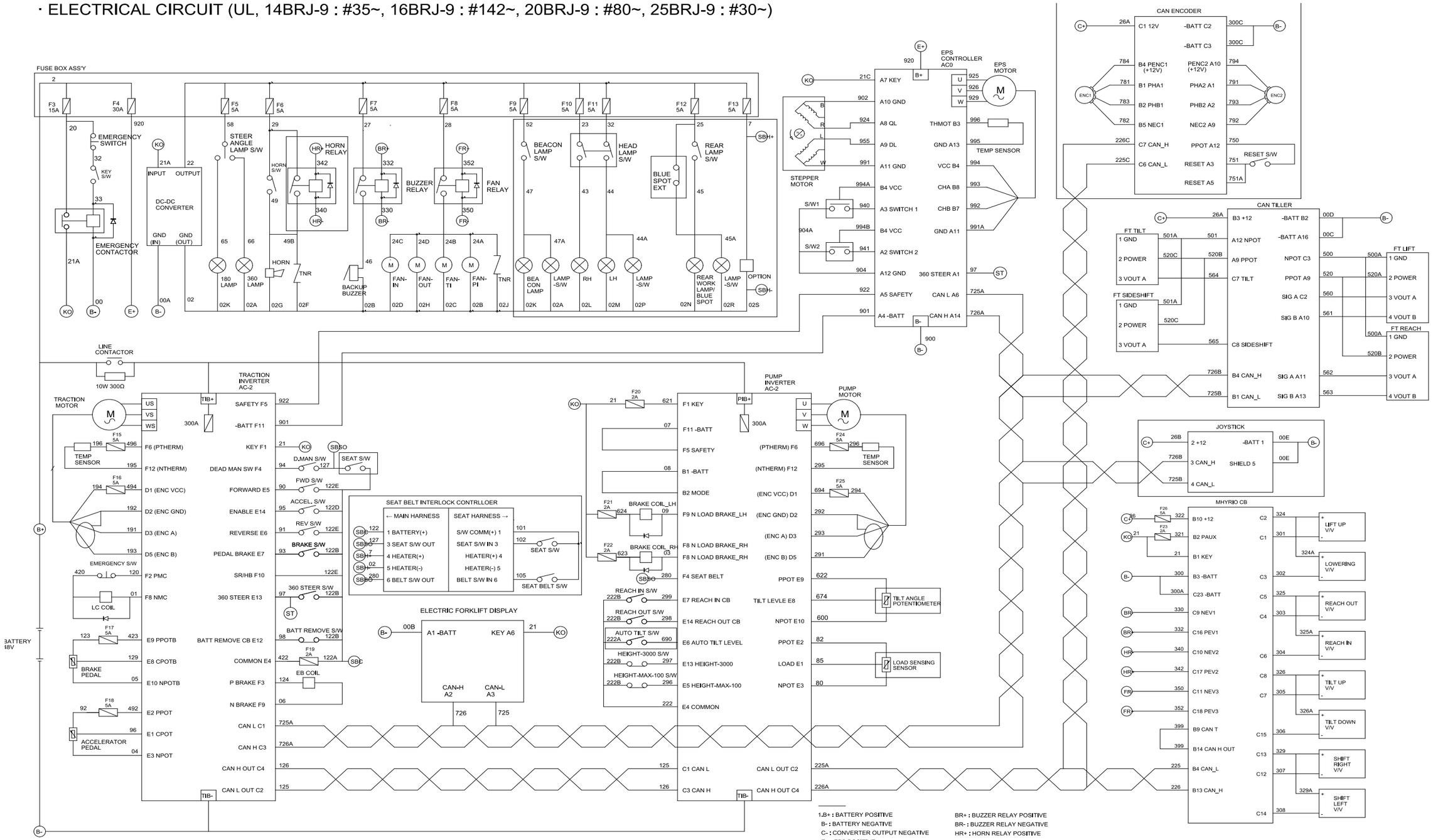


21HK-90013

· ELECTRICAL CIRCUIT (3/3, 14BRJ-9 : #0013-, 16BRJ-9 : #0109-, 20BRJ-9 : #0065-, 25BRJ-9 : #0016-)

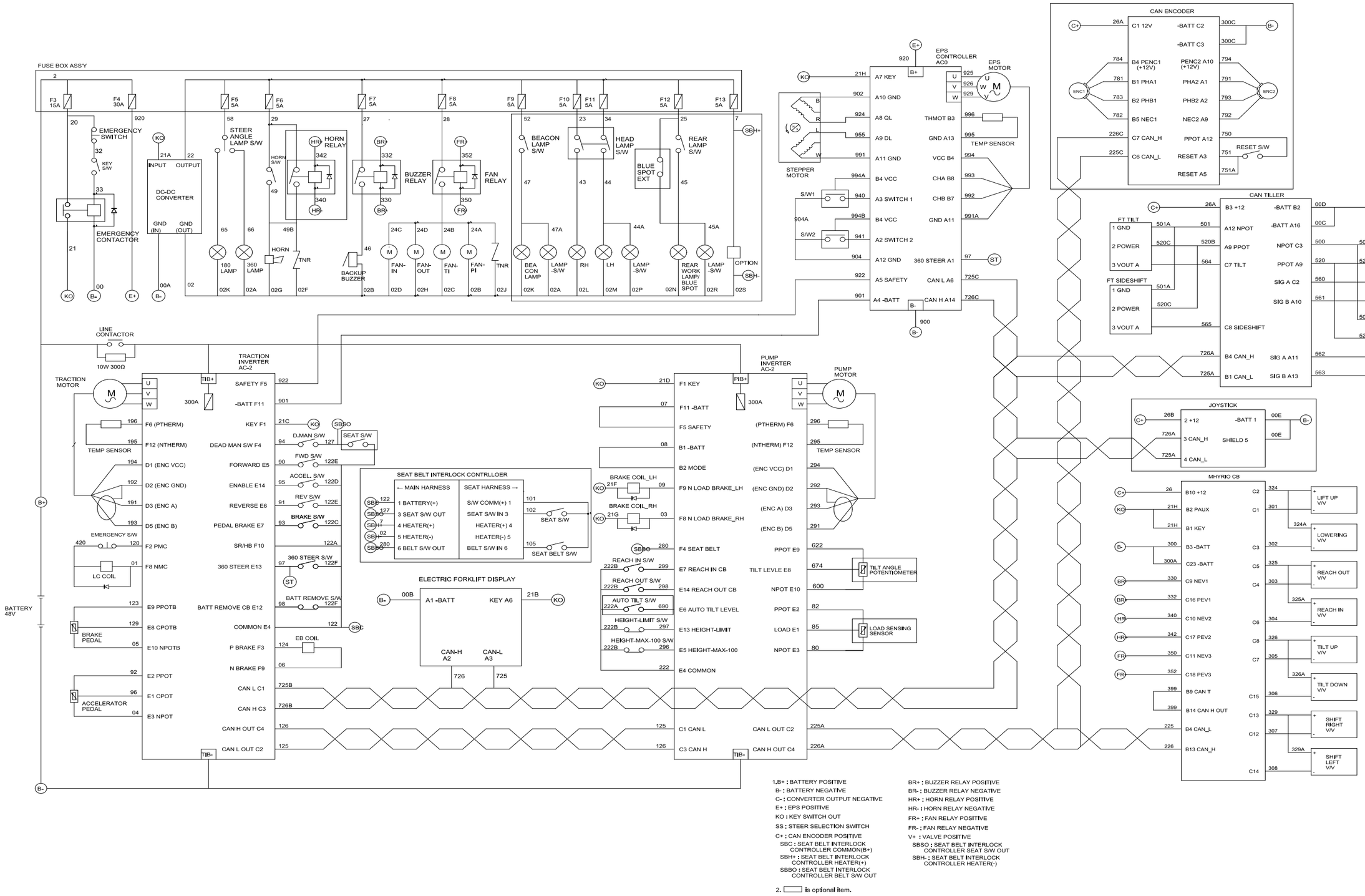


· ELECTRICAL CIRCUIT (UL, 14BRJ-9 : #35~, 16BRJ-9 : #142~, 20BRJ-9 : #80~, 25BRJ-9 : #30~)



1.B+ : BATTERY POSITIVE
B- : BATTERY NEGATIVE
C- : CONVERTER OUTPUT NEGATIVE
E+ : EPS POSITIVE
KO : KEY SWITCH OUT
SS : STEER SELECTION SWITCH
C+ : CAN ENCODER POSITIVE
SBC : SEAT BELT INTERLOCK CONTROLLER COMMON(B+)
SBH+ : SEAT BELT INTERLOCK CONTROLLER HEATER(+)
SBBO : SEAT BELT INTERLOCK CONTROLLER BELT S/W OUT
BR+ : BUZZER RELAY POSITIVE
BR- : BUZZER RELAY NEGATIVE
HR+ : HORN RELAY POSITIVE
HR- : HORN RELAY NEGATIVE
FR+ : FAN RELAY POSITIVE
FR- : FAN RELAY NEGATIVE
V+ : VALVE POSITIVE
SBSO : SEAT BELT INTERLOCK CONTROLLER SEAT S/W OUT
SBH- : SEAT BELT INTERLOCK CONTROLLER HEATER(-)
2. ▭ is optional item.
3. F3~F14 ARE CONTAINED IN FUSE BOX UL#1.
4. F15~F26 ARE CONTAINED IN FUSE BOX UL#2.

· ELECTRICAL CIRCUIT (NON-UL, 14BRJ-9 : #35~, 16BRJ-9 : #142~, 20BRJ-9 : #80~, 25BRJ-9 : #30~)



1,B+ : BATTERY POSITIVE
B- : BATTERY NEGATIVE
C- : CONVERTER OUTPUT NEGATIVE
E+ : EPS POSITIVE
KO : KEY SWITCH OUT
SS : STEER SELECTION SWITCH
C+ : CAN ENCODER POSITIVE
SBC : SEAT BELT INTERLOCK CONTROLLER COMMON(B+)
SBH+ : SEAT BELT INTERLOCK CONTROLLER HEATER(+)
SBBO : SEAT BELT INTERLOCK CONTROLLER BELT S/W OUT

BR+ : BUZZER RELAY POSITIVE
BR- : BUZZER RELAY NEGATIVE
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HR- : HORN RELAY NEGATIVE
FR+ : FAN RELAY POSITIVE
FR- : FAN RELAY NEGATIVE
V+ : VALVE POSITIVE
SBSO : SEAT BELT INTERLOCK CONTROLLER SEAT S/W OUT
SBH- : SEAT BELT INTERLOCK CONTROLLER HEATER(-)

2. ▭ is optional item.

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.

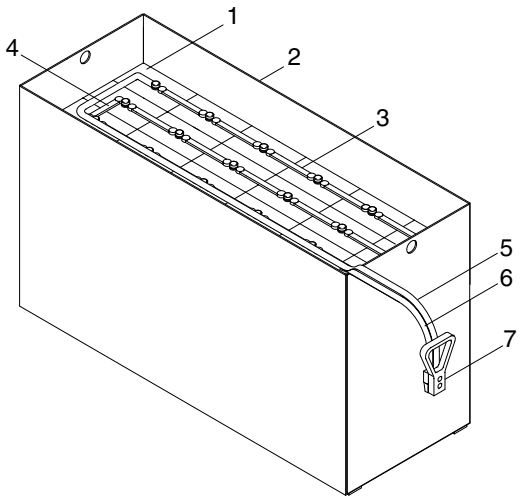
To drive the fork lift truck, a DRIVING CONTROL SYSTEM and some electric components such as direction change lever (forward/reverse section switch) and accelerator are required to select the driving direction and to control the speed of driving motor.

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

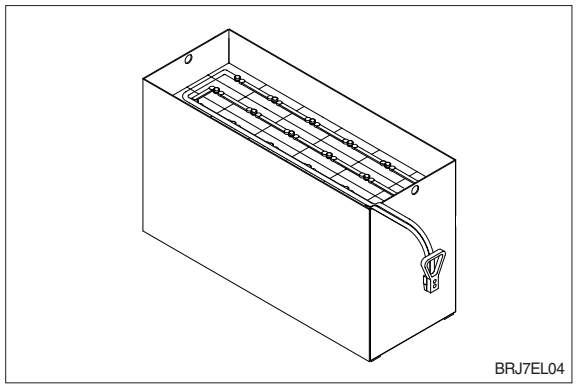


BRJ7EL03

1	Cells	7	Plug
2	Steel box	8	Spacer
3	Cell connector	9	Handle (Red)
4	Row connector	10	Screw
5	Positive leading cable	11	Spring washer
6	Negative leading cable		

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	14/16BRJ-9	20/25BRJ-9
Type	-	Lead Acid	
Rated voltage	V	48	
Capacity	AH/hr	420 (*560)	560 (*700)
Electrolyte	-	WET	
Dimension (W × D × H)	mm	1223 × 283 (*353) × 787	1223 × 353 (*425) × 787
Connector (CE spec)	-	SBE320	
Weight	kg	750 (*940)	940 (*1120)

* : Option

Fully charged specific gravity	1.280 (25°C)
End of discharge specific gravity	1.130 (25°C)
Discharge end voltage	48V
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 1.5V.

(2) Avoid over-charge

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

(3) Avoid excessive elevation of temperature

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

6) INSTRUCTION

(1) Unpacking

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

(2) Performance and maintenance of batteries

① Initial charge

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

a. By modified constant voltage charger

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

b. By constant voltage constant current charger

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

c. By constant current charger

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

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

② Discharge and capacity

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

That is, the capacity is indicated by AH (ampere hour) being calculated as the product of ampere (A) and time (H). However, even in the same type of batteries, the capacity varies with the discharge conditions (discharge current, battery temperature and specific gravity of electrolyte) Even if the batteries discharged its full capacity, if immediately charged to full, there will be no harmful effects remained. Ideal charging amount (AH) is 110-125% of the amount of previous discharge.

③ Specific gravity of electrolyte

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

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

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

S_t : Actually measured specific gravity at t °C

t : Electrolyte temperature (°C)

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

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

④ **Normal charge**

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

a. Charging by modified constant voltage automatic charger

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

b. Charging by constant current constant voltage automatic charger

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

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

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

⑤ **Equalizing charge**

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

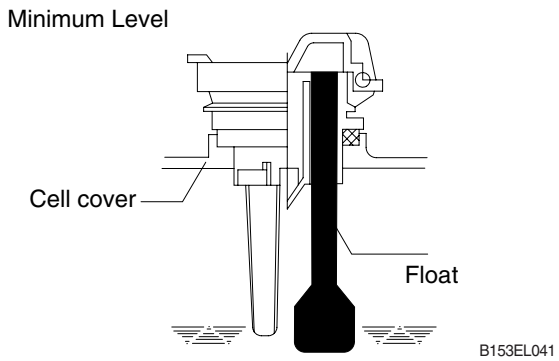
⑥ **Water replenishment**

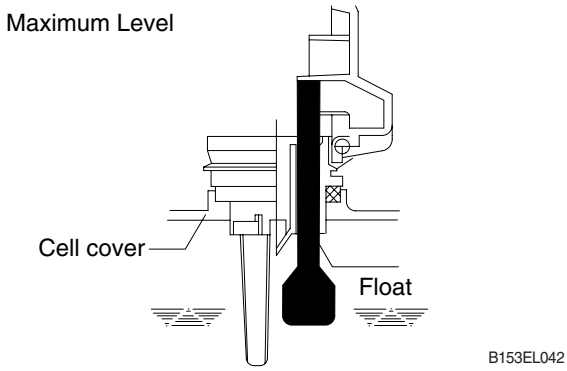
Only the water content of electrolyte is decreased due to electrolysis of water during charge and natural evaporation. If a battery used with the electrolyte decreased excessively, plates will deteriorate resulting in markedly shortening of battery life. Be sure to check the electrolyte level once every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

(for the purpose of uniform stirring of electrolyte by charging). If the electrolyte level is improper after completion of charging, you may topping up the electrolyte level to the maximum level .

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

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





⑦ Cleaning

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

⑧ Notice on charging

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

⑨ Repair of failure cell

a. To remove a cell from the circuit or battery from steel tray, it is first necessary that the intercell connector be removed.
b. Before performing any repairs, you must open one-touch caps for gas purging of all cells. After you have finished that, must remove connector covers and on-touch caps from failure cell including surrounding cells. All vent holes of cells removed of one-touch caps must cover by four layers of water dampened cloth and then proceed with repairs. Using an acid syringe withdraw sufficient electrolyte from failure cell to reduce the liquid levels until minimum level indicating of one touch caps.
c. The safe and most efficient method of removing a connector is with hand or electric drill (ø 25 ㎜) from failure cell as well as all surrounding cells.

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

d. Upon completion of drilling the intercell connectors, can be lifted off.
e. Lifted off the failure cell from circuit after removing of intercell connector.
f. Installing new cell and connector.
g. With surfaces properly cleaned and neutralized, position the connectors.
h. Place damp rags around each lead head. Hold tip of the welder in center of post move welder completely around top of post and out to the area where the post meets the connector. Move welder back to center of post and add molten lead until area is filled to top of connector. Again, move welder completely around area, with tip on molten lead. If you have jig for welding connector, have easier and better welding work.
i. When replacing electrolyte in a repaired cell, use sulphuric acid of the same specific gravity that is found in the balance of the battery.
j. Finally, rejoin connector covers and one-touch caps to the cells.

⑩ **Summary of daily maintenance**

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

(3) Others

① **Storage of batteries**

When batteries are stored, keep them distant from room heaters or other heat generating sources. Clean, cool and dry place where no direct sunlight is directed is suited for battery storage. Before putting into storage, it is important to charge the batteries and keep the electrolyte level at the specified level. When the temperature in storage location is higher than 20°C, check the specific gravity once a month, and when lower than 20°C, check it once every two months. If the measurements show values lower than 1.230 (20°C), it is required to charge the battery in accordance with the method described in NORMAL CHARGE.

② **Maintenance record**

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

③ **Electrolyte temperature**

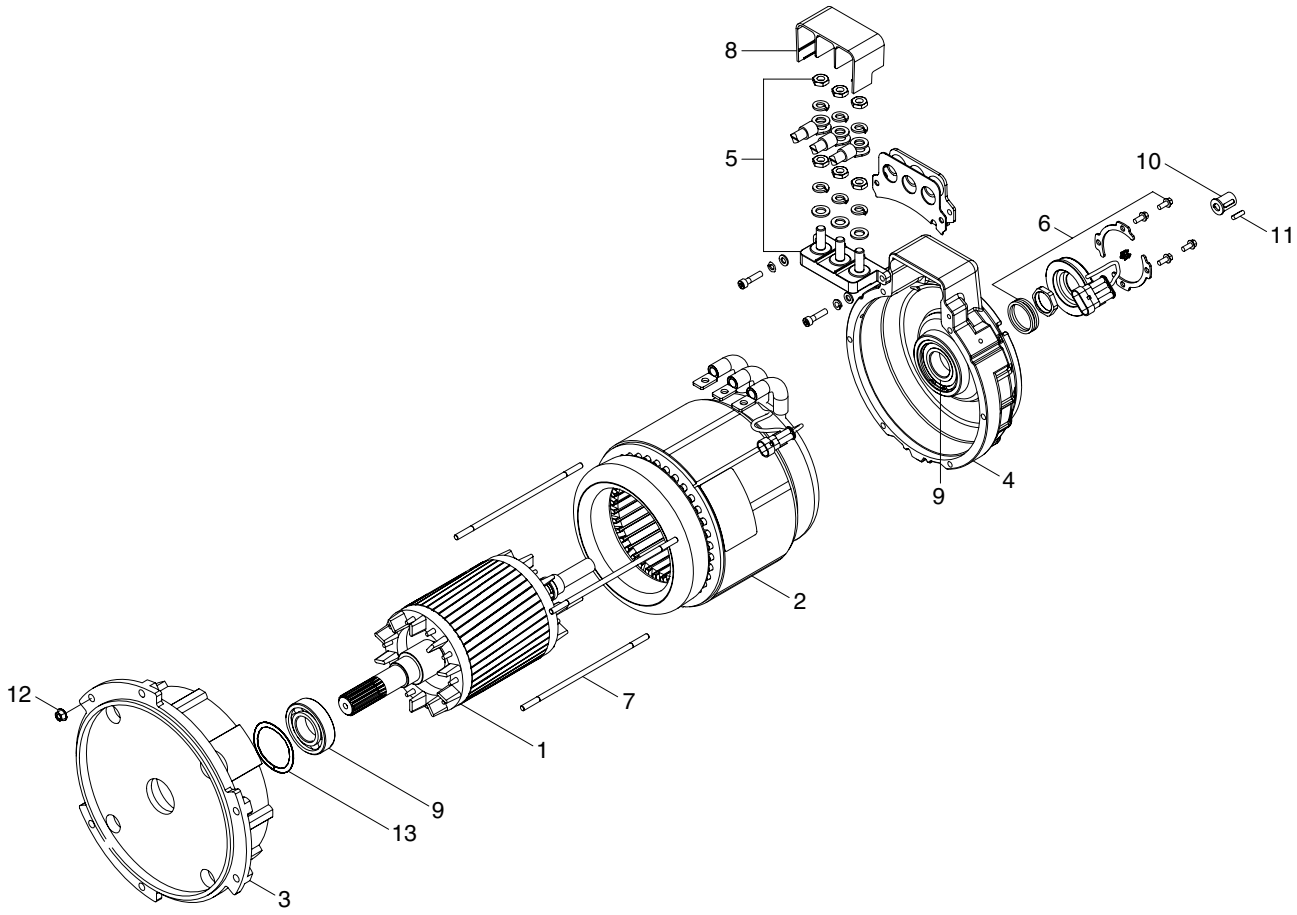
The operating temperature range of batteries is -10~45°C (temperature of electrolyte). If the batteries are exposed to cold atmosphere in discharged condition, the electrolyte may freeze, and in extreme cases, the capacity will be decreased, but, if not frozen, no adverse effects will be exerted over the life. Contrarily if the temperature is high, especially if used at above 55°C, the battery life will be considerably shortened. Care must be taken so that the temperature during charge will be maintained at 55°C or lower. Even under unavoidable circumstances it should not exceed 55°C.

7) TROUBLESHOOTING

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

3. DRIVE MOTOR

1) STRUCTURE



14BRJ9EL06

1	Rotor assy	6	Speed Sensor Kit	11	Sunk key
2	Stator assy	7	Stud bolt	12	Flange nut
3	Endbell De	8	Terminal protector	13	Wave washer
4	Endbell	9	Bearing		
5	Terminal A block	10	Shaft holder		

2) SPECIFICATION

Item	Unit	Specification
Type	-	AMBL4001P
Rated voltage	Vac	30
Rated output	kW	7.5
Insulation	-	Class F

3) MAINTENANCE INSTRUCTION

(1) Inspection

① Rotor assembly inspection

Rotor should always be cleaned with compressed air.

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

Rotor out diameter : ø 123.1 ± 0.05

Tool : Vernier calipers and standard tool

18BR9EL41

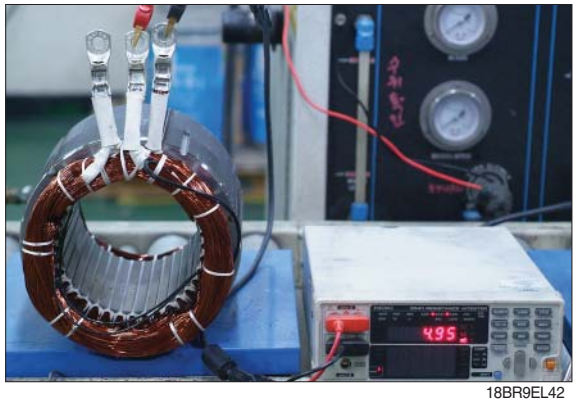
② Stator assembly inspection

Stator should always be cleaned with compressed air.

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

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

At that time resistance is around 6.3 mmΩ.

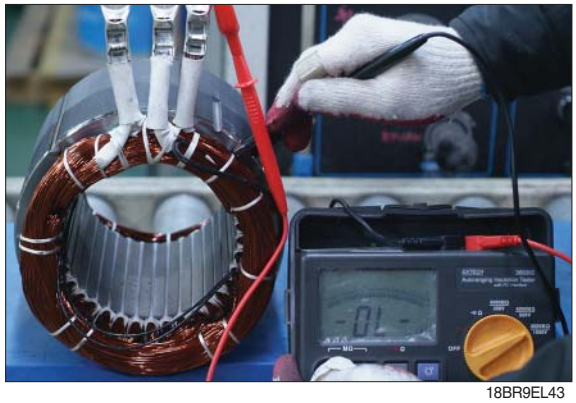


18BR9EL42

Insulation test

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

If the insulation is defective, replace with new parts.

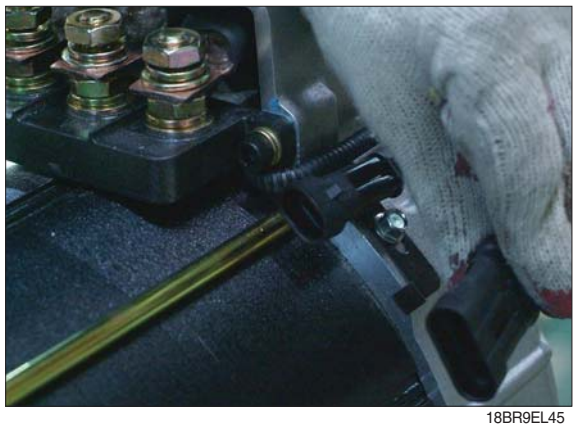


18BR9EL43

(2) Disassembly for AC motor

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

18BR9EL44



18BR9EL45

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

18BR9EL46

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

18BR9EL47

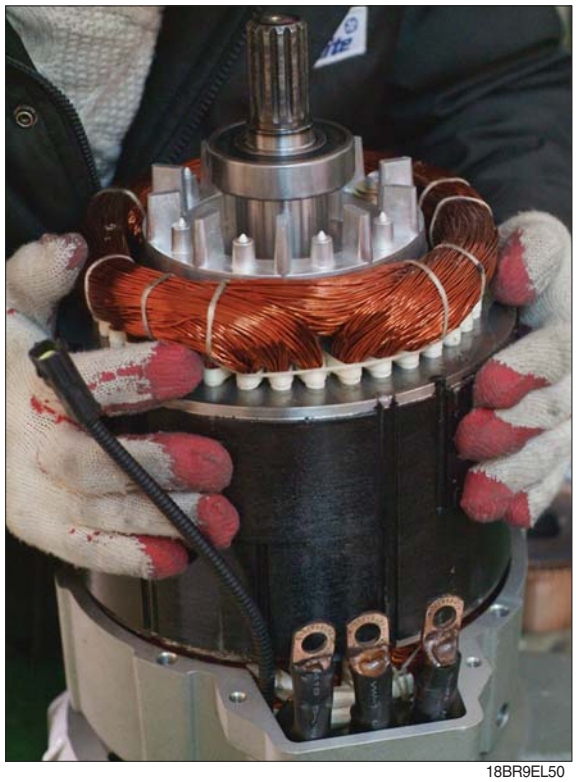
④ Remove 4 flange nuts with available general tool on the endbell drive side.

18BR9EL48

⑤ Remove endbell de and wave washer.

18BR9EL49

⑥ Remove stator assembly by hand or suitable tool.

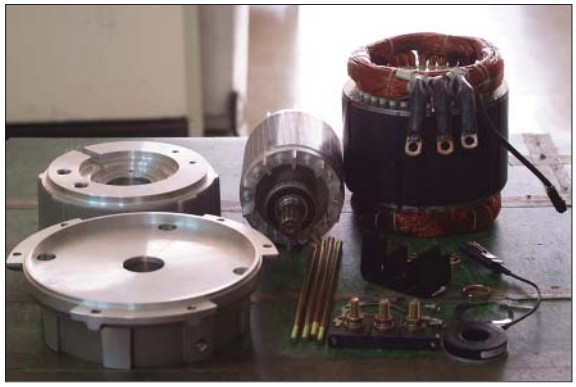


18BR9EL50

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

18BR9EL51

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



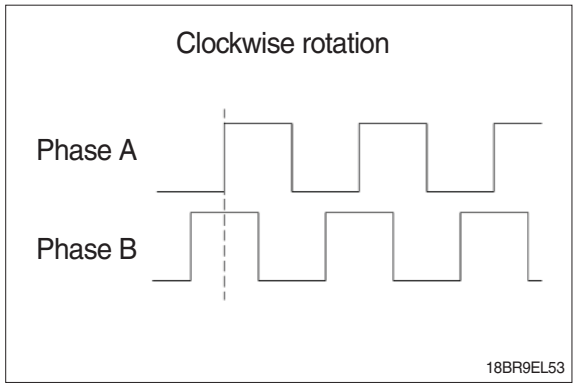
18BR9EL52

(3) Assembly and installation

Perform assembly in the reverse order of disassembling.

After assembling, check for speed sensor.

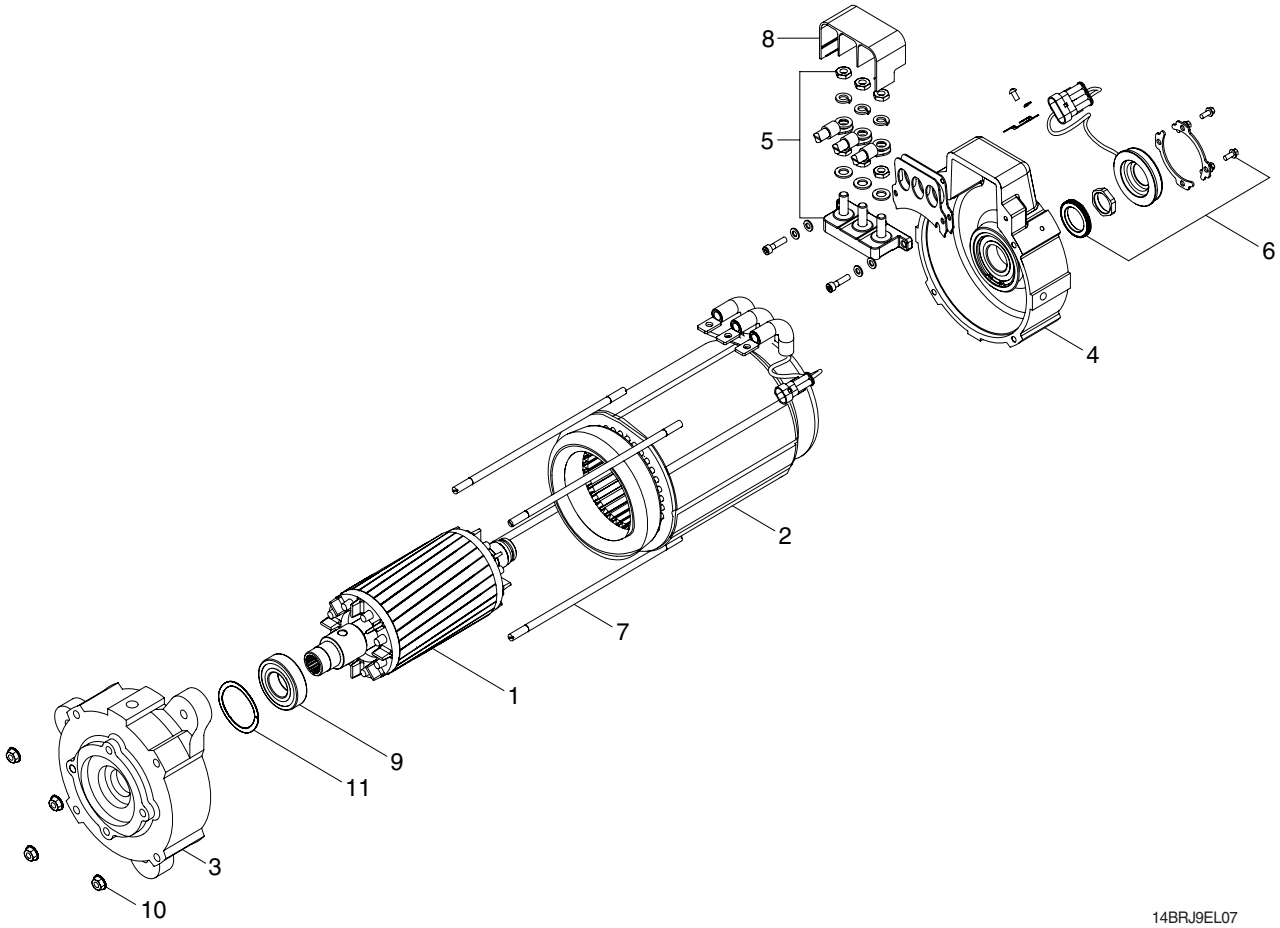
Normal signal is as right.



18BR9EL53

4. PUMP MOTOR

1) STRUCTURE



1	Rotor assy	5	Terminal A block	9	Bearing
2	Stator assy	6	Speed Sensor Kit	10	Flange nut
3	Endbell De	7	Stud bolt	11	Wave washer
4	Endbell	8	Terminal protector		

2) SPECIFICATION

Item	Unit	Specification
Type	-	ABDD 4003P
Rated voltage	Vac	30
Rated output	kW	14.0
Insulation	-	Class F

3) INTERNAL INVOLUTE SPLINE DATA

Item	Unit	Specification
Flat root side fit	-	Class 7
No of teeth	EA	9
Spline pitch	mm	16/32
Pressure angle	Degree	30
Major diameter	mm	16.535
Form diameter	mm	15.977
Minor diameter	mm	12.9286
Pin diameter	mm	2.743
Measurement over 2 pins	mm	10.251-0.1

4) INSPECTION

(1) Rotor assembly inspection

① Rotor should always be cleaned with compressed air.
If the dirt will not come off lightly wipe off with piece of cotton or soft cloth wetted with gasoline.
Rotor out diameter : ø 104.1 ± 0.05
Tool : Vernier calipers and standard tool

18BR9EL54

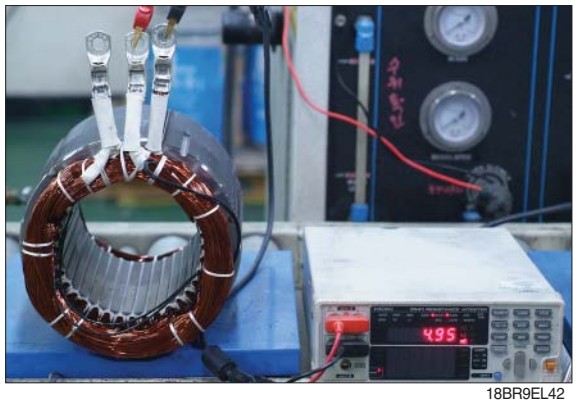
② **Stator assembly inspection**

Stator should always be cleaned with compressed air.

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

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

At that time resistance is around 3.5 mmΩ.

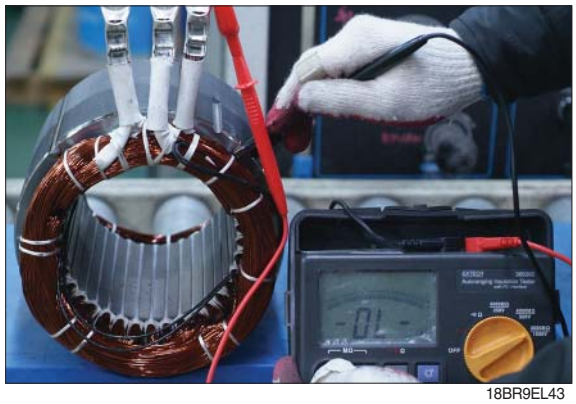


18BR9EL42

Insulation test

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

If the insulation is defective, replace with new parts.

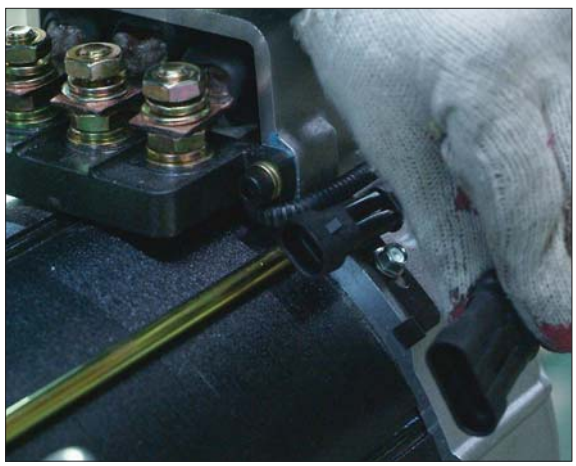


18BR9EL43

5) 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

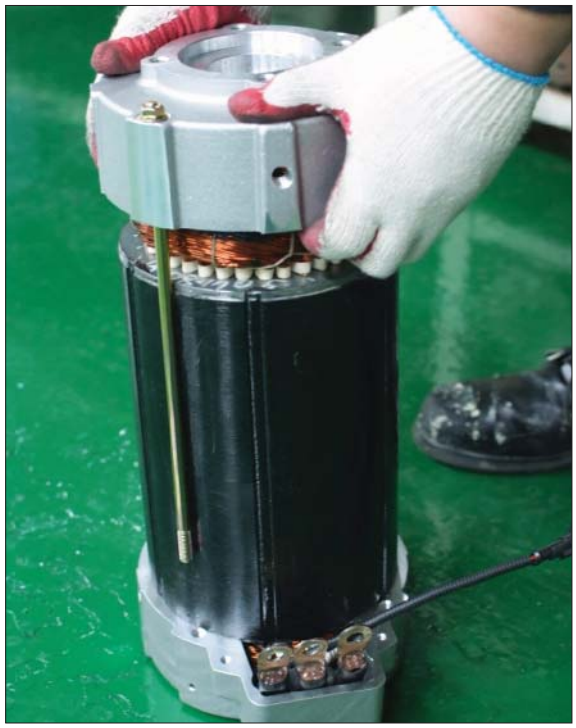
③ Remove 4 screw fixing speed sensor on the endbell side and then disassemble speed sensor, fixed nut and toothed wheel of the motor.

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).

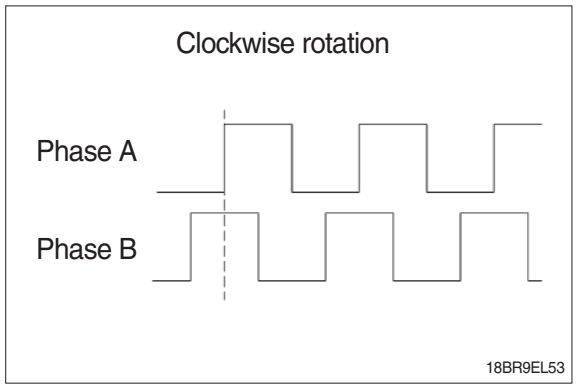
18BR9EL59

6) Assembly and installation

Perform assembly in the reverse order of disassembling.

After assembling, check for speed sensor.

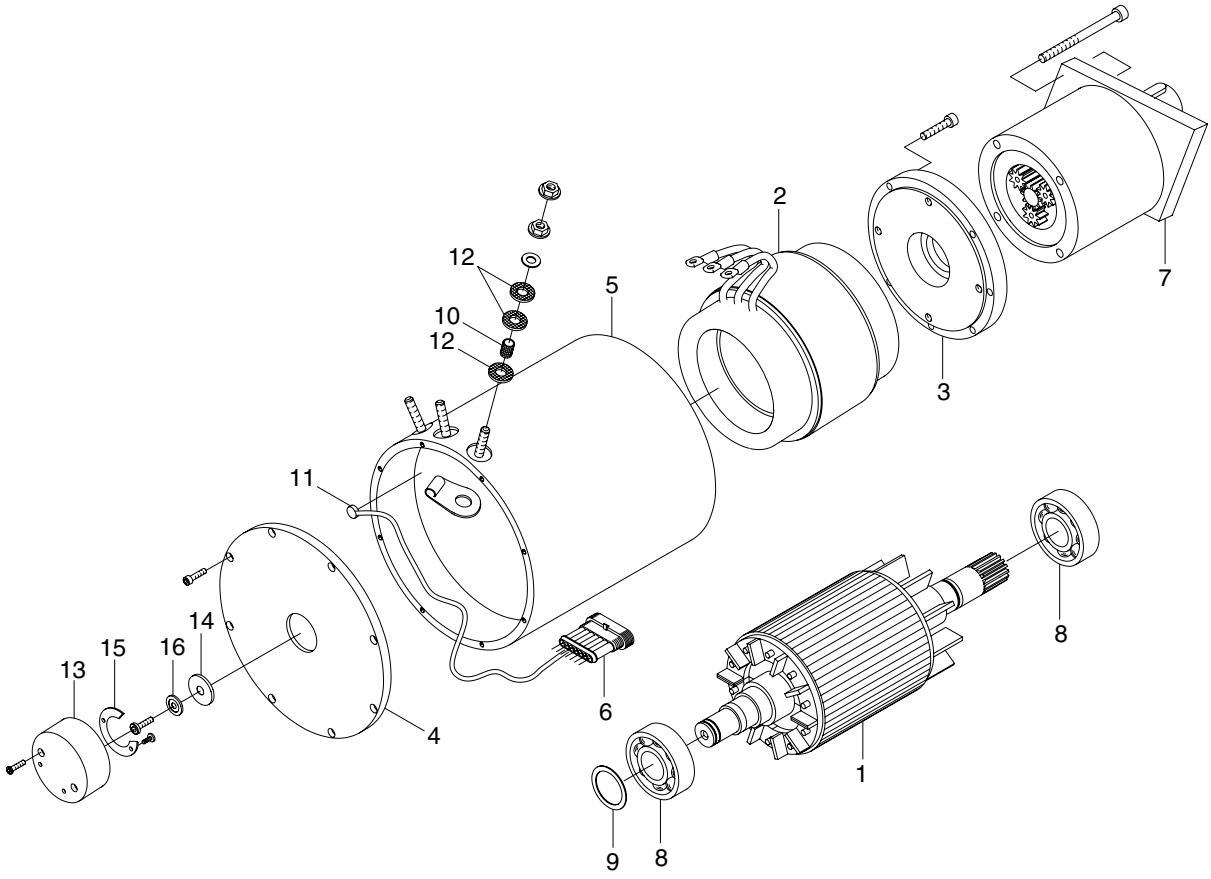
Normal signal is as right.



18BR9EL53

5. EPS MOTOR

1) STRUCTURE



BRJ7EL08

1	Rotor	9	Screw	17	Screw
2	Stator	10	Screw	18	Washer
3	Flange	11	Thickness ring	19	Bakelite washer
4	Flange	12	Flange nut	20	Sensor support
5	Casing	13	Bakelite pipe	21	Magnet
6	Super seal	14	Thermal	22	Screw
7	Gear	15	Screw	23	Sensor card
8	Bearing	16	Grower	24	Magnet support

2) SPECIFICATION

Item	Unit	Specification
Type	-	G104087A
Rated voltage	Vac	23
Rated output	kW	400
Insulation	-	Class H

3) MAINTENANCE INSTRUCTION

※ Before starting the maintenance please disconnect the power supply.

(1) Ball bearing

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

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

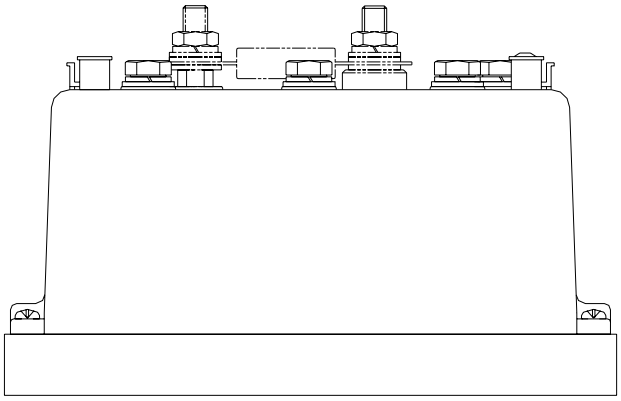
After approximately 10,000 operating hours the bearings have to be replaced.

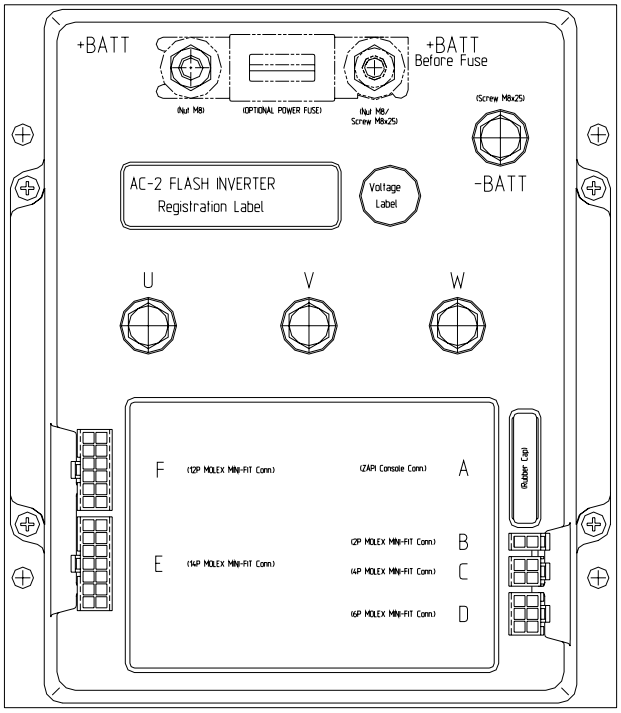
(2) Disassembly and assembly

The motor is assembled and disassembled according to the relevant sectional drawing and part list. (See page 7-17)

6. CONTROLLER SYSTEM

1) STRUCTURE





BRJ7EL11

(1) Specifications

Model	Model	Application	Type	Power	Current limit
14/16/20/25BRJ-9	AC2	Traction	AC	36-48V, 450A	450A/3min
	AC2	Pump	AC	36-48V, 450A	450A/3min

2) OPERATIONAL FEATURES

(1) Features

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

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

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

(2) Diagnosis

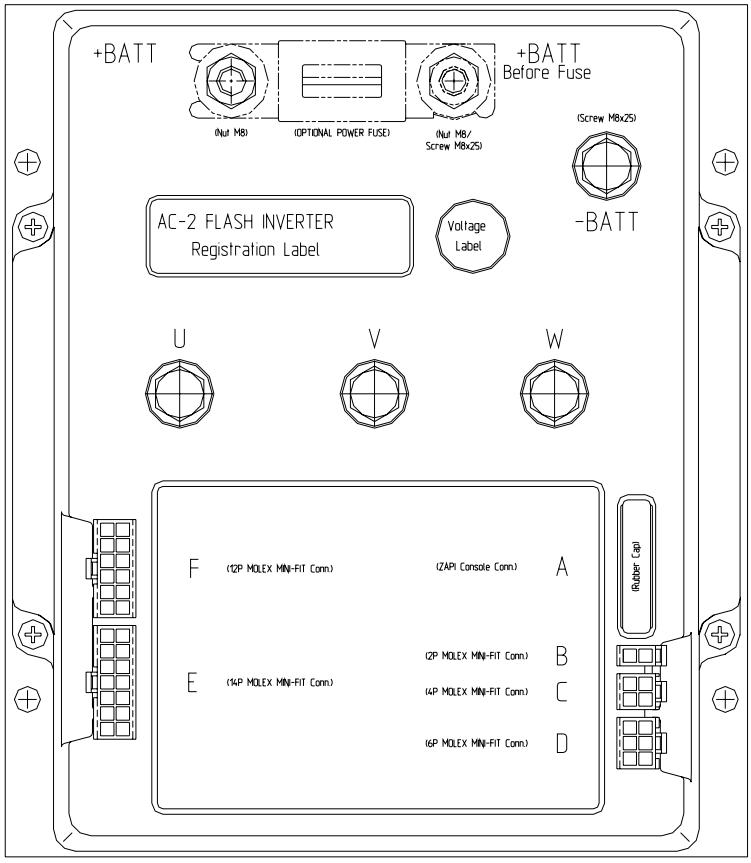
The microcontrollers continually monitor the inverter and carry out a diagnostic procedure on the main functions. The diagnosis is made in 4 points.

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



BRJ7EL12

No. of pin	Function	Description
A1	PCLRXD	Positive serial reception.
A2	NCLRXD	Negative serial reception.
A3	PCLTXD	Positive serial transmission.
A4	NCLTXD	Negative serial transmission.
A5	GND	Negative console power supply.
A6	+12	Positive console power supply.
A7	FLASH	It must be connected to A8 for the flash memory programming.
A8	FLASH	It must be connected to A7 for the flash memory programming.
C1	CAN_L	Low level CAN-BUS voltage I/O.
C2	CAN_L_OUT	Low level CAN-BUS voltage I/O.
C3	CAN_H	High level CAN-BUS voltage I/O.
C4	CAN_H_OUT	High level CAN-BUS voltage I/O.
D1÷D6		Incremental ENCODER connector.
E1	CPOT	Accelerator potentiometer wiper.
E2	PPOT	Positive of accelerator (+12V DC)
E3	NPOT	Negative of accelerator unit, tested for wire disconnection diagnosis.
E4	COMMON	Common of pedal/FWD/REV/ENABLE/PB microswitches.

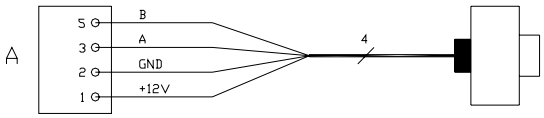
No. of pin	Function	Description
E5	FORW	Forward direction request input. It must be connected to the forward direction microswitch, active high.
E6	REVERSE	Reverse direction request input. It must be connected to the reverse direction microswitch, active high.
E7	PB	Brake request input. It must be connected to the brake pedal switch, active high.
E8	CPO TB	Brake potentiometer wiper.
E9	PPOTB	Positive of brake pedal (+12V DC)
E10	NPO TB	-BATT.
E12	BATT REMOVE CB	Battery removal status sensor input. It must be connected to the battery remove switch. Active low.
E13	360˚ STEER	Steering angle type selection input. It must be connected to the switch angle. Active high means 360˚ steer angle is selected. Active low means 180˚ steer angle is selected.
E14	ENABLE	Accelerator enable function input. It must be connected to the accelerator enable switch. Active high.
F1	KEY	Connected to the power supply through a microswitch (CH) with a 10A fuse in series.
F2	PMC	Positive of main contactor coil.
F3	PBRAKE	Positive of the electro mechanical brake coil.
F4	PEDAL S/W	PEDAL S/W ; It must be connected to the PEDAL microswitch ; It is active high.
F5	SAFETY	If not connected to -Batt the MC coil power output will be disabled.
F5	SAFETY	Input for motor temperature sensor.
F8	NMC	Negative of main contactor coil.
F9	NBRAKE	Output for driving a brake or an hydraulic steering contactor coil ; It drives the load to -Batt maximum current : 3A.
F10	SR/HB	Speed reduction (hand brake) input. Active low (switch opened). See also option chapter (not applicable).
F11	GND	-Batt.
F12	NTHERM	-Batt.

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.

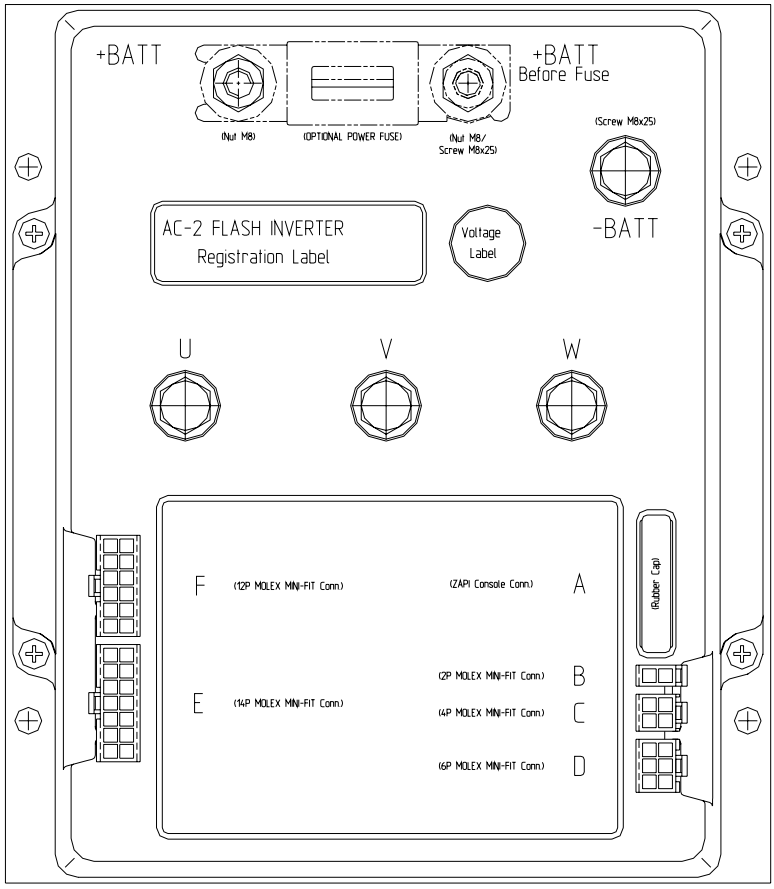
D1 : +12V - Positive of encoder power supply.
D2 : GND - Negative of encoder power supply.
D3 : A - Phase A of encoder.
D4 : B - Phase B of encoder.

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



BRJ7EL26

(2) Pump controller



BRJ7EL12

No. of pin	Function	Description
A1	PCLRXD	Positive serial reception.
A2	NCLRXD	Negative serial reception.
A3	PCLTXD	Positive serial transmission.
A4	NCLTXD	Negative serial transmission.
A5	GND	Negative console power supply.
A6	+12	Positive console power supply.
A7	FLASH	It must be connected to A8 for the flash memory programming.
A8	FLASH	It must be connected to A7 for the flash memory programming.
B1	-BATT	-Batt.
B2	MODE	This input allows the customer to select the software for traction or lifting application. Configuration : Mode : Open (not connected) : Traction inverter Mode : Close (connected with B1) : Pump inverter
C1	CAN_L	Low level CAN-BUS voltage I/O.
C2	CAN_L_OUT	Low level CAN-BUS voltage I/O.
C3	CAN_H	High level CAN-BUS voltage I/O.
C4	CAN_H_OUT	High level CAN-BUS voltage I/O.

No. of pin	Function	Description
D1÷D6		Incremental ENCODER connector.
E1	CPOT LOAD	Load sensor analog input
E2	PPOT LOAD	Positive of load sensor (+12VDC)
E3	NPOT LOAD	Negative of load sensor (ground).
E4	CM	Positive of height limit microswitch
E5	HEIGHT LIFT END	Lift end switch input. Active low.
E6	AUTO TILT LEVEL	Auto tilt leveling switch input. Active high.
E7	REACH IN CTB	Reach in cutback switch input. Active high.
E8	CPOT TILT LEVEL	Tilt up analog input
E9	PPOT TILT LEVEL	Positive of tilt angle sensor (+12VDC)
E10	NPOT TILT LEVEL	Negative of tilt angle sensor (ground).
E13	HEIGHT LIMIT	Height limit switch input. Active low.
E14	REACH OUT CB	Reach out cutback switch input. Active low.
F1	KEY	Connected to the power supply through a microswitch (CH) with a 10A fuse in series.
F2	P LOAD BRAKE_RH	Positive of right load brake output.
F3	P LOAD BRAKE_LH	Positive of left load brake output.
F5	SAFETY	If not connected to -Batt. the MC coil power output will be disabled. It can also be used as a general purpose input.
F6	PTHERM	Input for motor temperature sensor.
F8	N LOAD BRAKE_RH	Negative of right-load brake output.
F9	N LOAD BRAKE_LH	Negative of left-load brake output.
F11	BATT.	-Batt.
F12	NTHERM	-Batt.

4) FUNCTION CONFIGURATION

■ TRACTION CONTROLLER

Using the CONFIG MENU of the programming console, the user can configure the following functions (see "OPERATIONAL FEATURE" chapter for an explanation of "hydraulic steering function") :

(1) Submenu "SET OPTIONS"

① **Hour counter**

This option specifies the hour counter mode. It can be set one of two :

- RUNNING : The counter registers travel time only.
- KEY ON : The counter registers when the "key" switch is closed.

② **Battery check**

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

③ **Cutback mode**

- PRESENT : Input F10 is managed as a cutback speed input.
- ABSENT : Input F10 is managed as a handbrake input.

④ **Traction cutout**

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

⑤ **Lift cutout**

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

⑥ **Stop on ramp**

- ON : The stop on ramp feature (truck electrically hold on a ramp) is managed for a fixed time (6 sec.).
- OFF: The stop on ramp feature is not performed.

⑦ **Pedal brake**

- ANALOG : The mechanical brake pedal has a switch and a potentiometer installed. When the accelerator is released and the pedal brake is pushed the inverter performs an electrical braking whose intensity is proportional to the brake pedal potentiometer. The minimum intensity is established by the "Release braking" parameter, when the brake pedal is slightly pressed (brake switch close but brake potentiometer at the minimum). The maximum intensity is established by the "Pedal braking" parameter when the brake pedal is fully pressed (brake potentiometer at the maximum). In the middle positions, the electrical braking intensity is a linear function between minimum and maximum intensity.
- DIGITAL : The truck does not have a potentiometer installed on the mechanical brake pedal, but only a microswitch; when the accelerator pedal is released and the brake pedal is pushed (brake switch closed), the inverter performs an electrical braking following "Pedal braking" parameter.

⑧ **Set temperature**

- DIGITAL : A digital (ON/OFF) motor thermal sensor is connected to C25 (C35) input.
- ANALOG : An analog motor thermal sensor is connected to C25 (C35) (the curve can be customized on a customer request).
- NONE : No motor thermal sensor switch is connected.

⑨ **EPS**

- ON : If this option is set to ON, electric power steering function is used.
- OFF : If this option is set to OFF, electric power steering function isn't used.

⑩ **Display**

This option set the communication check between traction and display.

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

⑪ **S.R.O.**

If this option is set to on the static return to off is requested for starting the truck.
The required sequence is :

- Seat-direction lever-accelerator pedal or :
- Seat-accelerator pedal-direction lever within the weq. delay time

If this option is set to off the required sequence to start the truck is :

- Direction lever-accelerator pedal or :
- Accelerator pedal-direct lever within the seq. delay time

⑫ **Pedal type**

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

⑬ **Pedal brake stop**

If set to on the truck is stopped when the pedal brake is pressed.
If set to off the traction current is reduced to the half of the maximum current.

⑭ **Model selection**

There are 2 options, 14/16BRJ-9 , 20/25BRJ-9.
(Model setting is only avalible at the traction inverter side.)

⑮ **Traction cutback**

If the mast is lifted the height over free lift, traction speed reduction is working depends on the setting status of this function.

- ON : If set to on this function, traction speed control (TRAC. CTB. SPEED) is performed.
- OFF : If set to off this function, traction speed control (TRAC. CTB. SPEED) isn't performed.

⑯ **Joystick mode**

- ON : If set to on this function, joystick operation is activated.
- OFF : If set to off this function, joystick operation is disabled.

(2) Submenu "ADJUSTMENTS"

① **Set battery type**

It selects the nominal battery voltage.

② **Adjust battery**

Fine adjustment of the battery voltage measured by the controller.

③ **Throttle 0 zone**

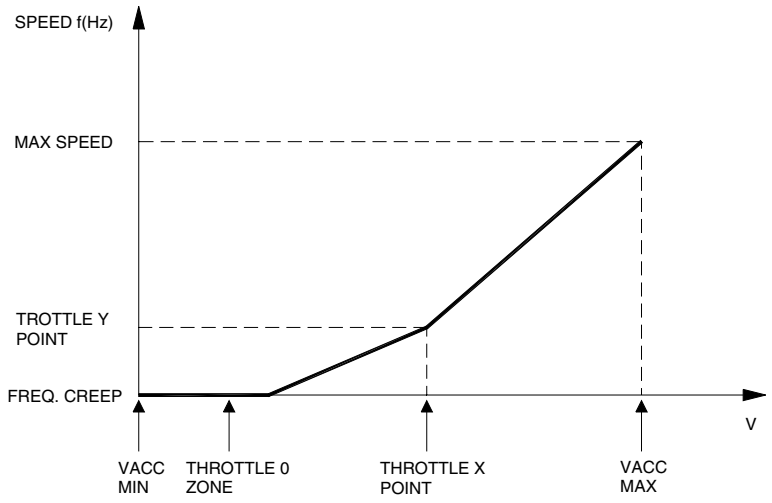
It establishes a deadband in the accelerator input curve.

④ **Throttle X point**

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

⑤ **Throttle Y point**

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



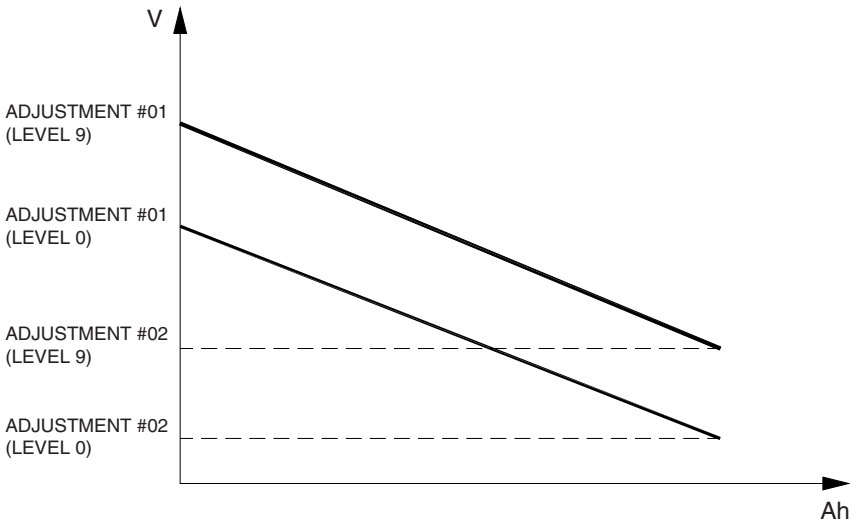
20B7EL17

⑥ **Adjustment #2 bdi**

It adjusts the lower level of the battery discharge table.

⑦ **Adjustment #1 bdi**

It adjusts the upper level of the battery discharge table.



BRJ7EL13

⑧ **Bdi adj start up**

Adjust the upper level of the battery charge table

When the key on, this setting table is applied.

⑨ **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.

⑩ **PWM on main contactor**

- OFF : The inverter applies the battery voltage to the coil on F8 output.
- ON : The PWM reduces the voltage to the set value.

⑪ **PWM on aux output**

- OFF : The inverter applies the battery voltage to the coil on F9 output.
- ON : The PWM reduces the voltage to the set value.

⑫ **MC/AUX PWM** : It sets the PWM level in % on the outputs F8 and F9. Here is used to drive a main contactor.

⑬ **Speed factor**

It adjust 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(㎝)

P = number of pair poles of the motor

⑭ **Adjustment #04** : This parameter determines the motor temperature level at which the "MOTOR TEMPERATURE" alarm is signalled. This parameter must be adjusted only if the "SET TEMPERATURE" (menu "SET OPTION") parameter is programmed "ANALOG"

(3) Submenu "PARAMETER CHANGE"

① **Acceleration delay** : It determines the acceleration ramp.

② **Acceleration cutback** : It controls the acceleration ramps when TRACTION CUTBACK is on.

③ **Release braking** : It controls the deceleration ramp when the travel request is released.

④ **Inverse braking** : It controls the deceleration ramp when the direction switch is inverted during travel.

⑤ **Pedal braking** : It determines the deceleration ramp when the travel request is released and the brake pedal switch is closed.

⑥ **Speed limit braking** : Deceleration ramp when the pedal position is changed but not completely released.

⑦ **Brake cutback** : It determines the deceleration ramp when the speed reduction input becomes active and the motor slow down.

⑧ **Max speed forward** : It determines the maximum speed in forward direction.

⑨ **Max speed backward** : It determines the maximum speed in backward direction.

⑩ **Turtle speed** : It determines the maximum speed at turtle mode.

⑪ **Batt remove speed** : It determines the maximum speed when battery remove switch is open.

⑫ **Cutback speed 1** : Typically from 10% to 100%. It determines the percentage of the max speed applied when the cutback switch is active. When set to 100% the speed reduction is ineffective.

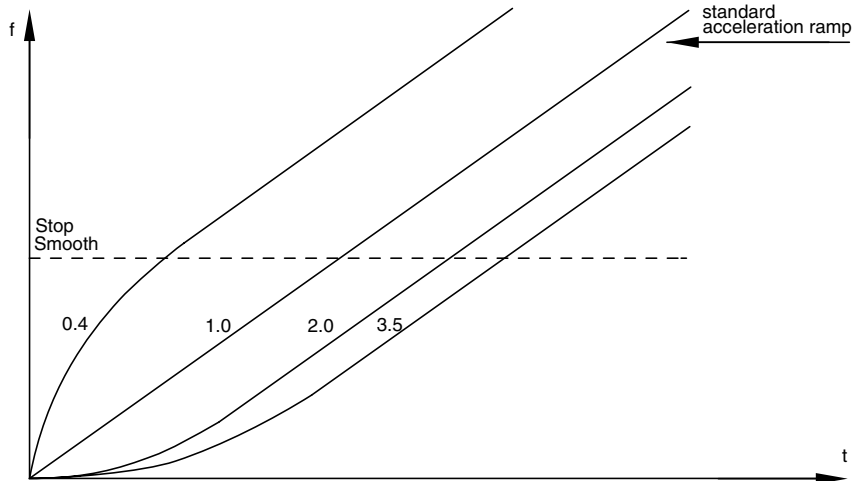
⑬ **Frequency creep** : Minimum speed when the forward or reverse switch is closed, but the accelerator is on a minimum position.

⑭ **Maximum current** : This parameter changes the maximum current of the inverter.

⑮ **Acc. smooth** : It gives a different from to the acceleration curve in the frequency range 0 Hz to "Stop smooth" value (seel the figure below).

⑯ **INV. smooth** : It gives a different from to the acceleration curve after a direction inversion in the frequency range 0 Hz to "Stop smooth" value (see the figure below).

⑰ **Stop smooth** : It sets the level of frequency where the smooth effect on the acceleration ramp ends.



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⑱ **Seat delay time** : It sets the delay time after the seat switch is off.

⑲ **Sequence delay** : It sets the delay from the accelerator enable to direction signal input.

⑳ **Chat time** : In seconds. When truck is key on, if the operator doesn't use the truck for the time (CHAT TIME), main contactor is open to save energy.

㉑ **Curve cutback** : Speed reduction when the truck is doing a curve. The parameter sets the speed setpoint when the truck driving wheels are running in opposite direction or when the maximum steering angle is reached.

㉒ **Dead angle** : It determines the tire angle range be able to get full speed.

㉓ **Traction cutback speed** : It sets the traction speed when traction cutback is on.

■ PUMP CONTROLLER

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

(1) Submenu "SET OPTIONS"

① **Hour counter**

This option specifies the hour counter mode. It can be set one of two:

- RUNNING : The counter registers travel time only.
- KEY ON : The counter registers when the "key" switch is closed.

② **Set motor sens**

- DIGITAL : A digital (ON/OFF) motor thermal sensor is connected to A25 input.
- ANALOG : An analog motor thermal sensor is connected A25 (the curve can be customized on a customer request).
- NONE : No motor thermal sensor switch is connected.

③ **Electrical distribution**

- ON : In case of BRJ truck that has electro solenoid valves, It is set to On.
- OFF : In case of BRJ truck that has manual valves, It is set to Off.

④ **Model selection**

There are 2 options, 14/16BRJ-9 , 20/25BRJ-9.

(Model setting is only avalible at the traction inverter side.)

⑤ **Digital lift**

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

⑥ **Lifting cutback**

If the mast is lifted the height over free lift, lift speed reduction is working depends on the setting status of this function.

- ON : If set to on this function, lift speed control is performed.
- OFF : If set to off this function, lift speed control isn't performed.

⑦ **Side shift function**

- OFF : The truck doesn't have the side shift function (default)
- ON : The truck has the side shift function (option)

⑧ **Lever full**

- OFF : Multi hydrulic function is not available at special condition for the safety. (Lift + reach out , lift + tilt down)
- ON : Multi hydrulic function is available.

⑨ **Height indicat.**

- OFF : Height indicator function is not activated.
- ON : Height indicator function is activated.

⑩ **Reach speed red**

If the mast is lifted the height over free lift, reach speed reduction is working depends on the setting status of this function.

- ON : If set to on this function, reach speed control is performed.
- OFF : If set to off this function, reach speed control isn't performed.

⑪ **Load sensor**

- None : Load sensing function is
- Option #1 : Load sensing function is activated. (sensing process is same as CB truck.)
- Option #2 : Load sensing function is activated. (only after lift & lowering function, sensing process is going on.)

⑫ **Fork leveling**

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

⑬ **Buzzer direction**

- Option #1 : When the truck is moving to fork direction, buzzer is working.
- Option #2 : When the truck is moving to anti-fork direction, buzzer is working.
- Option #3 : When the truck is moving to any direction, buzzer is working.

⑭ **Fan control**

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

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

⑮ **Overload type**

This option specifies how overload alarm works in overloaded situation.

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

(2) Submenu "ADJUSTMENTS"

① **Set battery type** : Selects the nominal battery voltage.

② **Adjust battery** : Fine adjustment of the battery voltage measured by the controller.

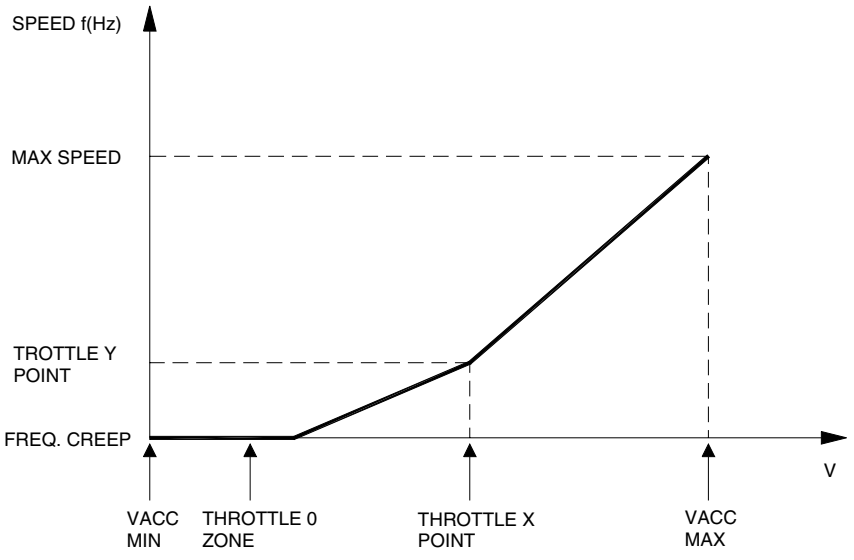
③ **Throttle 0 zone** : Establishes a deadband in the accelerator input curve.

④ **Throttle X point**

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

⑤ **Throttle Y point**

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



⑥ **Adjustment #04** : This parameter determines the motor temperature level at which the "MOTOR TEMPERATURE" alarm is signalled. This parameter must be adjusted only if the "SET TEMPERATURE" (menu "SET OPTION") parameter is programmed "ANALOG"

⑦ **PWM on main contactor**

-OFF: The inverter applies the battery voltage to the coil on F8 output.

-ON: The PWM reduces the voltage to the set value.

⑧ **PWM on aux output**

-OFF: The inverter applies the battery voltage to the coil on F9 output.

-ON: The PWM reduces the voltage to the set value.

⑨ **MC/AUX PWM** : It sets the PWM level in % on the outputs F8 and F9. Here is used to drive a main contactor.

⑩ **Fan ctl. temp :** if FAN CONTROL 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.

⑪ **Fork min speed :** (This parameter used for auto fork leveling function is on)
It sets the motor speed reduction pecentage of the set tilt speed, when fork leveling function is doing.

⑫ **Fork valve min :** (This parameter used for auto fork leveling function is on)
It sets the pecentage of tilt valve current , when fork leveling function is doing.

⑬ **Fork appr rng :** (This parameter used for auto fork leveling function is on)
It sets the pecentage of approach range from the center value, when fork leveling function is doing.

⑭ **Fork center dead :** (This parameter used for auto fork leveling function is on)
It sets the pecentage of center dead zone from the center value, when fork leveling function is doing.

⑮ **Reference weight :** (This parameter used for load sensor function)
This parameter is used to show and configurate the reference load weight.

⑯ **Overload weight :** (This parameter used for load sensor function)
This parameter is used to show and configurate the trigger condition for OVERLOAD alarm. If the loaded weight exceeds the weight indicated in this paramter, OVERLOAD alarm and function limitation will occur accroding to OVERLOAD TYPE paramter.

⑰ **Maximmum weight :** (This parameter used for load sensor function)
This parameter is used to show and configurate the maximum load weight.

⑱ **Minimum weight :** (This parameter used for load sensor function)
This parameter is used to show and configurate the minimum load weight.

⑲ **Load speed upd. :** (This parameter used for load sensor function)
To increase accuracy, Load Sensor only works when the traction motor speed is lower than as set in this parameter.

⑳ **Offset height :** (This parameter used for height indicator function)
It sets the free lift height.

㉑ **Max height 100 mm :** (This parameter used for height indicator function)
It sets the maximun lift height over 100 ㎜ digit. (ef. set value 10 means 1000 ㎜)
If fork is approached the set height, lifting function is not working.

㉒ **Max height 1 mm :** (This parameter used for height indicator function)
It sets the maximun lift height from 1 ㎜ to 99 ㎜ digit. (ef. set value 10 means 10 ㎜)
If fork is approached the set height, lifting function is not working.

(3) Submenu "PARAMETER CHANGE"

① **Acceleration delay :** It determines the acceleration ramp.
② **Deceleration delay :** It determines the acceleration ramp.
③ **Max speed up :** It determines the maximum lifting speed with a potentiometer control.
④ **Min speed up :** It determines the minimum lifting speed with a potentiometer control when the lifting enable switch is closed.
⑤ **Cutback speed :** Speed reduction when the cutback switch is active.
⑥ **Reach in speed :** It determines the reach in speed.
⑦ **Reach out speed :** It determines the reach out speed.
⑧ **Min reach speed :** It determines the minimum reach speed with a potentiometer control when the reach switch is closed.
⑨ **Shift speed :** It determines the sideshift speed.
⑩ **Min shift speed :** It determines the minimum sideshift speed with a potentiometer control when the sideshift switch is closed.
⑪ **Tilt speed :** It determines the tilt speed.
⑫ **Fork max speed :** (This parameter used for auto fork leveling function is on)
It sets the maximum motor speed for the tilt function, when fork leveling function is doing.
⑬ **Creep fork lev :** (This parameter used for auto fork leveling function is on)
It sets the minimum motor speed for the tilt function, when fork leveling function is doing.
⑭ **Fork dw. val max :** (This parameter used for auto fork leveling function is on)
It sets the pecentage of tilt valve current , when fork leveling function is doing from up position to down position.
⑮ **Lift speed red :** It sets the motor speed for the lifting function when lift end switch is off.
⑯ **Min tilt speed :** It determines the minimum tilt speed with a potentiometer control when the tilt switch is closed.
⑰ **Aux speed :** It determines the aux speed.
⑱ **Maximum current :** This parameter changes the maximum current of the inverter.
⑲ **Reach in ctb2 :** It sets the percentage of reach in valve current.
(This set value is applied only when reach in operation is doing in the reach in cutback stroke.)
⑳ **Reach out ctb2 :** It sets the percentage of reach out valve current.
(This set value is applied only when reach out operation is doing in the reach out cutback stroke.)
㉑ **Rein ctb cls del :** It sets the close delay of reach in valve after reach in cutback switch is on.
(This delay is applied only when reach in cutback switch status is from open to close on the reach in operation. If delay time is over, reach in valve is closed automatically.)
㉒ **Reout ct cls del :** It sets the close delay of reach out valve after reach out cutback switch is on.
(This delay is applied only when reach out cutback switch status is from open to close on the reach out operation. If delay time is over, reach out valve is closed automatically.)
㉓ **Reach in sp red :** It sets the motor speed for the reach in function when reach speed red is on.
㉔ **Reach out sp red :** It sets the motor speed for the reach out function when reach speed red is on.
㉕ **Lifting speed 2 :** It sets the motor speed for the lifting function when lifting cutback is on.

5) PROGRAMMING & ADJUSTMENTS

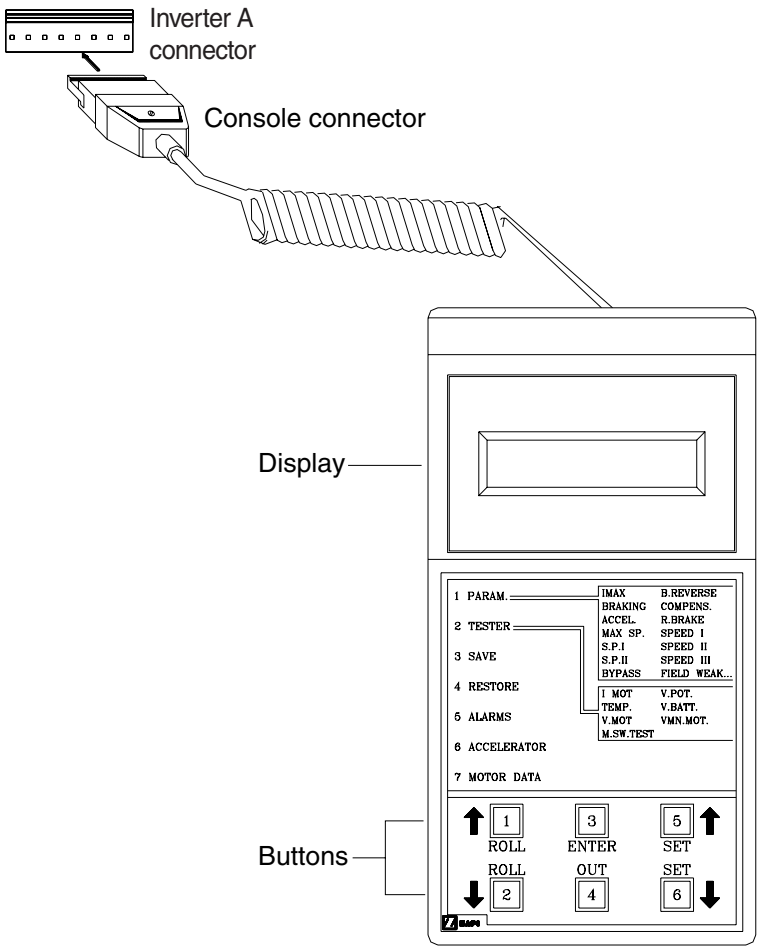
There are two ways to adjust parameter via a console or buttons on a display.

※ Adjustments via buttons on a display, please refer to the display section. (page 7-51)

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 "A" connector of the inverter.

(1) Descriptions of console



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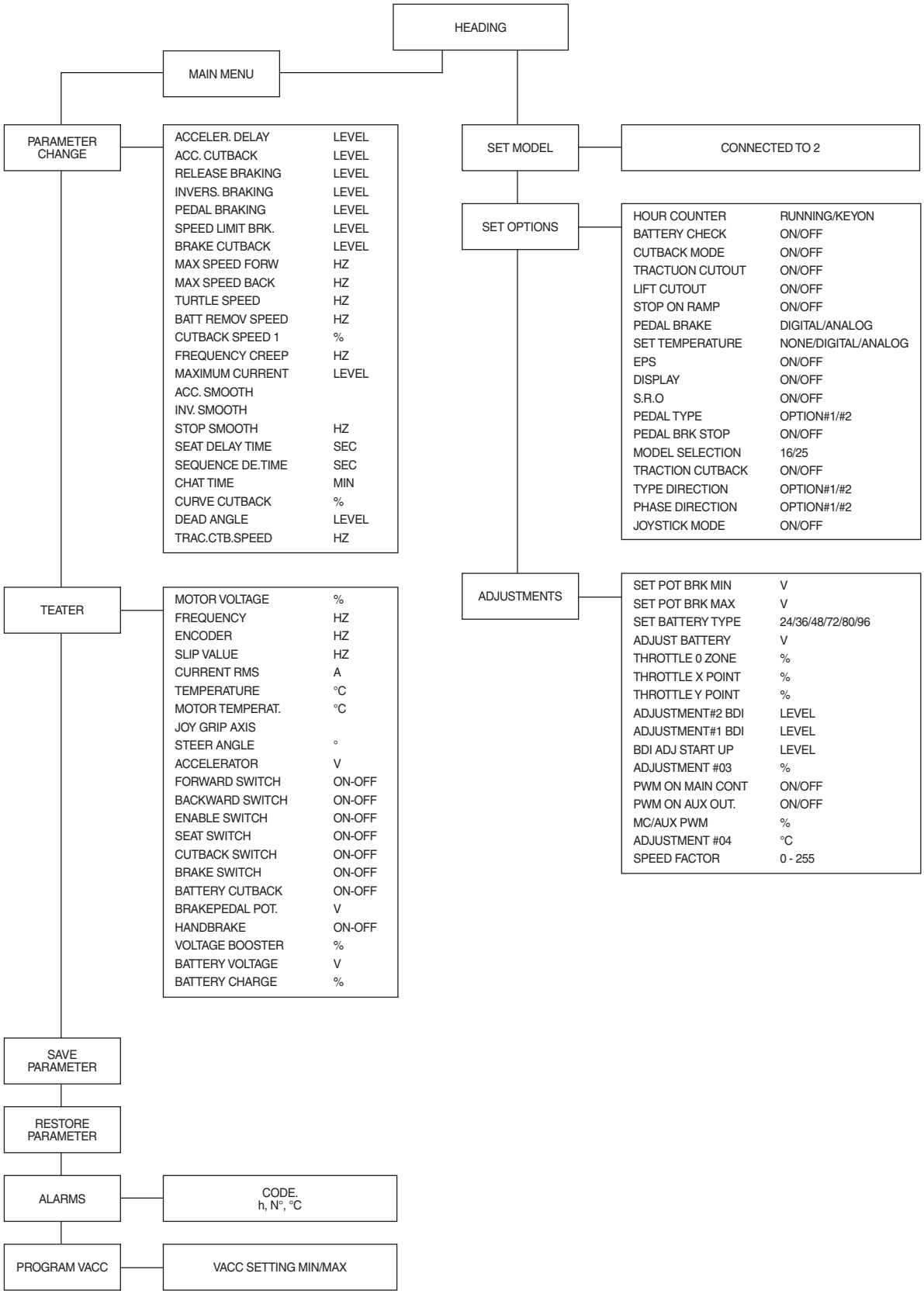
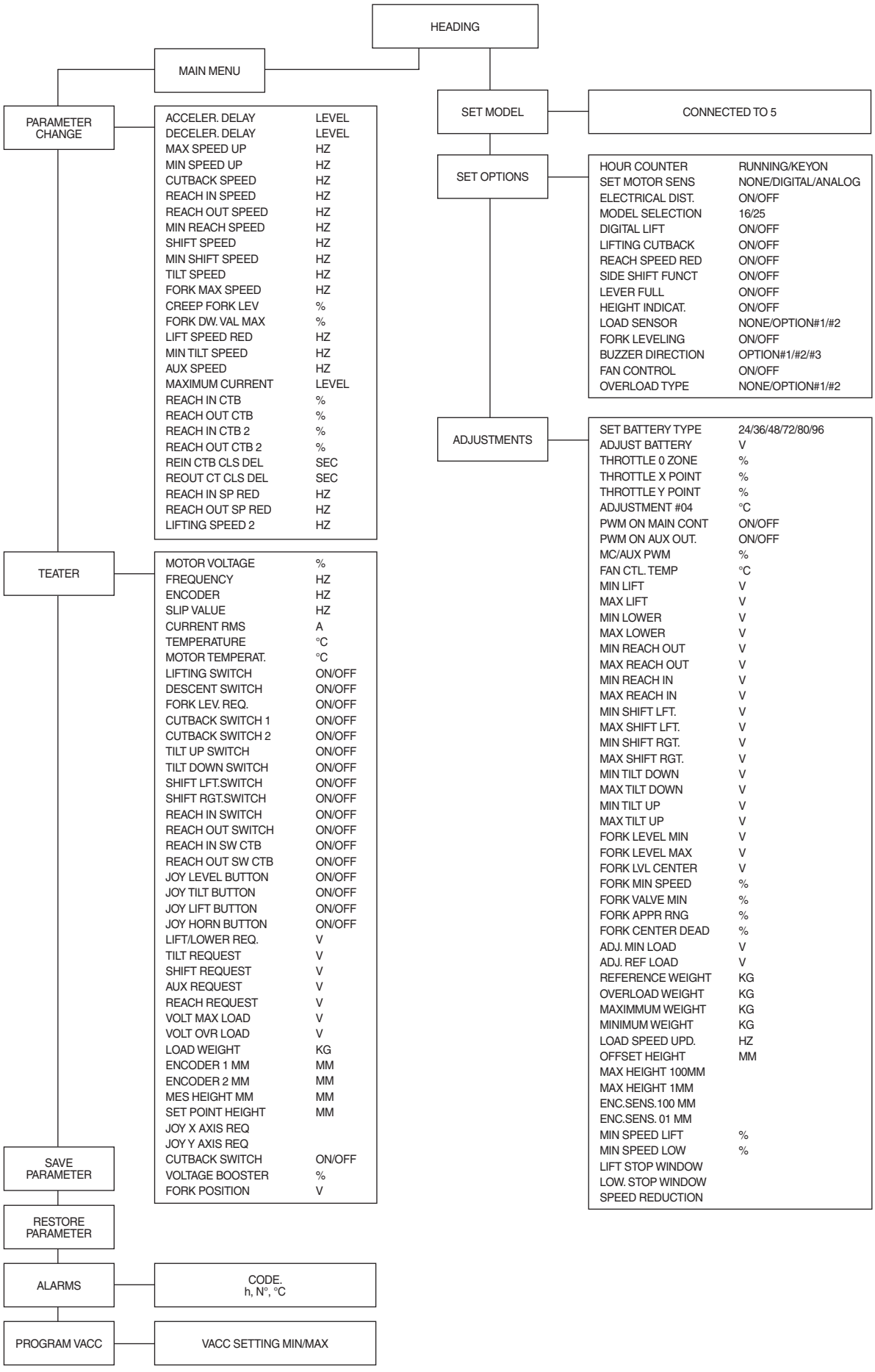
※ Digital consoles used to communicate with AC inverter controllers must be fitted with EPROM CK ULTRA, minimum "Release number 3.02".

(2) Description of standard console menu

① Traction controller



② Pump controller



(3) Description of ALARMS menu

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

① Opening Zapi display.

② Press ENTER to go into the general menu.

③ The display will show:

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

⑤ The display shows:

⑥ Press ENTER to go into the ALARMS function.

⑦ The display will show the most recent alarm.

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

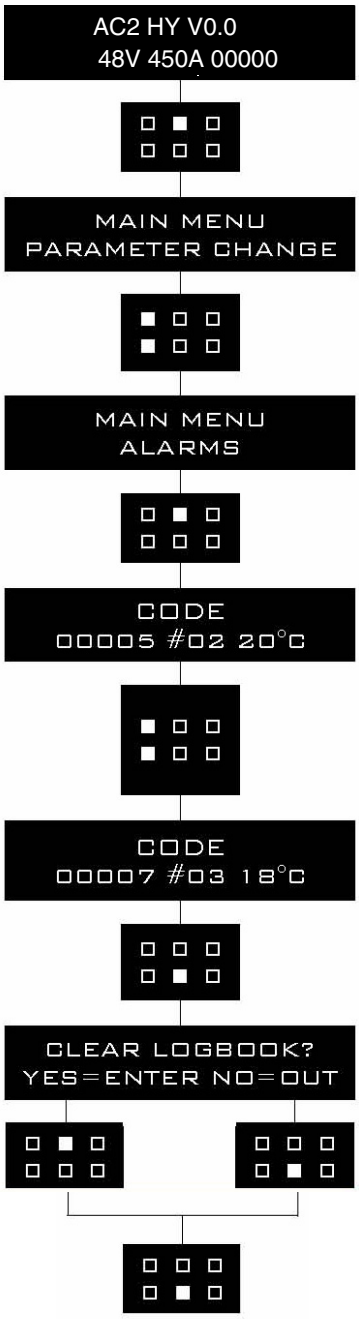
⑨ If an alarm has not occurred, the display will show: ALARM NULL.

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

⑪ The display will ask "CLEAR LOGBOOK?".

⑫ Press ENTER for yes, or OUT for NO.

⑬ Press OUT to return to the opening Zapi display.



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(4) Description of console PROGRAM VACC function

This function looks for and remembers the minimum and maximum potentiometer wiper voltage over the full mechanical range of the pedal. It enables compensation for non symmetry of the mechanical system between directions.
The operation is performed by operating the pedal after entering the PROGRAM VACC function.
Flow chart showing how to use the PROGRAM VACC function of 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 PROGRAM VACC. appear on the display.

⑤ The display shows:

⑥ Press ENTER to go into the PROGRAM VACC routine.

⑦ The display will show the minimum and maximum values of potentiometer wiper output. Both directions can be shown.

⑧ Press ENTER to clear these values. Display will show 0.0.

⑨ Select forward direction, close any interlock switches that may be in the system.

⑩ Slowly depress the accelerator pedal (or tiller butterfly) to its maximum value. The new minimum and maximum voltages will be displayed on the console plus an arrow indicating the direction.

⑪ Select the reverse direction and repeat Item10.

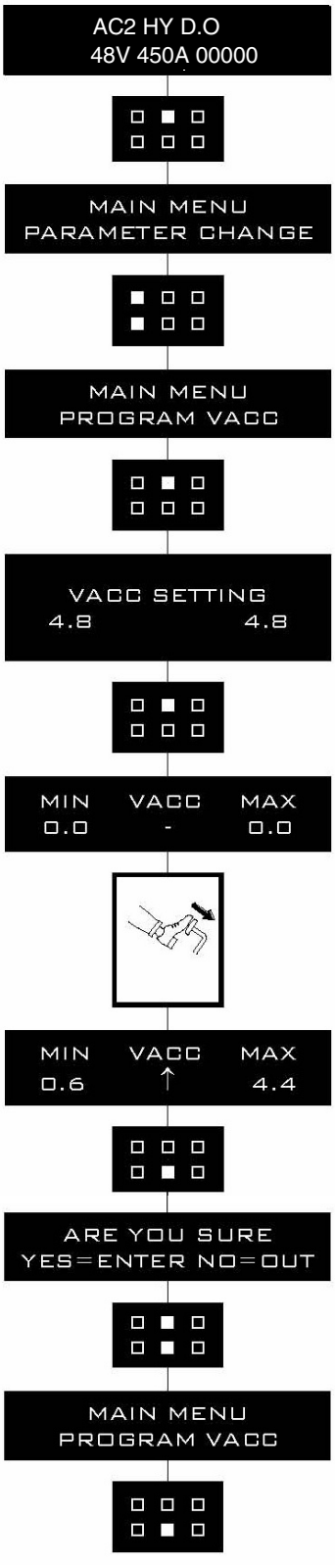
⑫ When finished, press OUT.

⑬ The display will ask : "ARE YOU SURE?".

⑭ Press ENTER for yes, or OUT for NO.

⑮ When finished, the console shows:

⑯ Press OUT again to return to the opening Zapi menu.



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6) TESTER MENU (IN DISPLAY, MONITORING MENU)

(1) Traction controller

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

① **Motor voltage**

This is the voltage supplied to the motor by the inverter; it is expressed as a percentage of the full voltage (which depends of the battery voltage).

② **Frequency**

This is the frequency of the voltage and current supplied to the motor.

③ **Encoder**

This is the speed of the motor, expressed in the same unit of the frequency; this information comes from the speed sensor.

④ **Slip value**

This is the difference of speed between the rotating field and the shaft of the motor, expressed in the same unit of the frequency.

⑤ **Current rms**

Root Mean Square value of the motor current.

⑥ **Temperature**

The temperature measured on the aluminum heat sink holding the MOSFET devices.

⑦ **Motor temperature**

This is the temperature of the motor; if the option is programmed "None" it shows 0°C.

⑧ **Joy grip axis**

This is the amount of joystick right rocker operation. (it selects the forward/backward direction)

⑨ **Steer angle**

This is the degree of steer tire angle.

⑩ **Accelerator**

The voltage of the accelerator potentiometer's wiper (CPOT). The voltage level is shown on the left hand side of the console display and the value in percentage is shown on the right hand side.

⑪ **Forward switch**

The level of the forward direction digital entry FW.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑫ **Backward switch**

The level of the reverse direction digital entry BW.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch

⑬ **Enable switch**

The level of the accel enable switch.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch

⑭ **Seat switch**

The level of the seat microswitch digital entry.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑮ **Cutback switch**

The level of the speed reduction microswitch.

- ON / GND = Input active, switch opened
- OFF / +VB = Input non active, switch closed.

⑯ **Brake switch**

The level of the pedal brake microswitch.

- ON / +VB = Input active, switch closed.
- OFF / GND = Input non active, switch open.

⑰ **Battery cutback**

The level of the battery remove switch.

- ON / +VB = Input active, switch closed.
- OFF / GND = Input non active, switch open.

⑱ **Brake pedal pot.**

Voltage of the brake potentiometer's wiper (CPOTB). The parameter is active only if the PEDAL BRAKING parameter is set ANALOG.

⑲ **Hand brake**

The level of the handbrake microswitch.

- ON / GND = Input active, switch opened.
- OFF / +VB = Input non active, switch closed.

⑳ **Voltage booster**

This is the booster of the voltage supplied to the motor in load condition; it is expressed in a percentage of the full voltage.

㉑ **Battery voltage**

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

㉒ **Battery charge**

The percentage charge level of the battery.

(2) Pump controller

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

① **Motor voltage**

This is the voltage supplied to the motor by the inverter; it is expressed as a percentage of the full voltage (which depends of the battery voltage).

② **Frequency**

This is the frequency of the voltage and current supplied to the motor.

③ **Encoder**

This is the speed of the motor, expressed in the same unit of the frequency; this information comes from the speed sensor.

④ **Slip value**

This is the difference of speed between the rotating field and the shaft of the motor, expressed in the same unit of the frequency.

⑤ **Current RMS**

Root mean square value of the motor current.

⑥ **Temperature**

The temperature measured on the aluminum heat sink holding the MOSFETdevices.

⑦ **Motor temperature**

This is the temperature of the motor; if the option is programmed "None" it shows 0°C.

⑧ **Lifting switch**

Status of the lifting switch.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑨ **Descent switch**

Status of the lowering switch.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑩ **Fork lev. Req.**

Status of the auto tilt leveling enable switch.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑪ **Cutback switch 1**

The level of the speed reduction1 microswitch.

- ON / GND = Input active, switch opened.
- OFF / +VB = Input non active, switch closed.

⑫ **Cutback switch 2**

The level of the speed reduction2 microswitch.

- ON / GND = Input active, switch opened.
- OFF / +VB = Input non active, switch closed.

⑬ **Tilt up switch**

Status of the tilt up switch.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑭ **Tilt down switch**

Status of the tilt down switch.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑮ **Shift left switch**

Status of the shift left speed switch.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑯ **Shift right switch**

Status of the shift right speed switch.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑰ **Reach in switch**

Status of the reach in switch.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑱ **Reach out switch**

Status of the reach out switch.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑲ **Reach in sw ctb**

Status of the reach in cutback switch.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑳ **Reach out sw ctb**

Status of the reach out cutback switch.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

㉑ **Joy level button**

Status of the tilt leveling enable switch on joystick.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

㉒ **Joy tilt button**

Status of the tilt enable switch on joystick.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

㉓ **Joy horn button**

Status of the horn switch on joystick.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

㉔ **Lift/lower request**

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

㉕ **Tilt request**

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.

㉖ **Shift request**

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

㉗ **Aux request**

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

㉘ **Reach request**

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

㉙ **Volt max load**

This shows the set max load voltate.

㉚ **Volt ovr load**

This shows the set overload voltage.

㉛ **Load weight**

This shows the measured load weight voltage.

㉜ **Encoder 1 mm**

This shows the encoder1 value for the height indicator.

㉝ **Encoder 2 mm**

This shows the encoder2 value for the height indicator.

㉞ **Mes height mm**

This shows the mesured height calculated by controller.

㉟ **Set point height**

This shows the preset height selected by operator.

㊱ **Joy X axis req**

This is the amount of joystick x axis operation.

㊲ **Joy Y axis req**

This is the amount of joystick y axis operation.

㊳ **Cutback switch**

The level of the speed reduction microswitch.

- ON / GND = Input active, switch opened.
- OFF / +VB = Input non active, switch closed.

㊴ **Voltage booster**

This is the booster of the voltage supplied to the motor in load condition; it is expressed in a percentage of the full voltage.

㊵ **Fork position**

This is the voltage signal of the tilt angle.

7) GENERAL SUGGESTION FOR SAFETY

For a proper installation take care of the following recommendations:

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

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

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

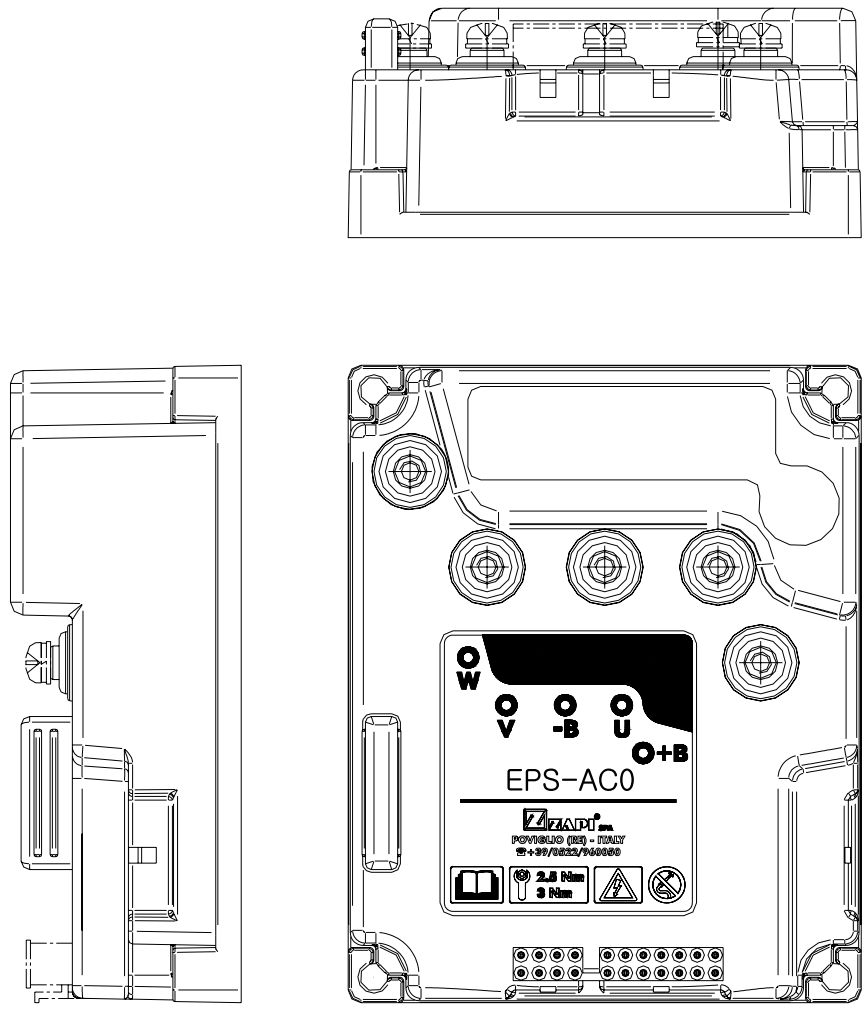
⚠ Do not connect the controller to a battery with a nominal voltage different than the value indicated on the controller label. A higher battery voltage may cause power section failure. A lower voltage may prevent the logic operating.

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

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

7. EPS CONTROLLER

1) STRUCTURE



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(1) Specifications

Model	Model	Application	Type	Power	Current limit
14/16/20/25BRJ-9	AC0	EPS	AC	36-48V, 45A	45A/2min

2) OPERATIONAL FEATURES

(1) Features

A list of eps-ac0 operational features follows below:

① Static sensitivity boost in open loop (steering sensitivity increases for a slow moving steering wheel).
② Static numbness in closed loop (steering sensitivity decreases for handle steer close to the straight-ahead direction).
③ Dynamic numbness in open loop (steering sensitivity reduces when the truck speed increases).
④ Dynamic numbness on request in closed loop (steering sensitivity reduces when the truck speed increases).
⑤ Truck speed reduces when the steering angle increases.
⑥ Alignment at the rest position in open loop application (to avoid the drift of the steered wheel when travelling with released steering wheel).
⑦ Embedded PID algorithm for automatic functions (AUTC).
⑧ Special debugging & troubleshooting system makes easier the fault catching.
⑨ Possibility to run in a stand-alone (not CAN Bus supported) configuration.
⑩ Motor control may be performed with encoder.
⑪ Redundant processing (two microprocessors aboard) fulfils the category #3 requirement including the set-point comes via CAN Bus from a remote unit.
⑫ Redundant set point and feedback sensors fulfil the category #3 requirement.

(2) Diagnosis

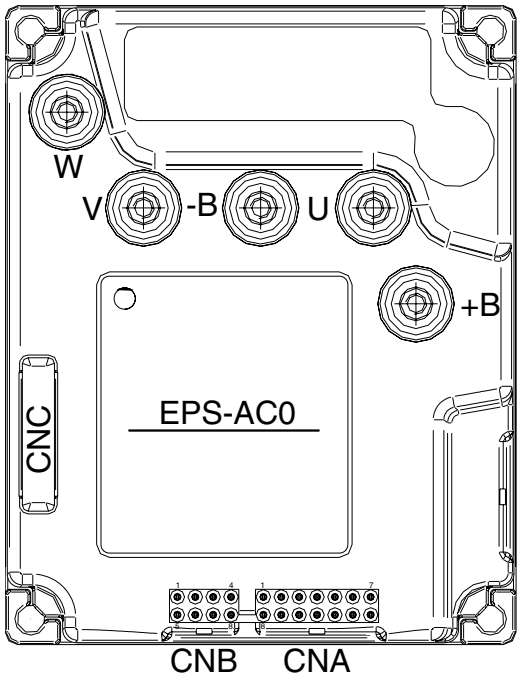
According to EN1175, most of the diagnoses deenergize steer and traction in less then 100 msec.

Few secondary alarm conditions require longer time for detection. They too deenergize steer and traction.

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

3) DESCRIPTION OF CONNECTORS

(1) EPS controller



BRJ7EL52

No. of pin	Function	Description
A2	SW 2	2nd toggle switch (90 degrees).
A3	SW 1	1st toggle switch (0 degrees).
A4	-BATT.	Safety switch lower voltage point.
A5	SAFETY	Safety switch higher voltage point.
A6	CAN L	Can bus low.
A7	KEY	Key in.
A8	QL	Stepper motor Q line.
A9	DL	Stepper motor D line.
A10	GND	GND. encoder D line negative supply
A11	GND	GND. encoder Q line negative supply and EPS motor encoder negative
A12	GND	GND. SW 1 & SW 2 negative.
A13	GND	GND. motor themal sensor negative.
A14	CANH	Can bus high.
B3	THMOT	Motor themal sensor (KTY84-130) input.
B4	VDC	Encoder positive supply.
B7	CHB	Encoder channel B.
B8	CHA	Encoder channel A.

No. of pin	Function	Description
C1	PCLRXD	Positive serial reception.
C2	NCLRXD	Negative serial reception.
C3	PCLTXD	Positive serial transmission.
C4	NCLTXD	Negative serial transmission.
C5	GND	Negative console power supply.
C6	+12	Positive console power supply.
C7	FLASH	It must be connected to A8 for the flash memory programming.
C8	FLASH	It must be connected to A7 for the flash memory programming.

4) FUNCTION CONFIGURATION

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

(1) Submenu "SET OPTIONS"

① MICRO CHECK

This option is useful to support debug and troubleshooting. It makes possible to inhibit the supervisor (slave uC) operations and allows the system to run with just the main uC. When entering this operating mode the safety contacts stay open. Therefore, traction shall be disabled.

It can be set one of two:

PRESENT: Default setting: enable the operations of the supervisor (slave uC).

ABSENT: Disable the operations of the supervisor (slave uC). The safety contacts stay opened.

② AUTOCENTERING

This option makes the automatic centering (AUTC) operation available. When it is set on, an automatic alignment of the steered wheel on the straight ahead toggle switch is always performed at key-on. When it is set off, the AUTC at key-on is still performed for any configuration but for the open loop (stepper motor at the steering wheel) without angle limitation. In this latest case, the centering must be manually executed. Besides, this option enables the AUTC on demand.

A centering request is required in this case to get the AUTC on-demand really performed.

③ RECOVERY AT REST

(Stepper motor version only).This option enables the function "alignment at the rest position"

It consists of the following steps:

- When releasing the stepper motor, the SW records the steered wheel angle.
- Then it is expected the steered wheel angle does not change meanwhile travelling with a released stepper motor.
- If the steered wheel angle changes more than 8 degrees, the system automatically turns back to the recorded position If the driver moves the stepper motor meanwhile an alignment at the rest position is in progress, the alignment will be aborted.

④ DIAG MOTOR TEMP

This option enables the diagnosis of the motor temperature. When it is set on and the motor temperature overtakes 150° , a MOTOR TEMPERAT alarm occurs.

The KTY84-130 motor thermal sensor must be connected between CNB#3 and a minus battery (CNA#13).

⑤ TRUCK TYPE

This option sets the truck type.

- Option #1 : 14/16/20/25BRJ-7
- Option #2 : 10/13BOP-7
- Option #3 : 15/18/20/23BRP-7
- Option #4 : 14/16/20/25BRJ-9

(2) Submenu "ADJUSTMENTS"

① SET BATTERY TYPE

Set this adjustment to the nominal battery voltage. Pay attention, never set SET BATTERY TYPE higher than 36 V for a 24/36 V controller. Never set SET BATTERY TYPE lower than 36V for a 36/48V controller.

② SET SAT. FREQ.

Set this adjustment to the corner frequency of the motor. SET SAT FREQ is to be meant as the maximum frequency at which the motor supplies the maximum torque (it is the superior limit of the constant torque characteristic). Frequency higher than SET SAT FREQUENCY gets the motor weakened.

③ AUTOTEACHING

This option (on/off) is used to launch the autoteaching procedure. Take care there is not mechanical angle limitation before to turn it on. Then recycle the key and the steering motor starts an automatic sequence to collect the ENC COUNT AT 360 and ENC COUNT AT 180. If the collected couple is consistent (ENC COUNT AT 180 stays inside the window from 3/8 to 6/8 of ENC COUNT AT 360) they are automatically saved on the settings SET ENC AT 360 and SET ENC AT 180. If the autoteaching procedure successful ends, the display switches from the DATA ACQUISITION alarm to the collected values (in the range 0 to 5Vdc. Left side shows the ENC COUNT AT 360 value; the right side shows the ENC COUNT AT 180 value). If the ouple of values is not consistent they were not saved and the display switches cyclically from the collected data to the DATA ACQUISITION inscription.

(3) Submenu "PARAMETER CHANGE"

① SPEED LIMIT

Level 0 to 9. It determines the scaling factor between the speed of the steering wheel and the speed of the steering motor but only when the steering wheel is fast turning. By increasing the SPEED LIMIT value, the steering motor speed increases too. In practice, it sets the maximum motor speed when the steering wheel is fast turning.

② AUX FUNCTION #3

Level 0 to 9. This setting performs the Dynamic Numbness compensation: it consists of a reduction in the steer sensitivity when the truck is driving at high speed. To get this goal, it is necessary to attenuate the scaling factor between the speed of the steering wheel and the speed of the steering motor. AUX FUNCTI ON #3 does that but only when the steering wheel is fast turning. This attenuation must be proportional to the drive speed. At full drive speed the attenuation of the scaling factor is maximum.

AUX FUNCTION #3 to Level 0 means no attenuation of the scaling factor with the truck speed.

AUX FUNCTION #3 to Level 9 means maximum attenuation of the scaling factor with the truck speed.

Obviously, to perform the Dynamic Numbness compensation, it is necessary to know the drive speed and so the eps-ac0 must be CAN Bus connected.

③ SENSITIVITY

Level 0 to 9. It determines the scaling factor between the speed of the steering wheel and the speed of the steering motor but only when the steering wheel is slow turning. By increasing the SENSITIVITY value, the steering motor speed increases too. In practice, it changes the sensitivity of the steering wheel when it is slow turning.

④ **AUX FUNCTION #2**

Level 0 to 9. This setting performs the dynamic numbness compensation: it consists of a reduction in the steer sensitivity when the truck is driving at high speed. To get this goal, it is necessary to attenuate the scaling factor between the speed of the steering wheel and the speed of the steering motor. AUX FUNCTI ON #2 does that but only when the steering wheel is slow turning. This attenuation must be proportional to the drive speed. At full drive speed the attenuation of the scaling factor is maximum.

AUX FUNCTION #2 to Level 0 means no attenuation of the scaling factor with the truck speed.

AUX FUNCTION #2 to Level 9 means maximum attenuation of the scaling factor with the truck speed.

Obviously, to perform the dynamic numbness compensation, it is necessary to know the drive speed and so the eps-ac0 must be CAN Bus connected.

⑤ **ANTIROLLBACK**

This parameter adjusts the stand still torque after the steer handle is released and the travel demand deactivated.

It is in percentage of the maximum current. Injecting a continuous current in the motor generates the stand still torque. It is useful (together with the CREEP SPEED parameter) to neutralize the recall torque generated by the elastic tyre on the steered wheel.

5) PROGRAMMING & ADJUSTMENTS

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

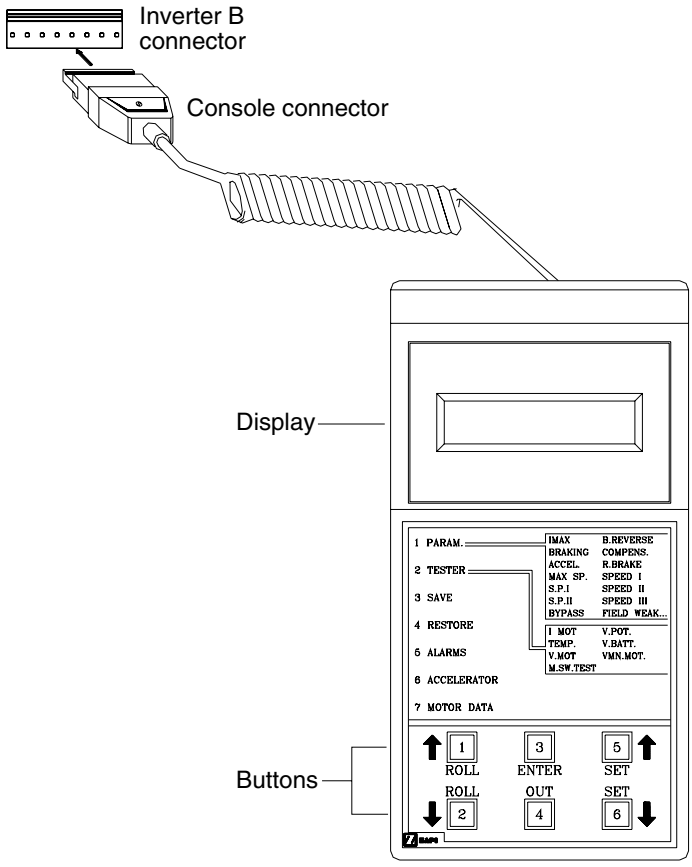
※ **Adjustments via buttons on a display, please refer to the display section.**

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 CNC connector of the inverter.

(1) Description of console



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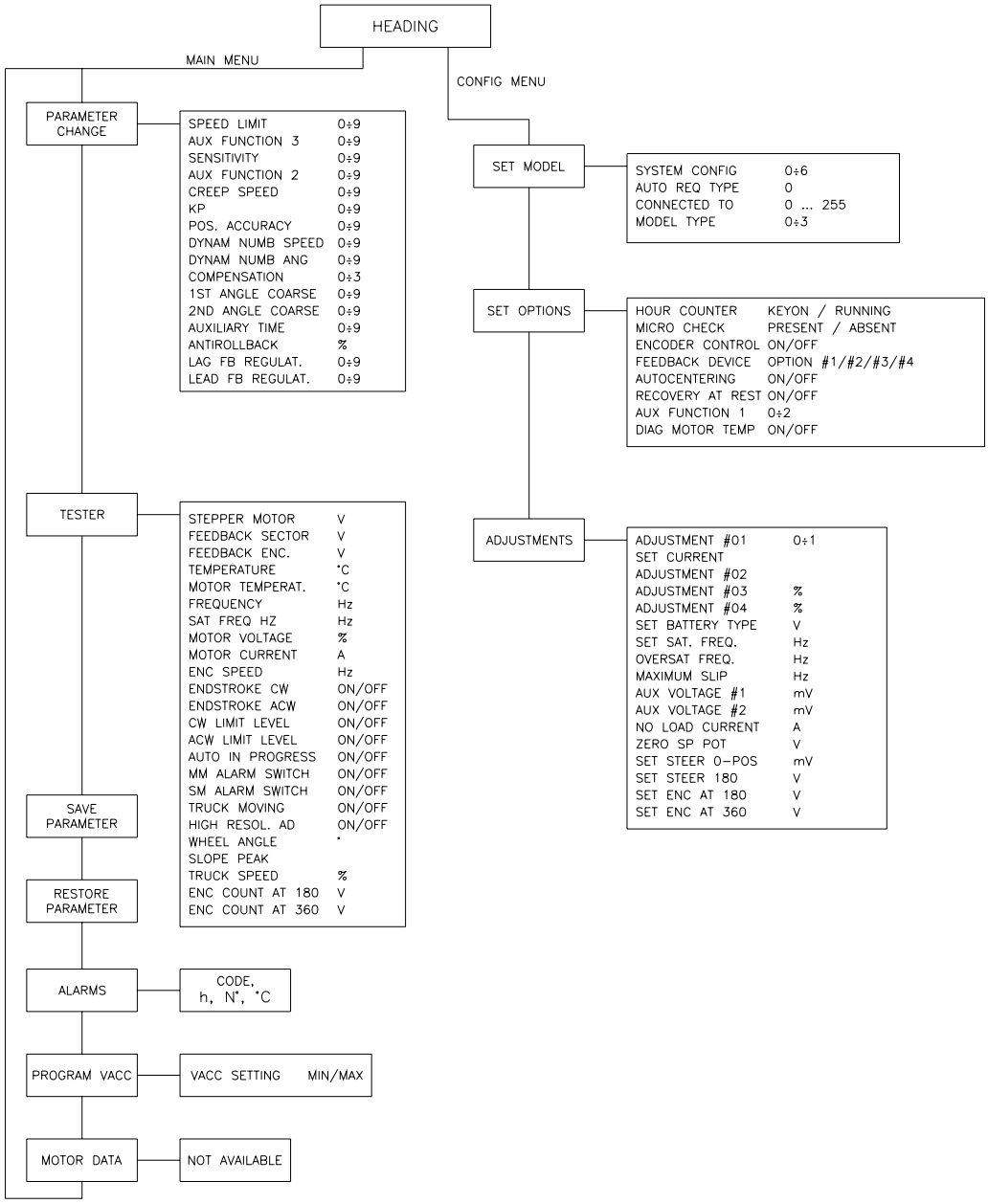
※ **Digital consoles used to communicate with AC inverter controllers must be fitted with EPROM CK ULTRA, minimum "Release Number 3.02".**

(2) Description of standard console menu



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6) TESTER MENU (IN DISPLAY, MONITORING MENU)

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) Stepper motor

Voltage value with 2 decimal digit. Measurement of the stepper motor speed with sign in the range 0 to 5 Vdc.

(2) Feedback sector

Voltage value with 2 decimal digit. Measurement (scaled in the range 0 to 5 Vdc) of the actual state of the toggle switches. The steered wheel revolution is divided into 4 quadrants (sectors) corresponding to two toggle switches configurations:

The steered wheel is in the 1ST sector (FEEDBACK SECTOR to 3.13V) when the configuration of the toggle switches is the one expected for a steered wheel angle in the range 0 to 90 degrees.

The steered wheel is in the 2ST sector (FEEDBACK SECTOR to 4.39V) when the configuration of the toggle switches is the one expected for a steered wheel angle in the range 90 to 180 degrees.

The steered wheel is in the 3RD sector (FEEDBACK SECTOR to 0.62V) when the configuration of the toggle switches is the one expected for a steered wheel angle in the range -180 to -90 degrees.

The steered wheel is in the 4TH sector (FEEDBACK SECTOR to 1.88V) when the configuration of the toggle switches is the one expected for a steered wheel angle in the range -90 to 0 degrees.

(3) Feedback ENC

Voltage value with 2 decimal digit. Measurement (scaled in the range 0 to 5 Vdc) of the position of the feedback encoder connected to CNB#7 and CNB#8.

(4) Temperature

Degrees. Temperature of the controller base plate.

(5) Motor temperature

Degrees. Temperature of the motor windings measured with the thermal sensor inside the motor and connected to CNB#3.

(6) Frequency

Hertz value with 2 decimal digit. This is the frequency applied to the steering motor.

(7) SAT. FREQ HZ

Hertz value with 2 decimal digit. This is a real time magnetic flux measurement: Vbattery/ SAT. FREQ HZ provides real time the linked flux in the motor. The flux in the motor is modulated from 75% to 100% of the maximum flux.

The maximum flux is Vbattery/SET SAT FREQ.

The minimum flux is Vbattery/(1.33*SET SAT FREQ). When the motor is loaded, SAT. FREQ HZ is equal to SET SAT FREQ; when the motor is lightened the flux reduces and SAT. FREQ HZ increases up to 1.33*SET SAT FREQ.

(8) Motor voltage

It is a percentage. 100% means the sine waves in the motor have the maximum PWM amplitude.

(9) Motor current

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

(10)ENC speed

Hertz value with 2 decimal digit. This is the speed of the motor measured with the encoder on the motor shaft.

(11)Endstroke CW

Provides real time the active state (ON) or not of the CW toggle switch (connected to CNA#3). It is On when CNA#3 is low.

(12)Endstroke ACW

Provides real time the active state (ON) or not of the CCW toggle switch (connected to CNA#2). It is On when CNA#2 is low.

(13)CW limit level

When the maximum angle limitation via feedback sensors is enabled (option LIMIT DEVICE to ON) and the FEEDBACK ENC overtakes the superior limit for the steered wheel angle limitation, the steered wheel angle will be limited and CW LIMIT LEVEL turns ON (active).

(14)ACW limit level

When the maximum angle limitation via feedback sensors is enabled (option LIMIT DEVICE to ON) and the FEEDBACK ENC is lower than the inferior limit for the steered wheel angle limitation, the steered wheel angle will be limited and ACW LIMIT LEVEL turns ON (active).

(15)Auto in progress

Provides real time the information the eps-ac0 follows the manual command (AUTO IN PROGRESS is OFF) or is executing an automatic centering (AUTO IN PROGRESS is ON).

(16)MM alarm switch

It is On when the safety contact belonging to the main uC is closed.

(17)SM alarm switch

It is On when the safety contact belonging to the slave uC (supervisor) is closed.

(18)Truck moving

It provides the state of the travel demand for driving the truck. This information is obtained either with the travel demands directly connected to CNA#1 or via CAN Bus (depending by the state of the CAN BUS setting).

(19)High resol AD

It turns ON when the set point potentiometer is processed with a high resolution AD (it occurs when the set pot potentiometer is close to the straight ahead position and SET HI RESOL AD is Level 1).

(20)Wheel angle

It provides the current angle of the drive wheel by the degree.

(21)Slope peak

This reading is just for debugging the maximum slope of the potentiometers connected to the eps-ac0. Especially for not redundant sensor equipments (just a single command potentiometer or just a single feedback potentiometer without encoder) a concern regarding the safety raises: if a single potentiometer fails a sudden movement of the steered wheel may occur with danger. To avoid this problem it is necessary to detect any failure in a single potentiometer. This is hard to do because the failure mode can be quite different. Anyway, the best countermeasure we can take is to seek for the wiper voltage changes faster than its physical limit. In fact, for the limited speed of the steering motor(or of the steering wheel), the slope in the wiper voltage must be limited under a certain threshold. When this slope threshold is overtook, the potentiometer may be assumed broken. So, it is useful to measure the maximum slope occurring in your application when right working, in order a right slope threshold can be chosen to avoid an alarm occurs when the potentiometer is not failed.

The SLOPE PEAK reading in the tester menu is a real time measurement of the slope peak of the potentiometers. In particular:

When the special adjustments DEBUG OUTPUT is other than Level 12 or 13, SLOPE PEAK supplies the slope peak of the CPOC1 set point potentiometer (CNA#9).

When the special adjustments DEBUG OUTPUT is Level 13, SLOPE PEAK supplies the slope peak of the CPOT feedback potentiometer (CNB#6).

When the special adjustments DEBUG OUTPUT is Level 12, SLOPE PEAK supplies the slope peak of the CPOC2 set point potentiometer (CNA#8).

The SLOPE PEAK measurement is the difference between two AD conversions of the selected potentiometer picked up with 16 msec long interval. The SLOPE PEAK reading can be converted in a Voltage change (V in volts) of the wiper voltage in an interval 16 msec long, with the formula:

V = SLOPE PEAK*5/1024 = Voltage change in Volts in 16 msec

(e.g. When SLOPE PEAK is 61 it means the selected potentiometer, in the worst case, changes 61*5/1024 =0.3 V in 16 msec.).

Obviously the SLOPE PEAK reading must be compared with the threshold for the STEER SENSOR KO alarmThe STEER SENSOR KO alarm may be adjusted.

(22)TRUCK SPEED

Percentage value. It represents the truck speed represented in percentage of the full drive speed. It is used for the dynamic numbness (i.e. the steering sensitivity reduces when the truck speed increases).

(23)ENC COUNT AT 360

Voltage value with two digits in the range 0 to +/-5Vdc value. This reading supplies the encoder counting corresponding to a complete steered wheel revolution in the range 0 to +/- 5.00Vdc. At rest it assumes a 5Vdc value, after a first valid falling edge on the straight ahead sensor it switches from 5Vdc to 0Vdc.

After a second valid falling edge on the straight ahead sensor it switches to an intermediate value (between 0Vdc and +/-5Vdc) corresponding to the encoder counting for a full steered wheel revolution.

See also 10.5 and 10.6. This reading may be manually saved on the adjustments SET ENC AT 360.

(24)ENC COUNT AT 180

Voltage value with two digits in the range 0 to +/-5Vdc value. This reading supplies the encoder counting corresponding to a quasi-half steered wheel revolution (measured between the first and the seconds end of the iron plate in figure 4-4- and 4-5) in the range 0 to +/- 5.00Vdc. At rest it assumes a 5Vdc value, after a first valid falling edge on the straight ahead sensor it switches from 5Vdc to 0Vdc. After a second valid falling edge on the straight ahead sensor it switches to an intermediate value (between 0Vdc and +/-5Vdc) corresponding to the encoder counting for a side to side iron plate rotation. See also 10.5 and 10.6. This reading may be manually saved on the adjustments SET ENC AT 180.

ENC COUNT AT 180 is expected being about a half of the ENC COUNT AT 360.

8. FINGERTIP CONTROLLER

1) INTRODUCTION OF FINGER TIP

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. That is what is called a finger tip or mini- lever system. The system is to apply electric levers 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

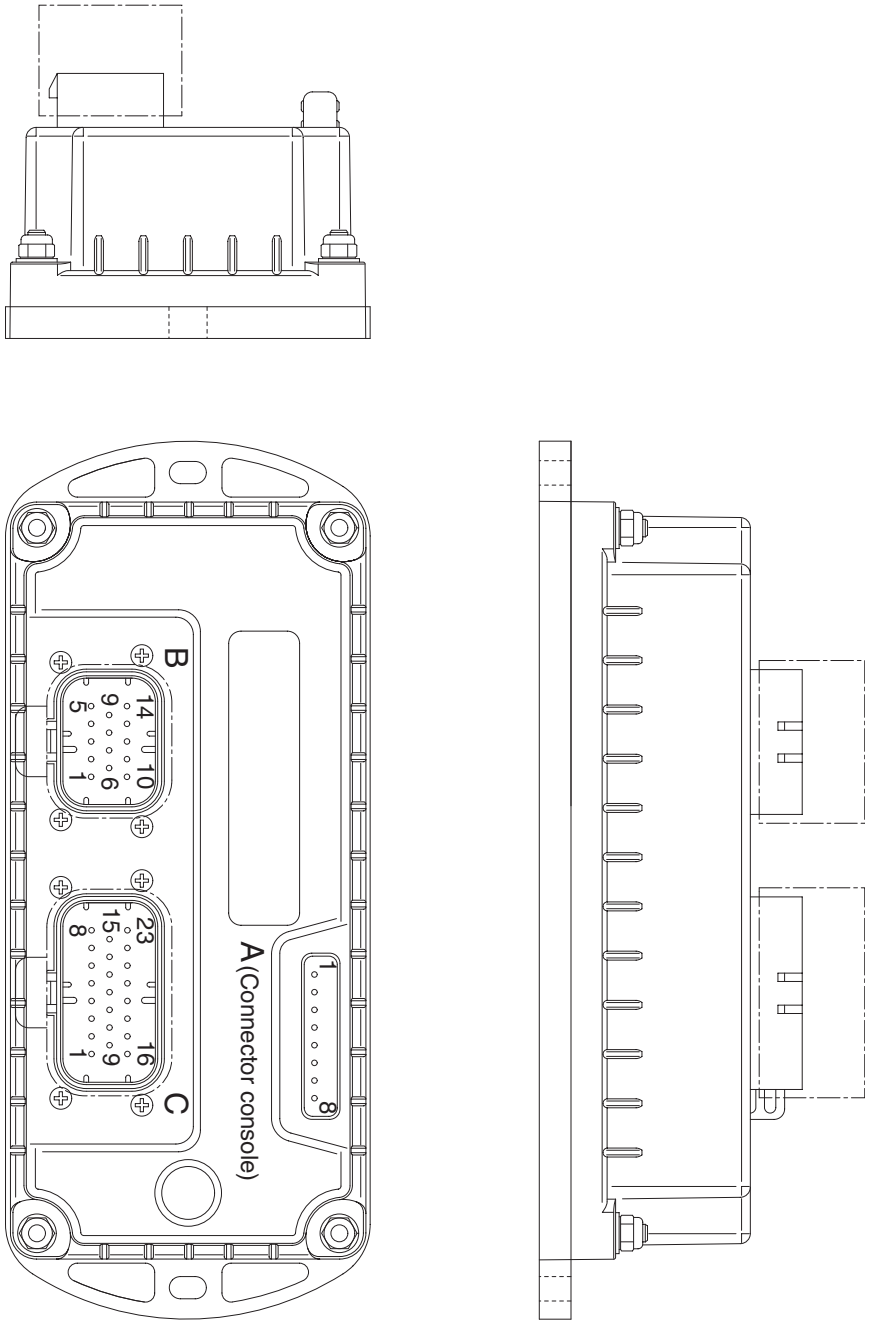
Voltage [V]	24/36/48/80V
Output for ON-OFF valves [n°]	3
Output for proportional valves [n°]	9
Digital inputs [n°]	3
Analog inputs [n°]	1
RS-232 [n°]	1
CAN [n°]	1
Protection	IP65

(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



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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 to insert a 120 ohm termination resistance
B10	PPO_S	Positive supply of analog devices (+12 V) (Joystick, cantiller, can encoder)
B13	CAN_H	Can high signal in
B14	CANH_OUT	Can high signal out
C1	NEVP1	Negative of the proportional electro valve lift up.
C2	PEVP1/2	Positive of the proportional electro valves lift up & lowering.
C3	NEVP2	Negative of the proportional electro valve lowering.
C4	NEVP3	Negative of the proportional electro valve reach out.
C5	PEVP3/4	Positive of the proportional electro valves reach in & reach out.
C6	NEVP4	Negative of the proportional electro valve reach in.
C7	NEVP5	Negative of the proportional electro valve tilt up.
C8	PEVP5/6	Positive of the proportional electro valves tilt up & tilt down.
C9	NEV1	Buzzer relay negative.
C10	NEV2	Horn relay negative.
C11	NEV3	Fan relay negative.
C12	NEVP7	Negative of the proportional electro valve side shift right.
C13	PEVP7/8	Positive of the proportional electro valves side shift right & left.
C14	NEVP8	Negative of the proportional electro valve side shift left.
C15	NEVP6	Negative of the proportional electro valve tilt down.
C16	PEV1	Buzzer relay positive.
C17	PEV2	Horn relay positive.
C18	PEV3	Fan relay positive.
C23	-BATT	Mhyrio CB negative supply

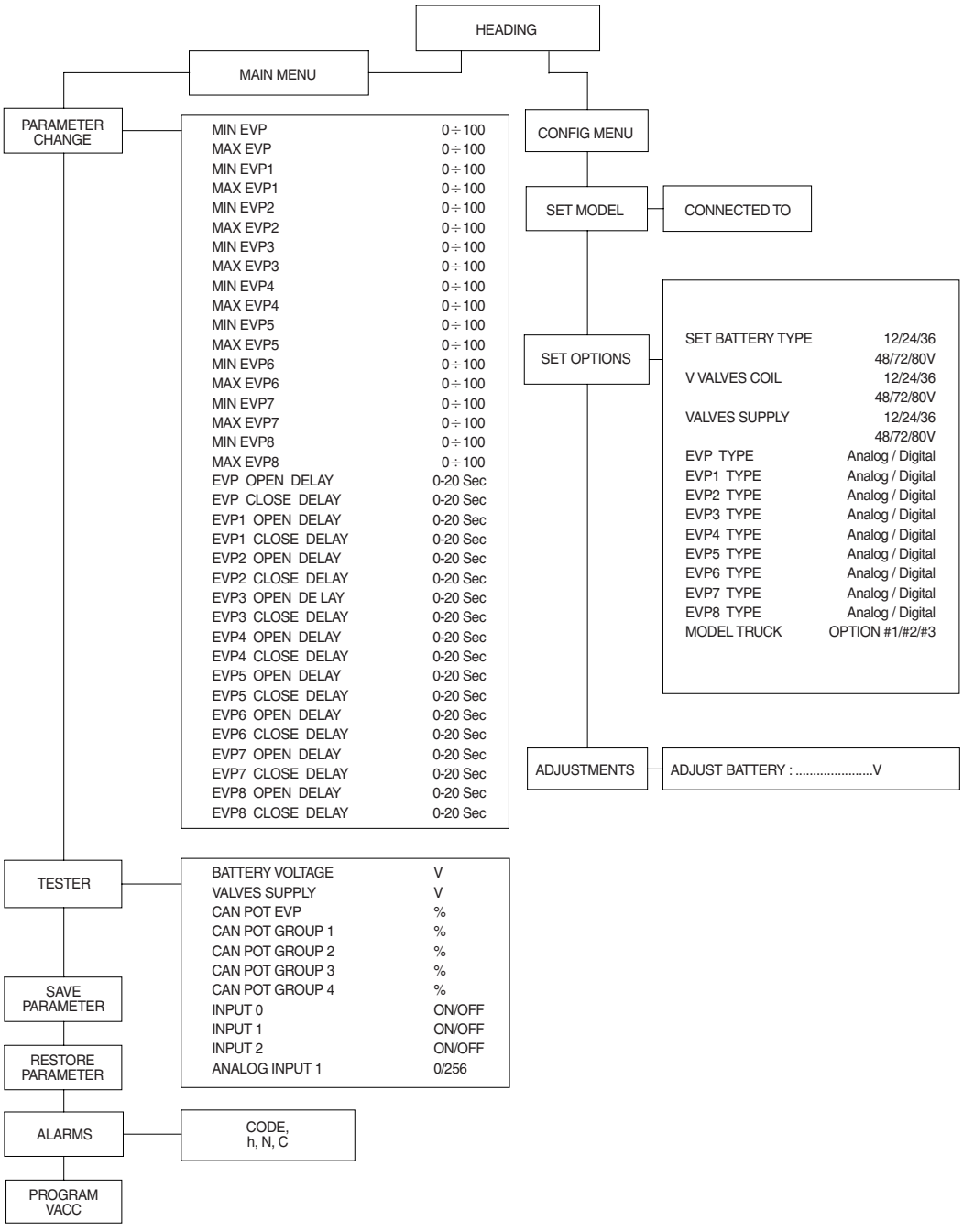
5) ADJUSTMENTS & FUNCTION

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"

① **Min EVP**

This parameter adjusts the minimum current of the SINGLE valve, if it is set as proportional (see "set option menu").

② **Max EVP**

This parameter adjusts the MAXIMUM current of the SINGLE valve, if it is set as proportional (see "set option menu").

③ **Min EVP1**

This parameter adjusts the minimum current of valve 1, if it is set as proportional (see "set option menu").

④ **Max EVP1**

This parameter adjusts the maximum current of valve 1, if it is set as proportional (see "set option menu").

⑤ **Min EVP2**

This parameter adjusts the minimum current of valve 2, if it is set as proportional (see "set option menu").

⑥ **Max EVP2**

This parameter adjusts the maximum current of valve 2, if it is set as proportional (see "set option menu").

⑦ **Min EVP3**

This parameter adjusts the minimum current of valve 3, if it is set as proportional (see "set option menu").

⑧ **Max EVP3**

This parameter adjusts the maximum current of valve 3, if it is set as proportional (see "set option menu").

⑨ **Min EVP4**

This parameter adjusts the minimum current of valve 4, if it is set as proportional (see "set option menu").

⑩ **Max EVP4**

This parameter adjusts the maximum current of valve 4, if it is set as proportional (see "set option menu").

⑪ **Min EVP5**

This parameter adjusts the minimum current of valve 5, if it is set as proportional (see "set option menu").

⑫ **Max EVP5**

This parameter adjusts the maximum current of valve 5, if it is set as proportional (see "set option menu").

⑬ **Min EVP6**

This parameter adjusts the minimum current of valve 6, if it is set as proportional (see "set option menu").

⑭ **Max EVP6**

This parameter adjusts the maximum current of valve 6, if it is set as proportional (see "set option menu").

⑮ **Min EVP7**

This parameter adjusts the minimum current of valve 7, if it is set as proportional (see "set option menu").

⑯ **Max EVP7**

This parameter adjusts the maximum current of valve 7, if it is set as proportional (see "set option menu").

⑰ **Min EVP8**

This parameter adjusts the minimum current of valve 8, if it is set as proportional (see "set option menu").

⑱ **Max EVP8**

This parameter adjusts the maximum current of valve 8, if it is set as proportional (see "set option menu").

⑲ **EVP Open delay**

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**

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**

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**

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**

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**

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**

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**

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**

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**

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**

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**

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**

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**

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**

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**

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**

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**

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).

② **V Valves Coil**

This parameter sets the ON/OFF valves coil nominal voltage.

③ **Valves Supply**

This parameter sets the voltage of the valve's coil positive supply.

④ **Model Truck**

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

- 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.

※ The method of discharging internal capacitor

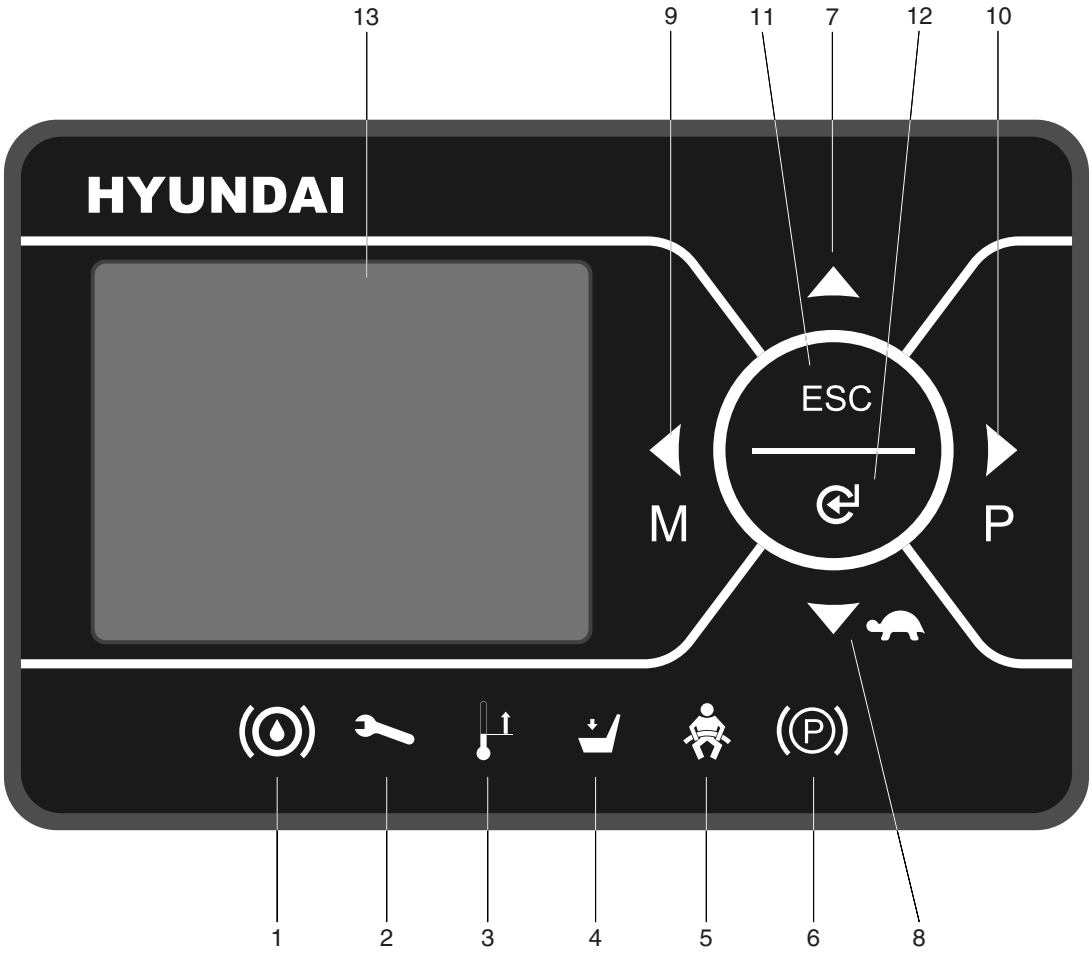
Bofore checking controllers, motors, cables and etc., discharge the internal capacitor in controllers by following below steps ;

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

9. DISPLAY

1) STRUCTURE

The instrument panel (display) has six built-in red LED, which provide the operator with an easy information about the status of some truck devices.

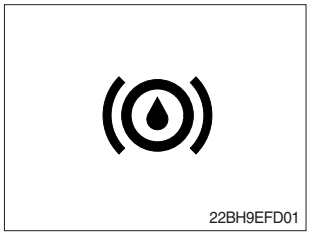


22BH9OM65

1 Oil level warning lamp
2 Wrench warning lamp
3 Thermometer warning lamp
4 Seat warning lamp
5 Seat belt warning lamp
6 Parking brake warning lamp
7 Up button
8 Down/turtle button
9 Left/menu button
10 Right/performance button
11 ESC button
12 Enter button
13 LCD function

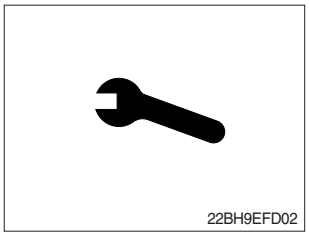
2) WARNING LAMP

(1) Brake oil level warning lamp



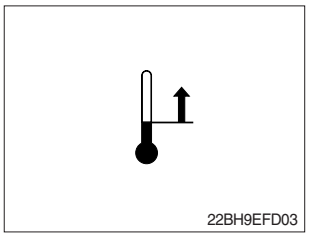
This LED lights when measured level of brake oil stored in reservoir tank is below the minimum acceptable mark.
This lamp doesn't work in BRJ-9 model, which doesn't have any hydraulic brake.

(2) Wrench warning lamp



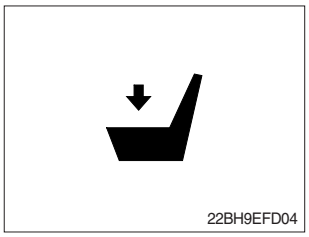
This LED lights when an electric device (controller, motor, cable, etc.) is in abnormal condition.

(3) Thermometer warning lamp



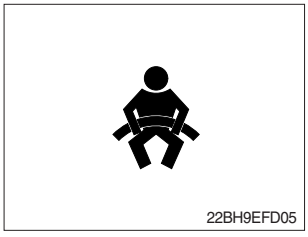
This LED lights when the controller or motor temperature is high.

(4) Seat warning lamp



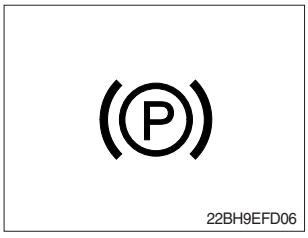
This LED lights when the operator is not on the seat.

(5) Seat belt warning lamp



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

(6) Parking brake warning lamp

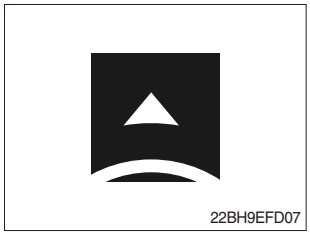


(1) This LED lights when the parking brake is activated.
This lamp doesn't work in BRJ-9 model do to a lack of parking brake.

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

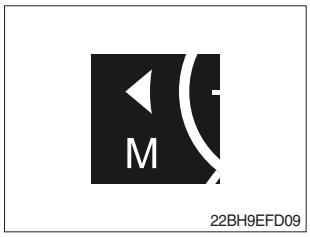


Press to select upward move.

(2) DOWN/TURTLE button

Press to select downward move.
TURTLE MODE ON/OFF

(3) LEFT/MENU button

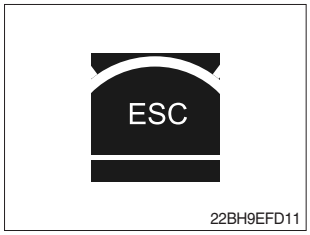


Press to select leftward move.
Go into the menu.

(4) RIGHT/PERFORMANCE button

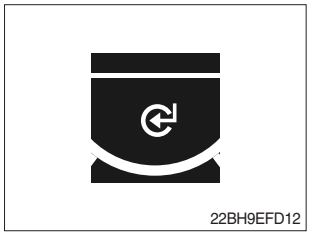
Press to select rightward move.
POWER MODE H/N/E

(5) Cancel (ESC) button



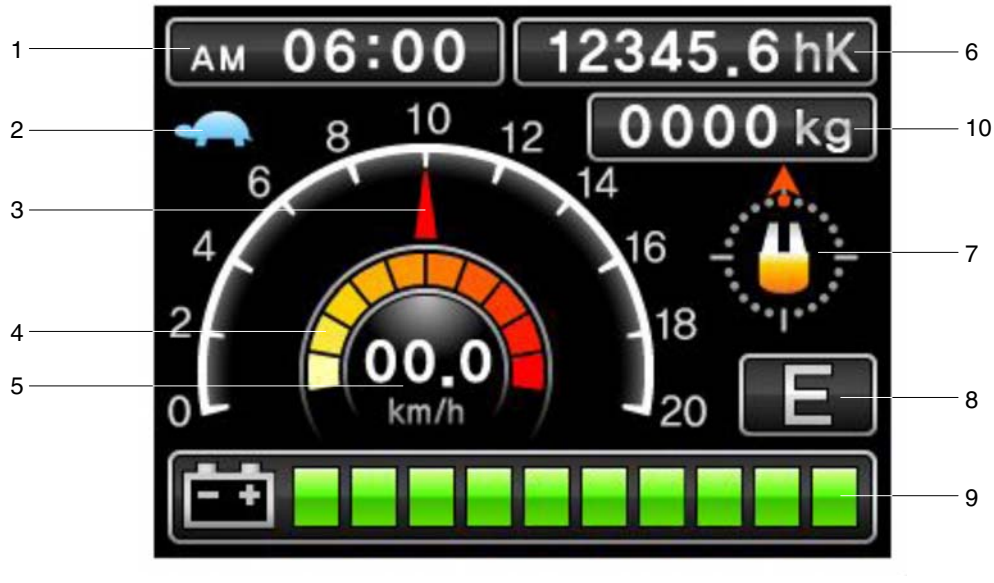
Press to select cancel.
Keep pressing this button shows PASSWORD entry field.

(6) ENTER button



Press to select Enter.

4) LCD FUNCTION



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 at page 7-78.

(2) Turtle mode

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

(3) Truck speed pointer

The speed of the truck is indicated with a pointer.

(4) Speed level

It indicates the speed level by 2 km.

(5) Truck speed

The truck speed is shown in number. The unit can be km/h or mph according to the display setting (see 7-78 page).

(6) Hour meter

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

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

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

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

(7) Wheel position and running direction

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

(8) Power mode

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

H (High) – corresponds to the highest performance

N (Normal) – corresponds to normal performance

E (Economic) – corresponds to economic performance

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

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

※ How to adjust BDI

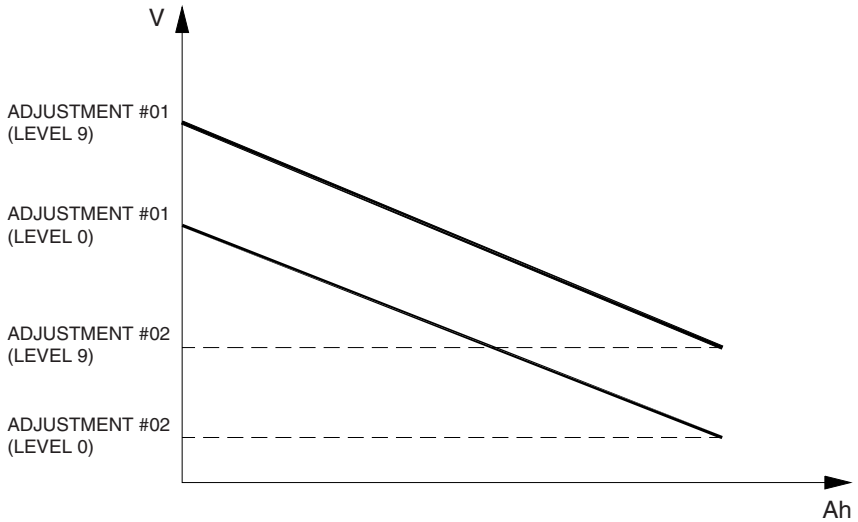
Service engineer can adjust BDI level simply by adjusting "adjustment #1, #2 BDI" parameter in truck menu - settings →traction → adjustments.

① Adjustment #1 BDI

It adjusts the upper level of the battery discharge table.

② Adjustment #2 BDI

It adjusts the lower level of the battery discharge table.



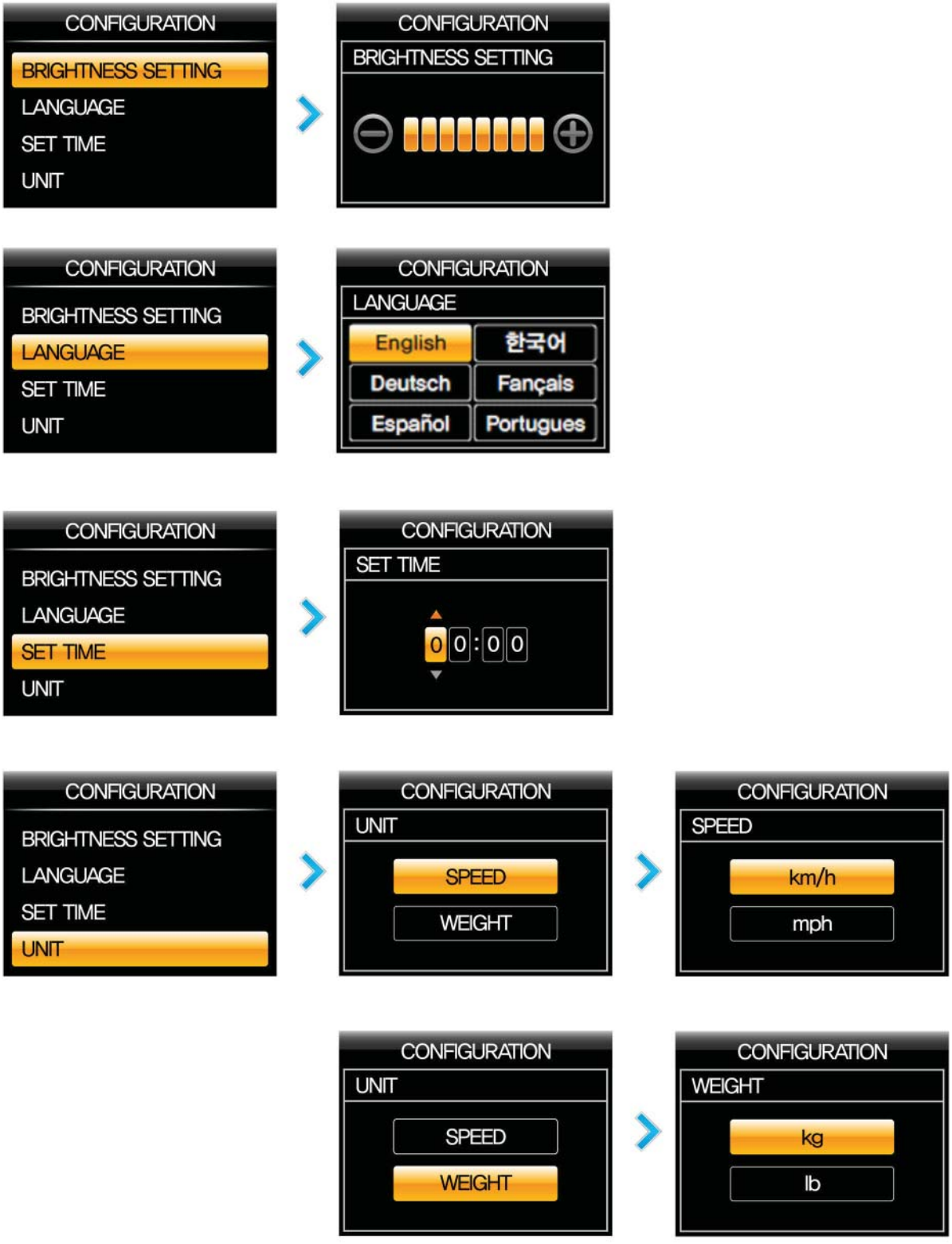
BRJ7EL13

(10) Load weight (option)

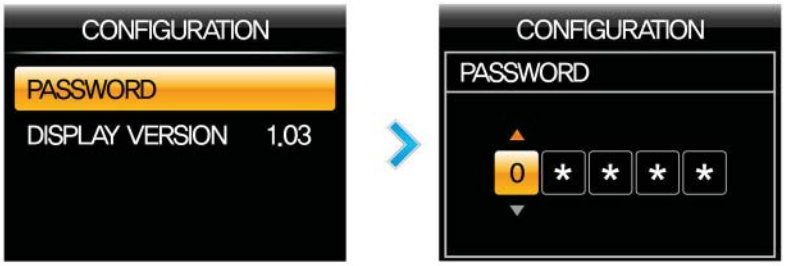
The indicator shows the weight the machine carrying at load.

- Indicator range : 0~6375 kg

5) HOW TO SET THE DISPLAY MENU



22BH9EFD14


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

22BH9EFD15

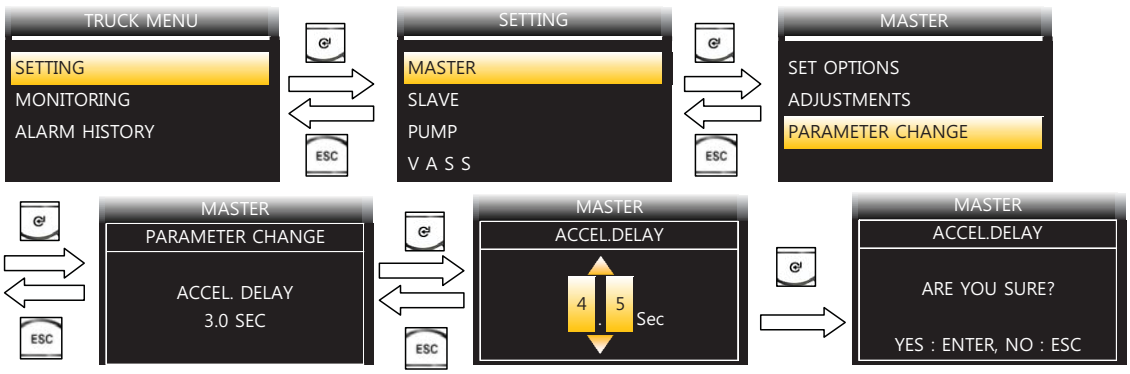
6) DESCRIPTION OF THE TRUCK MENU

(1) Access to truck menu

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

(2) How to change detail menus

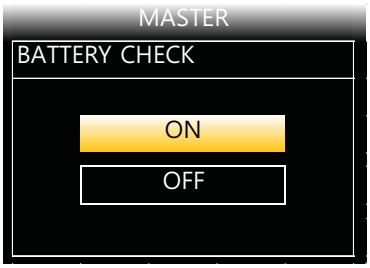
The detail items of menu can be changed as follows ;



22B9EL24

Selection can be made in 4 methods as follows ;

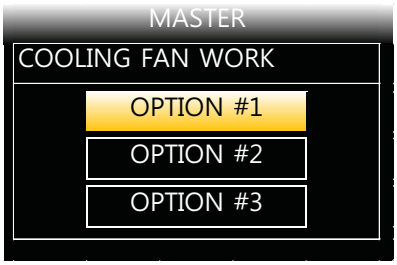
- ON/OFF Selection



22B9EL25

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

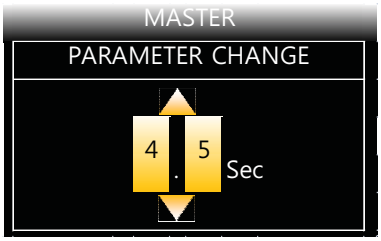
- Type Selection



22B9EL30

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

- Level Selection



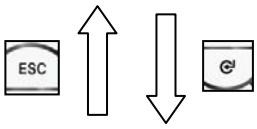
22B9EL30

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

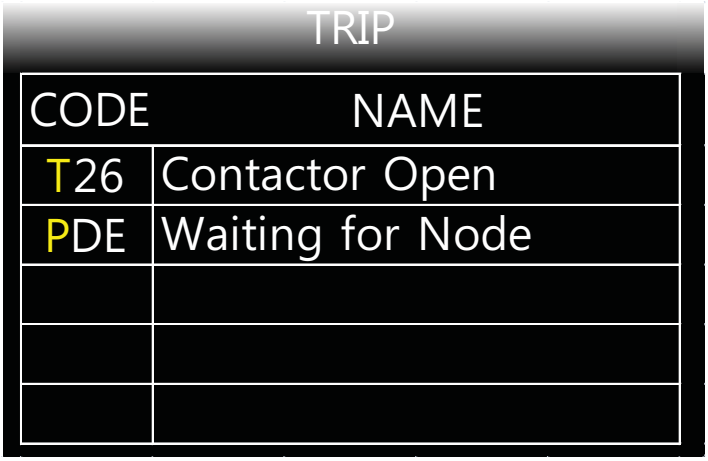
7) ALARM & ALARM HISTORY

(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 :

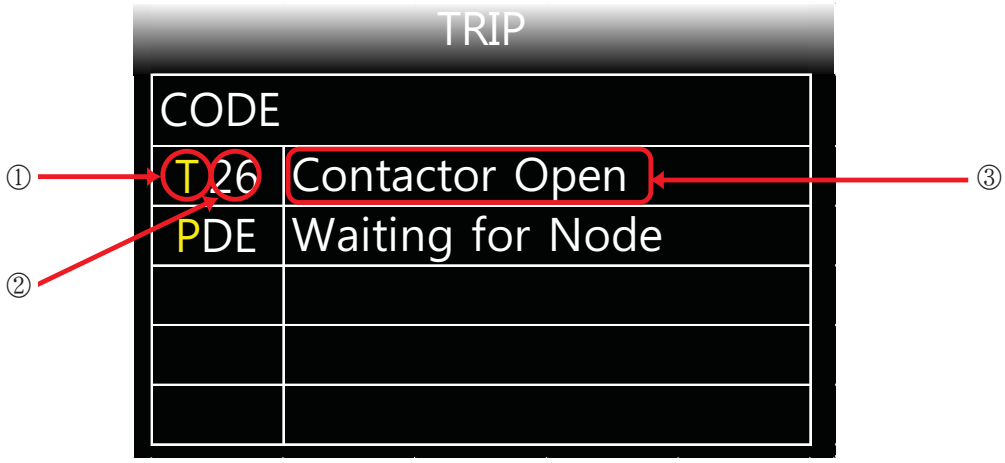


(Press more than 1 sec)



18BR9EL35

(2) Detail description of ALARM SCREEN

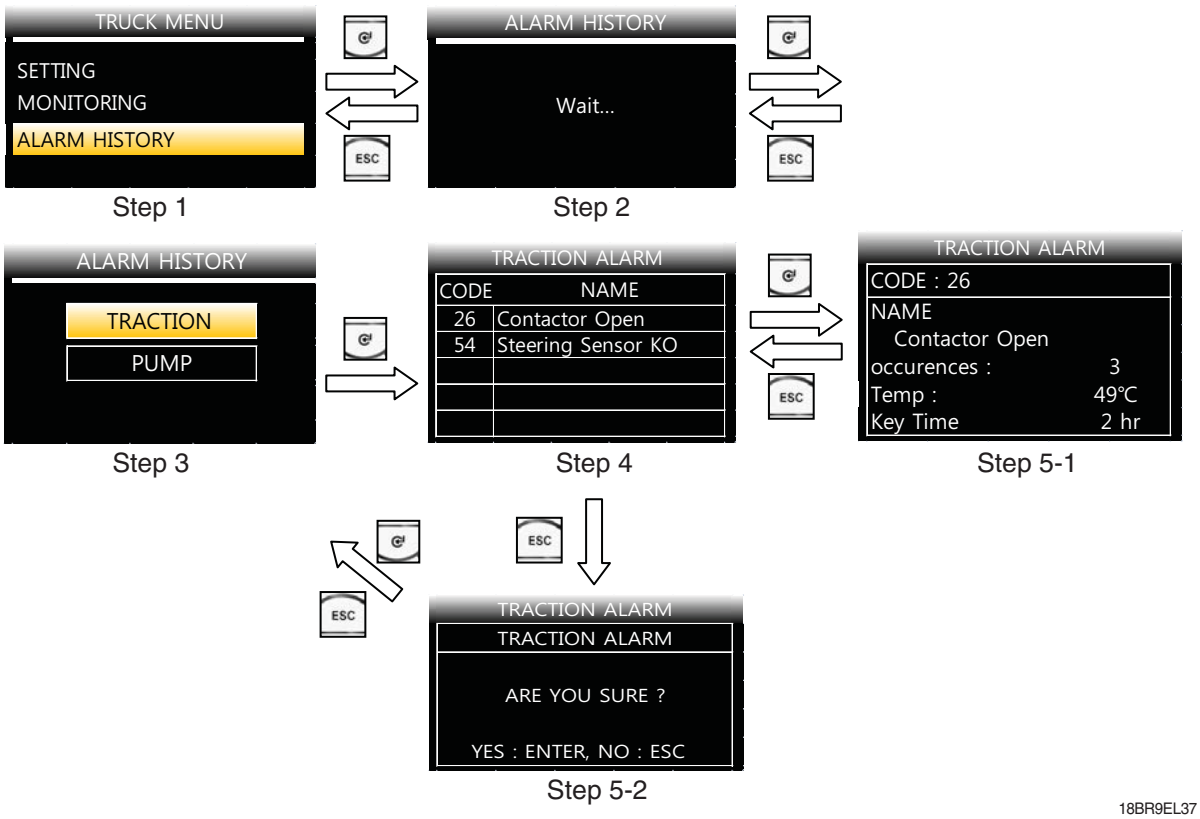


18BR9EL36

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 12) DIAGNOSTIC FAULT CODES (Page 7-93).
③ This shows a name of ALARM. Please refer to 12) DIAGNOSTIC FAULT CODES (page 7-93).

(3) Alatm history

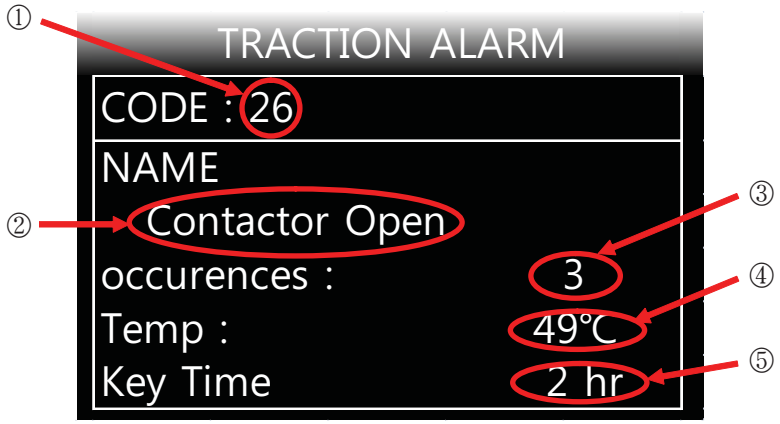
Alarm History can be looked up as follows ;



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.
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.

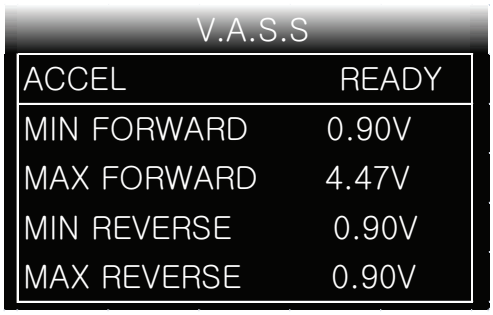
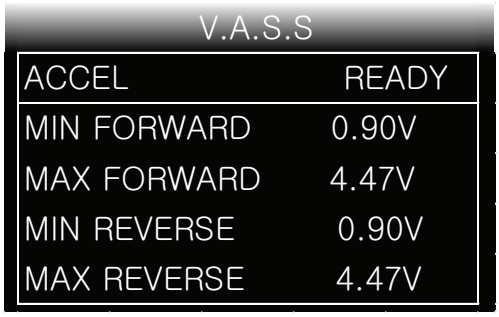
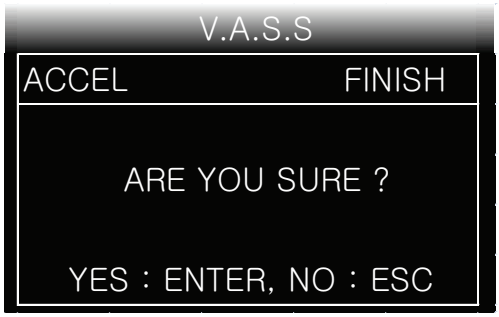
8) VASS SETUP USING DISPLAY MENU

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

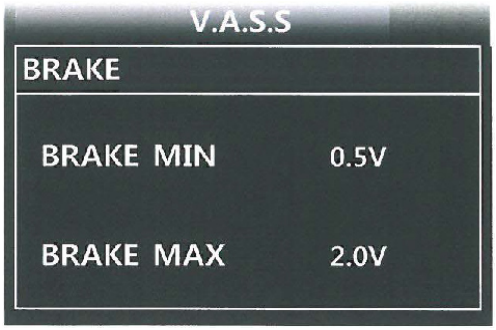
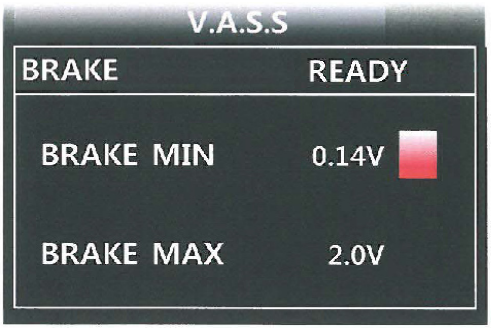
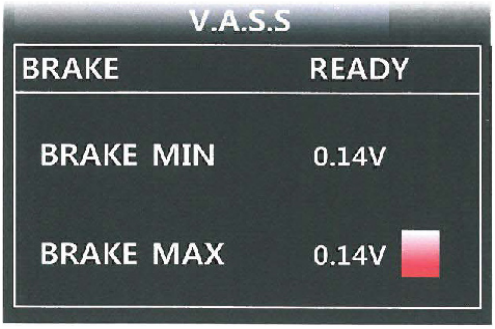
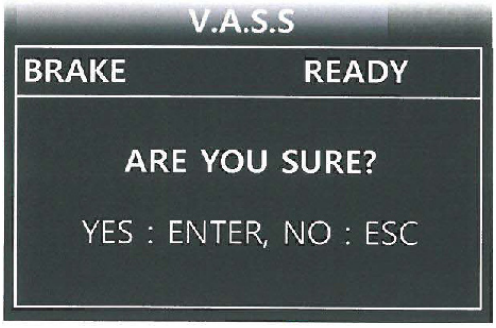
※ While even a motor is running, VASS can not be configurated properly, so please be sure that all motors are not running before entering configuration process & saving.

(1) ACCEL VASS setting method

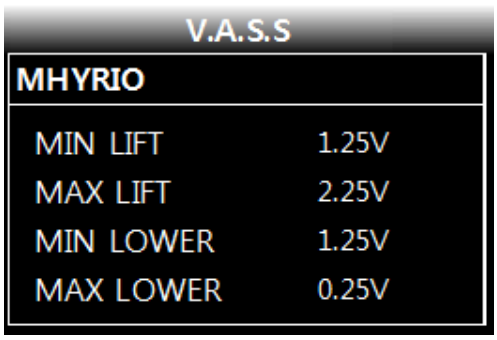
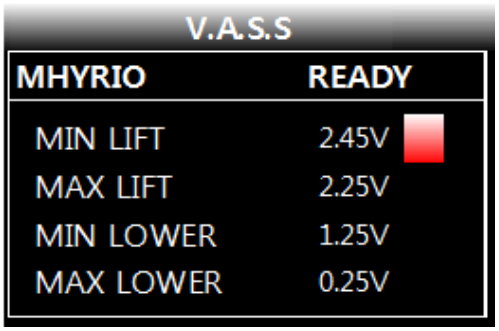
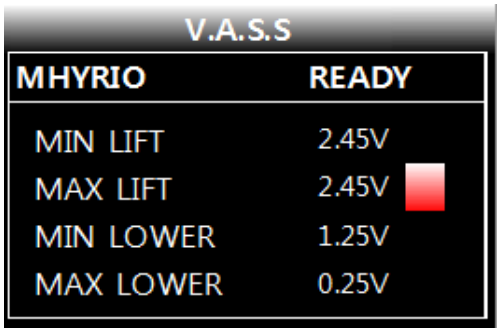
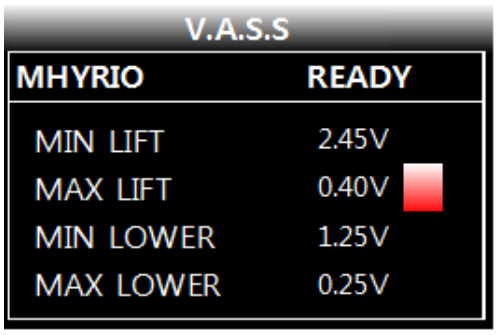
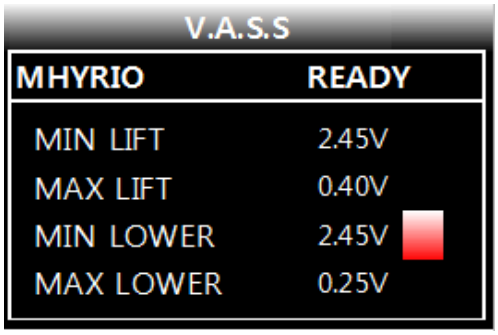
Step	Display	Description
1	V.A.S.S ACCEL MIN FORWARD 0.76V MAX FORWARD 1.76V MIN REVERSE 0.76V MAX REVERSE 1.76V	1. Access the ACCEL setting screen via "TRUCK MENU → SETTINGS → V.A.S.S → ACCEL". 2. Make sure that traction and hydraulic motors are not running and direction control switch is in NEUTRAL position and press the "ENTER" button.
2	V.A.S.S ACCEL READY MIN FORWARD 0.76V MAX FORWARD 1.76V MIN REVERSE 0.76V MAX REVERSE 1.76V	1. If “READY” appears beside ACCEL, you are in configuration process. 2. Set direction control switch in FORWARD position.
3	V.A.S.S ACCEL READY MIN FORWARD 0.90V MAX FORWARD 0.90V MIN REVERSE 0.76V MAX REVERSE 1.76V	1. Now, you can see that voltage value of MIN FORWARD and MAX FORWARD are changed. 2. Step on accel pedal fully, then Take foot off accel pedal.
4	V.A.S.S ACCEL READY MIN FORWARD 0.90V MAX FORWARD 4.47V MIN REVERSE 0.76V MAX REVERSE 1.76V	1. Now, you can see that voltage value of MAX FORWARD are changed. 2. Set direction control switch in REVERSE position. (Sometimes, depending on controller model, MIN FORWARD value looks like that it is fixed as 0.0V, which is normal.)

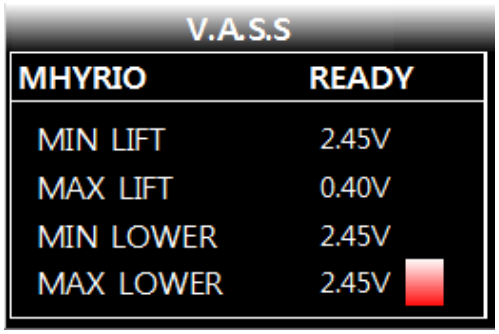
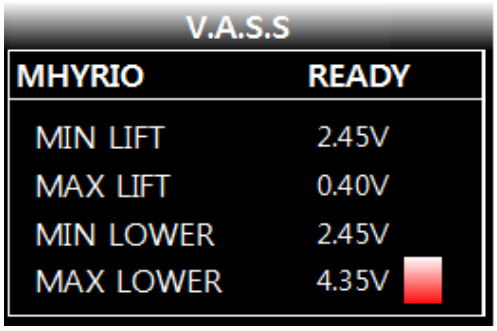
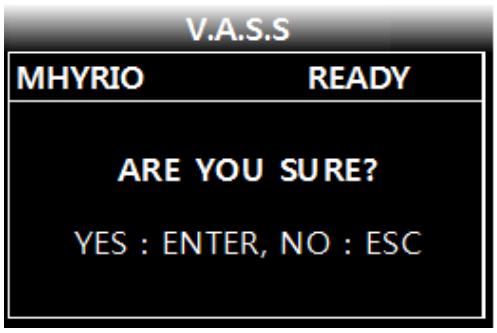
Step	Display	Description
5		1. Now, you can see that voltage value of MIN REVERSE and MAX REVERSE are changed. 2. Step on accel pedal fully, then Take foot off accel pedal.
6		1. Now, you can see that voltage value of MAX REVERSE are changed. 2. Make sure that traction and hydraulic motors are not running and direction control switch is in NEUTRAL position and press the "ENTER" button.
7		1. Press the "ENTER" button.

(2) BRAKE VASS setting method

Step	Display	Description
1		1. Access the BRAKE setting screen via "TRUCK MENU → SETTINGS → V.A.S.S → ACCEL". 2. Make sure that traction and hydraulic motors are not running and direction control switch is in NEUTRAL position and press the "ENTER" button.
2		1. When the READY indicator appears in the upper right corner of the screen, start setting. 2. Press the "ENTER" button while not to step on brake pedal to set the minimum value.
3		1. Go to brake maximum setting. 2. Step on brake pedal fully to set the maximum value.
4		1. The maximum value is rising as much as pressing the pedal. 2. Press the "ENTER" button while pressing the pedal fully.
5		1. The display will ask "ARE YOU SURE?" Press the "ENTER" button to save. ※ Check the setting values by reentering the setting screen via TRUCK MENU → SETTINGS → V.A.S.S → BRAKE.

(3) FINGERTIP LEVER VASS setting method

Step	Display	Description
1		1. Access the FINGERTIP LEVER setting screen via "TRUCK MENU → SETTINGS → V.A.S.S → MHYRIO". 2. In the left screen, use the "LEFT : MENU" and "RIGHT" button to select the LIFT, REACH, TILT, AUX lever. Set the LEVER by pressing the ENTER button as shown below. 3-SPOOL : LIFT, REACH, TILT 4-SPOOL : LIFT, REACH, TILT, AUX 3. For illustrative purposes, following will set the LIFT lever by pressing the "ENTER" button.
2		1. The screen change to MIN LIFT (lift up minimum value) setting and display the present lever value. 2. Leave the lever untactly and press the ENTER button to set MIN LIFT (lift up minimum value).
3		1. The screen change to MAX LIFT (lift up maximum value) setting and display the present lever value. 2. Pull the lever fully because of MAX LIFT (lift up maximum value) setting.
4		1. You can see that the MAX LIFT (lift up maximum value) has changed. 2. While pulling the LIFT lever fully, press the "ENTER" button to set the MIN LOWER value.
5		1. The screen change to MIN LOWER (lift down minimum value) setting and display the present lever value. 2. Leave the lever untactly and press the ENTER button to set MIN LOWER (lift down minimum value).

Step	Display	Description
6		1. The screen change to MAX LOWER (LIFT DOWN maximum value) setting and display the present lever value. 2. Push the lever fully because of the MAX LOWER (lift down maximum value) setting.
7		1. You can see that the MAX LOWER (lift down maximum value) has changed. 2. While pushing the LIFT lever fully (while keep the MAX LOWER condition), press the "ENTER" button.
8		1. The display will ask "ARE YOU SURE?" 2. While pushing the LIFT lever fully (while keep the MAX LOWER condition), press the "ENTER" button and finish the setting. 3. Set the REACH, TILT, AUX setting same as the LIFT method.

(4) LOAD WEIGHT VASS setting method

① Activate the LOAD SENSOR parameter to use LOAD WEIGHT menu as below.
TRUCK MENU → SETTINGS → PUMP → SET OPTIONS → LOAD SENSOR : ON

② Set standard weight (reference weight) value to lift for setting.
TRUCK MENU → SETTINGS → PUMP → ADJUSTMENTS → REFERENCE WEIGHT

③ Set the warning weight (overload weight) to warn when the weight exceeds the set weight.
TRUCK MENU → SETTINGS → PUMP → ADJUSTMENTS → OVERLOAD WEIGHT

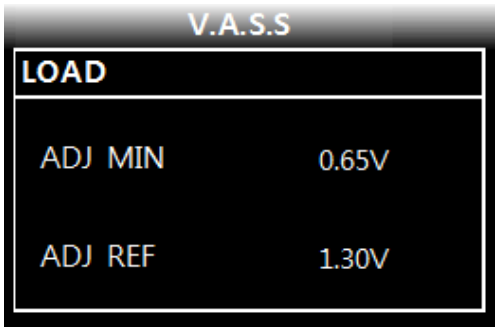
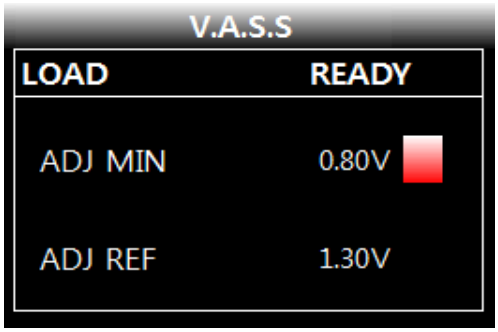
④ Set OVERLOAD TYPE to NONE to prevent occurring the warning.
TRUCK MENU -> SETTINGS -> PUMP -> SET OPTIONS -> OVERLOAD TYPE

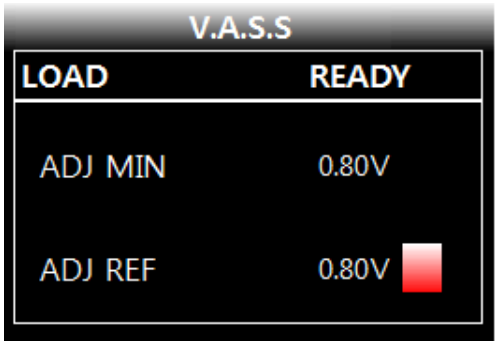
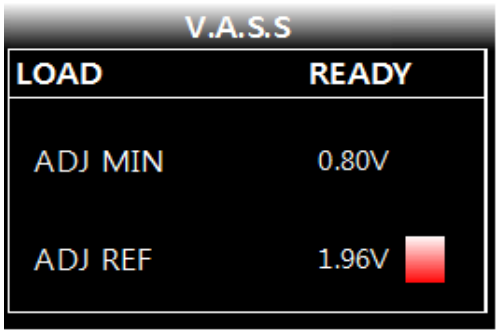
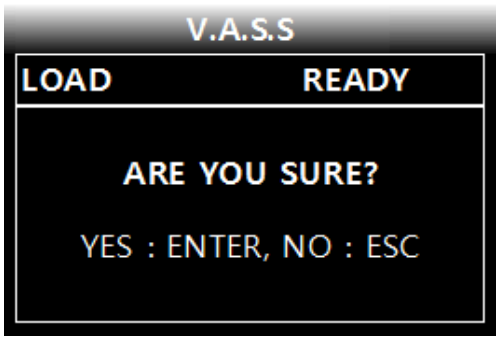
※ OVERLOAD TYPE parameter : Define the truck operation when the weight exceeds the set weight.

- NONE : No warning even if the load weight exceeds the OVERLOAD WEIGHT setting.
- OPTION #1 : OVERLOAD warning occurs when the lifting load weight exceeds the OVERLOAD WEIGHT setting value, and restriction the truck operation.
- OPTION #2 : OVERLOAD warning occurs only when the load weight exceeds the OVERLOAD WEIGHT setting.

※ The load sensor alarm occur and the truck stop when the lifting weight exceeds set the weight of the OVERLOAD WEIGHT parameter regardless of the OVERLOAD TYPE setting.

⑤ Set the LOAD SENSOR value as below.

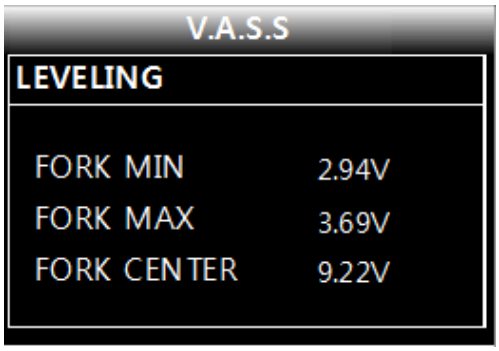
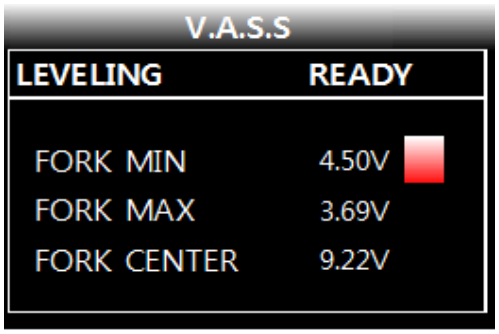
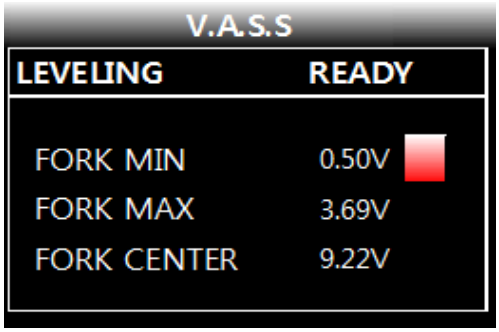
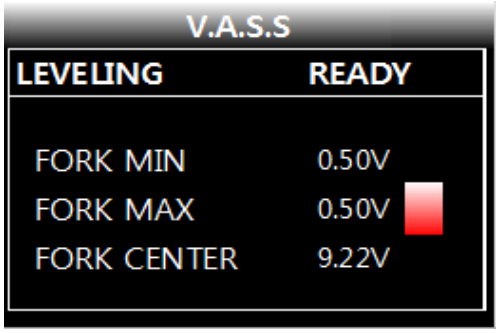
Step	Display	Description
1		1. Access the LOAD setting screen via TRUCK MENU -> SETTINGS -> V.A.S.S -> LOAD (LOAD SENSOR parameter setting : ON, see ①) 2. Make sure that traction and hydraulic motors are not running and direction control switch is in NEUTRAL position and press the "ENTER" button to start setting.
2		1. When the READY indicator appears in the upper right corner and red mark appears beside ADJ MIN of the screen, start ADJ MIN LOAD setting. Display the ADJ MIN value that LOAD SENSOR input value is the no-load condition and starting the setting. 2. Press the "ENTER" button to go to ADJ REF setting.

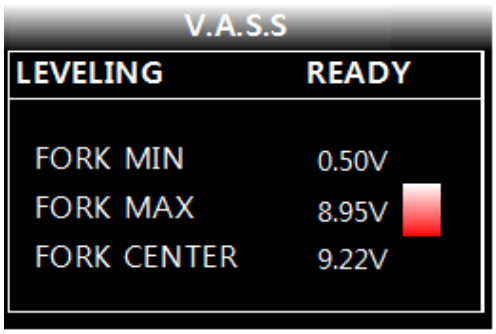
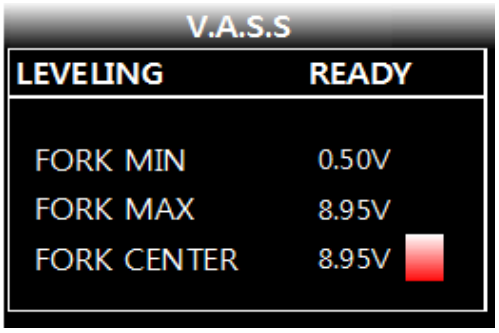
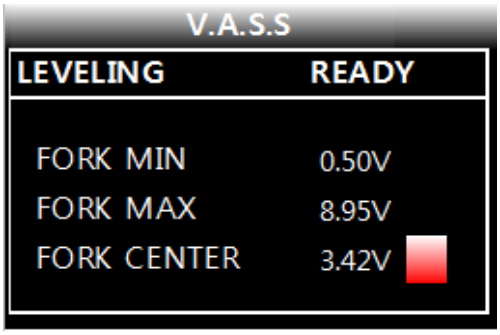
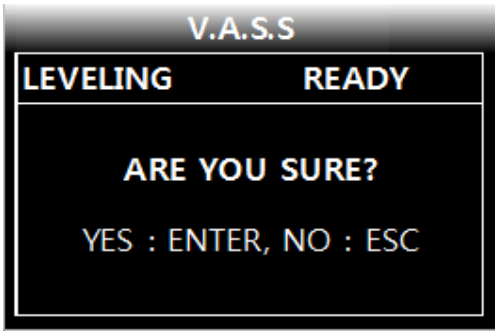
Step	Display	Description
3		1. The ADJ REF setting is started when red mark appears beside ADJ REF of the screen. 2. The ADJ REF setting defines reference weight of the LOAD SENSOR input value that the overload warning occurs. Set direction control switch in forward position and lift the reference weight up to about 50 cm from the ground. 3. You can see that the ADJ REF parameter value has changed as lifting the reference weight.
4		1. Lift the reference weight and wait about 5~10 seconds elapsed. Make sure that the ADJ REF value stabilizes, then press the ENTER button with the reference weight lifting condition.
5		1. The display will ask "ARE YOU SURE?" 2. Press the "ENTER" button to save and exit. 3. Leave the OVERLOAD TYPE parameter in step 4 as NONE. ※ For accuracy of LOAD SENSOR, the reference weight for the setting should be as heavy as possible within the range of not exceeding OVERLOAD WEIGHT.

(5) AUTO TILT LEVELING VASS setting method

① Activate the FORK LEVELING parameter to use AUTO TILT LEVELING menu as below.
TRUCK MENU → SETTINGS → PUMP → SET OPTIONS → FORK LEVELING : ON

② Set the FORK LEVELIN SENSOR value as below.

Step	Display	Description
1		1. Access the TILT SENSOR setting screen via TRUCK MENU → SETTINGS → V.A.S.S → FORK LEVELING. 2. As shown on the left screen, the TILT SENSOR setting screen appears. 3. Make sure that traction and hydraulic motors are not running and direction control switch is in NEUTRAL position and press the "ENTER" button to start the setting.
2		1. When the READY indicator appears in the upper right corner and red mark appears beside FORK MIN of the screen, start FORK MIN setting. Display the TILT SENSOR value at present. 2. Push the tilt lever forward (TILT OUT) fully to set the FORK MIN (TILT SENSOR value at maximum tilt out)
3		1. The FORK MIN value is changed as proceeding the TILT OUT. 2. Press the "ENTER" button at the maximum TILT OUT condition and go to the FORK MAX setting.
4		1. You can see that the red mark appears beside FORK MIN of the screen and the input value of the TILT SENSOR at present. 2. Pull the tilt lever backward (TILT IN) fully to set the FORK MAX (TILT SENSOR value at maximum tilt in).

Step	Display	Description
5		1. The FORK MAX value is changed as proceeding the TILT IN. 2. Press the "ENTER" button at the maximum TILT IN condition and go to the FORK CENTER setting.
6		1. You can see that the red mark appears beside FORK CENTER of the screen and the input value of the TILT SENSOR at present. 2. Adjust the tilt lever to set the FORK CENTER horizontally (TILT SENSOR value at fork horizontal condition).
7		1. The FORK CENTER value is changed as proceeding the TILT HORIZONTAL position. 2. Make sure that traction and hydraulic motors are not running and direction control switch is in NEUTRAL position and press the "ENTER" button when the FORK become a horizontal position.
8		(1) The display will ask "ARE YOU SURE?" (2) Press the "ENTER" button to save and exit

(6) HEIGHT INDICATOR setting and operation

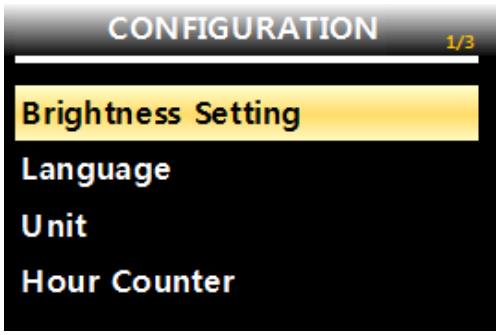
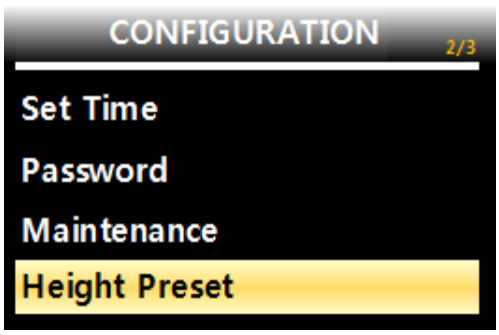
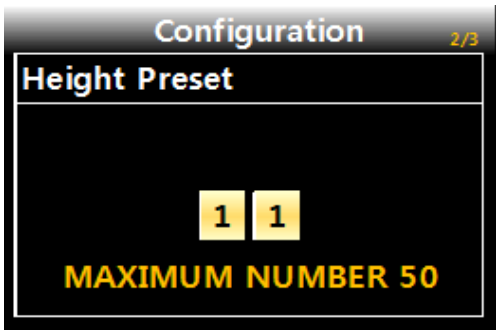
① HEIGHT INDICATOR function

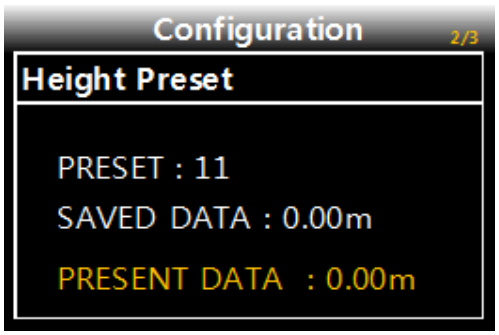
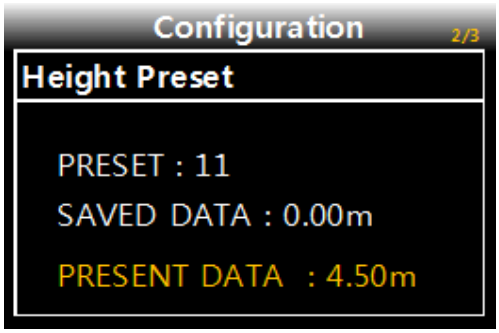
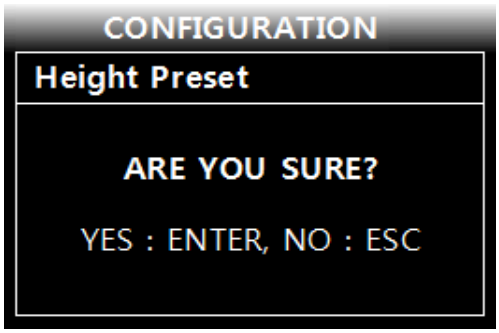
a. Display the fork height on the screen when the fork raise over the free cylinder range.

b. Set the fork height maximum 50 separate heights and call a set fork height via display and the fork stop the set fork height at the lifting up or down of fork.

② HEIGHT PRESET setting

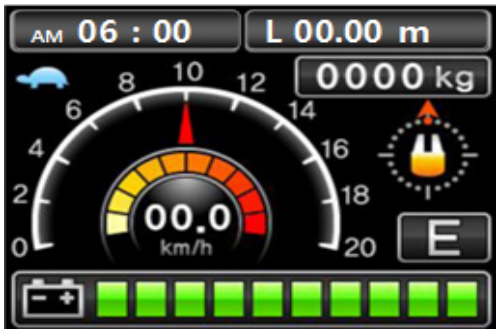
Set the HEIGHT PRESET as below.

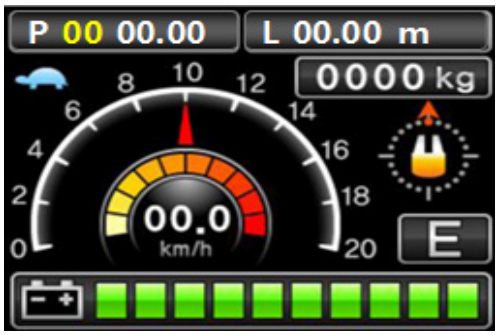
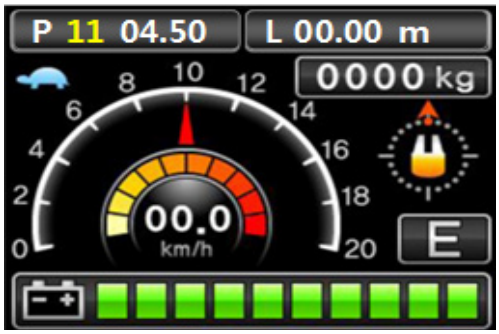
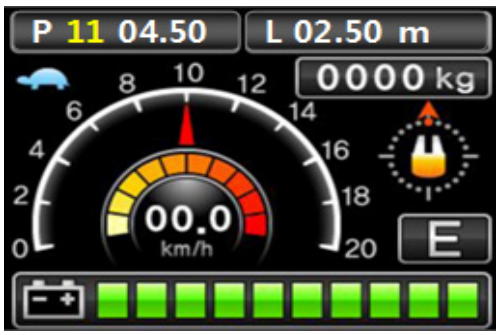
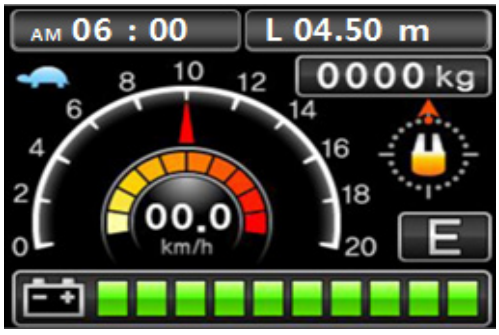
Step	Display	Description
1		1. In the main screen, access the USER menu by pressing the button "7 (M)" of the key pad. ※ Refer to page 7-89 for key pad button.
2		1. In the USER menu, find the HEIGHT PRESET menu by using "2 (UP)" button and "8 (DOWN)" button.
3		1. Press the "ENTER" button on the HEIGHT PRESET menu and go to the HEIGHT PRESET setting.
4		1. If you go to the HEIGHT PRESET setting menu, ask you the HEIGHT PRESET number for setting. 2. The HEIGHT PRESET is possible maximum 50 separate and input a number by key pad and press the "ENTER" button. (For illustrative purposes, following will select 11)

Step	Display	Description
5		1. Display the input PRESET number and the present HEIGHT PRESET of the number as white color. And display the present fork height as orange color below. ※ Note that the fork height is display zero (0) because the HEIGHT PRESET function is not operated in the free cylinder range.
6		1. Move the fork to the target height for height setting by operating the fork lift up or down. (For illustrative purposes, following will move fork to 4.5 m.) 2. Press "ENTER" button when the fork move to target height.
7		1. The display will ask "ARE YOU SURE?" 2. Press the "ENTER" button to save and finish setting.

③ HEIGHT PRESET operation

The HEIGHT PRESET is operated as below.

Step	Display	Description
1		1. Press the button "1 (H)" of the key pad in the main screen.

Step	Display	Description
2		1. The present time display change to the PRESET call screen and the number "00" blinks. 2. Input the HEIGHT PRESET number to call by using the number key of the key pad and press "ENTER" button. (For illustrative purposes, following will call 11 (4.5 m) of the HEIGHT PRESET)
3		1. Stop the blink for the PRESET call screen and display the setting height. (ex: 4.5 m) 2. Move the fork height to the setting height by operating the lift lever or joystick. ※ In the set of the PRESET setting, the fork move up or down to setting height direction only. (EX: If the present height is 3.5 m and PRESET height setting is 4.5 m, the fork move up only but does not move down.) 3. If you want to move reverse direction, cancel the PRESET condition by pressing the "ESC" button.
4		1. If you pull the lever or joystick continuingly, the height is measured from escaping the free cylinder range.
5		1. If you pull the lever or joystick continuingly, the fork stops setting height automatically and the PRESET is cancelled.

(7) REACH IN/OUT CUTBACK adjusting method

① Parameter description

The parameter that effort to the REACH IN/OUT CUTBACK as shown below.

A. REACH IN SPEED

Item	Description
Explanation	1) Hydraulic motor operating speed at the REACH IN operation. 2) Higher : Reach in speed up, mast stops near to the frame at CUTBACK. End operation shock become a large at CUTBACK. Lower : Reach in speed down, mast stops far from the frame at CUTBACK. End operation shock become a small at CUTBACK.
Application	1) The mast stop too near to or too far from the frame when reach in CUTBACK. 2) The REACH IN speed is too fast or too slow.
Caution	Too excessively higher, occur a noise and shock, too excessively lower, reach speed is remarkably down. If possible, leave a default value and adjust CUTBACK by using the valve opening (MIN, MAX, EVP3, 4) and delay (REIN, REOUT CTS DELAY).
Default value	14/16BRJ-9 : 19 Hz 20/25BRJ-9 : 20 Hz
Adjust range	Default value ± 1 Hz
Access	TRUCK MENU → SETTINGS → PUMP → PARAMETER CHANGE

B. REACH OUT SPEED

Item	Description
Explanation	1) Hydraulic motor operating speed at the REACH OUT operation. 2) Higher : REACH OUT speed up, mast stops near to the load wheel at CUTBACK. End operation shock become a large at CUTBACK. Lower : REACH OUT speed down, mast stops far from the frame at CUTBACK. End operation shock become a small at CUTBACK.
Application	1) The mast stop too near to or too far from the load wheel when reach in CUTBACK. 2) The REACH OUT speed is too fast or too slow.
Caution	Too excessively higher, occur a noise and shock, too excessively lower, reach speed is remarkably down. If possible, leave a default value and adjust CUTBACK by using the valve opening (MIN, MAX, EVP3, 4) and delay (REIN, REOUT CTS DELAY).
Default value	14/16/20/25BRJ-9 : 28 Hz
Adjust range	Default value ± 1 Hz
Access	TRUCK MENU → SETTINGS → PUMP → PARAMETER CHANGE

C. REACH IN CTB2

Item	Description
Explanation	1) After REACH IN CUTBACK, the REACH IN speed when the truck is re-operated. 2) Higher : After CUTBACK, the REACH IN speed up when the truck is re-operated. Shock become a large at re-operated. Lower : After CUTBACK, the REACH IN speed down when the truck is re-operated. Shock become a small at re-operated.
Application	1) After REACH IN CUTBACK, the REACH IN speed is too fast or too slow when the truck is re-operated.
Caution	Because this parameter is percent value of the valve opening, adjust the parameter after the valve opening (MIN, MAX EVP3, EVP4) adjustment is finished.
Default value	14/16/20/25BRJ-9 : 40 %
Adjust range	Default value ± 20 %
Access	TRUCK MENU → SETTINGS → PUMP → PARAMETER CHANGE

D. REACH OUT CTB2

Item	Description
Explanation	1) After REACH OUT CUTBACK, the REACH OUT speed when the truck is re-operated. 2) Higher : After CUTBACK, the REACH OUT speed up when the truck is re-operated. Shock become a large at re-operated. Lower : After CUTBACK, the REACH OUT speed down when the truck is re-operated. Shock become a small at re-operated.
Application	1) After REACH OUT CUTBACK, the REACH OUT speed is too fast or too slow when the truck is re-operated.
Caution	Because this parameter is percent value of the valve opening, adjust the parameter after the valve opening (MIN, MAX EVP3, EVP4) adjustment is finished.
Default value	14/16/20/25BRJ-9 : 30 %
Adjust range	Default value ± 20 %
Access	TRUCK MENU → SETTINGS → PUMP → PARAMETER CHANGE

E. REIN CTB CLS DEL

Item	Description
Explanation	1) Adjustment of take time until the valve is closed at REACH IN CUTBACK (ref figure at page 7-86-13). 2) Higher : The REACH IN stops slowly at CUTBACK. Higher than some level, do not operated CUTBACK and REACH IN is operated to the end. The mast stops near to the frame. Lower : The REACH IN stops fast at CUTBACK. The mast stops far from the load wheel at CUTBACK.
Application	The mast stops far from the frame because the CUTBACK dose not occur or stop too fast when REACH IN operation.
Caution	None
Default value	14/16/20/25BRJ-9 : 1.2 seconds
Adjust range	Default value ± 0.2 seconds
Access	TRUCK MENU → SETTINGS → PUMP → PARAMETER CHANGE

F. REOUT CT CLS DEL

Item	Description
Explanation	1) Adjustment of take time until the valve is closed at REACH OUT CUTBACK (ref figure at page 7-86-13). 2) Higher : The REACH OUT stops slowly at CUTBACK. Higher than some level, the CUTBACK is not operated and REACH IN is operated to the end. The mast stops near to the frame. Lower : The REACH IN stops fast at CUTBACK. The mast stops far from the load wheel at CUTBACK.
Application	The mast stops far from the frame because the CUTBACK dose not occur or stop too fast when REACH OUT operation.
Caution	None
Default value	14/16/20/25BRJ-9 : 1.2 seconds
Adjust range	Default value ± 0.2 seconds
Access	TRUCK MENU → SETTINGS → PUMP → PARAMETER CHANGE

G. MIN EVP 3

Item	Description
Explanation	1) Define the minimum opening of the REACH IN VALVE (ref figure at page 7-86-13) 2) Higher : The mast stops near to the frame at CUTBACK because the valve flow quantity is increased. Higher than some level, the CUTBACK is not operated completely and mast is moved slightly. Lower : The mast stops far from the frame at CUTBACK because the valve flow quantity is decreased.
Application	1) The mast stop too near to or too far from the frame at the REACH IN CUTBACK. 2) The mast is not stopped completely and is moved slightly.
Caution	1) Adjust that the parameter is not lower than 20 % and is not higher than 26 %.
Default value	14/16/20/25BRJ-9 : 23.5 %
Adjust range	20~26 %
Access	TRUCK MENU → SETTINGS → MHYRIO → PARAMETER CHANGE

H. MAX EVP 3

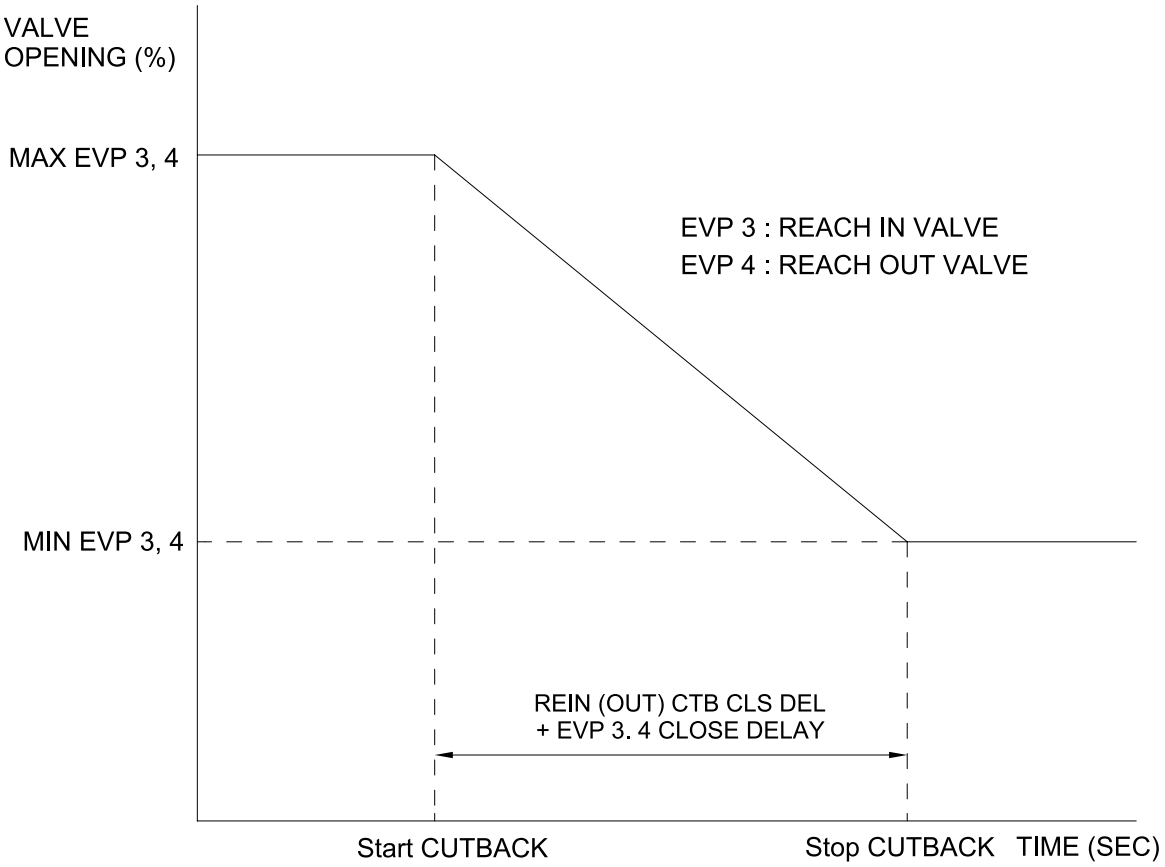
Item	Description
Explanation	1) Define the maximum opening of the REACH IN VALVE (ref figure at page 7-86-13) 2) Higher : The REACH IN speed is increased until some level because the valve opening is increased. The mast stops near to the frame at CUTBACK. Lower : The REACH IN speed is decreased until some level because the valve opening is decreased. Too excessively lowered, occur a noise and shock because of flow unbalance. The mast stops far from the frame at CUTBACK.
Application	1) The mast stop too near to or too far from the frame at the REACH IN CUTBACK. 2) If the truck has a vibration when pull the tilt lever maximally, raise a little.
Caution	1) Adjust that the parameter is not lower than 50 % and is not higher than 65 %.
Default value	14/16/20/25BRJ-9 : 58.4 %
Adjust range	50~65 %
Access	TRUCK MENU → SETTINGS → MHYRIO → PARAMETER CHANGE

I. MIN EVP 4

Item	Description
Explanation	1) Define the minimum opening of the REACH OUT VALVE (ref figure at page 7-86-13) 2) Higher : The mast stops near to the load wheel at CUTBACK because the valve flow quantity is increased. Higher than some level, the CUTBACK is not operated completely and mast is moved slightly. Lower : The mast stops far from the frame at CUTBACK because the valve flow quantity is decreased.
Application	1) The mast stop too near to or too far from the frame at the REACH IN CUTBACK. 2) The mast is not stopped completely and is moved slightly.
Caution	1) Adjust that the parameter is not lower than 20 % and is not higher than 26 %.
Default value	14/16/20/25BRJ-9 : 23.5 %
Adjust range	20~26 %
Access	TRUCK MENU → SETTINGS → MHYRIO → PARAMETER CHANGE

J. MAX EVP 4

Item	Description
Explanation	1) Define the minimum opening of the REACH OUT VALVE (ref figure at page 7-86-13) 2) Higher : The REACH OUT speed is increased until some level because the valve opening is increased. The mast stops near to the load wheel at CUTBACK. Lower : The REACH OUT speed is decreased until some level because the valve opening is decreased. Too excessively lowered, occur a noise and shock because of flow unbalance. The mast stops far from the load wheel at CUTBACK.
Application	1) The mast stop too near to or too far from the load wheel at the REACH OUT CUTBACK. 2) If the truck has a vibration when pull the tilt lever maximally, raise a little.
Caution	1) Adjust that the parameter is not lower than 65 % and is not higher than 75 %.
Default value	14/16/20/25BRJ-9 : 71.8 %
Adjust range	65~75 %
Access	TRUCK MENU → SETTINGS → MHYRIO → PARAMETER CHANGE



(Definition of each parameter for REACH IN/OUT)

BRJ97RC01

② REACH IN/OUT CUTBACK adjusting method

※ Each procedure carry out step by step in order and if the adjustment is not acceptable, go to the next method.

a. When the REACH IN/OUT CUTBACK is not to operated
- Check that the reset switch is normal for REACH IN/OUT sensor.
- Decrease 0.1 for the REIN/OUT CTB CLS DEL value.
- Decrease 1 % once for the MIN EVP3/4 value until allowable range.
- Decrease 0.1 for the REIN/OUT CTB CLS DEL value.
- Decrease 1 Hz for the REACH IN/OUT SPEED value.

b. When the mast is not stop but is moved slightly at the REACH IN/OUT CUTBACK.
- Decrease the MIN EVP3/4 value within allowable range until the mast dose not move any more.

c. When the mast stop far from the frame/load wheel at the REACH IN/OUT CUTBACK.
- Increase the MIN EVP3/4 value within the mast no moving when the truck stop.
- Increase 1 % once for the MIN EVP3/4 value within allowable range.
- Increase 0.1 once for the REIN/OUT CTB CLS DEL value within allowable range.
- Increase 1 Hz for the REACH IN/OUT SPEED value.

d. When the mast stop too near to the frame/load wheel at the REACH IN/OUT CUTBACK.
- Decrease the MIN EVP3/4 value within allowable range.
- Decrease 1 % once for the MIN EVP3/4 value within allowable range.
- Decrease 0.1 once for the REIN/OUT CTB CLS DEL value within allowable range.
- Decrease 1 Hz for the REACH IN/OUT SPEED value.

e. When the REACH IN/OUT speed slow after the REACH IN/OUT CUTBACK stop and re-operated.
- Increase the REACH IN/OUT CTB2 value within allowable range.

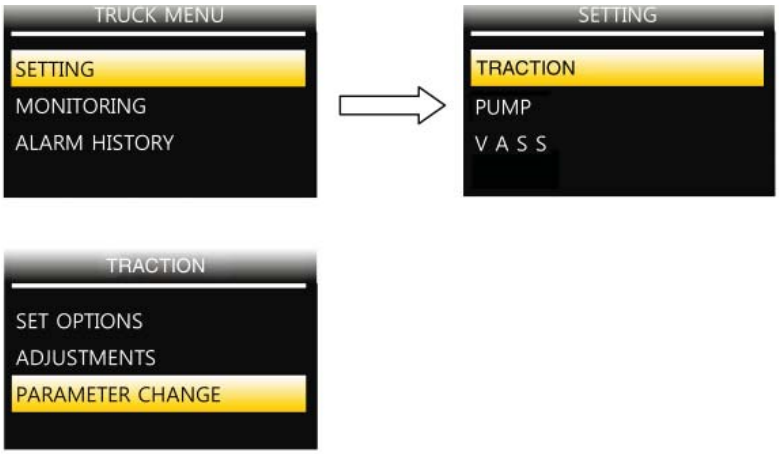
f. When the REACH IN/OUT speed fast after the REACH IN/OUT CUTBACK stop and re-operated.
- Decrease the REACH IN/OUT CTB2 value within allowable range.

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 7-80]

(1) Settings



20BC9EL42

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

① TRACTION->SET OPTIONS
Refer to 5-4)- ■ “TRACTION CONTROLLER”-(1) “SET OPTIONS” (page 7-32)

② TRACTION->ADJUSTMENTS
Refer to 5-4)- ■ ”TRACTION CONTROLLER”-(2) “ADJUSTMENTS” (page 7-33)

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

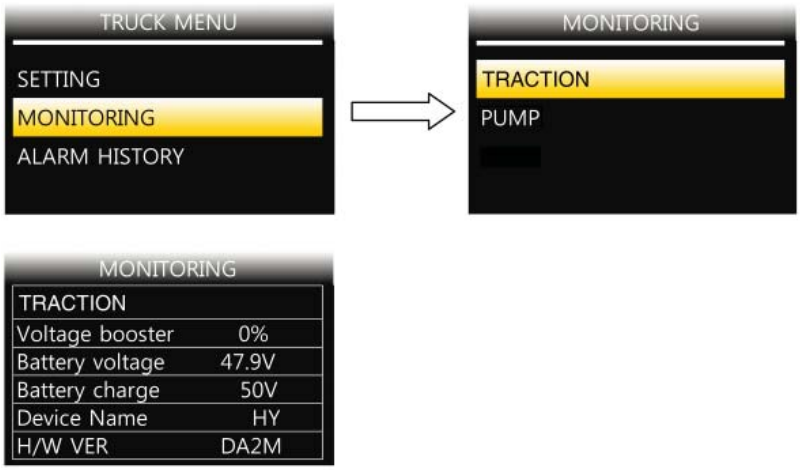
④ PUMP->SET OPTIONS
Refer to 5-4)- ■ “PUMP CONTROLLER”-(1) “SET OPTIONS” (page 7-36)

⑤ PUMP->ADJUSTMENTS
Refer to 5-4)- ■ ”PUMP CONTROLLER”-(2) “ADJUSTMENTS” (page 7-38)

⑥ PUMP->PARAMETER CHANGE
Refer to 5-4)- ■ ”PUMP CONTROLLER”-(3) “PARAMETER CHANGE” (page 7-40)

⑦ V.A.S.S
Refer to 6-8) “VASS SETUP USING DISPLAY MENU” (page 7-85)

(2) Monitoring



20BC9EL43

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

① TRACTION

Refer to 5-6)-(1) “Traction controller” (page 7-46)

② PUMP

Refer to 5-6)-(2) “Pump controller” (page 7-47)

③ EPS

Refer to 7-6) “EPS controller” (page 7-61)

④ FINGER TIP

Refer to 8-7) “FINGER TIP controller” (page 7-71)

(3) Alarm history

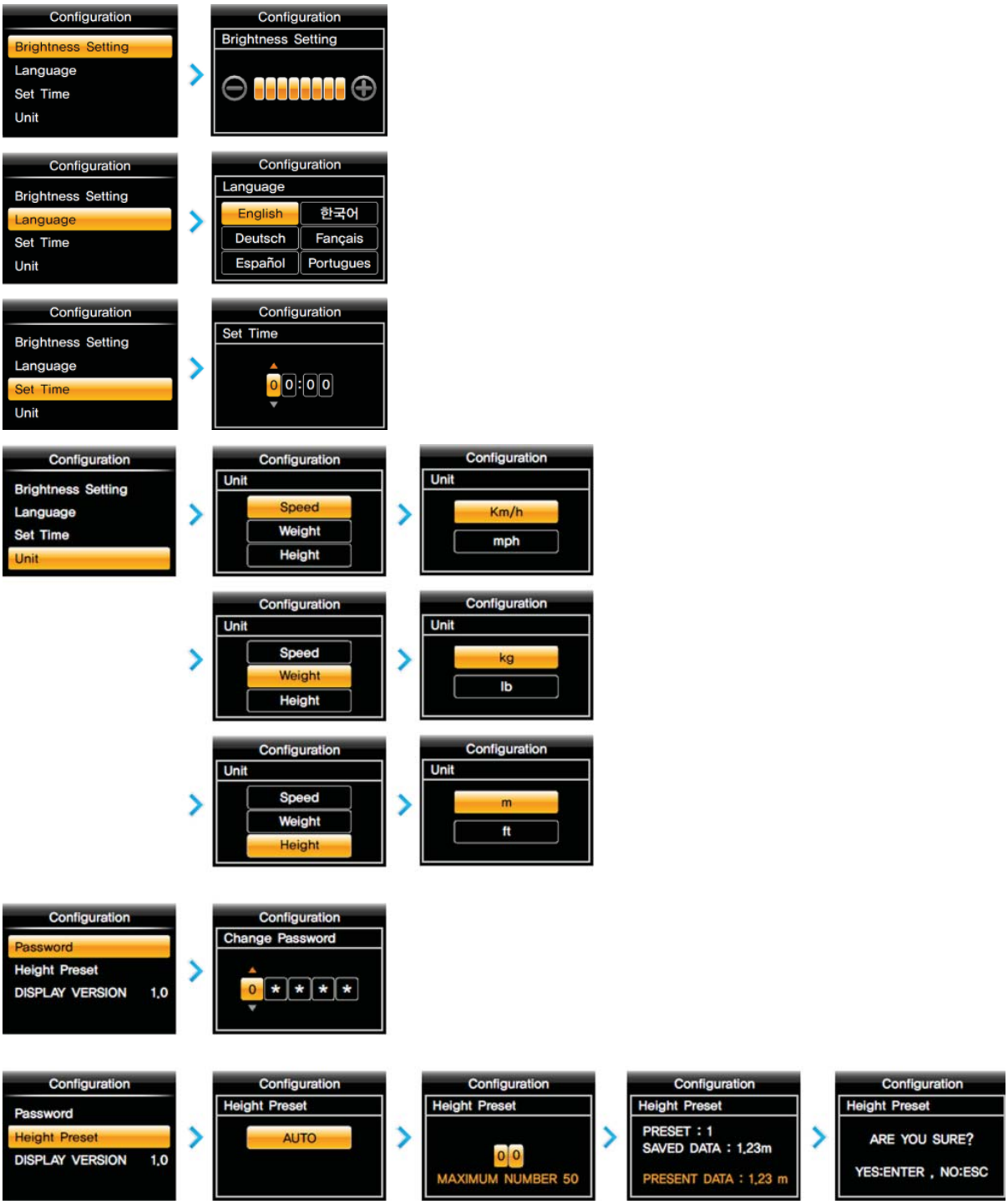
Refer to 6-7) “ALARM & ALARM HISTORY” (page 7-82)

10) LCD FUNCTION (for height indicator, OPTION)

(1) Main

14BRJ9EFD01

(2) User menu



14BRJ9EFD02/03

(3) Button

No.	Button	Function
1		1. Number 1 input button 2. Go into the HEIGHT PRESELECTOR menu
2		1. Number 2 input button 2. Upward move button in menu
3		1. Number 3 input button
4		1. Number 4 input button 2. Leftward move button in menu
5		1. Number 5 input button
6		1. Number 6 input button 2. Rightward move button in menu
7		1. Number 7 input button 2. Go into the menu
8		1. Number 8 input button 2. Downward move button in menu
9		1. Number 9 input button 2. Go into the POWER mode
10		1. Go into the ENGINEER/SERVICE password input menu 2. Return to previous/parent menu and cancel button
11		1. Number 0 input button 2. Go into the TURTLE mode
12		1. MENU/PARAMETER select button in menu

11) DESCRIPTION OF PROGRAMMABLE MENU

In truck menu → display, service engineer can adjust several parameters related to display as follows ;

① **Password**

This parameter turns on the password function.

- ON : Operater should enter the password which can be set in user menu, before operating truck.
- OFF : Password function is deactivated.

② **Maintenance**

This parameter turns on the maintenance alarm function, and sets the alarm period.

- ON : Maintenance alarm function is activated and followed by alarm period screen where service engineer can enter the alarm period.
- OFF : Maintenance alarm function is deactivated.

③ **Hour counter**

This parameter determines which hour counter is supposed to be shown in main screen.

- HK : Key on counter
- HP : Pump counter
- HT : Traction counter

④ **Seat belt**

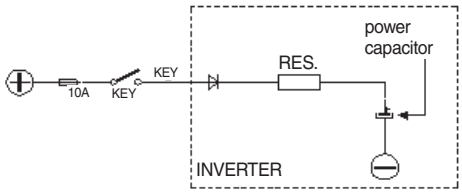
This parameter determines how seat belt lamp works.

- Option #1 : Seat belt lamp blinks for 5 seconds after truck starts on.
- Option #2 : Seat belt lamp lights unless seat & seat belt switch is closed.

12) DIAGNOSTIC FAULT CODES

Code	Alarm	Traction (T)	Pump (P)	Mhyrio (V)	EPS (E)	Description
6	SERIAL ERR#1				○	Main uC and Slave uC communicate via a local serial interface. This alarm occurs when the slave uC does not receive the communication from the main uC through this serial interface. It is necessary to replace the controller.
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.
D	EEPROM	○	○	○	○	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.
10	LOGIC FAILURE #4				○	This alarm occurs in the rest state if the output of the voltage amplifier of the phase Vw-Vv have a drift larger than ±0.25 V. It is necessary to replace the controller.
11	LOGIC FAILURE #3	○				Fault in the hardware section of the logic board which manages the hardware current protection. Replace the logic board.
					○	This alarm occurs in the rest state if the output of the voltage amplifier of the phase Vu-Vw have a drift larger than ±0.25 V. It is necessary to replace the controller.
12	LOGIC FAILURE #2	○	○			Fault in the hardware section of the logic board which manages the phase' s voltage feedback. Replace the logic board.
					○	This alarm occurs when the real voltage between phases W and V of the motor is different from the desired. It is necessary to replace the controller.
13	LOGIC FAILURE #1	○	○			This alarm signals that an undervoltage / overvoltage protection operation has occurred. Two possible reasons: A) A real undervoltage / overvoltage situation happened. B) Fault in the hardware section of the logic board which manages the overvoltage protection. Replace the logic card.
					○	This alarm occurs when the real voltage between phases W and U of the motor is different from the desired. It is necessary to replace the controller.
1E	VMN LOW	○	○			The test is carried out during initial diagnosis and in standby. Possible causes: A) Problem with the motor connections or the motor power circuit; check if the 3 phases are correctly connected; check if there's a dispersion of the motor towards ground; B) Inverter failure, replace it

Code	Alarm	Traction (T)	Pump (P)	Mhyrio (V)	EPS (E)	Description
1F	VMN HIGH	○	○			The test is carried out during initial diagnosis and in standby. Possible causes: A) Problem with the motor connections or the motor power circuit; check if the 3 phases are correctly connected; check if there's a dispersion of the motor towards ground; B) Inverter failure, replace it
20	VMN NOT OK				○	This alarm occurs in the initial rest state after key on if the outputs of the motor voltage amplifiers are not in the window from 2.2 to 2.8 Vdc. It is necessary to replace the controller.
25	CONTACTOR CLOSED	○				This alarm occurs. Before driving the MC coil, the controller checks if the contactor is stuck. The controller drives the bridge for some tens milliseconds, trying to discharge the capacitors bank. If the capacitor voltage does decrease by 20% of the key voltage the alarm is generated. It is suggested to verify the power contacts of line contactor ; to replace the LC is necessary.
26	CONTACTOR OPEN	○				The main contactor coil has been driven by the logic board, but the contactor does not close. Two possible reasons: A) The wires to the coil are interrupted or not well connected. B) The contact of the contactor is not properly working.
30	MAIN CONT.OPEN				○	This alarm occurs only when the setting CAN BUS is PRESENT. Then the eps-ac0 waits for a via CAN information that the traction controller has closed the main contactor. If this information lacks more than about 1.5 secs, this alarm occurs. Find, on the traction controller, the reason for keeping the main contactor open.
31	I=0 EVER	○	○			Traction or pump controller current too low
35	STBY I HIGH	○	○			Test carried out in standby. Check if the current is 0. If not verified, an alarm is signalled which inhibits machine operations. Possible causes: A) Current sensor failure; B) Logic failure: first replace the logic; if the defect persists, replace the power unit.
					○	This alarm occurs two ways: 1) In the initial rest state after key on, if the outputs of the current amplifiers are not comprised in the window 2.2 to 2.8 Vdc. 2) After the initial diagnosis this alarm occurs when the outputs of the current amplifiers at rest have a drift larger than ±0.15 V. It is necessary to replace the controller.

Code	Alarm	Traction (T)	Pump (P)	Mhyrio (V)	EPS (E)	Description
3C	CAPACITOR CHARGE	○	○			Follows the charging capacitor system:  When the key is switched ON, the inverter tries to charge the capacitor through a power resistance, and check if the capacitor are charged within a timeout. If this is not true: an alarm is signalled; the main contactor is not closed. Possible reasons: A) The charging resistance is opened; if it is opened. B) The charging circuit has a failure. C) There is a problem on the power modules.
3D	HIGH TEMPERATURE	○	○		○	Inverter temperature is greater than 75°C. The maximum current is reduced proportionally to the temperature increase. The inverter stops at 100°C. If the alarm is signalled when the inverter is cold: A) Check the wiring of the thermal sensor; B) Thermal sensor failure; C) Logic failure.
41	MOTOR TEMPERATURE	○	○		○	This warning is signalled if the motor temperature switch opens (digital sensor) or if the analog signal overtakes the cut off level. If it happens when the motor is cold, check the wiring. If all is ok, replace the logic board.
42	BATTERY LOW	○	○			If the "battery check" option is ON, a battery discharge algorithm is carried out. When the charge level is 10%, this alarm is signalled and the current is reduced to the half of the programmed level.
46	HIGH CURRENT				○	This alarm occurs if the circuit to limit via hardware the current in the motor is either always active at key-on or repeatedly active when the motor is turning. Check the motor is suited to work with the eps-ac 0 (not oversized). Otherwise it is necessary to replace the controller.
47	POWER FAILURE #3				○	This alarm occurs when the current in the phase V of the motor is zero and the motor is commanded for moving. Check the power fuse is OK. Check the battery positive arrives to the controller. Check the continuity of the wire in the phase V of the motor. Otherwise it is necessary to replace the controller.
48	POWER FAILURE #2				○	This alarm occurs when the current in the phase U of the motor is zero and the motor is commanded for moving. Check the power fuse is OK. Check the battery positive arrives to the controller. Check the continuity of the wire in the phase U of the motor. Otherwise it is necessary to replace the controller.

Code	Alarm	Traction (T)	Pump (P)	Mhyrio (V)	EPS (E)	Description
49	POWER FAILURE #3				○	This alarm occurs when the current in the phase W of the motor is zero and the motor is commanded for moving. Check the power fuse is OK. Check the battery positive arrives to the controller. Check the continuity of the wire in the phase W of the motor. Otherwise it is necessary to replace the controller.
4A	DRIVER SHORTED	○	○			When the key is switched ON, the μ P checks that the MC coil driver is not shorted; if it is, this alarm is signalled; replace the logic board.
4B	CONTACTOR DRIVER		○			When the initial diagnosis is finished, the traction logic closes the MC and checks the voltage on the drain of the driver. If this is not low, an alarm is signalled. Replace the logic.
4C	COIL SHORTED	○	○			When the key is switched ON the μ P checks the MC driver FF SR. If it does not react in a correct way to the μ P stimulus, the alarm is signalled. Replace the logic board. The FF SR makes an hardware control of the current in the MC coil. If this is too high, it opens the MC and the alarm is signalled.Check if there are external shortcircuit and if the ohmic value of the MC is correct; otherwise replace the logic.
4D	COIL INTERRUPTED	○	○			Main contactor line is interrupted
4E	VACC NOT OK	○	○			The test is made in standby. This alarm indicates that the accelerator voltage is 1 V greater than the minimum value programmed by the PROGRAM VACC function. Possible causes: A) The potentiometer is not correctly calibrated; B) The potentiometer is defective.
4F	INCORRECT START	○	○			This alarm signals an incorrect starting sequence. Possible causes: A) Running microswitch failure; B) Error in sequence made by the operator; C) Incorrect wiring; D) If the default persists, replace the logic.
50	FORW + BACK	○				The test is carried out continuously. An alarm is signalled when a double running request is made simultaneously. Possible causes: A) Defective wiring; B) Running microswitch failure; C) Incorrect operation; D) If the defect persists, replace the logic.
52	ENCODER ERROR	○	○			Two consecutive readings of the encoder speed are too much different in between: because of the inertia of the system it is not possible the encoder changes its speed a lot in a short period. Probably an encoder failure has occurred (e.g. one or two channels of the encoder are corrupted or disconnected). Check both the electric and the mechanical encoder functionality. Also the electromagnetic noise on the sensor bearing can be a cause for the alarm.

Code	Alarm	Traction (T)	Pump (P)	Mhyrio (V)	EPS (E)	Description
53	BAD ENCODER SIGN				○	It occurs when the ENC SPEED in the tester menu has opposite sign than FREQUENCY in the tester menu. Swap the channels of the encoder (CNB#8 with CNB#7).
54	STEER SENSOR KO				○	This alarm occurs if the command potentiometer (CPOC1 on CNA#9 or CPOC2 on CNA#8) changes with a jerk larger than MAX SP SLOPE . This alarm is used to catch a discontinuity in the voltages of the command potentiometer.
55	STEER HAZARD				○	This is just a warning to inform that the steering controller is limiting the angle in the steering direction. No speed reduction occurs on the traction.
56	PEDAL WIRE KO	○	○			This alarm is signalled if a fault is detected in the accelerator unit wiring (NPOT or PPOT cable is interrupted).
63	INPUT ERROR #1				○	It occurs when the voltage on CNA#4 (NK1: Lower potential terminal of the safety contacts is higher than 12 V before to turn the safety contacts closed. When the safety contacts are open, the voltage on CNA#4 is expected to be close to 0 Vdc and this is independent from whether the safety contacts are connected to a plus battery or to a minus battery. In the first case (safety contacts connected to a plus battery), when the safety contacts are open, CNA#4 is connected to a minus battery through a load. Only a harness mistake may connect NK1 to a higher than 12 V voltage.
D3	WRONG CONFIG				○	This alarm occurs when EPS configuration setting does'nt mach with traction controller. Please check the truck type setting. For BRJ-9 model, setting value is "4"
D4	TRUCK NOT CONFIG				○	
D5	TILT SENS. OUTRNG		○			Potentiometer tilt angle value are not in the setting range (between MIN and MAX).
	SL CENTERING				○	This alarm occurs when an automatic centering is requested from steady state condition. Then the slave uC expects the angle measured on the steered wheel goes into a window from -20 to +20 degrees before the traction turns moving. In case the traction turns moving with a steered wheel outside that window, this alarm occurs. It is necessary to replace the controller.
D6	HEIGHT MAX LIFT		○			This alarm occurs if the measured height is same as set max height. It is just warnning. But if the height is diffirent from real max height, please set max height again.
	SL EPS NOT ALL				○	This alarm occurs at key on: A) When the initial automatic centering is expected. B) The slave uC detects the encoder is at rest longer than two secs C) Within this two secs delay, the main uC does not communicate that the automatic centering was successfully ended. It is necessary to replace the controller.

Code	Alarm	Traction (T)	Pump (P)	Mhyrio (V)	EPS (E)	Description
D7	TILT WRONG DIR.		○			This alarm occurs if the user operate the tilt lever in a wrong direction, when the auto fork leveling function is activated. (for example, if tilt is backward, the user is doing backward tilt. It can cause this alarm. Because of wrong operation direction.)
	CAN BUS KO SL				○	This alarm occurs when the slave uC does not receive any CAN BUS frame from the main uC. It is necessary to replace the controller.
D8	OVERLOAD		○			Load weight sensor detects that loaded weight exceeds the weight limited in OVERLOAD WEIGHT programming. Remove the warning condition.
	MICRO SLAVE #8				○	It occurs when the encoder counting of the main uC is not matched with the encoder counting of the slave uC. It is necessary to replace the controller.
DA	CAN ENCODER		○			There is a problem related to the CAN-BUS line. The error is signalled if the pump controller does not receive any message from CAN ENCODER. First of all, check the wiring. If it is ok, the problem is on the logic board of CAN ENCODER, which must be replaced.
	CLOCK PAL NOT OK				○	The main uC sends an analog signal towards the slave uC to reset the slave uC on demand. When the slave uC detects this analog signal external to a window from 2.2 to 2.8 and not in the range to generate the reset on demand, the slave uC raises this alarm. It is necessary to replace the controller.
DB	ZERO POS RESET		○			After key on, Pump controller checks the status of zero reset switch. If the reset switch is open. This alarm occurs. Check the wire connection to the reset switch and sensing bracket. If they are fine, replace the switch.
	STEPPER MOTOR MISM				○	This alarm occurs if the frequency and the amplitude of the voltages from the stepper motor lines are mismatched in between (i.e. the voltage from the D and Q line of the stepper motor have high amplitude but with very low frequency). In normal condition when the amplitude of the stepper motor lines increases, the frequency of the stepper motor lines must increase too. This alarm occurs also if a stepper motor line (D or Q) is short circuited to minus battery. Check if a stepper motor line is short circuited to minus battery. Otherwise it is necessary to replace the controller.
DC	HEIGHT ENC LOCK		○			This alarm occurs if there is no signal from the height encoder for 3 sec for lift operation. check the wire to encoder sensor. If it is ok, change the encoder. This alarm occurs in case of lift end stroke, please set the max height again.
	MOTOR LOCKED				○	This alarm occurs if the current in the steering motor stays higher than 90% of the maximum current longer than 1 sec. Search for a mechanical problem locking the motor. To make easier the fault catching, set DEBUG OUTPUT to level 11.

Code	Alarm	Traction (T)	Pump (P)	Mhyrio (V)	EPS (E)	Description
DD	WRONG DIRECTION		○			This alarm occurs if the user operate the lift lever in a wrong direction, when the preset function is activated. (for example, if preset height is 3m and present height is 5m, the user is doing lifting. It can cause this alarm. Because of wrong operation direction.)
	MICRO SLAVE #4				○	It occurs in one of the following conditions : If the slave uC detects the stator voltage phasor rotates in the opposite direction respect to the sign of the stepper motor speed, this alarm occurs. (i.e. slave uC detects the actual sign of the frequency in the motor opposes the sign that the frequency should have according the command). It is necessary to replace the controller.
DE	FBSENS LOCKED				○	This alarm occurs only when option ENCODER CONTROL is off. Then, if the encoder is frozen and the steering motor is demanded for moving at higher than 40% of the maximum motor speed, this alarm occurs. Check the encoder is right working. This alarm may be masked (for the trouble shooting activity only) by setting special adjustment DEBUG OUTPUT to level 11 and recycling the key . Then it is possible to verify the reading ENC SPEED is frozen or not meanwhile the steering motor is turning.
E1	CURRENT GAIN				○	This alarm occurs when the parameters to compensate for the gain of the current amplifiers (ADJUSTMENT #03 and ADJUSTMENT #04) have the default values (i.e. the maximum current was not regulated). It is necessary to send the controller to Zapi to perform the maximum current regulation.
E2	NO SYNC				○	Every 16msec, inside the code cycle, the main uC rises and then lowers an input for the slave uC (SYNC). When the slave uC detects no edge for more than 100 msec on this input, this alarm occurs. This is just a watch dog function: when the main uC does not execute the code cycle it does not update the SYNC signal and the slave uC cuts off the steer and traction. It is necessary to replace the controller.
E3	SLIP PROFILE		○			Slip profile is wrong (es.slip freq0 >slip freq1)
	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.

<table>
<tr><th>Code</th><th>Alarm</th><th>Traction (T)</th><th>Pump (P)</th><th>Mhyrio (V)</th><th>EPS (E)</th><th>Description</th></tr>
<tr><td>E4</td><td>POSITION ERROR</td><td></td><td></td><td></td><td>○</td><td>This alarm occurs for an error in the redundant test of the feedback sensors. Here we have an encoder and two toggle switches. This alarm occurs whether the sector (toggle switches configuration) and the encoder counting are not matched. The sector is provided with the FEEDBACK SECTOR reading in the tester menu ; the encoder counting is provided with the WHEEL ANGLE reading in the tester menu.
<table>
<tr><th>WHEEL ANGEL (degrees)</th><th>Admitted SECTOR</th><th>Admitted PEEDBACK SECTOR</th></tr>
<tr><td>-22 to +22</td><td>1st or 4th</td><td>3.13V or 1.88V</td></tr>
<tr><td>+23 to +67</td><td>1ST</td><td>3.13V</td></tr>
<tr><td>+68 to +112</td><td>1st or 2nd</td><td>3.13V to 4.39V</td></tr>
<tr><td>+113 to +157</td><td>2nd</td><td>4.39V</td></tr>
</table>
<table>
<tr><th>WHEEL ANGEL (degrees)</th><th>Admitted SECTOR</th><th>Admitted PEEDBACK SECTOR</th></tr>
<tr><td>+158 to -158</td><td>2nd or 3rd</td><td>4.39V or 0.62V</td></tr>
<tr><td>-157 to -113</td><td>3rd</td><td>0.62V</td></tr>
<tr><td>-112 to -68</td><td>3rd or 4th</td><td>0.62V to 1.88V</td></tr>
<tr><td>-67 to -23</td><td>4th</td><td>1.88V</td></tr>
</table>
When the FEEDBACK SECTOR and WHEEL ANGLE don't meet the above correspondence, an alarm POSTION ERROR occurs in less than 100msec. If the alarm occurs when installing a new controller, be sure the AUX FUNCTION 11 corresponds to the toggle switches arrangement you have and SET ENC AT 360 was correctly set .</td></tr>
<tr><td></td><td>MODEL MISMATCH</td><td></td><td>○</td><td></td><td></td><td>Model truck selected for the pump is not the same of traction one</td></tr>
<tr><td></td><td>EVPG1 DRIV SHORT</td><td></td><td></td><td>○</td><td></td><td>One of the group 1 valves drivers is shorted; check the external connection, if it is ok the driver is probably damaged.</td></tr>
<tr><td>E5</td><td>AUX FUCNT KO</td><td></td><td>○</td><td></td><td></td><td>Potentiometer aux value and its complementer are not matched</td></tr>
<tr><td></td><td>EVPG2 DRIV SHORT</td><td></td><td></td><td>○</td><td></td><td>One of the group 2 valves drivers is shorted; check the external connection, if it is ok the driver is probably damaged.</td></tr>
<tr><td>E6</td><td>SHIFT FUCNT KO</td><td></td><td>○</td><td></td><td></td><td>Potentiometer shift value and its complementer are not matched</td></tr>
<tr><td></td><td>EVPG3 DRIV SHORT</td><td></td><td></td><td>○</td><td></td><td>One of the group 3 valves drivers is shorted; check the external connection, if it is ok the driver is probably damaged.</td></tr>
<tr><td>E7</td><td>TILT FUCNT KO</td><td></td><td>○</td><td></td><td></td><td>Potentiometer tilt value and its complementer are not matched</td></tr>
<tr><td></td><td>EVPG4 DRIV SHORT</td><td></td><td></td><td>○</td><td></td><td>One of the group 4 valves drivers is shorted; check the external connection, if it is ok the driver is probably damaged.</td></tr>
</table>

Code	Alarm	Traction (T)	Pump (P)	Mhyrio (V)	EPS (E)	Description
E8	LIFT FUCNT KO		○			Potentiometer lift value and its complementer are not matched
	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.
E9	AUX OUT OF RNG		○			Potentiometer aux value is out of range
	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.
EA	SHIFT OUT OF RNG		○			Potentiometer shift value is out of range
EB	TILT OUT OF RNG		○			Potentiometer tilt value is out of range
EC	CAN KO JOYSTICK	○				There is a problem related to the CAN-BUS line. The error is signalled if the traction controller does not receive any message from JOYSTICK. First of all, check the wiring. If it is ok, the problem is on the logic board of JOYSTICK, which must be replaced.
	LIFT OUT OF RNG		○			Potentiometer lift value is out of range
ED	WAITING DATA				○	This warning occurs only if CAN BUS is PRESENT. At key-on the eps-ac0 asks to the traction controller to send a list of parameters via CAN BUS. From the request until the parameters are correctly relieved, this warning occurs. The steer is not activated yet, and the safety relays remain open when this warning is present.
	SAFETY	○				This alarm is signalled when the "SAFETY" input is open. The "SAFETY" circuit gets active and opens the drivers of LC and EB and stops the machine. Verify the "SAFETY" input connection.
	ACQUIRE AUX		○			Acquired aux function value is not valid
EE	SAFETY KO	○				This alarm is present in combi systems (traction + pump). If a stopping alarm is detected on the pump, the traction also stops. The failure must be looked for in the pump inverter.
	ACQUIRE SHIFT		○			Acquired shift function value is not valid
	EPS NOT ALIGNED				○	This is a real alarm that cut off the traction. It occurs when the system tries to perform an automatic centering at key on but no straight ahead edge is detected within 6 secs. Check the straight ahead switch (SW1 to CNA#3) is right working.

Code	Alarm	Traction (T)	Pump (P)	Mhyrio (V)	EPS (E)	Description
EF	SLIP PROFILE	○				Slip profile is wrong (es.slip freq0 >slip freq1)
	ACQUIRE TILT		○			Acquired tilt function value is not valid
	WAITING FOR PEV			○		EVP Coil line is interrupet
	WAITING FOR TRAC				○	This warning occurs only if CAN BUS is PRESENT. At key-on the eps-ac0 needs an assent from the traction controller to close the safety contacts and to turn onto operational mode. Until this assent is not relieved, this warning occurs. The steer is not activated yet and the safety relays remain open when this warning is present.
F0	MOTOR STALL	○				Encoder locked
	ACQUIRE LIFT		○			Acquired lift function value is not valid
	KEY OFF				○	This fault is displayed when the controller detects a low logic level of Key-Off signal during Start-Up diagnosis. It is very likely the fault is due to an under voltage, so it is suggested to check: - Key input signal down-going pulses (below under voltage threshold) due to external loads, like DC/DC converters starting-up, relays or contactor switching, solenoids energizing / de-energizing. - Check the connection of power cables to the battery terminal, positive and negative, to MC and to controller +Batt and –Batt, which must be screwed with a torque comprised in the range 13 Nm÷15 Nm. - If no voltage transient is detected on the supply line and the alarm is present every time the key is switched ON, the failure is probably in the controller hardware, so it is necessary to replace the logic board.
F1	DATA ACQUSITION	○	○			This alarm is signalled in the current gain acquisition phase. Wait the end of the acquisition activity.
	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.
	ENCODER ERROR				○	It occurs when ENCODER CONTROL is set ON and the real frequency does not pursuit the commanded frequency. This condition is several times due to either, a mismatching between the Encoder resolution used in the SW and the real encoder resolution, or a wrong connection between the two encoder channels. In this latest case swap the channels of the encoder (CNB#8 with CNB#7).

Code	Alarm	Traction (T)	Pump (P)	Mhyrio (V)	EPS (E)	Description
F2	STEAR DEAD ANGLE	○				EPS Relay is open
	MOTOR STALL		○			Encoder locked
	COIL SHORTED			○		N/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.
	Q LINE SENSOR KO				○	This alarm occurs when the mean voltage on the quadrature line of the stepper motor (connection CNA#8) is not null: the voltage on every stepper motor line is a sine wave with null mean voltage. Check the continuity of the stepper motor connections. In particular the resistance between CNA#8 and the minus battery (with the stepper motor at rest) is expected being very low (close to 30 ohms).
F3	SEQUENCE FAULT	○				Wrong Sequence to begin traction(es. First pedal activated and then forward switch activated
	EV DRIVER KO			○		One of the On/Off valves drivers is open (it does not close when it is commanded by the microcontroller).
	D LINE SENSOR KO				○	This alarm occurs when the mean voltage on the direct line of the stepper motor (connection CNA#9) is not null: the voltage on every stepper motor line is a sine wave with null mean voltage. Check the continuity of the stepper motor connections. In particular the resistance between CNA#9 and the minus battery (with the stepper motor at rest) is expected being very low (close to 30 ohms).
F4	ANGLE NOT VALID	○				Angle from EPS is not valid
	JOYSTICK NOT OK		○			"The test is made in standby. This alarm indicates that the joystick can signal is different from can protocol. Possible causes: the joystick is defective."
	EVPG1 DRIVER KO			○		One of the Group 1 valves drivers is open (it does not close when it is commanded by the microcontroller).
	GAIN EEPROM KO				○	The parameters to compensate for the gain of the current amplifiers (ADJUSTMENT #03 and ADJUSTMENT #04) are recorded in a not volatile memory (eeprom) with a redundant handling. In fact every adjustment is recorded in three eeprom locations. If the values in these three locations are different in between this alarm occurs. It is necessary to send the controller to sevice man to perform the maximum current regulation.

Code	Alarm	Traction (T)	Pump (P)	Mhyrio (V)	EPS (E)	Description
F5	WRONG SET BATT.	○	○			When the key is turned ON, the controller check the battery voltage and verifies it is within a window around the nominal value. Replace the battery with a correct battery.
	EVPG2 DRIVER KO			○		One of the group 2 valves drivers is open (it does not close when it is commanded by the microcontroller).
	DATA ACQUISITION				○	This alarm occurs two ways: 1) When hardware setting AUTOTEACHING is turned On and the key recycled.Then, during the consequent autoteaching procedure,a DATA ACQUISITION alarm occurs 2) When acquiring the motor resistance or when adjusting the parameters to compensate for the gain of the current amplifiers (maximum current factory adjusted). Recycle the key.
F6	EPS IN ALARM	○				This alarm occurs in case EPS occur alarms. Because of EPS alarm, Traction function is disabled. This alarm warn this.
	SAFETY		○			This alarm is signalled when the "SAFETY" input is open. The "SAFETY" circuit gets active and opens the drivers of LC and EB and stops the machine. Verify the "SAFETY" input connection.
	EVPG3 DRIVER KO			○		One of the group 3 valves drivers is open (it does not close when it is commanded by the microcontroller).
	MICRO SLAVE KO				○	In stepper motor application, this alarm occurs if the main uC is detecting a direction of the stepper motor not matched with the one that the slave uC is detecting. In closed loop application, this alarm occurs if the main uC is detecting a direction of the steering error not matched with the one that the slave uC is detecting. Furthermore, this alarm occurs also if the main uC is detecting no steering limitation meanwhile the slave uC is detecting steering limitation. It is necessary to replace the controller.
F7	CAN BUS KO	○			○	The diagnosis of the CAN-BUS line is present only if the inverter uses this link (depends on the software version). It is signalled if the inverter 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.
	NO CAN MSG N.		○			
	EVPG4 DRIVER KO			○		One of the group 4 valves drivers is open (it does not close when it is commanded by the microcontroller).

Code	Alarm	Traction (T)	Pump (P)	Mhyrio (V)	EPS (E)	Description
F8	DISPLAY ENABLE	○				Comunication with display ok but waiting for display message
	UNDER VOLTAGE			○		This fault is signalled if an undervoltage condition is detected in the MHYRIO power supply
	S.P OUT OF RANGE				○	This alarm occurs for a fault on the command potentiometer (CPOC1 on CNA#9, CPOC2 on CNA#8). When a single command pot is chosen, the alarm occurs if its wiper (CPOC1) exits the range from 0.8 Vdc to 4.2 Vdc. When the twin pot is chosen, the alarm occurs if the sum of the two wiper voltages (CPOC1+CPOC2) exits the range from 4.5 Vdc to 5.5 Vdc.Check the connections of the potentiometer. This alarm occurs when one connection of the command potentiometer is broken.
F9	THERMIC SENS. KO	○	○			The range of inverter temperature sensor is always checked and a warning is signalled if it is out of range. When this alarm is signalled, check the connection of the sensors.
	EVP DRIVER KO			○		The single proportional valve driver is open (it does not close when it is commanded by the microcontroller).
FA	HANDBRAKE	○				The truck does not start because the handbrake switch is opened. Possible causes: A) Defective wiring; B) Failure of the microswitch; C) Incorrect operation of the operator; D) If the defect persist, replace the logic.
	HI SIDEDRIVER KO			○		The high side driver which supply the valves coils positive is shorted or open. Check the wire connection to CNB2 (PAUX) and fuse. If it is ok, change MHYRIO CB.
	MICRO SLAVE				○	It occurs two ways: A) In steady state condition, when the main uC finds the safety contact controlled by the slave uC has been opened, but no alarm information has been communicated from the slave uC to justify the opening of the safety contact. B) at key on,when the main uC has closed its own safety contact, it grants the local status bus to the slave uC that is expected to change properly the status bus configuration within 300msec. In case it doesn't, this alarm occurs. It is necessary to replace the controller.

Code	Alarm	Traction (T)	Pump (P)	Mhyrio (V)	EPS (E)	Description
FB	WAITING FOR NODE	○				The controller receives from a remote module via CAN BUS the information that it isn¡¯t possible to close the LC (the module isn¡¯t ready locked in an alarm state). Verify the other modules to determinate in which of them there is the problem.
	WAITING FOR TRAC		○			
	WAITING FOR TRAC			○		This fault is signalled if the battery voltage is non consistent with the set battery programmed in the 'set option' menu.
	KM OPEN				○	This alarm occurs if the slave uC detects the safety contact, of the main uC, open when expected being closed. It is necessary to replace the controller.
FC	CHAT MODE	○				No command (traction or pump) for CHAT TIME minutes
	HW PROTECTION		○			
	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.
	KS OPEN				○	This alarm occurs if the main uC detects the safety contact, of the slave uC, open when expected being closed. It is necessary to replace the controller.
FD	AUX OUTPUT KO	○	○			The μ P checks the driver of the electromechanical brake. If the status of the driver output does not correspond to the signal coming from the μ P, the alarm is signalled. Replace the logic.
	KM CLOSED				○	This alarm occurs at key on if the slave uC detects the safety contact, of the main uC, closed prior to be commanded. This alarm occurs if the connection CNA#5 (K1) is around a voltage of 12 Vdc when switching on the key. In fact, when the safety contacts are open, K1 is expected being connected to a battery voltage (not 12 V). Search for a harness problem or replace the controller.
FE	CAN BUS DISP KO	○				No Can Comunication with display
	DISPLAY ENABLE		○			Comunication with display ok but waiting for display message
	KS CLOSED				○	This alarm occurs if the main uC detects the safety contact, of the slave uC, closed prior to be commanded. This alarm occurs if the connection CNA#4 (NK1) is around a voltage of 12 Vdc when switching on the key. In fact, when the safety contacts are open, NK1 is expected being connected to a minus battery voltage (not 12 V). Search for a harness problem or replace the controller.

10. BATTERY CHARGER

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

1) BASIC INFORMATION

(1) What is charger

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

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

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

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

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

④ It prevents from under charging and overcharging.

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

(2) Notice on caring chargers

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

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

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

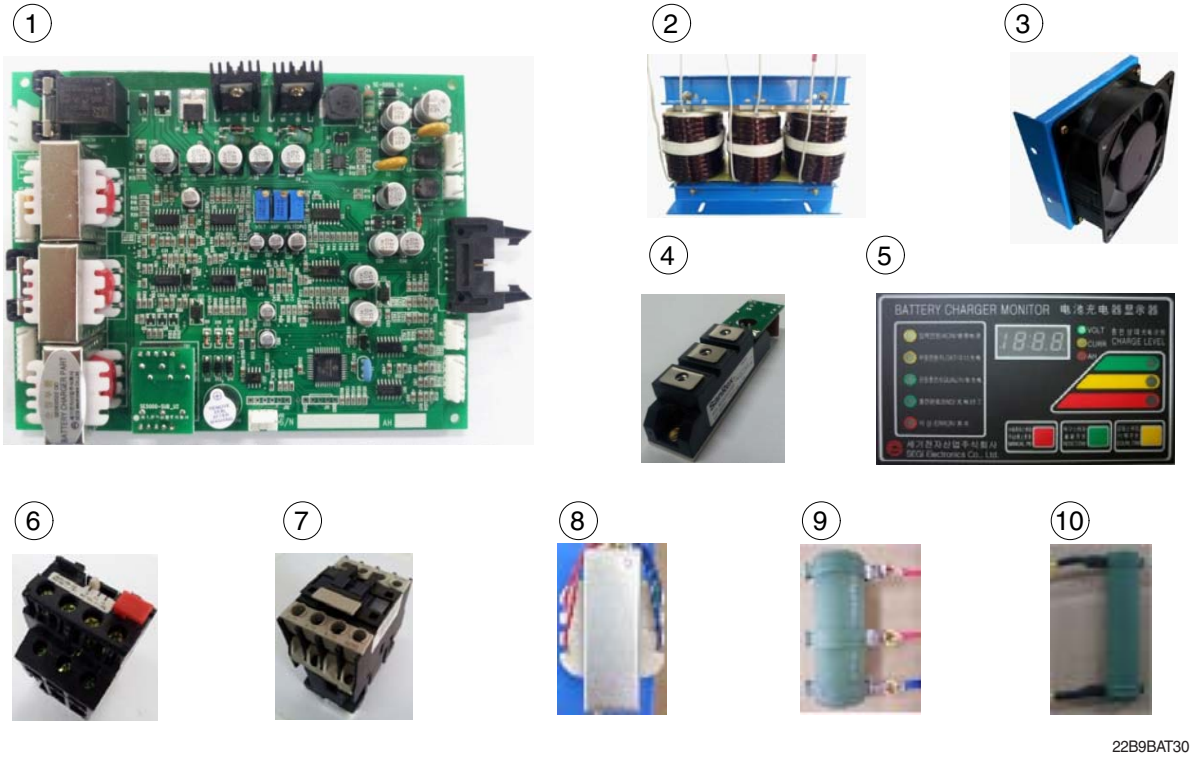
④ Check the electrolyte of the battery every week and provide distilled water immediately if it is required. (Electrolyte has to be provided between 10~12 ㎜ level on the positive plate inside storage battery)

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

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

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

(3) Names of each part (independent items)



22B9BAT30

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

2) CHARGER INSTALLATION METHOD

(1) Location for charger installation

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

(2) Check points before installing charger

① Enough capacity of AC input power source to operate charger.
② Standard electric wire for power source by capacity.

(3) Table for capacity of charger input cable

48 V battery	Capacity of cable	Input voltage	Remarks
200-365 AH	4P - 2.5 mm^2	Based on 3 ø 380 V 3 ø 440 V	For 3 ø 220V, one step higher capacity cable should be used. (2.5 mm^2 → 4mm^2)
400-580 AH	4P - 4 mm^2		
600-800 AH	4P - 6 mm^2		
850-1000 AH	4P - 10 mm^2		
24 V battery	-		
200-600 AH	4P - 2.5 mm^2		
700-1000 AH	4P - 4 mm^2		
80V battery	-		
500-600 AH	4P - 6 mm^2		
700-800 AH	4P - 10 mm^2		

3) HOW TO USE A CHARGER

(1) General charging method (Floating charging)

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

② Connect battery connecter and charger connecter.

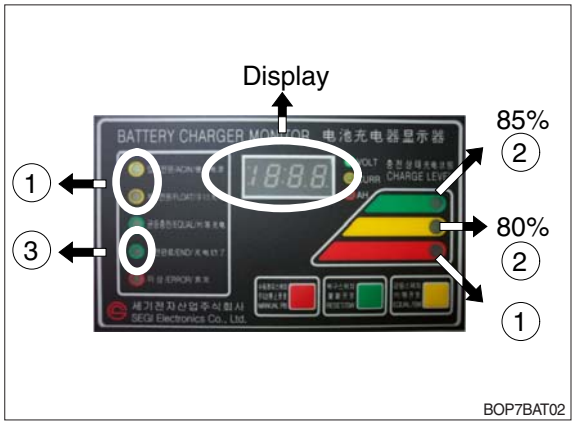
· **According to charging condition**

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

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

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

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



(2) Equalized charging

① **Equalized charging is**

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

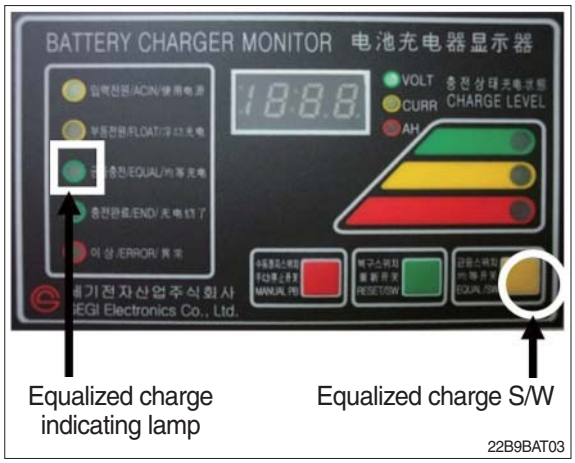
When equalized charging is required?

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

② **Tips for equalized charging**

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

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

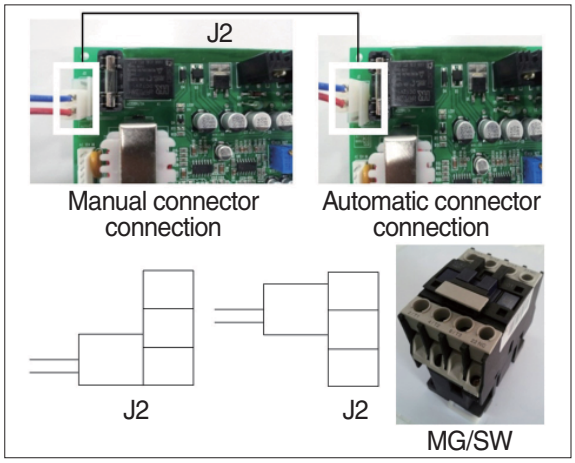


(3) Automatic/Manual switching method

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)



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

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

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 7-117
3	O.C	Over current - Refer to page 7-116, 7-118.
4	F.B	Battery error (After starting charging, the voltage doesn't go over 52V for 2 hours.) Check the battery.
5	O.T	Transformer over heat (Stop charging when it is over 160°C). - If input voltage is high, output current is over normal value and there is heat in the trans because of SCR control part fault. - Check the output current and PCB control board
6	O.H	Heatsink over heat (Stop charging when it is over 100°C). - Check the cooling fan, SCR connection cable contact point and control part.
7	A.O	Power supply error (input power 220/380V wrong wiring). - Refer to page 7-115.
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.

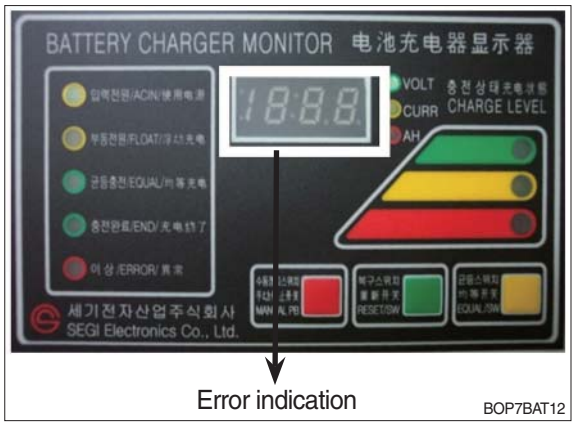
② A.O : Error on selection of input power source of 220V or 380V - Check it appropriately with full three phases.

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"

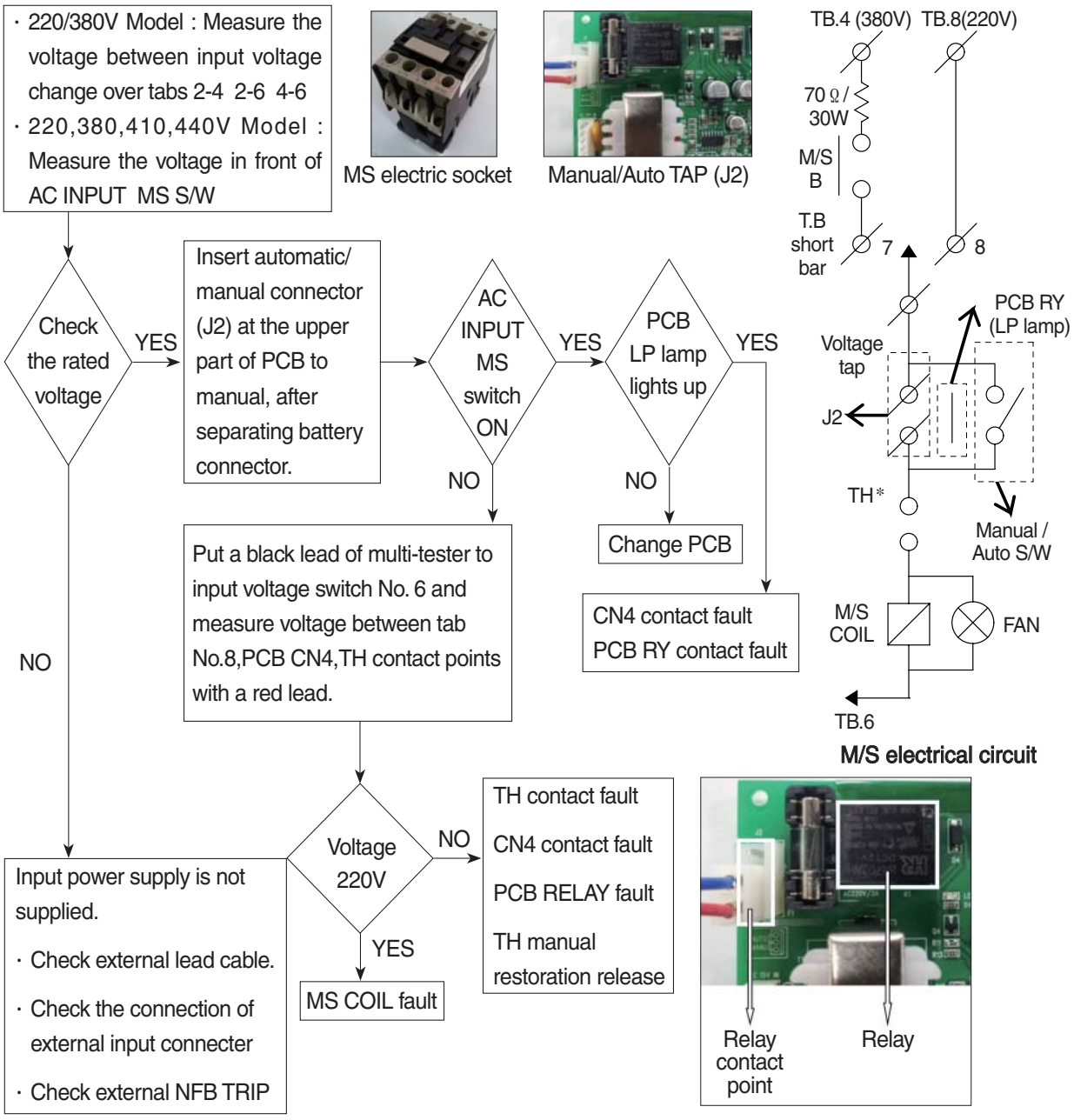
⑤ Charger TRIP is occurred after it started charging and charging completion lamp is on.

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

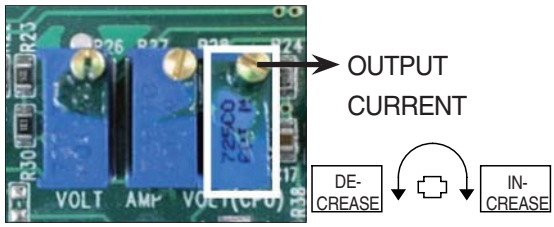
⑦ SCR module checking method

(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

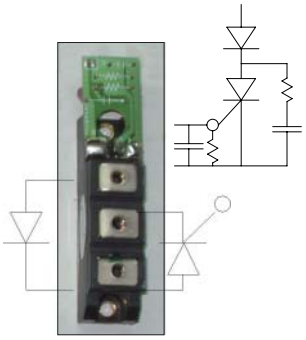
YES

Change TH

NO

Complete

* Refer to SCR Module checking method



YES

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

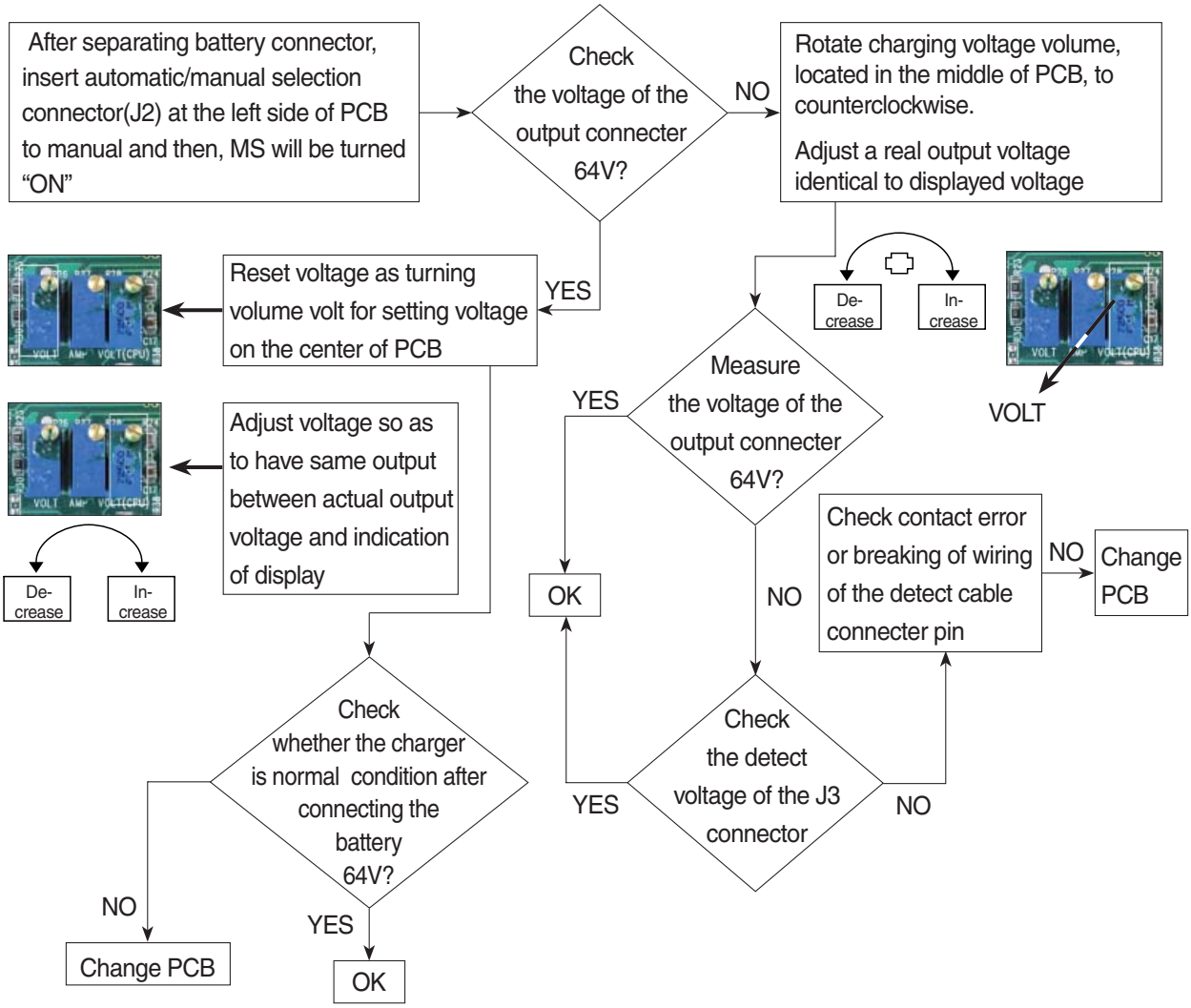
NO

Change PCB

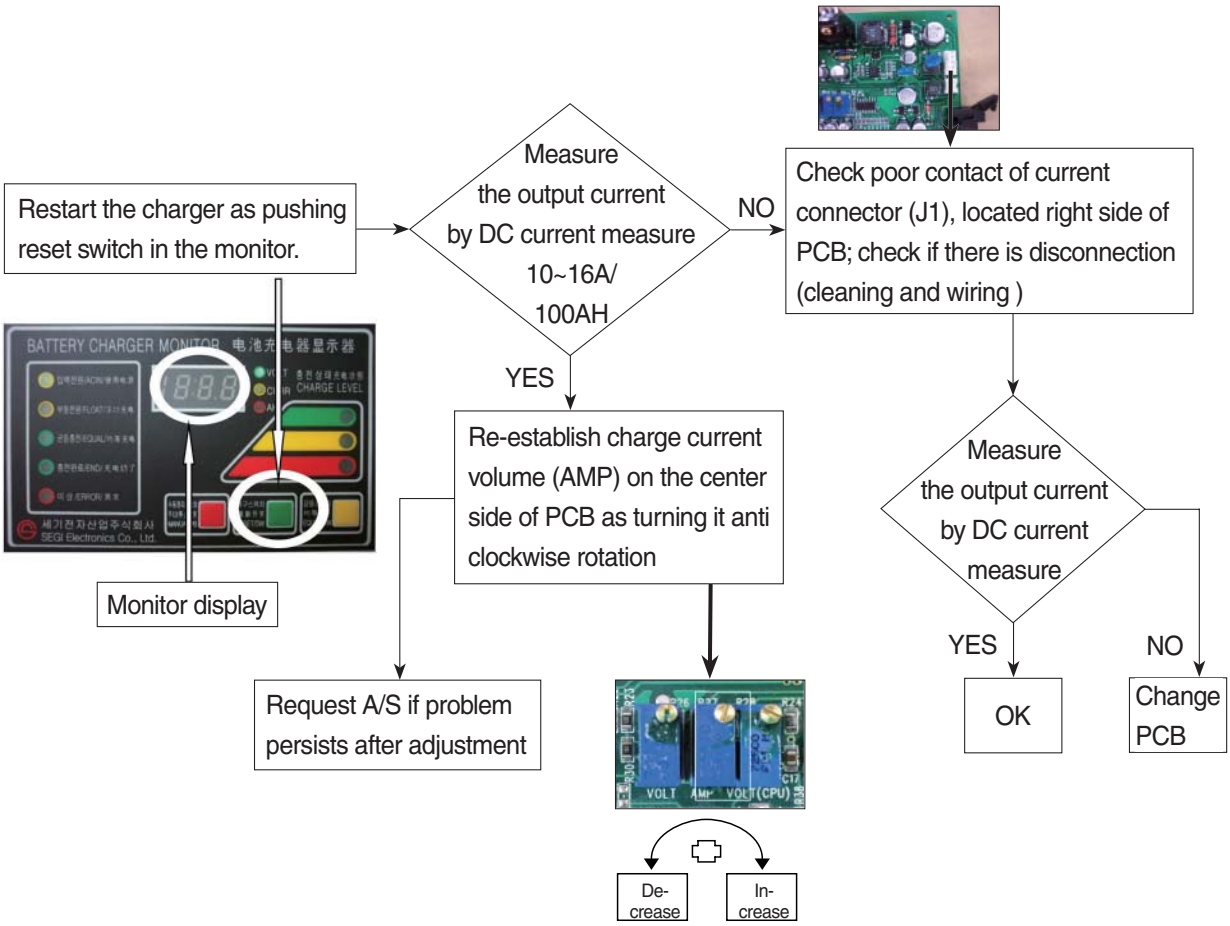
YES

Check the normal operating condition of the charger

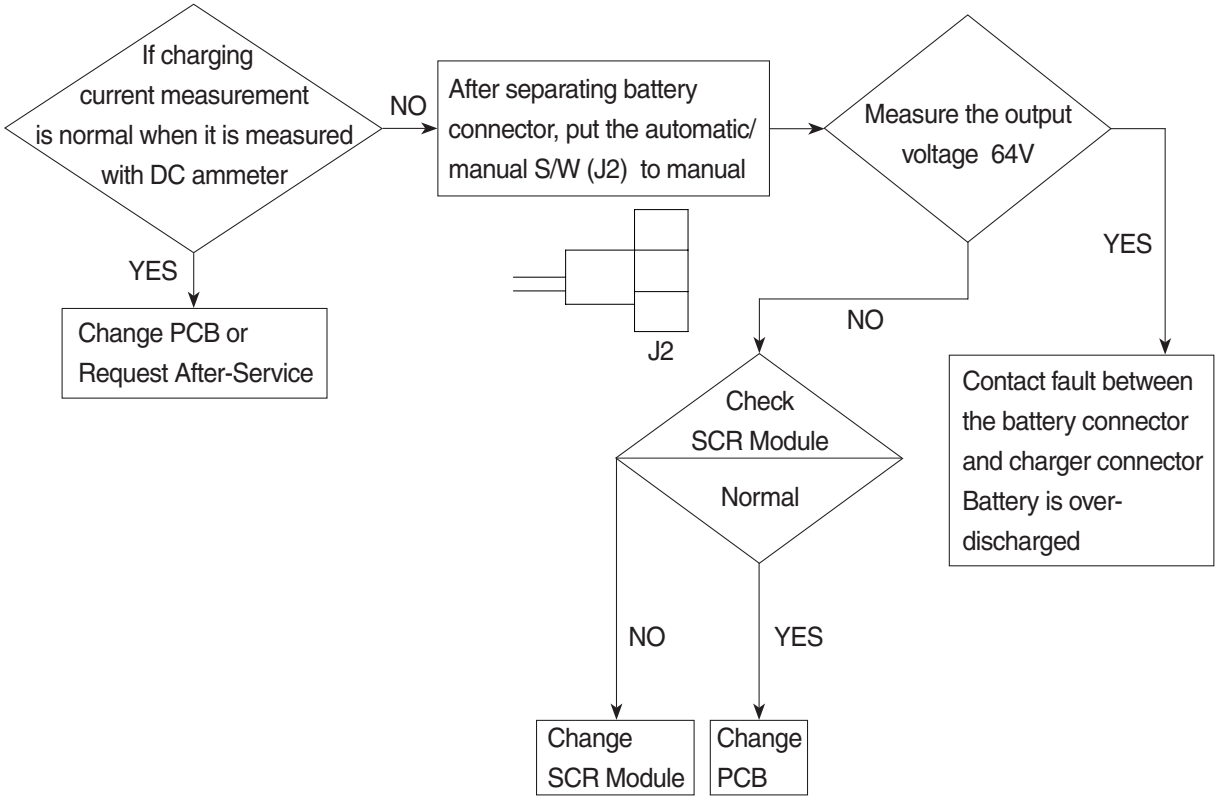
③ Charger TRIP is occurred after abnormality lamp is on.
In case error code is "O.V" → Over-voltage output / Set at 66V (In case of BATT 48V)
34V (In case of BATT 24V)
108V (In case of BATT 80V)



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

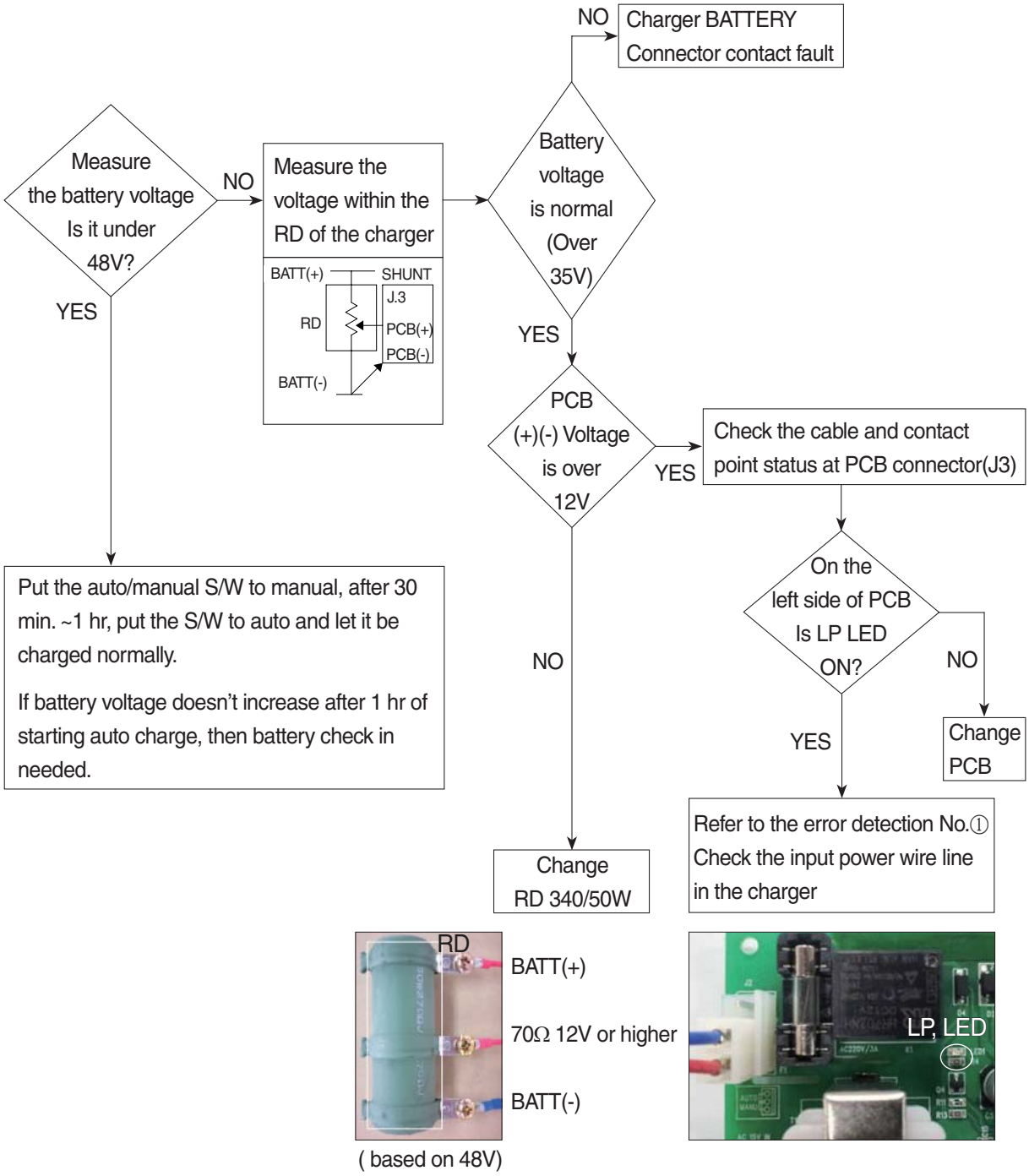


⑤ **Charger TRIP is occurred after it started charging and charging completion lamp is on.**
(In case input voltage is normal - Refer to the error detection No. 1)
Restore the charger as pushing reset switch.



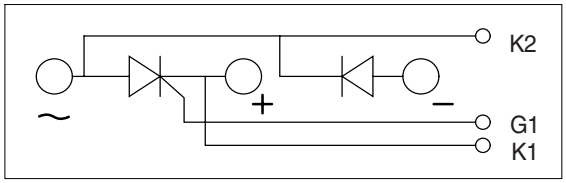
⑥ **Charger has no response even if the battery connector is connected.**

- In case only floating LED is on, charger input power is cut off or doesn't connect. (In case the input voltage is normal - Refer to the error detection No. ①)

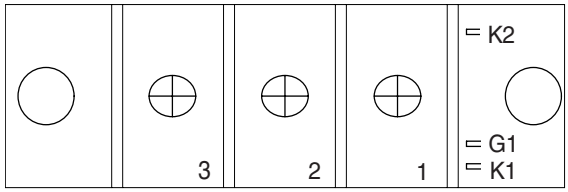


7) HOW TO CHECK THE SCR MODULE

Circuit

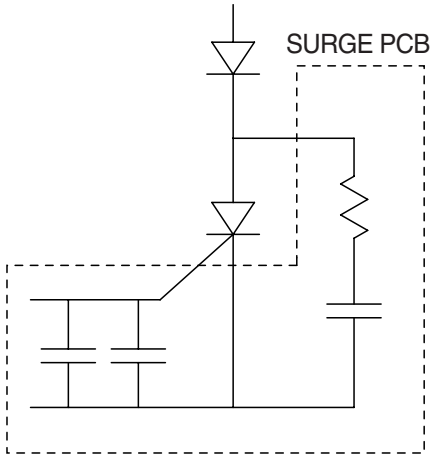


Real diagram

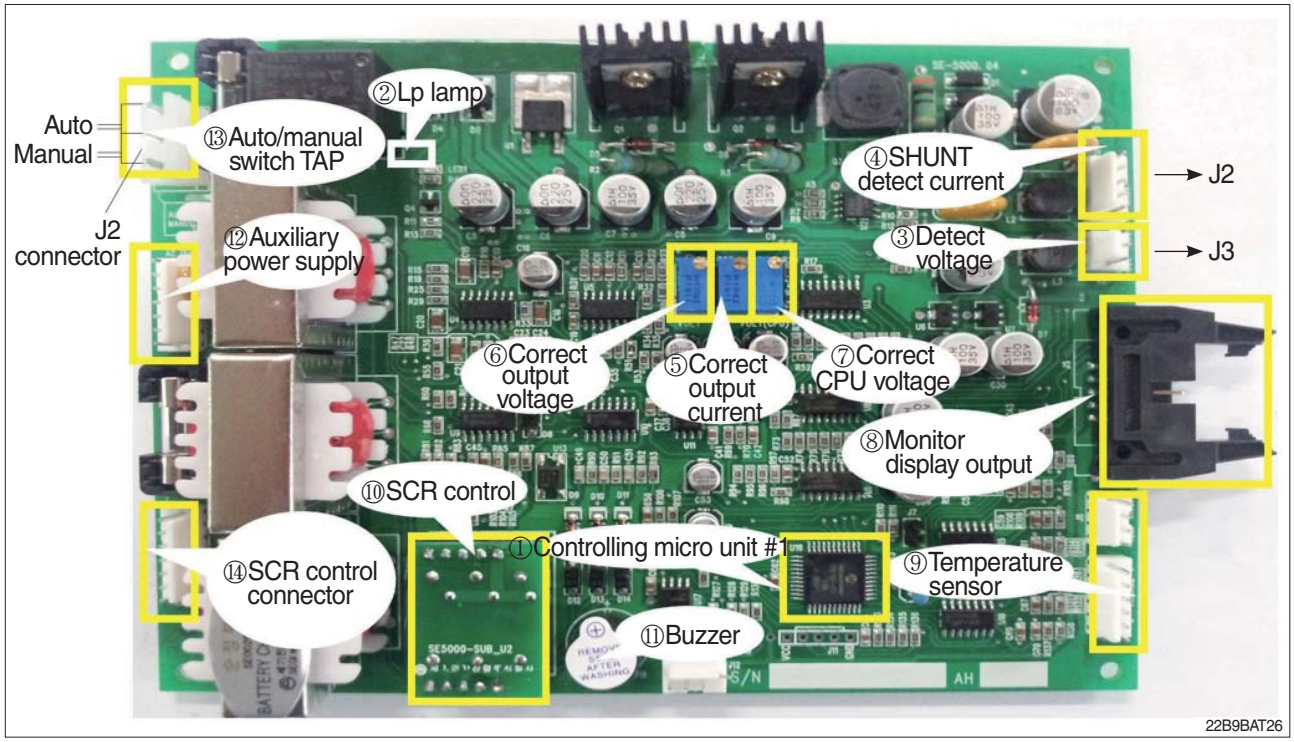


* Before checking SCR MODULE, be sure to disconnect bus bar and wire on the terminal.

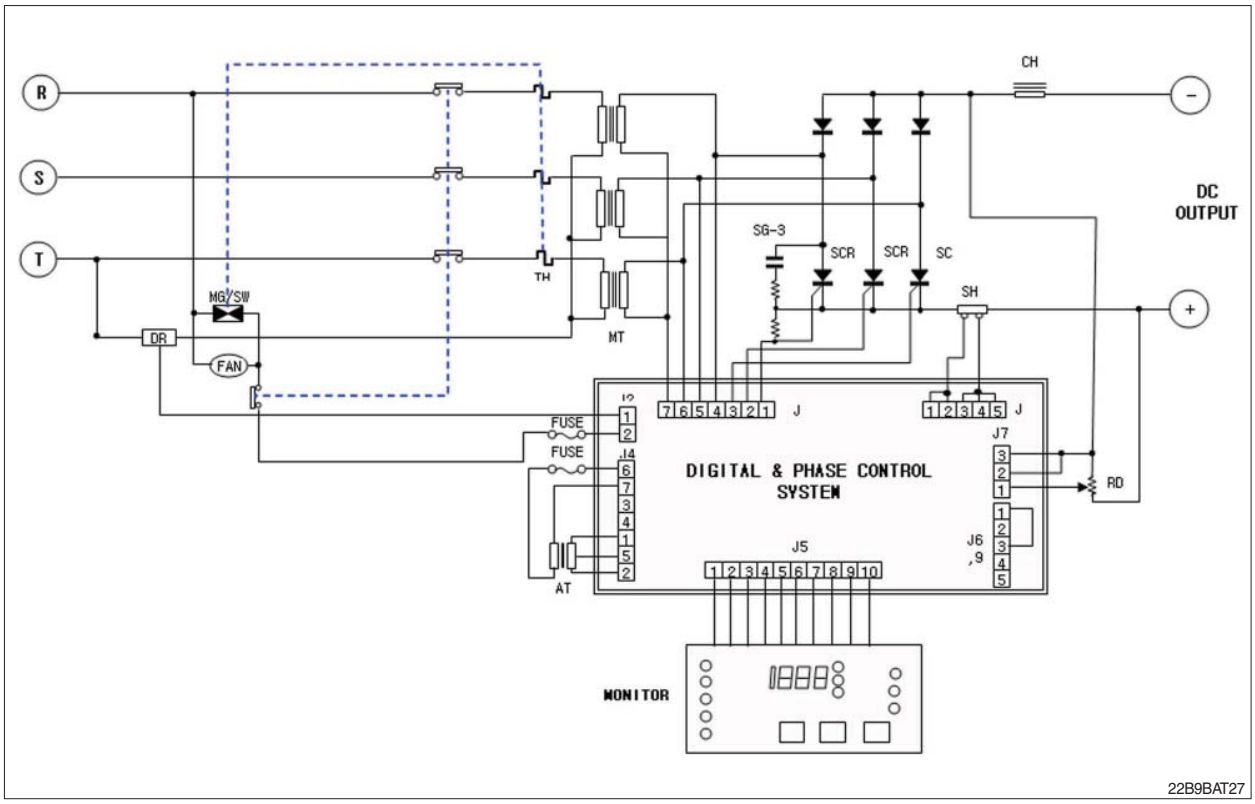
No.	Measuring point (Real diagram)	Measure value (Measurement of digital tester)
1	No.1 ~ No.3	Forward : Under 100 k ohm Reverse : Infinity (∞)
2	No.2 ~ No.3	Forward : Infinity (∞) Reverse : Infinity (∞)
3	G1 ~ K1	Forward : Under 100 ohm Reverse : Under 100 ohm But It depends on the module. If it is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



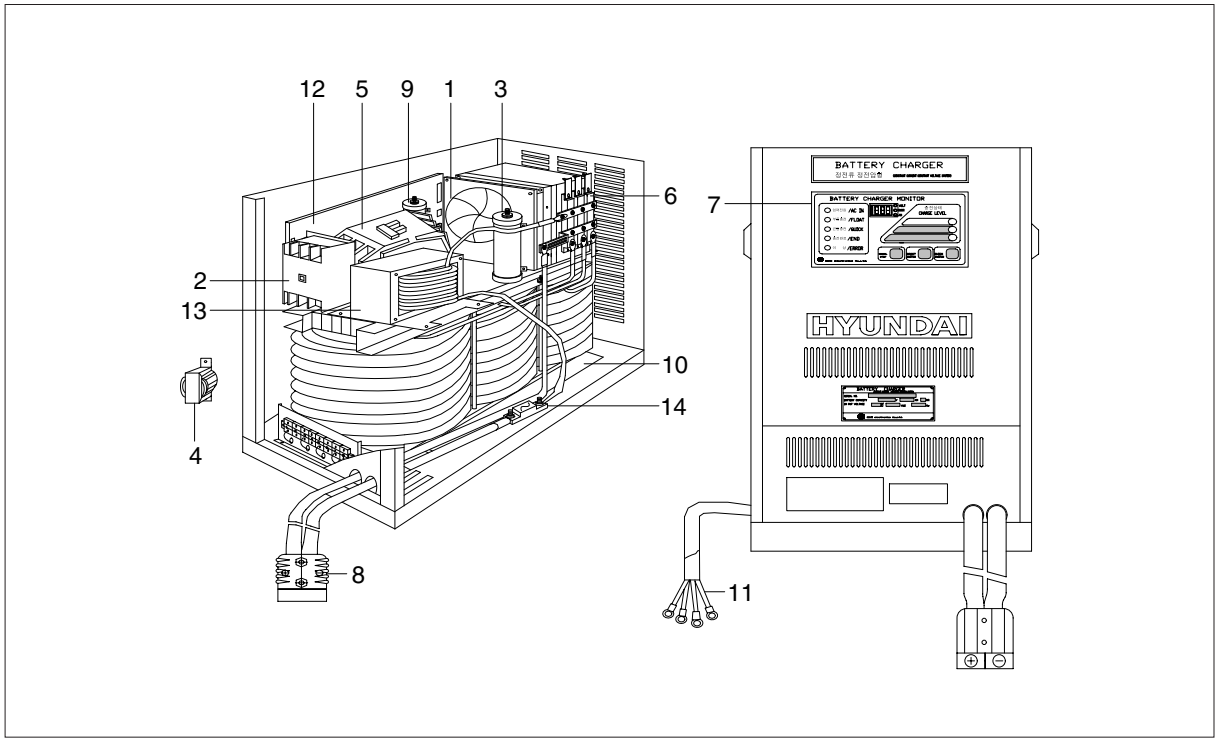
8) PCB MAJOR PARTS (NAME AND LOCATION)



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


R
S
T
MG/SW
DR
FAN
TH
MT
CH
SG-3
SCR
SCR
SC
SH
DC
OUTPUT
FUSE
FUSE
AT
DIGITAL & PHASE CONTROL
SYSTEM
J5
J7
RD
MONITOR
22B9BAT27

CHARGER INTERIOR PARTS



22B9BAT28

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