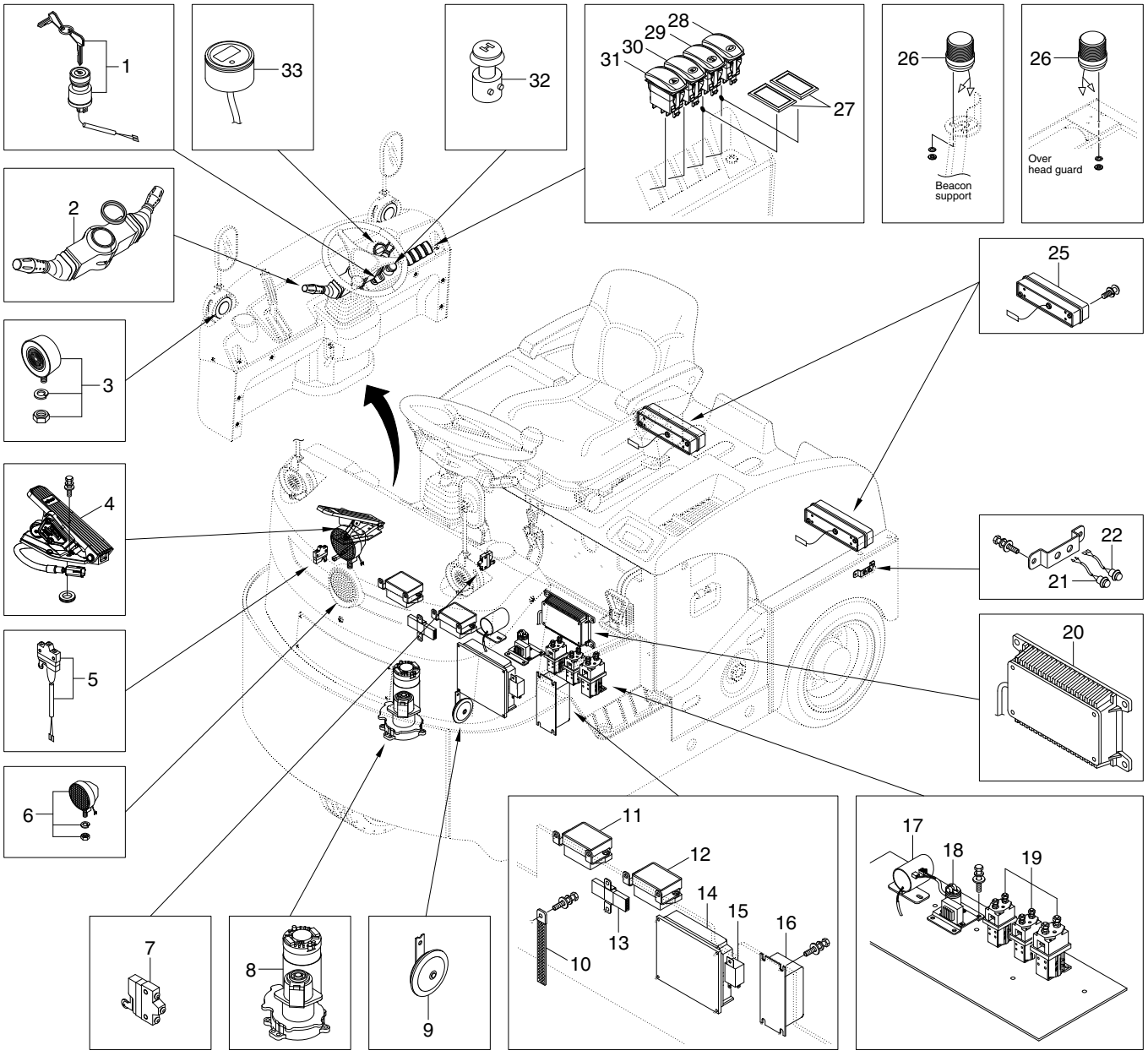
SECTION 6 ELECTRICAL SYSTEM

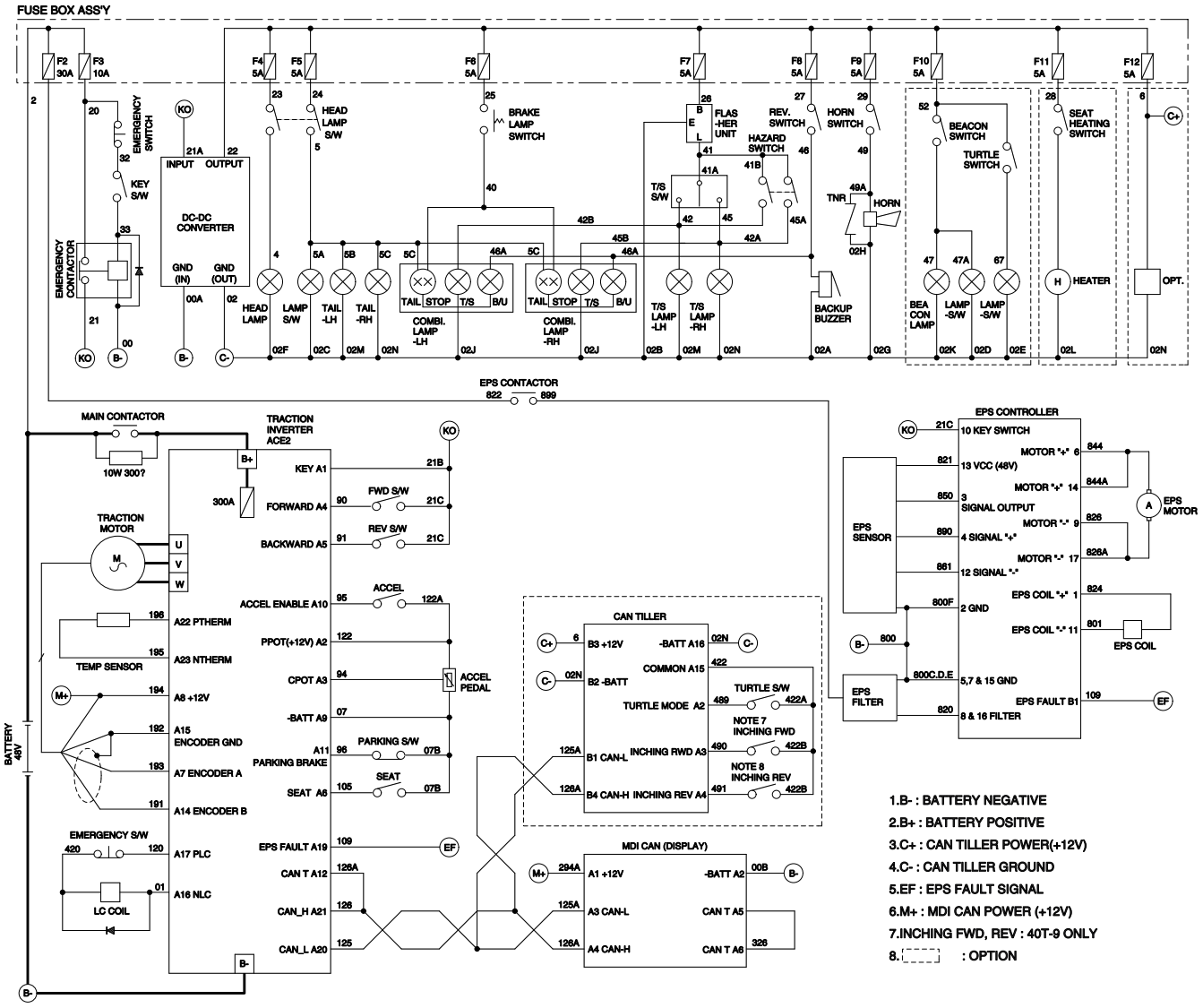
GROUP 1 COMPONENT LOCATION



1	Key switch	12	Fuse box-UL#1	25	Rear comb lamp
2	Combination switch	13	Cantiller	26	Beacon lamp
3	Turn signal lamp	14	Traction controller	27	Cover
4	Accelerator	15	Flasher unit	28	Turtle mode switch
5	Brake pedal switch	16	DC-DC converter	29	Beacon lamp switch
6	Head lamp	17	Back buzzer	30	Head lamp switch
7	Parking brake switch	18	EPS filter	31	Hazard switch
8	EPS motor	19	Contactor	32	Emergency switch
9	Horn	20	EPS controller	33	MDI can
10	Static strap	21	FWD inching switch		
11	Fuse box-UL#2	22	BWD inching switch		

GROUP 2 ELECTRICAL CIRCUIT

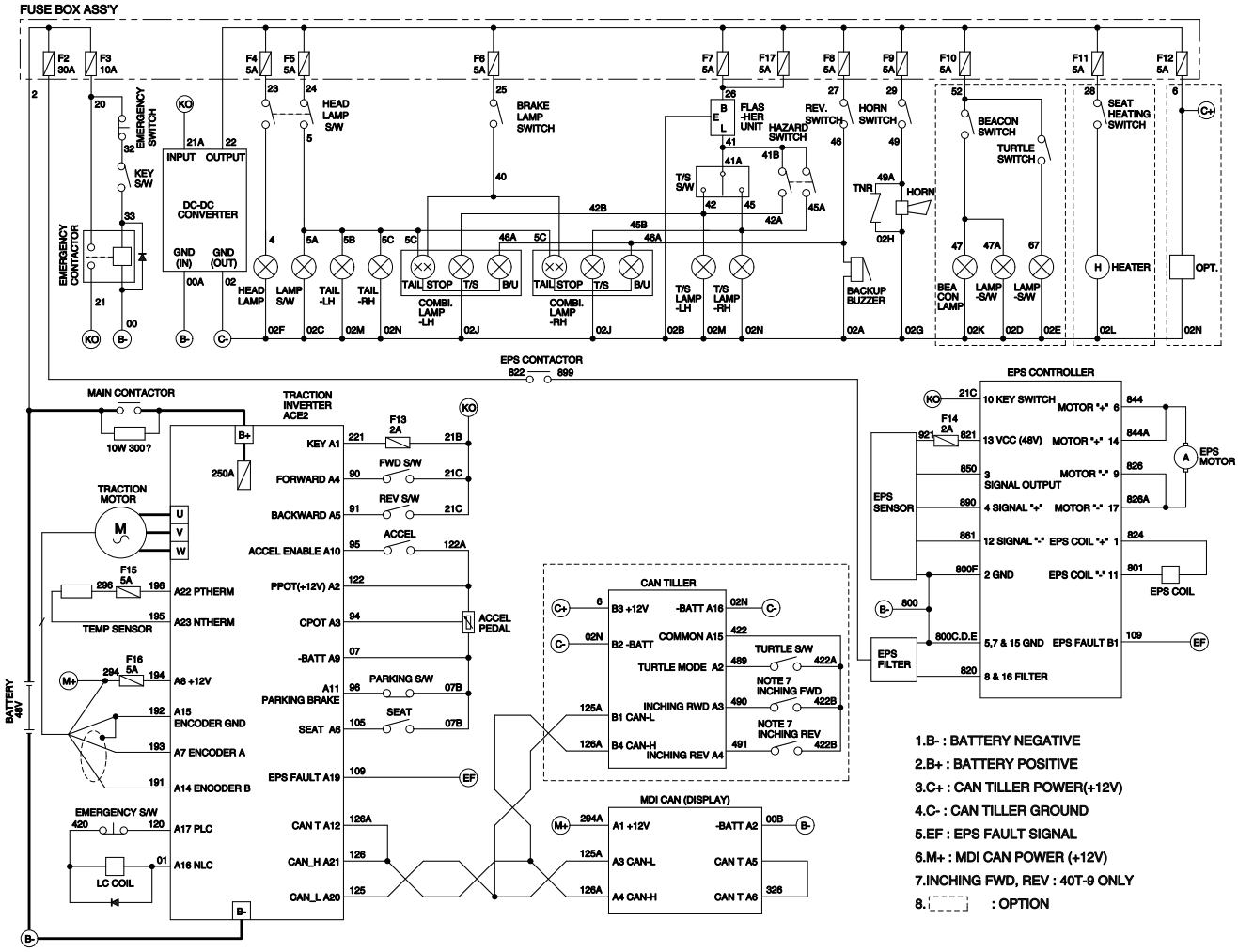
1. NON-UL



15P9EL02

※ The circuit diagram may differ from the equipment, so please check before a repair.

2. UL



15P9EL03

※ The circuit diagram may differ from the equipment, so please check before a repair.

GROUP 3 ELECTRIC COMPONENTS

1. FUNCTIONS OF BATTERY TRACTOR AND ELECTRIC COMPONENTS.

The major functions of battery troctor can be divided into DRIVING FUNCTION and LOADING & TRACTION FUNCTION.

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

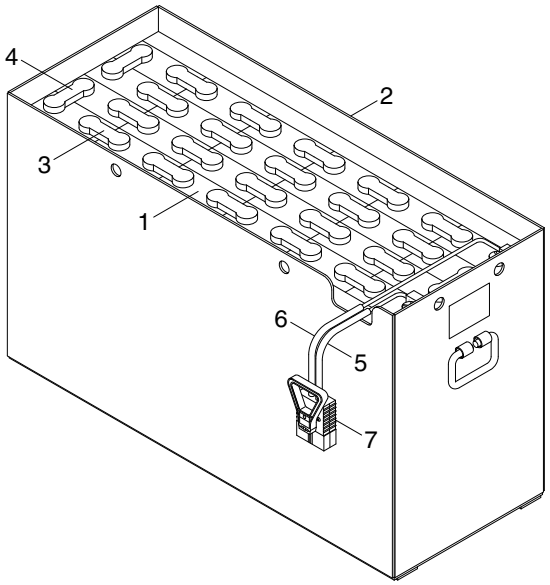
To drive the battery tractor, a DRIVING CONTROL SYSTEM and some electric components such as direction change lever (forward/reverse section switch) and accelerator are required to select the driving direction and to control the speed of driving motor.

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 and temperature sensors. The HYUNDAI battery tractor series are equipped with the most advanced DRIVING CONTROL SYSTEM currently available world-widely. The operator friendlyness features enable him to set the vehicle conditions properly according to each working circumstance easily on his seat, and the SELF-DIAGNOSTIC function displays current status of vehicle in working.

2. BATTERY

1) STRUCTURE

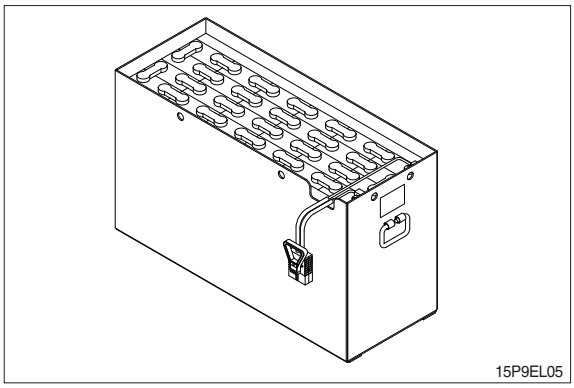


15P9EL04

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

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	Specifications	
		STD	OPT
Model	-	VCI 230	VCF 280
Rated voltage	V	48	
Capacity	AH/hr	230/5	280/5
Electrolyte	-	WET	
Dimension (W × D × H)	mm	965 × 380 × 580	
Connector (CE spec)	-	SB350	
Weight	kg	400	470

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 steel tray 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

Dry-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 varies 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 complete 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 ×1.0~1.5" at the start of charging, and at the final stage it is "5 hour rate current ×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

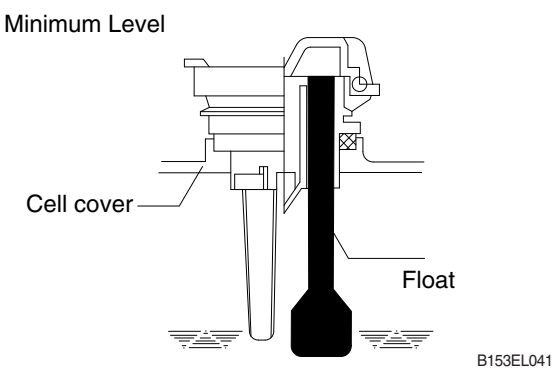
When large number of cells are used in a set of battery, the voltage and specific gravity of respective cells tend to become unequal, resulting in necessity of charging all the cells at an appropriate time in order to equalize them. This is called equalizing charge. Normally the equalizing charge should 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 are in most cases provided with timer, extend the time setting for 3-6 more hours.

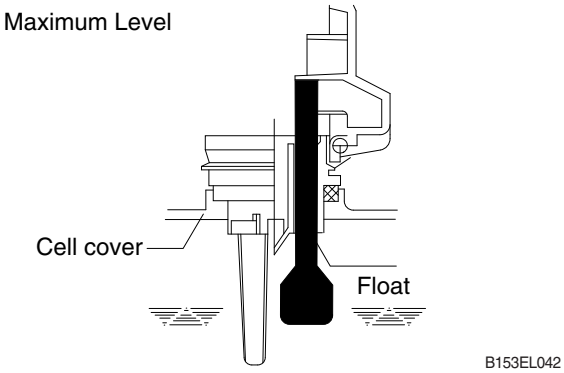
⑥ Water replenishment

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

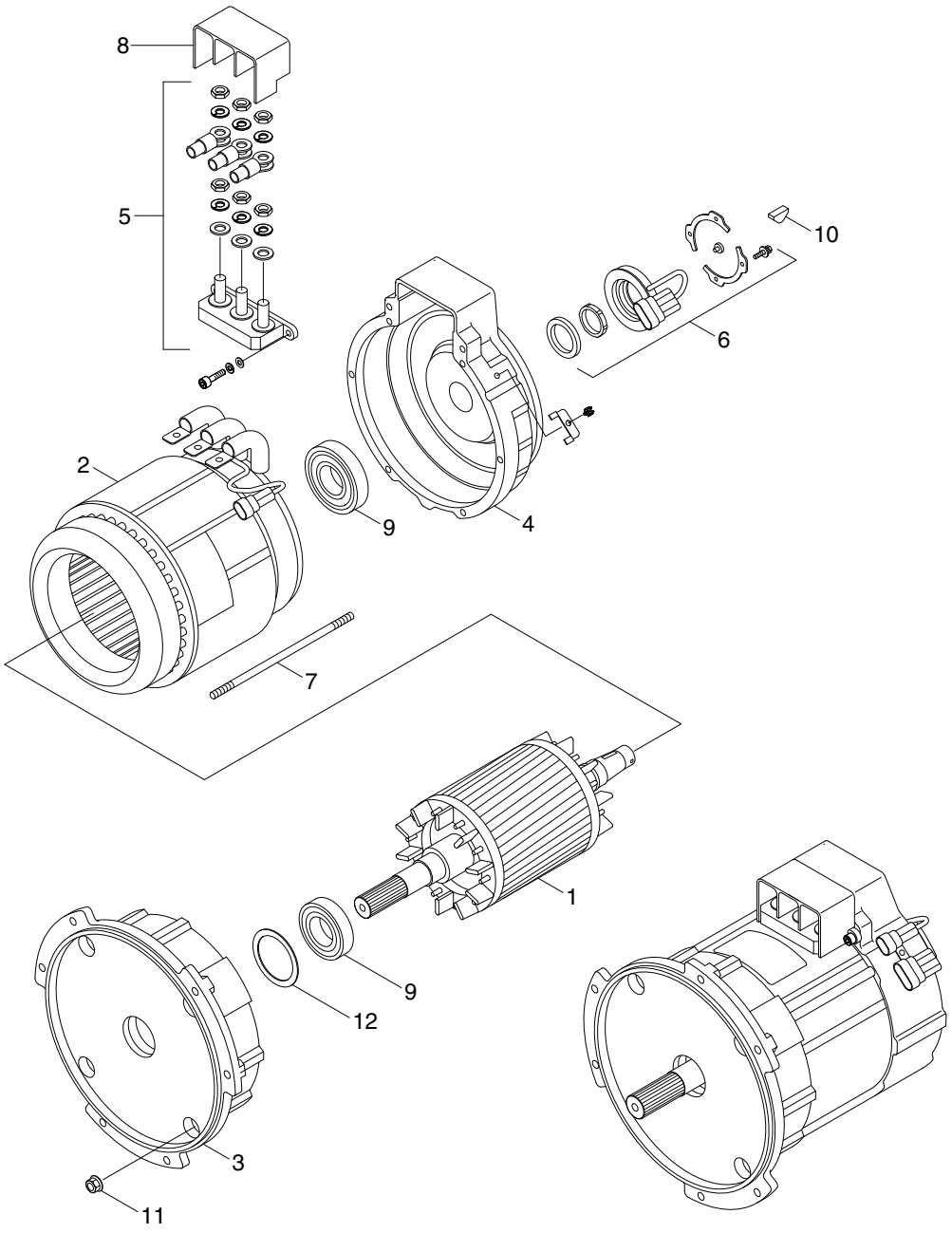
The operating temperature range of batteries is -10~45˚C (temperature of electrolyte). If the batteries are exposed to cold atmosphere in discharged condition, the electrolyte may freeze, and in extreme cases, the capacity will be decreased, but, if not frozen, no adverse effects will be exerted over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

1) STRUCTURE



15P9EL07

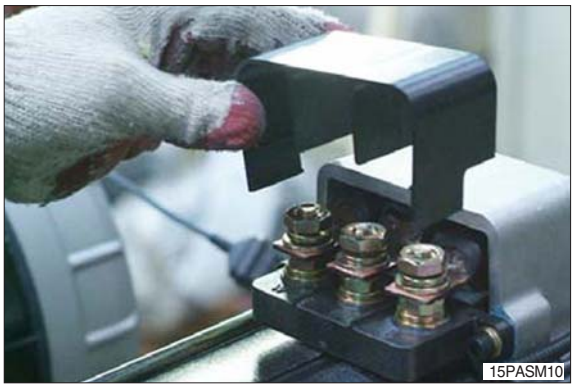
1	Rotor assy	5	Terminal block	9	Bearing
2	Stator assy	6	Speed sensor kit	10	Woodruff key
3	Endbell de	7	Stud bolt	11	Flange nut
4	Endbell	8	Terminal protector	12	Wave washer

2) SPECIFICATION

Item	Unit	Specifications
Model	-	AMBS 4001
Current	A	109
Rated voltage	V	30
Output	kW	4.0
Speed	rpm	1910

3) DISASSEMBLY

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

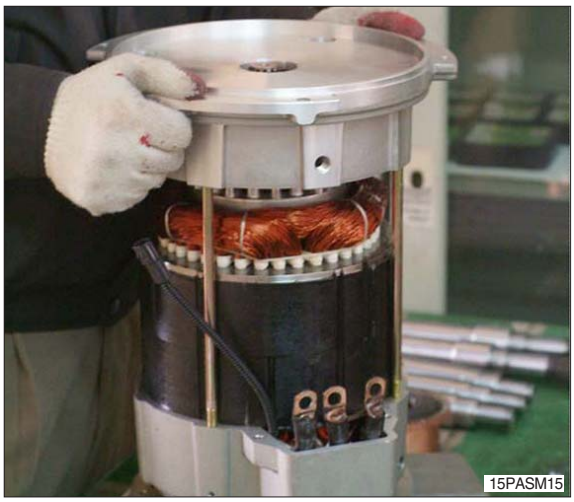


(2) Remove 3 nuts from terminal block of the motor to disassemble terminal block from the motor.

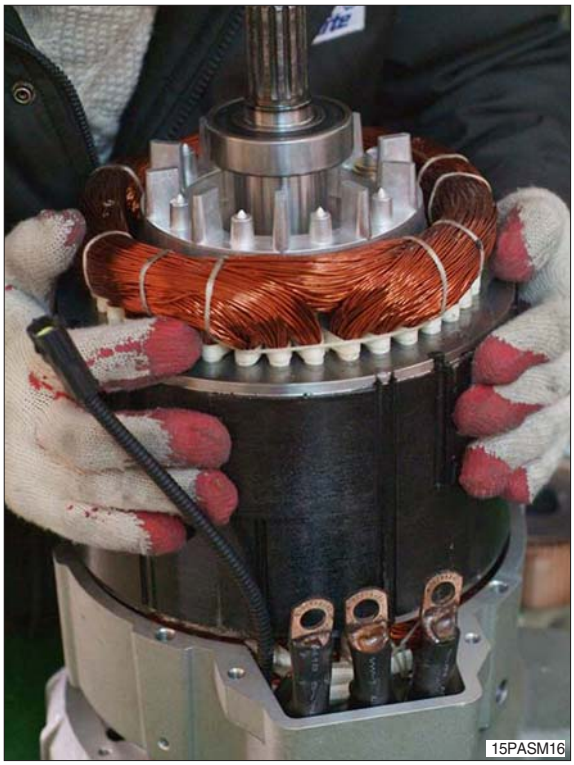
(3) Remove 4 screws fixing speed sensor on the enbell side and then disassemble speed sensor, fixed nut and toothed wheel of the motor.

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

(5) Remove endbell de and wave washer.

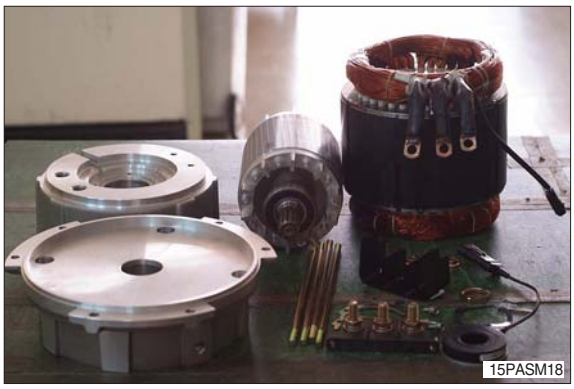


(6) Remove stator assembly by hand or suitable tool.



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

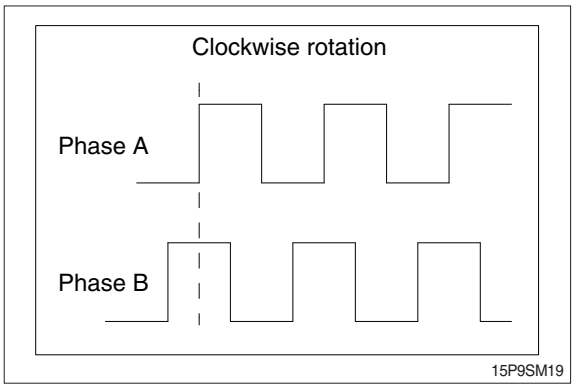
(8) The motor are composed of 5 parts. (Rotor assembly, stator assembly, endbell de, endbell, ETC)



4) ASSEMBLY AND INSTALLATION

(1) Perform assembly in the reverse order of disassembling.

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



5) 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.

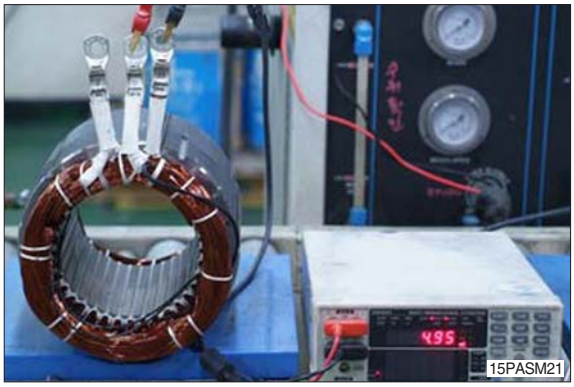
② Rotor out diameter : ø 123.1±0.05

③ Tool : Vernier calipers and standard tool

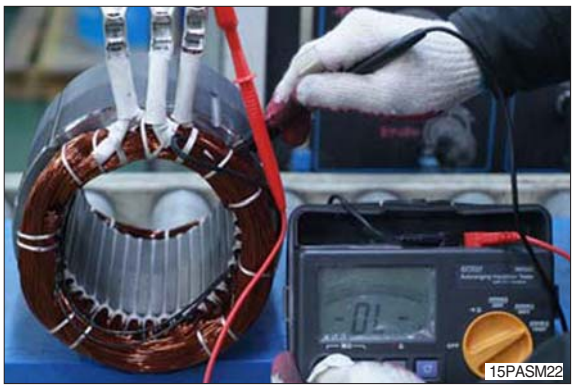
(2) Stator assembly inspection

① 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.

② Use mΩ tester and check for two power line of stator repeatedly (U-V, V-W, W-U).
At that time resistance is around 8.6 mΩ.

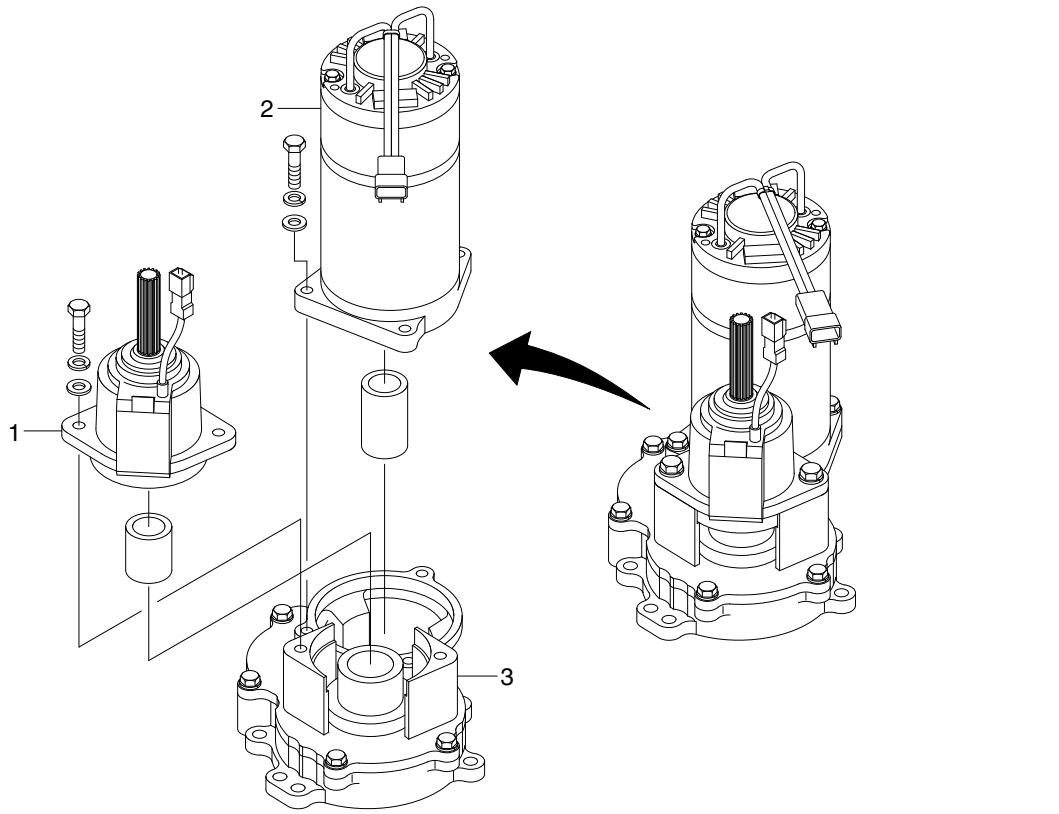


③ **Insulation test**
Use insulation tester (1000 Vac, min. 10MΩ) and measure as a picture.
If the insulation is defective, replace with new parts.



4. EPS MOTOR

1) STRUCTURE



15P9EL18

1 Torque sensor 2 Motor 3 Actuator

2) ACTUATOR ASSY

(1) Actuator assy consists of motor, torque sensor and actuator.

Actuator assy should always be cleaned with compressed air.


15PASM31

(2) Disassemble hexagon bolt (M8×20) which is assembled on torque sensor by using the below tool.

- Tool : Socket wrench set (socket : 13 ㎜)
- Part : Hexagon bolt (M8×20),
  M8 washer, M8 spring washer
- Quantity : 2EA


15PASM32


15PASM33

(3) Disassemble torque sensor from actuator assy.


15PASM34


15PASM35


15PASM36

(4) Disassemble joint coupling which is assembled on torque sensor.

- Part : Joint coupling
- Quantity : 1EA


15PASM37

(5) Disassemble hexagon bolt (M8×25) which is assembled on motor by using the below tool.

- Tool : Socket wrench set (socket : 13 ㎜)
- Part : Hexagon bolt (M8×25),
  M8 washer, M8 spring washer
- Quantity : 3EA


15PASM38

(6) Disassemble motor from actuator assy.

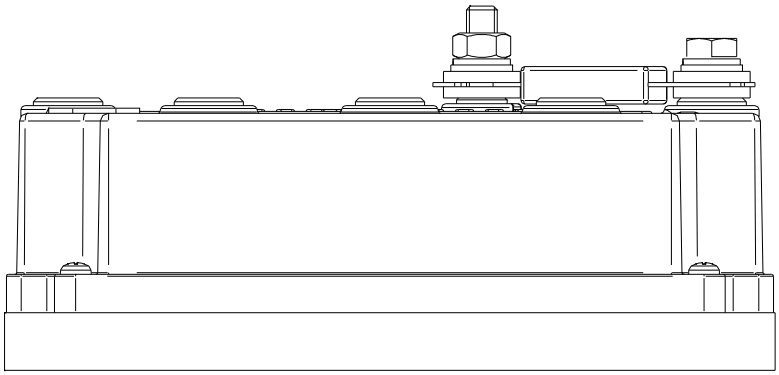
(7) Disassemble coupling which is assembled on motor.
- Part : Coupling
- Quantity : 1EA

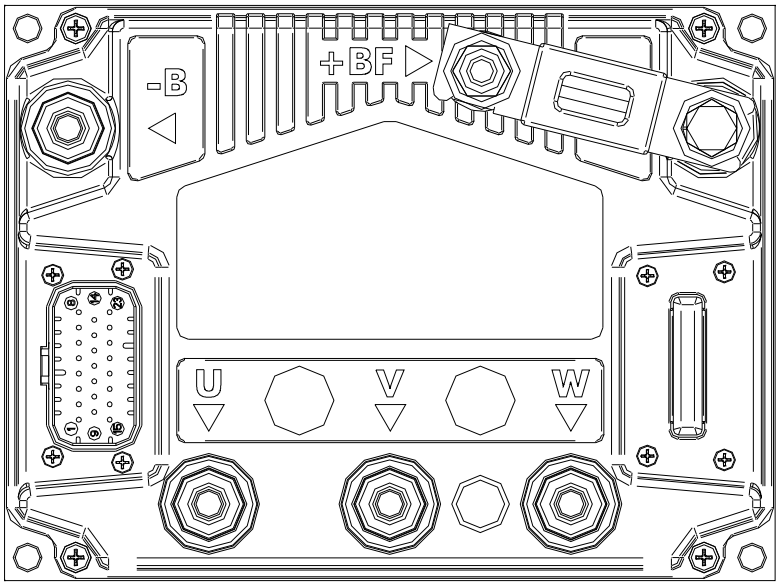
(8) The actuator assy is composed of 3 parts (actuator, motor, torque sensor).

※ Assembly procedure for EPS actuator is the reverse of disassembly procedure.

5. CONTROLLER SYSTEM

1) STRUCTURE





15P9EL11

(1) Specifications

Model	Model	Application	Type	Power	Current limit
15P/40T-9	ACE2	Traction	AC	36-48V, 300A	300A/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 Regenerative release braking based upon deceleration ramps.
④ Regenerative braking when the accelerator pedal is partially released (deceleration).
⑤ Direction inversion with regenerative braking based upon deceleration ramp.
⑥ Regenerative braking and direction inversion without contactors: only the main contactor is present.
⑦ Optimum sensitivity at low speeds.
⑧ Voltage boost at the start and with overload to obtain more torque (with current control).
⑨ Backing forward and reverse options are available, with the tune and the speed of the function programmable with Zapi console.
⑩ High efficiency of motor and battery due to high frequency commutations.
⑪ Modification of parameters through the programming console.
⑫ Internal hour-meter with values that can be displayed on the console.
⑬ Memory of the last five alarms with relative hour-meter and temperature displayed on the console.
⑭ Diagnostic function with Zapi console for checking main parameters.
⑮ Built in BDI feature.
⑯ Flash memory, software downloadable via serial link and via CANBUS.
⑰ Electrical power steering (EPS) system.

(2) Diagnosis

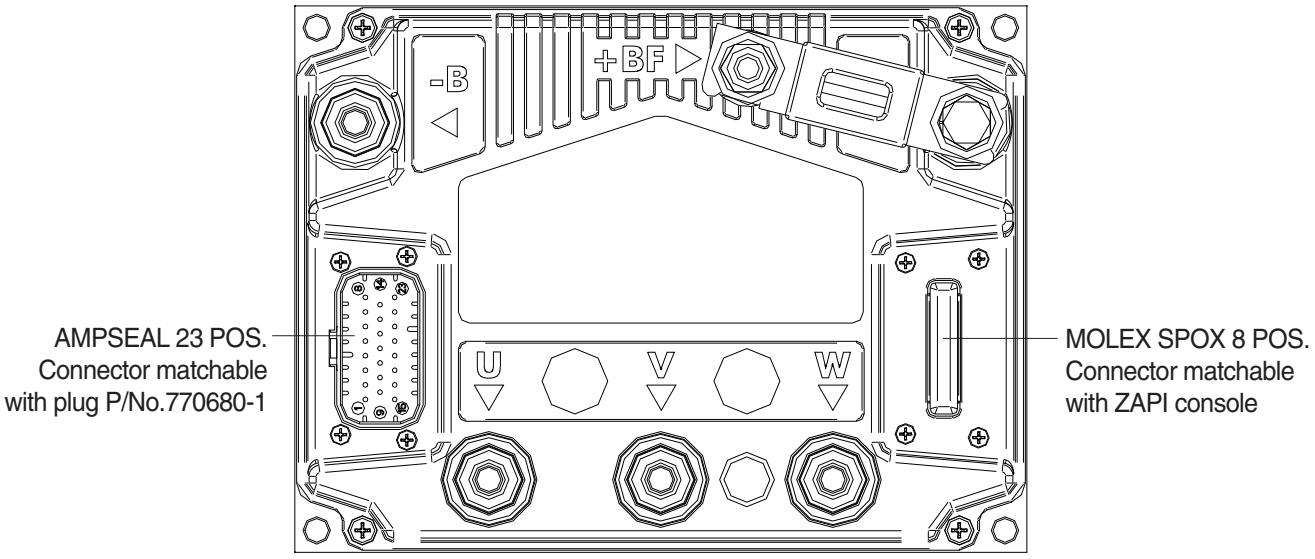
The microcontrollers continually monitor the inverter and carry out a diagnostic procedure on the main functions. The diagnosis is made in 4 points.

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

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

3) DESCRIPTION OF THE CONNECTORS

(1) Traction controller



15P9EL12

No. of pin	Function	Description
A1	KEY	Connected to the power supply (48V) from fuse box with a 10 A fuse in series.
A2	PPOT	Positive input of acclerator pedal. +12V
A3	CPOT	Signal of acclerator pedal
A4	FORWARD	FORWARD direction request signal; connected to direciton switch forward signal in combi switch. active high.
A5	BACKWARD	BACKWARD direction request signal; connected to direciton switch backward signal in combi switch. active high.
A6	SEAT	SEAT input; it must be connected to the SEAT microswitch; it is active when connected to -BATT (A9).
A7	ENC A	Encoder (traction motor speed sensor) phase A input.
A8	PENC (+12V)	Encoder (traction motor speed sensor) + supply (12V).
A9	NPOT, -BATT	Negative power supply. It is used as NPOT (Negative of accelerator pedal), and negative signal supply for parking brake (A11) & seat (A6)
A10	Accelerator enable	Signal of accelerator pedal enable (traction request) Switch ; it is active HIGH.
A11	Parking brake (Hand brake)	Parking brake (hand brake) input; it must be connected to the parking brake microswitch; it is active when connected to -BATT (A9).
A12	CAN-T	If it is connected with A21 (CAN H), it introduces the 120 Ohm termination resistance between CAN-L and CAN-H.
A13	SPEED3	Input for third speed request; it is active when connected to -Batt. (not being used)

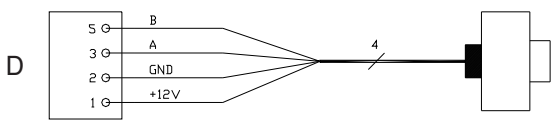
No. of pin	Function	Description
A14	ENCB	Encoder (traction motor speed sensor) phase B input.
A15	ENC GND	Encoder (traction motor speed sensor) negative supply.
A16	NLC	Negative PWM contol of line contactor (main contactor) coil .
A17	PLC/PAUX	Positive of the line contactor (main contactor).
A18	NAUX	Auxiliary coil output. The coil is driven to negative reference. (not being used)
A19	EPS Fault	Fault signal Input from EPS (Electronic Power Steering) controller. (Not being used)
A20	CAN-L	Low level CAN-BUS voltage I/O.
A21	CAN-H	High level CAN-BUS voltage I/O.
A22	PTHERM	Positive of traction motor temperature sensor.
A23	NTHERM	-Batt. Negative of traction motor temperature sensor.
B1	PCLRXD	Positive serial reception.
B2	NCLRXD	Negative serial reception.
B3	PCLTXD	Positive serial transmission.
B4	NCLTXD	Negative serial transmission.
B5	GND	Negative console power supply.
B6	+12	Positive console power supply.
B7	FLASH	It must be connected to A8 for the flash memory programming.
B8	FLASH	It must be connected to A7 for the flash memory programming.

Encoder installation

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

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

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



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4) FUNCTION CONFIGURATION

■ TRACTION CONTROLLER

(1) Submenu "SET OPTIONS"

① Display type

This parameter decides wich display is connected to the controller.

0 : No display
1 : MDI PRC connected
2 : ECO DISPLAY connected
3 : SMART DISPLAY connected
4 : MDI CAN connected (default)

The Parameter value is always supposed to be “4”. It is highly recommended not to change this parameter.

② Seat switch

This option handles the input CNA #6 (seat switch input). This input opens when the operator leaves the truck. It is connected to a key voltage when the operator is present. There are two levels:

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

The Parameter value is always supposed to be “SEAT”. It is highly recommended not to change this parameter.

③ Hour counter

- RUNNING : The hour counter registers travel time only.
- KEY ON (default) : The hour counter registers when the "key" switch is closed. The parameter value is always supposed to be “KEY ON”. It is highly recommended not to change this parameter.

④ Battery check

- Level 0 : The battery discharge level check is carried out but no alarm is signalled.
- Level 1 : The battery discharge level check is carried out and alarm will be signalled to notify a user, but traction won’t be limited or suspended.
- Level 2 (default) : The battery discharge level check is carried out; when the battery level reaches 10%, an alarm is signalled and the maximum current on traction motor is reduced to speed defined in “BATT MAX SPEED” parameter in “Parameter Change”.

⑤ Stop on ramp

- ON : The stop on ramp feature (truck electrically hold on a ramp) is managed for a time established by "auxiliary time" parameter in “Parameter Change”.
- OFF (default) : The stop on ramp feature is not performed.

⑥ Aux output #1 (Not being used)

This parameter defines the how PWM output on A18 (not being used) works, which is useless at this moment due to a non-use of A18 PWM output.

The Parameter value is always supposed to be “Level #2”. It is highly recommended not to change this parameter.

⑦ **Set motor temperature**

- NONE : No motor thermal sensor switch is connected between A22 and A23 inputs.
- DIGITAL : A digital (ON/OFF) motor thermal sensor is connected between A22 and A23 inputs.
- Option #1 (default) : An analogue motor thermal sensor is connected between A22 and A23 (the curve can be customized on a customer request).
- Option #3 : Another type of analogue motor thermal sensor is connected between A22 and A23 (the curve can be customized on a customer request).

The Parameter value is always supposed to be “Option #1”. It is highly recommended not to change this parameter. But in case of that a temp sensor of traction motor is failed, and if it is necessary to activate the truck before replacement of the sensor, a service engineer easily activate truck simply by changing this parameter to “NONE”.

⑧ **Cooling fan work**

This parameter was prepared for a cooling fan which doesn’t exist anymore. The parameter value is always supposed to be “NONE”. It is highly recommended not to change this parameter.

⑨ **Inching function**

This parameter activates “Inching switch” function. Default value is “OFF” and turn this parameter “ON” only if the truck is equipped with inching switch option.

⑩ **Turtle function**

This parameter activates “Turtle mode (speed reduction)” function. Default value is “OFF” and turn this parameter “ON” only if the truck is equipped with turtle mode (speed reduction) option.

⑪ **S.R.O. Function**

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 sequence delay (in parameter change. Unit : Second)

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

- Direction lever-accelerator pedal or :
- Accelerator pedal-direction lever within the sequence delay (in parameter change. Unit : Second)

⑫ **EPS error check**

Default value is “OFF”, and in case of “ON” status, A alarm will be signaled on display and traction operation will be suspended if the traction controller detect a safety signal (A19) coming from EPS controller is higher than 11 Volt (in normal condition, EPS controller send a ground level (0V, -Batt) through a safety signal (A19).

(2) Submenu "ADJUSTMENTS"

① Set battery type

It selects the nominal battery voltage (battery voltate). The Parameter value is always supposed to be “Battery voltage”. It is highly recommended not to change this parameter.

② Adjust battery

Fine adjustment of the battery voltage measured by the controller.

③ Throttle 0 zone

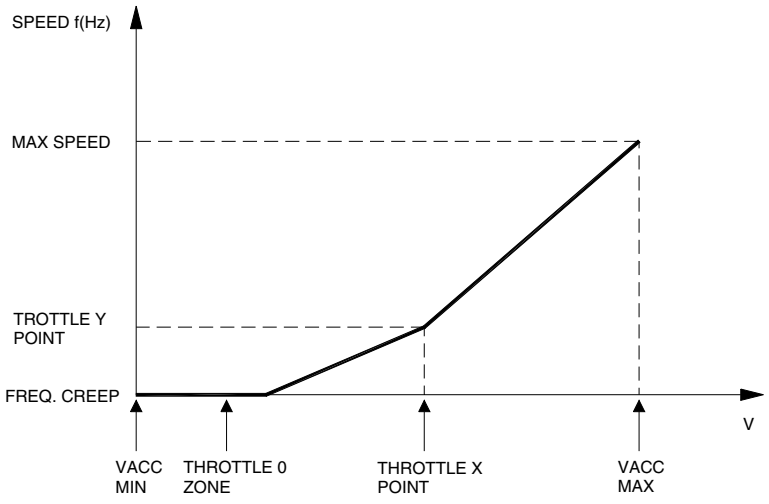
It establishes a deadband in the accelerator input curve (see also curve below). (default : 3%)

④ Throttle X point

This parameter changes the characteristic of the accelerator input curve. (default : 63%)

⑤ Throttle Y point

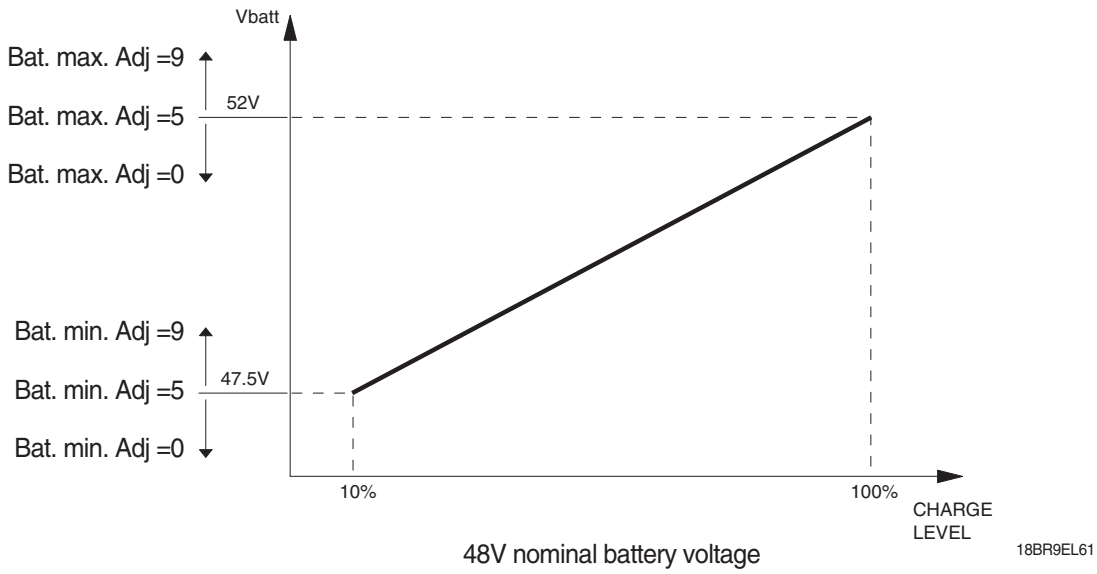
This parameter changes the characteristic of the accelerator input curve. (default : 36%)



VACC MIN and VACC MAX are minumum and maximum values of accelerator pedal input programmable by the "Program Vacc" function.

⑥ BAT. MIN ADJ, BAT. MAX ADJ

The battery charge detection uses two setting that specify the full charge voltage level (100%) and the discharge voltage level (10%). These two settings are the BAT. MAX ADJ and the BAT. MIN ADJ. It is possible to adapt the battery charge detection to your specific battery, by changing the above two settings (e.g. if the battery discharged detection occurs when the battery is not totally discharged, it is necessary to reduce the BAT. MIN ADJ setting as indicated in the next figure).



48V nominal battery voltage

* The actual parameter value is displayed in % value. In that case, the higher % means higher level.
  Default value : BAT. MIN ADJ (-4.5%), BAT. MAX ADJ (-2.5%)

⑦ **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. The default value is “20%”. It is highly recommended not to change this parameter.

⑧ **Check up done**

Default value is “OFF” and turn it ON when the required maintenance service has been executed to cancel the CHECK UP NEEDED warning. (Please refer to “Check up type” below)

⑨ **Check up type**

It specifies the handling of the CHECK UP NEEDED warning:

- NONE (default) : No CHECK UP NEENED warning.
- OPTION #1 : CHECK UP NEENED warning shown on the hand set and MDI after preset hours (“Maintenance time” parameter below)
- OPTION #2 : Equal to OPTION #1 but speed reduction after preset hours (“Maintenance time” parameter below)
- OPTION #3 : Equal to OPTION #2 but the truck definitively stops after preset hours (“Maintenance time” parameter below).

⑩ **Maintenance time**

Pleaes refer to “Check up type” parameter above. (Unit : Hours)

⑪ **Main cont volt**

It specifies the percentage of battery voltage supplied to main contactor (line contactor) coil (A17-A16) to close the contactor. The parameter value is always supposed to be “100%”. It is highly recommended not to change this parameter.

⑫ **Aux out volt (not being used)**

It specifies the percentage of battery voltage supplied to EB coil (A17-A16, Not being used) to apply the electro mechanic brake. As the Aux PWM is not being used, it is highly recommended to leave parameter value as it’s default of 25%.

⑬ **MAIN CONT. V RID**

It specifies the percentage of MAIN CONT VOLT parameter, supplied to main contactor (line contactor) coil (A17-A16) to keep the contactor closed. The parameter value is always supposed to be “75%”. It is highly recommended not to change this parameter.

Example 1

MAIN CONT VOLTAGE = 100%

MAIN CONT V RID = 75%

The contactor will be closed with full battery 100% voltage applied to the coil and then the voltage will be reduced to 75% of battery voltage.

Example 2

MAIN CONT VOLTAGE = 90%

MAIN CONT V RID = 90%

The contactor will be closed with 90% of battery voltage applied to the coil and then the voltage will be reduced to 81% (90% of 90%) of battery voltage.

⑭ **AUX OUTPUT V RID**

It specifies the percentage of AUX OUT VOLT parameter, supplied to EB coil (A17-A16, Not being used) to keep the electro mechanic brake applied. The Aux PWM is not being used, it is highly recommended to leave parameter value as it’s default of 100%.

⑮ **Adjustment #04 :**

This parameter determines the motor temperature level at which the "Motor temperature" alarm is signalled. This parameter must be adjusted only if the " SET MOT. TEMPERATURE " in "Set options" parameter is programmed as "Option #1". It is highly recommended to leave parameter value as its default of 135˚C.

⑯ **MOT. TEMP BLOCK**

This parameter determines the motor temperature level at which the operation of traction motor is suspended. This parameter must be adjusted only if the " SET MOT. TEMPERATURE " in "Set options" parameter is programmed as "Option #1". It is highly recommended to leave parameter value as its default of 145˚C.

(3) Submenu "PARAMETER CHANGE"

① **Acceleration 0**

It specifies the motor acceleration at 0 Hz. At level 0 the acceleration is maximum. Increasing the parameter's level (value) means that the acceleration decreases.

② **INV. accel 0**

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

③ **Acceleration 1**

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

④ **Acceleration 2**

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

⑤ **Acceleration 3**

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

⑥ **ACC PROF. FREQ 1**

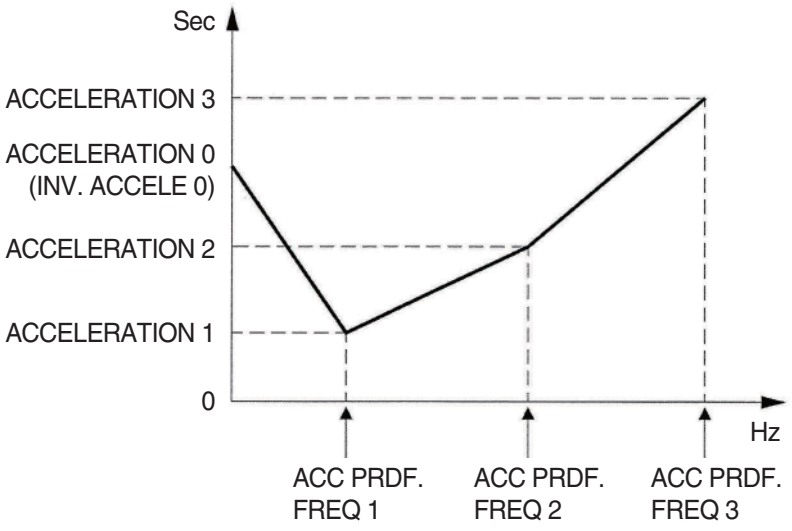
In correspondence to this frequency in [Hz] the acceleration is defined by the Acceleration 1 parameter.

⑦ **ACC PROF. FREQ 2**

In correspondence to this frequency in [Hz] the acceleration is defined by the Acceleration 2 parameter.

⑧ **ACC PROF. FREQ 3**

In correspondence to this frequency in [Hz] the acceleration is defined by the Acceleration 3 parameter.



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⑨ **ACC.TORQUE DEL. (Not being used)**

⑩ **DEC.TORQUE DEL. (Not being used)**

⑪ **Release braking**

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

⑫ **Inverse braking**

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

⑬ **Decel braking**

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

⑭ **Pedal braking**

Seconds. It controls the deceleration ramp when the pedal position is changed but not completely released. The parameter sets the time needed to decelerate the traction motor from 100 Hz to 0 Hz.

⑮ **Speed limit BRK**

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

⑯ **Inching braking**

Seconds. It controls the deceleration ramp when a inching button (optional) is released. The parameter sets the time needed to decelerate the traction motor from 100 Hz to 0 Hz.

⑰ **Max speed forward**

It determines the maximum speed in forward direction.

⑱ **Max speed backward**

It determines the maximum speed in backward direction.

⑲ **Batt. max speed**

In case of that the “Battery check” parameter in “Set options” is set as “LEVEL #2”, a speed of traction motor will be reduced automatically according to this parameter, as battery indicator reaches 10%.

⑳ **Sequence delay**

It sets the maximum delay time between the accelerator is pressed and the direction lever is moved out of the neutral position. If this time is expired the truck stops with warning on MDI display: “02A81 sequence delay”.

㉑ **Frequency creep**

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

㉒ **Maximum current**

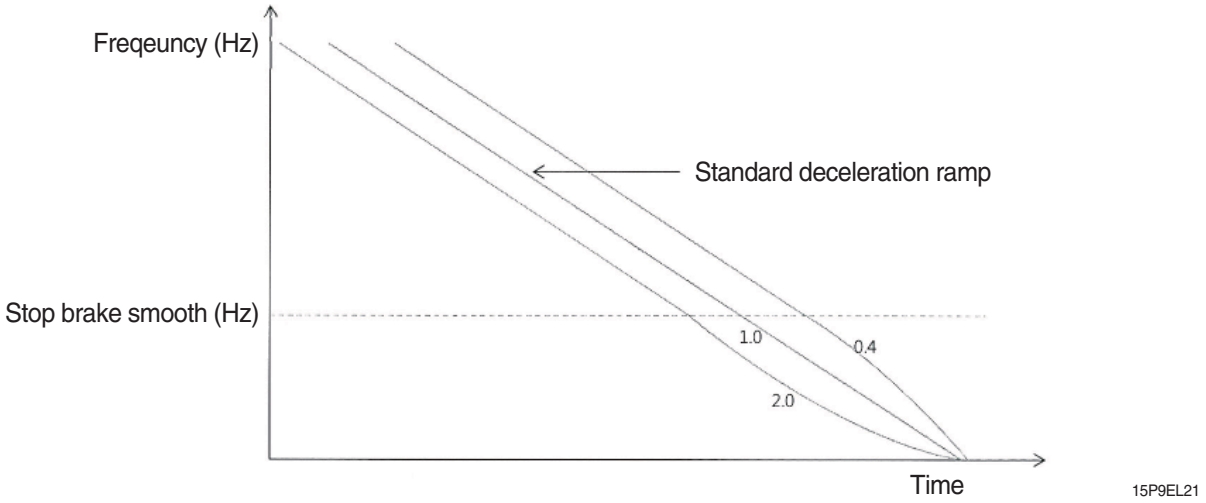
This parameter changes the maximum current of the controller. The parameter value is always supposed to be “80%”. It is highly recommended not to change this parameter.

㉓ **BRK SMOOTH**

It gives a parabolic form to the deceleration ramp.

㉔ **Stop brk smooth**

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



㉕ **Inching speed**

It determines the maximum speed of inching function (optional).

㉖ **Turtle speed**

It determines the maximum speed of turtle function (optional).

㉗ **Inching time**

This parameter determines maximum allowable time of inching function for a single press of button.

㉘ **Auxiliary time**

This parameter determines maximum holing time on ramp (Seconds) in case of that “Stop on ramp” parameter in “Set options” is set as “ON”. Please refer to “Stop on ramp” parameter in “Set options”.

※ The auxiliary time can be shorter or longer than preset value, depending on heat situation and current being applied on motor.

㉙ **Rollback speed**

This parameter determines maximum anti-roll back speed while truck is on ramp holing time on ramp (Seconds) in case of that “Stop on ramp” parameter in “Set options” is set as “ON”. Please refer to “Stop on ramp” Parameter in “Set options”.

※ The rollback speed can be faster or slower than preset value, depending on heat situation and current being applied on motor.

㉚ **FAN TEMPERATURE (Not being used)**

㉛ **Seat micro delay**

This parameter determine the time barrier gap between actual seat switch opening and start of warning signal to prevent a mis-warned situation which is caused by a short switch opening due to bumping. (Unit : 0.1 Second)

Parameter	Unit	Min value	Max value	Resolution
Acceleration 0 (*)	Sec	0.3	10	0.1
Inv. accel 0 (*)	Sec	0.3	10	0.1
Acceleration 1 (*)	Sec	0.3	10	0.1
Acceleration 2 (*)	Sec	0.3	10	0.1
Acceleration 3 (*)	Sec	0.3	10	0.1
Acc prof. freq 1	Hz	0	200	1
Acc prof. freq 2	Hz	0	200	1
Acc prof. freq 3	Hz	0	200	1
Release braking (**)	Sec	0.3	10	0.1
Invers braking (**)	Sec	0.3	10	0.1
Deceleration braking (**)	Sec	0.3	10	0.1
Pedal braking (**)	Sec	0.3	10	0.1
Speed limit braking (**)	Sec	0.3	10	0.1

(*) The acceleration time shown is the time from 0 Hz to 100 Hz. This is the ideal ramp calculated by the software; the real ramp could change as a function of motor control parameter setting and, obviously, as a function of the load.

(**) The braking feature is based upon deceleration ramps. The value shown in the table is the time to decrease the speed from 100 Hz to 0 Hz. This is the ideal ramps calculated by the software; the real ramp could change as a function of motor control parameter setting and, obviously, as a function of the load.

After changing a parameter, press ENTER to confirm data when requested by the message on the console. Parameters modified and optimized on one unit can be stored by the console (SAVE) and then released (RESTORE) on another inverter, thus allowing fast and standardized settings **"Programming & Adjustment"** for detail guide describing how to use a console)

5) TESTER (MONITORING) MENU

Using the the tester (Monitoring) MENU of programming console, a service engineer can check several informations of truck such as values of each sensors, currents/voltage being supplied to motor, heat situation. "**Programming & Adjustment**" for detail guide describing how to use a console).

(1) Submenu "Tester"

① **Battery voltage**

This is the voltage being supplied to the controller through key-input (A1). it is expressed as a percentage of the nominal battery voltage.

② **Motor voltage**

This is the voltage being supplied to the motor by the controller; it is expressed as a percentage of the nominal battery voltage.

③ **Frequency**

This is the speed of motor that the controller intends to apply on the motor.

④ **Encoder (motor speed sensor)**

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

⑤ **Slip value**

This is the difference of speed between the rotating field (above "Frequency", intended speed) and the shaft of the motor (above "Encoder", actual speed), expressed in the same unit of the frequency.

⑥ **Current rms**

Root mean square value of the motor current.

⑦ **ID Filtered RMS**

Direct Current of Vector Control (D-Axis). Normally useless for Service Engineer.

⑧ **IQ filtered RMS**

Quadrature current of vector control (Q-Axis). Normally useless for service engineer.

⑨ **Motor Power**

Power of motor (unit : watt). Normally useless for service engineer.

⑩ **Flux milli wb**

Magnetic flux of motor (unit : weber). Normally useless for service engineer.

⑪ **Motion torque**

Torque of motor. Normally useless for service engineer.

⑫ **Battery charge**

The percentage of charge level of the battery.

⑬ **Temperature**

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

⑭ **Motor temperature**

This is the temperature of the traction motor; if the "SET MOT. TEMPERATURE" in "Set options" is set as "None", it shows 0.

⑮ **Accelerator**

The voltage of the accelerator potentiometer's wiper (accelerator signal) (A3 CPOT).

⑯ **Forward switch**

The level of the forward direction digital input FW.

- ON / +VB = Input active, switch closed (direction switch : forward).
- OFF / GND = Input non active, switch open (direction switch : neutral or backward).

⑰ **Backward switch**

The level of the reverse direction digital input BW.

- ON / +VB = Input active, switch closed (direction switch : backward).
- OFF / GND = Input non active, switch open (direction switch : neutral or backward).

⑱ **Hand brake**

The level of the handbrake microswitch.

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

⑲ **Handle/Seat switch (A6 seat switch)**

The level of the seat microswitch digital input.

- ON / +VB = Input active, switch closed (user is on seat).
- OFF / GND = Input non active, switch open (user is out of seat).

⑳ **Enable switch**

The level of the accelerator enable digital input (traction request):

- ON / +VB = Input active, switch closed (pedal pressed).
- OFF / GND = Input non active, switch open (pedal peleased).

㉑ **Brake switch (Not being used)**

㉒ **Enable switch**

The level of the Accelerator enable digital input (traction request):

- ON / +VB = Input active, switch closed (pedal pressed).
- OFF / GND = Input non active, switch open (pedal released).

㉓ **EPS error**

The level of the EPS fault (A19) input. (refer to “EPS error check” in “Set options”)

- ON / +VB = EPS fault (A19) input is higher 11V (alarm condition)
- OFF / GND = EPS fault (A19) input sustains ground level (0V, -BATT)

㉔ **Turtle sw**

The level of the Turtle switch(Optional) digital input.

- ON / +VB = Input active, switch Pressed.
- OFF / GND = Input non active, switch un-Pressed

㉕ **Inch. fw sw**

The level of the Inching forward switch (optional) digital input.

- ON / +VB = Input active, switch pressed.
- OFF / GND = Input non active, switch un-pressed

㉖ **Inch. rv sw**

The level of the Inching backward switch (optional) digital input.

- ON / +VB = Input active, switch pressed.
- OFF / GND = Input non active, switch un-pressed

㉗ **2nd hourmeters**

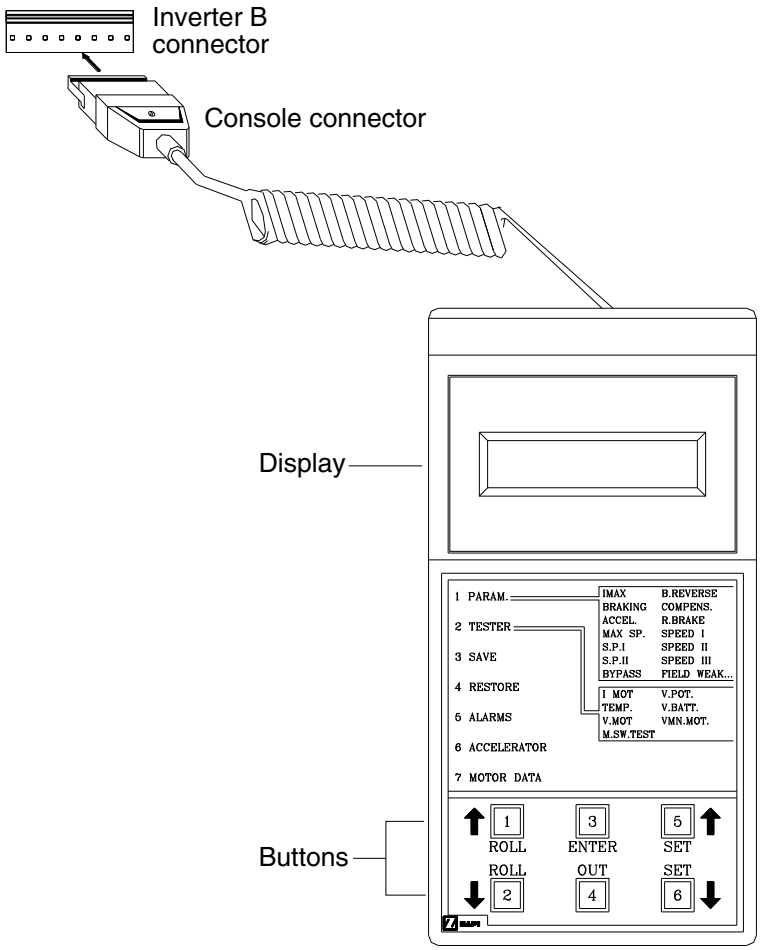
Key time logged in secondary hour counter.

6) PROGRAMMING & ADJUSTMENTS

※ ADJUSTMENTS VIA CONSOLE

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

(1) Descriptions of console



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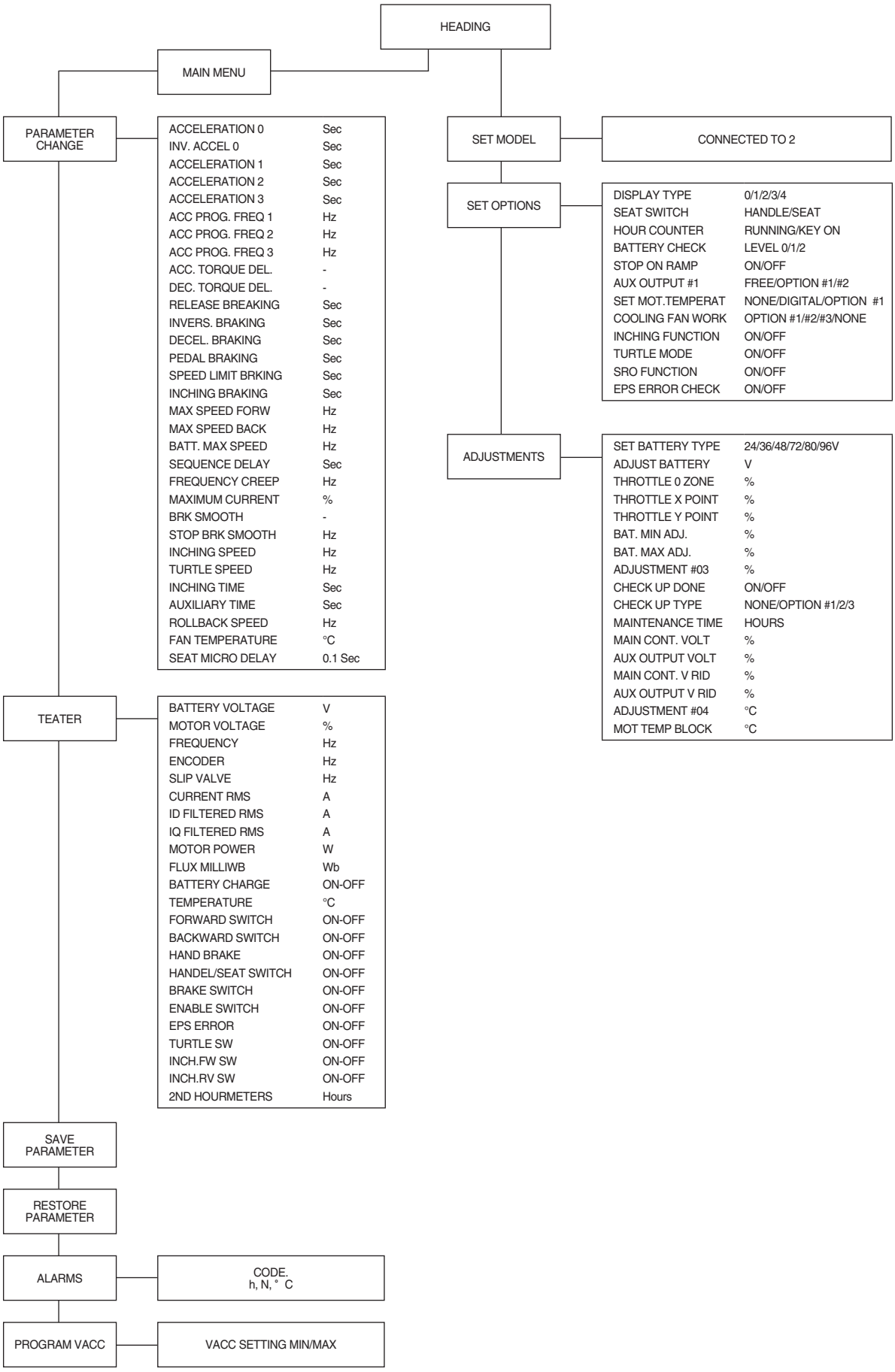
※ Please connect and disconnect it from the inverter after a key switch off.

(2) Description of standard console menu

① Traction controller



(3) Description of the console SAVE function

The SAVE function allows the operator to transmit the parameter values and configuration data of the chopper into the console memory. It is possible to load 64 different programmers.
The information saved in the console memory can then be reloaded into another chopper using the RESTORE function.
The data that is available via the SAVE function is as follows:
- All parameter values (Parameter change).
- Options (Set. options).

Flow chart showing how to use the SAVE 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 SAVE PARAM. appear on the display.

⑤ The display shows:

⑥ Press ENTER to go into the SAVE function.

⑦ If this facility has been used before the type of chopper data stored appears on the top main with a 2 digit reference.

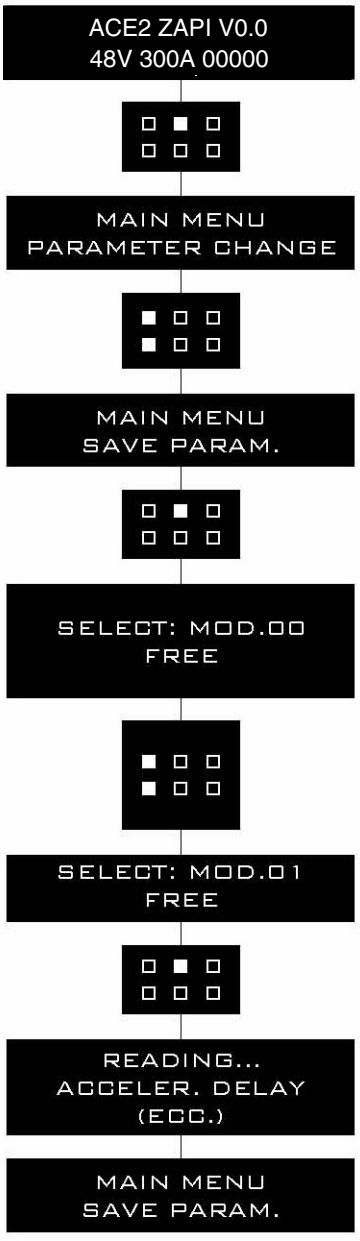
⑧ Keep pressing either ROLL UP or ROLL DOWN keys until the second Main indicates a FREE storage facility.

⑨ Press ENTER to commence SAVE routine.

⑩ You can see the items that are being stored whilst the SAVE routine is happening.

⑪ When finished, the console shows :

⑫ Press OUT to return to the opening Zapi display.



15P9EL21

(4) Description of the console RESTORE function

The RESTORE PARAM function allows transfer of the console's stored data into the memory of the chopper. This is achieved in a fast and easy way using the method previously used with the SAVE PARAM. function.
The data that is available via the RESTORE PARAM. function is as follows :
- All Parameter Values (Parameter change).
- Options (Set options)

⚠ When the RESTORE operation is made, all data in the chopper memory will be written over and replace with data being restored.

Flow chart showing how to use the RESTORE 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 SAVE PARAM. appear on the display.

⑤ The display shows:

⑥ Press ENTER to go into the RESTORE PARAM function.

⑦ The display shows the type of model stored, with a code number.

⑧ Keep pressing either ROLL UP or ROLL DOWN keys until the desired model appears on the display.

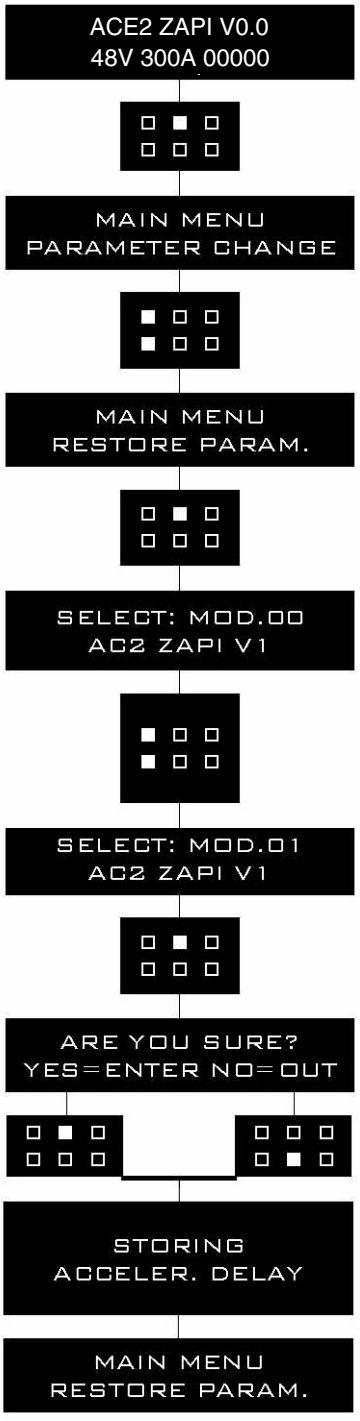
⑨ Press ENTER to commence restore operation.

⑩ The display asks "ARE YOU SURE?".

⑪ You can see the items that are being stored in the chopper memory whilst the RESTORE routine is happening

⑫ When finished, the console shows :

⑬ Press OUT to return to the opening Zapi display.



15P9EL22

(5) 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.

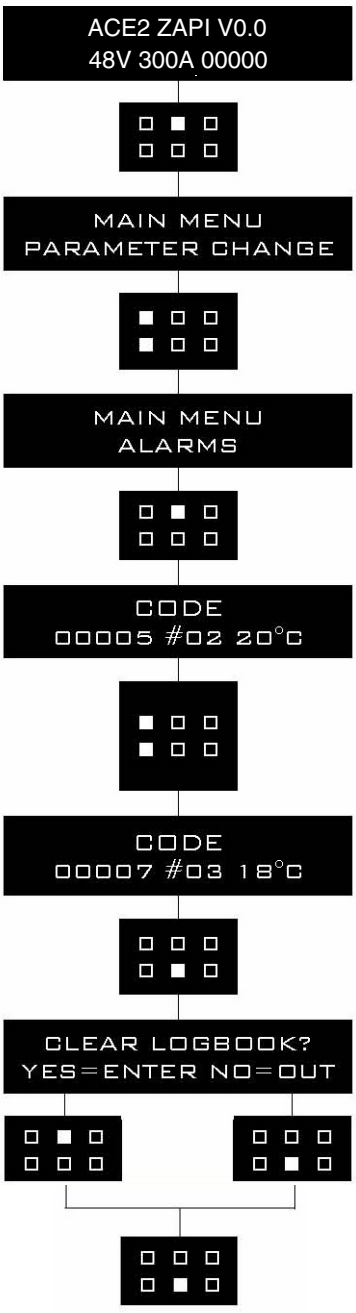
⑨ If an alarm has not occurred, the display will show: ALARM NULL.

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.



15P9EL23

(6) 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.

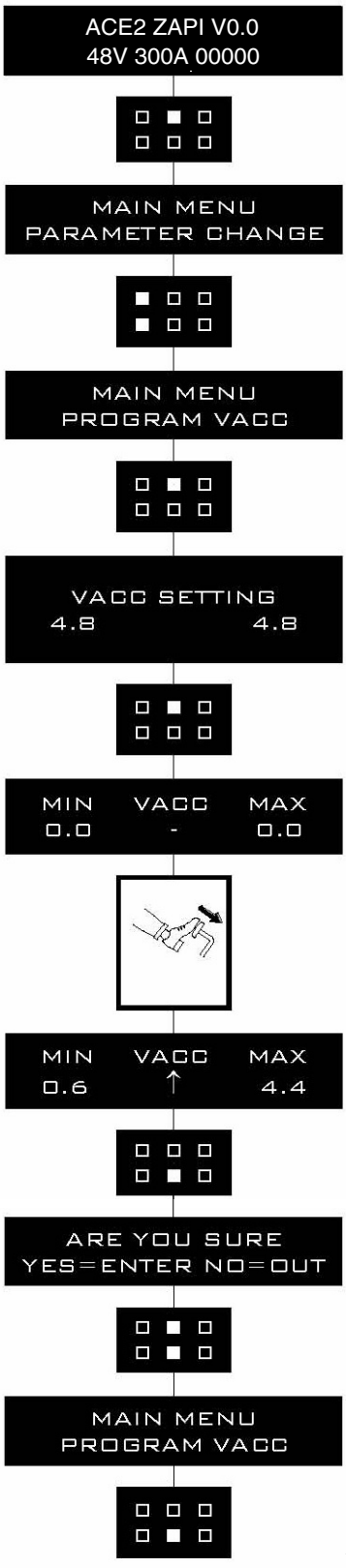
⑫ When finished, press OUT.

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.



15P9EL24

(7) DESCRIPTION OF CONSOLE USING

① Access to SET MODEL menu.

The only parameter present in SET MODEL function is CONNECTED TO.

By setting this parameter, operator can connect ZAPI console to every ZAPI product connected to CAN-BUS line. This functionality allows completely control of every ZAPI product without changing the position of the console connector.

a. Opening Zapi menu.

b. Press ROLL UP & SET UP buttons to enter CONFIG MENU.

c. The display will show: SET MODEL. If another menu is displayed, press ROLL UP or ROLL DOWN until SET MODEL appears.

d. Press ENTER to go into the SET MODEL.

e. The display will shows the first option, only CONNECTED TO option is present in this menu.

f. Press SET UP or SET DOWN buttons in order to select the desired value for selected option.

g. New desired value appears.

h. Press OUT to exit the menu.

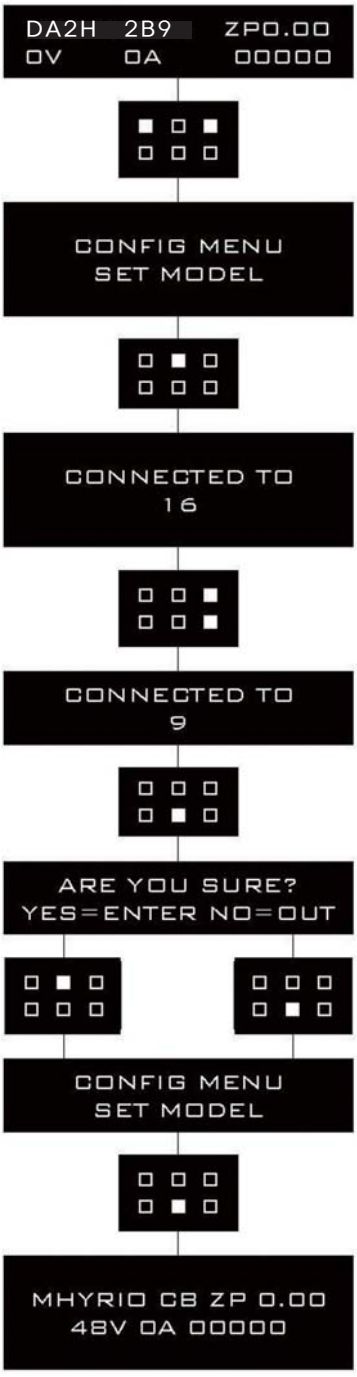
i. The display will ask "ARE YOU SURE?"

j. Press ENTER for YES, or OUT if you do not accept the changes.

k. SET MODEL menu appears.

l. Press OUT again. Console now disconnects and reconnects.

m. Display now shows the opening Zapi Menu of the ZAPI product corresponding to option selected at point g.



20B7EL28

② **Flow chart showing how to make changes to option menu :**

a. Opening Zapi menu.

b. Press ROLL UP & SET UP Buttons to enter CONFIG MENU.

c. The display will show: SET MODEL.

d. Press ROLL UP or ROLL DOWN until SET OPTIONS appears.

e. SET OPTIONS menu appears.

f. Press ENTER to go into the SET OPTIONS menu.

g. The display will show the first option.

h. Press ROLL UP or ROLL DOWN buttons until desired option appears.

i. Desired option appears.

j. Press SET UP or SET DOWN buttons in order to modify the value for selected option.

k. New value for selected option appears.

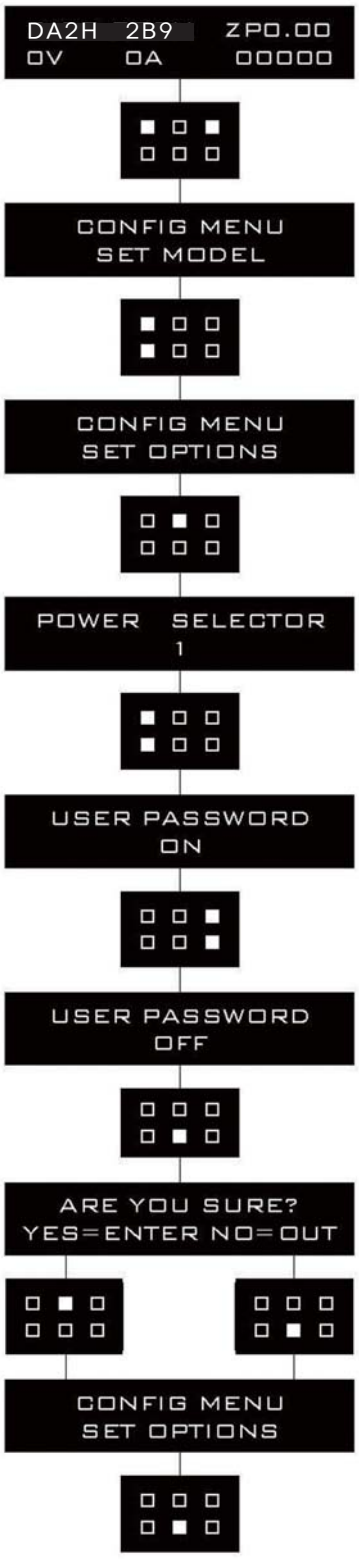
l. Press OUT to exit the menu.

m. Confirmation request appears.

n. Press ENTER to accept the changes, or press OUT if you do not accept the changes.

o. SET OPTIONS menu appears.

p. Press OUT again. Display now shows the opening Zapi menu.



20B7EL29

③ **Flow chart showing how to use the tester function of the digital console:**

a. Opening Zapi menu.

b. Press ENTER to go into the MAIN MENU.

c. The display will show: PARAMETER CHANGE.

d. Press ROLL UP or ROLL DOWN until TESTER menu appears on the display.

e. The display will show: TESTER.

f. Press ENTER to go into the TESTER function.

g. The first variable to be tested is shown on the display.

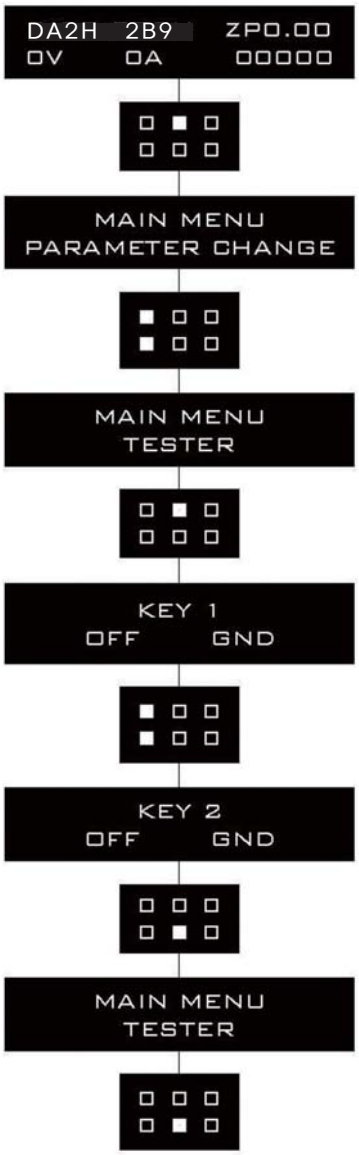
h. Press either ROLL UP or ROLL DOWN buttons.

i. Next variable for measurement appears.

j. When you have finished press OUT.

k. The Display will show: TESTER.

l. Press OUT again and return to opening Zapi menu.



20B7EL30

Remember it is not possible to make any changes using TESTER.
All you can do is measure as if you were using a pre-connected multimeter.

7) GENERAL SUGGESTION FOR SAFETY

For a proper installation take care of the following recommendations:

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

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

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

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

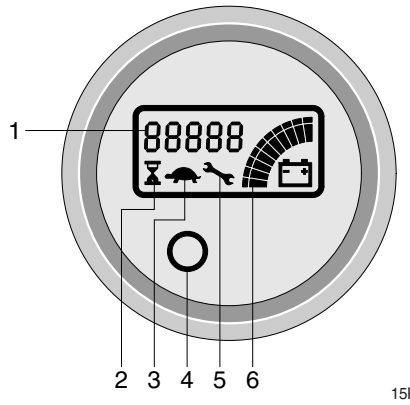
⚠ Take care all the inductive devices in the truck (horn, solenoid valves, coils, contactors) have a proper transient suppression device.

※ The method of discharging internal capacitor

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

① Disconnect the battery cable and turn hazard switch ON.
② Emergency contactor on and key on.
③ Wait for 30 seconds.
④ Discharging process is finished.

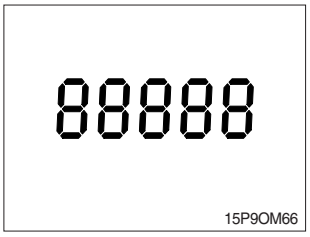
6. INSTRUMENT PANEL : DISPLAY



1 Letter indicator
2 Hourmeter indicator
3 Speed reduction indicator
4 Alarm LED
5 Maintenance indicator
6 Battery charge indicator

The MDI-CAN has only a LED. This LED is red and lights and blinks when an alarm is present.
When the key switch is ON, the MDI-CAN makes a general test lighting all the display liquid crystals, the LED and the backlight.

1) LETTER INDICATOR



(1) Hour meter

An alpha-numeric liquid crystal diaplay is fitted in the center of the unit that shows the hours worked. The display is backlight (the backlight is normally lighted).

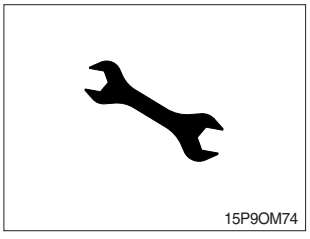
(2) Alarms

The same display can also indicate the alarm state, showing a code corresponding to the type of alarm. To attract attention, the red LED will start blinking when an alarm is generated.

(3) Software version

When the key switch is initially ON, the display shows the EPROM version for a few seconds (EPXXX where XXX represents the version) : MDI-CAN and then traction controller EPROM version appears, each one for 2 seconds.
Simultaneously the maintenance indicator appears.

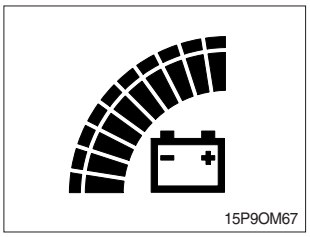
2) MAINTENANCE INDICATOR



(1) It is normally off; when it appears (fixed) it shows the request of programmed maintenance or the alarm state.

(2) In this case the relative code will be displayed. The information supplied by the MDI-CAN can be extremely useful. Failures can be quickly identified by the operator or service technician thereby finding the fastest solution to the problem.

3) BATTERY CHARGE INDICATOR

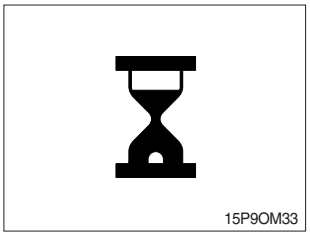


(1) The battery's state of charge indication is integrated in the LCD display; it is shown by ten notches.

(2) Each notch represent the 10% of the battery charge. As the battery becomes discharged, the notches turn off progressively, one after the other, in proportion to the value of the residual battery charge. This value, sent to the MDI-CAN by the controller via CAN-BUS, is displayed in the tester menu of the Zapi console connected to the controller.

(3) When battery low alarm appears in the controller, the battery symbol which is under the notches blinks.

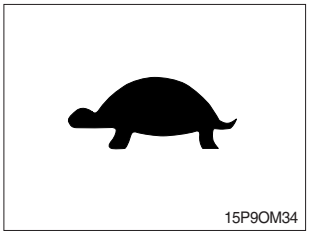
4) HOUR METER INDICATOR



(1) It is normally off; it blinks when the hour meter is working.

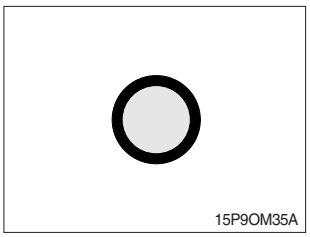
(2) When the key switch is ON, the MDI-CAN makes a general test lighting all the display liquid crystals, the LED and the backlight.

5) SPEED REDUCTION INDICATOR



(1) It is normally off; when it appears (fixed) it shows activation of the "soft" mode of the tractor, in which maximum speed and acceleration are reduced;

6) ALARM LED

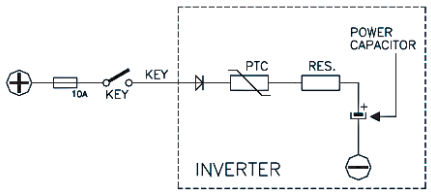


(1) This red alarm LED will start blinking when an alarm is generated.

7. ALARM CODE

1) TRACTION CONTROLLER

No	Error	Error code (display)	Error code (console)	LED flash	Description	
					Cause	Troubleshooting
1	ANALOG INPUT	02A96	237	6	This alarm occurs when the A/D conversion of the analog inputs gives frozen value, on all of the converted signals, for more than 400msec. The goal of this diagnosis is to detect a failure of the A/D converter or a problem in the code flow that omits the refreshing of the analog signal conversion.	- First, Check if accel pedal works fine (a service engineer easily figure out the output signal of accel pedal in tester menu), if not, check wires & connectors, then replace the accel pedal & reconfigurate in program VACC menu. Second, Reconfigurate accel pedal input in program VACC menu in console. Third, If all remedies indicated above doesn't work, a analog circuit in controller is prabably primary cause. Replace the controller
2	COIL SHORT HW KO	02A76	231	6	The hardware circuits which manages short circuits protection of LC and EB/AUX coils has a problem.	- This type of fault is not related to external components; replace the ACE logic board.
3	LOGIC FAILURE #3	02A17	17	1	Hardware problem in the logic card circuit for high current (overload) protection.	- This type of fault is not related to external components, so, when it is present it is necessary to replace the ACE logic board.
4	CAPACITOR CHARGE	02A60	60	3	When the key is switched ON, the inverter tries to charge the power capacitors through a series of a PTC and a power resistance, and check if the capacitor are charged within a timeout. If the capacitor voltage measured is less than 20% of the nominal battery voltage, an alarm is signalled; the main contactor is not closed.	- There is an external load in parallel to capacitor bank, which sinks current from the controller capacitors pre-charging circuit, thus preventing the caps from charging. Check if a lamp or a DC/DC converter or an auxiliary load is placed in parallel to capacitor bank. (which means that external contactor resistance attached on main contactor is supposed to be checked, ahead of replacing controller) - The charging resistance or PTC is opened; insert a power resistance across line contactor power terminals; if the alarm disappears, it means the controller internal charging resistance is damaged. - The charging circuit has a failure, inside the controller. - There is a problem in the controller power section inside the controller.



<table>
<tr><th rowspan="2">No</th><th rowspan="2">Error</th><th rowspan="2">Error code (display)</th><th rowspan="2">Error code (console)</th><th rowspan="2">LED flash</th><th colspan="2">Description</th></tr>
<tr><th>Cause</th><th>Troubleshooting</th></tr>
<tr><td>5</td><td>VMN LOW</td><td>02A72</td><td>30</td><td>3</td><td>1. Start-up test. Before switching the LC on, the software checks the power bridge: it turns on alternatingly the high side power mosfets and expects the phases voltage to increase toward the rail capacitor value. If the phases voltage is less than 66% of the rail capacitor voltage, this alarm occurs.
2. Motor running test. When the motor is running, power bridge is ON, the motor voltage feedback is tested; if it is lower than commanded value (a window of values are considered) fault status is entered.</td><td>- If the problem occurs at start up (the LC does not close at all), check:
- Motor internal connections (ohmic continuity)
- Motor power cables connections
- Motor leakage to truck frame
- If the motor connections are OK, the problem is inside the controller, replace it.
- If the alarm occurs during motor running, check:
- Motor connections
- If motor phases windings/cables have leakages towards truck frame
- That the LC power contact closer properly, with a good contact
- If no problem are found on the motors, the problem is inside the controller, replace it.</td></tr>
<tr><td colspan="5"></td><td colspan="2">Additional Note
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;
* The root cause is that the controller find a abnormal voltate level gap, normally caused by shorted circuits, between neutral phase and 3 phases.
1) Check if the FETs on controller are fine first.
2) If FETs are fine, disconnect all cables from the motor. Then check if the insulation between motor 3 phase studs & frame, motor body (including end shield), (motor 3 phase studs are supposed to be completely insulated from frame & motor body part)
3) If motor insulation is fine, then disconnect all cables & wire connectors from the controller, and check the inslation between all studs (3 Phase, Battery +, -) of the controller & frame.
4) If insulation of the controller & the motor is fine, only left parts causing short circuits are cables & wire harness. Check if the 3 phase cables connecting between the motor & the controller are insulated properly from frame & each others
5) For the last, if cables are fine, normally one of pins of connectors connected to the controller is shorted with frame. Disconnect all connectors from the controller, then find a shortd pin by testing each pin(on connector side)'s inslation between frame. If a pin is shorted with frame, please check along with the wire line.

B) Inverter failure, replace it</td></tr>
</table>

No	Error	Error code (display)	Error code (console)	LED flash	Description	
					Cause	Troubleshooting
6	DRIVER SHORTED	02A74	74	6	The driver of the main contactor coil is shorted.	- Check if there is a short or a low impedance pull-down between NMC (CNA #16) and -BATT. - The driver circuit is damaged in the logic board, which has to be replaced. When the key is switched ON, the uP checks that the MC coil driver is not shorted; if it is, this alarm is signalled; 1)Check the components & wires & connectors attached to PWM output of the controller - A17-A16 : Main contactor & diode - A17-A18 : Nothing (Check any dust or grease which can be a possible cause of shorted circuit) 2)If they are all fine, replace the controller
7	MC COIL SHORT	02A76	230	6	This alarm occurs when there is a short circuit of the MC coils connected to CNA #16 output. After the overload condition has been removed, the alarm exits automatically by releasing and then enabling a travel demand.	- The typical root cause for this error code to be displayed is in the harness or in the load coil. So the very first check to carry out concerns connections between controller outputs and loads. - In case no failures/problems have been found externally, the problem is in the controller, which has to be replaced. The main contactor (traction A17 - A16) is closed. 1)Check main contactor's coil & contact point. 2)If main contactor is fine, check if the proper voltage (36~48) (but normally 24~54 volts is fine) is being applied from the controller to contactor by measuring the voltage between two pins of the contactor's coil as connectors are properly attached on contactors. (** becuase pwm outputs from controller will be out when alarm occurs, you can measure only in very short term between key on & alarm happening) If pwm output(the voltage) is fine, replace the contactors. 3)If the pwm output is broken, check the wires & connectors between the controller & main contactor & emergency switch, free wheeling diode. -> If they are all fine, replace the controller.

<table>
<tr><th rowspan="2">No</th><th rowspan="2">Error</th><th rowspan="2">Error code (display)</th><th rowspan="2">Error code (console)</th><th rowspan="2">LED flash</th><th colspan="2">Description</th></tr>
<tr><th>Cause</th><th>Troubleshooting</th></tr>
<tr><td>8</td><td>VMN HIGH</td><td>02A0</td><td>31</td><td>3</td><td>1. Before switching the LC on, the software checks the power bridge: it turns on alternatingly the low side power mosfets and expects the phases voltage to decrease down to -BATT. If the phases voltage is higher than 10% of nominal battery voltage, this alarm occurs.
2. This alarm may occur also when the start up diagnosis is overcome, and so the LC is closed. In this condition, the phases' voltages are expected to be lower than 1/2 V batt. If it is higher than that value, fault status is entered.</td><td>- If the problem occurs at start up (the LC does not close at all), check:
· Motor internal connections (ohmic continuity)
· Motor power cables connections
· If the motor connection are OK, the problem is inside the controller, replace it.
- If the problem occurs after closing the LC (the LC closed and then opens back again), check:
· Motor connections
· If motor phases windings/cables have leakages towards truck frame
· If no problem are found on the motors, the problem is inside the controller, replace it.</td></tr>
<tr><td colspan="6">Additional Note
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;
* The root cause is that the controller find a abnormal voltate level gap, normally caused by shorted circuits, between neutral phase & 3 phases.
1) Check if the FETs on controller are fine first.
2) If FETs are fine, disconnect all cables from the motor. Then check if the insulation between motor 3 phase studs & frame, motor body (including end shield), (motor 3 phase studs are supposed to be completely insulated from frame & motor body part)
3) If motor insulation is fine, then disconnect all cables & wire connectors from the controller, and check the inslation between all studs (3 phase, battery +, -) of the controller & frame.
4) If insulation of the controller & the motor is fine, only left parts causing short circuits are cables & wire harness. Check if the 3 phase cables connecting between the motor & the controller are insulated properly from frame & each others
5) For the last, if cables are fine, normally one of pins of connectors connected to the controller is shorted with frame. Disconnect all connectors from the controller, then find a shortd pin by testing each pin(on connector side)'s inslation between frame. If a pin is shorted with frame, please check along with the wire line.

B) Inverter failure, replace it</td></tr>
</table>

No	Error	Error code (display)	Error code (console)	LED flash	Description	
					Cause	Troubleshooting
9	Program VACC OUT RANGE	02A85	226	2	The CPOT input red by the microcontroller is not comprised in the range Vacc_min ÷ Vacc_max, programmed through the "PROGRAMM VACC" function. The accelerator pedal input comming from accel pedal exceeds the preset range which has been set in Program VACC menu.	Acquire the maximum and minimum potentiometer value through the PROGRAM VACC function. If the alarm is still present, check the mechanical calibration and the functionality of the potentiometer. If the alarm is not disappeared the failure is in the ACE logic board, replace it. 1. Check if accel pedal works fine (a service engineer easily figure out the output signal of accel pedal in tester menu), if not, check wires & Connectors, then replace the accel pedal & reconfigurate in program VACC menu 2. Reconfigurate accel pedal input in program VACC menu in console 3. If all remedies indicated above doesn't work, a analog circuit in controller is prabably primary cause. replace the controller
10	STBY I HIGH	02A53	53	5	The current transducer or the current feedback circuit is damaged in the controller.	This type of fault is not related to external components so, when it is present, it is necessary to replace the controller. 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 inside the controller failure. B) Logic failure: first replace the logic; if the defect persists, replace the power unit.

No	Error	Error code (display)	Error code (console)	LED flash	Description	
					Cause	Troubleshooting
11	CONTACTOR OPEN	02A77	38	6	The main contactor coil has been driven by the controller, but the contactor does not close.	- It could be a problem of the contacts in the MC that are not working (does not pull-in), try replacing the MC. - If the contactors of MC are working correctly than the problem is in the controller, replace it. The main contactor (traction A17 - A16) is Opened. 1) Check main contactor's coil & contact point. 2) If main contactor is fine, check if the proper voltage (36~48) (but normally 24~54 volts is fine) is being applied from the controller to contactor by measuring the voltage between two pins of the contactor's coil as connectors are properly attached on contactors. (** becuase pwm outputs from controller will be out when alarm occurs, you can measure only in very short term between key on & alarm happening) If pwm output (the voltage) is fine, replace the contactors. 3) If the pwm output is broken, check the wires & connectors between the controller & main contactor & emergency switch, free wheeling diode. -> If they are all fine, replace the controller.
12	FOC LOST	02A99	253	2	1) Controller's hardware Settings related to motor characteristics has been changed, which is confidential & not allowed for a service engineer to access. 2) The motor is damaged which leads to a distortion of motor characterristics	Ask a technical assistanc of head quater.
13	AUX DRIV. SHRT.	02A0	254	6	A shorted circuit in PWM aux (A17-A18, Nothing on 40T-9, 15P-9) is detected.	- Check if there is a short or a low impedance pull-down between NEB/NAUX (CNA #18) and -BATT. - Check any dust or grease which can be a possible cause of shorted circuit. - The driver circuit is damaged in the logic board, which has to be replaced.

<table>
<tr><th rowspan="2">No</th><th rowspan="2">Error</th><th rowspan="2">Error code (display)</th><th rowspan="2">Error code (console)</th><th rowspan="2">LED flash</th><th colspan="2">Description</th></tr>
<tr><th>Cause</th><th>Troubleshooting</th></tr>
<tr><td rowspan="2">14</td><td rowspan="2">LOGIC FAILURE #1</td><td rowspan="2">02A54</td><td rowspan="2">19</td><td rowspan="2">1</td><td>This fault is displayed when the controller detects an over voltage or under voltage condition. Over voltage threshold is 45V, under voltage threshold is 9V in the 24V controller. In 48V controller over voltage threshold is 65V, under voltage threshold is 11V.</td><td>Troubleshooting of fault displayed at start-up or in standby; in these cases it is very likely the fault is due to an under voltage, so it is suggested to check:
- Key input signal down-going pulses (below under voltage threshold) due to external loads, like DC/DC converters starting-up, relays or contactor switching, solenoids energizing / de-energizing.
- Check the connection of power cables to the battery terminal, positive.</td></tr>
<tr><td colspan="2">Additional Note
This alarm signals that an undervoltage / overvoltage protection operation has occurred.

Two possible reasons:
A) A real undervoltage / overvoltage situation happened.
1) First, low charged level can cause a huge voltage drop during heavy duty, which leads to this error. so try to fully charge battery first.
2) If actual battery voltage is too low or too high, or one of cells are damaged, some times huge voltage drop can occur depending on work load ,which leads to this error. Check if actuall voltage level of battery & cells is fine.
3) If battery is fine, compare the actuall voltage, being supplied through "key" pin of controller, with battery voltage. If the gap is higher than 1~2 volt, which means components (key switch, fuse box, emergency switch, battery - cable,wires,etc...) between battery voltage & key voltage cause a serious voltage distortion. Check the wirings & circuits between battery & "key" pin with wiring diagram.
4) If circuits are fine, check if voltage value being displayed in tester menu matched with actuall "key" pin voltage. If the value is abnomally high or low, adjust battery level correctly (refer to "adjust battery" parameter in "adjustments" menu)

B) Fault in the hardware section of the logic board which manages the overvoltage protection. Replace the logic card.</td></tr>
<tr><td>15</td><td>LOGIC FAILURE #2</td><td>02A55</td><td>18</td><td>1</td><td colspan="2">Fault in the hardware section of the logic board which manages the phase's voltage feedback. Replace the logic board.</td></tr>
<tr><td>16</td><td>SAFETY INPUT</td><td>02A86</td><td>229</td><td>4</td><td colspan="2">As CNA #11 is being used as a parking brake digital input, the safety function is disabled. If this alarm happens, probably a failure inside the controller. Replace the controller</td></tr>
</table>

No	Error	Error code (display)	Error code (console)	LED flash	Description	
					Cause	Troubleshooting
17	FORW + BACK	02A80	80	2	This alarm occurs when both the travel demands (FWD and BWD) are active at the same time.	Check the wiring of the FWD and BWD travel demand inputs (combi switch beneath steerig handle) (a service engineer easily figure out the direction request signal in tester menu). Check the microswitches for ailures. A failure in the logic is possible too. So, when you have verified the travel demand switches are fine working and the wiring is right, it is necessary to replace the ACE-2 logic board.
18	INCORRECT START	02A79	79	2	This is a warning for an incorrect starting sequence.	The possible reasons for this alarm are (use the readings in the TESTER to facilitate the troubleshooting): - A travel demand active at key on - Presence man sensor active at key ON Check the wirings. Check the micro switches. It could be also an error sequence made by the operator. A failure in the logic is possible too; so when all of the above conditions were checked and nothing was found, replace the ACE logic board. This alarm signals an incorrect starting sequence. *Correct Sequence Parking brake, Seat -> Direction switch (FWD, BWD) -> Accel pedal enable Possible causes: A) Running microswitch failure in seat, direction (combi), accel enable switch B) Error in sequence made by the operator; C) Incorrect wiring. D) If the default persists, replace the logic.

No	Error	Error code (display)	Error code (console)	LED flash	Description	
					Cause	Troubleshooting
19	Program VACC NOT OK	02A78	78	4	The test is made at key-on and immediately after that both the travel demands have been turned off. This alarm occurs if the ACCELERATOR reading in the TESTER menu' is 1,0V higher than PROGRAM VACC min acquisition when the accelerator is released.	
						Acquire the maximum and minimum potentiometer value through the PROGRAM VACC function. If the alarm is still present, check the mechanical calibration and the functionality of the potentiometer. If the alarm is not disappeared the failure is in the ACE logic board, replace it.
					Additional Note 1. Check if accel pedal works fine (a service engineer easily figure out the output signal of accel pedal in tester menu), if not, check wires & connectors, then replace the accel pedal & reconfigurate in program VACC menu 2. Reconfigurate accel pedal Input in program VACC Menu in console 3. If all remedies indicated above doesn't work, a analog circuit in controller is prabably primary cause. Replace the controller	
20	CONTACTOR DRIVER	02A75	75	6	The MC coil driver is not able to drive the load. The device itself or its driving circuit is damaged.	This type of fault is not related to external components; replace the ACE2 logic board.
21	TH. PROTECTION	02A62	62	7	This alarm occurs when the temperature of the base plate is higher than 85°. Then the maximum current decreases proportionally with the temperature increases from 85° up to 105°. At 105° the current is limited to 0 Amps.	It is necessary to improve the controller cooling. For realise an adequately cooling in case of finned heat sink are important factor the flux [m3/h] and temperature [°C] of cooling air. In case of thermal dissipation realised with the controller base plate installed on truck frame it is important the thickness of frame and the planarity and roughness of its surface. If the alarm is signalled when the controller is cold, the possible reasons are a thermal sensor failure or a failure in the logic card. In this case, it is necessary to replace the controller.

No	Error	Error code (display)	Error code (console)	LED flash	Description	
					Cause	Troubleshooting
22	BATTERY LOW	02A0	66	32	Additional Note This alarm signals that an undervoltage / overvoltage protection operation has occurred. Two possible reasons: A) A real undervoltage / overvoltage situation happened. 1) First, low charged level can cause a huge voltage drop during heavy duty, which leads to this error. So try to fully charge battery first. 2) If actual battery voltage is too low or too high, or one of cells are damaged, some times huge voltage drop can occur depending on work load ,which leads to this error. Check if actuall voltage level of battery & cells is fine. 3) If battery is fine, compare the actuall voltage, being supplied through "key" pin of controller, with battery voltage. If the gap is higher than 1~2 volt, which means components (key switch, fuse box, emergency switch, battery - cable,wires,etc...) between battery voltage & key voltage cause a serious voltage distortion. Check the wirings & circuits between battery & "key" pin with wiring diagram. 4) If circuits are fine, check if voltage value being displayed in tester menu matched with actuall "key" pin voltage. If the value is abnomally high or low, adjust battery level correctly (refer to "adjust battery" parameter in "adjustments" menu) B) Fault in the hardware section of the logic board which manages the overvoltage protection. Replace the logic card.	
23	EPROM KO	02A71	13	1	It's due to a HW or SW defect of the non-volatile embedded memory supporting the controller parameters. This alarm does not inhibit the machine operations, but the truck will work with the default values.	Try to execute a CLEAR EEPROM operation (refer to console manual). Switch the key off and on to check the result. If the alarm occurs permanently, it is necessary to replace the controller. If the alarm disappears, the previously stored parameters will have been replaced by the default parameters.

No	Error	Error code (display)	Error code (console)	LED flash	Description	
					Cause	Troubleshooting
24	MOTOR TEMPERAT.	02A65	65	7	This warning occurs when the temperature sensor is opened (if digital) or has overtaken the threshold of 150° (if analogue).	Check the thermal sensor inside the motor (use the MOTOR TEMPERATURE reading in the TESTER menu); check the sensor ohmic value and the sensor wiring. If the sensor is OK, improve the cooling of the motor. If the warning is present when the motor is cool, then the problem is inside the controller. 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 even when the motor is cold, check the wiring & motor temp sensor. If all is ok, replace the logic board. *Refer to parameter "Set MOT. Temperature" in "Set options"& "Adjustment #4" in "Adjustment" of the controller. A) Motor thermal sensor failure B) Wirings & connectors of motor temp sensor (A22-A23) failure C) Controller failure

<table>
<tr><th rowspan="2">No</th><th rowspan="2">Error</th><th rowspan="2">Error code (display)</th><th rowspan="2">Error code (console)</th><th rowspan="2">LED flash</th><th colspan="2">Description</th></tr>
<tr><th>Cause</th><th>Troubleshooting</th></tr>
<tr><td rowspan="2">25</td><td rowspan="2">WRONG SET BAT.</td><td rowspan="2">02A0</td><td rowspan="2">251</td><td rowspan="2">0</td><td>At start-up, the controller checks the battery voltage and verify it is within a window around the nominal value.</td><td>- Check that the controller SET BATTERY TYPE parameter(In "Adjustments") value matches the battery nominal voltage.
- Check that TESTER MENU / BATTERY VOLTAGE parameter shows same value as the battery voltage measured with a voltmeter. If it does not match, then do an “ADJUST BATTERY” function.</td></tr>
<tr><td colspan="2">This alarm also can be signalled in case of that an undervoltage / overvoltage protection operation has occurred. if "Set battery type" parameter in "Adjustments" is fine, Two other possible reasons:
A) A real undervoltage / overvoltage situation happened.
1) first, low charged level can cause a huge voltage drop during heavy duty, which leads to this error. So try to fully charge battery first.
2) If actual battery voltage is too low or too high, or one of cells are damaged, some times huge voltage drop can occur depending on work load ,which leads to this error. Check if actuall voltage level of battery & cells is fine.
3) If battery is fine, compare the actuall voltage, being supplied through "key" pin of controller, with battery voltage. If the gap is higher than 1~2 volt, which means components (key switch, fuse box, emergency switch, battery - cable,wires,etc...) between battery voltage & key voltage cause a serious voltage distortion. Check the wirings & circuits between battery & "key" pin with wiring diagram.
4) If circuits are fine, check if voltage value being displayed in tester menu matched with actuall "key" pin voltage. If the value is abnomally high or low, adjust battery level correctly (refer to "adjust battery" parameter in "adjustments" menu)

B) Fault in the hardware section of the logic board which manages the overvoltage protection. Replace the logic card.</td></tr>
<tr><td>26</td><td>THERMIC SENS. KO</td><td>02A61</td><td>250</td><td>7</td><td>The output of the controller thermal sensor is out of range.</td><td>This type of fault is not related to external components; replace the controller.</td></tr>
<tr><td>27</td><td>AUX COIL SHORT</td><td>02A68</td><td>224</td><td>6</td><td colspan="2">When the key is switched ON, the uP checks that the MC coil driver is not shorted; if it is, this alarm is signalled;
1) Check the components & wires & connectors attached to PWM output of the controller
A17-A16 : Main contactor & diode
A17-A18 : Nothing (check any dust or greese which can be a possible cause of shorted circuit)
2) If They are all fine, replace the controller</td></tr>
</table>

No	Error	Error code (display)	Error code (console)	LED flash	Description	
					Cause	Troubleshooting
28	CHECK UP NEEDED	02A0	249	1	If "CHECK UP TYPE" parameter In "Adjustments" is set as OPTION #1,2,3 and if maintenance interval exceeds the time set in "Maintenance time" in "Adjustments", alarm occurs.	1) Turn "on" the parameter "CHECK UP DONE" in "Adjustment" and re-schedule the next maintenance in "MAINTENANCE TIME" parameter in "Adjustments" 2) If a customer doesn't want to be bothered by this alarm, turn "CHECK UP TYPE" parameter in "Adjustments" in "NONE"
29	NO CAN MSG.	02A67	248	8	Difference between CAN BUS KO & NO CAN MSG * CAN BUS KO : A specific controller can not receive any message from can bus line, which means entier can bus line is out of functions, unless the controller's internal circuits related to can bus line is out of controll. 1) Check the entire can bus line between traction controller, MDI dispaly, CAN TILLER (only attached in case of turtle or Inching Option) is fine (measeure the can resistance of 60 ohm between CAN High & Low lines while it is properly connected to controllers, simply by stripping little bit on surface of wires) 2) If CAN LINES & Connections are fine, replace the controller. * NO CAN MSG : A controller receive can massages well from other controller except a specific controller which is probably a cause of problem. The specific troubled controller can be found easily in console. (you can always check the soundness of each controller's CAN communication, simply by connecting other controllers, only two other controllers are CAN TILLER (Option), MDI display- with "SET MODEL" menu console. CAN tIller : #8, MDI display : #16, Traction controller : #2) 1) Find a troubled controller in tester menu. 2) Check the entire CAN BUS line connected to the troubled controller. 3) Check if there is any alarm in the troubled controller (sometimes when a seriou alarm happens, CAN communication is not working) 4) If any wires or connections are fine, replace the controller	
30	DATA ACQUISITION	02A0	247	0	This alarm is signalled in the current gain acquisition phase. Wait the end of the acquisition activity.	
31	AUX DRIV. OPEN	02A0	246	6	When the key is switched ON, the uP checks that the MC coil driver is not shorted; if it is, this alarm is signalled; 1) Check the components & wires & connectors attached to PWM output of the controller. A17-A18 : Nothing (Check any dust or greese which can be a possible cause of shorted circuit) 2) If they are all fine, replace the controller.	

No	Error	Error code (display)	Error code (console)	LED flash	Description	
					Cause	Troubleshooting
32	SAFETY OUTPUT	02A0	239	4	The safety out driver is shorted.	- If "EPS error check" parameter in "Set options" is activated, EPS contoller is supposed to send a specific voltage ,higher than 11V, to alert a traction controller in case of EPS error. Check EPS system first. - Check if there is a short or a low impedance pull-down between SAFETY OUT (CAN#19 - Connected to EPS controller) and -BATT. - The driver circuit is damaged in the logic board, which has to be replaced.
33	KEY OFF SHORT	02A76	232	1	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.

No	Error	Error code (display)	Error code (console)	LED flash	Description	
					Cause	Troubleshooting
34	HARDWARE FAULT	02A0	240	1	- HARDWARE FAULT 20 Before driving the MC coil, the controller checks if the Mosfets drivers are turned of by a not active (alarm status) Watch-dog signal. If they are not turned of then the alarm is generated. - HARDWARE FAULT 21 Before driving the MC coil, the controller checks if the EB/AUX driver is turned of by a not active (alarm status) Watch-dog signal. If it is not turned of then the alarm is generated. - HARDWARE FAULT A1 Before driving the MC coil, the controller checks if the MC/AUX driver is turned of by a not active (alarm status) Watch-dog signal. If it is not turned of then the alarm is generated.	The problem is inside the controller, no external component are involved, replace the logic board. The problem is inside the controller, no external component are involved, replace the logic board. The problem is inside the controller, no external component are involved, replace the logic board.
35	POWER MOS SHORT	02A89	233	2	Before switching the MC on, the software checks the power bridge: it turns on alternatingly the low side and high side power Mosfets and expects the phases voltage to decrease down to -BATT (increase up to +Batt). If the phases voltage do not follow the commands, this alarm occurs.	This type of fault is not related to external components; replace the controller.

No	Error	Error code (display)	Error code (console)	LED flash	Description	
					Cause	Troubleshooting
36	CONTACTOR CLOSED	02A75	37	6	Before driving the MC coil, the controller checks if the contactor is stuck. The controller drives the bridge for some tens milliseconds, trying to discharge the capacitors bank. If the capacitor voltage does decrease by 20% of the key voltage the alarm is generated.	It is suggested to verify the power contacts of LC; to replace the LC is necessary. The main contactor(traction A17 - A16) is closed. 1) Check main contactor's coil & contact point. 2) If main contactor is fine, check if the proper voltage (36~48) (but normally 24~54 volts is fine) is being applied from the controller to contactor by measuring the voltage between two pins of the contactor's coil as connectors are properly attached on contactors. (** becuase pwm outputs from controller will be out when alarm occurs, you can measure only in very short term between key on & alarm happening) If pwm output (the voltage) is fine, replace the contactors. 3) If the pwm output is broken, check the wires & connectors between the controller & main contactor & emergency switch, free wheeling diode. -> If they are all fine, replace the controller.
37	ENCODER ERROR	02A82	82	5	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. 1) Check the encoder (A7, 8, 14, 15 motor speed sensor) & wires (Check if "encoder" Hz & "Slip value" is working properly in TESTER menu.) A. Sign of "encoder" Hz should be same as "Frequnecy" -> if not, swap the phase #A & #B B. Value of "encoder" varies almost same as "Frequency" varies -> if not, that means the controller can't receive any signal from encoder. Replace the encoder & check the wires 2) If the alarm last even after replacement of encoder & checking wires & connector, replace the controller	
38	SEAT OPEN	02A0	228	2	Seat switch input (A6) is opened. 1) Check the seat switch. 2) Check the wires from -Batt (A9) to seat Input (a6) through seat switch.	

No	Error	Error code (display)	Error code (console)	LED flash	Description	
					Cause	Troubleshooting
39	WATCHDOG #1	02A8	223	3	At start-up the watch dog signal is already active before the software has generated it. At stby or running condition the watch dog signal is not active (in alarm status).	The WD hardware circuit or microcontroller output port are damaged. In both cases no external component are involved. Replace the logic board.
40	WATCHDOG #2	02A8	227	2	At start-up the watch dog signal is already active before the software has generated it. At stby or running condition the watch dog signal is not active (in alarm status).	The WD hardware circuit or microcontroller output port are damaged. In both cases no external component are involved. Replace the logic board.
41	FLASH CHECKSUM	02A71	241	1	After Key-on the software verifies the integrity of program stored in the flash memory, if the verify has a negative result this alarm is generated.	The problem is in the microcontroller flash memory, which could be damaged, or in the program stored inside, which could be corrupted. Try to program the logic again, if the alarms is still signalled the problem is in the microcontroller. Replace the ACE logic board.
42	WRONG RAM MEMORY	02A71	245	1	The algorithm implemented to check the main RAM registers finds a wrong contents: the register is “dirty”. This alarm inhibit the machine operations.	Try to switch the key off and then on, if the alarm is still present replace the ACE2 logic board.
43	SOFTWARE ERROR	02A0	244	4	1. Controller's Hardware Settings related to motor characteristics has been changed, which is confidential & not allowed for a service engineer to access. 2. The motor is damaged which leads to a distortion of motor characterristics.	Ask a technical assistanc of head quater.

No	Error	Error code (display)	Error code (console)	LED flash	Description	
					Cause	Troubleshooting
44	SENS MOT TEMP KO	02A65	243	7	The output of the motor thermal sensor is out of range.	Check the sensor ohmic value and the sensor wiring. If the sensor is OK, Then the problem is inside the ACE logic board, replace it. 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 even when the motor is cold, check the wiring & motor temp sensor. If all is ok, replace the logic board. *Refer to parameter "Set MOT.Temperature" in "Set options"& "Adjustment #4" in "Adjustment" of the controller. A) Motor thermal sensor failure. B) Wirings & connectors of motor temp sensor (A22-A23) failure. C) Controller failure.
45	HANDBRAKE	02A84	235	2	Hand brake (parking brake) switch signal is activated.	1)Release the hand brake. 2)If alarm last even after hand brake is relased. - Check the hand brake switch - Check the hand brake wirings, comming from A9 to A 11 through hand brake switch - If wirings & switch are properly working, replace the controller
46	CURRENT GAIN	02A92	236	0	The maximum current gain parameters are at the default values, which means the maximum current adjustment procedure has not been carried out yet.	Ask the assistance of a HQ technician to do the correct adjustment procedure of the current gain parameters.
47	WRONG 0 VOLTAGE	02A53	238	3	At start-up the high resolution VMN feedback is not comprised in a permitted window of values centred around 2,5V. The circuit is damaged in the controller.	It is suggested to check: - Motor internal connections (ohmic continuity) - Motor power cables connections - Motor leakage to truck frame - If the motor connections are OK, the problem is inside the controller, replace the logic board.

No	Error	Error code (display)	Error code (console)	LED flash	Description	
					Cause	Troubleshooting
48	PROG Program VACC NOT OK	02A78	220	4	The test is made at key-on and immediately after that both the travel demands have been turned off. This alarm occurs if the ACCELERATOR reading in the TESTER menu' is 1,0V higher than PROGRAM VACC min acquisition when the accelerator is released.	Acquire the maximum and minimum potentiometer value through the PROGRAM VACC function. If the alarm is still present, check the mechanical calibration and the functionality of the potentiometer. If the alarm is not disappeared the failure is in the ACE logic board, replace it.
					1. Check if accel pedal works fine (a service engineer easily figure out the output signal of accel pedal in Tester Menu), if not, check wires & connectors, then replace the accel pedal & re-configurate in program VACC Menu. 2. Reconfigurate accel pedal Input in program VACC Menu in console. 3. If all remedies indicated above doesn't work, a analog circuit in controller is prabably primary cause. replace the controller.	
49	TORQUE PROFILE	02A88	218	2	1. Controller's hardware settings related to motor characteristics has been changed, which is confidential & not allowed for a service engineer to access. 2. The motor is damaged which leads to a distortion of motor characterristics.	Ask a technical assistanc of head quater.
50	ENCODER LOCKED	02A82	242	5	Unless controller receive any signal from encoder (motor speed sensor) for more than 10 sec, since after controller apply power on motor, controller recognize that motor is stuck. 1) Check the encoder & It's connection (in tester menu, speed being reported from encoder can be seen in "Encoder" Menu). 2) Check wires between encoder (A7, 8, 14, 15) & the controller. 3) If alam keeps displaying even after replacement of encoder & checking the wires, replace the controller.	
51	WAITING FOR NODE	02A0	222	0	A traction controller is waiting for other controller to be ready, which means a cause of trouble is in other controller, not in traction controller. The specific troubled controller can be found easily in CONSOLE. (you can always check the soundness of each controller's CAN communication, simply by connecting other controllers, only two other controllers are CAN TILLER (only attached in case of turtle or inching wption), MDI display- with "SET MODEL" menu console. CAN tIller : #8, MDI display : #16, Traction controller : #2) 1) find a troubled controller in tester menu. 2) Check the entire CAN BUS Line connected to the troubled controller. 3) Check if there is any alarm in the troubled controller (sometimes when a seriou alarm happens, CAN communication is not working). 4) if any wires or connections are fine, replace the controller.	

No	Error	Error code (display)	Error code (console)	LED flash	Description	
					Cause	Troubleshooting
52	IQ MISMATCHED	02A31	219	2	1. Controller's hardware settings related to motor characteristics has been changed, which is confidential & not allowed for a service engineer to access. 2. The motor is damaged which leads to a distortion of motor characterristics.	Ask a technical assistanc of head quater.
53	EPS ERROR	02A97	225	2	The safety out driver is shorted.	- If "EPS error check" parameter in "Set options" is activated, EPS contoller is supposed to send a specific voltage ,higher than 11V, to alert a traction controller in case of EPS error. Check EPS system first. - Check if there is a short or a low impedance pull-down between SAFETY OUT (CAN#19 - connected to EPS controller) and -BATT. - The driver circuit is damaged in the logic board, which has to be replaced.
54	SEQUENCE FAULT	02A81	221	0	Operation Sequence is out of order. *Correct sequence Parking brake, seat -> Direction switch (forw, back) -> Accel pedal enable Possible causes: A) Running microswitch failure in seat, direction (combi), accel enable switch. B) Error in sequence made by the operator. C) Incorrect wiring. D) If the default persists, replace the logic.	

8. BATTERY CHARGER

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

1) BASIC INFORMATION

(1) What is charger

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

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

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

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

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

④ It prevents from under charging and overcharging.

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

(2) Notice on caring chargers

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

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

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

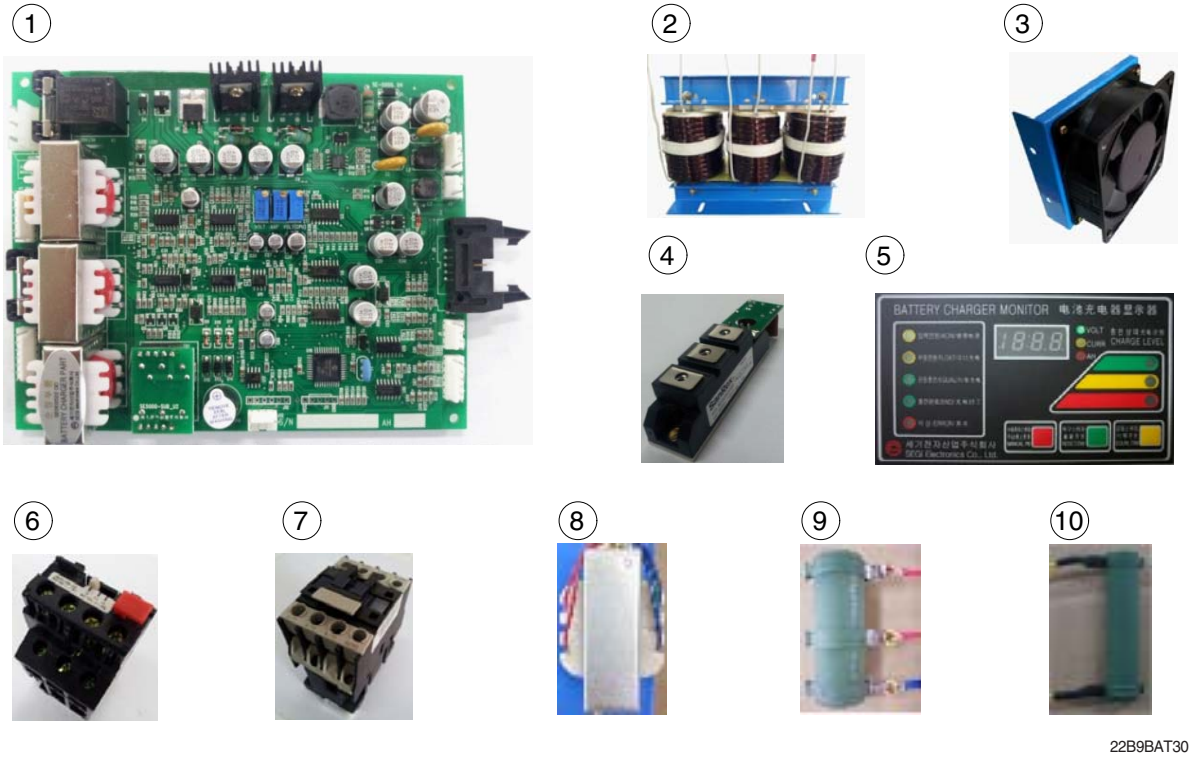
④ Check the electrolyte of the battery every week and provide distilled water immediately if it is required. (Electrolyte has to be provided between 10~12 ㎜ level on the positive plate inside storage battery)

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

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

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

(3) Names of each part (independent items)



22B9BAT30

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

2) CHARGER INSTALLATION METHOD

(1) Location for charger installation

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

(2) Check points before installing charger

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

(3) Table for capacity of charger input cable

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

3) HOW TO USE A CHARGER

(1) General charging method (Floating charging)

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

② Connect battery connecter and charger connecter.

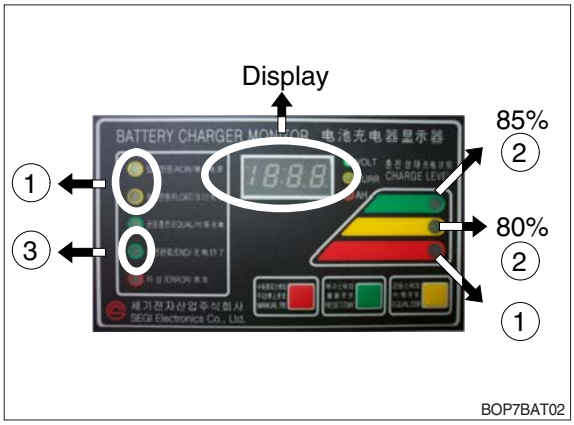
· **According to charging condition**

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

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

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

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



(2) Equalized charging

① **Equalized charging is**

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

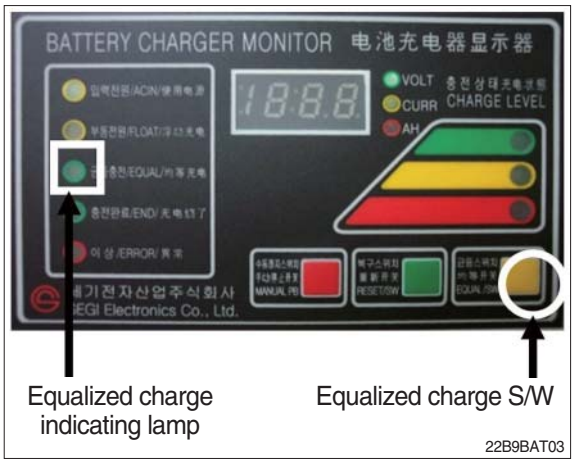
When equalized charging is required?

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

② **Tips for equalized charging**

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

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



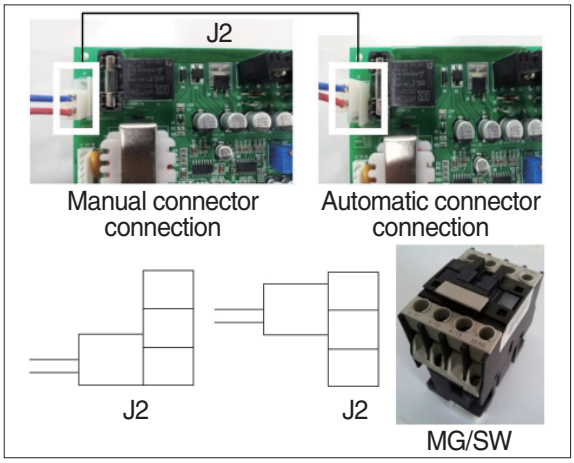
22B9BAT03

(3) Automatic/Manual switching method

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

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

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



22B9BAT04

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

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

BOP7BAT10

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

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

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

22B9BAT11

No	Code	Description of error
1	E.F	EPROM fail
2	O.V	Over voltage - Refer to page 6-81
3	O.C	Over current - Refer to page 6-80, 6-82.
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 6-79.
8	A.F	Power supply error (absent phase) - Check if input cable is open.
9	A.C	AC fail (black out) - Check if input voltage is right.
10	L.C	Low current (If this sign is on for setting value (60 sec), charging is over).
11	F	Manual stop.

4) CHECK POINTS BEFORE APPLYING A/S

(1) AC input power source switch is input.

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

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

(4) Check the front cover indicator.

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

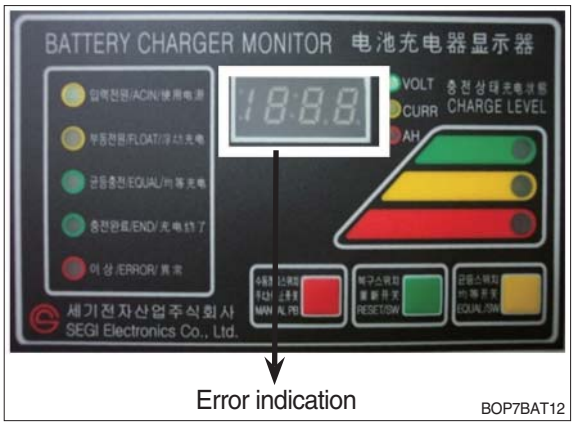
② A.O : Error on selection of input power source of 220V or 380V - Check it appropriately with full three phases.

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

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

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

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



5) ERROR DETECTION

(1) Error list

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

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

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

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

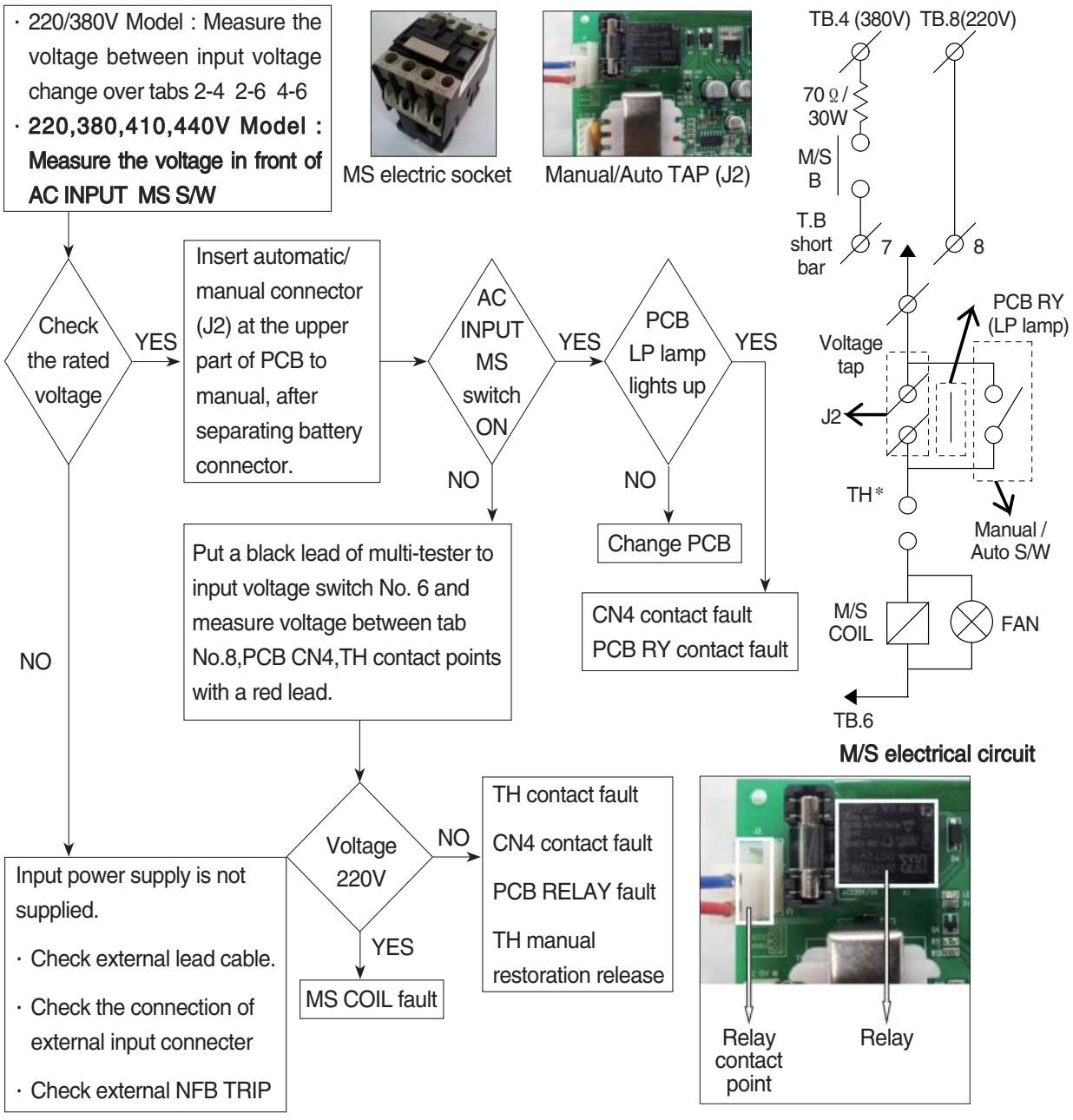
⑤ Charger TRIP is occurred after it started charging and charging completion lamp is on.

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

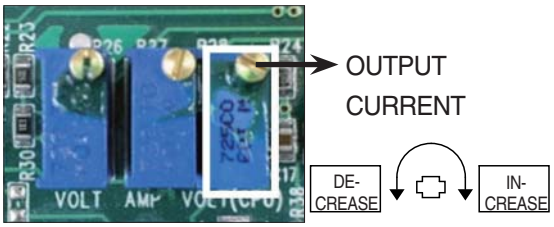
⑦ SCR module checking method

(2) Troubleshooting

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

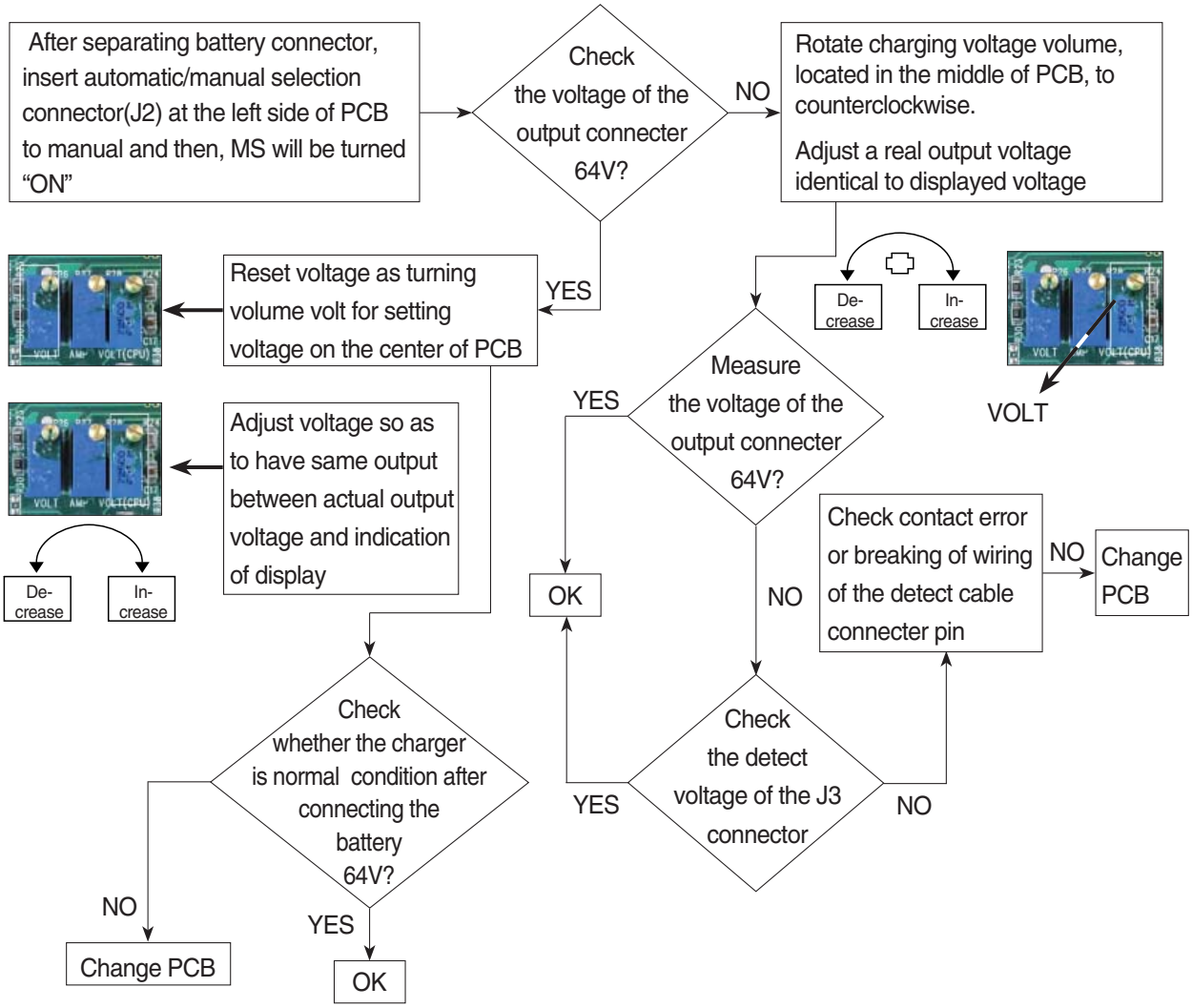


② ON and OFF is repeated with a few minutes intervals after starting charging.
Indicate "O.C" on the monitor.
- TH is operated (AC input over-current TRIP).

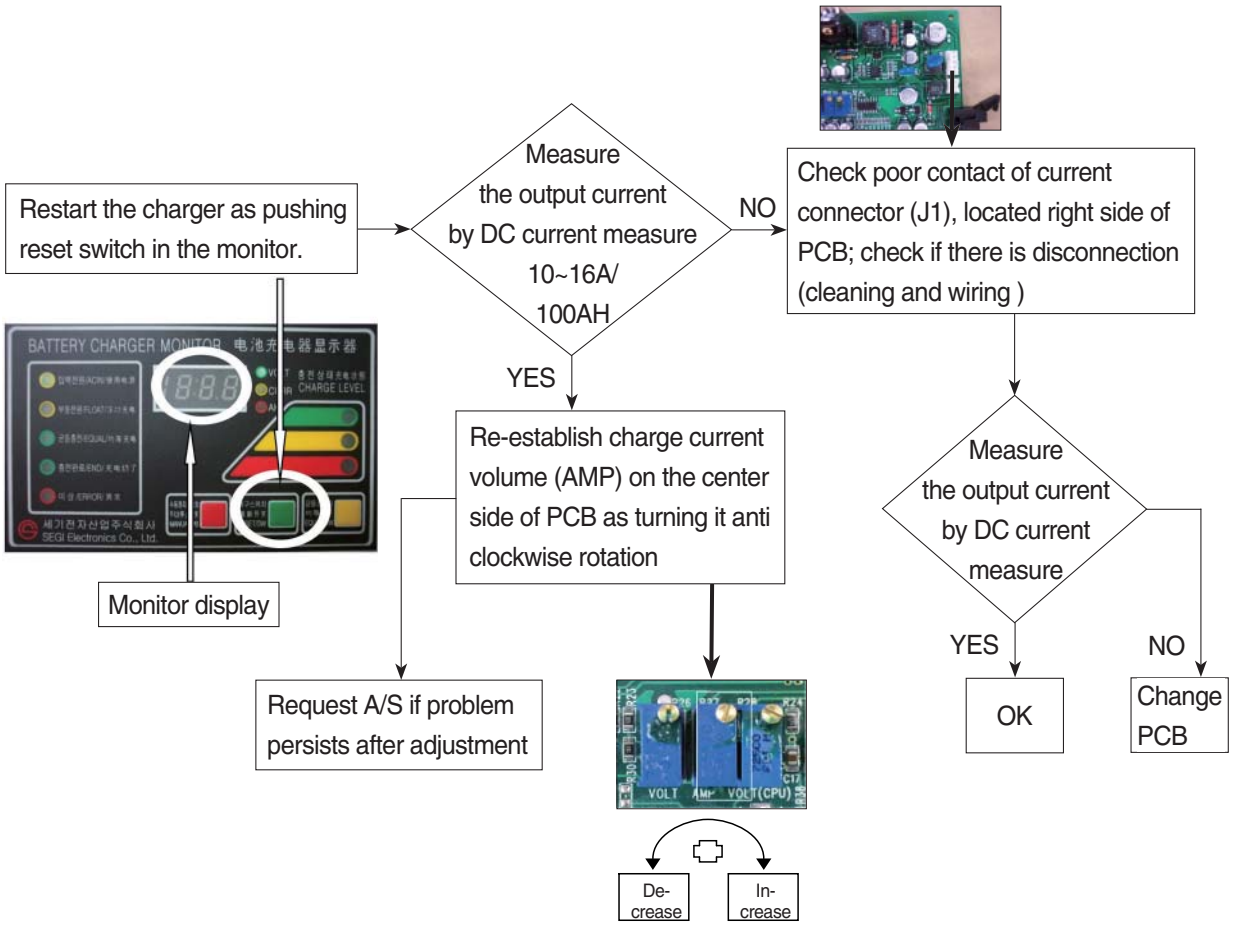


Trans noise is severe at MS ON status
NO
Measure output current using DC current measure
Current value : 10~16A /100AH
NO
Exceed Standard current
Adjust output current AMP, VR within PCB Re-adjust to VR
YES
· TH Setting fault
· Re-adjust TH setting value
TH. TRIP
YES
Change TH
NO
Complete
YES
* Refer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

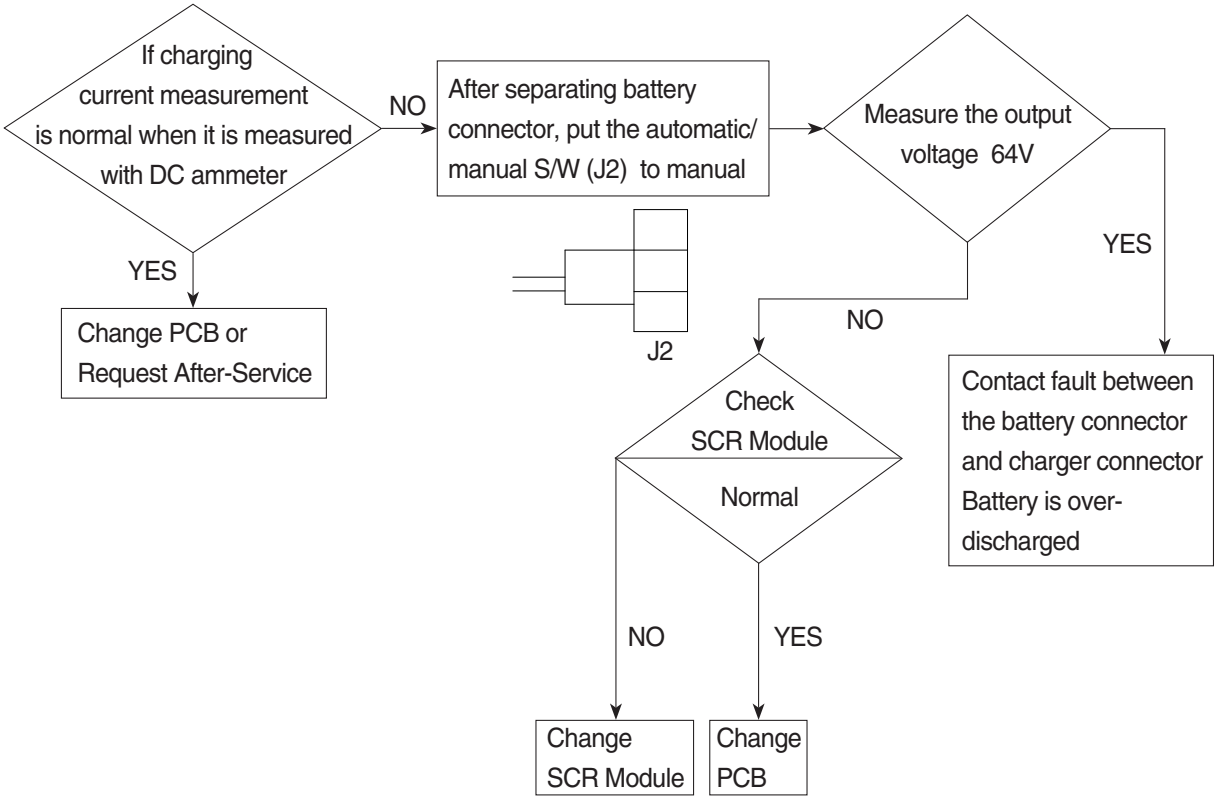
③ **Charger TRIP is occurred after abnormality lamp is on.**
In case error code is "O.V" → Over-voltage output / Set at 66V (In case of BATT 48V)
34V (In case of BATT 24V)
108V (In case of BATT 80V)



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

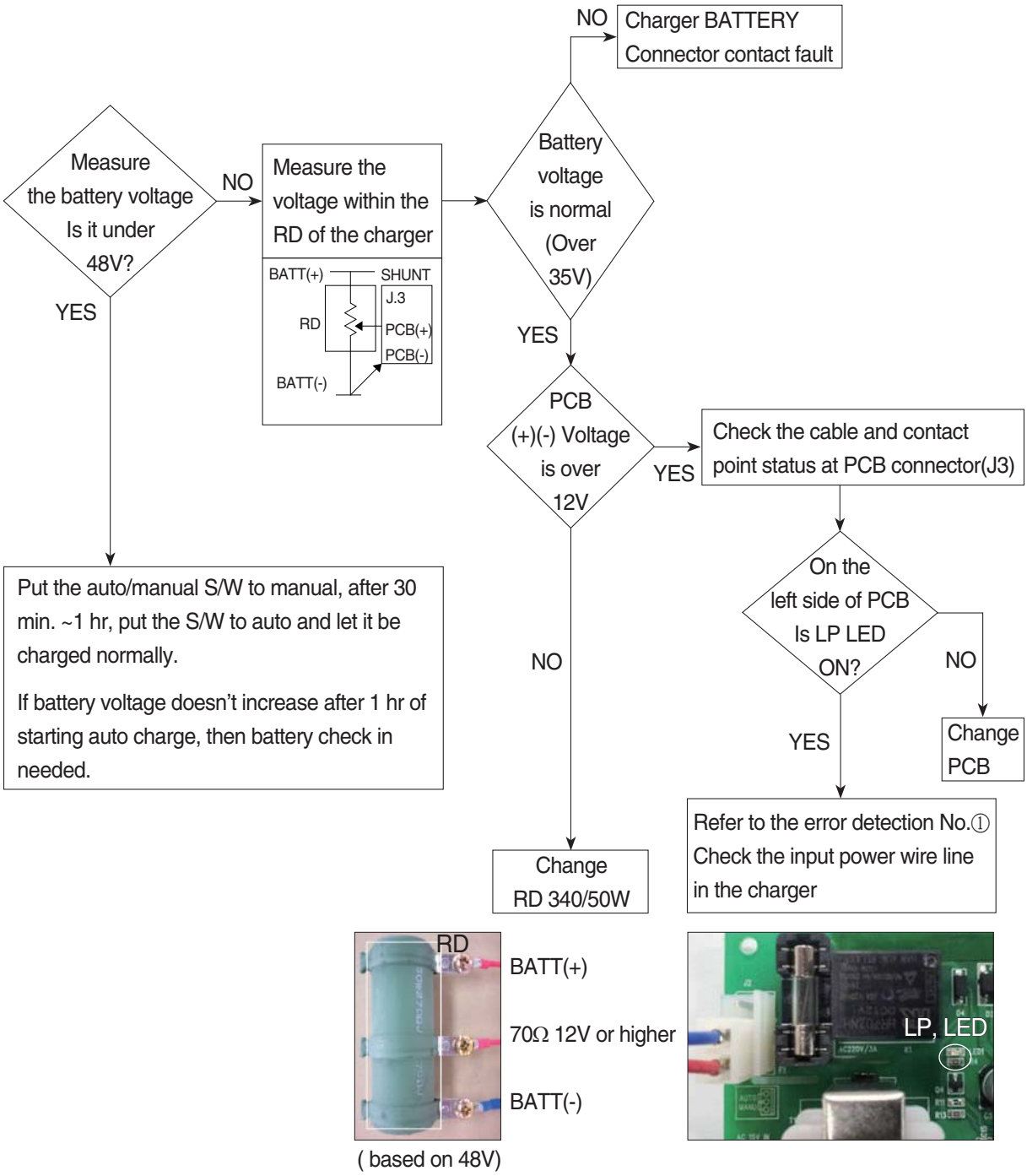


⑤ **Charger TRIP is occurred after it started charging and charging completion lamp is on.**
(In case input voltage is normal - Refer to the error detection No. 1)
Restore the charger as pushing reset switch.



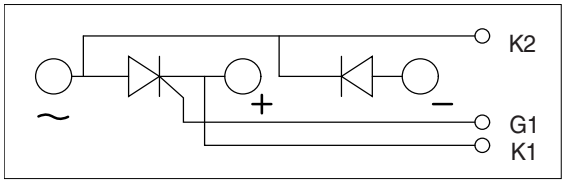
⑥ **Charger has no response even if the battery connector is connected.**

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

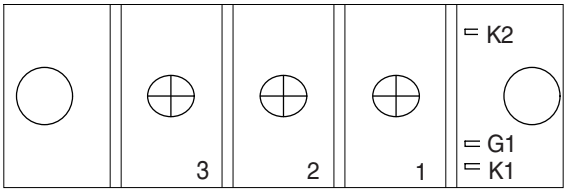


7) HOW TO CHECK THE SCR MODULE

Circuit

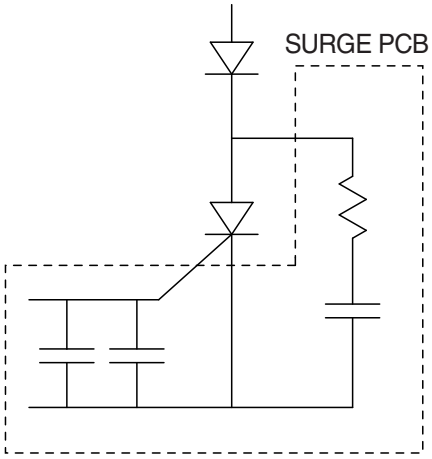


Real diagram

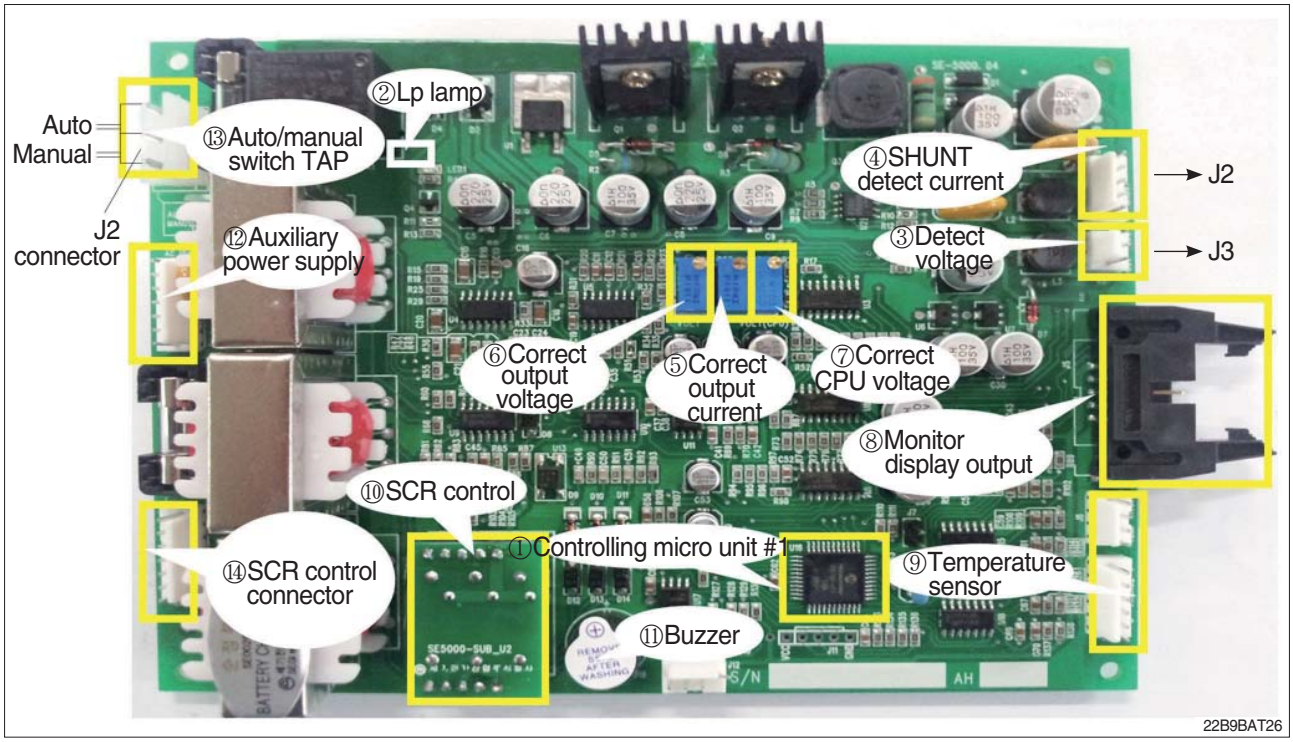


* Before checking SCR MODULE, be sure to disconnect bus bar and wire on the terminal.

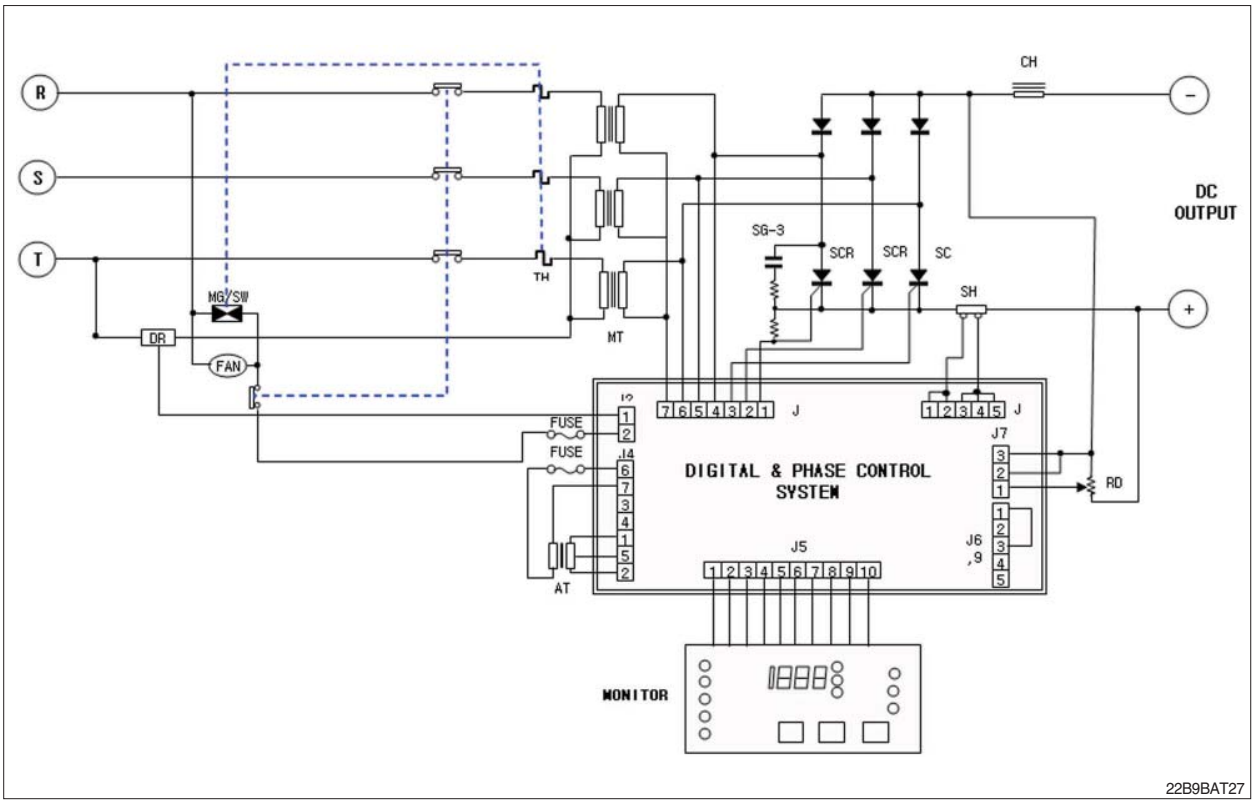
No.	Measuring point (Real diagram)	Measure value (Measurement of digital tester)
1	No.1 ~ No.3	Forward : Under 100 k ohm Reverse : Infinity (∞)
2	No.2 ~ No.3	Forward : Infinity (∞) Reverse : Infinity (∞)
3	G1 ~ K1	Forward : Under 100 ohm Reverse : Under 100 ohm But It depends on the module. If it is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



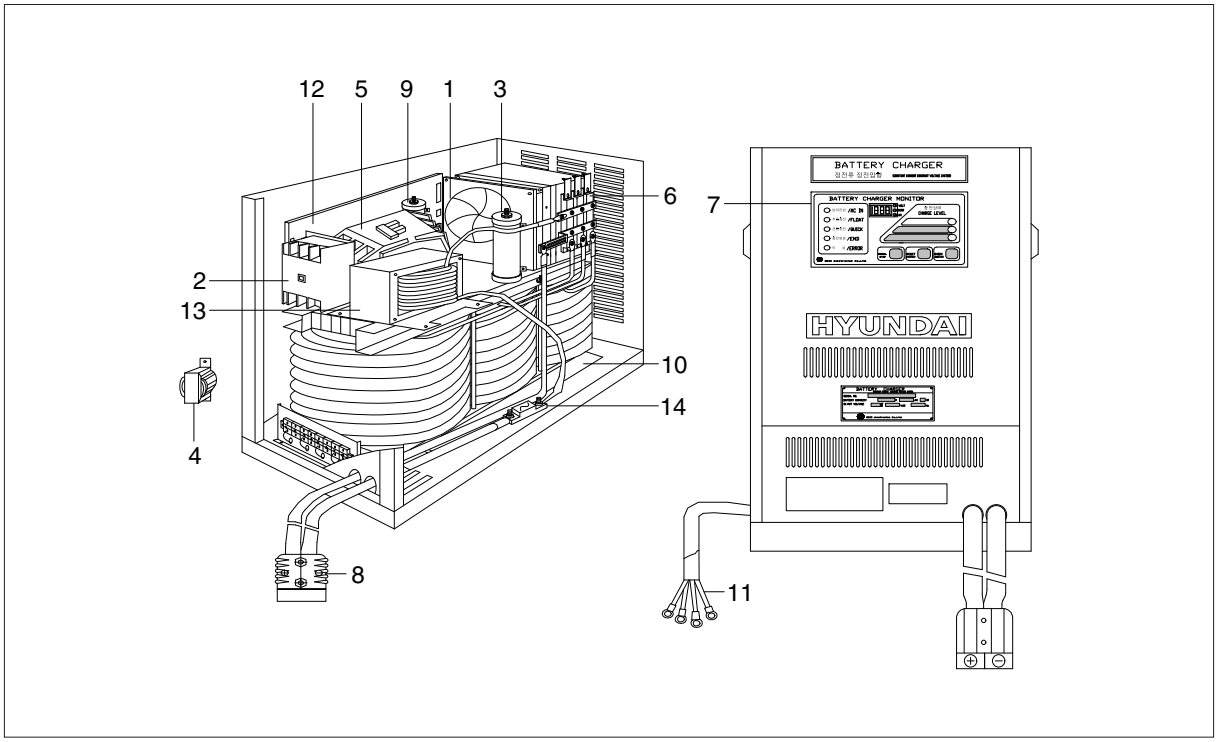
8) PCB MAJOR PARTS (NAME AND LOCATION)



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


R
S
T
MG/SW
DR
FAN
TH
MT
CH
DC
OUTPUT
SG-3
SCR
SCR
SC
SH
FUSE
FUSE
AT
DIGITAL & PHASE CONTROL
SYSTEM
J5
J6
J7
RD
MONITOR
22B9BAT27

CHARGER INTERIOR PARTS

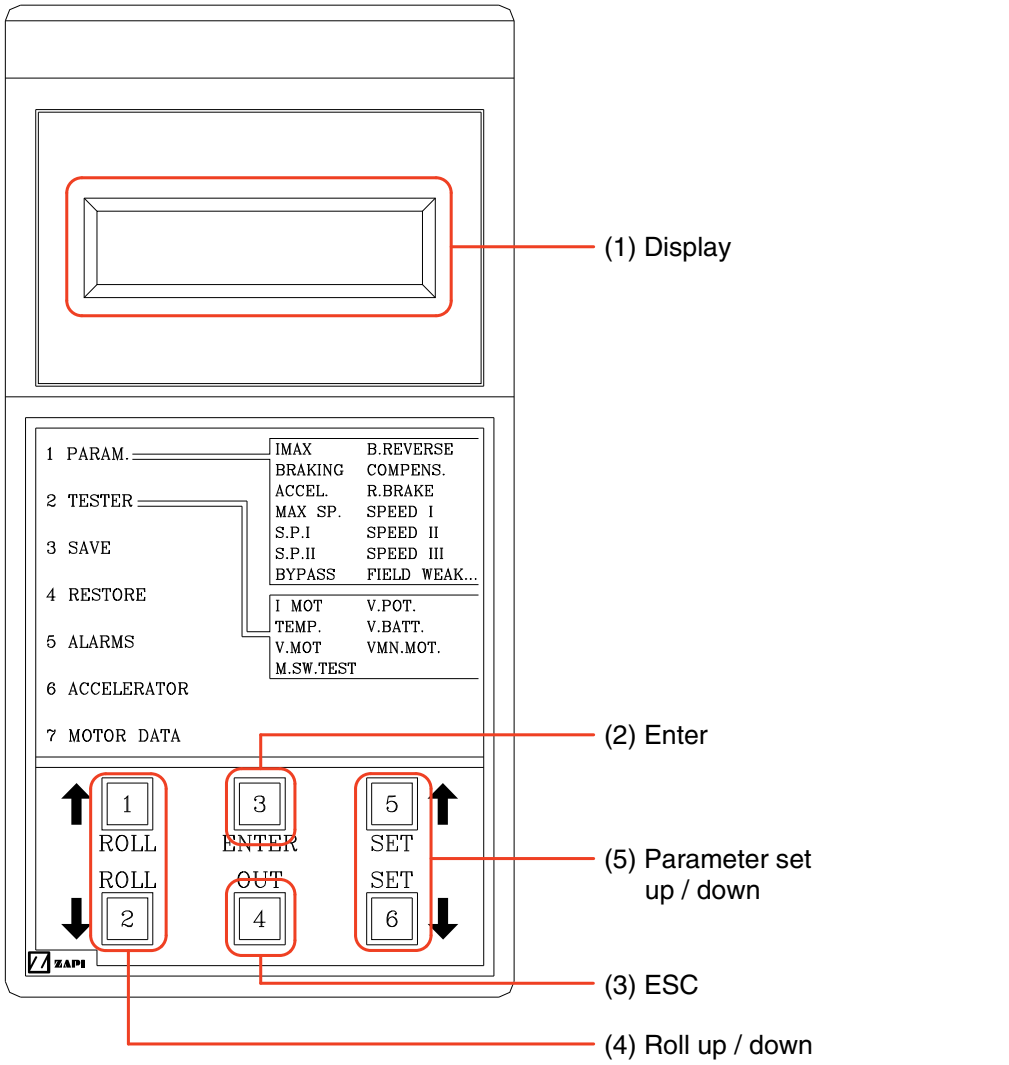


22B9BAT28

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	

9. QUICK CONFIGULATION GUIDE (ZAPI CONSOLE)

1) DESCRIPTIONS OF CONSOLE



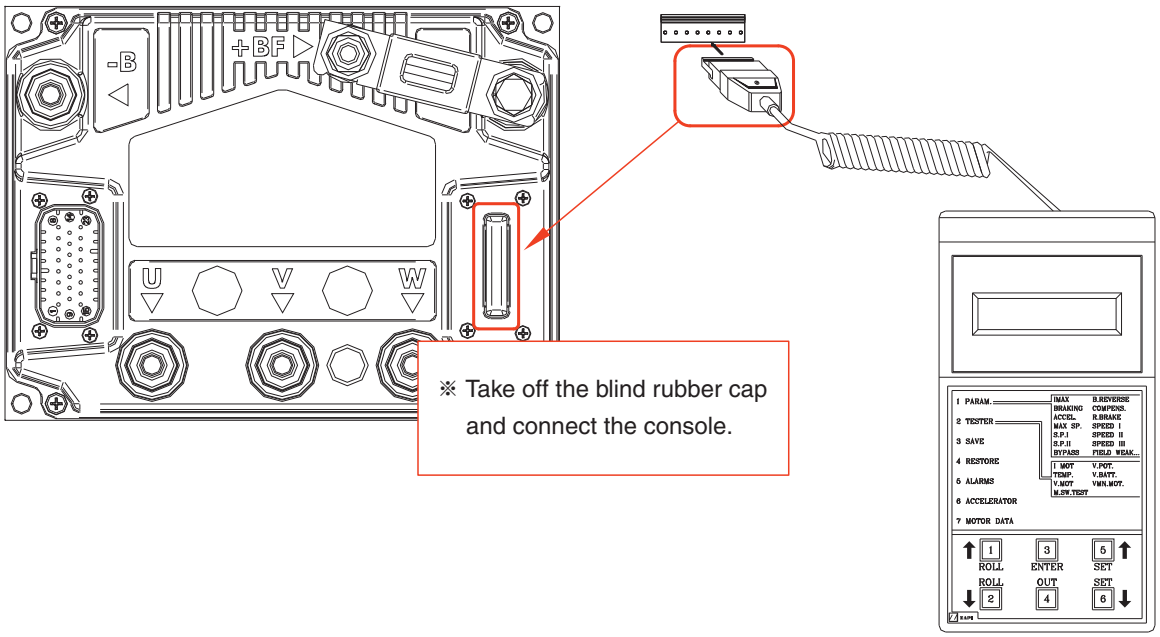
15P9ZAPI01

(1) Display : It shows descriptions of currently ongoing setting/diagnosis.
(2) Enter : It is used to enter particular menu or input YES.
(3) ESC : It is used to escape particular menu or input NO.
(4) Roll Up/Down : It is used to change menu/parameter shown the display.
(5) Parameter Set Up/Down : It is used to change value of parameter shown the display.

2) CONNECTION OF CONSOLE

The ZAPI controller of the traction/pump, fingertip (Mhyrio) and EPS have 7 pins of serial port as follows. Take off the blind rubber cap and connect the console.

Example : Traction controller of 40T-9



15P9ZAPI02

3) MAIN DISPLAY

Connect the ZAPI console first, main display will show as below.

The main screen is changed by normal condition and occurrence alarm of the controllers as follows.

(1) Normal condition

AE2T2BF4T9HY0.08 48V 300A 00005	Example : Traction controller of 40T-9

You can see various informations of the controller at normal condition as below.

① AE2 : First 3 letter shows information of the controller hardware.
AC2 : Controller of the AC2 series
AC3 : Controller of the AC3 series
DA2 : Controller of the dual AC2 series
AE0 : Controller of the ACE 0 series
AE2 : Controller of the ACE 2 series
MHYRIO : Controller of the fingertip
AC0 : Controller of the AC0 (controller of the BRJ-9, BRP-9, BOP-9 EPS)
Other controllers (MDI CAN, CAN-TILLER, CAN-ENCORDER) except above are shown just as it is.

② T : Role of the controllers
T : Traction controller (use only one traction controller incase one traction motor vehicle)
M : Traction master controller (master-slave dual structure of traction controller incase two traction motor vehicle)
S : Traction slave controller (master-slave dual structure of traction controller incase two traction motor vehicle)
P : Pump controller
None of particular role mark for other controllers.
③ 2BF4T9 : Inherent string for the model/controllers
④ HY0.08 : Software version for the controller. HY means Hyundai and software version is 0.08.
⑤ 48V : Rated voltage of the controller.
⑥ 300A : Rated current of the controller. Also, it is called capacity.
⑦ 00005 : Total operating time of the controller

(2) Main display when occurred alarm

Main screen displays the alarm statue as below when ★alarm or★warning of the controller occurred .

For example : Handbrake warning occurred.

Top line will be displayed * ALARM * and below line will be displayed description of ★Alarm or ★Warning.
The information and version of the controller can be checked by pressing 3 buttons at below line at the same time when alarm occurred.

★ Alarm : This is major problem and the vehicle can be operated after repaired by turning key OFF/ ON. Alarm is recorded in the alarm history.

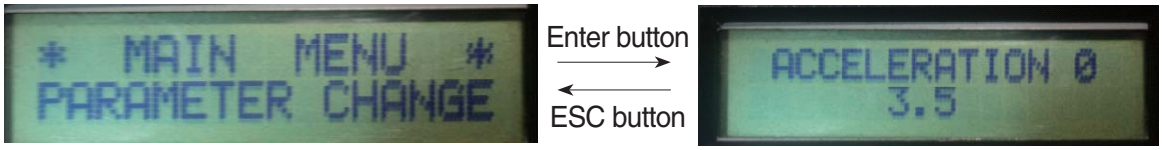
★ Warning : This is minor problem and the vehicle can be operated immediately after repaired. Alarm is not recorded in the alarm history.

4) CHANGE OF PARAMETER

Service engineer can adjust the parameters in the sub menu such as the Parameter change, Set options and Adjustments etc as follow if needed.
(Refer to service manual of the models for the parameter in the sub menu.)
Example : Change of INV. ACCEL 0 in the parameter change of the 40T-9 traction controller.

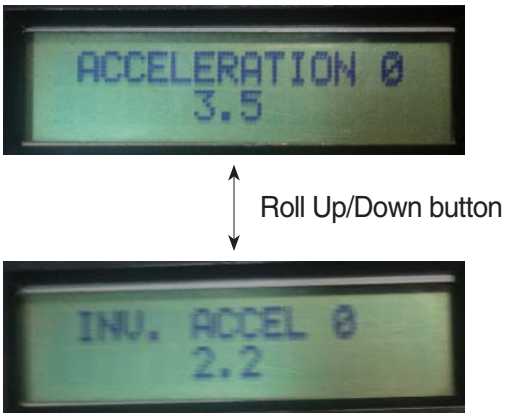
(1) Seek the sub menu you want. (Refer to "5) Descriptions of the sub menu" to go into the sub menu.)

(2) Press Enter button and go into the sub menu.

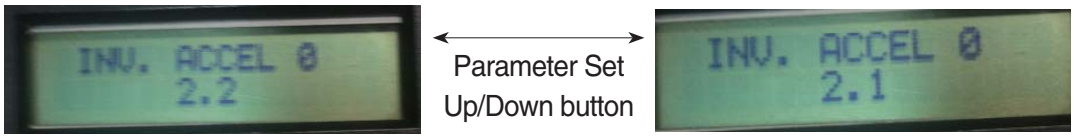


The display will show the first parameter of the sub menu after you go into the sub menu.

(3) Seek the parameter you want to change by using "Roll Up/Down" buttons.



(4) Change the parameter from current value to target value by using "Parameter Set Up/Down" buttons.



(5) If you want to change more other parameter in the sub menu, seek the parameter you want to change by using "Roll Up/Down" buttons and change the parameter from current value to target value by using "Parameter Set Up/Down" buttons same as above.

(6) You have changed all parameter in sub menu you want, display the save screen by pressing ESC button.

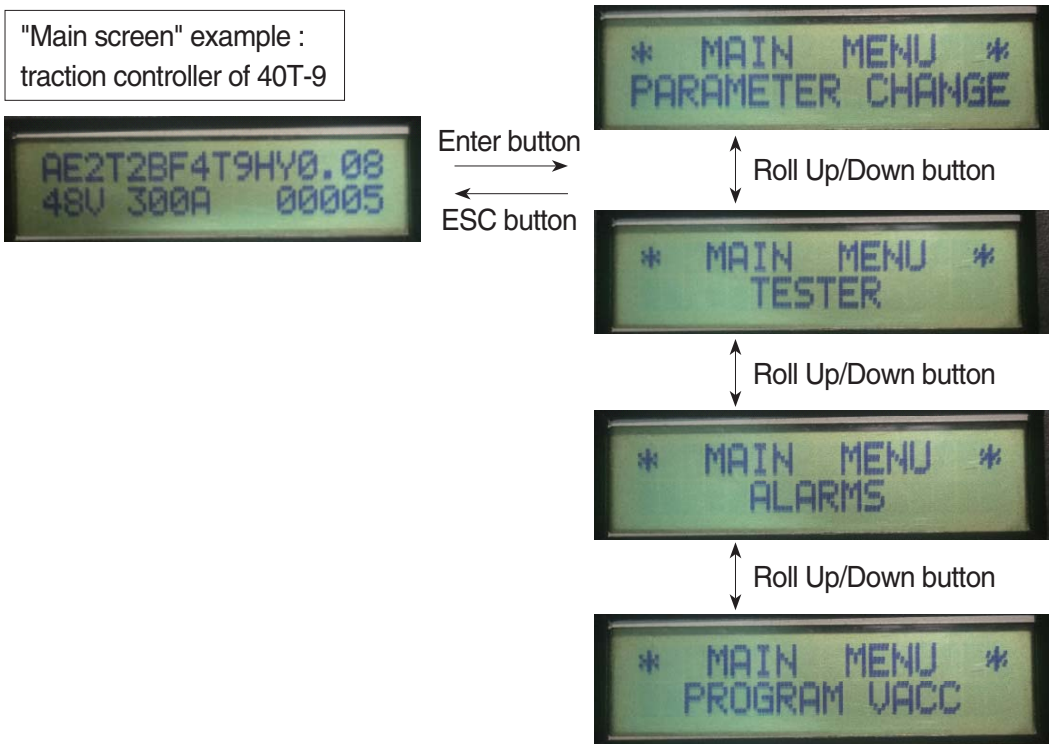
(7) If you press the Enter button, changed parameter will save in the controller and changed parameter will applied continuously after power off.
If you press the ESC button, parameter will be changed but not saved in the controller. As a result, the parameter will be returned previous value after power off/on.

5) DESCRIPTIONS OF THE SUB MENU

The console has various functions of parameter in the sub menu and the sub menu is included in the parents menu such as the Main menu and Config menu as follows.
(Refer to service manual of the models for the parameter in the sub menu.)

(1) Main menu

① Entering method : Go into the Main menu by pressing Enter button at "Main screen" (normal/ irrespectively alarm status) and you can seek a sub menu by using "Roll Up/Down" buttons.

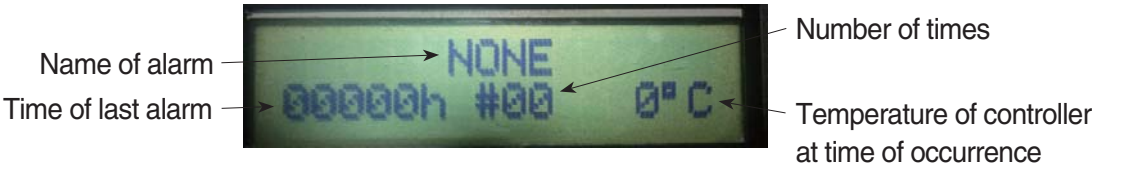


② Parameter Change : You can set parameters of vehicle performance and operating feeling etc.

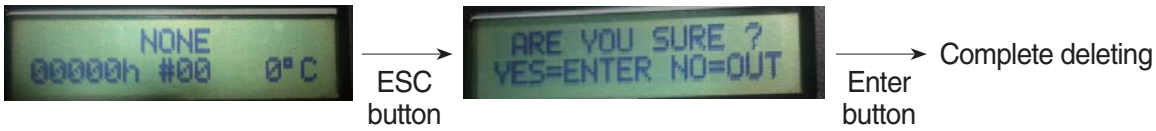
③ Tester : You can check current/voltage/temperature/operating status of vehicles and status of the sensors etc.

* Because tester menu is belong to monitoring menu, you can change the value of the parameter.

④ Alarms : This menu shows major alarms such as occurred time, number of times, temperature of controller at time of occurrence etc to maximum five that happened the controller.
The alarm can pass by using "Roll Up/Down" buttons.



Press "ESC" button on the alarm screen and "Enter" button on "Clear Logbook" screen, and then all saved alarm history is erased.



⑤ Program VACC

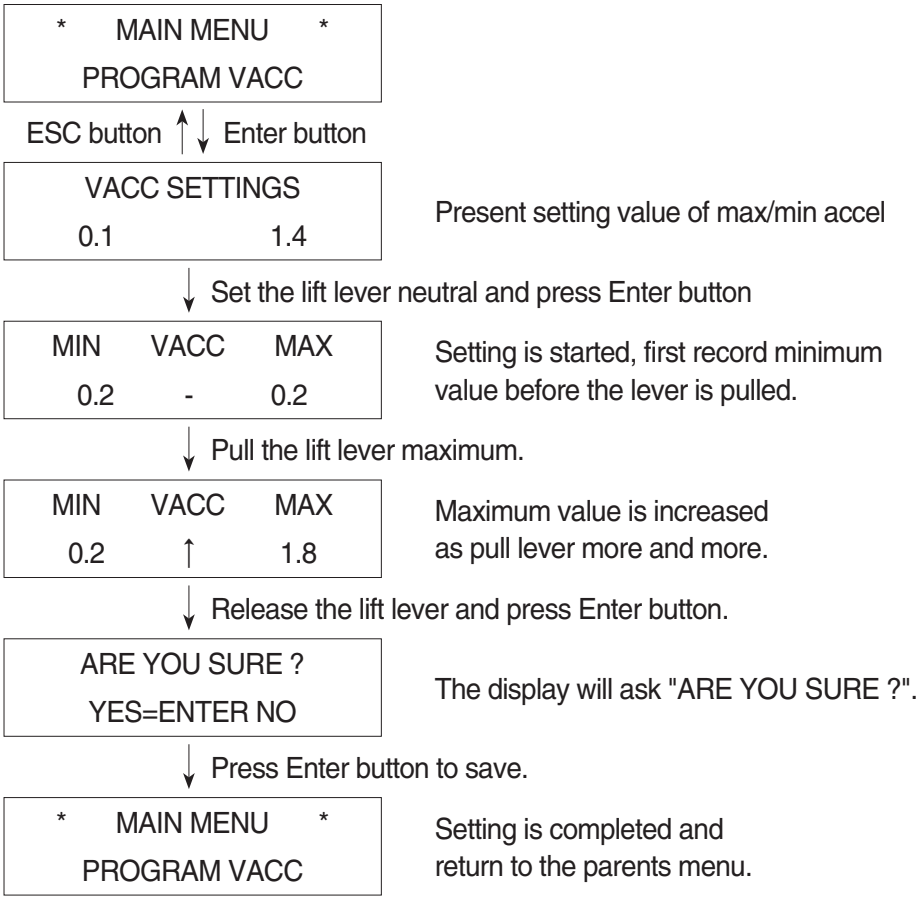
This menu is used to set the senor for accel pedal of the C/B type battery vehicle, towing tractor (15P/40T/80T-9) and 14/25BRJ-9, and the sensor for standard mechanical lift lever of C/B type battery vehicle as follows.

A. setting (the program VACC menu of the traction or traction master controller)

* MAIN MENU * PROGRAM VACC	
ESC button ↑ ↓ Enter button	
VACC SETTINGS 0.4 2.3	Present setting value of the max/min accel
↓ Set the forward/reverse gear neutral and press Enter button	
MIN VACC MAX 0.0 - 0.0	Reset forward max/min value to zero for setting.
↓ Forward gear ON	
MIN VACC MAX 0.4 ↑ 0.4	Forward setting is started, first record minimum value before the accel pedal step on.
↓ Stop on the accel pedal maximum.	
MIN VACC MAX 0.4 ↑ 2.5	Maximum value is increased as step on the accel pedal more and more.
↓ Step off the accel pedal and set forward/reverse gear neutral.	
MIN VACC MAX 0.0 - 0.3	Reset reverse max/min value to zero for setting.
↓ Reverse gear ON	
MIN VACC MAX 0.4 ↓ 0.4	Reverse setting is started, first record minimum value before the accel pedal step on.
↓ Stop on the accel pedal maximum.	
MIN VACC MAX 0.4 ↓ 2.5	Maximum value is increased as step on the accel pedal more and more.
↓ Step off the accel pedal and set the forward/reverse gear neutral.	
MIN VACC MAX 0.0 - 0.0	
↓ ESC button	
ARE YOU SURE ? YES=ENTER NO	The display will ask "ARE YOU SURE ?".
↓ Press Enter button to save.	
* MAIN MENU * PROGRAM VACC	Setting is completed and return to the parents menu.

* Above all setting values are only example and the model/Accel have a different value.

B. Lift Lever setting (Program VACC menu of pump controller)

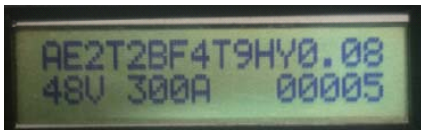


* Above all setting values are only example and the model/Accel have a different value.

(2) Config menu

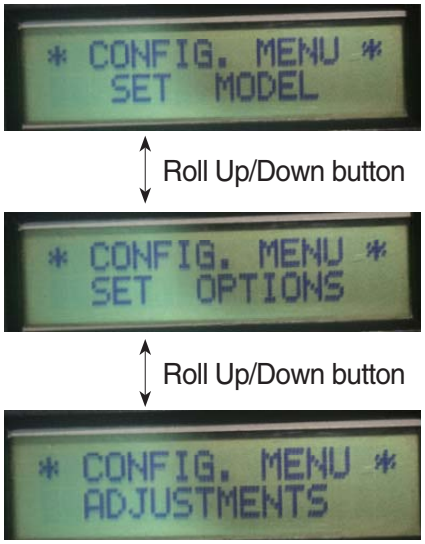
① Entering method : Go into "Config menu" by pressing once "Roll Up" + "Parameter Set Up" buttons at "Main screen" (normal/irrespectively alarm status) simultaneously and you can seek the sub menu by using "Roll Up/Down" buttons.

"Main screen" example : traction controller of 40T-9



Press "Roll Up" + "Parameter Set Up" buttons simultaneously

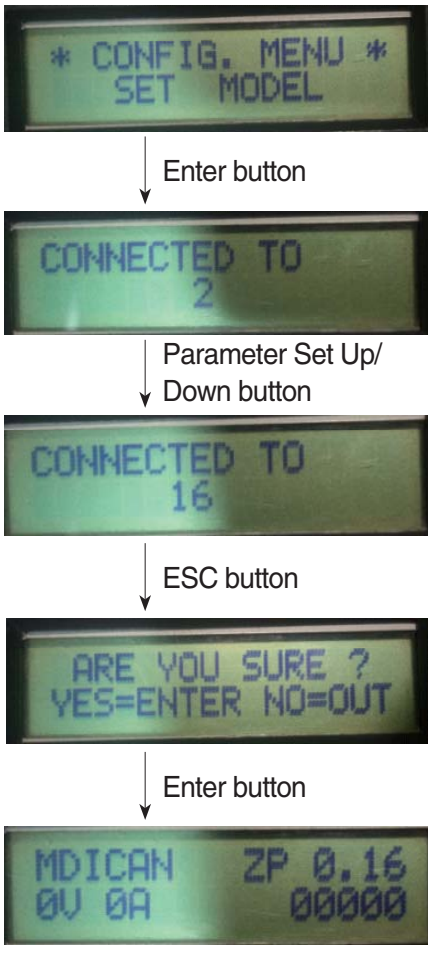
ESC button



② Set Options : Set outputs of the controllers for ON/OFF of major option functions.

③ Adjustment : Set detail settings of the sensors and options and battery maintenance etc.

④ Set Model : You can access from currently connected controller to other controller as follows.



Display will show the currently connected controller number (2:Traction).

Set the controller number you want to connect. (Refer to controller number at next page.)

Press Enter button when display ask "ARE YOU SURE?".

Display will show the main screen of the controller you want to connect.

* You have to check that main screen of connected controller is normal conditions or not because the connection is not linked by the alarm or wiring problems.
  If you are difficult to check the main screen due to alarm occurrence, you have to check the information of connected controller by pressing three buttons (Roll Down,ESC,Parameter Set Down) simultaneously.

* Refer to table below for the controllers number.

No.	Connection controller	Remark
2	Traction controller	One traction motor vehicles
3	Traction master controller	Two traction motor vehicles
4	Traction slave controller	
5	Pump controller	-
6	EPS controller	Only BRJ/BRP/BOP-9
8	CAN-Tiller	Equipped the fingertip option of the C/B vehicles Equipped the inching and turtle option of the 15P/40T/80T-9 vehicles BRJ/BRP/BOP-9
9	MHYRIO (fingertip) controller	Equipped the fingertip option of the C/B vehicles BRJ/BRP-9
16	MDI CAN or 7 series display	MDI CAN : 15P/40T/80T-9 7 series display : 7 series all battery vehicles