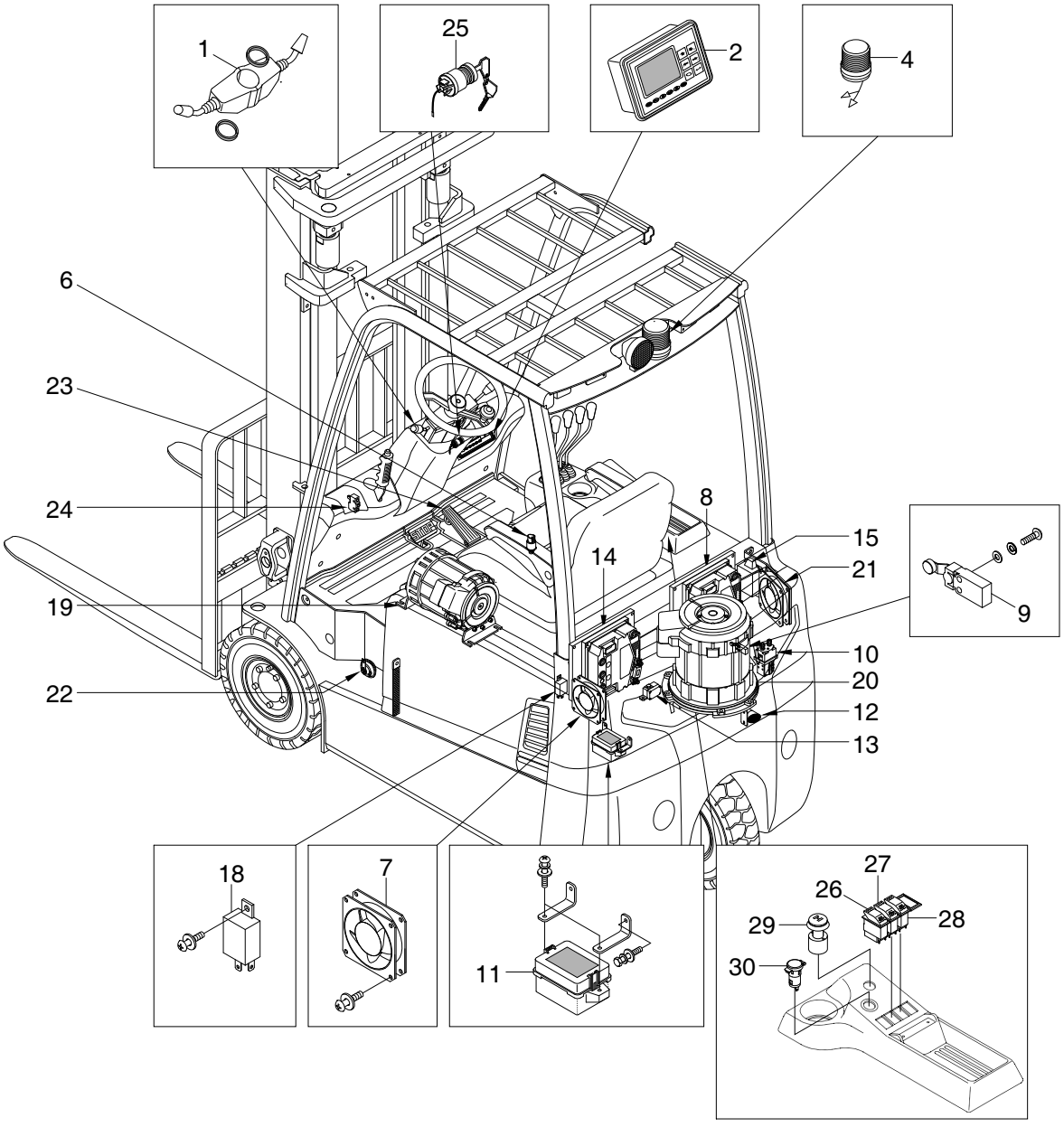
SECTION 7 ELECTRICAL SYSTEM

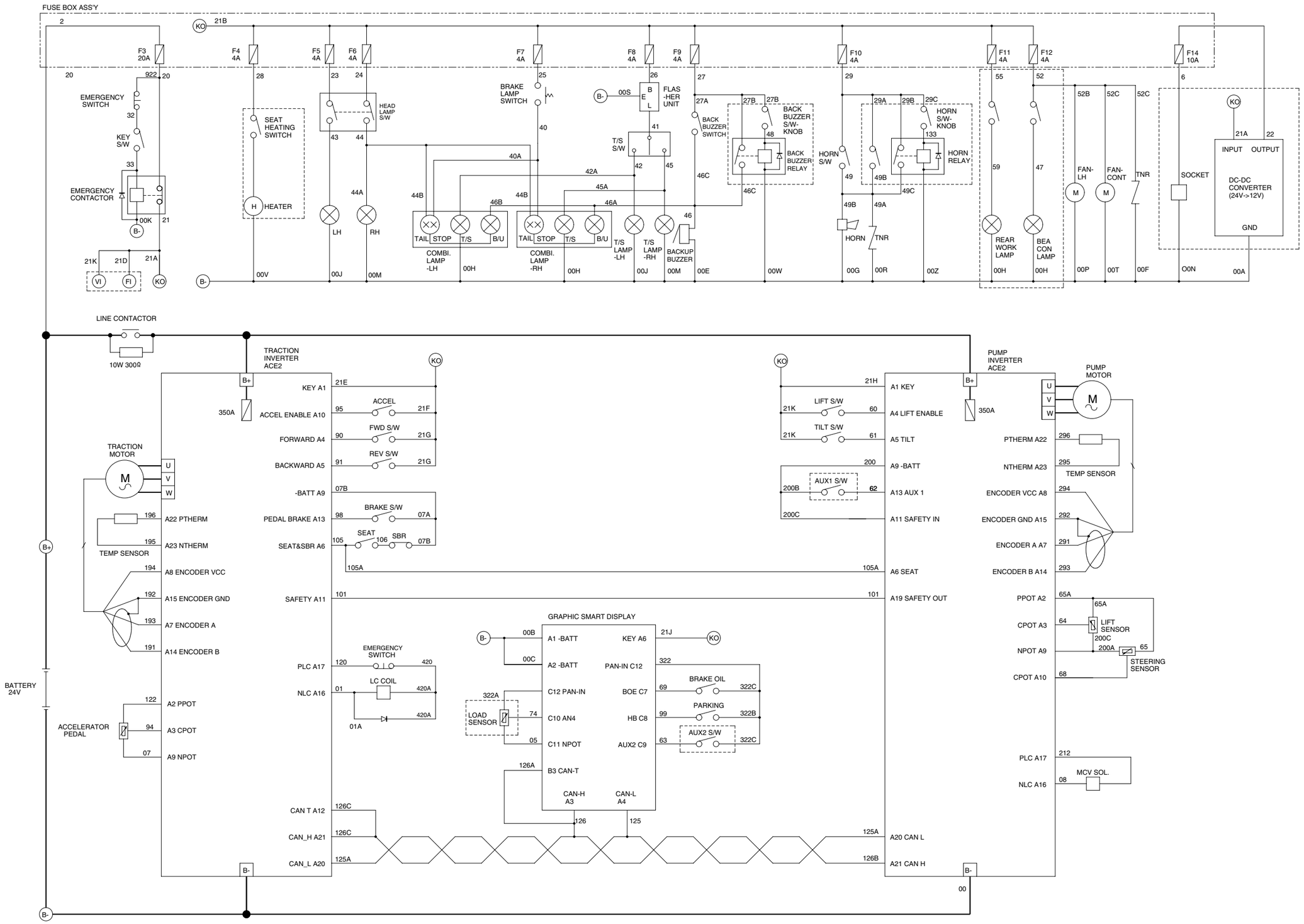
GROUP 1 COMPONENT LOCATION



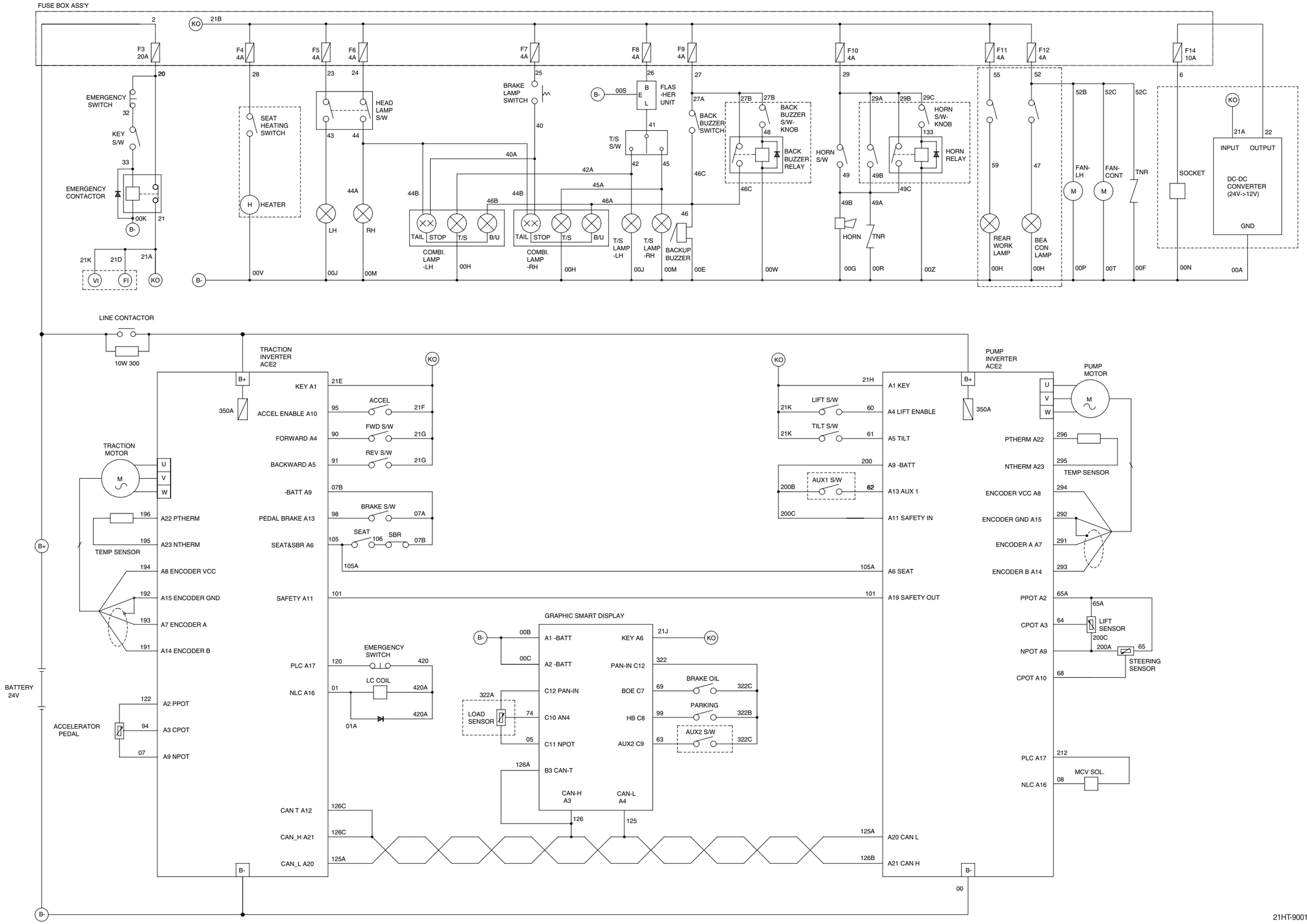
10BTR9EL02

1	Combination switch	11	Fuse box	22	Horn high
2	Display	12	Back buzzer	23	Accelerator assy
3	Converter	13	Angle sensor	24	Parking switch assy
4	Beacon lamp	14	Pump controller	25	Key switch assy
6	Pressure sensor	15	Fuse & relay cover assy	26	Head lamp switch
7	Fan	18	Flasher unit assy	27	Work lamp switch
8	Traction controller	19	Pump motor	28	Beacon switch
9	SBR switch assy	20	Traction motor	29	Emergency switch
10	Contactor	21	Fan	30	Socket assy

· ELECTRICAL CIRCUIT (1/12, NON-UL, 10BTR-9 : -#0039, 13BTR-9 : -#0062, 15BTR-9 : -#0205)

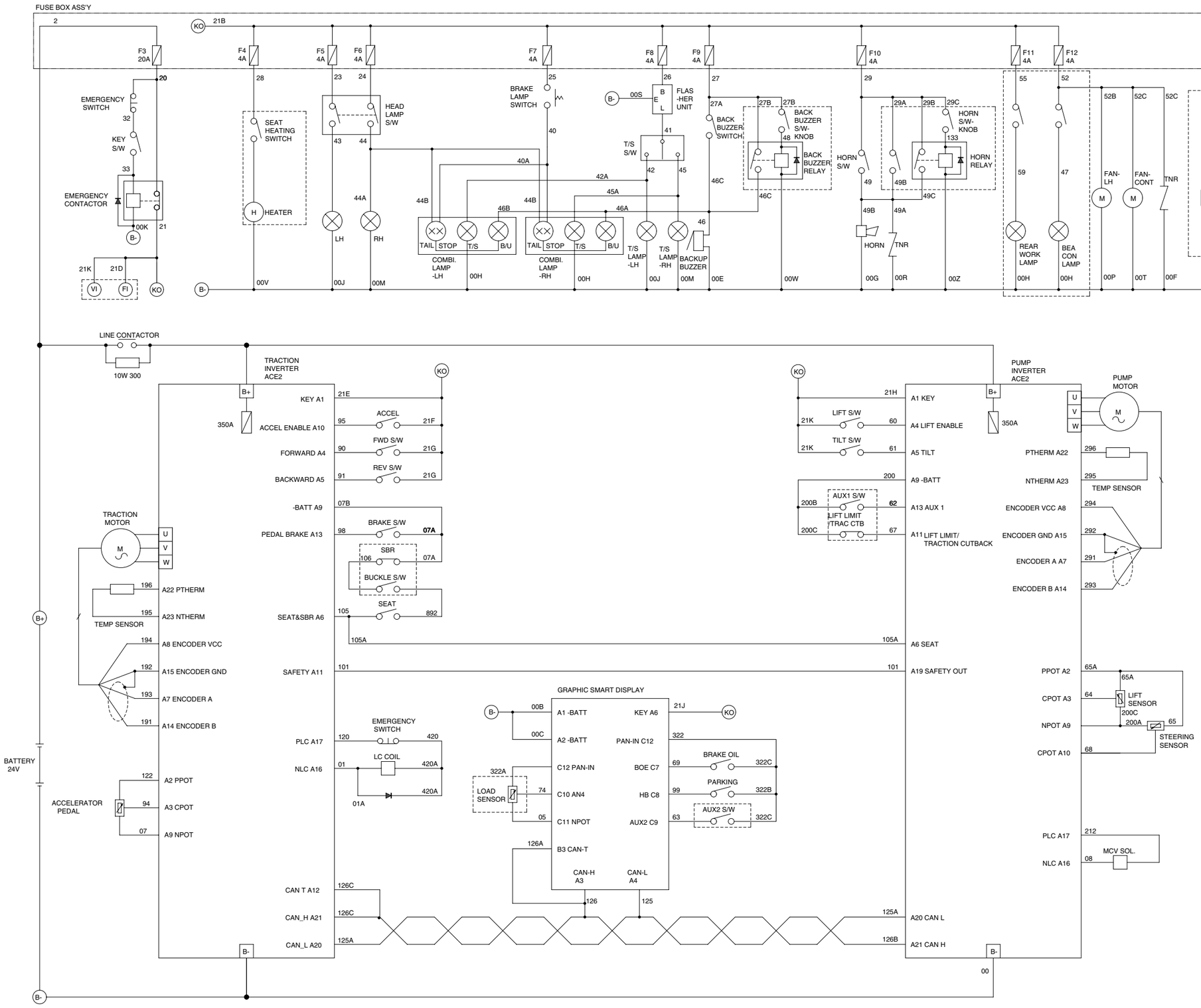


· ELECTRICAL CIRCUIT (2/12, NON-UL, 10BTR-9 : #0040-0047, 13BTR-9 : #0063-0066, 15BTR-9 : #0206-0255)



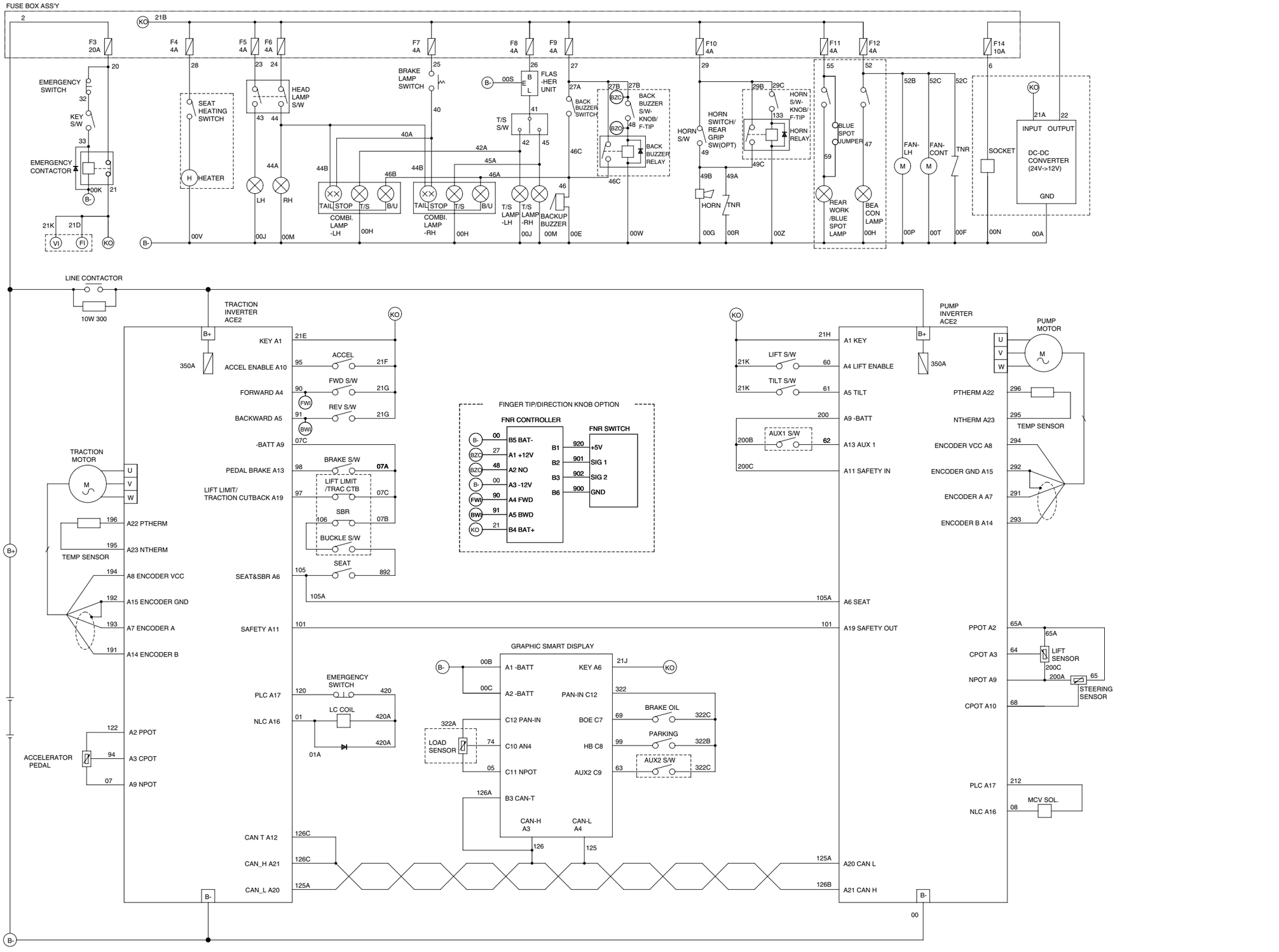
21HT-90016-01

· ELECTRICAL CIRCUIT (3/12, NON-UL, 10BTR-9 : #0048-0053, 13BTR-9 : #0067-0079, 15BTR-9 : #0256-0374)



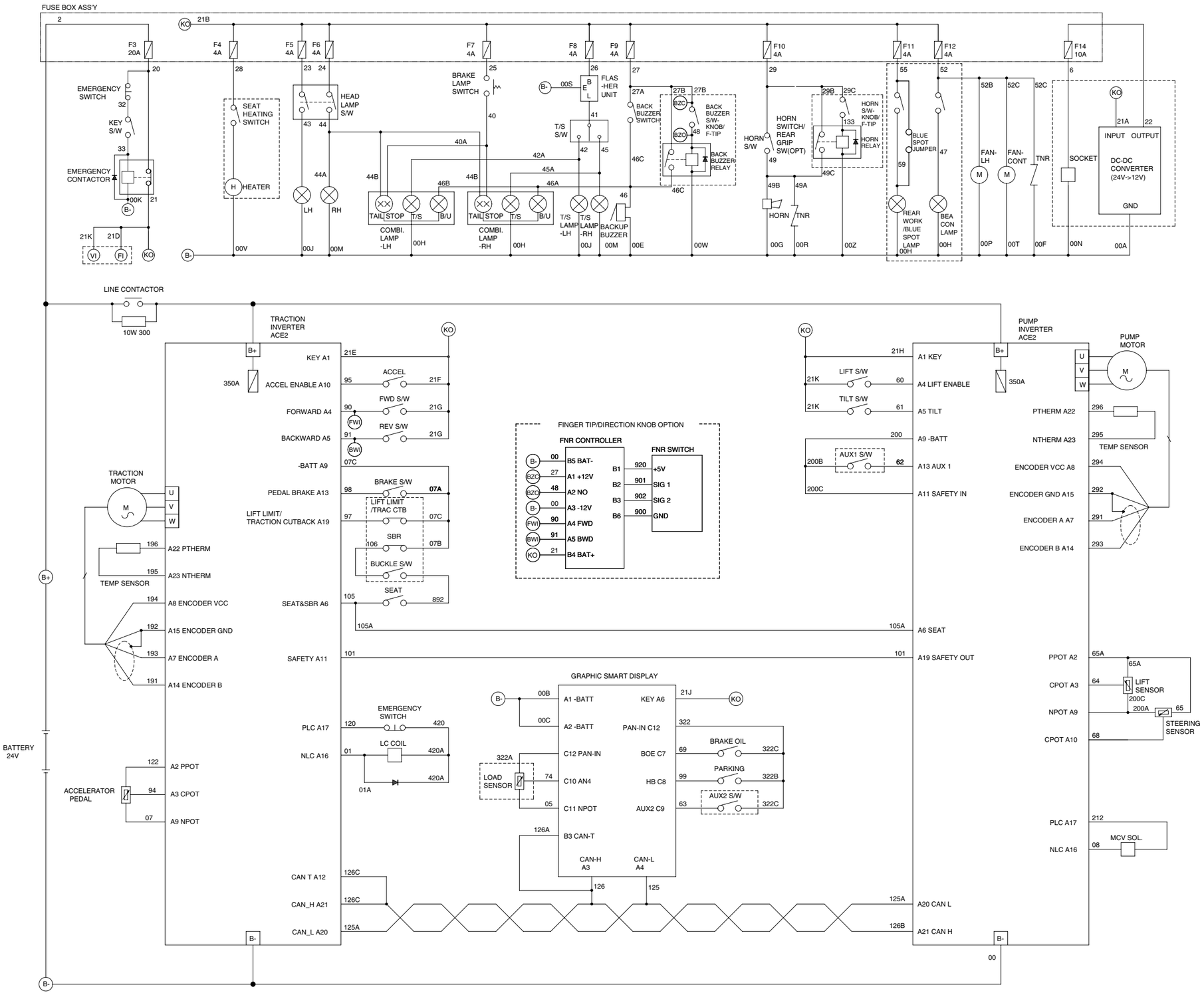
21HT-90017-00

· ELECTRICAL CIRCUIT (4/12, NON-UL, AUSTRALIA OPTION, 10BTR-9 : #0048-0053, 13BTR-9 : #0067-0079, 15BTR-9 : #0256-0374)



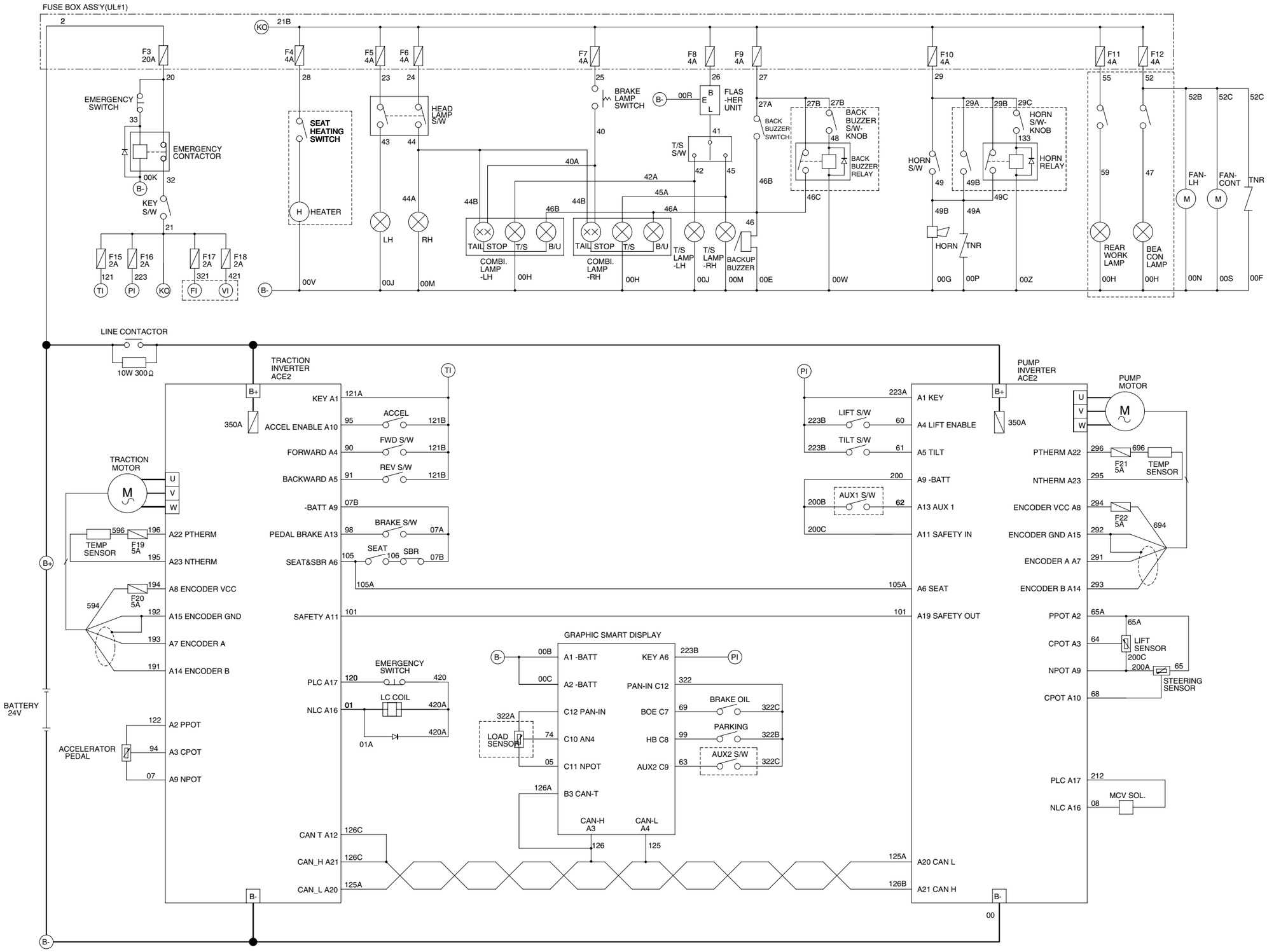
21HT-90018-01

· ELECTRICAL CIRCUIT (5/12, NON-UL, 10BTR-9 : #0054-, 13BTR-9 : #0080-, 15BTR-9 : #0375-)

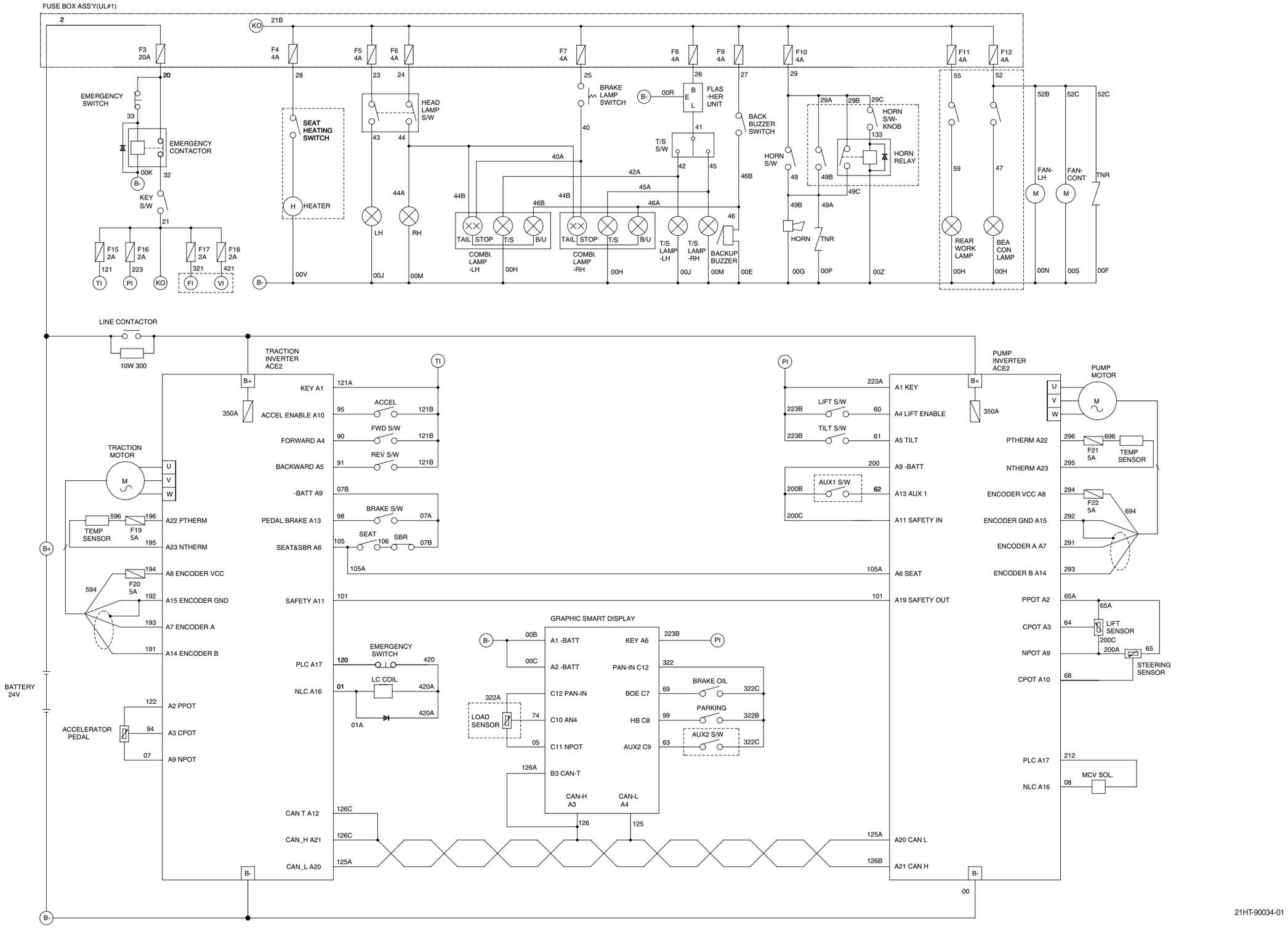


21HT-90019-00

· ELECTRICAL CIRCUIT (6/12, UL, 10BTR-9: -#0001, 13BTR-9: -#0001, 15BTR-9: -#0006)

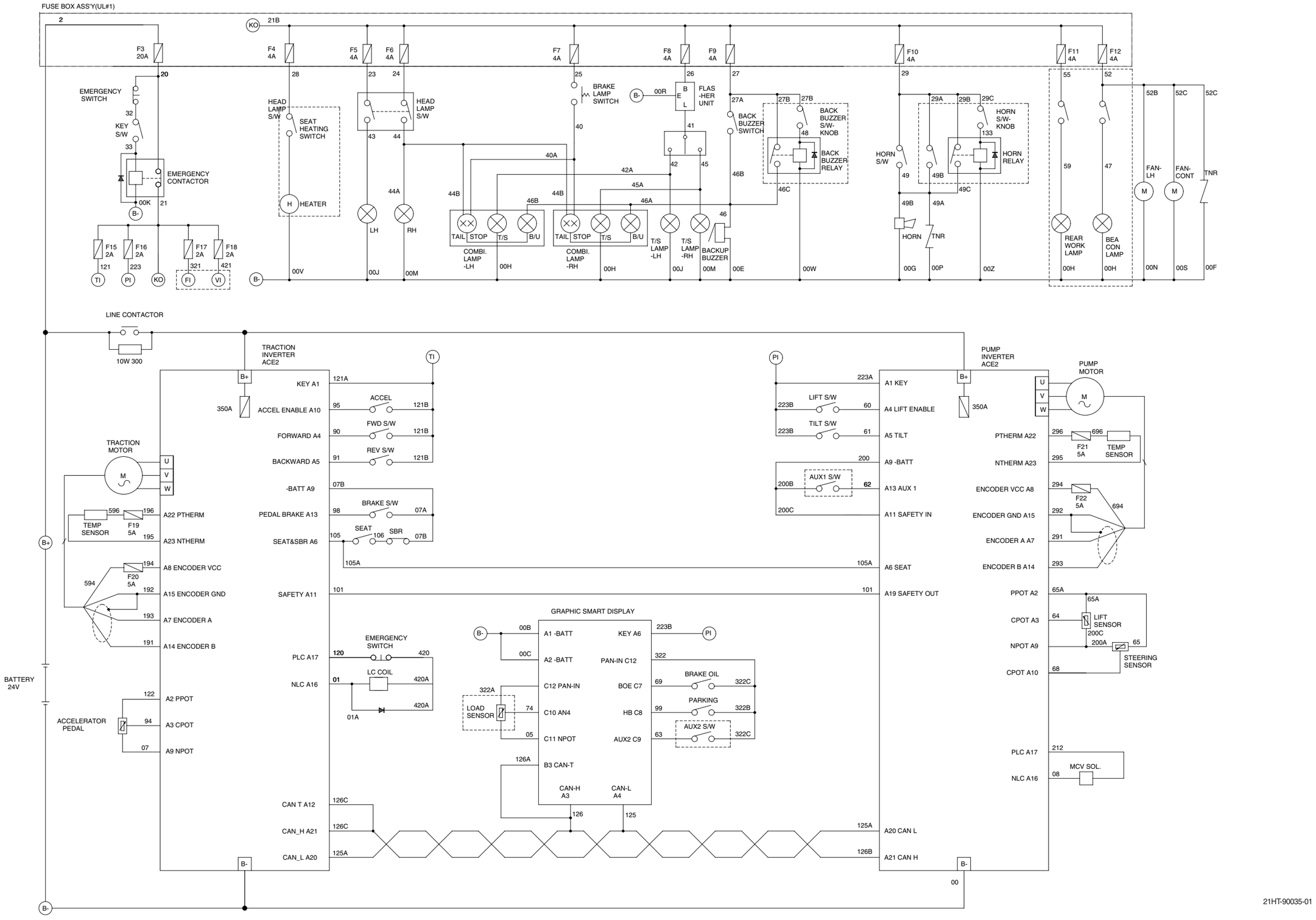


· ELECTRICAL CIRCUIT (7/12, UL, 10BTR-9: #0002-0039, 13BTR-9: #0002-0062, 15BTR-9: #0007-0205)



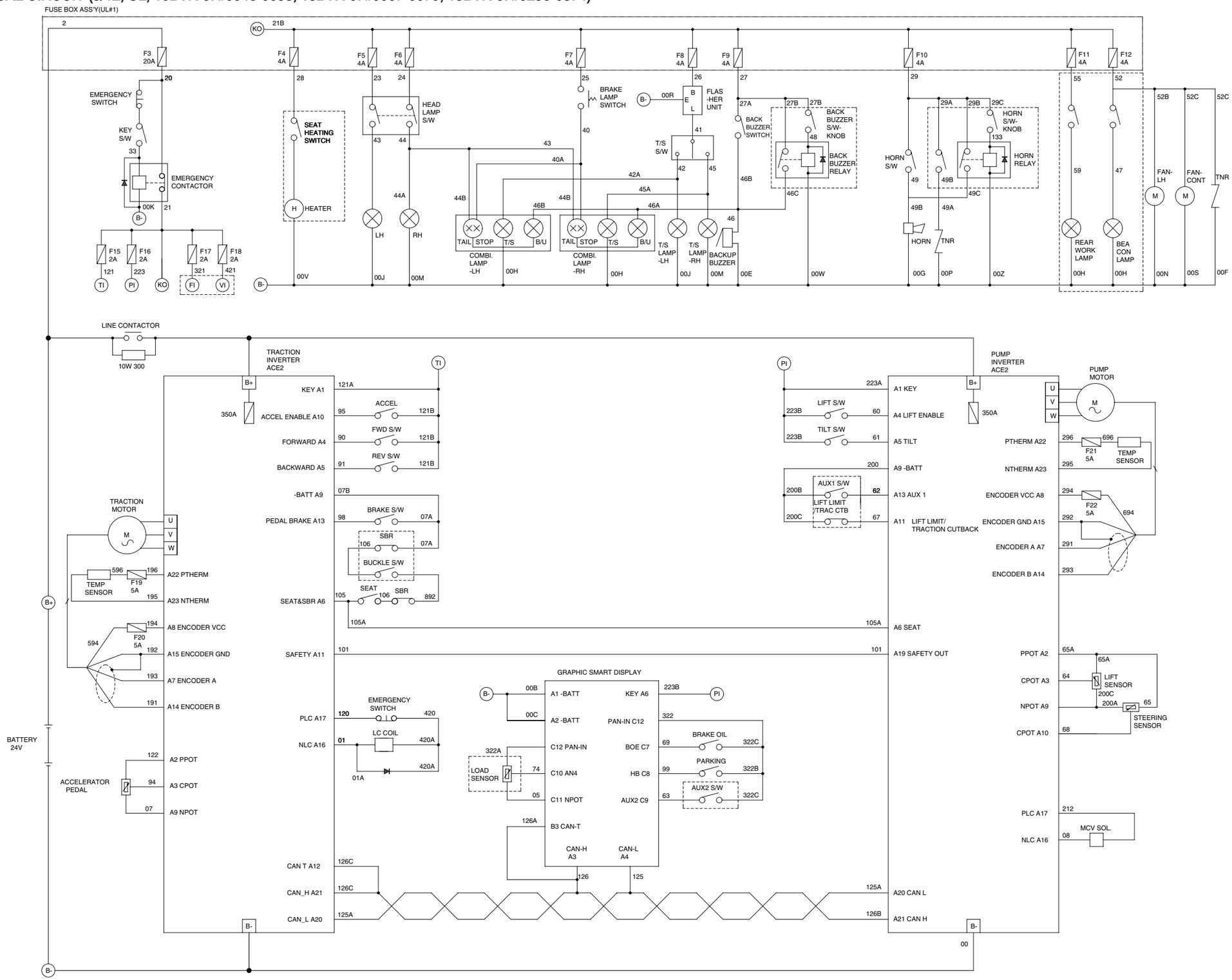
21HT-90034-01

· ELECTRICAL CIRCUIT (8/12, UL, 10BTR-9: #0040-0048, 13BTR-9: #0063-0067, 15BTR-9: #0206-0255)



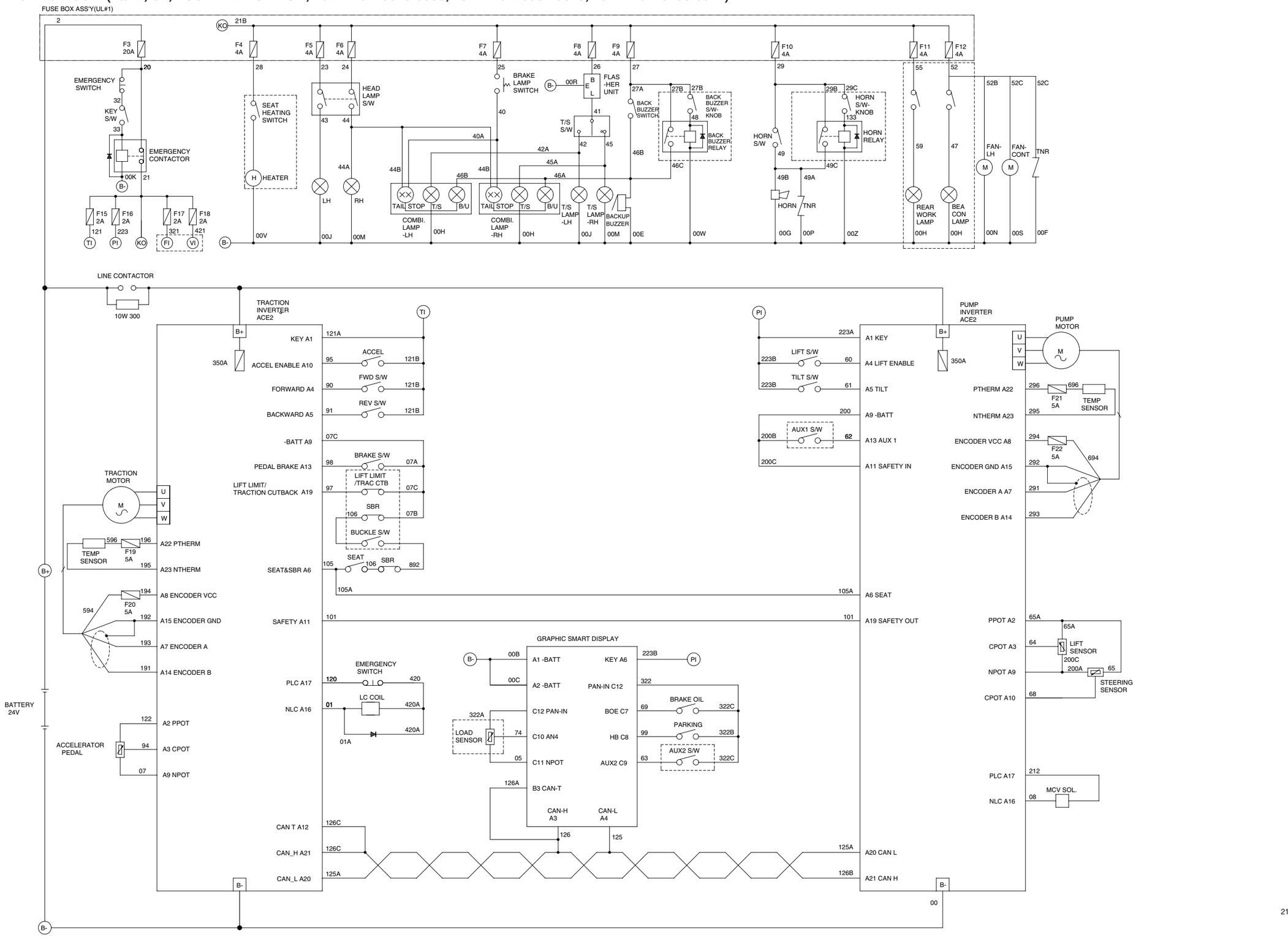
21HT-90035-01

· ELECTRICAL CIRCUIT (9/12, UL, 10BTR-9: #0048-0053, 13BTR-9: #0067-0079, 15BTR-9: #0256-0374)



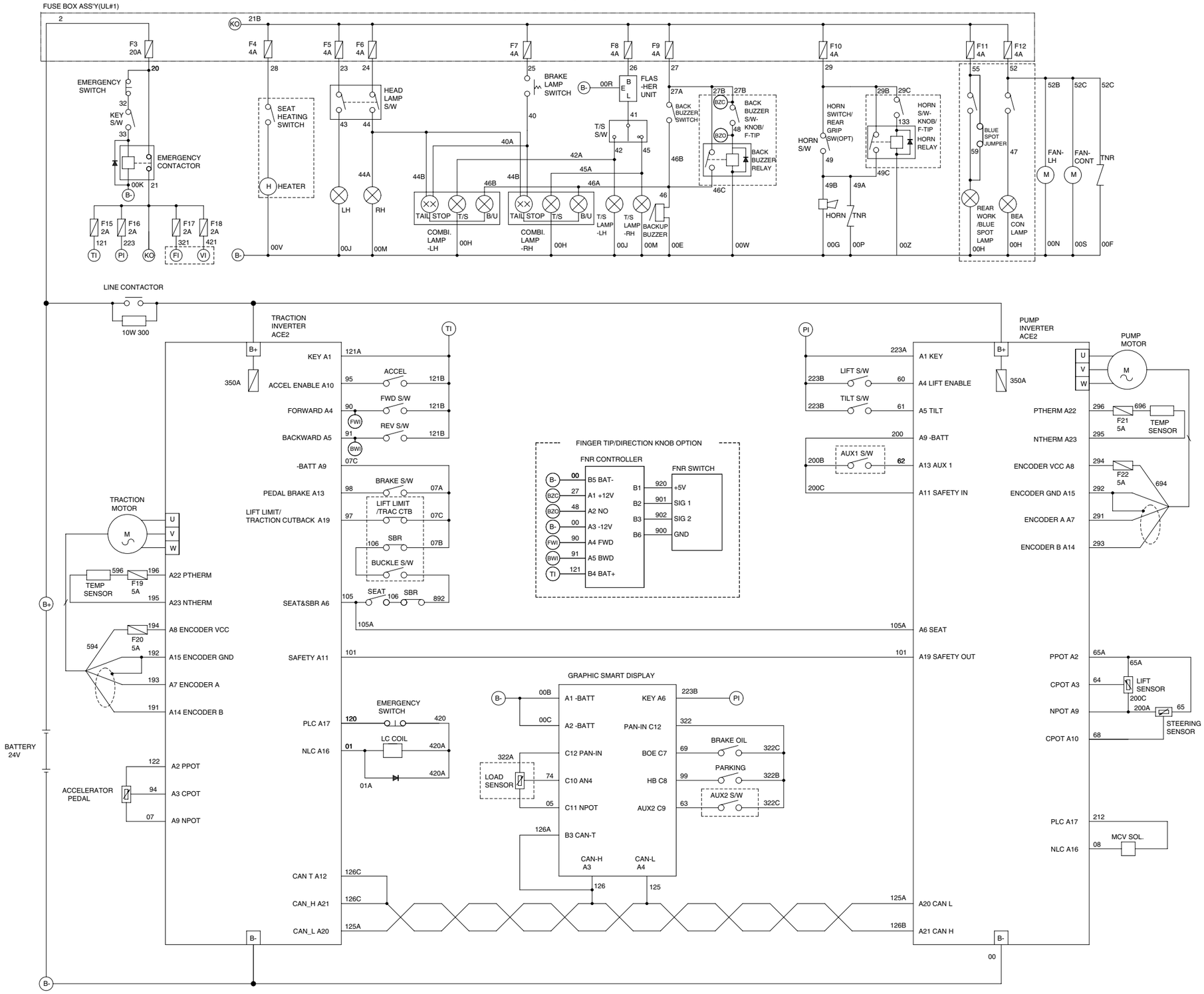
21HT-90036-00

· ELECTRICAL CIRCUIT (10/12, UL, AUSTRALIA OPTION, 10BTR-9: #0048-0053, 13BTR-9: #0067-0079, 15BTR-9: #0256-0374)



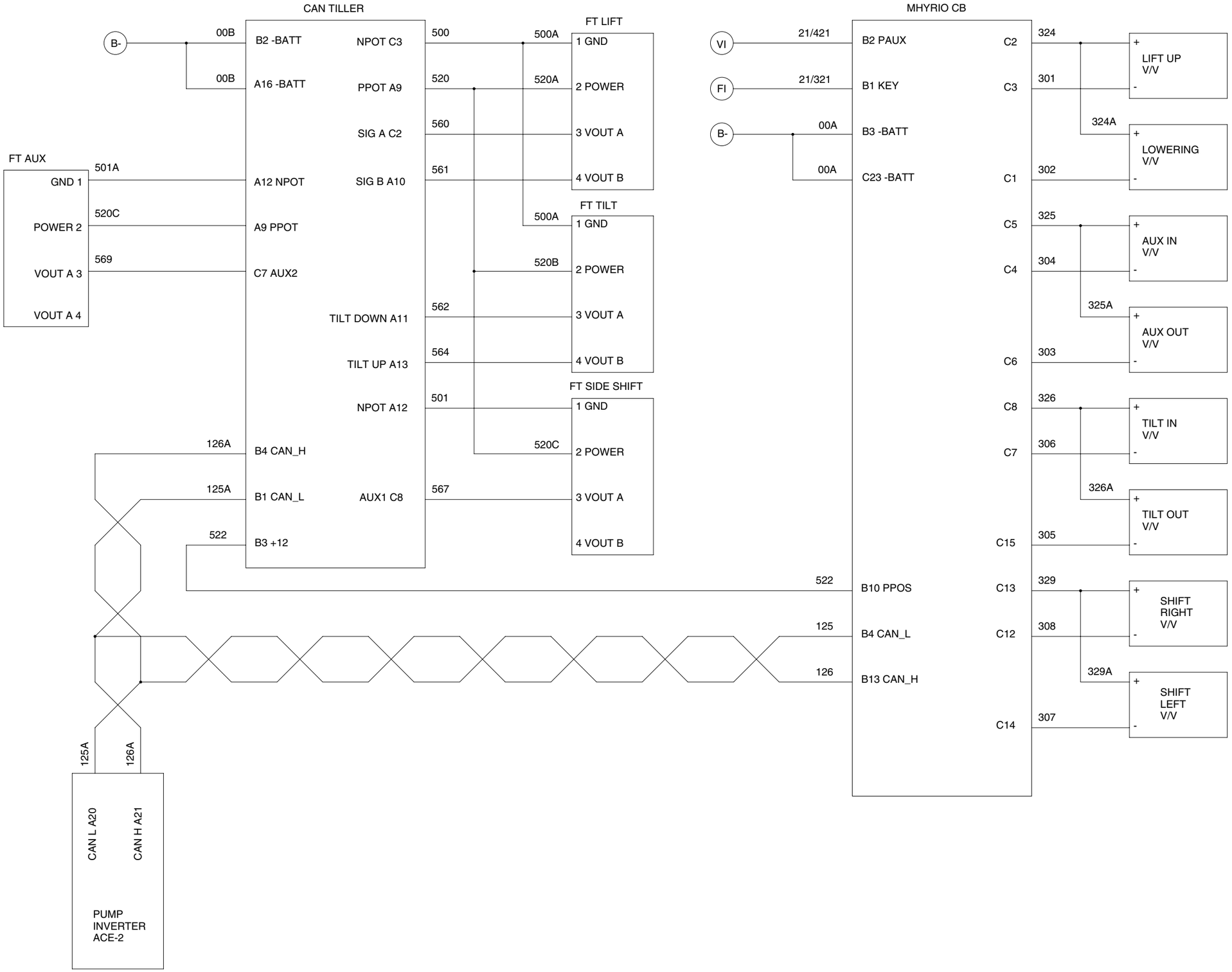
21HT-90037-01

· ELECTRICAL CIRCUIT (11/12, UL, 10BTR-9 : #0054-, 13BTR-9 : #0080-, 15BTR-9 : #0375-)



21HT-90038-00

· ELECTRICAL CIRCUIT (12/12, FINGERTIP)



21HT-90021-00

GROUP 3 ELECTRIC COMPONENTS

1. FUNCTIONS OF BATTERY FORKLIFT TRUCK AND ELECTRIC COMPONENTS.

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

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

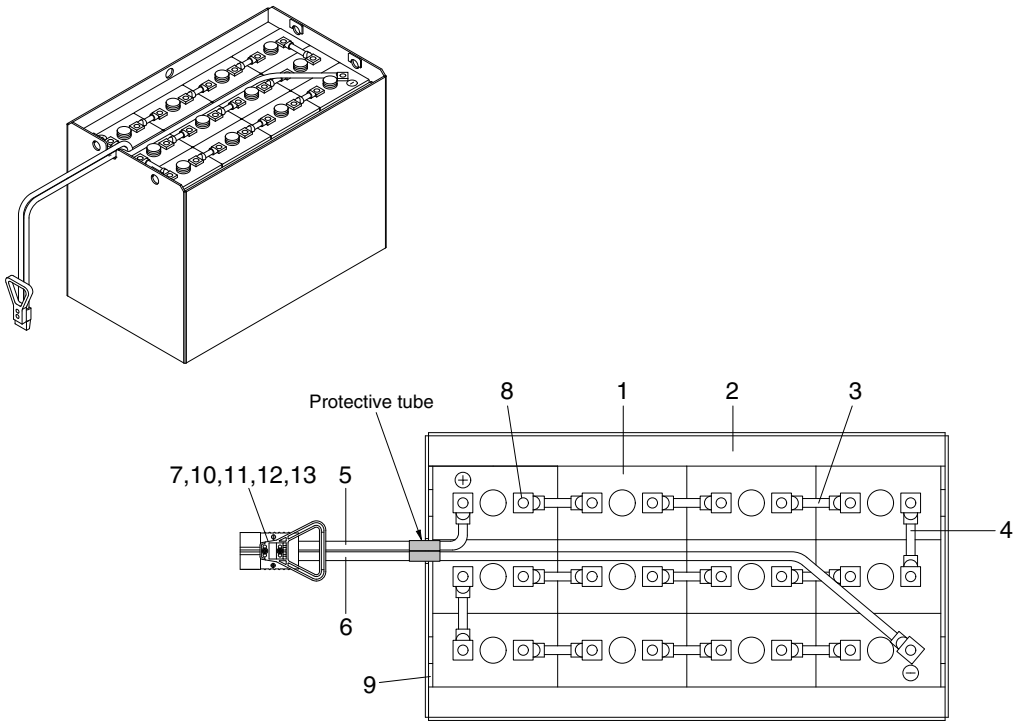
To drive the fork lift truck, a DRIVING CONTROL SYSTEM and some electric components such as direction change lever(forward/reverse section switch) and accelerator are required to select the driving direction and to control the speed of driving motor.

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

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

2. BATTERY

1) STRUCTURE

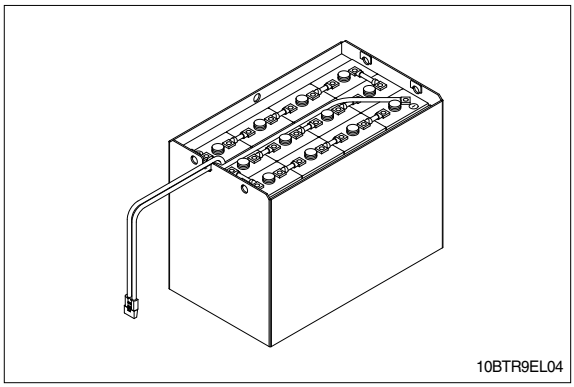


10BTR9EL03

1	Cells	8	Wrench bolt
2	Steel box	9	Spacer
3	Cell connector	10	Handle
4	Row connector	11	Screw
5	Positive leading cable	12	Nut
6	Negative leading cable	13	Spring washer
7	Plug		

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	10BTR-9	13BTR-9	15BTR-9
Type	-	5PzS625	6PzS750	
Rated voltage	V	24		
Capacity	AH/hr	625	750	
Electrolyte	-	WET		
Dimension(W × D × H)	mm	827 × 324 × 627	827 × 432 × 627	827 × 486 × 627
Connector	-	SB350		
Weight(Max/Min)	kg	478/432	630/570	727/657

Fully charged specific gravity	1.280(25° C)
End of discharge specific gravity	1.130(25° C)
Discharge end voltage	48V(option 36V)
Electrolyte	Refined dilute sulfuric
Replenishment fluid	Refined water(pure water)
Insulation resistance	More than 1MΩ

4) SAFETY PRECAUTIONS

(1) When a sulfuric acid contact with skin

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

(2) Strict prohibition of fire and ventilation

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

(3) Never place metallic articles on the batteries

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

(4) Handling of charger

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

5) OPERATION PRECAUTIONS

(1) Avoid over-discharge

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

(2) Avoid over-charge

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

(3) Avoid excessive elevation of temperature

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

6) INSTRUCTION

(1) Unpacking

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

(2) Performance and maintenance of batteries

① Initial charge

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

a. By modified constant voltage charger

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

b. By constant voltage constant current charger

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

c. By constant current charger

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

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

② Discharge and capacity

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

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

③ Specific gravity of electrolyte

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

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

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

S_t : Actually measured specific gravity at t °C

t : Electrolyte temperature (°C)

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

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

④ **Normal charge**

Charge the discharged batteries as quickly as possible. The temperature of electrolyte before starting the charging operation shall preferably be below 45℃, and the temperature during the charge should be maintained at no higher than 55℃. (Under any unavoidable situations, it should never be above 55℃). 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.

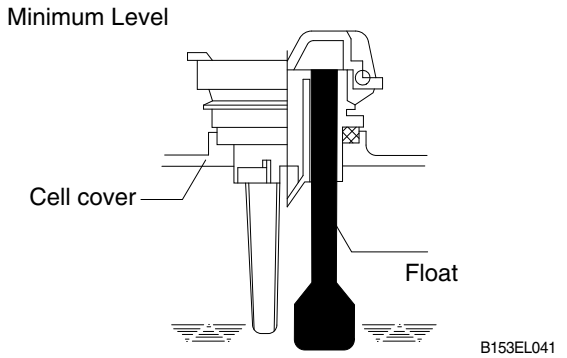
⑥ **Water replenishment**

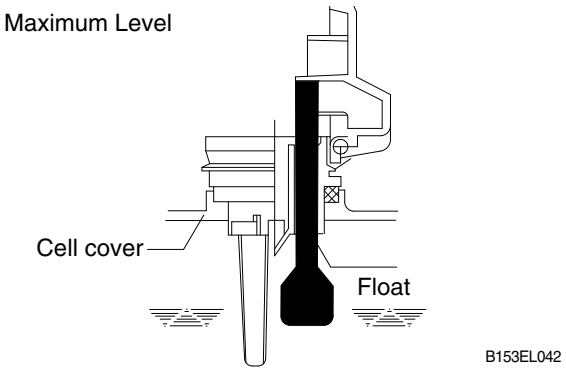
Only the water content of electrolyte is decreased due to electrolysis of water during charge and natural evaporation. If a battery used with the electrolyte decreased excessively, plates will deteriorate resulting in markedly shortening of battery life. Be sure to check the electrolyte level once every 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℃, check the specific gravity once a month, and when lower than 20℃, check it once every two months. If the measurements show values lower than 1.230(20℃), 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**

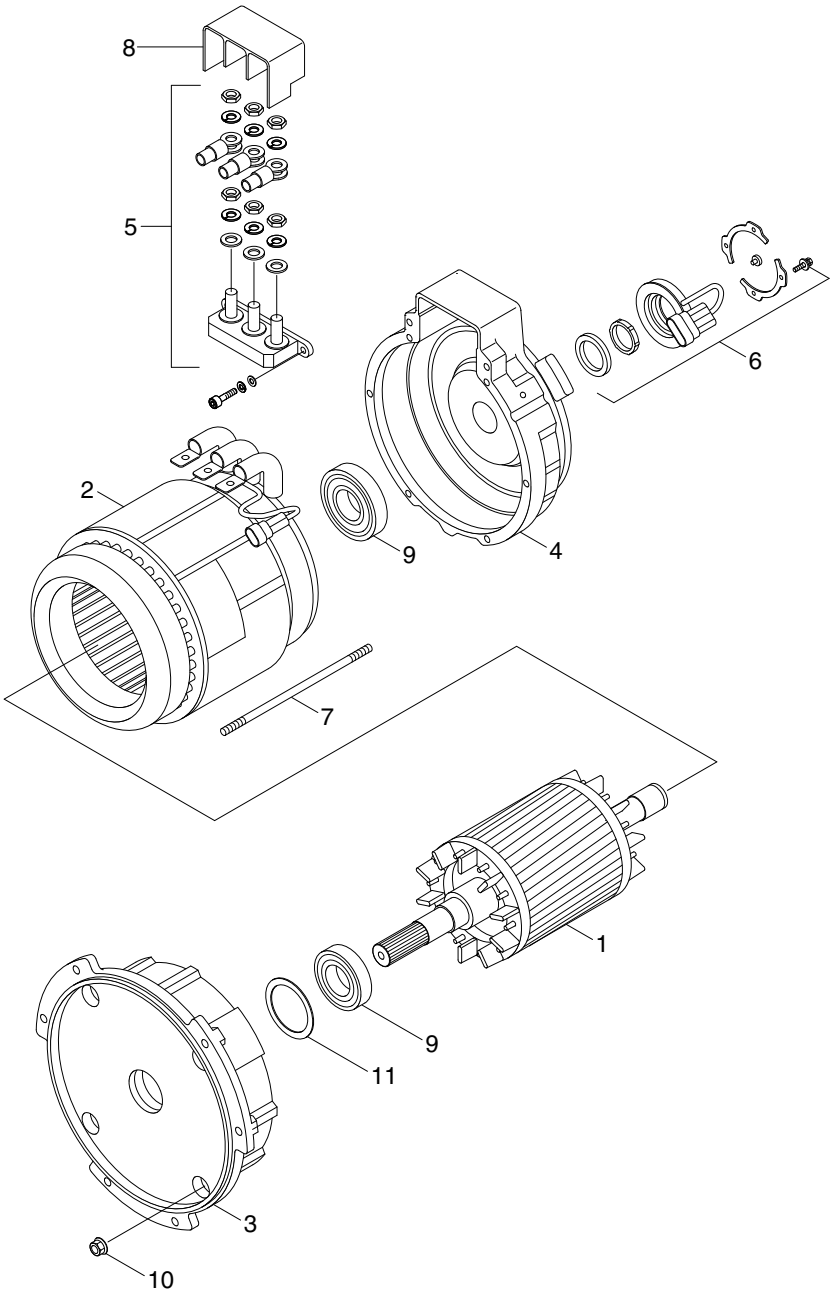
The operating temperature range of batteries is -10~45℃(temperature of electrolyte). If the batteries are exposed to cold atmosphere in discharged condition, the electrolyte may freeze, and in extreme cases, the capacity will be decreased, but, if not frozen, no adverse effects will be exerted over the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

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	· External impact, improper handling, excessive vibration	· Replace or install a new one
	· Termination of connector or pole post etc.	· Excessive temperature rising or vibration/external impact	· Replace
Sulfate	· Specific gravity drops and capacity is decreased.	· When left in state of discharge or left long without equalizing charge.	· Need equalizing charge
	· Charge voltage rises rapidly with immature gassing in earlier stage but specific gravity does not rise and charge can't be carried out.	· Insufficient charge.	· Need equalizing charge
		· When electrolyte is so decreased that plate is deposed.	· Need equalizing charge
		· When concentration of electrolyte rises.	· Adjust specific gravity
		· When impurities are mixed in electrolyte.	· 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.	· Replace
		· When left long period without refilling of water.	· Refill water in regular period
		· Short circuit.	· Replace
Rise of specific gravity	· May be easily detected by measurement of the specific gravity.	· Diluted sulfuric acid is used in refilling.	· Adjust specific gravity after full charge.
		· When the electrolyte level excessively drops.	· Refill distilled water.
Mixing of impurities	· Decrease of capacity.	· Metals such as iron, copper, nickel and manganese.	· 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.
	· Drop of charge and discharge voltage.	· Impurities such as sea water, chloric acid, nitric acid etc.	
	· Odor of generated gas and coloring of the electrolyte.	· Filling of impure water.	

3. DRIVE MOTOR

1) STRUCTURE



10BTR9EL07

1	Rotor assy	5	Terminal block(A)	9	Bearing
2	Startor assy	6	Speed sensor kit	10	Flange nut
3	Endbell De	7	Stud bolt	11	Wave washer
4	Endbell	8	Terminal protector		

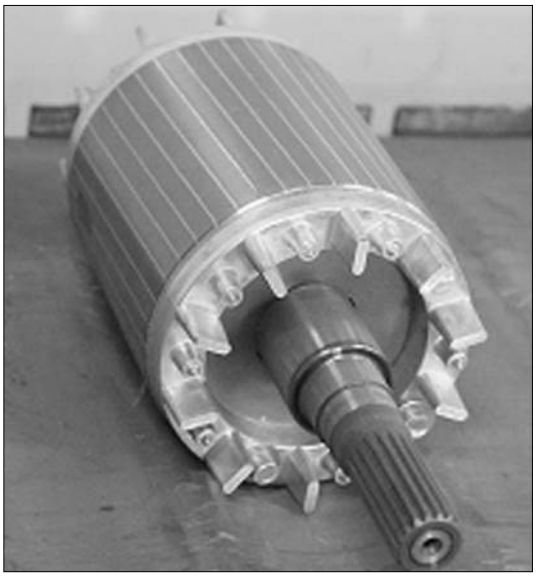
2) SPECIFICATION

Item	Unit	Specification
Type	-	AMDH6001
Rated voltage	V	16
Rated output	kW	4.3
Insulation	-	Class F

3) INSPECTION

(1) Rotor assembly inspection

- Rotor should always be cleaned with compressed air. If the dirt will not come off lightly wipe off with piece of cotton or soft cloth wetted with gasoline.
- Rotor out diameter : ø 123.1 ± 0.05
- Tool : Vernier calipers and standard tool

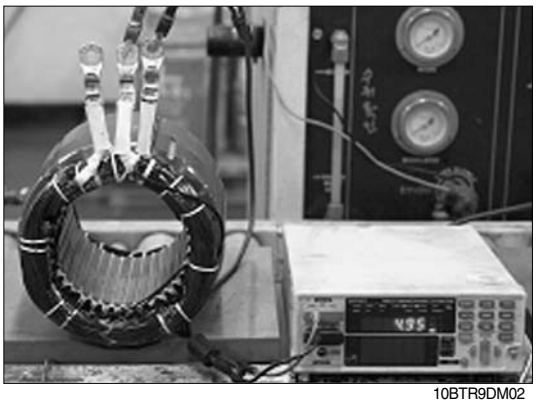


10BTR9DM01

(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 mmΩ tester and check for two power line of stator repeatedly (U-V, V-W, W-U).
At that time resistance is around 3.08 mmΩ.



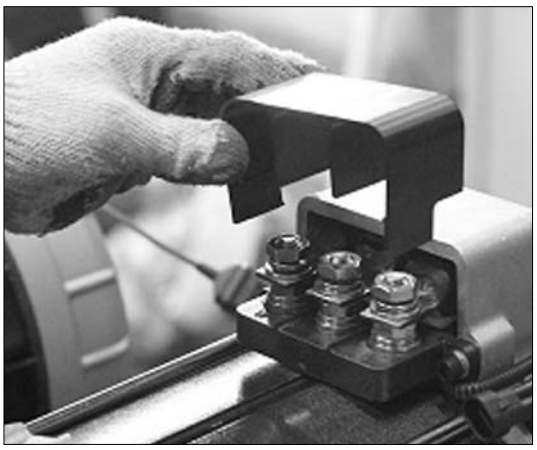
10BTR9DM02

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

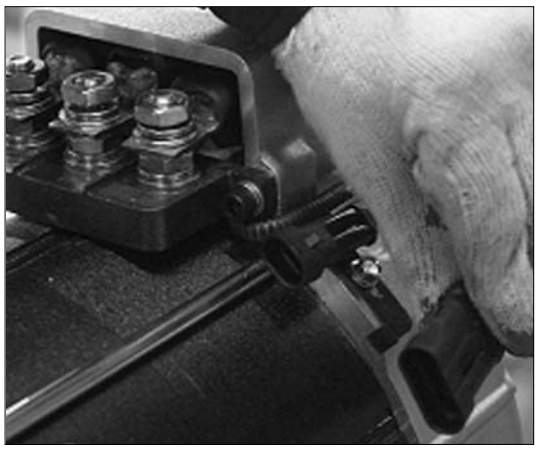
10BTR9DM03

4) DISASSEMBLY FOR AC MOTOR

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



10BTR9DM04

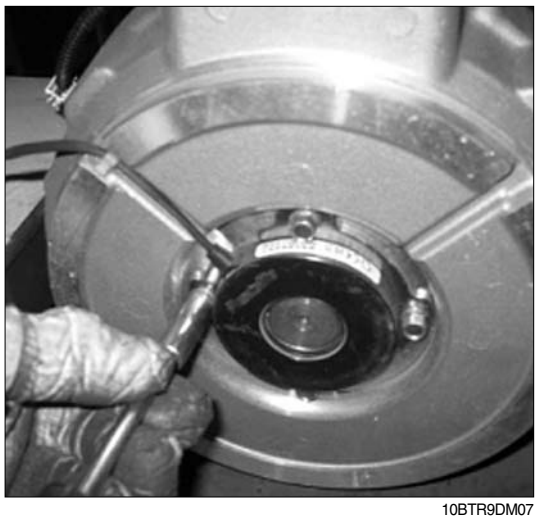


10BTR9DM05

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

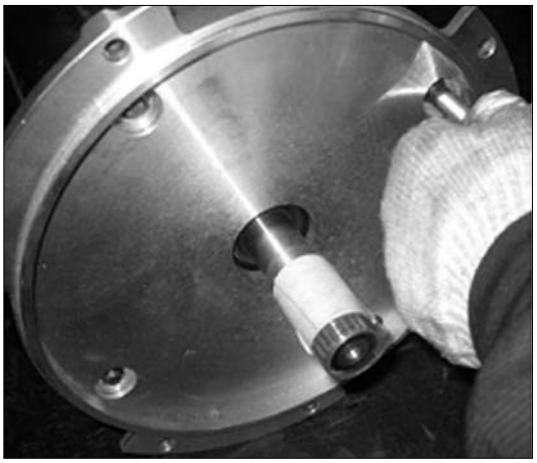
10BTR9DM06

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



10BTR9DM07

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



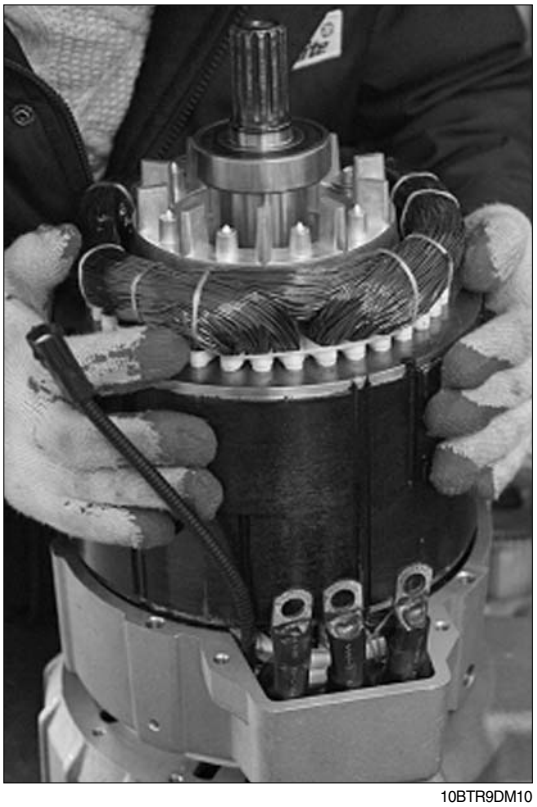
10BTR9DM08

(5) Remove endbell de and wave washer.

10BTR9DM09

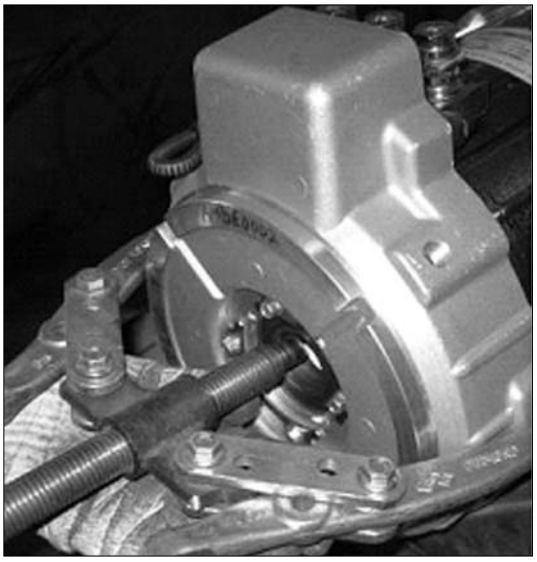
(6) Remove stator assembly by hand or suitable tool.

Removing stator



10BTR9DM10

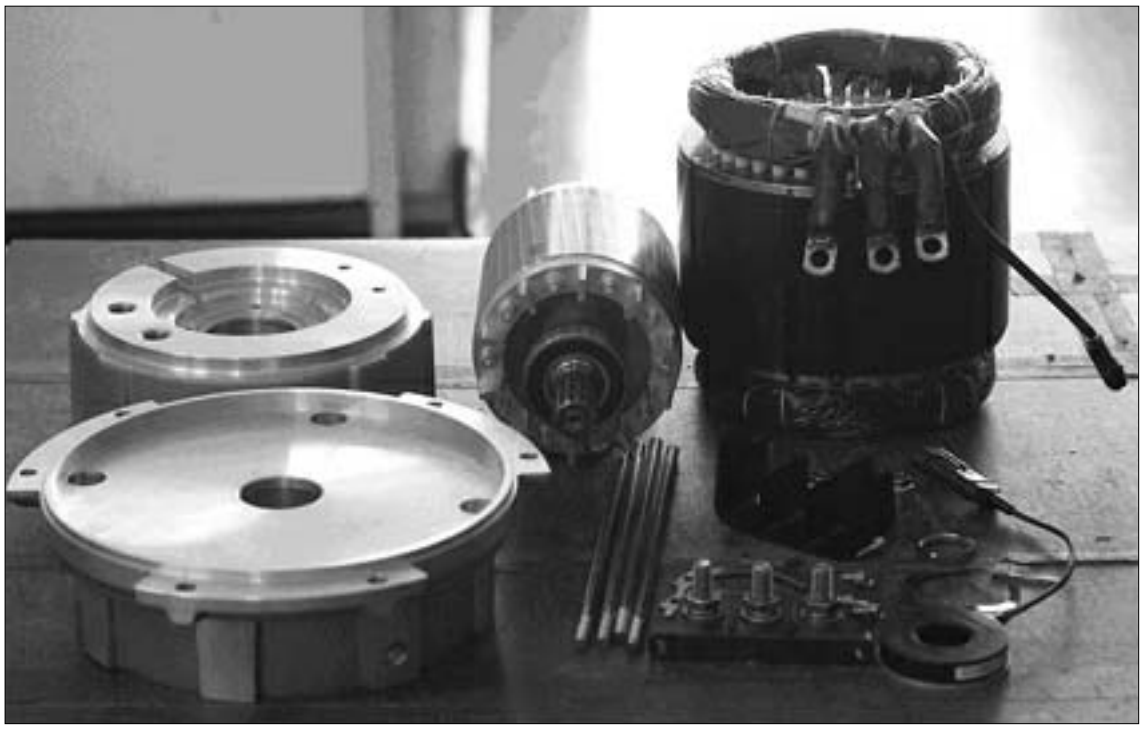
Removing endbell



10BTR9DM11

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

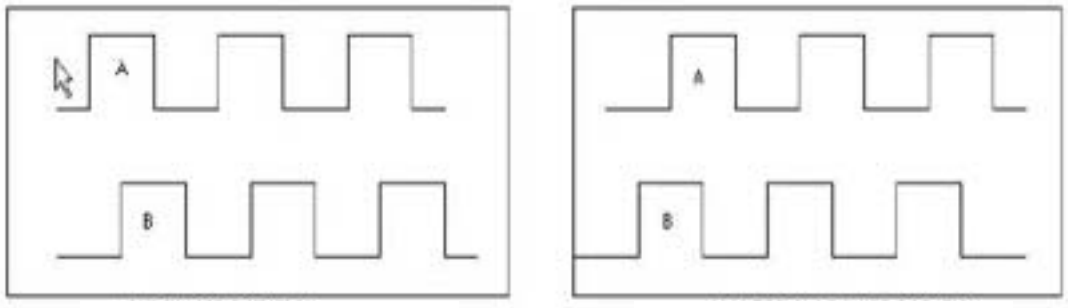
(8) The motor are composed of 5-parts
(Rotor assembly, stator assembly, enbell de, endbell, ETC)



10BTR9DM12

5) ASSEMBLY AND INSTALLATION

(1) Perform assembly in the reverse order of disassembling
(2) After assembling, check for speed sensor. Normal signal is as below.

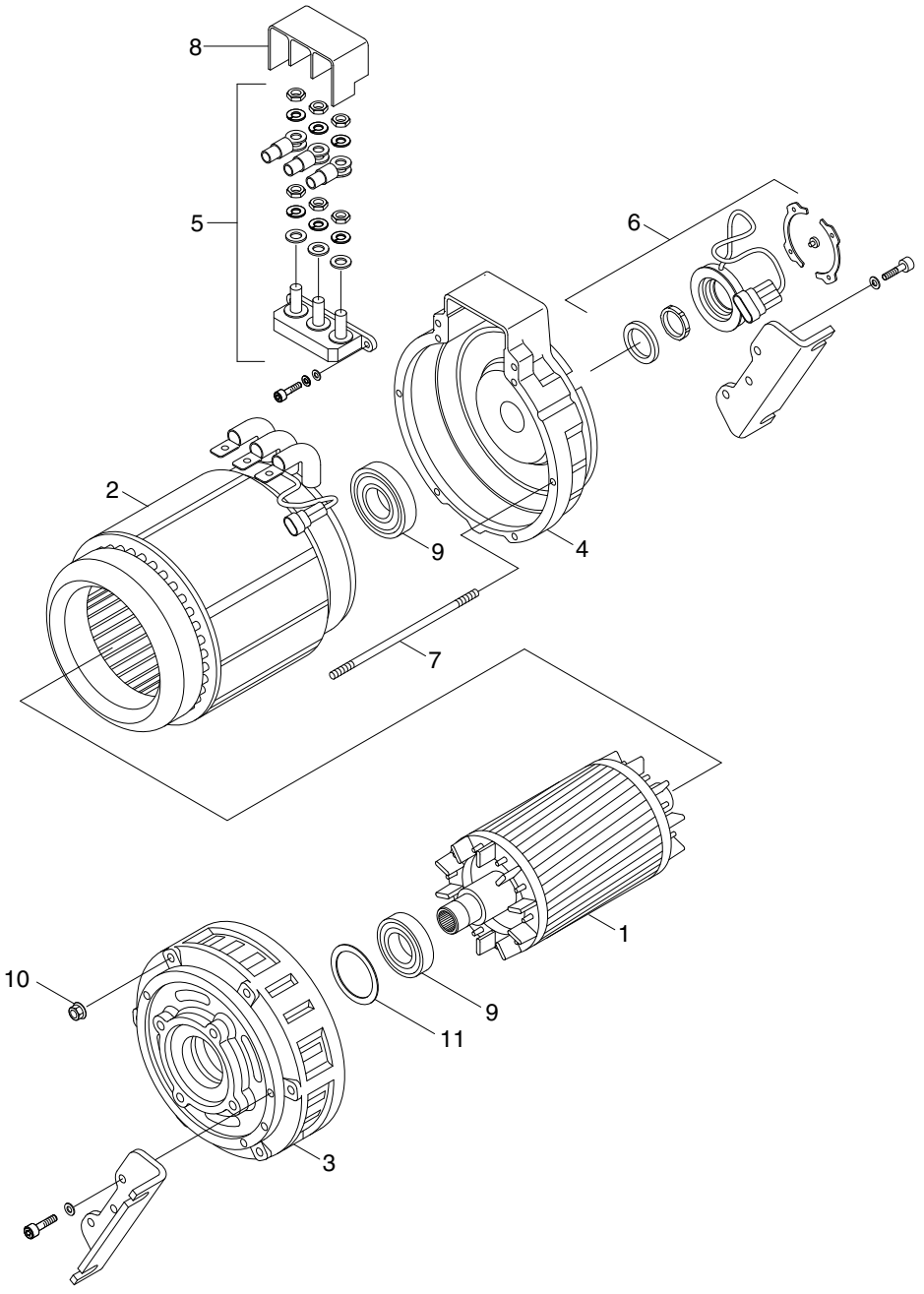


Clockwise rotation　　Counter clockwise rotation

10BTR9DM13

4. PUMP MOTOR

1) STRUCTURE



10BTR9EL16

1	Rotor assy	5	Terminal block(A)	9	Bearing
2	Startor assy	6	Speed sensor kit	10	Flange nut
3	Front endbell	7	Stud bolt	11	Wave washer
4	Rear endbell	8	Terminal, protector		

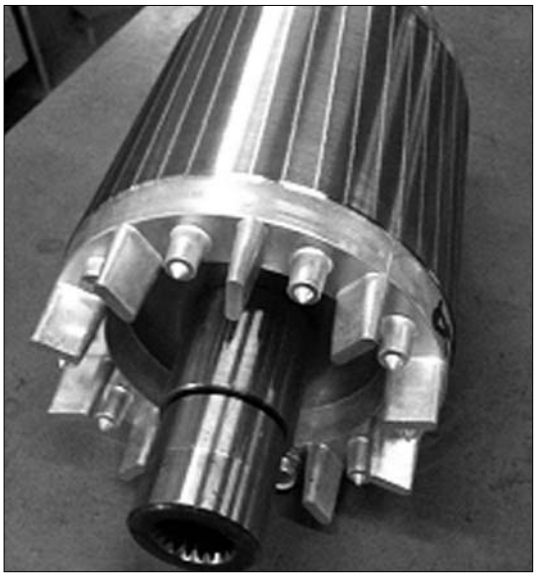
2) SPECIFICATION

Item	Unit	Specification
Type	-	AMDA4001
Rated voltage	V	16
Rated output	kW	9.0
Insulation	-	Class F

3) INSPECTION

(1) Rotor assembly inspection

- Rotor should always be cleaned with compressed air. If the dirt will not come off lightly wipe off with piece of cotton or soft cloth wetted with gasoline.
- Rotor out diameter : ø 123.1 ± 0.05
- Tool : Vernier calipers and standard tool

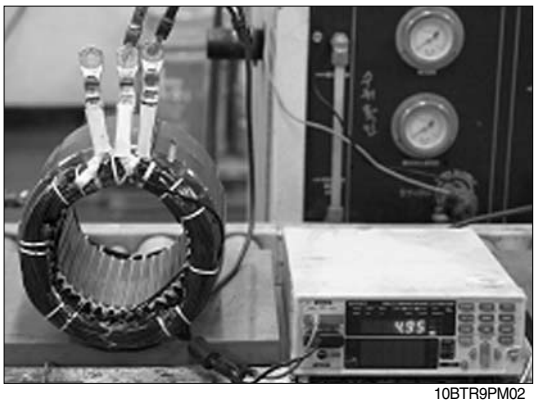


10BTR9PM01

(2) Stator assembly inspection

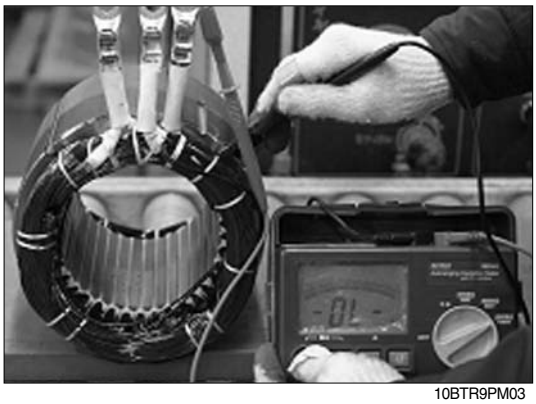
① Stator should always be cleaned with compressed air. If the dirt will not come off lightly wipe off with piece of cotton or soft cloth wetted with gasoline, using care not to damage the coil insulation.

② Use mmΩ tester and check for two power line of stator repeatedly (U-V, V-W, W-U).
At that time resistance is around 1.78 mmΩ.



10BTR9PM02

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

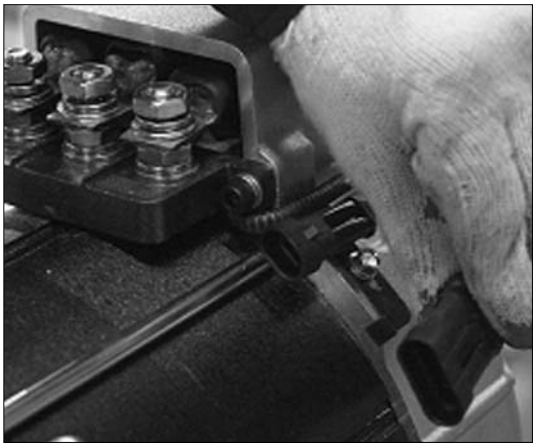


10BTR9PM03

4) DISASSEMBLY FOR AC MOTOR

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

10BTR9PM04



10BTR9PM05

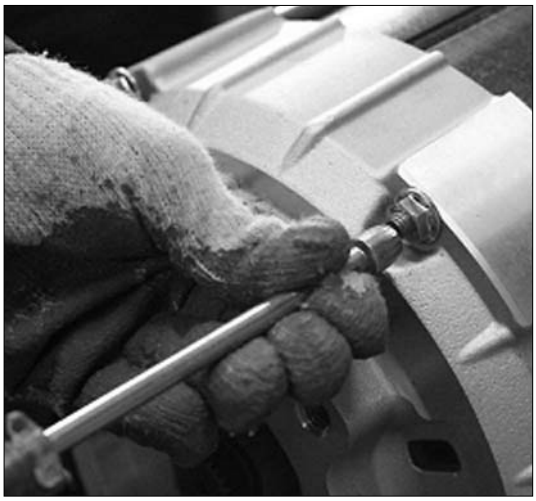
(2) Remove 3-nuts from terminal block of the motor to disassemble terminal block from the motor.

10BTR9PM06

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

10BTR9PM07

(4) Remove 6 flange nuts with available general tool on the endbell drive side.



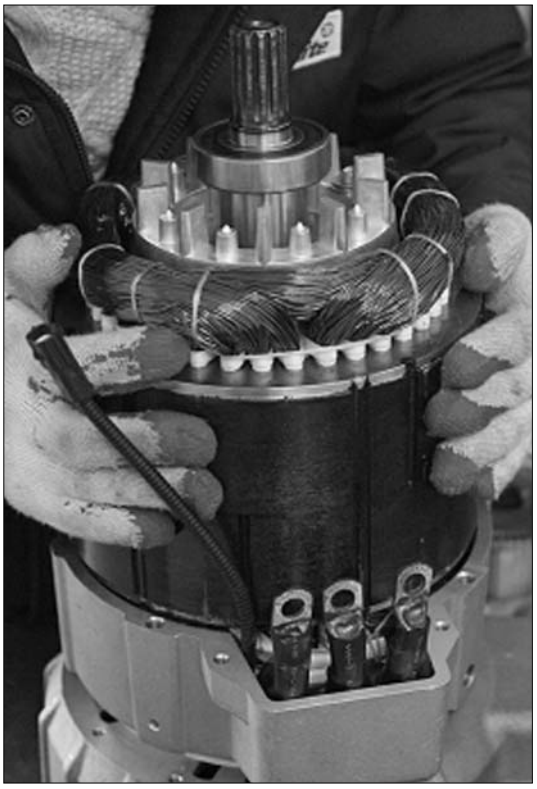
10BTR9PM08

(5) Remove endbell de and wave washer.

10BTR9PM09

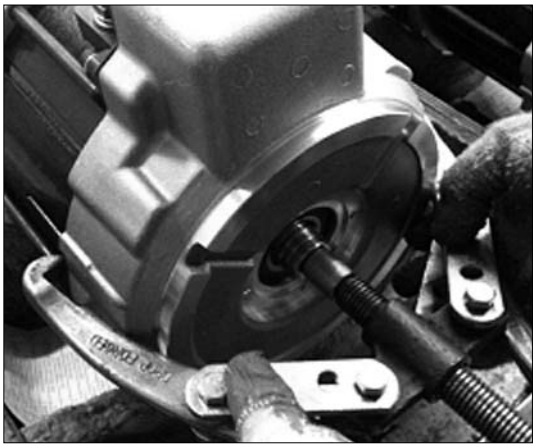
(6) Remove stator assembly by hand or suitable tool.

Removing stator



10BTR9PM10

Removing endbell



10BTR9PM11

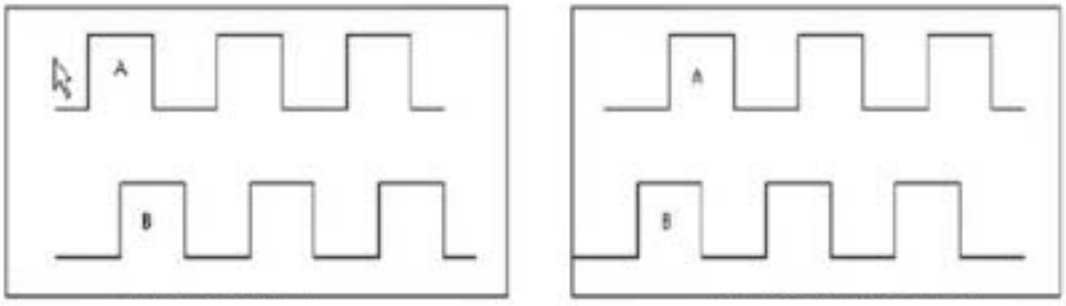
(7) Remove endbell from rotor assembly by hand-puller as a above picture.

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

10BTR9PM12

5) ASSEMBLY AND INSTALLATION

(1) Perform Assembly in the reverse order of disassembling.
(2) After Assembling, check for speed sensor. Normal signal is as below.

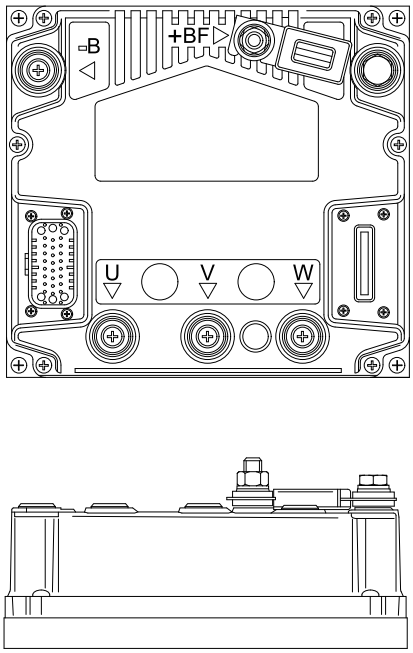


Clockwise rotation　　Counter clockwise rotation

10BTR9PM13

5. CONTROLLER SYSTEM

1) STRUCTURE (Traction controller/Pump controller)



Traction controller
Pump controller

10BTR9EL10

(1) Specifications

Model	Model	Normal battery voltage	Continuous output current	Current limit
10/13/15BTR-9	ACE2 24V 500Arms	24V	250Arms	500Arms / 3min

2) PIN MAP DESCRIPTION

(1) TRACTION INVERTER (ACE2)

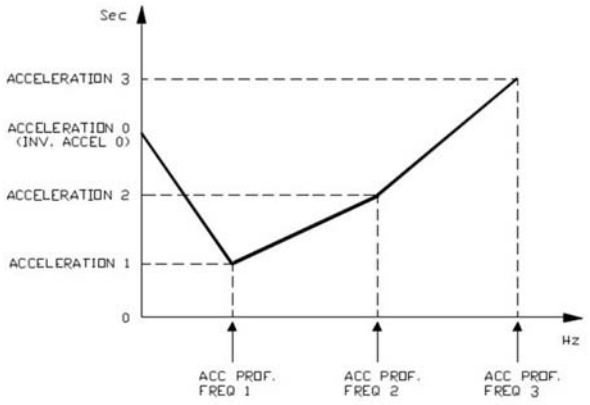
No. of Pin	Function	Description
A1	KEY	Input of the key switch signal.
A2	PPOT	Potentiometer positive.
A3	CPOT	Accelerator potentiometer wiper signal.
A4	FORW	Forward direction request input.
A5	REV	Backward direction request input.
A6	SEAT&SBR	SEAT and SBR(Side Battery Removal) input.
A7	ENC A	Traction motor encoder phase A.
A8	ENC VCC	Encoder positive power supply.
A9	- BATT	Negative power supply. It is used as NPOT, without PEDAL WIRE KO diagnosis, for acceleration potentiometer.
A10	ENABLE	Traction request input.
A11	SAFETY	It is connected to SAFETY OUT (CNA#19) of pump controller.
A12	CANT	If it is connected with A21. it introduces the120 Ohm termination resistance between CAN-L and CAN-H.
A13	PB	Pedal brake request input.
A14	ENC B	Traction motor encoder phase B.
A15	ENC GND	Encoder negative power supply.
A16	NLC	Main contactor coil output. The coil is driven to negative reference.
A17	PLC	Positive of the main contactor.
A18	NA	-
A19	NA	-
A20	CAN L	Low level CAN-BUS voltage I/O.
A21	CAN H	High level CAN-BUS voltage I/O.
A22	PTHERM	Input for traction motor temperature sensor.
A23	NTHERM	Negative of traction motor temperature sensor.

(2) PUMP INVERTER (ACE2)

No. of Pin	Function	Description
A1	KEY	Input of the key switch signal.
A2	PPOT	Positive of steering Potentiometer & lift potentiometer.
A3	CPOT	Lift potentiometer wiper signal.
A4	LIFT ENABLE	Input for lifting enable input.
A5	TILT	Input for tilt up and tilt down digital input.
A6	SEAT&SBR	SEAT and SBR(Side Battery Removal) input.
A7	ENC A	Pump motor encoder phase A.
A8	ENC VCC	Encoder positive power supply.
A9	- BATT	Negative power supply.
A10	CPOT	Steering potentiometer wiper.
A11	SAFETY IN	Connect to -BATT.
A12	NA	-
A13	AUX1	Input for shift right and shift left digital input.
A14	ENC B	Pump motor encoder phase B.
A15	ENC GND	Encoder negative power supply.
A16	NLC	MCV solenoid coil output.The coil is driven to negative reference.
A17	PLC	Positive of MCV solenoid coil.
A18	NA	-
A19	SAFETY OUT	it is connected to SAFETY IN (CNA#11) of traction controller.
A20	CAN L	Low level CAN-BUS voltage I/O.
A21	CAN H	High level CAN-BUS voltage I/O.
A22	PTHERM	Input for pump motor temperature sensor.
A23	NTHERM	Negative of pump motor temperature sensor.

3) MENU DESCRIPTION

(1) TRACTION INVERTER

PARAMETER CHANGE	
ACCELERATION 0	It specifies the motor acceleration at 0 Hz. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases.
INV. ACCEL 0	It specifies the motor acceleration at 0 Hz after an inversion of direction. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases.
ACCELERATION 1	It specifies the motor acceleration at ACC PROF. FREQ 1 [Hz]. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases.
ACCELERATION 2	It specifies the motor acceleration at ACC PROF. FREQ 2 [Hz]. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases.
ACCELERATION 3	It specifies the motor acceleration at ACC PROF. FREQ 3 [Hz]. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases.
ACC PROF. FREQ 1	In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 1 parameter.
ACC PROF. FREQ 2	In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 2 parameter.
ACC PROF. FREQ 3	In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 3 parameter.
 CONTROL 1	
RELEASE BRAKING	Seconds. It controls the deceleration ramp when the travel request is released. The parameter sets the time needed to decelerate the traction motor from 100Hz to 0Hz.
INVERS. 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 from100Hz to 0Hz.
DECEL. BRAKING	Seconds. It controls the deceleration ramp when the accelerator has turned down but not completely released. The parameter sets the time needed to decelerate the traction motor from 100Hz to 0Hz.
PEDAL BRAKING	Seconds. This parameter determines the deceleration ramp when the travel request is released and the brake pedal switch is closed. It sets the time needed to decelerate the traction motor from 100Hz to 0Hz.

PARAMETER CHANGE	
SPEED LIMIT BRK	Seconds. It controls the deceleration ramp when a speed reduction has been activated. The parameter sets the time needed to decelerate the traction motor from 100Hz to 0Hz.
CURVE BRAKING	Seconds. It controls the deceleration ramp when a curve speed reduction has been activated. The parameter sets the time needed to decelerate the traction motor from 100Hz to 0Hz.
MAX SPEED FORW	Hz. It determines the maximum speed in forward direction. when truck steer angle is in 10 degrees.
MAX SPEED BACK	Hz. It determines the maximum speed in backward direction. when truck steer angle is in 10 degrees.
TURTLE SPEED	Hz. It determines the maximum speed when turtle mode is activated.
CURVE CUTBACK	Speed reduction when the truck is doing a curve. The parameter sets the speed setpoint when the truck driving wheels are running in opposite direction (3 wheels truck, steering angle greater than roughly 67°); or when the maximum steering angle is reached (4 wheels truck, the internal wheel is stopped). In intermediate steering angles, the speed setpoint will be within a range between the straight wheel speed and the CURVE CUTBACK SPEED.
STEER DEAD ANGLE	It is the angle value at the speed start to reduction
FREQUENCY CREEP	Hz value. This is the minimum speed applied when the forward or reverse switch is closed, but the accelerator is at its minimum.
MAXIMUM CURRENT	Maximum level of the current (percentage of the maximum current of the controller).
BRK SMOOTH	It gives a parabolic form to the deceleration ramp.
STOP BRK SMOOTH	Hz. It sets the level of frequency where the smooth effect of the deceleration parabolic form ends.
AUXILIARY TIME	Time units value (seconds). For the encoder version, it determines the time duration the truck is hold on the ramp if the STOP ON RAMP option is ON.
SEQUENCE DE. TIME	It sets the maximum delay time between the accelerator is pressed and the direction lever is moved out of the neutral position. If this time is expired the truck stops with warning : "SEQUENCE FAULT"

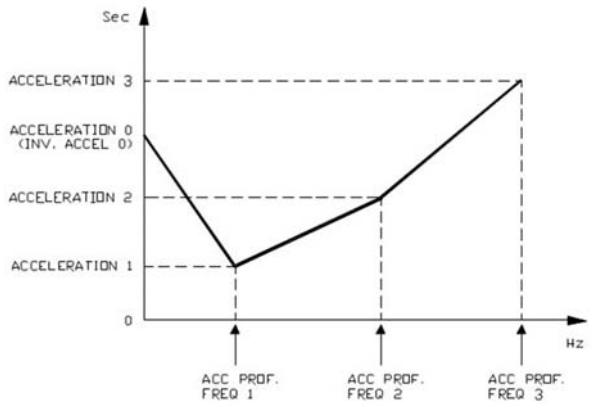
SET OPTION	
HOUR COUNTER	This option specifies the hour counter mode. It can be set one of two: - RUNNING: The counter registers travel time only. - KEY ON: The counter registers when the "key" switch is closed.
BATTERY CHECK	This option specifies the handling of the low battery charge detection. There are tree levels: - Level 0:Nothing happens, the battery charge level is calculated but is ignored, it means no action is taken when the battery is discharged. - Level 1:BATTERY LOW alarm is raised when the battery level is calculated being less than or equal to 10% of the full charge. The BATTERY LOW alarm reduces the maximum current down to 50% of the full truck current and the maximum truck speed down to 24% of the full truck speed and it inhibits the Lifting function. - Level 2:BATTERY LOW alarm is raised when the battery level is calculated being less than or equal to 10% of the full charge. But is ignored, it means no action is taken when the battery is discharged. - Level 3:BATTERY LOW alarm is raised when the battery level is calculated being less than or equal to 10% of the full charge. The BATTERY LOW alarm reduces the maximum truck speed down to 24% of the full truck speed and it inhibits the Lifting function.
STOP ON RAMP	Only when the encoder is present, it is possible to electrically hold the truck on a slope when the accelerator is released but the tiller is not released. - ON: The stop on ramp feature (truck electrically hold on a ramp) is managed for a time established by AUXILIARY TIME parameter. - OFF: The stop on ramp feature is not performed. That means the truck comes down slowly during the AUXILIARY TIME.
SET MOT.TEMPERAT	It can be set: - ANALOG: An analogue sensor for the control of the motor temperature is connected to CNA#22. Typically the temperature sensor is a PTC (positive thermal coefficient resistance), providing the sensor characteristic to Zapi the correct table can be loaded in the controller software. 1. DIGITAL: A digital (on/off) sensor for the motor temperature monitoring is connected to CNA#22 input. 2. NONE:No temperature sensor is connected.
S.R.O.	If this option is set to on the static return to off is requested for starting the truck. The required sequence is : ・Seat-direction lever-accelerator pedal or : ・Seat-accelerator pedal-direction lever within the seq. delay timeIf this option is set to off the required sequence to start the truck is : ・Direction lever-accelerator pedal or : ・Accelerator pedal-direction lever within the seq. delay time.
DISPLAY	OFF: when display is not connected to the CAN bus. ON: when display is connected to the CAN bus.

SET OPTION	
PEDAL TYPE	- OPTION #1 : The pedal position is sent to the display for graphic indication. - OPTION #2 : The speed set-point is sent to the display for graphic indication.
PEDAL BRK.STOP	If set to on the truck is stopped when the pedal brake is pressed. If set to off the traction current is reduced to the half of the maximum current.

ADJUSTMENTS	
MAX STEER RIGHT	This is the function to record in the controller EEPROM the steering poti output voltage when the wheels are fully turned right (maximum of the steering poti range).
MAX STEER LEFT	This is the function to record in the controller EEPROM the steering poti output voltage when the wheels are fully turned left (minimum of the steering poti range).
MAX STEER 0 POS.	This is the function to record in the controller EEPROM the steering poti output voltage when the wheels are straight.
SET STEER LEFT	This parameter sets the max steering angle in left direction.
SET STEER RIGHT	This parameter sets the max steering angle in right direction.
ADJUST BATTERY	Fine adjustment of the battery voltage measured by the controller.
THROTTLE 0 ZONE	Establishes a deadband in the accelerator input curve.
THROTTLE X POINT	This parameter, together with the THROTTLE Y POINT, changes the characteristic of the accelerator input curve : when the accelerator is de-pressed to X point per cent, the corresponding truck speed is Y point per cent of the Maximum truck speed. Therelationship between the accelerator position and the truck speed is linear between the THROTTLE 0 ZONE and the X point and also between the X point and the maximum accelerator position but with two different slopes.
THROTTLE Y POINT	This parameter, together with the THROTTLE X POINT, changes the characteristic of the accelerator input curve : when the accelerator is de-pressed to X point per cent, the corresponding truck speed is Y point per cent of the Maximum truck speed. The relationship between the accelerator position and the truck speed is linear between the THROTTLE 0 ZONE and the X point and also between the X point and the maximum accelerator position but with two different slope.
BAT. MIN ADJ.	Adjust the lower level of the battery charge table (Level 0 to 9).
BAT. MAX ADJ.	Adjust the upper level of the battery charge table (Level 0 to 9).
BDI ADJ. STARTUP	Adjust the upper level of the battery charge at the key on.
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.
CHECK UP DONE	Turn it On when the required Maintenance service has been executed to cancel the CHECK UP NEEDED warning.
CHECK UP TYPE	It specifies the handling of the CHECK UP NEEDED warning: - NONE: No CHECK UP NEENED warning. - OPTION#1: CHECK UP NEENED warning shown on the hand set and Graphic Smart Display after the setting value of "CHECK UP TIME" parameter. - OPTION#2: Equal to OPTION#1 but Speed reduction after the setting value of "CHECK UP TIME" plus 40 hours. - OPTION#3: Equal to OPTION#2 but the truck definitively stops after the setting value of "CHECK UP TIME" plus 80 hours.

ADJUSTMENTS	
CHECK UP TIME	Hours. It specifies the time of the CHECK UP NEEDED warning.
MAIN CONT VOLT	It specifies the percentage of battery voltage supplied to MC coil to close the contactor.
AUX OUTPUT VOLT	It specifies the percentage of battery voltage supplied to AUX coil to close the AUXILIARY electro valve.
MAIN CONT. V RID	It specifies the percentage of MAIN CONT VOLT parameter, supplied to MC coil to keep the contactor closed.
DISP SPD FACTOR	It adjusts the speed coefficient to have the correct speed indication on the display. This coefficient has to be regulated depending on truck mechanic characteristics. It results from the following formula :Speed factor = 88 * rr * p / Ø where: rr = total gearbox ratio. Ø = traction wheel diameter (cm). P = number of pair poles of the motor.
SEAT DELAY	It determines the delay time between the opening of the seat switch on CNA#6 digital input and the start of the truck electrical braking.
CHAT TIME DELAY	After no travel or pump request is active for the chat time the line contactor is automatically opened. To restart, the the operator needs to press the accelerator pedal or activate the hydraulic levers.

(2) PUMP INVERTER

PARAMETER CHANGE	
ACCELERATION 0	It specifies the motor acceleration at 0 Hz. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases.
ACCELERATION 1	It specifies the motor acceleration at ACC PROF. FREQ 1 [Hz]. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases.
ACCELERATION 2	It specifies the motor acceleration at ACC PROF. FREQ 2 [Hz]. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases.
ACCELERATION 3	It specifies the motor acceleration at ACC PROF. FREQ 3 [Hz]. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases.
ACC PROF. FREQ 1	In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 1 parameter.
ACC PROF. FREQ 2	In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 2 parameter.
ACC PROF. FREQ 3	In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 3 parameter.
 CONTROL 1	
RELEASE BRAKING	Seconds. It controls the deceleration ramp when the pump request is released. The parameter sets the time needed to decelerate the pump motor from 100Hz to 0Hz.
MAX SPEED LIFT	It determines the pump maximum speed when LIFT ENABLE switch is closed .
1ST SPEED COARSE	It determines the pump maximum speed when SPEED1 switch is closed .
2nd SPEED COARSE	It determines the pump maximum speed when SPEED2 switch is closed .
3rd SPEED COARSE	It determines the pump maximum speed when SPEED3 switch is closed .
HYD SPPED FINE	It determines the pump maximum speed when an hydraulic steering function request is received via CAN BUS.
HYDRO TIME	It is the remaining time after that the Hydro request goes down.
FREQUENCY CREEP	Minimum speed when the LIFT ENABLE switch is closed, but the accelerator is on a minimum position.
MAXIMUM CURRENT	This parameter changes the maximum current of the inverter.
AUXILARY TIME	Time units value (seconds). It is the time delay before close the EM brake when motor speed reach 0rpm.

SET OPTION	
HOUR COUNTER	This option specifies the hour counter mode. It can be set one of two: - RUNNING: The counter registers travel time only. - KEY ON: The counter registers when the "key" switch is closed.
BATTERY CHECK	This option specifies the handling of the low battery charge detection. There are tree levels: - Level 0:Nothing happens, the battery charge level is calculated but is ignored, it means no action is taken when the battery is discharged. - Level 1:BATTERY LOW alarm is raised when the battery level is calculated being less than or equal to 10% of the full charge. The BATTERY LOW alarm reduces the maximum current down to 50% of the full truck current and the maximum truck speed down to 23% of the full truck speed and it inhibits the Lifting function. - Level 2:BATTERY LOW alarm is raised when the battery level is calculated being less than or equal to 10% of the full charge. But is ignored, it means no action is taken when the battery is discharged. - Level 3:BATTERY LOW alarm is raised when the battery level is calculated being less than or equal to 10% of the full charge. The BATTERY LOW alarm reduces the maximum truck speed down to 23% of the full truck speed and it inhibits the Lifting function.
SET MOT.TEMPERAT	It can be set: - ANALOG: An analogue sensor for the control of the motor temperature is connected to CNA#22. Typically the temperature sensor is a PTC (positive thermal coefficient resistance), providing the sensor characteristic to Zapi the correct table can be loaded in the controller software. 1. DIGITAL: A digital (on/off) sensor for the motor temperature monitoring is connected to CNA#22 input. 2. NONE:No temperature sensor is connected.
DIGITAL LIFT	OFF : The lift sensor includes a lift switch and an analogue lift sensor. Lift speed can be controlled proportionally with lever position. ON : The lift sensor includes a lift switch only. Lift speed cannot be controlled proportionally.
JOY STICK	OFF : Use lever command valves; ON : Use fingertip command valves.
DISPLAY	OFF: Display Not present; ON: Display present.
SHIFT FUNCTION (option)	This menu appears when JOYSTICK (in the SET OPTION) is ON. OFF : The truck doesn't have the side shift function (default) ON : The truck has the side shift function
AUX FUNCTION (option)	This menu appears when JOYSTICK (in the SET OPTION) is ON. OFF : The truck doesn't have the aux function (default) ON : The truck has the aux function (option)
LEVER FULL (option)	This menu appears when JOYSTICK (in the SET OPTION) is ON. OFF : The restricted combinations of the fingertip lever are available. For example, lift plus tilt forward movement is disabled for safety. ON : All combinations of the fingertip lever are available.

ADJUSTMENTS	
LOAD SENSOR	ON : Load Sensing Function is activated OFF : Load Sensing Function is disactivated.
OVERLOAD TYPE	This option specifies how overload alarm works in overloaded situation. NONE : There would'n be any kind of alarms or limitations . OPTION #1 : If the weight of load filed on forks exceeds the overload weight set in overload parameter, OVER LOAD alarm will be displayed and followed by traction & pump limitation except lift down function. OPTION #2 : If the weight of load filed on forks exceeds the overload weight set in overload parameter, OVER LOAD alarm will be displayed.
ADJ MIN LOAD	This parameter is used to show and configurate the minimum voltage of load weight sensor output in case of empty weight loaded.
ADJ REF LOAD	This parameter is used to show and configurate the reference voltage of load weight sensor output in case of reference weight loaded.
REF. LOAD WEIGHT	This parameter is used to show and configurate the reference load weight.
MAX LOAD WEIGHT	This parameter is used to show and configurate the trigger condition for LOAD SENSOR alarm. If the loaded weight exceeds the weight indicated in this paramter, The TIP OVER accident can occur, which is fatal for driver' safety, so LOAD SENSOR alarm will be displayed and followed by traction & pump limitation except lift down function. * The figures in this parameter should be higher than OVERLOAD WEIGHT paratmer
OVERLOAD WEIGHT	This parameter is used to show and configurate the trigger condition for OVER LOAD alarm. If the loaded weight exceeds the weight indicated in this paramter, overload alarm and function limitation will occur accroding to OVERLOAD TYPE paramter. * The figures in this parameter should be higher than RATED LOAD W parameter and lower than MAX LOAD WEIGHT paratmer.
LOAD SPEED UPD	For accuracy, Load Sensor only works when the pump motor speed is lower than as set in this paramter.
ADJUST BATTERY	Fine adjustment of the battery voltage measured by the controller.
THROTTLE 0 ZONE	It establishes a dead band in the lift potentiometer input curve.
THROTTLE X POINT	This parameter, together with the THROTTLE Y POINT, changes the characteristic of the lift potentiometer input curve : when the potentiometer is depressed to X point per cent, the corresponding pump speed is Y point percent of the Maximum pump speed. The relationship between the lift potentiometer position and the pump speed is linear between the THROTTLE 0 ZONE and the X point and also between the X point and the maximum potentiometer position but with two different slopes.

ADJUSTMENTS	
THROTTLE Y POINT	This parameter, together with the THROTTLE X POINT, changes the characteristic of the lift potentiometer input curve : when the potentiometer is de-pressed to X point per cent, the corresponding pump speed is Y point per cent of the Maximum pump speed. The relationship between the potentiometer position and the pump speed is linear between the THROTTLE 0 ZONE and the X point and also between the X point and the maximum accelerator position but with two different slope.
MAIN CONT. VOLT	It specifies the percentage of battery voltage supplied to OPSS VALVE coil to close the contactor.
AUX OUTPUT VOLT	It specifies the percentage of battery voltage supplied to AUX coil to close the AUXILIARY electro valve.
MAIN CONT. V RID	It specifies the percentage of MAIN CONT VOLT parameter, supplied to MC coil to keep the contactor closed.
MAX. POT LOWER (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the maximum value for the lowering sensor.
MIN. POT LOWER (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the minimum value for the lowering sensor.
MAX. POT LIFT (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the maximum value for the lift sensor.
MIN. POT LIFT (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the minimum value for the lift sensor.
MAX. TILT DOWN (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the maximum value for the tilt down sensor.
MIN. TILT DOWN (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the minimum value for the tilt down sensor.
MAX. TILT UP (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the maximum value for the tilt up sensor.
MIN. TILT UP (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the minimum value for the tilt up sensor.
MAX. SHIFT LEFT (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the maximum value for the side shift left sensor.
MIN. SHIFT LEFT (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the minimum value for the side shift left sensor.
MAX. SHIFT RIGHT (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the maximum value for the side shift right sensor.
MIN. SHIFT RIGHT (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the minimum value for the side shift right sensor.
MAX. AUX OUT (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the maximum value for the aux out sensor.
MIN. AUX OUT (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the minimum value for the aux out sensor.
MAX. AUX IN (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the maximum value for the aux in sensor.
MIN. AUX IN (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the minimum value for the aux in sensor.

4) TESTER MENU

TRACTION INVERTER	
HOUR METER TRUCK	This parameter displays the working hour of traction controller.
BATTERY VOLTAGE	Voltage value with 1 decimal digit. Battery voltage value measured at the key on.
MOTOR VOLTAGE	Percentage value. It is the voltage generated by the inverter expressed in percent of the actual battery voltage. 100% means the sine wave width is close to the actual battery voltage; 0% means the sine wave width is null.
VOLTAGE BOOSTER	Percentage value. It is the booster contribute to the voltage really supplied to the motor expressed in per cent of the actual battery voltage.
FREQUENCY	Hz value. This is the frequency of the sine waves the inverter is supplying.
ENCODER	Hz value. This is the speed of the motor measured with the encoder and expressed in the same unit of the FREQUENCY reading.
SLIP VALUE	Hz value. This is the slip between the frequency and the speed of the motor(SLIP VALUE = FREQUENCY-ENCODER).
CURRENT RMS	Ampere value. Root Mean Square value of the line current in the motor.
MOTOR POWER	It is the motor power.
BATTERY CHARGE	Percentage value. It supplies the residual charge of the battery as a percentage of the full charge level.
TEMPERATURE	°C value. This is the temperature of the inverter base plate. This temperature is used for the HIGH TEMPERATURE alarm detection.
MOTOR TEMPERAT.	°C value. This is the temperature of the motor windings picked up with an analog sensor inside the motor. Normally this sensor is a PTC Philips KTY84-130. This temperature is used only to raise a warning. when the motor temperature overtakes the MOTOR OVERTEMP setting.
ACCELERATOR	From 0.0V to 5.0V. ACCELERATOR reading is in the range 0.0 to 5.0Vdc.
SEAT SWITCH	ON/OFF. This is the status of seat switch.
FORWARD SWITCH	ON/OFF. This is the status of forward signal.
BACKWARD SWITCH	ON/OFF. This is the status of backward signal.
ENABLE SWITCH	ON/OFF. This is the status of enable switch.
BRAKE SWITCH	ON/OFF. This is the status of pedal brake switch.
HANDBRAKE	ON/OFF. This is the status of pedal handbrake switch from display.
STEER ANGLE	° value. This is the angle of steering wheel.

PUMP INVERTER	
HOUR METER TRUCK	This parameter displays the working hour of pump controller.
BATTERY VOLTAGE	Voltage value with 1 decimal digit. Battery voltage value measured at the key on.
MOTOR VOLTAGE	Percentage value. It is the voltage generated by the inverter expressed in percent of the actual battery voltage. 100% means the sine wave width is close to the actual battery voltage; 0% means the sine wave width is null.
VOLTAGE BOOSTER	Percentage value. It is the booster contribute to the voltage really supplied to the motor expressed in per cent of the actual battery voltage.
FREQUENCY	Hz value. This is the frequency of the sine waves the inverter is supplying.
ENCODER	Hz value. This is the speed of the motor measured with the encoder and expressed in the same unit of the FREQUENCY reading.
SLIP VALUE	Hz value. This is the slip between the frequency and the speed of the motor(SLIP VALUE = FREQUENCY-ENCODER).
CURRENT RMS	Ampere value. Root Mean Square value of the line current in the motor.
MOTOR POWER	It is the motor power.
TEMPERATURE	℃ value. This is the temperature of the inverter base plate. This temperature is used for the HIGH TEMPERATURE alarm detection.
MOTOR TEMPERAT.	℃ value. This is the temperature of the motor windings picked up with an analog sensor inside the motor. Normally this sensor is a PTC Philips KTY84-130. This temperature is used only to raise a warning. when the motor temperature overtakes the MOTOR OVERTEMP setting.
SEAT SWITCH	ON/OFF. This is the status of seat switch.
LIFTING CONTROL	From 0.0V to 5.0V. LIFTING reading is in the range 0.0 to 5.0Vdc.
LIFTING SWITCH	ON/OFF. This is the status of the lift switch.
1ST SPEED SWITCH	ON/OFF. This is the status of the tilt switch.
2ND SPEED SWITCH	ON/OFF. This is the status of the sideshift switch.
3RD SPEED SWITCH	ON/OFF. This is the status of the HYD AUX switch, from display.
HYDRO SPEED REQ.	ON/OFF. This is the status of hydro speed request.
STEER POT.	From 0.0V to 5.0V. STEERING reading is in the range 0.0 to 5.0Vdc.
LOAD WEIGHT	From 0Kg to 2500Kg. It is the load sensor output
LOAD POT.	From 0.0V to 5.0V. LOAD SENSING reading is in the range 0.0 to 5.0Vdc.
LIFT/LOW REQUEST	Shadow when you are not in JOYMODE. From 0.0V to 5.0V and from 0% and 100%. LIFT/LOWER fingertip.
TILT REQUEST	Shadow when you are not in JOYMODE. From 0.0V to 5.0V and from 0% and 100%. TILT fingertip.
SHIFT REQUEST	Shadow when you are not in JOYMODE. From 0.0V to 5.0V and from 0% and 100%. SHIFT fingertip.
AUX REQUEST	Shadow when you are not in JOYMODE. From 0.0V to 5.0V and from 0% and 100%. AUX fingertip.

6. FINGERTIP CONTROLLER

1) INTRODUCTION OF FINGER TIP

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

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

2) GENERAL CHARACTERISTIC

(1) Functional characteristics

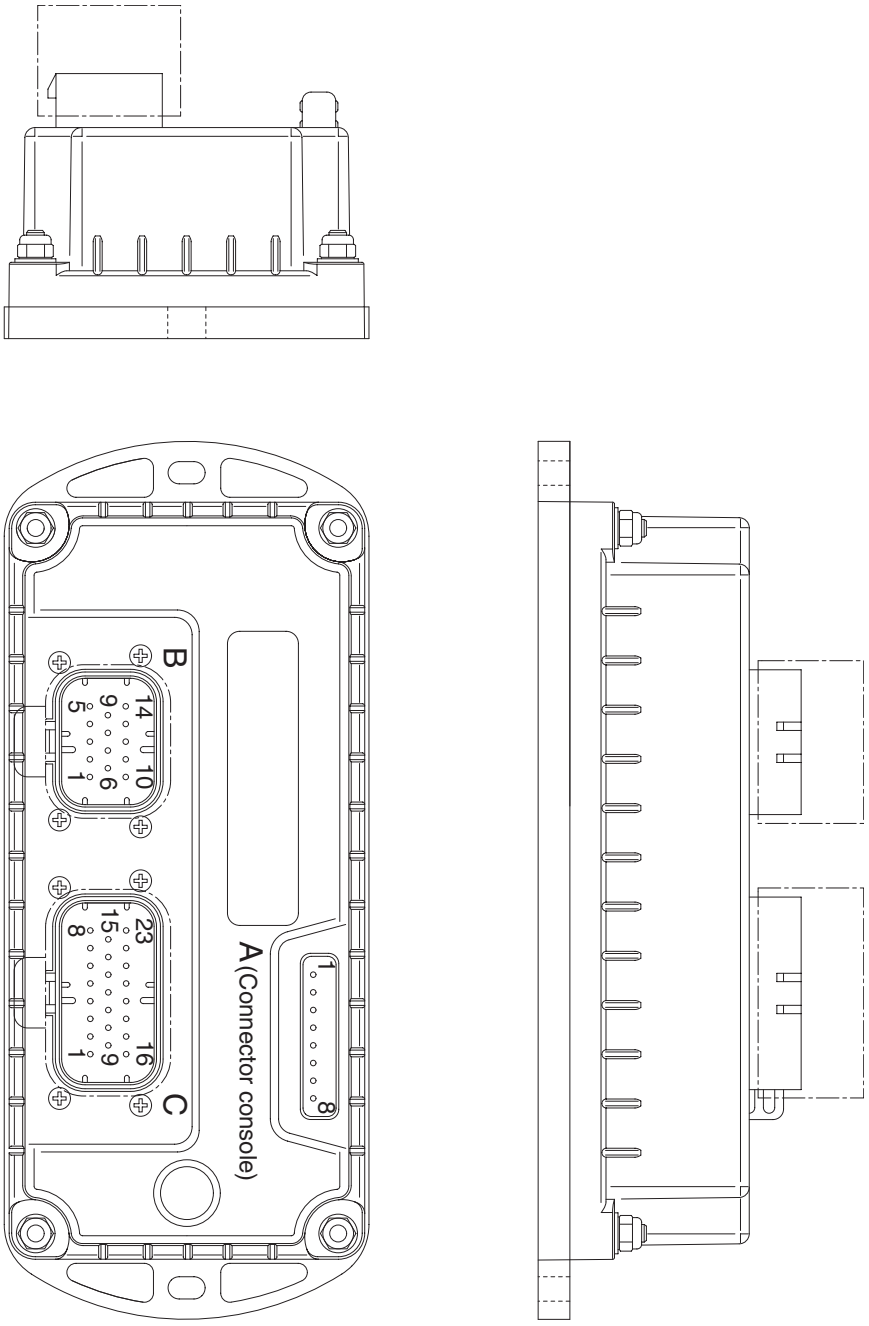
Voltage [V] ····· 24/36/48/80V
Output for ON-OFF valves [n°] ····· 3
Output for proportional valves [n°] ····· 9
Digital inputs [n°] ····· 3
Analog inputs [n°] ····· 1
RS-232 [n°] ····· 1
CAN [n°] ····· 1
Protection ····· IP65

(2) Input

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

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

3) STRUCTURE



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4) Description of connectors

No. of Pin	Function	Description
A1	PCLRXD	Serial communication interface
A2	NCLRXD	Serial communication interface
A3	PCLTXD	Serial communication interface
A4	NCLTXD	Serial communication interface
A5	GND	Negative supply.
A6	+12	+12V supply.
A7	-	
A8	-	
B1	+KEY	Mhyrio CB positive power supply
B2	PAUX	Input of valves positive power supply
B3	-BATT	Mhyrio CB negative supply
B4	CAN_L	CAN low signal in
B9	CAN_T	CAN termination : connect to CANH_OUT to insert a 120 ohm termination resistance
B10	PPO_S	Positive supply of analog devices (+12 V)
B13	CAN_H	Can high signal in
B14	CANH_OUT	Can high signal out
C1	NEVP1	Negative of the proportional electro valve lift up.
C2	PEVP1/2	Positive of the proportional electro valves lift up & lowering.
C3	NEVP2	Negative of the proportional electro valve lowering.
C4	NEVP3	Negative of the proportional electro valve reach in.
C5	PEVP3/4	Positive of the proportional electro valves reach in & reach out.
C6	NEVP4	Negative of the proportional electro valve reach out.
C7	NEVP5	Negative of the proportional electro valve tilt up.
C8	PEVP5/6	Positive of the proportional electro valves tilt up & tilt down.
C12	NEVP7	Negative of the proportional electro valve side shift right.
C13	PEVP7/8	Positive of the proportional electro valves side shift right & left.
C14	NEVP8	Negative of the proportional electro valve side shift left.
C15	NEVP6	Negative of the proportional electro valve tilt down.
C19	NEVP	Negative of buzzer relay
C20	PEVP	Positive of buzzer relay
C23	-BATT	Mhyrio CB negative supply

Type	Function	Description
SET BATTERY TYPE	12/24/36 /48/72/80	This parameter sets the battery nominal voltage, that is the key input voltage (MHYRIO supply)
V valves coil	12/24/36 /48/72/80	This parameter sets the ON/OFF valves coil nominal voltage.
Valves supply	12/24/36 /48/72/80	This parameter sets the voltage of the valve's coil positive supply.
EVP type	DIGITAL	It sets EVP single to ON-OFF valve type
	ANALOG	It sets EVP single to proportional valve type
EVP1 type	DIGITAL	It ses EVP1 to ON-OFF valve type
	ANALOG	It sets EVP1 to PROPORTIONAL valve type
EVP2 type	DIGITAL	It sets EVP2 to ON-OFF valve type
	ANALOG	It sets EVP2 to PROPORTIONAL valve type
EVP3 type	DIGITAL	It sets EVP3 to ON-OFF valve type
	ANALOG	It sets EVP3 to PROPORTIONAL valve type
EVP4 type	DIGITAL	It sets EVP4 to ON-OFF valve type
	ANALOG	It sets EVP4 to PROPORTIONAL valve type
EVP5 type	DIGITAL	It sets EVP5 to ON-OFF valve type
	ANALOG	It sets EVP5 to PROPORTIONAL valve type
EVP6 type	DIGITAL	It sets EVP6 to ON-OFF valve type
	ANALOG	It sets EVP6 to PROPORTIONAL valve type
EVP7 type	DIGITAL	It sets EVP7 to ON-OFF valve type
	ANALOG	It sets EVP7 to PROPORTIONAL valve type
EVP8 type	DIGITAL	It sets EVP8 to ON-OFF valve type
	ANALOG	It sets EVP8 to PROPORTIONAL valve type
MODEL TRUCK	OPTION #1	It sets every parameter to counter balanced type truck
	OPTION #2	It sets every parameter to BRJ type truck

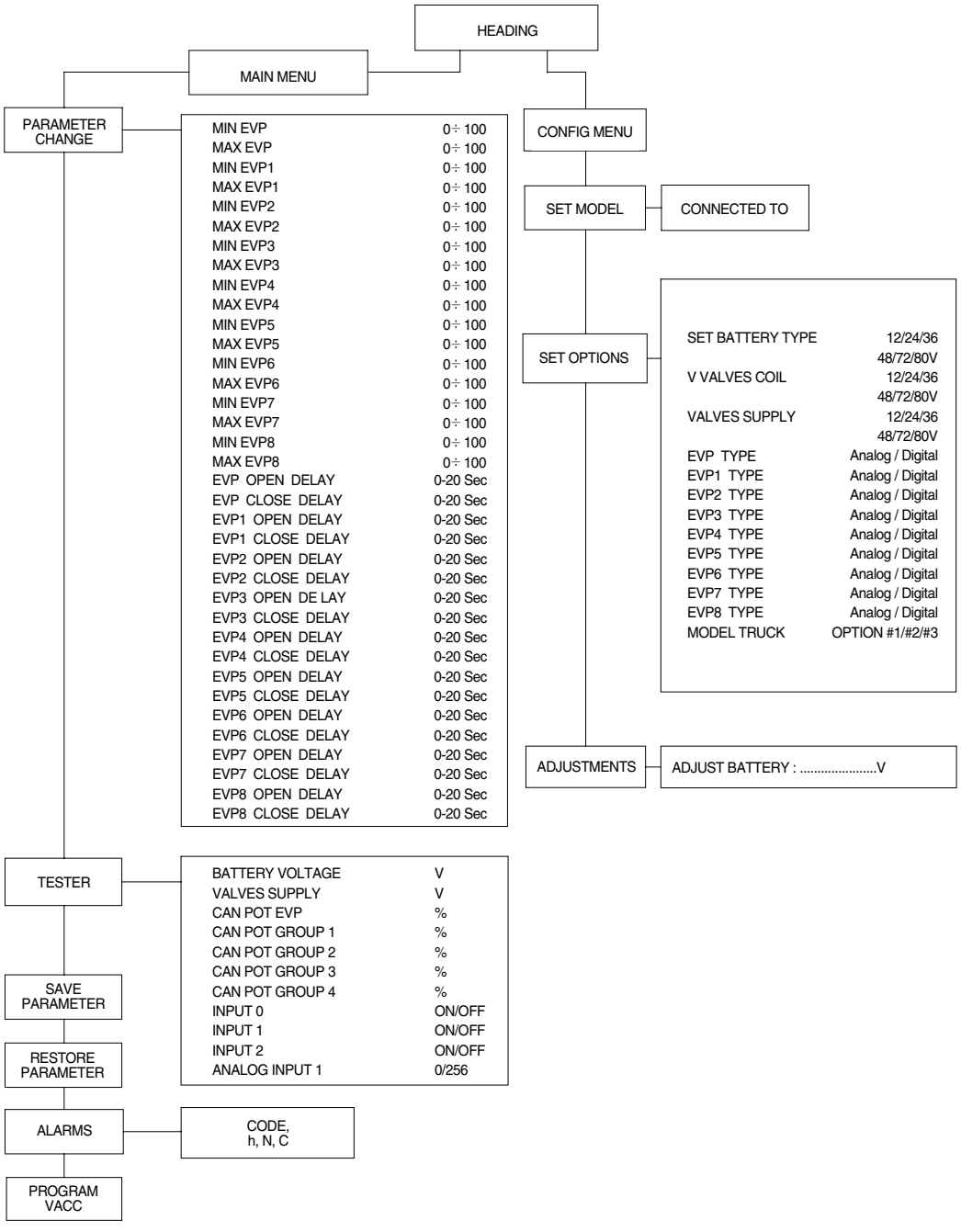
5) ADJUSTMENTS & FUNCTION

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

(1) Adjustments via console or buttons on a display

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

(2) Description of standard console menu



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(3) Description of parameters that may be programmed (parameter change)

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

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

The following parameters can be modified:

① **Min EVP**

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

② **Max EVP**

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

③ **Min EVP1**

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

④ **Max EVP1**

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

⑤ **Min EVP2**

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

⑥ **Max EVP2**

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

⑦ **Min EVP3**

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

⑧ **Max EVP3**

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

⑨ **Min EVP4**

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

⑩ **Max EVP4**

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

⑪ **Min EVP5**

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

⑫ **Max EVP5**

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

⑬ **Min EVP6**

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

⑭ **Max EVP6**

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

⑮ **Min EVP7**

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

⑯ **Max EVP7**

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

⑰ **Min EVP8**

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

⑱ **Max EVP8**

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

⑲ **EVP Open delay**

Single proportional valve current ramping up time: this parameter sets the single valve current ramp, to change from 0 A to operating current.

⑳ **EVP Close delay**

Single proportional valve current ramping down time: this parameter sets the single valve closing ramp, to change from operating current to 0 A.

㉑ **EVP1 Open delay**

EVP1 proportional valve current ramping up time: this parameter sets the EVP1 valve current ramp, to change from 0 A to operating current.

㉒ **EVP1 Close delay**

EVP1 proportional valve current ramping down time: this parameter sets the EVP1 valve closing ramp, to change the coil current from operating current to 0 A.

㉓ **EVP2 Open delay**

EVP2 proportional valve current ramping up time: this parameter sets the EVP2 valve current ramp, to change from 0 A to operating current.

㉔ **EVP2 Close delay**

EVP2 proportional valve current ramping down time: this parameter sets the EVP2 valve closing ramp, to change the coil current from operating current to 0 A.

㉕ **EVP3 Open delay**

EVP3 proportional valve current ramping up time: this parameter sets the EVP3 valve current ramp, to change from 0 A to operating current.

㉖ **EVP3 Close delay**

EVP3 proportional valve current ramping down time: this parameter sets the EVP3 valve closing ramp, to change the coil current from operating current to 0 A.

㉗ **EVP4 Open delay**

EVP4 proportional valve current ramping up time: this parameter sets the EVP4 valve current ramp, to change from 0 A to operating current.

㉘ **EVP4 Close delay**

EVP4 proportional valve current ramping down time: this parameter sets the EVP4 valve closing ramp, to change the coil current from operating current to 0 A.

㉙ **EVP5 Open delay**

EVP5 proportional valve current ramping up time: this parameter sets the EVP5 valve current ramp, to change from 0 A to operating current.

㉚ **EVP5 Close delay**

EVP5 proportional valve current ramping down time: this parameter sets the EVP5 valve closing ramp, to change the coil current from operating current to 0 A.

㉛ **EVP6 Open delay**

EVP6 proportional valve current ramping up time: this parameter sets the EVP6 valve current ramp, to change from 0 A to operating current.

㉜ **EVP6 Close delay**

EVP6 proportional valve current ramping down time: this parameter sets the EVP6 valve closing ramp, to change the coil current from operating current to 0 A.

㉝ **EVP7 Open delay**

EVP7 proportional valve current ramping up time: this parameter sets the EVP7 valve current ramp, to change from 0 A to operating current.

㉞ **EVP7 Close delay**

EVP7 proportional valve current ramping down time: this parameter sets the EVP7 valve closing ramp, to change the coil current from operating current to 0 A.

㉟ **EVP8 Open delay**

EVP8 proportional valve current ramping up time: this parameter sets the EVP8 valve current ramp, to change from 0 A to operating current.

㊱ **EVP8 Close delay**

EVP8 proportional valve current ramping down time: this parameter sets the EVP8 valve closing ramp, to change the coil current from operating current to 0 A.

(3-1) Description to change parameters by a console

The flow chart shows how to change parameters by a console.

① Opening finger tip controller menu (MHY CB)

② Press ENTER to go into the GENERAL MENU.

③ The display will show: PARAMETER CHANGE.

④ Press ENTER to go into the PARAMETER CHANGE menu.

⑤ The display will show the first parameter.

⑥ Press ROLL UP and ROLL DOWN buttons until desired parameter appears.

⑦ The names of the parameters appear on the display.

⑧ When the desired parameter appears, the display will show a level number that will be between 0 and 9. Press either SET UP or SET DOWN buttons to change the Level value.

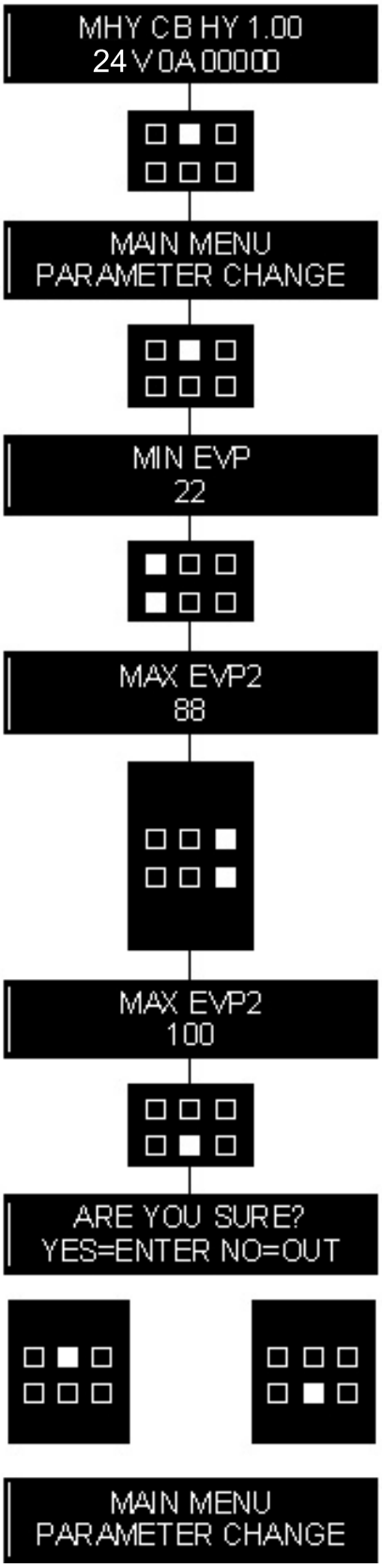
⑨ The display will show the new level.

⑩ When you are satisfied with the results of the changes you have made, press OUT.

⑪ The display asks: "ARE YOU SURE?".

⑫ Press ENTER to accept the changes, or press OUT if you do not wish to accept the changes and wish to make further modifications to the parameters.

⑬ The display will show: PARAMETER CHANGE.



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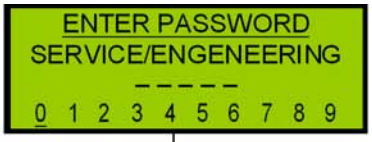
(3-2) Description to change parameters by a display

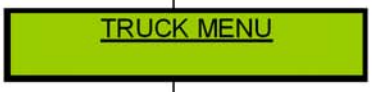
The flow chart shows how to change parameters by buttons on a display.

① Press [O] to enter password for 2~3 seconds.
The display will show: ENTER PASSWORD.



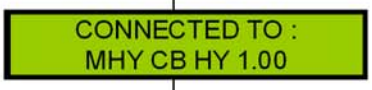
② Enter the password using [←M] [→P] and [↵].
After finishing entering it, press [←M] for 2~3 sec

③ The display will show: TRUCK MENU.



④ Press [↵].

⑤ The display will show : CONNECTED TO :

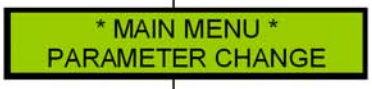


⑥ If the display doesn't show : MHY CB HY 1.00,
Press [↑] or [↓] until MHY CB HY 1.00 appears on the display. After that, press [↵]

⑦ The display will show : CONNECTED TO:
With more information.

⑧ Press [↵] to go into the GENERAL MENU.

⑨ The display will show :.PARAMETER CHANGE



⑩ Press [↵] to go into the PARAMETER CHANGE menu.

⑪ The display will show : MIN EVP

⑫ Press [↑] and [↓] until desired parameter appears.

⑬ The names of parameters appear on the display.

BTR9EL64

① When the desired parameter appears, the display will show a level number that will be between 0 and 9. Press either [M] or [P] to change the level value

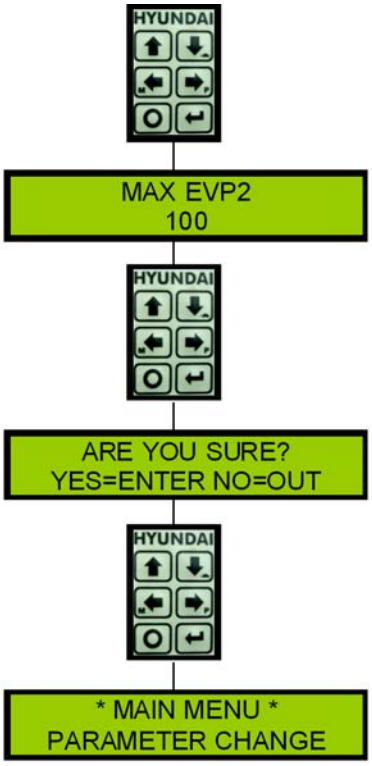
② The display will show the new level.

③ When you are satisfied with the results of the changes you have made, press [O].

④ The display asks : "ARE YOU SURE?"

⑤ Press [↵] to accept the changes,or press [O] if you do not wish to accept the changes and wish to make further modifications to the parameters.

⑥ The display will show: PARAMETER CHANGE



BRJ7EL65

(4) TESTER MENU

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

① Battery voltage
Level of battery voltage measured at the input of the key switch.

② Valves supply
Level of voltage at the positive valve supply input (B2).

③ CAN POT EVP
Single proportional valve current set point, received by canbus.

④ CAN POT group 1
Group 1 proportional valves current set point, received by canbus.

⑤ CAN POT group 2
Group 2 proportional valves current set point, received by canbus.

⑥ CAN POT group 3
Group 3 proportional valves current set point, received by canbus.

⑦ CAN POT group 4
Group 4 proportional valves current set point, received by canbus.

⑧ Input 0
Level of digital input 0:
- ON / +VB : input active, switch closed
- OFF / COND : input not active, switch open.

⑨ Input1
Level of digital input 1:
- ON / +VB : input active, switch closed
- OFF / COND : input not active, switch open.

⑩ Input 2

Level of digital input 2 :

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

⑪ Analog input 1

Voltage of the analog input.

(4-1) Description to check data by a console

The flow chart shows how to use the TESTER function of the digital console**.**

① Opening finger tip controller menu (MHY CB)

② Press ENTER to go into the GENERAL MENU.

③ The display will show: PARAMETER CHANGE.

④ Press ROLL UP or ROLL DOWN button until TESTER menu appears on the display.

⑤ The display shows: TESTER.

⑥ Press ENTER to go into the TESTER function.

⑦ The first variable to be tested is shown on the display.

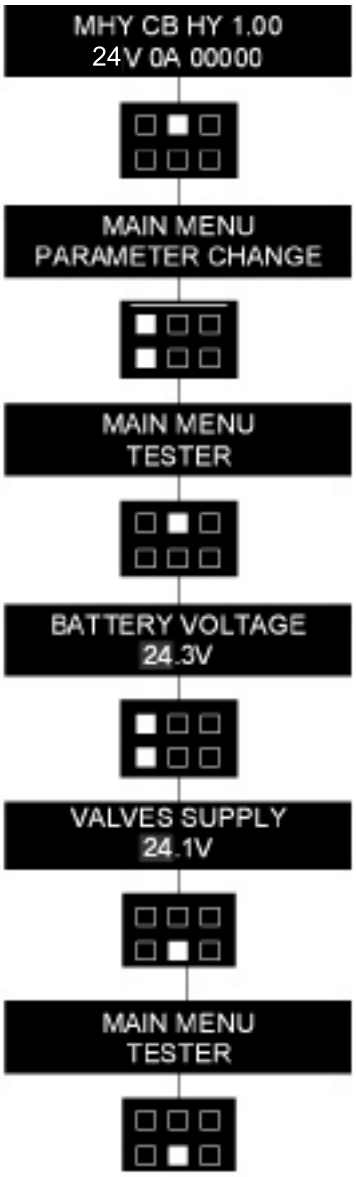
⑧ Press either ROLL UP or ROLL DOWN buttons.

⑨ Next variable for measurement appears.

⑩ When you have finished, press OUT.

⑪ The display shows: TESTER.

⑫ Press OUT again and return to opening HY menu.



BTR9EL66

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.

(4-2) Description to check data by a display

The flow chart shows how to use the TESTER function of buttons on a display.

① Press [O] to enter password for 2~3 seconds.
The Display will show: ENTER PASSWORD.

② Enter the password using [◀M] [▶P] and [↵].
After finishing entering it, press [◀M] for 2~3 sec

③ The display will show: TRUCK MENU.

④ Press [↵]

⑤ The display will show : CONNECTED TO :

⑥ If the display doesn't show : MHY CB HY 1.00,
Press [↑] or [↓] until MHY CB HY 1.00 appears on the display. After that, press [↵]

⑦ The display will show : CONNECTED TO:
With more information.

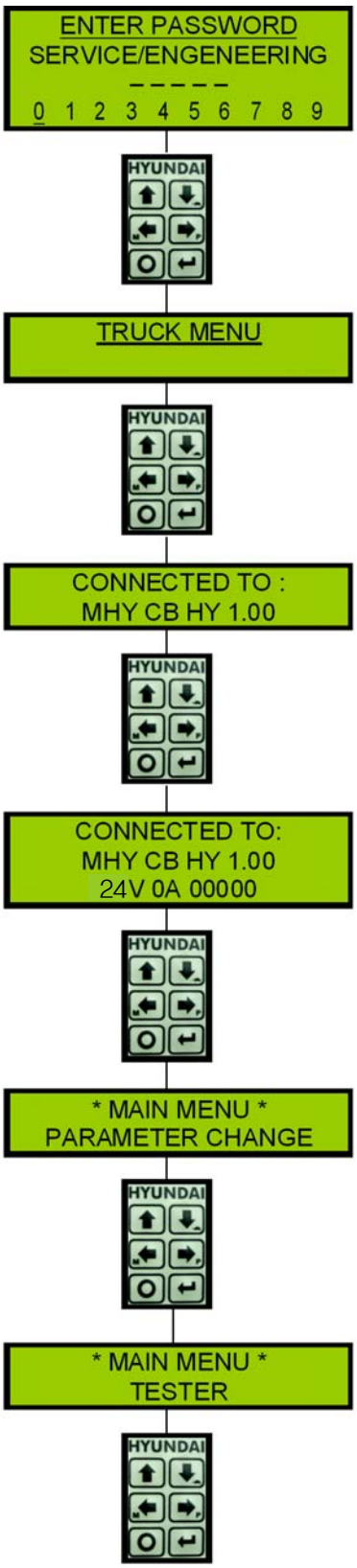
⑧ Press [↵] to go into the GENERAL MENU.

⑨ The display will show : PARAMETER CHANGE

⑩ Press [↑] or [↓] until TESTER menu appears on the display.

⑪ The display shows : TESTER

⑫ Press [↵] to go into the TESTER function.



BTR9EL67

① The first variable to be tested is shown on the display

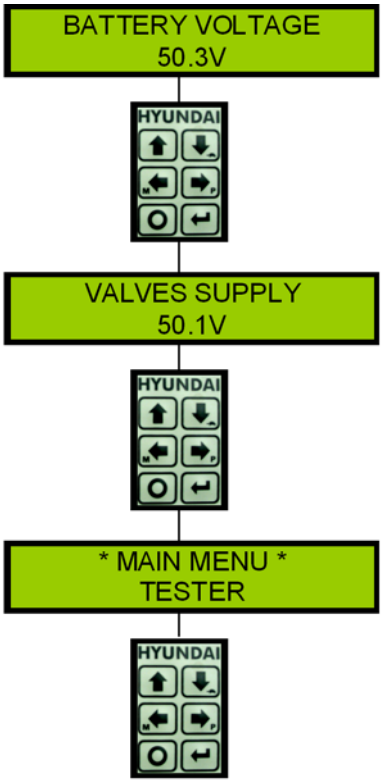
② Press either ⬆ or ⬇.

③ Next variable for measurement appears.

④ When you have finished, press O.

⑤ The display shows : TESTER

⑥ Press O again and return to MHY CB HY.



BRJ7EL68

6) ANALYSIS OF ALARMS

① **EEPROM KO**

Fault in the area of memory where the adjustment parameters are stored. This Alarm does not inhibit machine operation but operation goes on with default values; if fault is still present when the Key Switch is re-cycled, replace the logic. If the fault disappears, the previously stored Parameters will have been replaced by the default parameters.

② **CAN BUS KO**

There is a problem related to the CAN-BUS line. The error is signalled if the MHYRIO controller does not receive any message from the CAN-BUS line. First of all, check the wiring. If it is ok, the problem is on the logic board, which must be replaced.

③ **Watchdog**

The test is made in both running and standby. It is a self-diagnosing test within the logic. If an alarm should occur, replace the logic.

④ **WRONG SET BATTERY**

This fault is signalled if the battery voltage is non consistent with the set battery programmed in the 'set option' menu.

⑤ **Undervoltage**

This fault is signalled if an undervoltage condition is detected in the MHYRIO power supply.

⑥ **FF valves**

Flip-flop circuit, that manages on/off valve drivers short-circuit protection, does not reset in the correct way. The problem is probably in the hardware circuit.

⑦ **Coil shorted**

ON/OFF valves drivers are protected against coil short circuit; if a short is present across the coil, the flip-flop circuit is set and the alarm is signalled.

⑧ **EV driver short**

One of the on/off valves driver is shorted; check the external connection, if it is ok the driver is probably damaged.

⑨ **EVP driver short**

The single proportional valve driver is shorted; check the external connection, if it is ok the driver is probably damaged.

⑩ **EVPG1 driver short**

One of the Group 1 valves drivers is shorted; check the external connection, if it is ok the driver is probably damaged.

⑪ **EVPG2 driver short**

One of the Group 2 valves drivers is shorted; check the external connection, if it is ok the driver is probably damaged.

⑫ **EVPG3 driver short**

One of the Group 3 valves drivers is shorted; check the external connection, if it is ok the driver is probably damaged.

⑬ **EVPG4 driver short**

One of the Group 4 valves drivers is shorted; check the external connection, if it is ok the driver is probably damaged.

⑭ **EV driver KO**

One of the On/Off valves drivers is open (it does not close when it is commanded by the microcontroller).

⑮ **EVP driver KO**

The single proportional valve driver is open (it does not close when it is commanded by the microcontroller).

⑯ **EVPG1 driver KO**

One of the Group 1 valves drivers is open (it does not close when it is commanded by the microcontroller).

⑰ **EVPG2 driver KO**

One of the Group 2 valves drivers is open (it does not close when it is commanded by the microcontroller).

⑱ **EVPG3 driver KO**

One of the Group 3 valves drivers is open (it does not close when it is commanded by the microcontroller).

⑲ **EVPG4 driver KO**

One of the Group 4 valves drivers is open (it does not close when it is commanded by the microcontroller).

⑳ **HI side driver KO**

The high side driver which supply the valves coils positive is shorted or open.

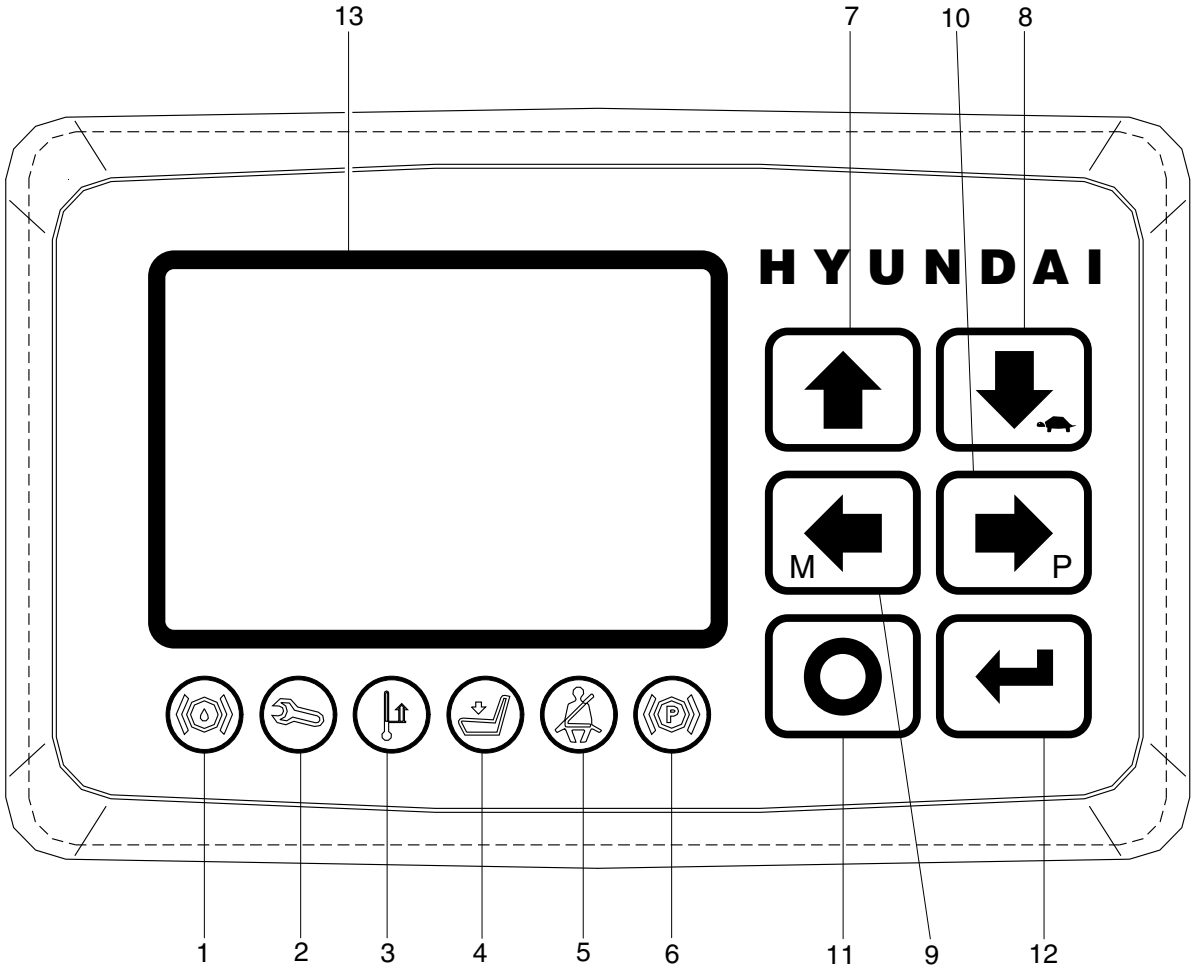
㉑ **Waiting for PEV**

There isn't the valves positive power supply. Check B2 input then verify the VALVES SUPPLY parameter is correctly set.

7. DISPLAY

1) STRUCTURE

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



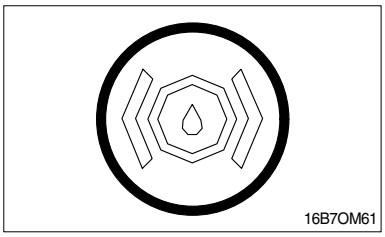
15B7OM65

1 Oil level warning lamp (option)
2 Wrench warning lamp
3 Thermometer warning lamp
4 Seat warning lamp
5 Seat belt warning lamp (option)
6 Handbrake warning lamp
7 Key 1 button
8 Key 2 button
9 Key 3 button
10 Key 4 button
11 Key 5 button
12 Key 6 button
13 LCD function

2) WARNING LAMP

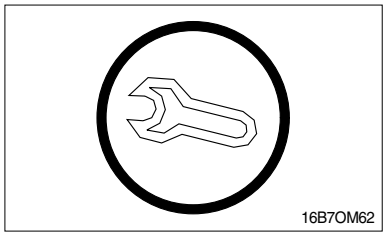
When the key switch is OFF, the display makes a general test lighting and switching OFF all the LED in sequence.

(1) Oil level warning lamp (Option)



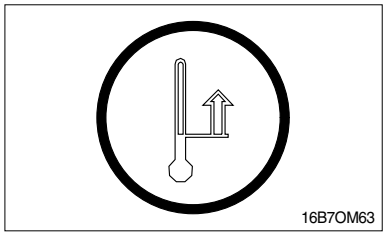
This LED lights when the measured oil level of the hydraulic circuit is under the minimum acceptable mark.
To connect the oil sensor output to the Analogue Input #1.

(2) Wrench warning lamp



This LED blinks when truck is in alarm condition.

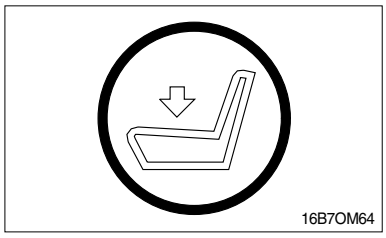
(3) Thermometer warning lamp



This LED blinks when one truck's controller is in alarm due IMS high temperature.

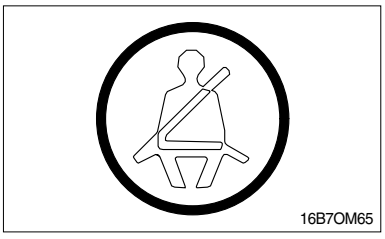
※ IMS : Input motor switch

(4) Seat warning lamp



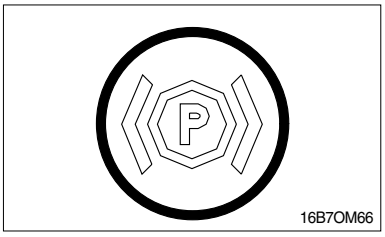
This LED lights when the operator is not on the seat.

(5) Seat belt warning lamp (Option)



(1) This LED lights to signal that the seat belt is not correctly fastened. To connect the Seat belt sensor to the Analogue Input #2.

(6) Handbrake warning lamp

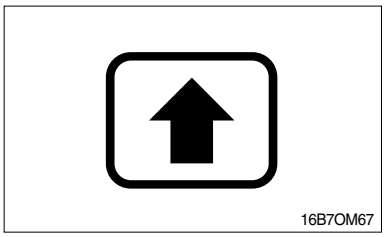


(1) This LED lights when the handbrake is activated.

3) TESTER MENU

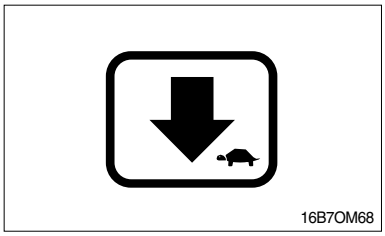
Status of keyboard buttons can be monitored in real time in the TESTER menu.

(1) Key 1 button



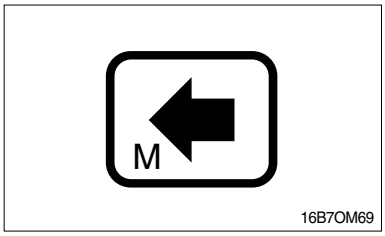
Status of ↑ keyboard button:
ON = Input active, button pushed
OFF = Input not active, button released

(2) Key 2 button



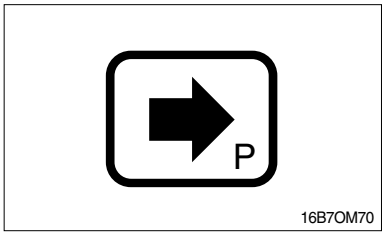
Status of ↓ TURTLE keyboard button:
ON = Input active, button pushed
OFF = Input not active, button released

(3) Key 3 button



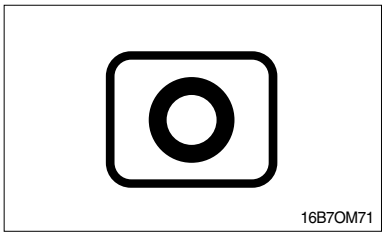
Status of ← M (Menu) keyboard button:
ON = Input active, button pushed
OFF = Input not active, button released

(4) Key 4 button



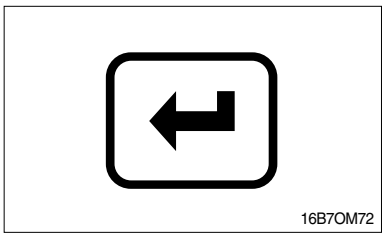
Status of → P (Performance) keyboard button:
ON = Input active, button pushed
OFF = Input not active, button released

(5) Key 5 button



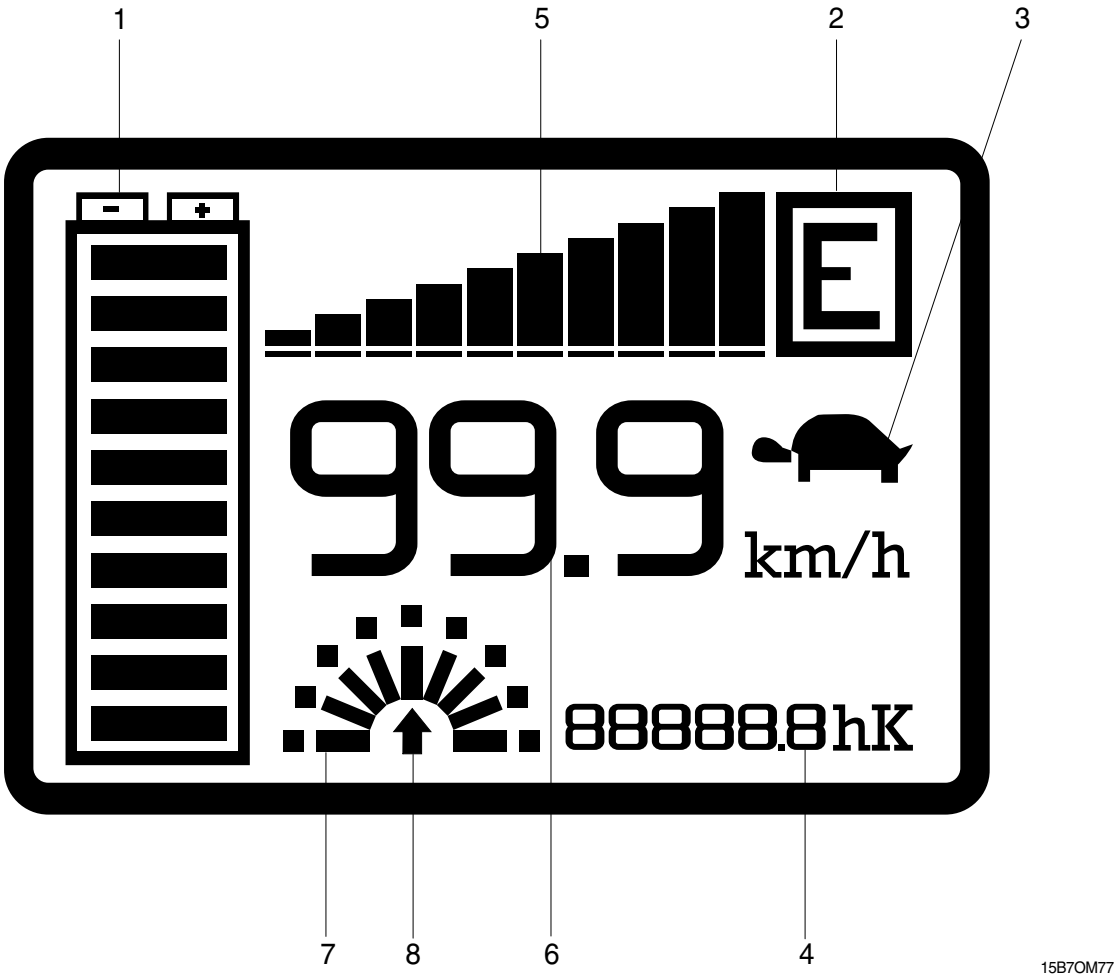
Status of O (Esc) keyboard button:
ON = Input active, button pushed
OFF = Input not active, button released

(6) Key 6 button



Status of ↵ (Enter) keyboard button:
ON = Input active, button pushed
OFF = Input not active, button release

4) LCD FUNCTION



(1) Battery's state of charge

The battery's state of charge indication is displayed on the left side of the unit (1); it is shown by ten notches. Each notch represents 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. When the residual battery charge is $\leq$ 20 % the notches displayed start to blink.

(2) Performance

The letter which appears in the rectangle displayed in the top right side of the unit (2) shows the performance mode which is being used in the controller.

Performances can be scrolled pressing button [P] . When one performance is selected, the related information will be sent via can-bus to traction and pump controllers that will manage this data. The standard functioning reduces truck performance passing from the high to economic performance.

The real meaning, in terms of parameters level of these performances, depends on software present on pump and traction controllers:

- "H" corresponds to highest performance;
- "N" corresponds to normal performance;
- "E" corresponds to economic performance;

(3) Turtle

The turtle symbol (3) is normally off; when it appears (fixed) it shows activation of the "soft" mode of the truck, in which maximum speed and acceleration are reduced. The "soft" mode can be activated pressing button [↓].

(4) Hour meter

The number displayed on the bottom right side of the unit (4) shows the Hours Worked.

The letter present near the hour meter shows which hour meter is displayed:

- K : the key hour meter is displayed;
- T : the traction hour meter is displayed;
- P : the pump hour meter is displayed; it increases if pump control is working.

(5) Accelerator

The accelerator level indication is displayed on the central top side of the unit (5); it is shown by ten notches. When the accelerator level is minimum only a notch is displayed, when the accelerator level is maximum all the ten notches are displayed. Each notch represents 1/10 of the difference between maximum and minimum accelerator level.

(6) Speed

The number displayed under the accelerator notches on the center of the unit (6) shows the truck speed. The unit can be km/h or mph depending on the SPEED UNIT parameter setting.

(7) Wheel position

The notch displayed on the left of the hour meter (7) represents the wheel (only one of the nine notches is displayed) and shows the steering angle (it corresponds to the relative truck direction if the truck is running).

(8) Running direction

The arrow (8) shows the set truck running direction. The arrow point is up when the truck is forward running; the arrow point is down when the truck is reverse running. If the truck doesn't run a dot is displayed instead of the arrow.

5) DESCRIPTION OF PROGRAMMABLE FUNCTIONS

(1) Menu set model

① Connect to

Using CANBUS link, every module connected to can net can act as the "access node" to the canbus net for the external world.

For example the ZAPI hand console (or the PC-Win console) can be physically connected to one module and, by the canbus, virtually connected to any other module of the net.

This parameter is used to select the module to which the user wishes to be connected.

Following the numbers associated to each module in Zapi canbus system are showed.

Number associated in canbus net	Module
02	TRACTION
05	PUMP
09	MHYRIO (Option)
16	GRAPHIC SMART DISPLAY

(2) Menu set options

① Power selector

It sets the truck performances.

OPTION #1 : H (High performance)

OPTION #2 : N (Normal performance)

OPTION #3 : E (Economic performance)

② Hour counter

It sets the hour counter displayed.

OPTION #1 : The key hour meter is displayed

OPTION #2 : The traction hour meter is displayed

OPTION #3 : The pump hour meter is displayed

③ Auxiliary output #1

The options are :

PRESENT : An external load is connected between PAUX and NAUX.
The related diagnosis are enabled.

ABSENT : No external load is connected between PAUX and NAUX.
The related diagnosis are disabled.

④ Auxiliary voltage #1

It specifies the percentage of battery voltage supplied to AUX coil to close the AUXILIARY electro valve. This parameter can be changed in the range 0% to 100%.

⑤ Speed unit

It sets the speed unit.

OPTION #1 : The speed unit is km/h

OPTION #2 : The speed unit is mph

⑥ User password

The options are :

ON : After key-on a user password is asked to utilize the Graphic Smart Display

OFF : No user password needed

⑦ **Maintenance**

The options are :

PRESENT : A maintenance hour-counter is incremented with key ON.
When the hours elapsed reach the programmed value with the display the warning "SERVICE REQUIRED" is shown.

ABSENT : No "SERVICE REQUIRED" warning

⑧ **Maintenance done**

It can be ON/OFF. This parameter is normally off. Setting the "MAINT. DONE" on at next key-on the maintenance hours are updated with the display' s hour meter contents. This operation erases the "MAINTENANCE NEEDED" warnig if it is present.

⑨ **Seat belt status**

It sets the "Seat belt" diagnostic LED indication in the following way:

OPTION #1 : No "Seat belt" indication. The diagnostic LED is not used.

OPTION #2 : If the seat belt are not fastened at Key-ON the diagnostic LED blinks for three times than it turns off.

OPTION #3 : The diagnostic LED blinks until the seat belt is fastened than it turns off.

⑩ **Steer angle**

The options are :

ON : It shows the direction of steering on display.

OFF : It don't shows the direction of steering on display. It just shows the direction of forward and backward.

⑪ **Model**

The options are :

Option #1 : Conunterbalanced type truck

Option #2 : Reach type truck

(3) Submenu "ADJUSTMENTS"

① **Delay display OFF**

This parameter sets the display ON "Service time". If the CNB#4 is connected to +batt after key-off the display is still supplied for a programmable time, follow the table below to choose your temporization :

Delay display off level	0	1	2	3	4	5	6	7	8	9
Service time [sec]	1	3	5	7	9	11	13	15	17	20

6) 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.

① Opening Zapi menu.

② Press ROLL UP & SET UP buttons to enter CONFIG MENU.

③ The display will show: SET MODEL. If another menu is displayed, press ROLL UP or ROLL DOWN until SET MODEL appears.

④ Press ENTER to go into the SET MODEL.

⑤ The display will shows the first option, only CONNECTED TO option is present in this menu.

⑥ Press SET UP or SET DOWN buttons in order to select the desired value for selected option.

⑦ New desired value appears.

⑧ Press OUT to exit the menu.

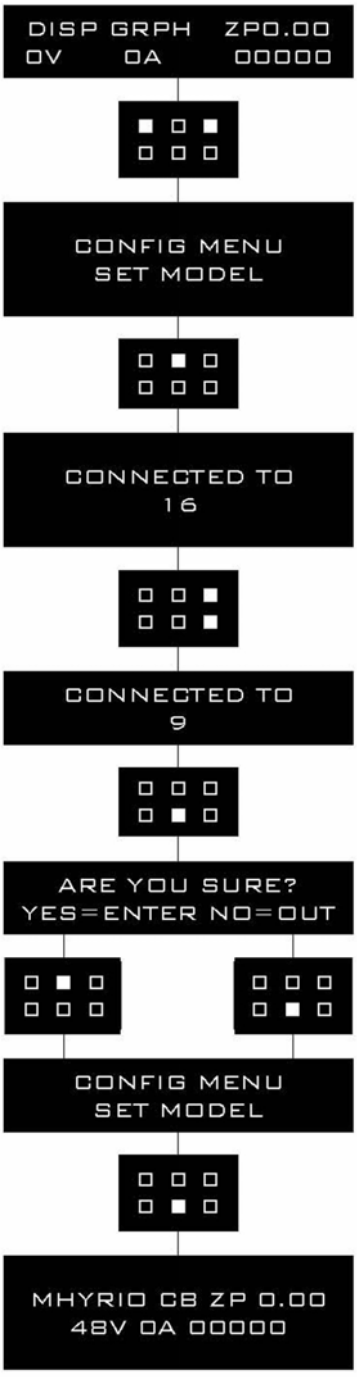
⑨ The display will ask "ARE YOU SURE?"

⑩ Press ENTER for YES, or OUT if you do not accept the changes.

⑪ SET MODEL menu appears.

⑫ Press OUT again. Console now disconnects and reconnects.

⑬ Display now shows the opening Zapi Menu of the ZAPI product corresponding to option selected at point 7.



20B7EL28

(2) Flow chart showing how to make changes to option menu:

① Opening Zapi menu.

② Press ROLL UP & SET UP Buttons to enter CONFIG MENU.

③ The display will show: SET MODEL.

④ Press ROLL UP or ROLL DOWN until SET OPTIONS appears.

⑤ SET OPTIONS menu appears.

⑥ Press ENTER to go into the SET OPTIONS menu.

⑦ The display will show the first option.

⑧ Press ROLL UP or ROLL DOWN buttons until desired option appears.

⑨ Desired option appears.

⑩ Press SET UP or SET DOWN buttons in order to modify the value for selected option.

⑪ New value for selected option appears.

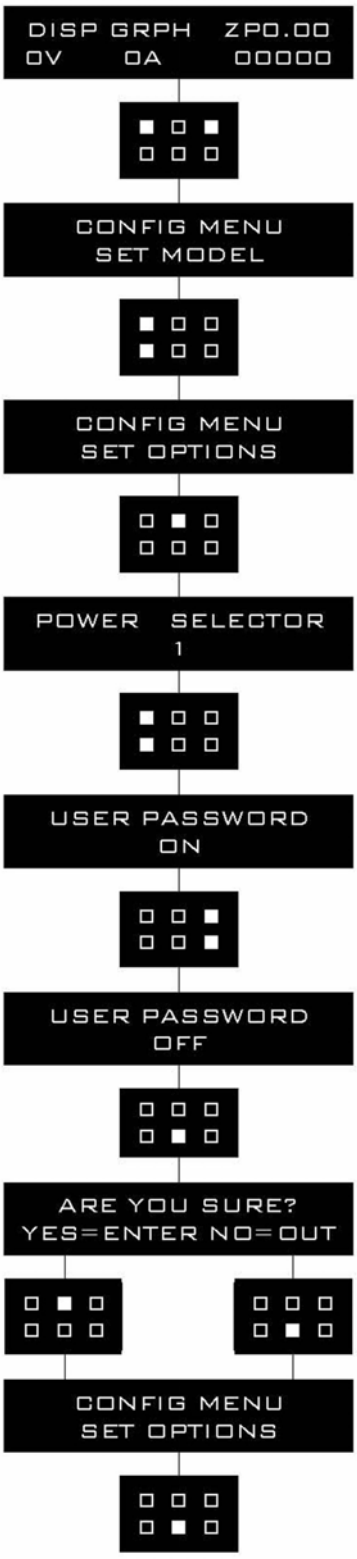
⑫ Press OUT to exit the menu.

⑬ Confirmation request appears.

⑭ Press ENTER to accept the changes, or press OUT if you do not accept the changes.

⑮ SET OPTIONS menu appears.

□ 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:

① Opening Zapi menu.

② Press ENTER to go into the MAIN MENU.

③ The display will show: PARAMETER CHANGE.

④ Press ROLL UP or ROLL DOWN until TESTER menu appears on the display.

⑤ The display will show: TESTER.

⑥ Press ENTER to go into the TESTER function.

⑦ The first variable to be tested is shown on the display.

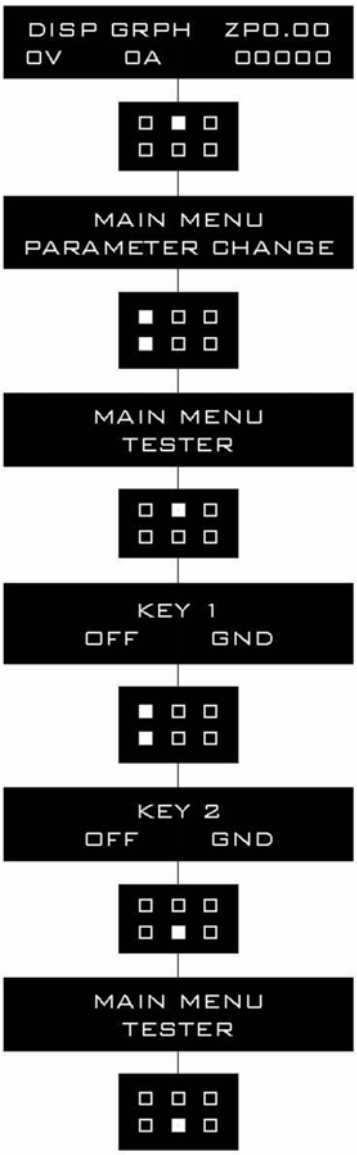
⑧ Press either ROLL UP or ROLL DOWN buttons.

⑨ Next variable for measurement appears.

⑩ When you have finished press OUT.

⑪ The Display will show: TESTER.

⑫ 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) DESCRIPTION OF ALARM 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 and the hour meter count. This function permits 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 menu.

② Press ENTER to go into the MAIN MENU.

③ The display will show:

④ Press ROLL UP or ROLL DOWN until ALARMS menu appears on the display.

⑤ The display will show:

⑥ Press ENTER to go into the ALARMS menu.

⑦ The display will show the most recent alarm.

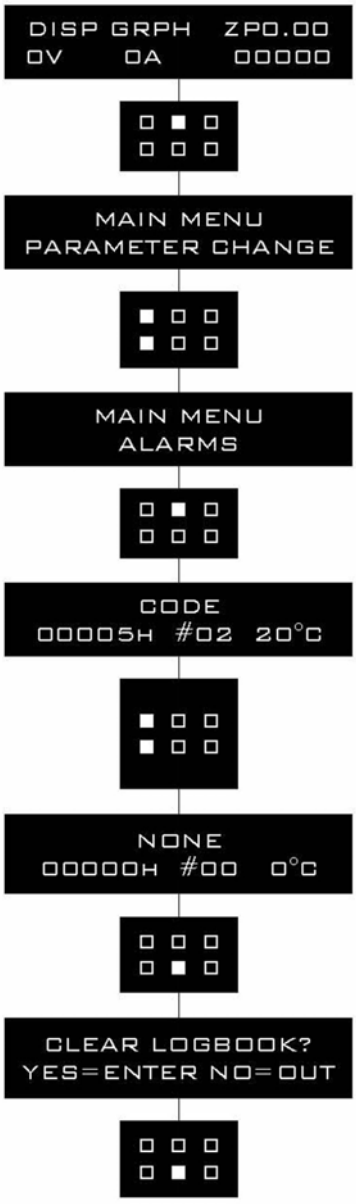
⑧ Each press of ROLL UP button brings up following alarms. Pressing ROLL DOWN returns to the most recent.

⑨ If an alarm has not occurred, the display will show: NONE.

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

⑪ The display will ask: "CLEAR LOGBOOK?" Press ENTER for Yes, or OUT for No.

⑫ Press OUT again and return to opening Zapi menu.



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8) STRUCTURE OF DISPLAY MENU

Graphic Smart Display present a software structure made by menus and submenus. It is possible to have access to Graphic Smart Display menu structure by the six operator buttons integrated in a membrane keyboard.

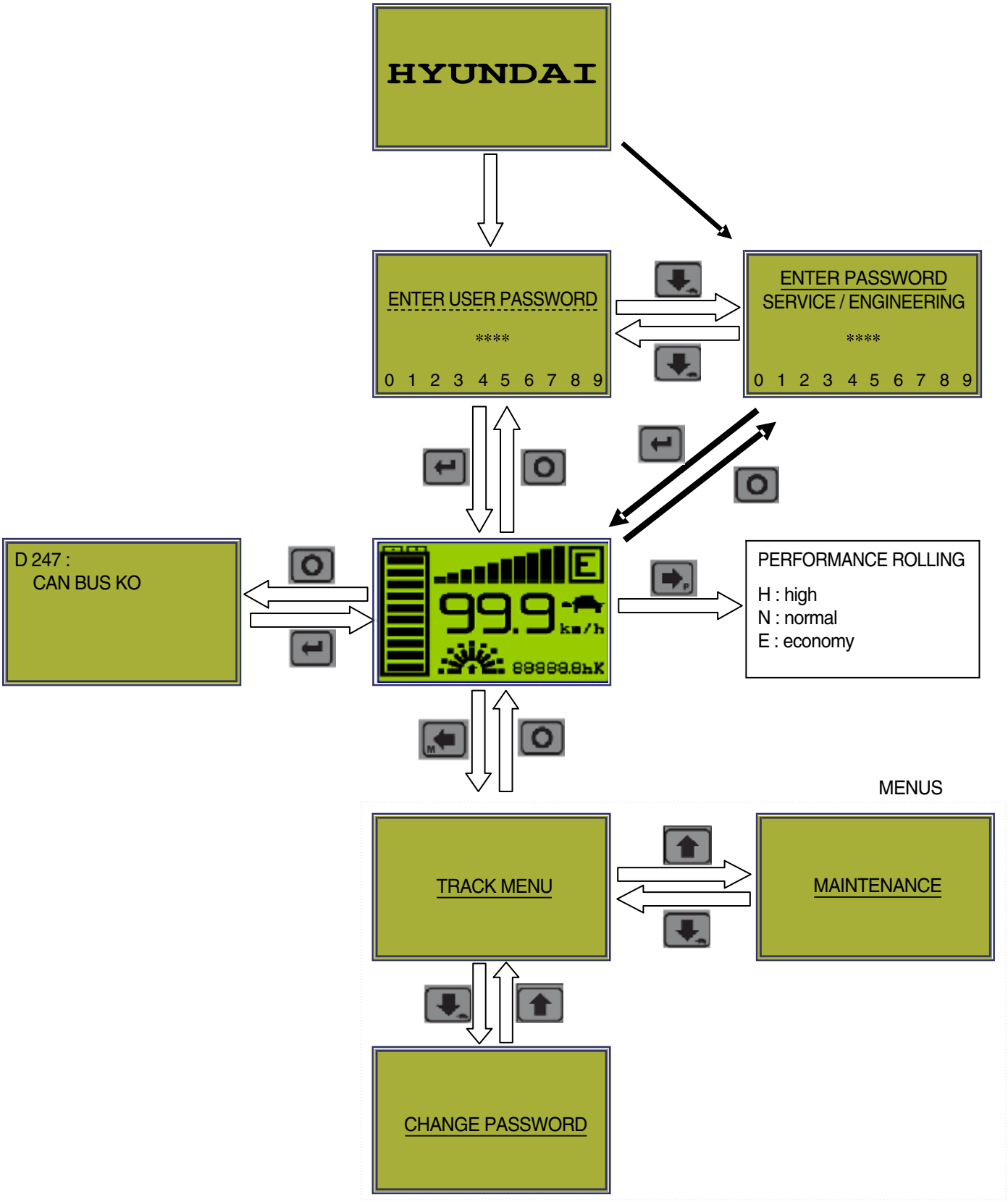
At turn on the display shows the HYUNDAI logo for some seconds, then asks the starting password to have access to the main page (if "USER PASSWORD" option is ON), otherwise it shows directly the main page (if "USER PASSWORD" option is OFF).

The main page, if there aren't alarms, shows battery charge, truck speed (in km/h or mph, it depends on "SPEED UNIT" parameter) and key/traction/pump hour meter (see "HOUR COUNTER" option); if alarms are present, it will show alarm code, node initials in which alarm has occurred and alarm description.

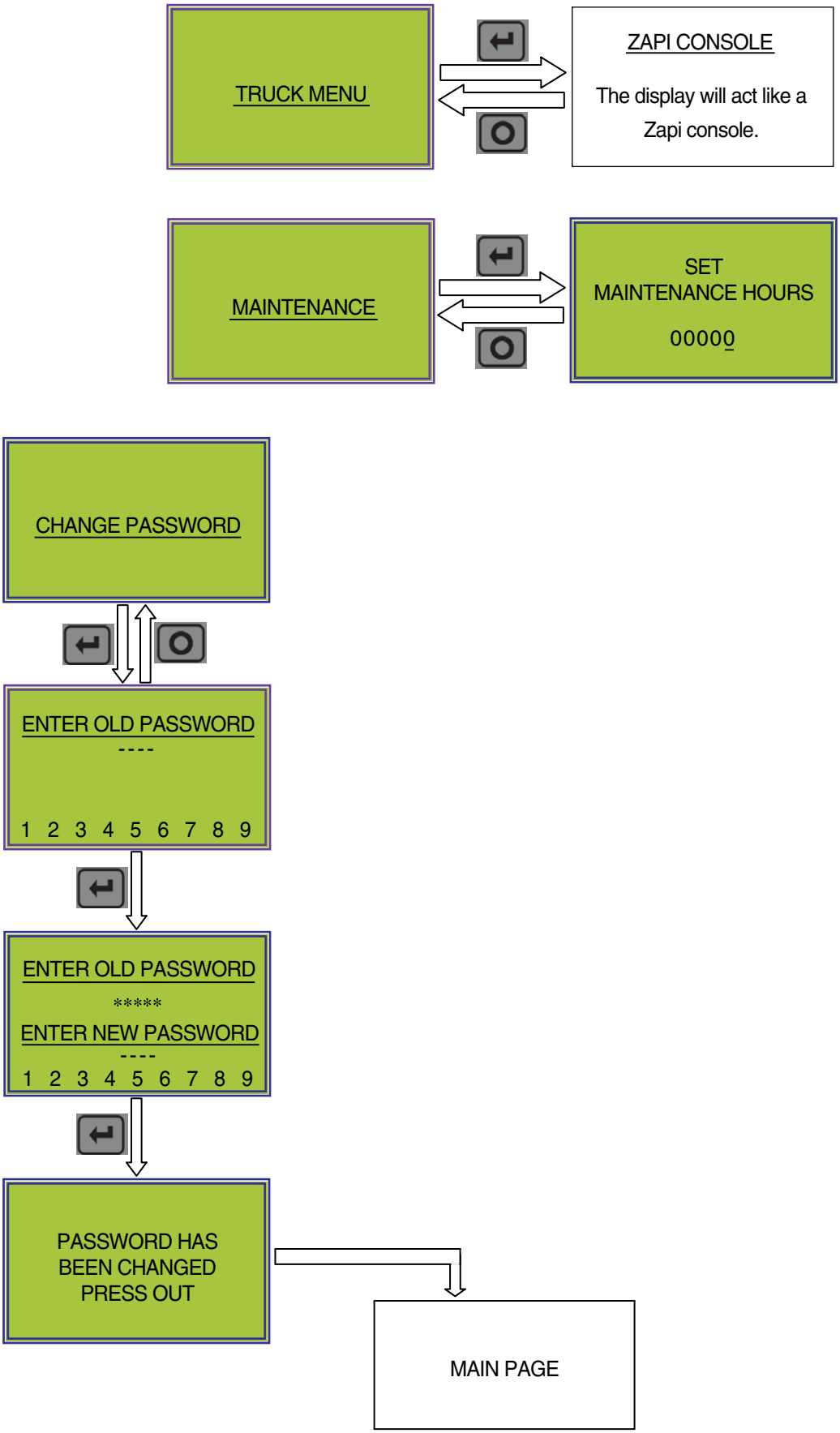
From the main page it is possible to have access to the ALARM page (if alarms occur) and to MENUS page. The CHANGE PASSWORD MENU is always accessible and visible, while the others ones are accesible and showed, by entering service password. To enter this password is necessary to push the out button (button #5) of membrane keyboard; this will show a entering password page.

By using service password it's possible to enter in all menus (TRUCK, CHANGE PASSWORD, MAINTENANCE).

It follows flow chart diagram of menu structure.


HYUNDAI
ENTER USER PASSWORD
****
0 1 2 3 4 5 6 7 8 9
ENTER PASSWORD
SERVICE / ENGINEERING
****
0 1 2 3 4 5 6 7 8 9
D 247 :
CAN BUS KO
99.9
km/h
88888.8hK
PERFORMANCE ROLLING
H : high
N : normal
E : economy
MENUS
TRACK MENU
MAINTENANCE
CHANGE PASSWORD

16B7SM23


TRUCK MENU
ZAPI CONSOLE
The display will act like a Zapi console.
MAINTENANCE
SET MAINTENANCE HOURS
00000
CHANGE PASSWORD
ENTER OLD PASSWORD
----
1 2 3 4 5 6 7 8 9
ENTER OLD PASSWORD
*****
ENTER NEW PASSWORD
----
1 2 3 4 5 6 7 8 9
PASSWORD HAS BEEN CHANGED PRESS OUT
MAIN PAGE

20B7EL41

(1) Performance rolling

From MAIN PAGE using membrane keyboard numbers, it is possible to select the performance mode which must be used in traction and pump controllers.
Performance can be chosen with button 4, and it is displayed in the top right side of the unit.
When one performance is selected, the related information will be sent via canbus to traction and pump controllers that will manage this data. The standard functioning reduces truck performance passing from high performance mode (H) to economy performance mode (E).
The real meaning, in terms of parameters level of these performances, depends on software present on pump and traction controllers.

Button 4 Selects in sequence the truck performance (H → N → E).

(2) Using dashboard like console

By entering the service or engineering password, from MAIN PAGE it's possible to have access to TRUCK MENU, which allows user to use dashboard as a real Zapi digital console connected to one module of canbus net.
Here with roll buttons (button 1 and 2 of membrane keyboard) and enter button (button 6), it is possible to choose which module of canbus net has to be connected to the display.
When the display has been connected, it works exactly like a Zapi digital console.
Buttons of membrane keyboard do the same functions of Zapi console keys.

Button 1 Performs function of the ROLL UP console key
Button 2 Performs function of the ROLL DOWN console key
Button 3 Performs function of the SET DOWN console key
Button 4 Performs function of the SET UP console key
Button 5 Performs function of the OUT console key
Button 6 Performs function of the ENTER console key

(3) Using of password menu (option)

From MAIN PAGE it's always possible to have access to CHANGE PASSWORD MENU. Here with ENTER button (button 6 of membrane keyboard) the operator can change user Graphic Smart Display password.
To edit password use these buttons:

SET UP / SET DOWN	Shifts cursor through 10 digits on the bottom side of unit
ENTER	Inputs digit selected or saves all changing
OUT	Cancels one digit or exits (if there is no digit input yet)

(4) Set maintenance hours (option)

By entering the service or engineering password from MAIN PAGE it's possible to access to MAINTENANCE MENU. Here the service can change the programmed work hours between two maintenances.
Buttons of membrane keyboard have the same functions in the RESET HOURMETERS MENU:

Button 1 Increases digit marked by cursor
Button 2 Decreases digit marked by cursor
Button 3 Shifts cursor on previous digit
Button 4 Shifts cursor on following digit
Button 5 Cancels all changing and out from hour meter submenu
Button 6 Saves all changing

9) ANALYSIS OF GRAPHIC SMART DISPLAY RELATED ALARMS

(1) Graphic Smart Display alarms

① WATCHDOG

Cause:

At start-up the watch dog signal is already active before the software has generated it. At standby or running condition the watch dog signal is not active (in alarm status).

Troubleshooting:

The WD hardware circuit or microcontroller output port are damaged. In both cases no external component are involved. Replace the logic board.

② COIL SHORTED

Cause:

This alarm occurs when there is a short circuit of the AUXILIARY coil connected to CNB#1 output. After the overload condition has been removed, the alarm exits automatically by releasing and then enabling a travel demand.

Troubleshooting:

A) 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 dashboard outputs and loads.

B) In case no failures/problems have been found externally, the problem is in the logic card, which has to be replaced.

③ DRIVER SHORTED

Cause:

The driver of the auxiliary electro valve coil is shorted.

Troubleshooting:

A) Check if there is a short or a low impedance pull-down between NAUX (CNB#1) and -BATT.

B) The driver circuit is damaged in the logic board, which has to be replaced.

④ AUX DRIVER OPEN

Cause:

The AUX coil driver is not able to drive the load. The device itself or its driving circuit is damaged.

Troubleshooting:

This type of fault is not related to external components; replace the logic board.

⑤ HARDWARE FAULT

Cause:

At key-on the dashboard checks if the AUX driver is turned off by a not active (alarm status) watch-dog signal. If it is not turned off then the alarm is generated.

Troubleshooting:

The problem is inside the logic, no external component are involved, replace the logic board.

⑥ **CAN BUS KO**

Cause:

Graphic Smart Display doesn't receive messages from canbus line or the hour meter synchronization at key-on fails.

Troubleshooting:

A) If this fault code is displayed together with other alarm messages, the fault is probably to be looked for in the Graphic Smart Display can interface, since the display seems to be unable to receive any can message. So it is suggested to check Graphic Smart Display canbus wiring and connection.

B) Otherwise, the fault is in the can interface of other modules present on canbus network.

(2) Graphic Smart Display warnings

① **EEPROM KO**

Cause:

It's due to an HW or SW defect of the non-volatile embedded memory supporting the dashboard parameters. This alarm does not inhibit the machine operations, but the truck will work with the Graphic Display parameters default values.

Troubleshooting:

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 logic. If the alarm disappears, the previously stored parameters will have been replaced by the default parameters.

② **MAINTENANCE NEEDED**

Cause:

This is just a warning to call for the time programmed maintenance.

Troubleshooting:

It is just enough to turn the MAINTENANCE DONE option to level ON after the maintenance is executed.

(3) Alarms visualization

When an alarm condition occurs, Graphic Smart Display gives the information showing the initial of module in which the alarm occurred, the alarm code and description.

For example, the information:

```
M 245:
    WRONG SET BAT
```

means that the alarm 245 - "WRONG SET BATTERY" occurred in the master traction controller (M).

Here the table with the alarm codes and the respective meaning is shown.

10) DIAGNOSTIC FAULT CODES

(1) Traction controller

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

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
60	CAPACITOR CHARGE	Alarm: power capacitor voltage does not increase when the key is turned ON; failure in the power section, or in the Logic PCB, or in the driver PCB, or in the motor	- To remove alarm condition - Check the contactor resistance (300 Ω, 10W) - Check the controller
62	TH. PROTECTION	Warning: Traction temperature higher than 75˚C	- To remove Warning cause
65	MOTOR TEMPERAT.	Warning: Traction motor temperature high	- To remove Warning cause - Check the motor temp-sensor
66	BATTERY LOW	Warning: battery charge level below 10%	- To remove Warning cause
74	DRIVER SHORTED	Alarm: line contactor coil driver is shorted	- If the alarm is present in Init status, remove the alarm cause - If the alarm has occurred in stby or running mode, it is necessary to remove alarm cause and to activate traction request
75	CONTACTOR DRIVER	Alarm: line contactor coil driver is open (not able to drive the coil to the correct voltage)	- To remove alarm cause and to activate traction request
78	VACC NOT OK	Warning: acc. signal (CPOT) voltage higher than VACC MIN +1V while the traction enable switch is open	- To remove Warning cause - Re-configurate VASS ACCEL
79	INCORRECT START	Warning: wrong traction request sequence	- To remove Warning cause
80	FORW + BACK	Warning: forward and reverse inputs are both active	- To remove Warning cause
82	ENCODER ERROR	Alarm: motor speed sensor (encoder) does not work properly	- To recycle the key - Check the motor encoder
84	STEER SENSOR KO	Alarm: steering sensor signal out of range	- To remove alarm cause
217	SENS MOT TEMP KO	Warning: The output of the motor thermal sensor is out of range	- To remove warning cause
221	SEAT MISMATCH	Alarm: seat input mismatch between PUMP and TRAC controller	- Check the wire connection. Need to recycle the key
223	WATCHDOG#1	Alarm: The watchdog signal #1 is not in the correct status	- To remove alarm cause

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
224	AUX COIL SHORT	Alarm: shortcircuit on EB/AUX coil	- To remove alarm cause
226	VACC OUT RANGE	Waring: The accelerator input is out of the range Vacc_min ÷ Vacc_max, which has been acquired with “PROGRAMM VACC” function	- Try to perform a program VACC
227	WATCHDOG#2	Alarm: The watchdog signal #2 is not in the correct status	- To remove alarm cause
228	CHAT TIME	Warning: the chat time has expired	- To activate traction or pump request
229	SAFETY INPUT	Alarm: The safety input is open (it is not connected to -Batt)	- To remove alarm cause
230	MC COIL SHORT	Alarm: shortcircuit on MC coil	- To remove alarm cause
231	COIL SHORT HW KO	Alarm: The harware to check a MC or EB/AUX coil shorted is damaged	- Check the controller
232	KEY OFF SHORT	Alarm: At Start-up the Keyoff logic signal is low	- Check the connection. Check the key input signal.
233	POWER MOS SHORT	Alarm: Short circuit on the power Mosfets	- Check the controller
234	DISPLAY ENABLE	Warning: the display enable signal has not been received to operate the truck	- To remove warning cause
235	HANDBRAKE	Warning: handbrake microswitch is open and a travel request is active	- To remove Warning cause
236	CURRENT GAIN	Warning: The Maximum current gain parameters are the default values, which means the maximum current adjustment procedure has not been carried out yet	- Check the controller
237	ANALOG INPUT	Alarm: the analog channel ready is not updated	- Check the controller
238	WRONG 0 VOLTAGE	Alarm: The motor phases voltage feedback are out of permitted range	- To remove alarm cause
239	SAFETY OUTPUT	Alarm: The Safety-out driver is damaged (shorted or open)	- To remove alarm cause
240	HARDWARE FAULT	Alarm: The mosfets driver are not switched off with watch-dog signal in alarm status	- Check the controller
241	FLASH CHECKSUM	Alarm: The program verify is not OK	- Try to program the controller again. Check the controller logic board

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
242	MOTOR STALL	Warning: the encoder signal is constantly zero when the maximum torque is applied to the motor	- To recycle the key - Check the motor and encoder
243	SEQUENCE FAULT	Warning: an incorrect start sequence has been detected on the seat, pedal and levers commands	- To remove Warning cause
245	WRONG RAM MEMORY	Alarm: The program checks the contents of main RAM registers and find a “dirty value”	- Check the controller
246	AUX DRIV.OPEN	Alarm: Driver of EB/AUX coil is damaged (not able to apply the brake)	- Check the controller
248	NO CAN MSG.	Alarm: Traction has lost Can communication with #X	- To remove alarm cause - Check if any other alarm happens (Some alarms such as CHAT TIME or PEDAL WIRE KO, alarms related to CONTACTOR, DISPLAY ENABLE, alarms related to CANBUS can make this alarm sometimes.) - Check the communication with all controllers
249	CHECK UP NEEDED	Warning: truck reached the hour time for maintenance	- Reset the checkup hour time
250	THERMIC SENS. KO	Warning: Traction temp. sensor is out of range	- To remove Warning cause
251	WRONG SET BAT.	Alarm: the battery voltage does not correspond to SET BATTERY programming	- To remove alarm cause
253	SLIP_PROFILE	Warning: Error on the parameters of the slip profile setting	- Check in the hardware settings menu the value of those parameters
254	AUX DRIV.SHRT.	Alarm: the EB/AUX driver is shorted so it is not able to open the contactor	- Check the controller

(2) Pump controller

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
13	EEPROM KO	Warning: Eeprom fault, controller will use default parameters	- To remove Warning cause
17	LOGIC FAILURE #3	Alarm: failure in over-load protection hw circuit	- To remove alarm condition + activation of pump request - Check the controller
18	LOGIC FAILURE #2	Alarm: failure in U, V, W voltage feedback circuit	- To remove alarm condition + activation of pump request
19	LOGIC FAILURE #1	Alarm: an overvoltage or undervolt. condition has been detected	- To recycle the key switch - Sometimes if battery voltage is too low, it can be happens - Check the controller
30	VMN LOW	Alarm: wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor	- If the alarm is present in Init status, remove the alarm condition - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a pump request - Check the U, V, W cable and motor and if there is any shorted circuit with frame or any other parts of truck - Check the controller
31	VMN HIGH	Alarm: wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor	- If the alarm is present in Init status, remove the alarm condition - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a pump request - Check the U, V, W cable and motor and if there is any shorted circuit with frame or any other parts of truck - Check the controller
37	CONTACTOR CLOSED	Alarm: line contactor power contact is stuck	- To remove alarm cause within a timeout; if the timeout is elapsed, it is necessary to re-cycle the key - Check the contactor & cables attached to the contactor
38	CONTACTOR OPEN	Alarm: line contactor power contact does not pull-in	- To remove alarm cause within a timeout; if the timeout is elapsed, it is necessary to re-cycle the key - Check the contactor & cables attached to the contactor
53	STBY I HIGH	Alarm: wrong voltage in the current sensor feedback circuit	- If the alarm is present in Init status, remove the alarm condition - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a pump request

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
60	CAPACITOR CHARGE	Alarm: power capacitor voltage does not increase when the key is turned ON; failure in the power section, or in the Logic PCB, or in the driver PCB, or in the motor	- To remove alarm condition - Check the contactor resistance (300 Ω, 10W) - Check the controller"
62	TH. PROTECTION	Warning: Pump temperature higher than 75˚C	- To remove Warning cause
65	MOTOR TEMPERAT.	Warning: Pump motor temperature high	- To remove Warning cause - Check the motor temp-sensor
74	DRIVER SHORTED	Alarm: line contactor coil driver is shorted	- If the alarm is present in Init status, remove the alarm cause - If the alarm has occurred in stby or running mode, it is necessary to remove alarm cause and to activate pump request
75	CONTACTOR DRIVER	Alarm: line contactor coil driver is open (not able to drive the coil to the correct voltage)	- To remove alarm cause and to activate pump request
78	VACC NOT OK	Warning: lift signal (CPOT) voltage higher than VACC MIN +1V while the lift enable switch is open	- To remove Warning cause - Re-configurate VASS ACCEL
79	INCORRECT START	Warning: wrong pump request sequence	- To remove Warning cause
80	FORW + BACK	Warning: forward and reverse inputs are both active	- To remove Warning cause
82	ENCODER ERROR	Alarm: motor speed sensor (encoder) does not work properly	- Tto recycle the key - Check the motor encoder
206	POT MISMATCH FT1	Alarm: FT1 dual signal mismatch	- Check the wire connections
207	POT MISMATCH FT2	Alarm: FT2 dual signal mismatch	- Check the wire connections
208	SHIFT OUT OF RNG	Warning: Shift signal is out of range	- Check the wire connections
209	AUX OUT OF RANGE	Warning: Aux signal is out of range	- Check the wire connections
210	TILT OUT OF RNG.	Warning: Tilt signal is out of range	- Check the wire connections
211	LIFT OUT OF RNG.	Warning: Lift signal is out of range	- Check the wire connections
212	ACQUIRE FT4	Warning: FT4 acquisition is wrong (aux)	- Make a new acquisition

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
213	ACQUIRE FT3	Warning: FT3 acquisition is wrong (shift)	- Make a new acquisition
214	ACQUIRE FT2	Warning: FT2 acquisition is wrong (tilt)	- Make a new acquisition
215	ACQUIRE FT1	Warning: FT1 acquisition is wrong (lift/lower)	- Make a new acquisition
216	MHYRIO IN ALARM	Warning: Mhyrio is in alarm	- To remove Warning cause
217	SENS MOT TEMP KO	Warning: The output of the motor thermal sensor is out of range.	- To remove warning cause
218	LOADSENS.OUT RNG	Warning: load sensor out of range	- To remove warning cause
219	FORKS OVERLOADED	Warning: overload weight is reached	- To remove warning cause
221	SEAT MISMATCH	Alarm: seat input mismatch between PUMP and TRAC controller	- Check the wire connection. Need to recycle the key
223	WATCHDOG#1	Alarm: The watchdog signal #1 is not in the correct status	- To remove alarm cause
224	AUX COIL SHORT	Alarm: shortcircuit on EB/AUX coil	- To remove alarm cause
226	VACC OUT RANGE	Waring:The lift input is out of the range Vacc_min ÷ Vacc_ max, which has been acquired with “PROGRAMM VACC” function	- Try to perform a program VACC
227	WATCHDOG#2	Alarm: The watchdog signal #2 is not in the correct status	- To remove alarm cause
228	CHAT TIME	Warning: the chat time has expired	- To activate traction or pump request
229	SAFETY INPUT	Alarm: The safety input is open (it is not connected to -Batt)	- To remove alarm cause
230	MC COIL SHORT	Alarm: shortcircuit on MC coil	- To remove alarm cause
231	COIL SHORT HW KO	Alarm: The harware to check a MC or EB/AUX coil shorted is damaged	- Check the controller
232	KEY OFF SHORT	Alarm: At Start-up the Keyoff logic signal is low	- Check the connection. Check the key input signal.
233	POWER MOS SHORT	Alarm: Short circuit on the power Mosfets	- Check the controller
234	DISPLAY ENABLE	Warning: the display enable signal has not been received to operate the truck	- To remove warning cause

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
235	HANDBRAKE	Warning: handbrake microswitch is open and a travel request is active	- To remove Warning cause
236	CURRENT GAIN	Warning: The Maximum current gain parameters are the default values, which means the maximum current adjustment procedure has not been carried out yet	- Check the controller
237	ANALOG INPUT	Alarm: the analog channel ready is not updated	- Check the controller
238	WRONG 0 VOLTAGE	Alarm: The motor phases voltage feedback are out of permitted range	- To remove alarm cause
239	SAFETY OUTPUT	Alarm: The Safety-out driver is damaged (shorted or open)	- To remove alarm cause
240	HARDWARE FAULT	Alarm: The mosfets driver are not switched off with watch-dog signal in alarm status	- Check the controller
241	FLASH CHECKSUM	Alarm: The program verify is not OK	- Try to program the controller again. Check the controller logic board
242	MOTOR STALL	Warning: the encoder signal is constantly zero when the maximum torque is applied to the motor	- To recycle the key - Check the motor and encoder
248	NO CAN MSG.	Alarm: Pump has lost Can communication with #X	- To remove alarm cause - Check if any other alarm happens (Some alarms such as CHAT TIME or PEDAL WIRE KO, alarms related to CONTACTOR, DISPLAY ENABLE, alarms related to CANBUS can make this alarm sometimes.) - Check the communication with all controllers
249	CHECK UP NEEDED	Warning: truck reached the hour time for maintenance.	- Reset the checkup hour time
250	THERMIC SENS. KO	Warning: Pump temp. sensor is out of range	- To remove Warning cause
251	WRONG SET BAT.	Alarm: the battery voltage does not correspond to SET BATTERY programming	- To remove alarm cause
253	SLIP_PROFILE	Warning: Error on the parameters of the slip profile setting.	- Check in the hardware settings menu the value of those parameters
254	AUX DRIV.SHRT.	Alarm: the EB/AUX driver is shorted so it is not able to open the contactor	- Check the controller

8. BATTERY CHARGER

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

1) BASIC INFORMATION

(1) What is charger

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

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

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

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

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

④ It prevents from under charging and overcharging.

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

(2) Notice on caring chargers

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

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

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

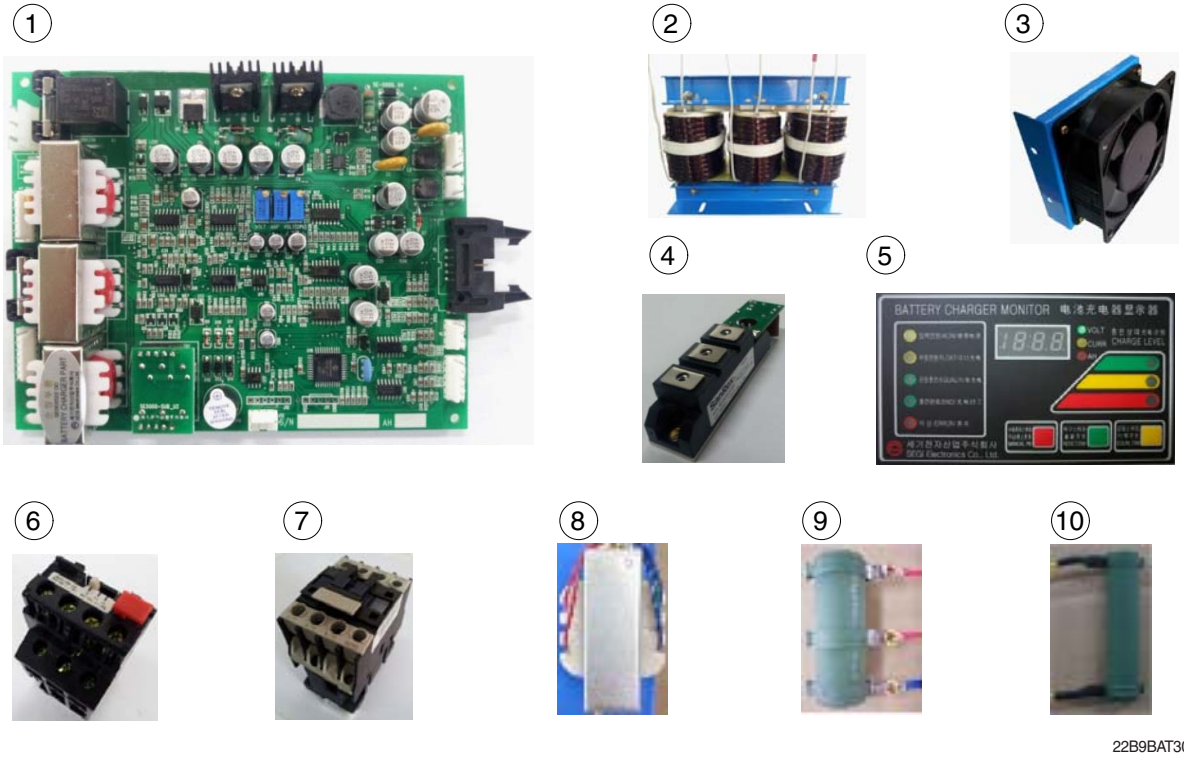
④ Check the electrolyte of the battery every week and provide distilled water immediately if it is required. (Electrolyte has to be provided between 10~12 ㎜ level on the positive plate inside storage battery)

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

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

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

(3) Names of each part (independent items)



22B9BAT30

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

2) CHARGER INSTALLATION METHOD

(1) Location for charger installation

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

(2) Check points before installing charger

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

(3) Table for capacity of charger input cable

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

3) HOW TO USE A CHARGER

(1) General charging method (Floating charging)

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

② Connect battery connecter and charger connecter.

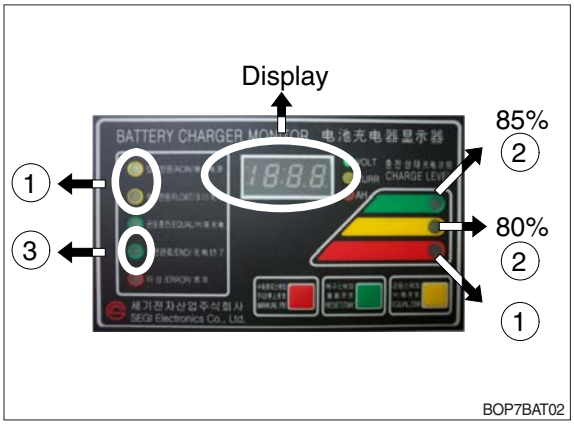
· **According to charging condition**

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

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

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

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



(2) Equalized charging

① **Equalized charging is**

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

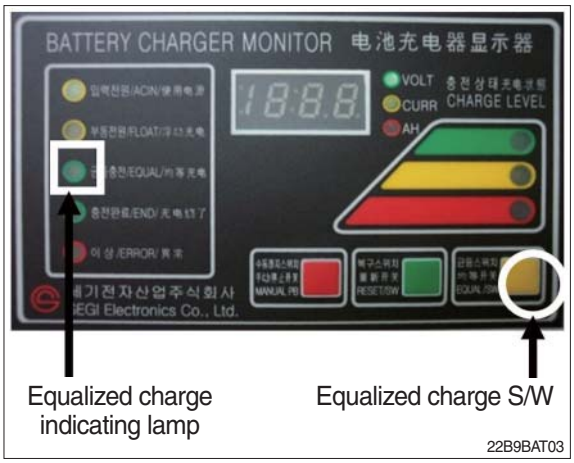
When equalized charging is required?

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

② **Tips for equalized charging**

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

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



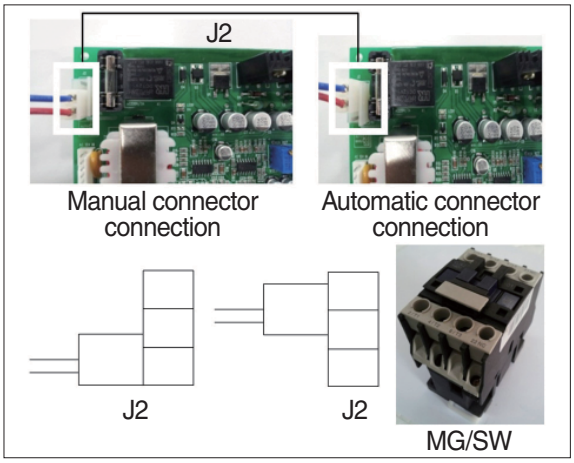
22B9BAT03

(3) Automatic/Manual switching method

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

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

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



22B9BAT04

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

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

BOP7BAT10

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

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

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

22B9BAT11

No	Code	Description of error
1	E.F	EPROM fail
2	O.V	Over voltage - Refer to page 7-90
3	O.C	Over current - Refer to page 7-89, 7-91.
4	F.B	Battery error (After starting charging, the voltage doesn't go over 52V for 2 hours.) Check the battery.
5	O.T	Transformer over heat (Stop charging when it is over 160°C). - If input voltage is high, output current is over normal value and there is heat in the trans because of SCR control part fault. - Check the output current and PCB control board
6	O.H	Heatsink over heat (Stop charging when it is over 100°C). - Check the cooling fan, SCR connection cable contact point and control part.
7	A.O	Power supply error (input power 220/380V wrong wiring). - Refer to page 7-88.
8	A.F	Power supply error (absent phase) - Check if input cable is open.
9	A.C	AC fail (black out) - Check if input voltage is right.
10	L.C	Low current (If this sign is on for setting value (60 sec), charging is over).
11	F	Manual stop.

4) CHECK POINTS BEFORE APPLYING A/S

(1) AC input power source switch is input.

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

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

(4) Check the front cover indicator.

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

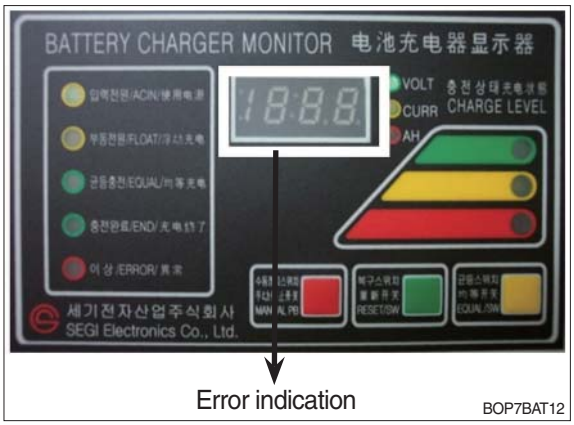
② A.O : Error on selection of input power source of 220V or 380V - Check it appropriately with full three phases.

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

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

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

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



5) ERROR DETECTION

(1) Error list

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

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

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

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

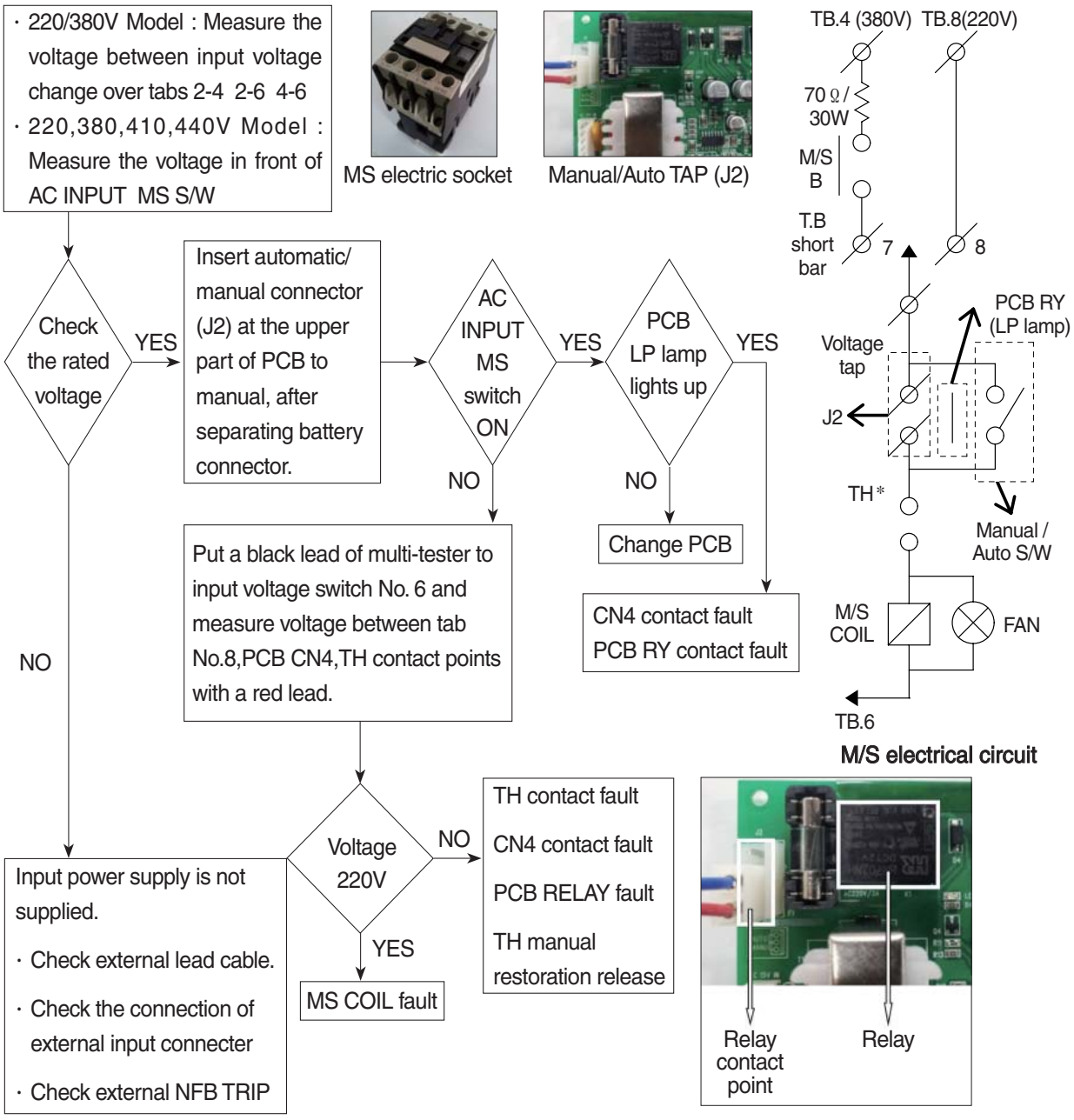
⑤ Charger TRIP is occurred after it started charging and charging completion lamp is on.

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

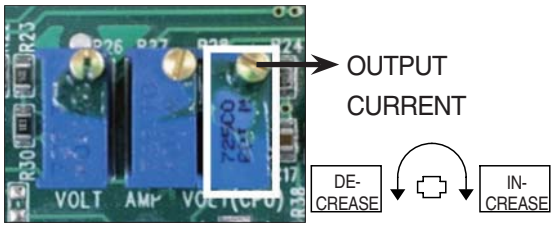
⑦ SCR module checking method

(2) Troubleshooting

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



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



Trans noise is severe at MS ON status

NO

Measure output current using DC current measure

Current value : 10~16A /100AH

NO

Exceed Standard current

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

YES

· TH Setting fault
· Re-adjust TH setting value

TH. TRIP

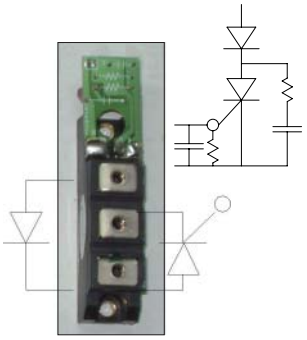
YES

Change TH

NO

Complete

* Refer to SCR Module checking method



YES

Rated Current SETTING

YES

NO

Complete

Change PCB

Separate the battery connector and tune the charger off

Check SCR Module

NO

Change SCR MODULE

YES

Check MAIN TRANS VOLT

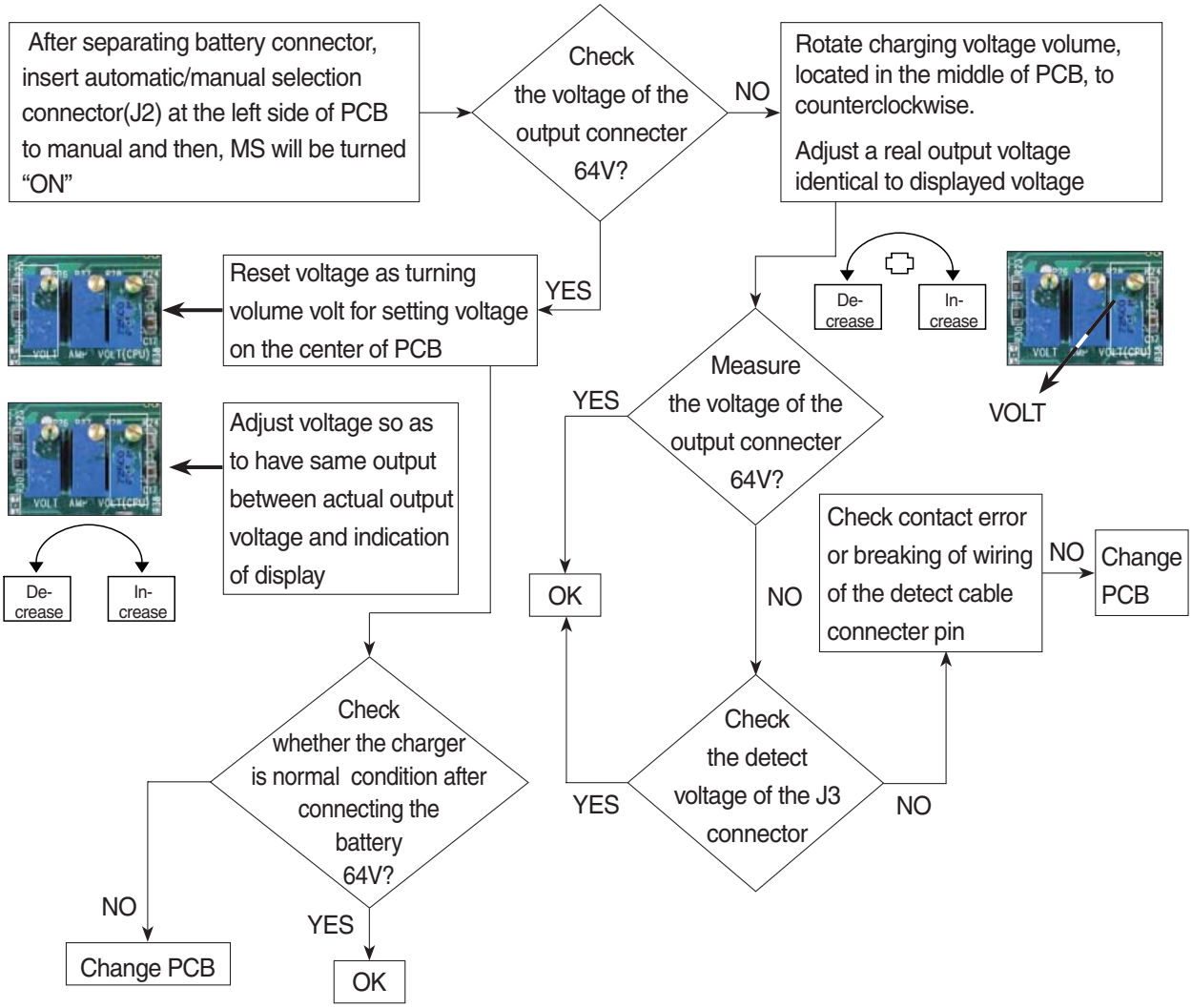
NO

Change PCB

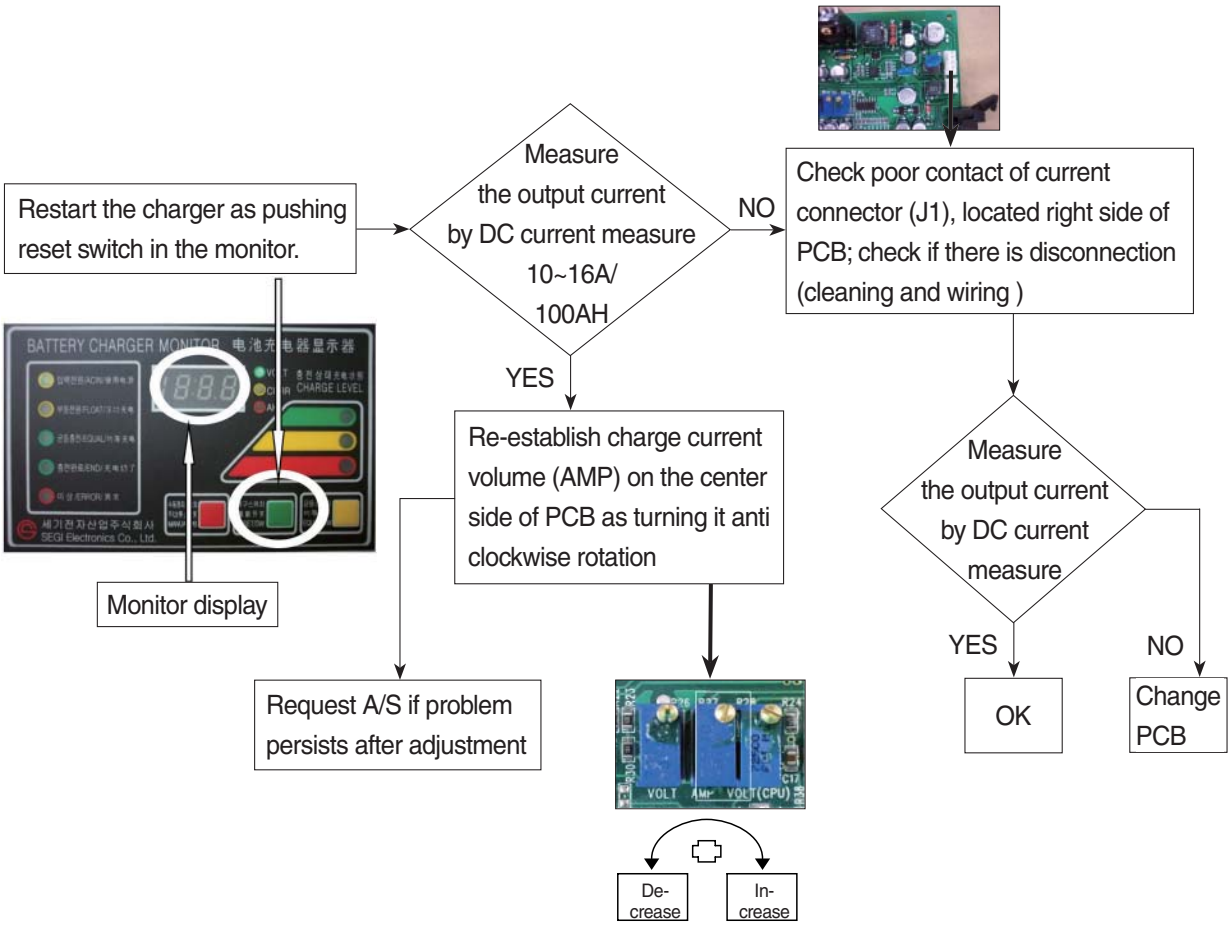
YES

Check the normal operating condition of the charger

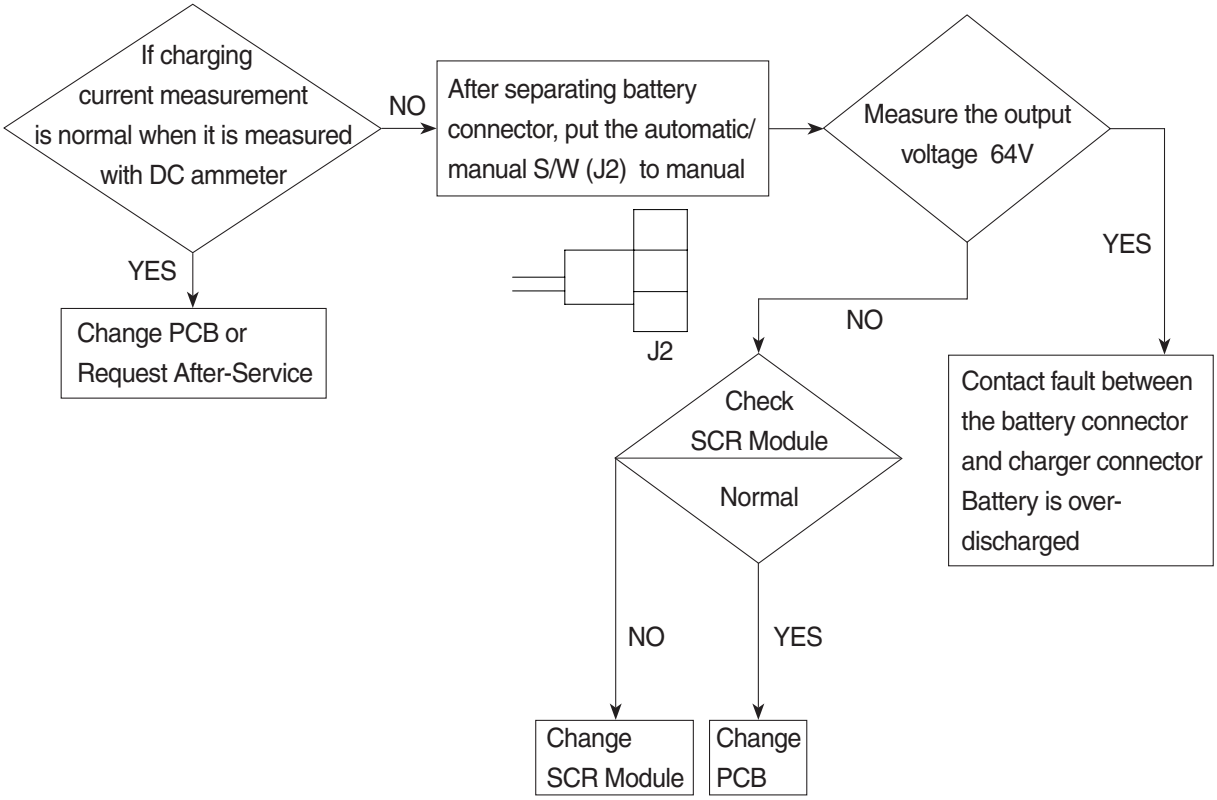
③ Charger TRIP is occurred after abnormality lamp is on.
In case error code is "O.V" → Over-voltage output / Set at 66V (In case of BATT 48V)
34V (In case of BATT 24V)
108V (In case of BATT 80V)



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

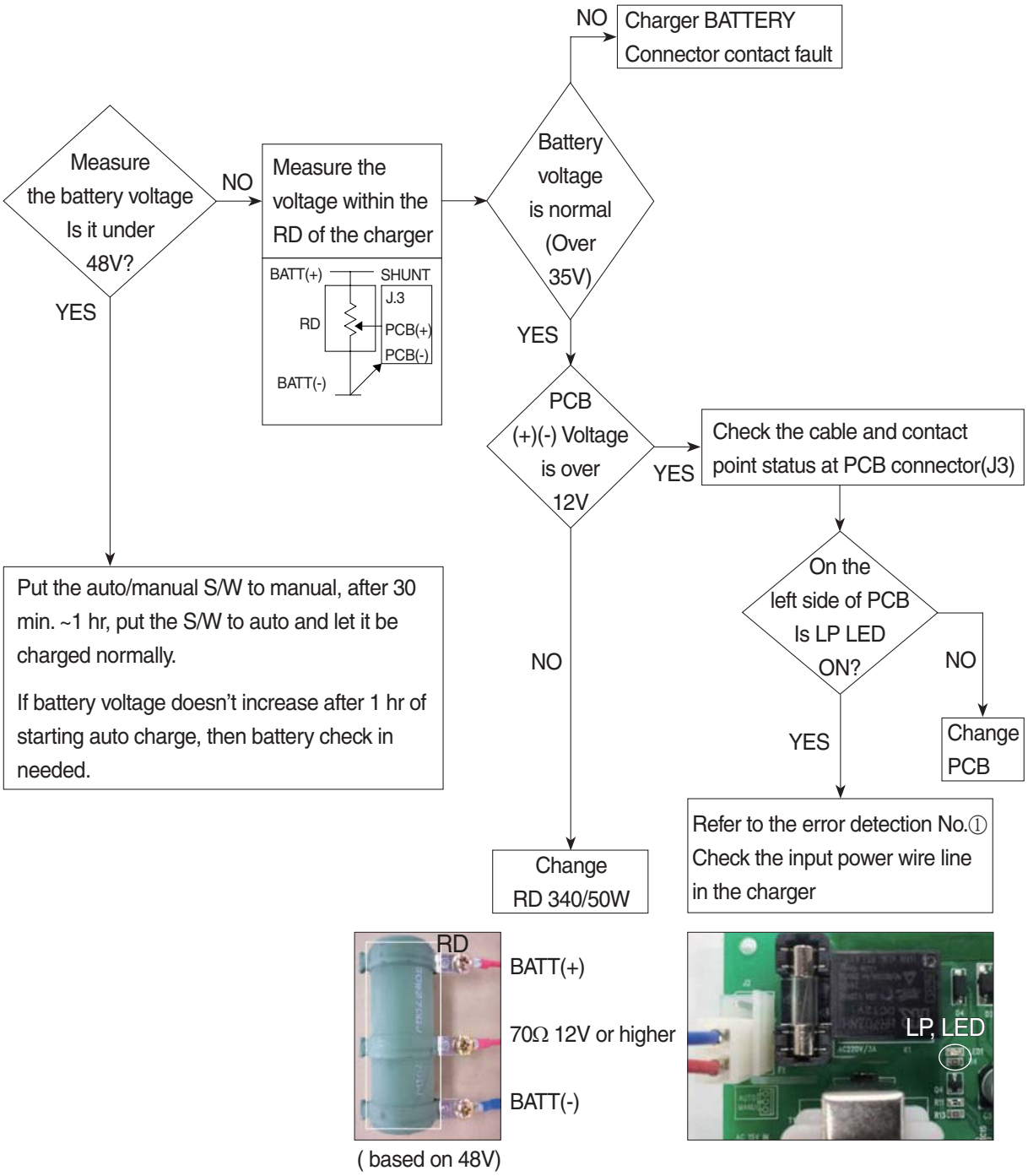


⑤ **Charger TRIP is occurred after it started charging and charging completion lamp is on.**
(In case input voltage is normal - Refer to the error detection No. 1)
Restore the charger as pushing reset switch.



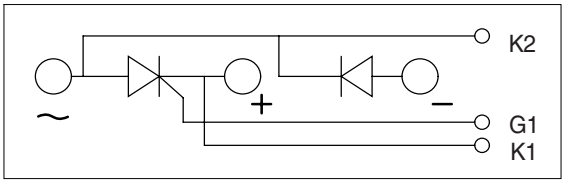
⑥ **Charger has no response even if the battery connector is connected.**

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

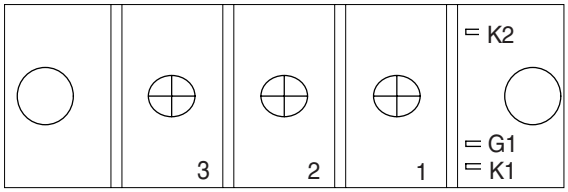


7) HOW TO CHECK THE SCR MODULE

Circuit

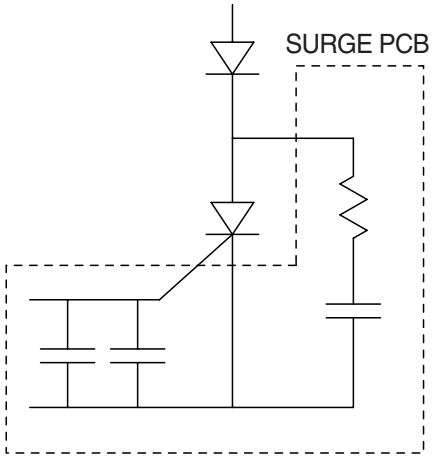


Real diagram

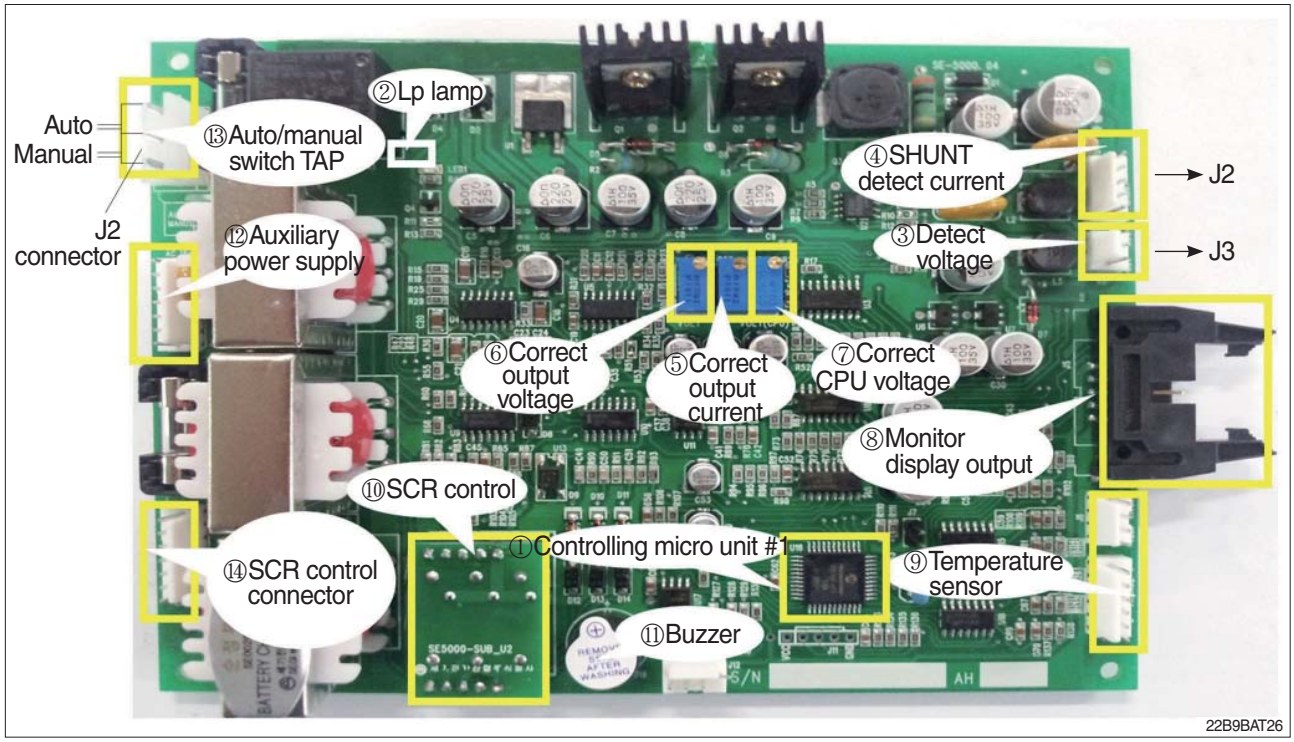


* Before checking SCR MODULE, be sure to disconnect bus bar and wire on the terminal.

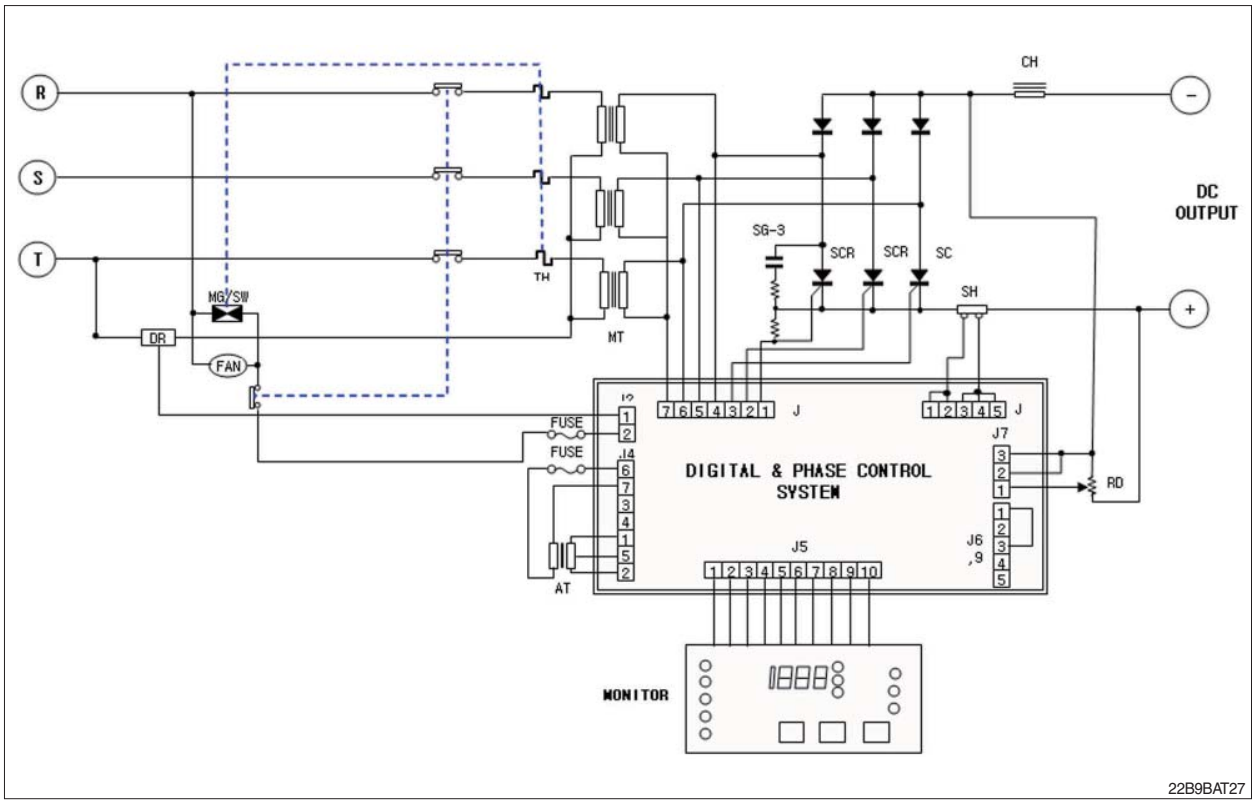
No.	Measuring point (Real diagram)	Measure value (Measurement of digital tester)
1	No.1 ~ No.3	Forward : Under 100 k ohm Reverse : Infinity (∞)
2	No.2 ~ No.3	Forward : Infinity (∞) Reverse : Infinity (∞)
3	G1 ~ K1	Forward : Under 100 ohm Reverse : Under 100 ohm But It depends on the module. If it is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



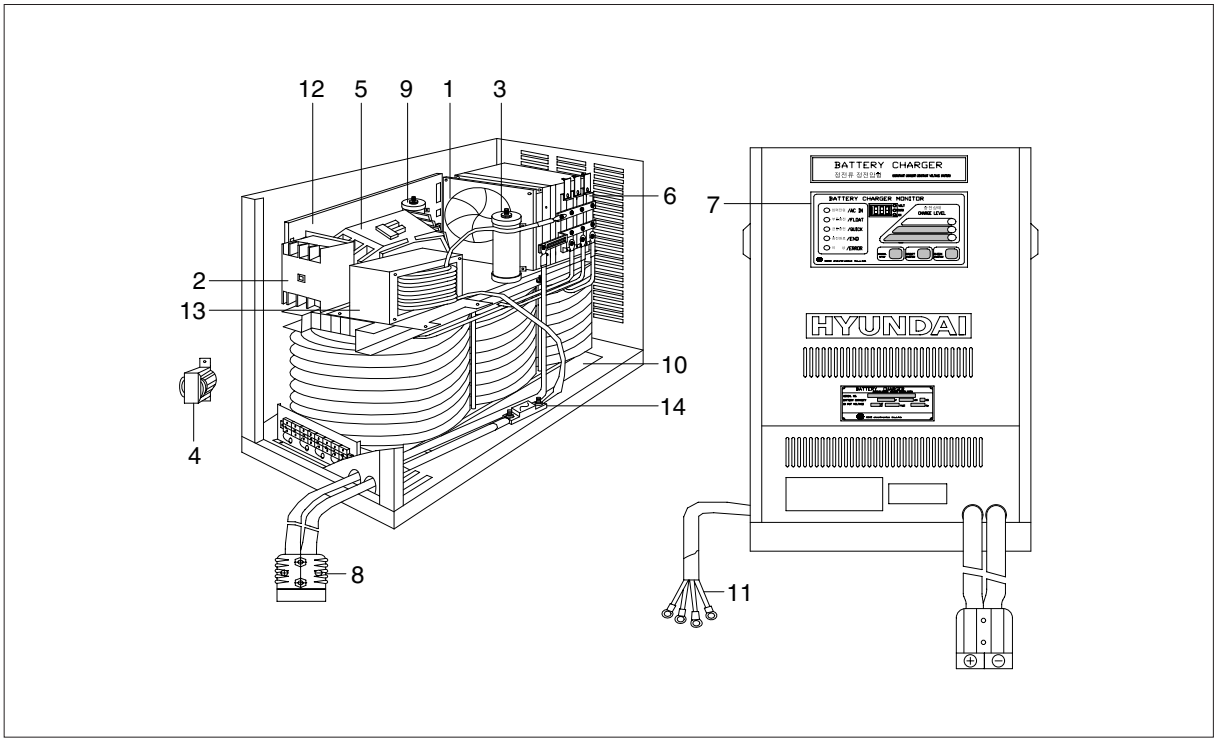
8) PCB MAJOR PARTS (NAME AND LOCATION)



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


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

CHARGER INTERIOR PARTS



22B9BAT28

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