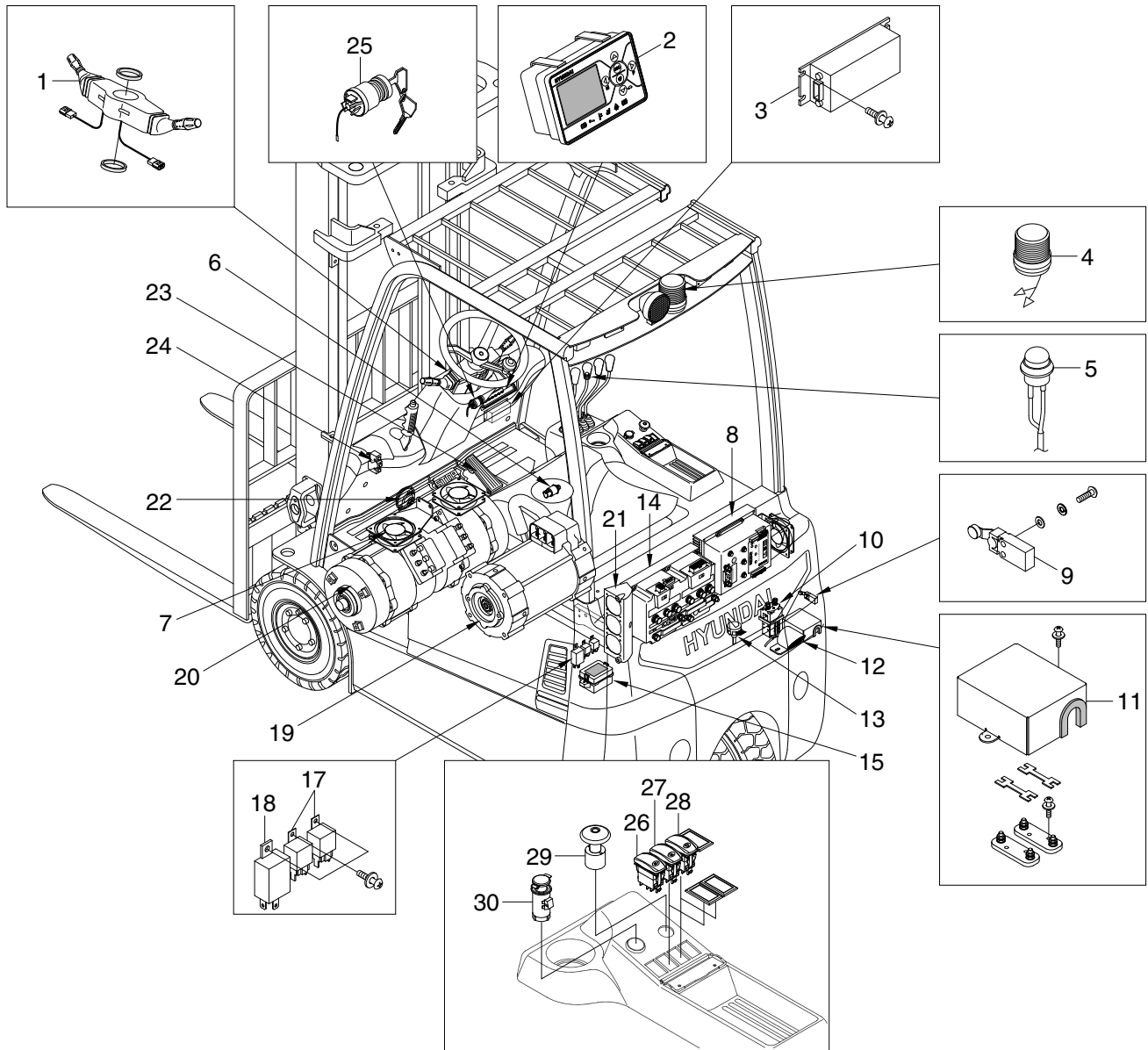


## SECTION 7 ELECTRICAL SYSTEM

Group 1	Component location .....	7-1
Group 2	Electrical circuit .....	7-2
Group 3	Electric components .....	7-4

# SECTION 7 ELECTRICAL SYSTEM

## GROUP 1 COMPONENT LOCATION

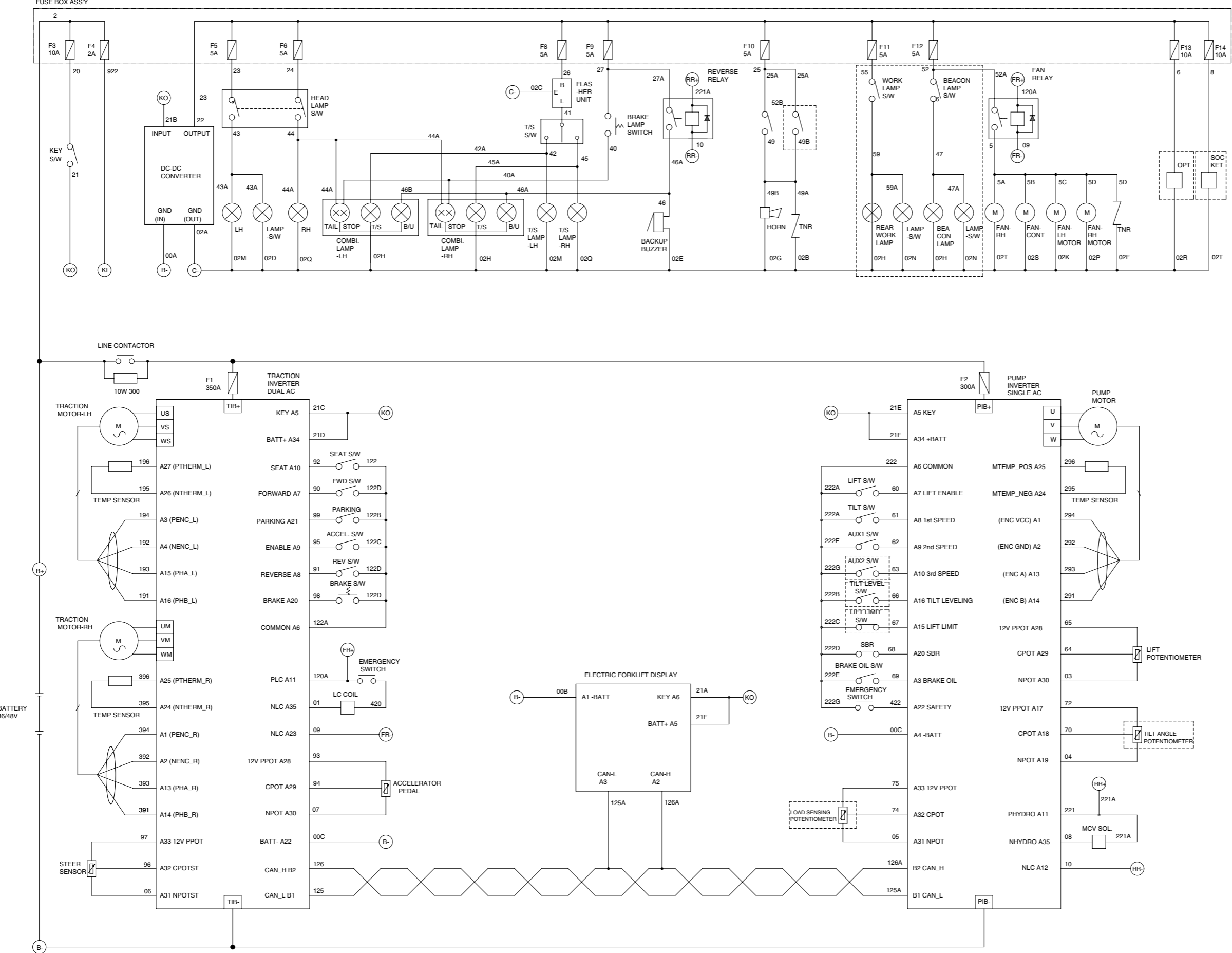


15BT9EL02A

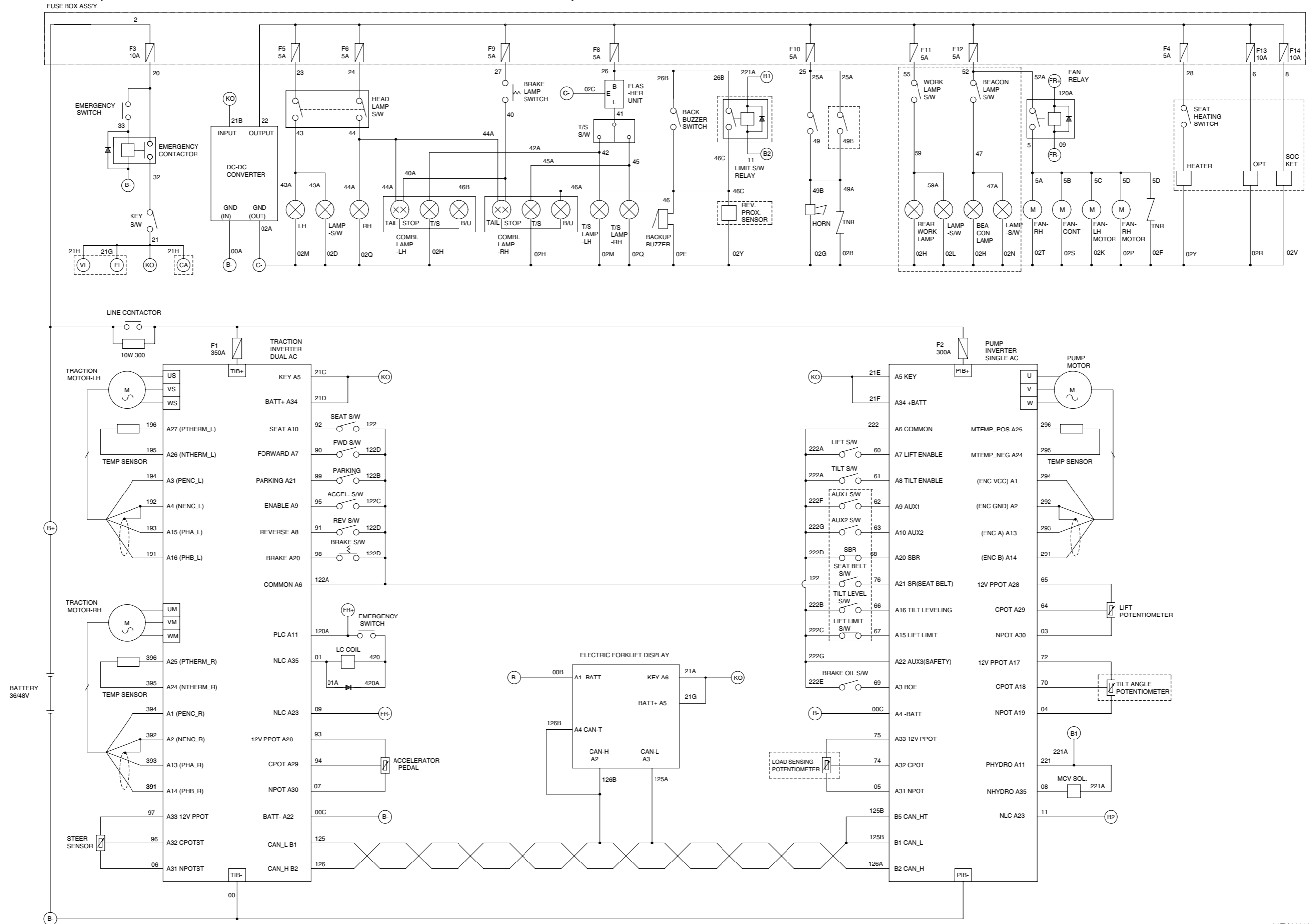
- |                      |                       |                             |
|----------------------|-----------------------|-----------------------------|
| 1 Combination switch | 12 Back buzzer        | 23 Accelerator assy         |
| 2 Display            | 13 Steering sensor    | 24 Parking switch assy      |
| 3 DC-DC converter    | 14 Controller-DUALAC2 | 25 Key switch assy          |
| 4 Beacon lamp        | 15 Fuse box assy      | 26 Head lamp switch         |
| 6 Pressure sensor    | 17 Relay              | 27 Rear working lamp switch |
| 7 Fan san-ACE120     | 18 Flasher unit assy  | 28 Beacon lamp switch (opt) |
| 8 Controller-AC2     | 19 Pump motor         | 29 Emergency switch assy    |
| 9 SBR switch assy    | 20 Traction motor     | 30 Socket assy              |
| 10 Contactor         | 21 Fan san-ACE120     |                             |
| 11 Main fuse cover   | 22 High horn          |                             |

# GROUP 2 ELECTRICAL CIRCUIT

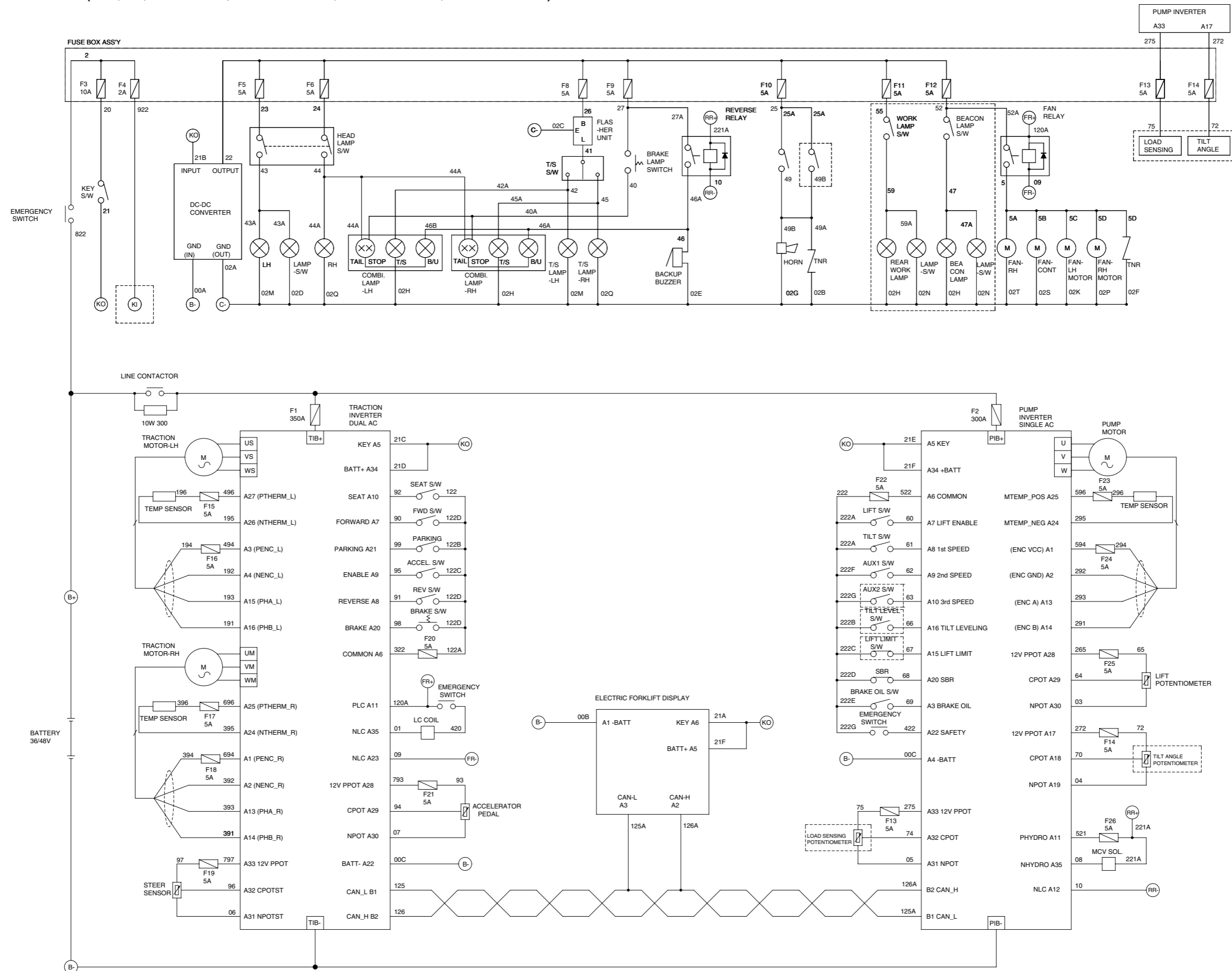
· ELECTRICAL CIRCUIT (1/17, NON-UL, SEMIKRON, 15BT-9 : -#0002, 18BT-9 : -#0003, 20BT-9 : -#0007)



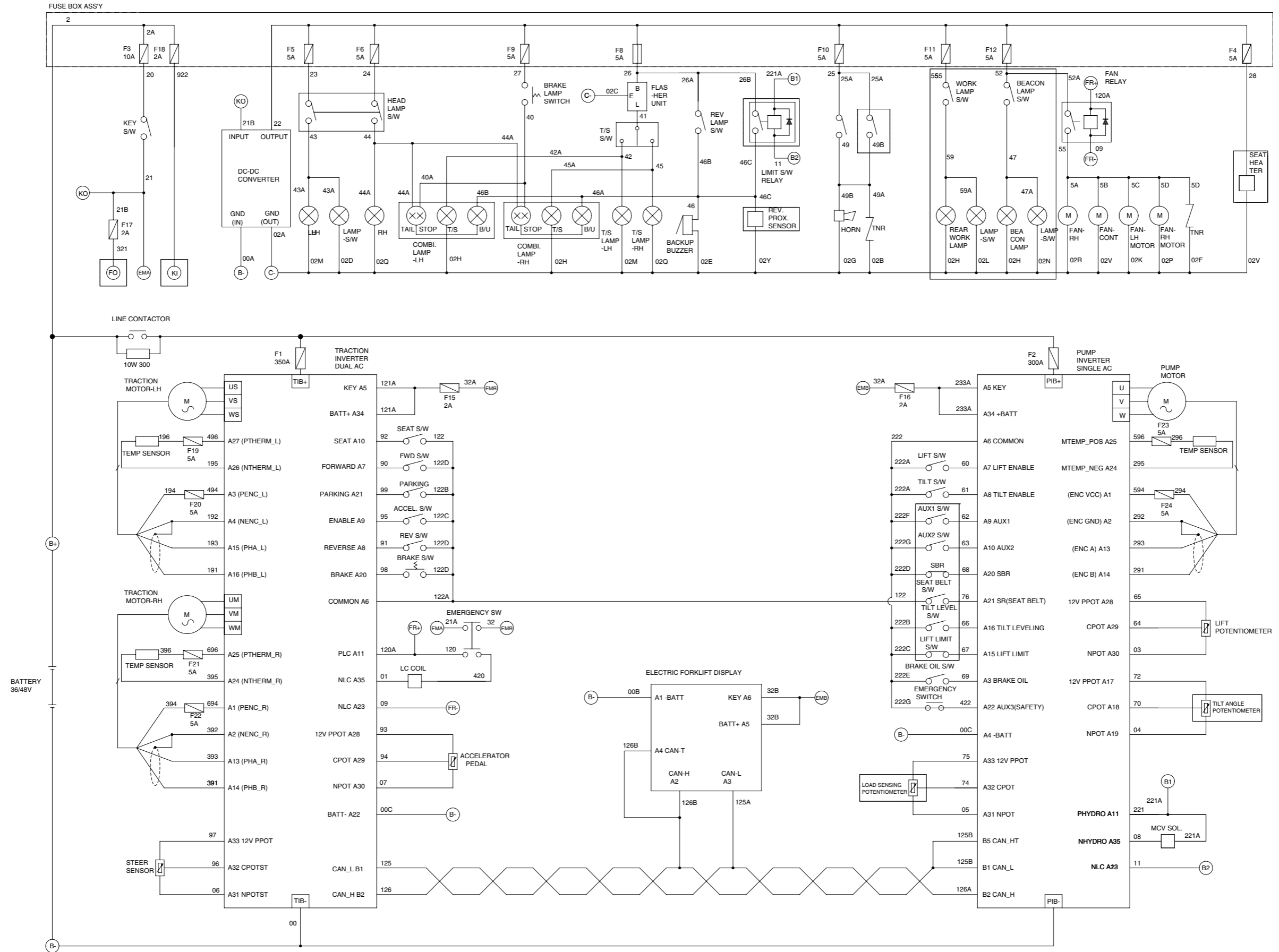
· ELECTRICAL CIRCUIT (2/17, NON-UL, SEMIKRON, 15BT-9 : #0003-, 18BT-9 : #0004-, 20BT-9 : #0008-)



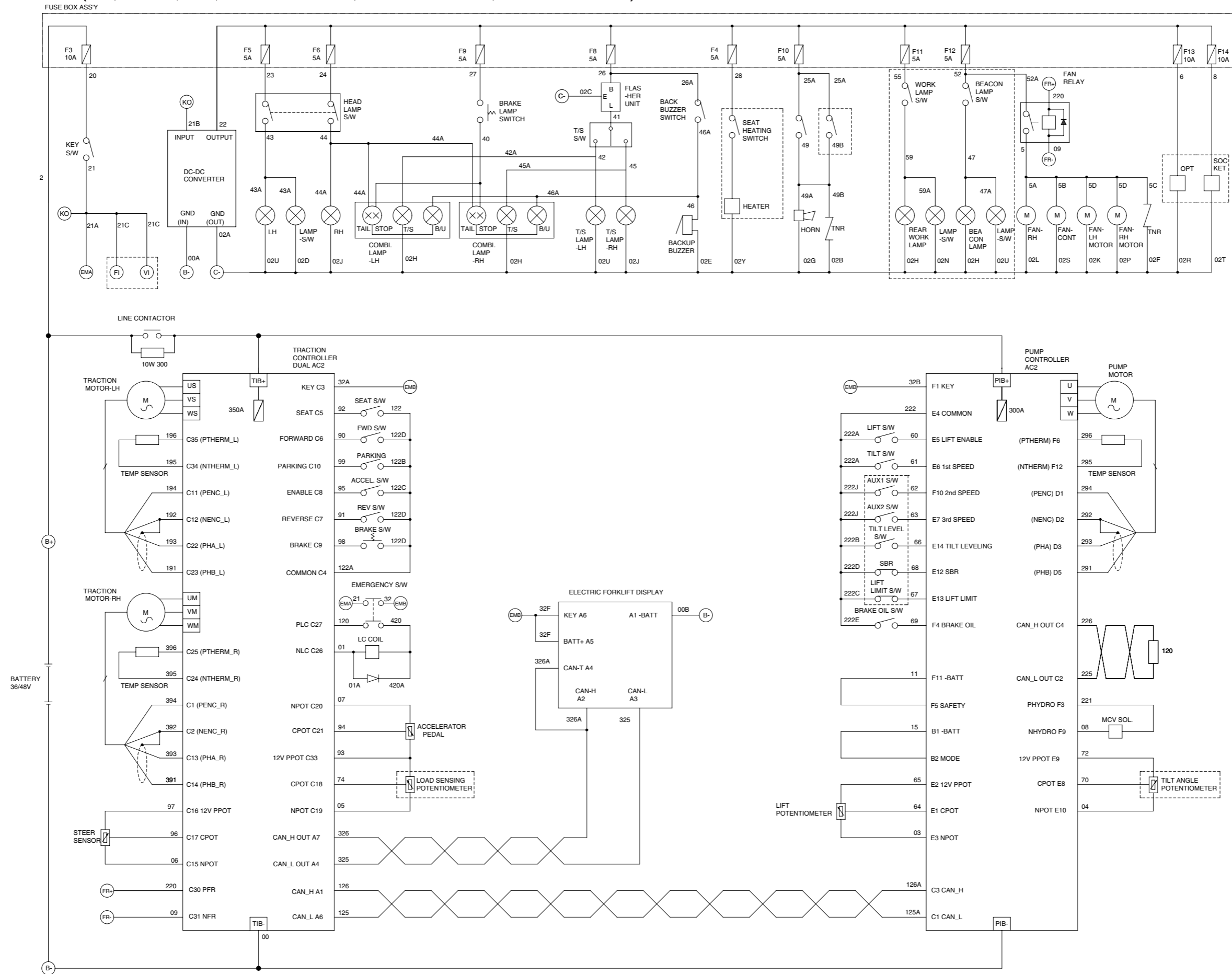
· ELECTRICAL CIRCUIT (3/17, UL, SEMIKRON, 15BT-9 : -#0002, 18BT-9 : -#0003, 20BT-9 : -#0007)



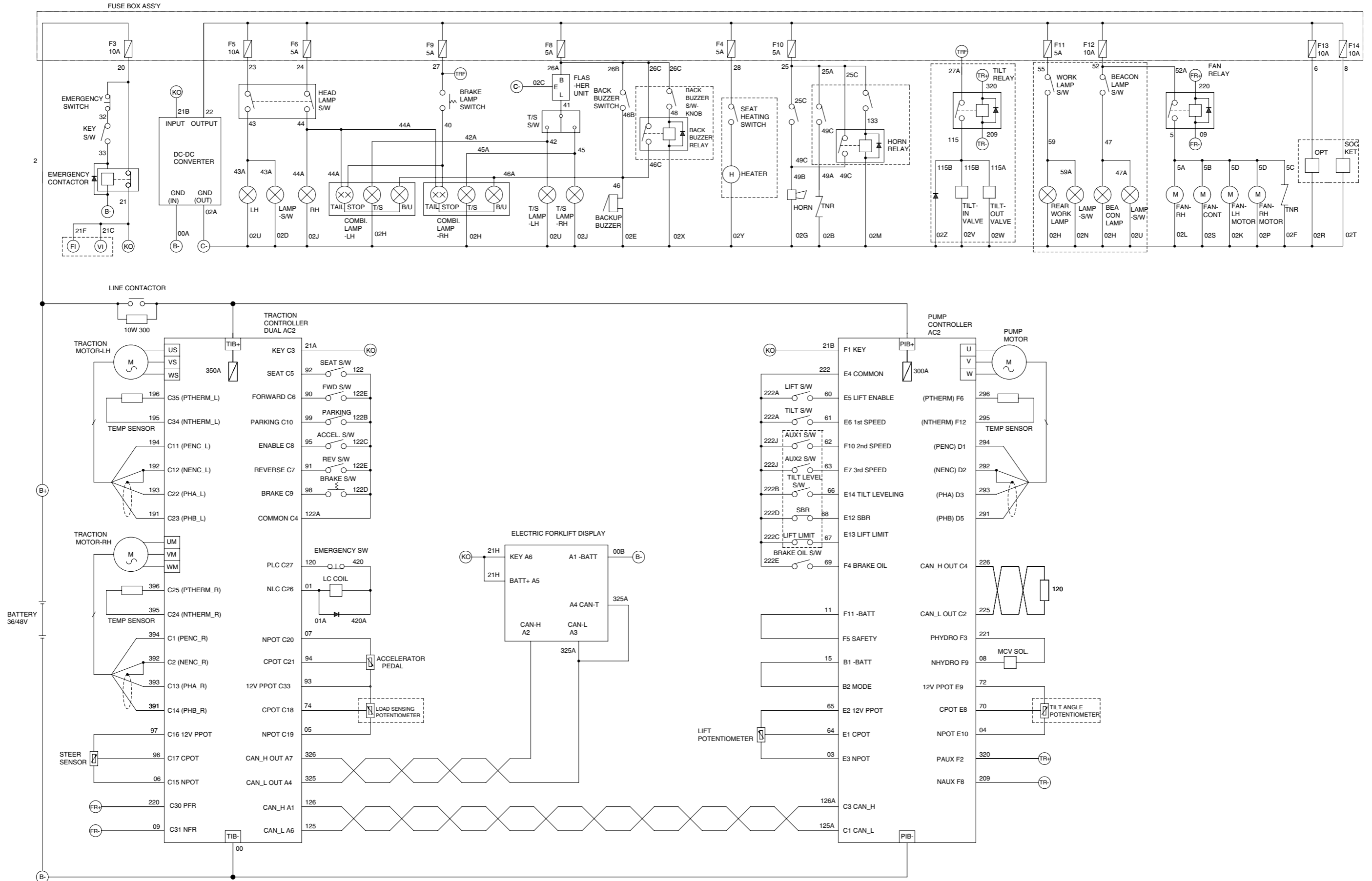
· ELECTRICAL CIRCUIT (4/17, UL, SEMIKRON, 15BT-9 : #0003-, 18BT-9 : #0004-, 20BT-9 : #0008-)



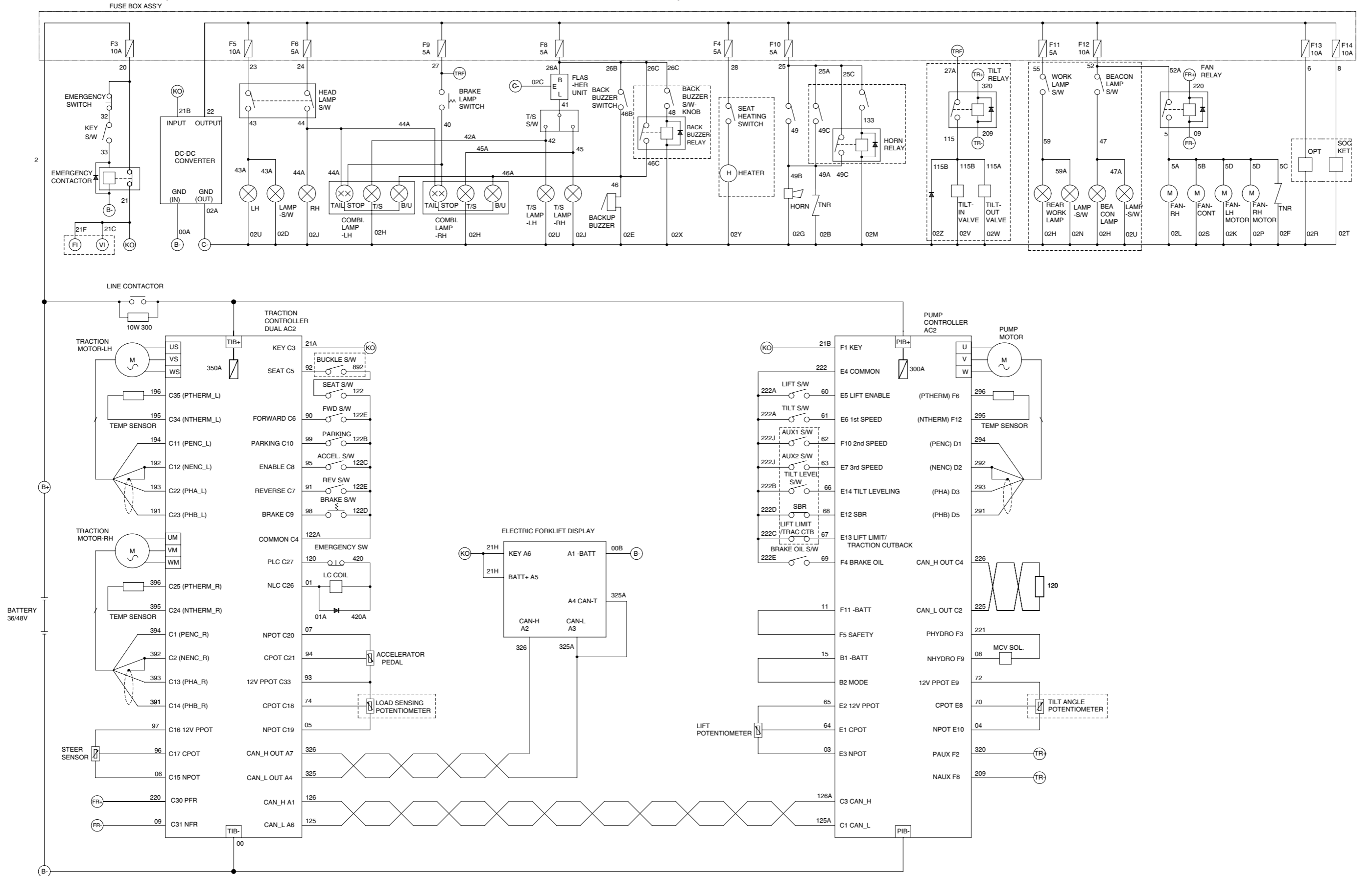
· ELECTRICAL CIRCUIT (5/17, NON-UL, ZAPI, 15BT-9 : #0003-0039, 18BT-9 : #0004-0058, 20BT-9 : #0008-0079)



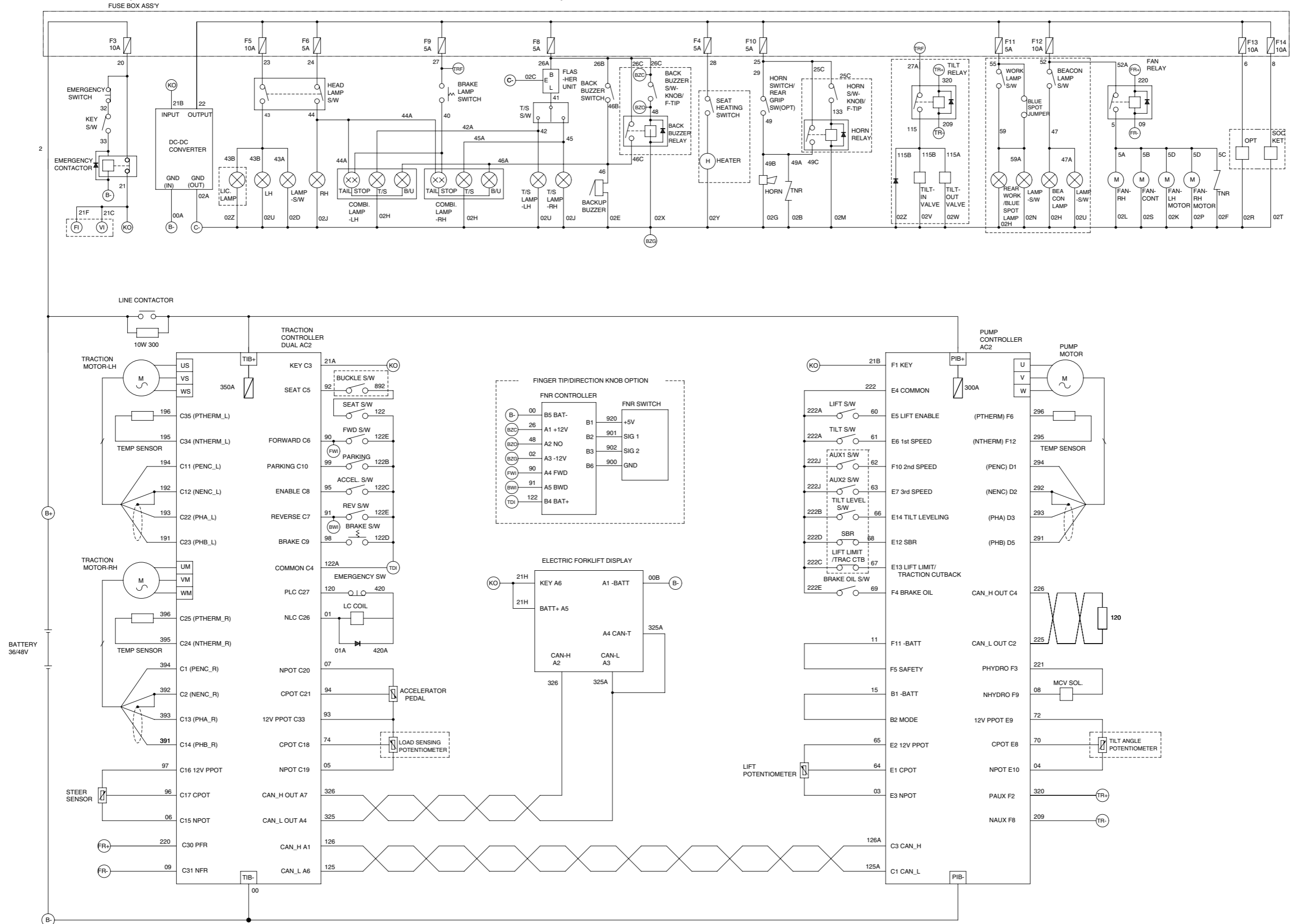
· ELECTRICAL CIRCUIT (6/17, NON-UL, ZAPI, 15BT-9 : #0040-0172, 18BT-9 : #0059-0228, 20BT-9 : #0080-0208)



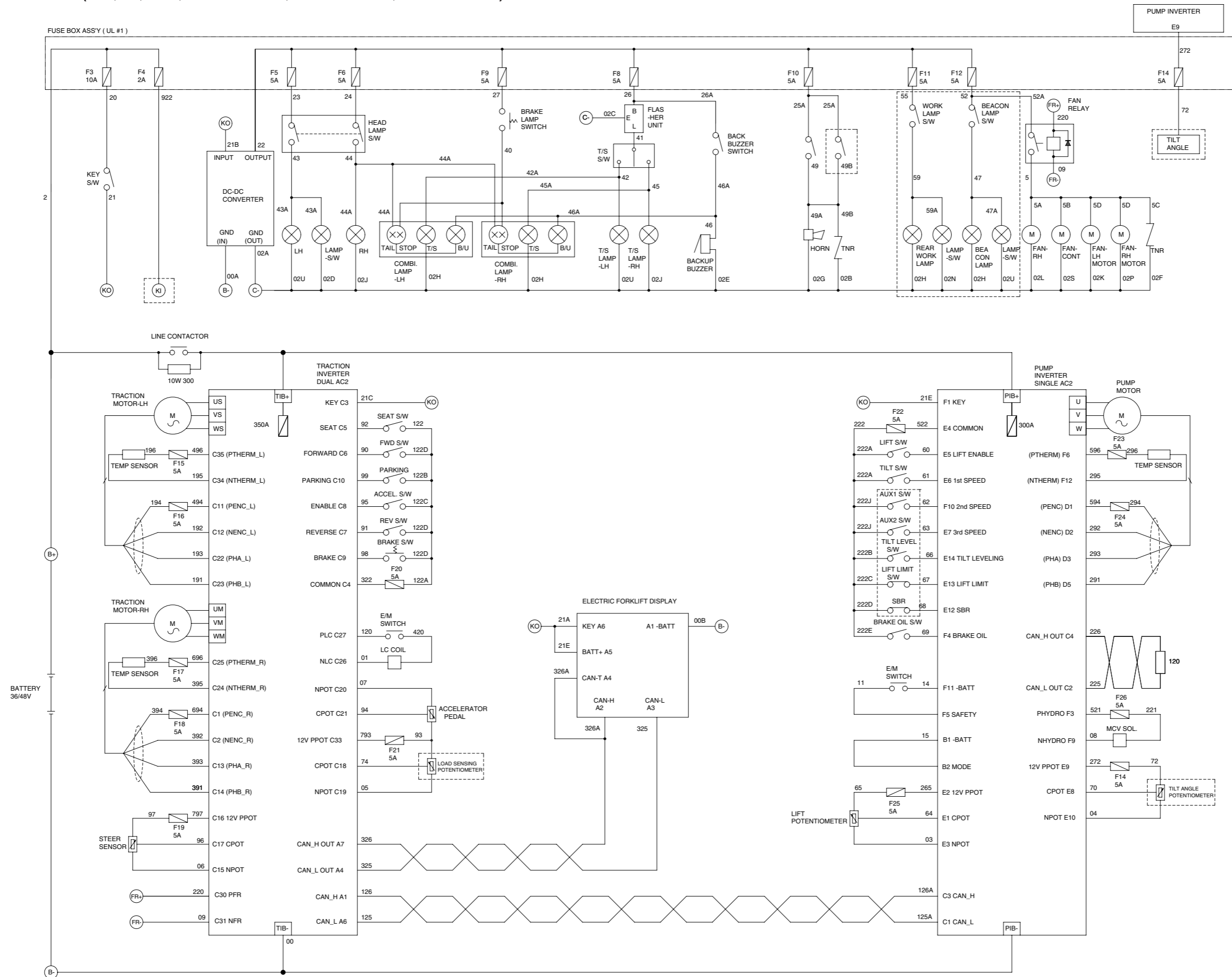
· ELECTRICAL CIRCUIT (7/17, NON-UL, ZAPI, 15BT-9 : #0173-0370, 18BT-9 : #0229-0482, 20BT-9 : #0209-0477)



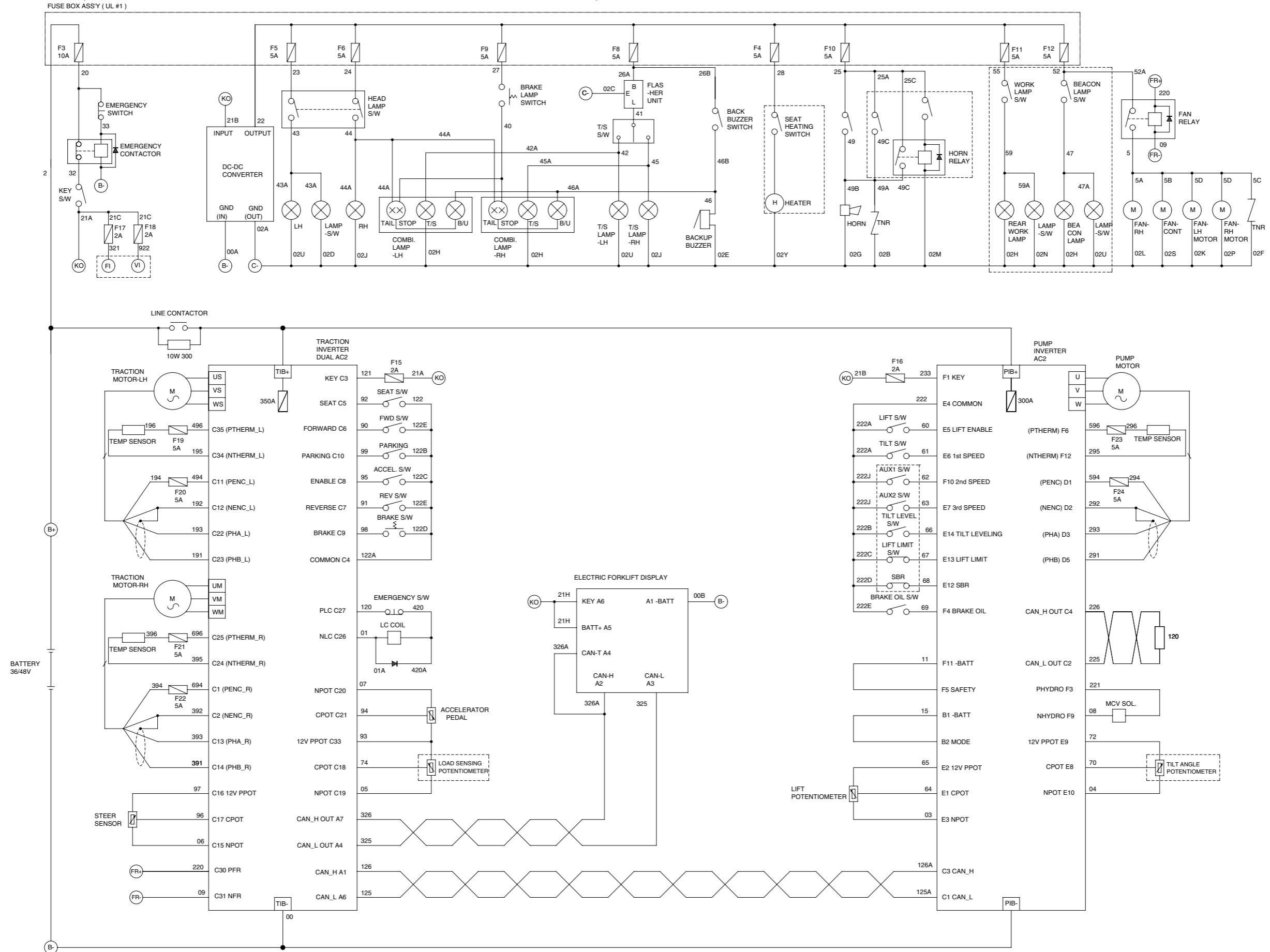
· ELECTRICAL CIRCUIT (8/17, NON-UL, ZAPI, 15BT-9 : #0371-, 18BT-9 : #0483-, 20BT-9 : #0478-)



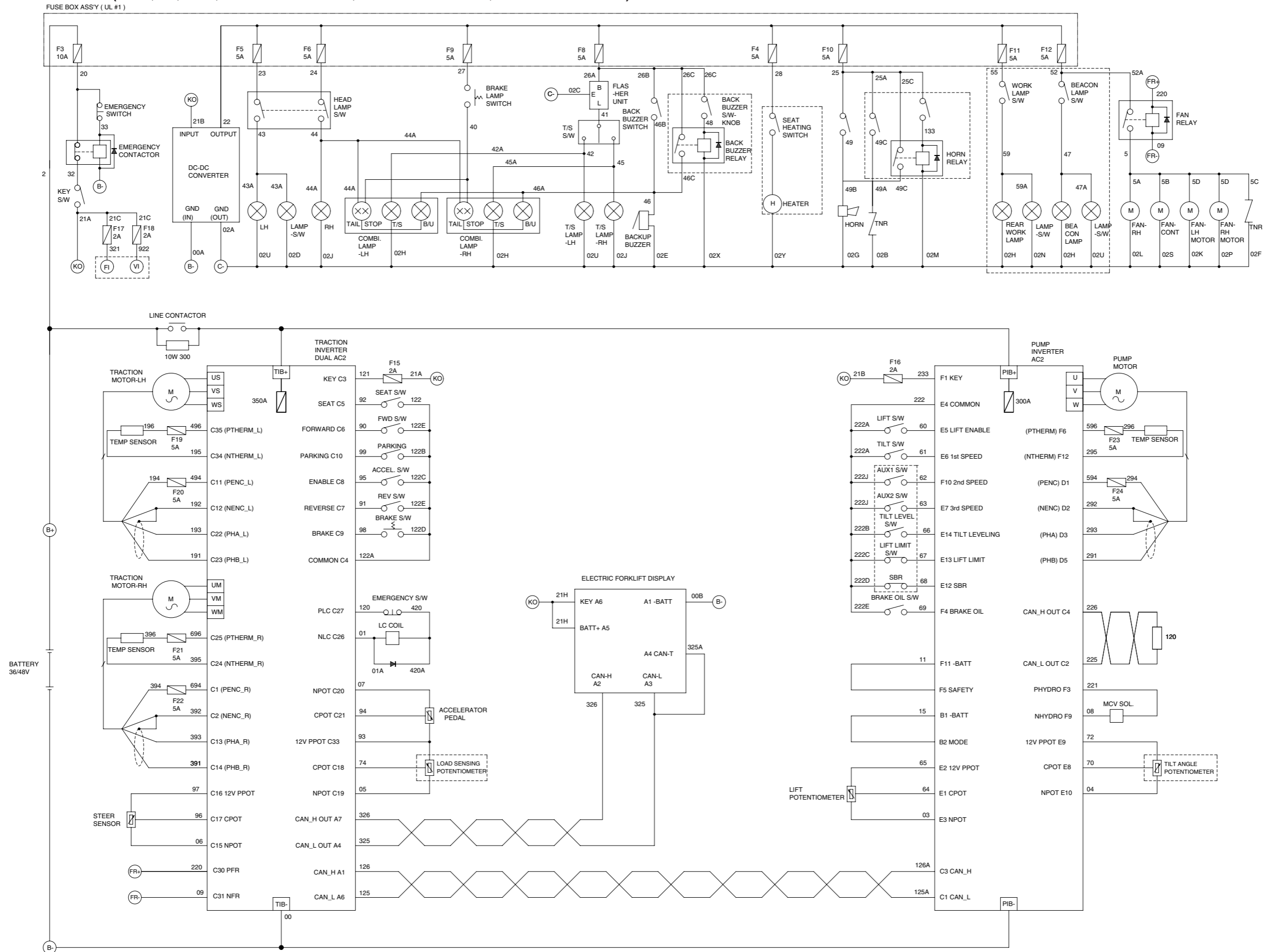
· ELECTRICAL CIRCUIT (9/17, UL, ZAPI, 15BT-9 : -#0002, 18BT-9 : -#0003, 20BT-9 : -#0007)



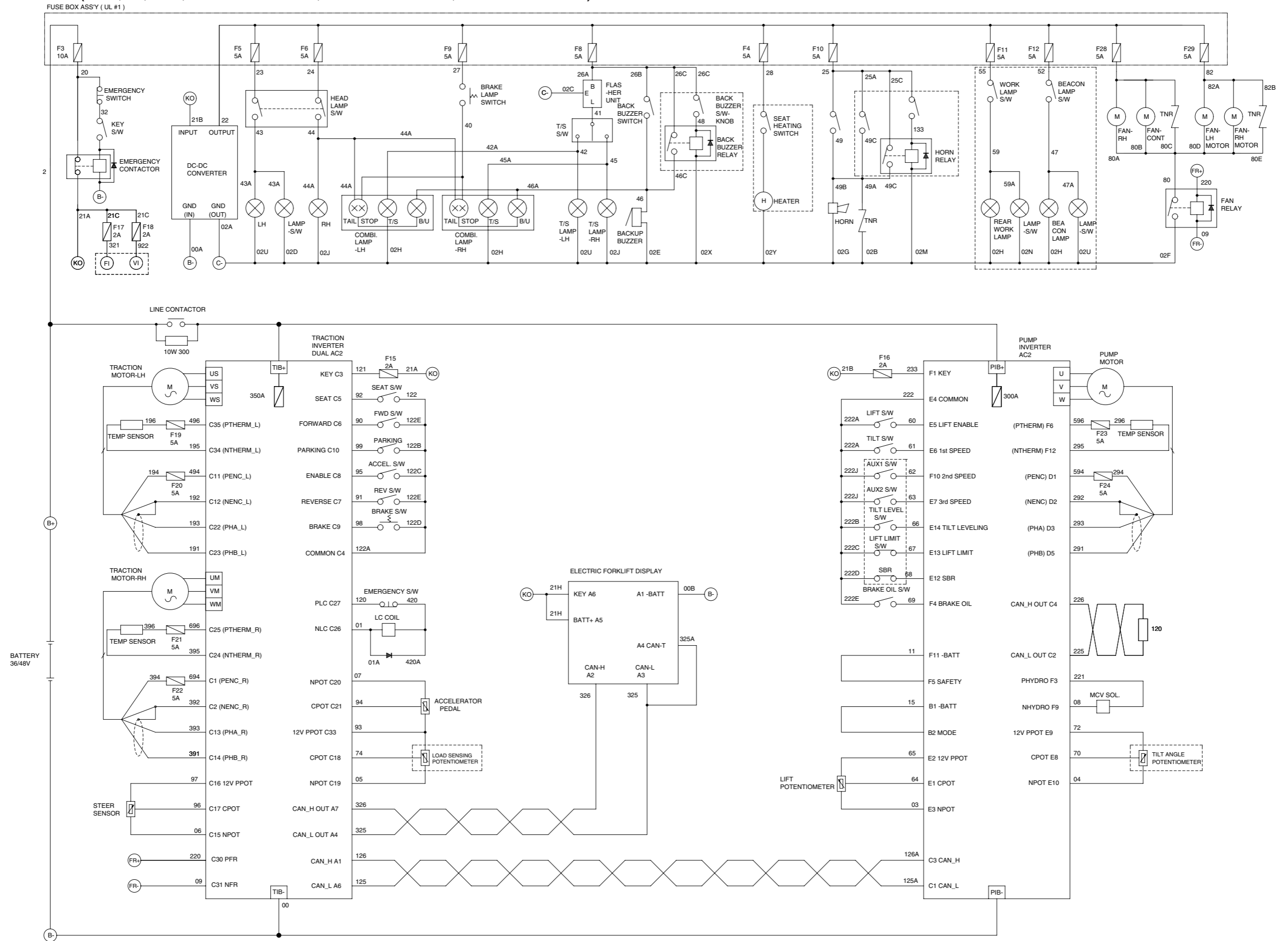
· ELECTRICAL CIRCUIT (10/17, UL, ZAPI, 15BT-9 : #0003-0027, 18BT-9 : #0004-0031, 20BT-9 : #0008-0057)



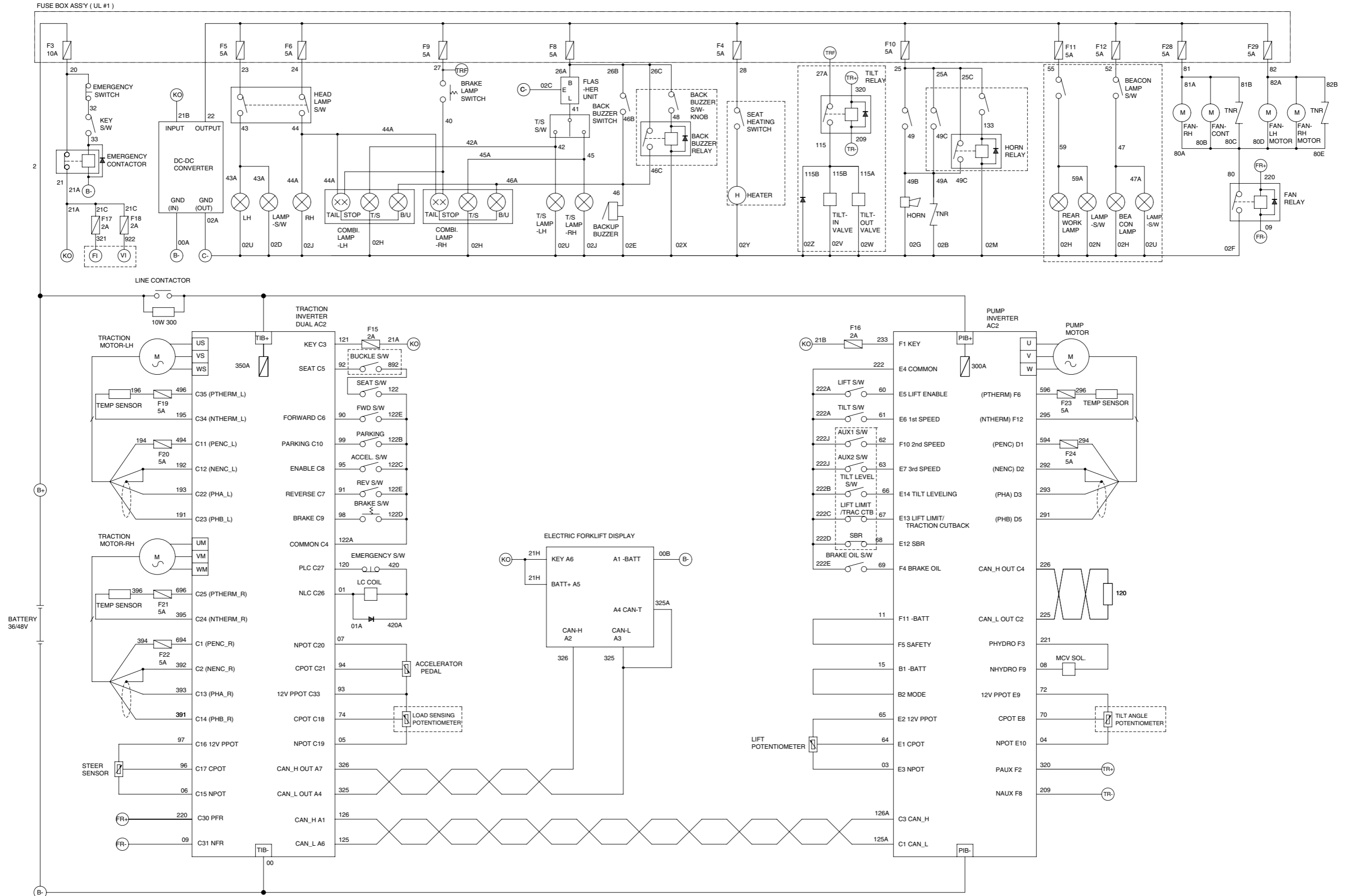
· ELECTRICAL CIRCUIT (11/17, UL, ZAPI, 15BT-9 : #0028-0038, 18BT-9 : #0032-0055, 20BT-9 : #0058-0070)



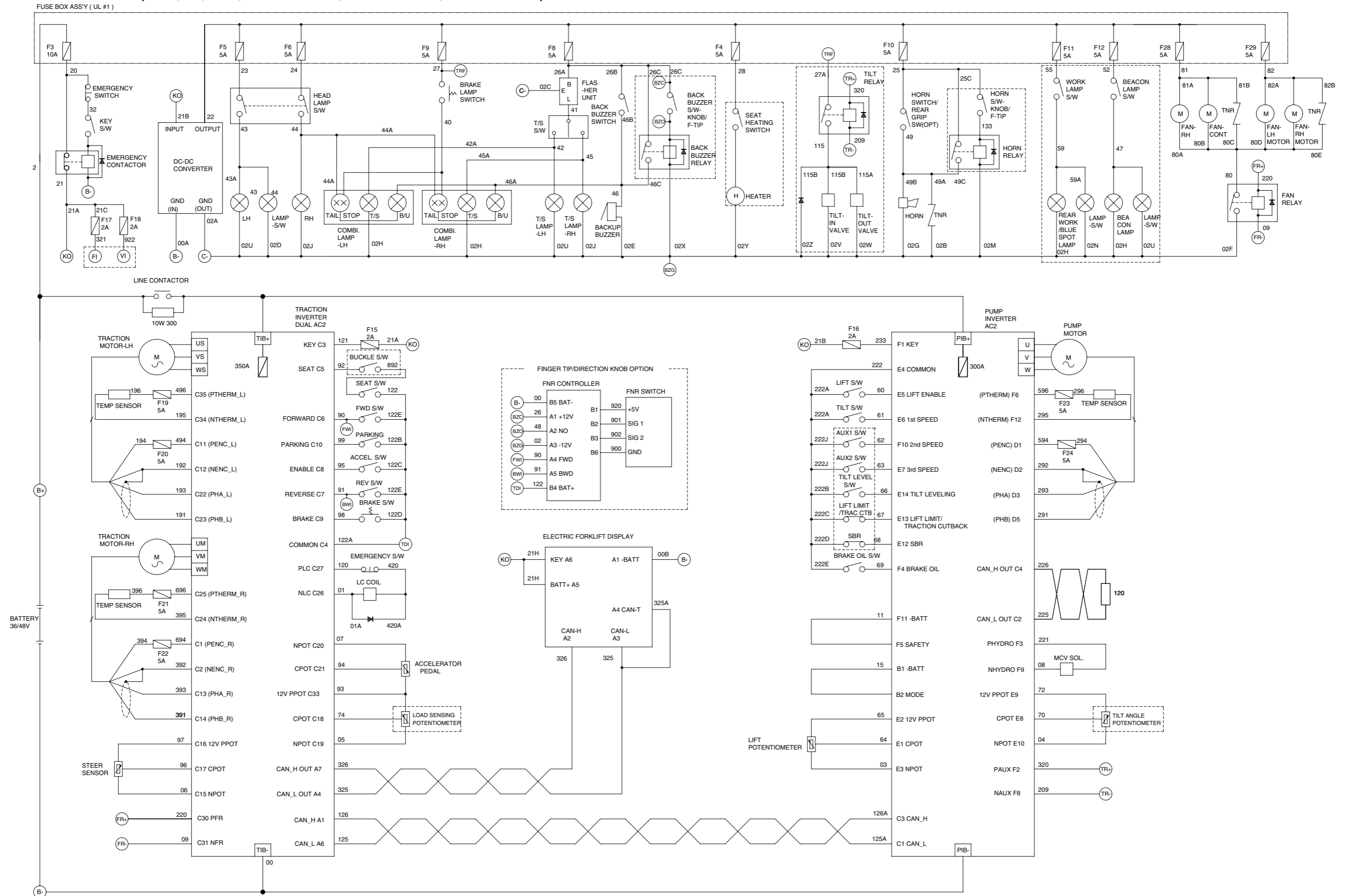
· ELECTRICAL CIRCUIT (12/17, UL, ZAPI, 15BT-9 : #0039-0039, 18BT-9 : #0056-0058, 20BT-9 : #0071-0079)



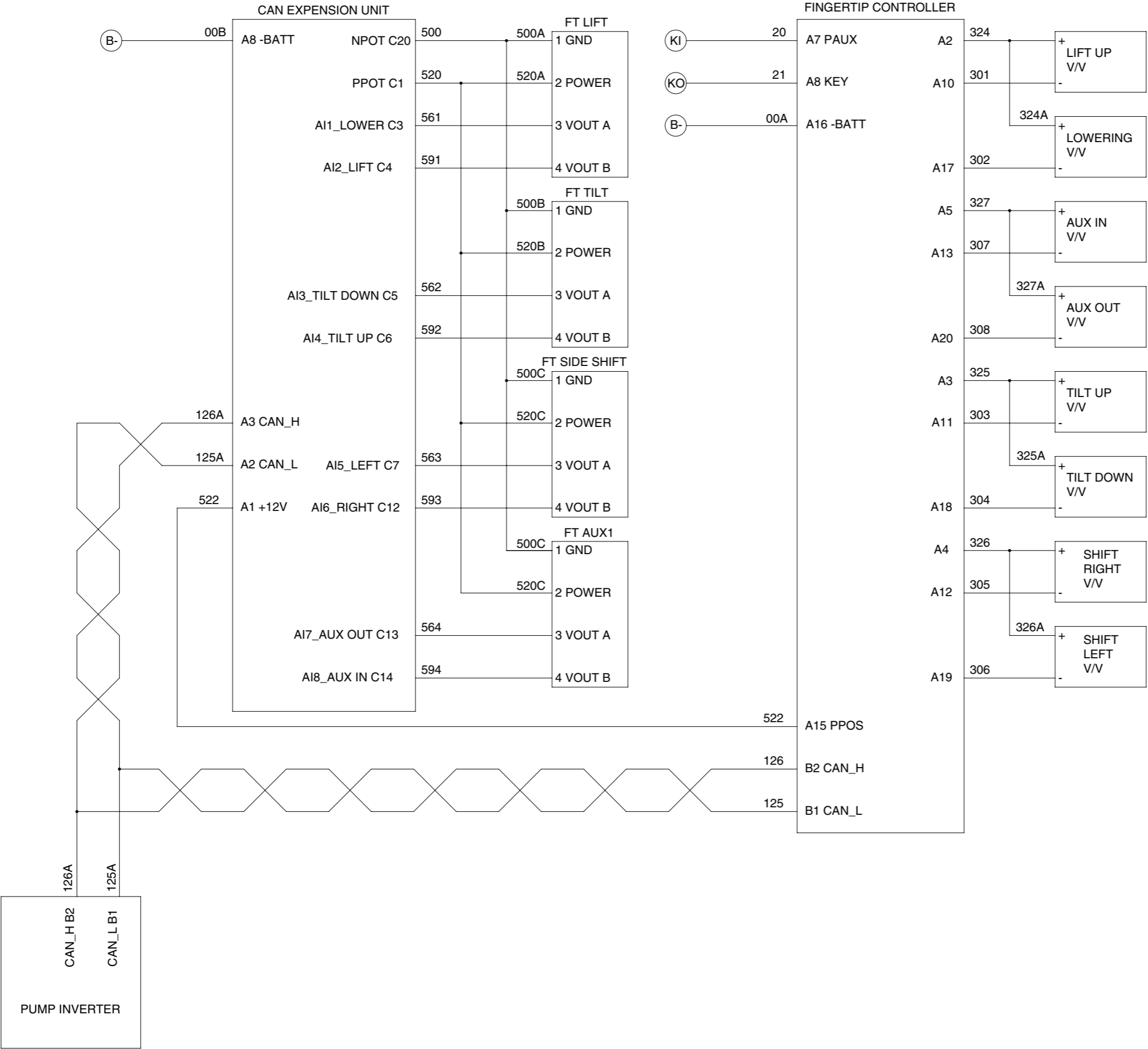
· ELECTRICAL CIRCUIT (13/17, UL, ZAPI, 15BT-9 : #0040-0370, 18BT-9 : #0059-0482, 20BT-9 : #0080-0477)



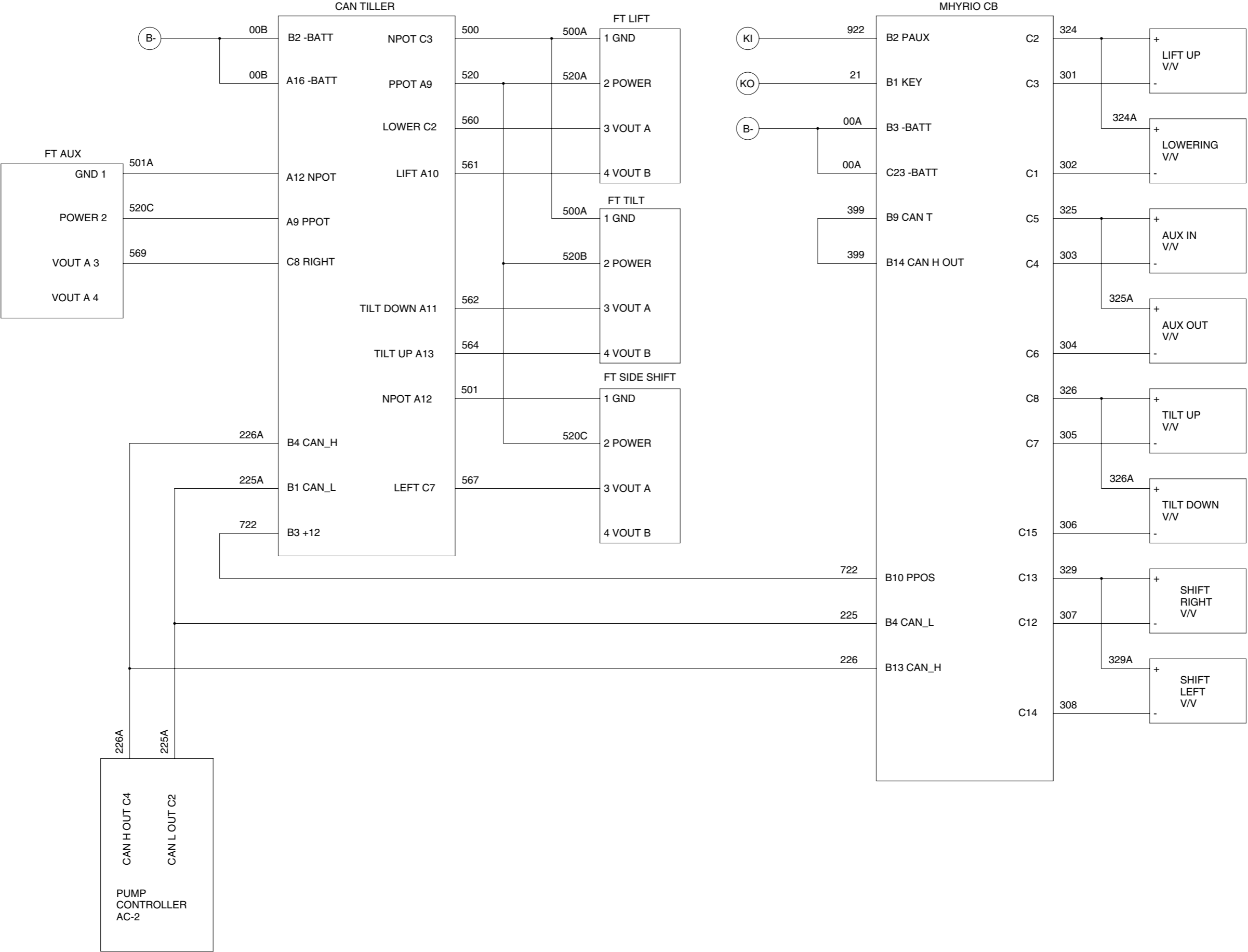
• ELECTRICAL CIRCUIT (14/17, UL, ZAPI, 15BT-9 : #0371-, 18BT-9 : #0483-, 20BT-9 : #0478-)



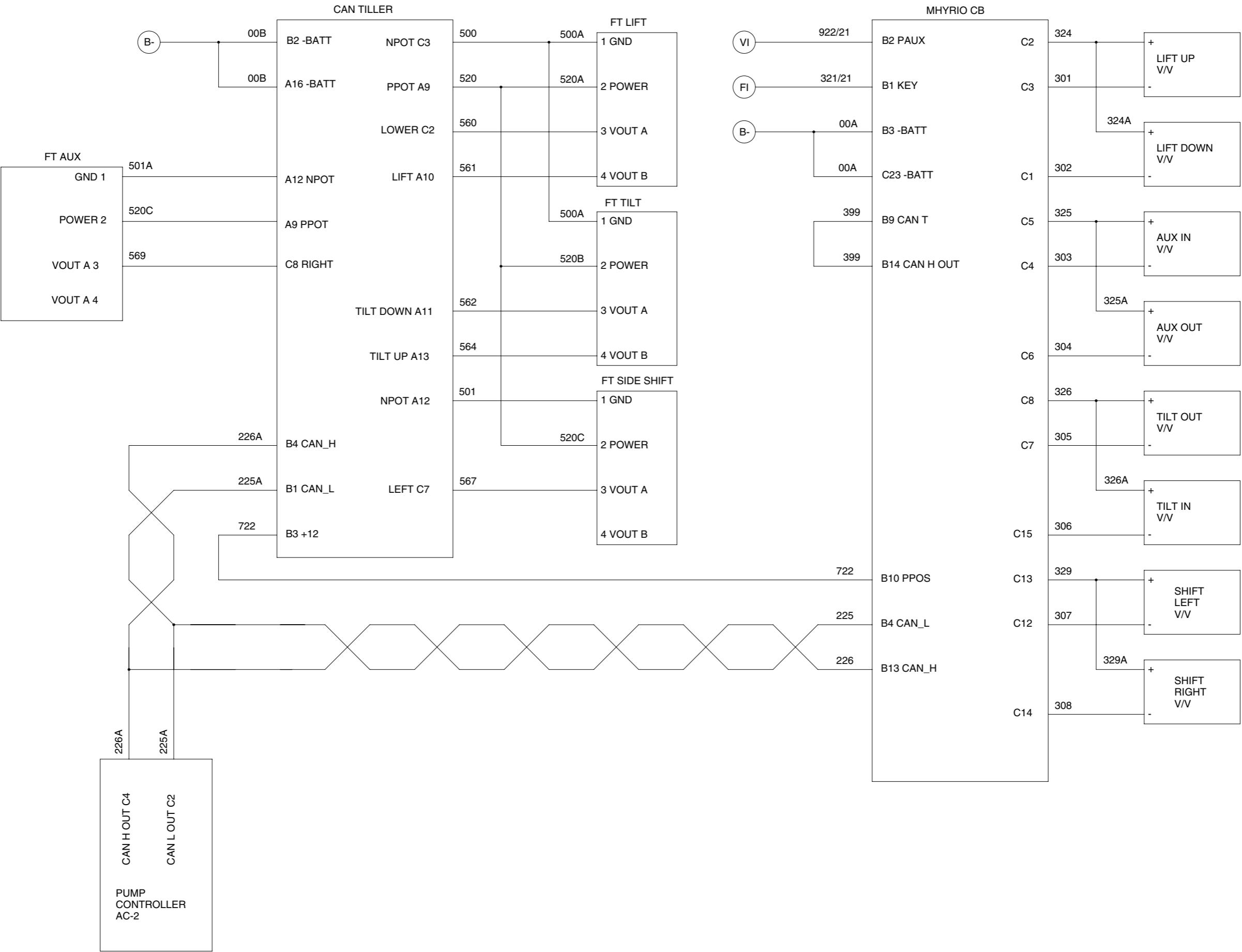
· ELECTRICAL CIRCUIT (15/17, FINGERTIP, SEMIKRON)



· ELECTRICAL CIRCUIT (16/17, FINGERTIP, ZAPI, 15BT-9 : -#0002, 18BT-9 : -#0003, 20BT-9 : -#0007)



· ELECTRICAL CIRCUIT (17/17, FINGERTIP, ZAPI, 15BT-9 : #0003-, 18BT-9 : #0004-, 20BT-9 : #0008-)



## **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 and 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.

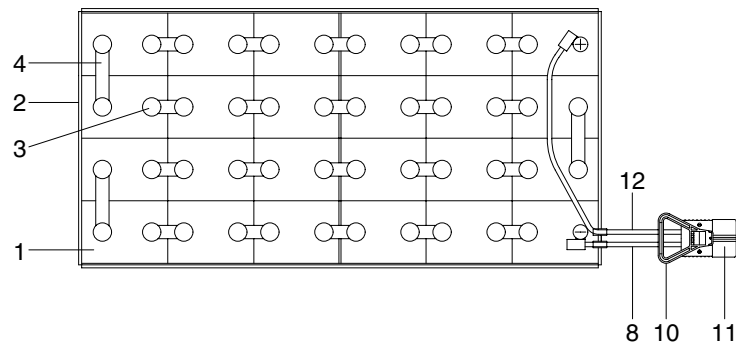
To drive the fork lift truck, a DRIVING CONTROL SYSTEM and some electric components such as direction change lever (forward/reverse section switch) and accelerator are required to select the driving direction and to control the speed of driving motor.

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, potentiometer 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



20BT9EL03A

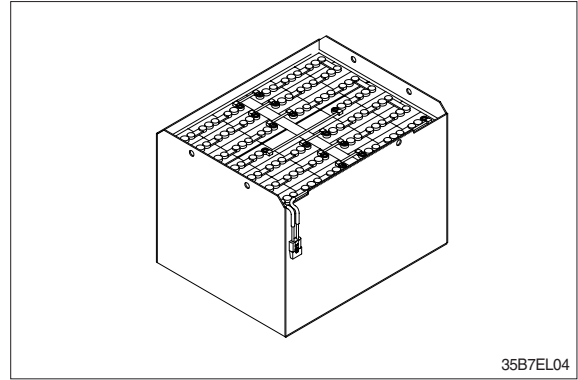
- 1 Cells
- 2 Steel box
- 3 Cell connector
- 4 Row connector

- 8 Negative leading cable
- 10 Handle (red)
- 11 Plug
- 12 Positive leading cable

## 2) GENERAL

As in the battery forklift, the battery is an energy source, the handling of the battery is very important.

The life and performance of the battery greatly depend on the ordinary handling and maintenance. Therefore, be sure to check and maintain the battery so that it may be kept best.



35B7EL04

## 3) SPECIFICATION AND SERVICE DATA

Item	Unit	15TB-9	18/20BT-9
Type	-	Lead Acid	
Rated voltage	V	48	
Capacity	AH/hr	510	585
Electrolyte	-	WET	
Dimension (W×D×H)	mm	978×545×635	978×630×635
Connector	-	SB 350 or SR 350 (SBE 320 BLUE)	
Weight	kg	850	1030

Fully charged specific gravity	1.280 (25°C)
End of discharge specific gravity	1.120 (25°C)
Discharge end voltage	48V
Electrolyte	Refined dilute sulfuric
Replenishment fluid	Refined (pure) water
Insulation resistance	1MΩ

#### **4) SAFETY PRECAUTIONS**

**(1) When 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 an explosion.

**(3) Never place metallic articles on the batteries**

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

**(4) Handling of charger**

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

#### **5) OPERATION PRECAUTIONS**

**(1) Avoid over-discharge**

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

**(2) Avoid over-charge**

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

**(3) Avoid excessive elevation of temperature**

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

#### **6) CHECKING**

**(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 decreases 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 (standard)

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  $0.1C \times 5$  hour rate nominal capacity current for 24 hours or more. The charge shall be terminated when one of the following conditions 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 if it is 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  $1.280 \pm 0.01$  (25°C) at full charge condition. If the electrolyte is decreased naturally while using, distilled water shall be replenished up to the specified level. (Never refill sulfuric acid).

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

#### ④ Normal charge

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

##### a. Charging by modified constant voltage automatic charger

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

$$\text{Charging time} = \frac{\text{Amount of previous discharge(AH)}}{\text{Capacity of charger(A)}} + 2 \sim 3(\text{H})$$

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.

##### c. Charging by constant current charger

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

#### ⑤ Equalizing charge

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

## ⑥ Replenishment of distilled water

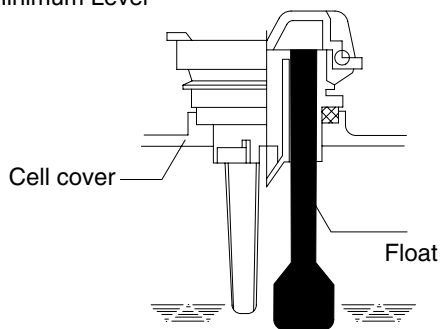
Only the water content of electrolyte is decreased due to electrolysis of distilled water during charge and natural evaporation. If a battery used with the electrolyte decreased excessively, plates will deteriorate resulting in markedly shortening of battery life. Be sure to check the electrolyte level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

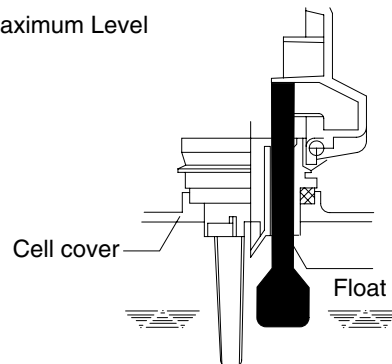
### a. Determination of replenishment time and methods (cell with ONE TOUCH CAP)

Confirm the electrolyte level by looking at the float in the ONE TOUCH CAP. If too low as shown in figure, replenish distilled 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.

Minimum Level



Maximum Level



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

**▲ 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. Be sure to check the electrolyte level once every 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 away from room heaters or other heat generating sources. Clean, cool and dry place where no direct sunlight is suited for battery storage. Before putting into storage, it is important to charge the batteries and keep the electrolyte level at the specified level.

When the temperature in storage location is higher than 20°C, check the specific gravity once a month, and when lower than 0°C, check it once every two months. If the measurements show values lower than 1.230 (20°C), it is required to charge the battery in accordance with the method described in NORMAL CHARGE.

#### ② Maintenance record

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

#### ③ Electrolyte temperature

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

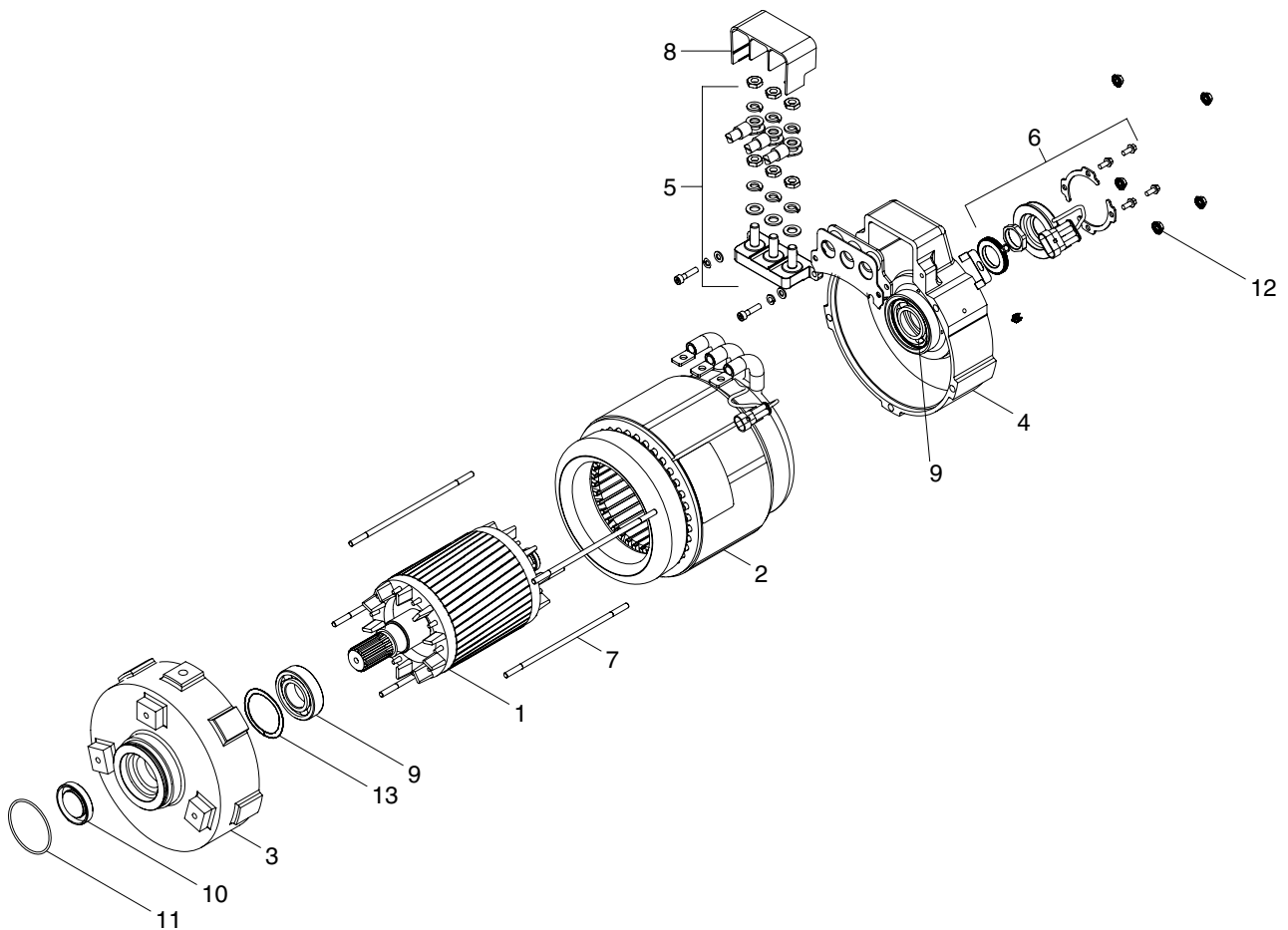
Contrarily if the temperature is high, especially if used at above 55°C, the battery life will be considerably shortened. Care must be taken so that the temperature during charge will be maintained at 55°C or lower. Even under unavoidable circumstances it should not exceed 55°C.

## 7) TROUBLESHOOTING

Nature of trouble	Symptoms	Causes	Corrective Action
Deformation	<ul style="list-style-type: none"> <li>Deformation of container. Lid or one touch cap</li> </ul>	<ul style="list-style-type: none"> <li>Excessive temperature rising or external impact</li> </ul>	<ul style="list-style-type: none"> <li>Replace</li> </ul>
Breakage	<ul style="list-style-type: none"> <li>Electrolyte leakage according to breakage of container, lid or one touch cap</li> <li>Termination of connector or pole post etc.</li> </ul>	<ul style="list-style-type: none"> <li>External impact, improper handling, excessive vibration</li> <li>Excessive temperature rising or external impact</li> </ul>	<ul style="list-style-type: none"> <li>Replace or install a new one</li> <li>Replace</li> </ul>
Sulfate	<ul style="list-style-type: none"> <li>Specific gravity drops and capacity is decreased.</li> <li>Charge voltage rises rapidly with immature gassing in earlier stage but specific gravity does not rise and charge can't be carried out.</li> </ul>	<ul style="list-style-type: none"> <li>When left in state of discharge or left long without equalizing charge.</li> <li>Insufficient charge.</li> <li>When electrolyte is so decreased that plate is deposited.</li> <li>When concentration of electrolyte rises.</li> <li>When impurities are mixed in electrolyte.</li> </ul>	<ul style="list-style-type: none"> <li>Need equalizing charge</li> <li>Need equalizing charge</li> <li>Need equalizing charge</li> <li>Adjust specific gravity</li> <li>Replace electrolyte</li> </ul>
Decrease and falling of specific gravity	<ul style="list-style-type: none"> <li>May be easily detected by measurement of the specific gravity.</li> </ul>	<ul style="list-style-type: none"> <li>Rise of temperature due to such trouble.</li> <li>When left long period without refilling of water.</li> <li>Short circuit.</li> </ul>	<ul style="list-style-type: none"> <li>Replace</li> <li>Refill water in regular period</li> <li>Replace</li> </ul>
Rise of specific gravity	<ul style="list-style-type: none"> <li>May be easily detected by measurement of the specific gravity.</li> </ul>	<ul style="list-style-type: none"> <li>Diluted sulfuric acid is used in refilling.</li> <li>When the electrolyte level excessively drops.</li> </ul>	<ul style="list-style-type: none"> <li>Adjust specific gravity after full charge.</li> <li>Refill distilled water.</li> </ul>
Mixing of impurities	<ul style="list-style-type: none"> <li>Decrease of capacity.</li> <li>Drop of charge and discharge voltage.</li> <li>Odor of generated gas and coloring of the electrolyte.</li> </ul>	<ul style="list-style-type: none"> <li>Metals such as iron, copper nickel and manganese.</li> <li>Impurities such as sea water, chloric acid, nitric acid etc.</li> <li>Filling of impure water.</li> </ul>	<ul style="list-style-type: none"> <li>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.</li> </ul>

### 3. DRIVE MOTOR

#### 1) STRUCTURE



20BT9EL07

- |                    |                      |                |
|--------------------|----------------------|----------------|
| 1 Rotor assy       | 6 Speed sensor kit   | 11 O-ring      |
| 2 Stator assy      | 7 Stud bolt          | 12 Flange nut  |
| 3 Endbell De       | 8 Protector-Terminal | 13 Wave washer |
| 4 Endbell          | 9 Bearing            |                |
| 5 Block-Terminal A | 10 Oil seal          |                |

## 2) SPECIFICATION

Item	Unit	Specification
Type	-	AMDN4001
Rated voltage	Vac	32
Rated output	kW	$4.7 \times 2$
Insulation	-	Class F

## 3) MAINTENANCE INSTRUCTION

※ Before starting the maintenance please disconnect the power supply.

### (1) Ball bearing

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

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

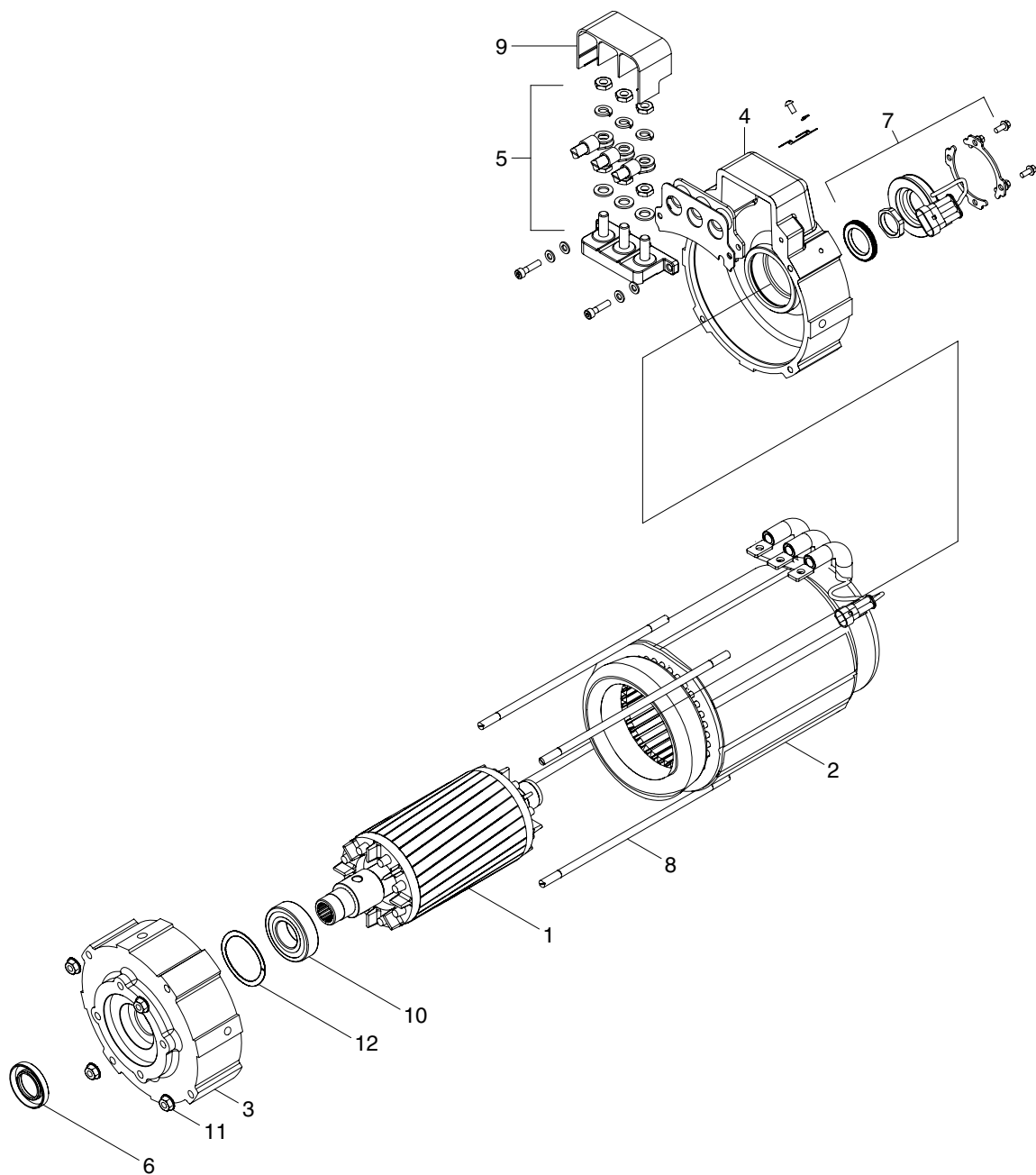
After approximately 10,000 operating hours the bearings have to be replaced.

### (2) Disassembly and assembly

The motor is assembled and disassembled according to the relevant sectional drawing and part list. (See page 7-13)

## 4. PUMP MOTOR

### 1) STRUCTURE



20BT9EL08

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

## 2) SPECIFICATION

Item	Unit	Specification
Type	-	ABDD4002
Rated voltage	Vac	30
Rated output	kW	14
Insulation	-	Class F

## 3) INTERNAL INVOLUTE SPLINE DATA

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

## 4) MAINTENANCE INSTRUCTION

※ Before starting the maintenance please disconnect the power supply.

### (1) Ball bearing

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

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

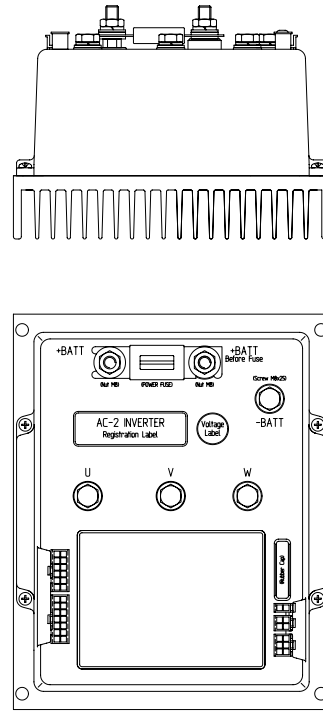
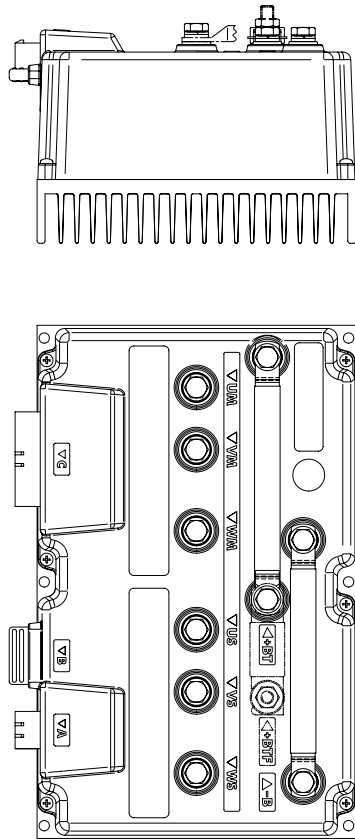
After approximately 10,000 operating hours the bearings have to be replaced.

### (2) Disassembly and assembly

The motor is assembled and disassembled according to the relevant sectional drawing and part list. (See page 7-15)

## 5. CONTROLLER SYSTEM

## 1) STRUCTURE



20B7EL10

### (1) Specifications

Model	Model	Application	Type	Power	Current limit
15/18/20BT-9	DUAL AC2	Traction	MOSFET	36-48V, 330+330A	330A/3min
	AC2	Pump	MOSFET	36-48V, 450A	450A/3min

## 2) OPERATIONAL FEATURES

### (1) Features

- ① Speed control.
- ② Optimum behavior on a slope due to the speed feedback:
  - The motor's speed follows the accelerator, starting a regenerative braking if the speed overtakes the speed set-point.
  - The system can perform an electrical stop on a ramp (the machine is electrically held on a slope) for a programmable time.
- ③ Electronic differential feature with torque balance between external and internal wheel.
- ④ Regenerative release braking based upon deceleration ramps.
- ⑤ Regenerative braking when the accelerator pedal is partially released (deceleration).
- ⑥ Direction inversion with regenerative braking based upon deceleration ramp.
- ⑦ Regenerative braking and direction inversion without contactors: only the main contactor is present.
- ⑧ Optimum sensitivity at low speeds.
- ⑨ Voltage boost at the start and with overload to obtain more torque (with current control).
- ⑩ Hydraulic steering function:
  - The traction inverter sends a "hydraulic steering function" request to the pump inverter on the can-bus line.
- ⑪ Backing forward and reverse options are available, with the tune and the speed of the function programmable with Zapi console or buttons on a display.
- ⑫ High efficiency of motor and battery due to high frequency commutations.
- ⑬ Modification of parameters through the programming console or buttons on a display.
- ⑭ Internal hour-meter with values that can be displayed on the console.
- ⑮ Memory of the last five alarms with relative hour-meter and temperature displayed on the console.
- ⑯ Diagnostic function with Zapi console for checking main parameters.
- ⑰ Built in BDI feature.
- ⑱ Flash memory, software downloadable via serial link and via CANBUS.

### (2) Diagnosis

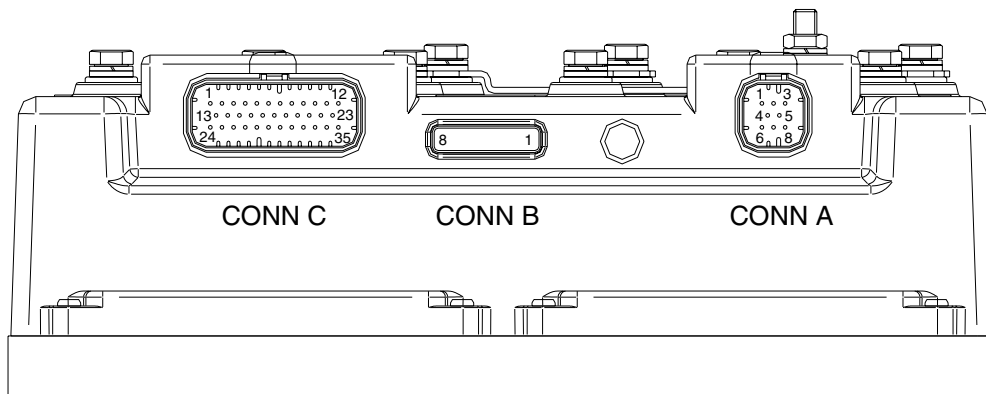
The microcontrollers continually monitor the inverter and carry out a diagnostic procedure on the main functions. The diagnosis is made in 4 points.

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

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

### 3) DESCRIPTION OF THE CONNECTORS

#### (1) Traction controller



20B7EL13

No. of Pin	Function	Description
A1	CAN_H	High level CANBUS.
A2	CANT_H	-
A3	CAN_POS	-
A4	CAN_L_OUT	Low level CANBUS: to be used as repetition for CAN_L line or to be connected to CANT_H to insert termination resistance.
A5	CANT_L	-
A6	CAN_L	Low level CANBUS.
A7	CAN_H_OUT	High level CANBUS: to be used as repetition for CAN_ H line or to be connected to CANT_L to insert termination resistance.
A8	CAN_NEG	-
B1	PCLRXD	Positive serial reception.
B2	NCLRXD	Negative serial reception.
B3	PCLTXD	Positive serial transmission.
B4	NCLTXD	Negative serial transmission.
B5	GND	Negative console power supply.
B6	+12	Positive console power supply.
B7	FLASH	-
B8	FLASH	-
C1	PENC_R	Positive of right motor encoder power supply (+12 V).
C2	NENC_R	Negative of right motor encoder power supply.
C3	KEY	Connected to + batt trough a key switch and a 10 A fuse in series.
C4	CM	Common of FW / REV / HB / PB / SEAT / ENABLE / SR / ACCEL.SW/microswitches.
C5	SEAT	Seat presence signal; active high.
C6	FORWARD	Forward direction request signal; active high.
C7	REVERSE	Reverse direction request signal; active high.
C8	ENABLE	Traction request signal; active high.
C9	PB	Pedal brake request signal; active high.
C10	HB	Hand brake
C11	PENC_L	Positive of left motor encoder power supply (+12 V).
C12	NENC_L	Negative of left motor encoder power supply.
C13	PHA_R	Right motor encoder phase A.
C14	PHB_R	Right motor encoder phase B.
C15	NPOTST	Negative of steering potentiometer
C16	PPOTST	Positive of steering potentiometer (+12 V).
C17	CPOTST	Steering potentiometer wiper signal.
C18	CPOTB	Load sensor potentiometer wiper signal.

No. of Pin	Function	Description
C19	NPOTB	-BATT.
C20	NPOT	Negative of accel pedal potentiometer.
C21	CPOT	Accel pedal potentiometer wiper signal.
C22	PHA_L	Left motor encoder phase A.
C23	PHB_L	Left motor encoder phase B.
C24	NTHERM_R	Negative of right traction motor temperature sensor.
C25	PTHERM_R	Right traction motor temperature signal.
C26	NLC	Output of main contactor coil driver (drives to -BATT).
C27	PLC	Positive of main contactor coil.
C28	NBRAKE (MCV SOL)	Output of solenoid coil.
C29	PBRAKE (MCV SOL)	Positive of solenoid coil.
C30	PAUX (FAN RELAY)	Positive of fan relay.
C31	NAUX (FAN RELAY)	Output of fan relay driver
C32	-BATT	
C33	PPOT	Accel/load sensor potentiometer positive, 5/10 V output; use load > 1 kohm.
C34	NTHERM_L	Negative of left traction motor temperature sensor.
C35	PTHERM_L	Left traction motor temperature signal.

## (1) Encoder installation

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

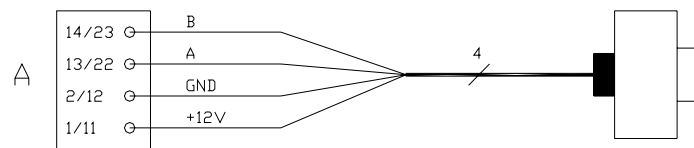
C11/C1 : +12V : Positive of encoder power supply.

C12/C2 : GND : Negative of encoder power supply.

C22/C13 : A : Phase A of encoder.

C23/C14 : B : Phase B of encoder.

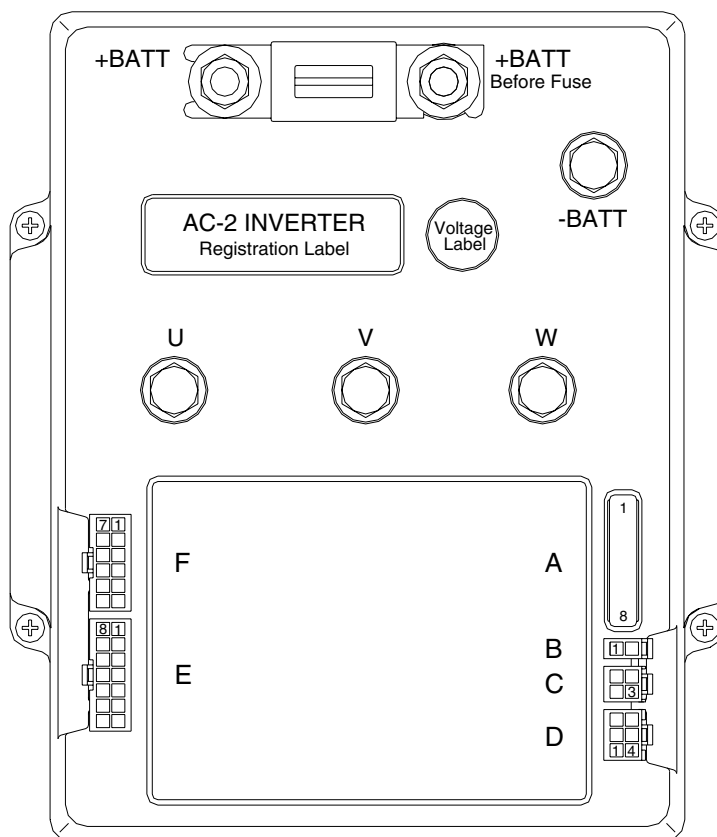
- ② Connection of encoder with open collector output; +12V power supply.



20B7EL26

- ③ The encoder power supply voltage and output electronic has to be communicated to ZAPI in order to correctly set the selection jumpers in the logic card.

## (2) Pump controller



20B7EL14

No. of pin	Function	Description
A1	PCLRXD	Positive serial reception.
A2	NCLRXD	Negative serial reception.
A3	PCLTXD	Positive serial transmission.
A4	NCLTXD	Negative serial transmission.
A5	GND	Negative console power supply.
A6	+12	Positive console power supply.
A7	FLASH	Must be connected to A8 for the flash memory programming (if used).
A8	FLASH	Must be connected to A7 for the flash memory programming (if used).
B1	-BATT	-Batt.
B2	MODE	This input allows the customer to select the software in case of double version.
C1	CAN-L	Low level CAN-BUS voltage I/O.
C2	CAN-L-OUT	Low level CAN-BUS voltage I/O.
C3	CAN-H	High level CAN-BUS voltage I/O.
C4	CAN-H-OUT	High level CAN-BUS voltage I/O.

No. of pin	Function	Description
D1 ÷ D6		Incremental ENCODER connector.
E1	CPOT	Accelerator potentiometer wiper.
E2	PPOT	Potentiometer positive: 10V output; keep load > 1KW.
E3	NPOT	Negative of accelerator unit, tested for wire disconnection diagnosis.
E4	CM	Common of LIFT ENABLE / 1 <sup>st</sup> SPEED / 2 <sup>nd</sup> SPEED / 3 <sup>rd</sup> SPEED / 4 <sup>th</sup> SPEED / HYDRO / SR microswitches.
E5	LIFT ENABLE	Input for potentiometer lifting enable input; it is active HIGH.
E6	1 <sup>st</sup> SPEED	Input for first speed request; it is active HIGH.
E7	3 <sup>rd</sup> SPEED	Input for third speed request; it is active HIGH.
E8	AN. IN.	Rotary encoder analog input.
E9	PPOT	Potentiometer positive: 10V output; keep load > 1KW.
E10	-BATT	-Batt.
E11	-BATT	-Batt.
E12	HYDRO REQ.	Input for hydraulic steering request. Active high.
E13	SR	Speed reduction input. Active low (switch opened).
E14	DIG. IN.	This is a digital input, free for customer request.
F1	KEY	Connected to the power supply through a microswitch (CH) with a 10A fuse in series.
F2	PMC	Positive of the auxiliary output.
F3	PHYDRO	Positive for MCV solenoid (OPSS valve, lock valve).
F4	4 <sup>th</sup> SPEED	Input for fourth speed request; it is active HIGH.
F5	SAFETY	If not connected to -batt the MC coil power output will be disabled. Can also be used as a general purpose input.
F6	PTHERM	Input for motor temperature sensor.
F7	CM	Common of LIFT ENABLE / 1 <sup>st</sup> SPEED / 2 <sup>nd</sup> SPEED / 3 <sup>rd</sup> SPEED / 4 <sup>th</sup> SPEED / HYDRO / SR microswitches.
F8	NMC	This output can be used for drive the main contactor coil (single pump configuration) or to drive an auxiliary load (combi configuration)
F9	NHYDRO	Negative for MCV solenoid (OPSS valve, lock valve).
F10	2 <sup>nd</sup> SPEED	Input for second speed request; it is active HIGH.
F11	GND	-Batt.
F12	NTHERM	-Batt.

## 4) FUNCTION CONFIGURATION

### ■ TRACTION CONTROLLER-MASTER

Using the CONFIG MENU of the programming console, or using a display, the user can configure the following functions.

#### (1) Submenu "SET OPTIONS"

##### ① Hour counter

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

##### ② Battery check

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

##### ③ Traction cutout

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

##### ④ Lift cutout

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

##### ⑤ S.R.O.

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

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

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

- Seat-direction lever-accelerator pedal or
- Seat-accelerator pedal-direction lever within the seq. delay time or
- Direction lever-seat-accelerator pedal

##### ⑥ Hydro key on

- ON / OFF : If this option is programmed ON the traction inverter manages an hydraulic steering function when the "key" is switched ON.

##### ⑦ Stop on ramp

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

##### ⑧ Aux input #1

- EXCLUSIVE HYDRO : Input C10 activates hydraulic steering function, output A31 is activated.
- OPTION #1 : Input C10 is the input for an handbrake device, active low (open switch).
- OPTION #2 : Input C10 is the input for a speed reduction device, active low (open switch).

⑨ **Set temperature**

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

⑩ **Steer table**

This parameter is used to set the correct steering table.

- OPTION #1 : The steering table is the one for 3 wheels truck.
- OPTION #2 : The steering table is the one for 4 wheels truck.

⑪ **Display**

If this option is set to on the communication with the Zapi graphic display is enabled.

**(2) Submenu "ADJUSTMENTS"**

① **Set battery type**

It selects the nominal battery voltage.

② **Adjust battery**

Fine adjustment of the battery voltage measured by the controller. Please increase or decrease the value 1 by 1 and check the voltage.

③ **Max steer right** (only available on console)

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

④ **Max steer left** (only available on console)

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

⑤ **Set steer 0-pos.** (only available on console)

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

⑥ **Set steer right**

This parameter sets the max steering angle in right direction.

⑦ **Set steer left**

This parameter sets the max steering angle in left direction.

⑧ **Throttle 0 zone**

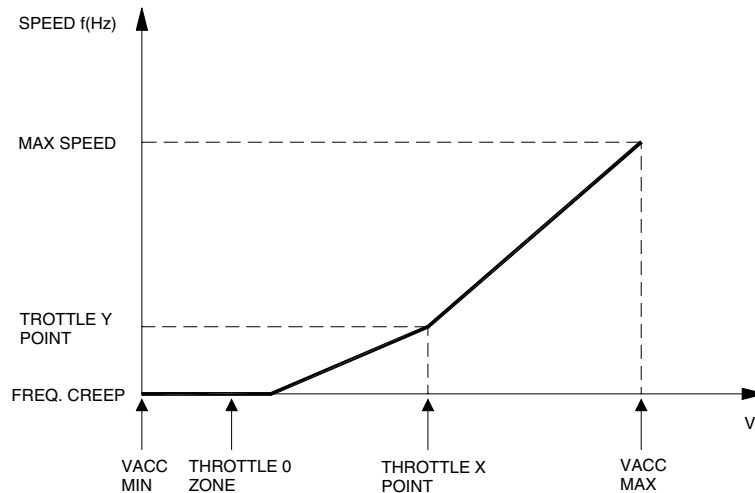
It establishes a deadband in the accelerator input curve (see also curve below).

⑨ **Throttle X point**

This parameter changes the characteristic of the accelerator input curve.

⑩ **Throttle Y point**

This parameter changes the characteristic of the accelerator input curve.



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VACC MIN and VACC MAX are values programmable by the "Program Vacci" function.

⑪ **Cooling fan work**

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

Option #1 : fans work always

Option #2 : fans work in case a temperature of controller or motor exceeds a temperature set in  
START TEMP. FAN menu

Options #2 : fans work when motors work.

⑫ **Start TEMP. FAN**

if COOLING FAN WORK menu is set as option #2, This menu is used to set a temperature limitation which allows fans to work when a temperature of controller or motor exceeds the limitation.

⑬ **Adjustment #2 bdi**

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

⑭ **Adjustment #1 bdi**

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

⑮ **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.

⑯ **Main cont. voltage**

This parameters adjusts the line contactor coil voltage (PWM output C26).

⑰ **Aux output voltage**

This parameters adjusts the electric brake coil voltage (PWM output C28).

⑱ **Adjustment #04 :**

This parameter determines the motor temperature level at which the "Motor temperature" alarm is signalled. This parameter must be adjusted only if the "Set temperature" (menu "Set option") parameter is programmed "Analog".

⑲ **Speed factor**

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

$$\text{Speed factor} = 88 * rr * p / \varnothing$$

where :

rr = total gearbox ratio

$\varnothing$  = traction wheel diameter (cm)

P = number of pair poles of the motor

⑳ **Load sensor (option)**

ON : Load Sensing Function is activated

OFF : Load Sensing Function is disactivated

㉑ **REF. load weight (option)**

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

㉒ **Overload weight (option)**

This parameter is used to show and configure the trigger condition for OVER LOAD alarm.

If the loaded weight exceeds the weight indicated in this parameter, OVER LOAD alarm and function limitation will occur according to OVERLOAD TYPE parameter.

㉓ **Overload type (option)**

This option specifies how overload alarm works in overloaded situation.

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

If re-configuration of V.A.S.S LOAD is required, please set this parameter as NONE, then proceed re-configuration.

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 & steering 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.

㉔ **Load speed UPD (option)**

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

### (3) Parameter change

① **Acceler. delay**

It determines the acceleration ramp.

Less value means better acceleration performance.

② **Release braking**

It controls the deceleration ramp when the travel request is released.

Less value means better braking performance.

③ **Invers. braking**

It controls the deceleration ramp when the direction switch is inverted during travel.

Less value means better braking performance.

④ **Pedal braking**

It determines the deceleration ramp when the travel request is released and the brake pedal switch is closed.

Less value means better braking performance.

⑤ **Speed limit brk.**

Deceleration ramp when the pedal position is changed but not completely released.

Less value means better braking performance.

⑥ **Brake cutback**

It determines the deceleration ramp when the speed reduction input becomes active and the motor slow down.

Less value means better braking performance.

⑦ **Max speed forw**

It determines the maximum speed in forward direction.

⑧ **Max speed back**

It determines the maximum speed in backward direction.

⑨ **Cutback speed 1**

Speed reduction when the cutback switch is active.

⑩ **Turtle speed**

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

⑪ **Curve cutback**

Speed reduction when the truck is doing a curve. The parameter sets the speed setpoint 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.

⑫ **Frequency creep**

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

⑬ **Maximum current**

This changes the maximum current of the inverter.

⑭ **Acc. smooth**

It gives a parabolic shape to the acceleration ramp.

⑮ **Inv. smooth**

It gives a parabolic shape to the acceleration ramp after a direction inversion.

⑯ **Stop smooth**

Hz. It sets the frequency where the smooth effect of the parabolic acceleration ends.

⑰ **Seat delay time**

It determines the delay time between the opening of the seat switch on CNC#5 digital input and the start of the truck electrical braking.

⑱ **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".

⑲ **CHAT TIME**

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.

## ■ TRACTION CONTROLLER-SLAVE

Using the config menu of the programming console, or using a display, the user can configure the following functions.

### (1) Submenu "SET OPTIONS"

Not available.

### (2) Submenu "ADJUSTMENTS"

#### ① Set battery type

It selects the nominal battery voltage.

#### ② Adjust battery

Fine adjustment of the battery voltage measured by the controller. Please increase or decrease the value 1 by 1 and check the voltage.

#### ③ Aux output voltage

This parameter adjusts the voltage of the auxiliary output coil (Fan relay), PWM output A31.

### (3) Parameter change

#### ① Release braking

It controls the deceleration ramp when the travel request is released.

Less value means better braking performance.

#### ② Seat delay time

It determines the delay time between the opening of the seat switch on CNC#5 digital input and the start of the truck electrical braking.

## ■ PUMP CONTROLLER

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

### (1) Submenu "SET OPTIONS"

#### ① Hour counter

- RUNNING : The counter registers travel time only.

- KEY ON : The counter registers when the "key" switch is closed.

#### ② Set temperature

- DIGITAL : A digital (ON/OFF) motor thermal sensor is connected to F6 input.

- ANALOG : An analog motor thermal sensor is connected F6 (the curve can be customized on a customer request).

- NONE : No motor thermal sensor switch is connected.

#### ③ Joystick (Option)

- OFF : The truck model includes mechanical lever distributor (default)

- ON : The truck model includes electro-hydraulic distributor and finger tips. Can communication with Can tiller and Hydro CB zapi modules is enabled.

#### ④ Shift function

- ON : Fingertip Side Shift function is activated.

- OFF : Fingertip Side Shift function is deactivated.

#### ⑤ Aux function

- ON : Fingertip Aux function is activated.

- OFF : Fingertip Aux function is deactivated.

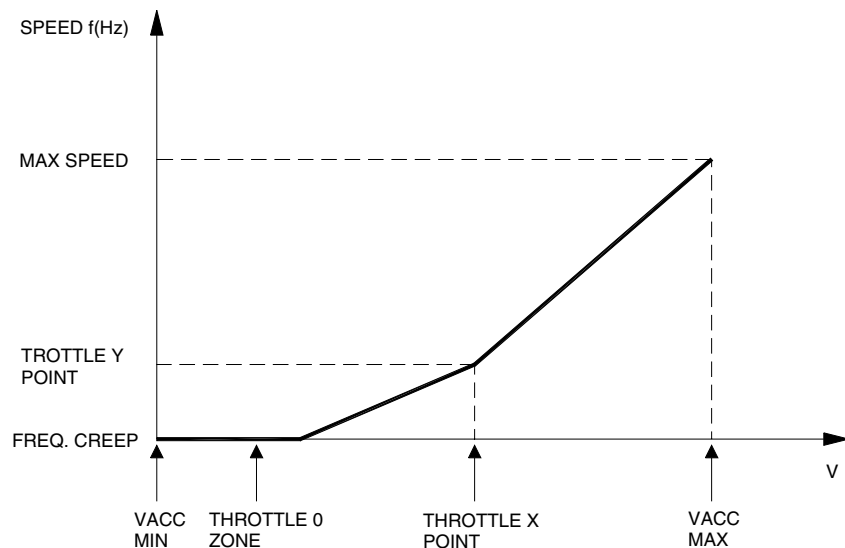
#### ⑥ Digital lift

- 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.

## (2) Submenu "ADJUSTMENTS"

- ① **Set battery type** : Selects the nominal battery voltage.
- ② **Adjust battery** : Fine adjustment of the battery voltage measured by the controller. Please increase or decrease the value 1 by 1 and check the voltage.
- ③ **Throttle 0 zone** : Establishes a deadband in the accelerator input curve (see also curve below).
- ④ **Throttle X zone** : This parameter changes the characteristic of the accelerator input curve.
- ⑤ **Throttle Y zone** : This parameter changes the characteristic of the accelerator input curve.



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VACC MIN and VACC MAX are values programmable by the "PROGRAM VACC" function.

- ⑥ **Adjustment #04** : This parameter determines the motor temperature level at which the "MOTOR TEMPERATURE" alarm is signalled. This parameter must be adjusted only if the "SET TEMPERATURE" (menu "SET OPTION") parameter is programmed "ANALOG"
- ⑦ **PWM on main contactor**
  - OFF: The inverter applies the battery voltage to the coil on F8 output (spare).
  - ON: The PWM reduces the voltage to the set value.
- ⑧ **PWM on aux output**
  - OFF: The inverter applies the battery voltage to the coil on F9 output (MCV solenoid coil).
  - ON: The PWM reduces the voltage to the set value.
- ⑨ **MC/AUX PWM**: It sets the PWM level in % on the outputs F8 and F9. Here is used to drive a main contact for pump.
- ⑩ **Fork leveling**
  - ON : AUTO TILT LEVELING function is activated.
  - OFF : AUTO TILT LEVELING function is disactivated.

### **(3) Parameter change**

#### **① Acceler delay**

It determines the acceleration ramp.

More value means better deceleration performance.

#### **② Deceler delay**

It determines the acceleration ramp.

More value means better deceleration performance.

#### **③ Max speed up**

Determines the maximum lifting speed with a potentiometer control.

#### **④ Min speed up**

Determines the minimum lifting speed with a potentiometer control when the lifting enable switch is closed.

#### **⑤ Cutback speed**

Determines the lift speed reduction in percentage when the speed reduction switch is activated.

#### **⑥ Tilt speed**

Tilt speed, fine regulation.

#### **⑦ Shift speed**

Shift speed, fine regulation.

#### **⑧ Aux speed**

Auxiliary function speed, fine regulation.

#### **⑨ Hyd speed fine**

Hydro speed, fine regulation (steering speed).

#### **⑩ Maximum current**

The maximum current of the inverter.

#### **⑪ Idle time**

Time delay when an hydraulic steering function request is switched off.

### **■ DISPLAY**

Operators can have below functions through display.

#### **(1) Password**

If determines to set the function of user password when key on.

- OFF : No use

- ON : Activate the user password (Default password is "00000" and it can be re-set at user-menu)

#### **(2) Maintenance**

If determines to set the function of maintenance alarm when if come to service interval.

- OFF : No use

- ON : Activate the maintenance alarm function.

#### **(3) Hour counter**

It indicates the machine operating hours.

- Key ON : Key on time

- Pump : Pump motor operating time.

- Traction : Traction motor operating time.

## 5) PROGRAMMING & ADJUSTMENTS

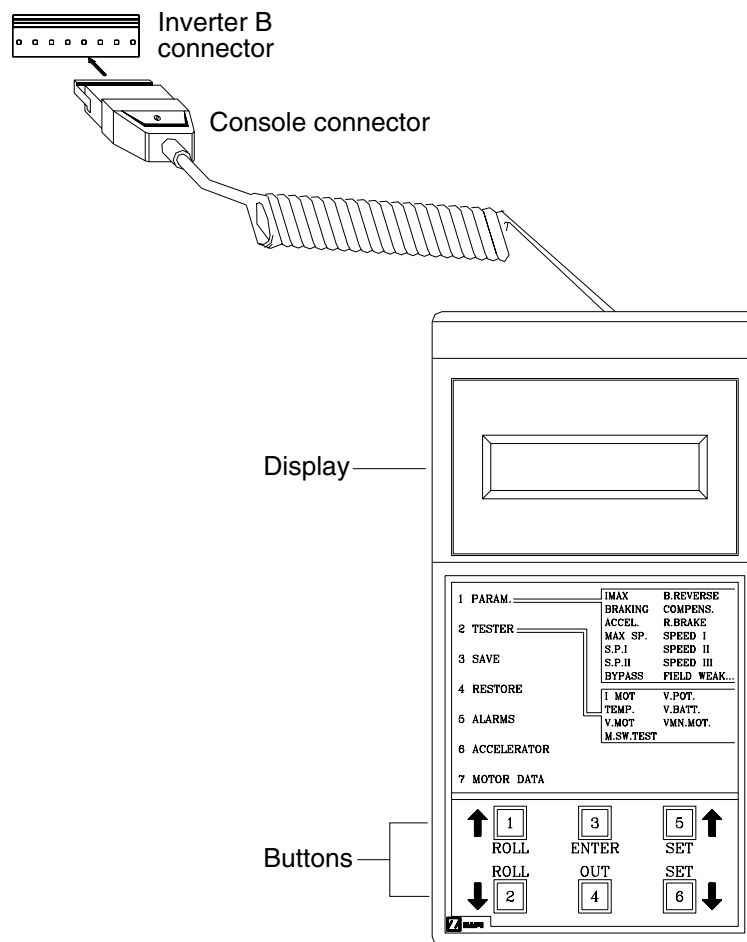
There are two ways to adjust parameter via a console or buttons on a display.

※ Adjustments via buttons on a display, please refer to the display section. (page 7-48)

### ADJUSTMENTS VIA CONSOLE (Option)

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

#### (1) Descriptions of console

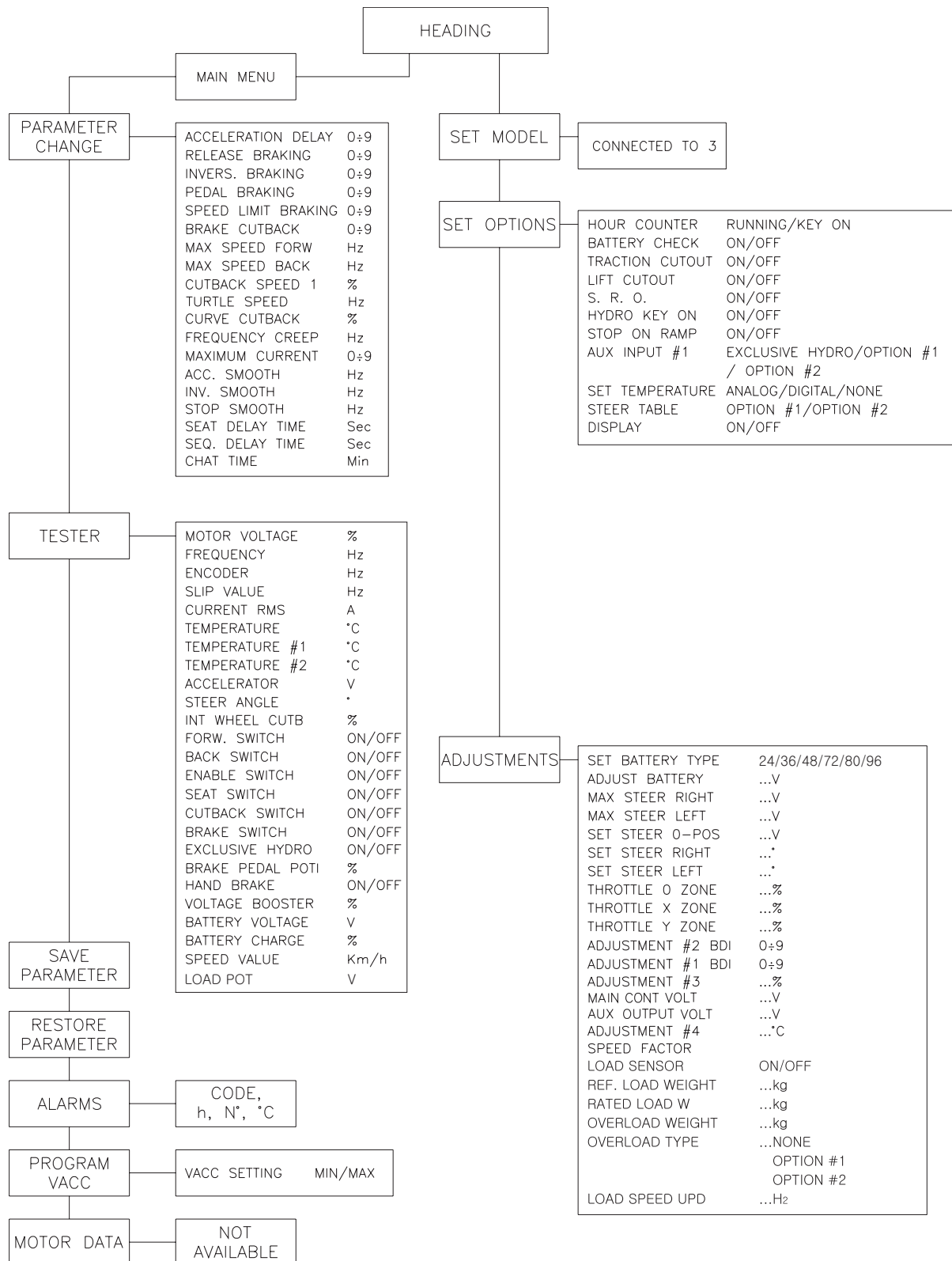


20B7EL15

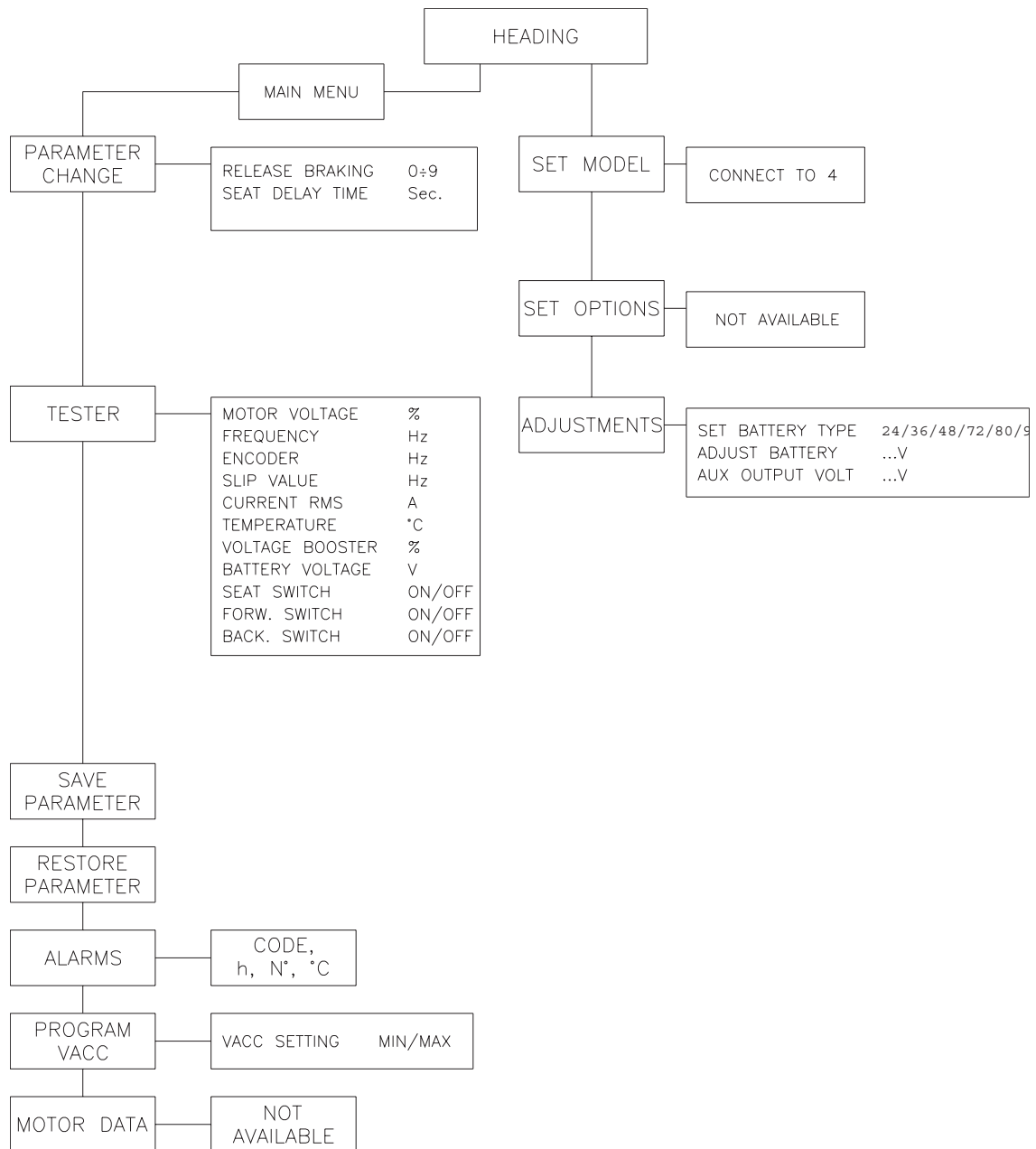
※ Please connect and disconnect it from the inverter after a key switch off.

## (2) Description of standard console menu

### ① Traction controller-Master

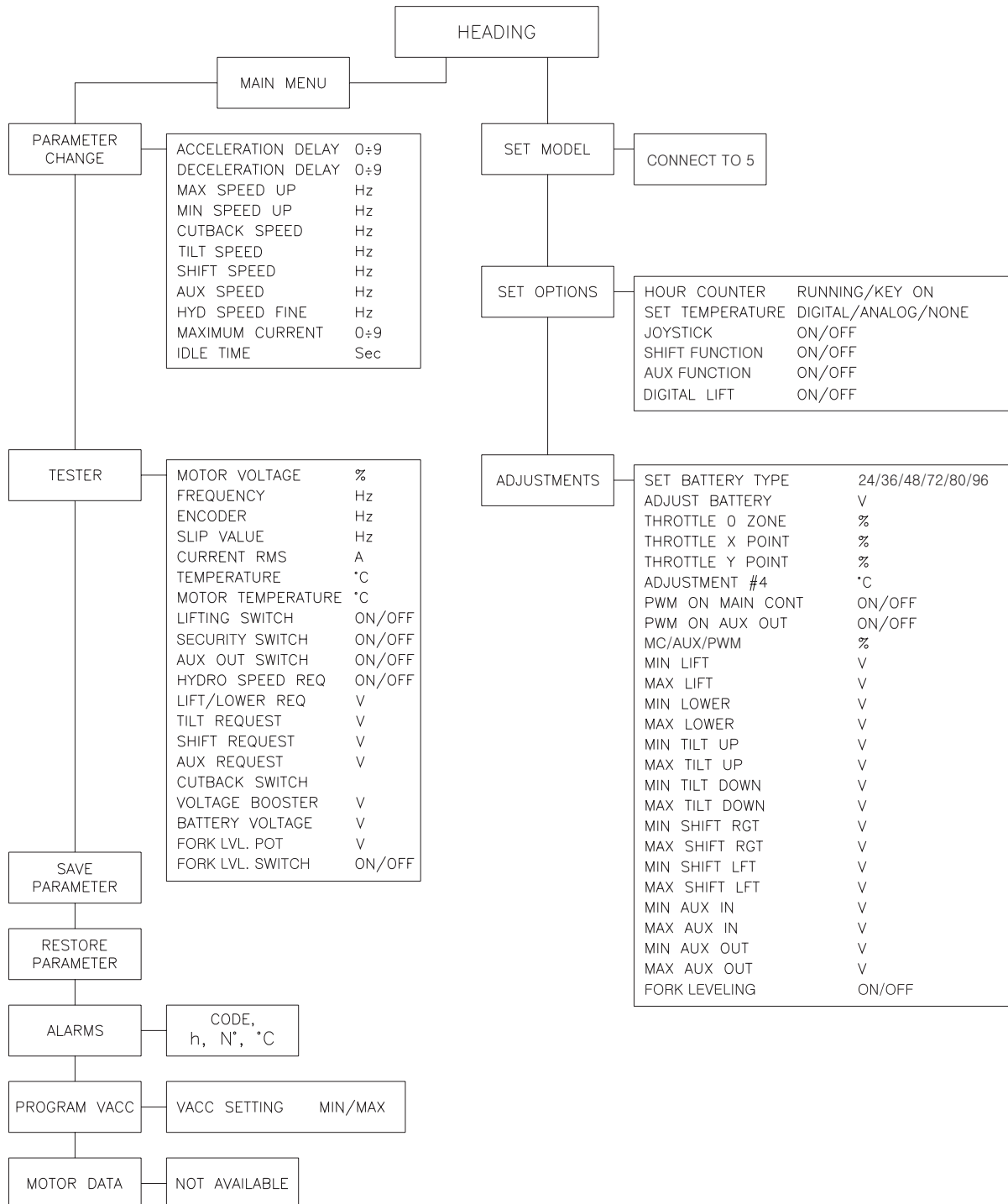


## ② Traction controller-Slave



22B9EL19

### ③ Pump controller



15BT9EL20

### (3) Description of the console SAVE function

The SAVE function allows the operator to transmit the parameter values and configuration data of the chopper into the console memory. It is possible to load 64 different programmers.

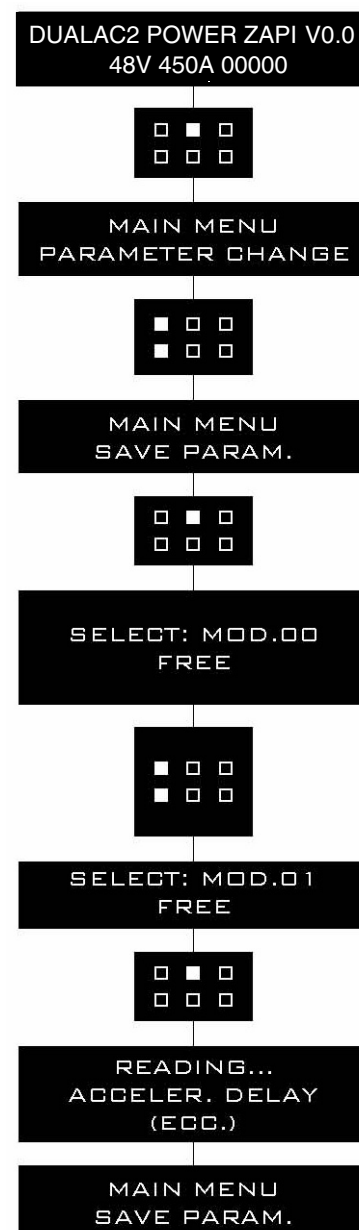
The information saved in the console memory can then be reloaded into another chopper using the RESTORE function.

The data that is available via the SAVE function is as follows:

- All parameter values (Parameter change).
- Options (Set. options).

Flow chart showing how to use the SAVE function of the digital console.

- ① Opening Zapi display.
- ② Press ENTER to go into the general menu.
- ③ The display will show:
- ④ Press ROLL UP or ROLL DOWN button until SAVE PARAM. appear on the display.
- ⑤ The display shows:
- ⑥ Press ENTER to go into the SAVE function.
- ⑦ If this facility has been used before the type of chopper data stored appears on the top main with a 2 digit reference.
- ⑧ Keep pressing either ROLL UP or ROLL DOWN keys until the second Main indicates a FREE storage facility.
- ⑨ Press ENTER to commence SAVE routine.
- ⑩ You can see the items that are being stored whilst the SAVE routine is happening.
- ⑪ When finished, the console shows :
- ⑫ Press OUT to return to the opening Zapi display.



#### (4) Description of the console RESTORE function

The RESTORE PARAM function allows transfer of the console's stored data into the memory of the chopper. This is achieved in a fast and easy way using the method previously used with the SAVE PARAM. function.

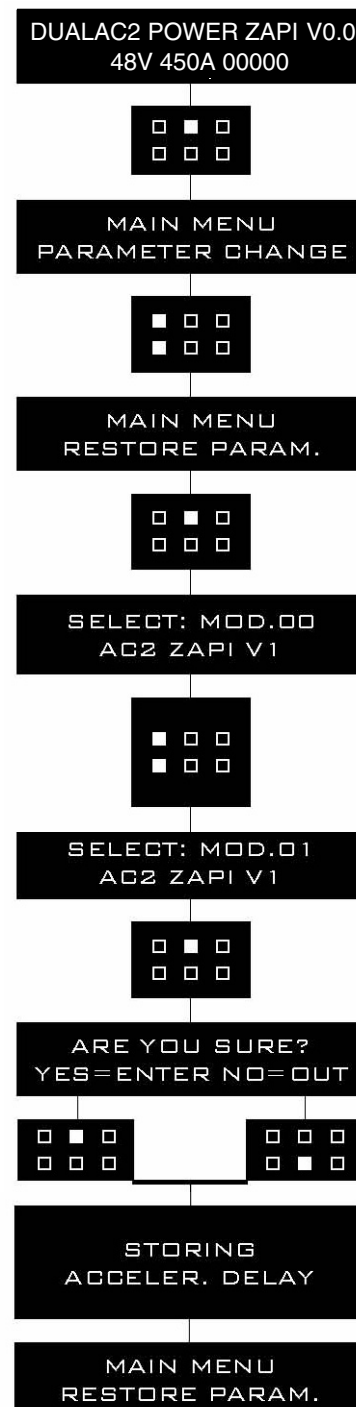
The data that is available via the RESTORE PARAM. function is as follows :

- All Parameter Values (Parameter change).
- Options (Set options)

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

Flow chart showing how to use the RESTORE function of the digital console.

- ① Opening Zapi display.
- ② Press ENTER to go into the general menu.
- ③ The display will show:
- ④ Press ROLL UP or ROLL DOWN button until SAVE PARAM. appear on the display.
- ⑤ The display shows:
- ⑥ Press ENTER to go into the RESTORE PARAM function.
- ⑦ The display shows the type of model stored, with a code number.
- ⑧ Keep pressing either ROLL UP or ROLL DOWN keys until the desired model appears on the display.
- ⑨ Press ENTER to commence restore operation.
- ⑩ The display asks "ARE YOU SURE?".
- ⑪ You can see the items that are being stored in the chopper memory whilst the RESTORE routine is happening
- ⑫ When finished, the console shows :
- ⑬ Press OUT to return to the opening Zapi display.



22B7EL22

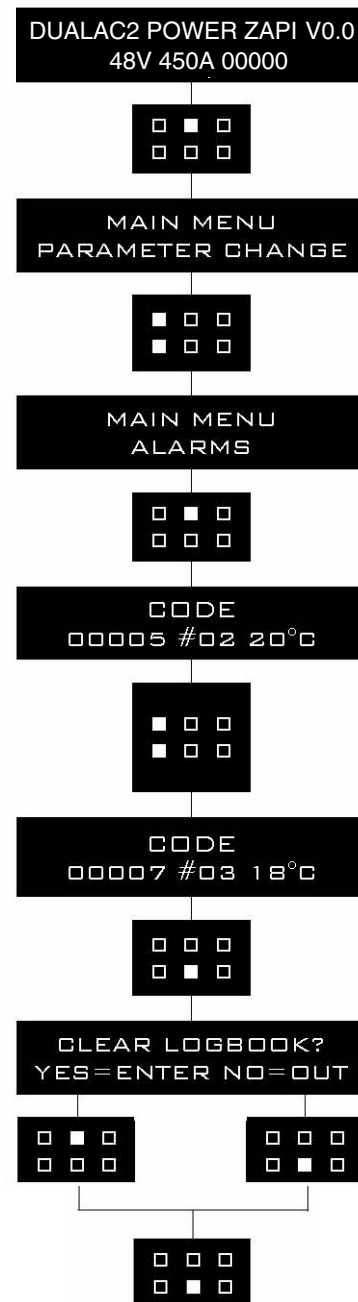
## (5) Description of alarms menu

The microprocessor in the controller records the last five alarms that have occurred. Items remembered relative to each alarm are: the code of the alarm, the number of times the particular Alarm occurred, the hour meter count, and the inverter temperature.

This function permits a deeper diagnosis of problems as the recent history can now be accessed.

Flow chart showing how to use the ALARMS function via the digital console.

- ① Opening Zapi display.
- ② Press ENTER to go into the general menu.
- ③ The display will show:
- ④ Press ROLL UP or ROLL DOWN button until PARAMETER CHANGE. appear on the display.
- ⑤ The display shows:
- ⑥ Press ENTER to go into the ALARMS function.
- ⑦ The display will show the most recent alarm.
- ⑧ Each press of the ROLL UP button brings up following alarms. Pressing ROLL DOWN returns to the most recent.
- ⑨ If an alarm has not occurred, the display will show: ALARM NULL.
- ⑩ When you have finished looking at the alarms, press OUT to exit the ALARMS menu.
- ⑪ The display will ask "CLEAR LOGBOOK?".
- ⑫ Press ENTER for yes, or OUT for NO.
- ⑬ Press OUT to return to the opening Zapi display.



22B7EL23

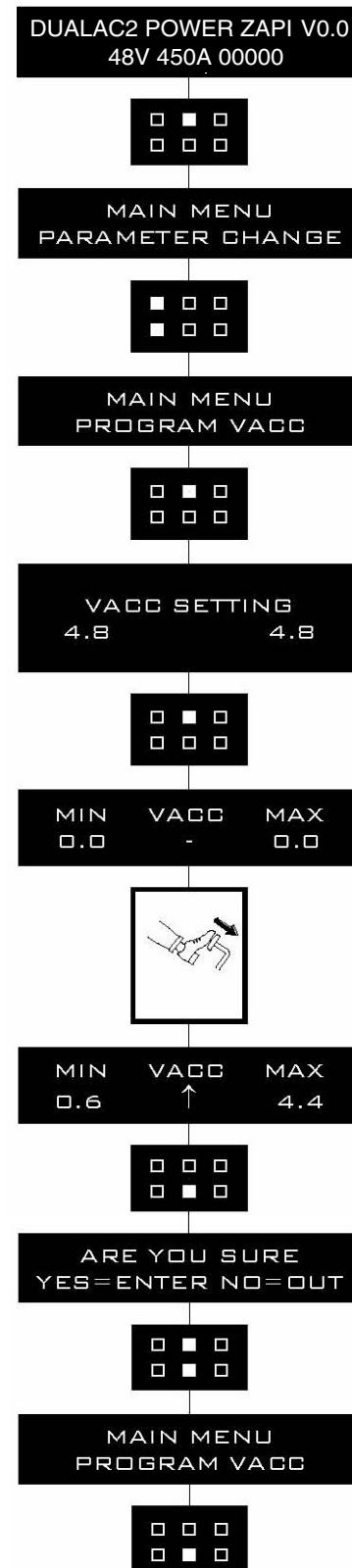
## (6) Description of console program vacc function

This function looks for and remembers the minimum and maximum potentiometer wiper voltage over the full mechanical range of the pedal. It enables compensation for non symmetry of the mechanical system between directions.

The operation is performed by operating the pedal after entering the PROGRAM VACC function.

Flow chart showing how to use the PROGRAM VACC function of the digital console:

- ① Opening Zapi display.
- ② Press ENTER to go into the general menu.
- ③ The display will show:
- ④ Press ROLL UP or ROLL DOWN button until PROGRAM VACC. appear on the display.
- ⑤ The display shows:
- ⑥ Press ENTER to go into the PROGRAM VACC routine.
- ⑦ The display will show the minimum and maximum values of potentiometer wiper output. Both directions can be shown.
- ⑧ Press ENTER to clear these values. Display will show 0.0.
- ⑨ Select forward direction, close any interlock switches that may be in the system.
- ⑩ Slowly depress the accelerator pedal (or tiller butterfly) to its maximum value. The new minimum and maximum voltages will be displayed on the console plus an arrow indicating the direction.
- ⑪ Select the reverse direction and repeat Item10.
- ⑫ When finished, press OUT.
- ⑬ The display will ask : "ARE YOU SURE?".
- ⑭ Press ENTER for yes, or OUT for NO.
- ⑮ When finished, the console shows:
- ⑯ Press OUT again to return to the opening Zapi menu.

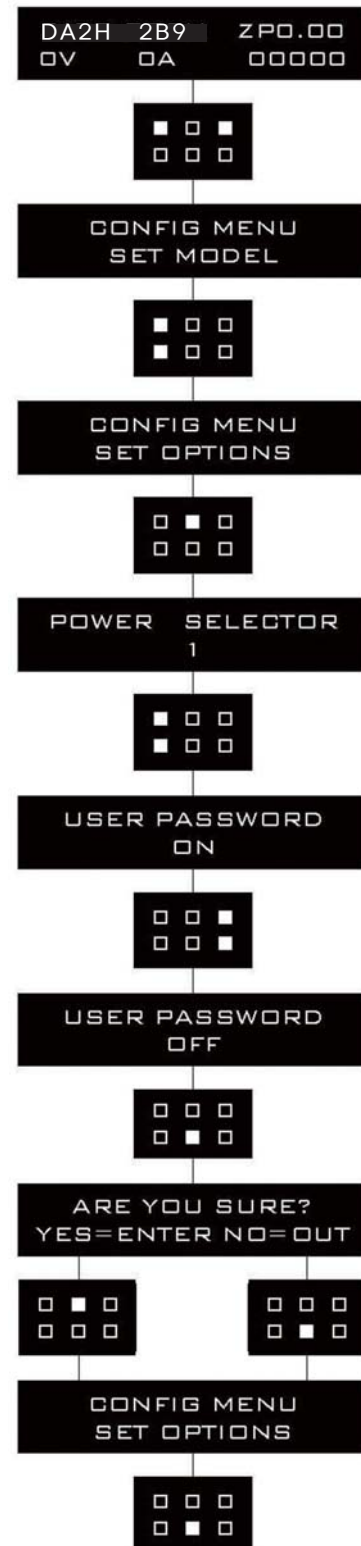


22B7EL24



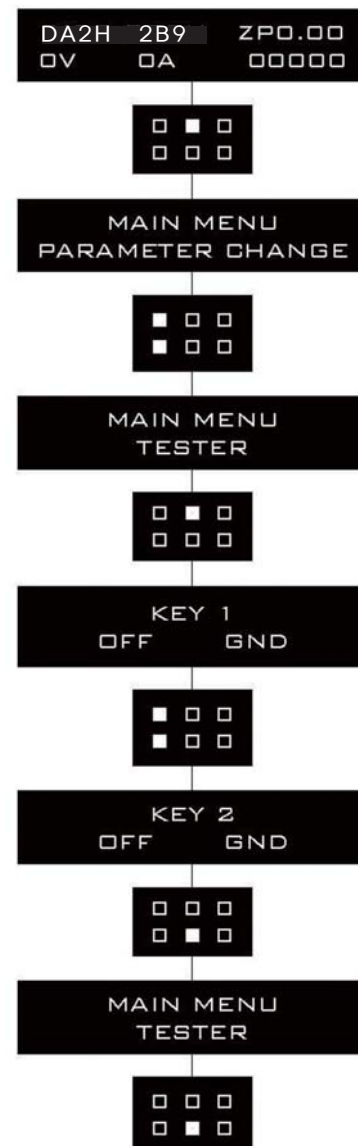
② Flow chart showing how to make changes to option menu :

- a. Opening Zapi menu.
- b. Press ROLL UP & SET UP Buttons to enter CONFIG MENU.
- c. The display will show: SET MODEL.
- d. Press ROLL UP or ROLL DOWN until SET OPTIONS appears.
- e. SET OPTIONS menu appears.
- f. Press ENTER to go into the SET OPTIONS menu.
- g. The display will show the first option.
- h. Press ROLL UP or ROLL DOWN buttons until desired option appears.
- i. Desired option appears.
- j. Press SET UP or SET DOWN buttons in order to modify the value for selected option.
- k. New value for selected option appears.
- l. Press OUT to exit the menu.
- m. Confirmation request appears.
- n. Press ENTER to accept the changes, or press OUT if you do not accept the changes.
- o. SET OPTIONS menu appears.
- p. Press OUT again. Display now shows the opening Zapi menu.



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

- a. Opening Zapi menu.
- b. Press ENTER to go into the MAIN MENU.
- c. The display will show: PARAMETER CHANGE.
- d. Press ROLL UP or ROLL DOWN until TESTER menu appears on the display.
- e. The display will show: TESTER.
- f. Press ENTER to go into the TESTER function.
- g. The first variable to be tested is shown on the display.
- h. Press either ROLL UP or ROLL DOWN buttons.
- i. Next variable for measurement appears.
- j. When you have finished press OUT.
- k. The Display will show: TESTER.
- l. Press OUT again and return to opening Zapi menu.



20B7EL30

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

## 6) MORNITORING MENU

In Console, This menu appears as "TESTER" MENU

### (1) Traction controller-Master

#### ① Motor voltage

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

#### ② Frequency

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

#### ③ Encoder

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

#### ④ Slip value

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

#### ⑤ Current rms

Root Mean Square value of the motor current.

#### ⑥ Temperature

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

#### ⑦ Temperature #1

This is the temperature of the right motor; if the option is programmed "None" (see page 7-26) it shows 0°.

#### ⑧ Temperature #2

This is the temperature of the left motor; if the option is programmed "None" (see page 7-26) it shows 0°.

#### ⑨ Accelerator

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

#### ⑩ Steer angle

This is the indication of the angular position of the steered wheel.

#### ⑪ Internal wheel cutback

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

#### ⑫ Forward switch

The level of the forward direction digital input FW.

- ON / +VB = Input active, switch closed.

- OFF / GND = Input non active, switch open.

#### ⑬ Backward switch

The level of the reverse direction digital input BW.

- ON / +VB = Input active, switch closed.

- OFF / GND = Input non active, switch open.

#### ⑭ Enable switch

The level of the enable digital input:

- ON / +VB = Input active, switch closed.

- OFF / GND = Input non active, switch open.

⑮ **Seat switch**

The level of the seat microswitch digital input.

- ON / +VB = Input active, switch closed.

- OFF / GND = Input non active, switch open.

⑯ **Cutback switch**

The level of the speed reduction microswitch.

- ON / GND = Input active, switch opened.

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

⑰ **Brake switch**

The level of the pedal brake microswitch.

- ON / +VB = Input active, switch closed.

- OFF / GND = Input non active, switch open.

⑱ **Exclusive hydro**

Status of the exclusive hydro switch.

- ON / +VB = Input active, switch closed.

- OFF / GND = Input non active, switch open.

⑲ **Brake pedal pot.**

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

⑳ **Hand brake**

The level of the handbrake microswitch.

- ON / GND = Input active, switch opened.

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

㉑ **Voltage booster**

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

㉒ **Battery voltage**

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

㉓ **Battery charge**

The percentage Charge level of the battery.

㉔ **Load pot**

Voltage value of load sensor.

**(2) Traction controller-Slave**

① **Motor voltage**

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

② **Frequency**

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

③ **Encoder**

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

④ **Slip value**

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

⑤ **Current rms**

Root mean square value of the motor current.

⑥ **Temperature**

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

⑦ **Voltage booster**

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

⑧ **Battery voltage**

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

⑨ **Seat switch**

The level of the seat microswitch digital input.

- ON / +VB = Input active, switch closed.

- OFF / GND = Input non active, switch opened.

⑩ **Forward switch**

The level of the forward direction digital input FW.

- ON / +VB = Input active, switch closed.

- OFF / GND = Input non active, switch opened.

⑪ **Backward switch**

The level of the reverse direction digital input BW.

- ON / +VB = Input active, switch closed.

- OFF / GND = Input non active, switch opened.

### **(3) Pump controller**

#### **① Motor voltage**

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

#### **② Frequency**

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

#### **③ Encoder**

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

#### **④ Slip value**

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

#### **⑤ Current rms**

Root Mean Square value of the motor current.

#### **⑥ Temperature**

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

#### **⑦ Motor temperature**

This is the temperature of the motor; if the option is programmed "None" it shows 0°.(refer to 7-31 page)

#### **⑧ Lifting switch:**

Status of the lifting switch.

- ON / +VB = Active entry of closed switch.

- OFF / GND = Non active entry of open switch.

#### **⑨ Security switch:**

Status of the SBR switch.

- ON / +VB = Active entry of closed switch.

- OFF / GND = Non active entry of open switch.

#### **⑩ Hydro speed req.:**

Status of the hydro speed request of the pump.

- ON / +VB = Active entry of closed switch.

- OFF / GND = Non active entry of open switch.

#### **⑪ Lift/lower req.:**

Level of the lift and lower analogue signal.

#### **⑫ Tilt request:**

Voltage of the tilt analogue signal.

#### **⑬ Shift request:**

Voltage of the shift analogue signal.

#### **⑭ Aux request:**

Voltage of the auxiliary analogue signal.

#### **⑮ Cutback switch:**

Status of the speed reduction switch.

- ON / GND = Active entry of open switch.

- OFF / +VB = Non active entry of closed switch.

⑩⑥ **Voltage booster:**

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

⑩⑦ **Battery voltage:**

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

⑩⑧ **Fork LVL. POT:**

V. Voltage value of Fork sensor.

⑩⑨ **Fork LVL. switch:**

- ON : Fork level switch is activated.
- OFF : Fork level switch is disactivated.

## 7) GENERAL SUGGESTION FOR SAFETY

For a proper installation take care of the following recommendations:

- ⚠ After operation, even with the key switch open, the internal capacitors may remain charged for some time. For safe operation, we recommend that the battery is disconnected, and a short circuit is made between battery positive and battery negative power terminals of the inverter using a resistor between 10 ohm and 100 ohm.
- ⚠ During battery charge, disconnect the controller from the battery.
- ⚠ Do not connect the controller to a battery with a nominal voltage different than the value indicated on the controller label. A higher battery voltage may cause power section failure. A lower voltage may prevent the logic operating.
- ⚠ Before doing any operation, ensure that the battery is disconnected and when all the installation is completed start the machine with the drive wheels raised from the floor to ensure that any installation error do not compromise safety.
- ⚠ Take care all the inductive devices in the truck (horn, solenoid valves, coils, contactors) have a proper transient suppression device.

### ※ The method of discharging internal capacitor

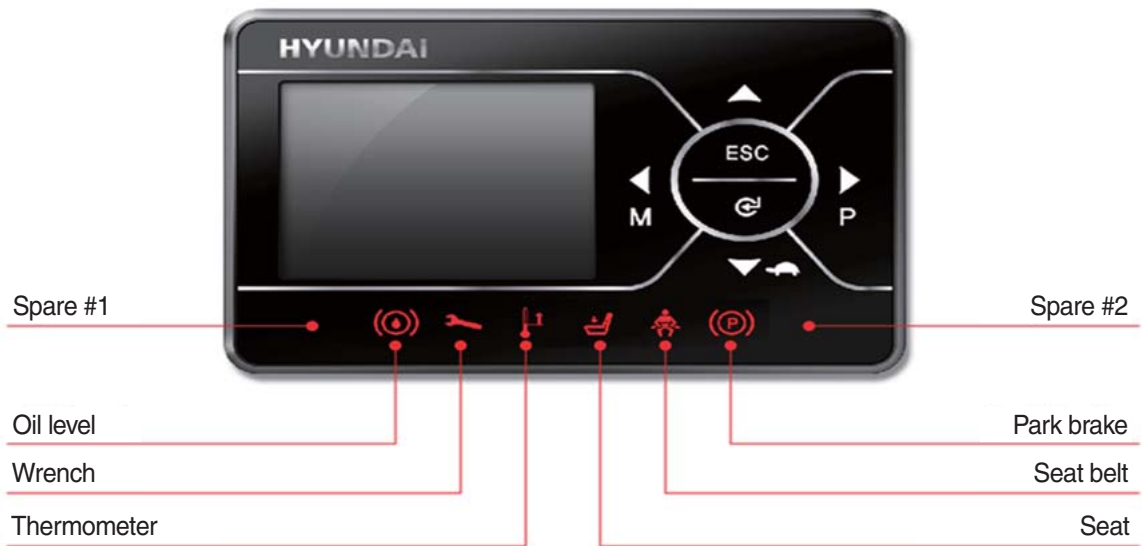
Before checking controllers, motors, cables and etc., discharge the internal capacitor in controllers by following below steps ;

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

## 6. INSTRUMENT PANEL : DISPLAY

### 1) STRUCTURE

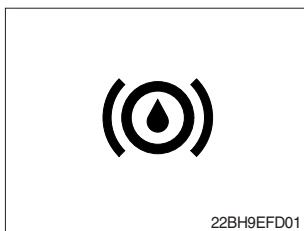
The DISPLAY has 6 red LEDs indicating the status information of the lift truck to the driver.



22BH9QM65

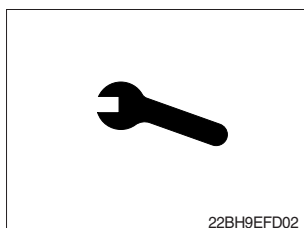
## 2) WARNING LAMP

### (1) Brake oil level warning lamp



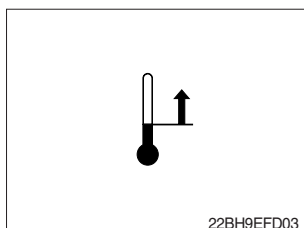
Blinks when the brake oil level in the reservoir is below the lower limit.

### (2) Wrench warning lamp



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

### (3) Thermometer warning lamp



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

### (4) Seat warning lamp



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

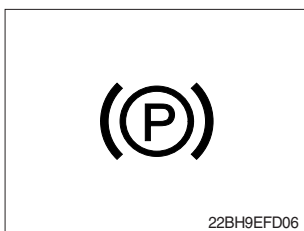
### (5) Seat belt warning lamp



(1) This LED blinks in following 2 cases.

- ① When operator starts the truck, LED blinks for 5 seconds, which means initial diagnosis is on going, and buttons on display will work properly just after the diagnosis is completed.
- ② LED blinks when the seat belt is not correctly fastened.

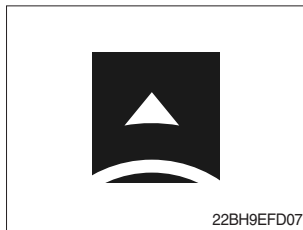
### (6) Handbrake warning lamp



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

### 3) BUTTONS

#### (1) UP button



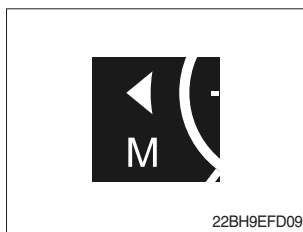
Press to select upward move

#### (2) DOWN button (DOWN/TURTLE button)



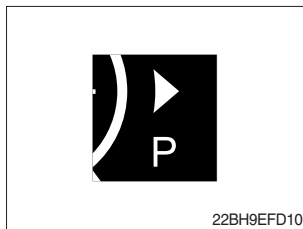
Press to select downward move  
TURTLE MODE ON/OFF

#### (3) LEFT/MENU button



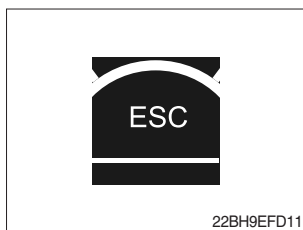
Press to select leftward move  
Go into the menu

#### (4) RIGHT/PERFORMANCE button



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

#### (5) Cancel (ESC) button



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

#### (6) ENTER button



Press to select Enter

#### 4) LCD FUNCTION (MAIN SCREEN)



MAIN SCREEN


22BH9EFD13

- |   |                     |    |                                      |
|---|---------------------|----|--------------------------------------|
| 1 | Current time        | 6  | Hour meter                           |
| 2 | Turtle mode         | 7  | Wheel position and running direction |
| 3 | Truck speed pointer | 8  | Power mode                           |
| 4 | Speed level         | 9  | BDI (Battery Discharge Indicator)    |
| 5 | Truck speed         | 10 | Load weight (option)                 |

##### (1) Current time

The number shows the current time according to the setting, which can be changed by DISPLAY Setting [6. 5), Page 7-56].

##### (2) Turtle mode

The turtle symbol is normally off. When this symbol appears, the Turtle Mode is activated regardless of the Power Mode of the truck to reduce the maximum speed to the setpoint. This mode can be activated by pressing the  button.

### **(3) Truck speed pointer**

The speed of the truck is indicated with a pointer.

### **(4) Speed level**

It indicates the speed level by 2 km.

### **(5) Truck speed**

The truck speed is shown in number. According to the DISPLAY setting km/h or mph unit is available.

### **(6) Hour meter**


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

- hK: the Key Hour shows the truck Key ON time;
- hT: the Traction Hour shows the Gate ON (driven) time of the traction motor.
- hP: the Pump Hour shows the Gate ON (driven) time of the pump motor.

### **(7) Wheel position and running direction**

The arrow point is up when the truck is forward running and points down when the truck is reverse running. The arrow point is moved to the leftward or the rightward according as the direction of the steering angle.

### **(8) Power mode**

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

- H (High) - corresponds to the highest performance
- N (Normal) - corresponds to normal performance
- E (Economic) - corresponds to economic performance

### **(9) BDI (Battery Discharge Indicator)**

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

#### **※ How to adjust BDI**

If necessary, service man can adjust BDI with adjustment #1, #2 BDI menu.

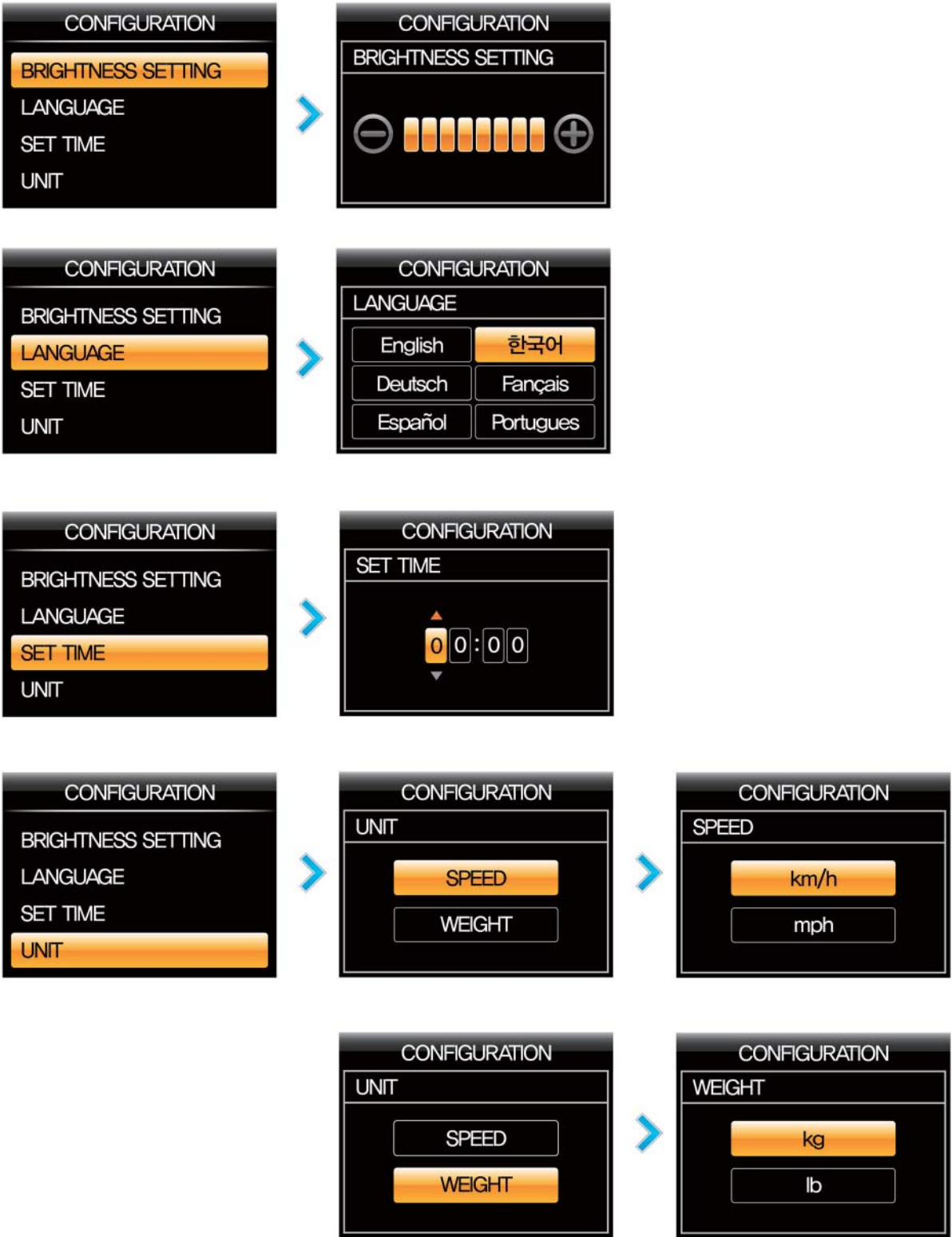
#### **① Adjustment #1 BDI**

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

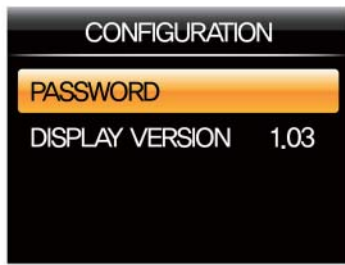
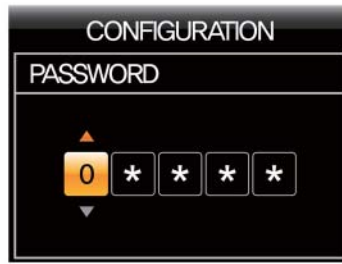
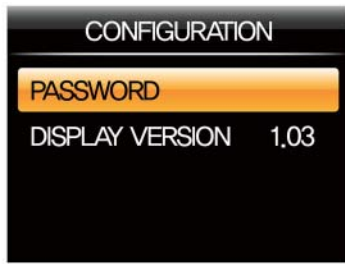
#### **② Adjustment #2 BDI**

It adjusts the lower level of the battery discharge table. Higher level means higher voltage. (for detail menu, please refer to page 7-27)

5) HOW TO USE DISPLAY MENU





22BH9EFD14



22BH9EFD15

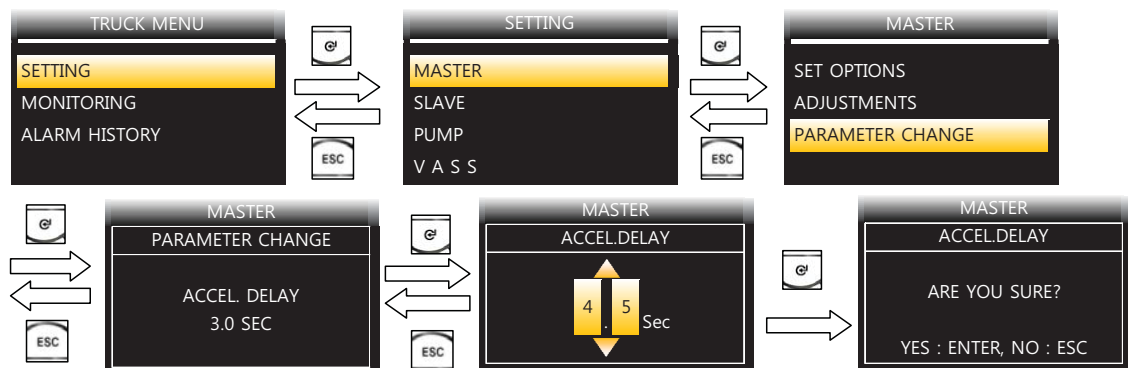
## 6) DESCRIPTION OF THE TRUCK MENU

### (1) Access to truck menu

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

### (2) How to change detail menus

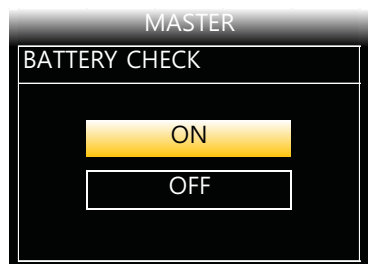
The detail items of menu can be changed as follows ;







22B9EL24

Selection can be made in 4 methods as follows ;

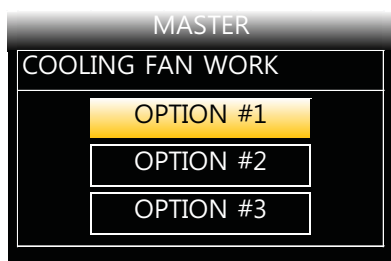
#### - ON/OFF Selection







22B9EL25

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

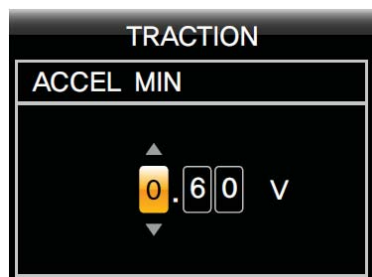
#### - Type Selection



22B9EL30

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

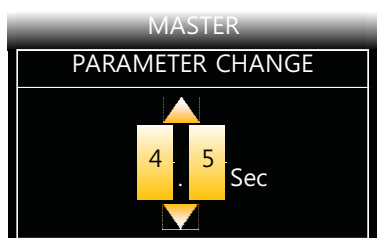
- Figure input







22B9EL31

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

- Level Selection





22B9EL30

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

7) ALARM & ALARM HISTORY

(1) How to check alarms

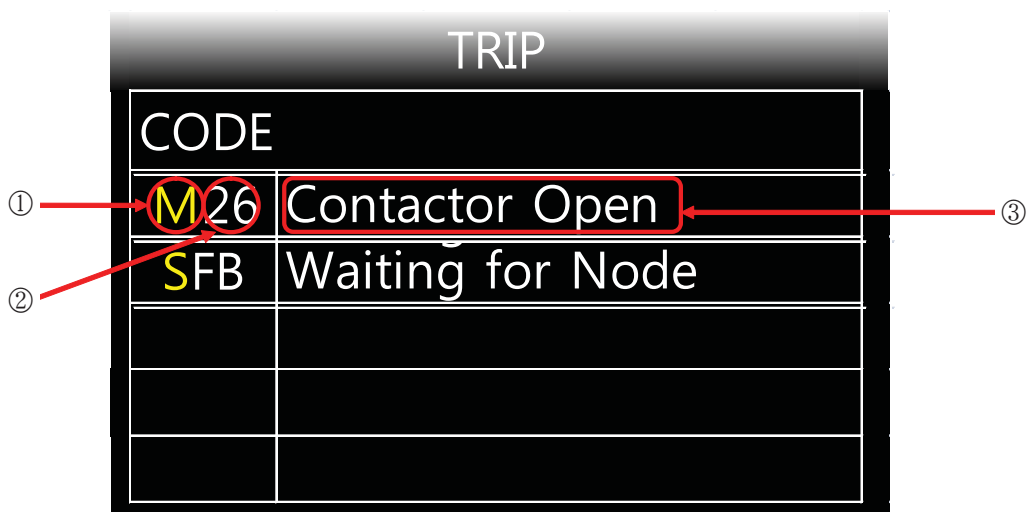
Normally, ALARM SCREEN pops up if any kind of a alarm happens, but service man can switch between a MAIN SCREEN and ALARM SCREEN with  ,  buttons as follows :



TRIP	
CODE	NAME
M26	Contactor Open
SFB	Waiting for Node

22B9EL35

## (2) Detail description of ALARM SCREEN

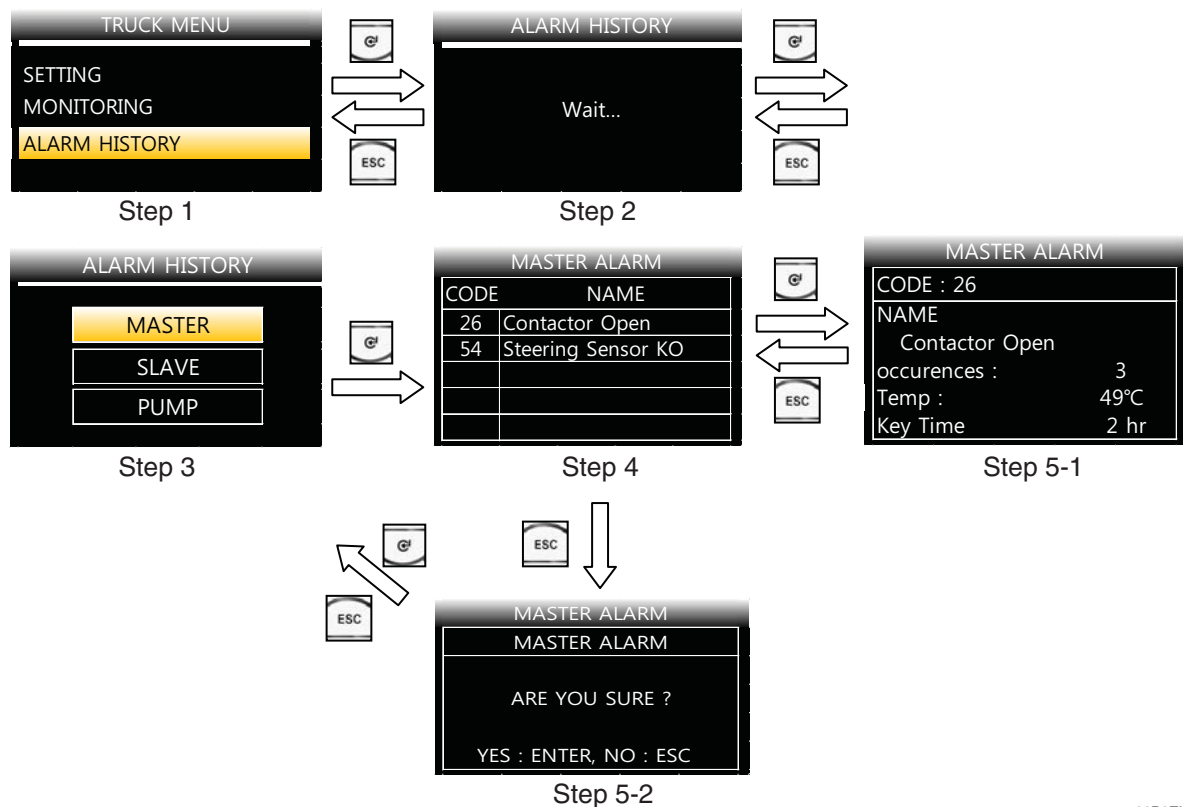


22B9EL36





- ① First yellow capital letter shows in which controller the alarm happens as below;  
 M : Traction-Master  
 S : Traction-Slave  
 P : Pump  
 V : Mhyrio CB
- ② Following two letters or digits show alarm code. Please refer to 7. ALARM CODE (Page 7-68).
- ③ This shows a name of ALARM. Please refer to 7. ALARM CODE (page 7-68).

## (3) Alarm history

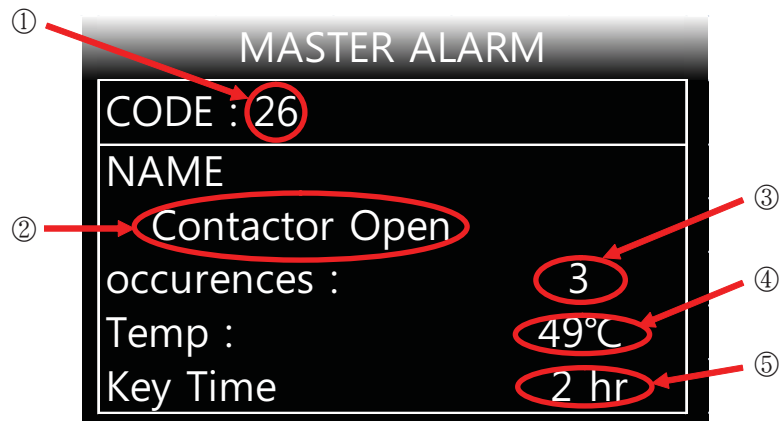
Alarm History can be looked up as follows ;



22B9EL37

- ① Step 1 : Service man can check the alarm history on ALARM HISTORY menu
- ② Step 2 : When service man enter the ALARM HISTORY menu, display read entire alarm records of all controller. So it takes 9~15 seconds to read.
- ③ Step 3 : When display finish to read alarm records, service man can choose each controller to read the alarm history.
- ④ Step 4 : When service man enters each controller's alarm history, service man can check simply up to 5 alarms and choose a specific alarm to read detail alarm information.
- ⑤ Step 5-1 : When service man press  button at Step 4, operator can see a detail alarm information of chosen alarm. Please refer to (4) DETAIL ALARM INFORMATION (as below).
- ⑥ Step 5-2 : When service man press  button at Step 4, service man can see a alarm clear menu. If service man press  button, Recorded alarms of selected controller will be erased. (to verify cleaned alarm records, service man should be back to Step 1 & 2 to refresh.)  
If operator press  button, just escape to step 3 without clearing

#### (4) Detail alarm information



22B9EL38

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

## 8) VASS SETUP USING DISPLAY MENU


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

(All figures in belows are just example.)

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

### (1) ACCEL VASS setting method

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

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

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

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

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

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

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

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

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

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

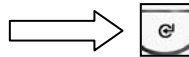
V.A.S.S	
ACCEL	READY
MIN FORWARD	0.90V
MAX FORWARD	4.47V
MIN REVERSE	0.90V
MAX REVERSE	4.47V

Now, you can see that voltage value of MAX REVERSE are changed.

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



V.A.S.S	
ACCEL	FINISH
ARE YOU SURE ?	
YES : ENTER, NO : ESC	



22B9EL39-2

## (2) LIFT VASS setting method

V.A.S.S	
LIFT	
MIN LIFT	0.10V
MAX LIFT	1.25V

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

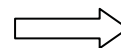


V.A.S.S	
LIFT	READY
MIN LIFT	0.25V
MAX LIFT	0.25V

If "READY" appears beside LIFT, you are in configuration process.

Now, operator can see that voltage value of MIN LIFT and MAX LIFT are changed.

Full the lift lever toward operator fully



V.A.S.S	
LIFT	READY
MIN LIFT	0.25V
MAX LIFT	6.20V

Now, you can see that voltage value of MAX LIFT are changed.

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




V.A.S.S	
LIFT	READY
ARE YOU SURE ?	
YES : ENTER, NO : ESC	






22B9EL40

### (3) STEER ANGLE VASS setting method

V.A.S.S	
STEER ANGLE	
STEER RIGHT	2.45V
STEER LEFT	4.24V
STEER 0-POS	3.64V

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



V.A.S.S	
STEER ANGLE	READY
STEER RIGHT	2.94V 
STEER LEFT	4.24V 
STEER 0-POS	3.64V 

If "READY" appears beside STEER ANGLE, you are in configuration process.

Now, operator can see that voltage value of STEER RIGHT is changed.

Turn steer handle to right-end fully, the value will be changed.






V.A.S.S	
STEER ANGLE	READY
STEER RIGHT	1.20V 
STEER LEFT	1.20V 
STEER 0-POS	3.64V 

Now, you can see that voltage value of STEER RIGHT is saved.

Turn steer handle to left-end fully, the voltage value will be changed.



V.A.S.S	
STEER ANGLE	READY
STEER RIGHT	1.20V 
STEER LEFT	7.84V 
STEER 0-POS	7.84V 

Now, you can see that voltage value of STEER LEFT is saved.

Turn steer handle to center position, the voltage value will be changed.

Please make sure that all traction motors are not running



V.A.S.S	
STEER ANGLE	READY
ARE YOU SURE ?	
YES : ENTER, NO : ESC	



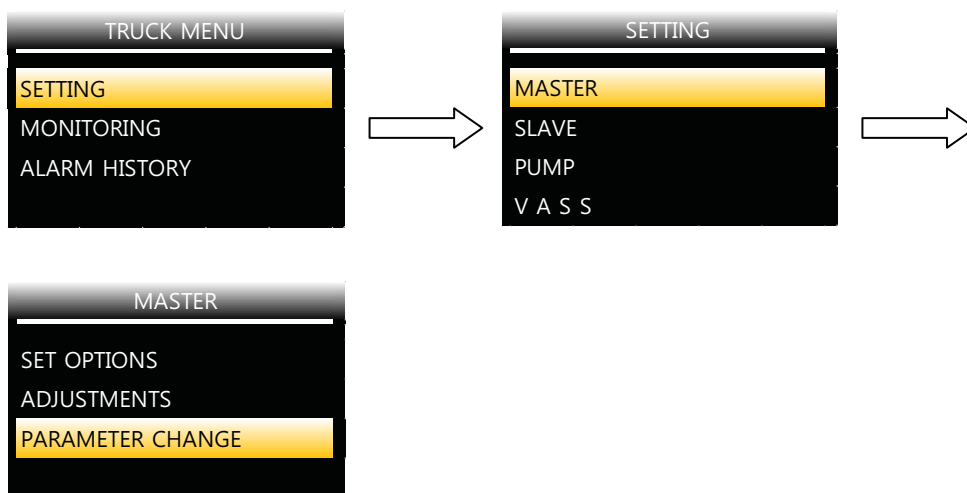
22B9EL41

## 9) STRUCTURE OF TRUCK MENU

TRUCK MENU is in order to make configuration of truck easily, and consists of 3 major categories :  
SETTING, MONITORING, ALARM HISTORY.

[To know how to get in to TRUCK MENU, refer to 6-6)-(1) "ACCESS TO TRUCK MENU" page 7-58]

### (1) Settings



22B9EL42

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

① MASTER->SET OPTIONS

Refer to 5-4)- ■ "TRACTION-MASTER CONTROLLER"-(1) "SET OPTIONS" (page 7-25)

② MASTER->ADJUSTMENTS

Refer to 5-4)- ■ "TRACTION-MASTER CONTROLLER"-(2) "ADJUSTMENTS" (page 7-26)

③ MASTER->PARAMETER CHANGE

Refer to 5-4)- ■ "TRACTION-MASTER CONTROLLER"-(3) "PARAMETER CHANGE" (page 7-29)

④ SLAVE->SET OPTIONS

Not available

⑤ SLAVE->ADJUSTMENTS

Refer to 5-4)- ■ "TRACTION-SLAVE CONTROLLER"-(2) "ADJUSTMENTS" (page 7-31)

⑥ SLAVE->PARAMETER CHANGE

Refer to 5-4)- ■ "TRACTION-SLAVE CONTROLLER"-(3) "PARAMETER CHANGE" (page 7-31)

⑦ PUMP->SET OPTIONS

Refer to 5-4)- ■ "PUMP CONTROLLER"-(1) "SET OPTIONS" (page 7-31)

⑧ PUMP->ADJUSTMENTS

Refer to 5-4)- ■ "PUMP CONTROLLER"-(2) "ADJUSTMENTS" (page 7-32)

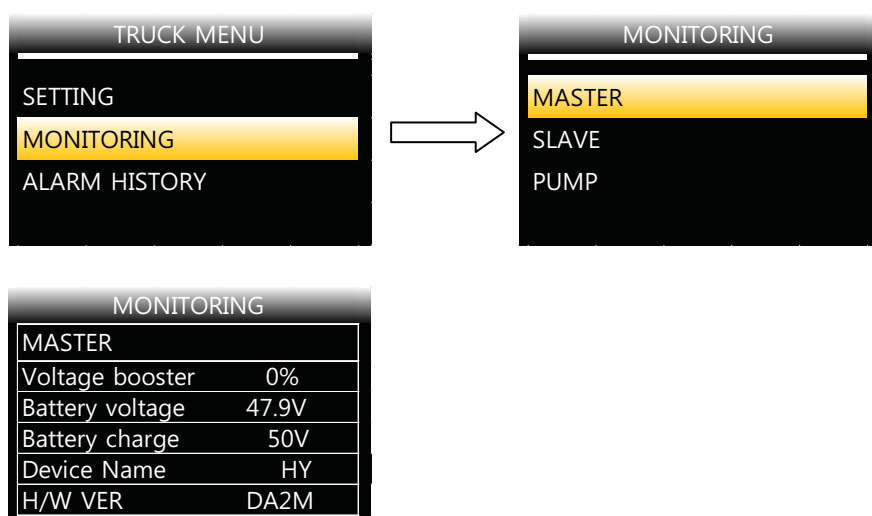
⑨ PUMP->PARAMETER CHANGE

Refer to 5-4)- ■ "PUMP CONTROLLER"-(3) "PARAMETER CHANGE" (page 7-33)

⑩ V.A.S.S

Refer to 6-8) "VASS SETUP USING DISPLAY MENU" (page 7-63)

## (2) Monitoring



22B9EL43

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

### ① MASTER

Refer to 5-6)-(1) "Traction controller-master" (page 7-45)

### ② SLAVE

Refer to 5-6)-(2) "Traction controller-Slave" (page 7-46)

### ③ PUMP

Refer to 5-6)-(3) "Pump controller" (page 7-48)

## (3) Alarm history

Refer to 6-7) "ALARM & ALARM HISTORY" (page 7-60)

## 7. ALARM CODE

### 1) TRACTION-MASTER & SLAVE CONTROLLER

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
08	WATCHDOG	Alarm: the Watchdog circuit has been triggered	<ul style="list-style-type: none"> <li>- If the alarm is present in Init status, remove the alarm condition</li> <li>- If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a traction request</li> </ul>
0D	EEPROM KO	Warning: Eeprom fault, controller will use default parameters	To remove Warning cause
11	LOGIC FAILURE #3	Alarm: failure in over-load protection hw circuit	<ul style="list-style-type: none"> <li>- To remove alarm condition + activation of traction request</li> <li>- Check the Controller</li> </ul>
12	LOGIC FAILURE #2	Alarm: failure in U, V, W voltage feedback circuit	To remove alarm condition + activation of traction request
13	LOGIC FAILURE #1	Alarm: an overvoltage or undervolt. condition has been detected	<ul style="list-style-type: none"> <li>- To recycle the key switch</li> <li>- Sometimes if battery voltage is too low, it can be happens</li> <li>- Check the Controller</li> </ul>
1E	VMN LOW	Alarm: wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor	<ul style="list-style-type: none"> <li>- If the alarm is present in Init status, remove the alarm condition</li> <li>- If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a traction request</li> <li>- Check the U,V,W cable and motor and if there is any shorted circuit with frame or any other parts of truck</li> <li>- Check the Controller</li> </ul>
1F	VMN HIGH	Alarm: wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor	<ul style="list-style-type: none"> <li>- If the alarm is present in Init status, remove the alarm condition</li> <li>- If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a traction request</li> <li>- Check the U,V,W cable and motor and if there is any shorted circuit with frame or any other parts of truck</li> <li>- Check the Controller</li> </ul>
25	CONTACTOR CLOSED	Alarm: line contactor power contact is stuck	<ul style="list-style-type: none"> <li>- To remove alarm cause within a timeout; if the timeout is elapsed, it is necessary to re-cycle the key</li> <li>- Check the contactor &amp; cables attached to the contactor</li> </ul>
26	CONTACTOR OPEN	Alarm: line contactor power contact does not pull-in	<ul style="list-style-type: none"> <li>- To remove alarm cause within a timeout; if the timeout is elapsed, it is necessary to re-cycle the key</li> <li>- Check the contactor &amp; cables attached to the contactor</li> </ul>
31	I = 0 EVER	Alarm: While truck is running, current value is 0 for more than 1 Sec	<ul style="list-style-type: none"> <li>- Check the Main contactor</li> <li>- Check the controller</li> </ul>

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
35	STBY I HIGH	Alarm: wrong voltage in the current sensor feedback circuit	<ul style="list-style-type: none"> <li>- If the alarm is present in Init status, remove the alarm condition</li> <li>- If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a traction request</li> </ul>
3C	CAPACITOR CHARGE	Alarm: power capacitor voltage does not increase when the key is turned ON; failure in the power section, or in the Logic PCB, or in the driver PCB, or in the motor	<ul style="list-style-type: none"> <li>- To remove alarm condition</li> <li>- Check the contactor resistance (300Ω, 10W)</li> <li>- Check the controller</li> </ul>
3D	HIGH TEMPERATURE	Warning: Master or Slave or both temperature higher than 75°C	<ul style="list-style-type: none"> <li>- To remove Warning cause</li> </ul>
41	MOTOR TEMPERA-TURE	Warning: Master or Slave or both motors temperature high	<ul style="list-style-type: none"> <li>- To remove Warning cause</li> <li>- Check the motor temp-sensor</li> </ul>
42	BATTERY LOW	Warning: battery charge level below 10%	<ul style="list-style-type: none"> <li>- To remove Warning cause</li> </ul>
4A	DRIVER SHORTED	Alarm: line contactor coil driver is shorted	<ul style="list-style-type: none"> <li>- If the alarm is present in Init status, remove the alarm cause</li> <li>- If the alarm has occurred in stby or running mode, it is necessary to remove alarm cause and to activate traction request</li> </ul>
4B	CONTACTOR DRIVER	Alarm: line contactor coil driver is open (not able to drive the coil to the correct voltage)	<ul style="list-style-type: none"> <li>- To remove alarm cause and to activate traction request</li> </ul>
4C	COIL SHORTED	Alarm: -Init: the LC and EB coil driver protection circuit is damaged -Stby or running: short on LC coil or EB coil"	<ul style="list-style-type: none"> <li>- If the alarm is present in Init status, remove the alarm cause</li> <li>- If the alarm has occurred in stby or running mode, it is necessary to remove alarm cause and to activate traction request</li> </ul>
4E	VACC NOT OK	Warning: acc. signal (CPOT) voltage higher than VACC MIN +1V while the traction enable switch is open	<ul style="list-style-type: none"> <li>- To remove Warning cause</li> <li>- Re-configure VASS ACCEL</li> </ul>
4F	INCORRECT START	Warning: wrong traction request sequence	<ul style="list-style-type: none"> <li>- To remove Warning cause</li> </ul>
50	FORWARD + BACKWARD	Warning: forward and reverse inputs are both active	<ul style="list-style-type: none"> <li>- To remove Warning cause</li> </ul>
52	ENCODER ERROR	Alarm: motor speed sensor (encoder) does not work properly	<ul style="list-style-type: none"> <li>- To recycle the key</li> <li>- Check the motor encoder</li> </ul>
54	STEER SENSOR KO	Alarm: steering sensor signal out of range	<ul style="list-style-type: none"> <li>- To remove alarm cause</li> </ul>
56	PEDAL WIRE KO	Alarm: fault in accelerator negative (NPOT) input circuit	<ul style="list-style-type: none"> <li>- To remove alarm cause and activate a traction request</li> </ul>
EE	LOADSENS ERROR	Alarm: Load weight sensor detects that loaded weight exceeds the weight limitation, or load weight sensor is not working properly	<ul style="list-style-type: none"> <li>- To remove alarm cause</li> <li>- Check the load weight sensor</li> </ul>

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
EF	OVERLOAD	Warning: Load weight sensor detects that loaded weight exceeds the weight limited in OVERLOAD WEIGHT programming.	- To remove warning cause
F0	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
F2	PUMP WARNING	Warning: a warning is active on the pump module	- To remove warning cause
F3	SEQUENCE FAULT	Warning: an incorrect start sequence has been detected on the seat, pedal and levers commands	- To remove Warning cause
F4	SLAVE WARNING	Warning: a warning is active on the SLAVE module	- To remove warning cause
F5	WRONG SET BATTERY	Alarm: the battery voltage does not correspond to SET BATTERY programming	- To remove alarm cause
F6 (master only)	SLAVE KO	Alarm: Master $\mu$ C detects a Slave $\mu$ C malfunctioning	- To recycle the key - Check if any other alarm happens (Some alarms such as CHAT TIME or PEDAL WIRE KO, alarms related to CONTACTOR, DISPLAY ENABLE, alarms related to CANBUS can make this alarm sometimes.) - Check the communication with all controllers (display TRUCK MENU->MONITORING->choose controller->H/W VER, S/W VER. If CAN communication is not available, H/W VER, S/W VER will be blank.)
F6 (slave only)	MASTER KO	Alarm: Slave $\mu$ C detects a Master $\mu$ C malfunctioning or a mismatch between inputs status and Master commands (via Canbus)	- To recycle the key - Check If any other alarm happens (Some alarms such as CHAT TIME or PEDAL WIRE KO, alarms related to CONTACTOR, DISPLAY ENABLE, alarms related to CANBUS can make this alarm sometimes.) - Check the communication with all controllers (display TRUCK MENU->MONITORING->choose controller->H/W VER, S/W VER. If CAN communication is not available, H/W VER, S/W VER will be blank.)"

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
F7	NO CAN MSG.N	Alarm: Master/Slave has lost Can communication with #X	<ul style="list-style-type: none"> <li>- To remove alarm cause</li> <li>- 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.)</li> <li>- Check the communication with all controllers (display TRUCK MENU-&gt;MONITORING-&gt; choose controller-&gt;H/W VER, S/W VER. If CAN communication is not available, H/W VER, S/W VER will be blank.)</li> </ul>
F8	DISPLAY ENABLE	Warning: the display enable signal has not been received to operate the truck	<ul style="list-style-type: none"> <li>- To remove warning cause</li> </ul>
F9	THERMIC SENSOR KO	Warning: Master or slave temp. sensor is out of range	<ul style="list-style-type: none"> <li>- To remove Warning cause</li> </ul>
FA	INPUT MISMATCH (slave only)	Alarm: Slave $\mu$ C has detected a mismatch between inputs status and the input status transmitted via Canbus by Master $\mu$ C	<ul style="list-style-type: none"> <li>- To recycle the key</li> </ul>
FA	HANDBRAKE (master only)	Warning: handbrake microswitch is open and a travel request is active	<ul style="list-style-type: none"> <li>- To remove Warning cause</li> </ul>
FB	WAITING FOR NODE	Warning: Master Controller signals that other controllers are in alarm status	<ul style="list-style-type: none"> <li>- To remove Warning cause</li> <li>- 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.)</li> <li>- Check the communication with all controllers (display TRUCK MENU-&gt; MONITORING-&gt; choose controller-&gt;H/W VER, S/W VER. If CAN communication is not available, H/W VER, S/W VER will be blank.)</li> <li>- Check other controllers</li> </ul>
FC	CHAT MODE	Warning: the chat time has expired	<ul style="list-style-type: none"> <li>- To activate traction or pump request</li> </ul>
FD	AUX OUTPUT KO	Alarm: MCV SOL driver shorted or open	<ul style="list-style-type: none"> <li>- If the alarm is present in Init status, remove the alarm cause</li> <li>- If the alarm has occurred in stby or running mode, it is necessary to remove alarm cause and to activate traction request</li> </ul>
FE	CANBUS KO DISPL.	Alarm: master has lost can communication with the display	To remove warning cause

## 2) PUMP CONTROLLER

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
08	WATCHDOG	Alarm: the Watchdog circuit has been triggered	<ul style="list-style-type: none"> <li>- If the alarm is present in Init status, remove the alarm condition</li> <li>- If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a traction request</li> </ul>
0D	EEPROM KO	Warning: Eeprom fault, controller will use default parameters	To remove Warning cause
12	LOGIC FAILURE #2	Alarm: failure in U, V, W voltage feedback circuit	<ul style="list-style-type: none"> <li>- To remove alarm condition + activation of traction request</li> <li>- Check the Controller</li> </ul>
13	LOGIC FAILURE #1	Alarm: an overvoltage or undervolt. condition has been detected	<ul style="list-style-type: none"> <li>- To recycle the key switch</li> <li>- Sometimes if battery voltage is too low, it can be happens</li> <li>- Check the Controller</li> </ul>
1E	VMN LOW	Alarm: wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor	<ul style="list-style-type: none"> <li>- If the alarm is present in Init status, remove the alarm condition</li> <li>- If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a traction request</li> <li>- Check the U, V, W cable and motor and if there is any shorted circuit with frame or any other parts of truck</li> <li>- Check the Controller</li> </ul>
1F	VMN HIGH	Alarm: wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor	<ul style="list-style-type: none"> <li>- If the alarm is present in Init status, remove the alarm condition</li> <li>- If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a traction request</li> <li>- Check the U, V, W cable and motor and if there is any shorted circuit with frame or any other parts of truck</li> <li>- Check the Controller</li> </ul>
31	I = 0 EVER	Alarm: While truck is running, current value is 0 for more than 1 Sec	<ul style="list-style-type: none"> <li>- Check the Main contactor</li> <li>- Check the controller</li> </ul>
35	STBY I HIGH	Alarm: wrong voltage in the current sensor feedback circuit	<ul style="list-style-type: none"> <li>- If the alarm is present in Init status, remove the alarm condition</li> <li>- If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a traction request</li> </ul>
3C	CAPACITOR CHARGE	Alarm: power capacitor voltage does not increase when the key is turned ON; failure in the power section, or in the Logic PCB, or in the driver PCB, or in the motor	<ul style="list-style-type: none"> <li>- To remove alarm condition</li> <li>- Check the contactor resistance (300Ω, 10W)</li> </ul>
3D	HIGH TEMPERATURE	Warning: Controller temperature higher than 75°C	<ul style="list-style-type: none"> <li>- To remove Warning cause</li> </ul>

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
41	MOTOR TEMPERA-TURE	Warning: Pump motor's temperature high	<ul style="list-style-type: none"> <li>- To remove Warning cause</li> <li>- Check the motor temp-sensor</li> </ul>
42	BATTERY LOW	Warning: battery charge level below 10%	To remove Warning cause
4A	DRIVER SHORTED	Alarm: line contactor coil driver is shorted	<ul style="list-style-type: none"> <li>- If the alarm is present in Init status, remove the alarm cause</li> <li>- If the alarm has occurred in stby or running mode, it is necessary to remove alarm cause and to activate traction request</li> </ul>
4B	CONTACTOR DRIVER	Alarm: line contactor coil driver is open (not able to drive the coil to the correct voltage)	To remove alarm cause and to activate traction request
4C	COIL SHORTED	Alarm : - Init: the LC and EB coil driver protection circuit is damaged - Stby or running: short on LC coil or EB coil	<ul style="list-style-type: none"> <li>- If the alarm is present in Init status, remove the alarm cause</li> <li>- If the alarm has occurred in stby or running mode, it is necessary to remove alarm cause and to activate traction request</li> </ul>
4E	VACC NOT OK	Warning: acc/lift signal (CPOT) voltage higher than VACC MIN +1V while the traction/lift enable switch is open	<ul style="list-style-type: none"> <li>- To remove Warning cause</li> <li>- Re-configure VASS LIFT</li> </ul>
4F	INCORRECT START	Warning: wrong traction/pump request sequence	To remove Warning cause
50	FORWARD + BACKWARD	Warning: forward and reverse inputs are both active	To remove Warning cause
52	ENCODER ERROR	Alarm: motor speed sensor (encoder) does not work properly	<ul style="list-style-type: none"> <li>- To recycle the key</li> <li>- Check the motor encoder</li> </ul>
56	PEDAL WIRE KO	Alarm: fault in accelerator/Lift negative (NPOT) input circuit	To remove alarm cause and activate a traction/pump request
DF	S B R SWITCH OPEN	SIDE BATTERY REMOVAL sensor is open	<ul style="list-style-type: none"> <li>- To remove Warning cause</li> <li>- Check the sensor</li> </ul>
E3	TILT SENS OUT RNG	Value of tilt sensor (AUTO TILT LEVELING) is out of range	<ul style="list-style-type: none"> <li>- Check the Tilt Sensor of AUTO TILT LEVELING Option</li> <li>- Re-configure Tilt Sensor of AUTO TILT LEVELING Option</li> </ul>
E4	T I L T S E N S LOCKED	Value of tilt sensor (AUTO TILT LEVELING) is fixed even tilt request is activated	<ul style="list-style-type: none"> <li>- Check the Tilt Sensor of AUTO TILT LEVELING Option</li> <li>- Re-configure Tilt Sensor of AUTO TILT LEVELING Option</li> </ul>
E5	AUX FUNCT KO	Fingertip aux function is not working properly	<ul style="list-style-type: none"> <li>- Check the MCV valve</li> <li>- Re-configure lever</li> <li>- Check the fingertip controller</li> </ul>
E6	SHIFT FUNCT KO	Fingertip shift function is not working properly	<ul style="list-style-type: none"> <li>- Check the MCV valve</li> <li>- Re-configure lever</li> <li>- Check the fingertip controller</li> </ul>

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
E7	TILT FUNCT KO	Fingertip tilt function is not working properly	<ul style="list-style-type: none"> <li>- Check the MCV valve</li> <li>- Re-configure lever</li> <li>- Check the fingertip controller</li> </ul>
E8	LIFT FUNCT KO	Fingertip lift function is not working properly	<ul style="list-style-type: none"> <li>- Check the MCV valve</li> <li>- Re-configure lever</li> <li>- Check the fingertip controller</li> </ul>
E9	AUX OUT OF RNG	Voltage value of AUX sensor is out of range	<ul style="list-style-type: none"> <li>- Re-configure the AUX lever</li> <li>- Check the AUX lever</li> </ul>
EA	SHIFT OUT OF RNG	Voltage value of SHIFT sensor is out of range	<ul style="list-style-type: none"> <li>- Re-configure the SHIFT lever</li> <li>- Check the SHIFT lever</li> </ul>
EB	TILT OUT OF RNG	Voltage value of TILT sensor is out of range	<ul style="list-style-type: none"> <li>- Re-configure the TILT lever</li> <li>- Check the TILT lever</li> </ul>
EC	LIFT OUT OF RNG	Voltage value of LIFT sensor is out of range	<ul style="list-style-type: none"> <li>- Re-configure the LIFT lever</li> <li>- Check the Lift lever</li> </ul>
ED	ACQUIRE AUX	Controller is configuring "AUX" lever function	<ul style="list-style-type: none"> <li>- Finish the configuration process</li> </ul>
EE	ACQUIRE SHIFT	Controller is configuring "SHIFT" lever function	<ul style="list-style-type: none"> <li>- Finish the configuration process</li> </ul>
EF	ACQUIRE TILT	Controller is configuring "TILT" lever function	<ul style="list-style-type: none"> <li>- Finish the configuration process</li> </ul>
F0	ACQUIRE LIFT	Controller is configuring "LIFT" lever function	<ul style="list-style-type: none"> <li>- Finish the configuration process</li> </ul>
F2	MOTOR STALL	Warning: the encoder signal is constantly zero when the maximum torque is applied to the motor	<ul style="list-style-type: none"> <li>- To recycle the key</li> <li>- Check the motor and encoder</li> </ul>
F4	FORK WRONG DIR	Direction of "AUTO TILT LEVELING" movement is not correct	<ul style="list-style-type: none"> <li>- Check if operator operates truck correctly</li> <li>- Check the Tilt Sensor of Fork leveling Option</li> <li>- Re-configure Tilt Sensor of Fork leveling Option</li> </ul>
F5	WRONG SET BATTERY	Alarm: the battery voltage does not correspond to SET BATTERY TYPE programming	<ul style="list-style-type: none"> <li>- To remove alarm cause</li> </ul>
F6	SAFETY KO	Alarm: the controller detects malfunction on safety circuit (PUMP CONTROLLER A12-A34)	<ul style="list-style-type: none"> <li>- To recycle the key</li> <li>- Check if any other alarms happen on controllers</li> <li>- Check the safety circuit</li> </ul>
F7	NO CAN MS	Alarm: Pump controller has lost Can communication with #X	<ul style="list-style-type: none"> <li>- To remove alarm cause</li> <li>- 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.)</li> <li>- Check the communication with all controllers (display TRUCK MENU-&gt;MONITORING-&gt; choose controller-&gt;H/W VER, S/W VER. If CAN communication is not available, H/W VER, S/W VER will be blank.)"</li> </ul>

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
F8	BRAKE OIL	Lack of Brake oil	- Check the brake oil tank & sensor
F9	THERMIC SENSOR KO	Warning: Controller temp. sensor is out of range	- To remove Warning cause
FB	WAITING FOR NODE	Warning: Controller signals that other controllers are in alarm status	<ul style="list-style-type: none"> <li>- To remove Warning cause</li> <li>- 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.)</li> <li>- Check the communication with all controllers (display TRUCK MENU-&gt;MONITORING-&gt;choose controller-&gt;H/W VER, S/W VER. If CAN communication is not available, H/W VER, S/W VER will be blank.)</li> <li>- Check other controllers."</li> </ul>
FD	AUX OUTPUT KO	Alarm: MCV SOL driver shorted or open	<ul style="list-style-type: none"> <li>- If the alarm is present in Init status, remove the alarm cause</li> <li>- If the alarm has occurred in stby or running mode, it is necessary to remove alarm cause and to activate traction request"</li> </ul>

## 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.

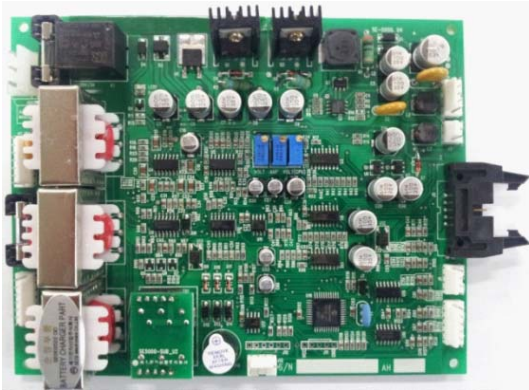
Therefore, it helps the battery to maintain its performance for longer time and to prolong the life of the battery.

#### (2) Notice on caring chargers

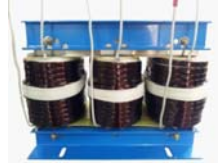
- ① If any abnormal status is found while using a charger, immediately stop using and check the charger. If it is impossible to take an appropriate measure for yourself, please apply for A/S.
- ② While charging, hydrogen and oxygen gas is produced. Use or approach of fire should be strictly prohibited.
- 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 mm 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)

①



②



③



④



⑤



⑥



⑦



⑧



⑨



⑩



22B9BAT30

- 1 Main PCB board
- 2 Main trans (Class H)
- 3 Cooling fan
- 4 SCR module

- 5 Monitor PCB
- 6 Overload
- 7 MG S/W
- 8 Assistant trans

- 9 Resistance (RD)
- 10 Resistance (DR)

## 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 <sup>2</sup>	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 <sup>2</sup> → 4mm <sup>2</sup> )
400-580 AH	4P - 4 mm <sup>2</sup>		
600-800 AH	4P - 6 mm <sup>2</sup>		
850-1000 AH	4P - 10 mm <sup>2</sup>		
24 V battery	-		
200-600 AH	4P - 2.5 mm <sup>2</sup>		
700-1000 AH	4P - 4 mm <sup>2</sup>		
80V battery	-		
500-600 AH	4P - 6 mm <sup>2</sup>		
700-800 AH	4P - 10 mm <sup>2</sup>		

### 3) HOW TO USE A CHARGER

#### (1) General charging method (Floating charging)

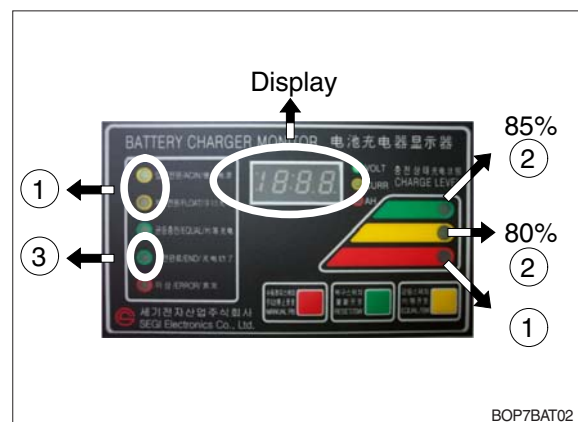
- ① Charging by this method supplies electric power to the charger as operating external AC power switch of the charger.
- ② Connect battery connector and charger connector.

##### · 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.



22B9BAT01



BOP7BAT02

#### (2) Equalized charging

##### ① Equalized charging is

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

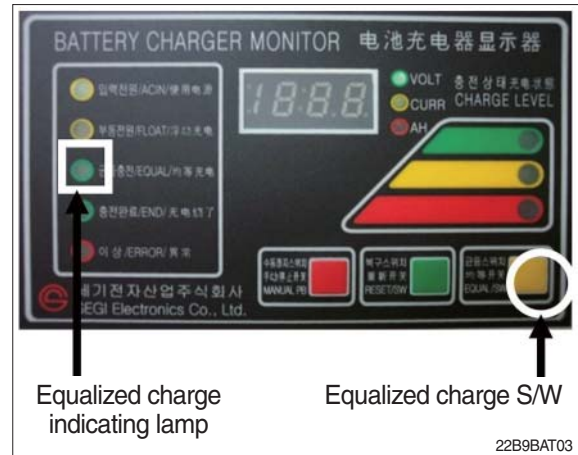
##### When equalized charging is required?

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

## ② Tips for equalized charging

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

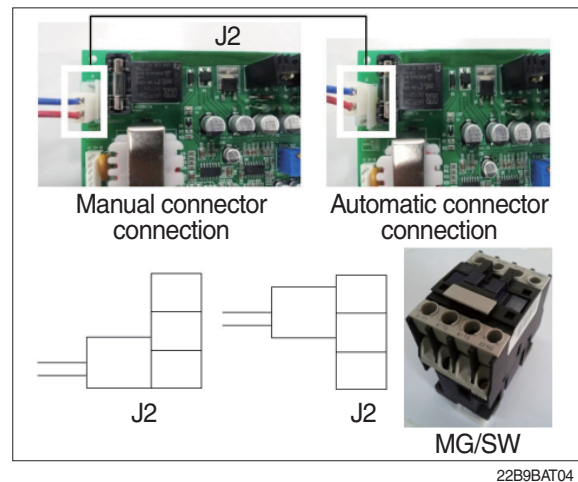
- ※ When the green charging condition lamp is on (over 85% charged), the equalized charging switch is locked that it does not operate even pushing the button.



## (3) Automatic/Manual switching method

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

- ※ In case of manual switching for charger checking, make sure that the battery connector is separated beforehand.
- ⊙ MG/SW operation (Refer to the charger trouble SHEET components manual)



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

- ① Plug it into a manual connector and input after 5 sec., a floating charge, charging status red LED lights up.
- ② After 15 sec., charging status yellow LED lights up.
- ③ After a green LED lights up, if measured voltage comes out as lulu 63V ~ lula 64V by measuring output voltage of battery connector side with multi-meter, then it is normal.
- ④ After 30 sec. of switching to a manual connector, if a buzzer sound rings continuously for 10 sec. and completion LED lights up, then it is normal.
- ⑤ If you confirm that the charger operates in normal after checking manual switching of the charger, make sure that the charger is switched to automatic.



- ⑥ If charger's out voltage is under 60 V, it is abnormal.

Please refer to the error sheet.

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

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



22B9BAT11

No	Code	Description of error
1	E.F	EPROM fail
2	O.V	Over voltage - Refer to page 7-86
3	O.C	Over current - Refer to page 7-85, 7-87.
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 7-84.
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  $64V \pm 1.0V$ .
- (5) Check other abnormalities as well. Then apply for A/S when on-site measurements are not applicable.



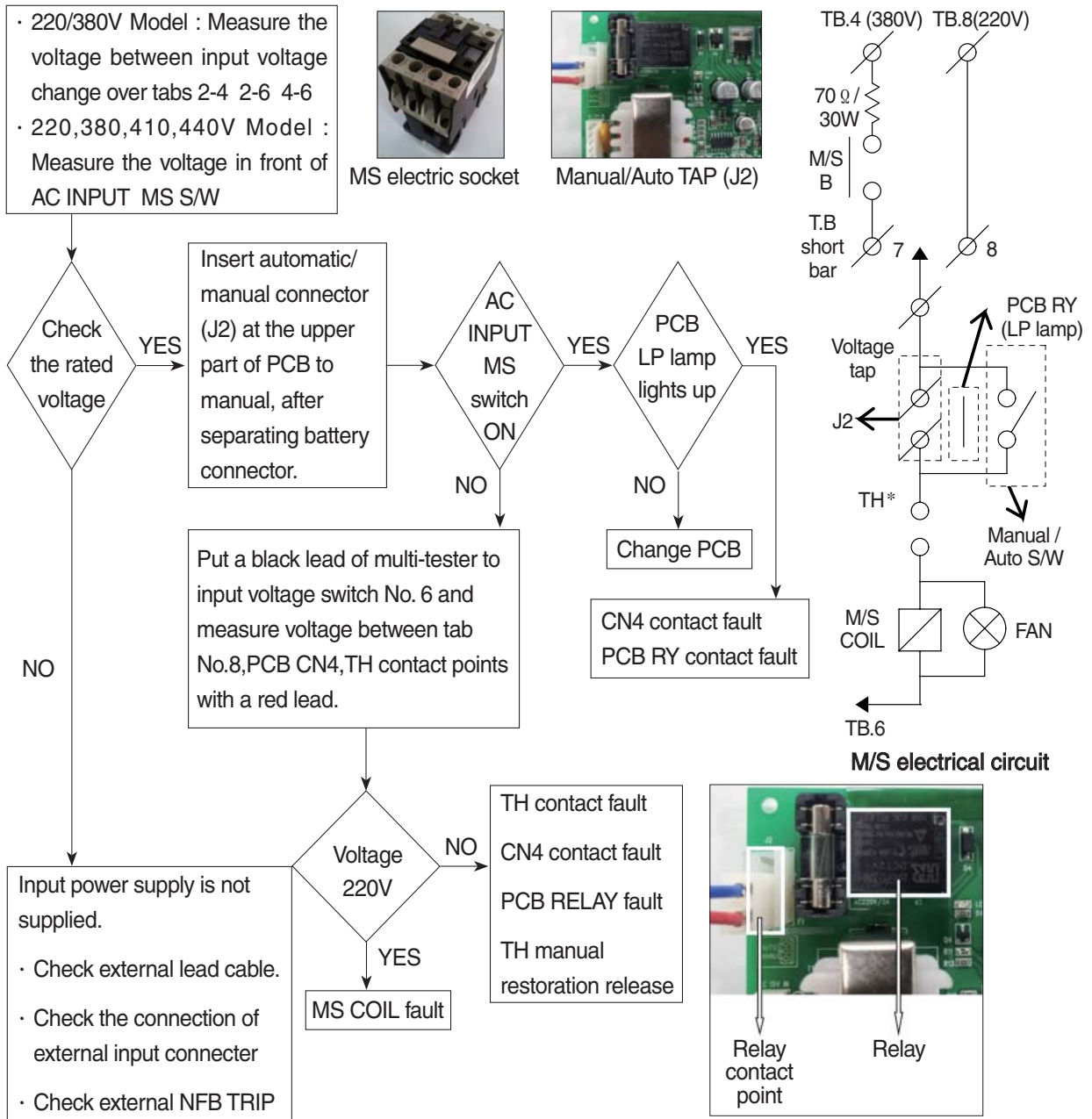
## 5) ERROR DETECTION

### (1) Error list

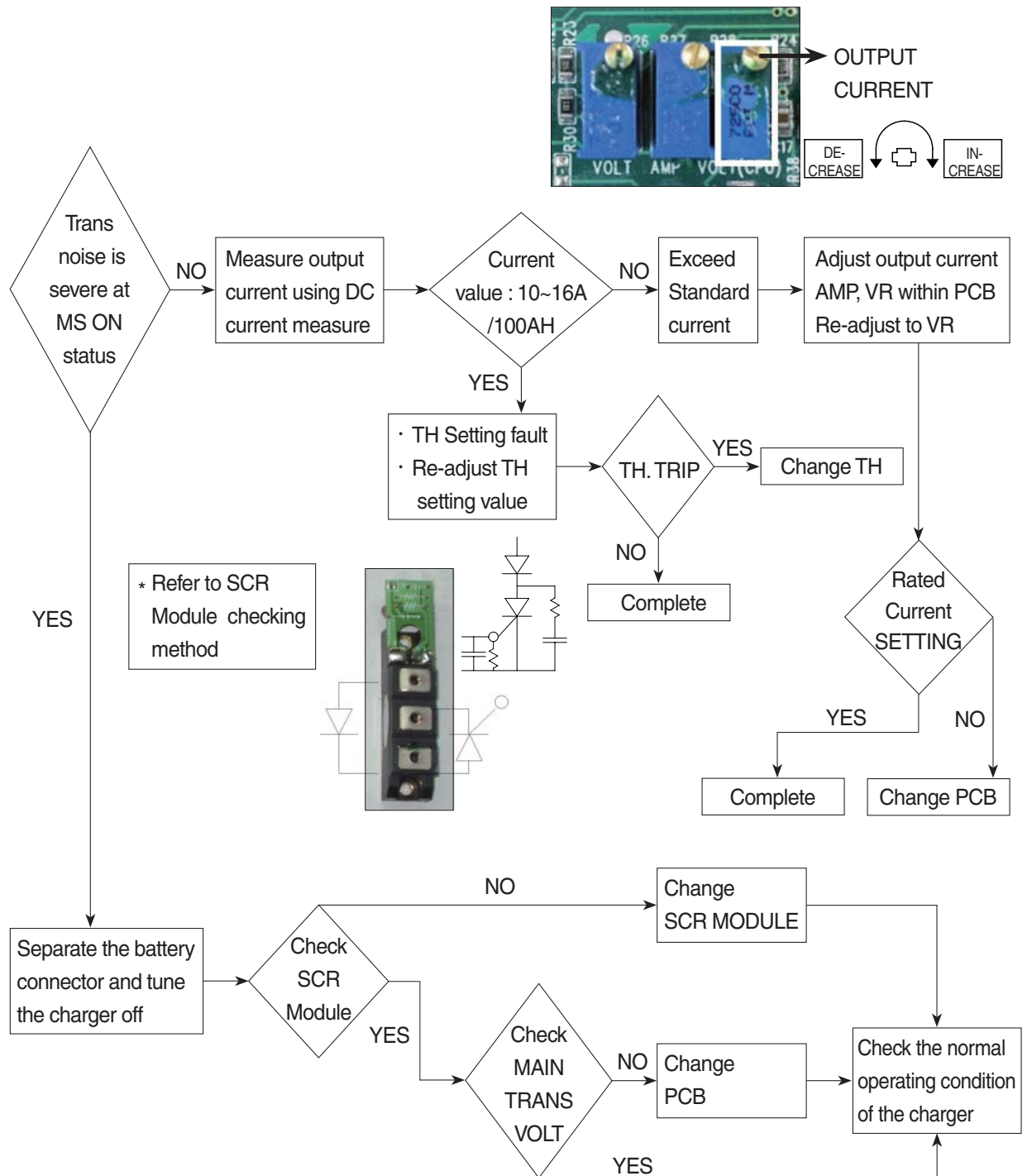
- ① Only floating charge lamp is on in the monitor but it is not charged.
- ② ON and OFF is repeated with a few minutes intervals even after starting charging.
- ③ Charger TRIP is occurred after abnormality lamp is on.  
In case error code is "O.V"
- ④ Charger TRIP is occurred after abnormality lamp 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.

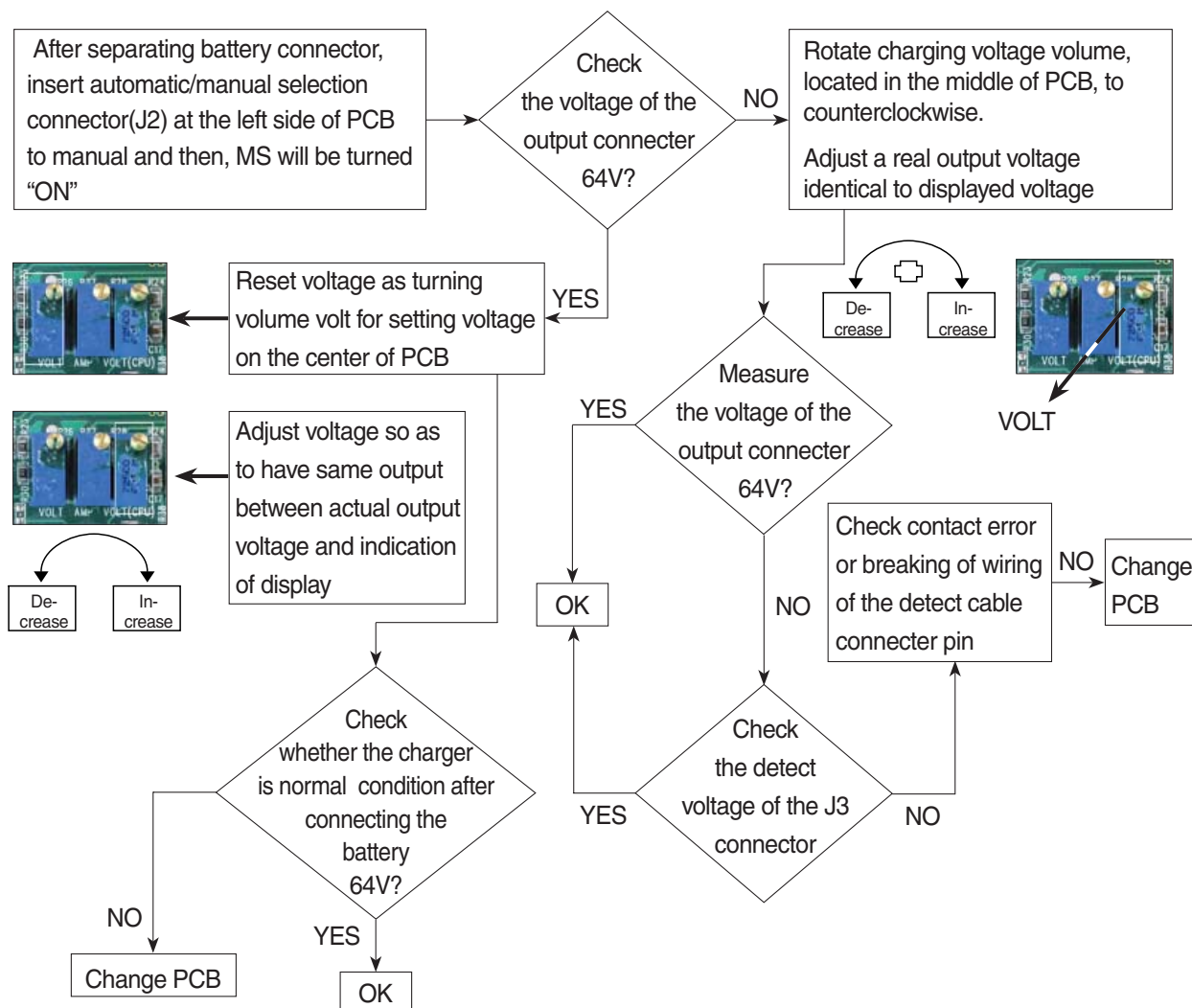


- ② ON and OFF is repeated with a few minutes intervals after starting charging.  
Indicate "O.C" on the monitor.  
- TH is operated (AC input over-current TRIP).



③ Charger TRIP is occurred after abnormality lamp is on.

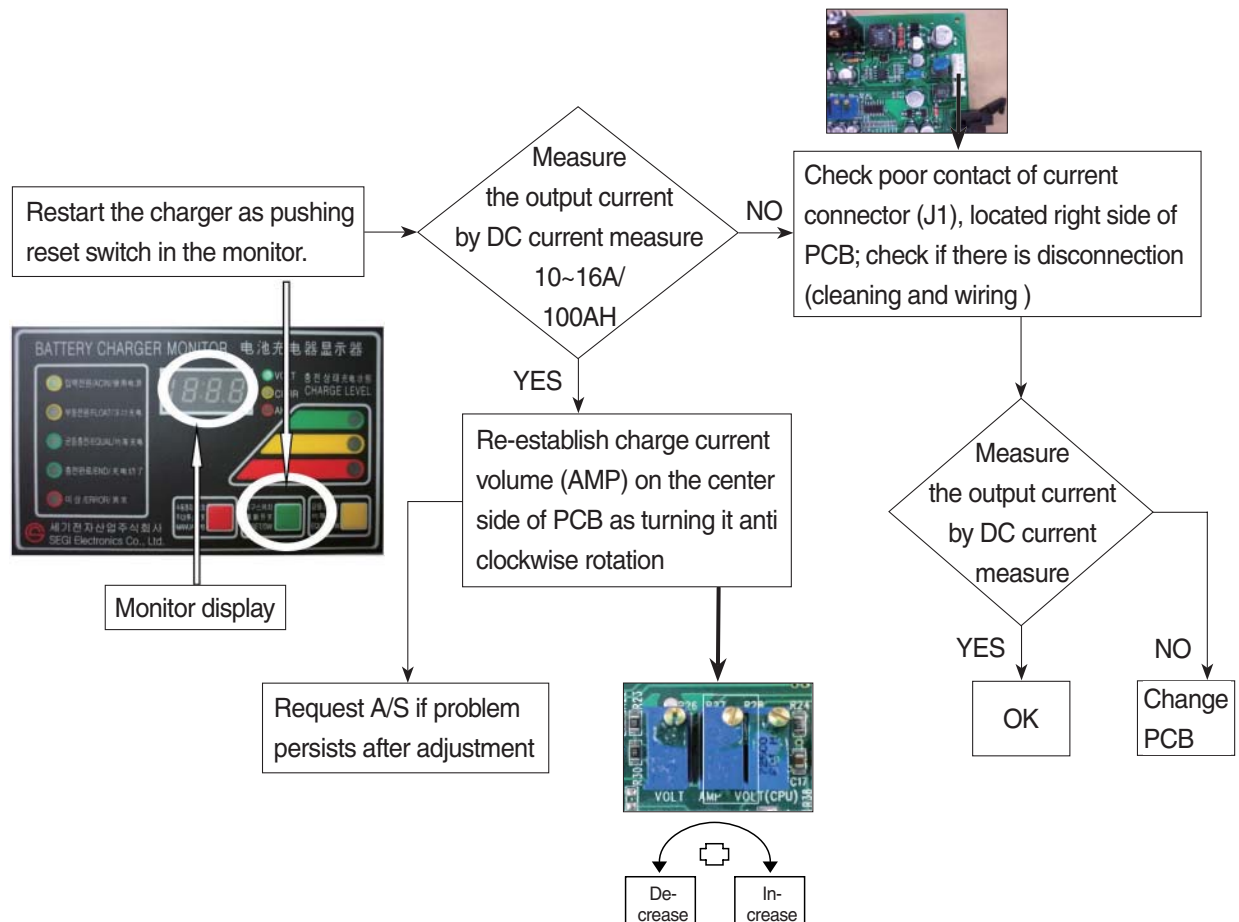
In case error code is "O.V" → Over-voltage output / Set at 66V (In case of BATT 48V)  
 34V (In case of BATT 24V)  
 108V (In case of BATT 80V)



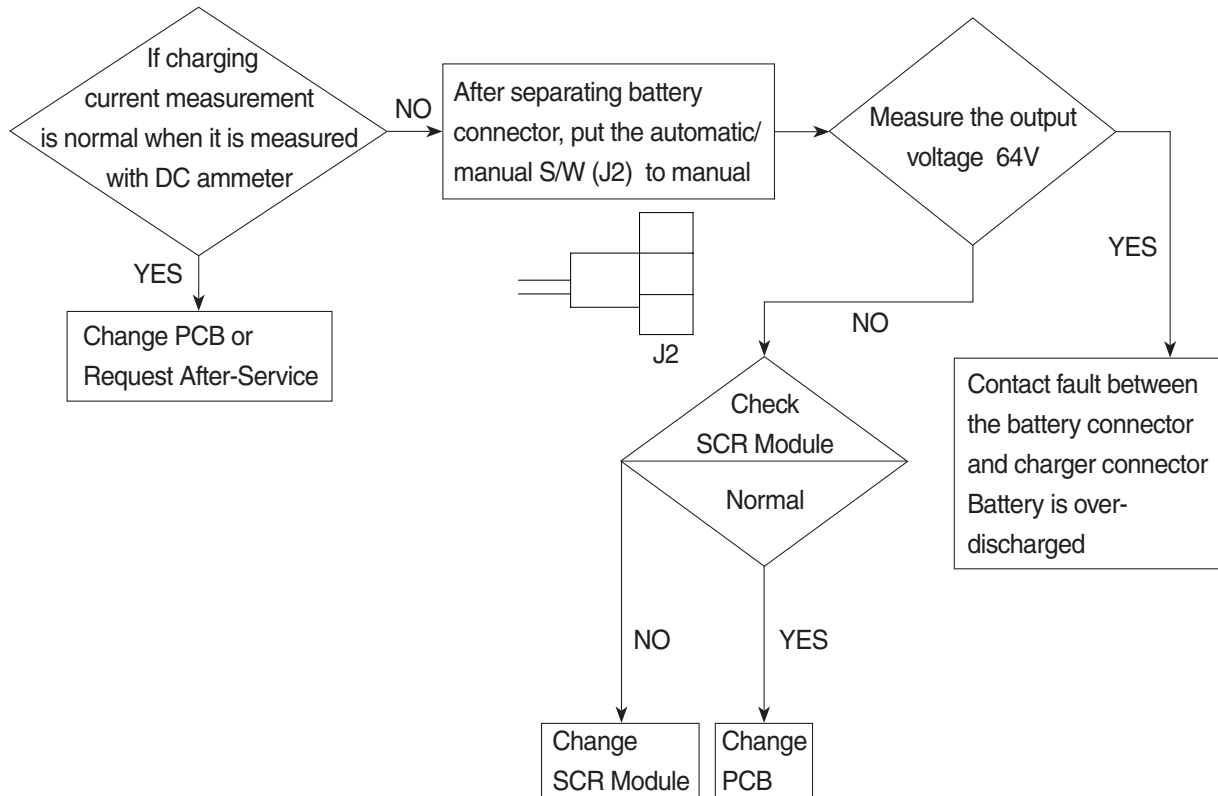
④ Charger TRIP is occurred after abnormality lamp is on.

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.

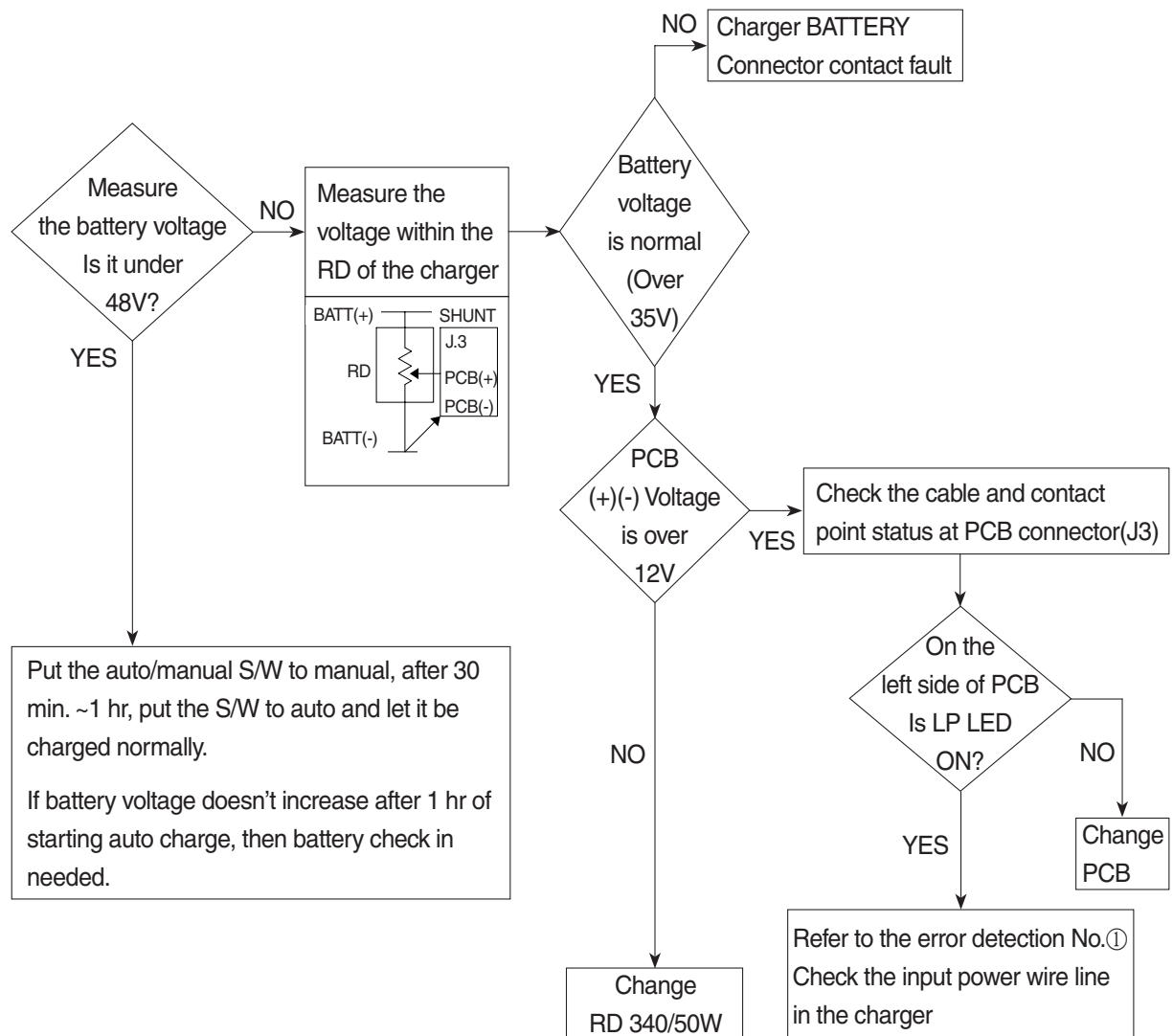


- ⑤ **Charger TRIP is occurred after it started charging and charging completion lamp is on.**  
**(In case input voltage is normal - Refer to the error detection No. 1)**  
**Restore the charger as pushing reset switch.**



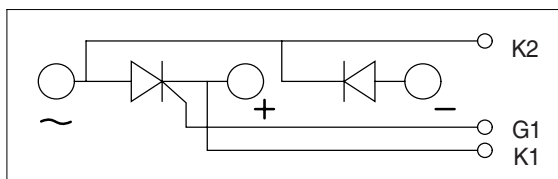
⑥ Charger has no response even if the battery connector is connected.

- 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 )

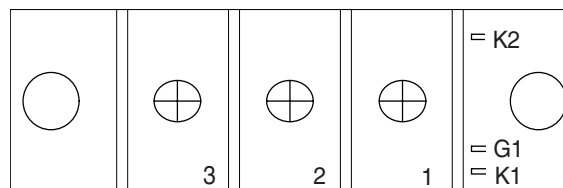


## 7) HOW TO CHECK THE SCR MODULE

Circuit

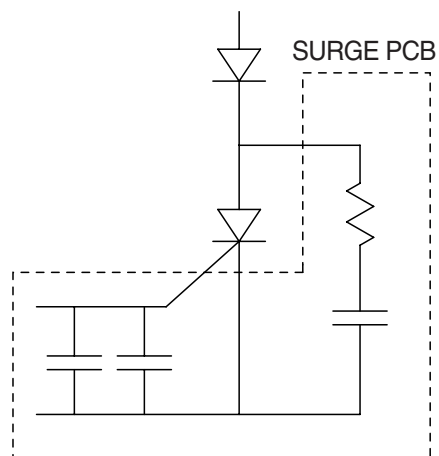


Real diagram

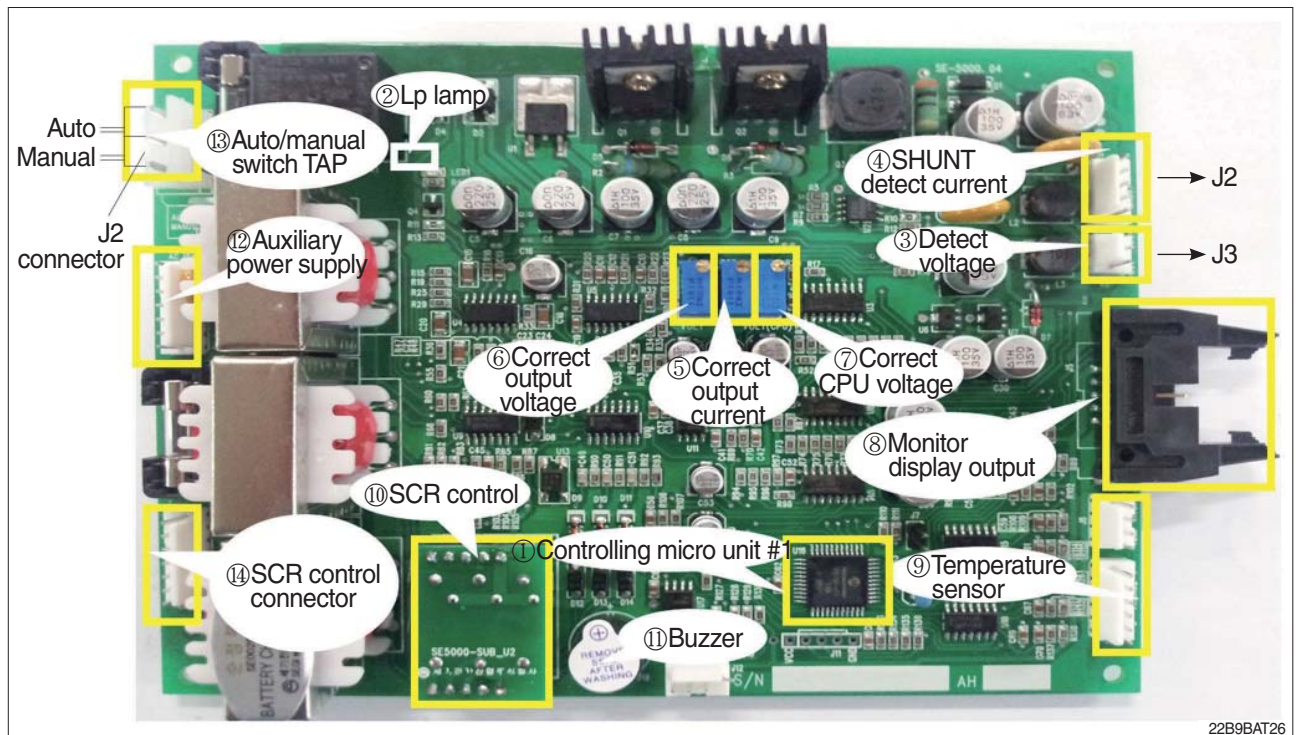


\* Before checking SCR MODULE, be sure to disconnect bus bar and wire on the terminal.

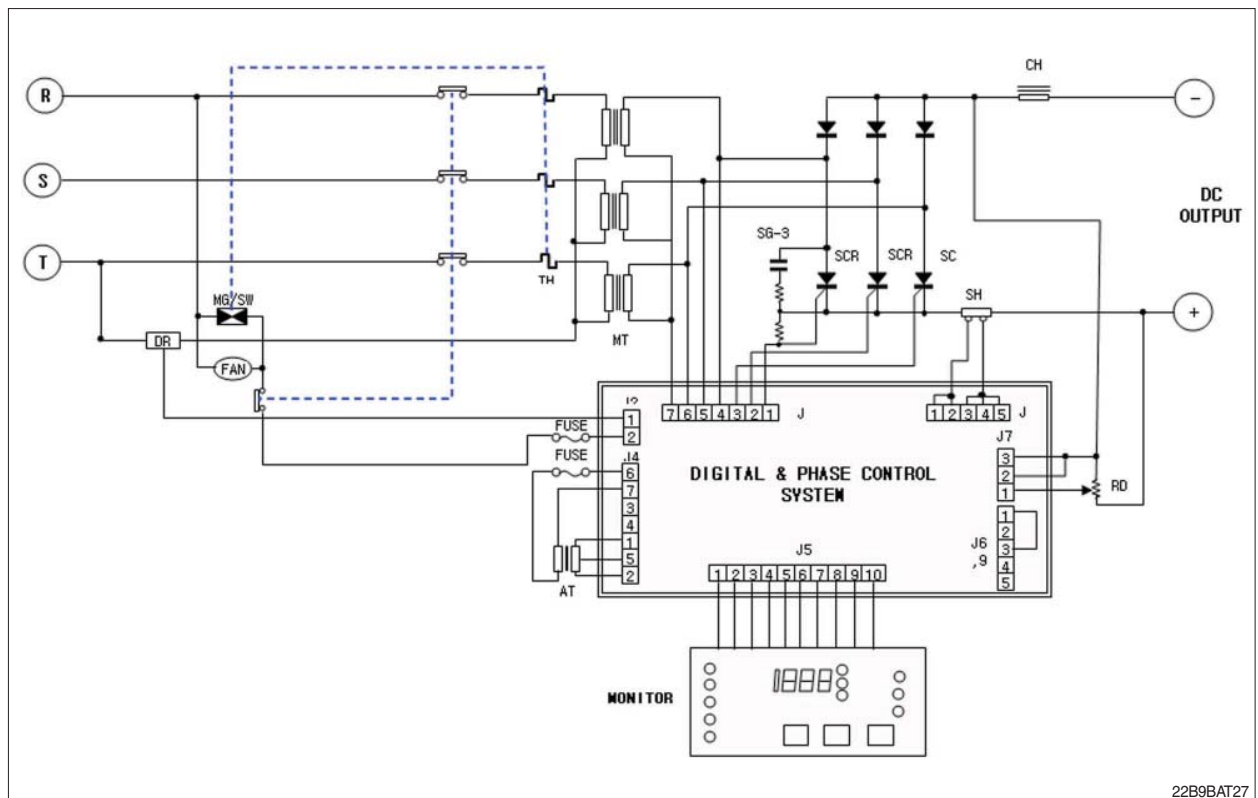
No.	Measuring point (Real diagram)	Measure value (Measurement of digital tester)
1	No.1 ~ No.3	Forward : Under 100 k ohm Reverse : Infinity ( $\infty$ )
2	No.2 ~ No.3	Forward : Infinity ( $\infty$ ) Reverse : Infinity ( $\infty$ )
3	G1 ~ K1	Forward : Under 100 ohm Reverse : Under 100 ohm But It depends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



## 8) PCB MAJOR PARTS (NAME AND LOCATION)

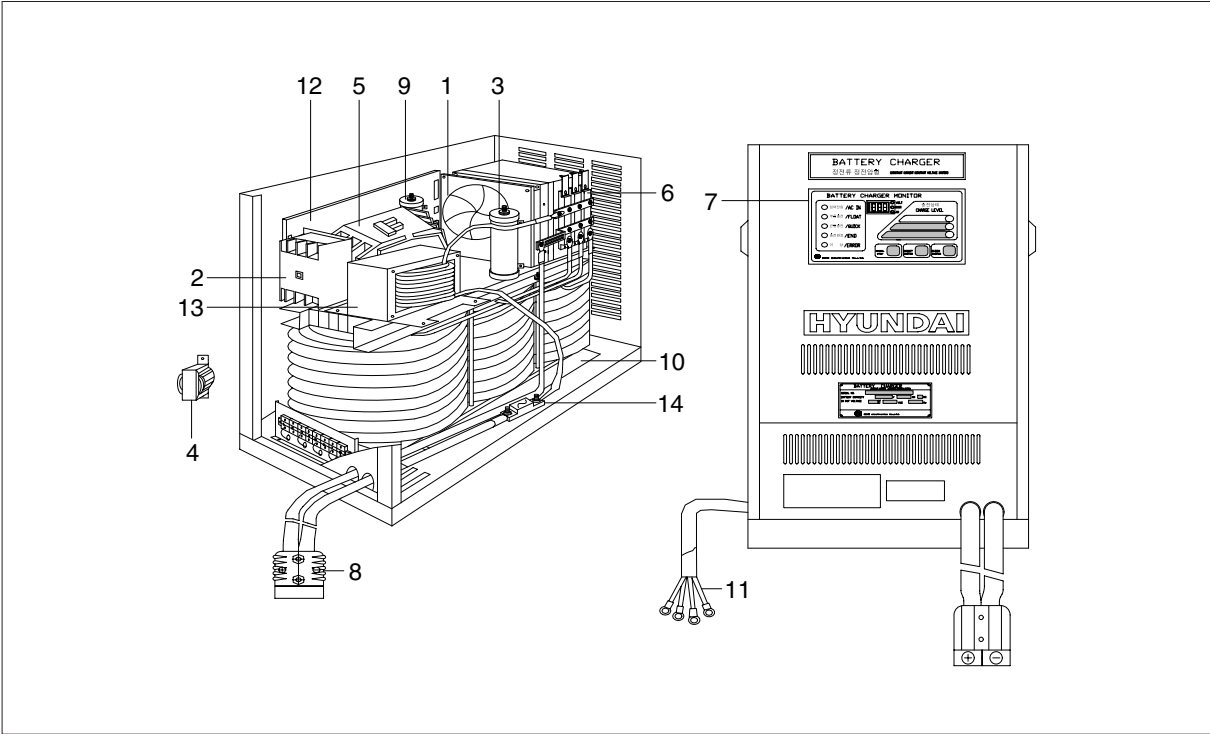


- |   |                        |    |                        |    |                        |
|---|------------------------|----|------------------------|----|------------------------|
| 1 | Controlling MICOM #1   | 6  | Correct output voltage | 11 | Buzzer                 |
| 2 | Lp lamp                | 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            |    |                        |



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	